August 24, 2023

NGC 1333, HST's 33rd Anniversary Image

HST Phase II Proposal Instructions for Cycle 31

HST Phase II Proposal Instructions for Cycle 31

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HST Phase II Proposal Instructions

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Chapter 1 HST Phase II Proposal Instructions Introduction

The HST Phase II Proposal Instructions describe how to prepare proposals to use the Hubble Space Telescope, with the Astronomer's Proposal Tool (APT).

On This Page

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

★ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

Proposals to observe with *Hubble Space Telescope* (*HST*) are reviewed in two phases managed by the Space Telescope Science Institute (STScI). In **Phase I,** proposers submitted an Observation Summary for review by the Telescope Allocation Committee (TAC). The Observation Summary provides only general descriptions of the targets and of the proposed observations. The TAC review results in a list of accepted proposals.

During **Phase II**, General Observers (GOs) with accepted proposals must provide complete details of their proposed observations so that STScI can conduct a full technical feasibility review. The Phase II information will then be used to schedule the actual observations and obtain data.

The *Phase II Proposal Instructions* has the following purposes:

- To describe the information that must be submitted to STScI by GOs during Phase II.
- To describe what you have to provide in APT (Astronomer's Proposal Tool).

- To show how to submit the information to STScI.

Proposers should be familiar with the *Cycle 31 Call for Proposals*, and with the Instrument Handbooks.

Format Definitions

Some of the modes/parameters are not generally available to proposers, and these are indicated as follows:

○ **Available but Unsupported** items (shown in magenta) may be used by GOs if there is strong scientific justification. In such cases calibrations will not be provided by STScI. There is limited user support from STScI for the reduction and analysis of data taken with Available-but-Unsupported modes, and that support may be provided at a low priority. Available-but-Unsupported-mode observations will be taken on a shared-risk basis, which means that observations that fail due to the use of this capability will not be repeated. Available-but-Unsupported modes can only be invoked if the Avail_Ok flag is set in the Phase II program.

○ **Restricted** items (shown in red) generally have no valid scientific use at all and are only used for instrumental calibration and maintenance. These should never be used without the approval of an Instrument Scientist for the science instrument (SI) in question. Use these items with caution!

○ **Engineering** text (shown in green).

To assist proposers with large programs, there is an option for proposers to export their APT file and then edit their proposal in a Text Proposal File. Text in brown has been added for proposers who elect to use this option. For guidelines on when you might use this template, see Using the Text Proposal File.

Significant Changes Since the Previous Cycle

Changes	Affected articles	Ticket (Internal link)
Ten new moons for Saturn	3.2.1 Solar System Standard Targets	PROPINST-91400
Enhanced documentation for Central Meridian Longitude (Solar System Observing Window)	3.2.4 Solar System Targets Observing Windows	PROPINST-91398
Generic targets now require either ON HOLD or ToO Special Requirement	3.3 Generic Targets	PROPINST-91401
Add "Flexible Thursday" Target of Opportunity	6.2 Visit-level Special Requirements 6.2.1 General Visit-level Special Requirements	PROPINST-91390

Update Gyro Guiding Accuracy	6.2.1 General Visit-level Special Requirements	PROPINST-91403
Add 4 Guide Star Acquisition Scenarios to support Solar System targets and Spatial Scans	6.4 Implementation Only Special Requirements	PROPINST-91397
FLASHCUR and FLASHEXP now allowed then CTE is not NONE (restricted mode)	10.2 ACS Wide Field Channel, WFC	PROPINST-91391
Change ACS Spectro-Polarimetry from Available to Supported mode	10.5.2 ACS WFC Permitted Filter Combinations	PROPINST-91396

Technical Content

Available Science Instruments for Cycle 31

ACS/WFC, ACS/SBC, COS, WFC3, STIS and FGS are available for this cycle.

Instrument Modes, Special Requirements, etc.

Some changes have been made to these Instructions since the previous version to correct errors and omissions, and to document new modes or options. There are too many to list, but as long as you use the most recent version the information provided should reflect our current state of knowledge.

Where to Find Additional Information

As you write your Phase II proposal, you will probably need to consult the Instrument Handbooks for additional information on one or more Science Instruments. These handbooks are available on the Web and a PDF version at HST Instrument Handbooks.

There are some policies that were delineated in the *Cycle 31 Call for Proposals*, which asked for Phase I proposals. You may wish to review those, particularly the sections discussing limited resources.

Change Log
Version Cycle 31 June - August 2023

1. Started updating the Cycle number
2. Added change log.

Version Cycle 30 September 2022

1. Added PDF to parent page and added link to PDF from this page.
2. Added change log.

Chapter 2 The Basics of Phase II Proposals

HST proposals are submitted using the Astronomer's Proposal Tool (APT), and in Phase II the details of the observations are prepared. This article describes the basics of preparing a Phase II program.

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

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Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

The computer software used to schedule and execute *HST* observations can interpret the proposal information only if it is in the proper format. Therefore, proposals must be filled out accurately, completely, and in strict accordance with the instructions in this document. Observers now have the capability and responsibility, with the help of their Program Coordinator (PC) and/or Contact Scientist (CS) for creating and submitting proposals that are not only syntactically correct but also feasible and schedulable. The Astronomer's Proposal Tool (APT) will help you achieve this.

Note: Starting with Cycle 27, proposers are now required to explicitly list and justify the use of all special requirements in the Phase I proposal. Special requirements not justified in the Phase I proposal may not be used in the Phase II proposal. See the Special Requirements section of HST Preparation of the PDF Attachment.

Astronomer's Proposal Tool (APT)

With APT you can prepare your Phase II program on your computer and then submit it electronically to STScI. You will use a copy of your Phase I proposal (marked up in XML), which contains all the information from your Phase I submission. If you haven't done so already, please consult the APT web page for detailed instructions on how to install and use APT on your computer. Observers without access to a suitable computer platform to run APT for Phase II should contact their PC.

Entering Information: The APT Graphical User Interface (GUI) versus the Text Proposal File

In the previous proposal entry system, RPS2, you could enter and edit information as text (usually in the form <keyword>=<value>) using a template and your favorite text editor. Also, you could use the Proposal Editor (PED), a graphical editor in RPS2 designed for editing your Phase II program.

In APT you can enter proposal information by using either the APT Form/Spreadsheet Editors via a GUI or a **Text Proposal File** that employs a "simplified" RPS2 syntax. This text file has been developed for APT as an alternative method for editing proposals outside of the APT GUI; you use a flat ASCII file format that is similar to the RPS2.prop file that was used in *HST* cycles 5-11. Small changes to the original RPS2 format were necessary to accommodate enhancements that came with APT, and some of the syntax has been made stricter in order to make reading of the file more robust. You create this file in APT by exporting your proposal into a text proposal file format (for details please see the APT web page).

Text Proposal File

Text Proposal File

Basic Syntax Rules

Users (particularly RPS2 old-timers) should be aware that some changes to the original RPS2 format were necessary to accommodate enhancements that came with APT; also, some of the syntax has been made stricter in order to make parsing of the file more robust (e.g., for special requirements).

Here are a few basic rules that must be followed:

- Commas or semicolons must be used to delimit items in a list (see specific rules in the following bullets). New lines for each item *will not* be sufficient delimiters.
- Semicolons *must* be used to delimit Special Requirements items.
- Commas *must* be used to delimit items in all other lists including target descriptions, target position, fluxes, optional parameters, and spectral elements.
- Only the shortest forms of the special requirements will be accepted (e.g., **POS**ition **TARG**et must be **POS TARG**). For more information on special requirements see Chapter 6: *Special Requirements*.
- Exposure lists in Special Requirements *must* be specified as a single range. No commas are allowed in an exposure list (e.g., use 1-5 instead of 1,2,3-5). As before, visit lists can have comma delimiters.
- The Time_Per_Exposure *must* be specified in seconds.
- Dates should be in the form 01-Jan-2005:00:00:00 (as an example) with the hours: minutes: seconds being optional. Other formats will not be supported except for JD, which is used for **ZERO-PHASE**.

Sample Text Proposal File Template

Your **Text Proposal File** should include the following and in the order given. Optional blocks are in square brackets ([]). The use of colons is required in the form given. Note that at least one of the three target types (Fixed, Solar System, or Generic) must be present unless the proposal contains only internal or predefined pointings. You can make your own template in APT from your Phase I proposal by opening it in APT and changing it to Phase II. Then enter your Phase II ID number, add a visit, and then export to a text proposal file (If you have already retrieved your proposal from STScI using the Phase II ID given to you by your PC, then the Phase II ID number will have already been filled in).

Proposal_Information
Title:
Proposal_ID:
Proposal_Category:
Cycle:
[Avail_Ok:]
[STScI_Edit_Number:]

Investigators
PI_Honorific:
PI_First_Name:
PI_Middle_Initial:
PI_Last_Name:
PI_Institution:
[CoI_Name:
CoI_Honorific:
CoI_Middle_Initial:
CoI_First_Name:
CoI_Last_Name:
CoI_Institution:
[Contact:]]

Abstract

Questions
Observing_Description:

[Fixed_Targets
Target_Number:
Target_Name:
[Alternate_Names:]
Description:
Position:
Equinox:J2000
Coordinate_Source:
[RV_or_Z:]
[RA_PM:]
[RA_PM_Units:]
[Dec_PM:]
[Dec_PM_Units:]
[Epoch:]
[Annual_Parallax:]
Flux:
[Other_Fluxes:]
[Comments:]]

[Solar_System_Targets

Target_Number:

Target_Name:

Description:

Level_1:

[Level_2:]

[Level_3:]

[Window:]

[Ephem_Uncert:]

[Acq_Uncert:]

Flux:

[Other_Fluxes:]

[Comments:]**]**

[Generic_Targets

Target_Number:

Target_Name:

Description:

Criteria:

Flux:

[Other_Fluxes:]

[Comments:]**]**

[Pattern_Data
Pattern_Number:
Primary_Pattern:
Pattern_Type:
Pattern_Purpose:
Number_Of_Points:
Point_Spacing:
Line_Spacing:
Coordinate_Frame:
Pattern_Orient:
Angle_Between_Sides:
Center_Pattern:
[Secondary_Pattern:
Pattern_Type:
Pattern_Purpose:
Number_Of_Points:
Point_Spacing:
Line_Spacing:
Coordinate_Frame:
Pattern_Orient:
Angle_Between_Sides:
Center_Pattern:]
[Pattern_Comments:]]

Visits
Visit_Number:
[Visit_Priority:]
[Visit_Requirements:]
[On_Hold_Comments:]
[Visit_Comments:]
Exposure_Number:
[Exposure_Label:]
Target_Name:
Config:
Opmode:
Aperture:
Sp_Element:
[Wavelength:]
[Optional_Parameters:]
Number_of_Iterations:
Time_Per_Exposure:
[Special_Requirements:]
[Sub_Exposures:]
[Comments:]

Using the APT GUI

In most of the fields in the APT graphical interface, you choose a keyword or parameter <value> in a list from a pull-down menu, or check a box. In a few other fields (e.g., **Other Fluxes**, **Observing Windows** and **Criteria** in the Targets forms) you enter free text in the field using the formats specified in this document. Required items are marked with a red "**x**" if you haven't selected or entered a <value>. Also, for many of the keywords, a tooltips message will appear when you place your pointer on the keyword: <value> area.

Using the Text Proposal File

When creating or editing large repetitive proposals, editing with APT's graphical interface can be inefficient and prone to error. We present two examples where you may want to use a text proposal file.

1. You are building a large repetitive program with many targets and visits in order to create a mosaic. Initially, you would use APT to build a proposal that has one or two targets and one of each of the unique visits. You would then run the Orbit Planner and Visit Planner to make sure that the visits fill the right number of orbits and schedule. Then, you would export this small template proposal to the Text Proposal File format, and use scripts or your favorite editor to build your program into a larger version. You would then import the resulting file back into APT for checking and processing.
2. You have already built a fairly large program in APT by creating unique exposures and visits, and then used the duplicate and multiple duplicate features in APT. Then, you discover that you need to make a small change to a large number of exposures (such as removing or adding an optional parameter). This would be tedious to do in the APT GUI, but straightforward in the Text Proposal File. Simply export your program to the Text Proposal File format, make your changes in an editor, and then import the Text Proposal File back into APT for new processing.

Table 2.1 summarizes some of the differences between the APT GUI and the Text Proposal File.

Table 2.1: Comparison of APT GUI and the Text Proposal File

	Data Entry Method	Syntax	Help Features and Error Checking
APT	Use the Form or Spreadsheet Editors via the APT User Interface	For most of the fields (exceptions noted below), choose a keyword <value> from a pull-down list, or check a checkbox, or enter a text <value> in the field provided.	1) Required data marked with a red x 2) Tooltips (e.g., a message noting a required item and its format) provided during data entry 3) Context-sensitive help available
Text Proposal File	After exporting your proposal from APT to the text file, edit it using your favorite editor.	Enter free text in the file in the form <keyword> = <value>. You must conform to the proper syntax described in this document.	None while editing. After editing your proposal, you must import it back into APT (see the APT web page for instructions). Once you have imported your program back into APT you can run the diagnostics tool.

APT Tools

APT also provides tools to help you plan your observations, such as an Aladin based visualization tool, an Orbit Planner and a Visit Planner (see the Using APT web page). If you have any problems using APT, or have any questions about your proposal, please feel free to contact your assigned Program Coordinator (PC) and/or Contact Scientist (CS). Programs without an assigned CS may also contact the STScI *HST* Help Desk (web: https://hsthelp.stsci.edu; email: help@stsci.edu) for help with APT. We encourage use of the new website where you can submit questions directly to the appropriate team of experts.

Submitting Your Program

After you submit your Phase II program, the APT system will give you an automatic electronic acknowledgment. This should be followed in a few days by an acknowledgment from your PC. If, at the time of submission, the proposal contains errors, the APT submission system will give a warning, but will allow the proposal to be submitted. However, the proposal will be flagged, and your PC will contact you within a few days to discuss how to proceed.

> ⭐ The resolution of errors in the Phase II Program is the responsibility of the Principal Investigator. The fact that APT may allow you to submit a program that contains errors does not mean that your program can or will be scheduled.
>
> We strive to make APT a useful aid for preparing and checking your Phase II program, but it is nevertheless imperfect. On rare occasions syntax errors are not detected. Also, APT does not check for guide stars. If there are guide star issues your PC will contact you with options.

What to Submit

Observers must submit their Phase II proposal to STScI by the Cycle 31 Phase II deadline. It should contain the following:

- **Updated Proposal Information:** This section includes the title, the abstract, a Phase II ID, a proposal description, PI and CoI information. Please note that some general information is very useful for a thorough and helpful technical review of your proposal. You may wish to include parts of your Phase I science discussion, but please note that all the Phase II information you provide will be freely available via the Web.
- **Target Information:** The information for one or more of the Fixed, Solar System, or Generic Targets must be completed. If necessary, proper motion and parallax information should be supplied for fixed targets. Detailed instructions for filling out the target data, as well as the proper motion and parallax information, are provided in sections 3.1 *Fixed Targets*, 3.3 *Generic Targets*, and 3.2 *Solar System Targets*.
- **Visit, Exposure Group, and Exposure Specifications:** These specifications include orientation information, scheduling requirements, SI information, exposure special requirements and so on. Required items will be clearly noted as you complete the specifications. General instructions for completing this section are provided in Chapter 4: *Visits, Exposures, and Exposure Groups*.

General Instructions

When you first bring up APT, you will have to convert the information in your Phase I proposal, which is an XML file, into a Phase II program format using the "Phase I->Phase II" conversion button on the APT User Interface.

Note the following general instructions and conventions when entering your Phase II information:

- After converting your Phase I Proposal into Phase II information, please verify that all the general information is correct and readable.
- Entries in text must precisely conform to the formats specified in this document. If you have decided to use the **Text Proposal File**, the order of the entries must be correct as well (see Text Proposal File).

- Proposal data text may contain only standard ASCII characters. All other symbols must be spelled out. Greek letters must be spelled out (e.g., **BETA-LYR**, **H-ALPHA**). The degree sign should be replaced with "D" (e.g., **BD+16D516**). Subscripts and superscripts are not allowed.
- When providing a Target "**Description**" please use the target keywords and syntax presented in Target Description tables (for Fixed and Solar System targets).

If you are unable to use the APT software, please contact your PC (listed in your notification letter) to make other arrangements.

Proposal Information [Proposal_Information]

This block contains basic information about the proposal including the **Title**, **Abstract**, **Category**, and **Cycle**. After converting your proposal from Phase I to Phase II, your Phase II program will have the program information filled out based on your Phase I submission.

Proposal Title

The title from your Phase I submission will be used.

Abstract

The abstract from your Phase I submission will be used. Please check this since you may need to update this text based on your final TAC allocation.

If a Phase II submission is not based on a Phase I proposal, please fill in missing information.

Phase II ID

This ID will be provided to you by your Program Coordinator.

STScI Edit Number

This field holds a counter for an operational version number of the proposal and cannot be edited by the user. If you are connected to the Internet, the version number in your proposal file is compared to the one in the STScI proposal database when a proposal is opened or submitted. In either case, if your file's version number is less than the database's number for that proposal, you will get a pop up warning that a more recent version is available (via APT's Retrieve from STScI). This prevents you from doing an update with an old copy of the proposal, or making edits to a version that does not include changes your PC has made to the proposal. The STScI software increments this number whenever the Phase II file is edited by STScI staff.

Proposal Cycle

Unless you have been told otherwise, the **Cycle** should be **30**. Multiple values of **Cycle** are not permitted.

Proposal Category

For those Phase II submissions that are not based on a Phase I proposal, the **Category** should be selected from one of the following:

GO (General Observer)
GO/DD (Director's Discretionary time)
SNAP (snapshot proposals)

For restricted parameters

The following proposal categories may also be used internally to STScI, but only as **Restricted**:

CAL/STIS, CAL/COS, CAL/WFC3, CAL/AST, CAL/OS, CAL/OTA, ENG/STIS, ENG/FGS, ENG/COS, ENG/WFC3, ENG/AST, ENG/SC, ENG/OTA, NASA, CAL/ACS, ENG/ACS

New proposal types can be created, but only if needed.

A **Category** of **SNAP** is used for "snapshot" programs. By their nature these programs take advantage of otherwise-unused blocks of telescope time for relatively short exposures. **SNAP** exposures therefore must carry as few restrictions as possible. In particular, Special Requirements should not ordinarily be used with **SNAP** programs (consult with your Program Coordinator if you feel you need to do so). Some special policies apply to **SNAP** programs: in particular, STScI will not repeat failed **SNAP** exposures.

Pure Parallels

For pure parallel proposals, check the "**Parallel**" checkbox next to the Proposal Category in the Proposal Information form. Please note that **SNAP/PAR** is not a valid proposal type.

Availability

You must choose **supported**. If the observing modes normally offered by STScI to GOs do not meet the needs of your program, please contact your Program Coordinator.

For available but unsupported parameters

The **Avail_Ok** keyword is intended for GOs who want to use **"Available but Unsupported"** engineering options, which are described throughout this document. The only legal value for **Avail_Ok** is **YES**. GOs may use **Available but Unsupported** options only if this keyword has been enabled by an Instrument Scientist (contact your PC or your Contact Scientist if your program has one). You will be asked to provide a scientific justification of your request. The instrument scientist will need to determine that the use of an **Available but Unsupported** mode is justified. If the **Avail_Ok** keyword is enabled, APT will perform full error checking on exposures with **Available but Unsupported** options in **GO** proposals. Otherwise APT will report a syntax error and any other problems with the exposure will not be detected.

Proposal types beginning with CAL or ENG may use any engineering option and are not required to supply the Avail_Ok keyword.

Proposal Description

Proposal Text Sections

These four sections are needed for STScI to execute your program properly. Not all questions will need to be answered by every observer, and note that the answers to these questions will be made public. As with the **Abstract**, please review this text to make certain the information is correct.

Description of Observations [Observing_Description]

Provide a detailed description of your observing plans. Text from your Phase I proposal will need updating based on your final TAC allocation and on details to be worked out in Phase II.

Investigators

This section contains the names of the Principal Investigator (**PI**), all Co-Investigators[1] (**CoI**), and their institute affiliations. This information comes from your Phase I proposal submission.

Phase II Contact

If a Co-Investigator is also to be a contact for a program, then the Phase II Contact keyword box should be checked. More than one Co-Investigator may be designated as a Contact. The Contact(s) will receive the same (non-budgetary) automated e-mails for the program as the PI.

If any of the Investigators have changed addresses between the Phase I and Phase II submissions (or any time after the Phase I submission), please contact your Program Coordinator with the updated address, or by logging on to MyST at: https://proper.stsci.edu/proper/authentication/auth. You cannot use the Phase II submission to implement address changes.

For Phase II submissions that are not based on a Phase I proposal, please fill in the information accordingly.

Target Information [Fixed_Targets, Solar_System_Targets, Generic_Targets]

Sections 3.1 *Fixed Targets*, 3.3 *Generic Targets*, and 3.2 *Solar System Targets* describe how to fill out the Target Lists.

Visit Information [Visits]

The Chapter 4: *Visits, Exposures, and Exposure Groups* article describes how to fill out the Visit and Exposure Specifications. Instructions for submitting parallel observations are given in Chapter 5: *Parallel Science Exposures*, and the detailed, instrument-specific parameters are described in the ACS , COS, FGS, STIS, and WFC3 chapters.

Examples and General Advice

Phase constraints for periodic observations

Phase constraints in a Phase II program are applicable when the observations are to follow a periodic event, such as an exoplanet transit or a regularly-variable object. The most important aspect to have in mind is that the phase range on an exposure sets a window over which that exposure may start.

In particular for exoplanet transit observations, it is important to set the phase range in a way that allows for an adequate out-of-transit baseline that includes one or more exposures before the ingress of the exoplanet. For example, setting a **PHASE 0.95 TO 0.05** for a transit with ingress happening at phase 0.98 may lead to missing the pre-transit time, since the exposure may be scheduled with a start time after the ingress. Consider instead **PHASE 0.94 TO 0.97**, since it would guarantee that the exposure starts before the ingress phase 0.98.

More details about the phase constraints of periodic observations can be found in Sections 6.2.3 *Timing Visit-level Special Requirements* and 6.3.2 *Timing Exposure-level Special Requirements*.

Acquisitions and Pointings

Getting *HST* located and oriented properly lies at the heart of successful observations, especially when a small aperture is being used, and there are a number of ways to do that. The remarks here apply specifically to fixed targets, and mostly apply to the use of small apertures, although many of them can be applied to moving targets as well. For more information, see Section 3.1 *Target Position Type*.

First, you have to acquire an object successfully that is at or near the position at which the science observation will be made. The object to be acquired should meet these conditions:

1. It should be a point source or nearly enough to point-like that the centering algorithms can determine a precise centroid.
2. The object's coordinates must be both precise and accurate and any proper motion must be known. This requirement boils down to the need for the object to fall within the search region at the time of the acquisition. For this to happen the coordinates must also be consistent with the Guide Star Catalog or they must fall within another system that can be related to the GSC. This is why the source of the acquired object's coordinates are required.
3. The object must be neither too bright nor too faint for the instrument mode used. These conditions are described in the various Instrument Handbooks.

The coordinates for the acquired object can be specified in several ways:

- As explicit absolute celestial coordinates, i.e., **RA** and **DEC**. See Equatorial Coordinates.
- As celestial coordinates relative to another nearby object, using offsets in **RA** and **DEC**. See Positional Offsets.
- As a **REGION**; see Region of Sky.

Second, once the acquisition has been made, the telescope must be repositioned to the precise point desired. This step is unnecessary, of course, if the object acquired in the first instance is the object to be observed. Repositioning can be implicit or explicit.

An **offset** is **implicit** when a target such as "XX-OFFSET" is acquired with some ACQ mode, and then "XX" is observed via a science exposure. This often leads to confusion because no specific motion of the telescope has been provided, but that motion is implied by specifying the separate targets with different coordinates. "XX-OFFSET" is specified for the acquisition because it is bright enough and point-like enough to be acquired successfully, but the coordinates specified by "XX" are what is to be observed.

An **offset** is **explicit** when you use a Special Requirement such as POS TARG to move the telescope away from the position acquired. In this scheme, the position specified in the acquisition is placed at the fiducial point for the aperture requested (in general the geometric center of the aperture). The **POS TARG** then moves the telescope relative to that nominal position. Thus **POS TARG**s are not cumulative, and always refer back to the original acquired position.

Examples

People who are looking for examples of APT files are encouraged to go to:

http://archive.stsci.edu/hst/abstract.html

and do a search for a selection of proposals from the most recent cycle. For any program that appears as though it could serve as a useful example, the APT file can be obtained by typing the proposal ID number into the search form at:

https://www.stsci.edu/hst/observing/program-information

Additionally, several examples of ACS dither patterns using POS TARGs which may be used in an APT proposal can be found on the ACS Web site at:

http://www.stsci.edu/hst/instrumentation/acs

Common Problems

Incorrect Proposal Format

When you are entering text in a field the formats described in this document must be followed **exactly**, since the information in the forms is interpreted by computer software. Some items that warrant repetition are:

- Visit numbers must be unique.
- Target names must be spelled exactly the same throughout the proposal.
- The format for target positions must be followed to the letter. For more information on coordinates, see Section 3.1 *Target Coordinates*.
- The format for Optional Parameters and Special Requirements must be followed to the letter.
- Observations which cannot be defined using the syntax in these Instructions may be described in Comments fields, but such comments should be used very sparingly, if at all, and their use may impede execution of a program.

Imprecise Target Positions

See the discussion of required position accuracies in the table of Required Coordinate Accuracies. The requirements are much more stringent than is typically the case for ground-based observations.

Lack of Acquisition Exposures with Small Apertures

When exposures are requested in very small apertures or fields of view, a separate acquisition exposure is generally required. Please consult the Instrument Handbooks for the instrument you are using.

Consideration of Limited Resources

Starting with Cycle 26, proposers are now required to explicitly list and justify the use of all special requirements in the Phase I proposal. Special requirements not justified in the Phase I proposal may not be used in the Phase II proposal.

Proposers should be aware that several of the Special Requirements impose serious constraints on the scheduling system because they require the use of limited resources; for example, RT ANALYSIS requires real-time use of the Tracking and Data Relay Satellite System (TDRSS) that is only available some of the time. Hence these Special Requirements should be requested only if they are absolutely necessary to achieve the scientific goals of a project. It is quite possible that some proposals will be impossible to schedule because of their resource requirements, rather than a lack of scientific merit. The limited-resource Special Requirements can force the planning system to schedule the observations at a less than optimal time. The use of limited-resource Special Requirements by many observers can reduce the overall efficiency with which the planning system can schedule the science program. For these reasons, these Special Requirements should only be used when necessary to achieve the science objectives of the program. The STScI will review the necessity for the Special Requirements and in some cases may suggest removing them, or using alternate methods to obtain the same goal.

The Table 2.2 summarizes the Special Requirements that involve seriously limited resources.

The need for many of these Special Requirements must be justified in the Proposal Description. Those are: **CVZ**, **SHADOW**, **LOW-SKY**, and **ON HOLD** for Targets of Opportunity.

Table 2.2: Limited-Resource Special Requirements

Limited Resource	Reason for constraint
ON HOLD [FOR <visit>]	Requires special handling (e.g., Targets of Opportunity).
RT ANALYSIS REQuires UPLINK	Requires real-time TDRSS links, which are difficult to schedule and may be withdrawn at last moment.
ORIENTation <angle1> TO <angle2> SAME ORIENTation AS <visit>	A specific orientation can be available for as little as a one-week period every six months.
SHADOW LOW-SKY CVZ	Available for only a fraction of orbits.
AFTER <date>	Constrain scheduling opportunities. Can be mutually incompatible.

BETWEEN <date1> AND <date2> **BEFORE <date>** **SEQuence <visits-checked> WITHIN <time>** **SEQuence <exposure-list> NON-INTerruptible** **PHASE <number1> TO <number2>**

[1]The number of CoIs is limited to 999.

Change Log

Version Cycle 31 June-July 2023

1. Added advice about phase constraints to the "Examples and General Advice"
2. Fixed links to the Call for Proposals in the Introduction and What to Submit and the HOM page in the Lack of Acq section.

Version Cycle 30 May 2022

Updated links to Cycle 30 Call for Proposals

Chapter 3 Targets

HST allows three different types of targets, Fixed, Solar System, and Generic. Each article contains the target's requirements.

Chapter Contents

3.1 Fixed Targets

The Fixed Targets form is used to specify fixed targets in some HST observations. The Astronomer's Proposal Tool (APT) is used to enter the targets into the proposal.

Sections

- 3.1.1 Target Descriptions

On This Page

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

The Targets list tells us where you wish to point *HST* and so must be filled out with care, precision, and accuracy. For proposals with a large number of fixed targets, please note that there is a capability to ingest a comma-separated text file with the appropriate target information.

Target Identification

The following information is required to identify and classify each target.

Target Number [Target_Number]

Each target in your program will be assigned its own unique number (which can be changed by the user) by APT (they are base 10 and go from 1 to 999). A different target must be defined whenever different coordinates or a different target description are required. Separate targets should be defined and listed if you plan to take observations at several points within an extended object. For example, if you were to take spectra at three different locations in the Crab Nebula, each point must have its own target number, name, and coordinates, such as CRAB1, CRAB2, and CRAB3.

> **For text file**
>
> If you are using the **Text Proposal File**, all target numbers and names within a proposal must be unique.

Target Name [Target_Name and Alternate_Name]

Target names provide unique designations for the targets that will be used throughout the proposal. These names will also be used to designate targets in the *HST* data archive. Prospective proposers and archival researchers use these names to determine whether *HST* has observed a particular object. This facility will be most useful if consistent naming conventions are used.

The following conventions must be followed in naming targets:

- A new target name must be defined for each (celestial) target. For example, for several pointings within a galaxy, one might define target names such as **NGC4486-NUC**, **NGC4486-JET**, **NGC4486-POS1**, and **NGC4486-POS2**.
- The length of a target name must be anywhere from 2 to 31 characters.
- **No blanks are permitted in target names**. Blanks between a letter and a numeral must be suppressed (e.g., **HD140283**, **NGC4378**), but a hyphen (and *not* an underscore) must replace blanks between two letters or two numerals (e.g., **ALPHA-CEN**, **NGC224-0040+4058**). Also, a hyphen should be used where required for clarity (e.g., **NGC4486-POS1**).
- Only letters, numerals, hyphens, periods (.), and **+** or **–** are allowed in target names; other punctuation is not permitted (e.g., **BARNARDS-STAR** is valid, but **BARNARD'S-STAR** is not). Greek letters must be spelled out (e.g., **ALPHA-ORI**). Letters may be upper-case or lower-case,

but will always be treated as if they are upper case (e.g. **Alpha-Cen** will be treated as if written **ALPHA-CEN**).

- Degree signs must be represented by an upper-case "**D**" (e.g., CD-42°14462 becomes **CD-42D14462**).
- Some special target names are reserved for calibrations and other purposes and may **not** be used for names of external pointings; see Table 3.1: *Designations of Special Targets* .

If desired, you may give one or two "common names" for your target, which will be entered in the **Alternate_Names**. For example, **HD124897** could have Alternate_Names of **ALPHA-BOO** and **ARCTURUS**.

Only **Target_Name** is used when the target name is repeated in the Visit and Exposure Specifications.

Catalogued Targets

If your target is in a well-known catalog (e.g. **SDSS, NGC, PG**), then use that catalog designation for the target name. This is the name your object will have in the Archive, so please try and select the most common name for the target to make it easier for archive researchers to find your target.

Uncatalogued Targets

Objects that have not been cataloged or named must be assigned one of the following designations:

1. Isolated objects must be designated by a code name (the allowed codes are **STAR**, **NEB**, **GAL**, **STAR-CLUS**, **GAL-CLUS**, **QSO**, **SKY**, **FIELD**, and **OBJ**), followed by a hyphen and the object's J2000 equatorial coordinates, if possible, rounded to seconds of time and seconds of arc (e.g., for a star at J2000 coordinates RA: 1H 34M 28S, DEC: –15D 31' 38", the designation would be **STAR-013428-153138**).
2. Uncataloged objects within star clusters, nebulae, or galaxies **must** be designated by the name of the parent body followed by a hyphen and the rounded J2000 coordinates, if possible, of the object (e.g., for a target within NGC 224 with J2000 coordinates RA: 0H 40M 12S, DEC: +40D 58' 48", the designation would be **NGC224-004012+405848**).
3. Positions within nebulae or galaxies may also be designated by the name of the parent object followed by a hyphen and a qualifier. The qualifier should be brief, but informative (e.g., the jet in NGC 4486 could be designated **NGC4486-JET**). Other examples are: **NGC5139-ROA24**, **LMC-R136A**, **ABELL30-CENTRAL-STAR**, **NGC205-NUC**.

Alternate Names

In addition to the catalog name, a target could be assigned at most two alternate "common names," or aliases, if they exist. Examples of common names are the following: **BARNARDS-STAR, OMEGA-CEN** and **M31**.

Special Targets

The names of certain types of targets must be designated by appending a code to the target name. For example, **-CALIB** should be appended to the name of a target that is being observed only as a calibration standard for other observations. These designations will assist in planning of the observing schedule. The possible codes are listed in Table 3.1: *Designations of Special Targets* .

Table 3.1: Designations of Special Targets

Target Type	Code	Description

External calibration target	**-CALIB**	An astronomical target used for calibration (e.g., **BD+28D4211-CALIB**). Internal calibration sources (e.g., **WAVE**) and calibrations using the Earth must not be included in the Target List.
Offset acquisition target	**-OFFSET**	A target that will be used for an offset acquisition; it is the object that will be acquired first, from which an offset will be applied to move to the target of interest (e.g., **3C273-OFFSET**).
		Two separate exposures must be defined on the Visit and Exposure Specifications; an acquisition of the **-OFFSET** target, and a science exposure of the (target of interest) program target. The location of the latter target may be specified either by equatorial coordinates or by an offset (see Target Position Type [Position]).
		For example: to observe the **JET** in **3C273,** first acquire "stellar-like" source **3C273-OFFSET,** then offset to program target **3C273-JET**.
Special designations		These are reserved designations and may not be used as the names of external pointing in a target list:
		ANTI-SUN, ANY, BIAS, CCDFLAT, DARK, EARTH-CALIB, DARK-EARTH-CALIB, DARK-NM, DEUTERIUM, NONE, ORBIT-POLE, ORBIT-POLE-NORTH, ORBIT-POLE-SOUTH, TUNGSTEN, WAVE

Target Category and Target Description [Description]

A target description must be selected for each target. The Target Description will be one of the key fields used by archival researchers in searching through the *HST* data archive; thus it is **extremely** important that the information be filled out completely and accurately for each target.

Each target *must* be assigned a single primary category from Table 3.2*: Target Categories*, and at least one descriptive keyword, chosen from the appropriate table. The discrete features and descriptors may be used as descriptive keywords for any category. A maximum of five descriptive keywords may be selected.

The categories in Table 3.2*: Target Categories*, and some of the descriptive keywords in the tables, are followed by explanatory text in parentheses. This text is provided only for explanatory purposes and is not part of the category or keyword itself.

Table 3.2: Target Categories

Category	Descriptive Keywords
SOLAR SYSTEM (Solar System Object)	Table 3.5 Solar System
STAR (Galactic Stellar Object)	Table 3.6 Star
EXT-STAR (Star in an External Galaxy)	Table 3.6 Star
STELLAR CLUSTER (Galactic Star Cluster, Group, or Association)	Table 3.7 Stellar Cluster
EXT-CLUSTER (Star Cluster in an External Galaxy)	Table 3.7 Stellar Cluster

GALAXY (Galaxy or AGN)	Table 3.8 Galaxy
CLUSTER OF GALAXIES (Galaxy Groupings, Clusters, Large-scale Structure	Table 3.9 Clusters of Galaxies
ISM (Interstellar Medium of the Galaxy)	Table 3.10 ISM
EXT-MEDIUM (Interstellar Medium of an External Galaxy)	Table 3.10 ISM
UNIDENTIFIED (Unidentified Objects)	Table 3.11 Unidentified
CALIBRATION (Calibration Observations)	Table 3.12 Calibration

> **For text file**
>
> If you are using the Text Proposal File, target description items must be separated by commas.

Target Extent [Extended]

This field is required for COS observations only. Both COS FUV and NUV observations of targets with FWHM larger than about 0.6 arcsec or radius larger than 0.35 arcsec should be considered as extended. "YES" should be selected for such targets and "NO" for targets of smaller angular extent. The field should be left blank if the target is not being observed by COS.

This definition is intended to provide an indication of whether or not the source extent might be large enough to affect the reliability of the default pipeline extraction algorithm. See COS ISR 2015-03 and Section 5.9 of the COS Instrument Handbook for further details.There are a number of other issues that should be considered when observing extended targets with COS, including the effects on spectral resolution and target acquisition. Please note that the exposure-level parameter EXTENDED has been deprecated and should not be selected for any Cycle 23 proposals or beyond.

Target Coordinates

The following information is required to allow for *HST* to be properly pointed at the target.

Required Accuracies of Target Positions

The *HST* Scientific Instruments (SIs) typically have very small apertures and fields of view. Target-acquisition apertures for several of the SIs are only a few seconds of arc in size. Since the *HST* has no video acquisition cameras, it is essential to have accurate coordinates for targets. In many cases targets will be placed in the final observing aperture after a sequence of target-acquisition observations. This will only work, however, if the target coordinates are sufficiently accurate and precise to place the target in the first of these acquisition apertures.

HST uses two guide stars to stabilize the pointing of the telescope and to place the target in the desired aperture. The fundamental problem, then, is to determine the position of the target **relative to the guide stars in the surrounding area** with sufficient accuracy to place the target in the aperture. The specific pair of guide stars to be used cannot be determined in advance of the observation; several possible pairs will often be available for each target. The guide stars are chosen from the Guide Star Catalog 2 (GSC2). Over the *HST* FOV, the relative position errors between guide stars is now (using Gaia astrometry) on the order of a few mas – i.e. better than HST can actually point. Note that these errors are derived at the epoch of the position measurement and will increase slowly in time due to proper motion.

The accuracies of positions typically needed for target acquisition with each of the SIs are shown in Table 3.3: *Required Coordinate Accuracies*, these are predicated upon the positions being in the ICRS frame, which is the reference frame of the GSC2 catalog. Inaccurate target coordinates can result in failed target acquisitions and can therefore waste valuable *HST* observing time. **As indicated in** Table 3.3: *Required Coordinate Accuracies*, **it is the observer's responsibility to provide accurate coordinates in all cases, but in particular they must be in the ICRS reference frame when using STIS or COS**. Although ICRS frame-based coordinates are not required for FGS observations, it is still prudent to check the accuracy of your coordinates. All observers can generate target confirmation charts in APT to help them verify the target coordinates in the ICRS reference frame.

> ⭐ *HST* proposals executed before July 1991, as well as engineering proposals of type OV, SV, SMOV, and CAL, should not be used to derive target coordinates. Coordinates from such proposals may be unreliable owing to poor calibration and/or engineering-related pointing changes made during the observations.

Table 3.3: Required Coordinate Accuracies

Instrument Configuration	Accuracy Required (1 sigma, arcsec)	ICRS Coordinates Required?
STIS	1	Yes
FGS	1	No
ACS/WFC	10	No
ACS/SBC	5	No
COS	0.4	Yes
WFC3/UVIS	10	No
WFC3/IR	10	No

Targets near the Celestial Poles: Be very careful if your target lies near a celestial pole. In this regime many precession routines break down and uncertainties in position are exacerbated. Also, patterns that you may execute with an instrument could cross the pole, leading to confusion in position. All these issues can be resolved, but careful attention is needed.

Target Position Type [Position]

A position type is required for each fixed target. The positions may be expressed in any one of three different ways:

- By specifying the **equatorial** coordinates (RA and DEC) of the target;
- By specifying a positional **offset** from another target.

For text file

If you are using the Text Proposal File, target position items must be separated by commas.

Equatorial Coordinates

If you specify the target position directly in terms of equatorial coordinates (as opposed to specifying an offset), then the right ascension and declination <values> must be provided:

RA: <value>	DEC: <value>
RA: +/– <uncertainty>	DEC: +/– <uncertainty>

- The coordinates must be in Equinox **J2000**.
- The uncertainties should represent the accuracy (1 sigma) of the target coordinates.
- The right-ascension value must be expressed in hours (**H**), minutes (**M**), and seconds of time (**S**). If expressed as decimal degrees (e.g. 15.5), APT will automatically convert to **HMS** format (e.g. 01H 02M 00.0S). Note that it is not possible to enter **RA** in decimal hours.
- The declination value must be expressed in degrees (**D**), minutes (**'**), and seconds (**"**) of arc. If expressed as decimal degrees (e.g. -20.5), APT will automatically convert to **DMS** format (e.g. -20D 30' 00.0").

The units must be selected (from a pull down list). The allowed values are:

Quantity and units specified	
RA: H-M-S	timemin, timesec, arcmin, arcsec
DEC: D-M-S	degrees, arcmin, arcsec

⭐ If the sign of the declination is not indicated, a positive declination is assumed, but we urge you to always include the sign as a way of reducing errors.

> **For text file**
>
> In the Text Proposal File you must use the following format for RA and DEC (note the comma delimiters):
>
> **RA** = <value> +/– <uncertainty>, **DEC** = <value> +/– <uncertainty>
>
> The comma following the right-ascension uncertainty is required.
>
> - The right-ascension value must be expressed in hours (H), minutes (M), and seconds (S) of time. The declination value must be expressed in degrees (D), minutes ('), and seconds (") of arc (For example: RA = 12H 7M 13.33S +/– 0.15S, DEC = +27D 3' 8.0" +/– 0.1"). Note that while APT accepts decimal RA/DEC, as does the target import capability, the.prop file still requires **H, M**, and **S** units for **RA**, and **D**,' and '' for **Dec**.
> - Units must be provided for both a value and its uncertainty (see Acceptable units for uncertainty).

> **For engineering parameters**
>
> IMPORTANT: Both SAVE OFFSET and USE OFFSET rely on accurate coordinate uncertainties in order to calculate slew times properly. Unspecified target coordinate uncertainties may lead to a failure in execution of USE OFFSET. Program Coordinators should ensure that target coordinate uncertainties have been provided by the observer and that they are accurate.

Positional Offsets

The position of a target may alternatively be specified as an offset from a reference target. Note, however, that offsets larger than 30 arcsec may complicate the target acquisition procedure. If larger offsets are desired, please contact your Program Coordinator.

Offsets are always in the sense **offset = target-coordinates** *minus* **reference-coordinates**.

Offset = Target - Reference

RA-OFF = 29.81s - 37.42s = -7.61s
DEC-OFF = 05' 02.6" - 04' 16.3" = +46.3"

Target star:
RA = 15h 18m 29.81s
Dec = +42 05' 02.6"

Reference star:
RA = 15h 18m 37.42s
Dec = +42 04' 16.3"

1'

4.279' x 4.581'
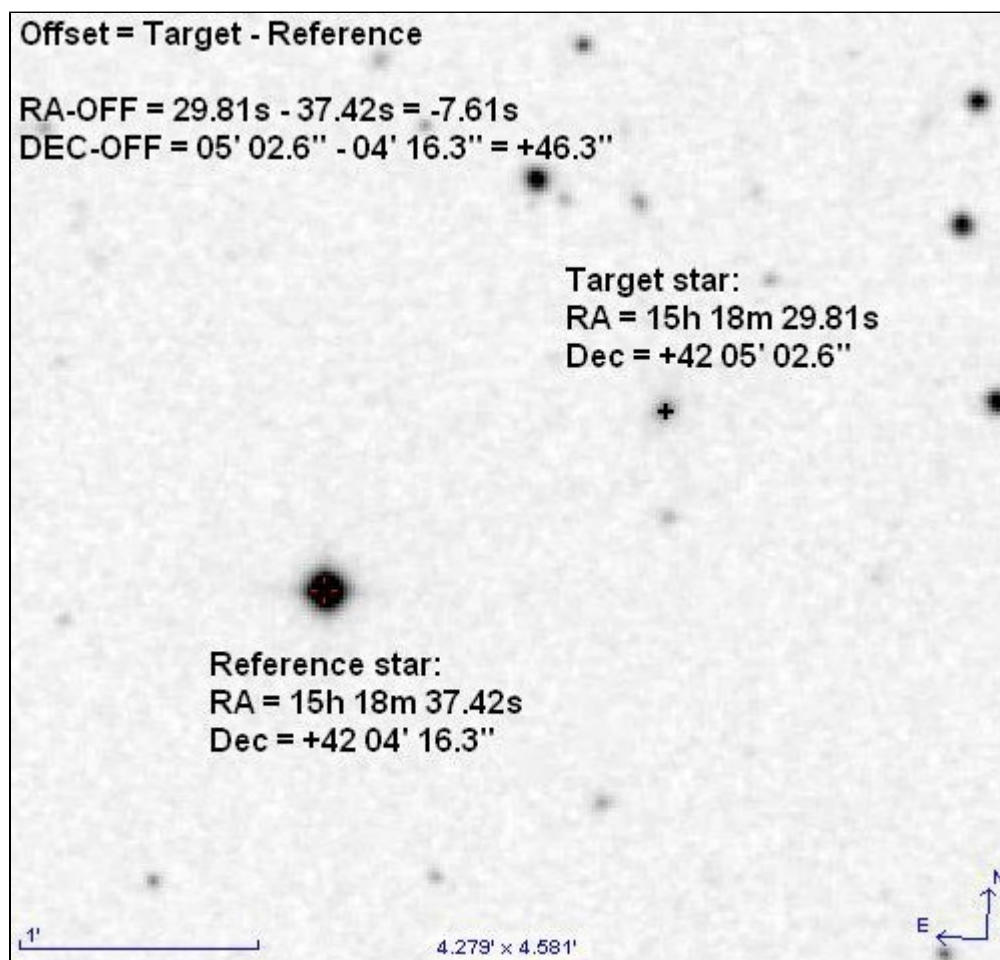
As with other similar quantities, we urge you to include the sign of the offset, even when it is positive, as a means of removing ambiguity.

Note that you select the <target name> which has the equatorial coordinates of the reference target, and that reference-target names have **–OFFSET** appended to them (see *Table 3.1: Designations of Special Targets*).

Positional offsets are only a convenient method of specifying target coordinates, and do **not** automatically imply a particular method of target acquisition; observers must explicitly specify any target acquisitions in their visits.

> ★ If your object has significant proper motion and the reference target does not have the same proper motion, do not use positional offsets to specify your object. The assumption for positional offsets is that both objects have the same proper motion. The proper motion for both objects is specified once on the reference target.

You specify the offset as a difference in **EQUATORIAL** coordinates from a target <name>.

Equatorial

Position Type: Offset   From Target: <target_name> Offset: RA: <value> DEC: <value>

The value for **RA** offset may be in units of seconds of time or decimal degrees, and the value for **DEC** offset may be in units of arcmin (') or arcsec ("), or in decimal degrees.

Example: NGC2654's right ascension is 2.34 seconds of time less than the reference target (NGC2654-OFFSET), and its declination is 1.6 arcsec greater than NGC2654-OFFSET. The specifications for NGC2654 would be:

Position Type: Offset	From Target: NGC2654-OFFSET	
Offset:	RA: -2.34S	DEC: 1.6"

> **For text file**
>
> The format for an offset specification as a difference in equatorial coordinates is:
>
> **RA-OFF =**<value>, **DEC-OFF =** <value>, **FROM** <target number>
>
> Note the commas separating the items. The value for **RA-OFF** may be in units of seconds (**S**) of time, or in decimal degrees (**D**), and the value for **DEC-OFF** may be in units of arcmin (') or arcsec ("), or in decimal degrees (**D**).

Determining Coordinates in the Reference Frame Appropriate for *HST* Observations

The *HST* reference frame is effectively defined by the positions of the Guide Stars that are selected for each pointing. At launch, we used the Guide Star Catalog (GSC1) which was an all-sky catalog of stars down to 15th magnitude built from Schmidt Sky Survey plates. That catalog was updated (GSC2) and calibrated to be on the International Celestial Reference System (ICRS), which has been adopted by the IAU as the fundamental reference frame. (In Cycle 28 the upgrade to GSC 2.4.2 incorporated guide star positions, proper motions and magnitudes from Gaia Data Release 2.) This simplifies the procedure for providing *HST* coordinates since it removes the necessity to tie the object coordinates back to the GSC1 and the plates used to construct it.

> ⭐ For observations that require accurate coordinates, such as those listed as ICRS Coordinates Required in the table of Required Coordinate Accuracies, it is vital that you provide positions derived in the ICRS reference frame.

General Guidelines

- If your target has a position that is in a catalog using the ICRS you may use the coordinates directly. These include GSC2, Hipparcos, Tycho, SDSS, 2MASS, FIRST, and Gaia.
- If your target is an extended object where the observation position does not correspond to the catalog coordinates, we recommend that you obtain an image of the field and measure your target coordinates in the ICRS reference frame.
- If your target has a relevant proper motion, you must provide the epoch of the coordinate as well as the proper motion values.

- Access to the GSC2, the Digitized Sky Survey (DSS) and other catalogs/surveys is built into the Aladin interface in APT (Note: for the DSS use the POS- S2UKSTU-Red plates that were used to build GSC2). Alternatively, you can also find links to query the GSC2 catalog and retrieve POSS2UKSTU-Red DSS images on the *HST* Support page. Do not use the data contained in the 102-volume set of CD ROMs distributed as the Digitized Sky Survey (DSS-I).

Getting Coordinates from the GSC2 or DSS

- If your target is a star brighter than m(V)~20 then it typically will be visible on the DSS images and present in the GSC2 catalog. Using the GSC2 position will ensure that the target is in the same reference frame as the selected guide stars.
- For extended sources visible on the photographic survey plates, we strongly recommend that you examine the DSS image and check your coordinates. Depending on the brightness, morphology and structure of the galaxy the GSC2 coordinate may not correspond to the aperture location you require for your observation. The DSS headers downloaded from STScI contain ICRS-based FITS WCS information to allow you to measure the image using various image analysis tools.
- Please note that the GSC2 coordinates for bright stars come from various sources which are more accurate than positions measured from the Schmidt plates.
- If you have used *HST* to observe a target in an earlier cycle and already have GSC1 based coordinates, you also have the option of using a 'Coordinate-Converter' that is available at the *HST* Support page. This is a simple web-based tool that allows one to enter either a GSC1 ID or coordinate. In the case of an ID it will directly look up the GSC2 coordinate for that object. If you enter a coordinate, it will derive a mean offset between GSC1 and GSC2 over the *HST* FOV and apply that correction to the position.

As a final check that the coordinates are correct, you must prepare a Confirmation Chart (in APT) showing the target coordinates (as entered in the proposal) overlaid on the field from the DSS. Ultimately, **you are responsible for verifying that the coordinates are correct** (see Required Accuracies of Target Positions).

Early Acquisition

If it is impossible to obtain adequate plate material to measure coordinates to the required accuracy (for example, a very crowded field which cannot be resolved using ground-based observations), it may be necessary to obtain an early acquisition image or to perform an acquisition that involves real-time interaction with the telescope (see General Exposure-level Special Requirements). In that case, enter coordinates as accurate as possible on the Target List.

For text file

Equinox for Coordinates [Equinox]

Enter the **Equinox** as **J2000**.

Coordinate Reference Frame [Reference_Frame]

Select one of the following **Reference_Frame** values for each target.

ICRS

To be used if the coordinate reference frame is tied to the International Celestial Reference System (ICRS).

Other

To be used if the coordinates are not ICRS.

Is Proper Motion or Parallax Relevant?

If a small aperture or occulting spot is to be used, even a relatively small proper motion or parallax may cause difficulties in acquiring the target. In such cases, the Proper Motion/Parallax data must be provided. Note, however, that proper motion and parallax values may **not** be specified for a target that is specified by a positional offset. Such targets will be taken to have the same proper motion and parallax as the reference target (see Positional Offsets).

The observer must determine whether or not proper motion or parallax is relevant. In general, this will depend on the size of the acquisition aperture of the SI that will be used and the epoch of the coordinates that have been provided. For example, the STIS uses a target acquisition area of 5 arcsec square. For a star whose coordinates are given for the epoch 1987.0, and that will be observed in 2013.0, a proper motion of approximately 0.05 "/year yields a total motion of 1.3", which is just greater than half the minimum center-to-edge distance (1.25") of the aperture, and therefore is relevant.

Proper Motion and Parallax Data

The following information is required for targets where proper motion and parallax are "relevant"; note that uncertainties for **RA_PM**, **Dec_PM**, and **Annual_Parallax** are not required. If a sign is not given for **RA_PM** or **Dec_PM**, a positive value will be assumed, but it is better to be explicit.

RA_PM

For proper motion in RA, the value can be in units of mas/year, arcsec/year or seconds of time/year. The selection of units is especially critical for RA_PM, as there is a large difference between 15 seconds of time/year and 15 arscec/year, so the observation will fail if improper units are provided.

Dec_PM

For proper motion in DEC, the value can be in units of mas/year or arcsec/year.

Epoch

The "Epoch of position" is the date of the data from which the position of a star with proper motion was measured, or to which it has been corrected. Any epoch may be given but it must be correctly specified. SIMBAD coordinates are usually corrected to epoch 2000 regardless of the original source epoch.

The "Epoch of position" may or may not be the same as the date of "Equinox for Coordinates" (required to be J2000 for *HST*). Remember that the "Epoch of position" is the date the target position is referred to, whereas the "Equinox of Coordinates" is the date of the coordinate frame, which changes because of the precession of the Earth's axis. For example, a star with a large proper motion may have its coordinates given in the J2000 system, but the numbers themselves are for epoch 1984, meaning that the star was at the specified position on January 1, 1984. Epoch should be of the form **20yy.y** or **19yy.y**. (Note: An epoch is purely a time, and one of the form "J1991.25" is invalid.)

Ordinarily the epoch of position is earlier than the present date. In the *Guide Star Catalog* (GSC), the equinox is J2000 while the epoch depends on the individual plate. It is *not necessary* to adjust your coordinates to be those that would be measured if the plate were taken in the year 2000. Note that some catalogs contain coordinates already adjusted to a common epoch. For instance Gaia Data Release 2 has a common epoch of 2015.5 while Gaia Data Release 3 has a common epoch of 2016.0.

Annual_Parallax

The unit for parallax is arcsec.

The example in the table below is for the object **DM–9D697 (Epsilon Eridani)**, where the proper motion data are taken from the SAO Catalog.

Keyword	Explanation	Units	Example
RA_PM	Proper Motion in RA	mas/yr, arcsec/yr or sec /yr	–0.0662 sec/yr
DEC_PM	Proper Motion in DEC	mas/yr or arcsec/yr	19 mas/yr
Epoch	Epoch of Position	**20yy.y** or **19yy.y**	1984.5
Annual_Parallax	Annual parallax	arcsec	0.30488

For some notes on proper motions and units, see Is Proper Motion or Parallax Relevant?.

Target Brightness and Bright Object Checking

Flux information is required to support bright object (ACS/SBC, COS, FGS, and STIS/MAMA) and persistence (WFC3/IR) checking on the target.

> ⭐ All flux information relevant for bright object checking must be provided.

Flux Data [Flux and Other_Fluxes]

Flux information must be provided for all targets, and there can be more than one entry for a given target. STScI uses flux information to check for over-illumination of sensitive detectors. All entries are values as observed at the Earth, rather than intrinsic values.

COS, ACS/SBC and STIS/MAMA proposals cannot be implemented without flux information for all targets because of the critical requirements to protect the detectors from damage by excessively bright objects. Note that all objects in the field need to be checked, and there is a Bright Object Tool in APT to support that checking.

The flux information is provided in two separate fields:

- Flux in V Magnitude with an uncertainty. This is required for targets observed by the FGS, STIS /FUV-MAMA, STIS/NUV-MAMA, COS and ACS/SBC. For all other instrument configurations, it's optional.
- **Other Fluxes** (separated by commas), which is entered in free text.

In the "**Other Fluxes**" field, the spectral type and reddening could be provided if you think it's important. As many additional flux values as appropriate for the requested exposures should be provided. For example, ultraviolet or emission-line fluxes should be given if the target is to be observed in the ultraviolet or through a narrow-band filter, or several magnitudes might be provided if the target is a variable star to be observed at various brightness levels. In some cases (Targets of Opportunity, variable objects, etc.) the estimated flux data may be very uncertain, but the best available estimates should nevertheless be given, along with appropriate uncertainties and comments.

It may be important to specify the flux of a background source as well as the target flux. For example, a globular cluster in M87 may be seen against the bright background of the galaxy. The suffix **–BKG** should be appended to a background flux specification in this case (e.g. SURF-BKG(B) = 20 +/– 0.2 mag/arcsec2). Use a comma to separate entries if more than one flux value is given.

> For text file
>
> If you are using the Text Proposal File, flux items in a list must be separated by commas.

General Guidelines on What Flux Data to Include

The following summary provides general guidelines for what flux information could be included in three general areas.

Target Flux

1. Magnitudes: V magnitude (point source), V surface brightness (extended source), or J magnitude (IR source).
2. Flux: flux at specified wavelength.
3. Color: B-V, U-B, J-K, etc.
4. Reddening: E(B-V). If no entry for E(B-V) is given, E(B-V) = 0 will be assumed.
5. Spectral type (point source).

Background Flux

1. Non-dispersive spectral element: Broad-band surface brightness or surface brightness at specified wavelength; BKG must be specified in the name of the flux parameter. For IR sources, this refers to the astronomical background and not the thermal background.
2. Dispersive spectral element: Surface brightness of continuum; -BKG must be specified in the name of the flux parameter. For IR sources, this refers to the astronomical background and not the thermal background.

Surface Flux

1. Non-dispersive spectral element: Flux (point source) or surface flux (extended source) in wavelength range of observation.
2. Dispersive spectral element: Continuum (point source) or surface (extended source) flux at wavelength of observation and size of the region specified,

or
Line flux (point source), line surface flux (extended source), and line width of brightest emission line in the wavelength range of observation.

> ⭐ Details of how the above flux information was derived should be given in the Observing Description or Target Comment, as appropriate. If any of the required flux data cannot be provided or are deemed to be unnecessary, these points must also be explained in that section. Incomplete flux information may delay the implementation of your proposal, especially in the case of ACS/SBC, COS and STIS/MAMA observations.

Radial Velocity or Redshift [RV_or_Z]

Give, if known, the heliocentric radial velocity or redshift of the target. The format is <velocity in km /sec> or <redshift>; examples are +1198 (Radial Velocity) and 1.95 (Z). The units must not be specified.

> For text file
>
> In the Text Proposal File the format is V = +1198 and Z = 1.95.

Bright-Object Constraints

Several of the Scientific Instruments must be protected against over-illumination. The Table 3.4: Bright Object Constraints summarizes the safety restrictions by instrument. You should not propose observations which violate these guidelines. Non-linearity, saturation, or other temporary effects which may occur at substantially fainter limits than those identified below are described in Section 7.7.2 in the STIS Instrument Handbooks.

APT contains a Bright Object Tool (BOT) that should be used to check on these constraints. Proposers should check the entire field using the Aladin interface provided in APT.

Table 3.4: Bright Object Constraints

Instrument	Description

STIS	The STIS MAMA (UV) detectors are subject to strict bright-object controls to prevent potentially fatal damage. Maximum permissible local and global count rates have been established for the STIS MAMA detectors, both for imaging and spectroscopy, and are given in the *STIS Instrument Handbook*. These limits have been translated into limiting magnitudes and fluxes for the various configurations and modes (see Table 13.45 for spectroscopy and Table 14.40 for imaging). Some of these limits are quite faint.
	All potential targets and field objects within a certain field of view, which depends on the configuration selected, should be checked for safety with the STIS Exposure Time Calculator (ETC available at http://etc.stsci.edu/) and with the Bright Object tool in APT[1]. Measured UV fluxes must be provided for any object within 1 magnitude of the brightness limits; if not previously available, they must be first observed with a safe STIS mode. Unless they can be screened with GSC2/DSS, magnitudes and colors, or a UV image, other fluxes must be provided for all objects in the fields of proposed STIS MAMA observations, including the background fields of solar-system targets. **ORIENT**s and/or **POS TARG**s may be used to avoid potentially problematic objects.
	There are no safety-related brightness limits for the STIS CCD. See the *STIS Instrument Handbook* for a description of saturation levels, residual charge, and other effects.
ACS	The ACS/SBC MAMA detector is subject to strict bright-object controls to prevent potentially fatal damage. Maximum permissible local and global count rates have been established for both imaging and spectroscopy; see the *ACS Instrument Handbook (Section 7.2)*. These limits have been translated into a table of magnitudes as a function of spectral type for the various configurations and modes (*ACS Instrument Handbook,* Table 7.4). Some of these limits are quite faint.
	All potential targets should be checked for safety with the ACS Exposure Time Calculator (ETC available at *http://etc.stsci.edu/etc/input/acs/imaging)* and with the Bright Object tool in APT. Measured UV fluxes must be provided for any objects within one magnitude of the spectroscopic limits. This requirement extends to both targets and field objects on the detector. **ORIENT**s and/or **POS TARG**s may be used to avoid the latter. Unless they can be screened with GSC2/DSS, magnitudes and colors, or a UV image, other fluxes must be provided for all objects in the fields of proposed SBC observations, including the background fields of solar-system targets.
	There are no safety-related brightness limits for the ACS/WFC CCD cameras. See the *ACS Instrument Handbook* for a description of saturation levels, residual charge, and other effects.
FGS	The FGS may not be used to view objects brighter than $mV = 1.8$. The FGS may view objects brighter than $mV = 8.0$ only if the neutral-density filter is in place.

COS	The detectors used in the COS/FUV and COS/NUV channels are both subject to strict bright-object controls to prevent potentially fatal damage. The maximum permissible local and global count rates have been established and are given in the *COS Instrument Handbook*. These limits have been translated into equivalent limiting magnitudes and fluxes. Some of these limits are quite faint. All potential targets and field objects within a certain field of view must be checked for safety with the COS Exposure Time Calculator (ETC available at http://etc.stsci.edu/etc/input/cos/spectroscopic/) and with the Bright Object tool in APT[1]. Measured UV fluxes must be provided for any object within one magnitude of the brightness limits. Unless they can be screened with GSC2/DSS, magnitudes and colors, or a UV image, other fluxes must be provided for all objects in the fields of proposed COS observations, including the background fields of solar-system targets. **ORIENT**s and /or **POS TARG**s may be used to avoid potentially problematic objects.
WFC3	There are no safety-related brightness limitations for either the UVIS or IR channels. Please refer to the *WFC3 Instrument Handbook*, Appendix D for a description of persistence of saturated images.

1 See http://apst.stsci.edu/apt/external/help/documentation/Running-BOT.html for a description of the APT Bright Object tool.

Comments [Comments]

Any additional information you wish may be entered in "**Comments**" area. Comments are not interpreted by the software, but are maintained in the data base and do appear on the formatted outputs.

Related Links

3.2 Solar System Targets
3.3 Generic Targets

Change Log
Version Cycle 31 July 2023

Fixed six links that were poorly formed.

Version Cycle 30 April - May 2022

PROPINST-91386 - Remove Reference Frame GSC1 for HST Fixed Targets

Updated Epoch section to replace common epoch example with more modern for GAIA DR2 and DR3 catalogs.

PROPINST-70842 (Remove HST Region targets)

Version Cycle 29 May 2021

Changes due to enhancement of guide star catalog with GAIA coordinates.

3.1.1 Target Descriptions

The Fixed Targets form is used to specify fixed targets in some HST observations. This article provides a list of target descriptions for the Astronomer's Proposal Tool (APT).

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Format definitions
Target Descriptions for the Astronomer's Proposal Tool (APT)
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Change Log

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Target Descriptions for the Astronomer's Proposal Tool (APT)

Table 3.5: Descriptive Keywords for Solar System

Descriptive Keywords for Solar System	
Planet	Feature
Dwarf-Planet	Offset
Satellite	Ring
Comet	Torus
Asteroid	Other

Table 3.6: Descriptive Keywords for STAR and EXT-STAR

Descriptive Keywords for STAR and EXT-STAR

Brown Dwarf	F0-F2	Herbig Ae/Be
Wolf Rayet	F3-F9	Horizontal Branch Star
Wolf Rayet – WC	FP	Interacting Binary
Wolf Rayet – WN	Late-type Degenerate	X-ray Novae
Main Sequence O	G V-IV	X-ray Burster
Giant O	G III-I	X-ray Transient
Supergiant O	K V-IV	LMXB (Low Mass X-ray Binary)
OE	K III-I	Gamma Ray Burster
OF	M V-IV	MXB (Massive X-ray Binary)
SDO	M III-I	RS CVn Star
WDO	L	W UMa Star
B0-B2 V-IV	T	Beta Lyrae Star
B3-B5 V-IV	S Star	Algol System
B6-B9.5 V-IV	Carbon Star	Barium Star
B0-B2 III-I	Long Period Variable	Blue Straggler
B3-B5 III-I	Irregular Variable	Neutron Star
B6-B9.5 III-I	Regular Variable	Pulsar
BE	Luminous Blue Variable	Binary Pulsar
BP	Dwarf Nova	FK Comae Star
SDB	Classical Nova	Pulsating Variable
DB	Nova-like	PG1159 Star
DA	Recurrent Nova	ZZ Ceti Star
DC	Polar (AM Her Star)	Cepheid
DZ	Intermediate Polar (DQ Her Star)	Supernova
A0-A3 V-IV	Symbiotic Star	Supernova Type Ia
A4-A9 V-IV	T Tauri Star	Supernova Type Ib
A0-A3 III-I	FU Orionis Star	Supernova Type II
A4-A9 III-I	Shell Star	RR Lyrae Star
AE	Eta Carinae Star	Planetary Nebula Central Star

AM	YSO	Emission Line Star
AP	Extra-solar Planet	Circumstellar Matter
AGB Star	Extra-solar Planetary System	Population II
Post-AGB Star	Pre-main sequence Star	
Composite Spectral Type	Low Mass Companion	

Table 3.7: Descriptive Keywords for STELLAR CLUSTER and EXT-CLUSTER

Descriptive Keywords for STELLAR CLUSTER and EXT-CLUSTER	
Globular Cluster	OB Association
Open Cluster	T Association
Young Association	

Table 3.8: Descriptive Keywords for GALAXY

Descriptive Keywords for GALAXY	
Spiral (Spiral Galaxy)	Quasar (Radio Loud)
Lenticular (Lenticular Galaxy)	Radio Galaxy
Elliptical (Elliptical Galaxy; Not A Dwarf Elliptical)	BL Lac (BL Lac or BLAZAR)
Dwarf Elliptical	Liner
Magellanic Irregular	Starburst
Amorphous Irregular	Ultraluminous IR Gal
Dwarf Compact (Dwarf Compact/HII Galaxy)	Interacting Galaxy
Dwarf Spheroidal	Lyman Alpha Cloud
BCM (Brightest Cluster Member)	Protogalaxy
BGM (Brightest Group Member)	Einstein Ring
LSB (Low Surface Brightness/HI Rich Galaxy)	High Redshift Galaxy ($z > 0.5$)
Seyfert	
QSO (Radio Quiet)	

Table 3.9: Descriptive Keywords for CLUSTER OF GALAXIES

Descriptive Keywords for CLUSTER OF GALAXIES	
Supercluster	Interacting Galaxy
Void	BCM (Brightest Cluster Member)
Group	BGM (Brightest Group Member)
Rich Cluster	Einstein Ring
Poor Cluster	Blank Sky
High Redshift Cluster ($z > 0.5$)	
Galaxy Pair	

Table 3.10: Descriptive Keywords for ISM and EXT-MEDIUM

Descriptive Keywords for ISM and EXT-MEDIUM	
Herbig-Haro Object	Cometary Nebula
Planetary Nebula	Molecular Cloud
HII Region	Bipolar Outflow
Reflection Nebula	Absorption Line System
Dark Cloud	Absorption Line System – Galactic
SNR (Supernova Remnant)	Absorption Line System – Extragalactic
Ring Nebula	Damped Lyman Alpha Cloud (Extragalactic)
HI Cloud	Coronal Gas (10^5–10^6 K)
High Velocity Cloud	Hot Gas (10^7–10^8 K)
Intermediate Velocity Cloud	IGM
IRAS Cirrus	ICM
PDR (Photon Dominated Region)	

Table 3.11: Descriptive Keywords for UNIDENTIFIED

Descriptive Keywords for UNIDENTIFIED

Radio Emitter	Ultraviolet Emitter	Blank Field	Low Latitude Field
Infrared Emitter	X-ray Emitter	Parallel Field	
Optical Emitter	Gamma Ray Emitter	High Latitude Field	

Table 3.12: Descriptive Keywords for CALIBRATION

Descriptive Keywords for CALIBRATION		
Astrometric	Narrow Band Filter Calibration	Target Acquisition Test
Photometric	FGS Stability	Detector Sensitivity Test
Wavelength	Quantum Efficiency Test	Focus Test
Point Spread Function	Pointing and Jitter Test	Spacecraft Glow
Occulting Finger Location	Raster & Step/Dwell Scan Verification	Occultation Mode Test
Ion	Spatial Distortion Test	Throughput Test
Taled	Polarimetry	Echelle Blaze Function
Scattered Light Test	Aperture Location	Virtual Pointing
Sky Background	Detector Linearity Test	FGS Transfer Function Test
Instrument Sensitivity Test	Carrousel Stability Test	Shutter Control Test

Table 3.13: Discrete Features and Descriptors for All Categories

Discrete Features and Descriptors for All Categories		
Corona	Disk	BLR (Broad Line Region)
Ring	Bulge	NLR (Narrow Line Region)
Ansae	Polar Ring	Filament
Protoplanetary Disk	Dust Lane	Ejecta
Wind	Spiral Arm	Knot
Accretion Disk	Shell	Star Forming Region
Jet	Tidal Tail	Shock Front
Lobe	Bar	Ionization Front
Hotspot	Multiple Nuclei	Conduction Front

Nucleus	Cooling Flow	Undesignated
Halo	Emission Line Nebula	Gravitational Lens

Change Log

None

3.2 Solar System Targets

The Solar System Targets form is used to specify moving targets in some HST observations. The Astronomer's Proposal Tool (APT) is used to enter the targets into the proposal.

Sections

- 3.2.1 Solar System Standard Targets
- 3.2.2 Solar System Targets Position Level 1
- 3.2.3 Solar System Targets Position Levels 2 and 3
- 3.2.4 Solar System Targets Observing Windows

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Format definitions

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Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

HST is able to point at and track solar system targets with sub-arcsecond accuracy. In order for target acquisition and tracking to succeed, planetary observers must specify positions for their targets in a precise and unambiguous manner. Therefore, it is imperative that the Solar System Target List (SSTL) be carefully and correctly completed. This section explains how to fill out the SSTL for any solar system target.

Ephemerides are generated using fundamental ephemeris information from NASA's Jet Propulsion Laboratory (JPL). Ephemerides can be generated for all known types of solar system targets, including planets, satellites, comets, asteroids, surface features on planets and satellites, and offset positions with respect to the centers of all the above bodies. The following instructions demonstrate how to define solar system targets in a way that allows accurate ephemeris generation.

The body-axes definitions, body dimensions, directions of rotation poles, rotation rates, and the definitions of cartographic coordinates used by STScI are normally identical to the values adopted in the report of the "IAU Working Group on Cartographic Coordinates and Rotational Elements of the Planets and Satellites: 1982" (Davies, M.E., et al., *Celestial Mechanics*, **29**, 309-321, 1983). In a few instances, the latter data have been updated due to new results obtained from the flyby spacecraft. Also, some new bodies have been added which were unknown at the time of the IAU report. For Jupiter and Saturn, the lambda(III) coordinate system is assumed, but lambda(I) or lambda(II) can be used. For Uranus and Neptune, coordinates follow the "Report of the IAU/IAG/COSPAR Working Group on Cartographic Coordinates and Rotation Rates of the Planets and Satellites" (Celestial Mechanics and Dynamic Astronomy, **46**, 197, 1989). If you need further information on these, please contact your Program Coordinator.

One exception exists to the requirements outlined above. Observers for solar system Targets of Opportunity (e.g., a "new" comet or asteroid, a solar-wind disturbance reaching the Jovian magnetosphere, etc.), should complete the Generic Target List and the Visit and Exposure Specifications (to the extent possible) in time for the Phase II deadline. If and when a suitable target appears, the proposer must complete the Solar System Target List and update the Visit and Exposure Specifications. **No target can be observed until the complete Phase II information is provided**.

There are new rules introduced in 2020 that govern orbital visibility for Moving Targets. See explanation in the Special Requirement VISIBILITY INTERVAL NO GYRO BIAS UPDATE ON MOVING TARGET.

In this article, each heading has a description followed by a keyword in square brackets (e.g., **[Target_Number]**).

Target Identification

The following information is required to identify and classify each target.

Target Number [Target_Number]

Each target in your program will be assigned its own unique number (which can be changed by the user) by APT (they are base 10 and go from 1 to 999). Target numbers must be positive, monotonically increasing integers. You should define a different target whenever a different target position or timing description is required. For example, separate targets should be defined if you plan to take spectra of several different surface features on a planet, or if you plan to observe the same feature with different timing constraints.

Target Name [Target_Name]

The name is used to identify a target; **all target names within a proposal must be unique**. The target name can be selected from the STScI list of **standard** targets (see the list in 3.2.1 *Solar System Standard Targets*; explanations of "Level 1" and "Level 2" are given below), or a name can be defined by the GO. The use of standard names is encouraged whenever possible.

The following conventions should be followed in naming targets:

- The length of a target name can be anywhere from 2 to 31 characters.
- **No blanks are permitted in target names**. A hyphen should replace blanks that would normally be used to separate fields (e.g. **IO-TORUS**, **COMET-BRADFIELD-1979X**).
- Only letters and numerals are allowed in target names; punctuation (other than hyphens and **+** or **–**) is not permitted.
- Construct target names so they make sense for your observing program. For example, if your program consisted of consecutive observations of three surface features on Mars, then three appropriate target names might be: **MARS-FEATURE1**, **MARS-FEATURE2**, and **MARS-FEATURE3**.

> ⭐ **Do not use just a standard name for a target when a specific portion of a body is being observed. For example, do not use "Saturn" as the target name for a feature or specific location that is defined relative to the position of Saturn as a standard target because this is confusing for the software that computes the positions of moving target**s.

Target Description [Description]

The target description is used to sort the solar system targets by class and will be useful to archival researchers. The first word in any target description **must** be one of the keywords listed below. The keyword is then followed with text that depends on the target class as described below.

Table 3.14: Target Description Keywords

Keyword	Description
PLANET	If the target is the center of a planet, enter **PLANET** followed by its name (e.g., **PLANET JUPITER**, **PLANET SATURN**).
DWARF-PLANET	If the target is the center of a dwarf planet, enter **DWARF-PLANET** followed by its name (e.g., **DWARF-PLANET CERES)**
SATELLITE	If the target is the center of the satellite of a planet, enter **SATELLITE** followed by the satellite name (e.g., **SATELLITE GANYMEDE**, **SATELLITE 1980S27**)

COMET	This keyword selects the type of non-standard moving target (Asteroid or Comet) for which an ephemeris needs to be provided. If the target is the nucleus of a comet, enter **COMET** followed by its common name or catalog designation (e.g., **COMET HALLEY**, **COMET 1979X**)
ASTEROID	This keyword selects the type of non-standard moving target (Asteroid or Comet) for which an ephemeris needs to be provided. If the target is the center of an asteroid, enter **ASTEROID** followed by its common name or its catalog number (e.g., **ASTEROID CERES**, **ASTEROID 452**)
FEATURE	If the target is a surface feature, enter **FEATURE** followed by the name of the parent body (e.g., **FEATURE JUPITER**, **FEATURE IO**)
OFFSET	If the target is an offset position with respect to a solar system body (but not a feature on its surface), enter **OFFSET** followed by the name of the parent (reference) object (e.g., **OFFSET COMET HALLEY**, **OFFSET JUPITER**)
RING	If the target is in a ring, enter **RING** followed by the name of the parent object (e.g., **RING JUPITER**, **RING SATURN**)
TORUS	If the target is a plasma torus, enter **TORUS** followed by the name of the parent object (e.g., **TORUS JUPITER**)
OTHER	If your target cannot be classified under any of the categories above, then enter **OTHER** followed by some description of the type of observation planned (e.g., **OTHER ASTROMETRIC REFERENCE**, **OTHER INTERPLANETARY MEDIUM**, **OTHER ZODIACAL LIGHT**)

Target Extent [Extended] for COS Observations Only

This field is required for COS observations only. Both COS FUV and NUV observations of targets with FWHM larger than about 0.6 arcsec or radius larger than 0.35 arcsec should be considered as extended. "YES" should be selected for such targets and "NO" for targets of smaller angular extent. The field should be left blank if the target is not being observed by COS.

This definition is intended to provide an indication of whether or not the source extent might be large enough to affect the reliability of the default pipeline extraction algorithm. See COS ISR 2015-03 and Section 5.9 of the COS Instrument Handbook for further details.There are a number of other issues that should be considered when observing extended targets with COS, including the effects on spectral resolution and target acquisition. Please note that the exposure-level parameter EXTENDED has been deprecated and should not be selected for any Cycle 23 proposals or beyond.

Pointing HST - Target Position

The following information is required to properly point HST at your target.

Target Pointing Specification (TPS) and Levels

Three fields are used to describe the target's position, referred to here as the **Target Pointing Specification** (TPS). The TPS has been defined using a hierarchical structure.

- **"Target Position Level 1 [Level_1]"refers to a target in orbit about the Sun.** Examples of Level 1 targets include planets, asteroids, and comets. When a Level 1 object is the desired target for observation, complete the Level 1 field and leave the other two target position fields blank.
- **"Target Position Level 2 [Level_2]" refers to a target whose motion is normally described with respect to a Level 1 object.** Examples of Level 2 targets include planetary satellites, surface features on planets or asteroids, and non-nuclear positions in the coma of a comet. When a Level 2 object is the desired target for observations, the Level 1 field contains information on the **parent** body, and the Level 2 field gives positions relative to this body. In this case, leave the Level 3 field blank.
- **"Target Position Level 3 [Level_3]" refers to a target whose motion is normally described with respect to a Level 2 object.** Examples are a surface feature on a planetary satellite or a pointing which is offset from the center of a planetary satellite. When a Level 3 object is the desired target for observation, then all three fields must be completed, with Level 1 giving the **parent** of the body described in Level 2, and Level 3 giving the position of the observed target with respect to the body in Level 2.

⭐ **No more than three levels are allowed. If you believe that your target cannot be described in this form, contact your Program Coordinator**.

For text file

If you are using the Text Proposal File, **TPS** items must be separated by commas.

Describing Targets

The targets specified in the target position fields can be described in up to four ways:

- By a name selected from a list of targets
- By orbital elements
- By coordinates with respect to another object
- Via target selection during a real-time observing session

Table 3.15 in *Solar System Standard Targets* gives the list of valid names for solar system targets. PIs are responsible for obtaining up-to-date orbital elements for bodies not in this table. Objects must be denoted by their IAU-adopted name. A good reference for object names can be found in the *Astronomical Almanac,* and in the Marsden comet catalog (Marsden, B. G., *Catalog of Cometary Orbits* , Enslow Publishers, Hillside, NJ, 1983). The Minor Body Name Resolver and Orbital Ephemeris Retriever may also be helpful. If you are uncertain whether or not your target can be referenced by name, contact your Program Coordinator.

In those cases where the target's position is given with respect to one of the **standard** targets, the latest available data from JPL on the bodies' physical dimensions, orientation, and rotation rates are used in calculating the target's position. **In those cases where all or part of the TPS for your target can be described using standard names, we strongly recommend that you do so**. Generally, this will result in the most accurate ephemeris generation for your target.

Minor Body Name Resolver and Orbital Ephemeris Retriever

When specifying an asteroid or a comet as the target, APT provides an option to resolve the target name and download the orbital elements directly from the JPL Horizons system. Using this APT capability to communicate directly with Horizons avoids possible copy and paste errors.

Alternatively, the user may manually enter the target name and the orbital elements. In all cases, the observer retains the responsibility for the correctness of the orbital elements regardless of the source from which they are obtained.

Specifying Time

Wherever there is an entry involving time, the format for that entry must be:

DD-MMM-YYYY:hh:mm:ss.s,

where **DD** is the day of the month, **MMM** is the first three letters of the month name, **YYYY** are the full four digits of the Gregorian calendar year, **hh** is the hour, **mm** is the minute, and **ss.s** are the decimal seconds. Only the necessary precision need be specified. *But the time after the colon must be completely specified or not at all*.

Examples:

02-AUG-1993:13:04:31

15-JAN-1994

Two different systems of time are used in this document. *TDB* refers to *Barycentric Dynamical Time* and can be considered synonymous with *ET* (*Ephemeris Time*), which was used before 1984. *UTC* refers to *Coordinated Universal Time*. The precise interpretation of each time value depends on the context in which it is used.

For engineering parameters (MOSS Planning Start, MOSS Planning End, MOSS Show Windows)

Moving Target Implementation Only Flags

These flags are set initially by a Program Coordinator, but can be made available to a GO. By default, the Start and End dates are not specified and Show Windows is unchecked.

MOSS Planning Start <date>	Overrides the start date for MOSS processing of Solar System Target Windows
MOSS Planning End <date>	Overrides the end date for MOSS processing of Solar System Target Windows
MOSS Show Windows	Indicates whether MOSS files should include SHOW WINDOW commands

---

Ephemeris Center [Ephem_Center]

Used to support HST observations of the Moon and other close moving targets closer than 3.8 million kilometers. Ephemeris Center must have one of two possible values: **EARTH** or **HUBBLE**.

EARTH (default)

A geocentric target ephemeris is computed and provided to HST. HST's on-board software then computes a correction for the parallax induced by the telescope's orbit. This is the default method and will work for most cases. However, HST's on-board parallax correction may be insufficient for a target closer than 3.8 million kilometers.

HUBBLE

An HST-centric target ephemeris is generated. In this case, no parallax correction is needed and none is performed. However, due to uncertainties in HST's own ephemeris, an HST-centric target ephemeris will have sufficient accuracy for only about 4 weeks into the future. An HST-centric ephemeris should be specified only for very close targets such as the Moon.

Ephemeris Uncertainty [Ephem_Uncert]

The <value> for ephemeris uncertainty is the distance along its trajectory that the target is expected to be from its ephemeris position, in kilometers (**KM**), or seconds of time (**S**). The latter reflects the fact that in general, the least well known parameter in an ephemeris is the perihelion time. This parameter is required for any moving target used in an exposure with the REQuires EPHEMeris CORRection Special Requirement.

> ⭐ A realistic estimate of ephemeris uncertainty is needed to schedule the time necessary to repoint the telescope to the improved position when it is known. It will not be possible for STScI to apply a correction larger than the specified uncertainty.

Acquisition Uncertainty [Acq_Uncert]

The <value> for acquisition uncertainty is the uncertainty in the position of the target in a direction perpendicular to the line of sight, in kilometers (**KM**) or arcsec (**"**).

> For available but unsupported parameters
>
> This parameter is required for any moving target used in an exposure with the USE OFFSET <id> Special Requirement. Note that there will have to be an exposure of the acquisition target with a corresponding SAVE OFFSET <id> Special Requirement. (There is no need for this keyword when observing fixed targets, because the specified target uncertainty is used).

> ⭐ A realistic estimate of ephemeris uncertainty is needed to schedule the time necessary to repoint the telescope to the improved position when it is known. It will not be possible for STScI to apply a correction larger than the specified uncertainty.

Observing Windows [Windows]

The observability of solar system targets is often constrained by various geometrical conditions (e.g. satellites observed at greatest elongation from their parent planet), or the desirability of coordinated observations (e.g. the observation of a planetary system at the same time as a spacecraft encounter with the system). The Window field is provided to allow the proposer to define geometric and timing

constraints. The proposer should specify any constraints necessary to achieve the scientific objectives of the programs. However, care should be taken in specifying constraints, since they can render the observations difficult or impossible to schedule.

Flux Data [Flux and Other_Fluxes]

Flux information must be provided for all targets, and there can be more than one entry for a given target. STScI uses flux information to check for over-illumination of sensitive detectors. All entries are values as observed at the Earth, rather than intrinsic values.

COS, ACS/SBC and STIS/MAMA proposals cannot be implemented without flux information for all targets because of the critical requirements to protect the detectors from damage by excessively bright objects. Note that all objects in the field need to be checked, and there is a Bright Object Tool in APT to support that checking.

The flux information is provided in two separate fields:

- Flux in V Magnitude with an uncertainty. This is required for targets observed by the FGS, STIS /FUV-MAMA, STIS/NUV-MAMA, COS and ACS/SBC. For all other instrument configurations, it's optional.
- **Other Fluxes** (separated by commas), which is entered in free text.

In the "**Other Fluxes**" field, the spectral type and reddening could be provided if you think it's important. As many additional flux values as appropriate for the requested exposures should be provided. For example, ultraviolet or emission-line fluxes should be given if the target is to be observed in the ultraviolet or through a narrow-band filter, or several magnitudes might be provided if the target is a variable star to be observed at various brightness levels. In some cases (Targets of Opportunity, variable objects, etc.) the estimated flux data may be very uncertain, but the best available estimates should nevertheless be given, along with appropriate uncertainties and comments.

It may be important to specify the flux of a background source as well as the target flux. For example, a globular cluster in M87 may be seen against the bright background of the galaxy. The suffix **–BKG** should be appended to a background flux specification in this case (e.g. SURF-BKG(B) = 20 +/– 0.2 mag/arcsec2). Use a comma to separate entries if more than one flux value is given.

> For text file
>
> If you are using the Text Proposal File, flux items in a list must be separated by commas.

General Guidelines on What Flux Data to Include

The following summary provides general guidelines for what flux information could be included in three general areas.

Target Flux

1. Magnitudes: V magnitude (point source), V surface brightness (extended source), or J magnitude (IR source).
2. Flux: flux at specified wavelength.
3. Color: B-V, U-B, J-K, etc.
4. Reddening: E(B-V). If no entry for E(B-V) is given, E(B-V) = 0 will be assumed.
5. Spectral type (point source).

Background Flux

1. Non-dispersive spectral element: Broad-band surface brightness or surface brightness at specified wavelength; BKG must be specified in the name of the flux parameter. For IR sources, this refers to the astronomical background and not the thermal background.
2. Dispersive spectral element: Surface brightness of continuum; -BKG must be specified in the name of the flux parameter. For IR sources, this refers to the astronomical background and not the thermal background.

Surface Flux

1. Non-dispersive spectral element: Flux (point source) or surface flux (extended source) in wavelength range of observation.
2. Dispersive spectral element: Continuum (point source) or surface (extended source) flux at wavelength of observation and size of the region specified,
   or
   Line flux (point source), line surface flux (extended source), and line width of brightest emission line in the wavelength range of observation.

> ⭐ Details of how the above flux information was derived should be given in the Observing Description or Target Comment, as appropriate. If any of the required flux data cannot be provided or are deemed to be unnecessary, these points must also be explained in that section. Incomplete flux information may delay the implementation of your proposal, especially in the case of ACS/SBC, COS and STIS/MAMA observations.

Comments [Comments]

This field should include in words what you are trying to define by coordinates and windows in the other fields. For example, for Target No. 3 on the sample form the **TPS** and **Window** fields define mathematically the location of the target and the valid observation times, but the **Comments** field is probably much more useful in helping an observation planner determine the proposer's objectives.

Examples of Target List Blocks

The sample targets defined in this section are provided as examples of completed forms using the syntax described in these instructions. This collection does not provide an example for every type of keyword but does give a good overall representation of the types of target selections that can be accommodated. Numerical data in these examples is fictional.

- **Example 1**: In this example the proposer wants to perform spectroscopy of a volcano on Io. The position of the target is given in planetographic coordinates. The proposer also wants to observe the target when it lies close to the central meridian and, thus, uses **CML** to specify the allowable range of the central meridian longitude.

Target_Number:	1
Name:	IO-VOLCANO
Description:	FEATURE IO

Level_1:	STD = JUPITER
Level_2:	STD = IO
Level_3:	TYPE = PGRAPHIC, LONG = 310, LAT = 13
Window:	CML OF IO FROM EARTH BETWEEN 280 340
Flux:	SURF(V) = 5 +/– 0.5, SURF-CONT(2300) = 5.2 +/– 0.2 E–14, SIZE = 1.0
Comments:	Observe IO volcano Loki when it is near the central meridian.

- **Example 2**: In this example the proposer wants to perform spectroscopy of the western ansa of the Io torus when Io is near greatest eastern elongation. The elongation condition is specified using the **OLG** keyword.

Target_Number:	1
Name:	IO-TORUS
Description:	TORUS JUPITER
Level_1:	STD = JUPITER
Level_2:	TYPE = TORUS, LONG = 90, LAT = 0, RAD = 4.3E5
Window:	OLG OF IO BETWEEN 90 100
Flux:	SURF-LINE(1304) = 1 +/– 0.5E–13, W-LINE(1304) = 2 +/– 1, SIZE = 1
Comments:	West ansa of IO Torus when IO is at greatest eastern elongation.

- **Example 3**: In this example the proposer wants to perform spectroscopy in the tail of comet Halley near the time of the Giotto spacecraft encounter. The latest orbital elements for the comet have been supplied by the proposer and these will be used for the ephemeris generation. The **POS_ANGLE** target reference system is used to specify the tailward pointing.

Target_Number:	3
Name:	COMET-HALLEY-TAIL

Description:	OFFSET COMET HALLEY
Level_1:	TYPE = COMET, Q = 0.5871167, E = 0.9672815, I = 162.2397156, O = 58.144397, W = 111.8489075, T = 09-FEB-86:11:01:04, EPOCH = 01-MAR-86, EQUINOX=B1950
Level_2:	TYPE = POS_ANGLE, RAD = 30, ANG = 180, REF = SUN
Flux:	SURF(V) = 12 +/– 1, SURF-LINE(1216) = 3.1 +/– 0.5E10, W-LINE(1216) = 0.1 +/– 0.5, SIZE = 1
Comments:	30 arcsec into tail of Halley during Giotto encounter. New orbital elements based on recent observations are provided.

Related Links

3.1 Fixed Targets
3.3 Generic Targets

Change Log
Version Cycle 31 July 2023

Fixed first link in Describing Targets

3.2.1 Solar System Standard Targets

The Solar System Targets form is used to specify moving targets in some HST observations. This article provides a list of standard solar system targets for the Astronomer's Proposal Tool (APT).

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List of Standard Solar System Targets for the Astronomer's Proposal Tool (APT).

Table 3.15: Solar System Standard Targets

Level 1	Level 2					
JWST						
Sun						
Mercury						
Venus						
Earth	Moon	Hubble				
Mars	Phobos	Deimos				
Jupiter	Io	Europa	Ganymede	Callisto	Amalthea	Himalia
	Elara	Pasiphae	Sinope	Lysithea	Carme	Ananke
	Leda	Thebe	Adrastea	Metis	Callirrhoe	Themisto
	Taygete	Chaldene	Harpalyke	Kalyke	Iocaste	Erinome
	Isonoe	Praxidike	Autonoe	Thyone	Hermippe	Aitne
	Eurydome	Euanthe	Euporie	Orthosie	Sponde	Kale
	Megaclite	Pasithee	Hegemone	Mneme	Aoede	Thelxinoe
	Arche	Kallichore	Helike	Carpo	Eukelade	Cyllene
	Kore	Herse	Dia	Valetudo	Pandia	Ersa
Saturn	Mimas	Enceladus	Tethys	Dione	Rhea	Titan
	Hyperion	Iapetus	Phoebe	Janus	Epimetheus	Helene

	Telesto	Calypso	Atlas	Prometheus	Pandora	Pan
	Paaliaq	Tarvos	Ijiraq	Suttungr	Kiviuq	Mundilfari
	Albiorix	Skathi	Erriapus	Siarnaq	Thrymr	Ymir
	Narvi	Methone	Pallene	Polydeuces	Daphnis	Aegir
	Bebhionn	Bergelmir	Bestla	Farbauti	Fenrir	Fornjot
	Hati	Hyrrokkin	Kari	Loge	Skoll	Surtur
	Anthe	Jarnsaxa	Greip	Tarqeq	Aegaeon	Gridr
	Angrboda	Skrymir	Gerd	Eggther	Beli	Gunnlod
	Thiazzi	Alvaldi	Geirrod			
Uranus	Ariel	Umbriel	Titania	Oberon	Miranda	Cordelia
	Ophelia	Bianca	Cressida	Desdemona	Juliet	Portia
	Rosalind	Belinda	Puck	Caliban	Sycorax	Prospero
	Setebos	Stephano	Trinculo	Francisco	Margaret	Ferdinand
	Perdita	Mab	Cupid			
Neptune	Triton	Nereid	Naiad	Thalassa	Despina	Galatea
	Larissa	Proteus	Halimede	Psamathe	Sao	Laomedeia
	Neso	Hippocamp				
Pluto	Charon	Nix	Hydra	Kerberos	Styx	
Ceres						
Haumea	Hiiaka	Namaka				
Eris	Dysnomia					
Makemake						

If you are uncertain whether or not your target can be referenced by name, contact your Program Coordinator for guidance.

Change Log

Version Cycle 31 June - Aug 2023

1. PROPINST-91400 - New Moons for Saturn

2. Removed old PR link from Change Log
3. Added JWST as a Level 1 target (because it is in APT)

Version Cycle 27 June 2018

1. PROPINST-93336 Added "VALETUDO - a moon of Jupiter"
2. PROPINST-91367 Added "HIPPOCAMP - a moon of Neptune"

Version Cycle 26 October 2018

1. PR.87913 Make solar system Standard Target Level 2 list alphabetical

Initial Conversion from the HST Cycle 25 Phase II Proposal Instructions (Engineering) Version Cycle 25 (June 2018)

3.2.2 Solar System Targets Position Level 1

The Solar System Targets form is used to specify moving targets in some HST observations. This article provides a description of the Level 1 specifications needed for the Astronomer's Proposal Tool (APT).

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> Format definitions
> Target Position Level 1 [Level_1]
> Table of Contents
> Change Log

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Target Position Level 1 [Level_1]

For the Level 1 position, specify your target in **one** of the following ways:

1. **STD =** <object name>, where the name must be from the list in 3.2.1 *Solar System Standard Targets*, or
2. **TYPE =** <name>.

The **TYPE =** <name> target description allows the specification of non-standard targets in a variety of formats and must be the first entry in the field if it is used.

For all cases, the required input data are described below. If the data are valid only over a specific period of time, then specify this time interval in the Windows field.

- If *COMET* is chosen, then a set of 2-body heliocentric orbital elements in the IAU Circular format must be supplied for the target.ASTEROID

Table 3.16: Positional Parameters for TYPE = COMET

Parameter	Definition

Orbital Elements	
Q = <value>	Perihelion distance, in AU
E= <value>	Eccentricity
I =<value>	Inclination, in degrees
O = <value>	Longitude of ascending node, in degrees
W = <value>	Argument of perihelion, in degrees
T = <value>	Time of perihelion passage, in *TDB*, *TDT*, or *UTC*
EQUINOX = <value>	either *B1950*, or *J2000*
EPOCH = <value>	Osculation date, in *TDB*, *TDT*, or *UTC*[1]
Non-gravitational Model Parameters	
[A1 = <value>]	Radial component of non-gravitational acceleration (AU/day^2)
[A2 = <value>]	Component of non-gravitational acceleration lying in the orbital plane and parallel to the instantaneous velocity vector (AU/day^2)
[A3 = <value>]	Component of non-gravitational acceleration directed perpendicular to the plane defined by *A1* and *A2* (AU/day^2)
[R0 = <value>]	Sublimation radius as normalizing radius (AU)
[ALN = <value>]	Normalizing factor
[NM = <value>]	Primary radial scaling law exponent
[NN = <value>]	N distance exponent
[NK = <value>]	K distance exponent
[DT = <value>]	Delay parameter (days)
[AMRAT = <value>]	Solar radiation pressure term (m^2/kg)

| SOURCE = <value> | A comment describing the source of the orbital elements. |

[1] TDB (Barycentric Dynamical Time), TDT (Terrestrial Dynamic Time), UTC (Coordinated Universal Time)

- If *ASTEROID* is chosen, then a set of 2-body heliocentric orbital elements in the *Minor Planet Circular* format must be supplied.

Table 3.17: Positional Parameters for TYPE = ASTEROID

Parameter	Definition
Orbital Elements	
A = <value>	Semi-major axis, in AU
E = <value>	Eccentricity
I = <value>	Inclination, in degrees
O = <value>	Longitude of ascending node, in degrees
W = <value>	Argument of perihelion, in degrees
M = <value>	Mean anomaly at *EPOCH*, in degrees
EQUINOX = <value>	J2000
EPOCH = <value>	Osculation date, in *TDB*, *TDT*, or *UTC*[2]
Non-gravitational Model Parameters	
[A 1 = <value>]	Radial component of non-gravitational acceleration (AU/day^2)
[A 2 = <value>]	Component of non-gravitational acceleration lying in the orbital plane and parallel to the instantaneous velocity vector (AU/day^2)
[A 3 = <value>]	Component of non-gravitational acceleration directed perpendicular to the plane defined by *A1* and *A2* (AU/day^2)
[R0 = <value>]	Scaling radius as normalizing radius (AU)

[ALN = <value>]	Normalizing factor
[NM = <value>]	Primary radial scaling law exponent
[NN = <value>]	N distance exponent
[NK = <value>]	K distance exponent
[AMRAT = <value>]	Solar radiation pressure term (m^2/kg)
SOURCE = <value>	A comment describing the source of the orbital elements.

[2] TDB (Barycentric Dynamical Time), TDT (Terrestrial Dynamic Time), UTC (Coordinated Universal Time)

The elements given above refer to the mean ecliptic and equinox of either B1950 or J2000 depending on which "value" is specified for **EQUINOX**. An example of **TYPE = COMET** is shown in Example 3.

> ⭐ It is the responsibility of the observer to supply accurate orbital elements to STScI when specifying TYPE=COMET or TYPE=ASTEROID.

Change Log
Version Cycle 31 June 2023

1. Updated link to Windows article.

3.2.3 Solar System Targets Position Levels 2 and 3

The Solar System Targets form is used to specify moving targets in some HST observations. This article provides a description of the Level 2 and 3 specifications needed for the Astronomer's Proposal Tool (APT).

On This Page

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Target Position Level 2 [Level_2]

Six **Target Reference Systems** (**TRS**s) are described in the following paragraphs. Please pay careful attention to the definitions of each **TRS**. Specify your target in **one** of the following ways:

STD = <object name> or TYPE = <name>

In this case <object name> is from the list of 3.2.1 *Solar System Standard Targets*, **or** the Type is:

PGRAPHIC

planetographic coordinates relative to Level 1 target

POS_ANGLE

polar coordinate offsets from Level 1 target

MAGNETO

position in magnetic coordinate system

TORUS

line-of-sight projected coordinate system

SAT

orbital elements of a satellite

PCENTRIC

planetocentric coordinates relative to Level 1 target

For the **PGRAPHIC**, **MAGNETO**, and **TORUS** coordinate systems, the north pole is defined to be the rotational pole in the northern celestial hemisphere. For planets with **direct** rotation, the angular momentum vector coincides with the north pole. For planets with **retrograde** rotation, the angular momentum vector coincides with the south pole.

Planetographic Coordinate System

Table 3.18: Parameters for TYPE = PGRAPHIC

LONG = <value>	planetographic longitude in degrees
LAT = <value>	planetographic latitude in degrees; use – to denote south latitude
[ALT = <value>]	planetographic altitude above the reference ellipsoid, in kilometers
[R_LONG = <value>][1]	rate of change of planetographic longitude, in degrees/day
[R_LAT = <value>][1]	rate of change of planetographic latitude, in degrees/day
[R_RAD = <value>][1]	rate of change of planetographic altitude, in kilometers/day
[EPOCH = <value>]	the reference time for the temporal variation, in TDB, TDT or UTC[2]

[1] **EPOCH** must also be specified with this quantity.

[2] TDB (Barycentric Dynamical Time), TDT (Terrestrial Dynamic Time), UTC (Coordinated Universal Time)

The **PGRAPHIC** TRS is the IAU planetographic coordinate system. It is a non-spherical coordinate system aligned with and rotating about the rotation axis of the Level 1 body, positive north, whose origin lies at the center of the reference body. Locations within this TRS are specified by longitude, latitude, and altitude above the surface, and are tracked as the object rotates. (The lambda(III) coordinate system defines the prime meridian in this coordinate system; if lambda(I) or lambda(II) coordinate systems are desired, note this in the **Comments** field.)

Planetographic Latitude is defined as the angle between the equator and the normal to the surface of the reference ellipsoid at the point of interest.

By definition, the planetographic longitude of the sub-Earth point increases with time. For planets with **direct** rotation, the planetographic longitude increases in a **left-handed** direction (to the West). For planets with retrograde rotation, the planetographic longitude increases in a **right-handed** direction (to the East). Longitudes should be specified in degrees West for planets with direct rotation and degrees East for planets with retrograde rotation.

If **ALT** is omitted, then the surface of the reference ellipsoid is assumed.

If the coordinates are constant in time, then none of the other **optional** entries should be used. If any coordinate is given as a function of time, then **EPOCH** is **required** and the time-varying coordinate is interpreted in the following way.

Example:

LONG = 20
LAT = -5
R_LONG = 45
EPOCH = 5-JAN-1990:15

For this example the longitude at any time, **T**, is given by: longitude = **LONG + R_LONG * (T – EPOCH)**

or, numerically,

longitude = **20 + 45 * (t – 5–JAN–1990:00:15:00)**

> ⭐ The same interpretation for time-varying coordinates also applies to the other TRSs described below.

Position Angle Coordinate System

Table 3.19: Parameters for TYPE = POS_ANGLE

RAD = \<value\>	Radius, in arcseconds
ANG = \<value\>	Position angle relative to the reference axis, in degrees
REF = NORTH	Reference axis is celestial north, or
REF = SUN	Reference axis is the apparent direction to the Sun as projected on the sky
[R_RAD = \<value\>][1]	Rate of change of radius, in arcseconds/day

[R_ANG = <value>][1]	Rate of change of position angle, in degrees/day
[EPOCH = <value>]	the reference time for the temporal variation, in TDB, TDT or UTC[2]

[1] **EPOCH** must also be specified with this quantity.

[2] TDB (Barycentric Dynamical Time), TDT (Terrestrial Dynamic Time), UTC (Coordinated Universal Time)

The **POS_ANGLE** TRS is a position-angle coordinate system (i.e. a two-dimensional polar-coordinate system). This TRS is useful for pointing at targets whose positions are known only in terms of an offset in projected celestial coordinates from another body. The origin of the system lies at the center of the Level 1 body. Locations are specified by giving the **apparent** distance from the origin (in projected celestial coordinates as viewed from the Earth) and the position angle from some **reference axis** to the target point.

When **REF = NORTH** the reference meridian passes through celestial north; and ANGLE is measured counter-clockwise from north through east. The RADIUS is the angular separation of the Level 2/3 object from the center of Level 1/2 object along this position angle, as shown in the following diagram.

Figure 1: Designating a BODY (B) with respect to a given CENTER (C) for REF=SUN. The position angle (PA) is measured counter-clockwise (north through east) from the reference meridian, which is the great circle connecting the CENTER with the North Celestial Pole (NCP). RADIUS is the angular distance CB along this position angle.
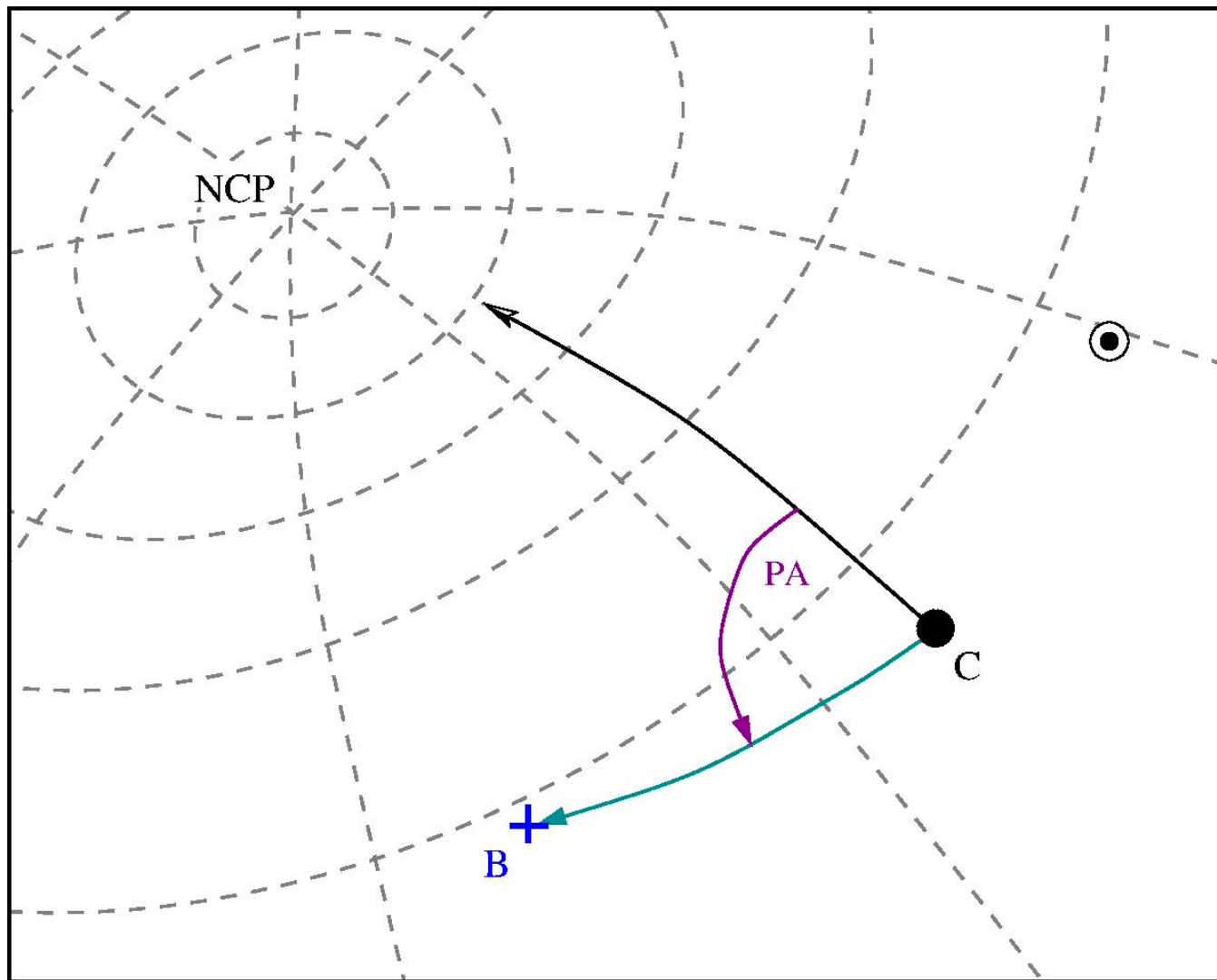
When **REF=SUN** the reference meridian passes through the apparent Sun (as seen from the observer), and ANGLE is measured counter-clockwise as seen on the sky. The RADIUS is the angular separation of the Level 2/3 object from the center of Level 1/2 object along this position angle, as shown in the following diagram.

Figure 2: Designating a BODY (B) with respect to a given CENTER (C) for REF=SUN. The position angle (PA) is measured counter-clockwise from the reference meridian, which is the great circle connecting the CENTER with the apparent position of the Sun on the celestial sphere. RADIUS is the angular distance CB along this position angle.
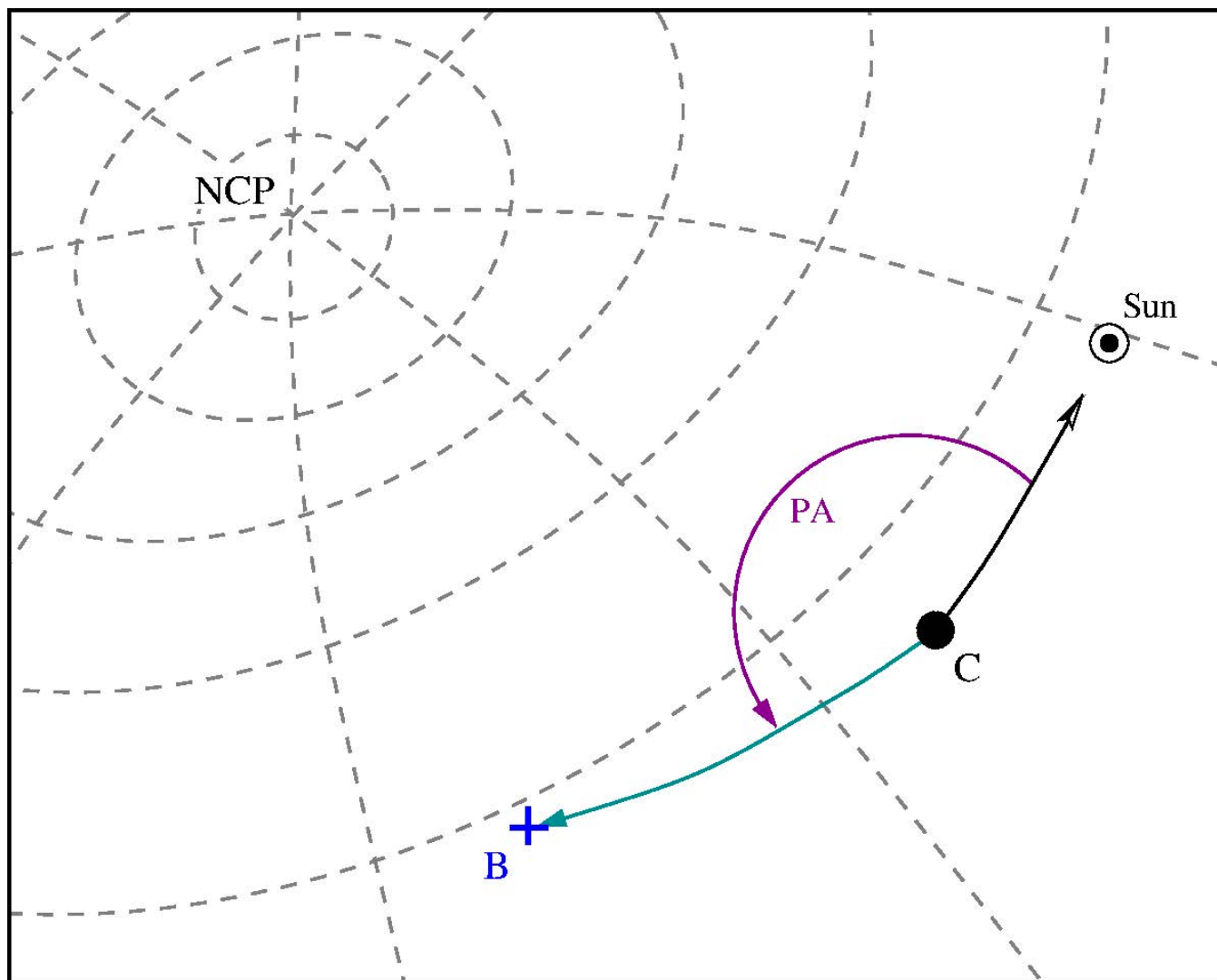
Magnetic Coordinate System

Table 3.20: Parameters for TYPE = MAGNETO

LONG = <value>	Magnetic longitude, in degrees
LAT = <value>	Magnetic latitude, in degrees; use – to denote south latitude
RAD = <value>	Magnetic radius, in kilometers
[POLE_LAT = <value>]	Cartographic latitude of the pole, in degrees

[POLE_LONG = <value>]	Cartographic longitude of the pole, in degrees
[O_LAT = <value>]	Cartographic latitude of the origin in degrees; use – to denote south latitude
[O_LONG = <value>]	Cartographic longitude of the origin in degrees
[O_RAD = <value>]	Cartographic radius of the origin, in kilometers

The **MAGNETO** TRS is intended to support observations fixed with respect to a planetary magnetic field. It is a spherical coordinate system rotating with the Level 1 body around the rotation axis, with a specified offset of the coordinate origin and inclination of the coordinate pole. The **MAGNETO** coordinate system is defined in the following manner:

1. Define a "cartographic" reference frame identical to the planetographic TRS, except use **spherical** latitudes.
2. Rotate the new coordinate system relative to the cartographic frame so the new pole is located at **POLE_LAT** (latitude) and **POLE_LONG** (longitude).
3. The final step is to translate the origin of the new system to the specified cartographic latitude, longitude, and radius (**O_LAT**, **O_LONG**, and **O_RAD**, respectively).

While the origin and coordinate axes may differ from those of the cartographic system, the rotation axis and rotation rate are identical to those of the cartographic system. Locations in the **MAGNETO** TRS are specified by longitude, latitude, and radius from the origin of the defined coordinate system, and are tracked as the object rotates.

Torus Coordinate System

Table 3.21: Parameters for TYPE = TORUS

LONG = <value>	Torus longitude, in degrees
LAT = <value>	Torus latitude, in degrees; use – to denote south latitude
RAD = <value>	Torus radius, in kilometers
[POLE_LAT = <value>]	Cartographic latitude of the pole, in degrees
[POLE_LONG = <value>]	Cartographic longitude of the pole, in degrees
[O_LAT = <value>]	Cartographic latitude of the origin in degrees; use – to denote south latitude
[O_LONG = <value>]	Cartographic longitude of the origin in degrees
[O_RAD = <value>]	Cartographic radius of the origin, in kilometers

If the **optional** fields above are left blank, they **default** to the nominal values for the Jupiter magnetic coordinate frame:

O_LONG = 0
O_LAT = +0
O_RAD = 0
POLE_LAT = +83
POLE_LONG = 202

The **TORUS** TRS is defined primarily to support observations of Jupiter's plasma torus and is closely related to the **MAGNETO** TRS. The difference between the two systems is in the definition of the prime meridian. For the **TORUS** TRS, the prime meridian is defined by the instantaneous longitude of the sub-observer point.

TORUS can also be useful for observers who want to observe in a coordinate system that is fixed relative to the apparent disk of the Level 1 body, e.g. central meridian observations. If the TORUS center is defined to be the same as the center of its associated Level 1 body:

O_LONG = 0
O_LAT = +0
O_RAD = 0
POLE_LAT = +90

then, in that case, the **TORUS** TRS **will not** rotate with the Level 1 body. If the **TORUS** center is defined differently from the Level 1 body center, then the polar axis of the **TORUS** TRS will precess with the Level 1 body's rotation.

A typical observation would be of the east or west ansa (point of maximum elongation) of an equatorial circle whose radius is roughly five times the equatorial radius of Jupiter (in this case, **LONG = 270** (90 for the west ansa), **LAT = 0, RAD = 3.57E05**). This coordinate system can also be used to support observations of a planetary ring ansa.

Satellite Elements Coordinate System

Table 3.22: Parameters for TYPE = SAT

A = <value>	Semi-major axis of satellite orbit, in km
EPOCH = <value>	Epoch of the elements, in TDB, TDT or UTC[1]
N = <value>	Mean motion of satellite, in degrees/day
L = <value>	Mean longitude at **EPOCH**, in degrees
[E = <value>]	Eccentricity of satellite orbit
[I = <value>]	Inclination of satellite orbit to the planetary equator, in degrees
[O = <value>]	Longitude of ascending node of the satellite orbit, in degrees
[W = <value>]	Longitude of periapse, in degrees
[O_RATE = <value>]	Rate of change of longitude of ascending node, in degrees/day
[W_RATE = <value>]	Rate of change of periapse, in degrees/day

[RAP = <value>]	Right Ascension of the parent planet pole at **EPOCH**
[DECP = <value>]	Declination of the parent planet pole at **EPOCH**
[EQUINOX = <value>]	**B1950** or **J2000**

[1] TDB (Barycentric Dynamical Time), TDT (Terrestrial Dynamic Time), UTC (Coordinated Universal Time)

When the target is a satellite of the object defined in the Level 1 field, but the satellite itself is not among the **standard** targets, then orbital elements must be specified. These elements refer to the motion of the satellite around the Level 1 object.

The "reference" axis for the angles defined above is the intersection of the Earth's equator at the standard epoch implied by the **EQUINOX** with the parent planet's equator at the **EPOCH** of the elements. The positive X-axis for the coordinate system used in the orbit calculation is obtained by taking the cross product of the Z-axis of the standard system (i.e. the system defined by the standard equator and equinox given by **EQUINOX**) with the pole of the planet. If **E, I, O, W, O_RATE**, and **W_RATE** are not supplied, then their values are assumed to be **0**. If **RAP** and **DECP** are not supplied, then the standard IAU values are used. If **RAP** and **DECP** are supplied, then they should be referred to the standard equator and equinox given by **EQUINOX**. If **EQUINOX** is not provided, we will assume J2000.

STScI maintains its ephemeris database with the best available elements, and you should use the **STD =** form for objects in the list of 3.2.1 *Solar System Standard Targets* unless there is compelling scientific justification for specifying orbital elements.

> ★ It is the responsibility of the observer to supply accurate orbital elements to STScI when specifying **TYPE=SAT**.

Planetocentric Coordinates

PCENTRIC: planetocentric coordinates relative to Level 1 target

For the PCENTRIC coordinate system, the north pole is defined to be the rotational pole in the northern celestial hemisphere. For planets with direct rotation, the angular momentum vector coincides with the north pole. For planets with retrograde rotation, the angular momentum vector coincides with the south pole.

Table 3.23: Parameters for TYPE = PCENTRIC

LONG = <value>	planetocentric longitude, in degrees
LAT = <value>	planetocentric latitude, in degrees; use – to denote south latitude
RAD = <value>	planetocentric radius, in kilometers
[R_LONG = <value>][1]	rate of change of planetocentric longitude, in degrees/day
[R_LAT = <value>][1]	rate of change of planetocentric latitude, in degrees/day

[R_RAD = <value>][1]	rate of change of planetocentric radius, in kilometers/day
[EPOCH = <value>]	the reference time for the temporal variation, in TDB, TDT or UTC[2]

[1] **EPOCH** must also be specified with this quantity.

[2] TDB (Barycentric Dynamical Time), TDT (Terrestrial Dynamic Time), UTC (Coordinated Universal Time)

The PCENTRIC TRS is the IAU planetocentric coordinate system. It is a right-handed spherical coordinate system aligned with and rotating about the rotation axis of the Level 1 body, positive north, whose origin lies at the center of the Level 1 body. Locations within this TRS are specified by longitude, latitude, and radius from the origin, and are tracked as the object rotates. (The lambda(III) coordinate system defines the prime meridian in this coordinate system; if lambda(I) or lambda(II) coordinate systems are desired, note this in the **Comments** field.)

Planetocentric longitude is always measured positively to the east relative to the prime meridian, regardless of which way the planet rotates. East is defined as the counter-clockwise direction around the planet, as seen from above its north pole, and the north pole is whichever pole more closely aligns with the Earth's north pole. Imagine a distant, non-orbiting observer viewing a directly rotating planet. Also, suppose that this observer is within the plane of the planet's equator. A point on the Equator that passes directly in front of this observer later in time has a lower planetocentric longitude than a point that did so earlier in time.

If **RAD** is omitted, then **RAD** is assumed to be the equatorial radius of the Level 1 body. Note that in general, if **RAD** is omitted, the point specified will not necessarily be on the visible surface of the planet. This is of special concern for oblate planets, e.g. Jupiter and Saturn, where a point at high latitude at the equatorial radius can appear above the limb of the planet in projection. When using this coordinate system for surface features on Jovian planets, it is best to specify the radius explicitly.

For spherical planets, planetographic and planetocentric latitudes are identical. For significantly nonspherical objects, there is no simple conversion between the two latitude systems.

For planets with retrograde rotation, the planetocentric and planetographic longitudes of a point are identical. For planets with direct rotation, the planetocentric and planetographic longitudes of a point have opposite sign.

Target Position Level 3 [Level_3]

The instructions for this field are identical to those for the Level 2 field except that "Level 3" should be substituted wherever "Level 2" occurs, and "Level 2" should be substituted wherever "Level 1" occurs.

Related Links

3.2.2 Solar System Targets Position Level 1

Change Log

Version Cycle 31 June 2023

Removed old PR link from Change Log.

Version Cycle 30 June 2022

PROPINST-91389 - Torus Solar System Target Description

Version Cycle 30 May 2022

PROPINST-91385 - Clarify Level-2 target types Pgraphic, Pcentric and Magneto

Version Cycle 26 October 2018

1. PR.88296 Improve planetographic description
   3.2.3 Solar System Targets Position Levels 2 and 3

Initial Conversion HST Cycle 25 Phase II Proposal Instructions (Engineering) Version Cycle 25 (June 2018)

3.2.4 Solar System Targets Observing Windows

Solar System Special Requirements (e.g., ANGULAR RATE, SOLAR PHASE) are used to restrict the scheduling of HST observations by moving target constraints. The Astronomer's Proposal Tool (APT) is used to enter the requirements into the proposal.

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

In general, "windows" which define when the target is visible to HST need not be explicitly identified, since these windows will be calculated by the STScI. Windows in this category include:

- Times when the target is not occulted by the Earth.
- Times when the target is not too close to the Sun, Moon, or the bright Earth limb.

- If the target is a planetary satellite, the times when it is not occulted by any other object in the planetary system.
- If the target is a surface feature on a body, the times when the feature is within the field of view of the *HST* (i.e. the feature is on that part of the body "facing" *HST*).

Some of these windows are enforced by Default Target Windows (see list near the bottom of this article). Those can actually be removed if required.

If you require **other** specific conditions to be satisfied (e.g. to observe when a satellite is near elongation, to observe when the central meridian longitude lies in a particular range, etc.), then these conditions must be specified in the **Window** field. However, the proposer must recognize that proposer-supplied windows might not overlap with the target "availability" windows defined above (calculated by STScI), in which case the observation cannot be scheduled. Note that atmospheric drag and other effects make it difficult to predict the exact position of the *HST* in its orbit far in advance. This leads to uncertainty in the exact timing of the target "availability" windows more than two or three months in advance.

The various keywords used to define windows are given in Table 3.24: *Keywords for Observing Windows* and described in detail below. Table 3.25: *Operators for Observing Windows* contains the list of operators that can be used to define a window.

Table 3.24: Keywords for Observing Windows

SEP	angular separation of two bodies as viewed from a third body
RANGE	distance between two bodies in AU
ANGULAR_RATE	angular rate in arcsec/sec
R_VEL	radial velocity of one body relative to another in km/sec
SIZE	angular diameter of one body as seen from another in arc-sec
PHASE	phase of one body as seen from another
OCC	when two bodies overlap as viewed from a third body
TRANSIT	when one body crosses another as viewed from a third body
ECL	when one body is in the shadow of another body
CML	central meridian longitude
OLG	orbital longitude
GAL	galactic latitude

Table 3.25: Operators for Observing Windows

LT	short for **less than**
GT	short for **greater than**
MAX	short for local **maximum** (i.e. inflection point). Accompanied by a non-zero tolerance value
MIN	short for local **minimum** (i.e. inflection point). Accompanied by a non-zero tolerance value

NOT	logical complement. May be used to specify when a condition does not exist. Each of the above keywords may be preceded by the **NOT** operator

The operator **NOT**, if present, should precede the keyword for the solar system target observing window, as in these examples:

NOT SEP OF IO JUPITER FROM EARTH GT 10

NOT RANGE JUPITER EARTH GT 10

NOT A_VEL IO RELATIVE JUPITER FROM EARTH GT 10

SEP

SEP is short for "Separation" and is used to find the times when the apparent separation between two objects, as observed from a third object, satisfies certain conditions. The separation between two bodies is defined as the angle between the closest points on the observed limbs of the spheres representing the objects as viewed from the observer (the radius of the sphere is equal to the largest radius of the tri-axial ellipsoid representation of the object). The syntax is:

[NOT] SEP OF <object 1> <object 2> **FROM** <observer> <condition> <angle>

where <object 1>, <object 2>, and <observer> must be **standard** targets that have been previously defined in the target position fields. The units for "angle" must be chosen from one of **D** (degrees), **'** (arc-minutes), or **"** (arc-seconds). The interpretation of the **SEP** keyword is as follows: when the <condition> is either **LT** or **GT** then times are found when the separation of "objects 1 and 2", as viewed from <observer>, is **less than** <angle> or **greater than** <angle> respectively. When the <condition> is **MAX** (**MIN**), then times are found when "objects 1 and 2" are at **maximum elongation** (**minimum separation**), as viewed from <observer>.

RANGE

RANGE is used to select windows based on the separation of objects in terms of distance (AU). The syntax is:

[NOT] RANGE <object 1> <object 2> <condition> <distance>

ANGULAR_RATE

[NOT] ANGULAR_RATE <object1> [**RELATIVE** <object2>] **FROM** <observer> <condition> <rate>

This requirement is used to select windows based on the **angular rate** of objects in terms of arcsec /sec. When <condition> is greater than (**GT**) or less than (**LT**), then <rate> is interpreted as the apparent **angular rate** of <object1> as observed from <observer> - unless <object2> is also specified. If <object2> is specified, then <rate> is interpreted as the apparent **angular rate** of <object1> relative to <object2> as observed from <observer>. When <condition> is local minimum (**MIN**) or local maximum (**MAX**), then <rate> is interpreted as a tolerance relative to local minimum or maximum inflection points rather than as an absolute **angular rate**.

R_VEL

R_VEL is used to select windows based on the change in distance between two objects (i.e. the Radial Velocity) in km/sec. The syntax is:

[NOT] R_VEL <object 1> <object 2> <condition> <velocity>

Positive values of <velocity> mean that the objects are moving away from each other while negative values mean that the objects are moving closer to each other.

SIZE

SIZE is used to select windows based on the apparent angular diameter of an object in arc-seconds. The syntax is:

[NOT] SIZE <object> <condition> <angle>

PHASE

PHASE is used for solar phase angle, and is used to find times when the angular phase of one body as seen from another is within a specified range. The syntax is:

[NOT] PHASE OF <object> **FROM** <observer> **BETWEEN** <angle 1> <angle 2>

where <angle> is the observer-object-sun angle, in degrees.

OCC

OCC is short for "Occultation" and is used to find times when one body appears to pass behind another body as viewed from a third body. The syntax is:

[NOT] OCC OF <occulted object> **BY** <occulting object> **FROM** <observer>

The <occulted object>, <occulting object>, and <observer> must be **standard** targets from the list in 3.2.1 *Solar System Standard Targets*. An occultation is defined to begin when the limb of the sphere representing the <occulted object> first touches the limb of the sphere representing the <occulting object>, as seen from the vantage point of the <observer>.

TRANSIT

TRANSIT is used to find times when one body appears to pass across the disk of another body as viewed from a third body. The syntax is:

[NOT] TRANSIT OF <transiting object> **ACROSS** <transited object> **FROM** <observer>

The <transiting object>, <transited object>, and <observer> must be **standard** targets from the list in 3.2.1 *Solar System Standard Targets*. A transit is defined to begin when the disk representing the <transiting object> is entirely in front of the disk representing the <transited object>, as seen from the vantage point of the <observer>. The transit ends when the limbs of the two disks come into contact again. Thus at any time in the transit the <transiting object> is entirely surrounded by the <transited object>.

ECL

ECLIPSE is used to find times when one body is in the shadow (cast in sunlight) of another body. The syntax is: [**NOT**] **ECLIPSE** <shadow type> <completeness> **OF** <eclipsed object> **BY** <eclipsing object> **FROM** <observer>. The <eclipsed object>, <eclipsing object>, and <observer> must be standard targets from the list in 3.2.1 *Solar System Standard Targets*. <shadow type> must be specified as either **PENUMBRAL** or **UMBRAL**. <completeness> must be specified as either **FULL** or **PARTIAL**. <observer> defaults to **EARTH**.

A partial eclipse is defined to begin when the observer would see the limb of the eclipsed sphere enter the umbra or penumbra of the eclipsing sphere. The partial eclipse ends when the last part of the limb of the eclipsed body would be observed to leave the umbra or penumbra of the eclipsing sphere. A full eclipse is defined to begin when the observer would see the entire eclipsed sphere enter the umbra or penumbra of the eclipsing sphere. The full eclipse ends when the entire eclipsed body would be observed to leave the umbra or penumbra of the eclipsing sphere.

CML

CML is short for "Central Meridian Longitude" and is used to find times when the sub-observer meridian of an object lies within a particular range. For planets and their satellites, planetographic coordinates are used (in the case of Jupiter, lambda(III)). For dwarf planets, a right-handed coordinate system is used. The syntax is:

[**NOT**] **CML OF** <object> **FROM** <observer> **BETWEEN** <angle 1> <angle 2>

The <object> and <observer> must be **standard** targets from the list in 3.2.1 *Solar System Standard Targets*. The keyword specifies those times when the central meridian longitude lies between <angle 1> and <angle 2> (both in degrees) as seen by the <observer>.

By definition, east is the direction to one's right hand side if you were on the body and facing north. For the Sun, the planets, and their satellites, the north pole is defined as parallel to the rotation axis and pointing to the north side of the plane whose normal vector is the angular momentum vector of the solar system (i.e. the north side of the ecliptic plane). For those dwarf planets and their satellites that have been visited by spacecraft (currently Ceres, Pluto, and Charon), north is defined as the spin axis around which they rotate in the right hand sense.

Planetographic longitude only equals planetocentric longitude (e.g. as produced by JPL Horizons) if the target body's rotation is retrograde.

OLG

OLG is short for "Orbital Longitude" and is used to select observation times based on a geocentric view (usually) of the object. **OLG** can be used on either a Level 1 or a Level 2 object. The syntax is:

[**NOT**] **OLG OF** <object 1> [**FROM** <object 2>] **BETWEEN** <angle 1> <angle 2>

where <angle 1> and <angle 2> are in degrees. **OLG** specifies those times when the orbital longitude lies between <angle 1> and <angle 2>. The default for <object 2> is the Earth. If <object 1> refers to a Level 2 body, usually a satellite, the orbital longitude is defined as follows (see Figure 3.1: *Orbital Longitude for Satellites*):

1. Construct a vector from <object 2> (Earth) to the Level 1 parent (planet) of the <object 1> (satellite).
2. Extend the vector "behind" the planet and project it onto the orbital plane of the satellite. This is the reference axis.
3. The orbital longitude is the angle from the reference axis to the position of the satellite measured in the direction of motion of the satellite. Valid values for the orbital longitude lie in the range 0–360°.

Orbital Longitude of 0° corresponds to superior conjunction, Orbital Longitude of 180° corresponds to inferior conjunction, and 90° and 270° correspond to greatest eastern and western elongation, respectively.

If "object 1" refers to a Level 1 body, e.g. a planet, asteroid, or comet, the orbital longitude is defined to be the angle between the Sun-Earth vector and the Sun-Planet vector, projected onto the planet's orbital plane, increasing in the direction of the planet's orbital motion (see Figure 3.2: *Orbital Longitude for Planets*).

Orbital Longitude of 0° corresponds to opposition, Orbital Longitude of 180° corresponds to conjunction with the Sun. However, Orbital Longitude of 90° or 270° does **not** correspond with quadrature. Orbital Longitude is **not** synonymous with "elongation" or "separation" from the sun.

Figure 3.1: Orbital Longitude for Satellites
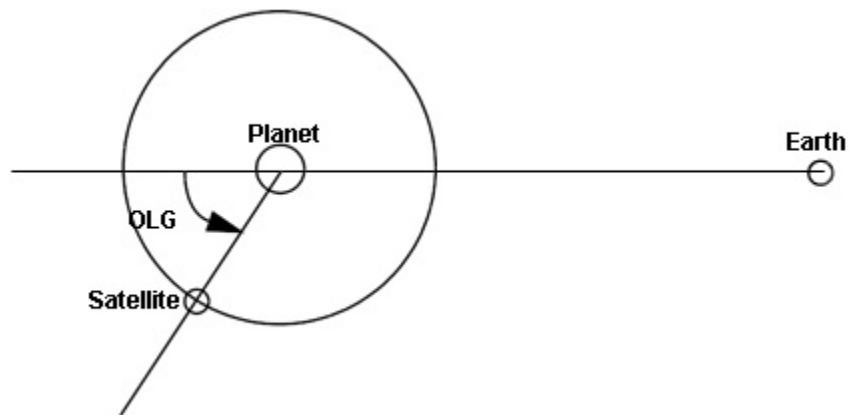
Figure 3.2: Orbital Longitude for Planets
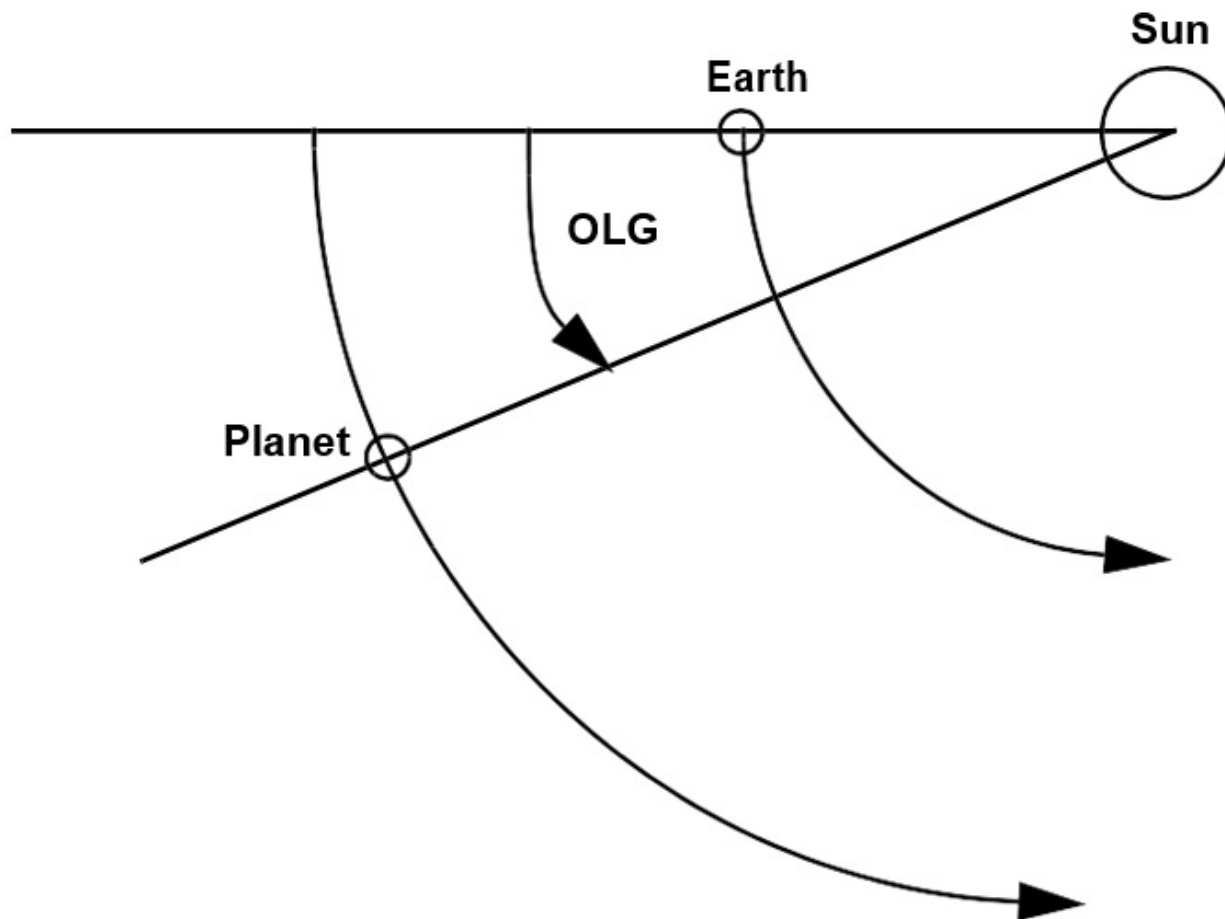
GALACTIC LATITUDE

GALACTIC LATITUDE is used to find times when the Galactic latitude of one object (as seen from a selected observer) is within a specified range. The syntax is:

[NOT] **GALACTIC LATITUDE OF** <object> **FROM** <observer> <condition> <angle 1> [angle 2]

The<observer> defaults to Earth. <condition> can be **GREATER THAN**, **LESS THAN**, or **BETWEEN**. <angle 1> and [angle 2] are the Galactic latitude in degrees. [angle 2] is only available when <condition> is **BETWEEN**.

Default Target Windows

Please note that the following defaults apply for solar system targets.

All targets in the Martian system except Mars:

- SEP OF <target> MARS FROM EARTH GT 10"
- NOT OCCULTATION OF <target> BY MARS FROM <observer>

Observations of Jupiter, Jupiter surface features, and offsets from Jupiter:

- NOT ECLIPSE PENUMBRAL PARTIAL OF <target> BY IO FROM EARTH
- NOT ECLIPSE PENUMBRAL PARTIAL OF <target> BY EUROPA FROM EARTH
- NOT ECLIPSE PENUMBRAL PARTIAL OF <target> BY GANYMEDE FROM EARTH
- NOT ECLIPSE PENUMBRAL PARTIAL OF <target> BY CALLISTO FROM EARTH

All targets in the Jovian system except Io:

- SEP OF <target> IO FROM EARTH GT 10"

All targets in the Jovian system except Europa:

- SEP OF <target> EUROPA FROM EARTH GT 10"

All targets in the Jovian system except Ganymede:

- SEP OF <target> GANYMEDE FROM EARTH GT 10"

All targets in the Jovian system except Callisto:

- SEP OF <target> CALLISTO FROM EARTH GT 10"

Observations of Saturn, Saturn surface features, and offsets from Saturn:

- NOT ECLIPSE PENUMBRAL PARTIAL OF <target> BY TITAN FROM EARTH

All targets in the Saturnian system except Rhea:

- SEP OF <target> RHEA FROM EARTH GT 10"

All targets in the Saturnian system except Titan:

- SEP OF <target> TITAN FROM EARTH GT 10"

All targets in the Uranian system except Uranus:

- **NOT OCC OF** <target> **BY URANUS FROM <observer>**

Observations of Neptune, Neptune surface features, and offsets from Neptune:

- **NOT ECLIPSE PENUMBRAL PARTIAL OF <target> BY TRITON FROM EARTH**

All targets in the Neptunian system except Neptune:

- **NOT OCC OF <target> BY NEPTUNE FROM <observer>**

All **TYPE=PGRAPHIC**, **TYPE=PCENTRIC**, and **TYPE=MAGNETIC** targets:

- **NOT OCC OF** <target> **BY** <parent body> **FROM <observer>**

These default windows will be superseded by any similar windows specified in the solar system target list. For example, if the target is Io and an Io-Callisto separation window is specified by the observer, then the observer's Io-Callisto separation window will apply and the default will not.

Change Log

Version Cycle 31 June - Aug 2023

1. PROPINST-91398 - CML Documentation Update
2. Removed old PR links from Change Log.

Version Cycle 29 (April 6, 2021)

1. PROPINST-91378 Removed language from Default Target Windows section related to removal of default target windows.

Version Cycle 27

1. PROPINST-89609 Added GALACTIC LATITUDE

Version Cycle 26

1. PR.88365 Correction to Offset legal units
   3.2.4 Solar System Targets Observing Windows
2. PR.88439 Default Solar System Target Windows
   3.2.4 Solar System Targets Observing Windows
3. PR.89779 Remove Default Solar System Windows for Separation from Jupiter and Saturn.
   11.5.2 COS Spectral Elements and Central Wavelengths, Default Target Windows

Initial Conversion from the HST Cycle 25 Phase II Proposal Instructions (Engineering) Version Cycle 25 (June 2018)

3.3 Generic Targets

On This Page

The Generic Targets form is used to specify generic targets in some HST observations. The Astronomer's Proposal Tool (APT) is used to enter the targets into the proposal.

Expand/Collapse all...

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

★ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

Generic targets are those that can only be described in terms of astronomical characteristics or a general location in the sky, and are used when the target will be specified at a later date (for example, Targets of Opportunity).

Visits using Generic targets must have either an **ON HOLD** or a **TARGET OF OPPORTUNITY** special requirement. The Generic target should be replaced by a fully specified Fixed or Solar System target when the **ON HOLD** is removed from the visit.

Target Number(s) [Target_Number]

The target number will be assigned by the APT software. This can be changed by the user.

> **For text file**
>
> If you are using the **Text Proposal File**, generic targets should be given individual names and numbers just like fixed targets.

Target Name [Target_Name]

A descriptive name must be provided for each target. If a name cannot be specified in advance, a provisional name should be supplied. When the actual observation is made, a more specific name will be added to the target designation. Either the provisional name or the updated name can then be used for archival searches (e.g., **SN** might be the provisional name, while **SN-1995D** might be the updated name). A unique target name **must** be assigned to each generic target.

Target Description [Description]

A target description must be selected for each target. The Target Description will be one of the key fields used by archival researchers in searching through the *HST* data archive; thus it is **extremely** important that the information be filled out completely and accurately for each target.

Each target *must* be assigned a single primary category from Table 3.2*: Target Categories*, and at least one descriptive keyword, chosen from the appropriate table. The discrete features and descriptors may be used as descriptive keywords for any category. A maximum of five descriptive keywords may be selected.

The categories in Table 3.2*: Target Categories*, and some of the descriptive keywords in the tables, are followed by explanatory text in parentheses. This text is provided only for explanatory purposes and is not part of the category or keyword itself.

Table 3.2: Target Categories

Category	Descriptive Keywords
SOLAR SYSTEM (Solar System Object)	Table 3.5 Solar System
STAR (Galactic Stellar Object)	Table 3.6 Star
EXT-STAR (Star in an External Galaxy)	Table 3.6 Star
STELLAR CLUSTER (Galactic Star Cluster, Group, or Association)	Table 3.7 Stellar Cluster
EXT-CLUSTER (Star Cluster in an External Galaxy)	Table 3.7 Stellar Cluster
GALAXY (Galaxy or AGN)	Table 3.8 Galaxy
CLUSTER OF GALAXIES (Galaxy Groupings, Clusters, Large-scale Structure	Table 3.9 Clusters of Galaxies
ISM (Interstellar Medium of the Galaxy)	Table 3.10 ISM

EXT-MEDIUM (Interstellar Medium of an External Galaxy)	Table 3.10 ISM
UNIDENTIFIED (Unidentified Objects)	Table 3.11 Unidentified
CALIBRATION (Calibration Observations)	Table 3.12 Calibration

> **For text file**
>
> If you are using the Text Proposal File, target description items must be separated by commas.

Flux Data [Flux]

Flux information must be provided for all targets, and there can be more than one entry for a given target. STScI uses flux information to check for over-illumination of sensitive detectors. All entries are values as observed at the Earth, rather than intrinsic values.

COS, ACS/SBC and STIS/MAMA proposals cannot be implemented without flux information for all targets because of the critical requirements to protect the detectors from damage by excessively bright objects. Note that all objects in the field need to be checked, and there is a Bright Object Tool in APT to support that checking.

The flux information is provided in two separate fields:

- Flux in V Magnitude with an uncertainty. This is required for targets observed by the FGS, STIS /FUV-MAMA, STIS/NUV-MAMA, COS and ACS/SBC. For all other instrument configurations, it's optional.
- **Other Fluxes** (separated by commas), which is entered in free text.

In the "**Other Fluxes**" field, the spectral type and reddening could be provided if you think it's important. As many additional flux values as appropriate for the requested exposures should be provided. For example, ultraviolet or emission-line fluxes should be given if the target is to be observed in the ultraviolet or through a narrow-band filter, or several magnitudes might be provided if the target is a variable star to be observed at various brightness levels. In some cases (Targets of Opportunity, variable objects, etc.) the estimated flux data may be very uncertain, but the best available estimates should nevertheless be given, along with appropriate uncertainties and comments.

It may be important to specify the flux of a background source as well as the target flux. For example, a globular cluster in M87 may be seen against the bright background of the galaxy. The suffix **–BKG** should be appended to a background flux specification in this case (e.g. SURF-BKG(B) = 20 +/– 0.2 mag/arcsec2). Use a comma to separate entries if more than one flux value is given.

> **For text file**
>
> If you are using the Text Proposal File, flux items in a list must be separated by commas.

General Guidelines on What Flux Data to Include

The following summary provides general guidelines for what flux information could be included in three general areas.

Target Flux

1. Magnitudes: V magnitude (point source), V surface brightness (extended source), or J magnitude (IR source).
2. Flux: flux at specified wavelength.
3. Color: B-V, U-B, J-K, etc.
4. Reddening: E(B-V). If no entry for E(B-V) is given, E(B-V) = 0 will be assumed.
5. Spectral type (point source).

Background Flux

1. Non-dispersive spectral element: Broad-band surface brightness or surface brightness at specified wavelength; BKG must be specified in the name of the flux parameter. For IR sources, this refers to the astronomical background and not the thermal background.
2. Dispersive spectral element: Surface brightness of continuum; -BKG must be specified in the name of the flux parameter. For IR sources, this refers to the astronomical background and not the thermal background.

Surface Flux

1. Non-dispersive spectral element: Flux (point source) or surface flux (extended source) in wavelength range of observation.
2. Dispersive spectral element: Continuum (point source) or surface (extended source) flux at wavelength of observation and size of the region specified,
   or
   Line flux (point source), line surface flux (extended source), and line width of brightest emission line in the wavelength range of observation.

> ⭐ Details of how the above flux information was derived should be given in the Observing Description or Target Comment, as appropriate. If any of the required flux data cannot be provided or are deemed to be unnecessary, these points must also be explained in that section. Incomplete flux information may delay the implementation of your proposal, especially in the case of ACS/SBC, COS and STIS/MAMA observations.

Comments [Comments]

Any additional information you wish may be entered in "**Comments**" area. Comments are not interpreted by the software, but are maintained in the data base and do appear on the formatted outputs.

Criteria [Criteria]

The "**Criteria**" field is before you describe your Generic Target. Examples are "Next SN in M31", "Next bright, galactic nova", or "GRB at z>5".

Expand/Collapse all...

Related Links

3.1 Fixed Targets
3.2 Solar System Targets

Change Log

Version Cycle 31 June - Aug 2023

PROPINST-91401 - Document change in ON HOLD behavior for Generic targets

Also removed bullet point: "The exposure is **SAME POS AS** another exposure (so that the pointing is determined by the other exposure)." because it is no longer the case.

Chapter 4 Visits, Exposures, and Exposure Groups

Visit and Exposure specifications are part of all HST observations. The Astronomer's Proposal Tool (APT) is used to fill out the template and schedule observations.

On This Page

Format definitions

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★ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[**<value>**]** - are optional.

Introduction

The *Visit and Exposure Specifications* are used to define the proposed exposures for all the Scientific Instruments. While the number of parameters needed to define all possible instrument configurations is large, the Visit and Exposure Specifications has been simplified by using standard Instrument Configurations and Operating Modes to set most of the instrument parameters to default values. The rest of the exposure keywords are used to define parameters that usually change from one exposure to the next, such as filters, exposure times, and special scheduling requirements.

Before proceeding further, it is useful to define more carefully what is meant by an **exposure**, a **subexposure**, and by a **visit**. (Note: APT also uses Exposure Groups or Containers.)

Exposures

An **exposure** consists of the events and data corresponding to a unique **Exposure_Number** within a given visit. The full description of an exposure is called an Exposure Specification. Although many data samples (see APT subexposures) may result from a single execution of an Exposure Specification (due to the Instrument Configuration, Operating Mode, and Optional Parameters chosen), they are considered to be **one** exposure. Also, you may specify multiple exposures in an Exposure Specification by entering an integer greater than 1 for the **Number_of_Iterations** keyword; additional exposures will be obtained consecutively (except for possible interruptions by Earth occultations, guide star acquisitions, and SAA passages).

Exposures defined within a visit will be obtained consecutively and in the order specified within a visit.

APT subexposures

Within an Exposure Specification, each data sample that will be taken onboard *HST* is represented in APT by a separate entity called a **subexposure**. Subexposures are used to track the duration of the sample (actual_duration) and the orbit number in which it occurs (orbit_number).

Visits

A **visit** is an exposure or series of consecutive exposures, with overheads, on a given target, and may consist of the following parts:

1. Guide-star acquisition (to point *HST* at the target)
2. Target acquisition (to place the target in an instrument aperture)
3. Science exposure(s) (to obtain the data)
4. Instrument overheads (to set up the instrument and read out the data)
5. Instrument calibrations (if more than the standard calibration is required)

If the visit lasts more than one orbit, it will continue with the following for each subsequent orbit:

1. Guide-star re-acquisition (to keep *HST* pointed and locked after Earth occultations)
2. Science exposure(s)
3. Instrument overheads
4. Instrument calibrations

Whenever one of the following occurs, a new visit must be defined:

- A change in target position of greater than 1°. (Contact your Program Coordinator for details regarding solar system objects that move more than about 30 arcsec during the observation and thus are likely to require multiple sets of guide stars).
- Repeated, periodic, or other time-separated observations with an interval between exposures such that one or more empty orbital visibility period (orbits with no exposures) would otherwise be required.
- Required change in spacecraft roll orientation.

Visits

Visit Number and Status

[Visit_Number]

You must assign each visit a unique visit number (base 36 values ranging from 01 - ZZ).

Visit_Status

This field reflects the visit's execution status and cannot be edited. If you are attached to the internet, the status value is read from the proposal database at STScI when the proposal is opened or saved. It is also saved in the proposal in case work is being done off line later on.

Visit_Status can have the following values: pi, implementation, scheduling, completed, failed, withdrawn. Note that visits with a status of "completed" or "failed" cannot be edited in APT. Also, if you attempt to edit visits with a status of "scheduling" or "withdrawn" you will get a pop up warning that you should let your PC know that you are changing that visit.

Visit Label [Visit_Label]

You can assign a label to each visit. This allows you to call each visit by a name that has more meaning than just the visit number. Please use only alphanumeric characters and hyphens.

Visit-level Special Requirements [Visit_Requirements]

A variety of visit-level Special Requirements may be chosen; these requirements apply to all exposures in the visit (see 6.3 *Exposure-level Special Requirements*). These requirements will be interpreted by the computer software that is used to schedule the observations; therefore **it is essential that the specific formats shown in** Conventions for Special Requirements **are followed precisely**. If none of the allowed Special Requirements appears to be sufficient, you can describe the requirements with a text explanation in **Visit_Comments**. **You should contact your Program Coordinator prior to entering such a comment in your proposal.**

Several of these Special Requirements require the use of limited resources or may impose serious constraints on the scheduling system (e.g., **ORIENT**, **CVZ**, **BETWEEN**). Use these Special Requirements with care.

The visit-level Special Requirements are described in detail in 6.2 *Visit-level Special Requirements*.

> **For text file**
>
> If you are using a **Text Proposal File** to modify your program, please be aware that only the shortest form of the special requirements will be accepted when you import your template back into APT (e.g., use **ORIENT** <angle1> **TO** <angle2>). Also, new lines will not be sufficient delimiters for a list of special requirements. You *must* use semicolons to separate special requirements items.

On Hold Comments [On_Hold_Comments]

If you have requested via the Special Requirement **ON HOLD** that a given visit be placed "on hold" (which means that the visit will not be scheduled until **you** have cleared the hold), then indicate why the visit is on hold, and how the hold is to be released. Examples of **On_Hold_Comments** are:

- Target of Opportunity
- Waiting for Early Acquisition data from visit <number>
- Waiting for non-*HST* data [to be obtained <date>]
- Conditional if <text>
- Conditional on <exposure-list> if <text>
- Select <number> of <exposure-list>

Visit Comments [Visit_Comments]

The comments field should be used only to record observing notes; it should **not** be used to specify scheduling requirements. Comments are not interpreted by the software, but are maintained in the database and do appear on printouts of the programs. Please contact your Program Coordinator prior to inserting comments to make certain there is no other way to specify the information. An Example of a Visit **Comments** is:

- UV observation of Target X

Exposures

Exposure Number [Exposure_Number]

APT will assign a unique integer number to an exposure. The smallest exposure number permitted is **1**, and the largest is **999**.

Note that exposure numbers for coordinated parallels must (and will be) sequential; see Coordinate Parallel Containers.

Exposure Label [Exposure_Label]

You can assign a label to each exposure. This allows you to call each exposure by a name that has more meaning than just the exposure number. Please use only alphanumeric characters and hyphens.

For example given three filters and multiple positions, then you might elect to call a sequence of 6 exposures North-U, North-V, North-B, Center-U, Center-V, and Center-B.

Target Name [Target_Name]

Choose a target from the Target List provided. In the case of certain external (see Table 4.1: *Special External Target Names*) and internal (see Table 4.2: *Internal Calibration Target Names*) calibration sources, a special code must be used. In general, calibration observations will be requested only rarely, since most calibrations will be carried out by STScI.

Due to scheduling constraints, fixed external targets and solar system targets may not be used in the same visit. Also, none of the external calibration targets (**EARTH-CALIB**, **DARK-EARTH-CALIB**, **ANTI-SUN**, **ORBIT-POLE-NORTH, ORBIT-POLE-SOUTH**) may be used in the same visit with another external target.

Astronomical Targets

The target name should be **exactly** as you entered it in the Target List (see Target Name). Only the prime target name is used; alternate names are not used.

Special Targets

If an internal calibration observation is requested on the Visit and Exposure Specifications, one of the specific "target" names in Table 4.2: *Internal Calibration Target Names* must be chosen. The calibration source should **not** be chosen in the Target List. See the Instrument Handbooks for details of the calibrations for each instrument.

The special external targets listed in Table 4.1: *Special External Target Names* may be specified in the **Name** without including them in the Target List.

Table 4.1: Special External Target Names

Name	Description and Restrictions
EARTH-CALIB	The sunlit Earth is used for a flat-field calibration. Because of bright object constraints, **EARTH–CALIB** may not be used in the STIS/FUV–MAMA, STIS/NUV–MAMA and ACS/SBC configurations. Also, **EARTH-CALIB** may not be used in the STIS/CCD configuration due to concern of UV polymerization of contaminants on the STIS optics.
DARK-EARTH-CALIB	The non-sunlit Earth is used for a flat-field calibration. Because of bright object constraints, **DARK-EARTH-CALIB** may not be used in the STIS/FUV-MAMA, STIS/NUV-MAMA and ACS/SBC configurations. **EARTH-CALIB** and **DARK-EARTH-CALIB** targeted exposures may not be used in the same visit.
ANTI-SUN	Target will be nearly opposite the Sun whenever scheduled.
ORBIT-POLE or ORBIT-POLE-NORTH	Target will be the North orbit pole.
ORBIT-POLE-SOUTH	Target will be the South orbit pole.

ANY	Allowed on pure-parallel and coordinated-parallel exposures. The target will be wherever the parallel aperture happens to point.

Specific astronomical objects used as external calibrators (e.g., standard stars) should be chosen in the Target List and Visit and Exposure Specifications as normal exposures, and the suffix **-CALIB** should be appended to their names, as discussed in Special Targets.

Table 4.2: Internal Calibration Target Names

STIS	COS
WAVE	WAVE
CCDFLAT	

Table 4.2 for available but unsupported modes, and restricted modes

Table 4.2: Internal Calibration Target Names Available but Unsupported and Restrict Modes

ACS	COS	WFC3	STIS	FGS
BIAS		BIAS	BIAS	DARK
DARK	DARK	DARK, DARK-NM	DARK	(POS mode only)
TUNGSTEN		TUNGSTEN	NONE	
DEUTERIUM	DEUTERIUM	DEUTERIUM		
NONE				

Instrument Configuration [Config]

Choose the Instrument Configuration to be used. The available choices are listed in Table 4.3: Instrument Configurations and Operating Modes, along with the corresponding Operating Modes that may be chosen in Opmode. Legal Apertures, Spectral Elements, and Optional Parameters are uniquely determined by the choice of the Instrument Configuration and Operating Mode. Detailed descriptions are provided in the instruments articles and the Instrument Handbooks.

Table 4.3: Instrument Configurations and Operating Modes

Instrument Configuration	Operating Modes
STIS/CCD	ACQ, ACQ/PEAK, ACCUM
STIS/FUV–MAMA or STIS/NUV–MAMA	ACCUM, TIME–TAG
FGS	POS, TRANS
ACS/WFC or ACS/SBC	ACCUM

COS/FUV	ACQ/SEARCH, ACQ/PEAKD, ACQ/PEAKXD, TIME-TAG, ACCUM
COS/NUV	ACQ/SEARCH, ACQ/IMAGE, ACQ/PEAKD, ACQ/PEAKXD, TIME-TAG, ACCUM
WFC3/UVIS	ACCUM
WFC3/IR	MULTIACCUM

For available but unsupported modes

Instrument Configuration	Operating Modes
WFC/UVIS	BIAS
FGS	WALKDOWN, LOS, MAP

For restricted Modes

Instrument Configuration	Operating Modes
ACS/WFC, ACS/HRC	ALIGN
ACS	ANNEAL
STIS	ALIGN, ANNEAL, MSMOFF
COS	ALIGN/APER, ALIGN/OSM
WFC3/UVIS, WFC3/IR	ALIGN
WFC3	ANNEAL

Operating Mode [Opmode]

Choose the Operating Mode to be used. Table 4.3: *Instrument Configurations and Operating Modes* lists all possibilities. See the Instrument Handbooks and the Instrument articles in this document for detailed discussions of the Operating Modes.

Aperture or Field of View [Aperture]

The desired aperture or field of view of the Scientific Instrument should be chosen (see Table 4.4: *Aperture and Field of View Names*). However, observers are cautioned that not all combinations of Apertures, Operating Modes, and Spectral Elements are available. See the Instrument Handbooks for details.

Table 4.4: Aperture and Field of View Names

Instrument	Reference
STIS	See 8.5.4 The Official STIS Aperture List

FGS	See Chapter 9 Fine Guidance Sensors, FGS
ACS	See 10.5.4 ACS WFC Allowed Combinations of Aperture
COS	See 11.5.3 COS Apertures
WFC3	See 12.1 Introduction to WFC3

Spectral Element [Sp_Element]

The desired Spectral Element should be chosen. Spectral Elements include filters (**F**), gratings and grisms (**G**), echelles (**E**), prisms (**PR**), polarizers (**POL**), linear ramps (**FR**), quadrant filters (**FQ**) and mirrors (**MIRROR**). The names of the filters, gratings, grisms, and echelles include the wavelength of the approximate midpoint of the bandpass, in nanometer.

Examples of the Spectral Element designations are the following:

F098M	A medium-band (**M**) WFC3 IR filter (**F**) with midpoint of coverage near 0.98 microns
G140L	A low-dispersion (**L**) STIS grating (**G**) with midpoint of coverage near 1400 Å
E230H	A high-dispersion (**H**) STIS echelle (**E**) with midpoint of coverage near 2300 Å
FQ232N	A narrow-band (**N**) WFC3 UVIS quadrant filter (**FQ**) with midpoint of coverage near 2320 Å

Polarizer or Crossed Filter

More than one element may be specified, if necessary, using these fields. Choose the desired element from the list provided in the instrument articles. They are also are described in the Instrument Handbooks.

> **For text file**
>
> If you are using the Text Proposal File, a second spectral element can be specified after the first one separated by a comma.

Central Wavelength or Range [Wavelength] (if Grating or Prism Used)

If a linear ramp filter, quadrant filter, grating, or prism is to be used, the central wavelength should be entered.

Wavelengths should be expressed in Å in the **observed** frame (but the units should be omitted). Use vacuum wavelengths below 2000 Å, and air wavelengths above 2000 Å.

For STIS and COS exposures, the central wavelength must obey one of the legal spectral element /wavelength combinations given in 8.5.1 *STIS Central Wavelengths* and 11.5.2 *COS Spectral Elements and Central Wavelengths*.

Number of times to Iterate the Exposure [Number_of_Iterations]

Choose the number of times the defined exposure is to be iterated; Choose **1** if only one execution of the exposure is desired. Typical reasons for iterating an exposure are to monitor temporal changes in a target or to keep CCD exposures short to minimize blooming by a bright star. If more than one execution is requested, iterations (in the form of additional subexposures) will be created and executed contiguously. Also note that for STIS, these subexposures can be interrupted by a wavecal. The wavecal can be suppressed using the optional parameter, **WAVECAL**; see 8.3.1 *CCD Modes* and 8.3.2 *MAMA Modes*.

Time per Exposure [Time_Per_Exposure]

Enter the exposure time (*in seconds*) for each separate exposure. It is important that observers consult the Instrument Handbooks, and the tools on the STScI Web pages.

Note that the exposure time is the **total** time for one execution of a defined exposure. Multiple executions may be specified by entering a value for **Number_of_Iterations**, or with certain Special Requirements. The exposure time entered may be divided among many samples or spectra (**subexposures**), depending on the Instrument Configuration, Operating Mode, and Optional Parameters. Generally, the exposure time is used only for the collection of photons, but there are exceptions for which instrumental overheads are included in the exposure time. For details, see the specification for each Operating Mode in the instrument articles. In the normal case, the exposure time entered may be used to obtain a single image, to obtain a series of spectra, or to perform a target acquisition.

Routine calibration exposures will be performed by STScI. If special internal calibrations are required for your program, consult the Internal Calibration Target tables in the instrument articles for information about what exposure times to use.

Use the Target Acquisition sections of the Instrument Handbooks and STScI Web tools to estimate exposure times used for acquisition exposures.

Exposure times may be changed during scheduling by STScI in order to place exposures in observing windows defined by orbital constraints (Earth blockage, passage through the SAA, etc.) and to improve overall efficiency. Changes to exposure times will be such that the exposure time is not changed by more than about 20%; note that increases, as well as decreases, in exposure time are possible.

> ⭐ **Target acquisition and peakup exposure times are not altered during scheduling.**

ETC RUN

Enter the ETC Run # in the ETC Request ID. Clicking on the icon next to this field will display that ETC Run in your web browser. APT will warn you if you do not supply this information for exposures using one of the sensitive detectors (such as the MAMAs).

Exposure-level Comments [Comments]

Information that cannot be made to conform to the required formats may be entered as a comment. Comments are not interpreted by the software, but are maintained in the database and do appear on printouts of the programs. Comments should be used sparingly, if at all. They are intended only for the small number of programs whose requirements cannot be met with standard and supported features. Please contact your Program Coordinator before entering comments that would affect the execution of an exposure.

Optional Parameters [Optional_Parameters]

The Operating Modes of the instruments frequently have parameters that may be adjusted. The default parameter values that have been defined for the various Instrument Configurations and Operating Modes can be overridden by entries in the Optional Parameters form. See the instrument articles in this document and the Instrument Handbooks for descriptions of the Optional Parameters.

If no values are changed in the Optional Parameters form, default values will be used.

> **For text file**
>
> If you use more than one Optional Parameter, they must be separated by commas (e.g., **BINAXIS1=1**, **BINAXIS2=1**).

Exposure-level Special Requirements [Special_Requirements]

A variety of exposure-level Special Requirements may be chosen; these requirements apply to individual exposures in a visit (see 6.2 *Visit-level Special Requirements*). These requirements will be interpreted by the computer software that is used to schedule the observations; therefore **it is essential that the formats of the keyword values shown in** 6.1 *Conventions for Special Requirements* **are followed precisely**. If none of the allowed Special Requirements appears to be sufficient, you can describe the requirements with a text explanation using the "**Comments**" keyword. You should contact your Program Coordinator prior to entering such a comment in your proposal.

Several of these Special Requirements require the use of limited resources or may impose serious constraints on the scheduling system (e.g., **RT ANALYSIS**, **REQ UPLINK**). These Special Requirements should be used with care.

> **For text file**
>
> If you are using a **Text Proposal File** to modify your program, please be aware that only the shortest form of the special requirements will be accepted by APT (e.g., **POS**ition **TARG**et must be entered as **POS TARG**). Also, new lines will not be sufficient delimiters for a list of special requirements. You *must* use semicolons to separate special requirements items.

Exposure Containers: Exposure Sequences, Coordinated Parallels and Patterns

In previous versions of the software, when you wanted to create a set of exposures to be executed in a special way (i.e. a coordinated parallel, a pattern, or a non-interruptible sequence), you would specify exposures separately and then link them with exposure-level special requirements. In APT, the exposure-level special requirements listed below have been replaced with the use of exposure containers or "groups". Once an exposure container has been created in APT, you then place the related exposures in this container instead of using the special requirements to link them.

These special requirements (see 6.3 *Exposure-level Special Requirements*) that have been replaced by these exposure containers or groupings (in parenthesis) are:

- **Exposure Sequences Container (Type: Sequence)** (replaces **SEQuence <exposure-list> NON-INTerruptible**):

The exposures placed in this container will be observed without gaps due to Earth occultation or SAA passages. See CREATING NON-INTERRUPTIBLE EXPOSURE SEQUENCES for the mechanics (i.e. a "how to") of making a SEQUENCE container.

- **Coordinated Parallel Container** (replaces **PARallel <parallel-exp-list> WITH <primary-exp-list>**):

The exposures in this container using the "primary" SI will execute in parallel with a sequence of exposures using a "parallel" SI. The "primary" SI will be the SI used in the first exposure in this container. See Coordinated Parallel Containers for more information, and CREATING COORDINATED PARALLEL OBSERVATIONS for the mechanics (i.e. a "how to") of making a PARALLEL container.

- **Pattern Container** (replaces **PATTERN**):

Each exposure placed in this container will be repeated at each point in a pattern of discrete pointing offsets from a target. The pattern # is assigned by APT. See Introduction to Patterns for more information, and CREATING AND USING PATTERNS for the mechanics (i.e. a "how to") of making a PATTERN container.

> ⭐ You can place containers within containers (e.g., a coordinated parallel container can be inside a pattern container).

> For engineering parameters
>
> Other exposure-level special requirements that have been replaced by these exposure containers or groups are:
>
> • **Exposure Sequences Container (Type: Same Obset**) (replaces **SAME OBSET <exposure-list>**)
>
> Overrides the normal decision of whether the exposures in the same list will be merged into the same OBSET.
>
> • **Exposure Sequences Container (Type: Same Alignment [Same Alignment])** (replaces **SAME ALIGNMENT <exposure-list>**)
>
> Overrides the normal decision of whether the exposures in the same list will be merged into the same alignment.
>
> • **Exposure Sequences Container (Type: Same Guide Stars)** (replaces **SAME GUIDE STARS <exposure-list>**)
>
> Overrides the normal decision of whether two obsets must share the same set of guide stars.

Subexposures

In an Exposure Specification, each data sample collected is represented in APT by a separate entity called a **subexposure**. A subexposure tracks the orbit number (**orbit_number**) of the sample, as well as any override to the default duration (**actual_duration**). You need not supply these values.

Actual_Duration

Unless the user (or the adjust feature in the Orbit Planner) fills in this field, it will be blank and defaults used. For example, if the exposure is CR-SPLIT, the sum of the exposure times of the subexposures will be equal to the parent exposure's exposure time. In all other cases the exposure time of each subexposure will be equal to the exposure time of the parent exposure.

Note, however, that if the **actual_duration** field is filled, this value overrides the default. So the total exposure time for an exposure will be equal to the sum of the actual_durations of the subexposures regardless of the original exposure time.

Orbit_Number

This determines which orbit the subexposure will be placed in. Generally, unless you need to control the orbit structure of the visit, this field can be left alone and will be filled in by the Orbit Planner.

Change Log
Version Cycle 31 June 2023

1. Fixed a typo (CCDFLATE)
2. Updated links in Table 4.4

3. Removed the STIS available modes comment just below Table 4.4 (unneeded)
4. Removed two unneeded links to the CfP.

Version Cycle 30 May 2022

Updated links to Cycle 30 Call for Proposals

Chapter 5 Parallel Science Exposures

HST allows two different types of parallel observations,Coordinated, and Pure. This article contains the their descriptions.

On This Page

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

The instruments onboard *HST* have small apertures that must be accurately pointed to achieve useful scientific results. However, the value of "parallel" observations was recognized during the earliest stages of *HST*'s design because by turning on other instruments one could discover new objects and new phenomena, or just acquire highly detailed images of random regions of the sky that are the equivalent of a survey. This parallel capability was present to a limited degree at launch, but it has become especially important since the fourth servicing mission. Now WFC3 and ACS can work at the same time with COS or STIS.

Parallel science uses two or more Science Instruments at the same time. The **primary** observation determines the pointing of *HST* and always takes precedence. The **parallel** observation is the one enabled to take place because the primary observation permits suitable conditions, but the parallel observation must *never* interfere with the primary. Although parallel observations are conceptually simple (e.g., "Turn on ACS while COS is in use"), they are, in fact, complex to execute. Commanding the instruments for parallels and primaries at the same time requires strict observance of complex timing rules in order to avoid damage to instruments. Some special restrictions must be applied in order to effectively schedule and execute parallel observations. For additional information see Parallel Observations with *HST.*

From the point of view of the *HST* ground systems there are two types of parallel exposures: **pure** and **coordinated** parallels.

- **Coordinated parallels** are written to be part of the same proposal, with the intention of scheduling the primary and the parallels together. Coordinated parallels are inextricably linked with their primaries: *both* must be scheduled in order for *either* to be scheduled.
- **Pure parallels** are defined at the beginning of the observing cycle based on the structure of available primary visits. They are scheduled simultaneously with and according to the plan windows of those primary visits. Pure parallels may not affect the scheduling of primary visits. This type of parallel must be used whenever the primary and parallel exposures come from different proposals.

> ★ The *HST* pointing control system will automatically correct for differential aberration effects for the Primary observations. There will be a small smearing effect in the parallel SI which cannot be corrected on-board. The magnitude of the effect will vary with the primary target location and aperture, but will be a maximum of ±0.020 arcsec.

Parallel Science Limitations

These restrictions are to ensure that parallels can be scheduled and executed safely and efficiently:

- Parallel observations have some special restrictions on the targets that may be specified; see Pure Parallels and Coordinated Parallels for details.
- All scheduling constraints (pointing, orientation, and relative timing) that apply to coordinated primaries and parallels must be specified only on the primary exposure.
- No visit-level special requirements, and only a few exposure-level special requirements, are applicable to pure parallel visits.
- Exposures parallel with any instrument mode which permits motion of *HST* (e.g., interactive or onboard acquisitions) are *not* supported.

- Neither parallel exposures nor the primary of a coordinated parallel may have real-time (i.e. TDRS contact) requirements of any kind.
- In order to protect the COS and STIS/MAMA detectors from inadvertent over-illumination, these configurations may be used for coordinated parallels only if an exact ORIENT (e.g., **ORIENT 20D TO 20D**) is specified (ORIENT can have a range). Also, the coordinates of the parallel field must be determined and the parallel target or field must pass the same bright-object screening applied to COS and STIS/MAMA primary observations.
- ACS/SBC may not be used for coordinated parallels.
- There is a limit of *one* COS time-tag exposure in a parallel exposure or as the primary exposure of a coordinated parallel.
- Parallel observations may not be made during STIS MAMA **TIME-TAG** observations.

These limitations are discussed further in the following sections.

Pure Parallels

Pure parallel proposals are identified by the Proposal Category. All visits in such proposals will be interpreted as pure parallel visits.

Instrument Configuration

Pure parallel exposures are limited to the following instrument configurations and modes:

Configuration	Operating Mode
ACS/WFC	ACCUM
WFC3/UVIS	ACCUM
WFC3/IR	MULTIACCUM
S/C	DATA

Every exposure in a pure parallel proposal must use the same instrument.

Special Requirements

No visit-level or exposure special requirements are allowed in pure-parallel visits.

Exposure Containers

In pure-parallel visits you can use the following containers (see Exposure Containers: Exposure Sequences, Coordinated Parallels and Patterns):

- Exposure Group Container (Type: Sequence)
- Coordinated Parallel Container

For example, a pure parallel Visit may include an exposure using WFC3/IR and a coordinated exposure using ACS/WFC.

Coordinated Parallel Containers

> **For text file**
>
> In the text proposal file format, coordinated parallel exposures are indicated with the exposure-level special requirement:
>
> **PAR** <parallel-exp-list> **WITH** <primary-exp-list>
>
> This designates a set of one or more parallel exposures which will execute in parallel with a set of one or more primary exposures in the same visit. The **PAR WITH** special requirement must be specified on the first exposure in the <primary-exp-list>. Exposures in the <parallel-exp-list> have to appear immediately after the exposures in <primary-exp-list>. Parallel exposure numbers must follow this sequence as well.

The APT User Interface

> ⭐ This special requirement Parallel has been replaced in the APT GUI with the use of Coordinated Parallel Exposure Containers. See Exposure Containers: Exposure Sequences, Coordinated Parallels and Patterns.

A **Coordinated Parallel Container** designates a set of one or more parallel exposures (<parallel-exp-list>) that will execute in parallel with a set of one or more primary exposures (<primary-exp-list) in the same visit. The SI used in the first exposure defines the primary SI (and therefore defines the <primary-exp-list>). All other exposures that use the same SI will also be considered primary.

All exposures using a different SI will be considered parallel. Parallel exposures using the same SI will be executed in the order specified in the container. The first parallel exposure which uses a given instrument will be executed as early as possible, but not before the first primary exposure.

Instrument Configuration

The exposures in <primary-exp-list> and <parallel-exp-list> are limited to the following instrument configurations and modes:

Configuration	Operating Mode
STIS/FUV-MAMA[1]	ACCUM
STIS/NUV-MAMA[1]	ACCUM
STIS/CCD	ACCUM
FGS[2]	POS
ACS/WFC[3]	ACCUM
COS/FUV[4]	TIME-TAG[5] or ACCUM

COS/NUV[4]	TIME-TAG[5] or ACCUM
WFC3/UVIS	ACCUM
WFC3/IR	MULTIACCUM

[1]In order to protect the STIS MAMA detectors from inadvertent over-illumination, these configurations may be used as coordinated parallels only if an exact ORIENT (e.g., **ORIENT 20D to 20D**) is specified. Also, the coordinates of the parallel field must be determined and the parallel target or field must pass the same bright-object screening applied to MAMA primary observations.

[2]FGS may only be used as primary, never parallel.

[3]ACS exposures cannot be used in both the <primary-exp-list> and the <parallel-exp-list>, and all ACS exposures in the <parallel-exp-list> must use the same configuration.

[4]In order to protect the COS FUV and NUV detectors from inadvertent overillumination, these configurations may be used as the coordinated parallel observation only if an exact ORIENT (e.g., **ORIENT 20D to 20D**) is specified. Also, the coordinates of the parallel field must be determined and the parallel target or field must pass the same bright-object screening applied to COS primary observations.

[5]COS Time-tag exposures are limited to a single one in a parallel exposure or as the primary exposure of a coordinated parallel.

All exposures in <primary-exp-list> must have the same Instrument Configuration (Config) and the same Aperture or Field of View (Aperture). No exposure in <parallel-exp-list> may use the same SI as the primary exposures.

Targets

Coordinated parallels may specify fixed, generic, or solar system targets; the special target ANY; or internal targets. However, the pointing of *HST* will be determined only by the primary exposures. Any pointing conditions to be applied on the primary+parallel combination must be specified on the **primary** exposures via exposure-level special requirements, or on the visit as a whole via visit-level special requirements. All external exposures in a given <primary-exp-list> must have the same pointing. This generally means the same target, aperture, and **POS TARG**.

If a parallel exposure specifies a fixed target, it should be a different target from the primary ones and should appear in the Target List. In this case, an ORIENT special requirement is **required** to ensure that the parallel target is in the aperture. It is the observer's responsibility to verify that the specified orientation will place the parallel target in the aperture; STScI will not check the geometry. Contact your Program Coordinator if you need assistance.

If the parallel target is diffuse and the orientation does not matter, or if there is no parallel target as such and the intent is just to sample whatever the parallel aperture happens to fall on, you should select the **ANY** target (which should not appear in your Target List).

Special Requirements

The **RT ANALYSIS** exposure-level special requirement is disallowed for both primary exposures (any exposure in a <primary-exp-list>) and parallel exposures.

> For engineering parameters
>
> **EXPAND**, **MAX**imum **DUR**ation [<time or percentage>], and **MIN**imum **DUR**ation [<time or percentage>] are also disallowed for both primary exposures (any exposure in a <primary-exp-list>) and parallel exposures.

The following exposure-level special requirements are allowed for primary exposures, but not for parallels:

LOW-SKY
PHASE <number1> **TO** <number2>
POSition **TAR**get <x-value>, <y-value>
REQuires **EPHEM**eris **CORR**ection <id>
REQuires **UPLINK**
SAME POSition **AS** <exposure>
SAVE OFFSET <id>
SHADOW
USE OFFSET <id>
AFTER BY <time1> [**TO** <time2>]

Allowed without restriction:

> **SEQ**uence <exposure-list> **NON-INT**erruptible (replaced by the Exposure Group Container in APT; see Exposure Containers: Exposure Sequences, Coordinated Parallels and Patterns.

> For available but unsupported and restricted parameters
>
> | |
> |---|
> | SAA CONTOUR <model number> (for WFC3, ACS/WFC, and S/C modes) |
> | SPECial COMmanding [INSTR <NAME>] |

No parallel exposure may appear in the <exposure-list> of an **RT ANALYSIS FOR** Special Requirement, or be the <exposure> referenced by a SAME POS AS special requirement.

Number of Iterations

The **Number_Of_Iterations** must be set to **1** for any COS exposure in a coordinated parallel container.

Ordering Restrictions and Interpretations

⭐ In Coordinated Parallel Containers, the SI used in the first exposure defines the "primary" SI.

If the exposures in the <parallel-exp-list> contain exposures that use different SIs, an attempt will be made to execute each set of exposures with the same SI in parallel with the other sets. All exposures within a given set must be contiguous in the container. Within a set, exposures will be executed in the order they appear.

Due to readout conflicts and limits on the number of SIs which may execute simultaneously, parallel exposures sometimes have to be delayed. If a parallel exposure conflicts with an exposure in its primary list, the parallel will be delayed. If two parallel exposures using different SIs conflict, the exposure which appears later in the container will be delayed.

Following a set of exposures in a Parallel Container, subsequent exposures not in the container will be delayed until after all the primary and parallel exposures have completed.

> For text file
>
> In the **Text Proposal File**, the exposures in the <parallel-exp-list> of a **PAR WITH** special requirement must appear immediately after the exposures in <primary-exp-list>.

Efficiency Considerations

Within a set of coordinated-parallel exposures, the ground system will not break up sequences of exposures that are too long to fit in an orbit, as it does for non-coordinated-parallel exposures. Each group of exposures with the same SI **must** be short enough to fit in one orbit. If it is necessary to take coordinated-parallel data over multiple orbits, a separate **Parallel Container**—with a new set of exposures—should be specified for each orbit.

Change Log

Version Cycle 31 July - August 2023

Corrected the link in the introduction to the UIR_Parallels.pdf

Expand/Collapse all...

Chapter 6 Special Requirements

HST has special requirements that are used to specify scheduling constraints for both visits and exposures, and this article contains the descriptions of those requirements.

Chapter Contents

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

See more about Special Requirements:

Limited Resources

Some special requirements that affect scheduling must be indicated in the Phase 1 proposal. These are noted in the tables below as well as in the text explanations of the requirements.

💡 Use the tables below to go directly to information for a particular special requirement.

The following Special Requirements are applicable at the visit level, and they will affect **all** the exposures within that particular visit.

Supported Formats for Visit-level Special Requirements

FORMAT	EXAMPLE	
Guiding Requirements		
PCS MODE Fine	PCS MODE Fine	
PCS MODE Gyro	PCS MODE Gyro	
GUIDing TOLernace <angle> (arcsec)	GUID TOL 0.020"	
DROP TO GYRO [NO REACQuisition]	DROP TO GYRO	
Special Observation Requirements		
CVZ	CVZ	*Must be indicated in Phase 1 proposal*
SCHEDulability <percentage>	SCHED 100%	
NOTRACK	NOTRACK	
TARGET OF OPPORTUNITY RESPONSE TIME <time>	TARGET OF OPPORTUNITY RESPONSE TIME 24.0 H	*Must be indicated in Phase 1 proposal*
TARGET OF OPPORTUNITY FLEX DAY (FLEXIBLE THURSDAY)	TARGET OF OPPORTUNITY FLEX DAY (FLEXIBLE THURSDAY)	*Must be indicated in Phase 1 proposal*
Conditional Requirements		
ON HOLD FOR [<visit>]	ON HOLD FOR 15	*Must be indicated in Phase 1 proposal*
Target Orientation Requirements		
ORIENTation <angle1> TO <angle2>	ORIENT 18° TO 22°	*Must be indicated in Phase 1 proposal*
ORIENTation <angle1> TO <angle2> FROM <visit>	ORIENT 18° TO 22° FROM 5	*Must be indicated in Phase 1 proposal*

SAME ORIENTation AS <visit>	SAME ORIENT AS 5	*Must be indicated in Phase 1 proposal*
Timing Requirements		
AFTER <date>	AFTER 12-JUL-2001: 12:06	*Must be indicated in Phase 1 proposal*
AFTER <visit> [BY <time1> TO <time2>]	AFTER 6 BY 7D TO 9D	*Must be indicated in Phase 1 proposal*
BEFORE <date>	BEFORE 14-SEP-1999	*Must be indicated in Phase 1 proposal*
BETWEEN <date1> AND <date2>	BETWEEN 21-DEC-1999 AND 31-DEC-1999	*Must be indicated in Phase 1 proposal*
GROUP <visits> WITHIN <time>	GROUP 5-10 WITHIN 60D	*Must be indicated in Phase 1 proposal*
PERIOD <time> ZERO-PHASE (HJD) <date>	PERIOD 1.23H AND ZERO-PHASE (HJD) 2444000	*Must be indicated in Phase 1 proposal*
SEQuence <visits-checked> WITHIN <time>	SEQ Visits 5-7 WITHIN 24H	*Must be indicated in Phase 1 proposal*
VISIBILITY INTERVAL CORON	VISIBILITY INTERVAL CORON	
VISIBILITY INTERVAL NO GYRO BIAS UPDATE ON MOVING TARGET	VISIBILITY INTERVAL NO GYRO BIAS UPDATE ON MOVING TARGET	
Limited-Access Requirements		
BRIGHT EARTH AVOIDance <angle in degrees>[1]	BRIGHT EARTH AVOID 25	

PARallel	PAR	
GYRO MODE <value>	GYRO MODE 2G	

[1] The <angle in degrees> is currently limited to 25. All other angles from 0º to 90º are Restricted.

The following Special Requirements apply to individual exposures within a visit. All instances of <exposure-list> or <exposure> refer **only** to exposures in the same visit as the exposure carrying the requirement.

Supported Formats for Exposure-level Special Requirements

FORMAT	EXAMPLE	
Target Acquisition Requirements		
INTeractive ACQuisition (obsolete)	No longer available; see text.	
Special Observation Requirements		
SPATIAL SCAN <Scan_Rate>, <Scan_Orient>, <Scan_Direction>, <Scan_Line_Separation>, <Scan_Number_Lines>		
PARallel <parallel-exp-list> WITH <primary-exp-list>	See Exposure Containers: Exposure Sequences, Coordinated Parallels and Patterns PAR 4-6 WITH 1-3	*Must be indicated in Phase 1 proposal*
Special Communications Requirements		
RT ANALYSIS	RT ANALYSIS	
REQuires UPLINK	REQ UPLINK	
REQuires EPHEMeris CORRection <id>	REQ EPHEM CORR OFF-13	
Target Position Requirements		
POSition TARGet <X-value>,<Y-value>	POS TARG +6.3,-8.1	
SAME POSition AS <exposure>	SAME POS AS 6	
PATTERN <#> [<exposure-list>] (*Replaced by Pattern Containers in the APT User Interface*))	See Exposure Containers: Exposure Sequences, Coordinated Parallels and Patterns and 7 Pointings and Patterns PATTERN 5 1-4	
Timing Requirements		

LOW-SKY	LOW-SKY	*Must be indicated in Phase 1 proposal*
PHASE <number1> TO <number2>	PHASE 0.09 TO 0.11	*Must be indicated in Phase 1 proposal*
SEQuence <exposure-list> NON-INTerruptible	See Exposure Containers: Exposure Sequences, Coordinated Parallels and Patterns and 7 Pointings and Patterns SEQ 2-5 NON-INT	*Must be indicated in Phase 1 proposal*
SHADOW	SHADOW	*Must be indicated in Phase 1 proposal*

For engineering parameters

FORMAT	EXAMPLE
Special Communications Requirements	
FORMAT [AN or FN or HN or PN]	FORMAT FN
Visit Special Requirements	
VISIBILITY INTERVAL <time>	VISIBILITY INTERVAL 5000 S
Exposure Special Requirements	
MAXimum DURation (time or %) <value>	MAX DUR 125%
MINimum DURation (time or %) <value>	MIN DUR 1200S
EXPAND (pure parallel exposures only)	EXPAND
NEW OBSET [FULL ACQ]	NEW OBSET
NEW ALIGNMENT	NEW ALIGNMENT
SAME OBSET <exposure-list> (replaced by Exposure Group containers in the APT User Interface)	See Exposure Containers: Exposure Sequences, Coordinated Parallels and Patterns and 7 Pointings and Patterns SAME OBSET 10-20
SAME ALIGNMENT <exposure-list> (in APT replaced by Exposure Group containers in the APT User Interface)	See Exposure Containers: Exposure Sequences, Coordinated Parallels and Patterns and 7 Pointings and Patterns SAME ALIGNMENT 20-30
SAME GUIDE STARS <exposure-list> (in APT replaced by Exposure Group containers in the APT User Interface)	See Exposure Containers: Exposure Sequences, Coordinated Parallels and Patterns and 7 Pointings and Patterns SAME GUIDE STARS 10-20
GSPAIR <pair-id->	GSPAIR 0748300182F10000000000F0
OBSET ID <id>	OBSET ID A2
EXP PCS MODE [FINE	GYRO]	EXP PCS MODE FINE
GS ACQ SCENARIO [PAIR	SINGLE	GYRO	<scenario>]	GS ACQ SCENARIO SINGLE

For available but unsupported parameters

FORMAT	EXAMPLE
Target Acquisition Requirements	
SAVE OFFSET <id>	SAVE OFFSET OFF-1
USE OFFSET <id>	USE OFFSET OFF-1
Special Observation Requirements	
SAA CONTOUR <model number> (for WFC3, ACS/WFC and S/C modes; Restricted for ACS/SBC, CAL and ENG proposals)	SAA CONTOUR 02
QASISTATES <si> <detector> <start> <end>	QASISTATES ACS ACS/WFC A1 B2
QESIPARM <parameter> <value>	QESIPARM A1 B1
QELOGSHEET <parameter> <value>	QELOGSHEET AP_1 B1
Timing Requirements	
AFTER BY <time> [TO <time2>]	AFTER BY 15M to 16M

For restricted parameters

FORMAT	EXAMPLE
Target Acquisition Requirements	
USE OFFSET <id> Use for any CALibration, ENGineering or SMOV program	USE OFFSET 9100-1
Special Observation Requirements	
SPECial COMmanding [INSTR <NAME>]	SPEC COM INSTR ESPFORMAT

Expand/Collapse all...

6.1 Conventions for Special Requirements

Special Requirements (e.g., BETWEEN, POS TARG) are generally used to restrict the scheduling of HST observations by various constraints. The Astronomer's Proposal Tool (APT) is used to enter the requirements into the proposal, using specific rules and conventions.

On This Page

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction to Special Requirements: Syntax and Rules

Special requirements provide flexibility in specifying the scheduling requirements of observations. Many Special Requirements, directly or indirectly, restrict the times when observations can be scheduled. These should be used to provide the schedulers at STScI with enough constraints to ensure that the observations are properly scheduled. **Special Requirements should not be used unless necessary to accomplish the scientific objectives of the program.**

The Special Requirements are summarized in *Supposed Formats for Visit-level Special Requirements* and *Supposed Formats for Exposure-level Special Requirements* tables, and a detailed description of each requirement is provided.

Rules and Conventions

You should observe the following conventions and rules for Special Requirements:

- Items inside angular brackets (< >) in the Special Requirement descriptions are to be replaced with the relevant information. All indicated items must be provided, except for items inside square brackets ([ ]), which are optional.
- A <date> specification in a Special Requirement must either be a geocentric date expressed in Universal Time (UT) or a heliocentric Julian Date. A UT date *must* be entered in the form DD-MMM-YYYY:hh:mm:ss, where MMM represents the first three letters of the month name. Fractional seconds are not allowed and anything beyond the day specification is optional. For example, **14-DEC-2001:17:05:41** refers to 14 December 2001, geocentric UT 17H05M41S. Only the necessary precision need be employed (e.g., **14-DEC-2001** might be adequate). The SOGS day of the year format, YYYY.ddd:hh:mm:ss (where ddd is the day of the year from 001 to 365), is also accepted.

  Julian Dates must be entered in the form JDnnnnnnn.nnn (e.g., **JD2444123.4**) and are legal only for the **ZERO-PHASE** special requirement. All Julian Dates will be interpreted as **heliocentric**.

- You should select the units of all <time> specifications from a list provided to you. The options are: days (**D**), orbits (**ORBITS**), hours (**H**), minutes (**M**), or seconds (**S**).
- A visit-level Special Requirement (**Visit_Requirements**) applies to **ALL** the exposures within that visit.
- An exposure-level Special Requirement (**Special_Requirements**) applies **ONLY** to that exposure **and any other referenced exposures within the same visit**.

For text file

Additional Rules and Conventions for the Text Proposal File

If you are editing the Text Proposal File to modify your program, please observe these additional syntax rules:

- You *must* use only the portions of the keywords that are shown in upper-case letters in *Supposed Formats for Visit-level Special Requirements* and *Supposed Formats for Exposure-level Special Requirements* tables, and in the discussion of each requirement. The portions in lower-case letters are included for clarity only. For example, **SEQ** must be entered rather than **SEQUENTIAL**.

- Exposures must be referred to by their exposure numbers. <exposure> must be replaced by the number of a single exposure. An <exposure-list> must be replaced by a single range of exposure numbers separated by a hyphen (e.g. **SEQ 2-5 NON-INT**). *Commas are NOT allowed in exposure lists.*

- Multiple Special Requirements *mus*t be separated by a semi-colon (**;**). Please note that separate lines are not sufficient to delimit items in a list. Do not use commas to separate Special Requirements items.

Related Links

Change Log
None

6.2 Visit-level Special Requirements

Visit Special Requirements summary

HST has special requirements that are used to specify scheduling constraints at the visit level, and this article contains the descriptions of those requirements.

Sections

- 6.2.1 General Visit-level Special Requirements
- 6.2.2 Target Orientation Visit-level Special Requirements
- 6.2.3 Timing Visit-level Special Requirements

On This Page

  Visit Special Requirements summary
  Sections
  Format definitions
  More about Visit-level Special Requirements
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Format definitions

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Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

More about Visit-level Special Requirements

💡 Use the table below to go directly to information for a particular visit-level special requirement.

The following Special Requirements are applicable at the visit level, and they will affect **all** the exposures within that particular visit.

Supported Formats for Visit-level Special Requirements

FORMAT	EXAMPLE	
Guiding Requirements		
PCS MODE Fine	PCS MODE Fine	
PCS MODE Gyro	PCS MODE Gyro	
GUIDing TOLernace <angle> (arcsec)	GUID TOL 0.020"	
DROP TO GYRO [NO REACQuisition]	DROP TO GYRO	
Special Observation Requirements		
CVZ	CVZ	*Must be indicated in Phase 1 proposal*
SCHEDulability <percentage>	SCHED 100%	
NOTRACK	NOTRACK	
TARGET OF OPPORTUNITY RESPONSE TIME <time>	TARGET OF OPPORTUNITY RESPONSE TIME 24.0 H	*Must be indicated in Phase 1 proposal*
TARGET OF OPPORTUNITY FLEX DAY (FLEXIBLE THURSDAY)	TARGET OF OPPORTUNITY FLEX DAY (FLEXIBLE THURSDAY)	*Must be indicated in Phase 1 proposal*
Conditional Requirements		
ON HOLD FOR [<visit>]	ON HOLD FOR 15	*Must be indicated in Phase 1 proposal*
Target Orientation Requirements		
ORIENTation <angle1> TO <angle2>	ORIENT 18° TO 22°	*Must be indicated in Phase 1 proposal*
ORIENTation <angle1> TO <angle2> FROM <visit>	ORIENT 18° TO 22° FROM 5	*Must be indicated in Phase 1 proposal*

SAME ORIENTation AS <visit>	SAME ORIENT AS 5	*Must be indicated in Phase 1 proposal*
Timing Requirements		
AFTER <date>	AFTER 12-JUL-2001: 12:06	*Must be indicated in Phase 1 proposal*
AFTER <visit> [BY <time1> TO <time2>]	AFTER 6 BY 7D TO 9D	*Must be indicated in Phase 1 proposal*
BEFORE <date>	BEFORE 14-SEP-1999	*Must be indicated in Phase 1 proposal*
BETWEEN <date1> AND <date2>	BETWEEN 21-DEC-1999 AND 31-DEC-1999	*Must be indicated in Phase 1 proposal*
GROUP <visits> WITHIN <time>	GROUP 5-10 WITHIN 60D	*Must be indicated in Phase 1 proposal*
PERIOD <time> ZERO-PHASE (HJD) <date>	PERIOD 1.23H AND ZERO-PHASE (HJD) 2444000	*Must be indicated in Phase 1 proposal*
SEQuence <visits-checked> WITHIN <time>	SEQ Visits 5-7 WITHIN 24H	*Must be indicated in Phase 1 proposal*
VISIBILITY INTERVAL CORON	VISIBILITY INTERVAL CORON	
VISIBILITY INTERVAL NO GYRO BIAS UPDATE ON MOVING TARGET	VISIBILITY INTERVAL NO GYRO BIAS UPDATE ON MOVING TARGET	
Limited-Access Requirements		
BRIGHT EARTH AVOIDance <angle in degrees>[1]	BRIGHT EARTH AVOID 25	

PARallel	PAR	
GYRO MODE <value>	GYRO MODE 2G	

[1] The <angle in degrees> is currently limited to 25. All other angles from 0º to 90º are Restricted.

Related Links

6.3 Exposure-level Special Requirements

Change Log

Version Cycle 31 June-July 2023

PROPINST-91390 Add "Flexible Thursday" Target of Opportunity

Version Cycle 30 April 2022

PROPINST-91383 Emphasize which special requirements should have been preapproved in Phase I (Added to table)

Version Cycle 29 April 2021

- PROPINST-91379 - VISIBILITY INTERVAL MOVING TARGET

6.2.1 General Visit-level Special Requirements

General Special Requirements (e.g., GUIDING, CVZ) are generally used to restrict the scheduling of HST observations by various constraints. The Astronomer's Proposal Tool (APT) is used to enter the requirements into the proposal.

On This Page

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

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Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

Most general special requirements directly or indirectly restrict the times when observations (and/or their component visits) can be scheduled. These should be used to provide the schedulers at STScI with enough constraints to ensure that the observations are properly scheduled. **Special requirements should not be used unless necessary to accomplish the scientific objectives of the proposal.**

Guiding

There are currently two tracking modes available during *HST* observations. One of the modes employs guide stars and the Fine Guidance Sensors: Fine Lock. Alternatively, observations can be made while the *HST* is stabilized with gyros. (In this scenario no guide star acquisition occurs.) The typical guiding accuracies for the two modes are listed in the Table 6.1: *Accuracies of Guiding Modes*.

PCS MODE Fine

Specifies the use of Fine Lock as the guiding mode for the exposures defined in that particular visit. This Special Requirement is the default and any use of the GUIDing TOLerance <angle> overrides this Special Requirement.

PCS MODE Gyro

Specifies the use of Gyro hold (see Table 6.1: *Accuracies of Guiding Modes*) as the guiding mode for the exposures defined in that particular visit. This mode is available **ONLY** with the ACS/WFC, S/C, STIS /CCD and WFC3. It is prohibited with other SIs because of concern that gyro drift will result in inadvertent exposure to bright objects. Note that the RMS absolute pointing error for gyro hold is 14 arcsec with a drift rate that can vary from 0.01 to 0.1 arcsec/sec and can vary during exposures. This Special Requirement overrides the default and any use of the GUIDing TOLerance <angle> Special Requirement.

GUIDing TOLerance <angle>

This special requirement specifies a non-default guiding tolerance for the exposures contained within that particular visit. The <angle> is the allowed maximum pointing error for the observations; the units must be given in arcsec. It should be used in situations when it is permissible for a portion of the observation to be taken while guiding on gyros. It is also used as a trigger for the guide star handoff capability and is useful for fast moving targets. The handoff process involves using a single pair of guide stars for as long as possible. When a given exposure cannot be completed with a given pair of guide stars, guidance is transferred to gyro control. The fine guidance sensors are slewed to and acquire a new pair of guide stars before the exposure in question begins. The error in this procedure is due to the accumulated drift during gyro control, typically a few tenths of an arcsec at most. Note that this is much less than the nominal error between guide star pairs. The planning system will schedule the observations so that the expected pointing-error buildup remains below the <angle> specified. Guide star handoff will only be used if a single pair of guide stars cannot be found for the observation. If you need to use the guide star handoff capability, then set **GUIDing TOLerance** to at least 0.11".

Note that the difficulty in finding guide stars for these types of observations may prevent them from being scheduled. **If you plan to use this Special Requirement, please contact your Program Coordinator for further details and discussions.**

DROP TO GYRO [NO REACQuisition]

This Special Requirement allows the system to drop guide-star control for exposures with pointings (target/aperture positions) that are too far (more than 2 arcmin) from the first pointing in the visit to use the same guide stars. If this Special Requirement is not used, such exposures will have to be taken using a separate pair of guide stars. The **NO REACQ** qualifier will disable guide-star reacquisition after dropping to gyro control, even if subsequent pointings are close enough to the first pointing in the visit to allow guide-star control to be resumed. This Special Requirement has no meaning for internal observations and visits with PCS MODE Gyro. This Special Requirement is allowed **ONLY** with the ACS/WFC, WFC3 and STIS/CCD SI/detector combinations (see the above discussion of PCS MODE Gyro). **DROP TO GYRO** is not allowed with the ACS/SBC, STIS/MAMA and COS configurations because of concern about bright objects.

See the discussion of the GUIDing TOLerance <angle> Special Requirement concerning the pointing drift that will occur while the spacecraft is under gyro control. Due to this drift, this requirement is useful primarily for short observations (bright targets) where pointing is not critical (e.g., imaging). This capability might be used if, after spending most of an orbit obtaining spectra of a target, you want to get a quick image without having to acquire a new set of guide stars.

> For engineering parameters (GYRO Mode)
>
> ## GYRO Mode <value>
>
> This specifies the gyro mode in which the visit is to be executed. The allowed values for <value> are **None Selected**, **1G**, **2G**, **3GFHST** or **3GOBAD**. Normally, the value is set to **None Selected**; do not change it unless your PC tells you to do otherwise.
>
> > ★ For Two Gyro Mode guiding accuracy information, see the Two Gyro Mode Handbook at:
> >
> > http://www.stsci.edu/files/live/sites/www/files/home/hst/documentation/_documents/two-gyro/HST-Two-Gyro-Handbook_Version-3-2006.pdf

Guiding Accuracies

Table 6.1: Accuracies of Guiding Modes

Guiding Mode	Guiding Accuracy
Gyro hold	Drift rates can vary from 0.01 to 0.1 arcsec/sec and can vary during the exposures
Fine lock	RMS jitter ~0.005 arcsec (RSS both axes)
Coarse track	RMS jitter ~0.005 arcsec (RSS both axes)

All observations will be performed using Fine Lock guiding by default whenever possible. If difficulties are encountered finding guide stars, you will be contacted by STScI. It has been determined that using Coarse Track guiding for long periods of time is hazardous to the health of the Fine Guidance Sensors, so use of this tracking mode will be considered for extreme cases only. If you cannot find what you feel to be an appropriate tracking mode, you are urged to contact your Program Coordinator for help resolving the issue.

Special Observations Requirements

CVZ

Requests that a visit be scheduled within the Continuous Viewing Zone. When this requirement is specified, observers are allowed the entire 96-minute orbit in which to schedule their observations, instead of restricting them to an orbital visibility period. (This Special Requirement **must have been indicated in the Phase 1 proposal**.)

> ⭐ Caution: CVZ visits are limited to a few narrow scheduling opportunities during a cycle. A detailed definition of the CVZ is given in the HST Observation Types and Special Requirements.

Note: The CVZ Special Requirement does not necessarily enforce scheduling in an uninterrupted manner. Observations could be scheduled in SAA impacted or earth occulted orbits if that would benefit the overall efficiency of the telescope. If it is required that all (or a subset) of the exposures be done without interruption, the exposure level Special Requirement SEQuence <exposure-list> NON-INTerruptible should be used.

SCHEDulability <percentage>

This Special Requirement allows the observer to adjust the amount of orbital visibility period allowed in each orbit. The visibility at a given pointing varies throughout the year with the 56-day precessional cycle of the *HST* orbit. This variation is small at zero declination (about 4 minutes between best case and worst case) but increases sharply as the Continuous Viewing Zone is approached. There is a trade-off between visibility and schedulability: visits with longer visibilities allow more science to be packed into each orbit, but are harder to schedule because the long visibility may only be attainable for a few short intervals during the year. Visits with shorter visibilities are less efficient in terms of how much can be done in each orbit, but are easier to schedule.

<Percentage> specifies the percent of *HST* orbits in which the visit should be schedulable. The higher the percentage, the shorter the visibility. For example, **SCHEDulability 80** would allow only enough visibility in each orbit for the visit to be schedulable in the best 80% of *HST* orbits. **SCHEDulability 100** would allow the least amount of time per orbit, but would ensure that the visit would "fit" in every available *HST* orbit. Schedulability values are defined at 10% intervals, so percentages will be rounded to the nearest multiple of 10%. *If this Special Requirement is not supplied, visits will default to* **30***, except in certain cases noted in the following table.* <percentage> values below **30** are not allowed.

Program Type	Default Schedulability

Large GO Programs (see the HST Proposal Categories)	100
SMOV	100
Two-Gyro	70

The **SCHED**ulability Special Requirement may be necessary when an **ORIENT**ation **<angle1> TO <angle2>** or **BETWEEN <date1> AND <date2>**) visit-level Special Requirement or a **PHASE <number1> TO <number2>** exposure-level Special Requirement is specified with a very small tolerance, restricting the visit to only a few days during the cycle. In this case <percentage> should be set to a high enough number to ensure that the visit can schedule in orbits within its time window.

There are special rules that govern orbital visibility for Moving Target. See explanation in the Special Requirement VISIBILITY INTERVAL NO GYRO BIAS UPDATE ON MOVING TARGET.

Servicing mission proposals need to be schedulable at any time in order to accommodate changes in the schedule. The default **SCHED** value for SM proposals is therefore **100%**.

NOTRACK

In certain cases a program will observe a moving target, but without tracking it. For example, a fast-moving comet might be observed by first executing a guide star acquisition, to remove pointing uncertainty, followed by an observation on gyros to acquire the comet data. This should be done without tracking both to save time and to avoid unnecessary use of spacecraft hardware.

The default is to track a moving target, but tracking can be turned off by specifying **NOTRACK** for each visit as appropriate. **NOTRACK** has no effect on a visit unless it is for a moving target.

TARGET OF OPPORTUNITY RESPONSE TIME <time>

This requirement specifies that the current visit is to be executed as a Target of Opportunity. **<time>** (**H**ours or **D**ays) is the requested time after the activation request is submitted to STScI that the observation should be started. The minimum time allowed is 3 weeks for programs approved for non-disruptive targets of opportunity. Shorter times may be specified for programs approved for disruptive targets of opportunity. *The minimum response time is 24 Hours* (See the ToO User Information Report). (This Special Requirement **must have been indicated in the Phase 1 proposal**.)

TARGET OF OPPORTUNITY FLEX DAY (FLEXIBLE THURSDAY)

Once a month, the Hubble schedule will include a "Flexible Thursday" (beginning at approximately 12:00 UT and generally running for 24 hours) with targets that can be rescheduled relatively easily. The trigger for Flexible Thursday observations must be received by 10:00 UT on the preceding Tuesday, with a fully executable Phase II proposal and no further changes allowed. This requirement specifies that the current visit is to be executed in this manner. (This Special Requirement **must have been indicated in the Phase 1 proposal**.)

Flex Day ToO visits are subject to a number of constraints to ensure easy scheduling:

1. No observations of solar system targets
2. No links to other visits
3. Must be maximally schedulable (use the **Sched 100** Special Requirement)

4. No use of bright object sensitive detectors (COS/FUV, COS/NUV, STIS/FUV, STIS/NUV, ACS/SBC)
5. No longer than 5 orbits
6. No constraints relative to the South Atlantic Anomaly
7. No spatial scanning
8. No timing constraints or orient restrictions

For available but unsupported parameters (BEA, PAR)

BRIGHT EARTH AVOIDance <angle in degrees>

Requests that the current visit schedule with the specified **minimum** Bright Earth Avoidance (BEA) angle. The specified <angle in degrees> is currently limited to 25. All other allowed angles (0 to 90 degrees) are Restricted.

The minimum, default BEA angles for visits with external observations (visits consisting of all internal exposures will default to 0.0 degrees) are as follows:

Instrument	default BEA angle
ACS	20.0°
COS	20.0°
FGS (astrometry)	15.5°
WFC3	20.0°
STIS/CCD	20.0°
STIS/MAMA	17.0°

Efficiency and schedulability may be reduced with this Special Requirement. Also, this Special Requirement may not be combined with **LOW-SKY** or **SHADOW**. The BEA angle will be the largest of the minimum angles required by any prime or parallel instrument operating in the visit.

PARallel

Specifies that the current visit is to execute as a parallel. This Special Requirement is only needed for those situations where the ground system does not automatically set up the visit as a parallel.

Visits that include spacecraft (S/C) mode exposures that also need to execute as a parallel typically will need this Special Requirement.

Conditional Requirements

ON HOLD [FOR <visit>]

When the **FOR <visit>** is specified, an **AFTER <visit> [BY <time1> TO <time2>]** requirement must also be specified in order to indicate the necessary time separation between the two visits to allow for time to receive/analyze the first visit's data, and rewrite/resubmit/reschedule the second visit. (This Special Requirement **must have been indicated in the Phase 1 proposal**.)

Related Links

6.2.2 Target Orientation Visit-level Special Requirements
6.2.3 Timing Visit-level Special Requirements

Change Log
Version Cycle 31 June-August 2023

1. PROPINST-91390 Document new "Flexible Thursday ToOs" ToOs
2. Removed old PR link from Change Log, fixed two links to CP.
3. PROPINST-91403 Gyro Guiding Accuracy

Version Cycle 30 April-May 2022

PROPINST-91361 ON HOLD Not Needed with TARGET OF OPPORTUNITY

PROPINST-91383 Emphasize which special requirements should have been preapproved in Phase I (CVZ already had words, but added to ToO and On Hold For)

Version Cycle 26 October 2018

1. PR.89899 Remove NOTRACK Reference to Exposures
   6.2.1 General Visit-level Special requirements

Initial Conversion from Chapter 4 of HST Cycle 25 Phase II Proposal Instructions (Engineering) Version Cycle 25 (June 2018)

6.2.2 Target Orientation Visit-level Special Requirements

General Special Requirements (e.g., GUIDING, CVZ) are generally used to restrict the scheduling of HST observations by various constraints. The Astronomer's Proposal Tool (APT) is used to enter the requirements into the proposal.

On This Page

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

Most general special requirements directly or indirectly restrict the times when observations (and/or their component visits) can be scheduled. These should be used to provide the schedulers at STScI with enough constraints to ensure that the observations are properly scheduled. **Special requirements should not be used unless necessary to accomplish the scientific objectives of the proposal.**

The solar arrays of HST must be kept pointed at the Sun (to within a modest angle) in order for the spacecraft to have the electrical power it needs. As the Sun moves through the heavens over the course of a year, this requirement for the solar arrays translates into a position angle on the sky on which HST's detectors lie. Therefore an observer-imposed requirement to, say, orient a slit in a particular position angle means that observation must be done at a specific time. When a special aperture orientation is requested, this will generally be accommodated by scheduling the observation during the time interval when that orientation naturally results in the solar array being positioned nearly perpendicular to the Sun (this is called the "nominal" orientation).

In order to achieve a specific orientation and satisfy spacecraft roll constraints, an observation generally must be scheduled within a fairly narrow time interval. The placement and duration of time intervals that satisfy this constraint will depend on the ecliptic coordinates of the target. The observer must take this into consideration when specifying additional timing constraints (e.g., **BETWEEN**, **BEFORE**, **AFTER**). For a discussion of nominal roll and how it changes with time based on ecliptic latitude, see the section on Nominal and Off-Nominal Roll below.

The placement of the instruments in the *HST* coordinate system is shown in the Field of View (FOV).

Figure 6.1: The *HST* FOV with the locations of the SI and the FGS apertures in the (U2,U3) focal plane. The layout of the instrument entrance apertures in the telescope focal plane as projected onto the sky are shown. The scale in arcseconds is indicated.
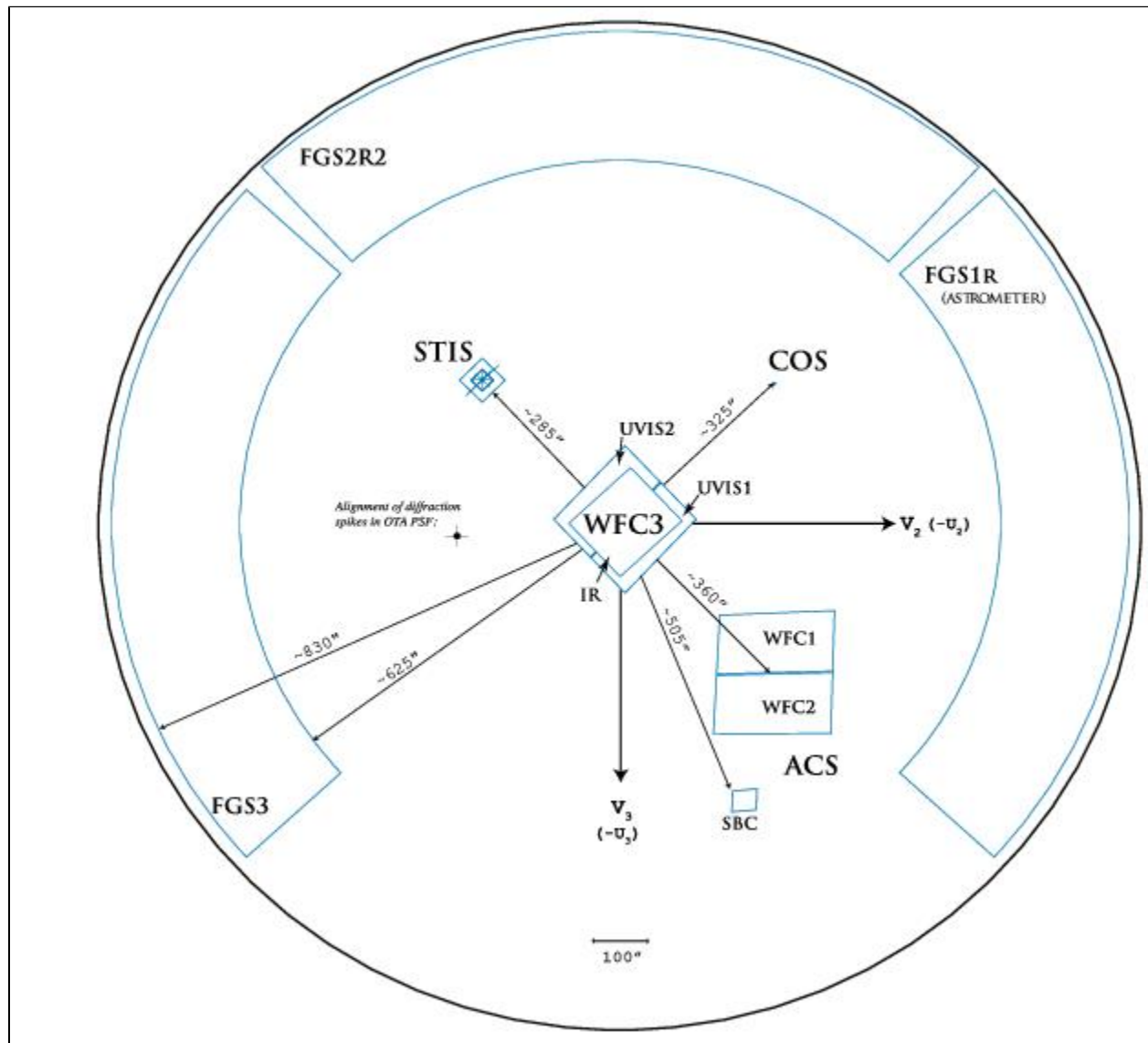
Observers can constrain the orientation of the instrument(s) on the sky during a visit by specifying the position angle of the HST reference vector U3; i.e., by specifying the rotation from North towards East to this U3 axis direction. To constrain the orientation of an axis of an aperture, a slit, an aperture pair, etc., we therefore need to know how this selected axis is oriented with respect to U3. Table 6.3: *Approximate Separation and Orientations between the Science Instruments* provides this information, i.e., the angle measured from the selected axis direction to U3, which we will call the offset angle. To obtain the North to U3 angle, **ORIENT**, the observer should add the offset angle for the selected axis and the desired position angle on the sky of the selected axis:

ORIENT = offset angle(selected axis) + PAaxis

If the selected axis is the y axis of the aperture, this becomes

ORIENT = offset angle(y axis) + PA(y axis) = offset angle(y axis) + ORIENTAT

where ORIENTAT is defined as the position angle of the y axis of the aperture (and will appear in the science header), and offset angle(y axis) is, for example, 135° for WFC3/UVIS apertures (Table 6.2: Accuracies of Guiding Modes).

The above equation can be used to select values of **ORIENT** to avoid. As explained in Table 6.2: Accuracies of Guiding Modes, the Y axis of a WFC3/UVIS aperture is aligned with the columns of the CCD chip. Saturated pixels bleed flux along columns. (See WFC3 ISR 2010-10.) If the position angle of the Y axis, PA(y axis), coincides with the position angle of the vector from the target to a badly saturated star, PA(star), flux from the saturated core of the star will bleed towards the target along columns. For a star due north of a target (PA(star) = 0), one should avoid using **ORIENT** = 135 + 0 = 135 degrees if the bleeding flux may reach the target. Bleeding occurs in both directions along the columns, so **ORIENT** = 135 + 180 = 315 degrees should also be avoided. For a star at position angle N degrees, avoid **ORIENT** = 135 + N degrees and also **ORIENT** = 135 + N + 180 degrees. To allow for geometric distortion and errors in the angles, create an avoidance zone by adding a buffer of +/-10° to these **ORIENT**s. (A wider buffer zone may unnecessarily limit scheduling opportunities.) Thus, in summary, specify **ORIENT** ranges such that (ORIENT - PA(y axis)) = (ORIENT - PA(star)) is not within +/-10° of 135° and 315°.

If the target is faint, one may need to avoid placing it on the diffraction spikes from a bright star, which are oriented at about 45° from the columns on the WFC3/UVIS detector. (See WFC3 ISR 2011-03.) Therefore, avoid (ORIENT - PA(y axis)) = 45° from 135° and 315° (from above), so avoid (ORIENT - PA(y axis)) = 0°, 90°, 180°, and 270°. As above, create an avoidance zone by adding a buffer of +/-10°. The WFC3/IR detector has the same offset angle as the WFC3/UVIS detector (see Table 6.2: Accuracies of Guiding Modes), and uses the same Y axis convention (the Y axis is aligned with columns), so the same numbers apply to the WFC3/IR detector.

Instrument Orientation Tables

Table 6.2: Accuracies of Guiding Modes

For more information refer to http://www.stsci.edu/hst/instrumentation/focus-and-pointing/apertures

Instrument	Item		Offset Angle 1	Comments
FGS (see Figure 9.1: *The FGS TARG and Interfermometer Coordinate Systems*)	+X axis for FGS1		180°	
	+X axis for FGS2		90°	
	+X axis for FGS3		0°	
STIS (see Figure 8.1: *STIS Coordinate System*)	All configurations:			Nominal, +/- 4°
	Long Slit Spatial/+AXIS2/+Y	45°		
	Dispersion/+AXIS1/+X	135°		
	Toward increasing occultation:			

	WEDGEA	45°	
	WEDGEB	135°	
WFC3 (see Figure 12.1: *UVIS Aperture Diagram* and Figure 12.2: *IR Aperture Diagram*)	UVIS +Y (UVIS CCD column, same as the Y_POSTARG direction)	135°	
	IR +Y	135°	
	UVIS +X (UVIS CCD row)	221°	
	IR +X	224°	
COS (see Figure 11.1: *COS Aperture Coordinate System*)	FUV +Y (spatial axis)	135°	
	NUV +Y (spatial axis)	135°	
	FUV +X (dispersion axis)	45°	
	NUV +X (dispersion axis)	45°	
ACS (see Figure 10.1: *ACS Coordinate System*)	WFC1 + Y axis	2°	
	WFC2 + Y axis	2°	
	SBC + Y axis	180°	
	WFCENTER + Y axis	2°	
	WFCENTER + Y axis	2°	

For available but unsupported parameters (STIS)

Instrument	Item	Offset Angle	Comments
STIS	Planetary slits spatial:		
	P45	90°	
	N45	0°	
	BAR5	146°	
	BAR10	45°	

[1] The Offset Angle is the angle from the axis defined in the Item column to the +U3 axis in the counterclockwise (or +U3 through +U2) direction. To compute the angle needed in the **ORIENT** Special Requirement, add this Offset Angle in column 3 to the Sky Position Angle (measured North through East). These angles are calculated from current alignment calibrations and reflect uncertainties of +/- 1°, except where greater uncertainties are indicated in the table comments. For the best estimate of an error for a specific SI, which is usually much less than 1°, consult with the SI team or go to the SI web pages available at: http://www.stsci.edu/hst/instrumentation.

⭐ **For any detailed orientation requirements, please describe your requirements clearly in the proposal text and give angles and offsets. Please feel free to contact your Program Coordinator for assistance in preparing your orientations.**

Figure 6.2: *Relationship between ORIENT, offset angle, and position angle* shows the relationship between these angles in the case that the selected axis is the y axis of the aperture, but can be generalized to other cases as described below the figure. The projection of the aperture on the sky may be skewed, as shown in the figure.

Figure 6.2: Relationship between ORIENT, offset angle, and position angle
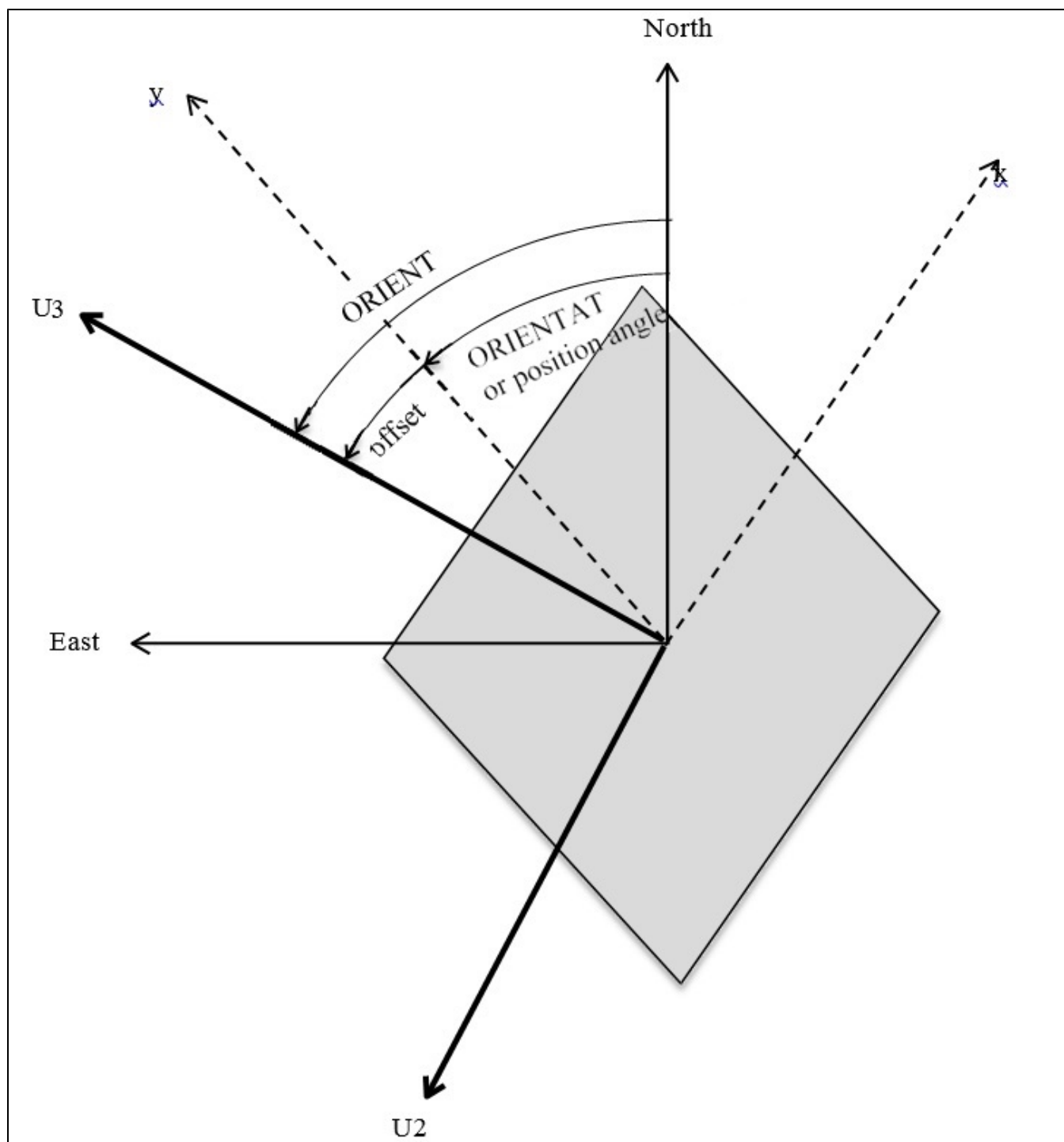
This figure illustrates the meanings of ORIENT, ORIENTAT, and offset angle. ORIENTAT (a keyword in the science data header) refers specifically to the y axis of an aperture and is measured from North to the y Axis. In the general case, to allow for other choices of axis, we call the angle from North to the selected axis the position angle or PAaxis. All angles are measured in the North through East direction, anti-clockwise in the on-sky view.

Table 6.2: *Accuracies of Guiding Modes* gives offset angles to an accuracy of +/- 1° for each instrument (or larger if indicated in the Comments column). These should be adequate for most purposes. There are differences of fractional degrees between the offset angles of different apertures on the same instrument because the angles are measured locally at the fiducial point of each aperture. The most accurate offset angles for the x and y axes for each aperture on each instrument may be found under http://www.stsci.edu/hst/instrumentation/focus-and-pointing/apertures

These angles are in the V2,V3 system, which is rotated by exactly 180° from the U2,U3 system, and are measured in the opposite sense, i.e. from V3 to the axis. So before doing the above calculation, subtract these tabulated axis angles from 180°. For example, to assign the offset angle for the UVIS-FIX y axis, read the V3 to Y axis angle, which is 44.8°, and subtract this from 180° to get 135.2° (compared to 135° from Table 6.2: *Accuracies of Guiding Modes*). Similarly, the UVIS-FIX x axis is -41.4° from V3, leading to a U3 offset angle of 221.4° (compared to 221° from Table 6.2: *Accuracies of Guiding Modes*).

As another example, suppose that an observer determines that ORIENTAT=30.0° is the optimal orientation of the WFC3/IR GRISM1024 aperture to avoid the overlap of G141 spectra in a moderately dense field (see Section 8.3 of the *WFC3 Instrument Handbook*). In this case, offset angle(y axis) = 180.0 – 44.7 = 135.3° (compared to 135° from Table 6.3: *Approximate Separation and Orientations between the Science Instruments*), so ORIENT = 135.3 + 30.0 = 165.3°. Note that the skew of the projected aperture on the sky is very small (44.7-(-45.2)=89.9~90°).

Further examples of computing the ORIENT of a visit are illustrated in Figures 6.3, 6.4, 6.5, and 6.6.

To control the placement of two instruments on an astronomical field in coordinated parallel exposures, one can make use of the angle between the U3 axis and the line connecting the centers of the two instruments, as specified and described in Table 6.3: *Approximate Separation and Orientations between the Science Instruments*). For example, for some of the visits in the Frontier Fields programs that use aperture WFCENTER on ACS/WFC in parallel to aperture IR-FIX on WFC3/IR:

ORIENT=offset(WFC3 to ACS/WFC)+PAaxis (axis = vector from WFC3 to ACS/WFC)

The desired PAaxis was 280°. From Table 6.3: *Approximate Separation and Orientations between the Science Instruments*, the offset angle (WFC3 TO ACS/WFC) is 133°, so ORIENT = 133 + 280 = 413° = 53°. The placement of the apertures on the sky is shown in Figure 6.6: *Orientation computation for ACS/WFC*.

Table 6.3: Approximate Separation and Orientations between the Science Instruments

Instrument	Apertures	Separation[1] (arcsec)	Offset Angle[2] (degrees)
ACS	WFC3 to ACS/WFC	356	133°
	STIS to WFC	663	136°
	STIS to SBC	817	150°
STIS	WFC3 to STIS	308	315°

| COS | WFC3 to COS | 318 | 45° |

[1] The vector separations are calculated from current estimates of the locations of the WFC3, COS, and STIS apertures. These values can change with time.

[2] The Offset Angle is defined as the angle from the line connecting the two Science Instruments to the +U3 axis in the counterclockwise direction (the +U3 through +U2 direction). These numbers are calculated from current estimates and reflect uncertainties of +/- 1°, except where greater uncertainties are indicated in the table.

> ⭐ For any detailed orientation requirements, please describe your requirements clearly in the proposal text and give angles and offsets. Please feel free to contact your Program Coordinator for assistance in preparing your orientations. The above tabulated values are meant to be representative, and because of instrument-specific details the value you need may differ. Please refer to the Observatory Pointing and Apertures pages for current values: http://www.stsci.edu/hst/instrumentation/focus-and-pointing/apertures

Specifying ORIENT

The value or range of values of **ORIENT** required for a visit should be specified in the Special Requirement ORIENTation <angle1> TO <angle2> or, to relate the **ORIENT** of one visit to that of another visit, ORIENTation <angle1> TO <angle2> FROM <visit> or SAME ORIENTation AS <visit>. Each of these Special Requirements is discussed below. If there is any uncertainty in specifying an orientation, please document the calculations in the Visit_Comments and contact your Program Coordinator for clarification.

If a visit contains multiple targets requiring different guide stars, the spacecraft orientation will normally be reset to the "nominal" orientation each time a new set of guide stars is acquired. However, if the visit has Special Requirement ORIENTation <angle1> TO <angle2> FROM <visit> or SAME ORIENTation AS <visit>, the spacecraft orientation will *not* change during the visit, even if multiple sets of guide stars are needed.

> ⭐ ORIENTation Special Requirements are a limited resource and should be used only when necessary.

ORIENTation <angle1> TO <angle2>

Specifies that a specific absolute roll angle or orientation of the spacecraft is required for the exposures within the current visit. <angle1> and <angle2> denote a region within which the position of the U3 axis on the sky (measured North through East) must fall at the time of the observation; both limits must be between 0° (**0°**) and 360° (**360°**). If necessary, it is possible for <angle1> and <angle2> to be equal, but the size of the region between the two limits should be made as large as possible to make scheduling easier. Note that in most instances the angles can have a 180° offset and still work. If this is desired (for greater scheduling flexibility), please specify the additional possible angles. (This Special Requirement **must have been indicated in the Phase 1 proposal**.)

Note also that this Special Requirement can list several acceptable angle ranges:

ORIENTation <angle1> **TO** <angle2>

ORIENTation <angle3> **TO** <angle4>

ORIENTation <angle5> **TO** <angle6>

ORIENTation <angle7> **TO** <angle8> . . .

Both angles are measured in a counterclockwise direction, so if the orientation region crosses zero (celestial North), <angle1> would be greater than <angle2>. Otherwise, <angle1> should be less than <angle2>. It is also possible for the orientation region to be larger than 180°. You are encouraged to enter both the aperture angle(s) and the offset angle used to calculate these angles in the **Visit_Comments**.

Note: If the visit uses multiple targets, the direction of North from the first target will be used. The spacecraft will not roll between targets, so that the U3 position angle at the new target may be slightly different from that of the first target.

ORIENTation <angle1> TO <angle2> FROM <visit>

Specifies that a roll angle or orientation of the spacecraft, **relative** to another visit's spacecraft orientation, is required for the exposures within the current visit. <angle1> and <angle2> denote a region of permitted orientation of the current visit relative to <visit>. <angle1> and <angle2> must be between -180° (**-180°**) and +180° (**180°**). If necessary, it is possible for <angle1> and <angle2> to be equal, but the size of the region between the two limits should be made as large as possible to make scheduling easier.

Both angles are measured in a counterclockwise direction, so if the orientation region crosses a point 180° from <visit>, <angle1> should be positive and <angle2> negative. Otherwise, <angle1> should be less than <angle2>. It is possible for the orientation region to be larger than 180°.

(This Special Requirement **must have been indicated in the Phase 1 proposal**.) To specify that the current visit be scheduled at the same orientation as another visit, use the SAME ORIENTation AS <visit> Special Requirement.

> ⭐ Note that only one ORIENT ... FROM"may be specified for a visit.

Nominal and Off-Nominal Roll

Orientation constraints translate into timing constraints. Generally, if the spacecraft is unable to roll far enough "off-nominal" to satisfy the required difference in orientation between the two visits, they will be forced apart in time in order to schedule both at near nominal roll. "Nominal roll" is the orientation determined by the necessity of keeping the solar panels perpendicular to the Sun. Targets near the ecliptic have two values of nominal roll through the year 180° apart. Near the ecliptic pole, nominal roll varies by about a degree per day.

In general, the off-nominal roll is limited to less than +/- 30° except when the target is within 2° of opposition (i.e., exactly opposite the Sun in the sky as viewed from the Earth). Observations scheduled with solar elongations between 90° and 178° can be done at up to 15 to 30° off nominal, depending on the exact elongation. For observations scheduled when the target is within 90° of the Sun, the off-nominal roll is limited to 5°. The legal syntax for <angle1> and <angle2> allows angles between -180° (**-180°**) and +180° (**180°**). Please contact your Program Coordinator for details if necessary.

SAME ORIENTation AS <visit>

Sometimes any orientation (or any orientation within the range of the **ORIENT** Special Requirement) is acceptable the first time an object is observed, but must then be the same for subsequent observations of that target. This Special Requirement requests that the exposures in the current visit be made at the same telescope roll angle as the observations specified in <visit>. If timing Special Requirements are also used, then an incompatibility may result or the observations may be difficult to schedule. (This Special Requirement **must have been indicated in the Phase 1 proposal**.)

Examples of Orientation Angle Computations

We show four examples in Figures 6.3 to 6.6 of how to compute the **ORIENT** of an aperture for WFC3, STIS, FGS and ACS/WFC. In Figure 6.7: *Orientation computation for ACS/WFC in parallel to WFC3*, we show an example of how to compute the **ORIENT** for the axis joining two apertures for parallel exposures with WFC3 and ACS/WFC.

Figure 6.3: Orientation computation for WFC3/UVIS
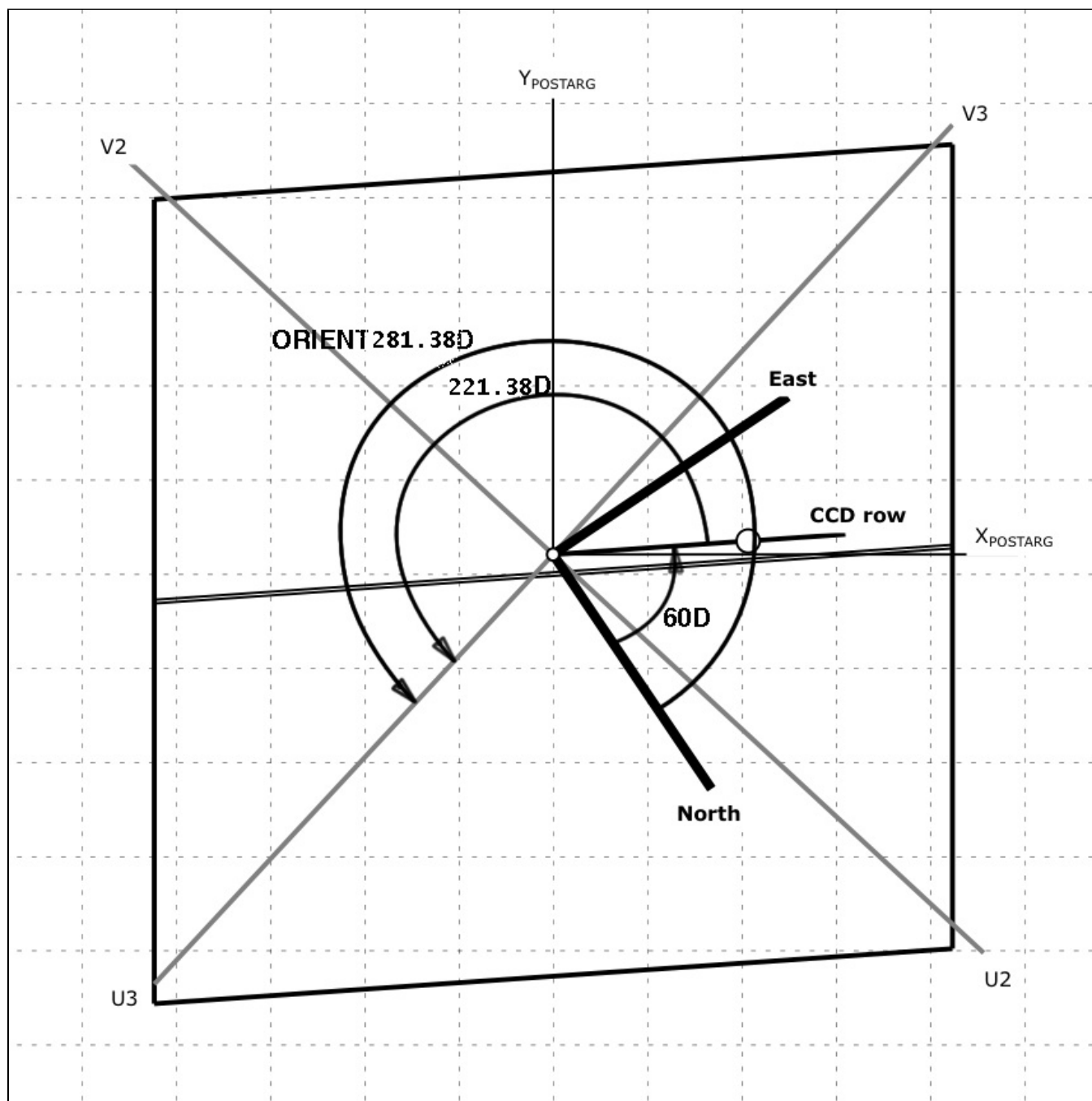
Using the WFC3 UVIS CCD, we wish to image a faint object that is in the vicinity of a bright star. We also want to minimize bleeding of the signals of the bright star onto the faint target. Therefore, the telescope is rolled so that both the target and bright star are imaged on the same row (signals bleed along columns). The target is imaged at the default UVIS aperture position, as shown in the figure. The figure shows the projection of the UVIS detector on the sky; the dashed grid represents the POSTARG coordinate system. For this example, the position angle of the bright star with respect to the faint target is 60°. Note that the CCD rows are not aligned with the X_POSTARG direction, whereas columns are aligned with the Y_POSTARG direction. The value of the ORIENT angle (the position angle of U3) is 60° (the position angle of the axis of interest) + 221° (the offset angle of the CCD row to U3 as given in Table 6.2: *Accuracies of Guiding Modes*) = 281°. Using the more accurate offset angle computed from the SIAF table for WFC3 as described in the text (offset = 180° - (-41.38°) = 221.38°), the **ORIENT** is 60° + 221.38° = 281.38°.

Figure 6.4: Orientation computation for STIS
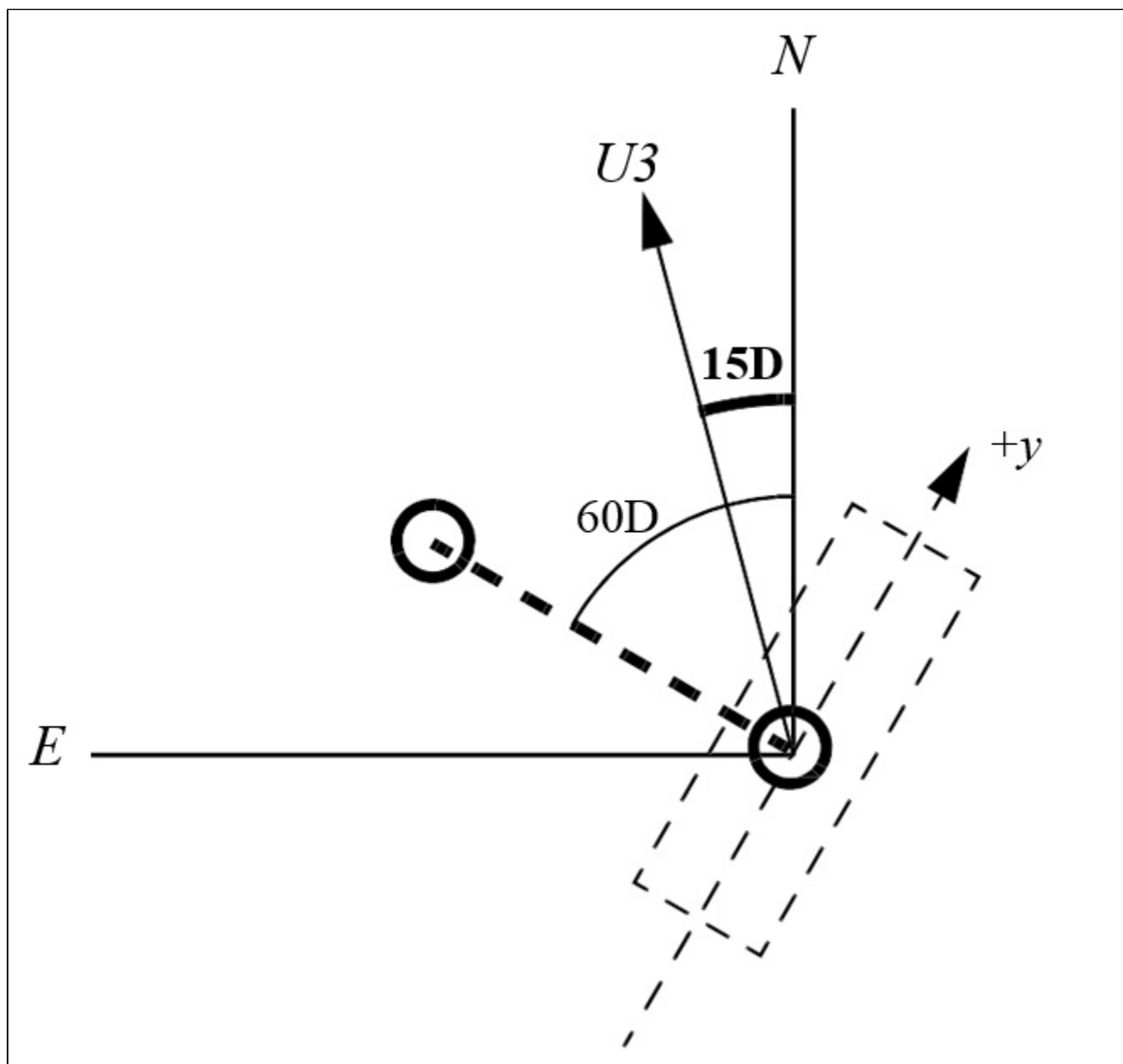
In this example we consider a close binary system in which the position angle of the line joining the stars is 60°. We wish to position the slit to exclude light from the companion star, so that the +Y axis (the long direction of the slit) is at -30°. The U3 axis (Table 6.2) lies at 45° from +Y, or at PA 15°. If a tolerance of 12° is allowed, we would then specify ORIENT 3° TO 27°. Because of the symmetry of the slit, it would also work if the orientation were flipped 180°, so the net specification is:

ORIENT 3° TO 27°

ORIENT 183° TO 207°

Figure 6.5: Orientation computation for FGS-1R, in TRANS mode
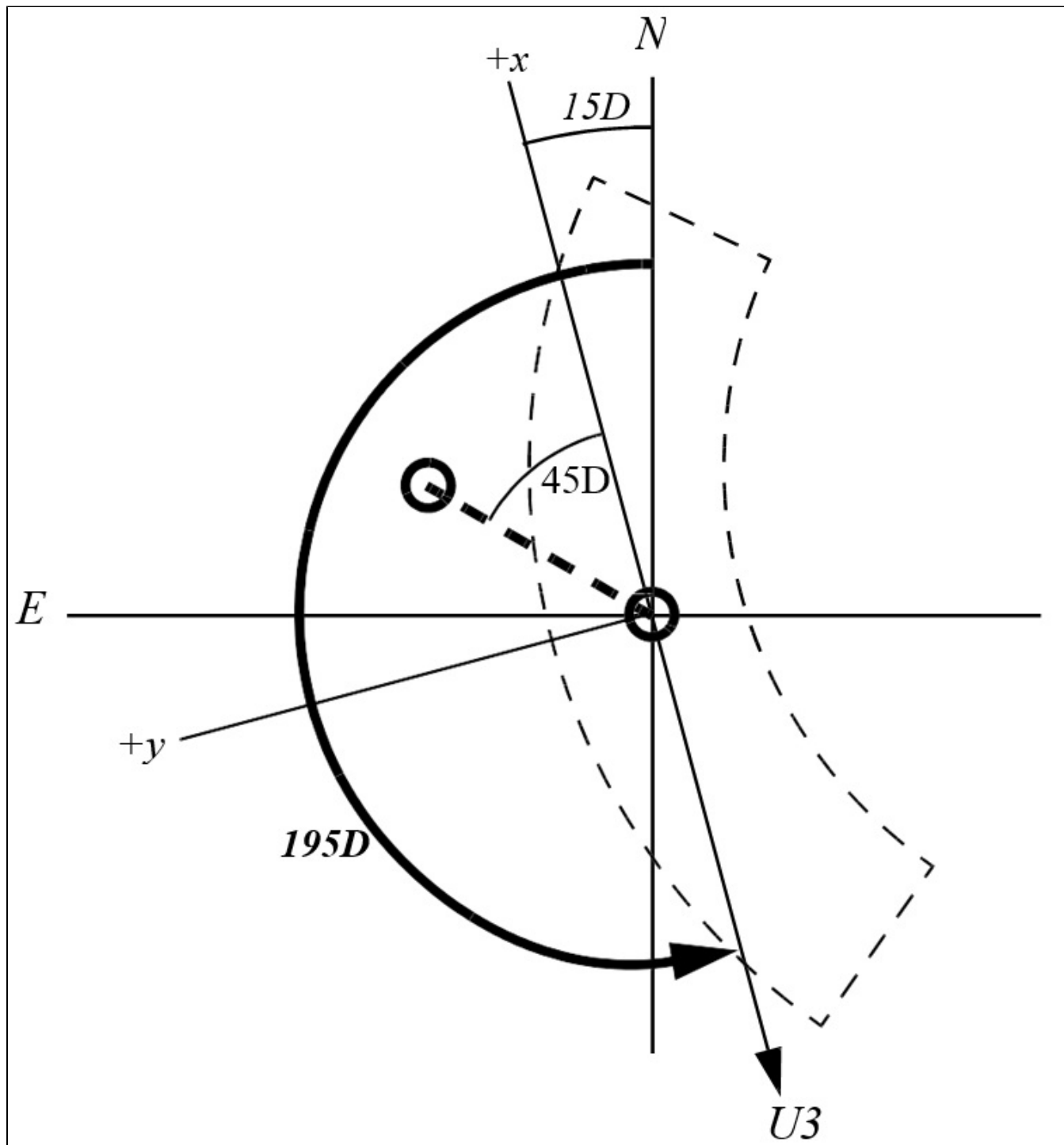
In this example we consider the same close binary system in which the position angle of the line joining the stars is 60°. The scans will be done parallel to the line joining the binary components, with a tolerance of 20°. TRANS mode scans move the instantaneous field of view at an angle of 45° relative to the FGS1 axes. The +X axis will have a PA of 60°, minus the 45° offset, or 15°. The U3 axis is 180° from +X (Table 6.2: *Accuracies of Guiding Modes*), thus we specify:

ORIENT 175° to 215°

Figure 6.6: Orientation computation for ACS/WFC
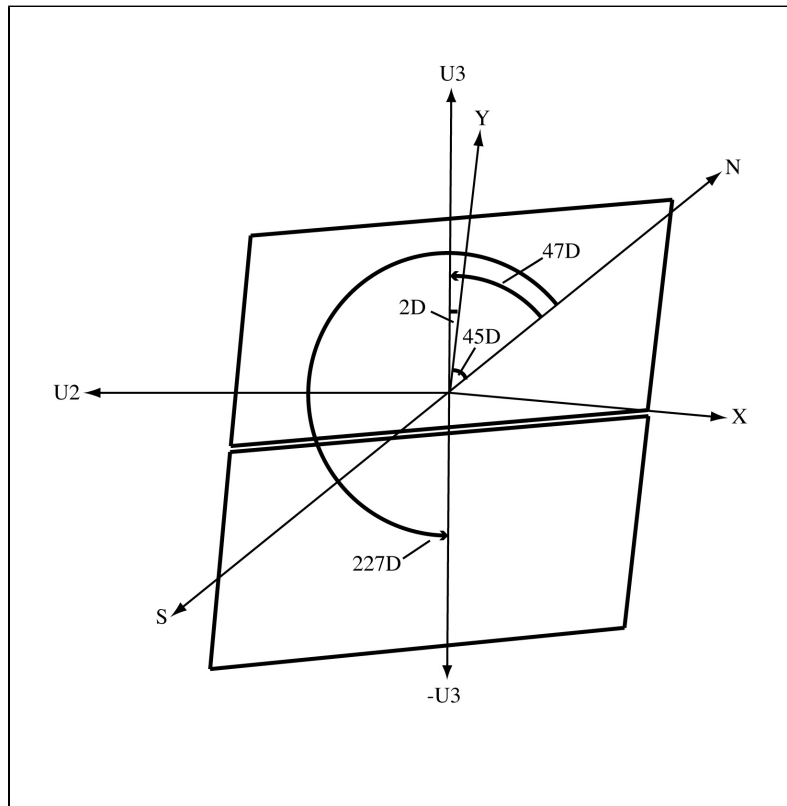
The target has a very bright neighboring star 10" away to the Northeast (PA = 45°). This star will saturate, leaving a bleeding trail along the entire y-axis of the detector. A user should therefore normally orient the telescope so that the bleeding trail does not run through the target; in other words, if keeping the target position at the same place on the chip, the bright star should be displaced from the target by means of an **ORIENT** which puts the offending star away from the target by +/- 10°. Adding an **ORIENT** constraint is the way to do this if wanting to keep the target at the nominal position with no x-axis displacement of the target, and is the primary purpose of this example. An alternate method if the **ORIENT** cannot be changed for some reason would be to displace the target position in the x-axis by some sufficient amount to avoid having the charge bleed down the same and adjacent y-axis columns onto the target. For larger extended targets, however, this method would require a much larger displacement of the target coordinates along the x-axis and may be impractical. Simply changing the **ORIENT** is the usual preferred method, or perhaps some combination of change in target position and **ORIENT** may help in some situations if absolutely necessary.

From Table 6.3: *Approximate Separation and Orientations between the Science Instruments*, we know that the U3 axis is 2° from the +y axis (measured north to east). Therefore, avoid the **ORIENT** angle that places the bright star on the y axis: 47° (45° + 2°, PA_star + angle from U3 to Y). Since blooming affects the entire detector y-axis, also avoid the angle 180° away, 227° (47° + 180°). For added caution, avoid +/- 10° about those angles. The **ORIENT**s to avoid are from 37° to 57° and from 217° to 237°. Therefore, keeping the same target position, it is safe to use **ORIENT 57° TO 217°** and **ORIENT 237° TO 37°**.

Figure 6.7: Orientation computation for ACS/WFC in parallel to WFC3
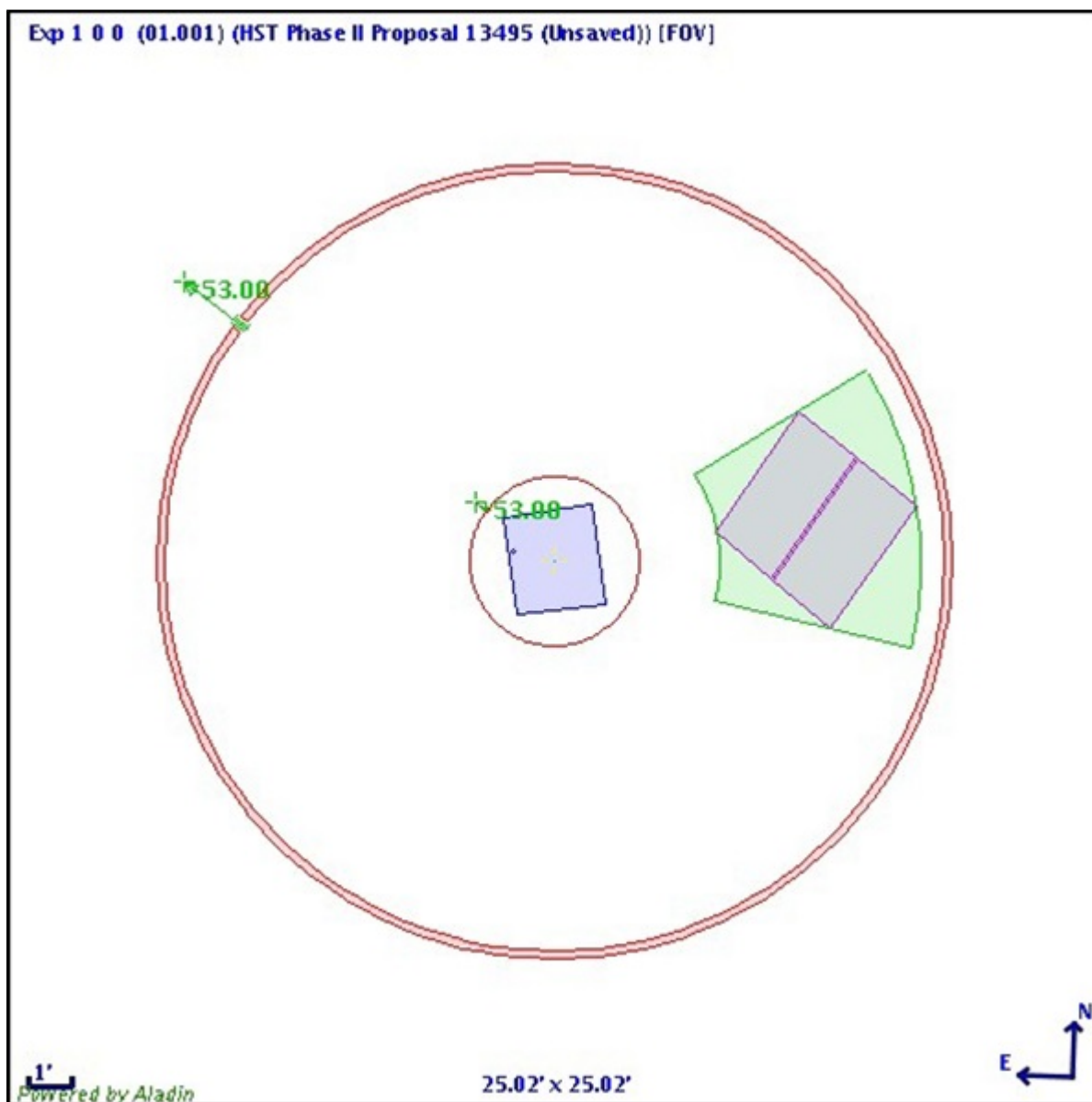
To control the placement of two instruments on an astronomical field in coordinated parallel exposures, one can make use of the angle between the U3 axis and the line connecting the centers of the two instruments. For example, to use aperture WFCENTER on ACS/WFC in parallel to aperture IR-FIX on WFC3/IR:

ORIENT=offset (WFC3 to ACS/WFC)+PAaxis (axis = vector from WFC3 to ACS/WFC)

For some of the visits in the Frontier Fields programs, the desired PAaxis was 280°. From Table 6.3: *Approximate Separation and Orientations between the Science Instruments*, the offset angle (WFC3 TO ACS/WFC) is 133°, so **ORIENT** = 133° + 280° = 413° = 53°.

Related Links

6.2.1 General Visit-level Special Requirements
6.2.3 Timing Visit-level Special Requirements

Change Log

Version Cycle 31 July 2023

Fixed a link to the WFC3IHB

Version Cycle 30 April 2022

PROPINST-91383 Emphasize which special requirements should have been preapproved in Phase I (Applied to Orient, Orient From, and Same Orient)

6.2.3 Timing Visit-level Special Requirements

Timing Special Requirements (e.g., AFTER, GROUP) are used to restrict the scheduling of HST observations by timing constraints. The Astronomer's Proposal Tool (APT) is used to enter the requirements into the proposal.

On This Page

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.
⭐ Black text indicates an important note.
Magenta text indicates available but unsupported parameters (requires prior approval from STScI).
Red text indicates restricted parameters (for STScI use only).Brown text indicates text file parameters.
Items in brackets - **<value>** - are required values.
Items in square brackets - **[<value>]** - are optional.

Introduction

Most general special requirements directly or indirectly restrict the times when observations (and/or their component visits) can be scheduled. These should be used to provide the schedulers at STScI with enough constraints to ensure that the observations are properly scheduled. **Special requirements should not be used unless necessary to accomplish the scientific objectives of the proposal.**

AFTER <date>

Specifies that the visit must start after the date given by <date>. The capability to designate a specific exposure within a visit to start after a certain time is not supported by this Special Requirement; that case is intended to be handled by adjusting timing within the visit. (This Special Requirement **must have been indicated in the Phase 1 proposal**.)

AFTER <visit> [BY <time1> TO <time2>]

Specifies that the visit must start after the indicated <visit>. The **BY** <time1> **TO** <time2> option allows specification of the time interval (and its allowable range) that must elapse between the **start** of the referenced visit and the **start** of the current visit. For example, **AFTER 6 BY 7H TO 9H** requests that the current visit start no earlier than 7 hours and no later than 9 hours after the start of visit 6. The capability to designate a specific exposure within a visit to start after a certain time is not supported by this Special Requirement; that case is intended to be handled by adjusting timing within the visit. (This Special Requirement **must have been indicated in the Phase 1 proposal**.)

Note: If the difference between <time1> and <time2> is too small, the visit may be impossible to schedule. A difference of at least 90 minutes (about 1 orbit) is recommended. Also note that <time1> must be as long as the anticipated duration of the referenced visit.

BEFORE <date>

Specifies that the current visit must start before the <date> given. The capability to designate a specific exposure within a visit to start before a certain time is not supported by this Special Requirement; that case is intended to be handled by adjusting timing within the visit. (This Special Requirement **must have been indicated in the Phase 1 proposal**.)

BETWEEN <date1> AND <date2>

Specifies that the current visit must start between <date1> and <date2>. For example, **BETWEEN 14-SEP-1999 AND 21-SEP-1999** indicates that the visit must be started after 14 September 1999 and before 21 September 1999. The capability to designate a specific exposure within a visit to start at a certain time is not supported by this Special Requirement; that case is intended to be handled by adjusting timing within the visit. (This Special Requirement **must have been indicated in the Phase 1 proposal**.)

Multiple **BETWEEN** Special Requirements may be specified on a visit. The visit will be allowed to execute during any of the time intervals specified. For example, the combination of **BETWEEN 14-SEP-1999 AND 21-SEP-1999** and **BETWEEN 10-OCT-1999 AND 1-NOV-1999** means that the visit must be started either between 14 September 1999 and 21 September 1999, or between 10 October 1999 and 1 November 1999. Multiple **BETWEEN** intervals on the same visit may not overlap: all the other intervals must either end earlier than <date1> or start later than <date2>.

> ⭐ The BEFORE, AFTER <date>, and BETWEEN Special Requirements are mutually exclusive. A visit which specifies one may not specify either of the other two, although multiple BETWEENs are allowed. Note that any BEFORE or AFTER <date> may be replaced by a BETWEEN with a sufficiently early start date or late end date. However, AFTER <visit> may be combined with BETWEEN or BEFORE.

GROUP <visits> WITHIN <time>

Specifies that visits included in the visit list provided must all start within the <time> given. The number of visits in a Group Within set cannot exceed 32. If the interval given is shorter than the least interval possible, the visits will be scheduled as close together as possible. For example, **GROUP 7-10 WITHIN 12H** requests that visits 7 through 10 all start execution within a 12-hour interval. (This Special Requirement **must have been indicated in the Phase 1 proposal**.)

Note that **GROUP WITHIN** is only a timing Special Requirement, and it implies nothing about relative ordering. **GROUP 7-10 WITHIN 12H** could possibly execute in the order 10, 7, 9, 8, for example.

PERIOD <time>   ZERO-PHASE (HJD) <date>

Supplies the period and zero-phase for observations to be made at a specific phase of a periodically variable target. <time> is the period in days, hours, minutes or seconds, and <date> is the date of the zero-phase with respect to the Sun (i.e., HJD, not a calendar date). Note that, while this requirement is at the visit level, the actual **PHASE** Special Requirement is on the exposure level. (This Special Requirement **must have been indicated in the Phase 1 proposal**.)

If a target has multiple periods which must be satisfied simultaneously, the **PERIOD ZERO-PHASE** Special Requirement should refer to the shorter of the two periods and the longer period can be specified using multiple **BETWEEN** Special Requirements that cover the next year and a half. Be sure to discuss this with your Program Coordinator. (Example: The target is a X-ray pulsar. The observation needs to occur in a particular phase of the 35-hour binary period as well as a particular phase of the 2-month on/off period. Use the **PERIOD ZERO-PHASE** Special Requirement for the 35-hour period and then specify the 2-month period with multiple **BETWEEN**s.)

SEQuence <visits-checked> WITHIN <time>

Specifies that visits included in the provided visit list must start within the <time> given, and must be ordered according to their visit number. If the interval given is shorter than the least interval possible, the visits will be scheduled as close together as possible. For example, **SEQuence Visits 7-10 WITHIN 10H** means that visit 10 must begin execution within 10 hours of the start time of visit 7, with visits 8 and 9 executing between. SEQuence does not change the order of visits. (This Special Requirement **must have been indicated in the Phase 1 proposal**.)

Note that all SEQ WITHIN visits will be executed in numerical order, so **SEQuence Visits 2, 1, 4 WITHIN** and **SEQuence Visits 1, 2, 4 WITHIN** do the same thing.

VISIBILITY INTERVAL CORON

This special requirement overrides the orbital visibility period normally computed for the visit. The computed CORON orbital visibility period is based on the target declination and the amount of slew time needed to execute the orientation change specified in the proposal. This should not be used in conjunction with the CVZ or SCHEDulability <percentage> Special Requirements.

Please note that this special requirement reduces the visibility interval used to plan your orbits to a half orbit. It is ordinarily implementation-only; see VISIBILITY INTERVAL <time>.

VISIBILITY INTERVAL NO GYRO BIAS UPDATE ON MOVING TARGET

This special requirement overrides the orbital visibility period normally computed for the visit. This should not be used in conjunction with the CVZ or SCHEDulability <percentage> Special Requirements.

As HST is aging, one of its gyros needs a calibration, called a "gyro bias update", to be conducted no less frequently than every third HST orbit in order to maintain satisfactory performance. Initially, a gyro bias update could be conducted only when the telescope was at fixed pointing. When this was the case, it was necessary to limit the duration of moving target visits to no more than 2 orbits.

More recently, an update to the HST onboard software has enabled a gyro bias update to be conducted during a moving target visit. However, that ability comes at the price of consuming 6 minutes at the end of the target visibility interval. In order to reserve sufficient time for gyro bias updates during moving target visits, APT defaults to showing a target visibility interval that is 6 minutes less than would otherwise be the case.

If VISIBILITY INTERVAL NO GYRO BIAS UPDATE ON MOVING TARGET is specified, then APT will provide the full target visibility interval without the 6 minute truncation. However, the visit will then be limited to a duration of no more than 2 orbits.

Related Links

6.2.1 General Visit-level Special Requirements
6.2.2 Target Orientation Visit-level Special Requirements

Change Log

Version Cycle 30 April 2022

PROPINST-91383 Emphasize which special requirements should have been preapproved in Phase I (After, After by, Before, Between, Group Within, Period, Seq Within)

Version Cycle 29 April 2021

1. PROPINST-91379 - VISIBILITY INTERVAL NO GYRO BIAS UPDATE ON MOVING TARGET

6.3 Exposure-level Special Requirements

Exposure Special Requirements summary

HST has special requirements that are used to specify scheduling constraints at the exposure level, and this article contains the descriptions of those requirements.

Sections

- 6.3.1 General Exposure-level Special Requirements
- 6.3.2 Timing Exposure-level Special Requirements
- 6.3.3 Target Position Exposure-level Special Requirements

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Format definitions
More about Exposure-level Special Requirements
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Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

More about Exposure-level Special Requirements

💡 Use the table below to go directly to information for a particular exposure-level special requirement.

The following Special Requirements apply to individual exposures within a visit. All instances of <exposure-list> or <exposure> refer **only** to exposures in the same visit as the exposure carrying the requirement.

Supported Formats for Exposure-level Special Requirements

FORMAT	EXAMPLE	
Target Acquisition Requirements		
INTeractive ACQuisition (obsolete)	No longer available; see text.	
Special Observation Requirements		
SPATIAL SCAN <Scan_Rate>, <Scan_Orient>, <Scan_Direction>, <Scan_Line_Separation>, <Scan_Number_Lines>		
PARallel <parallel-exp-list> WITH <primary-exp-list>	See Exposure Containers: Exposure Sequences, Coordinated Parallels and Patterns PAR 4-6 WITH 1-3	*Must be indicated in Phase 1 proposal*
Special Communications Requirements		
RT ANALYSIS	RT ANALYSIS	
REQuires UPLINK	REQ UPLINK	
REQuires EPHEMeris CORRection <id>	REQ EPHEM CORR OFF-13	
Target Position Requirements		
POSition TARGet <X-value>,<Y-value>	POS TARG +6.3,-8.1	
SAME POSition AS <exposure>	SAME POS AS 6	
PATTERN <#> [<exposure-list>] (*Replaced by Pattern Containers in the APT User Interface*))	See Exposure Containers: Exposure Sequences, Coordinated Parallels and Patterns and 7 Pointings and Patterns PATTERN 5 1-4	
Timing Requirements		
LOW-SKY	LOW-SKY	*Must be indicated in Phase 1 proposal*

PHASE <number1> TO <number2>	PHASE 0.09 TO 0.11	*Must be indicated in Phase 1 proposal*
SEQuence <exposure-list> NON-INTerruptible	See Exposure Containers: Exposure Sequences, Coordinated Parallels and Patterns and 7 Pointings and Patterns SEQ 2-5 NON-INT	*Must be indicated in Phase 1 proposal*
SHADOW	SHADOW	*Must be indicated in Phase 1 proposal*

FORMAT	EXAMPLE
For engineering parameters	
Special Communications Requirements	
FORMAT [AN or FN or HN or PN]	FORMAT FN
Visit Special Requirements	
VISIBILITY INTERVAL <time>	VISIBILITY INTERVAL 5000 S
Exposure Special Requirements	
MAXimum DURation (time or %) <value>	MAX DUR 125%
MINimum DURation (time or %) <value>	MIN DUR 1200S
EXPAND (pure parallel exposures only)	EXPAND
NEW OBSET [FULL ACQ]	NEW OBSET
NEW ALIGNMENT	NEW ALIGNMENT
SAME OBSET <exposure-list> (replaced by Exposure Group containers in the APT User Interface)	See Exposure Containers: Exposure Sequences, Coordinated Parallels and Patterns and 7 Pointings and Patterns SAME OBSET 10-20
SAME ALIGNMENT <exposure-list> (in APT replaced by Exposure Group containers in the APT User Interface)	See Exposure Containers: Exposure Sequences, Coordinated Parallels and Patterns and 7 Pointings and Patterns SAME ALIGNMENT 20-30
SAME GUIDE STARS <exposure-list> (in APT replaced by Exposure Group containers in the APT User Interface)	See Exposure Containers: Exposure Sequences, Coordinated Parallels and Patterns and 7 Pointings and Patterns SAME GUIDE STARS 10-20
GSPAIR <pair-id->	GSPAIR 0748300182F10000000000F0
OBSET ID <id>	OBSET ID A2
EXP PCS MODE [FINE	GYRO]	EXP PCS MODE FINE
GS ACQ SCENARIO [PAIR	SINGLE	GYRO	<scenario>]	GS ACQ SCENARIO SINGLE

For available but unsupported parameters

FORMAT	EXAMPLE
Target Acquisition Requirements	
SAVE OFFSET <id>	SAVE OFFSET OFF-1
USE OFFSET <id>	USE OFFSET OFF-1
Special Observation Requirements	
SAA CONTOUR <model number> (for WFC3, ACS/WFC and S/C modes; Restricted for ACS/SBC, CAL and ENG proposals)	SAA CONTOUR 02
QASISTATES <si> <detector> <start> <end>	QASISTATES ACS ACS/WFC A1 B2
QESIPARM <parameter> <value>	QESIPARM A1 B1
QELOGSHEET <parameter> <value>	QELOGSHEET AP_1 B1
Timing Requirements	
AFTER BY <time> [TO <time2>]	AFTER BY 15M to 16M

For restricted parameters

FORMAT	EXAMPLE
Target Acquisition Requirements	
USE OFFSET <id> Use for any CALibration, ENGineering or SMOV program	USE OFFSET 9100-1
Special Observation Requirements	
SPECial COMmanding [INSTR <NAME>]	SPEC COM INSTR ESPFORMAT

Related Links

6.2 Visit-level Special Requirements

Change Log

Version Cycle 31 July 2023

Fixed the links in the right hand column

Version Cycle 30 April 2022

PROPINST-91383 Emphasize which special requirements should have been preapproved in Phase I (Added to table)

6.3.1 General Exposure-level Special Requirements

General Special Requirements (e.g., POS TARG, PHASE) are generally used to restrict the scheduling of HST observations by various constraints. The Astronomer's Proposal Tool (APT) is used to enter the requirements into the proposal.

On This Page

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

★ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

Most general special requirements directly or indirectly restrict the times when observations (and/or their component visits) can be scheduled. These should be used to provide the schedulers at STScI with enough constraints to ensure that the observations are properly scheduled. **Special requirements should not be used unless necessary to accomplish the scientific objectives of the proposal.**

Target Acquisition

Separate target acquisition exposures must be specified at the beginning of most visits, depending on the target and the science instrument used. Target acquisition exposures are used to remove coordinate uncertainties and to identify targets. Once a target acquisition has been performed, HST can move the target from aperture to aperture or move the aperture around the target (with slew accuracies of about 10 milliarcseconds) as long as the same guide stars can be used. Onboard acquisitions are automatically identified by the software. Acquisition exposures must still be specified, but no Special Requirement is needed or appropriate.

Acquisition of a target using an offset target requires that both be defined in the Target List(s). The first exposure will be an onboard or interactive acquisition of a target from which the offset will be made. This target must be designated as an offset acquisition target by appending **-OFFSET** to the end of the target name (see Table 3.1: *Designations of Special Targets*). The appropriate offsets will automatically be made from this position to slew to the target of interest.

INTeractive ACQuisition (obsolete)

> ⭐ INT ACQ is restricted and it should not be used at all.

Interactive acquisitions may no longer be performed with HST. However, the same results can be achieved in other ways, and you should consult your Program Coordinator for more information.

For available but unsupported parameters (SAVE OFFSET, USE OFFSET)

SAVE OFFSET <id>

This requirement is used to save the results of a target acquisition sequence for use by one or more subsequent exposures, which are normally in different visits. **SAVE OFFSET** indicates that this exposure will generate a pointing correction (or "offset") for future science exposures which specify **USE OFFSET** with the same <id>.

The purpose of the **SAVE OFFSET/USE OFFSET** procedure is to allow more efficient and flexible scheduling of observations. This Special Requirement is especially useful for replacing **INTeractive ACQ**uisitions, which are no longer supported. Unlike the former **INTeractive ACQ**uisition Special Requirement, the **SAVE OFFSET/USE OFFSET** procedure is not considered a limited resource. It should be used whenever it is possible to leave at least 3 days between this exposure and the first science exposure which uses the acquisition (in some instances this time delay can be reduced to as little as three orbits).

Target acquisition time may be saved if repeated observations of the same target are planned for multiple visits. In the first visit, the relevant target acquisition exposure should include the **SAVE OFFSET** <id> Special Requirement. Subsequent visits to the same target do not require repeating the target acquisition procedure; these exposures can simply specify the **USE OFFSET** <id> Special Requirement.

In either case, unless the **RT ANALYSIS** Special Requirement is placed on the same exposure, visits which use an offset will be scheduled at least 3 days after the initial **SAVE OFFSET** visit. This allows time for the data to be downlinked and analyzed. The offset may **not** be saved and used in the same visit. For exposures with modes beginning with "**ACQ**," visits which use an offset will be scheduled at least 3 days after the initial **SAVE OFFSET** visit.

The <id> is an alphanumeric string of up to six characters in length. No two **SAVE OFFSET** Special Requirements in a proposal may use the same <id>, and every <id> from a **SAVE OFFSET** exposure must be used in at least one **USE OFFSET** exposure.

> ★ IMPORTANT: Both SAVE OFFSET and USE OFFSET rely on accurate coordinate uncertainties in order to calculate slew times properly. Unspecified target coordinate uncertainties may lead to a failure in execution of USE OFFSET. Program Coordinators should ensure that target coordinate uncertainties have been provided by the observer and that they are accurate.

USE OFFSET <id>

This Special Requirement is used to apply the results of a previous target acquisition sequence (one that specified **SAVE OFFSET** with the same <id>). Only one **USE OFFSET** Special Requirement is allowed per exposure, but it is permissible to use multiple offset <id>'s in the same visit. STScI personnel will help determine the necessary offsets. These offsets may require a minute or two of orbital visibility time.

As described under **SAVE OFFSET**, this Special Requirement is useful for replacing the former **INT**eractive **ACQ**uisition. The observer is usually required to be present at STScI at the time the **SAVE OFFSET** exposure is taken to determine the offset. Please contact your Program Coordinator.

Unless the **SAVE OFFSET** exposure also has the **RT ANALYSIS** Special Requirement, the **SAVE OFFSET** and **USE OFFSET** exposures must be in separate visits, and the visits will be scheduled at least 3 days apart. If the **SAVE OFFSET** exposure uses a mode beginning with "**ACQ**," visits using an offset will be scheduled at least 3 days after the initial **SAVE OFFSET** visit. It is not possible to override this separation with an **AFTER** Special Requirement. The **SAME ORIENT**ation Special Requirement is implicit and need not be specified directly. See the discussion on target orientation for an explanation of the restrictions this places on how far apart the visits may be scheduled.

If the exposure is on a moving target, the maximum target acquisition uncertainty must be specified in the solar-system target list (see Acquisition Uncertainty). If the exposure is on a fixed target, the position uncertainty in the fixed target list (see Required Accuracies of Target Positions) is used to determine the maximum offset. STScI will be unable to schedule corrections larger than this maximum offset, so too small an uncertainty may limit the usefulness of the **USE OFFSET** procedure. However, offsets larger than about 1 arcminute may make scheduling difficult. If your observation requires a correction this large, contact your Program Coordinator.

> The <id> is an alphanumeric string of up to six characters in length, and must be identical to the <id> defined by the preceding exposure with the **SAVE OFFSET** Special Requirement. Note that the <id> need only be unique within the proposal. It is not possible to use offsets across multiple proposals.

For restricted parameters (USE OFFSET)

USE OFFSET <id> Use for any CALibration, ENGineering or SMOV program

The <id> is an alphanumeric string of up to six characters in length. Although there is no formal requirement for it, we suggest using your proposal number, followed by a number such as the visit number or a counter that increments with each ACQ mode exposure in the proposal.

This Supported version of USE OFFSET <id> is not associated with an instance of Special Requirement SAVE OFFSET <id>.

Special Observation Requirements

SPATIAL SCAN <Scan_Rate>, <Scan_Orient>, <Scan_Direction>, <Scan_Line_Separation>, <Scan_Number_Lines>

HST has the capability of performing a single and multi line continuous (boustrophedonic or serpentine) scans relative to the target. Such scans may be useful for observing very bright targets without sacrificing visibility to serial buffer dumps, for example.

Spatial Scans are obtained by moving the spacecraft in a way that moves the target in the instrument aperture along a path in the POS TARG coordinate frame (see **POSition TARGet <X-value>, <Y-value>**) as designated by the observer. The scan is defined relative to the aperture fiducial point within the SI aperture.

Only one exposure may be executed during a spatial scan, and only one spatial scan may be executed during an exposure. STScI will schedule a spatial scan so that the constant rate portion of the first scan begins at the start of the exposure and the constant rate portion of the last scan ends at the end of the exposure.

Table 6.4: Spatial Scan Parameters[1]

Parameter	Description	Allowed Values	Required

Scan_Rate (arcsec /sec)	The constant angular rate at which the target will move with respect to the POS TARG coordinate frame.	0.0 to 0.999999 arcsec/sec for multi-line scans under FGS control. 0.0 to 4.999999 arcsec/sec for single-line scans under FGS control. 0.0 to 7.84 arcsec /sec under Gyro control.	Yes
Scan_Orient (Degrees)	The orientation of the scan line with respect to the POS TARG coordinate frame. It is measured from the POS TARG +X-axis toward the +Y-axis.	0 to 360°	Yes
Scan_Direction	The "direction" of the scan.	"Forward", "Reverse" and "RoundTrip"[2] Only "Forward" multi-line scans are supported.	Yes
Scan_Line_Separation (arcsec)	The separation between the adjacent scan lines in arcseconds. The total width of the scan can be found by Scan_Width = Scan_Line_Separation × (Scan_Number_Lines - 1)	0.0 arcsec for all single line scans. For multi-line scans: • 0.0 to 1.25 arcsec • if Scan Rate ≤ 0.25 arcsec/sec • 0.0 to $10.0 \times$ $\text{Scan\_Rate}^{1.5}$ arcsec if Scan_Rate > 0.25 arcsec/sec	Yes

Scan_Number_Lines	The number of scan lines to perform.	1 to 63 lines if Scan_Rate ≤ 0.999999 arcsec/sec and under FGS control or if Scan_Rate ≤ 7.84 arcsec/sec and under Gyro control 1 line only if the Scan_Rate > 0.999999 arcsec/sec and under FGS control	Yes

[1] See also General Considerations for Spatial Scans. Note that only multi-line "Forward" spatial scans are supported.

[2] A "Forward" scan will start at the aperture fiducial point (nominal target position; see point **a** in Figure 6.8: *"Foward" Spatial Scan*) and proceed to the end of the scan (point **b** in Figure 6.8: *"Foward" Spatial Scan*). A "Reverse" scan will run opposite to the corresponding "Forward" one, with it ending at the aperture fiducial point (i.e., from point b to point a in Figure 6.9: *"Reverse" Spatial Scan*) and is also subject to consideration 9 below. A "RoundTrip" scan will be performed as two scans: a "Forward" scan followed by a "Reverse" scan with identical setup parameters.

General Considerations for Spatial Scans

1. The allowed combinations are ACS/WFC ACCUM, STIS/CCD ACCUM, WFC3/IR MULTIACCUM and WFC3/UVIS ACCUM.
2. The maximum **Scan_Rate** is 4.999999 arcsec/sec under FGS control and 7.84 arcsec/sec under Gyro control. Spatial Scans will be performed under FGS control by default. If you want faster rate than permitted under FGS control, you must use either the visit level special requirement PCS MODE Gyro or exposure level special requirement EXP PCS MODE [FINE | GYRO]. Please contact your PC about the advantages and disadvantages of Gyro control with Spatial Scans, and how to use of these special requirements.
3. The SI Optional Parameter **CR-SPLIT** must be **NO** via default or an explicit specification.
4. The angular length of a scan will be determined from the total exposure time (including some overheads in the case of WFC3/IR), the **Scan_Rate**, the **Scan_Line_Separation** and the **Scan_Number_Lines**. For multi-line scans, the total exposure time encompasses all of the scan lines plus the turn around maneuvers between the lines. It is your responsibility to ensure that the scan does not extend off the detector unless necessary to accomplish the goals of the observation.
5. Only Multi-line "Forward" spatial scans are supported.
6. The turnaround maneuver time is computed in two parts and then combined
   a. The time to ramp-up/ramp-down each scan line: Ramp-up_Time = max(sqrt(100 * Scan_Rate), 5) seconds
   b. The time for the transverse move from one scan line to the next: If Scan_Line_Separation ≤ 10 arcsec then Transverse_Time = max((800 * Scan_Line_Separation)**(1/3), 10) seconds else Transverse_Time = (Scan_Line_Separation + 10) seconds
   c. Then we combine the Ramp-up_Time and the Transverse_Time to determine the time for each turnaround maneuver:

Turnaround_Time = max(2 * Ramp-up_Time, Transverse_Time) seconds.
Be sure to round to the next higher integer before using it to determine your exposure time.

7. During a scan the telescope moves. Consequently, for a scan under FGS control, the guide stars will move within the fields of view of the FGS being used. It is essential that none of the guide stars moves out of the field of view of its FGS. Therefore, requesting a scan under FGS control imposes additional selection requirements on the available guide stars, which will effectively reduce the number of stars that can be used for the observation. The degree of this reduction will depend on the length of the scan relative to the width of the FGS fields of view (4 arcmin). If the size of the scan precludes finding good guide stars, the observation will not be schedulable unless Gyro Hold (see Table 6.1: *Accuracies of Guiding Modes*) can be used (see special requirements GUIDing TOLerance <angle>, DROP TO GYRO [NO REACQuisition], PCS MODE Gyro, EXP PCS MODE [FINE | GYRO]. Please contact your PC to discuss the advantages and disadvantages of using these special requirements).

8. The entire scan must complete during a single target visibility period. "RoundTrip" scans are expanded into individual "Forward" and "Reverse" scans. As a result, those individual scans may be split between different target visibilities unless the "RoundTrip" exposure is within a SEQ NON-INT container.

9. The scan specifications in Spatial Scan Parameters apply to the aperture fiducial point in the SI aperture for the exposure unless you use a POSition TARGet <X-value>,<Y-value> or PATTERN special requirement. When you use POS TARG, the scan is performed relative to the point defined by the POS TARG. When you use PATTERN, the scan will be performed for each exposure of the PATTERN relative to its pattern point.

10. Scans are not permitted for exposures with Moving Targets.

11. Scans are not permitted for exposures with Internal Targets.

12. Special Requirement SAME POSition AS <exposure> is not permitted on and can not refer to a Spatial Scan exposure.

13. Spatial Scan exposures are not permitted in Coordinated Parallel Containers (Special Requirement PARallel WITH is not permitted on and can not refer to a Spatial Scan exposure).

14. Spatial Scan exposures are not permitted in Pure Parallel visits. Pure Parallel visits may not be in parallel with Spatial Scan exposures.

15. The Spatial Scan parameters describe the desired scan in the POSition TARGet <X-value>,<Y-value> coordinate frame. You may need to adjust the Scan_Orient appropriately to account for the geometric distortion of the detector. You may also have to adjust the Scan_Rate, which is arcsec/sec in the POS TARG frame, to account for the geometric distortion of the detector if you need a particular pixel traverse rate.

16. Since a multi-line scan is executed as a single exposure, the turnaround part of the scan may be imaged on the detector. This turnaround will **not** occur at constant velocity or at constant rate. If this is not desired, then a series of single-line scans should be used instead. See Figure 6.10: *Multi-line "Forward" Spatial Scan*.

17. We advise observers that neither the CALWF3 pipeline nor generic analysis software is designed to calibrate spatially scanned ACS, STIS or WFC3 data and you should plan accordingly.

Figure 6.8: "Foward" Spatial Scan
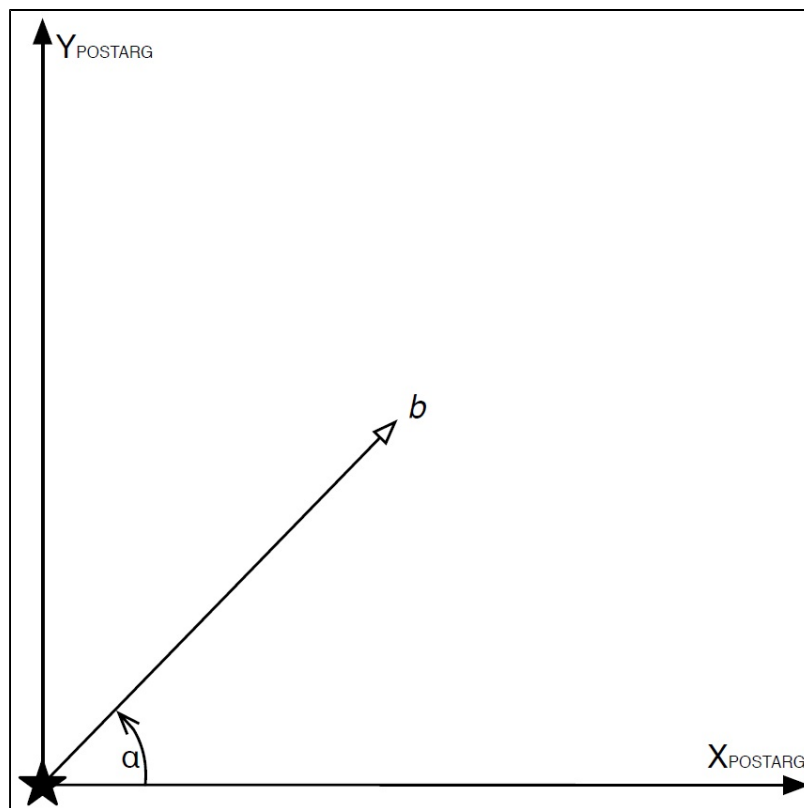
The figure shows a single-line "Forward" scan from point a to point b at a Scan_Orient angle α with the target at the aperture fiducial point at the start of the scan.

Figure 6.9: "Reverse" Spatial Scan
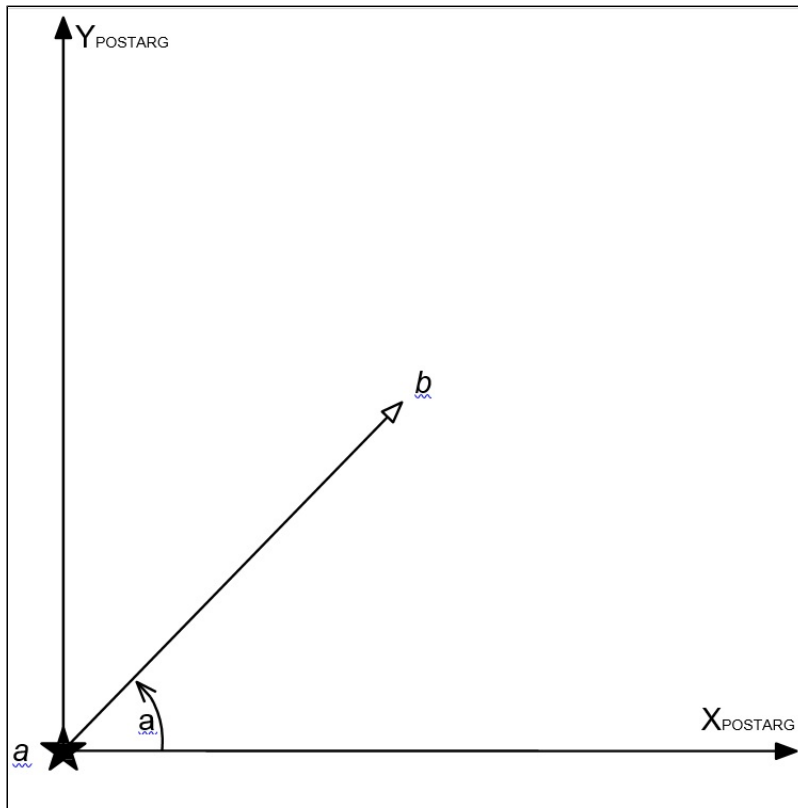
The figure shows a "Reverse" scan starting with the target at point b, moving at Scan_Orient angle α, and ending with the target at the aperture fiducial point (point a).

Figure 6.10: Multi-line "Forward" Spatial Scan
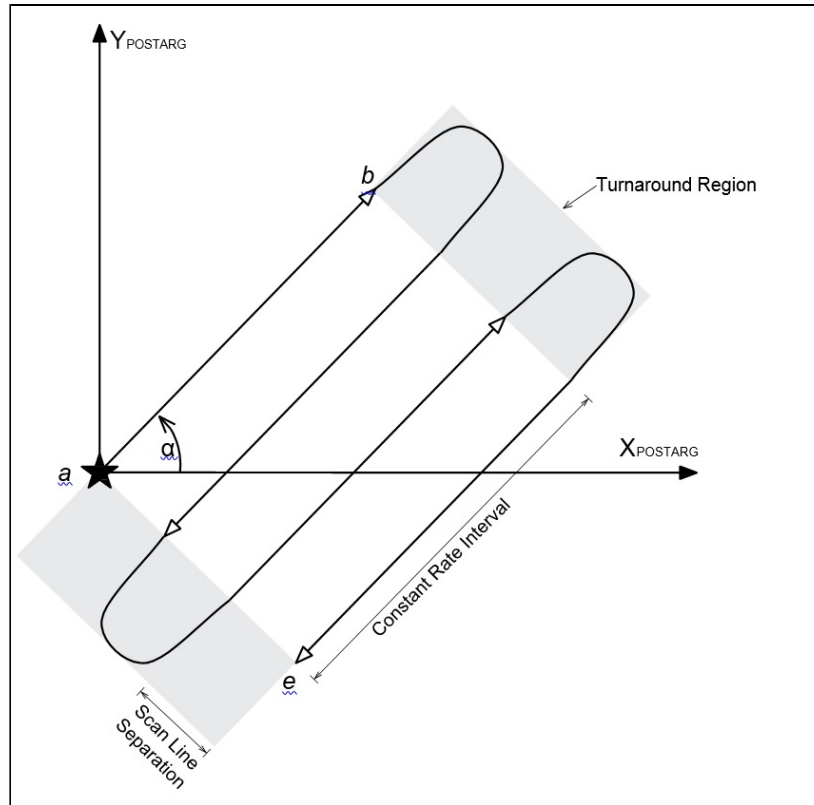
The figure shows a multi-line "Forward" scan where the exposure will start with the target at point *a* and ends with the target at point *e*. Note that the turnaround portions take place during the exposure and may be imaged by the detector. If this is not desired, then a series of single-line scans should be used instead.

PARallel <parallel-exp-list> WITH <primary-exp-list>

⭐ This special requirement has been replaced in the APT User Interface with the use of Coordinated Parallel Containers. See Exposure Containers: Exposure Sequences, Coordinated Parallels and Patterns.

This special requirement specifies that the exposures in <parallel-exp-list> will execute in parallel with a sequence of exposures in <primary-exp-list>. In the **Text Proposal File**, both <primary-exp-list> and <parallel-exp-list> must be replaced by either a single exposure number, or a range of exposure numbers separated by a hyphen. See Coordinated Parallel Containers for more details. (This Special Requirement **must have been indicated in the Phase 1 proposal**.)

For available but unsupported parameters (SAA CONTOUR, QASISTATES, QESIPARM, QELOGSHEET)

SAA CONTOUR <model number>

(available but unsupported for WFC3, ACS/WFC and S/C modes; restricted for ACS/SBC, CAL and ENG proposals)

Specifies the contour of the South Atlantic Anomaly (SAA) to be used for scheduling this exposure. If this requirement is not provided, a default SAA contour appropriate to the SI will be assigned (see table below). Use of less a restrictive model may improve the schedulability of observations that can tolerate higher radiation levels. The following model numbers are allowed (ordered from most to least restrictive).

SAA Model	Instrument for which model is default
05	FGS Astrometry
29	WFC3/UVIS
30	WFC3/IR
27	ACS/WFC
28	ACS/SBC
24	STIS/CCD
25	STIS/MAMA
31	COS/FUV
32	COS/NUV
02	FGS Guiding
11	no avoidance

The SAA contours in use in August 2014 are displayed in Figure 6.11: *SAA contours for the HST instruments.* Older definitions of the contours are shown at:

http://www.sesd.stsci.edu/et/seu/seu.html

Figure 6.11: SAA contours for the HST instruments
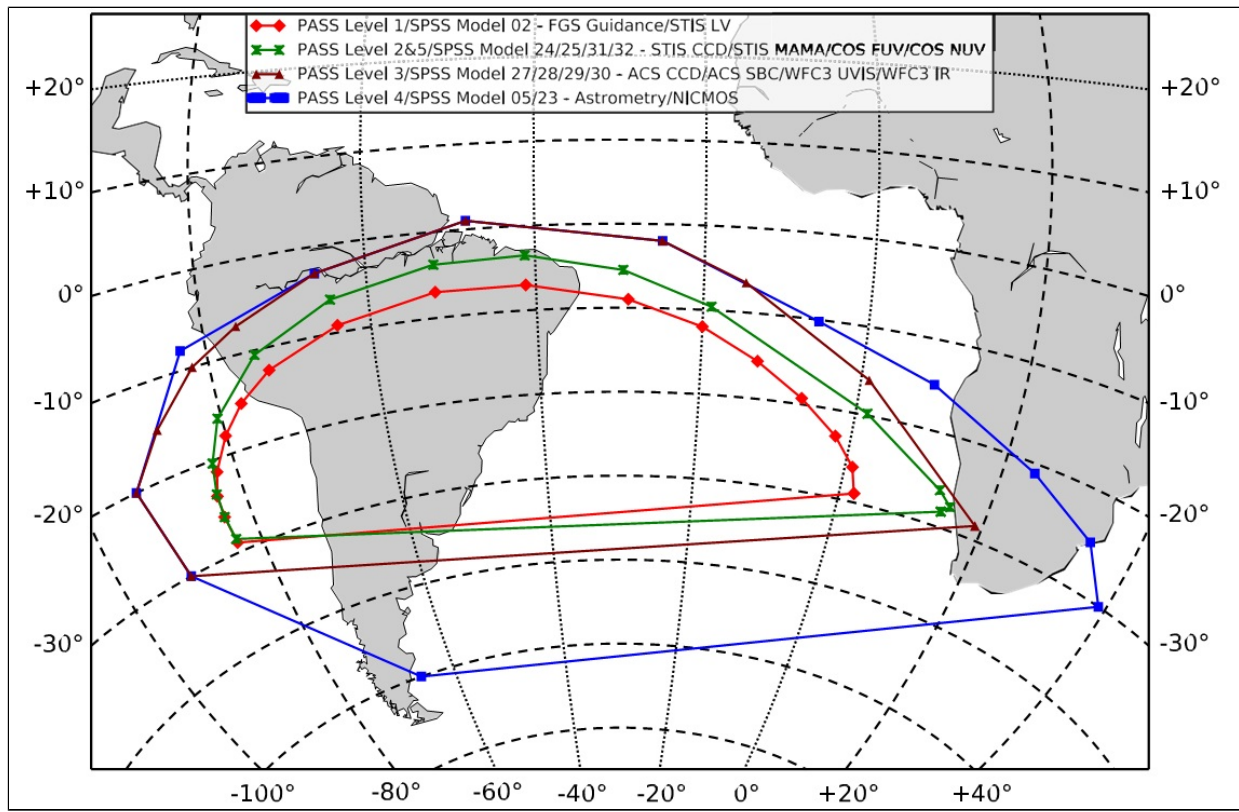
02 is the minimal FGS contour needed to avoid radiation at levels that would interfere with guide star lock. The default contours vary by SI but are more restrictive (meaning lower maximum radiation levels and longer SAA interruption times) than the 02 contour for all instruments.

A value of 11 means the SAA constraint will be ignored entirely. This requires a drop to gyro control for the exposure (also see the discussions under PCS MODE Fine, PCS MODE Gyro, and DROP TO GYRO [NO REACQuisition]), even if the visit as a whole is done under FGS control.

QASISTATES <si> <detector> <start> <end>

This special requirement is for non-standard qasi_states values. <si> must be one of: ACS, COS, FGS, NIC, STIS, WFC3, HUB, S/C, OMCE, WFS, or CSTR. <detector> must be any string of 1 to 4 alphanumeric characters. If <detector> is NONE or SI, no value will be populated into the PMDB field qasi_states.detector. <start> and <end> must each be a string of 1 to 8 alphanumeric characters.

QESIPARM <parameter> <value>

This special requirement is for non-standard qesiparm values. <parameter> is any string of 1 to 15 non-whitespace characters. <value> is any string of 1 to 15 non-whitespace characters.

Multiple **QESIPARM** requirements are permitted on an exposure, but no two **QESIPARM** requirements on the same exposure may specify the same <parameter>.

QELOGSHEET <parameter> <value>

This special requirement is for non-standard qelogsheet values.
must be one of: AP_1, AP_2, AP_3, AP_4, CONFIG, EXPTIME, MINWAVE, OPMODE, SP_1, SP_2, SP_3, SP_4, TARGNAME.

If <parameter> = AP_, then <value> may be any string of 1 to 15 non-whitespace characters. If <parameter> = SP_, then <value> may be any string of 1 to 20 non-whitespace characters.

If <parameter> = CONFIG, OPMODE, or TARGNAME, then <value> may be any string of 1 to 50 non-whitespace characters.

If <parameter> = EXPTIME, MINWAVE, then <value> may be any string of 1 to 50 numeric characters.

Multiple **QELOGSHEET** * requirements are permitted on an exposure, but no two *QELOGSHEET requirements on the same exposure may specify the same <parameter>.

> For restricted parameters (Spec Comm)
>
> # SPECial COMmanding [INSTR <NAME>]
>
> Use of this Special Requirement indicates that the proposer is requesting a capability which is currently beyond the ability of the ground system to support. The intended use of this parameter is for engineers and Instrument Scientists to be able to investigate conditions on the spacecraft using spacecraft capabilities which are not part of the ground system. Details of the requirements will need to be specified in the proposal text and/or in Visit and Exposure Specifications comments.
>
> Exposures with the Special Requirement **SPECial COMmanding will not be split** for earth occultations or SAA passages.
>
> A very limited subset of the **SPEC**ial **COM**manding instructions can be specified directly by the proposer. The name of the special instruction to be used should be indicated by the value of <NAME>, where <NAME> must begin with an "E" or "R". The use of any other **SPEC**ial **COM** manding instruction will generate an error. Note that the optional specification, **INSTR** used when specifying a <NAME>, stands for **INSTR**uction, not instrument. The need for a special commanding instruction whose name is not known, or does not begin with an "E" or "R," should be noted by specifying **SPEC COM** on the exposure line without the optional specification **INSTR** <NAME>.
>
> It must be noted that special commanding instructions are commonly written to support specific exposure lines in one proposal for a particular proposal Cycle. Generally, they are not appropriate for use with other exposure lines in any proposal. Indeed, they may not be appropriate for later duplicate proposals because changes to the ground system or flight software with which they interact may have occurred. Therefore, any reuse of existing special commanding instructions via optional specification [INSTR <name>] must be coordinated with the Flight Systems Engineering team.

Special Communications Requirements

RT ANALYSIS

Specifies that the current science exposure must be made available to the observer for analysis in real time. Any science exposures whose execution depends upon a decision based on the real-time analysis should have **RT ANALYSIS** specified. The REQuires UPLINK Special Requirement may also be used with **RT ANALYSIS** to establish the ground-to-spacecraft link. The current exposure will be available for analysis at least 16 minutes (for fixed targets) prior to that uplink; for moving targets the time is 24 minutes.

This Special Requirement is a limited resource and should only be used when necessary (please consult with your PC prior to using this mode). Justification for its necessity should be included in the **Real_Time_Justification** text.

Note that the exposures in the <exposure-list> **must** be in the same visit as the current exposure, and **RT ANALYSIS** may not be used if the exposure uses patterns or if Number_of_Iterations > 1.

REQuires UPLINK

Indicates that a real-time command uplink is needed to execute this exposure. An uplink will be scheduled prior to the current exposure. This Special Requirement should be used with RT ANALYSIS to replace the capability formerly available with INTeractive ACQuisition (obsolete) and it should specifically identify which exposures need an uplink, assuming that the uplink already provided is not sufficient. This Special Requirement can also be used without RT ANALYSIS if the information which needs to be uplinked is not dependent on real-time analysis of HST data. Usage of this Special Requirement is considered a limited resource and should only be used when necessary. Justification for its necessity should be included in the **Real_Time_Justification** text.

> ⭐ Note that for ALIGN mode exposures (with any configuration) that use REQuires UPLINK, no Optional Parameters are allowed.

REQuires EPHEMeris CORRection <id>

Indicates that a correction for position errors due to moving-target and/or HST ephemeris uncertainty may be needed to execute the exposure. This Special Requirement is only valid for exposures with moving targets. The offset will be uplinked during an available ("generic") uplink prior to the earliest exposure that uses it. The pointing correction may require a minute or two of orbital visibility time.

An ephemeris correction is needed in two cases:

1. When observing an object within about 1 AU of the Earth. In this case, the uncertainty in the position of HST accumulated between the time the schedule is built and the time it is executed can cause the observation to miss the target. (The HST ephemeris is inaccurate by as much as 60 seconds, which translates into a positional error on the moving target). The offset can be easily calculated by STScI personnel in this case.
2. When observing an object with an uncertain ephemeris. In this case, updated positions may be used until shortly before the observation actually executes, even though the elements in the program are out of date. Again, STScI personnel can easily determine the proper offset.

With moving targets, the maximum target ephemeris uncertainty must be specified in the solar-system target list (see 3.2 *Solar System Targets*. STScI will be unable to schedule corrections larger than the maximum offset derived from this uncertainty, so too small an uncertainty may limit the usefulness of the **REQ EPHEM CORR** procedure. However, offsets larger than about 1 arcminute may make scheduling difficult. If your observation requires a correction this large, contact your Program Coordinator.

The <id> is an alphanumeric string of up to six characters in length. Exposures with the same **REQ EPHEM CORR** ID (whether in the same visit or in different visits) will use the same offset and must be taken at the same orientation. If exposures in different visits use the same ID, the visits involved are all subject to the same scheduling restrictions as SAME ORIENTation AS <visit>. The **SAME ORIENT** Special Requirement is implied across such a set of visits, and need not be specified directly.

> ⭐ Note that REQ EPHEM CORR uses the uncertainties in target coordinates to determine the size of a possible offset maneuver. Therefore those uncertainties must be supplied accurately.

For engineering parameters (FORMAT)

FORMAT [AN or FN or HN or PN]

Engineering telemetry of the specified format will be obtained during an exposure. If **FORMAT** is specified, a legal value must be used. There is no default value for **FORMAT**.

Format can be used only for **FGS** and **S/C DATA** mode exposures.

⭐ A maximum 3 hour duration is allowed in either FN or PN format before having to return to AN or HN format so that valid thermal data may be transmitted for at least 10 minutes.

Related Links

6.3.2 Timing Exposure-level Special Requirements
6.3.3 Target Position Exposure-level Special Requirements

Change Log

Version Cycle 31 July 2023

> Added an anchor to SAA Contour

Version Cycle 30 April 2022

> PROPINST-91383 Emphasize which special requirements should have been preapproved in Phase I (Par With)

6.3.2 Timing Exposure-level Special Requirements

Timing Special Requirements (e.g., LOW SKY, PHASE) are used to restrict the scheduling of HST observations by timing constraints. The Astronomer's Proposal Tool (APT) is used to enter the requirements into the proposal.

On This Page

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

★ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

Most general special requirements directly or indirectly restrict the times when observations (and/or their component visits) can be scheduled. These should be used to provide the schedulers at STScI with enough constraints to ensure that the observations are properly scheduled. **Special requirements should not be used unless necessary to accomplish the scientific objectives of the proposal.**

LOW-SKY

Requests that the current exposure be taken when the total background light is no more than 30% greater than the yearly minimum value of the zodiacal background for that target. To minimize Earth shine, the exposure will also be taken when the target is at least 40° from the bright Earth. This limits orbital visibility time to about 48 minutes per orbit. Efficiency and schedulability are reduced with this Special Requirement, but to a much lesser degree than with SHADOW. This Special Requirement may not be combined with SHADOW or used in a CVZ visit. (This Special Requirement **must have been indicated in the Phase 1 proposal**.)

PHASE <number1> TO <number2>

Requests that the exposure start in the specified phase range (<number1> to <number2>) of a periodic variation. <number1> and <number2> should be between 0.0 and 1.0. The PERIOD <time> ZERO-PHASE (HJD) <date> used in the calculation should have been already entered at the visit level. With short periods, the phase range (difference between <number1> and <number2>) should be made as wide as possible to make scheduling easier. (This Special Requirement **must have been indicated in the Phase 1 proposal**.)

Please note that there is no need to repeat the **PHASE** Special Requirement for multiple exposures within the same Visit (unless you are attempting to specify different phases for those exposures). Instead, specify **PHASE** for only the first exposure in the Visit. If the phase window you specify is short, you may need to adjust **PHASE** for the first exposure so that the subsequent ones start before the phase window ends.

> ★ Note that Number_of_Iterations must be 1 if PHASE is specified.

SEQuence <exposure-list> NON-INTerruptible

> ★ This has been replaced in APT with the use of Exposure Group Containers. See Exposure Containers: Exposure Sequences, Coordinated Parallels and Patterns.

Specifies that exposures defined in the <exposure-list> be observed without gaps due to Earth occultation or SAA passages. Gaps between exposures may still be necessary to allow time for activities which are necessary to set up for the next exposure, such as pointing changes, readouts of the SI buffers, and SI reconfigurations. This requirement must be included for a series of FGS exposures which are to be executed within the same orbit. (This Special Requirement **must have been indicated in the Phase 1 proposal**.)

> For text file
>
> In the **Text Proposal File**, the exposure list must be a range of numbers separated by a hyphen, such as **SEQ NON-INT 55-60**.

Note: If this requirement is placed on **one** exposure (e.g., **SEQ 20 NON-INT**) and **Number_of_Iterations** > 1, the sequence of subexposures will not be split.

SHADOW

Requests that the current exposure be taken while *HST* is in the umbral shadow of the Earth. It is primarily useful when contamination by geocoronal emission (Lyman alpha, OI 1304Å, etc.) must be minimized. However, it does not minimize zodiacal light, which is the principal source of background at wavelengths longer than 3500Å (see the LOW-SKY Special Requirement).

Exposures using this Special Requirement are limited to about 32 minutes per orbit (including overheads). Scheduling may only be feasible for a small percentage of the year. This Special Requirement may not be combined with LOW-SKY or used in a CVZ visit. (This Special Requirement **must have been indicated in the Phase 1 proposal**.)

For available but unsupported parameters (AFTER BY)

AFTER BY <time> [TO <time2>]

This Special Requirement, when specified on an exposure within a visit (as opposed to on a visit level), specifies the minimum amount of <time> between the start of the previous exposure and the current exposure's start. **This <time> should never be longer than one orbit**. When a **TO** <time2> is added, it specifies the maximum time between the start of the previous exposure and the current exposure's start. If the interval given is shorter than the least interval possible, the exposures will be scheduled as close together as possible. Also note that <time2> may not exceed 36 hours. **If you plan to use this Special Requirement, please contact your Program Coordinator for further details and discussions**.

Related Links

6.3.1 General Exposure-level Special Requirements
6.3.3 Target Position Exposure-level Special Requirements

Change Log
Version Cycle 31 June 2023

1. Fixed typo
2. Fixed Links to CVZ

Version Cycle 30 April 2022

> PROPINST-91383 Emphasize which special requirements should have been preapproved in Phase I (Low-Sky, Phase, Seq Non-Int, Shadow)

6.3.3 Target Position Exposure-level Special Requirements

Target Position Special Requirements (e.g., POSition TARGet, SAME POSition) are used to restrict the pointing of HST observations. The Astronomer's Proposal Tool (APT) is used to enter the requirements into the proposal.

On This Page

Format definitions

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Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

Most general special requirements directly or indirectly restrict the times when observations (and/or their component visits) can be scheduled. These should be used to provide the schedulers at STScI with enough constraints to ensure that the observations are properly scheduled. **Special requirements should not be used unless necessary to accomplish the scientific objectives of the proposal.**

PATTERN

⭐ **The Pattern Special Requirement has been replaced in the APT User Interface with the use of Pattern containers. See** Exposure Containers: Exposure Sequences, Coordinated Parallels and Patterns**.**

Patterns used with instruments to create dithers or mosaics fall within "target position," but the details have been incorporated into a separate chapter because of the scope of the subject. See Chapter 7: *Pointings and Patterns*.

POSition TARGet <X-value>,<Y-value>

Specifies a non-default placement of the target, relative to the aperture fiducial point in the instrument field of view, for the current exposure, which must be on an external target. The X and Y positions are in units of arcseconds (i.e., do **not** enter "arcsec" after each value). The X-Y coordinate system and the default positioning for each scientific instrument are in these articles:

- 10.5.6 *ACS Aperture Coordinate System*
- 11.5.4 *COS Coordinate System*
- 9.3.1 *FGS POS TARG and Interferometer Coordinate Systems*
- 8.5.3 *STIS Coordinate Systems*
- 12.5.3 *WFC3 Coordinate System*

 An aperture's fiducial point is ordinarily close to the geometric center of that aperture. Details may be found in the Instrument Handbooks.

> ⭐ Note that a POS TARG is a motion relative to the aperture fiducial point, and so they are not cumulative.

Proposers using this Special Requirement should be aware of the following caveats:

- Changing the pointing in this way can cause overheads to be repeated at each **POS TARG** pointing. If a large number of pointings need to be obtained within one orbital visibility period, it may be more efficient to use a pattern designed for this purpose; see Chapter 7: *Pointings and Patterns*.
- The *primary intent* of a **POS TARG** is to move the specified target to a non-standard position *in* the "aperture."

The **POS TARG** offsets are defined in detector coordinates and do not correspond to a particular motion on the sky unless a specific **ORIENT** is defined (e.g **ORIENT 85 TO 85**). Restricting the **ORIENT** to a specific value will imply a very tight timing constraint. In almost all situations, the preferred method of offset target acquisition is to create an additional target specification for the object of interest (separate RA/DEC or relative RA-OFF/DEC-OFF offset parameters, as described in Positional Offsets).

On the other hand, if you are using the **POS TARG** to move an object of concern "out" of the aperture, failure to specify an **ORIENT** could result in the target getting pushed further onto the detector (e.g., if your **POS TARG** assumed an **ORIENT** of **0**, but the observation occurred at an **ORIENT** of **180**, you would move the star further onto the detector).

SAME POSition AS <exposure>

SAME POS AS <exposure> requests that the current exposure be done at the same position on the sky and with the same telescope roll as <exposure>. Note that <exposure> *must* be in the same visit as the current exposure. This requirement is implicit for exposures within a visit with the same aperture, target, and **POS TARG** combination.

This requirement is used in many astrometric observations, so that the telescope doesn't try to center successive targets in the astrometer pickle before observing it.

For other instruments, **SAME POS AS** should be used sparingly and with caution. For example, **SAME POS AS 1** will cause the *spacecraft* to return to the pointing of exposure 1. Thus if the current exposure has a different (non concentric) aperture from 1 and specifies **SAME POS AS 1**, the target will be placed in the aperture used by exposure 1, not the aperture currently requested. Further, specifying **SAME POS AS** an onboard acquisition exposure will undo the offsets determined in the acquisition process.

> ⭐ Do not use SAME POS AS with dithering patterns (Chapter 7: *Pointings and Patterns*) because it will negate them. SAME POS AS means exactly the same position as another exposure.

> For engineering parameters (SAME POS)
>
> **SAME POS AS** <exposure> can be used if the pointing of an internal exposure is required to be the same as that of an external exposure in the same visit, or if the same orient needs to be maintained across different obsets in a single visit.
>
> Care must be employed when using the special requirement "**SAME POS AS** <exposure>" during an exposure where the spectral element is a ramp filter (any filter starting with "**FR**" or "**LRF**"), since this special requirement will cause the ramp observations to be executed with the aperture used in the earlier <exposure>. If the latter aperture is not centered on the ramp aperture and/or does not encompass the full ramp aperture, the ramp observations will not have the desired central wavelength and transmission efficiency. To use a ramp filter with this special requirement you must contact your Contact Scientist or an Instrument Scientist (via the helpdesk (https://stsci.service-now.com/hst).

Change Log
Version Cycle 31 July 2023

Fixed the link to the Instrument Handbooks in the POS TARG section

6.4 Implementation Only Special Requirements

HST has special requirements that are used to specify scheduling constraints that are used by the Program Coordinators, and this article contains the descriptions of those requirements.

Format definitions

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Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

Most general special requirements directly or indirectly restrict the times when observations (and/or their component visits) can be scheduled. These should be used to provide the schedulers at STScI with enough constraints to ensure that the observations are properly scheduled. **Special requirements should not be used unless necessary to accomplish the scientific objectives of the proposal.**

Visit Special Requirements

VISIBILITY INTERVAL <time>

This Special Requirement will override the visibility interval normally computed for the visit. No pads will be added, nor will any adjustment be performed based on the target declination. This should not be used in conjunction with the CVZ or SCHEDulability <percentage> Special Requirements.

This Special Requirement may also have the value CORON.

Exposure Special Requirements

MAXimum DURation (time or %) <value>

Allows the Program Coordinator to set limits on the expansion of primary exposures to take advantage of unused orbital visibility. The TRANS tunable constant (enable--adjust t) must be set in a proposal override file to activate MAX DUR. If <time> is specified, the exposure will not be lengthened beyond <time>.If <percentage> is specified, the exposure will not be lengthened beyond <percentage> of the specified exposure time. If <time or percentage> is omitted, the exposure will not be lengthened at all.

MINimum DURation (time or %) <value>

Allows the Program Coordinator to limit shortening of exposures to allow them to fit in a orbital visibility period. The TRANS tunable constant (enable--adjust t) must be set in a proposal override file to activate MIN DUR. If <time> is specified, the exposure may be shortened until its duration is <time>, but not further. If <percentage> is used, the exposure will be shortened until its duration is decreased to, at most, <percentage> of the specified exposure time.If <time or percentage> is omitted, the exposure will not be shortened at all.

EXPAND (pure parallel exposures only)

Allows the proposer to choose which exposures within an orbit will be expanded to take advantage of unused time at the end of the orbit (note that the exposures will be expanded to fill the orbit unless the MAXimum DURation (time or %) value Special Requirement is also listed). This special requirement can only be used in pure parallel observations; it has no effect on primary exposures. If there is no EXPAND within the orbit, the last exposure in the orbit will be considered for expansion (up to an additional 20%) first, followed by the previous one and the one before that, etc. Exposures containing the EXPAND requirement are considered first for expansion.

NEW OBSET [FULL ACQ]

NEW ALIGNMENT

These Special Requirements will override the normal decision of whether an exposure will be merged into the same alignment or OBSET as the previous. Using it will force the exposure to start a new OBSET or alignment regardless of the existence or the criticality of any merging rules to the contrary (but error checking will be performed).

In addition, it is possible to force a full guide star acquisition at the beginning of an obset, even if TRANS would not insert one there. The syntax for this capability is **NEW OBSET FULL ACQ**.

SAME OBSET <exposure-list>

> ⭐ This has been replaced in the APT GUI with the use of Exposure Groups. See Exposure Containers: Exposure Sequences, Coordinated Parallels and Patterns.

This Special Requirement will override the normal decision of whether the exposures in the same list will be merged into the same OBSET. Using it will force the exposures in <exposure-list> to be included in the same OBSET regardless of the existence or the criticality of any breaking rules to the contrary (but error checking will be performed).

Note that this differs from the **SAME GUIDE STARS** Special Requirement, which does not necessarily place any requirements on how exposures are to be arranged into obsets.

SAME ALIGNMENT <exposure-list>

> ⭐ This has been replaced in the APT GUI with the use of Exposure Groups. See Exposure Containers: Exposure Sequences, Coordinated Parallels and Patterns.

Note that this differs from the **SEQ NON-INT** Special Requirement, which is purely a timing requirement (it requires exposures not to be separated by earth occultation), and does not necessarily place any requirements on how exposures are to be arranged into alignments. This Special Requirement will override the normal decision of whether the exposures in the same list will be merged into the same alignment. Using it will force the exposures in <exposure-list> to be included in the same alignment regardless of the existence or criticality of any breaking rules to the contrary (but error checking will be performed). The exception is that the alignment may be split if it exceeds the time constraints of the orbital visibility period.

SAME GUIDE STARS <exposure-list>

> ⭐ This has been replaced in the APT GUI with the use of Exposure Groups. See Exposure Containers: Exposure Sequences, Coordinated Parallels and Patterns.

This Special Requirement will override the normal decision of whether two obsets must share the same set of guide stars. If two members of <exposure-list> are placed in different obsets, those two obsets will be forced to share the same guide stars regardless of the existence or criticality of any rules which would otherwise assign them separate guide star sets.

GSPAIR <pair-id->

This Special Requirement will tell NGSS to use the specific guide star pair indicated. For pairs, <**pair-id**> is the 24-character NGSS guide star pair id and is of the form **nnnnnnnnnnFdmmmmmmmmmmFe**, where nnnnnnnnnn and mmmmmmmmmm are the 10-character guide star ids of the two stars. The Fs are required; d and e are the FGS numbers that the stars are to appear in (that is, 1, 2, or 3). Note that the ordering of the stars is as NGSS will construct the pair.

For singles, <**pair-id**> is as above except mmmmmmmmmm = '0000000000' and e = '0.'

OBSET ID <id>

This allows a non-default OBSET id to be chosen. <id> must be a two-character alphanumeric string and may be specified only once per obset.

EXP PCS MODE [FINE | GYRO]

These Special Requirements allow the PCS requirements for a particular exposure to be overridden. The PCS mode for an OBSET is still computed based on the most restrictive PCS mode in that OBSET. Therefore, in order to override the PCS mode for an entire OBSET with a less restrictive value, it is necessary to place this Special requirement on every exposure within the OBSET, or it should be used at the Visit level.

It is possible for an alignment to be executed on GYRO in an OBSET that uses FGS guiding. If **EXP PCS MODE GYRO** is included on every exposure within an alignment, it will be executed using gyro guiding, even if it is included in an OBSET which uses FGS guiding.

These may also be entered as **EXP PCS MODE F** and **EXP PCS MODE G**.

GS ACQ SCENARIO [PAIR | SINGLE | GYRO | <scenario>]

This Special Requirement allows the guide star acquisition scenario for an obset to be overridden. This may be specified only once per obset.

> ★ The uncertainty associated with single guide star acquisition poses a danger to the ACS/SBC, STIS /MAMA and COS detectors. Use of any single guide star acquisition scenario requires approval after an appropriate additional bright object check.

Tables 1 and 2 summarize the legal values for <scenario>.

Table 1: FGS Guiding Scenarios

Scenario Name	Gyro Mode	FGS Guiding Mode	SAA Free Orbits Only	Use FGS 3	Comments
One Gyro Scenarios					
BASE1O	1G	Pair	No	No	Default for "PAIR" Scenario
BASE1O3	1G	Pair	No	Yes	
BASE1ONS	1G	Pair	Yes	No	
BASE1ON3	1G	Pair	Yes	Yes	
ONEB1O	1G	Single	No	No	Default for "SINGLE" Scenario
ONEB1O3	1G	Single	No	Yes	
ONEB1ONS	1G	Single	Yes	No	

ONEB1ON3	1G	Single	Yes	Yes	
Two Gyro Scenarios					
BASE1T	2G	Pair	No	No	Default for "PAIR" Scenario
BASE1T3	2G	Pair	No	Yes	
BASE1TNS	2G	Pair	Yes	No	
BASE1TN3	2G	Pair	Yes	Yes	
ONEB1T	2G	Single	No	No	Default for "SINGLE" Scenario
ONEB1T3	2G	Single	No	Yes	
ONEB1TNS	2G	Single	Yes	No	
ONEB1TN3	2G	Single	Yes	Yes	
Three Gyro Scenarios (3GFHST)					
BASE1	3GFHST	Pair	No	No	Default for "PAIR" Scenario
BASE13	3GFHST	Pair	No	Yes	
BASE1NDS	3GFHST	Pair	Yes	No	
BASE1N3	3GFHST	Pair	Yes	Yes	
ONEB1	3GFHST	Single	No	No	Default for "SINGLE" Scenario
ONEB13	3GFHST	Single	No	Yes	
ONEB1NDS	3GFHST	Single	Yes	No	
ONEB1N3	3GFHST	Single	Yes	Yes	
COURS1	3GFHST	Pair			Requires Special Permission
ONEC1	3GFHST	Single			Requires Special Permission
Three Gyro Scenarios (3GOBAD)					
BASE1B	3GOBAD	Pair	No	No	Default for "PAIR" Scenario
BASE1B3	3GOBAD	Pair	No	Yes	
BASE1BE	3GOBAD	Pair	No	Yes	60s extended time compared to BASE1B3, default "PAIR" Scenario for MT and Spatial Scan Visits
BASE1BR	3GOBAD	Pair	No	Yes	Default Scenario for MT and Spatial Scan Obsets (to turn off FGS2)

BASE1BNE	3GOBAD	Pair	Yes	Yes	60s extended time compared to BASE1BN3, recommended for use with MT and Spatial Scan Visits
BASE1BNR	3GOBAD	Pair	Yes	Yes	available to turn off FGS2 for MT and Spatial Scan Obsets
BASE1BNS	3GOBAD	Pair	Yes	No	
BASE1BN3	3GOBAD	Pair	Yes	Yes	
ONEB1B	3GOBAD	Single	No	No	Default for "SINGLE" Scenario
ONEB1B3	3GOBAD	Single	No	Yes	
ONEB1BE	3GOBAD	Single	No	Yes	60s extended time compared to ONEB1B3, default "SINGLE" Scenario for MT and Spatial Scan Visits
ONEB1BR	3GOBAD	Single	No	Yes	available to turn off FGS2 for MT and Spatial Scan Obsets
ONEB1BNE	3GOBAD	Single	Yes	Yes	60s extended time compared to ONEB1BN3, recommended for use with MT and Spatial Scan Visits
ONEB1BNR	3GOBAD	Single	Yes	Yes	available to turn off FGS2 for MT and Spatial Scan Obsets
ONEB1BNS	3GOBAD	Single	Yes	No	
ONEB1BN3	3GOBAD	Single	Yes	Yes	
Mode Independent Scenarios					
PAIR		Pair	No	No	Use Default Pair Scenario
SINGLE		Single	No	No	Use Default Single Scenario

Table 2: Gyro Guiding Scenarios

Name (Cannot be set in APT)	Gyro Mode
GYROO	1G
GYROT	2G
GYRO	3GFHST
GYROB	3GOBAD

192

Change Log

Version Cycle 31 June - Aug 2023

1. PROPINST-91397 - New Guide Star Acquisition Scenarios added to Table 1
2. Removed old PR link from Change Log.

Version Cycle 26 October 2018

1. PR.91178 New 3GOBAD guiding scenarios

Initial Conversion HST Cycle 25 Phase II Proposal Instructions (Engineering) Version Cycle 25 (June 2018)

Chapter 7 Pointings and Patterns

Most HST observations are obtained with some motion of the telescope (e.g., dithering, mosaicking), and there are predefined patterns available in APT to support these motions.

Chapter Contents

- 7.1 STIS Patterns
- 7.2 ACS Patterns
- 7.3 WFC3 Patterns

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Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Pointing the Telescope

Acquiring an astronomical target and keeping it fixed in an aperture is the heart of observing with *HST*. Properly specifying target coordinates and motions is essential, of course, as is finding and acquiring suitable guide stars. Earlier chapters in this document have provided detailed instructions on how to specify coordinates and acquisitions for both fixed and moving targets; see 3.1 *Fixed Targets* and 3.2 *Solar System Targets*.

Introduction to Patterns

Rarely does an observer ask to look at precisely one point on the sky. Instead, small-scale repositionings of the aperture may be made to fully sample a region spatially, or larger-scale movements may be made to mosaic a region of the sky. These movements are known as patterns.

Here we describe the patterns syntax in APT for both the User Interface and the Text Proposal File; these descriptions provide both general capabilities and pre-defined "convenience" patterns.

APT User Interface

Creating Patterns

1. First, you specify the pattern or patterns you want to use by using the "Patterns" form; then you select the type of pattern (or patterns) you want from a list, filling in the fields (where you can) with the values you want, or leave them to their assigned default values.
2. Then you can create a Pattern Container in a visit, and then place your exposures in this container.

If the exposures in the Pattern Container contain other expansion constructs (such as **Number_Of_Iterations** > 1 or one of the **CR-SPLIT** Optional Parameters), the multiple exposures will be taken at each pattern point.

General Pattern Container Rules

If the exposures contain coordinated parallels, it must contain the entire parallel sequence (both parallel and primary exposures in the Coordinated Parallel Container), and only those exposures. All parallel exposures will be taken at each pattern point. Only one pattern is allowed within any sequence.

All primary exposures in the exposure list (container) must have the same initial pointing: i.e., the same instrument configuration, aperture, target, and **POS TARG** offsets (if any).

Patterns may be specified for a moving target. In this case the pattern is taken while the target is being tracked and the offsets obtained will be a combination of target motion and motion imposed by the pattern relative to the target.

SAME POSition AS <exposure> is not allowed on an exposure that is part of a pattern. Patterns are also not allowed with FGS TRANS mode (which specifies a separate scan with the FGS star selectors).

Text Proposal File

In the Text Proposal File, a pattern is specified as an exposure-level Special Requirement.

PATTERN <#> [<exposure-list>]

This specifies that each exposure in <exposure-list> (or the current exposure if no <exposure-list> is provided) should be repeated at each point in a pattern of discrete pointing offsets from the target. The <#> should be an integer between 1 and 999 that corresponds to the **Pattern_Number** of a pattern defined in the **Pattern_Data** block of the Text Proposal File. Details for providing **Pattern_Data** are given in the next section.

If the exposures in the <exposure-list> contain other expansion constructs (such as **Number_of_Iterations** > 1 or one of the **CR-SPLIT** Optional Parameters), the multiple exposures will be taken at each pattern point.

If the <exposure-list> contains coordinated parallels, it must contain the entire parallel sequence (both <parallel-exp-list> and <primary-exp-list> from the **PARALLEL WITH** Special Requirement; see **"PARallel <parallel-exp-list> WITH <primary-exp-list>"**), and only those exposures. All parallel exposures will be taken at each pattern point. Only one **PATTERN** Special Requirement is allowed within any sequence.

All primary exposures in <exposure-list> must have the same initial pointing: i.e., the same instrument configuration, aperture, target, and **POS TARG** offsets (if any).

Patterns may be specified for a moving target. In this case the pattern is taken while the target is being tracked and the offsets obtained will be a combination of target motion and motion imposed by the pattern relative to the target.

Notes: The exposure-level Special Requirement, "SAME POSition AS <exposure>", is **not** allowed on an exposure that is part of a pattern: Also, Patterns are not allowed with FGS **TRANS** mode (which specifies a separate scan with the FGS star selectors).

Patterns are identified by the **Pattern_Number** field under the **Pattern_Data** block in the **Text Proposal File**. The value of **Pattern_Number** must be an integer between 1 and 999. If an exposure anywhere in the proposal uses the **PATTERN <#> [<exposure-list>]** Special Requirement and <#> matches **Pattern_Number**, the specified exposures will be repeated at each point of the pattern. It is also possible to specify two nested patterns for an exposure or set of exposures. In this case, instead of taking the exposures at each point of the first pattern, the entire **Secondary_Pattern** will be executed at each point, creating a two-dimensional matrix of pointing offsets. The parameters for the first pattern appear under the **Primary_Pattern** label in the **Text Proposal File**. If a second pattern is to be used, a similar **Secondary_Pattern** label followed by the same set of parameters should be added below the first.

The Pattern Parameters form looks like this in the **Text Proposal File**:

```
Pattern_Data

Pattern_Number:11 !unique identifier
```

```
Primary_Pattern:
Pattern_Type:STIS-MAMA-BOX
Pattern_SI:STIS
Pattern_Shape:PARALLELOGRAM
Pattern_Purpose:DITHER
Number_of_Points:4
Point_Spacing:0.559
Line_Spacing:0.559
Coordinate_Frame:POS-TARG
Pattern_Orient:26.565
Angle_Between_Sides:143.1
Center_Pattern:NO
```

Not all fields are required in all cases (see the examples below), and for some patterns both a **Primary_Pattern** and a **Secondary_Pattern** must be described. If none of the instrument-specific patterns will work, it is also possible to specify more generic lines and spirals.

How to Fill out the Pattern Parameters Form

The Pattern Parameters Form allows a pattern of pointing offsets to be defined. Patterns are useful for several different purposes: dithering to remove the effects of detector artifacts or to increase spatial resolution, mosaicing to cover a larger area on the sky, or moving away from the target to sample the background.

It is also possible to specify two nested patterns for an exposure or set of exposures. In this case, instead of taking the exposures at each point of the first pattern, the entire **Sub-Pattern** (or **Secondary_Pattern** in the **Text Proposal File**) will be executed at each point, creating a two-dimensional matrix of pointing offsets.

Pattern Parameters

The Pattern Parameters Form has the following fields:

Pattern_Number

A unique identifier from 1 to 999; this is assigned in APT.

Pattern_Type

This specifies the type (and shape) of a pattern (generally an instrument-specific name; see Convenience Patterns), and, depending on the type, may constrain or completely determine the values of the other parameters. Many pattern types have been defined for the different instruments, as given below. Pattern parameters that are determined by the pattern type, or have default values, need not (or cannot) be changed in the form.

Some pattern types are intended for use with a combination of two patterns (**Primary_Pattern** and **Sub-Pattern**). With such pattern types the **Sub-Pattern** is mandatory. The **Pattern_Type** may specify that a parameter of the **Sub-Pattern** is constrained or determined by the value of the corresponding parameter of the **Primary_Pattern**. Whenever two patterns are used, the **Pattern_Type** of the **Sub-Pattern** defaults to the pattern type of the **Primary_Pattern**.

A **Pattern_Type** defined for a particular instrument is legal only if the first primary exposure in the pattern uses that instrument. Generic pattern types are valid with any instrument. Patterns specific to individual instruments are described in Convenience Patterns. The following are generic pattern types.

Pattern_Type: LINE

This specifies a linear pattern of offsets; all other parameters are open.

Pattern_Type: SPIRAL

This specifies a spiral pattern: all other parameters are open.

Pattern_Type: BOX

This specifies a box pattern; the **Number_Of_Points** = **4** and all other parameters are open.

Pattern_Purpose

This is a required text field which describes the scientific purpose of the pattern, but it is treated as a comment to help evaluate the Phase II program. There are four legal values: **DITHER**, **MOSAIC**, **BACKGROUND**, and **OTHER:**

DITHER means small-scale motions used to improve spatial resolution and data quality.

MOSAIC means movement of the aperture to sample different parts of an object or regions of sky.

BACKGROUND means a movement away from a source to sample the sky background, ordinarily used with infrared instruments.

OTHER means that the reason for the pattern should be provided in the **Comments** field. Unless a default is determined via the **Pattern_Type**, this parameter is required, although you may edit it from the default value to another valid value.

Number_of_Points

This specifies the number of points in the pattern; allowed values are from 2 to 50. Unless a default is determined via the **Pattern_Type**, this parameter is required.

Point_Spacing

This specifies the spacing between adjacent points in a pattern, in arcsec. For parallelogram patterns **Point_Spacing** will specify the length of the segment between the first two pattern points. The value of **Point_Spacing** ranges from 0 to 1440 arcsec. Unless a default is determined via the **Pattern_Type**, this parameter is required.

Note: patterns larger than about 130 arcsec (defined by the maximum pointing change between any two points in the pattern) may not be done on a single set of guide stars. For such patterns, unless the entire visit uses gyro guiding (PCS MODE Gyro), the visit-level Special Requirement **DROP TO GYRO IF NECESSARY** (see **"DROP TO GYRO [NO REACQuisition]"**) must be specified to allow the farther pattern points to execute under gyro guiding.

Unless PCS MODE Gyro is specified on the visit, all patterns must be contained within a circle of radius 24 arcmin (1440 arcsec), with the first pattern point at the center.

Line_Spacing

This parameter is relevant only for parallelogram (box) patterns; it specifies the length of the second pattern segment of the parallelogram in arcsec. The allowed range is from 0 to 1440.0 arcsec.

Angle_Between_Sides

This parameter is relevant only for parallelogram (box) patterns; it specifies the angle (from 0 to 360) between sides of the parallelogram in degrees measured clockwise from the first pattern segment to the second.

Coordinate_Frame

This field has two legal values, **POS-TARG** and **CELESTIAL**. It specifies whether the pattern is being done in the **POS TARG** (spacecraft) frame or the celestial frame (by specifying offsets from the original target position on the sky). For patterns with a **Pattern_Purpose** of **DITHER**, **POS-TARG** is the only legal value.

Pattern_Orient

This field specifies the orientation of the first segment of the pattern with respect to the chosen frame, in degrees. If **Coordinate_Frame**: **POS-TARG**, this angle will be measured from the POS TARG +X axis toward the +Y axis. If **Coordinate_Frame**: **CELESTIAL**, it will be measured North through East, and will specify the direction of an offset from the target on the sky.

A value of 0 will cause the first pattern segment to be oriented along the POS TARG +X axis if **Coordinate_Frame**: **POS-TARG**, and along the North vector on the sky if **Coordinate_Frame**: **CELESTIAL**.

Center_Pattern

This indicates whether the pattern should be centered relative to the pointing (hereafter referred to as the "default pointing") that the exposures would have had in the absence of a pattern. For a primary pattern (**Primary_Pattern**), the default pointing is the target position, unless the **POS TARG** Special Requirement (see "**POSition TARGet <X-value>,<Y-value>**") is used to shift the target relative to the aperture. For a secondary pattern (**Sub-Pattern**), the default pointing is the pointing offset from the target determined by the given pattern point in **Primary_Pattern**.

Legal values for **Center_Pattern** are **YES** (check in box provided) and **NO** (no check). The default is **NO**, unless overridden via the **Pattern_Type**. If **Center_Pattern**: **NO**, the first pattern point is placed at the default pointing. If **Center_Pattern**: **YES**, the first pattern point is offset so that the default pointing is placed at the geometric center of the pattern.

Sub-Pattern (or Secondary_Pattern in the Text Proposal File) Information

If applicable, the **Sub-Pattern** information must be provided (Type, Shape, Number of Points, etc.).

Note that if you are using the **Text Proposal File**, a **Sub-Pattern** is labeled as a Secondary_Pattern.

Convenience Patterns

The following patterns use the new syntax but have been constructed to duplicate the earlier pattern forms (if applicable). Their nomenclature is meant to be obvious; for example, "**STIS-CCD-BOX**" means the former "box" pattern for the STIS CCD. After each description we show what the information would look like.

A specific entry for a parameter (such as 4 for **Number_of_Points** with **STIS-CCD-BOX**) means that value may not be changed and doing so will cause an error. An indicated range (such as 0.0275-2.75 for **Point_Spacing** in **STIS-MAMA-BOX**) means you may select from within that range, and a "?" means any numeric value may be entered.

As previously noted, you may also nest patterns, but not all combinations make sense. If you use both a **Primary_Pattern** and a **Sub-Pattern** (or **Secondary_Pattern** in the **Text Proposal File**), they should be for the same instrument or at least one should be generic. Note that any convenience pattern can be added as a **Sub-Pattern** when a generic pattern is selected as the **Primary_Pattern**. If a pattern with large steps is to be combined with a pattern with small steps, the **Primary_Pattern** should contain the large steps, to minimize the time spent on pointing maneuvers. In the following sections, we show which patterns may be selected as a **Sub-Pattern** when the indicated convenience pattern is the **Primary_Pattern**. The observer should consult the references given within the instrument-specific subsections for detailed advice on selecting patterns and modifying pattern parameters. Do not mix instrument-specific patterns.

See 7.1 *STIS Patterns*, 7.2 *ACS Patterns*, and 7.3 *WFC3 Patterns* for the pattern details for each instrument. Note that COS does not have any predefined patterns.

Related Links

7.1 STIS Patterns
7.2 ACS Patterns
7.3 WFC3 Patterns

Change Log
None

7.1 STIS Patterns

Many HST STIS observations are obtained with some motion of the telescope (e.g., dithering, mosaicking), and there are predefined patterns available in APT to support these motions.

On This Page

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

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Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

There are 5 different predefined patterns that can be used with STIS, which are shown in Table 7.1: STIS Predefined Patterns. To see an illustration of the STIS **POS-TARG** reference frame, see 8.5.3 STIS Coordinate Systems.

Table 7.1: STIS Predefined Patterns

STIS Patterns
STIS-PERP-TO-SLIT
STIS-ALONG-SLIT
STIS-CCD-BOX

STIS-MAMA-BOX

STIS-SPIRAL-DITH

Pattern_Type: STIS-PERP-TO-SLIT

This is normally used with a spectroscopic slit. It produces a scan along the POS TARG X-axis of the aperture; this is used to map a two-dimensional region of the sky (see Chapter 11 of the *STIS Instrument Handbook*). The target is moved perpendicular to the slit along the AXIS1 (dispersion) direction.

Pattern_Type:STIS-PERP-TO-SLIT
Pattern_Purpose:MOSAIC
Number_of_Points:?
Point_Spacing:?
Coordinate_Frame:POS-TARG
Pattern_Orient:0
Center_Pattern:?

Permitted Sub-Pattern (Secondary_Pattern) values: STIS-ALONG-SLIT, LINE.
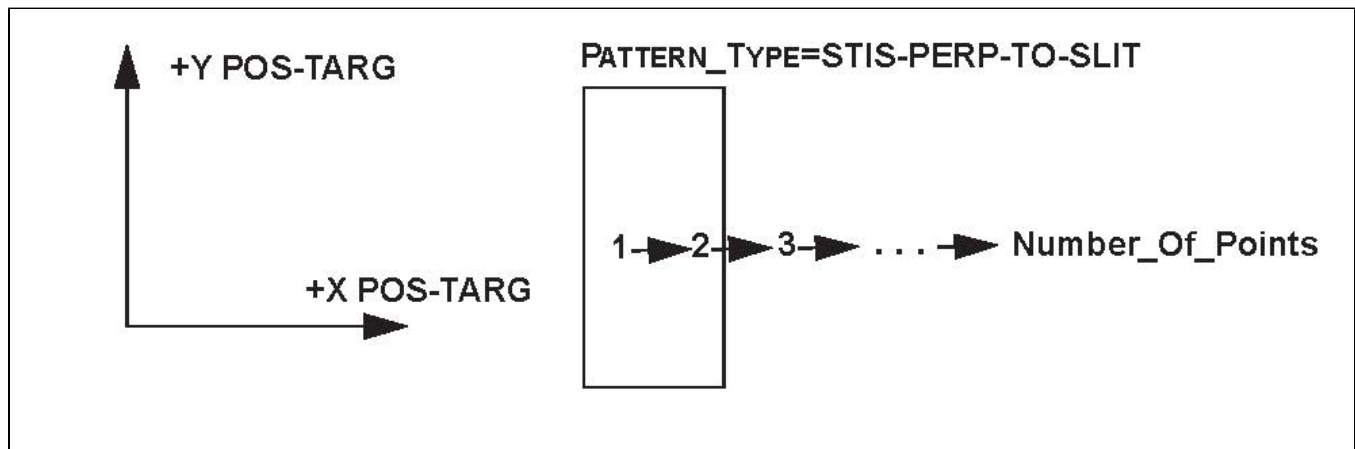
Pattern_Type: STIS-ALONG-SLIT

This is also normally used with a spectroscopic slit. It produces a scan along the POS TARG Y-axis of the aperture; this is used to step a target along the long slit to dither bad pixels or improve spatial resolution (see the *STIS Instrument Handbook*). The target is moved along the slit in the AXIS2 (cross-dispersion or spatial) direction.

```
Pattern_Type:STIS-ALONG-SLIT
Pattern_Purpose:DITHER
Number_of_Points:?
Point_Spacing:?
Coordinate_Frame:POS-TARG
Pattern_Orient:90
Center_Pattern:?
```

Permitted Sub-Pattern (Secondary_Pattern) values: none.

To see an illustration of the STIS POS-TARG reference frame, see 8.5.3 *STIS Coordinate Systems*.
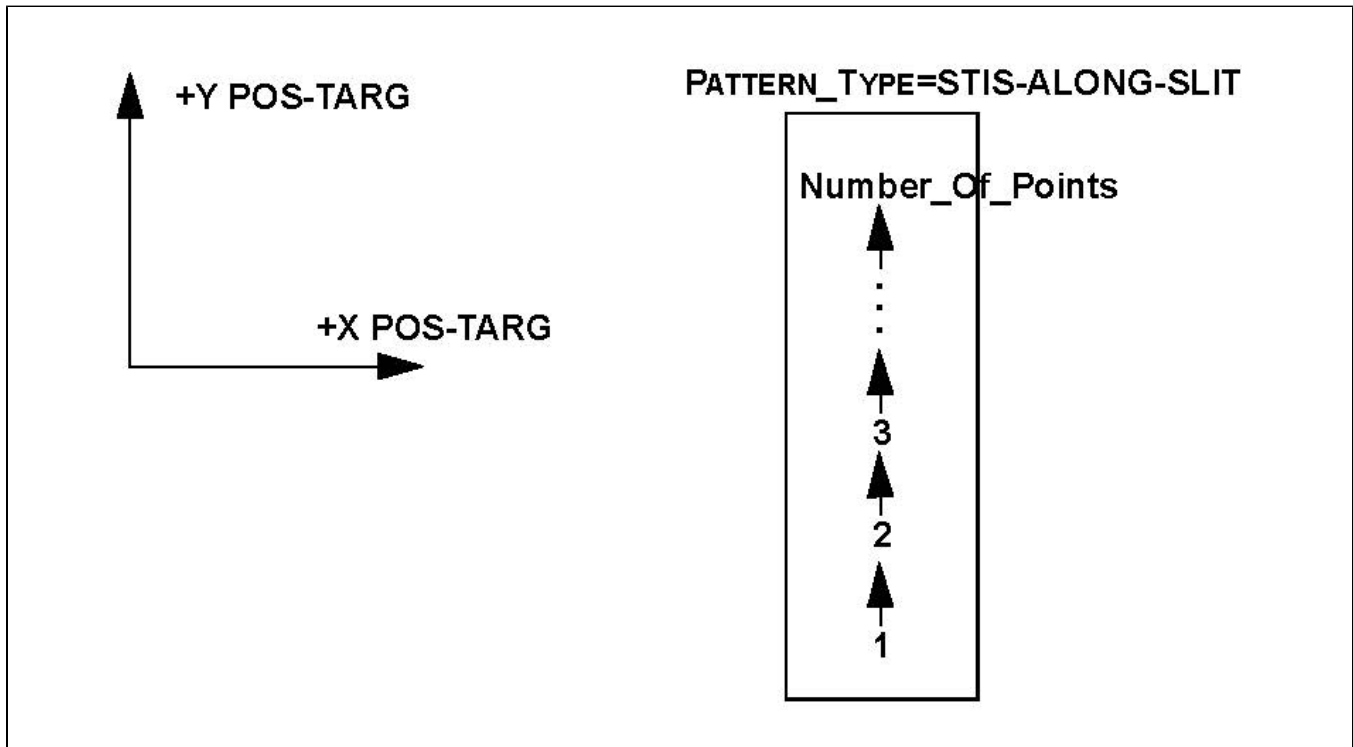
Pattern_Type: STIS-CCD-BOX

This will produce a four-point parallelogram scan designed for dithering across the CCD pixels. With the default Point_Spacing of 0.567, the four points of the parallelogram will be obtained at the following POS TARG (X,Y) offsets relative to the default aperture position:

(0.0", 0.0") (0.5070", 0.2535") (0.7605", 0.7605") (0.2535", 0.5070")

This default produces a parallelogram pattern (see diagram) with projected offsets from the starting point of 5n integer pixels in each coordinate, so that the above arcsec values correspond to pixel values of (0, 0), (10, 5), (15, 15), and (5, 10). With these integer-pixel offsets, the pattern is optimized to simultaneously compensate for hot pixels and small-scale detector non-uniformities. The pattern can be rescaled (e.g., by a factor of 0.5) to achieve shifts of N+half pixels for resolution enhancement by changing the Point_Spacing.

```
Pattern_Type:STIS-CCD-BOX
Pattern_Purpose:DITHER
Number_of_Points: 4
Point_Spacing:0.0567-5.67 (default 0.567)
Line_Spacing: Equal to Point_Spacing (may not be changed)
Angle_Between_Sides:143.1 (may not be changed)
Coordinate_Frame: POS-TARG
Pattern_Orient:? (default 26.6)
Center_Pattern: ?
```

Permitted Sub-Pattern (Secondary_Pattern) values: none.

To see an illustration of the STIS POS-TARG reference frame, see 8.5.3 *STIS Coordinate Systems*.
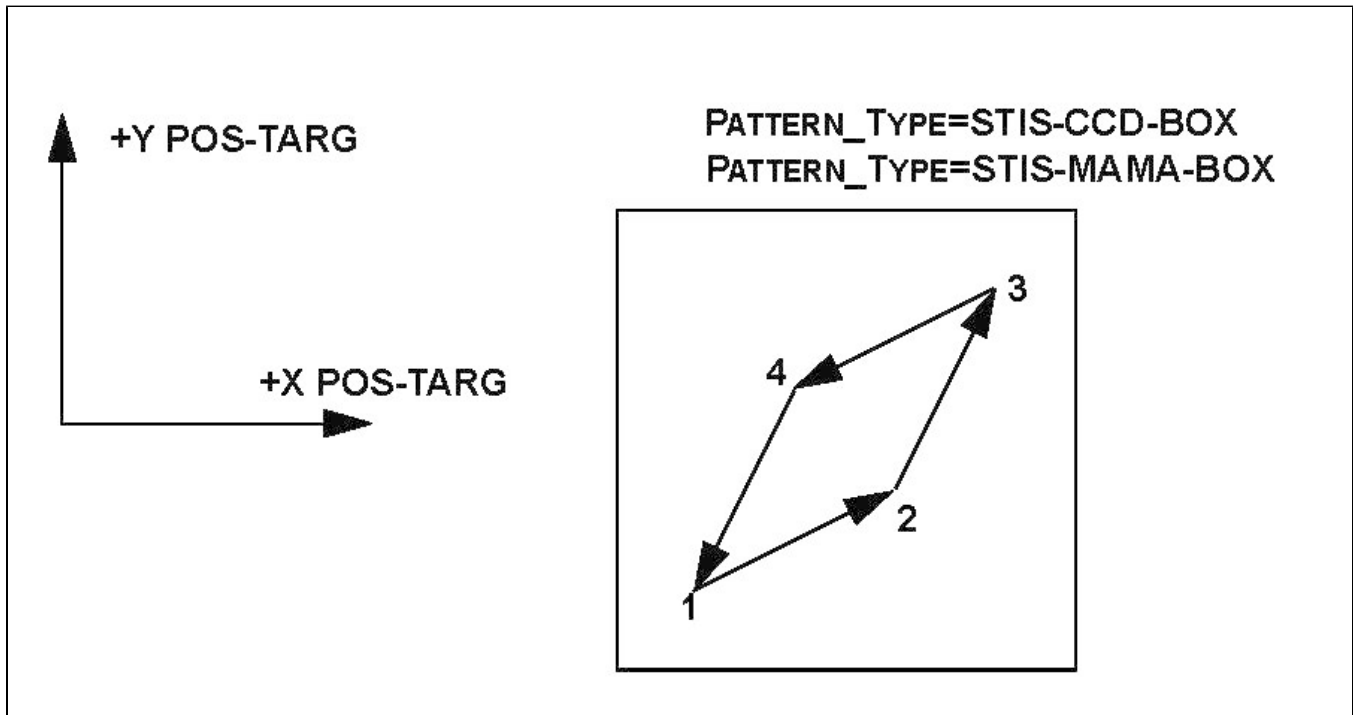
Pattern_Type: STIS-MAMA-BOX

This will produce a four-point parallelogram scan designed for dithering across the MAMA pixels. With the default Point_Spacing of 0.275, the four points of the parallelogram will be obtained at the following POS TARG (X,Y) offsets relative to the default aperture position:
(0.0", 0.0") (0.246", 0.123") (0.369", 0.369") (0.123", 0.246")

This default produces a parallelogram pattern (see diagram) with projected offsets from the starting point of 5n integer pixels in each coordinate, so that the above arcsec values correspond to pixel values of (0, 0), (10, 5), (15, 15), and (5, 10). With these integer-pixel offsets, the pattern is optimized to simultaneously compensate for hot pixels and small-scale detector non-uniformities. The pattern can be rescaled (e.g., by a factor of 0.5) to achieve shifts of N+half pixels for resolution enhancement by changing the Point_Spacing.

```
Pattern_Type:STIS-MAMA-BOX
Pattern_Purpose:DITHER
Number_of_Points:4
Point_Spacing:0.0275-2.75 (default 0.275)
Line_Spacing:Equal to Point_Spacing (may not be changed)
Angle_Between_Sides:143.1 (may not be changed)
Coordinate_Frame:POS-TARG
Pattern_Orient:? (default 26.6)
Center_Pattern:?
```

Permitted Sub-Pattern (Secondary_Pattern) values: none.

Pattern_Type: STIS-SPIRAL-DITH

This produces a spiral dither pattern, starting at the center and moving outward counterclockwise. Note that a STIS-SPIRAL-DITH with four points yields a square pattern, but the optimum pattern for detector dithering to enhance resolution is either STIS-CCD-BOX or STIS-MAMA-BOX.

```
Pattern_Type:STIS-SPIRAL-DITH
Pattern_Purpose:DITHER
Number_of_Points:?
Point_Spacing:?
Coordinate_Frame:POS-TARG
Pattern_Orient:? (default 0)
Center_Pattern:?
```

Permitted Sub-Pattern values: none.

To see an illustration of the STIS POS-TARG reference frame, see 8.5.3 *STIS Coordinate Systems*.
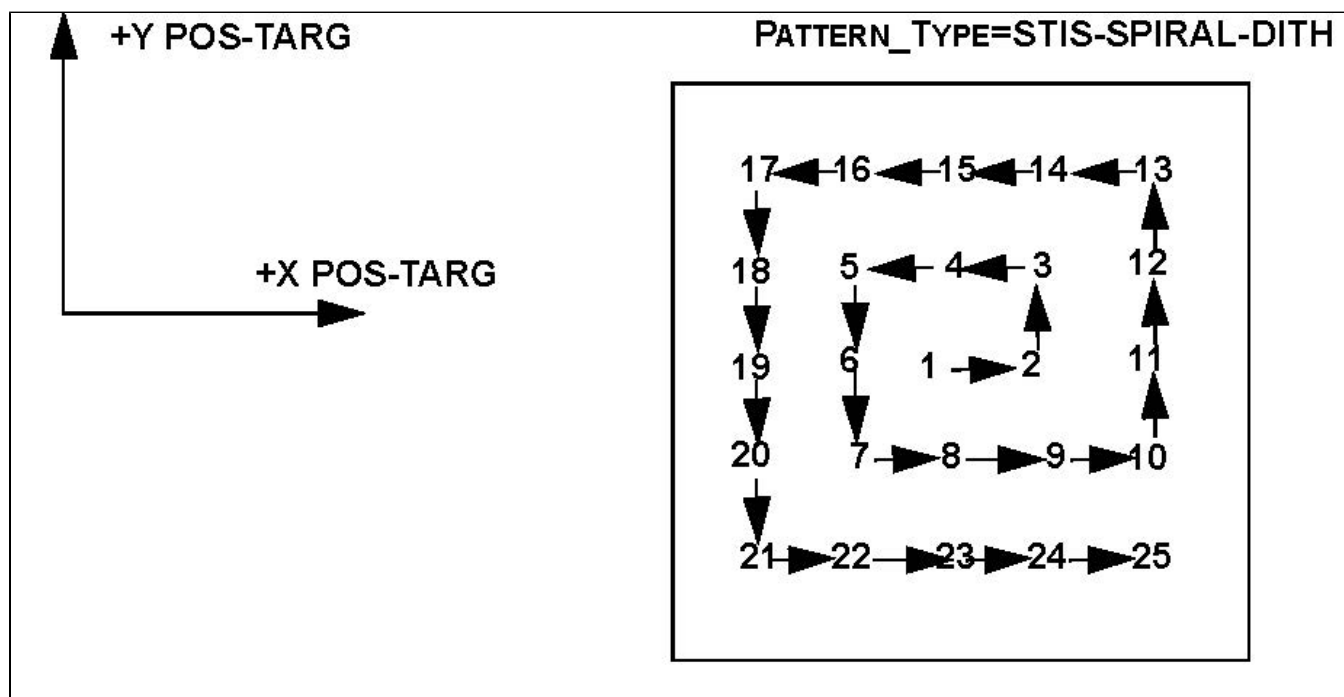
Related Links

Change Log

Version Cycle 31 July 2023

Fixed a link to the STIS IHB

7.2 ACS Patterns

Most HST ACS observations are obtained with some motion of the telescope (e.g., dithering, mosaicking), and there are predefined patterns available in APT to support these motions.

On This Page

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

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Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

There are 8 different predefined patterns that can be used with ACS, which are shown in Table 7.2.

Table 7.2: ACS Patterns

ACS Patterns
ACS-WFC-DITHER-LINE
ACS-WFC-DITHER-BOX
ACS-WFC-MOSAIC-LINE

ACS-WFC-MOSAIC-BOX
ACS-SBC-DITHER-LINE
ACS-SBC-DITHER-BOX
ACS-SBC-MOSAIC-LINE
ACS-SBC-MOSAIC-BOX

For general information on ACS pointing, and a library of carefully designed dither and mosaic pointing patterns (ready for use in a Phase II proposal), see the following web page:

http://www.stsci.edu/hst/instrumentation/acs/proposing/dither-strategies

In addition to the default patterns provided below, many non-default variations are included in the pattern library (e.g., for hot pixel rejection, sub-pixel dithering, etc.). As of Cycle 25, the ACS Team has incorporated the latest understanding of the Wide Field Channel (WFC) geometric distortion into a revised set of default parameters for the ACS-WFC-DITHER-LINE and ACS-WFC-DITHER-BOX convenience patterns discussed below. The matrix transformation between WFC pixel offsets and POSTARG offsets, provided on the webpage listed above, has also been updated.

Pattern_Type: ACS-WFC-DITHER-LINE

General WFC dither line pattern. The default for this pattern shifts the image by 5 pixels in **x** and 60 in **y** in order to span the gap between the two WFC detectors.

```
Pattern_Type: ACS-WFC-DITHER-LINE
Pattern_Purpose: DITHER
Number_Of_Points: 2-9 (default 2)
Point_Spacing: 0.01 - 10.0 (default 3.034)
Coordinate_Frame: POS-TARG
Pattern_Orient:? (default 85.29)
Center_Pattern:? (default NO)
```

Permitted **Sub_Pattern** (Secondary_Pattern) values: any other ACS/WFC patterns, **LINE**, **BOX**, **SPIRAL**

> 💡 *Note: All ACS/WFC users are encouraged to use some form of dithering to allow for correction of hot pixels during data processing. The standard **CR-SPLIT** approach does not eliminate hot pixels (see Optional Parameters). Users who would normally have taken that approach in the past are now encouraged to define and use instead the pattern:*
>
> *Pattern_Type: ACS-WFC-DITHER-LINE*
> *Pattern_Purpose: DITHER*
> *Number_Of_Points: 2*
> *Point_Spacing: 0.146*
> *Coordinate_Frame: POS-TARG*
> *Pattern_Orient: 47.17*
> *Center_Pattern: NO*
>
> *This pattern will allow simultaneous elimination of hot pixels and cosmic ray hits in post-observation processing. The pattern parameters shift the image by 2 pixels in x and 2 in y along the direction that minimizes the effects of scale variation across the detector.*

Pattern_Type: ACS-WFC-DITHER-BOX

This is the default WFC box pattern. It is a 4-point pattern with relative pixel coordinates (0, 0), (5.0, 1.5), (2.5, 4.5), (-2.5, 3.0) — a parallelogram pattern with a combination of integer and sub-pixel shifts, which is relatively compressed in one dimension compared to its STIS counterpart. This minimizes the effect of scale variation across the detector.

```
Pattern_Type: ACS-WFC-DITHER-BOX
Pattern_Purpose: DITHER
Number_Of_Points: 4
Point_Spacing: 0.01 - 10.0 (default 0.2637)
Line_Spacing: 0.01 - 10.0 (default 0.1856)
Angle_Between_Sides: 0 - 360 (default 69.02)
Coordinate_Frame: POS-TARG
Pattern_Orient: 0 - 360 (default 20.7)
Center_Pattern:? (default NO)
```

Permitted **Sub_Pattern** (Secondary_Pattern) values: any other ACS/WFC patterns, **LINE**, **BOX**, **SPIRAL**

Pattern_Type: ACS-WFC-MOSAIC-LINE

General WFC mosaic line pattern. The default shift is in the **y** direction by 47% of the detector dimension, resulting in a field-of-view that is about 200 × 300 arcsec. This is a compromise which allows the 2-point WFC mosaic to be performed with one set of guide stars and to cover the inter chip gap as well.

```
Pattern_Type: ACS-WFC-MOSAIC-LINE
Pattern_Purpose: MOSAIC
Number_Of_Points: 2-9 (default 2)
Point_Spacing: 10.0 - 130.0 (default 96.816)
Coordinate_Frame: POS-TARG
Pattern_Orient:? (default 90.0)
Center_Pattern:? (default YES)
```

Permitted **Sub_Pattern** (Secondary_Pattern) values: any other ACS/WFC patterns, **LINE**, **BOX**, **SPIRAL**

Pattern_Type: ACS-WFC-MOSAIC-BOX

This is a 4-point box pattern for creating a WFC mosaic roughly 400 × 300 arc seconds. This pattern strikes a compromise with a y-shift that covers the inter chip gap (with one set of guide stars) and the maximum x-shift to expand the field of view. So another set of guide stars would be needed only for the x shifts, which are 95% of the detector x dimension (~193 arcsec).

> 💡 Note: This pattern is not supported in the STScI ground system because it would require two sets of guide stars, so no pattern parameters are given. The pattern can be set up by hand using the following **POS TARG** offsets:
>
> Point 1: -96.497, -55.801
> Point 2: -96.497, 41.015
> Point 3: 96.497, 55.801
> Point 4: 96.497, -41.015

Another useful WFC mosaic box pattern would maximize the field of view (~400 × 400 arcseconds). For this pattern, both the x and y shifts are ~95% of the detector dimensions, and would require multiple guide stars.

This pattern is also not supported in the ground system, but may be set up by hand using the following **POS TARG** offsets:

Point 1: -96.497, -104.084
Point 2: -96.497, 89.298
Point 3: 96.497, 104.084
Point 4: 96.497, -89.298

Pattern_Type: ACS-SBC-DITHER-LINE

General SBC dither line pattern. This pattern shifts the image on the diagonal (10 pixels in **x** and **y**).

```
Pattern_Type: ACS-SBC-DITHER-LINE
Pattern_Purpose: DITHER
Number_Of_Points: 2-9 (default 2)
Point_Spacing: 0.01 - 10.0 (default 0.472)
Coordinate_Frame: POS-TARG
Pattern_Orient:? (default 44.40)
Center_Pattern:? (default NO)
```

Permitted **Sub_Pattern** (Secondary_Pattern) values: any other ACS/SBCpatterns, **LINE**, **BOX**, **SPIRAL**

Pattern_Type: ACS-SBC-DITHER-BOX

Same as ACS-WFC-DITHER-BOX, but for the SBC detector.

```
Pattern_Type: ACS-SBC-DITHER-BOX
Pattern_Purpose: DITHER
Number_Of_Points: 4
Point_Spacing: 0.01 - 10.0 (default 0.179)
Line_Spacing: 0.01 - 10.0 (default 0.116)
Angle_Between_Sides: 0 - 360 (default 63.65)
Coordinate_Frame: POS-TARG
Pattern_Orient: 0 - 360 (default 20.02)
Center_Pattern:? (default NO)
```

Permitted **Sub_Pattern** (Secondary_Pattern) values: any other ACS/SBC patterns, **LINE**, **BOX**, **SPIRAL**

Pattern_Type: ACS-SBC-MOSAIC-LINE

General SBC mosaic line pattern. This pattern shifts the image by 95% in **y** to roughly double the FOV.

```
Pattern_Type: ACS-SBC-MOSAIC-LINE
Pattern_Purpose: MOSAIC
Number_Of_Points: 2-9 (default 2)
Point_Spacing: 10.0 - 130.0 (default 28.801)
Coordinate_Frame: POS-TARG
Pattern_Orient:? (default 90.0)
Center_Pattern:? (default YES)
```

Permitted **Sub_Pattern** (Secondary_Pattern) values: any other ACS/SBC patterns, **LINE**, **BOX**, **SPIRAL**

Pattern_Type: ACS-SBC-MOSAIC-BOX

This is a large 4-point box pattern for creating a mosaic roughly 4 times the SBC field-of-view, or ~64 × 64 arcsec. The shifts are 95% of the detector dimensions (~973 pixels or ~32 arcsec) along both the *x* and *y* axes of the detector.

```
Pattern_Type: ACS-SBC-MOSAIC-BOX
Pattern_Purpose: MOSAIC
Number_Of_Points: 4
Point_Spacing: 10.0 - 130.0 (default 28.801)
Line_Spacing: 10.0 - 130.0 (default 32.957)
Angle_Between_Sides: 0 - 360 (default 264.24)
Coordinate_Frame: POS-TARG
Pattern_Orient: 0 - 360 (default 90.0)
Center_Pattern:? (default YES)
```

Permitted **Sub_Pattern** (Secondary_Pattern) values: any other ACS/SBC patterns, **LINE**, **BOX**, **SPIRAL**

Related Links

Change Log

Version Cycle 30 August 2022

PROPINST-91387 (Update to ACS WFC Dither Box Pattern)

7.3 WFC3 Patterns

Most HST WFC3 observations are obtained with some motion of the telescope (e.g., dithering, mosaicking), and there are predefined patterns available in APT to support these motions.

On This Page

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

There are 12 different predefined patterns that can be used with WFC3, which are shown in Table 7.3: *WFC3 Patterns*.

Table 7.3: WFC3 Patterns

WFC3 Patterns

WFC3-UVIS-DITHER-LINE
WFC3-UVIS-DITHER-LINE-3PT
WFC3-UVIS-DITHER-BOX
WFC3-UVIS-GAP-LINE
WFC3-UVIS-MOS-DITH-LINE
WFC3-UVIS-MOS-BOX-LRG
WFC3-UVIS-MOSAIC-LINE
WFC3-IR-DITHER-LINE
WFC3-IR-DITHER-LINE-3PT
WFC3-IR-DITHER-BOX-MIN
WFC3-IR-DITHER-BOX-UVIS
WFC3-IR-DITHER-BLOB

Please see ISR WFC3 2010-09 and the *WFC3 Instrument Handbook* (Sections 6.10, 7.10 and Appendix C) for information on dither strategies and patterns. For general advice on dither strategies, see the DrizzlePac website. The step sizes in pixels specified below apply to the central regions of the detectors. For smaller steps, the step sizes are accurate over a larger region of the detectors. (The step size in pixels depends on the geometric distortion; see Appendix B of the *WFC3 Instrument Handbook*.)

Additional UVIS dither patterns that optimize PSF sampling are being introduced for cycle 28, including patterns with more than 4 steps. The steps are prescribed in pixels and POS-TARGs in ISR WFC3 2020-07. We will be releasing a *new* dither pattern (defined via postargs) later this cycle, which will optimize pixel phase sampling when the two primary imagers (WFC3 & ACS) are used simultaneously.

WFC3 dither patterns designed to subsample pixels can now optionally be selected as secondary patterns when WFC3 patterns with larger steps are selected as primary patterns. WFC3 patterns can also be added as secondary patterns to any of the generic pattern types (**BOX, LINE, SPIRAL**). When combining patterns, the smaller dither pattern should be the secondary pattern to minimize the time spent moving the telescope. **We remind the user that IR dither patterns should be at least 10 pixels to avoid self-persistence for sources that are larger than 5 pixels in size. The standard box pattern is significantly smaller than this.** For more information, see ISR WFC3 2016-14.

Pattern_Type: WFC3-UVIS-DITHER-LINE

This pattern dithers the UVIS aperture by (2.5, 2.5) pixels to sample the point spread function with fractional pixel steps. The default values are optimized for a 2-step pattern.

```
        Pattern_Type: WFC3-UVIS-DITHER-LINE
        Pattern_Purpose: DITHER
        Number_Of_Points: 2 - 9 (default 2)
        Point_Spacing:? (default 0.145)
        Coordinate_Frame: POS-TARG
        Pattern_Orient:? (default 46.840)
        Center_Pattern:? (default NO)
```

Pattern_Type: WFC3-UVIS-DITHER-LINE-3PT

This pattern dithers the UVIS aperture by (2.33, 2.33) pixels to sample the point spread function with fractional pixel steps. The default values are optimized for a 3-step pattern.

```
        Pattern_Type: WFC3-UVIS-DITHER-LINE-3PT
        Pattern_Purpose: DITHER
        Number_Of_Points: 3 - 9 (default 3)
        Point_Spacing:? (default 0.135)
        Coordinate_Frame: POS-TARG
        Pattern_Orient:? (default 46.840)
        Center_Pattern:? (default NO)
```

Pattern_Type: WFC3-UVIS-DITHER-BOX

This pattern for WFC3/UVIS samples the point spread function with fractional pixel steps and produces spacings of more than one column to move hot columns. The relative steps in pixels are (0, 0), (4.0, 1.5), (2.5, 4.0), and (-1.5, 2.5).

```
        Pattern_Type: WFC3-UVIS-DITHER-BOX
        Pattern_Purpose: DITHER
        Number_Of_Points: 4
        Point_Spacing: ? (default 0.173)
        Line_Spacing: ? (default 0.112)
        Angle_Between_Sides: ? (default 81.785)
        Coordinate_Frame: POS-TARG
        Pattern_Orient: ? (default 23.884)
        Center_Pattern: NO
```

Pattern_Type: WFC3-UVIS-GAP-LINE

This pattern dithers over the gap between the two chips of the UVIS detector with relative steps of (-2.25,-30.25) and (2.25,30.25) pixels. Additional subpixel dithering can be achieved by adding one of the WFC3-UVIS dither patterns as a Secondary Pattern.

Primary_Pattern:

```
Pattern_Type: WFC3-UVIS-GAP-LINE
Pattern_Purpose: MOSAIC
Number_of_Points:? (default 2)
Point_Spacing:? (default 2.414)
Coordinate_Frame: POS-TARG
Pattern_Orient:? (default 85.759)
Center_Pattern: YES
```

Permitted **Sub-Pattern** (Secondary_Pattern) values:

WFC3-UVIS-DITHER-BOX,
WFC3-UVIS-DITHER-LINE,
WFC3-UVIS-DITHER-LINE-3PT

Pattern_Type: WFC3-UVIS-MOS-DITH-LINE

The primary pattern dithers over the gap between the two chips of the UVIS detector with relative steps of (-4.5,-60.25), (0, 0), and (4.5, 60.25) pixels. The secondary pattern adds a dither of (2.5, 1.5) pixels to the primary pattern (Use WFC3-UVIS-GAP-LINE if you need a greater selection of permitted Secondary Patterns.).

Primary_Pattern:

```
Pattern_Type: WFC3-UVIS-MOS-DITH-LINE
Pattern_Purpose: MOSAIC Number_of_Points:? (default 3)
Point_Spacing:? (default 2.400)
Coordinate_Frame: POS-TARG Pattern_Orient:? (default 85.754)
Center_Pattern: YES
```

Secondary_Pattern:

```
Pattern_Type: WFC3-UVIS-MOS-DITH-LINE
Number_of_Points:? (default 2)
Pattern_Purpose: DITHER Point_Spacing:? (default 0.119)
Coordinate_Frame: POS-TARG
Pattern_Orient:? (default 33.606)
Center_Pattern: NO
```

Pattern_Type: WFC3-UVIS-MOS-BOX-LRG

This pattern produces a UVIS mosaic that can be executed with a single set of guide stars. It dithers the gap between the chips so that no region lies in the gap more than once. The relative steps in pixels are approximately (-1000, -997), (1000, -1001), (1000, 997), and (-1000,1001). Subpixel dithering can be achieved by adding one of the WFC3-UVIS dither patterns as a Secondary Pattern.

```
Pattern_Type: WFC3-UVIS-MOS-BOX-LRG
Pattern_Purpose: MOSAIC
Number_of_Points: 4
Point_Spacing: ? (default 79.40)
Line_Spacing: ? (default 77.50)
Angle_Between_Sides: ? (default 95.30)
Coordinate_Frame: POS-TARG
Pattern_Orient: ? (default 5.55)
Center_Pattern: YES
```

Permitted **Sub-Pattern** (Secondary_Pattern) values:

WFC3-UVIS-DITHER-BOX,
WFC3-UVIS-DITHER-LINE,
WFC3-UVIS-DITHER-LINE-3PT

Pattern_Type: WFC3-UVIS-MOSAIC-LINE

This pattern is designed for observations using the full WFC3/UVIS detector for primary exposures and the full ACS/WFC detector for parallel exposures. It dithers over the inter-chip gap on both detectors. The relative steps on the WFC3/UVIS detector are (0, 0) and (36.5, 71.5) pixels. Subpixel dithering can be achieved by adding one of the WFC3-UVIS dither patterns as a Secondary Pattern.

```
Pattern_Type: WFC3-UVIS-MOSAIC-LINE
Pattern_Purpose: MOSAIC
Number_of_Points: 2-9 (default 2)
Point_Spacing: ? (default 3.264)
Coordinate_Frame: POS-TARG
Pattern_Orient: ? (default 63.697)
Center_Pattern: NO
```

Permitted **Sub-Pattern** (Secondary_Pattern) values:

WFC3-UVIS-DITHER-BOX,
WFC3-UVIS-DITHER-LINE,
WFC3-UVIS-DITHER-LINE-3PT

Pattern_Type: WFC3-IR-DITHER-LINE

This pattern for WFC3/IR takes steps large enough for photometric accuracy and samples the point spread function with fractional pixel steps. The relative steps in pixels are (0, 0) and (3.5, 3.5). The default values are optimized for a 2-step pattern.

```
Pattern_Type: WFC3-IR-DITHER-LINE
Pattern_Purpose: DITHER
Number_of_Points: 2 - 9 (default 2)
Point_Spacing:? (default 0.636)
Coordinate_Frame: POS-TARG
Pattern_Orient:? (default 41.788)
Center_Pattern: NO
```

Pattern_Type: WFC3-IR-DITHER-LINE-3PT

This pattern for WFC3/IR takes steps large enough for photometric accuracy and samples the point spread function with fractional pixel steps. The relative steps in pixels are (0, 0) and (3.33, 3.33). The default values are optimized for a 3-step pattern.

```
Pattern_Type: WFC3-IR-DITHER-LINE-3PT
Pattern_Purpose: DITHER
Number_of_Points: 3 - 9 (default 3)
Point_Spacing:? (default 0.605)
Coordinate_Frame: POS-TARG
Pattern_Orient:? (default 41.788)
Center_Pattern: NO
```

Pattern_Type: WFC3-IR-DITHER-BOX-MIN

This pattern for WFC3/IR takes steps just large enough for photometric accuracy and samples the point spread function with fractional pixel steps. The relative steps in pixels are (0, 0), (4.0, 1.5), (2.5, 4.0), and (-1.5, 2.5).

```
Pattern_Type: WFC3-IR-DITHER-BOX-MIN
Pattern_Purpose: DITHER
Number_of_Points: 4
Point_Spacing: ? (default 0.572)
Line_Spacing: ? (default 0.365)
Angle_Between_Sides: ? (default 74.653)
Coordinate_Frame: POS-TARG
Pattern_Orient: ? (default 18.528)
Center_Pattern: NO
```

Pattern_Type: WFC3-IR-DITHER-BOX-UVIS

This is a four-point box pattern that produces an IR mosaic covering approximately the same area as the UVIS detector. IR imaging with aperture IR-FIX is intended to be accompanied by a UVIS exposure (or small dither pattern) using the aperture UVIS-FIX or UVIS-CENTER. If UVIS-FIX is used, the UVIS exposures should use the Target Position Requirement POS TARG 0.0", -12" to achieve the same centering of the target in the UVIS exposures and the IR mosaic. Subpixel dithering can be achieved by adding one of the WFC3-IR dither patterns as a Secondary Pattern.

```
Pattern_Type: WFC3-IR-DITHER-BOX-UVIS
Pattern_Purpose: DITHER
Number_of_Points: 4
Point_Spacing: 23.020
Line_Spacing: 35.212
Angle_Between_Sides: 89.287
Coordinate_Frame: POS-TARG
Pattern_Orient: 0.713
Center_Pattern: YES
```

Permitted **Sub-Pattern** (Secondary_Pattern) values:

WFC3-IR-DITHER-BOX-MIN,
WFC3-IR-DITHER-LINE,
WFC3-IR-DITHER-LINE-3PT

Pattern_Type: WFC3-IR-DITHER-BLOB

This pattern dithers over the IR "blobs,"described in ISR WFC3 2010-09, using relative steps of (-14.25,-14.25) and (14.25,14.25) pixels. Additional subpixel dithering can be achieved by adding one of the WFC3-IR dither patterns as a Secondary Pattern.

```
Pattern_Type: WFC3-IR-DITHER-BLOB
Pattern_Purpose: DITHER
Number_of_Points:? (default 2)
Point_Spacing:? (default 5.183)
Coordinate_Frame: POS-TARG
Pattern_Orient: 41.859
Center_Pattern: YES
```

Permitted **Sub-Pattern** (**Secondary_Pattern**) values:

WFC3-IR-DITHER-BOX-MIN,
WFC3-IR-DITHER-LINE,
WFC3-IR-DITHER-LINE-3PT

Related Links

7.1 STIS Patterns
7.2 ACS Patterns

Change Log
Version Cycle 31 July 2023

Added a note about a future WFC3/ACS dither.

Chapter 8 Space Telescope Imaging Spectrograph, STIS

The Space Telescope Imaging Spectrograph (STIS) is one of the scientific instruments on HST, and this article contains instructions for how to specify observations for STIS using the Astronomer's Proposal Tool (APT).

Chapter Contents

8.1 Introduction to STIS

HST observations with STIS are specified using the Astronomer's Proposal Tool (APT), and this article provides instructions for completing those observations.

On This Page

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

The Instrument Configurations and Operating Modes described here are used for the Visit and Exposure Specifications. The legal Specifications are discussed in a summary fashion in the following sections. More complete descriptions of Instrument Configurations, Modes, Apertures, Spectral Elements, etc. are available in the *STIS Instrument Handbook*.

Note that many of the Optional Parameters have default values; in such cases, **an entry for an Optional Parameter in the Visit and Exposure Specifications is necessary only if it is desired to override the default value**. In the STScI proposal system, the physical units of Optional Parameter quantities are always implicit and should never be entered by the observer.

STIS has a large number of apertures. A complete list of supported apertures is provided in table Table 8.7: *Supported STIS Apertures*. That table should be taken as definitive if any additional information in this chapter appears to conflict.

Table 8.1: *Supported Optional Parameters for STIS Instrument Modes* lists the permitted Instrument Configurations, Operating Modes, Spectral Elements, and Optional Parameters for the STIS.

Note also that in addition to the automatic wavelength calibrations added by the system, the following observer-added contemporaneous calibrations may also be made:

- CCDFLAT (fringe flats) for G750L and G750M observations longward of 7000 Å.
- WAVE calibrations either for added wavelength precision or to replace auto **WAVECAL**s to control when they execute. See the *STIS Instrument Handbook* for more information.

⭐ Some STIS modes will work without an initial ACQuisition (such as slitless spectroscopy and imaging), but in general the user must ensure that ACQuisitions are included where needed. An ACQ/PEAK should always be preceded by an ACQuisition.

STIS Optional Parameters

Table 8.1: Supported Optional Parameters for STIS Instrument Modes

Config.	Mode	Spectral Elements	Optional Parameters
STIS/CCD	ACQ	MIRROR	ACQTYPE, DIFFUSE–CENTER, CHECKBOX
	ACQ /PEAK	MIRROR, G230LB, G230MB, G430L, G430M, G750L, G750M	SIZEAXIS2
	ACCUM		CR–SPLIT, GAIN, BINAXIS1, BINAXIS2, SIZEAXIS2, WAVECAL
STIS/FUV–MAMA	ACCUM	MIRROR, G140L, G140M, E140M, E140H	BINAXIS1, BINAXIS2, WAVECAL
	TIME–TAG		BUFFER–TIME, WAVECAL
STIS/NUV–MAMA	ACCUM	MIRROR, G230L, G230M, E230M, E230H	BINAXIS1, BINAXIS2, WAVECAL
	TIME–TAG		BUFFER–TIME, WAVECAL

Table 8.1: For available but unsupported parameters

Configuation	Mode	Spectral Elements	Optional Parameters
STIS/CCD	ACQ		GAIN
	ACQ /PEAK		SIZEAXIS1, CENTERAXIS2, CENTER- AXIS1, SEARCH, NUM–POS, STEP– SIZE, CENTROID, GAIN
	ACCUM		SIZEAXIS1, CENTERAXIS2, CENTER- AXIS1, PREFLUSH, LAMP=TUNGSTEN
STIS/NUV– MAMA	ACCUM	PRISM	
	TIME– TAG	PRISM	
STIS	MSMOFF		SETOFFSET , GRATING1 , GRATING2 , GRATING3, WAVELENGTH

Table 8.1: For restricted parameters

Configuation	Mode	Spectral Elements	Optional Parameters
STIS/CCD	ACCUM		LAMP = HITM1, HITM2, LINE, DEUTERIUM, SLIT–STEP, AMP
STIS/CCD	ACCUM	MIRROR	POS
STIS/CCD	ACCUM	G430M	POS for Central Wavelength = 5471
STIS/FUV– MAMA, STIS /NUV– MAMA	ACCUM	X140H, X140M, X230H, X230M	LAMP, SLIT–STEP
STIS/FUV– MAMA	ACCUM	G140L	POS for Central Wavelength = 1425
STIS	ALIGN	DEF	FOCUS, XTILT, YTILT
	ANNEAL		

For the MAMA cross-disperser modes (**X140H, X140M, X230H, X230M**), these definitions are reversed; **AXIS1** is the "cross-dispersion" (or spatial) direction, and **AXIS2** is in the dispersion direction.

The following sections provide further details of the entries to be made on the Visit and Exposure Specifications when a particular **STIS/CCD**, **STIS/FUV–MAMA**, or **STIS/NUV–MAMA** or **STIS** Mode /Configuration is chosen.

Note: The **AXIS1** and **AXIS2** coordinate system is defined in Section 3.1 of the *STIS Instrument Handbook*. Array sizes are given as **AXIS1** x **AXIS2**. For CCD and MAMA first-order grating and MAMA echelle spectroscopic modes, **AXIS1** is in the dispersion direction, and **AXIS2** is in the "cross-dispersion" (or spatial) direction.

Related Links

Change Log

Version Cycle 31 July 2023

Fixed a link to the STIS IHB near the bottom of the page.

Version Cycle 30 April 2022

PROPINST-91382 Document STIS PRISM as available mode

PROPINST-91381 Document MSMOFF use by GOs now that it is an available mode

Expand/Collapse all...

8.2 Target Acquisition Modes

⚠️ *GO's preparing Phase 2 proposals which are critically dependent upon precise astrometry (mainly spectroscopic observations) should be aware that a subset of existing ACS and WFC3 datasets in the MAST archive have astrometric errors due to imperfect fits to GAIA stars during post-processing. This may result in incorrect scale factors in the image headers leading to errors on the order of ~1 arc second. Observers should consult the Phase 2 Proposal Instructions and the MAST web page. Please see item 3 in the [WFC3 STAN Issue 31, June 2020](#) for more information. A description of the WCS naming conventions used in ACS and WFC3 data is at [Improvements in HST Astrometry](#). Instructions on resetting the WCS to the pipeline defaults is given in the Jupyter notebook [Using updated astrometry solutions](#).*

Observations with HST's STIS instrument generally require a target acquisition before obtaining science data, and the Astronomer's Proposal Tool ([APT](#)) has parameters for specifying these observations.

[Expand/Collapse all...](#)

Format definitions

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Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

HST pointing now uses the GSC2 catalog to determine the position of guide stars. Following the initial guide star acquisition for your visit, the target location in the aperture plane should now be known to an accuracy of 0.2 to 0.5 arcseconds. This is a considerable improvement over the 1-2 arcsecond accuracy achieved using GSC1. However, for STIS spectroscopic observations of an external target, any uncertainty in the target position along the dispersion direction will directly translate into an uncertainty in the zero point of the wavelength scale. Therefore, for most STIS spectroscopic science observations, even those using large apertures, and for any science observations using the coronagraphic bars, it is strongly recommended that a target acquisition (**ACQ** Mode) exposure and possibly one or more acquisition peakup exposures (**ACQ/PEAK** Mode) be done to center your target. The CCD detector may be used for acquisitions of targets that will be observed in the CCD and MAMA **ACCUM** and **TIME-TAG** modes. Details on STIS target acquisition modes are in the *STIS Instrument Handbook*.

> 💡 *The STIS Target Acquisition Exposure Time Calculator (ETC) and Target Acquisition Simulator are tools provided by STScI to help plan acquisitions. You can find these tools at: http://www.stsci.edu/hst/instrumentation/stis/data-analysis-and-software-tools.*

Mode = ACQ Config = STIS/CCD

The STIS onboard flight software locates the target in the STIS FOV for subsequent science exposures. At the end of the onboard acquisition process, HST is repositioned to place the target in the aperture specified on the first science exposure in the series.

Onboard acquisitions of two different types of targets are supported: point and extended sources. The total flux within a sequence of overlapping "checkboxes" within an acquisition subarray is determined, and the target position is located within the brightest checkbox.

The visual magnitude from the Target List, along with the exposure time, will be used to verify that the integrated target flux through the selected acquisition aperture is appropriate for CCD target acquisition. Details on the CCD target acquisition sequence and limiting magnitudes for the acquisition apertures and spectroscopic slits can be found in the *STIS Instrument Handbook*.

Aperture or FOV

See Table 8.7: *Supported STIS Apertures*.

Enter one of the following apertures:

Entry	Description

F28X50LP	Optical longpass; preferred target acquisition aperture
F28X50OII	[OII] 3740 Å; use for bright sources or emission-line objects
F28X50OIII	[OIII] 5007 Å; use for bright sources or emission-line objects[1]
F25ND3	Neutral density filter for overly bright targets; ND = ~10^{-3}
F25ND5	Neutral density filter for overly bright targets; ND = ~10^{-5}
50CCD	Clear aperture for very faint sources

[1] Please note that this filter has a substantial red leak; see the *STIS Instrument Handbook*.

Spectral Element

MIRROR is the only valid spectral element for this Mode.

Optional Parameters

See Table 8.1 *Supported Optional Parameters for STIS Instrument Modes* for a listing by operating mode of all Optional Parameters. Here are descriptions for those Optional Parameters for **ACQ** mode.

ACQTYPE

=POINT (default), DIFFUSE

Specifies the type of onboard target acquisition algorithm used in locating the target. Onboard algorithms are available for acquiring a point or extended (diffuse) source.

With the default value of **POINT**, an acquisition subarray of 100 × 100 CCD pixels (5 × 5 arcsec) and a checkbox of 3 × 3 CCD pixels are always used. The target position is the flux-weighted centroid of the brightest checkbox within the subarray.

With the **DIFFUSE** acquisition type, the acquisition subarray is a square array. The number of pixels on each side is 101 + **CHECKBOX** (see below). The target position is either the geometric center or the flux-weighted centroid of the brightest checkbox, depending on the **DIFFUSE–CENTER** parameter.

DIFFUSE–CENTER

=FLUX–CENTROID (default), GEOMETRIC–CENTER

Specifies whether the target position of a extended source is to be located as the flux weighted centroid (**FLUX–CENTROID**) or the geometric center (**GEOMETRIC–CENTER**) of the brightest checkbox. **DIFFUSE– CENTER** is only permitted if **ACQTYPE=DIFFUSE**.

CHECKBOX =3–105 (pixels; odd only)

Specifies the length of a side of a square pixel array over which the light intensity is summed to locate the brightest region of the acquisition. This parameter is required for extended targets (**ACQTYPE=DIFFUSE**). It is not allowed for point sources (**ACQTYPE=POINT**), for which a fixed checkbox size based on the PSF will be used. The value of **CHECKBOX** should equal the size of the brightest area of the source the observation is attempting to locate. The dimension of the acquisition subarray will be 101 pixels plus the **CHECKBOX** parameter. The value of **CHECKBOX** must be an odd number.

For available but unsupported parameters

GAIN =4 (default), 1, 2, 8 (e/DN)

Specifies the gain of the CCD electronics in e/DN.

Number of Iterations

The **Number_of_Iterations** must be **1** in this Mode.

Time Per Exposure

The procedures to determine the exposure time for the **ACQ** exposures are given in the *STIS Instrument Handbook.*

The exposure time for **ACQ** exposures on GO proposals must be less than 5 minutes for **ACQTYPE=POINT** acquisitions, and for **ACQTYPE=DIFFUSE** acquisitions must be less than 500/(101+ **CHECKBOX**) minutes.

Special Requirements

None.

Mode = ACQ/PEAK Config = STIS/CCD

In **ACQ/PEAK** Mode, a series of exposures is taken at several HST pointings offset along the detector axes, and the HST is repositioned to maximize (peak up) or minimize (peak down) the light intensity within a default or proposer-specified detector subarray. **AXIS1** and **AXIS2** are in the dispersion and cross-dispersion (or spatial) directions respectively. For more information, including when peakups are required, see the *STIS Instrument Handbook.*

Mode **ACQ/PEAK** should always be preceded by an **ACQ**uisition.

Aperture or FOV

The aperture used for the **ACQ/PEAK** exposure will generally be identical to the aperture used for the subsequent science exposure. For maximum centering accuracy, a peakup aperture smaller than the science exposure may be chosen. Peakups are required whenever an aperture dimension is less than or equal to 0.1 arcsec. Two peakups are recommended for the **0.1X0.03** aperture: one with the **0.2X0. 09** aperture followed by another with the **0.1X0.03** aperture.

See Table 8.7: *Supported STIS Apertures* for the allowed **ACQ/PEAK** apertures. Note that you cannot perform a peakup with an E2 aperture (i.e., **52X...** apertures ending with the **E2** suffix), which are designed for use in conjunction with CCD Fringe Flats. If you need an **ACQ/PEAK** exposure prior to using an E2 aperture, perform the peakup using the **52X0.1E1** aperture. Then select the appropriate E2 aperture for the following science exposures.

When an **ACQ/PEAK** exposure using the occulting bar aperture **52X0.2F1** is specified, a peakdown rather than a peakup will automatically be performed. A peakup will be performed otherwise. To peak up on the width of a slit with an occulting bar before peaking down on the bar itself, the occulting bar aperture name with **–R** appended to it should be used. Such exposures will peak up on a reference point offset from the occulting bar along the slit's length.

<div style="border:1px solid magenta; color:magenta;">

For available but unsupported parameters

A peakdown on the target intensity will automatically be performed for **SEARCH=LINEARAXIS2** (spatial) scans on occulting bar apertures **52X0.05F1, 52X0.05F2, 52X0.1B0.5, 52X0.1B1. 0, 52X0.1B3.0, 52X0.1F1, 52X0.1F2, 52X0.2F2, 52X0.5F1, 52X0.5F2, 52X2F1, 52X2F2, BAR5, BAR10, WEDGEA0.6, WEDGEA1.0, WEDGEA1.8, WEDGEA2.0, WEDGEA2.5, WEDGEA2.8, WEDGEB1. 0, WEDGEB1.8, WEDGEB2.0, WEDGEB2.5, WEDGEB2.8**.

</div>

Spectral Element

MIRROR is the recommended spectral element for this mode unless the object is too bright. See the STIS Instrument Handbook for additional guidance on selecting the spectral element. See Table 8.2: *Supported Central Wavelengths for STIS Gratings Spectral*.

Wavelength

Enter the value of the central wavelength in Angstroms. Table 8.2: *Supported Central Wavelengths for STIS Gratings Spectral* gives the allowed values of the central wavelength for each grating. Consult the *STIS Instrument Handbook section 13.3 Gratings* for the associated minimum and maximum wavelength and other information pertaining to the gratings.

> ★ **No wavelength should be specified if MIRROR is the spectral element.**

Optional Parameters

See Table 8.1 *Supported Optional Parameters for STIS Instrument Modes* for a listing by operating mode of all Optional Parameters. Here are descriptions for those Optional Parameters for **ACQ/PEAK** mode.

> **SIZEAXIS2 =DEF (default); 30–1022 (pixels, dispersive elements), 16–1022 (pixels, MIRROR)**

Specifies the size of a CCD subarray in detector coordinates along the **AXIS2** (cross-dispersion or spatial) direction.

The default subarray with **SIZEAXIS2=DEF** depends on the aperture and spectral element. With the **MIRROR** element, the default subarray will generally be 32 × 32 CCD pixels centered on the aperture. However, the **F1** fiducial slits use a 32 × 64 subarray. A subarray of 16 × 16 is also allowed when **MIRROR** is used.

For available but unsupported parameters

The **F2** fiducial slits use a 32 × 128 subarray, and the planetary slits (**36X0.05P45**,**36X0.05N45**, **36X0.6P45**, **36X0.6N45**) use a 64 × 32 subarray..

With a first-order CCD grating (**G230LB**, **G230MB**, **G430L**, **G430M**, **G750L**, **G750M**), the default subarray will generally be 1022 × 32 CCD pixels. However, the **F1** fiducial slits use a 1022 × 64 subarray. The **F2** fiducial slits use a 1022 × 128 subarray. These subarrays have been chosen to minimize cosmic ray perturbations on the acquisition process.

For available but unsupported parameters

The **SIZEAXIS2**, **SIZEAXIS1**, **SEARCH**, **NUM–POS**, and **STEP–SIZE** parameters are required with the following apertures: **BAR5, BAR10, WEDGEA0.6, WEDGEA1.0, WEDGEA1.8, WEDGEA2.0, WEDGEA2.5, WEDGEA2.8, WEDGEB1.0, WEDGEB1.8, WEDGEB2.0, WEDGEB2.5, WEDGEB2.8, 0.5X0.5, 6X0.5, 52X0.1B0.5, 52X0.1B1.0, 52X0.1B3.0, 52X0.5, 52X0.5F1, 52X0.5F1–R, 52X0.5F2, 52X0.5F2–R, 52X2, 52X2F1, 52X2F1–R,52X2F2, and 52X2F2–R.**

SIZEAXIS1 =DEF (default); 30–1060 (pixels, dispersive elements), 16–1060 (pixels, MIRROR)

Specifies the size of a CCD subarray in detector coordinates along the **AXIS1** (dispersion) direction. The default subarray with **SIZEAXIS1=DEF** depends on the aperture and spectral element, as given under **SIZEAXIS2** above.

CENTERAXIS2 =TARGET (default); 17–1009 (pixels, dispersive elements), 10– 1016 (pixels, MIRROR)

Specifies the center of a CCD subarray in detector coordinates along the **AXIS2** (cross-dispersion or spatial) direction. The default value of **TARGET** means that the subarray will be centered on the detector coordinates of the target (which change with **POS**ition **TARG**et offsets).

CENTERAXIS1 =TARGET (default); 17–1047 (pixels, dispersive elements), 10– 1054 (pixels, MIRROR)

Specifies the center of a CCD subarray in detector coordinates along the **AXIS1** (dispersion) direction. The default value of **TARGET** means that the subarray will be centered on the detector coordinates of the target.

SEARCH =DEF (default), SPIRAL, LINEARAXIS1, LINEARAXIS2

Specifies whether an **ACQ/PEAK** exposure should consist of a **SPIRAL, LINEARAXIS1**, or **LINEARAXIS2** scan of vehicle positions (in detector coordinates) to peak up or peak down the light intensity through a spectroscopic slit. The default value will be based on the slit and scan type requested for the exposure. See the *STIS Instrument Handbook* for default values.

💡 *If any of the parameters SEARCH, NUM–POS, or STEP–SIZE have non-default values, then all three parameters must have non-default values.*

NUM–POS =DEF (default); 3–49 (pixels; odd only)

Specifies the number of dwell positions (including the initial target position) in an **ACQ/PEAK** scan. The default value will be based on the slit and scan type requested for the exposure; see the *STIS Instrument Handbook* for default values. Only odd numeric values are allowed. If **SEARCH=SPIRAL**, the value of **NUM–POS** must be **9**, **25**, or **49**.

STEP–SIZE **=DEF (default); 1–1000 (milliarcsec)**

Specifies the size in milli-arcseconds of each vehicle step in a centering scan. The default value will be based on the slit and scan type requested for the exposure. See the *STIS Instrument Handbook* for default values.

CENTROID =YES (default), NO

Specifies the algorithm to center the target. If **CENTROID=YES**, the flight software uses a flux-weighted centroiding technique to determine the optimum position.

If **CENTROID=NO**, the brightest dwell point will be used for the optimum position. A peakdown will automatically be performed if the selected aperture (see Table 8.7: *Supported STIS Apertures*) contains an occulting bar or wedge. For all other apertures, a peakup is performed. The occulting-bar apertures are those listed in the paragraph at the end of the "Aperture or FOV" section above.

GAIN =4 (default); 1, 2, 8 (e/DN)

Specifies the gain of the CCD electronics in e/DN.

Number of Iterations

The **Number_of_Iterations** must be **1** in this Mode.

Time Per Exposure

The procedures to determine the exposure time for the **ACQ/PEAK** exposure are given in the *STIS Instrument Handbook.*

Special Requirements

None.

Change Log
Version Cycle 31 July 2023

Fixed broken links to the STIS IHB

Version Cycle 30 May 2022

Made edits and corrections suggested by the STIS team.

Version Cycle 29 May 2021

Made edits and corrections suggested by the STIS team.

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8.3 Imaging and Spectroscopy

HST's STIS instrument can obtain both imaging and spectroscopic data, and this article contains links for the parameters for specifying both types of data.

Sections

- 8.3.1 CCD Modes
- 8.3.2 MAMA Modes

8.3.1 CCD Modes

Observations with HST's STIS instrument can be done with the CCD detector, and the Astronomer's Proposal Tool (APT) has parameters for specifying these observations.

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

There is 1 mode for obtaining imaging and spectroscopic data with the STIS CCD detector, and that is ACCUM.

Mode = ACCUM Config = STIS/CCD

The STIS CCD has only one operating mode, **ACCUM,** in addition to the target acquisition modes. **ACCUM** Mode is used for both imaging and spectroscopy. Photons are counted on the CCD as accumulated charge which is read out at the end of the exposure and converted to DN at a selectable gain. The DN are stored as 16-bit words in a data memory array. A full detector readout is 1062 × 1044 pixels, which includes 19 leading pixels and 19 trailing pixels of overscan per line and 20 virtual overscan lines. A CCD subarray does not include the virtual overscan or any of the physical pixels bordering the outer edges of the array, so that the maximum permitted subarray size is 1060 × 1022 pixels.

Aperture or FOV

See Table 8.7 *Supported STIS Apertures*.

Spectral Element

See Table 8.2 *Supported Central Wavelengths for STIS Gratings*.

Wavelength

Enter the value of the central wavelength in Angstroms. Table 8.2 *Supported Central Wavelengths for STIS Gratings* gives the allowed values of the central wavelength for each grating. Consult the *STIS Instrument Handbook* for the associated minimum and maximum wavelength and other information pertaining to the gratings.

> ⭐ No wavelength should be specified if MIRROR is the spectral element.

Optional Parameters

See Table 8.1: *Supported Optional Parameters for STIS Instrument Modes* for a listing by operating mode of all Optional Parameters. Here are descriptions for those Optional Parameters for the imaging and spectroscopic modes.

CR–SPLIT = 2 (default) – 8; NO (primary and coordinated parallel exposures)

= NO (only legal value for pure parallel exposures)

Specifies the number of subexposures into which the specified exposure is to be split for the purpose of cosmic ray elimination in post-observation data processing (see the *STIS Instrument Handbook*). The specified exposure time will be divided equally among the number of **CR–SPLIT** exposures requested. If **CR– SPLIT=NO**, the exposure is taken as specified without splitting. If a pattern of offsets is specified (see Chapter 7: *Pointings and Patterns*), the specified number of exposures will be taken at each pattern point.

CR-SPLIT=NO must always be used with pure parallel exposures in this mode. If omitted, the assumed value of **CR-SPLIT** for pure parallels is **NO**.

CR-SPLIT=NO is always assumed for internal exposures. If explicitly stated, the only permitted value for internals is **CR-SPLIT=NO**.

CR-SPLIT=NO must be used with Spatial Scan exposures (see Special Observation Requirements, SPATIAL SCAN).

GAIN =1 (default), 4, 2, 8 (e/DN)

Specifies the gain of the CCD electronics in e/DN.

BINAXIS1, BINAXIS2 =1 (default), 2, 4 (pixels) for either

Specifies the number of CCD pixels along the **AXIS1** or dispersion (**BINAXIS1**) and the **AXIS2** or cross-dispersion (**BINAXIS2**) directions that are binned to a single signal value as the detector is read out. The default values result in each pixel being read out and downlinked to the ground. See the discussion of binning in the *STIS Instrument Handbook*.

BINAXIS1 and **BINAXIS2** are not permitted in conjunction with CCD subarray parameter **SIZEAXIS2**.

For available but unsupported parameters

BINAXIS1 and **BINAXIS2** are not permitted in conjunction with CCD subarray parameters **SIZEAXIS1**, **CENTERAXIS2**, and **CENTERAXIS1**.

SIZEAXIS2 = FULL (default); 30–1022 (pixels)

Specifies the size of a CCD subarray in detector coordinates along the **AXIS2** (cross-dispersion or spatial) direction. The default value of **FULL** for science exposures will result in the readout of a full detector array of 1044 pixels (including virtual overscan) in the **AXIS2** direction. The subarray will be centered on the detector coordinates of the target (which change with **POS**ition **TARG**et offsets), unless **CENTERAXIS** is set to a value to force centering at a particular row; however, the subarray edge will never be shifted beyond the top or bottom edge of the detector.

WAVECAL=NO

Turns off the automatic scheduling of wavelength calibration exposures for external spectroscopic science exposures. A value of **WAVECAL=NO** will disable the automatic wavelength calibrations for the entire visit. If **WAVECAL=NO** is specified, the following rules will apply:

- At least one **target=WAVE** exposure must be added in every block of exposures with the same spectral element and central wavelength. For a list of all *allowed aperture/wavelength combinations,* go to:

    http://www.stsci.edu/hst/instrumentation/stis/proposing/go-wavecal-aperture-selection

- At least one **TARGET=WAVE** exposure must be added before and/or after the science exposure (s) or **CCDFLAT** exposure.

No more than 60 minutes may elapse between any science exposure and a corresponding **WAVE** exposure. Aperture selection must be the same as would have been selected for an automatic wavelength calibration exposure. Exposure time must be specified by selecting the "Use Default Time" checkbox.

Instructions for adding a **GO WAVECAL** exposure see 8.5.2 *STIS Internal Calibration Targets*.

For available but unsupported parameters

⭐ **Entering a non-default exposure time is an available option.**

SIZEAXIS1 =FULL (default); 30–1060 (pixels)

Specifies the size of a CCD subarray in detector coordinates along the **AXIS1** (dispersion) direction. The default value of **FULL** for science exposures will result in the readout of a full detector array of 1062 pixels (including physical overscan) in the **AXIS1** direction.

CENTERAXIS2 =TARGET (default); 17–1009 (pixels)

Specifies the center of a CCD subarray in detector coordinates along the **AXIS2** (cross-dispersion or spatial) direction. The default value of **TARGET** means that the subarray will be centered on the detector coordinates of the target (which changes with **POS**ition **TARG**et offsets).

CENTERAXIS1 =TARGET (default); 17–1047 (pixels)

Specifies the center of a CCD subarray in detector coordinates along the **AXIS1** (dispersion) direction. The default value of **TARGET** means that the subarray will be centered on the detector coordinates of the target.

PREFLUSH =NO (default), YES

Requests a one-hour flush of the CCD before taking the CCD ACCUM exposure on which it is specified. Note that **PREFLUSH** can be scheduled during SAA passage.

LAMP =TUNGSTEN

Identifies the internal STIS calibration lamp **TUNGSTEN** to be used for a calibration exposure. Exposures using **LAMP** will be scheduled as internal, non-pointed exposures and must have the target name **NONE.** Specifying a lamp exposure in this way turns on one bulb in the lamp, in contrast to specifying **TARGET = CCDFLAT** which turns on two bulbs in the lamp.

For restricted parameters

⭐ **Selecting an alternative WAVE aperture is a restricted option.**

LAMP =HITM1, HITM2, LINE, DEUTERIUM (no default)

Identifies the internal STIS calibration lamp to be used for a calibration exposure. Exposures using LAMP will be scheduled as internal, non-pointed exposures and must have the target name **NONE**. If **LAMP=HITM1**, **HITM2**, **LINE**, or **DEUTERIUM**, exposure times greater than 1000 seconds should be used with care to avoid overuse of the line lamps.

SLIT–STEP =0 (default); –31000 to 31000 (steps)

This parameter is only allowed with LAMP values of **TUNGSTEN** or **DEUTERIUM**. It allows the slit projection on the detector to be offset from the default position. **SLIT–STEP** is given in slit wheel resolver steps (70 per CCD pixel). Within the range of –10000 to 10000 steps, the field of view remains within the chosen aperture. For optimum flat fielding, it is necessary to break up the full flat-field integration time into multiple (3–5) exposures, and slightly offset the slit projection on the detector from exposure to exposure. This allows smoothing out of the physical inhomogeneities along the slit surfaces and allows flats to be obtained under the fiducial bars.

Note that adding the **SLIT-STEP** Optional Parameter causes the aperture wheel to be moved by the indicated offset, but only if the aperture wheel is moved on the current exposure. Specifying **SLIT-STEP** alone does not cause such a movement of the aperture wheel. The aperture wheel moves whenever the currently specified aperture differs from that of the previous exposure. If the aperture is not changed, **SLIT-STEP** has no effect.

AMP = A, B, C, D (no default)

Use this parameter to specify a particular CCD readout amplifier to be used for the logsheet line. Optional Parameter **AMP** should not be used with **WAVE** or **CCDFLAT** internal calibration targets.

POS = (no default), 3.2-0, 3.2-1, 3.2-2, 3.2-3 and 3.2-4 for Spectral Element G430M and Central Wavelength 5471 = 3.6-0, 3.6-1, 3.6-2, 3.6-3, 3.6-4, 3.6-5, 3.6-6, 3.6-7 and 3.6-8 for Spectral Element MIRROR

This parameter is used to set up a limited number of non-standard MSM positions for the **G430M /5741** setting and the CCD imaging mirror (**MIRVIS**) that shift the position at which the image or spectrum is projected onto the STIS CCD detector. This is accomplished by tilting the optical element away from its nominal position. Once set, the new position will persist in subsequent exposures with the same setting without the need of re-entering the optional parameter. This changes only when a different **POS** parameter is provided or a different MSM position is commanded.

NOTE: Repeating the command unnecessarily should be avoided since it adds considerable overheads. Table 9.2 gives the allowed values of **POS**, cylinder positions, offsets from nominal position and optical element.

POS Value	CYL1	CYL2	CYL3	Y-offset (pixels)	OPT-ELM	central wavelengths
3.2-0 (nominal)	2426	5261	3338	0	G430M	5741
3.2-1	2521	5187	3264	411	G430M	5741
3.2-2	2472	5222	3299	204	G430M	5741
3.2-3	2383	5303	3380	-208	G430M	5741
3.2-4	2344	5249	3426	-418	G430M	5741
3.6-0 (nominal)	866	4921	2739	0	MIRVIS	N/A
3.6-1	205	5714	3532	-401	MIRVIS	N/A
3.6-2	269	5581	3399	-200	MIRVIS	N/A
3.6-3	5384	317	3895	197	MIRVIS	N/A
3.6-4	5539	93	3671	393	MIRVIS	N/A
POS Value	CYL1	CYL2	CYL3	X-offset (pixels)	OPT-ELM	central wavelengths
3.6-0 (nominal)	866	4921	2739	0	MIRVIS	N/A
3.6-5	1503	4137	1955	404	MIRVIS	N/A
3.6-6	1706	4002	1820	205	MIRVIS	N/A
3.6-7	1328	4526	2344	-202	MIRVIS	N/A
3.6-8	1431	4493	2311	-403	MIRVIS	N/A

Number of Iterations

Enter the number of times this exposure should be iterated. For instance, specifying 10 iterations and a **Time_Per_Exposure** of 10 seconds will give a total exposure time of 100 seconds. There are many observational situations when two or more exposures should be taken of the same field (e.g., to keep a bright object from blooming by keeping the exposure time short).

The value entered for the **Time_Per_Exposure** is the total exposure time for a particular exposure specification. If the **Number_of_Iterations** is **n**, the entire exposure specification will be iterated **n** times. However, if **CR–SPLIT** is used, the total exposure time will actually be apportioned among shorter exposures: specifying an exposure time of 10 seconds and **CR–SPLIT=2** results in two exposures of 5 seconds each.

If **Number_of_Iterations > 1** is specified with a pattern, the pattern is executed once with the specified number of iterations being taken at each point in the pattern. If no pattern is specified, the specified number of iterations will be taken at the single pointing.

Number_of_Iterations must be **1** for STIS pure parallels (except for **CCDFLAT**; see **Target_Name = CCDFlat**).

> ★ CR–SPLIT and multiple iterations are mutually exclusive capabilities. If Number_of_Iterations > 1 on an external exposure, CR–SPLIT=NO must be specified.

Time Per Exposure

Time_Per_Exposure must be an integral multiple of 0.1 second. If it is not its value will be truncated down to the next lower integral multiple of 0.1 sec. If the exposure time is less than 0.1 sec, it will be set to the CCD minimum value of 0.1 sec. The maximum permissible **Time_Per_Exposure** for this mode is 17179.8 seconds.

> For available but unsupported parameters
>
> ## Spatial Scans
>
> If the exposure is a Spatial Scan (see Special Observation Requirements, **SPATIAL SCAN**). and the Number of Iterations > 1, a small slew will be inserted between the exposures so the scans will repeat the same path on the detector each time. This will sacrifice orbital visibility time. Consider alternating Scan_Direction instead.
>
> ## Special Requirements
>
> **,,,,""> "SPATIAL SCAN <Scan_Rate>, <Scan_Orient>, <Scan_Direction>, <Scan_Line_Separation>, <Scan_Number_Lines>"**
>
> See Special Observation Requirements, **SPATIAL SCAN** for information on executing an exposure as a Spatial Scan.
>
> Special Requirement **SAME POSition AS** is not permitted on, and may not refer to a Spatial Scan exposure. Spatial Scan exposures are not permitted in Same Alignment or Coordinated Parallel containers or in Pure Parallel visits.
>
> Special requirements **SAME ALIGNMENT** and **PARallel WITH** are not permitted on, and may not refer to a Spatial Scan exposure. Pure Parallel visits may not contain Spatial Scan exposures.
>
> As noted in **SPATIAL SCAN** the **Scan_Orient** is specified in **POS TARG** coordinates. For long slits, a **Scan_Orient = 90°** will scan along the slit axis in the positive direction, whereas a **Scan_Orient = 270°** will scan along the slit axis in the negative direction.

Related Links

8.3.2 MAMA Modes

Change Log

Version Cycle 31 July 2023

Fixed a link to the STIS IHB in the Wavelength section.

8.3.2 MAMA Modes

Observations with HST's STIS instrument can be done with both the FUV-MAMA or NUV-MAMA detectors, and the Astronomer's Proposal Tool (APT) has parameters for specifying these observations.

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

★ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

There are 2 modes for obtaining imaging and spectroscopic data with the STIS MAMA detectors, and those are ACCUM and TIME-TAG.

Mode = ACCUM Config = STIS/FUV–MAMA, Config = STIS/NUV–MAMA

The two MAMAs are photon-counting detectors that provide a two-dimensional ultraviolet capability. **ACCUM** Mode should be used for observations with count rates exceeding 20,000 cts/s. Dispersion (in spectroscopic modes) runs along **AXIS1**; the spatial direction of the slit (cross-dispersion) is along **AXIS2**.

There are 1024 × 1024 physical pixels in the MAMA array, but each physical pixel is sampled by three electrodes, allowing centroiding of electron clouds to half-pixel accuracy. In **ACCUM** Mode, the MAMAs accumulate counts in the STIS data buffer as they are received, producing images with 2048 × 2048 "high-resolution" pixels with half physical pixel coordinates. Images can be binned either by the STIS flight software (using the **BINAXIS1** and **BINAXIS2** optional parameters described below) or on the ground, to produce images with 1024 × 1024 physical pixels. All optional parameters are specified in physical pixel coordinates. For a more detailed description, see the discussion of MAMA **ACCUM** mode in the *STIS Instrument Handbook 11.1 Basic Operating Modes*.

> ⭐ **Subarrays may not be used with the MAMA detectors.**

Aperture or FOV

See Table 8.7 *Supported STIS Apertures*.

> For restricted parameters
>
> For the restricted gratings X140H, X140M, X230H, and X230M, the following apertures may be used: 0.05X29, 0.05X31NDA, 0.05X31NDB, 0.09X29, 0.2X29.

Spectral Elements

See table Table 8.2 *Supported Central Wavelengths for STIS Gratings*.

Wavelength

Enter the value of the central wavelength in Angstroms. Table 8.2 *Supported Central Wavelengths for STIS Gratings* gives the allowed values of the central wavelength for each spectroscopic spectral element. Consult the *STIS Instrument Handbook section 13.3 Gratings* for the associated minimum and maximum wavelength and other information pertaining to the spectroscopic elements.

> ⭐ **No wavelength should be specified if the MIRROR is the spectral element.**

Optional Parameters

See Table 8.1 *Supported Optional Parameters for STIS Instrument Modes* for a listing by operating mode of all Optional Parameters. Here are descriptions for those Optional Parameters for **MAMA ACCUM** mode.

BINAXIS1, BINAXIS2 =DEF (default), NO, YES (for either)

These parameters specify whether onboard rebinning is to be performed on the accumulated image in memory after the exposure is completed. MAMA photon events are stored in memory in half-pixel coordinates (high-resolution pixels). This rebinning is a summation of two high-resolution pixels in the **AXIS1** or dispersion (**BINAXIS1**) and the **AXIS2** or cross dispersion (**BINAXIS2**) directions to values corresponding to the physical pixels of the detector. The default values for all spectral elements and apertures are not to rebin in either direction, resulting in four high-resolution pixel values for each physical pixel.

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For restricted parameters

For the spectral elements X140H, X140M, X230H, and X230M, the normal interpretation of AXIS1 and AXIS2 is reversed: AXIS1 is the cross-dispersion or spatial direction; AXIS2 is in dispersion direction.

</div>

> ⭐ *When used with the MAMA detectors, BINAXIS1 and BINAXIS2 must have the same value.*

WAVECAL=NO

Turns off the automatic scheduling of wavelength calibration exposures for external spectroscopic science exposures. A value of **WAVECAL=NO** will disable the automatic wavelength calibrations for the entire visit. If **WAVECAL=NO** is specified, the following rules will apply:

- At least one **TARGET=WAVE** exposure must be added in every block of exposures with the same spectral element and central wavelength. For a list of all allowed aperture/wavelength combinations, go to:

  http://www.stsci.edu/hst/instrumentation/stis/proposing/go-wavecal-aperture-selection

- At least one **TARGET=WAVE** exposure must be added before and/or after the science exposure (s) or **CCDFLAT** exposure.

No more than 60 minutes may elapse between any science exposure and a corresponding **WAVE** exposure. Aperture selection must be the same as would have been selected for an automatic wavelength calibration exposure. Exposure time must be specified as "Default Time".

Instructions for adding a **GO WAVECAL** exposure see 8.5.2 *STIS Internal Calibration Targets*.

<div style="border:1px solid magenta">

For available but unsupported parameters

Entering a non-default exposure time is an available option.

</div>

<div style="border: 2px solid red; padding: 1em;">

For restricted parameters

> ★ *When used with the MAMA detectors, BINAXIS1 and BINAXIS2 must have the same value.*

LAMP =HITM1, HITM2, LINE, DEUTERIUM, KRYPTON (no default)

The internal STIS calibration lamp is to be used for a calibration exposure. Exposures using **LAMP** will be scheduled as internal, non-pointed exposures and must have the target name **NONE**. If **LAMP=HITM1**, **HITM2**, **DEUTERIUM**, **KRYPTON**, or **LINE**, exposure times greater than 1000 seconds should be used with care to avoid overuse of the line lamps.

For LAMP=HITM1, HITM2, KRYPTON, DEUTERIUM, or LINE, there are additional restrictions for the MAMAs on the legal combinations of apertures, spectral elements, and central wavelengths beyond those given in the tables. Consult the STIS instrument group.

SLIT–STEP =0 (default); –10000 to 10000 (steps)
This parameter is only allowed with **LAMP** values of **DEUTERIUM** or **KRYPTON**. It allows the slit projection on the detector to be offset from the default position. **SLIT–STEP** is given in slit wheel resolver steps (35 per MAMA pixel). Within the legal range of –10000 to 10000 steps, the field of view remains within the chosen aperture. For optimum flat fielding, it is necessary to break up the full flat-field integration time into multiple (3–5) exposures, and slightly offset the slit projection on the detector from exposure to exposure. This allows smoothing out of the physical inhomogeneities along the slit surfaces and allows flats to be obtained under the fiducial bars.

Note that adding the SLIT-STEP Optional Parameter causes the aperture wheel to be moved by the indicated offset, but only if the aperture wheel is moved on the current exposure. Specifying SLIT-STEP alone does not cause such a movement of the aperture wheel. The aperture wheel moves whenever the currently specified aperture differs from that of the previous exposure. If the aperture is not changed, SLIT-STEP has no effect.

POS = (no default), 1.1-0 and 1.1-1 for Spectral Element G140L and Central Wavelength 1425

</div>

Number of Iterations

Enter the number of times (**Number_of_Iterations**) this exposure should be iterated, and the exposure time (**Time_Per_Exposure**) per iteration.

If **Number_of_Iterations > 1** is specified with a pattern, the pattern is executed once with the specified number of iterations being taken at each point in the pattern. If no pattern is specified, the specified number of iterations will be taken at the single pointing.

Time Per Exposure

Time_Per_Exposure must be an integral multiple of 0.1 second. If it is not its value will be truncated down to the next lower integral multiple of 0.1 sec. If the exposure time is less than 0.1 sec, it will be set to the MAMA minimum value of 0.1 sec. The maximum permissible Time_Per_Exposure for this mode is 6553.5 seconds.

Mode = TIME–TAG Config = STIS/FUV–MAMA, Config = STIS/NUV–MAMA

TIME–TAG Mode is used for imaging and spectroscopy with high time resolution. When used in **TIME–TAG** Mode, the MAMA produces an event stream with a time resolution of 125 microseconds. If the incoming event rate exceeds about 300,000 counts per second, not all events get registered due to finite electronic response time. The **AXIS1** and **AXIS2** half-pixel coordinates (11 bits each) of each photon event, along with 9 bits of fine-resolution time data, are stored as a 32-bit word in data buffer memory. See the discussion of **TIME–TAG** Mode in the *STIS Instrument Handbook*.

Aperture or FOV

See Table 8.7 *Supported STIS Apertures*.

> For restricted parameters
>
> For the restricted gratings X140H, X140M, X230H, and X230M, the following apertures may be used: 0.05X29, 0.05X31NDA, 0.05X31NDB, 0.09X29, 0.2X29.

Spectral Element

See Table 8.2 *Supported Central Wavelengths for STIS Gratings*.

Wavelength

Enter the value of the central wavelength in Angstroms. Table 8.2 *Supported Central Wavelengths for STIS Gratings* gives the allowed values of the central wavelength for each spectroscopic spectral element. Consult the *STIS Instrument Handbook section 13.3 Gratings* for the associated minimum and maximum wavelength and other information pertaining to the spectroscopic elements.

> ⭐ No wavelength should be specified if the MIRROR is the spectral element.

Optional Parameters

See Table 8.1 *Supported Optional Parameters for STIS Instrument Modes* for a listing by operating mode of all Optional Parameters. Here are descriptions for those Optional Parameters for **MAMA TIME-TAG** mode.

BUFFER– TIME =40 or greater (integer seconds)

This required parameter specifies how often the STIS data buffer transfers data to the *HST* onboard science data recorder during the exposure. STIS has a data buffer capacity of 4×10^6 photon events and can transfer data in 8-MByte blocks (half the buffer capacity).

The value of **BUFFER–TIME** should be equal to or less than the half-buffer capacity (2×10^6 counts) divided by the estimated maximum average count rate in photons per second (see the *STIS Instrument Handbook* for details). If more than two buffer dumps are expected during an exposure, **BUFFER-TIME** must be greater than 99 sec (the time needed to complete a buffer dump) to avoid gaps in the observing sequence when both half-buffers are dumping. If both conditions cannot be met simultaneously, observers should consider using ACCUM mode.

Note that BUFFER–TIME should include expected counts from the detector dark current as well as the detected photon events, factoring in the instrument quantum efficiency. A conservative value of BUFFER–TIME is recommended (err slightly on the low side) to avoid data loss. The STIS exposure time calculator can be used to predict the appropriate buffer time. For more details, see the STIS Instrument Handbook.

WAVECAL=NO

Turns off the automatic scheduling of wavelength calibration exposures for external spectroscopic science exposures. A value of **WAVECAL=NO** will disable the automatic wavelength calibrations for the entire visit. If **WAVECAL=NO** is specified, the following rules will apply:

- At least one **TARGET=WAVE** exposure must be added in every block of exposures with the same spectral element and central wavelength. For a list of all *allowed aperture/wavelength combinations,* go to: http://www.stsci.edu/hst/instrumentation/stis/proposing/go-wavecal-aperture-selection

- At least one **TARGET=WAVE** exposure must be added before and/or after the science exposure (s) or **CCDFLAT** exposure.

No more than 60 minutes may elapse between any science exposure and a corresponding **WAVE** exposure. Aperture selection must be the same as would have been selected for an automatic wavelength calibration exposure. Exposure time must be specified by selecting the "Use Default Time" checkbox.

Instructions for adding a **GO WAVECAL** exposure see 8.5.2 *STIS Internal Calibration Targets*.

For available but unsupported and restricted parameters

The typical exposure time option is available, but changes to the typical WAVE Aperture are restricted.

Number of Iterations

Number_of_Iterations must be **1** in this mode.

Time Per Exposure

Time_Per_Exposure must be an integral multiple of 0.1 second. If it is not its value will be truncated down to the next lower integral multiple of 0.1 sec. Enter the total time of data collection as **Time_Per_Exposure**. An exposure time of less than 0.1 sec will be set to the minimum MAMA exposure time of 0.1 second. The maximum permissible **Time_Per_Exposure** for this mode is 6553.5 seconds.

If **BUFFER–TIME** < 99 seconds, photon events will be generated faster than data can be transferred out of the buffer during the exposure. In this case, Time_Per_Exposure *should be less than or equal to 2 * ***BUFFER–TIME*** so that the exposure can complete before data transfer is necessary. A **BUFFER–TIME** of 99 seconds corresponds to a maximum average count rate of 20,200 counts/sec.

Note that TIME–TAG exposures have the potential to rapidly use up the HST onboard storage capacity. Caution is advised on any exposure with an exposure time greater than 30 * BUFFER–TIME, which corresponds to 6×10^7 counts, or about 2 GBits (close to 20% of the solid-state recorder capacity). Please see the STIS Instrument Handbook*.*

Special Requirements

The special requirements **RT ANALYSIS** and **PAR**allel **WITH** are not permitted on **TIME–TAG** Mode exposures.

For an available but unsupported mode and its restricted parameters

Mode = MSMOFF Config = STIS

This mode is used for special MSM offset management. One can set special offsets, zero the offsets, or restore the current month's offsets. This mode will be used in special calibration programs that require special MSM offsetting.

★ MSMOFF exposures should come after all ACQ and ACQ/PEAK exposures in a visit.

Target Name

The special value **NONE** must be specified.

Aperture or FOV

Do not enter a value.

Spectral Element

Do not enter a value.

Wavelength

Do not enter a value.

Optional Parameters

1. The first MSMOFF mode exposure in a visit must specify SETOFFSET, GRATING1, and, optionally, GRATING2 and GRATING3.
2. An intermediate MSMOFF mode exposure in a visit must specify SETOFFSET, GRATING1 (only), and WAVELENGTH (if needed).
3. The last MSMOFF mode exposure in a visit must specify SETOFFSET = RESTORE, GRATING1, and, optionally, GRATING2 and GRATING3.

SETOFFSET = ZERO, RESTORE, or <dither ID> (no default)

This required parameter selects the MSM offset function. ZERO sets the MSM offsets to 0 for the requested grating(s). RESTORE resets to the current month's MSM offsets for the requested grating(s). <dither ID> causes a different month's offsets to be loaded for the requested grating(s). The <dither ID> is a 4 digit integer composed of a 2-digit month number followed by '00' (e.g., 0300 would indicate the March MSM offsets).

GRATING1 = ALL, G140L, G140M, G230L, G230M, (no default)

This required parameter specifies the first grating or requests all gratings.

GRATING2 = G140L, G140M, G230L, G230M, (no default)

Specifies the second grating, if applicable.

GRATING3 = G140L, G140M, G230L, G230M, (no default)

Specifies the third grating, if applicable.

WAVELENGTH = <a legal wavelength for the GRATING1 optic> (no default)

This optional parameter is used only for intermediate MSMOFF mode exposures within a visit. It must be set whenever the spectral element and central wavelength of the prior STIS exposure match the next STIS exposure and the spectral element matches GRATING1 (Note well: GRATING1 cannot be set to ALL when WAVELENGTH is specified). WAVELENGTH should be set to the central wavelength of the next STIS exposure.

Number of Iterations

The Number_of_Iterations must be 1.

Time Per Exposure

DEF.

Related Links

8.3.1 CCD Modes

Change Log

Version Cycle 30 June 2022

PROPINST-91388 New restrictions for STIS MSMOFF Mode

Version Cycle 30 April 2022

PROPINST-91381 Document MSMOFF use by GOs now that it is an available mode

Version Cycle 29 May 2021

Made edits and corrections suggested by the STIS team.

8.4 STIS Restricted Engineering Modes

HST's STIS instrument can obtain data necessary for instrument maintenance, and the Astronomer's Proposal Tool (APT) has parameters for specifying these STScI observations.

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Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Mode = ALIGN Config = STIS

This Mode is used to move the STIS internal focus and tilt mechanisms via stored commanding for the purpose of on-orbit alignment of the aberration correction optics. **ALIGN** exposures do not acquire science data and must be interleaved with science mode exposures to obtain data, with the alignment mechanisms at a variety of positions for the ground alignment process. The values of the Optional Parameters specify the positions of the three alignment mechanisms in motor steps, relative to a nominal zero position.

The mechanism positions at nominal zero will be set via real-time command, which allows a preplanned scan of a mechanism's position to be specified without knowledge of where in the mechanism range the scan will be executed. Since the absolute positions are set in real time, a check that the pre-planned scans about the nominal zero positions do not violate the mechanism range limits cannot be performed by the scheduling system. The proposer must ensure that the alignment scans are within the allowed limits.

ALIGN exposures may be interleaved with STIS science exposures as part of either a Tip/Tilt Raster Scan or a Focus Scan.

Target Name

The special value **NONE** must be specified.

Aperture or FOV

Do not enter a value.

Spectral Element

Do not enter a value.

Wavelength

Do not enter a value.

Optional Parameters

Note that no Optional Parameters may be used with ALIGN mode when the REQ UPLINK Special Requirement is used.

FOCUS =0 (default); –4791 to +4791 (steps)

Specifies the relative position from a nominal zero position of the STIS focus mechanism, in motor steps. The absolute position of the nominal zero is set by real-time command.

XTILT, YTILT =0 (default); –115 to +115 (steps) (for either)

Specifies the relative position from a nominal zero position of the STIS X or Y tilt alignment mechanism, in motor steps. The absolute position of the nominal zero is set via real-time command.

Note: If a particular position for any of these mechanisms is needed for a series of exposures, the appropriate parameter (**FOCUS**, **XTILT**, or **YTILT**) must be specified with the same value on **every** exposure in the series. If any parameter is specified on an exposure and then omitted on the subsequent exposure, the corresponding mechanism position will be moved back to the nominal zero.

Number of Iterations

The **Number_of_Iterations** must be 1.

Time Per Exposure

Proposers may specify a positive value of **Time_Per_Exposure** to provide for additional time after the move has completed to wait prior to the start of the subsequent STIS exposure. This time may be desirable if, for instance, the Corrector move in the **ALIGN** Mode exposure could adversely affect the thermal environment (due to running the motors) and a cool-down time is required before the science exposure. If no wait is needed, enter 0S.

Mode = ANNEAL Config = STIS

This Mode allows specification of periods of time during which STIS should be configured to anneal the CCD for removal of hot pixels. The total annealing time will be the specified exposure time plus a minimum default value (12 hours). **ANNEAL** exposures do not collect science data.

Because of the long time required to configure the STIS for **ANNEAL** Mode, **ANNEAL** exposures must be in a visit with no other exposures.

Target Name

The special value **NONE** must be specified.

Aperture or FOV

Do not enter a value.

Spectral Element

Do not enter a value.

Wavelength

Do not enter a value.

Optional Parameters

There are no Optional Parameters in this Mode.

Number of Iterations

The Number_of_Iterations must be 1.

Time Per Exposure

The value is the time to be added to the minimum default value (12 hours), which will determine the total time for the annealing procedure.

Special Requirements

SAA CONTOUR defaults to model 11 (non-intersecting). The ANNEAL exposure only triggers the reconfigurations that actually perform the anneal process so this potentially long exposure does not have to avoid the SAA. Using any other model may result in inefficient scheduling with the potential for the CCD Detector to be left in unusual states longer than necessary. Changing to something other than model 11 should be thoroughly discussed with the Commanding, Engineering and Ops personnel and may require system level changes beyond what is capable in the proposal.

Change Log

Version Cycle 31 June 2023

1. Removed old PR link from Change Log.
2. Fixed malformed link to APT web page.

Version Cycle 30 April 2022

PROPINST-91381 Document MSMOFF use by GOs now that it is an available mode

Version Cycle 26 October 2018

1. PR.90925 Document that ACS, STIS, WFC3 ANNEAL exposures will use SAA Model 11
   8.4 STIS Restricted Engineering Modes

Initial Conversion HST Cycle 25 Phase II Proposal Instructions (Engineering) Version Cycle 25 (June 2018)

8.5 STIS Reference Information

This article contains reference information for STIS.

Sections

- 8.5.1 STIS Central Wavelengths
- 8.5.2 STIS Internal Calibration Targets
- 8.5.3 STIS Coordinate Systems
- 8.5.4 The Official STIS Aperture List

8.5.1 STIS Central Wavelengths

There are many central wavelength settings allowed for HST's STIS. This article provides a list of those central wavelengths for the Astronomer's Proposal Tool (APT).

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Format definitions

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Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Table 8.2: Supported Central Wavelengths for STIS Gratings Spectral

Spectral Element	Central Wavelength (Angstroms)
E140H	1234, 1271, 1307, 1343, 1380, 1416, 1453, 1489, 1526, 1562, 1598
E140M	1425
E230H	1763, 1813, 1863, 1913, 1963, 2013, 2063, 2113, 2163, 2213, 2263, 2313, 2363, 2413, 2463, 2513, 2563, 2613, 2663, 2713, 2762, 2812, 2862, 2912, 2962, 3012
E230M	1978, 2124, 2269, 2415, 2561, 2707
G140L	1425
G140M	1173, 1218, 1222, 1272, 1321, 1371, 1387, 1400, 1420, 1470, 1518, 1540, 1550, 1567, 1616, 1640, 1665, 1714
G230L	2376
G230LB	2375

G230M	1687, 1769, 1851, 1884, 1933, 2014, 2095, 2176, 2257, 2338, 2419, 2499, 2579, 2600, 2659, 2739, 2800, 2818, 2828, 2898, 2977, 3055
G230MB	1713, 1854, 1995, 2135, 2276, 2416, 2557, 2697, 2794, 2836, 2976, 3115
G430L	4300
G430M	3165, 3305, 3423, 3680, 3843, 3936, 4194, 4451, 4706, 4781, 4961, 5093, 5216, 5471
G750L	7751
G750M	5734, 6094, 6252, 6581, 6768, 7283, 7795, 8311, 8561, 8825, 9286, 9336, 9806, 9851

Table 8.3: Available but unsupported Wavelengths for STIS Gratings.

Spectral Element	Central Wavelength (Angstroms)
G750L	8975
G750M	10363
PRISM	1200, 2125

Table 8.4: Wavelengths for Restricted Gratings.

Spectral Element	Central Wavelength (Angstroms)
X140H	1232, 1269, 1305, 1341, 1378, 1414, 1451, 1487, 1523, 1560, 1587
X140M	1425
X230H	1760, 2010, 2261, 2511, 2760, 3010 (primary tilts)
X230M	1975, 2703 (primary tilts)

Related Links

8.5.2 STIS Internal Calibration Targets
8.5.3 STIS Coordinate Systems
8.5.4 The Official STIS Aperture List

Change Log

Version Cycle 30 April 2022

PROPINST-91382 Document STIS PRISM as available mode

8.5.2 STIS Internal Calibration Targets

The following internal calibration targets are available for the STIS. These should not be included in your proposal if the routine calibrations are sufficient for your program. See the STIS Instrument Handbook for details.

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Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

★ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Target_Name = WAVE

An observer-specified wavelength calibration exposure for a selected spectral element, central wavelength, and aperture. Permitted in the **STIS/CCD**, **STIS/FUV–MAMA**, and **STIS/NUV–MAMA** configurations, only in **ACCUM** Mode. Few optional parameters may be specified (see Optional Parameter). The **Number_of_Iteration**s must be **1**. **Note**: For the **STIS/CCD** configuration, a gain of 4 e /DN will be used. Observer-specified wavecals may be used in addition to or in place of automatic wavecals.

Exposures with the **WAVE** internal target must immediately precede or follow an external science exposure (i.e., an **ACCUM** or **TIME–TAG** Mode exposure with an external pointing) which uses the same spectral element and central wavelength as the **WAVE** exposure. These exposures will use the same calibration lamp configuration as the automatic wave calibrations discussed below (based on the spectral element, central wavelength, and aperture specified). The exposure time for a **WAVE** exposure must be set to **DEF**, which will use the same default exposure time as the automatic wave calibrations.

> available but unsupported
>
> If an exposure time other than DEF is specified, than the specified value will be used. To avoid overuse of the line lamps, the exposure time should not exceed 5 minutes.

An **ACCUM** Mode wavelength calibration will be automatically performed for external **STIS/CCD**, **STIS/FUV–MAMA**, and **STIS/NUV–MAMA** spectrographic science exposures which use **ACCUM** or **TIME–TAG** Mode at a single central wavelength with any of the spectral elements in Table 8.2 *Supported Central Wavelengths for STIS Gratings*. A wavelength calibration exposure will be added prior to the first such science exposure and after each subsequent science exposure at the same central wavelength if more than 40 minutes of orbital visibility time have elapsed since the previous wavelength calibration (see the *STIS Instrument Handbook* for an explanation). The calibration lamp configuration, exposure time, and calibration aperture (if different from the science aperture) will be based on the grating, central wavelength, and aperture of the science exposure. Specifying the Optional Parameter **WAVECAL=NO** in any exposure line will disable all automatic wavecals for that entire visit. PIs are advised to use an **Exposure Group Container** (**Type: Sequence**) with their wavelength calibrations and science observation so they schedule close together. For a   detailed description of wavelength calibration exposures, see the *STIS Instrument Handbook*.

Aperture

Only certain aperture-grating combinations can be used for MAMA **TARGET=WAVE** observations because the line lamps can be too bright for the MAMA detectors when used with wide slits. The apertures that may be selected depend on the grating being used, and are given in the following table.

Table 8.5: Legal aperture-grating combinations when TARGET=WAVE

Grating	Legal Aperture for TARGET=WAVE
G230LB	52X0.05 52X0.1 52X0.2 52X0.2F2
G230MB	52X0.05 52X0.1 52X0.2 52X0.2F2
G430L	52X0.05 52X0.1 52X0.2 52X0.2F2
G430M	52X0.05 52X0.1 52X0.2 52X0.2F2
G750L	52X0.05 52X0.1 52X0.2 52X0.2F2
G750M	52X0.05 52X0.1 52X0.2 52X0.2F2
G140L	52X0.05 52X0.1 52X0.2 52X0.2F2
G140M	52X0.05 52X0.1 52X0.2 52X0.2F2
G230L	52X0.05 52X0.1 52X0.2 52X0.2F2 31X0.05NDC
G230M	52X0.05 52X0.1 52X0.2 52X0.2F2
PRISM	52X0.05 52X0.2
E140H	0.2X0.2 6X0.2 0.1X0.03 0.2X0.09

E140M	0.2X0.2 6X0.2 0.1X0.03 0.2X0.06
E230H	0.1X0.09 0.1X0.2 6X0.2 0.1X0.03 0.2X0.2 0.2X0.09
E230M	0.2X0.2 6X0.2 0.1X0.03 0.2X0.06

Spectral Element

Any legal value except **MIRROR.**

> For restricted parameters
>
> The following are available as Restricted spectral elements: **X140H**, **X140M**, **X230H**, and **X230M**.

Optional Parameter

In general, no Optional Parameters are allowed for a **WAVE** exposure. However,

CR-SPLIT=NO is allowed. No other value of **CR-SPLIT** is legal.

> For restricted parameters
>
> In addition, Optional Parameter POS may be used; see ACCUM Mode Optional Parameters for STIS /CCD and STIS/FUV-MAMA configurations.

Target_Name = CCDFLAT

A calibration exposure using the internal STIS CCD flat field lamps.

Observations using the **G750L** and **G750M** elements at wavelengths longer than about 7000 Angstroms are affected by fringing in the CCD. Due to shifting of the spectrum relative to the detector caused by the Mode Select Mechanism uncertainty (see Section 11.2 of the *STIS Instrument Handbook*), the reference flats taken by the Institute and maintained in the Calibration Data Base will often not rectify the fringes as well as a flat field taken contemporaneously with the science data at the same Mode Select Mechanism setting (i.e., without moving the grating wheel between the science and flat field observations). See Section 11.2 of the *STIS Instrument Handbook* for the most recent suggestions and recommendations for implementing a "fringe flat".

A CCDFLAT exposure is permitted only with the **STIS/CCD** configuration in **ACCUM** mode. No optional parameters except **BINAXIS1** and **BINAXIS2** are permitted and should match what is used in the corresponding science exposure.. The number of iterations must be **2**. A **CCDFLAT** exposure is taken to calibrate fringing. The user may specify **Time_Per_Exposure** as **DEF**, in which case the default exposure time is used, or as a duration less than the default exposure time. The default exposure time is: MAX {0.1 sec, [**Time_Factor** × 0.1/(**Width** × **BINAXIS1** × **BINAXIS2**)]} where:

- Time_Factor is a function of Spectral Element and Wavelength and is given in Table 8.6: Time_Factor for Spectral Elements and Wavelengths,
- Width (in arcsec) can be obtained from Table 8.7: *Supported STIS Apertures*,
- and **BINAXIS1** and **BINAXIS2** are defined in CCD Modes Optional Parameters. The default is set to **BINAXIS1=1** and **BINAXIS2=1**, but you may specify a value of 1, 2, or 4 for either quantity.

Note: A gain of 4 e/DN will be used with Target = CCDFLAT.

Exposures with the **CCDFLAT** internal target must immediately precede or follow an external science exposure (i.e., an **ACCUM** exposure with an external pointing), or the wavecal associated with that external science exposure, which uses the same spectral element and central wavelength as the **CCDFLAT** exposure.

Section 11.2 of the *STIS Instrument Handbook* describes the use of **CCDFLAT**. It recommends the following procedure:

- Specify **Target_Name=CCDFLAT** to indicate that the exposure is a fringe flat. **GAIN=4** is automatically used, and the exposure uses two bulbs in the tungsten lamp.
- Specify **Number_of_Iterations=2**, to allow cosmic ray rejection and to assure adequate signal to noise. (Other STIS pure parallel exposures may not have **Number_of_Iterations**>1, but **CCDFLAT** is an exception.)
- Specify **Config, Opmode, Sp_Element**, and **Wavelength**. **Config** must be **STIS/CCD**. **Opmode** must be **ACCUM**. **Sp_Element** and **Wavelength** must be from Table 8.6.
- Specify **Aperture**, using one of those listed below for **CCDFLAT**. For an extended source, you generally should use the same slit for the flat as for the science exposure. For a point source, you should use the appropriate small echelle slit (**0.3X0.09, 0.2X0.06**). *However*, for a point source observed with the E1 and E2 series of apertures (except for the **52X0.05E1** aperture), you should use the **52X0.1** slit for **CCDFLAT** exposures. For example, if you were using the **52X0.2E1** slit for your science exposure, you would use the **52X0.1** (for a point source) or the **52X0.2** slit (for an extended source) for the **CCDFLAT** exposures. (See Section 11.2 of the *STIS Instrument Handbook* for further details and discussion)

- Specify **Time_Per_Exposure** as **DEF**AULT. The default exposure time (in seconds) is given by the formula in the third paragraph above which assures a signal to noise of 100 per pixel over the wavelength range of 6000 Å to 1 micron. You may also specify your own value for **Time_Per_Exposure**, but it must then be shorter than the default.

Note that CCD flats are often moved into the occultation period whenever they occur in the first or last exposure in an orbit. Fringe flats only work if they are taken with no movement of the Mode Select Mechanism. Be sure to place the fringe flat exposure immediately before or after the science exposure or associated wavecal to which it pertains. In some instances (such as a long series of exposures), you may wish to bracket your science observing with fringe flats in order to take into account any possible thermal shifts.

Table 8.6: Time_Factor for Spectral Elements and Wavelengths.

Spectral Element	Central Wavelength	Time_Factor (sec)
G750L	7751	25
G750M	6768	90
	7283	80
	7795	80
	8311	85
	8561	85
	8825	70

	9286	60
	9336	50
	9806	85
	9851	90

Aperture

52X0.05, 52X0.1, 52X0.2, 52X0.2F1, 52X0.5, 52X2, 0.3X0.09, or 0.2X0.06.

The **0.3X0.09** and **0.2X0.06** slits should be used for point-source targets. The **52X0.1** slit should be used for point sources observed in the E1, E2 apertures. The remaining slits are intended for use on extended targets. To choose the best slit, see Section 11.2 of the *STIS Instrument Handbook*.

Spectral Element

It must be **G750L** or **G750M**. A central wavelength must be specified for **CCDFLAT**. Use only the central wavelengths in Table 8.6: *Time_Factor for Spectral Elements and Wavelengths*.

For restricted parameters

Target_Name = BIAS

A CCD readout without an exposure (i.e., the exposure time must be specified as **0S**) in order to measure the detector bias. Permitted only with the **STIS/CCD** configuration in **ACCUM** Mode. Optional parameters are limited to **GAIN**, **BINAXIS1**, **BINAXIS2**, **SIZEAXIS1**, **SIZEAXIS2**, **CENTERAXIS1**, **CENTERAXIS2**, **PREFLUSH,** and **AMP.**

A **BIAS** exposure is allowed to have **CR-SPLIT=NO**, but no other value of **CR-SPLIT** is legal.

Aperture

DEF = no change from previous exposure.

Spectral Element

DEF = no change from previous exposure.

Target_Name = DARK

An exposure taken with the detector shuttered from external light to measure the detector dark current. Optional parameters in the **STIS/CCD** configuration are limited to **GAIN**, **BINAXIS1**, **BINAXIS2**, **SIZEAXIS1**, **SIZEAXIS2**, **CENTERAXIS1**, **CENTERAXIS2**, **PREFLUSH,** and **AMP.** Optional parameters in the MAMA configurations are limited to **BINAXIS1**, **BINAXIS2**, and **BUFFER–TIME**.

A CCD **DARK** exposure is allowed to have **CR-SPLIT=NO**, but no other value of **CR-SPLIT** is legal.

Aperture

DEF = no change from previous exposure.

Spectral Element

DEF = no change from previous exposure.

Target_Name = NONE

For STIS the target **NONE** is an internal target restricted to the following uses:

- The target to be specified for configuration **STIS** in **ALIGN** mode
- The target to be specified for configuration **STIS** in **ANNEAL** mode.
- The target to be specified for configurations **STIS/CCD, STIS/NUV-MAMA** and **STIS/FUV-MAMA** in **ACCUM** mode. When used in **ACCUM** mode, the optional parameter **LAMP** must be specified.

Related Links

Change Log

Version Cycle 31 June 2023

1. Fixed broken link
2. Numerous small changes in the CCDFlat section

Version Cycle 30 May 2022

PROPINST-91382 Document STIS PRISM as available mode

8.5.3 STIS Coordinate Systems

STIS is located off-axis in the focal plane of HST. This article shows how the detector reference frame compares to HST's U2, U3 reference frame.

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Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Knowledge of the STIS coordinate system relative to the spacecraft coordinate system is necessary to use the **POSition TARGet <X-value>,<Y-value>** Special Requirement properly. The figure below shows the sense of the U2 and U3 axes for the various STIS apertures. For more information see the The STIS Instrument Handbook.

Figure 8.1: STIS Coordinate System
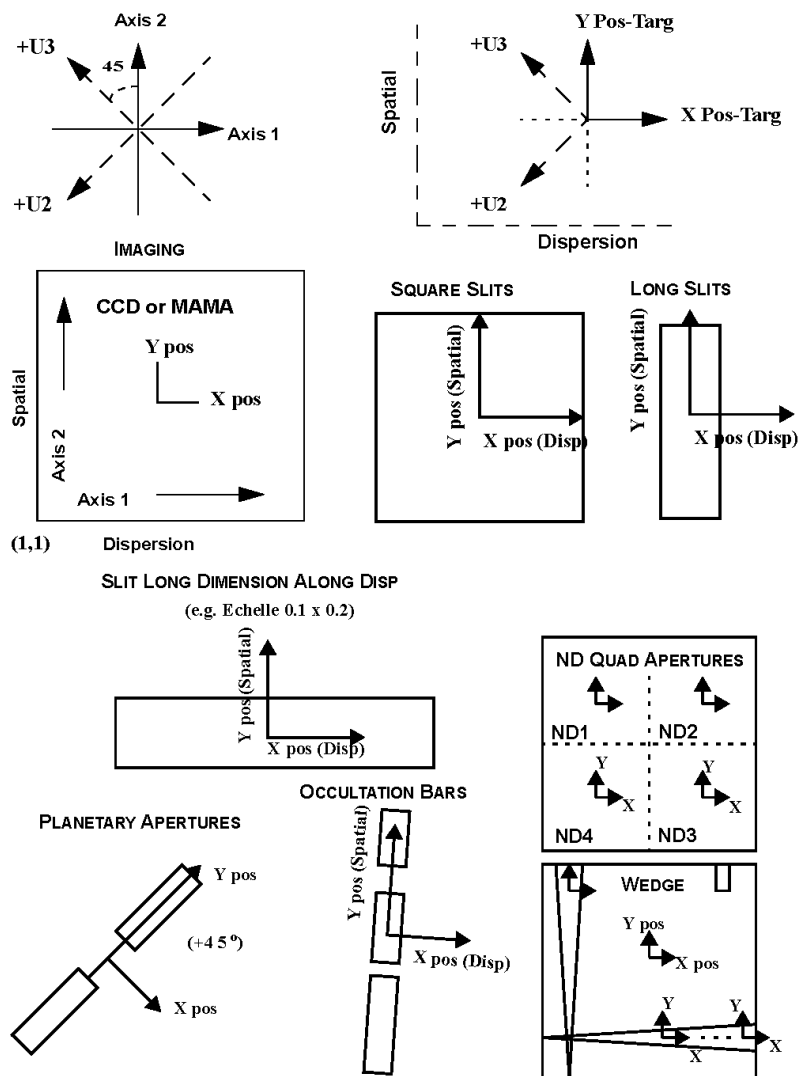
Shown projected onto the sky, as used with the POS TARG Special Requirement

Related Links

Change Log

Version Cycle 31 June 2023

Added link to the STIS IHB

8.5.4 The Official STIS Aperture List

There are many apertures available for HST's STIS detectors, and this articles shows which ones are allowed for the different operating modes.

On This Page

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

★ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Table 8.7 lists the current STIS apertures. The supported ones for GOs are noted with an "Ok." This table has been carefully checked for completeness and accuracy, and should be taken as the final word for the current cycle.

Revisions to documents occur as needed to keep them up-to-date. If a discrepancy is found in this or other documents (such as the *Data Handbook* or *STIS Instrument Handbook*), the table here should be considered definitive and correct.

Table 8.7: Supported STIS Apertures

Aperture Name	Dimensions (arcsec)		Description	STIS/CCD						
				ACQ	ACQ/PEAK					
	Length	Width		MIRROR	MIRROR	G230LB	G230MB	G430L	G430M	G7
F means a forbidden combination; R means a Restricted combination; A means Available but Unsupp...										
Echelle Slits										
0.1X0.03	0.1	0.025	Very high spectral resolution	F	Ok	Ok	Ok	Ok	Ok	Ok

0.1X0.09	0.1	0.09	Echelle slit	F	A	A	A	A	A	A
0.1X0.2	0.1	0.2	Echelle slit	F	A	A	A	A	A	A
0.2X0.06	0.2	0.063	Echelle slit	F	Ok	Ok	Ok	Ok	Ok	Ok
0.2X0.09	0.2	0.09	Echelle slit	F	Ok	Ok	Ok	Ok	Ok	Ok
0.2X0.2	0.2	0.2	Echelle slit	F	A	A	A	A	A	A
0.2X0.05ND	0.2	0.05	Filtered Slit; Neutral Density=2.0	F	Ok	Ok	Ok	Ok	Ok	Ok
0.2X0.06FPA	0.2	0.063	Offset in dispersion direction	F	Ok	Ok	Ok	Ok	Ok	Ok
0.2X0.06FPB	0.2	0.063	Offset in dispersion direction	F	Ok	Ok	Ok	Ok	Ok	Ok
0.2X0.06FPC	0.2	0.063	Offset in dispersion direction	F	Ok	Ok	Ok	Ok	Ok	Ok
0.2X0.06FPD	0.2	0.063	Offset in dispersion direction	F	Ok	Ok	Ok	Ok	Ok	Ok
0.2X0.06FPE	0.2	0.063	Offset in dispersion direction	F	Ok	Ok	Ok	Ok	Ok	Ok
0.2X0.2FPA	0.2	0.2	Offset in dispersion direction	F	A	A	A	A	A	A
0.2X0.2FPB	0.2	0.2	Offset in dispersion direction	F	A	A	A	A	A	A
0.2X0.2FPC	0.2	0.2	Offset in dispersion direction	F	A	A	A	A	A	A
0.2X0.2FPD	0.2	0.2	Offset in dispersion direction	F	A	A	A	A	A	A
0.2X0.2FPE	0.2	0.2	Offset in dispersion direction	F	A	A	A	A	A	A
0.3X0.05ND	0.33	0.05	Filtered Slit; Neutral Density=3.0	F	Ok	Ok	Ok	Ok	Ok	Ok
6X0.2	6.0	0.2	Echelle slit	F	A	A	A	A	A	A

31X0.05NDA	31.0	0.05	Filtered long slit;ND=0.4	F	Ok	Ok	Ok	Ok	Ok	Ok
31X0.05NDB	31.0	0.05	Filtered long slit;ND=0.8	F	Ok	Ok	Ok	Ok	Ok	Ok
31X0.05NDC	31.0	0.05	Filtered long slit;ND=1.2	F	Ok	Ok	Ok	Ok	Ok	Ok
First-Order Slits										
52X0.05	52.0	0.034	Long slit	F	Ok	Ok	Ok	Ok	Ok	Ok
52X0.1	52.0	0.1	First order slit	F	Ok	Ok	Ok	Ok	Ok	Ok
52X0.2	52.0	0.2	First order slit	F	A	A	A	A	A	A
52X0.2F1	52.0	0.2	First order slit; Fiducial=0.5 arcsec	F	A	A	A	A	A	A
52X0.2F1–R	52.0	0.2	Reference for peaking up in slit width	F	Ok	Ok	Ok	Ok	Ok	Ok
52X0.5	52.0	0.5	First order slit	F	R	R	R	R	R	R
52X2	52.0	2.0	First order slit	F	R	R	R	R	R	R
Large Apertures										
25MAMA	24.7	24.7	Clear MAMA aperture	F	F	F	F	F	F	F
50CCD	50.0	50.0	Clear CCD aperture	Ok	F	F	F	F	F	F
50CORON	50.0	50.0	Coronagraph aperture	F	F	F	F	F	F	F
F25CIII	24.7	24.7	CIII filtered **NUV–MAMA**	F	F	F	F	F	F	F
F25CN182	24.7	24.7	182nm Cont. filtered **NUV–MAMA**	F	F	F	F	F	F	F
F25CN270	24.7	24.7	270nm Cont. filtered **NUV–MAMA**	F	F	F	F	F	F	F
F25LYA	24.7	24.7	Lyman-alpha filtered **FUV–MAMA**	F	F	F	F	F	F	F

F25MGII	24.7	24.7	MGII filtered **NUV–MAMA**	F	F	F	F	F	F	F
F25ND3	24.7	24.7	ND 3 filtered MAMA & CCD	Ok	F	F	F	F	F	F
F25ND5	24.7	24.7	ND 5 filtered MAMA & CCD	Ok	F	F	F	F	F	F
F25NDQ1	13.4	9.7	ND step filtered MAMA & CCD (Quad1)	R	F	F	F	F	F	F
F25NDQ2	13.8	15.1	ND step filtered MAMA & CCD (Quad2)	R	F	F	F	F	F	F
F25NDQ3	11.4	15.3	ND step filtered MAMA & CCD (Quad3)	R	F	F	F	F	F	F
F25NDQ4	11.8	9.5	ND step filtered MAMA & CCD (Quad4)	R	F	F	F	F	F	F
F25QTZ	24.7	24.7	Quartz filtered MAMA aperture	F	F	F	F	F	F	F
F25SRF2	24.7	24.7	SrF2 filtered MAMA aperture	F	F	F	F	F	F	F
F28X50LP	28.0	50.0	Long pass filtered CCD aperture	Ok	F	F	F	F	F	F
F28X50OII	28.0	50.0	OII filtered CCD aperture	Ok	F	F	F	F	F	F
F28X50OIII	28.0	50.0	OIII filtered CCD aperture	Ok	F	F	F	F	F	F
Coronagraphic Apertures										
BAR5	50.0	50.0	Bar in coronagraph aperture; 5.0 x0.3 arcsec	F	R	R	R	R	R	R

BAR10	50.0	50.0	Bar in coronagraph aperture; 10.0x3.0 arcsec	F		R	R	R	R	R	R
WEDGEA0.6	50.0	50.0	Wedge A in coronagraph aper.; Width=0.6 arcsec	F	F	F	F	F	F	F
WEDGEA1.0	50.0	50.0	Wedge A in coronagraph aper.; Width=1.0 arcsec	F	R	R	R	R	R	R
WEDGEA1.8	50.0	50.0	Wedge A in coronagraph aper.; Width=1.8 arcsec	F	R	R	R	R	R	R
WEDGEA2.0	50.0	50.0	Wedge A in coronagraph aper.; Width=2.0 arcsec	F	R	R	R	R	R	R
WEDGEA2.5	50.0	50.0	Wedge A in coronagraph aper.; Width=2.5 arcsec	F	R	R	R	R	R	R
WEDGEA2.8	50.0	50.0	Wedge A in coronagraph aper.; Width=2.8 arcsec	F	R	R	R	R	R	R
WEDGEB1.0	50.0	50.0	Wedge B in coronagraph aper.; Width=1.0 arcsec	F	R	R	R	R	R	R
WEDGEB1.8	50.0	50.0	Wedge B in coronagraph aper.; Width=1.8 arcsec	F	R	R	R	R	R	R

WEDGEB2.0	50.0	50.0	Wedge B in coronagraph aper.; Width=2.0 arcsec	F		R	R	R	R	R	R	R
WEDGEB2.5	50.0	50.0	Wedge B in coronagraph aper.; Width=2.5 arcsec	F		R	R	R	R	R	R	R
WEDGEB2.8	50.0	50.0	Wedge B in coronagraph aper.; Width=2.8 arcsec	F		R	R	R	R	R	R	R
Offset CCD Slits											
52X0.05E1	52.0	0.034	Offset 19.7 arcsec in +Y POS (spatial) from center of 52X0.05 slit	F		Ok	Ok	Ok	Ok	Ok	Ok
52X0.1E1	52.0	0.1	Offset 19.7 arcsec in +Y POS (spatial) from center of 52X0.1 slit	F		Ok	Ok	Ok	Ok	Ok	Ok
52X0.2E1	52.0	0.2	Offset 19.7 arcsec in +Y POS (spatial) from center of 52X0.2 slit	F		A	A	A	A	A	A
52X0.5E1	52.0	0.5	Offset 19.7 arcsec in +Y POS (spatial) from center of 52X0.5 slit	F		R	R	R	R	R	R
52X2E1	52.0	2.0	Offset 19.7 arcsec in +Y POS (spatial) from center of 52X2 slit	F		R	R	R	R	R	R
52X0.2E2	52.0	0.2	Offset from E1 by 0.06 arcsec in -X POS (dispersion)	F		F	F	F	F	F	F

52X0.5E2	52.0	0.5	Offset from E1 by 0.053 arcsec in -X POS (dispersion)	F	F	F	F	F	F	F
52X2E2	52.0	2.0	Offset from E1 by 0.048 arcsec in -X POS (dispersion)	F	F	F	F	F	F	F
25MAMAD1	24.7	24.7	Offset by 6.8 arcsec in -Y POS (spatial)	F	F	F	F	F	F	F
F25QTZD1	24.7	24.7	Offset by 6.8 arcsec in -Y POS (spatial)	F	F	F	F	F	F	F
F25SRF2D1	24.7	24.7	Offset by 6.8 arcsec in -Y POS (spatial)	F	F	F	F	F	F	F
52X0.05D1	52.0	0.034	Offset by 6.8 arcsec in -Y POS (spatial)	F	Ok	Ok	Ok	Ok	Ok	Ok
52X0.1D1	52.0	0.1	Offset by 6.8 arcsec in -Y POS (spatial)	F	Ok	Ok	Ok	Ok	Ok	Ok
52X0.2D1	52.0	0.2	Offset by 6.8 arcsec in -Y POS (spatial)	F	F	A	A	A	A	A
52X0.5D1	52.0	0.5	Offset by 6.8 arcsec in -Y POS (spatial)	F	F	F	F	F	F	F
52X2D1	52.0	2.0	Offset by 6.8 arcsec in -Y POS (spatial)	F	F	F	F	F	F	F

Table 9.5 (cont): Available but Unsupported and Restricted STIS Apertures

Available-but-Unsupported STIS Apertures

Aperture Name	Dimensions (arcsec)		Description	STIS/CCD						
				ACQ	ACQ/PEAK					
	Length	Width		MIRROR	MIRROR	G230LB	G230MB	G430L	G430M	G750L

F means a forbidden combination; R means a Restricted combination; A means Available but Unsupp											
Echelle Slits											
0.1X0.06	0.1	0.063		F	A	A	A	A	A	A
0.2X0.5	0.2	0.5		F	A	A	A	A	A	A
0.3X0.06	0.33	0.063		F	A	A	A	A	A	A
0.3X0.09	0.33	0.09		F	A	A	A	A	A	A
0.3X0.2	0.33	0.2		F	A	A	A	A	A	A
0.5X0.5	0.5	0.5		F	R	R	R	R	R	R
1X0.06	1.0	0.063		F	A	A	A	A	A	A
1X0.2	1.0	0.2		F	A	A	A	A	A	A
6X0.06	6.0	0.063		F	A	A	A	A	A	A
6X0.5	6.0	0.5		F	R	R	R	R	R	R
First-Order Slits											
2X2	2.0	2.0	First order slit, clear MAMA aper.	F	R	R	R	R	R	R
52X0.05F1	52.0	0.034	Long slit; Fiducial=0.5 arcsec	F	A	A	A	A	A	A
52X0.05F1–R	52.0	0.034	Ref. for peaking up in slit width	F	A	A	A	A	A	A
52X0.05F2	52.0	0.034	Long slit; Fiducial=0.9 arcsec	F	A	A	A	A	A	A
52X0.05F2–R	52.0	0.034	Ref. for peaking up in slit width	F	A	A	A	A	A	A
52X0.1B0.5	52.0	0.1	Occulting Bar; Width-0.5 arcsec	F	A	A	A	A	A	A
52X0.1B0.5–R	52.0	0.1	Ref. for peaking up in slit width	F	A	A	A	A	A	A

52X0.1B1.0	52.0	0.1	Occulting Bar; Width=1.0 arcsec	F	A	A	A	A	A	A
52X0.1B1.0–R	52.0	0.1	Ref. for peaking up in slit width	F	A	A	A	A	A	A
52X0.1B3.0	52.0	0.1	Occulting Bar; Width=3.0 arcsec	F	A	A	A	A	A	A
52X0.1B3.0–R	52.0	0.1	Ref. for peaking up in slit width	F	A	A	A	A	A	A
52X0.1F1	52.0	0.1	Long slit; Fiducial=0.5 arcsec	F	A	A	A	A	A	A
52X0.1F1–R	52.0	0.1	Ref. for peaking up in slit width	F	A	A	A	A	A	A
52X0.1F2	52.0	0.1	Long slit; Fiducial=0.9 arcsec	F	A	A	A	A	A	A
52X0.1F2–R	52.0	0.1	Ref. for peaking up in slit width	F	A	A	A	A	A	A
52X0.2F2	52.0	0.2	Long slit; Fiducial=0.9 arcsec	F	A	A	A	A	A	A
52X0.2F2–R	52.0	0.2	Ref. for peaking up in slit width	F	A	A	A	A	A	A
52X0.5F1	52.0	0.5	Long slit; Fiducial=0.5 arcsec	F	R	R	R	R	R	R
52X0.5F1–R	52.0	0.5	Ref. for peaking up in slit width	F	R	R	R	R	R	R

52X0.5F2	52.0	0.5	Long slit; Fiducial=0.9 arcsec	F	R	R	R	R	R	R
52X0.5F2–R	52.0	0.5	Ref. for peaking up in slit width	F	R	R	R	R	R	R
52X2F1	52.0	2.0	Long slit; Fiducial=0.5 arcsec	F	R	R	R	R	R	R
52X2F1–R	52.0	2.0	Ref. for peaking up in slit width	F	R	R	R	R	R	R
52X2F2	52.0	2.0	Long slit; Fiducial=0.9 arcsec	F	R	R	R	R	R	R
52X2F2–R	52.0	2.0	Ref. for peaking up in slit width	F	R	R	R	R	R	R
Large Apertures										
6X6	6.0	6.0	Clear MAMA aperture	F	F	F	F	F	F	F
36X0.05N45	35.7	0.05	Planetary slit; −45 deg	F	A	A	A	A	A	A
36X0.05P45	35.7	0.05	Planetary slit; +45 deg	F	A	A	A	A	A	A
36X0.6N45	35.7	0.6	Planetary slit; −45 deg	F	R	R	R	R	R	R
36X0.6P45	35.7	0.6	Planetary slit; +45 deg	F	R	R	R	R	R	R

Restricted STIS Apertured

Aperture Name	Dimensions (arcsec)		Description	STIS/CCD						
				ACQ	ACQ/PEAK					
	Length	Width		MIRROR	MIRROR	G230LB	G230MB	G430L	G430M	G750L
F means a forbidden combination; R means a Restricted combination; A means Available but Unsupp										
Cross-Disperser Slits										
0.05X29	0.054	29.0	Cross-disperser slit	F	R	R	R	R	R	R
0.05 X31NDA	0.05	31.0	Filtered Cross-disp. slit; ND=0.8	F	R	R	R	R	R	R
0.05 X31NDB	0.05	31.0	Filtered Cross-disp. slit; ND=0.4	F	R	R	R	R	R	R
0.09X29	0.09	29.0	Cross-disperser slit	F	R	R	R	R	R	R
0.2X29	0.2	29.0	Cross-disperser slit	F	R	R	R	R	R	R

Related Links

8.5.1 STIS Central Wavelengths
8.5.2 STIS Internal Calibration Targets

Change Log

Version Cycle 31 July 2023

Removed two references to "Cycle 30" in favor of low maintenance "Current Cycle"

Version Cycle 30 April 2022

PROPINST-91382 Document STIS PRISM as available mode

Chapter 9 Fine Guidance Sensors, FGS

The Fine Guidance Sensors (FGS) are one of the scientific instruments on HST, and this article contains instructions for how to specify observations for FGS using the Astronomer's Proposal Tool (APT).

Chapter Contents

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Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

The Instrument Configurations and Operating Modes described in the following section are used for the Visit and Exposure Specifications. A summary of the legal Visit and Exposure Specifications entries is provided; more complete descriptions of Instrument Configurations, Modes, Apertures, Spectral Elements, etc. are available in the *FGS Instrument Handbook*.

Note that many of the Optional Parameters have default values; in such cases, **an Optional Parameter entry in the Visit and Exposure Specifications is necessary only if it is desired to override the default value**. In the STScI proposal system the physical units of Optional Parameter quantities are always implicit and should never be entered by the observer.

Optional Parameters whose descriptions begin with the phrase "USE WITH CAUTION" pose a risk to the intended science if a non-default value is used inappropriately. These parameters are italicized in Table 9.1: *Supported Instrument Parameters for the FGS*. You may wish to discuss the use of these parameters with your Contact Scientist, if you have one, or with an Instrument Scientist via https://stsci.service-now.com/hst.

Please note that spatial scans are *not* permitted with the FGSs. Also note that *only* FGS1 will be calibrated as a science instrument for Cycle 25.

Table 9.1: *Supported Instrument Parameters for the FGS* lists the permitted Instrument Configuration, Operating Modes, Fields of View, Spectral Elements, and Optional Parameters for the FGS.

Table 9.1: Supported Instrument Parameters for the FGS

Config	Mode	Field of View	Spectral Elements	Optional Parameters
FGS	POS	1, 2, 3	FGS 1, 2, and 3: **F583W, F5ND, F550W, PUPIL** FGS 1 and 3: **F605W;** FGS 2 only: **F650W**	NULL, *ACQ-DIST*, *COUNT*, *FES-TIME*
	TRANS	1, 2, 3	FGS 1, 2, and 3: **F583W, F5ND, F550W, PUPIL** FGS 1 and 3: **F605W;** FGS 2 only: **F650W**	SCANS, STEP-SIZE, *ACQ-DIST*

a**vailable but unsupported parameters**

Table 1: Additional Instrument Parameters for the FGS

Config.	Mode	Field of View	Spectral Elements	Optional Parameters
FGS	POS	1, 2, 3	F605W, F583W, F5ND, F650W, F550W, PUPIL	LOCK (Restricted)

The 9.1 *FGS POS Mode* and 9.2 *FGS TRANS Mode* articles provide further details of the entries to be made on the Visit and Exposure Specifications when a particular **FGS** Mode/Configuration is chosen.

Change Log

Version Cycle 31 July - August 2023

Updated link to the FGS IHB

9.1 FGS POS Mode

Observations with HST's FGS instrument can be done in POS Mode to obtain single star positions, and the Astronomer's Proposal Tool (APT) has parameters for specifying these observations.

On This Page

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

★ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Mode=POS, Config=FGS

Introduction

This is the basic single-star positional Operating Mode of the FGS. It may be used to measure the relative positions of fixed or slowly moving (<= 0.080 arcsec/sec) targets with a precision of 0.001 to 0.002 arcsec per single observation. To measure the relative position of a target with respect to field stars, several reference targets must be observed in the same visit. In addition, a few stars (reference and/or target) should be observed multiple times during a visit to map any positional drift of the field due to HST pointing characteristics (see the *FGS Instrument Handbook*). In this Operating Mode the program star or asteroid is first acquired and then held in fine lock for the specified exposure time. This procedure is repeated for the other targets.

The default values of the Optional Parameters are set in this Mode to provide acceptable data for single, zero angular diameter stars. The default acquisition consists of a spiral search for a target within a radius of 15 arcsec, followed by fine-lock tracking of the target. In this default mode star selectors are moved to null the Fine Error Signal and their positions are recorded every 0.025 sec.

Aperture or FOV

1, 2, 3

Requests use of a specific FGS (see Figure 9.1: *FGS POS TARG and Interferometer Coordinate Systems* .

Spectral Element

The available spectral elements are listed in Table 9.2: *Spectral Elements for the FGS* . Only one filter can be used at a time. The **F583W** is the recommended element for all observations requiring the Optical Field Angle Distortion (OFAD) calibration. **F583W** cannot be used if the target magnitude $m <$ 8.0. **F5ND** must be used if $m < 8.0$. An **F5ND/F583W** cross-filter calibration is supported.

Optional Parameters

NULL=YES (default), NO

NULL determines whether the Star Selectors will be repositioned immediately after the **FES-TIME** or after a small delay. Consult with your Contact Scientist or an Instrument Scientist (at https://stsci. service-now.com/hst) before specifying the non-default value; most astrometry programs require **NULL=YES**.

NULL=YES (the default) means that the next fine-error-averaging time (FEAT) interval will not begin until the star selectors have completed the repositioning of the FGS instantaneous field of view (IFOV) to the null position determined by the just-completed FEAT. This is the recommended procedure for all fixed targets.

NULL=NO means that the next FEAT begins immediately after the previous FEAT, implying that the star selectors will not necessarily remain fixed during the FEAT. If the FES-TIME = 0.025 sec, **NULL=NO** has no effect. **NULL=NO** is ordinarily useful only for observations of moving targets.

ACQ-DIST

=DEF (default); 0.0 - 90.0

USE WITH CAUTION—This Optional Parameter determines the size (in arcsec) of the acquisition search region. The default value is 15 arcsec. A larger search radius takes more time and is generally not necessary given HST's pointing performance.

COUNT

=DEF (default); 1 - 2621400

USE WITH CAUTION—The default count rate will be determined from the target *V* magnitude, and the filter and FGS, using simple scaling rules. The *FGS Instrument Handbook* should be consulted for the default background rates. These Optional Parameters are used to verify the value of **FES-TIME.** If a non-default value is needed, enter the expected target and sky count rates (in counts per second) for the FGS (see the *FGS Instrument Handbook* and consult with your Contact Scientist or an Instrument Scientist).

FES-TIME

=DEF (default); 0.025, 0.05, 0.1, 0.2, 0.4, 0.8, 1.6, 3.2

USE WITH CAUTION—This optional parameter sets the averaging time (in seconds) for the Fine Error Signal, and consequently, the interval at which the star selectors are adjusted to null the Fine Error Signal.

For POS mode, the default value **DEF** will be calculated from the default or specified **COUNT** optional parameter value and the selected FGS and FILTER. For TRANSfer mode, the default (and required) value is 0.025 sec, regardless of target brightness. See the *FGS Instrument Handbook* for details.

It is necessary that the proposer include the target *V* magnitude for all targets. We recommend including the *B–V* index so that the Instrument Scientist who reviews your Phase II program can assess your calibration needs.

<div style="border:1px solid red">

LOCK

=FINE (default); COARSE; 0.0 - 1.0

Tracking of the target in fine lock (FINE) or coarse track (COARSE) may be selected with this Optional Parameter. The fraction of the exposure time in fine lock may be specified by entering a value between 0.0 and 1.0. If 0.0 is entered, fine lock will be tested but no measurements will be made. LOCK=FINE and LOCK=1.0 produce identical results. If LOCK=COARSE, the values of several other Optional Parameters are overridden: FES-TIME and NULL will be ignored.

</div>

Time Per Exposure

The value to be entered is the photon-collecting time (in seconds) for measuring the position of the target. See the *FGS Instrument Handbook* for exposure time calculations.

Special Requirements

Enter the **ORIENT**ation visit-level Special Requirement (see **"ORIENTation <angle1> TO <angle2>"**) if the arrangement of the target or reference stars requires a particular orientation of the FGS field of view. **ORIENT**ation may be required to keep the targets in the field of view when more than one target is observed.

The **"POSition TARGet <X-value>,<Y-value>"** special requirement can be used to offset a target from the aperture reference position. For the FGS, the aperture reference frame is centered near the geometric center of the field of view, and is *not* equivalent to the FGS detector reference frame. The two frames have different parities and origins (see Figure 9.1: *FGS POS TARG and Interferometer Coordinate Systems* and the *FGS Instrument Handbook*).

The "SAME POSition AS <exposure>" special requirement should be used to keep the position of the spacecraft held constant over the course of all observations within a visit. To ensure that all exposures within a visit are scheduled within the same orbit, use the "SEQuence <exposure-list> NON-INTerruptible" special requirement.

Related Links

9.2 FGS TRANS Mode

9.2 FGS TRANS Mode

Observations with HST's FGS instrument can be done in TRANS Mode to obtain binary star positions or sizes of extended targets, and the Astronomer's Proposal Tool (APT) has parameters for specifying these observations.

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Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[**<value>**]** - are optional.

Mode=TRANS, Config=FGS

Introduction

This Operating Mode is useful for the measurement of the relative positions of close binary stars or the sizes of extended targets. In this Mode the interference fringe pattern (or "S-curve") is measured by scanning the FGS instantaneous FOV across the target at 45° with respect to the interferometer axes and recording the Fine Error Signal (FES) every 0.025 sec.

Acquisition is accomplished with a nominal 15 arcsec-radius spiral search. The S-curve is measured by a series of continuous sweeps of the field of view across the target.

Moving targets can be observed if they are listed as a series of fixed targets. This observing strategy is discussed in the *FGS Instrument Handbook*.

Aperture or FOV 1, 2, 3

Requests use of a specific FGS (see Figure 9.3.1 *FGS POS TARG and Interferometer Coordinate Systems*).

Spectral Element

The available spectral elements are listed in Table 9.2: *Spectral Elements for the FGS*. Only one filter can be used at a time. The **F583W** is the recommended element for programs requiring the use of POS and TRANS modes combined because of the Optical Field Angle Distortion (OFAD) calibration, which is available only for **F583W**. **F583W** cannot be used if the target magnitude m<8.0. **F5ND** must be used if m<8.0. Unless special S-curve calibration observations are requested, only certain combinations of filter and target color will be calibrated. Please refer to the *FGS Instrument Handbook* for more information.

Optional Parameters

SCANS

=1 (default) - 200

The value entered is the number of individual scans to make through the target, with alternate scan lines taken in the same direction.

STEP-SIZE

=1.0 (default); 0.3 - 10.0

The resolution by which the S-curve is sampled (in milliarcseconds) is specified by this Optional Parameter. The instantaneous field of view moves SQRT(2) × **STEP-SIZE** between samples (since the motion is always at 45° with respect to the interferometer axes). **STEP-SIZE** values of 0.6 or 1.0 are recommended (see the *FGS Instrument Handbook*).

The exposure time is calculated as follows:

- Texp = [**SCANS** * t(samp) * L(axis)] / **STEP–SIZE,** where
- **SCANS** = the number of individual scan lines,
- *t(samp)* = 0.025 sec, and
- *L(axis)* = the length of each scan in milliarcseconds as projected onto the *x* or *y* axis (see the *FGS Instrument Handbook* for recommendations and minimum length)

The minimum scan rate is 0.035 arcsec/sec along the diagonal.

ACQ-DIST

=0.0 - 90.0

USE WITH CAUTION—This Optional Parameter determines the size (in arcsec) of the acquisition search region. The default value is 15 arcsec. A larger search radius takes more time and is generally not necessary given HST's pointing performance.

Time Per Exposure

The exposure time (*Texp*) is the total photon-collecting time (in seconds) for all *Nscan* scans. The time per individual scan line is *Texp*/*Nscan*. See the discussion in **STEP-SIZE** above and the *FGS Instrument Handbook*.

Special Requirements

Enter the **ORIENT**ation visit-level Special Requirement (see **"ORIENTation <angle1> TO <angle2>"**) if the arrangement of the target or reference stars requires a particular orientation of the FGS field of view. **ORIENT**ation may be required to keep the targets in the field of view when more than one target is observed.

The **"POSition TARGet <X-value>,<Y-value>"** special requirement can be used to offset a target from the aperture reference position. For the FGS, the aperture reference frame is centered near the geometric center of the field of view, and is *not* equivalent to the FGS detector reference frame. The two frames have different parities and origins (see Figure 9.3.1 *FGS POS TARG and Interferometer Coordinate Systems* and the *FGS Instrument Handbook*).

The **"SAME POSition AS <exposure>"** special requirement should be used to keep the position of the spacecraft held constant over the course of all observations within a visit. To ensure that all exposures within a visit are scheduled within the same orbit, use the **"SEQuence <exposure-list> NON-INTerruptible"** special requirement.

Related Links

9.1 FGS POS Mode

Change Log
None

9.3 FGS Reference Information

This article contains reference information for FGS.

Sections

- 9.3.1 FGS POS TARG and Interferometer Coordinate Systems
- 9.3.2 FGS Spectral Elements

9.3.1 FGS POS TARG and Interferometer Coordinate Systems

This article shows how the FGS detectors' reference frame compare to HST's U2, U3 reference frame for POS Mode.

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Brown text indicates text file parameters.

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Items in square brackets - **[<value>]** - are optional.

The **POS TARG** reference frame must be used to specify Special Requirements **POS TARG** and **ORIENT**ation. Note that the FGS interferometer axes and **POS TARG** axes have different origins and parities. The interferometer reference frame is used in pipeline processing only.

ON-SKY PROJECTION
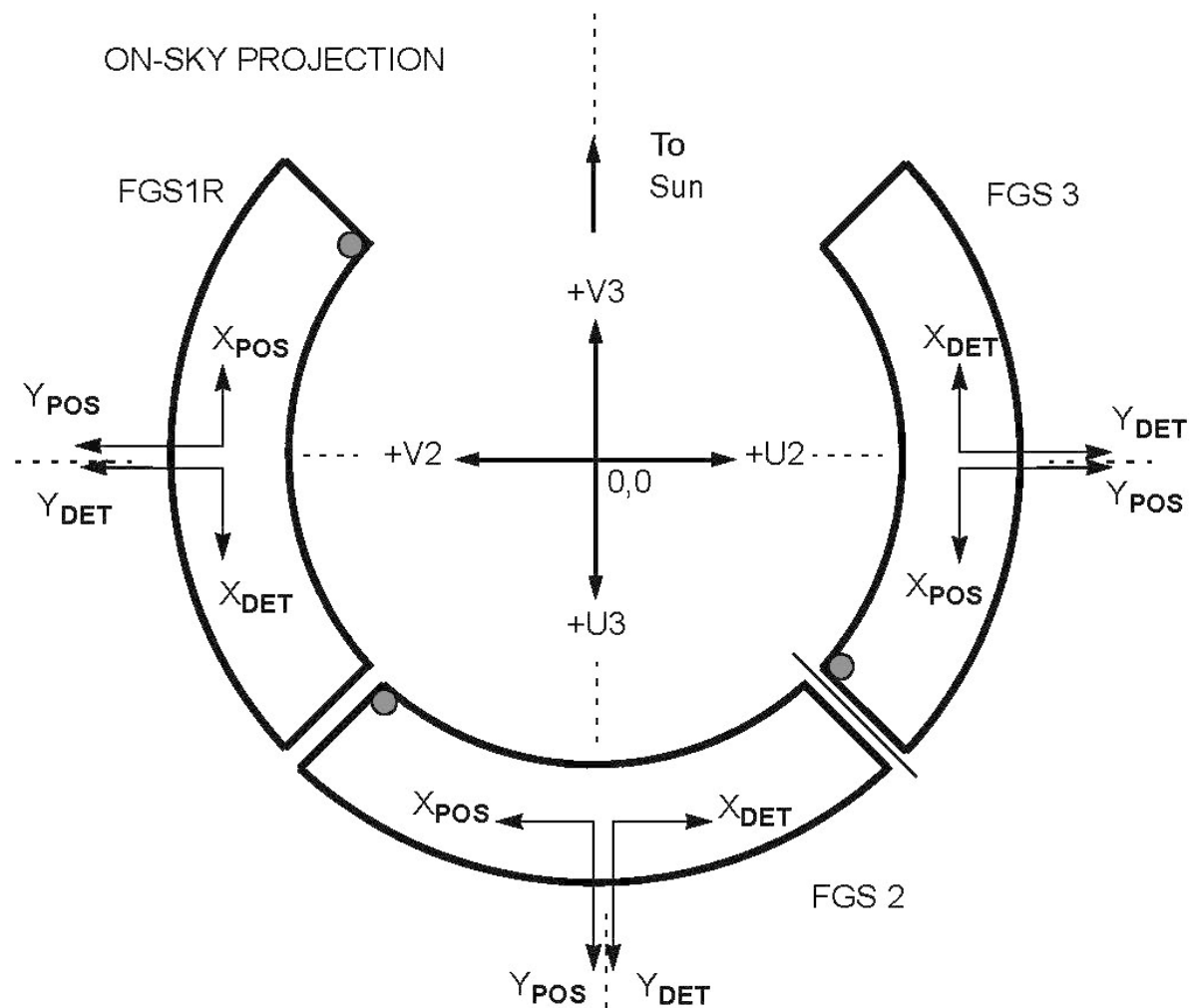
X,Y_{DET} = Detector Coordinate Frame in Object Space

X,Y_{POS} = POS TARG Reference Frame Used in Phase II Proposal

The **POS TARG** reference frame must be used to specify Special Requirements **POS TARG** and **ORIENT**ation. Note that the FGS interferometer axes and **POS TARG** axes have different origins and parities. The interferometer reference frame is used in pipeline processing only.

Change Log
None

9.3.2 FGS Spectral Elements

There are several spectral elements allowed for HST's FGSs. This article provides a list of those spectral elements for the Astronomer's Proposal Tool (APT)

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Items in square brackets - **[<value>]** - are optional.

Table 9.2: Spectral Elements for the FGS

Name	Comments	Effective Wavelength (Å)	Full Width at Half Maximum (Å)
F583W	"Clear" filter	5830	2340
F5ND	Neutral Density (5 mag)	....	....
F605W[1]	"Astrometry Clear" filter	6050	1900
F650W[2]	"Red" filter	6500	750
F550W	"Yellow" filter	5500	750
PUPIL	Pupil stop	5830	2340

[1]F605W is to be specified with FGS3 and FGS1.

[2]F650W is to be specified with FGS2 only.

Table 9.3: Restricted Internal Calibration Targets for the FGS

The following internal calibration targets are available for the FGS. These should not be included in your proposal if the routine calibrations are sufficient for your program (see the FGS Cycle 25 Calibration Plan Instrument Report). For further details see the *FGS Instrument Handbook*.

Table 2: Internal Calibration Targets for the FGS

Target Name	Description	Spectral Element	Time Per Exposure
DARK	The star selectors slew the FGS Field of View off the Pickle Aperture and the dark counts are recorded for a time interval given by the exposure time. This occurs for target = **DARK** for POS Mode. Internal Test Source activated	Any	Enter a specific time
ITS			

Change Log
None

Chapter 10 Advanced Camera for Surveys, ACS

The Advanced Camera for Surveys (ACS) is one of the scientific instruments on HST, and this article contains instructions for how to specify observations for ACS using the Astronomer's Proposal Tool (APT).

Chapter Contents

10.1 Introduction to ACS

HST observations with ACS are specified using the Astronomer's Proposal Tool (APT), and this article provides instructions for completing those observations.

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Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

The Instrument Configurations and Operating Modes described in this chapter are used for the Visit and Exposure Specifications. The legal Visit and Exposure Specifications entries are discussed in the following sections. More complete descriptions of Instrument Configurations, Modes, Apertures, Spectral Elements, etc. are available in the *ACS Instrument Handbook*.

Many of the Optional Parameters have default values. In such cases an Optional Parameter entry in these Specifications is necessary only if it is desired to override the default value. In the STScI proposal system, the physical units of Optional Parameter quantities are always implicit and should never be entered by the observer.

The following tables list the permitted Instrument Configurations, Operating Modes, Apertures, Spectral Elements, and Optional Parameters for the ACS.

Table 10.1: Supported Instrument Parameters for the ACS

Config.	Mode	Aperture	Spectral Elements	Optional Parameters

| ACS /WFC | ACCUM | WFC, WFC-FIX, WFC1, WFC2, WFC1-CTE, WFC1-FIX, WFC2-FIX, WFCENTER, WFC1-IRAMP, WFC1-MRAMP, WFC2-MRAMP, WFC2-ORAMP, WFC1-IRAMPQ, WFC1-MRAMPQ, WFC2-ORAMPQ, WFC1A-512, WFC1A-1K, WFC1A-2K, WFC1B-512, WFC1B-1K, WFC1B-2K, WFC2C-512, WFC2C-1K, WFC2C-2K, WFC2D-512, WFC2D-1K, WFC2D-2K | See Table 10.3: *Spectral Elements for use with ACS/WFC Configuration* | CR-SPLIT, GAIN, AUTOIMAGE, FLASH |
| ACS /SBC | ACCUM | SBC, SBC-FIX, SBC-LODARK | See Table 10.7: *Spectral Elements for use with ACS/SBC Configuration* | |

For available but unsupported parameters

Config.	Mode	Aperture	Spectral Elements	Optional Parameters
ACS /WFC	ACCUM	WFC1-512, WFC1-1K, WFC1-2K, WFC2-2K, WFC2-MRAMPQ		SIZEAXIS1, SIZEAXIS2, CENTERAXIS2, CENTERAXIS1, COMPRESSION, AMP

For restricted parameters

Config.	Mode	Aperture	Spectral Elements	Optional Parameters
ACS /WFC	ACCUM			CTE, FLASHCUR, FLASHEXP, READTYPE, SPEED
A C S /WFC	ALIGN			FOCUS, TILT
A C S /HRC	ALIGN			FOCUS, TILT
ACS	ANNEAL			

For available but unsupported parameters

Table 10.2: Internal Calibration Targets for the ACS

Target Name	Description[1]	Spectral Element
BIAS	A CCD readout without an exposure (i.e., the exposure time must be specified as 0) in order to measure the detector bias. Permitted only with the **ACS/WFC** in **ACCUM** mode. GOs should request **BIAS** exposures only when needed to match external or lamp subarray exposures specified via Optional Parameters **SIZEAXIS2** and/or **SIZEAXIS1**. STScI will provide **BIAS** reference files for other instances of ACS subarrays (i.e., when you specify F892N or a polarizer with a WFC exposure, or use a subarray aperture). The following restrictions apply to subarray BIAS exposures: Special Requirements **POS TARG** and **PATTERN** may not be specified, and Optional Parameters **CENTERAXIS1** and **CENTERAXIS2** may not have the value **TARGET**. STScI will not support such specifications. To ensure proper location of a subarray BIAS exposure taken to match a subarray external or lamp exposure: 1. Specify the Aperture to be the same as that of the external or lamp exposure. 2. Provide identical subarray Optional Parameter Specifications. 3. If a WFC external or lamp subarray exposure uses a ramp filter, specify the ramp filter also. See the *ACS Instrument Handbook* for more details. However, be aware that even though the ramp filter needs to be specified, it will not be used for the BIAS exposure. Instead, predefined filters will be used for the BIAS exposure. The specified ramp filter is used to determine the subarray center for the BIAS exposure.	**DEF**[2] or any ramp filter in Table 10.3: *Spectral Elements for use with ACS/WFC Configuration*

[1] Use of Optional Parameters with internal targets:

No Optional Parameters are permitted with ACS/SBC

All internal target exposures will be taken as single exposures (i.e., an implicit **CR-SPLIT=NO**).

Optional Parameters permitted with **BIAS** are: **GAIN; COMPRESSION; AMP; SIZEAXIS2; SIZEAXIS1; CENTERAXIS2; CENTERAXIS1; READTYPE; SPEED**.

[2] **DEF** means the spectral element currently in place for the ACS/WFC, and means an opaque position for the ACS/SBC. For ACS/WFC Target Name BIAS, the spectral elements are predefined by the STScI ACS Instrument team.

For restricted parameters

Table 10.2 (cont). Internal Calibration Targets for the ACS

Target Name	Description[3]	Spectral Element
DARK	An exposure taken with the detector shuttered from external light to measure the detector dark current. Permitted only with the **ACS/WFC** and **ACS/SBC** in **ACCUM** mode. The following restrictions apply to subarray **DARK** exposures: Special requirements **POS TARG** and **PATTERN** may not be specified and Optional Parameters **CENTERAXIS1** and **CENTERAXIS2** may not have the value **TARGET**. STScI will not support such specifications.	DEF[4]
TUNGSTEN	An exposure taken with the tungsten flat-field lamp. Permitted only with the **ACS/WFC** in **ACCUM** mode. The following restrictions apply to subarray **TUNGSTEN** exposures: Special requirements **POS TARG** and **PATTERN** may not be specified and Optional Parameters **CENTERAXIS1** and **CENTERAXIS2** may not have the value **TARGET**. STScI will not support such specifications.	Any element from Table 10.3: *Spectral Elements for use with ACS/WFC Configuration*
DEUTERIUM	An exposure taken with the deuterium flat-field lamp. Permitted only with the **ACS/SBC** in **ACCUM** mode. The exposure time should normally not exceed 1000 seconds. The following restrictions apply to subarray **DEUTERIUM** exposures: Special requirements **POS TARG** and **PATTERN** may not be specified and Optional Parameters **CENTERAXIS1** and **CENTERAXIS2** may not have the value **TARGET**. STScI will not support such specifications.	Any element from tables 10.3: *Spectral Elements for use with ACS/WFC Configuration* or 10.7: *Spectral Elements for use with ACS/SBC Configuration*
DARK	Required target for **ALIGN** and **ANNEAL** modes	None

[3] Use of Optional Parameters with internal targets:

No Optional Parameters are permitted with ACS/SBC

All internal target exposures will be taken as single exposures (i.e., an implicit **CR-SPLIT=NO**).

Optional Parameters permitted with **BIAS** are: **GAIN; COMPRESSION; AMP; SIZEAXIS2; SIZEAXIS1; CENTERAXIS2; CENTERAXIS1; READTYPE; SPEED**.

Optional Parameters permitted with **DARK** and **TUNGSTEN** are: **GAIN; COMPRESSION; FLASH; FLASHCUR; FLASHEXP; AMP; CTE; SIZEAXIS1; SIZEAXIS2; CENTERAXIS1; CENTERAXIS2; READTYPE; SPEED**

Optional Parameters permitted with **DEUTERIUM** are: **None**

[4] **DEF** means the spectral element currently in place for the ACS/WFC, and means an opaque position for the ACS/SBC. For ACS/WFC Target Name BIAS, the spectral elements are predefined by the STScI ACS Instrument team.

Related Links

10.2 ACS Wide Field Channel, WFC
10.3 ACS Solar Blind Channel, SBC
10.4 ACS Restricted Engineering Modes
10.5 ACS Reference Information

Change Log

Version Cycle 31 June 2023

 Removed old PR link from Change Log.

Version Cycle 26 October 2018

 1. PR.90827 2018 ACS Proposal Instructions - New Aperture SBC-LODARK

Initial Conversion HST Cycle 25 Phase II Proposal Instructions (Engineering) Version Cycle 25 (June 2018)

10.2 ACS Wide Field Channel, WFC

> *Observations with HST's ACS instrument can be done with the Wide Field Channel (WFC), and the Astronomer's Proposal Tool (APT) has parameters for specifying these observations.*

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Format definitions

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Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

There is one detector on ACS that can be used to obtain optical and infrared data, and that is the WFC.

Mode = ACCUM Config = ACS/WFC

Photons are counted on the Wide Field Channel CCD as accumulated charge, which is read out at the end of the exposure and converted to DN at a selectable gain. The DN are stored as 16-bit words in a data memory array. A full detector readout is 4144 × 4136 pixels, which includes 24 leading pixels and 24 trailing pixels of overscan per line and 40 virtual overscan lines.

Aperture or FOV

Allowed apertures for this mode are: **SBC** or **SBC-FIX** or **SBC-LODARK.**

Note: that the prisms are not permitted when the Aperture is **SBC-LODARK***.*

WFC	WFC-FIX	WFC1	WFC2	WFC1-FIX
WFC2-FIX	WFCENTER	WFC1-CTE	WFC1-512	WFC1-1K
WFC1-2K	WFC2-2K	WFC1-IRAMP	WFC1-MRAMP	WFC2-MRAMP
WFC2-ORAMP	WFC1-IRAMPQ	WFC1-MRAMPQ	WFC2-MRAMPQ	WFC2-ORAMPQ
WFC1A-512	WFC1A-1K	WFC1A-2K	WFC1B-512	WFC1B-1K
WFC1B-2K	WFC2C-512	WFC2C-1K	WFC2C-2K	WFC2D-512
WFC2D-1K	WFC2D-2K			

An appropriate ramp aperture (names contain "**RAMP**") must be specified when a ramp filter (names begin with "**FR**") is used, and may be specified for other spectral elements. Two readout options are allowed with ACS ramp filters: (1) full WFC readout (i.e., 4K × 4K pixels designated by "**RAMP**" apertures), or (2) one WFC quadrant readout (i.e., 2K × 2K pixels designated by "**RAMPQ**" apertures). Because the field of view of any ramp filter segment lies completely within one WFC quadrant, the **RAMPQ** apertures are usually more practical and preferred, as described below. No other apertures (subarray or otherwise) are supported for ramp filter observations. Moreover, STScI discontinued support of user-defined subarrays for all filters and grisms after SM4.

Because all four WFC quadrants are clocked simultaneously during readout, the amount of time (2.5 minutes) to read out the full 4K × 4K frame is the same as the time to read out one 2K × 2K quadrant. Consequently, there is no advantage to using the **RAMPQ** apertures from the perspective of readout time alone. However, users can record up to four images with the **RAMPQ** apertures (instead of just one image with the **RAMP** apertures) before triggering the data buffer dump to the solid state recorder. By dividing the buffer dump into smaller segments, the users can obtain shorter exposure without incurring large overheads during the buffer dump. This allows more efficient packing exposures in each HST orbit.

Only apertures **WFC**, **WFC1** or **WFC2** may be used with the following spectral elements: **POL0UV**, **POL60UV**, **POL120UV**, **POL0V**, **POL60V**, **POL120V**, and **F892N** (unless a ramp aperture and filter are also specified). The actual position of the target within the FOV for these spectral element/aperture combinations will be determined by the STScI based on detector performance.

The aperture **WFC1-CTE** is available to mitigate CTE loss. The **WFC1-CTE** aperture has the same area as the **WFC1** aperture except that the reference position is 200 pixels from the upper-right corner of Chip 1, in both the AXIS1 and AXIS2 directions. Therefore **WFC1-CTE** is not appropriate for highly extended targets. Observations of targets placed here will be less affected by CTE loss than those placed at other commonly used apertures that are closer to the center of the detector.

For apertures **WFC1-512, WFC1-1K, WFC1-2K, WFC2-2K** and the quadrant ramp apertures (names end with "**RAMPQ**" except **WFC2-MRAMPQ**), the proposal processing software will assign a subarray encompassing the field of view of the aperture. Applicable overscan and bias calibrations are automatically available. See the *ACS Instrument Handbook* for details. These subarrays cannot be modified by the use of subarray Optional Parameters.

Target location on the detector is the same for a full-frame ramp aperture and the corresponding subarray readout quadrant ramp aperture.

For Apertures WFC<chip><amp>-<size>, where <chip> = 1 or 2, <amp> = A, B, C, or D, and <size> = 512, 1K, or 2K, the proposal processing software will assign a subarray whose dimensions are 2048 × 512, 2048 × 1024, or 2048 × 2048 pixels in the imaging area, to be read out through the <amp> readout amplifier. All of these subarrays will also have 24 columns of physical pre-overscan, making the full X size 2072. The 2K subarrays will also have 20 rows of virtual overscan, making the full Y size 2068. Note that the appropriate one of these 2K subarrays will be used by default when a polarizer/F892N or quadrant ramp Aperture is selected.

Table 10.6: *Allowed Aperture, Spectral Element & Readout Combinations* summarizes rules for Aperture and Spectral Element combinations, and whether a full-frame, optional subarray, or fixed subarray readout is done.

Spectral Element

For the available ACS/WFC spectral elements, see Table 10.3: *Spectral Elements for use with ACS /WFC Configuration*.

> For restricted parameter
>
> When the **CTE** Optional Parameter is specified as **JCTWE** or **JCTWFS** for a **TUNGSTEN** exposure, the proposer may specify a pair of WFC-allowed spectral elements, one from each WFC filter wheel.

> ⭐ When F892N or a polarizer is specified, STScI will automatically assign a subarray containing the entire FOV provided by those spectral elements. The subarray is one-quarter the size of the full WFC array. Those subarray parameters may not be overridden.

> For restricted parameter
>
> Therefore, F892N and the polarizers may not be specified when Optional Parameter **CTE** is specified as **JCTWFS** or **JCTWE**.

Wavelength

If a ramp filter (any spectral element beginning with the letters "**FR**") is specified, enter the desired central wavelength in Ångstroms. Table 10.5: *Wavelength Ranges for the WFC Ramp Filters* gives the allowed minimum and maximum wavelength for each ramp filter.

> ⭐ A wavelength should not be specified if a ramp filter is not being used.

Optional Parameters

CR-SPLIT

= 2 - 8; NO (default)

Specifies the number of sub-exposures into which the exposure is to be split for the purpose of cosmic ray elimination in post-observation data processing (see the *ACS Instrument Handbook*). The specified exposure time will be divided equally among the number of **CR-SPLIT** exposures requested. If **CR-SPLIT=NO**, the exposure is taken without splitting. If a pattern is also specified (see Chapter 7: Pointings and Patterns), the specified number of sub-exposures will be taken at each pattern point.

> ⭐ In May 2020, the number of hot pixels were measured to be ~1.5% of the total number of available pixels (see Figure 3 and Figure 5 in McDonald et. al. ACS ISR 2020-05 "Anneal Efficacy in the Advanced Camera for Surveys Wide Field Channel"). This is similar to the number of pixels affected by cosmic rays in a 1000 sec exposure (between 1.5% and 3%). Hot pixels are growing at a rate of ~0.1% per year (see Figure 5 in ACS ISR 2020-05). The standard CR-SPLIT approach allows for cosmic-ray subtraction, but without additional dithering, does not allow for correction of hot pixels. Hence, we recommend that users who would otherwise have used a single CR-SPLIT, now use some form of dithering instead. For example, a simple ACS-WFC-DITHER-LINE pattern has been developed based on integer pixel offsets (see 7.2 *ACS Patterns*). This will allow the simultaneous removal of both hot pixels and cosmic ray hits in post-observation processing.

> **For available but unsupported parameters**
>
> Every internal Exposure Specification will be taken as a single exposure (i.e., an implicit **CR-SPLIT=NO**). Thus the **CR-SPLIT** parameter is not permitted to be specified for internal exposures.
>
> If the exposure is a **Spatial Scan** numerical values of **CR-SPLIT** are not permitted. See Special Requirements, Spatial Scan.

GAIN

= 0.5, 1, 1.4, 2 (default) (e/DN)

Specifies the gain of the CCD electronics in e/DN.

AUTOIMAGE

= YES (default), NO

Controls the automatic scheduling of image exposures for the purpose of spectra zero point determination of grism observations. By default, a single short image through a standard filter will be taken in conjunction with each Exposure Specification using the grism for external science observations. A value **AUTOIMAGE=NO** will disable the automatic scheduling of the image exposure for the Exposure Specification on which it is specified. The parameter is allowed only on external science observations using the grism.

> **For available but unsupported parameters**
>
> Automatic images will not be added to **Spatial Scan** grism exposures, and **AUTOIMAGE=YES** may not be specified on such exposures. Instead, add your own image exposure with the same Aperture and **POSition TARGet** special requirement, if any, as the **Spatial Scan**. See documentation of the special requirement Spatial Scan for more information.

> **For available but unsupported parameters (SIZEAXIS2, SIZEAXIS1, CENTERAXIS2, CENTERAXIS1, COMPRESSION, AMP)**

SIZEAXIS2

= FULL (default); 16 - 2046 (pixels)

Specifies the size of a WFC subarray in detector coordinates along the AXIS2 direction. Care must be taken in specifying a WFC detector subarray to ensure that the subarray is fully contained in one of the two WFC chips that compose the WFC detector array.

SIZEAXIS2 may not be used when the Spectral Element specification includes F892N or a polarizer, or when a fixed subarray Aperture is specified (see Table 10.6: *Allowed Aperture, Spectral Element & Readout Combinations*).

The default value FULL will result in a full detector readout of 4144 × 4136 pixels, unless Optional Parameter SIZEAXIS1 has a numerical value, in which case the readout will be SIZEAXIS1 × 2046 pixels. Subarrays will be centered at the reference position of the Aperture used for the exposure. CENTERAXIS2 may be used to override this default behavior.

SIZEAXIS1

= FULL (default); 16 - 4140 (pixels)

Specifies the size of a WFC subarray in detector coordinates along the AXIS1 direction. Care must be taken in specifying a WFC detector subarray to ensure that the subarray is fully contained in one of the two WFC chips that compose the WFC detector array.

SIZEAXIS1 may not be used when the Spectral Element specification includes F892N or a polarizer, or when a fixed subarray Aperture is specified (see Table 10.6: *Allowed Aperture, Spectral Element & Readout Combinations*).

When SIZEAXIS1 is given a numerical value, it must be even. The default value FULL will result in a full detector readout of 4144 × 4136 pixels, unless Optional Parameter SIZEAXIS2 has a numerical value, in which case the readout will be 4140 x SIZEAXIS2 pixels. Subarrays will be centered at the reference position of the Aperture used for the exposure. CENTERAXIS1 may be used to override this default behavior.

CENTERAXIS2

= 9 - 2039, 2057 - 4087, TARGET

Specifies the center pixel in the AXIS2 direction. CENTERAXIS2 may be specified only if SIZEAXIS2 is also specified as a number. The default is to center a subarray at the aperture reference position.

The value TARGET is used to center a subarray on the target's detector coordinates, which may differ from the aperture reference if a POSition TARGet offset is specified.

> ★ CENTERAXIS2 values between 9 - 2039 are on WFC Chip 2 and the values between 2057 - 4087 are on WFC Chip 1.

CENTERAXIS1

= 11 - 4135, TARGET

Specifies the center pixel in the AXIS1 direction. CENTERAXIS1 may be specified only if SIZEAXIS1 is also specified as a number. The default is to center a subarray at the aperture reference position.

The value **TARGET** is used to center a subarray on the target's detector coordinates, which may differ from the aperture reference if a **POS**ition **TARG**et offset is specified.

COMPRESSION

= DEF (default), NONE, 1.3 - 3.5

Specifies the compression factor to be used in determining a fixed size for the WFC image after onboard compression. If the actual compression achieved onboard is greater than the specified value, fill data will be added to the compressed science data. If the actual compression factor is less than the specified value, science data will be lost. A value **NONE** will disable onboard compression. The default value will depend on the target type and the **GAIN** parameter. The table of default compression factors can be found in the *ACS Instrument Handbook*. Compression of images with low gain values should be avoided because an actual compression factor of less than 1.3 is likely and thus science data will be lost.

AMP

= A, B, C, D (values allowed for subarrays)

= ABCD, AD, BC (values allowed for full-frame)

= AD, BC (only values allowed when CTE = JCTWFS or JCTWE)

Indicates the readout amplifier(s) to use for this exposure. For full-frame exposures, the default is **ABCD**. For subarrays, the default readout amplifier will be the one closest to the subarray. If the exposure will be a subarray care must be taken to ensure that the readout amplifier specified is on the same WFC chip as the subarray. Refer to Table 10.6: *Allowed Aperture, Spectral Element & Readout Combinations* and the *ACS Instrument Handbook* for details.

AMP may not be specified if one of the amplifier-specific subarray apertures is specified, if one of the quadrant ramp apertures (names end with "RAMPQ") is specified, or if a polarizer or F892N is specified.

The value AD is not recommended for use with the aperture **WFC1-CTE**. If this aperture is selected, **AMP** should include B since this aperture's reference position is near readout amplifier B.

AMP must be specified when **CTE** = **JCTWFS** or **JCTWE**. Only amplifier values **AD** and **BC** are permitted for **CTE**.

For restricted parameters (CTE, READTYPE, SPEED)

CTE

= NONE (default), JCTWFS, JCTWE

Indicates that the exposure specified will be for the purpose of making a charge transfer efficiency (**CTE**) measurement. The parameter value specifies which type of CTE measurement to obtain. **JCTWE** is for an EPER image, while **JCTWFS** is for an FPR image. **CTE** images must be specified with **TUNGSTEN** as the target, except as noted below.

When **CTE** is specified as **JCTWE** or **JCTWFS**, Optional Parameter **AMP** must also be specified, and FLASHCUR, FLASHEXP, and **GAIN** are the only other Optional Parameters that may be specified.

CTE may not be specified if a subarray aperture is used (**WFC1-512, WFC1-1K, WFC1-2K**, or **WFC2-2K**).

> ⭐ To obtain a bias subtraction image with a CTE timing pattern, specify:
>
> 1. The desired CTE value,
> 2. The target as **DARK**, not **BIAS**, and
> 3. **Time_per_Exposure** as 0.5 S.

READTYPE

= DSINT (default), CLAMP

Indicates the type of readout for WFC exposures. The default value **DSINT** is for the dual slope integrator readout method. The value **CLAMP** is for the clamp and sample readout method.

SPEED

= FULL (default), HALF

Indicates the speed of readout for WFC exposures. The default value **FULL** is for the pre-SM4 readout timing. The value **HALF** is for a half speed readout which may be desirable for reducing read noise.

FLASH =

0 (default - means no post-flash), 1 - 5733

Specifies the number of electrons per pixel to add to the image by illuminating the detector with the post-flash LED. The upper limit corresponds to the longest flash permitted.

Estimate the number of background electrons expected using the ACS ETC. Also refer to ACS ISR 2012-04 "Assessing ACS/WFC Sky Backgrounds" (Sokol et al.) to see expected background levels for the given exposure time. If the background in the area of interest is less than 20 electrons, pixel based CTE corrections may be off by a significant amount (or may not work very well). Add post flash to elevate the background to 20 electrons or more in the area of your target or region of interest.

Note that the level of the ACS post-flash is highly spatially variable and the commanded value of flash is the value seen in the central region, and other regions have lower values. See ACS ISR 2014-01 "Post-Flash Capabilities of the Advanced Camera for Surveys Wide Field Channel (ACS/WFC)" (Ogaz et al.) for more details. You should evaluate and assess the need for it based on the anticipated sky background levels and the scientific and technical purposes behind the design of your intended observations. If you have an assigned ACS Contact Scientist, that person may be able to help, or if not, you may contact the ACS Help Desk at https://stsci.service-now.com/hst.

To summarize: use of ACS post-flash may be recommended by the ACS ETC in some circumstances where there will be low background in an exposure, especially due to use of very short exposure times or narrow-band filters, etc. (See also ACS ISR 2012-04 by Sokol et al.) However, use of this capability should be considered very carefully and may also greatly complicate your data analysis in many situations, due to the highly nonuniform nature and significant variation in the flash level over the ACS/WFC field of view which is documented more fully in ACS ISR 2014-01 (Ogaz et al., 2014). You can also read more about the ACS post-flash in the example and discussion in Section 9.6.6 of the *ACS Instrument Handbook*. You may also request help from your assigned Contact Scientist, if you have one, or you may request help from the ACS group through the help desk at https://stsci.service-now.com/hst.

For restricted parameters (FLASHCUR, FLASHEXP)

If **FLASH** is specified, neither **FLASHCUR** nor **FLASHEXP** may be specified.

FLASHCUR

= LOW, MEDIUM, HIGH (no default)

Specifies the LED current for post-flash. If **FLASHCUR** is specified, **FLASHEXP** must also be specified and **FLASH** may not be specified.

FLASHEXP

= 0.1 – 409.5

Specifies the duration of an LED post-flash. If **FLASHEXP** is specified, **FLASHCUR** must also be specified and **FLASH** may not be specified.

Number of Iterations

Enter the number of times this Exposure Specification should be iterated, each with the specified Time_per_Exposure.

⭐ CR-SPLIT and multiple iterations are mutually exclusive capabilities. If Number_of_Iterations > 1 on an external exposure, CR-SPLIT=NO must be specified.

For available but unsupported parameters

If the exposure is a Spatial Scan and **Number of Iterations** > 1, a small slew will be inserted between the exposures so the scans will repeat the same path on the detector each time. This will sacrifice orbital visibility time. Consider alternating the Scan_Direction instead.

Time Per Exposure

Enter the exposure time, in seconds, for the Exposure Specification. If **Number_of_Iterations** = 1, the **Time_per_Exposure** is divided equally among the **CR-SPLIT** copies, if any. If **Number_of_Iterations** > 1, each iteration comprises a single exposure whose duration is **Time_per_Exposure**.

Note that exposure time for an individual WFC exposure, after any CR-SPLIT is applied, must be an integer multiple of 0.1 second and in the range of 0.5 to 3600 sec. The value 0.6 sec. is not allowed.

For available but unsupported parameters

Time_per_Exposure must be 0 when the target is BIAS.

Special Requirements for Available but unsupported parameters (SPATIAL SCAN, SAA CONTOUR)

SPATIAL SCAN **<Scan_Rate>**, **<Scan_Orient>**, **<Scan_Direction>**, **<Scan_Line_Separation>**, **<Scan_Number_Lines>**

See 6.3.1 General Exposure-level Special Requirements, Spatial Scan for information on executing an exposure as a Spatial Scan. Special Requirement **SAME POSition AS** is not permitted on, and may not refer to a Spatial Scan exposure. Spatial Scan exposures are not permitted in Same Alignment or Coordinated Parallel containers or in Pure Parallel visits.

Special requirements **SAME ALIGNMENT** and **PARallel WITH** are not permitted on, and may not refer to a Spatial Scan exposure.

Pure Parallel visits may not contain Spatial Scan exposures

SAA CONTOUR

This is Available-but-Unsupported for ACS/WFC.

Related Links

10.3 ACS Solar Blind Channel, SBC

Change Log
Version Cycle 31 June - Aug 2023

1. PROPINST-91391 - Document FLASHCUR and FLASHEXP with CTE != NONE now allowed as restricted mode
2. Removed unneeded link to Special Requirements in note about Spatial Scans and AUTOIMAGE.
3. Fixed link to SAA Contour
4. Fixed link to ACS IHB in Flash section.

Version Cycle 30 May 2022

Made edits and corrections suggested by the ACS team.

Version Cycle 29 May 2021

Updated the starred note under CR-Split with update hot pixel count and reference.

10.3 ACS Solar Blind Channel, SBC

Observations with HST's ACS instrument can be done with the Solar Blind Channel (SBC), and the Astronomer's Proposal Tool (APT) has parameters for specifying these observations.

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Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

There is one detector on ACS that can be used to obtain ultraviolet data, and that is the SBC.

Mode = ACCUM Config = ACS/SBC

The SBC uses a MAMA detector which is a photon-counting device that provides a two-dimensional ultraviolet capability. The MAMA accumulates photons in the ACS data buffer as they are received, producing images with 1024 × 1024 pixels. For a more detailed description, see the discussion of SBC ACCUM mode in the *ACS Instrument Handbook*.

Aperture or FOV

The permitted apertures for this mode are **SBC** or **SBC-FIX or SBC-LODARK.**

*Note: that the prisms are not permitted when the Aperture is **SBC-LODARK**.*

SBC must be specified if spectral element **PR110L** or **PR130L** is specified (STScI software will adjust the HST pointing to compensate for the refraction).

Spectral Element

See Table 10.7: *Spectral Elements for use with the ACS/SBC Configuration*.

Note: the prisms are not permitted when the Aperture is SBC-LODARK.

Wavelength

No wavelength should be specified for this mode.

Optional Parameters

There are no Optional Parameters in this Mode.

Unlike WFC, SBC exposures with a dispersing spectral element (**PR110L** or **PR130L**) will not have an additional image exposure scheduled automatically (see WFC **ACCUM** mode descriptions of optional parameter **AUTOIMAGE**). If an image exposure is desired in combination with a prism exposure, it must be entered as a separate exposure specification. It is best to place it immediately before or after the prism exposure in the same visit (see the *ACS Instrument Handbook* for more details).

A direct imaging exposure is required for the prism wavelength calibration. Note that its bright-object constraints will be more stringent than those of the prism exposure, so the least sensitive filter feasible is recommended.

Number of Iterations

Enter the number of times this Exposure Specification should be repeated.

Time Per Exposure

Enter the exposure time to apply to each iteration.

Note that **Time_per_Exposure** for individual SBC exposures must be an integer multiple of 0.1 second and must be in the range of 0.1 to 3600 sec.

Special Requirements

For restricted parameters

SAA CONTOUR

Related Links

[10.2 ACS Wide Field Channel, WFC](#)

Change Log

None

10.4 ACS Restricted Engineering Modes

HST's ACS instrument can obtain data necessary for instrument maintenance, and the Astronomer's Proposal Tool (APT) has parameters for specifying these observations.

Format definitions

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Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Mode = ALIGN Config = ACS/WFC or ACS/HRC

This Mode is used to move the ACS internal focus and tilt mechanisms for the WFC or SBC via stored commanding for the purpose of on-orbit alignment of the aberration correction optics. **ALIGN** exposures do not acquire science data and must be interleaved with science mode exposures to obtain data, with the alignment mechanisms at a variety of positions for the ground alignment process. The proposer must ensure that the alignment scans are within the allowed mechanism limits. The mechanism positions corresponding to the nominal zero positions of the alignment scan will be set via real-time command. This will be accomplished in a program by specifying an **ALIGN** mode exposure with the special requirement **REQ UPLINK**. Because the positions of the mechanisms are set via real-time command, no Optional Parameters are permitted in conjunction with the **REQ UPLINK** Special Requirement in order to prevent commanding the mechanisms via stored commands.

Target Name

The special value **NONE** must be specified.

Aperture or FOV

Do not enter a value.

Spectral Element

Do not enter a value.

Wavelength

Do not enter a value.

Optional Parameters

FOCUS

= 0 (default); -858 to +858 (steps)

Specifies the relative position from a nominal zero position of the focus mechanism, in motor steps. The absolute position of the nominal zero is set by real-time command.

TILT

= NO (default), YES

Specifies whether a tilt of the corrector mechanisms will be commanded. If this parameter is set to **YES**, the maximum time required to move both cylinders of the tilt mechanism will be included in the alignment time.

Number of Iterations

The **Number_of_Iterations** must be 1.

Time Per Exposure

Proposers may specify a positive value of **Time_Per_Exposure** to provide for additional time after the move has completed to wait prior to the start of the subsequent ACS exposure. This time may be desirable if, for instance, the Corrector move in the **ALIGN** Mode exposure could adversely affect the thermal environment (due to running the motors) and a cool-down time is required before the science exposure.

Special Requirements

Optional parameters are not allowed to be specified for **ALIGN** exposures with the **REQ UPLINK** Special Requirement.

Mode = ANNEAL Config = ACS

This Mode allows specification of periods of time during which ACS should be configured to anneal the CCDs for removal of hot pixels. The total annealing time will be the specified exposure time plus a minimum default value (6 hours). **ANNEAL** exposures do not collect science data. Because of the long time required to configure the ACS for **ANNEAL** Mode, an **ANNEAL** exposure must be the only exposure in its visit.

Target Name

The special value **NONE** must be specified.

Aperture or FOV

Do not enter a value.

Spectral Element

Do not enter a value.

Wavelength

Do not enter a value.

Optional Parameters

There are no Optional Parameters in this Mode.

Number of Iterations

The **Number_of_Iterations** must be 1.

Time Per Exposure

The value is the time to be added to the minimum default value (6 hours), which will determine the total time for the annealing procedure.

Special Requirements

SAA CONTOUR defaults to model 11 (non-intersecting). The ANNEAL exposure only triggers the reconfigurations that actually perform the anneal process so this potentially long exposure does not have to avoid the SAA. Using any other model may result in inefficient scheduling with the potential for the ACS instrument to be left in the HOLD state (i.e., with several boxes powered off) longer than necessary. Changing to something other than model 11 should be thoroughly discussed with the Commanding, Engineering and Ops personnel and may require system level changes beyond what is capable in the proposal.

Change Log

Version Cycle 31 June 2023

Removed old PR link from Change Log.

Version Cycle 30 May 2022

Made edits and corrections suggested by the ACS team.

Version Cycle 26 October 2018

1. PR.90925 Document that ACS, STIS, WFC3 ANNEAL exposures will use SAA Model 11

Initial Conversion HST Cycle 25 Phase II Proposal Instructions (Engineering) Version Cycle 25 (June 2018)

10.5 ACS Reference Information

This article contains reference information for ACS.

Sections

- 10.5.1 ACS WFC Spectral Elements
- 10.5.2 ACS WFC Permitted Filter Combinations
- 10.5.3 ACS WFC Ramp Filter Ranges
- 10.5.4 ACS WFC Allowed Combinations of Aperture, Spectral Element, and Readout
- 10.5.5 ACS SBC Spectral Elements
- 10.5.6 ACS Aperture Coordinate System

10.5.1 ACS WFC Spectral Elements

There are many spectral elements (filters and polarizers) allowed for HST's ACS/WFC. This article provides a list of those spectral elements for the Astronomer's Proposal Tool (APT).

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Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Table 10.3: Spectral Elements for use with ACS/WFC Configuration[1]

Wheel	Position	Name	Description	Allowed Configurations
1	2	**F555W**	Johnson V	**ACS/WFC**
1	3	**F775W**	SDSS i	**ACS/WFC**
1	4	**F625W**	SDSS r	**ACS/WFC**
1	5	**F550M**	narrow V	**ACS/WFC**
1	6	**F850LP**	SDSS z	**ACS/WFC**
1	8	**POL0UV**	UV polarizer 0°	**ACS/WFC**
1	9	**POL60UV**	UV polarizer 60°	**ACS/WFC**
1	10	**POL120UV**	UV polarizer 120°	**ACS/WFC**
1	11	**F892N**	methane	**ACS/WFC**
1	12	**F606W**	broad V	**ACS/WFC**

1	13	**F502N**	O III	**ACS/WFC**
1	14	**G800L**	GRISM	**ACS/WFC**
1	15	**F658N**	Ha	**ACS/WFC**
1	16	**F475W**	SDSS g	**ACS/WFC**
2	2	**F660N**	N II	**ACS/WFC**
2	3	**F814W**	Johnson I	**ACS/WFC**
2	4	**FR388N**	O II Ramp	**ACS/WFC**
2	4	**FR423N**	O II Ramp	**ACS/WFC**
2	4	**FR462N**	O II Ramp	**ACS/WFC**
2	5	**F435W**	Johnson B	**ACS/WFC**
2	6	**FR656N**	Ha ramp	**ACS/WFC**
2	6	**FR716N**	Ha ramp	**ACS/WFC**
2	6	**FR782N**	Ha ramp	**ACS/WFC**
2	8	**POL0V**	visible polarizer 0°	**ACS/WFC**
2	10	**POL60V**	visible polarizer 60°	**ACS/WFC**
2	12	**POL120V**	visible polarizer 120°	**ACS/WFC**
2	16	**FR914M**	Broad Ramp	**ACS/WFC**
2	16	**FR853N**	IR Ramp	**ACS/WFC**
2	16	**FR931N**	IR Ramp	**ACS/WFC**
2	17	**FR459M**	Broad Ramp	**ACS/WFC**
2	17	**FR647M**	Broad Ramp	**ACS/WFC**
2	17	**FR1016N**	IR Ramp	**ACS/WFC**
2	18	**FR505N**	O III Ramp	**ACS/WFC**
2	18	**FR551N**	O III Ramp	**ACS/WFC**
2	18	**FR601N**	O III Ramp	**ACS/WFC**

[1]For available but unsupported parameters (CLEAR)

In addition to the filter names in the table, the proposer may specify the spectral element for ACS/WFC ACCUM exposures as **CLEAR** if no spectral element is desired. But this should be done in consultation with an ACS Instrument Scientist as STScI does not provide calibration reference files for the mode.

Normally only one spectral element may be specified for an exposure. The exceptions are:

The polarizers must be used with another spectral element. This is required to maintain focus. The UV polarizers (POL0UV, POL60UV, POL120UV) must be used with a spectral element on wheel 2 except for: POL0V, POL60V, POL120V, and any inner or outer ramp filter segment (see Table 10.5: *Wavelength Ranges for the WFC Ramp Filters*. The visible polarizers (POL0V, POL60V, POL120V) must be used with a spectral element on wheel 1 except for: F850LP, F892N, POL0UV, POL60UV, and POL120UV.

For restricted parameters

When Optional Parameter **CTE** is specified (but not as **NONE**), and the Target is **TUNGSTEN**, other wheel 1 spectral element plus wheel 2 spectral element pairs are permitted, provided that both are legal for the WFC.

Related Links

10.5.2 ACS WFC Permitted Filter Combinations
10.5.3 ACS WFC Ramp Filter Ranges
10.5.4 ACS WFC Allowed Combinations of Aperture, Spectral Element, and Readout
10.5.5 ACS SBC Spectral Elements
10.5.6 ACS Aperture Coordinate System

Change Log
None

10.5.2 ACS WFC Permitted Filter Combinations

Only a subset of possible combinations of spectral elements are permitted with the ACS/WFC, and this article shows these combinations.

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Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

Only a subset of possible combinations of spectral elements are permitted. In the following tables, an "**S**" indicates combinations that are supported.

Combinations marked with an "**A**" are Available-but-Unsupported. Combinations marked with an "**I**" (Internal) indicate filters for **DARK** or **BIAS** images.

⭐ **The observing mode Imaging Spectropolarimetry** – which uses both Grism G800L and Polarizers (POL0V, POL60V, POL120V) – **is being offered on a shared risk basis.** Proposers should contact their contact scientist for guidance and see the *ACS Instrument Handbook*.

Table 10.4: Permitted WFC filter combinations for Mode = ACCUM

		Filter Wheel 1 Spectral Element								
		F555W	F775W	F625W	F550M	F850LP	POL0UV	POL60UV	POL120UV	F892N
Filter Wheel 2	F660N						A	A	A	

Spectral Element									
F814W						A	A	A	
FR388N						A	A	A	
FR423N									
FR462N									
F435W						A	A	A	
FR656N						A	A	A	
FR716N									
FR782N									
POL0V	A	S	A	A					
POL60V	A	S	A	A					
POL120V	A	S	A	A					
PR200L									
F344N									
FR914M						A	A	A	
FR853N									
FR931N									
FR459M						A	A	A	
FR647M									
FR1016N									
FR505N						A	A	A	
FR551N									
FR601N									

Related Links

Change Log

Version Cycle 31 June - Aug 2023

PROPINST-91396 - Document change of HST/ACS Spectro-Polarimetry from Available to Supported

10.5.3 ACS WFC Ramp Filter Ranges

There are many wavelength ranges allowed for HST's ACS/WFC. This article provides a list of those wavelength ranges for the Astronomer's Proposal Tool (APT).

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Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Table 10.5: Wavelength Ranges for the WFC Ramp Filters

Name	Minimum Wavelength (Å)	Maximum Wavelength (Å)	WFC FOV location
FR388N	3710	4049	middle
FR423N	4049	4420	inner
FR462N	4420	4824	outer
FR505N	4824	5266	middle
FR551N	5266	5748	inner
FR601N	5748	6274	outer
FR656N	6274	6848	middle
FR716N	6848	7474	inner
FR782N	7474	8158	outer
FR853N	8158	8905	inner
FR931N	8905	9719	outer

FR1016N	9719	10609	outer
FR459M	3810	5366	middle
FR647M	5366	7574	inner
FR914M	7574	10709	middle

Related Links

10.5.1 ACS WFC Spectral Elements
10.5.2 ACS WFC Permitted Filter Combinations
10.5.4 ACS WFC Allowed Combinations of Aperture, Spectral Element, and Readout
10.5.5 ACS SBC Spectral Elements
10.5.6 ACS Aperture Coordinate System

Change Log
None

10.5.4 ACS WFC Allowed Combinations of Aperture, Spectral Element, and Readout

> *Only a subset of possible combinations of aperture, spectral element, and readout pattern are permitted with the ACS/WFC, and this articles shows these combinations.*

On This Page

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

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Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Table 10.6: Allowed Aperture, Spectral Element & Readout Combinations

Aperture	Allowed Spectral Elements[1]	Readout
WFC	F S	full frame[2]
WFC-FIX	F F	full frame
WFC1	FS	full frame[2, 3]
WFC1-FIX	F	full frame[3]
WFC2	S	full frame[2,3]
WFC2-FIX	F	full frame[3]
WFCENTER	F	full frame
WFC1-CTE	F	full frame[3]

WFC1-CTE	F	full frame[3]
WFC1-512	F	subarray fixed by STScI
WFC1-1K	F	subarray fixed by STScI
WFC1-2K	F	subarray fixed by STScI
WFC2-2K	F	subarray fixed by STScI
WFC1-IRAMP	F I	full frame[3]
WFC1-MRAMP	F M S	full frame[3]
WFC2-MRAMP	F M S	full frame[3]
WFC2-ORAMP	F O	full frame[3]
WFC1-IRAMPQ	F I	subarray fixed by STScI
WFC1-MRAMPQ	F M S	subarray fixed by STScI
WFC2-MRAMPQ	F M S	subarray fixed by STScI
WFC2-ORAMPQ	F O	subarray fixed by STScI
WFC1A-512	F	subarray fixed by STScI
WFC1B-512	F	subarray fixed by STScI
WFC2C-512	F	subarray fixed by STScI
WFC2D-512	F	subarray fixed by STScI
WFC1A-1K	F	subarray fixed by STScI
WFC1B-1K	F	subarray fixed by STScI
WFC2C-1K	F	subarray fixed by STScI
WFC2D-1K	F	subarray fixed by STScI
WFC1A-2K	F	subarray fixed by STScI
WFC1B-2K	F	subarray fixed by STScI
WFC2C-2K	F	subarray fixed by STScI
WFC2D-2K	F	subarray fixed by STScI

[1]F = normal WFC filters and **G800L,**
S = small elements (polarizers and **F892N**),
I = inner ramp filter segments,
M = middle ramp filter segments,
O = outer ramp filter segments

[2] A subarray fixed by STScI will apply to **WFC**, **WFC1**, **WFC2** when a small spectral element (polarizer of **F892N**) is selected.

[3] A user specified subarray may be requested via Optional Parameters **SIZEAXIS1** and/or **SIZEAXIS2.**

Related Links

10.5.1 ACS WFC Spectral Elements
10.5.2 ACS WFC Permitted Filter Combinations
10.5.3 ACS WFC Ramp Filter Ranges
10.5.5 ACS SBC Spectral Elements
10.5.6 ACS Aperture Coordinate System

Change Log
None

10.5.5 ACS SBC Spectral Elements

There are many spectral elements (filters and prisms) allowed for HST's ACS/SBC. This article provides a list of those spectral elements for the Astronomer's Proposal Tool (APT).

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Table 10.7: Spectral Elements for use with the ACS/SBC Configuration

Wheel	Position	Name	Description
3	2	**F115LP**	MgF2
3	3	**F125LP**	CaF2
3	5	**F140LP**	BaF2
3	6	**F150LP**	crystal quartz
3	8	**F165LP**	Suprasil
3	9	**F122M**	Ly-a
3	11	**PR130L**	CaF2 PRISM
3	12	**PR110L**	LiF2 PRISM

Related Links

10.5.1 ACS WFC Spectral Elements
10.5.2 ACS WFC Permitted Filter Combinations
10.5.3 ACS WFC Ramp Filter Ranges
10.5.4 ACS WFC Allowed Combinations of Aperture, Spectral Element, and Readout
10.5.6 ACS Aperture Coordinate System

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None

10.5.6 ACS Aperture Coordinate System

ACS is located off-axis in the focal plane of HST. This article shows how the detector reference frame compares to HST's U2, U3 reference frame.

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

★ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

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Figure 10.1: *ACS Coordinate System* shows how the POS-TARG coordinates, X and Y, are related to the U2,U3 and detector Axis1 and Axis2 directions. The Y axis is parallel to Axis2. The X axis is normal to Y but differs from the Axis1 direction by about 5°. This diagram correctly shows the WFC and SBC orientations, but it does **not** represent their relative sizes or positions.

Figure 10.1: ACS Coordinate System
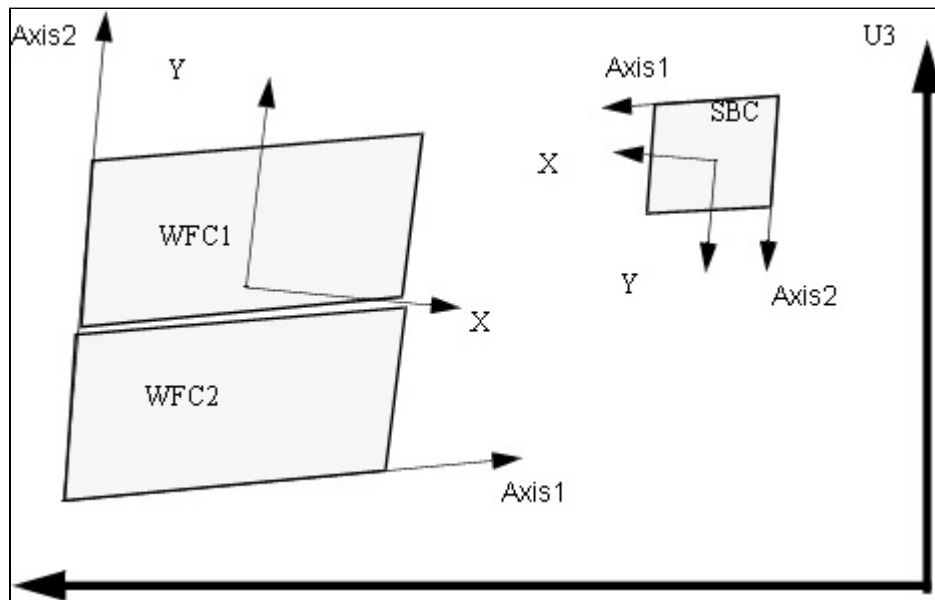
Related Links

[10.5.1 ACS WFC Spectral Elements](#)
[10.5.2 ACS WFC Permitted Filter Combinations](#)
[10.5.3 ACS WFC Ramp Filter Ranges](#)
[10.5.4 ACS WFC Allowed Combinations of Aperture, Spectral Element, and Readout](#)
[10.5.5 ACS SBC Spectral Element](#)

Change Log
None

Chapter 11 Cosmic Origins Spectrograph, COS

The Cosmic Origins Spectrograph (COS) is one of the scientific instruments on HST, and this article contains instructions for how to specify observations for COS using the Astronomer's Proposal Tool (APT).

Chapter Contents

11.1 Introduction to COS

HST observations with COS are specified using the Astronomer's Proposal Tool (APT), and this article provides instructions for completing those observations.

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Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

The Instrument Configurations and Operating Modes described in this chapter are used to specify exposures on the Visit and Exposure Specifications. More complete descriptions of Instrument Configurations, Modes, Apertures, Spectral Elements, etc. are available in the *COS Instrument Handbook*.

COS FUV operations at Lifetime Position 6 (LP6) for long G160M exposures began at the start of Cycle 30. LP6 is located 6.5" above LP1 in the cross-dispersion direction, and 1.1" above LP5. G160M observations with two or less science exposures per orbit are executed by default at LP6. Users with orbits containing more than two G160M science exposures should select LP4 if justified in the Phase I proposal and with approval by the COS team. Users are strongly advised to consult Chapters 2.1 and 9.5.1 of the COS Instrument Handbook for more details. The blue modes (G130M /1055 and G130M/1096) remain at LP2, and G130M/1222 remains at LP4. G140L FUV TIME-TAG /ACCUM science observations are executed at LP3, but G140L spectroscopic acquisitions remain at LP4. G130M FUV TIME-TAG/ACCUM science observations with cenwaves 1291, 1300, 1309, 1318, and 1327 are executed at LP5. If justified in the Phase I proposal, observations of Lyman Alpha with G130M are available at LP3 (with spectroscopic acquisitions remaining at LP5). The defaults for SEGMENT and FP-POS optional parameters for all cenwaves are unchanged.

Since Cycle 26, two new **COS/FUV** central wavelengths (cenwaves), G140L/800 and G160M/1533, are being offered for **TIME-TAG** and **ACCUM** exposures. These modes are not offered for dispersed-light acquisitions. The G140L/800 mode places a broad range of wavelengths (800–1950 Å) on Segment A of the **COS FUV** detector, with a small astigmatic height at low wavelengths. The G160M/1533 mode extends the G160M coverage by 44 Å towards shorter wavelengths to overlap with the longest wavelengths of the G130M/1222 mode, allowing high signal-to-noise coverage of the full FUV bandpass with only two settings without placing Lyman-alpha on the detector. A more detailed motivation for these cenwaves is given in the *COS Instrument Handbook*.

New from Cycle 25 Onward

Restrictions on allowed observing modes with the G130M grating, which were put in place beginning in Cycle 25 at LP4 also apply at LP5. These restrictions, commonly referred to as "COS2025 restrictions", are designed to reduce the impact of geocoronal Lyman-alpha emission on FUV detector segment B, since this emission is a principal agent of gain sag. The restrictions affect the choice of **SEGMENT** and **FP-POS** available for certain G130M central wavelength settings (cenwaves), and apply to both science exposures and dispersed-light acquisitions. The policies can be summarized as follows:

- Observations with cenwave 1291, 1300, 1309, 1318, and 1327 have restrictions on Optional Parameters **FP-POS** and detector **SEGMENT** at LP4 and LP5:
    - for 1291 observations, only two **FP-POS** positions (3 and 4) are allowed if **SEGMENT=BOTH** or **SEGMENT=B**.
    - for 1300, 1309, 1318, and 1327 observations, only **SEGMENT=A** is allowed, but all four **FP-POS** positions can (and should) be used.
- Users of the 1291, 1300, 1309, 1318, and 1327 settings whose science case involves the study of Galactic Lyman-alpha and who would be adversely affected by these **FP-POS** and **SEGMENT** restrictions are allowed to request their observations be taken at LP3. At LP3, all four **FP-POS** and both **SEGMENTS** can be used for each of these five central wavelengths, as has been the case in the past. Such requests will be reviewed by the COS team.
- All COS users are urged to check the COS2025 website at: http://www.stsci.edu/hst /instrumentation/cos/proposing/cos2025-policies for detailed information about the COS2025 restrictions.

Observations with the G160M and G140L gratings and with the NUV channel are unaffected by the COS2025 policies. The supported FUV settings for Cycle 30 and beyond are summarized in Table 11.1 (for science exposures) and Table 11.2 (for dispersed-light acquisitions).

New from Cycle 30 Onward

To extend the lifetime of the FUV detector, starting in Cycle 30 COS operates at 5 different lifetime positions simultaneously. The default lifetime positions for each available central wavelength can be summarized as follows (see also Table 11.1 Supported settings for FUV ACCUM and TIME-TAG exposures):

- Observations with G130M central wavelengths 1055 and 1096 continue to be taken at LP2.
- Observations with G130M central wavelength 1222 continue to be taken at LP4.
- Observations with G130M central wavelengths 1291, 1300, 1309, 1318, and 1327 are taken at LP5
- Science observations with G140L central wavelengths 800, 1105, 1230, and 1280 are taken at LP3, target acquisitions are taken at LP4.
- Observations with G160M central wavelengths 1533, 1577, 1589, 1600, 1611, and 1623 are taken at LP6. G160M observations can be requested at LP4 with approval by the COS team. See Chapter 2 in the *COS Instrument Handbook* for the circumstances under which G160M observations can be conducted at LP4.

G130M science observations with central wavelengths 1291, 1300, 1309, 1318, and 1327 are AVAILABLE at LP3 with approval from the COS team and if justified in the Phase I proposal, but LP3 is not AVAILABLE for spectroscopic acquisitions.

Due to low throughput, the NUV G285M grating is now AVAILABLE but unsupported, and can be requested with approval by the COS team.

Table 11.1: Supported settings for FUV ACCUM and TIME- TAG exposures in Cycle 30 and beyond

Setting	SEGMENT[1]	FP-POS	Default LP
G130M/1055	A, B, **BOTH**	1, 2, 3, 4, ALL	LP2
G130M/1096	A, B, **BOTH**	1, 2, 3, 4, ALL	LP2
G130M/1222	A, B, **BOTH**	1, 2, 3, 4, ALL	LP4
G130M/1291[2]	A, B, **BOTH**	3, 4	LP5
G130M/1300	A	1, 2, 3, 4, ALL	LP5
G130M/1309	A	1, 2, 3, 4, ALL	LP5
G130M/1318	A	1, 2, 3, 4, ALL	LP5
G130M/1327	A	1, 2, 3, 4, ALL	LP5
G140L/800	A	1, 2, 3, 4, ALL	LP3

G140L/1105	A	1, 2, 3, 4, ALL	LP3
G140L/1230	A, B, **BOTH**	1, 2, 3, 4, ALL	LP3
G140L/1280	A, B, **BOTH**	1, 2, 3, 4, ALL	LP3
G160M/1533	A, B, **BOTH**	1, 2, 3, 4, ALL	LP6
G160M/1577	A, B, **BOTH**	1, 2, 3, 4, ALL	LP6
G160M/1589	A, B, **BOTH**	1, 2, 3, 4, ALL	LP6
G160M/1600	A, B, **BOTH**	1, 2, 3, 4, ALL	LP6
G160M/1611	A, B, **BOTH**	1, 2, 3, 4, ALL	LP6
G160M/1623	A, B, **BOTH**	1, 2, 3, 4, ALL	LP6

[1] Default values for the **SEGMENT** optional parameter are in bold.

[2] G130M/1291 observations using **SEGMENT=A** can use all FP-POS settings (1, 2, 3, 4, ALL), but G130M/1291 observations using **SEGMENT=B** or **SEGMENT=BOTH** are restricted to **FP-POS=3, 4**.

Table 11.2: Supported settings for FUV spectroscopic target acquisitions in Cycle 30 and beyond

Setting	SEGMENT[1]	Default LP
G130M/1291	A, B, **BOTH**	LP5
G130M/1300	A	LP5
G130M/1309	A	LP5
G130M/1318	A	LP5
G130M/1327	A	LP5
G140L/1105	A	LP4
G140L/1280	A, B, **BOTH**	LP4
G160M/1577	A, B, **BOTH**	LP6
G160M/1589	A, B, **BOTH**	LP6
G160M/1600	A, B, **BOTH**	LP6

G160M/1611	A, B, **BOTH**	LP6
G160M/1623	A, B, **BOTH**	LP6

[1] Default values for the SEGMENT optional parameter are in **bold**.

At Lifetime Positions 3 (LP3) and 4 (LP4) of the COS/FUV detector, observations of extended objects and observations using the Bright Object Aperture (**BOA**) might not be properly calibrated due to the extraction algorithm used ("two-zone"). In these two cases the standard pipeline calibration will not always produce the flux accuracy achieved for point sources observed with the Primary Science Aperture (**PSA**), and it will be the responsibility of the user to evaluate the adequacy of the spectral extraction and, if necessary, undertake any customized extractions. See COS ISR 2015-03 for further details.

Use of the BOA at Lifetime Position 5 (LP5) and 6 (LP6) is not permitted so cannot be used with grating/wavelength combinations that use LP5 or LP6; those need to request use of LP3 or LP4 respectively.

NUV science and target acquisition observations are not affected by the FUV lifetime position moves. COS target acquisitions of extended targets have always had caveats, as discussed in the 'Special Cases' section of the *COS Instrument Handbook*.

Table 11.3: *Instrument Parameters for COS* lists the permitted Instrument Configurations, Operating Modes, Apertures, Spectral Elements, and Optional Parameters for COS.

Table 11.3: Instrument Parameters for COS

Config	Mode	Aperture	Spectral Elements	Optional Parameters
COS /FUV	ACQ /SEARCH	PSA, BOA	See Table 11.5: *COS Spectral Elements and Central Wavelengths*	SEGMENT, SCAN-SIZE, STEP-SIZE, CENTER
	ACQ /PEAKXD	PSA, BOA		SEGMENT NUM-POS, STEP-SIZE, CENTER,
	ACQ /PEAKD	PSA, BOA		SEGMENT, NUM-POS, STEP-SIZE, CENTER,
	TIME-TAG	PSA, BOA, WCA, FCA		SEGMENT, BUFFER-TIME, EXTENDED[1], FP-POS, FLASH,
	ACCUM	PSA, BOA		SEGMENT, EXTENDED[1], FP-POS
COS /NUV	ACQ /SEARCH	PSA, BOA	See Table 11.5: *COS Spectral Elements and Central Wavelengths*	SCAN-SIZE, STEP-SIZE, CENTER

A C Q /IMAGE	PSA, BOA	MIRRORA, MIRRORB	
A C Q /PEAKXD	PSA, BOA	See Table 11.5: *COS Spectral Elements and Central Wavelengths*	STRIPE
A C Q /PEAKD	PSA, BOA		NUM-POS, STEP-SIZE, CENTER
TIME-TAG	PSA, BOA, WCA, FCA		BUFFER-TIME EXTENDED [1], FP-POS, FLASH
ACCUM	PSA, BOA		FP-POS

[1] Deprecated, see *Target Extent*

COS restricted parameters

Table 11.3 (cont): Additional Instrument Parameters for COS (Restricted)

Config	Mode	Aperture	Spectral Elements	Optional Parameters
COS	ALIGN /APER	None	None	XAPER, YAPER
	ALIGN /OSM	None	None	FOCUS, OSM1ROT, OSM2ROT
COS /FUV	ACQ /SEARCH	PSA, BOA	See Table 11.5: *COS Spectral Elements and Central Wavelengths*	LOCAL- THRESHOLD
	ACQ /PEAKXD	PSA, BOA		LOCAL- THRESHOLD
	ACQ /PEAKD	PSA, BOA		LOCAL- THRESHOLD
	TIME- TAG	PSA, BOA, WCA, FCA		CURRENT, STIM- RATE, WAVECAL
	ACCUM	PSA, BOA		STIM-RATE, WAVECAL
COS /NUV	ACQ /SEARCH	PSA, BOA		LOCAL- THRESHOLD
	ACQ /PEAKXD	PSA, BOA		NUM-POS, STEP- SIZE, CENTER
	ACQ /PEAKD	PSA, BOA		LOCAL- THRESHOLD
	TIME- TAG	PSA, BOA, WCA, FCA		CURRENT, WAVECAL
	ACCUM	PSA, BOA		WAVECAL

During HST Cycles 20-23 COS Lifetime Positions (LPs) were selectable via the "**LIFETIME-POS**" optional keyword for FUV and NUV exposures for three different detector locations: 'Original', 'Alternate', and 'Current'. Beginning with Cycle 24, this nomenclature has been deprecated and replaced with calling the LP by number (e.g., LP3).

For the NUV channel, there will always only be one lifetime position (LP1 or the old 'Original'). Therefore, the "**LIFETIME-POS**" optional parameter is no longer available for NUV exposures beginning with Cycle 24.

Note: If a non-default value of "**LIFETIME-POS**" is used and there are coordinated parallels, the position of the parallel aperture(s) could be offset by a small amount in Aladin.

COS available parameters

Table 3 (cont): Additional Instrument Parameters for COS (Available)

Config	Mode	Aperture	Spectral Elements	Optional Parameters
COS /FUV	ACQ /SEARCH	PSA, BOA	See table Table 11.5: *COS Spectral Elements and Central Wavelengths*	LIFETIME-POS [1]
	ACQ /PEAKXD	PSA, BOA		
	ACQ /PEAKD	PSA, BOA		
	TIME-TAG	PSA, BOA, WCA		
	ACCUM	PSA, BOA		

[1] The Optional Parameter LIFETIME-POS is required for G130M, G160M and G140L observations that are not in SUPPORTED mode (i.e., that are in AVAILABLE or RESTRICTED mode).

Related Links

11.2 COS Target Acquisition Modes
11.3 COS Observing Modes
11.4 COS Restricted Engineering Modes
11.5 COS Reference Information

Change Log

Version Cycle 31 June-July 2023

1. Removed old PR links from Change Log.
2. Removed sentence about LP6 "exposures longer than 2400s" (warning was removed by TRANS-91445)

Version Cycle 30 April 2022

PROPINST-91380 Document COS FUV Lifetime Position 6

Version Cycle 29 May 2021

Worked on comments from the COS team related to the changes for LP5.

Version Cycle 29 April 2021

1. PROPINST-91377 APT requirements for supporting COS FUV Lifetime Position 5
2. PROPINST-89772 Remove c1223 from Proposal Instructions (From Cycle 26)

Version Cycle 26 October 2018

1. PR.89723 APT requirements for new COS cenwave G160M/1533
   11.1 Introduction to COS
2. PR.89726 APT requirements for new COS cenwave G140L/800
   11.1 Introduction to COS

Initial Conversion from the HST Cycle 25 Phase II Proposal Instructions (Engineering) Version Cycle 25 (June 2018)

11.2 COS Target Acquisition Modes

> ⊘ *GO's preparing Phase 2 proposals which are critically dependent upon precise astrometry (mainly spectroscopic observations) should be aware that a subset of existing ACS and WFC3 datasets in the MAST archive have astrometric errors due to imperfect fits to GAIA stars during post-processing. This may result in incorrect scale factors in the image headers leading to errors on the order of ~1 arc second. Observers should consult the Phase 2 Proposal Instructions and the MAST www page. Please see item 3 in the [WFC3 STAN Issue 31, June 2020](#) for more information. A description of the WCS naming conventions used in ACS and WFC3 data is at [Improvements in HST Astrometry](#). Instructions on resetting the WCS to the pipeline defaults is given in the Jupyter notebook [Using updated astrometry solutions](#).*

> *Observations with HST's COS instrument generally require a target acquisition before obtaining science data, and the Astronomer's Proposal Tool ([APT](#)) has parameters for specifying these observations.*
>
> *COS FUV target acquisitions are not currently offered with the new FUV cenwaves G140L/800 and G160M/1533.*

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Sections

- [11.2.1 COS FUV Target Acquisition Modes](#)
- [11.2.2 COS NUV Target Acquisition Modes](#)

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Format definitions

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Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

Mode = ACQ/SEARCH Config = COS/FUV
Mode = ACQ/PEAKXD Config = COS/FUV
Mode = ACQ/PEAKD Config = COS/FUV
Mode = ACQ/SEARCH Config = COS/NUV
Mode = ACQ/IMAGE Config = COS/NUV
Mode = ACQ/PEAKXD Config = COS/NUV
Mode = ACQ/PEAKD Config = COS/NUV

For COS science observations of targets whose coordinates are not known to at least 0.4", you need to use the target search (**ACQ/SEARCH** Mode) and either the image acquisition (**ACQ/IMAGE** Mode) or peakup stages (**ACQ/PEAKXD** Mode followed by **ACQ/PEAKD** Mode) to center your target. For targets whose coordinates are accurate to 0.4" or better, the target search step (**ACQ/SEARCH**) can be skipped at the GOs own risk. For more details on these modes, see the *COS Instrument Handbook.*

Related Links

11.2.1 COS FUV Target Acquisition Modes
11.2.2 COS NUV Target Acquisition Modes

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None

11.2.1 COS FUV Target Acquisition Modes

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Format definitions

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Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Mode = ACQ/SEARCH Config = COS/FUV

> **Restricted**
>
> This mode invokes a procedure in the COS onboard flight software that searches for the target and locates it in the selected COS aperture for subsequent science exposures. A series of exposures are taken at different HST pointings in a spiral pattern from the initial pointing, and then the HST is repositioned to maximize the light intensity through the COS aperture.

This mode is required for targets whose coordinates are not known to at least 0.4". Most COS observation sequences that use ACQ/SEARCH Mode will also need to use other acquisition exposures (**ACQ/IMAGE**, **ACQ/PEAKD**, and/or **ACQ/PEAKXD**) to achieve proper centering of the target in the science aperture.

Information from the Target List, along with the exposure time, will be used to verify that the integrated target flux through the selected aperture is appropriate for target acquisition. Details on the target acquisition sequence and limiting magnitudes for the **PSA** and **BOA** apertures can be found in the *COS Instrument Handbook*.

This method uses dispersed light from the object to be observed. Subarrays are used to avoid geocoronal airglow lines and detector features, which could bias the target acquisition calculations, as well as portions of the detector which are not illuminated by the target's spectrum. The subarray dimensions depend on the selected grating; see the *COS Instrument Handbook* for details.

Aperture or FOV

The aperture used for the **ACQ/SEARCH** Mode exposure does not need to be the same as the aperture used for the subsequent **TIME-TAG** or **ACCUM** science exposures. The following apertures are allowed:

- **PSA** Primary Science Aperture
- **BOA** Bright Object Aperture   (but not permitted for grating/wavelength combinations that use lifetime position LP5 or LP6; those need to request use of LP4)

Use of the **BOA** is recommended on bright targets to attenuate the flux and allow the acquisition to proceed without triggering bright object violations.

Spectral Element

Enter a spectral element from Table 11.5: *COS Spectral Elements and Central Wavelengths* for the **COS/FUV** configuration. In order to minimize overheads, this will generally be the same as the one used for the subsequent target acquisition exposures and **TIME-TAG** or **ACCUM** science observation. Target acquisition with the COS FUV detector is in dispersed light only.

Wavelength

Enter the value of the central wavelength in Angstroms. Table 11.5: *COS Spectral Elements and Central Wavelengths* gives the allowed values of the central wavelength for each grating.

> **Available**
>
> In Table 11.6: *Additional configurations offered in AVAILABLE mode*, lists the AVAILABLE G130M and G160M central wavelengths that are not offered in **SUPPORTED** mode.

Optional Parameters

SEGMENT

= BOTH (default except for these cases: G140L, λ=1105 Å, and G130M, λ=1300,1309, 1318,1327 Å at LIFETIME-POS=LP4 and LP5)

= A (default and only allowed value for these cases: G140L, λ=1105 Å, and G130M, λ=1300, 1309, 1318, 1327 Å at LIFETIME-POS=LP4 and LP5)

= B (not permitted for G140L, λ=1230 Å; restricted for G140L, λ=1280 Å)

Indicates which segment of the FUV detector to use for an acquisition. A value of **BOTH** will activate both segments. Segments A and B record the long and short wavelength portions of the spectrum respectively. If **A** is selected, only segment A of the detector will be activated for photon detection, and the spectrum will contain data from only that half of the detector. If **B** is selected, only segment B of the detector will be activated and used to generate data. Use of a single segment may be warranted for sources that are too bright to observe safely over the entire detector. Target acquisitions at LP4 or LP5 with **G130M**, λ=**1300**, **1309**, **1318**, **1327** Å will use **SEGMENT=A** only, in order to protect the **SEGMENT=B** from illumination by geocoronal Lyman-alpha emission. See the *COS Instrument Handbook* for more information.

If you use the **G140L** grating at the 1105 Angstrom wavelength setting, **SEGMENT** defaults to **A** (see the following explanatory note).

Note: No target acquisition subarrays are defined for segment **B** when the **G140L** grating is used, because the count rate after excluding areas contaminated by geocoronal airglow lines is expected to be too low to support target acquisition. Also, when **G140L** is used at the 1105 Angstrom setting, the zeroth-order light from the target falls onto segment **B** and becomes a bright object concern.

SCAN-SIZE
= 2, 3, 4, 5 (points)

A required parameter which specifies the size of the square spiral search region in terms of the number of dwell points on a side (e.g., 2 × 2, 3 × 3, 4 × 4, or 5 × 5). A larger search pattern samples a larger area, but the time required scales as the square of **SCAN-SIZE**. In some cases it may be advisable to use two **ACQ** exposures, such as a 3 × 3 search followed by a 2 × 2 search; this strategy uses less time than a single 4 × 4 search. For more details on target acquisition strategies, consult the *COS Instrument Handbook*.

STEP-SIZE
= 1.767 (default); 0.2 - 2.0 (arcsec)

Specifies the size in arcseconds of each step in the spiral search. Both the **PSA** and **BOA** are 2.5 arcsec in diameter. The recommended offset of 1.767 arcsec is the offset at which diagonal dwell points just overlap, and the maximum spacing that provides continuous coverage. Simulations show that offsets larger than 1.767 arcsec will introduce errors due to unsampled areas within the search pattern.

CENTER

= DEF (default), FLUX-WT, FLUX-WT-FLR, BRIGHTEST

Specifies the method used for locating the target within the search pattern. Two methods are available: a flux-weighted centroiding algorithm (**FLUX-WT** or **FLUX-WT-FLR**) and a return to the brightest dwell point (**BRIGHTEST**).

If **FLUX-WT-FLR** is used, the minimum number of counts measured from any of the dwell points (the "floor") will be subtracted from the number at other dwell points before computing the centroid. The idea behind this threshold is to reduce the contribution of background counts. Note that this has the effect of eliminating the dwell point with the minimum counts from the centroid calculation. This drastically reduces the centering accuracy for **SCAN-SIZE=2**; therefore **FLUX-WT-FLR** is not allowed if **SCAN-SIZE=2** (**FLUX-WT** is recommended).

The default is to use **FLUX-WT-FLR** with a **SCAN-SIZE** of 3 or larger. See the *COS Instrument Handbook* for recommendations on when to use these different methods.

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Restricted

LOCAL-THRESHOLD (Restricted)

= 10 (default); 0-64 (percent)

The flux-weighted centroiding algorithm contains a check that removes dwell points from the calculation if the number of counts at that point is below a certain percentage of the maximum number of counts measured at any dwell point. The idea behind the local threshold is also to reduce noise by ignoring points that do not contain any appreciable flux from the target. LOCAL-THRESHOLD allows adjustment of this threshold. The default threshold is 10% of the maximum, but the appropriate threshold may depend on the science; see the *COS Instrument Handbook* for more information. LOCAL-THRESHOLD applies only to the flux-weighted centroids and is not allowed with CENTER=BRIGHTEST.

</div>

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Available

LIFETIME-POS (Available)

= DEF (default), LP1, LP2, LP3, LP4, LP5, LP6, LP7, LP8

Specifies which FUV lifetime adjustment position (LP) to use for this exposure. This Optional Parameter can be set in RESTRICTED or AVAILABLE mode, and is required if **SPECTRAL ELEMENT = G130M, G160M** or **G140L**. For G130M LP5 is the only option in AVAILABLE mode. For G160M, it may take the value of LP4 or LP6. For G140L, LP4 is the only option in AVAILABLE mode. If the optional parameter is not selected, or if "**DEF**" is selected, the ground commanding will assign the current default LP for each exposure based upon the central wavelengths. For further details see 11.1 *Introduction to COS* article.

</div>

Number of Iterations

The **Number_Of_Iterations** must be 1 in this Mode.

Time Per Exposure

Enter the total time of data collection at each dwell point as **Time_Per_Exposure**. **Time_Per_Exposure** must be an integral multiple of 0.1 seconds. If it is not, its value will be rounded down to the next lower integral multiple of 0.1 sec, or set to 0.1 seconds if a smaller value is specified.

The procedures to determine the exposure time for the **ACQ/SEARCH** Mode exposure are given in the *COS Instrument Handbook*. The COS Exposure Time Calculator should be used to estimate the exposure time based on the nature of the source. The exposure time will be repeated at every dwell point in the search.

Special Requirements

The special requirement "POSition TARGet <X-value>,<Y-value>" is not permitted on **ACQ/SEARCH** exposures.

Mode = ACQ/PEAKXD Config = COS/FUV

ACQ/PEAKXD mode invokes a procedure in the COS onboard flight software that places the target near an optimal position within the selected aperture in the cross-dispersion direction on the detector.

> Available
>
> The **NUM-POS** = 1 FUV ACQ/PEAKXD procedure used during Cycles 19-24 for FUV **LIFETIME-POS** = 1, 2, and 3 (LP1, LP2, and LP3) is different from the algorithm being used at **LIFETIME-POS**=4 (LP4), **LIFETIME-POS**=5 (LP5) and **LIFETIME-POS**=6 (LP6) in Cycles 25 and later (**NUM-POS** > 1). The **NUM-POS**=1 ACQ/PEAKXD procedure is:
>
> 1. The optimum cross-dispersion position of the science aperture is determined by flashing the calibration lamp and measuring the mean cross-dispersion location of the calibration spectrum.
> 2. The target spectrum is recorded for the specified period of time, and its mean cross-dispersion position is also computed.
> 3. Then, HST is repositioned so that the target location coincides with the opti- mum cross-dispersion position for the target spectrum within the aperture.
>
> For Cycle 25 and later, all target acquisitions will use the **NUM-POS**>1 algorithm.
>
> Note that the previous **ACQ/PEAKXD** functionality is retained by specifying **NUM-POS** = 1. If **NUM-POS**=1, then the optional parameters **STEP_SIZE** and **CENTER** may not be specified as they are not used by the **NUM-POS**=1 algorithm. NUM-POS=1 is not allowed when aperture **PSA** is selected and **LIFETIME-POS=LP6** is specified (or is the default).

For Cycle 25 and onward, the **ACQ/PEAKXD** centering algorithm has been enhanced in the COS flight software to employ the **ACQ/PEAKD** algorithm, but executed in the cross-dispersion direction. Three optional parameters (**NUM-POS**, **STEP-SIZE**, and **CENTER**) have been added to **ACQ/PEAKXD** in APT to support this enhancement. A linear scan is performed in the cross-dispersion direction, with the number of dwell points corresponding to the value of **NUM-POS**. The optional parameters **NUM-POS**, **STEP-SIZE** and **CENTER** have default values that are appropriate for centering a point source with target coordinates accurate to 0.4".

The optional parameters, **LIFETIME-POS** and **LOCAL-THRESHOLD**, have been implemented in engineering mode.

If the target coordinates are not accurate to 0.4", **ACQ/PEAKXD** Mode should normally be preceded by an **ACQ/SEARCH** to ensure that the target is positioned in the aperture. Details on the target acquisition sequence and limiting magnitudes for the **PSA** and **BOA** can be found in the *COS Instrument Handbook*.

Subarrays are used during target acquisition to avoid undesirable detector features (e.g., hot spots) and geocoronal airglow lines, which could bias the target acquisition calculations, as well as portions of the detector which are not illuminated by the input spectrum. The subarray dimensions depend on the selected grating and central wavelength; see the *COS Instrument Handbook* for details.

Aperture or FOV

The aperture used for the **ACQ/PEAKXD** Mode exposure need not be the same as the aperture used for the subsequent **TIME-TAG** or **ACCUM** science exposures. The following apertures are allowed:

- **PSA** Primary Science Aperture
- **BOA** Bright Object Aperture   (but not permitted for grating/wavelength combinations that use lifetime position LP5 or LP6; those need to request use of LP4)

As with spectroscopic observations, use of the **BOA** is recommended on relatively bright targets to attenuate the flux and allow the acquisition to proceed without triggering bright object violations.

Spectral Element

Enter a spectral element from Table 11.5: *COS Spectral Elements and Central Wavelengths* for the **COS/FUV** configuration. In order to minimize overheads, this will generally be the same as the one used for the subsequent **ACQ/PEAKD** and **TIME-TAG** or **ACCUM** science observation.

Wavelength

Enter the value of the central wavelength in Angstroms. Table 11.5: *COS Spectral Elements and Central Wavelengths* gives the allowed values of the central wavelength for each grating.

> Available
>
> All FUV dispersed light target acquisitions (PEAKD, PEAKXD, ACQ/SEARCH) for AVAILABLE mode observations will be performed at LIFETIME-POS = 4 for all G140L acquisitions, LIFETIME-POS = 4 or LIFETIME-POS = 6 for all G160M acquisitions or LIFETIME-POS = 5 for G130M acquisitions, following the restrictions in Table 11. 5: *COS Spectral Elements and Central Wavelengths*.

Optional Parameters

SEGMENT

= BOTH (default except for these cases: G140L, λ=1105 Å, and G130M, λ=1300,1309, 1318,1327 Å at LIFETIME-POS=LP4 and LP5)

= A (default and only allowed value for these cases: G140L, λ=1105 Å, and G130M, λ=1300, 1309, 1318, 1327 Å at LIFETIME-POS=LP4 and LP5)

= B (not permitted for G140L, λ=1230 Å; restricted for G140L, λ= 1280 Å)

For a description see Optional Parameters.

Available

LIFETIME-POS (Available)

= DEF (default), LP1, LP2, LP3, LP4, LP5, LP6, LP7, LP8

Specifies which FUV lifetime adjustment position (LP) to use for this exposure. This Optional Parameter can be set in RESTRICTED or AVAILABLE mode, and is required if **SPECTRAL ELEMENT = G130M, G160M** or **G140L**. For G130M LP5 is the only option in AVAILABLE mode. For G160M , it may take the value of LP4 or LP6. For G140L, LP4 is the only option in AVAILABLE mode. If the optional parameter is not selected, or if "**DEF**" is selected, the ground commanding will assign the current default LP for each exposure based upon the central wavelengths. For further details see 11.1 *Introduction to COS* article.

NUM-POS
1, 3 (default), 5, 7, & 9 (points)

Specifies the number of dwell positions (including the initial target position) in a **ACQ/PEAKXD** scan. The time required for the scan scales with the number of positions. **NUM-POS** values of 3 should be used with the flux-weighted centroid algorithm without the "flooring" option (**CENTER=FLUX-WT**), while values greater than 3 should always use the "flooring" centering option (**CENTER=FLUX-WT-FLR**). In most cases, **NUM-POS** equals 3 (the default) is recommended for **FUV PEAKXD** acquisitions.

Available

NUM-POS=1 uses the original **ACQ/PEAKXD** algorithm that flashes the calibration lamp, measures the cross-dispersion position of the target, and moves it to the desired cross-dispersion position. **NUM-POS** values other than one use the **ACQ/PEAKD** algorithm, but in the cross-dispersion direction.

NUM-POS=1 is not permitted when using the PSA and **LIFETIME-POS=LP6** is specified (or is the default).

STEP-SIZE
= DEF (default), 0.01 - 2.0 (arcsec)

This parameter specifies the size in arcseconds (") of each step in the linear scan. This parameter defaults to 1.30" when **NUM-POS=3**, 1.0" when **NUM-POS**=5, 0.80" when **NUM-POS=7**, and 0.65" when **NUM-POS=9**. These default values are tuned to point-sources with initial centering accuracies of 0.4" or better. Note that both the **PSA** and **BOA** are 2.5 arcsec in diameter. Assuming the target is already positioned in the aperture, a scan that greatly exceeds the aperture diameter is not likely to be useful.

Available

This parameter is used only when **NUM-POS** > 1.

CENTER
= DEF (default), FLUX-WT, FLUX-WT-FLR, BRIGHTEST

Specifies the method used for locating the target within the search pattern. Two methods are available: (1) a flux-weighted centroiding algorithm (**FLUX-WT** or **FLUX-WT-FLR**) or (2) a return to the brightest dwell point (**BRIGHTES**T). If **FLUX-WT-FLR** is used, the minimum number of counts measured from any of the dwell points (the "floor") will be subtracted from the number at each of the other dwell points before computing the centroid. The idea behind this threshold is to reduce the contribution of background counts and extreme points at the edges of the scan. The defaults are to use the flux-weighted centroid algorithm without the "flooring" option (**FLUX-WT**) when **NUM-POS**=3, and with the "flooring" option (**FLUX-WT-FLR**) when **NUM-POS>3**.

> Available
>
> This parameter is used only if **NUM-POS** > 1. See the *COS Instrument Handbook* for more details.

> Restricted
>
> **LOCAL-THRESHOLD**
>
> **= 10 (default); 0-64 (percent)**
>
> The flux-weighted centroiding algorithm contains a check that removes dwell points from the calculation if the number of counts at that point is below a certain percentage of the maximum number of counts measured at any dwell point. The idea behind the local threshold is also to reduce noise by ignoring points that do not contain any appreciable flux from the target. LOCAL-THRESHOLD allows adjustment of this threshold. The default threshold is 10% of the maximum, but the appropriate threshold may depend on the science; see the *COS Instrument Handbook* for more information. LOCAL-THRESHOLD applies only to the flux-weighted centroids and is not allowed with CENTER=BRIGHTEST.

Number of Iterations

The **Number_Of_Iterations** must be 1.

Time Per Exposure

Enter the time of data collection as **Time_Per_Exposure**. **Time_Per_Exposure** must be an integral multiple of 0.1 seconds. If it is not, its value will be rounded down to the next lower integral multiple of 0.1 sec, or set to 0.1 seconds if a smaller value is specified. The procedures to determine the exposure time for the **ACQ/PEAKXD** exposure are given in the *COS Instrument Handbook*.

Beginning with Cycle 25, **FUV ACQ/PEAKXD** exposures with **NUM-POS > 1** will use both FUV segments, so the combined count rate for both segments should be used to calculate the exposure times. The exceptions to this are when **SEGMENT = A or B** is specified as an optional parameter, or when acquiring with the G140L grating. In these cases, only the single segment count rate should be considered.

> Available
>
> FUV exposures that use **NUM-POS** = 1 should only use counts from the **FUVA** segment when calculating the exposure time.

Special Requirements

The special requirement "POSition TARGet <X-value>,<Y-value>" is not permitted on **ACQ/PEAKXD** exposures.

Mode = ACQ/PEAKD Config = COS/FUV

ACQ/PEAKD Mode invokes a procedure in the COS onboard flight software that takes a series of exposures at different HST pointings offset in the dispersion direction, and HST is repositioned to maximize (peak up) the light intensity through the COS aperture. Details on the target acquisition sequence and limiting magnitudes for the PSA and BOA can be found in the *COS Instrument Handbook*.

ACQ/PEAKD Mode should always be preceded by an **ACQ/PEAKXD** exposure. In addition, if the target coordinates are not accurate to 0.4", the **ACQ/PEAKD** should be preceded by both an **ACQ/SEARCH** and an **ACQ/PEAKXD** exposure to ensure that the target is positioned in the aperture and well centered in the cross-dispersion direction.

Subarrays are used during target acquisition to avoid geocoronal airglow lines, which could bias the target acquisition calculations, as well as portions of the detector which are not illuminated by the input spectrum. The subarray dimensions depend on the selected grating and central wavelength; see the *COS Instrument Handbook* for details.

Aperture or FOV

The aperture used for the **ACQ/PEAKD** Mode exposure need not be the same as the aperture used for the subsequent **TIME-TAG** or **ACCUM** science exposures. The following apertures are allowed:

- **PSA** Primary Science Aperture
- **BOA** Bright Object Aperture (but not permitted for grating/wavelength combinations that use lifetime position LP5 or LP6; those need to request use of LP4)

As with spectroscopic observations, use of the **BOA** is recommended on relatively bright targets to attenuate the flux and allow the acquisition to proceed without triggering bright object violations.

Spectral Element

Enter a spectral element from Table 11.5: *COS Spectral Elements and Central Wavelengths*. for the COS/FUV configuration. In order to minimize overheads, this will generally be the same as the one used for the subsequent **TIME-TAG** or **ACCUM** science observation. Target acquisition with the COS FUV detector is in dispersed light only.

Wavelength

Enter the value of the central wavelength in Angstroms.

> Available
>
> All FUV dispersed light target acquisitions (PEAKD, PEAKXD, ACQ/SEARCH) for AVAILABLE mode observations will be performed at LIFETIME-POS = 4 (LP4), **LIFETIME-POS**=5 (LP5) and **LIFETIME-POS** =6 (LP6), following the restrictions in Table 11.5: *COS Spectral Elements and Central Wavelengths*.

Optional Parameters

SEGMENT

= BOTH (default except for these cases: G140L, λ=1105 Å, and G130M, λ=1300,1309, 1318,1327 Å at LIFETIME-POS=LP4 and LP5)
= A (default and only allowed value for these cases: G140L, λ=1105 Å, and G130M, λ=1300, 1309, 1318, 1327 Å at LIFETIME-POS=LP4 and LP5)
= B (not permitted for G140L, λ=1230 Å; restricted for G140L, λ= 1280 Å)

This is the same as in **ACQ/SEARCH** Mode; see Optional Parameters.

NUM-POS
= 3, 5 (default), 7, 9 (points)

Specifies the number of dwell positions (including the initial target position) in an **ACQ/PEAKD** scan. The time required for the scan scales with the number of positions. The default value of **5** is recommended in combination with the flux-weighted centroid centering method with the "flooring" option (**FLUX-WT-FLR**). If you select **NUM-POS=3**, we recommend using the flux-weighted centroid algorithm without the "flooring" option (**FLUX-WT**). See the *COS Instrument Handbook* for more details on these recommendations.

STEP-SIZE
= 0.01 - 2.0 (arcsec)

A required parameter that specifies the size in arcseconds of each step in the linear scan. The optimal step size may depend on the number of positions and the centering method; see the *COS Instrument Handbook* for details. Note that both the **PSA** and **BOA** are 2.5 arcsec in diameter. Assuming the target is already positioned in the aperture, a scan that greatly exceeds the aperture diameter is not likely to be useful.

CENTER
= DEF (default), FLUX-WT, FLUX-WT-FLR, BRIGHTEST

Specifies the method used for locating the target within the search pattern. Two methods are available: (1) a flux-weighted centroiding algorithm (**FLUX-WT** or **FLUX-WT-FLR**) or (2) a return to the brightest dwell point (**BRIGHTEST**).

If **FLUX-WT-FLR** is used, the minimum number of counts measured from any of the dwell points (the "floor") will be subtracted from the number at other dwell points before computing the centroid. The idea behind this threshold is to reduce the contribution of background counts and extreme points at the edges of the scan.

The defaults are to use the flux-weighted centroid algorithm without the "flooring" option (**FLUX-WT**) when **NUM-POS=3**, and the "flooring" option (**FLUX-WT-FLR**) when **NUM-POS > 3**. See the *COS Instrument Handbook* for more details.

Restricted

LOCAL-THRESHOLD (Restricted)

= 10 (default); 0-64 (percent)

This is the same as in **ACQ/SEARCH** Mode; see Optional Parameters.

Available

LIFETIME-POS (Available)

= DEF (default), LP1, LP2, LP3, LP4,LP5, LP6, LP7, LP8

Specifies which FUV lifetime adjustment position (LP) to use for this exposure. This Optional Parameter can be set in RESTRICTED or AVAILABLE mode, and is required if **SPECTRAL ELEMENT** = **G130M**, **G160M** or **G140L**. For G130M LP5 is the only option in AVAILABLE mode. For G160M, it may take the value of LP4 or LP6. For G140L, LP4 is the only option in AVAILABLE mode. If the optional parameter is not selected, or if "**DEF**" is selected, the ground commanding will assign the current default LP for each exposure based upon the central wavelengths. For further details see 11.1 *Introduction to COS*.

Number of Iterations

The **Number_Of_Iterations** must be 1 in this Mode.

Time Per Exposure

Enter the total time of data collection at each dwell point as **Time_Per_Exposure**. **Time_Per_Exposure** must be an integral multiple of 0.1 seconds. If it is not, its value will be rounded down to the next lower integral multiple of 0.1 sec, or set to

0.1 seconds if a smaller value is specified.

The procedures to determine the exposure time for the **ACQ/PEAKD** exposure are given in the *COS Instrument Handbook*. The exposure time will be repeated at every dwell point in the search

Special Requirements

The special requirement "POSition TARGet <X-value>,<Y-value>" is not permitted for **ACQ/PEAKD** exposures.

Expand/Collapse all...

Related Links

11.2.2 COS NUV Target Acquisition Modes

Change Log

Version Cycle 30 April 2022

PROPINST-91380 Document COS FUV Lifetime Position 6

Version Cycle 29 May 2021

Worked on comments from the COS team related to the changes for LP5.

Version Cycle 29 April 2021

1. PROPINST-91377 APT requirements for supporting COS FUV Lifetime Position 5

11.2.2 COS NUV Target Acquisition Modes

[Expand/Collapse all...](#)

On This Page

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Mode = ACQ/SEARCH Config = COS/NUV

This mode invokes a procedure in the COS onboard flight software that searches for the target and locates it in the selected COS aperture for subsequent science exposures. A series of exposures are taken at different HST pointings in a spiral pattern from the initial pointing, and then the HST is repositioned to maximize the light intensity through the COS aperture. This mode is required for targets whose coordinates are not known to at least 0.4". Most COS observation sequences that use **ACQ/SEARCH** mode will also need to use other acquisition exposures (**ACQ/IMAGE**, **ACQ/PEAKD**, and /or **ACQ/PEAKXD**) to achieve proper centering of the target in the science aperture.

Details on the target acquisition sequence and limiting magnitudes for the **PSA** and **BOA** can be found in the *COS Instrument Handbook*.

This method in the NUV uses undispersed or dispersed light from the object to be observed. In dispersed light, the total counts from all three stripes are used to maximize the photon counting statistics. There are no appreciably bright airglow lines in the NUV portion of the spectrum, but subarrays are still used to exclude portions of the detector which are not illuminated by the input spectrum or image; this improves accuracy by reducing the contribution from background counts. The subarray dimensions depend on the selected spectral element; see the *COS Instrument Handbook* for details.

Aperture or FOV

The following apertures are allowed:

- **PSA** Primary Science Aperture
- **BOA** Bright Object Aperture

Use of the **BOA** is recommended on bright targets to attenuate the flux and allow the acquisition to proceed without triggering bright object violations.

Spectral Element

Enter a spectral element from Table 11.5: *COS Spectral Elements and Central Wavelengths* for the **COS/NUV** configuration. If a grating is selected, this will generally be the same as the one used for the subsequent **TIME-TAG** or **ACCUM** science observation. If the **MIRRORA** or **MIRRORB** spectral element is selected, the search for the target will be done in undispersed light. Use of the **MIRRORB** spectral element (possibly in conjunction with the **BOA** aperture) will attenuate the flux and allow undispersed-light acquisitions to be done on targets that would otherwise trigger bright object checks.

Wavelength

Enter the value of the central wavelength in Angstroms. Table 11.5: *COS Spectral Elements and Central Wavelengths* gives the allowed values of the central wavelength for each grating.

Note: No wavelength should be specified if **MIRRORA** or **MIRRORB** is the spectral element.

Optional Parameters

SCAN-SIZE
= 2, 3, 4, 5 (points)

This is a required parameter that specifies the size of the square spiral search region in terms of the number of dwell points on a side (e.g. 2 × 2, 3 × 3, 4 × 4, or 5 × 5). A larger search pattern samples a larger area, but the time required scales as the square of **SCAN-SIZE**.

Note: 2 × 2 dispersed light searches with the NUV channel should be avoided in most cases, as simulations show significantly degraded accuracy; a 2 × 2 search can even worsen the alignment of a target that is initially well centered. For more details on target acquisition strategies, please consult the *COS Instrument Handbook*.

STEP-SIZE
= 1.767 (default); 0.2 - 2.0 (arcsec)

Specifies the size in arcseconds of each step in the spiral search. Both the **PSA** and **BOA** are 2.5 arcsec in diameter. The recommended offset of 1.767 arcsec is the offset at which diagonal dwell points just overlap, and the maximum spacing that provides continuous coverage. Simulations show that offsets larger than 1.767 arcsec will introduce errors due to unsampled areas within the search pattern.

CENTER
= DEF (default), FLUX-WT, FLUX-WT-FLR, BRIGHTEST

Specifies the method used for locating the target within the search pattern. Two methods are available: (1) a flux-weighted centroiding algorithm (**FLUX-WT** or **FLUX-WT-FLR**), or (2) a return to the brightest dwell point (**BRIGHTEST**).

If **FLUX-WT-FLR** is used, the minimum number of counts measured from any of the dwell points (the "floor") will be subtracted from the number at other dwell points before computing the centroid. The idea behind this threshold is to reduce the contribution of background counts. Note that this has the effect of eliminating the dwell point with the minimum counts from the centroid calculation. This drastically reduces the centering accuracy for **SCAN-SIZE=2**; therefore **FLUX-WT-FLR** is not allowed if **SCAN-SIZE=2** (**FLUX-WT** is recommended).

Because of the higher detector background of the NUV detector, use of the floored threshold is considered necessary to achieve acceptable accuracy with the flux-weighted centroiding algorithm. Therefore, the default is to use **FLUX-WT-FLR** with a **SCAN-SIZE** of 3 or larger. See the *COS Instrument Handbook* for recommendations on using these different methods.

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LOCAL-THRESHOLD restricted

LOCAL-THRESHOLD

= 10 (default); 0-64 (percent)

The flux-weighted centroiding algorithm contains a check that removes dwell points from the calculation if the number of counts at that point is below a certain percentage of the maximum number of counts measured at any dwell point. The idea behind the local threshold is also to reduce noise by ignoring points that do not contain any appreciable flux from the target. LOCAL-THRESHOLD can adjust this threshold. The default threshold is 10% of the maximum, but the appropriate threshold may depend on the science.

</div>

Number of Iterations

The **Number_Of_Iteration**s must be 1 in this Mode.

Time Per Exposure

Enter the total time of data collection at each dwell point as **Time_Per_Exposure**. **Time_Per_Exposure** must be an integral multiple of 0.1 seconds. If it is not, its value will be rounded down to the next lower integral multiple of 0.1 sec, or set to 0.1 seconds if a smaller value is specified.

The procedures to determine the exposure time for the **ACQ/SEARCH** Mode exposure are given in the *COS Instrument Handbook*. The exposure time will be repeated at every dwell point in the search.

Special Requirements

The special requirement "POSition TARGet <X-value>,<Y-value>" is not permitted on **ACQ/SEARCH** exposures.

Mode = ACQ/IMAGE Config = COS/NUV

ACQ/IMAGE Mode invokes a procedure in the COS onboard flight software that takes an image in undispersed light using the NUV mirror to center the target within the selected aperture. This procedure consists of several steps.

1. The position of the science aperture on the detector (which may drift with time) is located by flashing the calibration lamp (also in undispersed light) and measuring the location of the calibration image.
2. The target acquisition image is then taken within a 4 × 4 arcsec subarray centered at the expected center of the science aperture.
3. Next, a 9 × 9 pixel checkbox is passed across the subarray to identify the region with the maximum counts. Within the checkbox, a flux-weighted centroiding algorithm is used to calculate the expected target position.
4. Finally, HST is repositioned to place that location at the center of the science aperture, and a subsequent exposure is commanded and downlinked to verify that the target ended up in the preferred location.

Use of **ACQ/IMAGE** Mode requires that the science aperture (1.25 arcsec radius) contain appreciable flux from the target. This operation is theoretically limited to sources within 2 arcsec of the center of the aperture; an initial pointing error less than 1.0 arcsec is recommended. If the uncertainty in the initial target position is greater than this, the use of **ACQ/IMAGE** should be preceded by an exposure in **ACQ/SEARCH** mode to locate the target. Details on the target acquisition sequence and limiting magnitudes for the **PSA** and **BOA**, as well as subarray dimensions for the calibration and acquisition images, can be found in the *COS Instrument Handbook*.

Aperture or FOV

The following apertures are allowed:

- **PSA** Primary Science Aperture
- **BOA** Bright Object Aperture

Spectral Element

Enter either **MIRRORA** or **MIRRORB**. The gratings are not allowed in this Mode. Use of the **MIRRORB** spectral element and/or the **BOA** aperture will attenuate the flux and allow an image acquisition to be done on targets that would otherwise trigger bright object violations.

Wavelength

The Wavelength parameter does not apply to this Mode and should be left blank.

Optional Parameters

There are no Optional Parameters for this Mode.

Number of Iterations

The **Number_Of_Iterations** must be 1 in this Mode.

Time Per Exposure

Enter the total time of data collection as **Time_Per_Exposure**. **Time_Per_Exposure** must be an integral multiple of 0.1 seconds. If it is not, its value will be rounded down to the next lower integral multiple of 0.1 sec, or set to 0.1 seconds if a smaller value is specified. This time will be used both for the acquisition image and the subsequent confirmation image.

The procedures to determine the exposure time for the **ACQ/IMAGE** exposure are given in the *COS Instrument Handbook*.

Special Requirements

The special requirement "POSition TARGet <X-value>,<Y-value>" is not permitted on **ACQ /IMAGE** exposures.

Mode = ACQ/PEAKXD Config = COS/NUV

ACQ/PEAKXD Mode invokes a procedure in the COS onboard flight software that places the target near an optimal position within the selected aperture in the cross-dispersion direction on the detector. This procedure consists of several steps.

1. The optimum cross-dispersion position of the science aperture on the detector is located by flashing the calibration lamp and measuring the mean cross-dispersion location of the calibration spectrum.
2. Then the target spectrum is recorded in dispersed light for the specified period of time, and its mean cross-dispersion position is also computed.
3. Finally, HST is repositioned so that the target location coincides with the optimum cross-dispersion position for the target spectrum within the aperture.

If the target coordinates are not accurate to 0.4", an **ACQ/PEAKXD** should be preceded by an **ACQ/SEARCH** to ensure that the target is positioned in the aperture.

Information from the Target List, along with the exposure time, will be used to verify that the integrated target flux through the selected aperture is appropriate for target acquisition. Details on the target acquisition sequence and limiting magnitudes for the **PSA** and **BOA** can be found in the *COS Instrument Handbook*.

In **ACQ/PEAKXD** Mode, acquisition subarrays are limited to a single stripe. The subarray dimensions may also depend on the selected grating; see the *COS Instrument Handbook* for details.

Aperture or FOV

The aperture used for the **ACQ/PEAKXD** Mode exposure will generally be the same as the aperture used for the subsequent **TIME-TAG** or **ACCUM** science exposures. The following apertures are allowed:

- **PSA** Primary Science Aperture
- **BOA** Bright Object Aperture

As with spectroscopic observations, use of the **BOA** is recommended on relatively bright targets to attenuate the flux and allow the acquisition to proceed without triggering bright object violations.

Spectral Element

Enter one of the gratings from Table 11.5: *COS Spectral Elements and Central Wavelengths* for the COS/NUV configuration. This will generally be the same as the one used for the subsequent **TIME-TAG** or **ACCUM** science observation. This Mode only uses dispersed light, so the mirror may not be used.

Wavelength

Enter the value of the central wavelength in Angstroms. Table 11.5: *COS Spectral Elements and Central Wavelengths* gives the allowed values of the central wavelength for each grating. Due to increased NUV detector background and mechanism position uncertainties, certain NUV central wavelength settings have proven to be unreliable in the **NUV ACQ/PEAKXD** target acquisition phase. The NUV central wavelengths settings listed in bold in Table 11.5: *COS Spectral Elements and Central Wavelengths* have been proven reliable for **ACQ/PEAKXD** using **STRIPE=DEF**. **NUV ACQ/PEAKXD** exposures should use one of these settings. See the *COS Instrument Handbook* for further details. Users who wish to use other central wavelengths, or non-default STRIPE settings, should contact the COS team via the Help Desk.

Optional Parameters

STRIPE
= DEF (default), SHORT, MEDIUM, LONG

Identifies the spectral stripe to use for the acquisition subarray. The shortest wavelengths of the spectrum are projected onto the stripe designated by **SHORT**, wavelengths in the middle of the range onto the stripe designated by **MEDIUM**, and the longest wavelengths onto the stripe designated by **LONG**. To determine the mapping between the selected spectral wavelength and the wavelength coverage in each stripe, please see the *COS Instrument Handbook*.

There are special restrictions with the **G230L** grating, which positions first-order light on the detector only for certain stripes. The **MEDIUM** stripe is required for the 2635 central wavelength, the **SHORT** stripe is required for the 3360 wavelength, and either **SHORT** or **MEDIUM** may be used for the 2950 and 3000 wavelengths. The **LONG** stripe may not be used with **G230L** at all.

Note: A value of **DEF** is normally the same as **MEDIUM**. The one exception is with the **G230L** grating and the 3360 wavelength, where only the **SHORT** stripe is allowed. **STRIPE=DEF** is preferred because the flight software only stores the cross-dispersion offset between the location of the calibration spectrum and the optimal location of the science spectrum for the **DEF** stripe. The true offset varies by +/− 2.5 pixels between stripes, so there will be a slight error in the calculated "optimal" position of the target spectrum if **SHORT** or **LONG** is used. This might cause a small drop in flux, but is not expected to affect the success of target acquisition.

Number of Iterations

The **Number_Of_Iterations** must be 1 in this Mode.

Time Per Exposure

Enter the total time of data collection as **Time_Per_Exposure**. **Time_Per_Exposure** must be an integral multiple of 0.1 seconds. If it is not, its value will be rounded down to the next lower integral multiple of 0.1 sec, or set to 0.1 seconds if a smaller value is specified.

The procedures to determine the exposure time for the **ACQ/PEAKXD** exposure are given in the *COS Instrument Handbook*.

Special Requirements

The special requirement "POSition TARGet <X-value>,<Y-value>" is not permitted for **ACQ/PEAKXD** exposures.

Mode = ACQ/PEAKD Config = COS/NUV

ACQ/PEAKD Mode invokes a procedure in the COS onboard flight software that takes a series of exposures at different HST pointings offset in the dispersion direction, and the HST is repositioned to maximize (peak up) the light intensity through the COS aperture.

The visual magnitude from the Target List, along with the exposure time, will be used to verify that the integrated target flux through the selected aperture is appropriate for target acquisition. Details on the target acquisition sequence and limiting magnitudes for the **PSA** and **BOA** can be found in the *COS Instrument Handbook*.

An **ACQ/PEAKD** should always be preceded by an **ACQ/PEAKXD** exposure. In addition, if the target coordinates are not accurate to 0.4", the **ACQ/PEAKD** should be preceded by both **ACQ/SEARCH** and **ACQ/PEAKXD** exposures to ensure that the target is positioned in the aperture and well centered in the cross-dispersion direction.

There are no appreciably bright airglow lines in the NUV portion of the spectrum, but subarrays are still used to exclude portions of the detector which are not illuminated by the input spectrum or image; this improves accuracy by reducing the contribution from background counts. The subarray dimensions depend on the selected grating; see the *COS Instrument Handbook* for details. For this Mode, there is no need to specify the spectral stripe as in **ACQ/PEAKXD** Mode because the subarrays include counts from all stripes to maximize the photon counting statistics.

Aperture or FOV

The aperture used for the **ACQ/PEAKD** Mode exposure will generally be the same as the aperture used for the subsequent **TIME-TAG** or **ACCUM** science exposures. The following apertures are allowed:

- **PSA** Primary Science Aperture
- **BOA** Bright Object Aperture

Use of the **BOA** is recommended on relatively bright targets to attenuate the flux and allow the acquisition to proceed without triggering bright object violations.

Spectral Element

Enter one of the gratings from Table 11.5: *COS Spectral Elements and Central Wavelengths* for the COS/NUV configuration. This will generally be the same as the one used for the subsequent **TIME-TAG** or **ACCUM** science observation. This Mode only uses dispersed light, so the mirror may not be used.

Wavelength

Enter the value of the central wavelength in Angstroms. Table 11.5: *COS Spectral Elements and Central Wavelengths* gives the allowed values of the central wavelength for each grating.

Optional Parameters

NUM-POS
= 3, 5 (default), 7, 9 (points)

Specifies the number of dwell positions (including the initial target position) in an **ACQ/PEAKD** scan. The time required for the scan scales with the number of positions. When the flux-weighted centroid centering method with the "flooring" option is used (**FLUX-WT-FLR**), increasing the number of positions will improve the accuracy, but simulations show that value of a 5 does almost as well as 9. For more details consult the *COS Instrument Handbook*.

STEP-SIZE
= 0.01 - 2.0 (arcsec)

This is a required parameter that specifies the size in arcseconds of each step in the linear scan. The optimal step size may depend on the number of positions and the centering method; see the *COS Instrument Handbook* for details. Note that both the **PSA** and **BOA** are 2.5 arcsec in diameter. Assuming the target is already positioned in the aperture, a scan that greatly exceeds the aperture diameter is not likely to be useful.

CENTER
= DEF (default), FLUX-WT, FLUX-WT-FLR, BRIGHTEST

Specifies the method used for locating the target within the search pattern. Two methods are available: (1) a flux-weighted centroiding algorithm (**FLUX-WT** or **FLUX-WT-FLR**), or (2) a return to the brightest dwell point (**BRIGHTEST**).

If **FLUX-WT-FLR** is used, the minimum number of counts measured from any of the dwell points will be subtracted from the number at other dwell points before computing the centroid. The idea behind this threshold is to reduce the contribution of background counts and extreme points at the edges of the scan.

The defaults are to use the flux-weighted centroid algorithm without the "flooring" option when **NUM-POS=3**, and to use the "flooring" option when **NUM-POS > 3**. See the *COS Instrument Handbook* for more details on these recommendations.

<div style="border:1px solid red">

Restricted

LOCAL-THRESHOLD

= 10 (default); 0-64 (percent)

This is the same as in ACQ/SEARCH Mode; see Optional Parameters.

</div>

Number of Iterations

The **Number_Of_Iterations** must be 1 in this Mode.

Time Per Exposure

Enter the total time of data collection as **Time_Per_Exposure**. **Time_Per_Exposure** must be an integral multiple of 0.1 seconds. If it is not, its value will be rounded down to the next lower integral multiple of 0.1 sec, or set to 0.1 seconds if a smaller value is specified.

The procedures to determine the exposure time for the **ACQ/PEAKD** exposure are given in the *COS Instrument Handbook*.

Special Requirements

The special requirement "POSition TARGet <X-value>,<Y-value>" is not permitted for **ACQ /PEAKXD** exposures.

Expand/Collapse all...

Related Links

11.2.1 COS FUV Target Acquisition Modes

Change Log
None

11.3 COS Observing Modes

HST's COS instrument can obtain both spectroscopic data in both ACCUM and TIME-TAG mode, and this article contains links for the parameters for specify both types of data.

Sections

- 11.3.1 COS FUV Observing Modes
- 11.3.2 COS NUV Observing Modes

Change Log

Version # (date month xx, 20xx)

1. PR #### - text

11.3.1 COS FUV Observing Modes

Observations with HST's COS instrument can be done with the FUV detector, and the Astronomer's Proposal Tool (APT) has parameters for specifying these observations.

Expand/Collapse all...

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

★ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

There is one detector on COS that can be used to obtain far-ultraviolet data, and that is the FUV.

Mode = TIME-TAG Config = COS/FUV

In **TIME-TAG** Mode, the COS FUV detector produces an event stream with a time resolution of 32 milliseconds. The X and Y pixel coordinates of each photon event are stored in a 32-bit word in data buffer memory. At the start of an exposure and after every subsequent 32-millisecond period which contains photon events, a 32-bit time-of-day word is written to the data memory. The **TIME-TAG** is the recommended data-taking mode unless the target's brightness leads to a total count rate in excess of that supported by this mode.

Aperture or FOV

The following apertures are allowed:

- **PSA** Primary Science Aperture
- **BOA** Bright Object Aperture (but not permitted for grating/wavelength combinations that use lifetime position LP5 or LP6; those need to request use of LP3 or LP4)
- **WCA** Wavelength Calibration Aperture; required for Target=**WAVE**
- **FCA** Flat-field Calibration Aperture; required for Target=**DEUTERIUM**

Spectral Element

Enter a spectral element from Table 11.5: *COS Spectral Elements and Central Wavelengths* for the COS/FUV configuration.

Wavelength

Enter the value of the central wavelength in Angstroms. Table 11.5: *COS Spectral Elements and Central Wavelengths* gives the allowed values of the central wavelength for each grating. Table 11.6: *Additional configurations offered in AVAILABLE mode* lists the AVAILABLE G130M and G160M central wavelengths that are not offered in SUPPORTED mode, (after following the link to the table you will need to click on expand to see the table).

Optional Parameters

SEGMENT

= BOTH (default except for these cases: G140L/1105, G140L/800 and G130M/1300, 1309, 1318, 1327 at LIFETIME-POS=LP4 and LP5)
= A (default and only allowed value for these cases: G140L/1105, G140L/800 and G130M/1300, 1309, 1318, 1327 at LIFETIME-POS=LP4 and LP5)
= B (not permitted for G140L/1230)

Specifies which segment of the FUV detector to use for an observation. A value of **BOTH** will activate both segments. If **A** is selected, only segment A of the detector will be activated for photon detection, and the spectrum will contain data from only that half of the detector. If **B** is selected, only segment B of the detector will be activated and used to generate data. The use of only a single segment may be warranted with sources that are too bright to observe safely over the entire detector, or when a source has a much higher expected count rate in one segment than the other and the important science is in the segment with the low count rate. Observations at LP5 with **G130M**, λ=**1300**, **1309**, **1318**, **1327 Å** will use **SEGMENT=A** only, in order to protect the FUV detector **SEGMENT=B** from illumination by geocoronal Lyman-alpha emission. See the *COS Instrument Handbook* for more information.

If you specify grating **G140L** with the 800 or 1105 wavelength setting (or with the 1230 Angstrom wavelength setting when **FP_POS** is set to **4** or **ALL)**, **SEGMENT** defaults to **A**.

For exposures with **SEGMENT = B** <u>only</u> and the central wavelength set to either 1055 or 1096, the wavelength solution is compromised because the wavelength calibration lamp produces no counts at the short wavelengths seen by those settings. The best solution involves inserting a wavecal with segment **A** turned on with the same setting and **FP-POS**. A warning will be triggered whenever 1055 /FUVB or 1096/FUVB settings are used (both **ACCUM** and **TIME-TAG** mode). The Phase II program can be submitted with this warning but the appropriate course of action must be discussed with the Contact Scientist assigned to the program before the observations are executed.

BUFFER-TIME
= 80 or greater (integer seconds)

Specifies the estimated minimum time in which 2.35×10^{6} photon events (half of the COS data buffer capacity) will be accumulated during a **TIME-TAG** exposure. **BUFFER-TIME** is a required parameter if the target is not **WAVE**. If the target is **WAVE**, then **BUFFER-TIME** may not be specified unless the proposal is a calibration or engineering one.

If the predicted total number of events from a **TIME-TAG** exposure exceeds the COS data buffer capacity of 4.7×10^{6} photon events, data must be transferred to the HST onboard science recorder during the exposure. Transfers of data from the COS buffer during an exposure will be made in 9-MByte blocks (half the buffer capacity). The value of **BUFFER-TIME** should be the half-buffer capacity $(2.35 \times 10^{6}$ counts) divided by the estimated maximum average count rate in photons per second.

Note that **BUFFER-TIME** should include expected counts from the detector dark current and stim pulses (see the *COS Instrument Handbook*) as well as the detected photon events, factoring in the instrument quantum efficiency. A conservative value of **BUFFER-TIME** is recommended (err slightly on the low side) to avoid data loss.

The absolute minimum **BUFFER-TIME** of 80 seconds corresponds to a maximum average count rate of ~30,000 counts/sec over the entire detector, which is the maximum rate at which the flight software is capable of processing counts. The COS Exposure Time Calculator (ETC) should be used to estimate a suitable value for **BUFFER-TIME**. See the *COS Instrument Handbook* for more information.

EXTENDED
= NO (default), YES

Indicated whether the target is an extended source. This parameter is still in APT, but has been functionally replaced by the **EXTENDED** target parameter. Selecting this parameter will only trigger a warning message asking you to set the TARGET description parameter instead. This exposure-level parameter should not be selected for any Cycle 23 proposals and beyond. See the description in Target Extent.

FP-POS
= ALL, 1, 2, 3 (pre-Cycle 19 default), 4

This optional parameter is **required** for external and **WAVE** targets. It specifies whether to take the exposure at a single offset, at multiple offsets, or at no offset from the nominal central wavelength. Obtaining exposures at small wavelength offsets from the specified central wavelength aids in the correction of the fixed-pattern defects of the detector. For the best data quality, we strongly recommend using all four **FP-POS** positions (**ALL**). There are two exceptions: For G130M/1291 when **SEGMENT = B** or **BOTH**, only **FP-POS = 3**, **4** are allowed. And when **LIFETIME-POS=LP6** is specified (or is the default) it is permitted to use fewer than 4 FP-POS based on the S/N of the observations (see Chapter 9 of the *COS Instrument Handbook*). Please see Table 11.5: *COS Spectral Elements and Central Wavelengths* for more information.

For **FP-POS**=**All** the specified exposure time will not be split for external targets (i.e., it is the exposure time for each **FP-POS** exposure).

The values **FP-POS=1, 2,** or **4** will result in the exposure being taken at an offset from the specified central wavelength. **FP-POS=3** will result in the exposure being obtained at the nominal central wavelength (i.e., at zero offset). The exposure will be for the specified exposure duration. See the *COS Instrument Handbook* for specifics of the offsets and for guidance on how to use this capability.

> Restricted
>
> Since the settings **FP-POS=4** or **ALL** and spectral element/wavelength of **G140L**/1230 Å places zero-order light on segment B, the use of this combination of settings must be strongly justified.

Note for internal targets: FP-POS is not allowed for internal targets except Target=**WAVE** and **DEUTERIUM**. Allowed values for exposures with Target=**WAVE** and **DEUTERIUM** are **FP-POS=1, 2, 3** or **4**.

FLASH
= YES (default; restricted for G130M, λ=1055 or 1096 Å and SEGMENT=B), NO, SnnnnDmmm

Indicates whether or not to "flash" the wavelength calibration lamp during exposures. These flashes are needed to compensate for the effect of post-move drift of the Optics Select Mechanisms. The default behavior will be that the wavecal lamp is turned on briefly at the start of an externally targeted exposure, and at intervals later in the exposure. The grating-dependent "flash" durations and the time-since-move-dependent flash intervals will be defined by the STScI. Specifying the value **NO** will disable automatic flashing for the current exposure.

FLASH will automatically be set to **NO** for exposures having central wavelengths of either 1055 or 1096 Angstroms and **SEGMENT** set to **B**. Under these circumstances the wavelength calibration lamp produces no counts at the short wavelengths seen by these settings. The appropriate course of action must be discussed with your Contact Scientist before your observations can be executed under these conditions. **(Restricted) FLASH** can be set to **YES**.

When flashing is enabled, the exposure time must be at least as long as a single flash. Flash durations, as functions of grating and central wavelength, are given in Table 11.8: *COS WAVECAL Exposure Parameters*.

When aperture **BOA** is selected, **FLASH** *may not* be specified and defaults to **NO**.

When aperture **PSA** is selected and **LIFETIME-POS=LP6** is specified (or is the default), **FLASH** *may not* be specified and defaults to **NO**.

Restricted

Engineering and calibration proposals may also specify a 9 character string, **SnnnnDmmm**, where **nnnn** is a four digit value for the separation between flash starts and **mmm** is a three digit value for the duration of each flash. Both values are in seconds, **mmm** must be at least 2 seconds, and **nnnn** must be greater than **mmm** by at least 2 seconds.

Engineering and calibration proposals may also specify **FLASH** with the **WAVE** target. This will produce an exposure of the requested exposure time, but with a standard flash sequence rather than having the wavelength calibration lamp on for the entire exposure. The default value of **FLASH** is **NO** when the target= **WAVE**.

WAVECAL (Restricted)
= YES (default), NO

Indicates whether automatic wavelength calibrations should be performed for this exposure specification. **WAVECAL=NO** should not be present unless explicit approval from the contact scientist has been received.

STIM-RATE (Restricted)
= DEF (default), 0, 2, 30, 2000

Selects a rate for the electronic stim pulses produced by the time-to-digital converters on the FUV detector. During the exposure, two pulses per segment (a total of four if both segments are used) will be generated to track image drift during science and calibration images. The objective is to attain at least several hundred counts in each stim pulse per exposure. Four stim rates are available, at **0, 2, 30,** and **2000** counts per second per segment. A value of **0** turns the stims off altogether.

If this parameter is omitted or given as **DEF**, a stim rate will be selected based on the specified **Time_Per_Exposure**. Exposures longer than 100 seconds will use the 2-Hz rate, exposures from 10-100 seconds will use the 30-Hz rate, and exposures shorter than 10 seconds will use the 2000-Hz rate. See the *COS Instrument Handbook* for more information.

CURRENT (Restricted)
= DEF (default), LOW, MEDIUM, HIGH

Specifies the current setting to be used with the calibration lamp. **DEF** will provide the default current for the spectral element and central wavelength specified for the exposure. See table *WAVECAL Exposure Parameters* for default values (Note that **DEF=MEDIUM**).

If Target=**DEUTERIUM**, **CURRENT** must be specified and cannot be **DEF** or **HIGH**.

If Target=**WAVE**, then **CURRENT** is permitted only if **Sp_Element=G140L** and **SEGMENT=B**.

LIFETIME-POS (Restricted)
= DEF (default), LP1, LP2, LP3, LP4,LP5, LP6, LP7, LP8

Specifies which FUV lifetime adjustment position (LP) to use for this exposure. If the optional parameter is not selected, or if "DEF" is selected, the ground commanding will assign the current default LP for each exposure based upon the central wavelengths. For further details see *11.1 Introduction to COS*.

Number of Iterations

Number_Of_Iterations must be **1** in this Mode.

Time Per Exposure

Enter the total time of data collection as **Time_Per_Exposure. Time_Per_Exposure** must be an integral multiple of 0.1 seconds (if it is not, its value will be rounded down to the next lower integral multiple of 0.1 sec, or set to 0.1 seconds if a smaller value is specified), and may range from 0.1 to 6500 seconds. Values much larger than 3000 seconds are normally appropriate only for visits with the CVZ special requirement.

For Target=**WAVE**, enter **DEF** for **Time_Per_Exposure**.

> Restricted
>
> Engineering and calibration proposals may specify a value for **Time_Per_Exposure**, subject to the restrictions defined above.

If **BUFFER-TIME** < 110 seconds, photon events may be generated faster than data can be transferred out of the buffer during the exposure. In this case, **Time_Per_Exposure** should be less than or equal to 2 * **BUFFER-TIME** so that the exposure can complete before data transfer is necessary. A **BUFFER-TIME** of 110 seconds corresponds to an average count rate of ~21,000 counts/sec.

Note that **TIME-TAG** exposures have the potential to rapidly use up the HST onboard storage capacity. Caution is advised on any exposure with an exposure time greater than 25 * **BUFFER-TIME**, which corresponds to ~6 × 10^7 counts, or about 2 GBits (close to 20% of the solid-state recorder capacity).

Special Requirements

The special requirement **RT ANALYSIS** is not permitted on **TIME-TAG** exposures.

Mode = ACCUM Config = COS/FUV

In **ACCUM** Mode, the detector coordinates of each photon event are used to reference a 16-bit word in a memory array, which is incremented as each event occurs. An **ACCUM** mode image in the COS /FUV configuration is 16,384 × 128 pixels in each of the two detector segments. The COS data buffer can hold two such images, assuming both segments are used. **ACCUM** should be used only when absolutely necessary, such as for high count-rate targets. **TIME-TAG** is the recommended data-taking mode unless the target's brightness leads to a total count rate in excess of that possible with this mode.

Aperture or FOV

The following apertures are allowed:

PSA Primary Science Aperture

BOA Bright Object Aperture (but not permitted for grating/wavelength combinations that use lifetime position LP5 or LP6; those need to request use of LP3 or LP4)

Spectral Element

Enter a spectral element from Table 11.5: *COS Spectral Elements and Central Wavelengths* for the COS/FUV configuration.

Wavelength

Enter the value of the central wavelength in Angstroms. Table 11.5: *COS Spectral Elements and Central Wavelengths* gives the allowed values of the central wavelength for each grating. Table 11.6: Additional configurations offered in AVAILABLE mode lists the AVAILABLE G130M and G160M central wavelengths that are not offered in SUPPORTED mode.

Optional Parameters

SEGMENT

= BOTH (default except for these cases: G140L/1105, G140L/800 and G130M/1300, 1309, 1318, 1327 at LIFETIME-POS=LP4 and LP5)
= A (default and only allowed value for these cases: G140L/1105, G140L/800 and G130M/1300, 1309, 1318, 1327 at LIFETIME-POS=LP4 and LP5)
= B (not permitted for G140L/1230)

This is the same as in **TIME-TAG** Mode. See *Optional Parameters*.

EXTENDED
= NO (default), YES

Indicated whether the target is an extended source. This parameter is still in APT, but has been functionally replaced by the **EXTENDED** target parameter. Selecting this parameter will only trigger a warning message asking you to set the TARGET description parameter instead. This exposure-level parameter should not be selected for any Cycle 23 proposals and beyond. Please see the description in Target Extent.

FP-POS
= ALL, 1, 2, 3 (pre-Cycle 19 default), 4

This optional parameter is required for external and WAVE targets. It specifies whether to take the exposure at a single offset, at multiple offsets, or at no offset from the nominal central wavelength. Obtaining exposures at small wavelength offsets from the specified central wavelength aids in the correction of the fixed-pattern defects of the detector. For the best data quality, we strongly recommend using all four FP-POS positions (ALL), except for G130M/1291 when SEGMENT = B or BOTH, where only FP-POS = 3, 4 are allowed. And when LIFETIME-POS=LP6 is specified (or is the default) it is permitted to use fewer than 4 FP-POS based on the S/N of the observations (see Chapter 9 of the *COS Instrument Handbook*). Table 11.1: *Supported settings for FUV ACCUM and TIME- TAG exposures* for more information.

FP-POS=**All** indicates that the specified exposure time will be the exposure time for each **FP-POS** position.

The values **FP-POS=1, 2** or **4** will result in the exposure being taken at an offset from the specified central wavelength. **FP-POS=3** will result in the exposure being obtained at the nominal central wavelength (i.e., at a zero offset). The exposure will be for the specified exposure duration. See the *COS Instrument Handbook* for specifics of the offsets and for guidance on how to use this capability.

Restricted

Since the settings **FP-POS=4** or **ALL** and spectral element/wavelength of **G140L**/1230 Å places zero-order light on segment B, the use of this combination of settings must be strongly justified.

WAVECAL (Restricted)
= YES (default), NO

Indicates whether automatic wavelength calibrations should be performed for this exposure specification. **WAVECAL=NO** should not be present unless explicit approval from the contact scientist has been received.

STIM-RATE (Restricted)
= DEF (default), 0, 2, 30, 2000

This is the same as in **TIME-TAG** Mode; see *Mode = TIME-TAG Config = COS/FUV*.

Available

LIFETIME-POS (Available)
= DEF (default), LP1, LP2, LP3, LP4,LP5, LP6, LP7, LP8

Specifies which FUV lifetime adjustment position (LP) to use for this exposure. This Optional Parameter can be set in **RESTRICTED** or **AVAILABLE** mode, and is required in both cases if **SPECTRAL ELEMENT = G130M**, **G160M** or **G140L**. For G130M it may take the value LP2, LP3, LP4 or LP5 depending on the **WAVELENGTH** setting. For G160M, LP4 and LP6 are the options in AVAILABLE mode. For G140L, LP3 is the only option in AVAILABLE mode. For further details see 11.1 *Introduction to COS* article.

Number of Iterations

Enter the number of times this exposure should be iterated, and the exposure time (**Time_Per_Exposure**) per iteration.

Time Per Exposure

Time_Per_Exposure must be an integral multiple of 0.1 seconds (if it is not, its value will be rounded down to the next lower integral multiple of 0.1 sec, or set to 0.1 seconds if a smaller value is specified), and may range from 0.1 to 6500 seconds. Values much larger than 3000 seconds are normally appropriate only for visits with the **CVZ** special requirement.

Note: **ACCUM** Mode exposures longer than 900 seconds using the **G130M** or **G160M** gratings may blur the FUV spectra by 1-2 pixels (~1/6 to 1/3 of a resolution element) due to wavelength dependent deviations from the mean Doppler correction.

Expand/Collapse all...

Related Links

11.3.2 COS NUV Observing Modes

Change Log

Version Cycle 31 August 2023

Correction from COS team

Version Cycle 30 April 2022

PROPINST-91380 Document COS FUV Lifetime Position 6

Version Cycle 29 May 2021

Worked on comments from the COS team related to the changes for LP5.

Version Cycle 29 April 2021

1. PROPINST-91377 APT requirements for supporting COS FUV Lifetime Position 5

11.3.2 COS NUV Observing Modes

Observations with HST's COS instrument can be done with the NUV detector, and the Astronomer's Proposal Tool (APT) has parameters for specifying these observations.

Expand/Collapse all...

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

There is one detector on COS that can be used to obtain near-ultraviolet data, and that is the NUV.

Mode = TIME-TAG Config = COS/NUV

In **TIME-TAG** mode, the COS detectors produce an event stream with a time resolution of 32 millisec. The X and Y pixel coordinates of each photon event are stored in a 32-bit word in data buffer memory. At the start of an exposure, and after every subsequent 32 millisec interval which contains photons events, a 32-bit time-of-day word is written to the data memory.

Aperture or FOV

Allowed apertures for this mode are:

- **PSA:** Primary Science Aperture
- **BOA**: Bright Object Aperture
- **WCA** Wavelength Calibration Aperture; required for Target=**WAVE**
- **FCA** Flat-field Calibration Aperture; required for Target=**DEUTERIUM**

Spectral Element

See Table 11.5: *COS Spectral Elements and Central Wavelengths*.

Wavelength

Enter the value of the central wavelength in Angstroms. Table 11.5: *COS Spectral Elements and Central Wavelengths* gives the allowed values of the central wavelength for each grating.

Note: No wavelength should be specified if **MIRRORA** or **MIRRORB** is the Spectral Element.

Optional Parameters

= 80 or greater (integer seconds)

Specifies the estimated minimum time in which 2.35×10^6 photon events (half of the COS data buffer capacity) will be accumulated during a **TIME-TAG** exposure. **BUFFER-TIME** is a required parameter if the target is not **WAVE**. If the target is **WAVE**, then **BUFFER-TIME** may not be specified unless the proposal is a calibration or engineering.

If the predicted total number of events from a **TIME-TAG** exposure exceeds the COS data buffer capacity of 4.7×10^6 photon events, data must be transferred to the HST onboard science recorder during the exposure. Transfers of data from the COS buffer during an exposure will be made in 9-MByte blocks (half the buffer capacity). The value of **BUFFER-TIME** should be the half-buffer capacity (2.35×10^6 counts) divided by the estimated maximum average count rate in photons per second.

Note that **BUFFER-TIME** should include expected counts from the detector dark current (see the *COS Instrument Handbook*) as well as the detected photon events, factoring in the instrument quantum efficiency. A conservative value of **BUFFER-TIME** is recommended (err slightly on the low side) to avoid data loss.

The absolute minimum **BUFFER-TIME** of 80 seconds corresponds to a maximum average count rate of ~30,000 counts/sec over the entire detector, which is the maximum rate at which the flight software is capable of processing counts.

EXTENDED
= NO (default), YES

Indicated whether the target is an extended source. This parameter is still in APT, but has been functionally replaced by the **EXTENDED** target parameter. Selecting this parameter will only trigger a warning message asking you to set the TARGET description parameter instead. This exposure-level parameter should not be selected for any Cycle 23 proposals and beyond. Please see the description in Target Extent.

FP-POS
= ALL, 1, 2, 3 (pre-Cycle 19 default), 4

This optional parameter is **required** for external and **WAVE** targets. It specifies whether to take the exposure at a single offset, at multiple offsets, or at no offset from the nominal central wavelength. Obtaining exposures at small wavelength offsets from the specified central wavelength aids in the correction of the fixed-pattern defects of the detector. For the best data quality, we recommend using all four **FP-POS** positions (**ALL**).

FP-POS=**ALL** indicates that the specified exposure time will be the exposure time for each **FP-POS** position.

The values **FP-POS=1, 2** or **4** will result in the exposure being taken at an offset from the specified central wavelength. **FP-POS=3** will result in the exposure being obtained at the nominal central wavelength (i.e., at a zero offset). The exposure will be for the specified exposure duration. See the *COS Instrument Handbook* for specifics of the offsets and for guidance on how to use this capability.

Note: **FP-POS** is not allowed to be specified when the spectral element is **MIRRORA** or **MIRRORB**.

Note: for internal targets: **FP-POS** is not allowed for internal targets except Target=**WAVE** and **DEUTERIUM**. Allowed values for exposures with Target=**WAVE** and **DEUTERIUM** are **FP-POS=1, 2, 3** or **4**.

FLASH
= YES (default), NO, SnnnnDmmm

Indicates whether or not to "flash" the wavelength calibration lamp during exposures. These flashes are needed to compensate for the effect of post-move drift of the Optic Select Mechanisms. The default behavior will be that the wavecal lamp is turned on briefly at the start of an externally targeted exposure, and at intervals later in the exposure. The grating-dependent "flash" durations and the time-since-move-dependent flash intervals will be defined by the STScI. Specifying the value **NO** will disable automatic flashing for the current exposure.

Note: **FLASH** is not allowed to be specified (and defaults to **NO**) when the spectral element is **MIRRORA** or **MIRRORB** unless this is a calibration or engineering proposal, or the aperture is BOA.

When flashing is enabled, the exposure time must be at least as long as a single flash. Flash durations, as functions of grating and central wavelength, are given in table Table 11.8: *WAVECAL Exposure Parameters*.

Restricted

Engineering and calibration proposals may also specify a 9 character string, **SnnnnDmmm**, where **nnnn** is a four digit value for the separation between flash starts and **mmm** is a three digit value for the duration of each flash. Both values are in seconds; **nnnn** must be at least 2 seconds and **nnnn** must be greater than **mmm** by at least 2 seconds.

Engineering and calibration proposals may also specify **FLASH** with the **WAVE** target. This will produce an exposure of the requested exposure time, but with a standard flash sequence rather than having the wavelength calibration lamp on for the entire exposure. The default value of **FLASH** is **NO** when the target= **WAVE**.

WAVECAL
= YES (default), NO

Indicates whether automatic wavelength calibrations should be performed for this exposure specification. **WAVECAL=NO** should not be present unless explicit approval from the contact scientist has been received.

CURRENT (Restricted)

= DEF (default), LOW, MEDIUM, HIGH

Specifies the current setting to be used with the calibration lamp. **DEF** will provide the default current for the spectral element and central wavelength specified for the exposure. See Table 12.7 for default values.

If Target=**DEUTERIUM**, **CURRENT** must be specified and cannot be **DEF**.

If **TARGET=WAVE**, **CURRENT=HIGH** is not permitted and **CURRENT=MEDIUM** is not permitted if the spectral element is **MIRRORA**.

Number of Iterations

Number_Of_Iterations must be **1** in this Mode.

Time Per Exposure

Enter the total time of data collection as **Time_Per_Exposure. Time_Per_Exposure** must be an integral multiple of 0.1 seconds (if it is not, its value will be rounded down to the next lower integral multiple of 0.1 sec, or set to 0.1 seconds if a smaller value is specified), and may range from 0.1 to 6500 seconds. Values much larger than 3000 seconds are normally appropriate only for visits with the CVZ special requirement.

For Target=**WAVE**, enter **DEF** for **Time_Per_Exposure**. Engineering and calibration proposals may specify a value for **Time_Per_Exposure**, subject to the restrictions defined above.

If **BUFFER-TIME** < 110 seconds, photon events may be generated faster than data can be transferred out of the buffer during the exposure. In this case, **Time_Per_Exposure** should be less than or equal to 2 * **BUFFER-TIME** so that the exposure can complete before data transfer is necessary. A **BUFFER-TIME** of 110 seconds corresponds to an average count rate of ~21,000 counts/sec.

*Note:***TIME-TAG** exposures have the potential to rapidly use up the HST onboard storage capacity. Caution is advised on any exposure with an exposure time greater than 25 * **BUFFER-TIME**, which corresponds to ~6 × 10^7 counts, or about 2 GBits (close to 20% of the solid-state recorder capacity).

Special Requirements

The special requirement **RT ANALYSIS** is not permitted on **TIME-TAG** exposures.

Mode = ACCUM Config = COS/NUV

In **ACCUM** Mode, the detector coordinates of each photon event are used to reference a 16-bit word in a memory array, which is incremented, as each event occurs. An **ACCUM** mode image in the COS /NUV configuration is 1024 × 1024 pixels. The COS data buffer can hold 9 such images. **ACCUM** should be used only when absolutely necessary, such as for high count-rate targets. **TIME-TAG** is the recommended data-taking mode unless the target's brightness leads to a total count rate in excess of that possible with this mode.

Aperture or FOV

The following apertures are allowed:

PSA Primary Science Aperture

BOA Bright Object Aperture

Spectral Element

Enter a spectral element from Table 11.5: *COS Spectral Elements and Central Wavelengths* for the COS/NUV configuration.

Wavelength

Enter the value of the central wavelength in Angstroms. Table 11.5: *COS Spectral Elements and Central Wavelengths* gives the allowed values of the central wavelength for each grating.

Note: No wavelength should be specified if **MIRRORA** or **MIRRORB** is the spectral element.

Optional Parameters

EXTENDED
= NO (default), YES

Indicated whether the target is an extended source. This parameter is still in APT, but has been functionally replaced by the **EXTENDED** target parameter. Selecting this parameter will only trigger a warning message asking you to set the TARGET description parameter instead. This exposure-level parameter should not be selected for any Cycle 26 proposals and beyond. Please see the description in Target Extent .

FP-POS
= ALL, 1, 2, 3 (pre-Cycle 19 default), 4

This optional parameter is **required** for external and **WAVE** targets. It specifies whether to take the exposure at a single offset, at multiple offsets, or at no offset from the nominal central wavelength. Obtaining exposures at small wavelength offsets from the specified central wavelength aids in the correction of the fixed-pattern defects of the detector. For the best data quality, we recommend using all four **FP-POS** positions (**ALL**).

FP-POS=**ALL** indicates that the specified exposure time will be the exposure time for each **FP-POS** position.

The values **FP-POS**=**1, 2** or **4** will result in the exposure being taken at an offset from the specified central wavelength. **FP-POS**=**3** will result in the exposure being obtained at the nominal central wavelength (i.e., at a zero offset). The exposure will be for the specified exposure duration. See the *COS Instrument Handbook* for specifics of the offsets and for guidance on how to use this capability.

Note: **FP-POS** is not allowed to be specified when the spectral element is **MIRRORA** or **MIRRORB**.

Restricted

WAVECAL (Restricted)
= YES (default), NO

Indicates whether automatic wavelength calibrations should be performed for this exposure specification. **WAVECAL=NO** should not be present unless explicit approval from the contact scientist has been received.

Number of Iterations

Enter the number of times this exposure logsheet line should be iterated, and the exposure time (**Time_Per_Exposure**) per iteration.

Time Per Exposure

Time_Per_Exposure must be an integral multiple of 0.1 seconds (if it is not, its value will be rounded down to the next lower integral multiple of 0.1 sec, or set to 0.1 seconds if a smaller value is specified), and may range from 0.1 to 6500 seconds. Values much larger than 3000 seconds are normally appropriate only for visits with the CVZ special requirement.

Expand/Collapse all...

Related Links

[11.3.1 COS FUV Observing Modes](#)

Change Log
Version Cycle 30 May 2022

Made edits and corrections suggested by the COS team.

11.4 COS Restricted Engineering Modes

HST's COS instrument can obtain data necessary for instrument maintenance, and the Astronomer's Proposal Tool (APT) has parameters for specifying these observations.

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Format definitions

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⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Mode = ALIGN/APER Config = COS

This Mode is used to move the COS aperture mechanism via stored commanding for the purpose of on-orbit alignment of the aperture to the light path. **ALIGN/APER** exposures do not acquire science data and must be interleaved with science mode exposures to obtain data, with the aperture mechanism at a variety of positions for the ground alignment process. The values of the Optional Parameters specify the position of the aperture plate in motor steps in two dimensions, relative to a nominal zero position.

The mechanism positions at nominal zero will be set via real-time command. This allows a preplanned scan of the aperture mechanism to be specified without knowledge of where in the mechanism range the scan will be executed. Since the absolute positions are set in real time, a check that the specified offsets relative to nominal zero do not violate the mechanism range limits cannot be performed by the ground system. The proposer is responsible for ensuring that the aperture mechanism remains within its allowed limits at all times. If an attempt is made to command the mechanism beyond allowed limits, the flight software will reject the request and the mechanism will not be moved. Note that for relative moves in a non-preferred direction, a certain number of additional steps must be reserved for "overshoot" commanding.

Separate nominal zero positions are defined for each aperture. The first **ALIGN/APER** exposure in a visit should normally be preceded by a science mode exposure which selects the aperture; if this is not done, the aperture mechanism will start at the PSA position. If a science mode exposure is used to specify a different aperture from previous science exposures in the visit, the aperture mechanism will be placed at the nominal zero position for the new aperture and any offsets from previous **ALIGN /APER** exposures will be lost.

Target Name

The special value **NONE** must be specified.

Aperture or FOV

Do not enter a value.

Spectral Element

Do not enter a value.

Wavelength

Do not enter a value.

Optional Parameters

Note that no Optional Parameters may be used with **ALIGN/APER** mode when the **REQ UPLINK** Special Requirement is used.

XAPER (Restricted)

= 0 (default); -560 to +560 (steps)

Specifies the relative position from a nominal zero position of the COS aperture mechanism X (cross-dispersion axis) position, in motor steps. The absolute position of the nominal zero is set via real-time command.

YAPER (Restricted)

= 0 (default); -200 to +200 (steps)

Specifies the relative position from a nominal zero position of the COS aperture mechanism Y (dispersion axis) position, in motor steps. The absolute position of the nominal zero is set via real-time command.

Note: If a particular position for the aperture mechanism is needed for a series of **ALIGN/APER** exposures, the appropriate parameters (**XAPER** and/or **YAPER**) must be specified with the same value on every **ALIGN/APER** exposure in the series. If either parameter is specified on an **ALIGN/APER** exposure and then omitted on the subsequent exposure, the mechanism position in the corresponding dimension will be moved back to nominal zero.

Number of Iterations

The **Number_Of_Iterations** must be **1**.

Time Per Exposure

Proposers may specify a positive value of **Time_Per_Exposure** to provide for additional time after the move has completed to wait prior to the start of the subsequent COS exposure. This time may be desirable if, for instance, the mechanism move could adversely affect the thermal environment (due to running the motors) and a cool-down time is required before the science exposure. If no wait is needed, enter 0 seconds.

Special Requirements

An **ALIGN/APER** (or **ALIGN/OSM**) Mode exposure with the **REQ**uires **UPLINK** special requirement is used as a placeholder for real-time commanding to uplink new nominal zero positions. The mechanisms will be moved to their home positions at the end of this exposure, so no mechanism moves need be commanded in real-time to begin using the newly-uplinked nominal position(s).

Mode = ALIGN/OSM Config = COS

This Mode is used to move the COS **OSM1** and **OSM2** mechanisms via stored commanding for purposes of optimizing the distance between the gratings and the secondary mirror, and positioning the gratings with respect to the detectors. **ALIGN/OSM** exposures do not acquire science data and must be interleaved with science mode exposures to obtain data, with the OSMs at a variety of positions for the ground alignment process. The values of the Optional Parameters specify the positions of the **OSM1** focus and the **OSM1** and **OSM2** rotational mechanisms in motor steps, relative to a nominal zero position.

The mechanism positions at nominal zero will be set via real-time command. This allows a preplanned scan of a mechanism's position to be specified without knowledge of where in the mechanism range the scan will be executed. Although the **OSM1** and **OSM2** rotational mechanisms have unlimited rotation, the **OSM1** focus mechanism has range limits. Since the absolute positions are set in real time, the ground system cannot check that the specified offset relative to nominal zero does not violate the mechanism range limits.

The proposer is responsible for ensuring that the **OSM1** focus mechanism remains within its allowed limits at all times. If an attempt is made to command the focus mechanism beyond allowed limits, the flight software will reject the request and the mechanism will not be moved. Note that for relative moves in a non-preferred direction, a certain number of additional steps must be reserved for "overshoot" commanding.

Separate nominal zero positions for the **OSM1** focus and rotational mechanisms are defined for each **FUV** grating and central wavelength, as well as for the **NCM1** mirror which is used with the **NUV** channel. Similarly, separate nominal zero positions for the **OSM2** rotational mechanism are defined for each **NUV** grating and central wavelength, as well as for the two mirror positions. The first **ALIGN /OSM** exposure in a visit should normally be preceded by a science mode exposure which selects the spectral element and wavelength. If this is not done, the mechanisms will begin from their default positions: the **G130M** grating at **1222** angstroms for **OSM1**, and MIRRORA for **OSM2**. If a science mode exposure is used to specify a different spectral element or central wavelength from previous science mode exposures in the visit, the proposer should first remove the existing mechanism offsets by inserting an **ALIGN/OSM** exposure with zero offsets (focus and rotation) before the grating/central wavelength change. If this procedure is not followed, there may be timing problems in the resulting command sequence. The science mode exposure with the different spectral element or central wavelength will then be executed with the mechanism placed at the nominal position for that spectral element/ central wavelength. Note that it is not possible to cycle through gratings while retaining offsets to the **OSM1** focus position.

Target Name

The special value NONE must be specified.

Aperture or FOV

Do not enter a value.

Spectral Element

Do not enter a value.

Wavelength

Do not enter a value.

Optional Parameters

Note that no Optional Parameters may be used with **ALIGN/APER** mode when the **REQ UPLINK** Special Requirement is used.

FOCUS (Restricted)

= 0 (default); -2200 to +2000 (steps)

Specifies the relative position from a nominal zero position of the COS **OSM1** "z" focus position relative to the HST secondary mirror, in motor steps. The absolute position of the nominal zero is set via real-time command.

OSM1ROT (Restricted)

= 0 (default); -600 to +600 (steps)

Specifies the relative position from a nominal zero position of the COS **OSM1** rotational mechanism, in motor steps. The absolute position of the nominal zero is set via real-time command.

OSM2ROT (Restricted)

= 0 (default); -700 to +700 (steps) (TBR)

Specifies the relative position from a nominal zero position of the COS **OSM2** rotational mechanism, in motor steps. The absolute position of the nominal zero is set via real-time command.

Note: If a particular position for any of these mechanisms is needed for a series of **ALIGN/OSM** exposures, the appropriate parameter (**FOCUS**, **OSM1ROT**, or **OSM2ROT**) must be specified with the same value on every **ALIGN/OSM** exposure in the series. If any parameter is specified on an **ALIGN/OSM** exposure and then omitted on the subsequent exposure, the corresponding mechanism position will be moved back to nominal zero.

Number of Iterations

The **Number_Of_Iterations** must be **1**.

Time Per Exposure

Proposers may specify a positive value of **Time_Per_Exposure** to provide for additional time after the move has completed to wait prior to the start of the subsequent COS exposure. This time may be desirable if, for instance, the mechanism move could adversely affect the thermal environment (due to running the motors) and a cool-down time is required before the science exposure. If no wait is needed, enter **0** seconds.

Special Requirements

An **ALIGN/OSM** (or **ALIGN/APER**) Mode exposure with the **REQ**uires **UPLINK** special requirement is used as a placeholder for real-time commanding to uplink new nominal zero positions. The mechanisms will be moved to their home positions at the end of this exposure, so no mechanism moves need be commanded in real-time to begin using the newly-uplinked nominal position(s).

Change Log

Version Cycle 29 May 2021

Worked on comments from the COS team related to OSM1 and OSM2 default mechanism positions.

11.5 COS Reference Information

This article contains reference information for COS.

Sections

- 11.5.1 COS Internal Calibration Targets
- 11.5.2 COS Spectral Elements and Central Wavelengths
- 11.5.3 COS Apertures
- 11.5.4 COS WAVECAL Exposure Parameters
- 11.5.5 COS Coordinate System

11.5.1 COS Internal Calibration Targets

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Format definitions

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Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Table 11.4: Internal Calibration Targets for COS

Target Name	Mode	Description	Aperture and Spectral Element
WAVE [1]	TIME-TAG	A wavelength calibration exposure for the grating and central wavelength being used for the spectroscopic science observations. The number of iterations must be 1.	Aperture = **WCA**, Spectral Element = Any element from Table 11.5: *COS Spectral Elements and Central Wavelengths*[2] except **MIRRORA** and **MIRRORB**

[1] Exposures specified with the **WAVE** internal target will use the same calibration lamp configuration and exposure time as the automatic wave calibrations discussed below (based on the spectral element and central wavelength used). If **Time_Per_Exposure** is not specified as **DEF**, the specified exposure time will be used. To avoid overuse of the line lamps, the exposure time should not exceed 5 minutes.

Unless specifically requested in the Exposure Specification, a **TIME-TAG** Mode wavelength calibration will be automatically performed for each set of external spectrographic science exposures using the same spectral element, central wavelength, and OSM offset, including each subexposure of an exposure specification with optional parameter **FP-POS=ALL**. A wavelength calibration exposure will be added prior to the first such science exposure and after each subsequent science exposure if more than 40 minutes of orbital visibility time have elapsed since the previous wavelength calibration exposure. The calibration lamp configuration and exposure time will be based on the grating and central wavelength of the science exposure. For a detailed description of wavelength calibration exposures, see the *COS Instrument Handbook*. The automatic addition of wavecals may be disabled using the **WAVECAL** parameter.

[2] **DEF** = same as the prior or subsequent spectroscopic science observation (i.e., if no element is specified, then the previously used one is assumed. **MIRRORA** or **MIRRORB** may be used in engineering programs.

Restricted Table 11.4 (cont)

Table 11.4: Internal Calibration Targets for COS

Target Name	Mode	Description	Aperture and Spectral Element
DEUTERIUM (Restricted)	TIME-TAG	An exposure taken with the deuterium flat-field lamp. The number of iterations must be 1.	Aperture = **FCA**, Spectral Element = Any element from Table 11.5: *COS Spectral Elements and Central Wavelengths* except **MIRRORA** and **MIRRORB**
DARK (Restricted)	TIME-TAG only	An exposure taken with the detector shuttered from external light to measure the detector dark current.	DEF[3]

[3] **DEF** = no change from previous exposure. If the visit does not contain a prior COS exposure on a non-**DARK** target, STScI will assign a default aperture, spectral element and wavelength. For the COS/FUV configuration, the default aperture is **PSA**, the default spectral element is **G130M**, and the default central wavelength is 1222. For the COS/NUV configuration, the default aperture is **PSA**, the default spectral element is **MIRRORA**. **DEF** should be specified for the aperture and spectral element, while the central wavelength should be left blank.

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Related Links

11.5.2 COS Spectral Elements and Central Wavelengths
11.5.3 COS Apertures
11.5.4 COS WAVECAL Exposure Parameters
11.5.5 COS Coordinate System

Change Log

Version Cycle 29 May 2021

Worked on correctinos from the COS team in the restricted section.

11.5.2 COS Spectral Elements and Central Wavelengths

This article lists the legal COS spectral element/wavelength combinations for the COS/FUV and COS/NUV configurations.

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Format definitions

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Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

The following table specifies the legal COS spectral element/wavelength combinations for the COS/FUV and COS/NUV configurations. For information on the Lifetime Positions used for each central wavelength see Table 11.1 Supported settings for FUV ACCUM and TIME-TAG exposures):

Table 11.5: COS Spectral Elements and Central Wavelengths

Configuration	Spectral Element	Central Wavelengths (Angstroms)
COS/FUV	G130M	1055[1], 1096[1], 1222[1], 1291, 1300, 1309, 1318, 1327
	G140L	800[1], 1105, 1230, 1280
	G160M	1533[1], 1577, 1589, 1600, 1611, 1623
COS/NUV[2]	G185M	**1786**, 1817, 1835, 1850, 1864, 1882, 1890, 1900, **1913**, **1921**, **1941,**1953, 1971, 1986, 2010

G225M	2186, 2217, 2233, **2250**, 2268, **2283**, **2306**, 2325, 2339, 2357, 2373, 2390, 2410
G230L	**2635**, **2950**, **3000**, **3360**
G285M	2617, 2637, 2657, 2676, 2695, 2709, 2719, 2739, 2850, 2952, 2979, 2996, 3018, 3035, 3057, 3074, 3094
MIRRORA[3]	N/A
MIRRORB[4]	N/A

[1]Target acquisition modes are not allowed with this central wavelength.

[2]Due to increased COS NUV detector background and mechanism position uncertainties, certain central wavelength settings have proven to be unreliable in the **NUV ACQ/PEAKXD** target acquisition phase. The central wavelengths settings that appear in **bold** are the preferred central wavelengths for **STRIPE=DEF NUV ACQ/PEAKXD** exposure. See the *COS Instrument Handbook* and Mode = ACQ/PEAKD Config = COS/NUV for more details.

[3]The **MIRRORA** spectral element positions a flat mirror in the beam to produce an image of the sky with a field of view slightly larger than the diameter of the aperture. If you intend to produce an image and there are no special bright object concerns, **MIRRORA** should be used. Restricted for wavecals and forbidden for flats.

[4]**MIRRORB** uses the same mirror which has an order-blocking filter in front of it, so that the light is reflected off the front surface of the filter rather than the mirror itself. **MIRRORB** attenuates the image and is suitable for use with bright objects. Restricted for wavecals and forbidden for flats.

For available but unsupported Configurations at non default lifetime positions

Table 11.6: Additional configurations offered in AVAILABLE mode.

(Note that while these G130M/LP3 combinations and G160M/1533 are AVAILABLE for **TIME-TAG** and **ACCUM** modes, they are not AVAILABLE for spectroscopic ACQs.)

Spectral Element	Central Wavelength (A)	LIFETIME-POS	Available for ACQs?	SEGMENT (DEFAULT)	FP-POS
G130M	1291	LP3	No	A, B, **BOTH**	1, 2, 3, 4, ALL
G130M	1300	LP3	No	A, B, **BOTH**	1, 2, 3, 4, ALL
G130M	1309	LP3	No	A, B, **BOTH**	1, 2, 3, 4, ALL
G130M	1318	LP3	No	A, B, **BOTH**	1, 2, 3, 4, ALL
G130M	1327	LP3	No	A, B, **BOTH**	1, 2, 3, 4, ALL
G160M	1533	LP4	No	A, B, **BOTH**	1, 2, 3, 4, ALL
G160M	1577	LP4	Yes	A, B, **BOTH**	1, 2, 3, 4, ALL
G160M	1589	LP4	Yes	A, B, **BOTH**	1, 2, 3, 4, ALL
G160M	1600	LP4	Yes	A, B, **BOTH**	1, 2, 3, 4, ALL
G160M	1611	LP4	Yes	A, B, **BOTH**	1, 2, 3, 4, ALL
G160M	1623	LP4	Yes	A, B, **BOTH**	1, 2, 3, 4, ALL

Related Links

11.5.1 COS Internal Calibration Targets
11.5.3 COS Apertures
11.5.4 COS WAVECAL Exposure Parameters
11.5.5 COS Coordinate System

Change Log

Version Cycle 31 June 2023

Removed old PR link from Change Log.

Version Cycle 30 April 2022

PROPINST-91380 Document COS FUV Lifetime Position 6

Version Cycle 29 May 2021

Worked on comments from the COS team related to the changes for LP5.

Version Cycle 29 April 2021

1. PROPINST-91377 APT requirements for supporting COS FUV Lifetime Position 5
2. PROPINST-89772 Remove c1223 from Proposal Instructions (From Cycle 26)

Version Cycle 26 October 2018

1. PR.89179 Remove COS 1223 cenwave from user accessibility
   11.5.2 COS Spectral Elements and Central Wavelengths
2. PR.89772 Remove c1223 from Proposal Instructions
   11.5.2 COS Spectral Elements and Central Wavelengths

Initial Conversion from the HST Cycle 25 Phase II Proposal Instructions (Engineering) Version Cycle 25 (June 2018)

11.5.3 COS Apertures

There are a few apertures available for HST's COS detectors, and this articles describes those apertures.

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Format definitions

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Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Valid COS apertures are listed in Table 11.7: *COS Apertures*. Science observations should use the **PSA** or **BOA** apertures. The **BOA** aperture is the same size as the **PSA** but contains a neutral-density filter that attenuates the source by a factor of ~200. The WCA is intended for wavelength calibrations using the WAVE target.

Table 11.7: COS Apertures

Aperture	Definition	Size	Usage
PSA	Primary Science Aperture	2.5 arc-seconds	Default science aperture
BOA	Bright Object Aperture	2.5 arc-seconds	Contains neutral density filter (ND2) for bright objects Not permitted for grating/wavelength combinations that default to lifetime position LP5 or LP6 ; those need to request use of LP3 or LP4 respectively.

WCA	Wavelength Calibration Aperture	20 microns (dispersion) × 100 microns (cross-dispersion)	Wavelength Calibrations

Restricted FCA

The FCA is to be used with the DEUTERIUM target for flat-field exposures.

Aperture	Definition	Size	Usage
FCA	Flat-Field Calibration Aperture	0.75 mm × 1.75 mm	Flat field Calibrations with the deuterium lamp

Related Links

11.5.1 COS Internal Calibration Targets
11.5.2 COS Spectral Elements and Central Wavelengths
11.5.4 COS WAVECAL Exposure Parameters
11.5.5 COS Coordinate System

Change Log

Version Cycle 30 April 2022

PROPINST-91380 Document COS FUV Lifetime Position 6

11.5.4 COS WAVECAL Exposure Parameters

This article lists the exposure times and current settings for the wavelength calibration lamp exposures as a function of spectral element and central wavelength.

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Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Table 11.8: *WAVECAL Exposure Parameters* lists the exposure times and current settings for the wavelength calibration lamp exposures as a function of spectral element and central wavelength.

Table 11.8: WAVECAL Exposure Parameters

Grating	Central Wavelength	Lamp Current Specification	Exposure Time (seconds)[1]	BUFFER TIME (sec)	Flash Duration (sec)
G130M	1055	**MEDIUM**	142	510	142
	1096	**MEDIUM**	52	180	52
	1222	**MEDIUM**	52	120	52
	1291	**MEDIUM**	12	120	12
	1300	**MEDIUM**	12	120	12
	1309	**MEDIUM**	12	120	12
	1318	**MEDIUM**	12	120	12
	1327	**MEDIUM**	12	120	12

G160M	1533	**MEDIUM**	12	120	12
	1577	**MEDIUM**	12	120	12
	1589	**MEDIUM**	12	120	12
	1600	**MEDIUM**	12	120	12
	1611	**MEDIUM**	12	120	12
	1623	**MEDIUM**	12	120	12
G140L	800	**MEDIUM**	7	120	7
	1105	**MEDIUM**	7	120	7
	1230	**MEDIUM**	7	120	7
	1280	**MEDIUM**	7	120	7
G185M	1786	**MEDIUM**	12	220	12
	1817	**MEDIUM**	12	220	12
	1835	**MEDIUM**	12	240	12
	1850	**MEDIUM**	22	180	22
	1864	**MEDIUM**	32	180	32
	1882	**MEDIUM**	17	120	17
	1890	**MEDIUM**	12	120	12
	1900	**MEDIUM**	22	140	22
	1913	**MEDIUM**	17	140	17
	1921	**MEDIUM**	12	140	12
	1941	**MEDIUM**	12	180	12
	1953	**MEDIUM**	17	180	17
	1971	**MEDIUM**	17	180	17
	1986	**MEDIUM**	12	180	12
	2010	**MEDIUM**	12	180	12
G225M	2186	**MEDIUM**	7	120	7
	2217	**MEDIUM**	12	120	12
	2233	**MEDIUM**	7	120	7
	2250	**MEDIUM**	22	120	22

	2268	**MEDIUM**	12	120	12
	2283	**MEDIUM**	12	120	12
	2306	**MEDIUM**	12	120	12
	2325	**MEDIUM**	12	280	12
	2339	**MEDIUM**	12	280	12
	2357	**MEDIUM**	12	240	12
	2373	**MEDIUM**	22	240	22
	2390	**MEDIUM**	7	240	7
	2410	**MEDIUM**	7	280	7
G285M	2617	**MEDIUM**	12	300	12
	2637	**MEDIUM**	12	300	12
	2657	**MEDIUM**	7	300	7
	2676	**MEDIUM**	22	300	22
	26 95	**MEDIUM**	22	330	22
	2709	**MEDIUM**	12	330	12
	2719	**MEDIUM**	7	330	7
	2739	**MEDIUM**	7	430	7
	2850	**MEDIUM**	22	430	22
	2952	**MEDIUM**	7	430	7
	2979	**MEDIUM**	17	430	17
	2996	**MEDIUM**	17	140	17
	3018	**MEDIUM**	22	140	22
	3035	**MEDIUM**	27	160	27
	3057	**MEDIUM**	32	160	32
	3074	**MEDIUM**	32	160	32
	3094	**MEDIUM**	32	160	32
G230L	2635	**MEDIUM**	7	100	7
	2950	**MEDIUM**	7	180	7
	3000	**MEDIUM**	7	180	7

	3360	MEDIUM	12	140	12
MIRRORA	N/A	LOW	7	80	7
MIRRORB	N/A	MEDIUM	12	80	12

[1] Based on Kenneth Sembach, "Cosmic Origins Spectrograph PtNe Wavelength Calibration Exposure Times," COS Technical Instrument Report 2006-01 (v1)

Related Links

11.5.1 COS Internal Calibration Targets
11.5.2 COS Spectral Elements and Central Wavelengths
11.5.3 COS Apertures
11.5.5 COS Coordinate System

Change Log

Version Cycle 29 April 2021

1. PROPINST-89772 Remove c1223 from Proposal Instructions (From Cycle 26)

11.5.5 COS Coordinate System

COS is located off-axis in the focal plane of HST. This article shows how the detector reference frame compares to HST's U2, U3 reference frame.

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Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Knowledge of the COS coordinate system relative to the spacecraft coordinate system is necessary to use the "**POSition TARGet <X-value>,<Y-value>**" Special Requirement properly. Figure 11.1: *COS Aperture Coordinate System* shows the sense of the U2, U3, V2, and V3 axes relative to the COS aperture.

Figure 11.1: COS Aperture Coordinate System
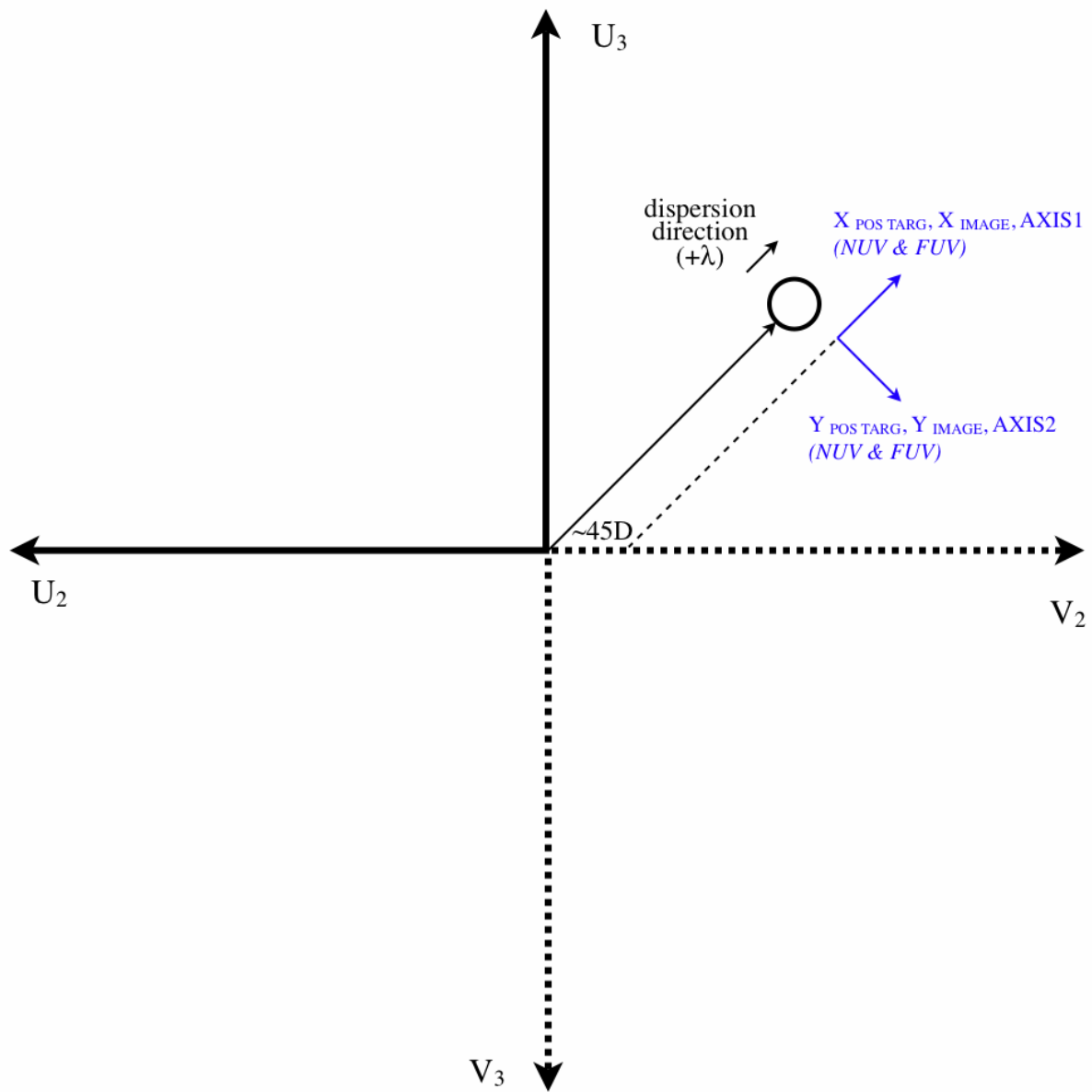
Related Links

[11.5.1 COS Internal Calibration Targets](#)
[11.5.2 COS Spectral Elements and Central Wavelengths](#)
[11.5.3 COS Apertures](#)
[11.5.4 COS WAVECAL Exposure Parameters](#)

Change Log

None

Chapter 12 Wide Field Camera 3, WFC3

The Wide Field Camera 3 (WFC3) is one of the scientific instruments on HST, and this article contains instructions for how to specify observations for WFC3 using the Astronomer's Proposal Tool (APT).

Chapter Contents

12.1 Introduction to WFC3

HST observations with WFC3 are specified using the Astronomer's Proposal Tool (APT), and this article provides instructions for completing those observations.

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Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

The Instrument Configurations and Operating Modes described in the following section are used to define exposures on the Visit and Exposure Specifications. The legal Visit and Exposure Specifications entries are summarized in the following sections. More complete descriptions of Instrument Configurations, Modes, Apertures, Spectral Elements, Detector Characteristics, etc. are available in the *WFC3 Instrument Handbook*.

Note that many of the Optional Parameters have default values; in such cases, an entry for an Optional Parameter in the Visit and Exposure Specifications is necessary only if it is desired to override the default value. The physical units of Optional Parameter quantities are always implicit and should never be entered by the observer.

Table 12.1 lists the permitted WFC3 Instrument Configurations, Operating Modes, Apertures, Spectral Elements, and Optional Parameters.

Table 12.1: Supported Instrument Parameters for WFC3

Config	Mode	Aperture	Spectral Elements	Optional Parameters

| WFC3 /UVIS | ACCUM | See Table 12.3: *Apertures for WFC3/UVIS* | See Table 12.22: *Spectral Elements for use with WFC3 /UVIS* | CR-SPLIT, BIN, FLASH, INJECT, BLADE, SIZEAXIS2, SIZEAXIS1, CENTERAXIS2, CENTERAXIS1, AMP, GAIN, CURRENT, CTE. FLASHEXP, FLASHCUR |
| WFC3 /IR | MULTI ACCUM | See Table 12.4: *Apertures for WFC3/IR* | See Table 12.23: *Spectral Elements for use with WFC3/IR* | SAMP-SEQ, NSAMP, GAIN |

For restricted parameters

Table 12.1: Parameters for WFC3 (Restricted)

Config.	Mode	Aperture	Spectral Elements	Optional Parameters
WFC3/UVIS, WFC3/IR	ALIGN			FOCUS, TILT (Restricted)
WFC3	ANNEAL			

For available but unsupported (Internal Calibration Targets)

Table 12.2: Internal Calibration Targets for WFC3 (Available but Unsupported)

Config	Target Name	Description[1]	Spectral Element
WFC3 /UVIS	BIAS	A CCD readout without an exposure (i.e., the exposure time must be specified as 0) in order to measure the detector bias level. GOs should request BIAS exposures only when needed to match external exposures taken with subarrays via optional parameters SIZEAXIS2 and /or SIZEAXIS1. STScI will provide BIAS reference files for all other situations (full-frame exposures or exposures obtained with a subarray aperture)[2]. To ensure the proper placement of the BIAS subarray with respect to the external exposure, 1. Specify the same Aperture on the BIAS exposure as on the external one. 2. Specify exactly the same subarray Optional Parameters on the BIAS exposure as on the external exposure. To obtain a BIAS-like image for CTE EPER exposures, specify CTE=EPER , set the Target to DARK or DARK-NM and Time_Per_Exposure=0.5S.	DEF[3]

[1]Only the **GAIN, AMP, INJECT, BIN, CR-SPLIT, SIZEAXIS1, SIZEAXIS2, CENTERAXIS1**, and **CENTERAXIS2** Optional Parameters are permitted on **BIAS** exposures. (**FLASH** is not permitted.) **CR-SPLIT** may be specified only with the value **NO**. All **BIAS** exposures will be taken as single exposures (i.e., an implicit **CR-SPLIT = NO** will be applied).

[2]The Optional Parameters **CENTERAXIS1** and **CENTERAXIS2** may not have the value **TARGET**, nor may the Special Requirements **POS TARG** or **PATTERN** be specified with subarray **BIAS** exposures; STScI will not support such specifications.

[3]**DEF** means no change from the previous WFC3 UVIS exposure. The spectral element for **BIAS** exposures does not matter because the shutter is not opened.

For restricted (Internal Calibration Targets)

Table 12.2 (cont): Internal Calibration Targets for WFC3 (Restricted)

Config	Target Name	Description[1]	Spectral Element
WFC3 /UVIS	DARK	An exposure taken with the UVIS detector isolated from external light to measure the detector dark current.	DEF[2]
WFC3 /UVIS	DARK-NM	A UVIS Dark exposure without the Channel Select Mechanism (CSM) being in a particular position and with the ability to specify a filter position.	Any element from Table 12.22: *Spectral Elements for use with WFC3/UVIS*
WFC3 /UVIS	TUNGSTEN	An exposure taken with the UVIS detector with the Tungsten flat-field lamp powered on.	Any element from Table 12.22: *Spectral Elements for use with WFC3/UVIS*
WFC3 /UVIS	DEUTERIUM	An exposure taken with the UVIS detector with the Deuterium lamp powered on.	Any element from Table 12.22: *Spectral Elements for use with WFC3/UVIS*
WFC3 /IR	DARK	An exposure taken with the IR detector isolated from external light to measure the detector dark current.	BLANK[3]
WFC3 /IR	DARK-NM	An IR Dark exposure without the CSM being in a particular position	BLANK
WFC3 /IR	TUNGSTEN	An exposure taken with the IR detector with the Tungsten flat-field lamp powered on.	Any element from Table 12.23: *Spectral Elements for use with WFC3/IR*

[1]Optional parameters **SAMP-SEQ, NSAMP, CR-SPLIT, CURRENT, GAIN, AMP, BIN, INJECT, SIZEAXIS1, SIZEAXIS2** are permitted for all internal target exposures.
BLADE is allowed only for targets **TUNGSTEN** and **DEUTERUIUM**. **CTE** is allowed only if the target is **TUNGSTEN, DARK-NM or DARK**. **CR-SPLIT** may be specified only with the value **NO**. All internal target exposures will be taken as single exposures (i.e., an implicit **CR-SPLIT = NO** for UVIS exposures).

[2]**DEF** means no change from the previous WFC3 UVIS exposure. The spectral element for **DARK** exposures does not matter because the shutter is not opened.

[3]The spectral element for IR **DARK** exposures must be **BLANK** to block the light path to the detector.

Related Links

Change Log

Version Cycle 30 August 2022

Fix links in Table 12.1

12.2 WFC3 UVIS Observing Mode

Observations with HST's WFC3 instrument can be done with the UVIS detector, and the Astronomer's Proposal Tool (APT) has parameters for specifying these observations.

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Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

There is one detector on WFC3 that can be used to obtain ultraviolet and optical data, and that is the UVIS.

Mode = ACCUM Config = WFC3/UVIS

ACCUM is the only observing mode for the UVIS channel. Photons are detected in the WFC3 CCD as accumulated charge, which is read out at the end of the exposure and converted to DN at a selectable gain. The DN are stored as 16-bit words in a data memory array. Detector dimensions are specified as the number of columns by the number of rows (X by Y dimensions in the pipeline images). Parallel readout occurs along columns, then serial readout occurs along a row. (For more information see Section 6.4 in the *WFC3 Instrument Handbook*) A full detector readout is 4206 columns by 4140 rows, which includes 110 columns of serial overscan (of which 50 are physical and 60 are virtual) and 38 rows of parallel overscan (all virtual). The light sensitive (imaging) area of the detector is 4096 × 4102 pixels (columns × rows). Subarrays are comprised only of the physical pixels, which are contained within a 4146 × 4102 pixel region. Subarrays may contain light sensitive pixels and physical overscan pixels, but they do not contain virtual pixels.

Aperture or FOV

Observers determine the placement of the FOV of a WFC3 image on a target by specifying the target coordinates, the WFC3 fiducial point, and the WFC3 detector readout, and the telescope orientation (via the ORIENT special requirement, or by default). HST will be pointed so that the target is imaged at the fiducial point, plus any displacement from that point, which is specified by the observer with the POSition TARGet <X-value>,<Y-value> special requirement. Each WFC3 Aperture has a predefined fiducial point (see Table 12.3: *Apertures for WFC3/UVIS*), or if a quadrant filter or grism spectral element is used, the fiducial point is determined from the combination of aperture and spectral element in use. The full detector is read out unless the aperture name ends in "**SUB**" (or if a subarray is specified via optional parameters).

With regard to fiducial points, two types of apertures are defined in Table 12.3: *Apertures for WFC3 /UVIS*. The first type is designed for placing targets at the "optimum location" of a region on the detector: either the entire 4096 × 4102 pixel array (**UVIS**, **UVIS-CENTER**), one of the two physical 4096 × 2051 CCD chips (**UVIS1**, **UVIS2**), one of the 2048 × 2051 quadrants of the detector (**UVIS-QUAD**), a region near a read-out amplifier (an aperture with the suffix **-CTE**), or within a predefined subarray (an aperture with the suffix **-SUB**). The default location within these apertures will be routinely adjusted by STScI to reflect any changes in CCD performance (e.g., new charge transfer traps, bad columns, etc.). These apertures are appropriate for targets that are small compared to the scale size of defects in the chips.

The second set of apertures defines the "geometric center" of the region and will remain fixed in aperture coordinates. These will **not** be adjusted for changes in CCD characteristics. These apertures are designated with the suffix **-FIX**, and should be used to specify the location of the target relative to the CCDs. These "geometric center" apertures are appropriate for pointings designed to position an extended scene within the WFC3 FOV. For **UVIS-FIX**, the "geometric center" is on CCD chip 1, ~10 arcseconds above the gap between the two chips. The fiducial point of the **UVIS-IR-FIX** aperture is the same as that of the **IR-FIX** aperture. Switching between the UVIS and IR channels using those two apertures will not cause HST to repoint. The fiducial points of the **UVIS1-FIX** and **UVIS2-FIX** apertures are at the centers of those chips.

The **UVIS** aperture is required for exposures using the **G280** spectral element. In this case the STScI ground system will substitute a special aperture that has approximately the same pointing, but is optimized for use with the grism. An undispersed (i.e., bandpass filter) image exposure should be taken in conjunction with the grism exposure using the **G280-REF** aperture to enable measurement of the grism exposure wavelength zero-point.

The **UVIS-QUAD, UVIS-QUAD-FIX,** and **UVIS-QUAD-SUB** apertures are allowed only with one of the quadrant filters (see Table 12.22: *Spectral Elements for use with WFC3/UVIS*), and one of these apertures must be specified if a quadrant filter is used. The choice of aperture only affects the telescope pointing; it does not restrict the area of the detector that is read out, except for **UVIS-QUAD-SUB** which will read out only the quadrant of the detector corresponding to the filter specified. UVIS-QUAD and UVIS-QUAD-FIX refer to the full array unless Optional Parameters describing user-defined subarrays are specified.

Apertures with sub-array readouts are provided in order to reduce operational overhead time when imaging targets that do not require the full FOV of the UVIS channel. 2K × 2K apertures for each of the four quadrants are provided (**UVIS1-2K2A-SUB, UVIS1-2K2B-SUB, UVIS2-2K2C-SUB,** and **UVIS2-2K2D-SUB**). For the Amplifier C quadrant, 1K × 1K and 512 × 512 subarray apertures are provided both near the center of the FOV (**UVIS2-M1K1C-SUB and UVIS2-M512C-SUB**), and near the amplifier (**UVIS2-C1K1C-SUB and UVIS2-C512C-SUB**).

Full-frame apertures (**UVIS2-C1K1C-CTE** and **UVIS2-C512C-CTE**) are provided for placement of targets nearer to the C readout amplifier (same reference positions as the **UVIS2-C1K1C-SUB** and **UVIS2-C512C-SUB** apertures, respectively) to allow full-frame readout with better CTE performance than for targets placed at the reference positions of other full-frame apertures.

For available but unsupported

Additional sub-array apertures for CCD chip 1 are available. They are the full-chip aperture **UVIS1-2K4-SUB**, the 512 × 512 sub-arrays in the corners (**UVIS1-C512A-SUB** and **UVIS1-C512B-SUB**), and the 512 × 512 sub-array near the middle of the UVIS FOV, **UVIS1-M512-SUB**. These apertures are intended to support the WFC3 calibration program.

For restricted

Additional apertures on CCD chip 2 are provided to support the WFC3 calibration program. They are the full-chip aperture **UVIS2-2K4-SUB**, the 512 × 512 sub-array in a corner **UVIS2-C512D-SUB**, and a 512 × 512 sub-array near the middle of the UVIS FOV, **UVIS2-M512-SUB**.

The UVIS aperture is required for ACCUM exposures that specify optional parameter **CTE = EPER**.

Table 12.3: Apertures for WFC3/UVIS

Aperture	Description
UVIS	Two-CCD mosaic with the reference point at a targetable location near the geometric center (Optimum Center).
UVIS-FIX	Initial version of UVIS that remains fixed even if UVIS is modified later. Geometric center of full two-CCD FOV.
UVIS-CENTER	Two-CCD mosaic with the reference point at the "center" of a distortion corrected view. This point is equidistant from each pair of opposite corners and falls on UVIS2 close to the gap. Useful for designing mosaics, especially if combining images with different orientations.
UVIS1	Optimum center of CCD 1

UVIS1-FIX	Geometric center of CCD 1
UVIS2	Optimum center of CCD 2
UVIS2-FIX	Geometric center of CCD 2
UVIS-IR-FIX	Same fiducial point as **IR-FIX** in Table 12.4: *Apertures for WFC3/IR*
G280-REF	Grism reference aperture for undispersed exposures
UVIS-QUAD	Optimum center of quadrant corresponding to selected quadrant filter (offset from the center of the quadrant toward the nearest corner of the detector by about 8 to 10 arcsec in X and in Y)
UVIS-QUAD-FIX	Geometric center of quadrant corresponding to selected quadrant filter
UVIS2-C1K1C-CTE	Full-frame with target at same reference position as UVIS2-C1K1C-SUB (see below); for better CTE performance
UVIS2-C512C-CTE	Full-frame with target at same reference position as UVIS2-C512C-SUB (see below); for better CTE performance
UVIS-QUAD-SUB	Optimum center of the quadrant corresponding to the selected quadrant filter, with a 2072 × 2050 subarray (2072 includes 23 pixels of the physical overscan and 2049 image pixels) to read out approximately on that quadrant
UVIS1-2K4-SUB	Optimum center of CCD 1 using a 4142 × 2050 subarray (4142 includes 46 pixels of physical overscan)
UVIS2-2K4-SUB	Optimum center of CCD 2 using a 4142 × 2050 subarray (4142 includes 46 pixels of physical overscan)
UVIS1-M512-SUB	512 × 512 subarray on CCD 1 near the center of UVIS FOV, for best image quality
UVIS2-M512-SUB	512 × 512 subarray on CCD 2 near the center of UVIS FOV, for best image quality

UVIS1-2K2A-SUB UVIS1-2K2B-SUB UVIS2-2K2C-SUB UVIS2-2K2D-SUB	2048 × 2050 full quadrant subarrays (optimum center - same center as UVIS-QUAD for matching N,M,W filter exposures to quadrant filter exposures)
UVIS2-M1K1C-SUB	1024 × 1024 subarray, quadrant C near detector center (optimum center)
UVIS2-C1K1C-SUB	1024 × 1024 subarray, near amp C (optimum center)
UVIS2-M512C-SUB	512 × 512 subarray on CCD 2 near the center of UVIS FOV; for best image quality
UVIS1-C512A-SUB UVIS1-C512B-SUB	536 × 512 subarray (536 includes 23 pixels of physical overscan and 513 image pixels) located in the corner of CCD 1 near either amp A or B (optimum center)
UVIS2-C512C-SUB	536 × 512 subarray (536 includes 23 pixels of physical overscan) located in the corner of CCD 2 near amp C (optimum center)
UVIS2-C512D-SUB	536 × 512 subarray (536 includes 23 pixels of physical overscan and 513 image pixels) located in the corner of CCD 2 near amp D (optimum center)

Spectral Element

See Table 12.22: *Spectral Elements for use with WFC3/UVIS*

Wavelength

This parameter does not apply to WFC3 observations and should be left blank.

Optional Parameters

CR-SPLIT
= 2 - 8, NO (default)

Specifies the number of sub-exposures into which the original exposure is to be split for the purpose of cosmic ray elimination in post-observation data processing (see the *WFC3 Instrument Handbook*). The specified exposure time will be divided equally among the number of **CR-SPLIT** exposures requested. If **CR-SPLIT=NO**, the exposure is taken without splitting. The use of CR-SPLIT is not recommended in general. Consider dithering rather than repeating identical pointings.

> For available but unsupported (BIAS)
>
> If the target is **BIAS, DARK, DARK-NM, TUNGSTEN,** or **DEUTERIUM**, then the only legal value for **CR-SPLIT** is **NO**. If **CR-SPLIT** is not specified, an implicit **CR-SPLIT=NO** will be applied to the exposure.

If the exposure is a **Spatial Scan** (see Special Observation Requirements), numerical values of **CR-SPLIT** are not permitted.

BIN
=NONE (default), 2, 3 (pixels)

Specifies the number of CCD pixels in each dimension that are binned to a single signal value as the detector is read out. If the value **NONE** is specified, or the optional parameter is not provided, the exposure will be read out unbinned. A value of 2 produces 2 × 2 binning; a value of 3 produces 3 × 3 binning. See the discussion of binning in the *WFC3 Instrument Handbook*.

BIN=2 or **3** are not permitted in conjunction with the CCD subarray parameters **SIZEAXIS2** or **SIZEAXIS1** or with any subarray aperture (**-SUB**). **BIN=2 or 3 are not permitted in conjunction with CTE=EPER.**

> For available but unsupported
>
> **Custom Subarrays**
>
> Subarrays are specified by a user in the AXIS frame, which is an image-based coordinate system defined in the *WFC3 Instrument Handbook*, Chapter 6 and shown in Figure 12.1: *UVIS Aperture Diagram*. The AXIS1 coordinate varies along rows of the detector and AXIS2 varies along detector columns. Restrictions on which of the physical pixels (i.e., rows and columns) may be included in a user-specified subarray are also presented in Chapter 6 of the *WFC3 Instrument Handbook*. With the Optional Parameters listed below, a user specifies the lengths of the rectangular sides of the subarray and the position of center of the subarray, both of which have units of pixels.
>
> **SIZEAXIS2 = FULL (default), 16 - 2050 (pixels)**
>
> Specifies the number of pixels of a UVIS subarray along the AXIS2 direction (i.e., along a column). Care must be taken in specifying a UVIS detector subarray to ensure that the subarray is fully contained on one of the two CCD chips that comprise the UVIS detector. SIZEAXIS2 may not be specified if the Aperture is a subarray aperture (-SUB).

The default value of FULL will result in a full-detector readout of 4206 × 4140 pixels (which includes the various overscan pixels), unless Optional Parameter SIZEAXIS1 is not FULL, in which case the readout will be SIZEAXIS1 × 2050 pixels. Subarrays will be centered at the reference position of the Aperture used for the exposure, unless Optional Parameter CENTERAXIS2 is used to specify the center of the subarray in the AXIS2 direction. Note that for all subarrays, the target will be placed on the detector at the Aperture reference position, plus any POSition TARGet offset specified on the exposure.

SIZEAXIS1= FULL (default), 16 - 4142 (pixels)

Specifies the number of pixels of a UVIS subarray along the AXIS1 direction (i.e., along a row). The numerical value, if specified, must be an even number. Care must be taken in specifying a UVIS detector subarray to ensure that the subarray is fully contained on one of the two CCD chips that comprise the UVIS detector. SIZEAXIS1 may not be specified if the Aperture is a subarray aperture (-SUB).

The default value of FULL will result in a full-detector readout of 4206 × 4140 pixels (which includes the various overscan pixels), unless Optional Parameter SIZEAXIS2 is not FULL, in which case the readout will be 4142 × SIZEAXIS2 pixels. Subarrays will be centered at the reference position of the Aperture used for the exposure, unless Optional Parameter CENTERAXIS1 is used to specify the center of the subarray in the AXIS1 direction. Note that for all subarrays, the target will be placed on the detector at the Aperture reference position, plus any POSition TARGet offset specified on the exposure.

CENTERAXIS2 = 9 - 2043, 2059 - 4093, TARGET

Specifies the center pixel in the AXIS2 direction (i.e., along a column). CENTERAXIS2 may be specified only if Optional Parameter SIZEAXIS2 is also specified. The default is to center the subarray at the aperture reference position. The value TARGET is used to center a subarray on the target's detector coordinates, which may differ from the aperture reference position if a POSition TARGet Special Requirement is present on the exposure (see "POSition TARGet <X-value>,<Y-value>"). Note that for all subarrays, the target will be placed on the detector at the Aperture reference position, plus any POSition TARGet offset specified on the exposure. Note also that if the target is BIAS, DARK, DARK-NM, DEUTERIUM, or TUNGSTEN, CENTERAXIS2=TARGET is not allowed.

CENTERAXIS1 = 11 - 4137, TARGET

Specifies the center pixel in the AXIS1 direction (i.e., along a row). CENTERAXIS1 may be specified only if Optional Parameter SIZEAXIS1 is also specified. The default is to center the subarray at the aperture reference position. The value TARGET is used to center a subarray on the target's detector coordinates, which may differ from the aperture reference position if a POSition TARGet Special Requirement is present on the exposure (see "POSition TARGet <X-value>,<Y-value>"). Note that for all subarrays, the target will be placed on the detector at the Aperture reference position, plus any POSition TARGet offset specified on the exposure. Note also that if the target is BIAS, DARK, DARK-NM, DEUTERIUM, or TUNGSTEN, CENTERAXIS1=TARGET is not allowed.

For restricted

AMP = A, B, C, D, AC, AD, BC, BD, ABCD

Specifies the readout amplifier or combination to use for the exposure. If the entire detector (both CCD chips) is being read out, then the single amplifier selections are not allowed. If a subarray is being used, the value of AMP must correspond to the CCD chip containing the subarray, and only a single amplifier may be used (i.e., value must be either A, B, C, or D).

GAIN = 1.0, 1.5 (default), 2.0, 4.0 (e/DN)

Specifies the gain of the CCD electronics in e/DN.

CURRENT = LOW, MEDIUM, HIGH

Specifies the current to be used for the Deuterium lamp exposures. This optional parameter may only be used if the target is DEUTERIUM. At LOW and MEDIUM currents, the lamp may be powered on for a maximum of 255 minutes. For thermal reasons, at HIGH current, the lamp may not be on for more than 60 minutes; after any set of exposures using HIGH current, the lamp will automatically be powered off for at least 60 minutes to allow for cool down of the calibration system.

For available but unsupported and restricted

INJECT = NONE (default), YES
= CONT, LINE10, LINE17, LINE25

Specifies whether to do charge injection or not. Charge injection is used for correcting the effects of charge transfer inefficiency. (See the description of the optional parameter **FLASH** (below), the supported mode for reducing the effects of CTI.)

The specific mode of charge injection may be specified. The values **LINE10, LINE17**, and **LINE25** specify the spacing of lines (rows) receiving injected charge ("discrete" charge injection); the lines receiving charge are fixed to the CCDs and do not change with the specification of subarrays. **CONT** specifies that every line (row) of the detector will receive injected charge ("continuous" charge injection).

BLADE = A (Available)
= B (Restricted)

Allowed only when the "Time Per Exposure" is less than 60 seconds. For short exposures, the two sides of the UVIS shutter produce notably different PSFs. Programs that can benefit from using the superior side may specify Optional Parameter BLADE = A. Approval from your Contact Scientist is required.

Engineering and calibration proposals may also specify BLADE = B.

<div style="border:1px solid red">

For restricted

CTE =NONE (default), EPER

Indicates that the exposure specified will be for the purpose of making a charge transfer efficiency (CTE) measurement. The value EPER is for obtaining an Extended Pixels Edge Response image. CTE measurement images must be specified with TUNGSTEN as the target, except as noted below. When CTE is specified as EPER, GAIN is the only other optional parameter that may be specified, and aperture UVIS must be specified.

Note: To obtain a bias subtraction image with a CTE timing pattern, specify
- CTE = EPER
- Target = DARK or DARK-NM (not BIAS)
- Time_Per_Exposure = 0.5 S.

</div>

FLASH =0 (default) - 40

Specifies the number of electrons per pixel to add to the image by illuminating the detector with the post-flash LED. When associated exposures are created by specifying multiple iterations, or by applying a PATTERN, or by using the optional parameter CR-SPLIT, this value applies to each member of the association. Updated advice and documentation on charge transfer efficiency (CTE) losses can be found on the CTE landing page and references therein. This guidance will also be located under current status on WFC3's main page.

If **FLASH** is specified, neither **FLASHCUR** nor **FLASHEXP** may be specified.

<div style="border:1px solid red">

For restricted

FLASHEXP = 0.0 - 409.5 (seconds; no default) (Restricted)

Specifies the "exposure time" of the LED post-flash. If **FLASHEXP** is specified, **FLASHCUR** must also be specified and **FLASH** may not be specified. **FLASHCUR = LOW, MEDIUM, HIGH (no default) (Restricted)** Specifies the LED current to use for the post-flash. If **FLASHCUR** is specified, **FLASHEXP** must also be specified and **FLASH** may not be specified.

</div>

Number of Iterations

Enter the number of times this exposure should be iterated, and the duration in seconds of each iteration. There are many observational situations when two or more identical exposures should be taken of the same field (e.g., to keep a bright object from blooming by keeping the exposure time short). If the **Number_Of_Iterations** is n, the entire exposure will be iterated n times.

The value entered for the **Time_Per_Exposure** is the exposure time for each iteration of the specified exposure. For instance, specifying **Number_Of_Iterations = 10** and a **Time_Per_Exposure** of 10 seconds will produce a total exposure time of 100 seconds. This differs from the situation with a **CR-SPLIT**, when the total exposure time will be apportioned among shorter exposures: specifying an exposure time of 10 seconds and **CR-SPLIT=2** results in two exposures of 5 seconds each.

Note: **CR-SPLIT** and multiple iterations are mutually exclusive capabilities. If **Number_Of_Iterations > 1** on an external exposure, **CR-SPLIT=NO** must be specified.

Time Per Exposure

Time_Per_Exposure must be an integer multiple of 0.1 second and in the range of 0.5 to 3600 sec. The value of 0.6 sec is not allowed.

If the exposure is a **Spatial Scan** (see Special Observations Requirements) and **Number of Iterations** > 1, a small slew will be inserted between the exposures so the scans will repeat the same path on the detector each time. Depending on detector setup and slew length, this may sacrifice orbital visibility time. Consider alternating the Scan_Direction instead.

For exposures that specify BIAS as the target, the exposure time must be 0.

Special Requirements

,,,,"">"SPATIAL SCAN <Scan_Rate>, <Scan_Orient>, <Scan_Direction>, <Scan_Line_Separation>, <Scan_Number_Lines>"

See Special Observations Requirements for information on executing an exposure as a Spatial Scan. Special Requirement **SAME POSition AS** is not permitted on and may not refer to a Spatial Scan exposure. Spatial Scan exposures are not permitted in Coordinated Parallel containers or in Pure Parallel visits.

Special requirement **PARallel WITH** is not permitted on and may not refer to a Spatial Scan exposure. Pure Parallel visits may not contain Spatial Scan exposures.

> For Available but Unsupported
>
> **SAA CONTOUR**
>
> This is Available-but-Unsupported for WFC3/UVIS ACCUM.

Related Links

12.3 WFC3 IR Observing Mode

Change Log

Version Cycle 31 June - August 2023

1. Fixed the link to the WFC3 IHB in the first paragraph

Version Cycle 30 June 2022

> Edit suggested by the WFC3 team

Version Cycle 30 April 2022

PROPINST-91384 (Document update to WFC3 op FLASH upper limit)

12.3 WFC3 IR Observing Mode

Observations with HST's WFC3 instrument can be done with the IR detector, and the Astronomer's Proposal Tool (APT) has parameters for specifying these observations.

Sections

- 12.3.1 Predefined Sample Sequences for MULTIACCUM Mode

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Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

There is one detector on WFC3 that can be used to obtain infrared data, and that is the IR.

Mode = MULTIACCUM Config = WFC3/IR

MULTIACCUM is the only observing mode for the IR channel. An exposure in **MULTIACCUM** mode begins with an array reset followed by an initial readout. Next, one or more nondestructive readouts are obtained at user-selectable times. All of the readouts, including the initial readout, are recorded onboard and returned to the ground for analysis. The difference between each successive pair of reads is the image data accumulated between reads.

There are two major advantages of this approach. First, the multiple readouts provide a way to record what is happening in a pixel before it saturates, increasing dynamic range. Second, the multiple readouts can be compared to remove cosmic ray effects. See the *WFC3 Instrument Handbook* for more information.

Aperture or FOV

Placement of the target on the detector is controlled by the specified Aperture, the POSition TARGet <X-value>,<Y-value> special requirement (if used), the telescope orientation (via the "ORIENTation <angle1> TO <angle2>" special requirement or by default), and in some instances the Spectral Element. The apertures for the IR channel and their valid combinations with spectral elements are defined in Table 12.4: *Apertures for WFC3/IR*. The current values of the aperture coordinates of the Aperture+Spectral Element combinations in Table 12.3: *Apertures for WFC3/UVIS* may be found on the *HST* Apertures Web Page.

The **IR** aperture is designed for placing targets at the "optimum center" of the detector. The default location within this aperture may be adjusted by STScI to reflect any changes in detector performance. This aperture is appropriate for targets that are small compared to the scale size of defects in the chips.

The **IR-FIX** aperture defines the geometric center of the detector and will remain FIXED in aperture coordinates. This location will **not** be adjusted for changes in detector characteristics, and should be used to specify the location of the target relative to the detector. This geometric center aperture is appropriate for pointings designed to position an extended scene within the WFC3 FOV.

Three apertures are provided that use the same pointing of the telescope as used for three associated UVIS apertures. Using an associated pair of apertures for UVIS and IR exposures will avoid a small angle maneuver between the exposures. The IR apertures are **IR-UVIS**, **IR-UVIS-CENTER**, and **IR-UVIS-FIX**, which are associated with, respectively, the apertures **UVIS**, **UVIS-CENTER**, and **UVIS-FIX**.

IR subarrays are specified by selecting the appropriate aperture. The **IRSUBnn** or **IRSUBnn-FIX** apertures will result in the use of the subarray readout mode of the IR detector with the size of the subarray being that indicated by the aperture name (**nn** = **512**, **256**, **128**, or **64**). The use of the subarray readout mode will result in different sample times than for full detector readouts listed in SAMP-SEQ=RAPID table. Not all combinations of subarray size and sample sequence are supported. See the discussion under the **SAMP-SEQ** Optional Parameter for more details. The subarray readouts will have a border of five reference pixels added around the edge of the subarray used for imaging, making the total data sizes 1024 × 1024 (full-frame), 74 × 74, 138 × 138, 266 × 266, and 522 × 522 pixels.

The **IRSUBnn** apertures will place the target at the "optimum center" of the corresponding subarray; note that these positions may be different for the different subarrays. The default position of each of these apertures will be updated by STScI to reflect changes in instrument performance. These apertures are appropriate for targets that are small compared to the scale size of defects on the detector.

The **IRSUBnn-FIX** apertures define the geometric center of the subarray and will remain fixed in aperture coordinates. These locations will **not** be adjusted for changes in detector performance.

Five apertures are specialized for use with the two IR grisms (**G102** and **G141**) and to obtain band pass filter images for use as wavelength zero-point references. According to the FOV, the apertures are named **GRISMmm**, where **mm** = 1024 (full frame), 512, 256, 128, 64. The subarrays are the same as the **IRSUBnn** apertures. The fiducial pixel for each Aperture+Spectral Element combination is optimized to best position the first-order spectrum in the FOV. For **GRISM1024**, **GRISM512**, and **GRISM256**, the same fiducial pixel is used for **G102** and **G141** and for reference band pass filter exposures. For **GRISM128** and **GRISM64** different fiducial pixels are used for **G102** and **G141** that best center each first-order spectrum in the FOV. The fiducial pixel for a bandpass filter exposure with those two apertures is midway between the two grism fiducial pixels.

> For available but unsupported parameter (IRSUBnn)
>
> The **IR** aperture is required for exposures using the **G102** or **G141** spectral elements. In this case the STScI ground system will substitute a special aperture which has approximately the same pointing but is optimized for use with the selected grism. If an undispersed image exposure is taken in conjunction with the grism exposure, it is recommended that the appropriate grism reference aperture (**G102-REF** or **G141-REF**) be used on the undispersed image exposure to provide an optimal pointing offset between the two exposures.
>
> For consistency with Cycle 18 proposals, the subarray aperture + grism spectral element combinations shown in Table 12.4: *Apertures for WFC3/IR* also will be Available But Unsupported. However, to position the first-order spectrum within the sub-array, the **POS**ition **TARG**et special requirement must be used.

Table 12.4: Apertures for WFC3/IR

Aperture	Spectral Element	Description
IR	Fnnn[1], G102, G141	Full frame, Optimum center of detector
IR-FIX	Fnnn	Full frame, Geometric center of detector
IR-UVIS IR-UVIS-CENTER IR-UVIS-FIX	Fnnn	Full frame, Fiducial points match paired UVIS apertures in Table 12.3: *Apertures for WFC3/UVIS*
IRSUB64	Fnnn, G102, G141	Optimum center of the 64 × 64 subarray
IRSUB64-FIX	Fnnn	Geometric center of the 64 × 64 subarray
IRSUB128	Fnnn, G102, G141	Optimum center of the 128 × 128 subarray
IRSUB128-FIX	Fnnn	Geometric center of the 128 × 128 subarray
IRSUB256	Fnnn, G102, G141	Optimum center of the 256 × 256 subarray
IRSUB256-FIX	Fnnn	Geometric center of the 256 × 256 subarray

IRSUB512	Fnnn, G102, G141	Optimum center of the 512 × 512 subarray
IRSUB512-FIX	Fnnn	Geometric center of the 512 × 512 subarray
GRISM1024	G102, G141, Fnnn	Full frame **G102** or **G141** spectra
GRISM512	G102, G141, Fnnn	512 × 512 subarray for grism spectra, or grism reference
GRISM256	G102, G141, Fnnn	256 × 256 subarray for grism spectra, or grism reference
GRISM128	G102, G141, Fnnn	128 × 128 subarray for grism spectra, or grism reference
GRISM64	G102, G141, Fnnn	64 × 64 subarray for grism spectra, or grism reference
G102-REF	Fnnn	**G102** reference aperture for undispersed exposures
G141-REF	Fnnn	**G141** reference aperture for undispersed exposures

[1] '**Fnnn**' denotes any of the band pass filters, but neither of the grisms

Spectral Element

See 12.5.2 *WFC3 IR Spectral Elements*.

Wavelength

This parameter should be left blank.

Optional Parameters

SAMPSEQ

=RAPID, SPARS5, SPARS10, SPARS25, SPARS50, SPARS100, SPARS200, STEP25, STEP50, STEP100, STEP200, STEP400, MIF600, MIF900, MIF1200, MIF1500

A required parameter specifying the name of a predefined sequence of times from the start of the exposure at which the nondestructive readouts (samples) are performed. The structure and purpose of each class of sequence (**RAPID, STEP, SPARS, MIF**) is described in the paragraphs below. **SPARS5** was introduced in Cycle 23. The number of readouts (up to 15, plus one for the initial readout) taken for each exposure is controlled by the **NSAMP** parameter (see below).

SAMP-SEQ=RAPID gives the sample times (defined as the time from the start of the initial readout to the start of a given readout) for each sequence and image size. Different types of sequences are provided. The **RAPID** sequence provides linear sampling as fast as possible (limited by the readout time for the selected image size) and is intended for bright targets that could saturate in the other sample sequences. All sample sequences with the full detector apertures are supported. But note that only a limited number of combinations of subarray size and sample sequence are supported.

Sequences **STEP25, STEP50, STEP100, STEP200, and STEP400** begin with four rapid samples (five readouts), switch to logarithmic spacing up to the given number of seconds (25-400), and then continue with linear spacing for the remainder of the sequence with adjacent steps separated by 25-400 seconds depending on the selected sequence. These sequences are intended to compensate for any nonlinearities near the start of the exposure and to provide increased dynamic range for images that contain both faint and bright targets.

Sequences **SPARS5, SPARS10, SPARS25, SPARS50, SPARS100, and SPARS200** begin with one rapid sample (two readouts) then provide linear spacing to allow observers to "read up the ramp" at evenly spaced intervals. The variety of sampling intervals allows this basic strategy to be applied over a wide range in target flux.

> For available but unsupported sequences
>
> Sequences **MIF600, MIF900, MIF1200, and MIF1500** provide pseudo-Fowler sampling (described in the *WFC3 Instrument Handbook*) of the signal, using total exposure times of 600 seconds through 1500 seconds in 300 second increments. They start with a series of rapid readouts (7 reads, but the initial read is to be ignored in processing due to potential reset anomalies), followed by three widely spaced readouts, and finish with six rapid readouts at the end of the exposure. The six initial useful readouts and the six final readouts are to be averaged then differenced to form the final difference image. The middle reads are provided for cosmic ray and saturation detection. These sequences should always be specified with **NSAMP = 15**.

The different sequences are designed to efficiently fill the orbital visibility period with one, two, or several exposures. See the *WFC3 Instrument Handbook* for recommendations on which sequences to use in different situations.

**NSAMP
=1-15**

A required parameter specifying the number of samples in a predefined sequence that should actually be taken, not counting the initial readout. **SAMP-SEQ=RAPID** defines 15 sample times for each sequence. If an **NSAMP** value smaller than 15 is used, samples will be taken at only the first **NSAMP** times from this table.If an NSAMP value smaller than 5 is used, the flux determined by "up the ramp" fitting will be less reliable.

The total number of readouts will be **NSAMP** plus one (for the initial readout), giving a maximum of 16 readouts for a single execution of a **MULTIACCUM** exposure. Each readout will be recorded and will appear in the final data set.

> For restricted parameters (Gain)
>
> **GAIN
> = 2.0, 2.5(default), 3.0, 4.0 (e/DN)**
>
> Specifies the gain of the detector electronics in e/DN.

Number of Iterations

Enter the number of times this exposure should be iterated. This option should be used in observational situations when two or more identical exposures should be taken of the same field. If the **Number_Of_Iterations** is n, the exposure will be iterated n times.

If the exposure is a Spatial Scan (Special Observations Requirements) and **Number of Iterations** > 1, a small slew will be inserted between the exposures so the scans will repeat the same path on the detector each time. This will sacrifice orbital visibility time. Consider alternating the Scan_Direction instead.

Time Per Exposure

Time_Per_Exposure must be **DEF** in this Mode. The exposure time is unnecessary, because it is specified by **SAMPSEQ** and **NSAMP**.

Table 12.5: *Predefined Sample Sequences for MULTIACCUM Mode.* provides a link to the individual MULTIACCUM mode tables. The tables show the sequence of 15 sample times corresponding to the different **SAMP-SEQ** values, in seconds from the start of the initial readout to the start of the readout for the given sample. These values are given to the nearest millisecond.

Table 12.5: Predefined Sample Sequences for MULTIACCUM Mode.

Predefined Sample Sequences for MULTIACCUM Mode
SAMP-SEQ=RAPID
SAMP-SEQ= SPARS5
SAMP-SEQ=SPARS10
SAMP-SEQ= SPARS25
SAMP-SEQ=SPARS50
SAMP-SEQ=SPARS100
SAMP-SEQ=SPARS200
SAMP-SEQ=STEP25
SAMP-SEQ=STEP50
SAMP-SEQ=STEP100
SAMP-SEQ=STEP200
SAMP-SEQ=STEP400

For available but unsupported MULTIACCUM mode tables

Predefined Sample Sequences for MULTIACCUM Mode
SAMP-SEQ=MIF600
SAMP-SEQ=MIF900
SAMP-SEQ=MIF1200

Special Requirements

See Special Observations Requirements **SPATIAL SCAN** for information on executing an exposure as a Spatial Scan.

Special requirement **SAME POSition AS <exposure>** is not permitted on and may not refer to a Spatial Scan exposure. Spatial Scan exposures are not permitted in Coordinated Parallel containers or in Pure Parallel visits.

Special requirements **SAME ALIGNMENT** and **PARallel WITH** are not permitted on and may not refer to a Spatial Scan exposure. Pure Parallel visits may not contain Spatial Scan exposures.

For available but unsupported mode parameters (SAA CONTOUR)

SAA CONTOUR

This is Available-but-Unsupported for WFC3/IR MULTIACCUM.

Related Links

12.2 WFC3 UVIS Observing Mode

Change Log
None

12.3.1 Predefined Sample Sequences for MULTIACCUM Mode

This article provides Sample Sequences for WFC3 MULTIACCUM Mode.

On This Page

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

★ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Table 12.6: SAMP-SEQ=RAPID

	Image Size				
Sample Number	Full Frame	512 × 512	256 × 256	128 × 128	64 × 64
1	2.932	0.853	0.278	0.113	0.061
2	5.865	1.706	0.556	0.225	0.122
3	8.797	2.559	0.833	0.338	0.182
4	11.729	3.412	1.111	0.451	0.243
5	14.661	4.265	1.389	0.564	0.304
6	17.594	5.118	1.667	0.676	0.365
7	20.526	5.971	1.945	0.789	0.425
8	23.458	6.824	2.223	0.902	0.486
9	26.391	7.677	2.500	1.014	0.547

10	29.323	8,530	2.778	1.127	0.608
11	32.255	9.383	3.056	1.240	0.669
12	35.187	10.236	3.334	1.352	0.729
13	38.120	11.089	3.612	1.465	0.790
14	41.052	11.942	3.889	1.578	0.851
15	43.984	12.795	4.167	1.691	0.912

Table 12.7: SAMP-SEQ= SPARS5

	Image Size				
Sample Number	Full Frame	512 × 512	256 × 256	128 × 128	64 × 64
1	2.932	0.853	0.278	0.113	0.061
2	7.933	3.775	2.624	2.294	2.190
3	12.934	6.696	4.970	4.475	4.319
4	17.935	9.618	7.317	6.656	6.449
5	22.935	12.539	9.663	8.837	8.578
6	27.936	15.461	12.009	11.019	10.707
7	32.937	18.382	14.356	13.200	12.836
8	37.938	21.304	16.702	15.381	14.966
9	42.938	24.225	19.048	17.562	17.094
10	47.939	27.147	21.394	19.743	19.224
11	52.940	30.068	23.741	21.925	21.353
12	57.941	32.990	26.087	24.106	23.483
13	62.942	35.911	28.433	26.287	25.612
14	67.942	38.833	30.780	28.468	27.741
15	72.943	41.754	33.126	30.649	29.830

Table 12.8: SAMP-SEQ=SPARS10

	Image Size				
Sample Number	Full Frame	512 × 512	256 × 256	128 × 128	64 × 64
1	2.932	0.853	0.278	0.113	0.061

2	12.933	8.775	7.624	7.294	7.190
3	22.934	16.696	14.971	14.475	14.320
4	32.935	24.618	22.317	21.657	21.449
5	42.936	32.540	29.664	28.838	28.579
6	52.937	40.462	37.010	36.020	35.708
7	62.938	48.383	44.357	43.201	42.837
8	72.939	56.305	51.703	50.382	49.967
9	82.940	64.227	59.050	57.564	57.096
10	92.941	72.148	66.396	64.745	64.226
11	102.942	80.070	73.743	71.926	71.355
12	112.943	87.992	81.089	79.108	78.485
13	122.944	95.913	88.436	86.289	85.614
14	132.945	103.835	95.782	93.471	92.744
15	142.946	111.757	103.129	100.652	99.873

Table 12.9: SAMP-SEQ= SPARS25

| | Image Size | | | | |
Sample Number	Full Frame	512 × 512	256 × 256	128 × 128	64 × 64
1	2.932	0.853	0.278	0.113	0.061
2	27.933	23.774	22.624	22.293	22.190
3	52.933	46.696	44.970	44.475	44.319
4	77.934	69.617	67.316	66.655	66.448
5	102.934	92.538	89.662	88.836	88.577
6	127.935	115.459	112.008	111.017	110.706
7	152.935	138.381	134.354	133.198	132.835
8	177.936	161.302	156.700	155.379	154.964
9	202.936	184.223	179.046	177.560	177.093
10	227.937	207.144	201.392	199.741	199.222
11	252.937	230.066	223.738	221.922	221.351
12	277.938	252.987	246.084	244.103	243.480

13	302.938	275.908	268.430	266.284	265.609
14	327.939	298.829	290.776	288.465	287.738
15	352.940	321.751	313.122	310.646	309.867

Table 12.10: SAMP-SEQ=SPARS50

	Image Size				
Sample Number	Full Frame	512 × 512	256 × 256	128 × 128	64 × 64
1	2.932	0.853	0.278	0.113	0.061
2	52.933	48.774	47.624	47.294	47.190
3	102.933	96.695	94.970	94.474	94.319
4	152.934	144.617	142.316	141.655	141.448
5	202.934	192.538	189.662	188.836	188,577
6	252.935	240.459	237.008	236.017	235.705
7	302.935	288.380	284.354	283.198	282.834
8	352.935	336.301	331.700	330.379	329.963
9	402.936	384.223	379.046	377.560	377.092
10	452.936	432.144	426.392	424.740	424.221
11	502.937	480.065	473.738	471.921	471.350
12	552.937	527.986	521.084	519.102	518.479
13	602.938	575.907	568.430	566.283	565.608
14	652.938	623.828	615.775	613.464	612.737
15	702.939	671.750	663.121	660.645	659.866

Table 12.11: SAMP-SEQ=SPARS100

	Image Size				
Sample Number	Full Frame	512 × 512	256 × 256	128 × 128	64 × 64
1	2.932	0.853	0.278	0.113	0.061
2	102.933	98.774	97.624	97.293	97.190
3	202.933	196.695	194.970	194.474	194.318

4	302.933	294.616	292.315	291.655	291.447
5	402.934	392.537	389.661	388.836	388.576
6	502.934	490.458	487.007	486.016	485.705
7	602.934	588.379	584.353	583.197	582.884
8	702.935	686.300	681.699	680.378	679.962
9	802.935	784.221	779.045	777.559	777.091
10	902.935	882.143	876.390	874.739	874.220
11	1002.936	980.064	973.736	971.920	971.349
12	1102.936	1077.985	1071.082	1069.101	1068.478
13	1202.936	1175.906	1168.428	1166.282	1165.606
14	1302.936	1273.827	1265.774	1263.462	1262.735
15	1402.937	1371.748	1363.120	1360.643	1359.864

Table 12.12: SAMP-SEQ=SPARS200

	Image Size				
Sample Number	Full Frame	512 × 512	256 × 256	128 × 128	64 × 64
1	2.932	0.853	0.278	0.113	0.061
2	202.932	198.774	197.623	197.293	197.189
3	402.932	396.695	394.969	394.474	394.318
4	602.932	594.615	592.315	591.654	591.446
5	802.933	792.536	789.660	788.835	788.575
6	1002.933	990.457	987.006	986.015	985.704
7	1202.933	1188.378	1184.351	1183.196	1182.832
8	1402.933	1386.299	1381.697	1380.376	1379.961
9	1602.933	1584.219	1579.043	1577.557	1577.089
10	1802.933	1782.140	1776.388	1774.737	1774.218
11	2002.933	1980.061	1973.734	1971.918	1971.346
12	2202.933	2177.982	2171.079	2169.098	2168.475
13	2402.933	2375.903	2368.425	2366.278	2365.603
14	2602.933	2573.823	2565.770	2563.459	2562.732

| 15 | 2802.933 | 2771.774 | 2763.116 | 2760.639 | 2759.860 |

Table 12.13: SAMP-SEQ=STEP25

	Image Size				
Sample Number	Full Frame	512 × 512	256 × 256	128 × 128	64 × 64
1	2.932	0.853	0.278	0.113	0.061
2	5.865	1.706	0.556	0.225	0.122
3	8.797	2.559	0.833	0.338	0.182
4	11.729	3.412	1.111	0.451	0.243
5	24.230	13.833	10.957	10.132	9.872
6	49.230	36.755	33.303	32.313	32.001
7	74.231	59.676	55.649	54.494	54.130
8	99.231	82.597	77.995	76.675	76.259
9	124.232	105.518	100.341	98.855	98.388
10	149.232	128.440	122.688	121.036	120.517
11	174.233	151.361	145.034	143.217	142.646
12	199.233	174.282	167.380	165.398	164.775
13	224.234	197.203	189.726	187.579	186.904
14	249.234	220.125	212.072	209.760	209.033
15	274.235	243.046	234.418	231.941	231.162

Table 12.14: SAMP-SEQ=STEP50

	Image Size				
Sample Number	Full Frame	512 × 512	256 × 256	128 × 128	64 × 64
1	2.932	0.853	0.278	0.113	0.061
2	5.865	1.706	0.556	0.225	0.122
3	8.797	2.559	0.833	0.338	0.182
4	11.729	3.412	1.111	0.451	0.243
5	24.230	13.833	10.957	10.132	9.872

6	49.230	36.755	33.303	32.313	32.001
7	99.231	84.676	80.649	79.494	79.130
8	149.231	132.597	127.995	126.674	126.259
9	199.232	180.518	175.341	173.855	173.388
10	249.232	228.439	222.687	221.036	220.517
11	299.232	276.361	270.033	268.217	267.646
12	349.233	324.282	317.379	315.398	314.775
13	399.233	372.203	364.725	362.579	361.904
14	449.234	420.124	412.071	409.760	409.033
15	499.234	468.045	459.417	456.940	456.162

Table 12.15: SAMP-SEQ=STEP100

	Image Size				
Sample Number	Full Frame	512 × 512	256 × 256	128 × 128	64 × 64
1	2.932	0.853	0.278	0.113	0.061
2	5.865	1.706	0.556	0.225	0.122
3	8.797	2.559	0.833	0.338	0.182
4	11.729	3.412	1.111	0.451	0.243
5	24.230	13.833	10.957	10.132	9.872
6	49.230	36.755	33.303	32.313	32.001
7	99.231	84.676	80.649	79.494	79.130
8	199.231	182.597	177.995	176.674	176.259
9	299.231	280.518	275.341	273.855	273.388
10	399.232	378.439	372.687	371.036	370.516
11	499.232	476.360	470.033	468.217	467.645
12	599.232	574.281	567.379	565.397	564.774
13	699.233	672.202	664.724	662.578	661.903
14	799.233	770.123	762.070	759.759	759.032
15	899.233	868.044	859.416	856.939	856.161

Table 12.16: SAMP-SEQ=STEP200

	Image Size				
Sample Number	Full Frame	512 × 512	256 × 256	128 × 128	64 × 64
1	2.932	0.853	0.278	0.113	0.061
2	5.865	1.706	0.556	0.225	0.122
3	8.797	2.559	0.833	0.338	0.182
4	11.729	3.412	1.111	0.451	0.243
5	24.230	13.833	10.957	10.132	9.872
6	49.230	36.755	33.303	32.313	32.001
7	99.231	84.676	80.649	79.494	79.130
8	199.231	182.597	177.995	176.674	176.259
9	399.231	380.518	375.341	373.855	373.387
10	599.231	578.438	572.686	571.035	570.516
11	799.231	776.359	770.032	768.216	767.645
12	999.231	974.280	967.378	965.396	964.773
13	1199.231	1172.201	1164.723	1162.577	1161.902
14	1399.231	1370.122	1362.069	1359.757	1359.030
15	1599.231	1568.043	1559.414	1556.938	1556.159

Table 12.17: SAMP-SEQ=STEP400

	Image Size				
Sample Number	Full Frame	512 × 512	256 × 256	128 × 128	64 × 64
1	2.932	0.853	0.278	0.113	0.061
2	5.865	1.706	0.556	0.225	0.122
3	8.797	2.559	0.833	0.338	0.182
4	11.729	3.412	1.111	0.451	0.243
5	24.230	13.833	10.957	10.132	9.872
6	49.230	36.755	33.303	32.313	32.001
7	99.231	84.676	80.649	79.494	79.130

8	199.231	182.597	177.995	176.674	176.259
9	399.231	380.518	375.341	373.855	373.387
10	799.232	778.439	772.687	771.036	770.516
11	1199.232	1176.360	1170.033	1168.217	1167.646
12	1599.233	1574.282	1567.379	1565.398	1564.775
13	1999.233	1972.203	1964.725	1962.579	1961.904
14	2399.234	2370.124	2362.071	2359.760	2359.033
15	2799.235	2768.046	2759.417	2756.941	2756.162

Available but unsupported MIF sequences

MIF Sequences

Table 12.18: SAMP-SEQ=MIF600

	Image Size				
Sample Number	Full Frame	512 × 512	256 × 256	128 × 128	64 × 64
1	2.932	0.853	0.278	0.113	0.061
2	5.865	1.706	0.556	0.225	0.122
3	8.797	2.559	0.833	0.338	0.182
4	11.729	3.412	1.111	0.451	0.243
5	14.661	4.265	1.389	0.564	0.304
6	17.594	5.118	1.667	0.676	0.365
7	159.531	144.976	140.950	139.794	139.430
8	301.468	284.834	280.232	278.911	278.496
9	443.405	424.692	419.515	418.029	417.562
10	585.343	564.550	558.798	557.147	556.627
11	588.275	565.403	559.076	557.259	556.688
12	591.207	566.256	559.353	557.372	556.749
13	594.139	567.109	559.631	557.485	556.810
14	597.072	567.962	559.909	557.598	556.871
15	600.004	568.815	560.187	557.710	556.931

Table 12.19: SAMP-SEQ=MIF900

	Image Size				
Sample Number	Full Frame	512 × 512	256 × 256	128 × 128	64 × 64
1	2.932	0.853	0.278	0.113	0.061
2	5.865	1.706	0.556	0.225	0.122
3	8.797	2.559	0.833	0.338	0.182
4	11.729	3.412	1.111	0.451	0.243
5	14.661	4.265	1.389	0.564	0.304
6	17.594	5.118	1.667	0.676	0.365
7	234.531	219.976	215.949	214.794	214.430
8	451.468	434.834	430.232	428.911	428.496
9	668.405	649.691	644.515	643.029	642.561
10	885.342	864.549	858.797	857.146	856.627
11	888.274	865.402	859.075	857.259	856.687
12	891.206	866.255	859.353	857.371	856.748
13	894.139	867.108	859.631	857.484	856.809
14	897.071	867.961	859.908	857.597	856.870
15	900.003	868.814	860.186	857.710	856.931

Table 12.20: SAMP-SEQ=MIF1200

	Image Size				
Sample Number	Full Frame	512 × 512	256 × 256	128 × 128	64 × 64
1	2.932	0.853	0.278	0.113	0.061
2	5.865	1.706	0.556	0.225	0.122
3	8.797	2.559	0.833	0.338	0.182
4	11.729	3.412	1.111	0.451	0.243
5	14.661	4.265	1.389	0.564	0.304
6	17.594	5.118	1.667	0.676	0.365
7	309.531	294.976	290.949	289.793	289.430
8	601.467	584.833	580.232	578.911	578.495
9	893.404	874.691	869.514	868.028	867.561
10	1185.341	1164.548	1158.796	1157.145	1156.626
11	1188.273	1165.401	1159.074	1157.258	1156.687
12	1191.206	1166.255	1159.352	1157.371	1156.747
13	1194.138	1167.108	1159.630	1157.483	1156.808
14	1197.070	1167.961	1159.908	1157.596	1156.869
15	1200.003	1168.814	1160.185	1157.709	1156.930

Table 12.21: SAMP-SEQ=MIF1500

	Image Size				
Sample Number	Full Frame	512 × 512	256 × 256	128 × 128	64 × 64
1	2.932	0.853	0.278	0.113	0.061
2	5.865	1.706	0.556	0.225	0.122
3	8.797	2.559	0.833	0.338	0.182
4	11.729	3.412	1.111	0.451	0.243
5	14.661	4.265	1.389	0.564	0.304
6	17.594	5.118	1.667	0.676	0.365
7	384.530	369.976	365.949	364.793	364.430
8	751.467	734.833	730.231	728.910	728.495
9	1118.404	1099.690	1094.513	1093.027	1092.560
10	1485.340	1464.548	1458.796	1457.144	1456.625
11	1488.273	1465.401	1459.073	1457.257	1456.686
12	1491.205	1466.254	1459.351	1457.370	1456.747
13	1494.137	1467.107	1459.629	1457.483	1456.807
14	1497.069	1467.960	1459.907	1457.595	1456.868
15	1500.002	1468.813	1460.185	1457.708	1456.929

Change Log

None

12.4 WFC3 Restricted Engineering Modes

HST's WFC3 instrument can obtain data necessary for instrument maintenance, and the Astronomer's Proposal Tool (APT) has parameters for specifying these observations.

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Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Mode = ALIGN Config = WFC3/UVIS or WFC3/IR

This Mode is used to move the WFC3 internal focus and tilt mechanisms for the UVIS or IR channel (depending on the selected configuration) via stored commanding for the purpose of on-orbit alignment of the aberration correction optics. ALIGN exposures do not acquire science data and must be interleaved with science mode exposures to obtain data, with the alignment mechanisms at a variety of positions for the ground alignment process.

The proposer must ensure that the alignment scans are within the allowed mechanism limits. The mechanism positions, corresponding to the nominal zero positions of the alignment scan, will be set via real-time command. This will be accomplished in a proposal by specifying an ALIGN mode exposure with the special requirement REQuires UPLINK. Because the positions of the mechanisms are set via real-time command, optional parameters are disallowed in conjunction with the REQuires UPLINK special requirement to prevent commanding the mechanisms via stored commands.

Any visit which contains ALIGN mode exposures must use a single configuration for all exposures (including the science exposures), either WFC3/UVIS or WFC3/IR but not both. The use of internal targets (other than NONE) in visits containing Mode=ALIGN exposures is not allowed. A WFC3/IR visit must contain an external target exposure.

Target Name

The special value NONE must be specified.

Aperture or FOV

Do not enter a value.

Spectral Element

Do not enter a value.

Wavelength

Do not enter a value.

Optional Parameters

FOCUS

= 0 (default); -11232 to +11232 (steps)

Specifies the relative position from a nominal zero position of the focus mechanism, in motor steps. The absolute position of the nominal zero is set by real-time command.

TILT

= NO (default), YES

Specifies whether a tilt of the corrector mechanisms will be commanded. If this parameter is set to **YES**, the maximum time required to move both cylinders of the tilt mechanism will be included in the alignment time. You should consult with the Commanding Team regarding QESIPARM and QELOGSHEET special requirements needed to specify the tilt scan.

Number of Iterations

The **Number_Of_Iterations** must be 1.

Time Per Exposure

Proposers may specify a positive value of **Time_Per_Exposure** to provide for additional time after the move has completed to wait prior to the start of the subsequent WFC3 exposure. This time may be desirable if, for instance, the corrector move in the **ALIGN** Mode exposure could adversely affect the thermal environment (due to running the motors) and a cool-down time is required before the science exposure.

Special Requirements

Optional parameters may not be specified for **ALIGN** exposures with the

REQuires **UPLINK** special requirement.

Mode = ANNEAL Config = WFC3

This Mode allows specification of periods of time during which the WFC3 will be warmed for hot pixel repair. The total annealing time will be the specified exposure time plus a minimum, default value (12 hours). The **ANNEAL** exposures do not collect science data. The **Anneal** exposure must be in its own visit due to the time required to configure the instrument for the procedure.

Target Name

The special value **NONE** must be specified.

Aperture or FOV

Do not enter a value.

Spectral Element

Do not enter a value.

Wavelength

Do not enter a value.

Optional Parameters

IRTEMP

= COLD, WARM

This parameter must be specified.

No WFC3 science can be scheduled during an **IRTEMP=WARM,** anneal. WFC3 IR science can be scheduled during an **IRTEMP=COLD** anneal (see **Time Per Exposure**).

Number of Iterations

The Number_Of_Iterations must be 1.

Time Per Exposure

The STScI ground system enforces a minimum anneal time of 12 hours. If a longer time is needed, specify a total time that includes this 12 hour minimum.

- Any value less than 12 hours (43200 seconds) will result in a 12 hour anneal.
- Any value greater than 0 will prevent IR science from scheduling during the initial specified portion of an **IRTEMP=COLD** anneal. Therefore, specify a Time_Per_Exposure = 0 for a nominal 12 hour **IRTEMP=COLD** anneal during which parallel IR is permitted.

Special Requirements

SAA CONTOUR defaults to model 11 (non-intersecting). The ANNEAL exposure only triggers the reconfigurations that actually perform the anneal process so this potentially long exposure does not have to avoid the SAA. Using any other model may result in inefficient scheduling with the potential for the detectors to be left in unusual states longer than necessary. Changing to something other than model 11 should be thoroughly discussed with the Commanding, Engineering and Ops personnel and may require system level changes beyond what is capaable in the proposal.

Change Log

Version Cycle 31 June 2023

    Removed old PR link from Change Log.

Version Cycle 26 October 2018

1. PR.90925 Document that ACS, STIS, WFC3 ANNEAL exposures will use SAA Model 11
   12.4 WFC3 Restricted Engineering Modes

Initial Conversion HST Cycle 25 Phase II Proposal Instructions (Engineering) Version Cycle 25 (June 2018)

12.5 WFC3 Reference Information

This article contains reference information for WFC3.

Sections

- [12.5.1 WFC3 UVIS Spectral Elements](#)
- [12.5.2 WFC3 IR Spectral Elements](#)
- [12.5.3 WFC3 Coordinate System](#)

12.5.1 WFC3 UVIS Spectral Elements

There are many spectral elements (filters and grism) allowed for HST's WFC3/UVIS. This article provides a list of those spectral elements for the Astronomer's Proposal Tool (APT).

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Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

The UVIS channel has 12 filter wheels with four spectral elements each. Only one spectral element may be specified for an exposure.

The quadrant filters pass light in four discrete bands in different quadrants of the detector. These may be selected just like any other filter, but the selected filter will only produce data in one quadrant of the detector. Exposures with a quad filter must be done with the **UVIS-QUAD**, **UVIS-QUAD-FIX** or **UVIS-QUAD-SUB** aperture. Use of the first two apertures will result in the read out of data from all four quad filters in the slot while the last aperture will result in the read out of only the quadrant of the quad filter specified.

Table 12.22: Spectral Elements for use with WFC3/UVIS

Name	Wheel	Position	Pivot[1] Wavelength (Å)	Effective Width[2] (Å)	Description
F200LP	2	3	5686.9	(6500)	Clear; grism reference
F218W	3	1	2183.0	351.7	ISM feature
F225W	3	2	2341.0	547.3	UV Wide
F275W	9	1	2715.3	480.8	UV Wide
F280N	4	2	2796.8	22.9	MgII 2795/2802

F300X	1	2	2829.8	753.0	Extremely wide UV
F336W	4	1	3361.1	553.8	U, Stromgren u
F343N	4	3	3438.0	140.0	[NeV] 3426
F350LP	11	2	6812.0	(4500)	Long Pass
F373N	9	4	3729.6	39.2	[OII] 3726/3728
F390M	8	1	3893.8	210.5	CaII continuum
F390W	11	1	3904.6	953.0	Washington C
F395N	10	4	3953.7	72.9	CaII H&K (3933/3968)
F410M	9	2	4107.0	182.8	Stromgren v
F438W	10	1	4318.7	676.8	WFPC2 B
F467M	9	3	4680.7	218.0	Stromgren b
F469N	3	4	4687.5	37.2	HeII 4686
F475W	6	1	4760.6	1488.9	SDSS g'
F475X	10	3	4917.1	2199.6	Extremely wide blue
F487N	2	1	4870.7	48.4	Hβ4861
F502N	2	2	5009.0	57.8	[OIII] 5007
F547M	8	2	5447.0	714.0	Stromgren y
F555W	7	1	5309.8	1595.1	WFPC2 V
F600LP	6	3	8430.2	(4000)	Long Pass
F606W	6	2	5907.0	2304.2	WFPC2 Wide V
F621M	8	3	6216.7	631.0	11% passband
F625W	5	1	6254.0	1575.4	SDSS r'
F631N	1	3	6303.0	43.1	[OI] 6300
F645N	4	4	6451.6	85.0	Continuum
F656N	1	4	6561.1	13.9	Hα 6563
F657N	3	3	6565.1	96.3	Wide (Hα +[NII])
F658N	11	3	6585.2	23.6	[NII] 6583
F665N	5	2	6654.4	109.0	z (Hα + [NII])
F673N	5	3	6764.5	100.5	[SII] 6717/6731
F680N	5	4	6878.6	323.6	z (Hα + [NII])

F689M	7	4	6886.0	708.6	11% passband
F763M	8	4	7636.3	798.6	11% passband
F775W	10	2	7733.6	1486.0	SDSS i'
F814W	7	2	8304.7	2543.3	WFPC2 Wide I
F845M	6	4	8468.9	886.7	11% passband
F850LP	7	3	9756.4	(1500)	SDSS z'
F953N	2	4	9529.7	84.6	[SIII] 9532
Quadrant Filters (Readout Amplifier included in the Position)					
FQ232N	12	1C	2326.9	32.2	CII] 2326
FQ243N	12	1D	2420.6	34.8	[Ne IV] 2425
FQ378N	12	1B	3790.9	89.2	z ([OII] 3726)
FQ387N	12	2A	3873.0	23.1	[NeIII]3868
FQ422M	12	2C	4217.7	113.3	Blue Continuum
FQ436N	12	2D	4366.7	35.7	[OIII] 4363 + Hγ 4340
FQ437N	12	1A	4370.6	24.6	[OIII] 4363
FQ492N	12	2B	4932.1	101.0	z (Hβ)
FQ508N	11	4A	5089.7	117.9	z ([OIII] 5007)
FQ575N	11	4C	5755.9	12.9	[NII] 5754
FQ619N	12	4A	6197.5	61.6	CH_4 6194
FQ634N	12	4C	6347.5	66.2	6194 continuum
FQ672N	11	4D	6716.1	14.9	[SII] 6717
FQ674N	11	4B	6729.5	10.0	[SII] 6731
FQ727N	12	4D	7274.7	64.8	CH_4 7270
FQ750N	12	4B	7500.6	68.8	7270 continuum
FQ889N	12	3A	8891.8	93.7	CH_4 25 km-agt[3]
FQ906N	12	3C	9056.7	94.0	CH_4 2.5 km-agt
FQ924N	12	3D	9246.3	89.2	CH_4 0.25 km-agt
FQ937N	12	3B	9371.1	91.9	CH_4 0.025 km-agt

UV Grism				
G280	1	1	(2775)	1850	UV grism

[1]"Pivot wavelength" is a measure of the effective wavelength of a filter (see A. Tokunaga & W. Vacca 2006, PASP, 117, 421). It is calculated here based only on the filter transmission. Values are approximate for the long-pass filters. All wavelength measurements in this table were made in air.

[2]Full width at 50% of peak transmission for wide and medium bands, and at 10% of peak transmission for narrow bands. For long-pass filters, the widths are approximate and include convolution with the detector QE.

[3]km-agt (km-amagat) is a unit of vertical column density, equal to 2.69×10^{24} molecules/cm^2

Related Links

12.5.2 WFC3 IR Spectral Elements
12.5.3 WFC3 Coordinate System

Change Log
Version Cycle 30 June 2022

Edit suggested by the WFC3 team (removed IR Spectral Element table which was a duplicate of the one in section 12.5.2)

12.5.2 WFC3 IR Spectral Elements

There are many spectral elements (filters and grisms) allowed for HST's WFC3/IR. This article provides a list of those spectral elements for the Astronomer's Proposal Tool (APT).

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Format definitions

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Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

The IR channel has a single filter wheel with 17 spectral elements and one blank element. Only one spectral element may be specified for an exposure.

Table 12.23: Spectral Elements for use with WFC3/IR

Name	Position	Pivot[1] Wavelength (nm)	Effective Width[2] (nm)	Description
F098M	6	982.93	169.48	Blue grism reference
F105W	5	1048.95	292.30	Wide *Y*
F110W	4	1141.40	503.40	Wide *YJ*
F125W	2	1245.90	301.50	Wide *J*
F126N	15	1258.26	11.83	[FeII]
F127M	11	1273.64	68.79	H_2O/CH_4 continuum
F128N	12	1283.30	13.54	Paschenβ
F130N	13	1300.62	13.28	Paschenβ continuum

F132N	14	1319.04	13.07	Paschenβ (redshifted)
F139M	10	1383.80	64.58	H_2O/CH_4 line
F140W	8	1392.10	399.00	Wide *JH* gap; red grism reference
F153M	9	1533.31	68.78	H_2O and NH_3
F160W	1	1540.52	287.88	WFC3 *H*
F164N	17	1645.13	17.48	[FeII]
F167N	16	1667.26	17.16	[FeII] continuum
G102	7	(1025)	250	Blue high-resolution grism
G141	3	(1410)	600	Red low-resolution grism
B L A N K (restricted)	0	N/A	N/A	Blank (opaque)

[1]"Pivot wavelength" is defined in Table 12.22: *Spectral Elements for use with WFC3/UVIS*. All wavelength measurements in this table were made in air.

[2]Full width at 50% of peak transmission.

Related Links

12.5.1 WFC3 UVIS Spectral Elements
12.5.3 WFC3 Coordinate System

Change Log
Version Cycle 30 June 2022

Edit suggested by the WFC3 team (renumbered IR Spectral Element table which had been duplicated in section 12.5.1)

12.5.3 WFC3 Coordinate System

WFC3 is located on-axis in the focal plane of HST. This article shows how the detector reference frame compares to HST's U2, U3 reference frame.

On This Page

Format definitions

Boldface type indicates the name of an APT parameter or a value for a parameter.

⭐ Black text indicates an important note.

Magenta text indicates available but unsupported parameters (requires prior approval from STScI).

Red text indicates restricted parameters (for STScI use only).

Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

Figures 12.1 and 12.2 illustrate the locations of the UVIS and IR apertures. In the figures, the outlines of the full-detector apertures of both the UVIS and IR channels are indicated, as projected onto the sky and with respect to the HST U2-U3 coordinate system.

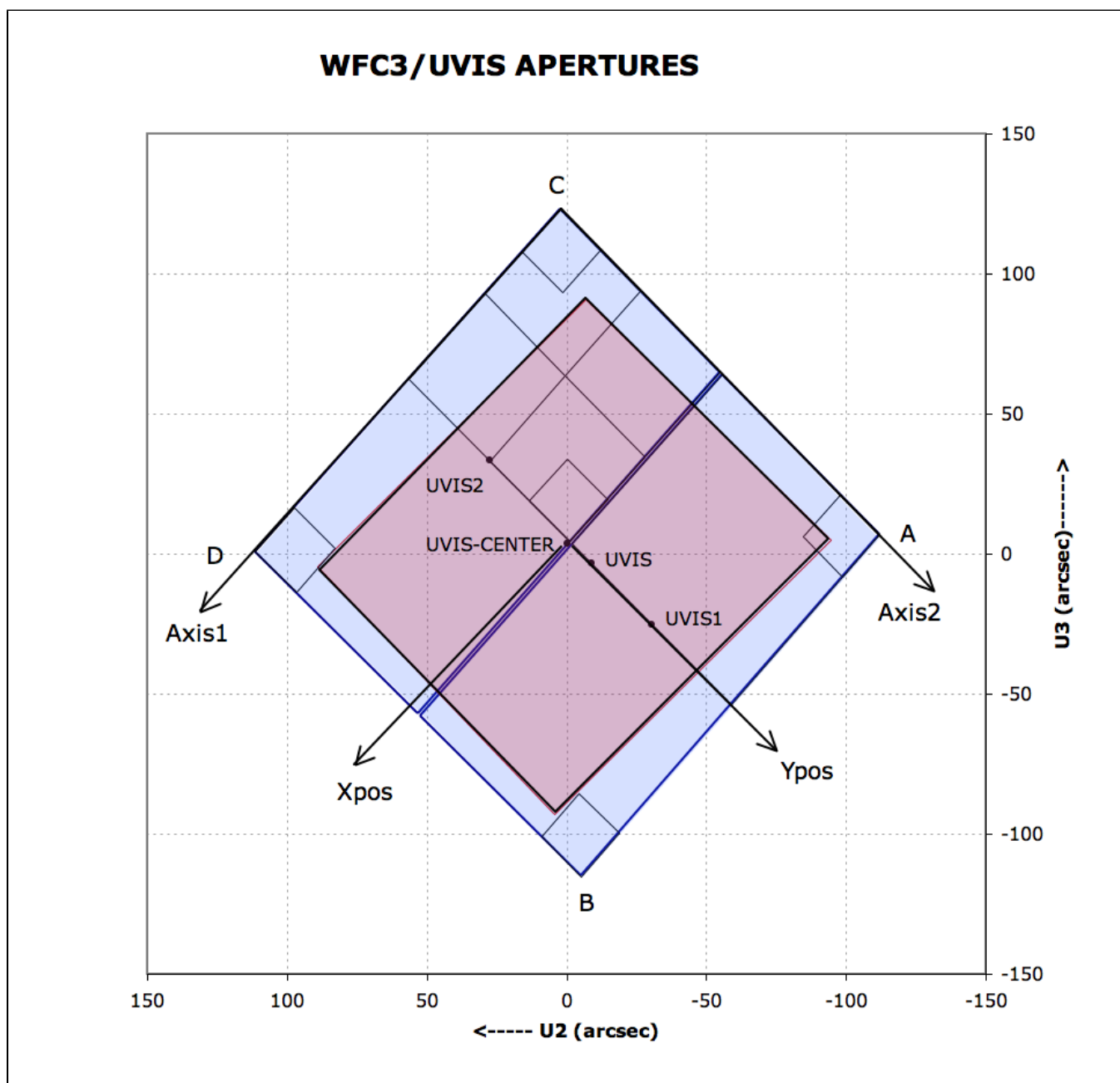**Figure 12.1: UVIS Aperture Diagram**

Figure 12.1: *UVIS Aperture Diagram* illustrates the fiducial points of the full-detector apertures (UVIS, UVIS1, UVIS2, and UVIS-CENTER), and the outlines of the 2K × 2K, 1K × 1K, and 512 × 512 subarray apertures. Also indicated are the positions of the four readout amplifiers (A, B, C, and D). The regions imaged by the UVIS detector (represented by blue fill) and by the IR detector (represented by red fill) are also indicated. The POSition TARGet coordinate system for the UVIS-CENTER aperture, with its origin at that aperture's fiducial point, is illustrated. Although the POSition TARGet coordinate systems for the other apertures are not illustrated, they are oriented the same, but have origins at each aperture's fiducial point.
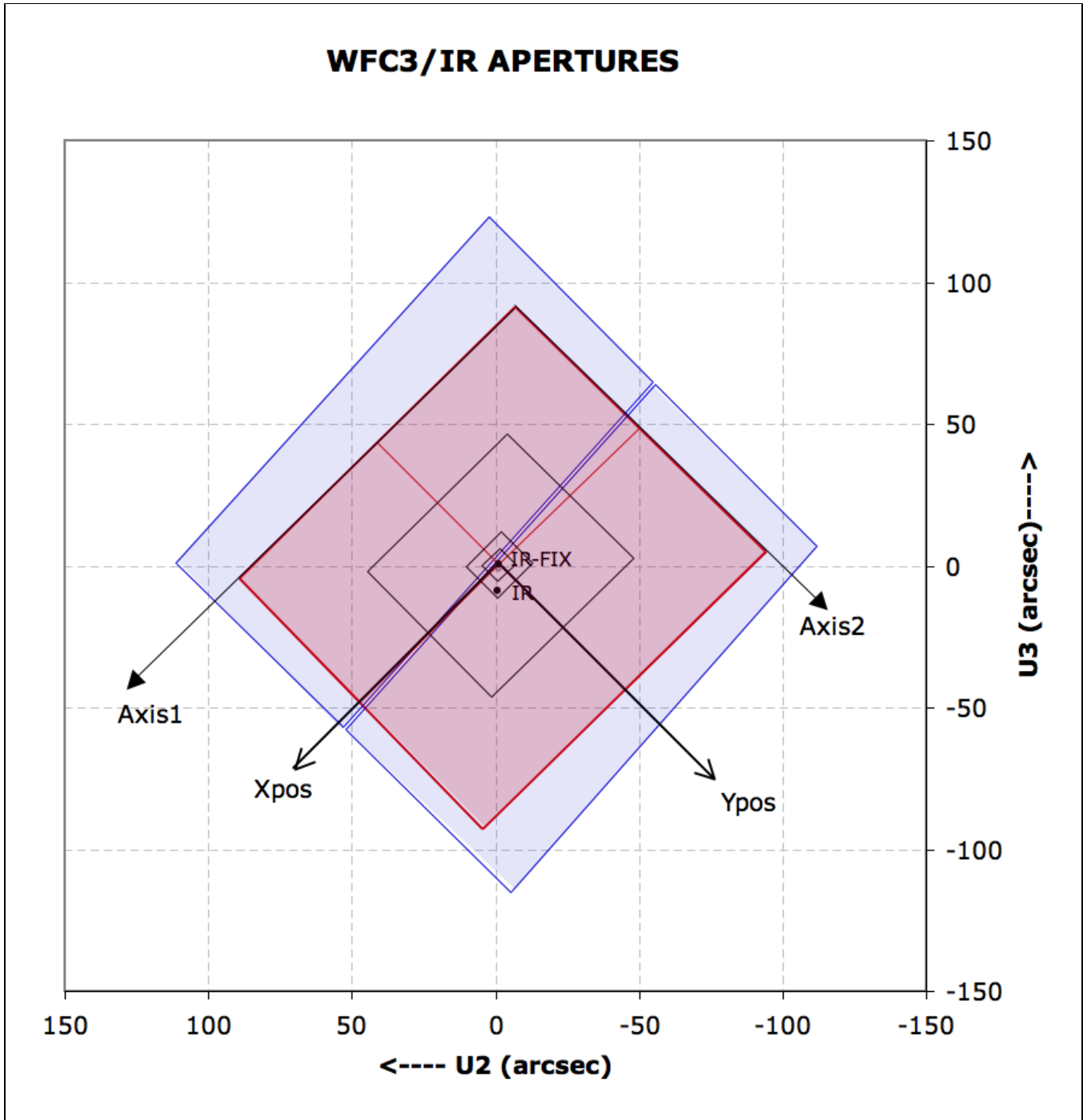
Figure 12.2: IR Aperture Diagram

Figure 12.2: *IR Aperture Diagram* illustrates the fiducial points of two of the full-detector apertures (IR and IR-FIX), and the outlines of the concentric subarray apertures (512 × 512, 256 × 256, 128 × 128, and 64 × 64). The regions imaged by the UVIS detector (represented by blue fill) and by the IR detector (represented by red fill) are also indicated. The POSition TARGet coordinate system for the IR-FIX Aperture, with its origin at that aperture's fiducial point, is illustrated. Although the POSition TARGet coordinate systems for the other apertures are not illustrated, they are oriented the same, but have origins at each aperture's fiducial point.

Related Links

[12.5.1 WFC3 UVIS Spectral Elements](#)
[12.5.2 WFC3 IR Spectral Elements](#)

Change Log
None

Chapter 13 Spacecraft Mode, SC

Spacecraft (S/C) mode is designed for engineering staff to specify telemetry requirements and allow pointings of HST without science instrument usage or telemetry contacts.

On This Page

Format definitions

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Brown text indicates text file parameters.

Items in brackets - **<value>** - are required values.

Items in square brackets - **[<value>]** - are optional.

Introduction

Spacecraft (S/C) mode exposures are designed to be used primarily by the engineering staff. S/C mode allows for two main capabilities that are not readily available in other operations modes:

1. It enables specification of telemetry requirements for science or engineering or both.
2. It enables specification of a S/C pointing without the use of any science instrument (SI) or telemetry contacts.

Data Mode

Mode = DATA Config = S/C

This mode allows for the specification of the spacecraft telemetry requirements and optionally the spacecraft pointing. If there is no pointing requirement, the target should be specified as **DARK**. If telemetry is desired for an exposure using another configuration, the **FORMAT** exposure-level Special Requirement should be used.

Aperture or FOV

> **NONE**

Specifies no pointing requirement.

> **V1**

Specifies the **V1** axis as the reference position. Note: other positions can be specified using the **POS**ition **TARG**et special requirement.

Special Requirements

Special requirements should be used to specify real-time links and/or tape recorder operations (see Special Communications Requirements).

- **RT ANALYSIS** should be used when a downlink is required.
- **FORMAT** should be used if data is to go to the tape recorder.
- **REQ**uires **UPLINK** should be used when an uplink is required.
- **REQ**uires **UPLINK** and **RT ANALYSIS** should both be used when a down- link and an uplink are both necessary.

Pointing Mode

Mode = POINTING Config = S/C

This mode supports the specification of the spacecraft pointing and control without any other requirements (i.e. telemetry or command). If the internal target **DARK** is used, no pointing requirement is imposed. In this case time is allocated in the planning process. The use of this time should be completely specified in the comments and text description of the observations.

Aperture or FOV

> **V1**

All pointings are specified with respect to the origin of the V1 axis. To position the target at other places in the FOV use the **POS**ition **TARG**et special requirement.

Change Log
None