



Hubble Space Telescope Status

Cycle 25 TAC Presentation

John W. MacKenty

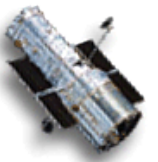
June 11, 2017

Welcome!



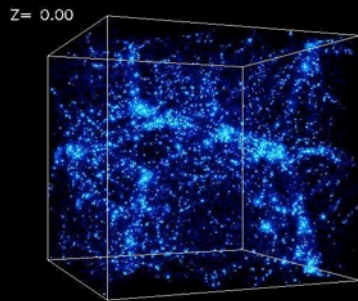
- Thank you all for serving on the Cycle 25 HST TAC
- The Hubble Space Telescope has now completed 27 years in operation!
 - We are now 8 years past Servicing Mission 4
 - At that time planning was for 5 years of operations
 - In most respects, Hubble is working now at its very best
 - There is some slight instrument performance degradation
 - But we (GOs and STScI+GSFC) have become smarter in how we use the observatory
- Over the next several days, the team in this room has the privilege and responsibility of defining what Hubble does next.....

Hubble is As Powerful As Ever



Deep, precise, stable pan-chromatic imaging
Slitted and slitless spectroscopy, coronagraphy, astrometry

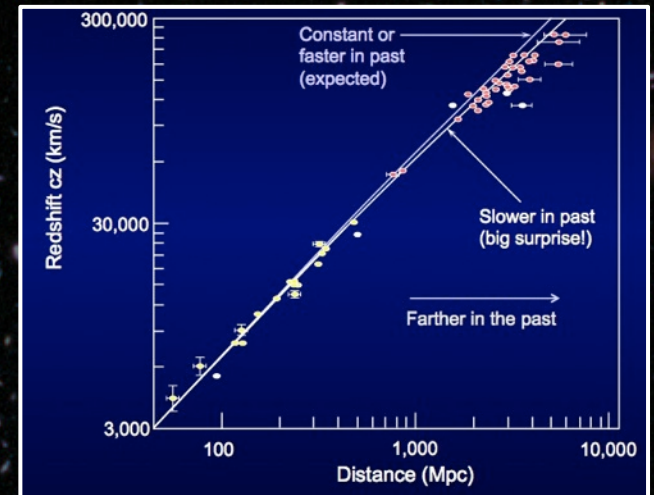
Architecture of the universe



Life stories of galaxies



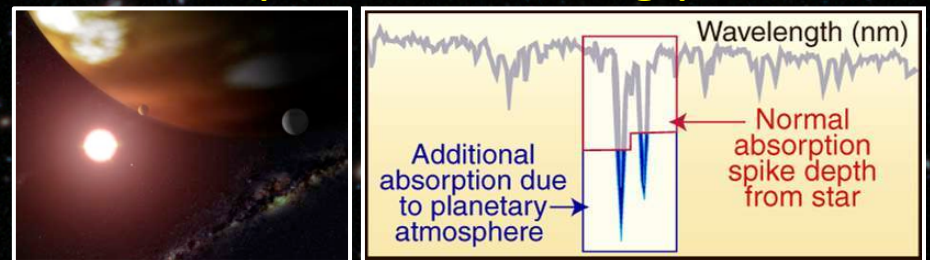
Mysteries of dark matter and dark energy

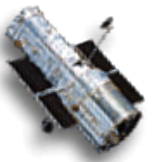
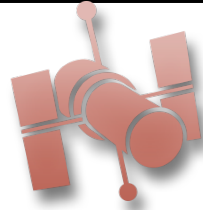


Births and deaths of stars



Recipes for building planets





Operate Hubble out to 2020 or beyond so that there is at least one year of overlapping science observations with the James Webb Space Telescope, performed in a manner that maximizes the science return of both observatories by taking full advantage of Hubble's unique capabilities and the astronomical community's scientific curiosity.

How long will Hubble continue to operate?

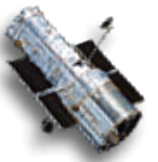
As long as it remains scientifically productive

What is needed to keep Hubble scientifically productive?

Current best estimate:
>4 years of overlap!

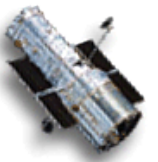
- An operating observatory
- Capable science instruments
- Scientific drivers (demand)
- Adequate staffing and user support
- Appropriate funding
- Common purpose & teamwork

The Road to 2020+




	Current Status (2017)	Expectations (2017-2021)
Observatory Health	Excellent (even better than expected after SM4)	<ul style="list-style-type: none"> • Good reliability of science instruments and major systems well beyond 2020 (NESC) • Known modes of degradation
Orbit Decay	Nominal orbit	<ul style="list-style-type: none"> • Orbit stable until mid-2030s
Scheduling Efficiency	~50%, near all-time high Averaging >84 orbits/week	<ul style="list-style-type: none"> • Efficiency declines to ~40 upon transition to reduced-gyro mode (see next slide)
Scientific Productivity	~800 papers per year; ~40 PhDs per year	<ul style="list-style-type: none"> • Publication rate remains high • New discoveries continue
Demand	>1000 proposals per year; 6:1 oversubscription (time)	<ul style="list-style-type: none"> • No near-term decrease expected
Staffing	Lean operations	<ul style="list-style-type: none"> • Work efficiencies are harder to achieve beyond FY17 without loss of capability
Mission Funding	\$98.3M/year total budget	<ul style="list-style-type: none"> • Uncertain mission budget presents challenges
Grant Funding	\$28-30M/year in grants to the community	<ul style="list-style-type: none"> • Strong support for science analysis

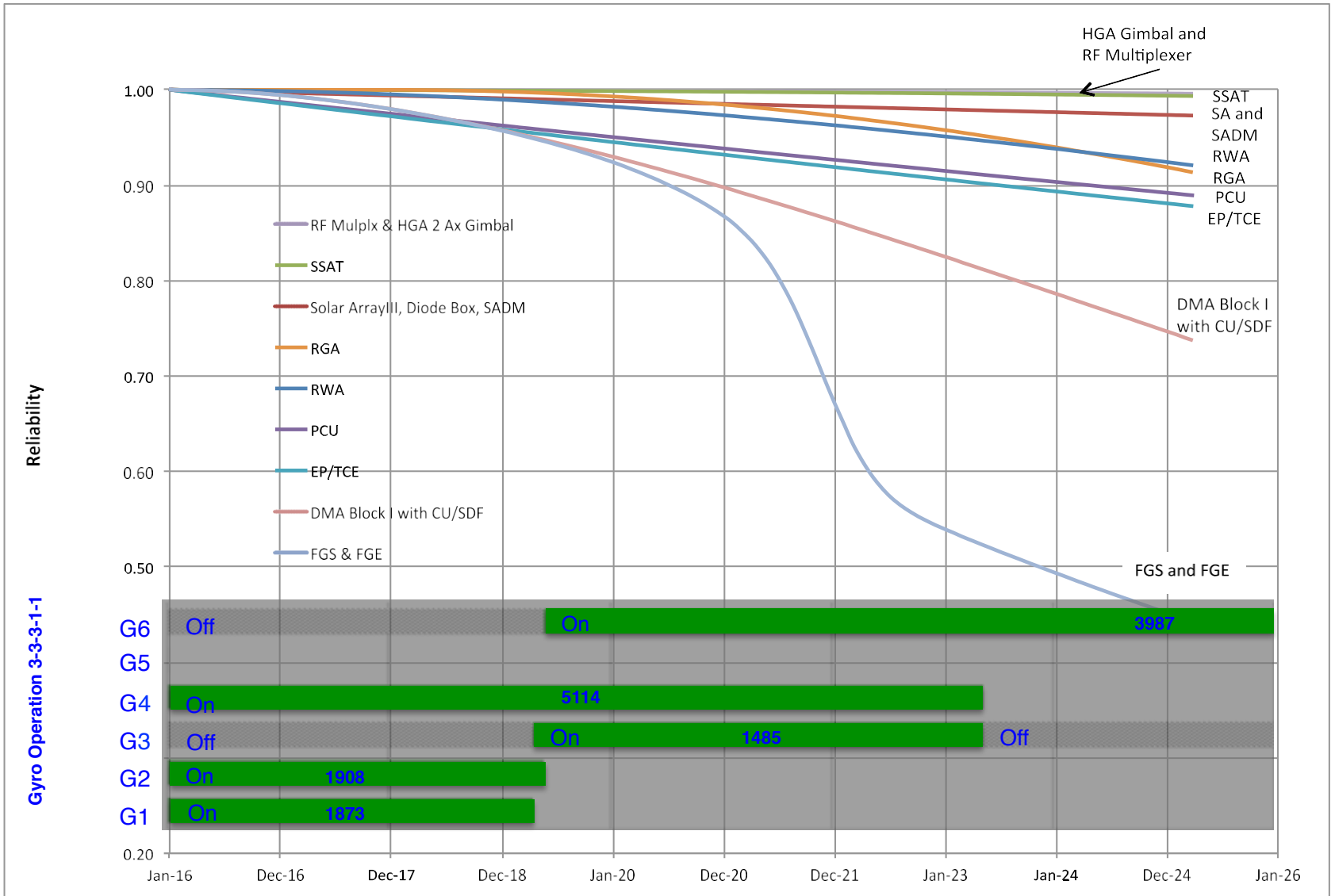
Hubble is in Excellent Health



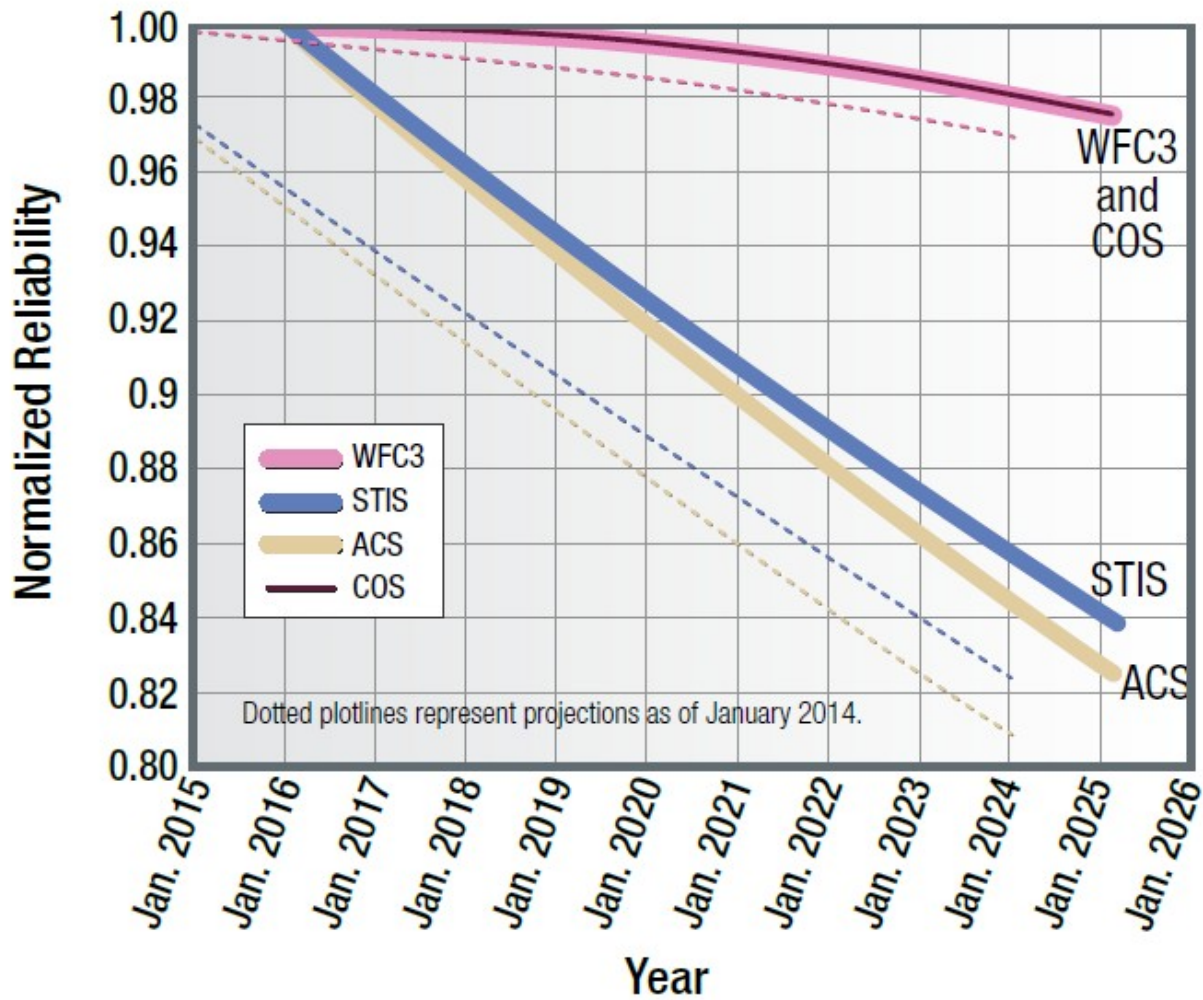
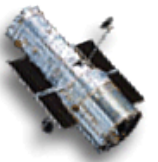
Observatory Systems Status

 Science Instruments	ACS	Operating well. Improved CTE corrections and SBC cals.
	COS	Far-UV sensitivity remains excellent. Moving to LP4 in October 2017 with new operating strategy.
	STIS	Operating well. BAR5 coronagraphy competitive with ground reaching 1E-6 with ADI and KLIP. Spatial scanning now available.
	WFC3	Excellent stability, sensitivity, astrometry. Spatial scanning and Tiling (DASH) available. CTE corrections for UVIS channel. Persistence maps available for IR channel.
Fine Guidance Sensors		Slow degradation being monitored, understood.
Electrical and Power System		Batteries and solar arrays - no serious issues.
Pointing and Control System		GYRO lifetime estimates indicate 3-gyro operation until ~2023. One-gyro science operation >2036.
Data Management System		Lockups are rare (1-2x per year) and understood.
Thermal Control System		Excellent, no serious issues.

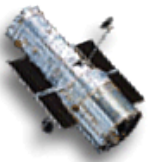
Critical System Reliability



Critical System Reliability Science Instruments

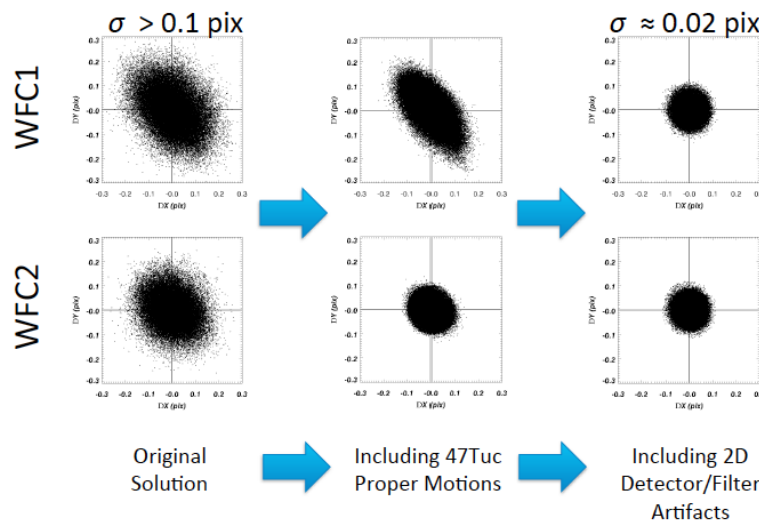


Advanced Camera for Surveys

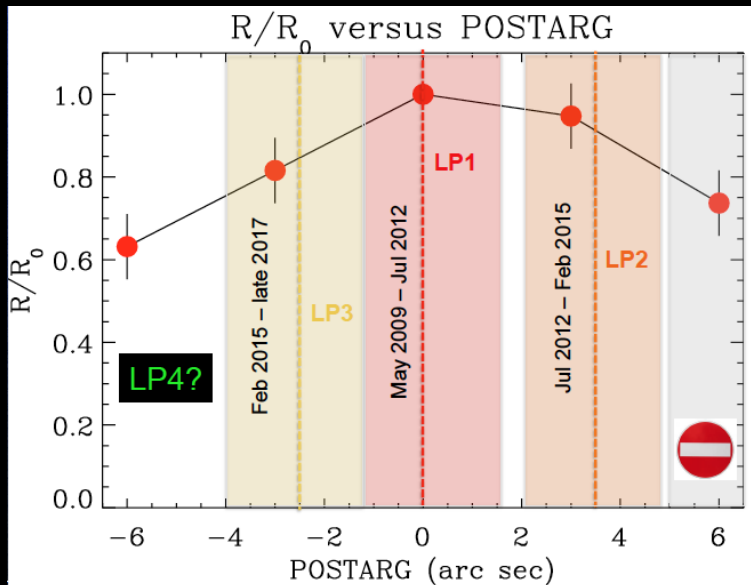
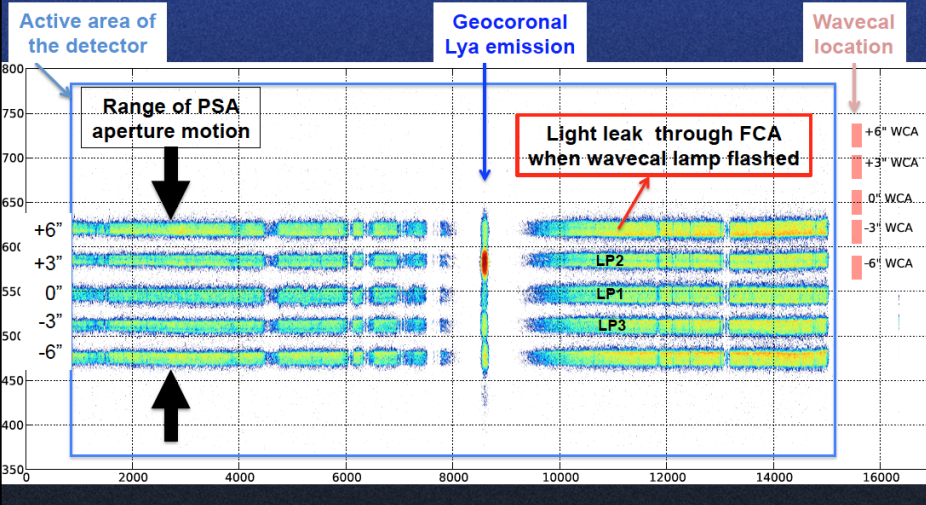


- ACS astrometry is now improved (outgrowth in part of Frontier Fields)
 - Time dependence is well understood and modeled
 - Improved 47 Tuc proper motions and Detector/Filter corrections → 1 mas
- Observers should pay attention to CTE for low background (<20e-) images
 - Improved CTE correction algorithm (based on UVIS) becoming available
- Improved calibrations of SBC PSF wings, darks, and flats

WFC G.Dist.: Astrometric Residuals

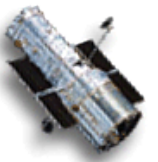


Cosmic Origins Spectrograph(1)



- COS currently operating at Lifetime Position #3 until Oct 2017
- Duration at each LP a function of number of photons on detector
 - Geocoronal Ly-alpha creates holes or dead regions on detector
- Off-center LP's result in some resolution loss
- Slow throughput declines otherwise COS operating very well
- Current usage approach would result in significant decrease in COS usefulness in late 2019 with exhaustion of LP4
 - An LP5 may be possible with issues

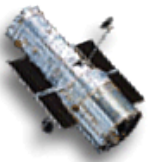
Cosmic Origins Spectrograph (2)



- COS2025 – a strategy to maintain full COS capabilities until 2025+
 - Places all geocoronal Ly-alpha in G130M at a single detector location
 - Will rapidly create a second “gap” in the detector at LP4
 - Some efficiency hit for programs requiring full wavelength coverage or highest possible S/N → let us work this out with GO’s in PHASE 2
 - TAC should ignore this change in strategy for Cycle 25 selections
 - Discussed with STUC and approved in May 2017
- Observations of M-dwarfs stars
 - COS count rate limits may pose a concern for observations of bright or variable sources
 - Observer must demonstrate observation is safe (long standing policy)
 - STScI augmented policy recently to accept 1:10,000 risk with clarified rules
 - Bright object limit issues will be resolved between GO and STScI at PHASE 2
 - TAC should judge the science and not get bogged down in implementation

STIS Performance is Stable

Celebrating 20 Years in Space



New Items:

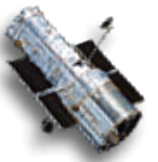
Spatial scanning with the STIS CCD can be used as an available-but-unsupported mode. Spatial scanning may be beneficial to programs requiring high S/N spectral observations that are limited by pixel level flat fielding and IR fringing.

BAR5 Coronagraph Provides 10^6 Contrast or Better

Ongoing work to improve echelle calibrations



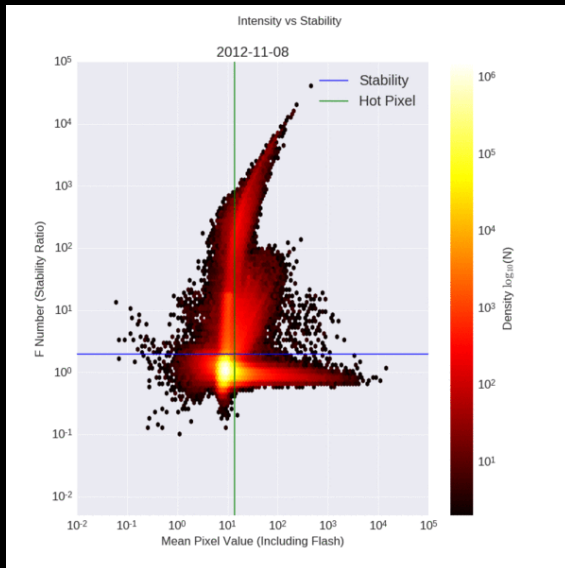
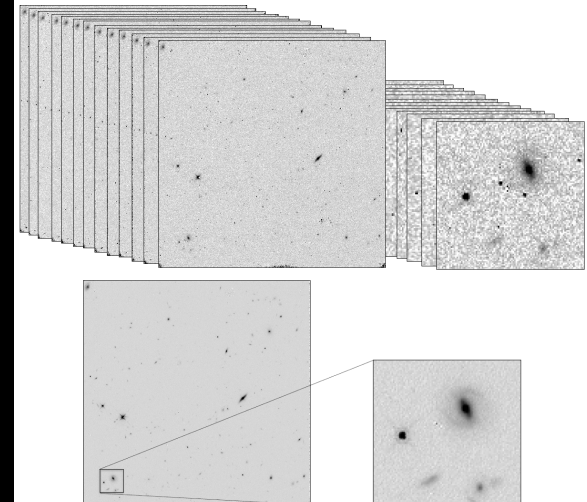
Wide Field Camera 3



WFC3 Continues to Operate Nominally

IR "DASH" Mode:

- Up to 8 tiles per orbit
- Gyro pointing with post-observation removal of small drifts (~ 0.25 pixel)

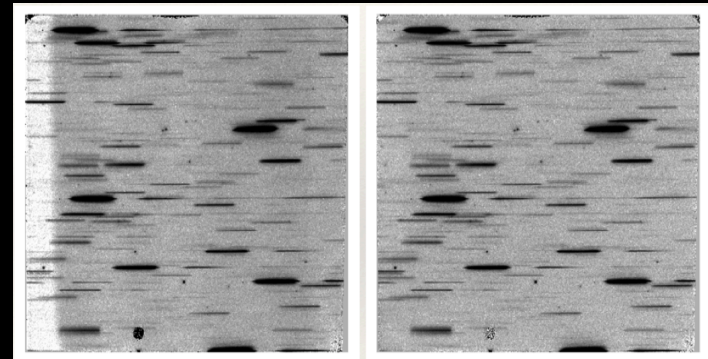


Improved identification and tracking of "bad" pixels:

- Flagging of hot, sink, and unstable pixels

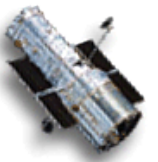
Improved background subtraction:

- G102, G141, F110W & F105W are sensitive to HeI 1.083 μ m sky line when HST is in daylight

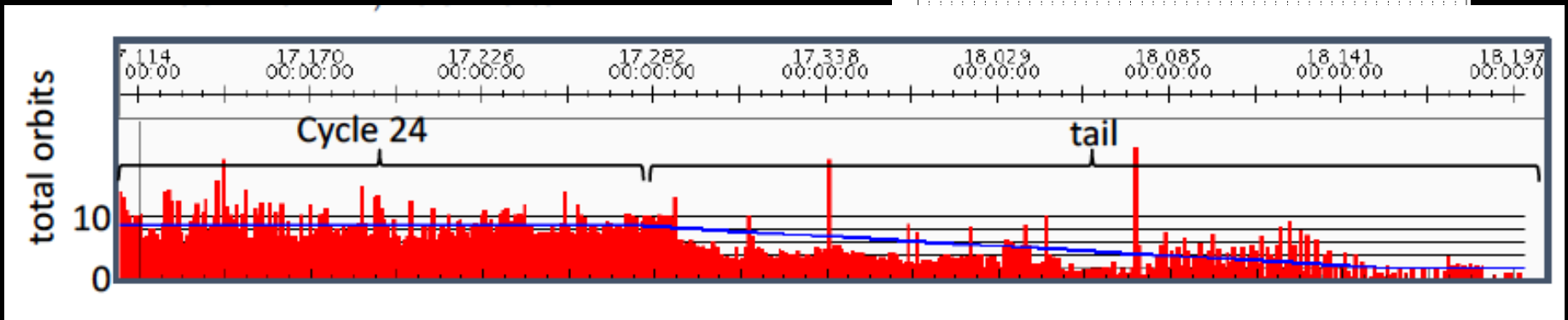
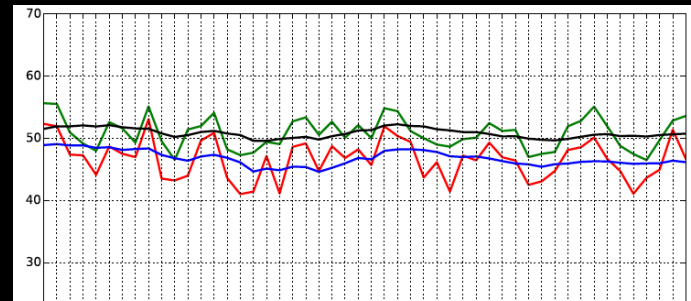


The WFC3/ can observe point sources as bright as $V \sim 0$ mag using the GRISMs in spatial scanning mode

Long Range Plan Highlights

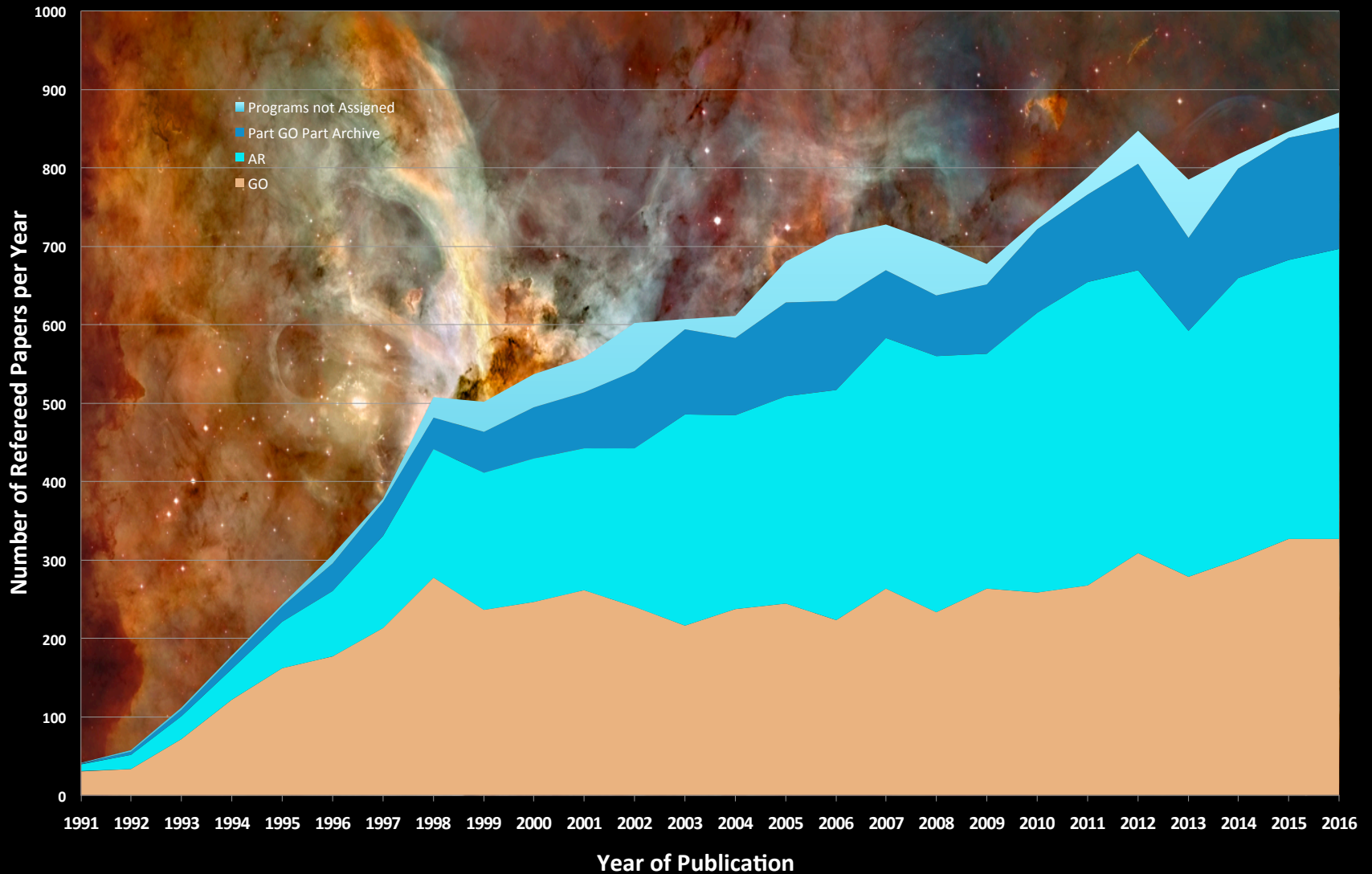


- **Cycle 24 efficiency remains high (83.3 orbits/week)**
 - 84.0 orbits/week since Cycle 17.
 - Key factors:
 - (+) Flexible mix of science accepted by TAC.
 - (+) Larger-than-normal "tail".
 - (-) Impacts of highly constrained observations (Juno, Exoplanets).

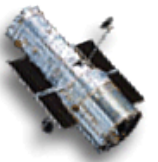


HST Science Productivity Remains High

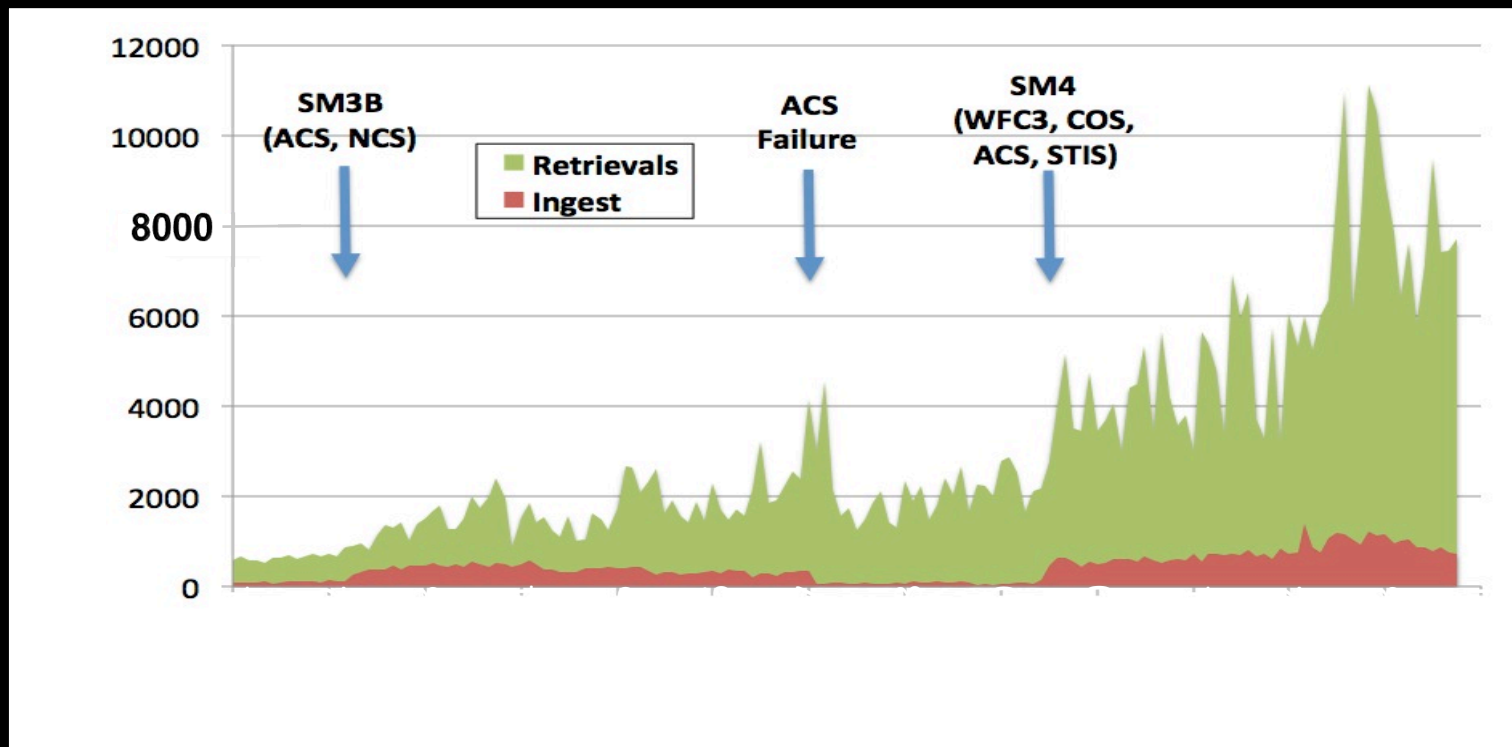
Refereed Papers per Year



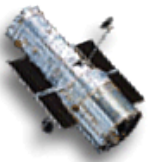
Data from the Programs You Select Will Produce Science for Years to Come



- HST archive size is >100 TB
- HST archive retrievals doubled after Servicing Mission 4 in May 2009
- >12,000 registered archive users (85 countries, 50 states)
- HST archive now online cache for rapid retrieval & improved/scripted queries



Please Share Your Science with the Public



- **Scientist PR submission form**
 - Alerts News Chief
 - Automatically logs entry for news team
 - Initiates follow-up from STScI to PI
 - <http://outreachoffice.stsci.edu/newspolicy/>
- **Archive auto-notice**
 - Reminds PI of pending “end of program”
 - Encourages communication to STScI about publications and newsworthy results



Congratulations! Your program, GO-12345, “Amazing HST Observations”, is nearing completion. As your program draws to a close, we would like to ask you to coordinate with Space Telescope Science Institute to improve the dissemination of your results and help us better follow HST usage.....

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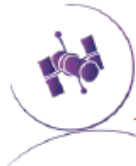
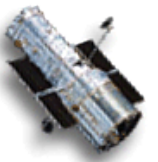
Brief description of result *

Leave the Scheduling to Us



- In reviewing Cycle 25 proposals, Panels and TAC should focus on the best science
 - Leave scheduling constraints to us to consider in the context of the entire Cycle 25 pool of recommended proposals

Hubble may be 27 years old, but its best years are still ahead....



Hubble still going strong

