

A photograph of the Hubble Space Telescope in orbit above Earth. The telescope is a complex structure with a cylindrical body, solar panels, and a large white mirror at the front. It is positioned diagonally across the frame. Below it, the Earth's horizon is visible, showing a thin blue line of the atmosphere and a vast expanse of brown and white land and clouds. The background is the deep black of space.

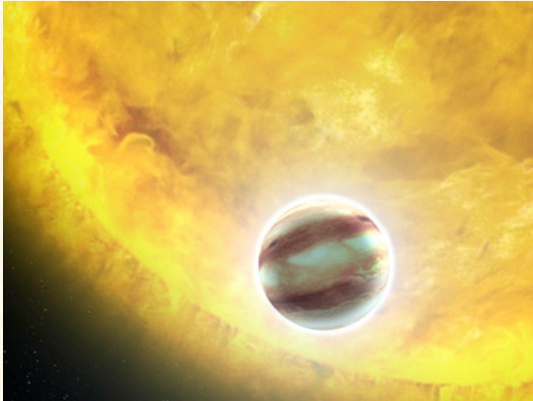
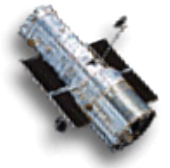
HST Update

STUC Meeting – November 2011

Brad Whitmore

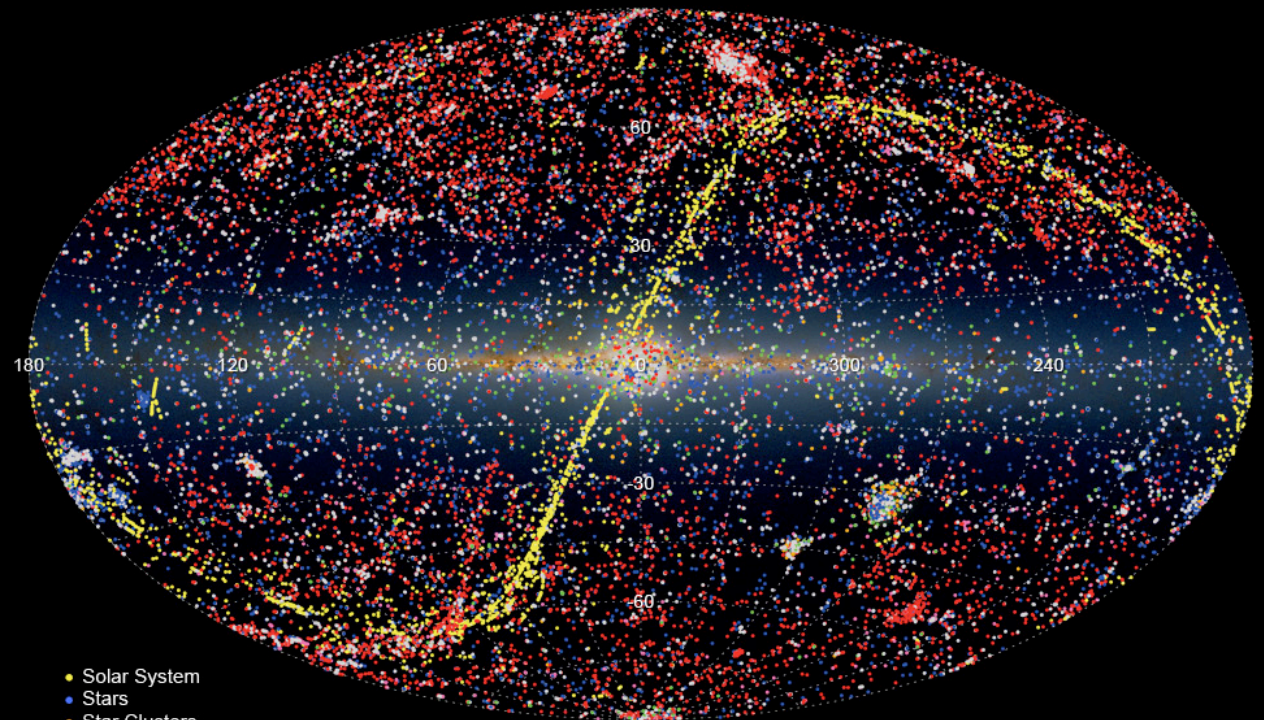


Hubble Makes 1,000,000th Observation



Exoplanet HAT-P-7b
WFC3 IR grism
PI = Drake Deming

*Hubble Space Telescope Observations
as of June 27, 2011*



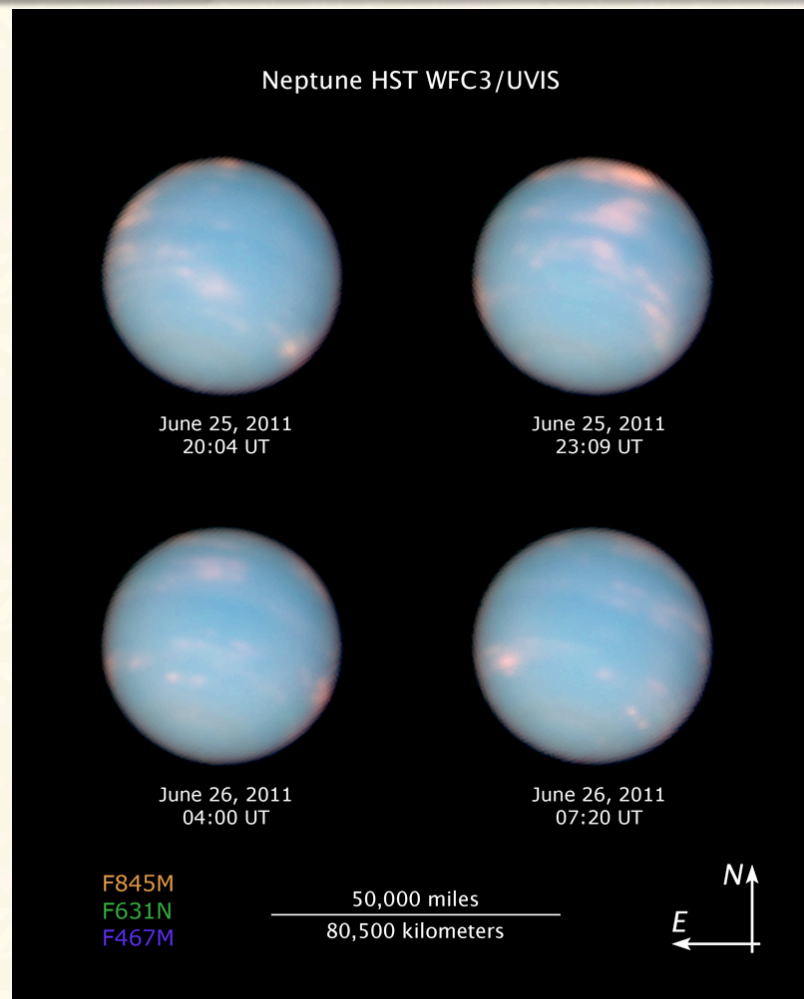
- Solar System
- Stars
- Star Clusters
- ISM/Nebulae
- Galaxies/AGN
- Galaxy Clusters
- Other

Background: Two Micron All Sky Survey

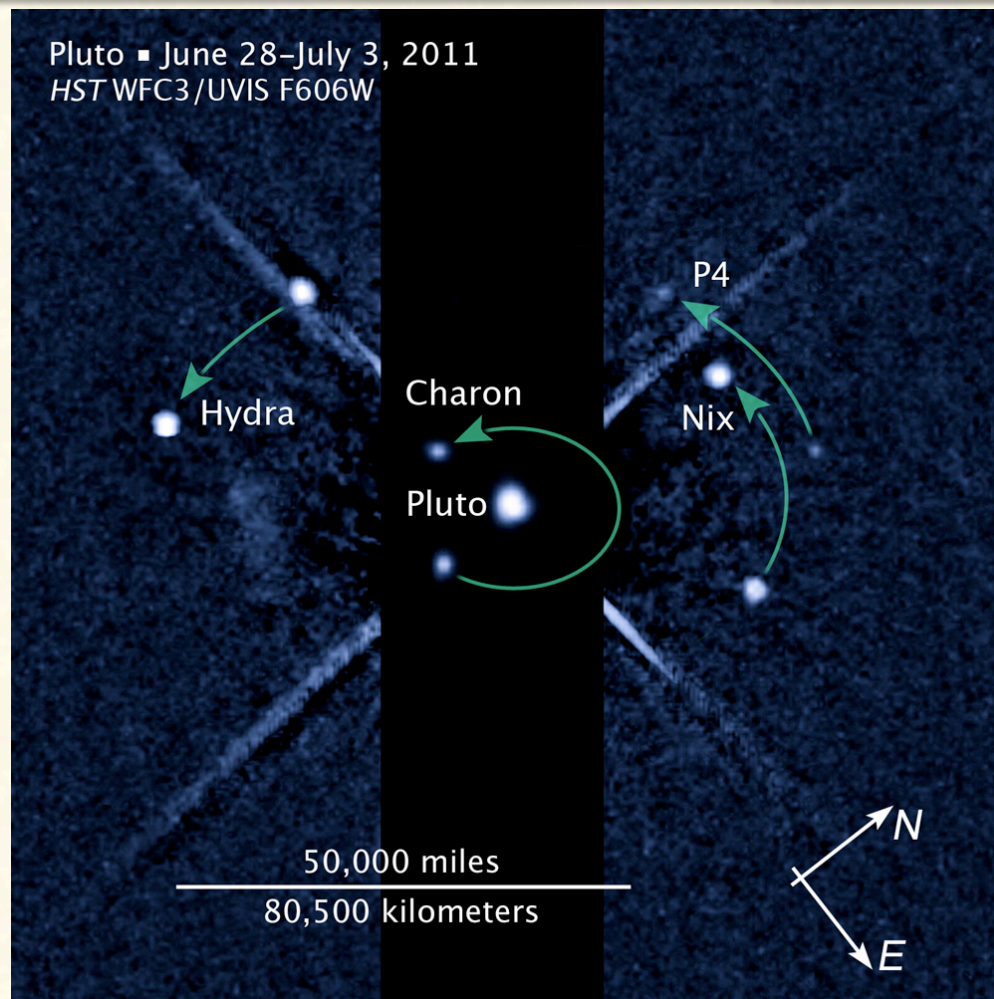


Hubble Observes Neptune

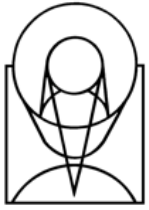
Hubble Discovers Another Moon Around Pluto



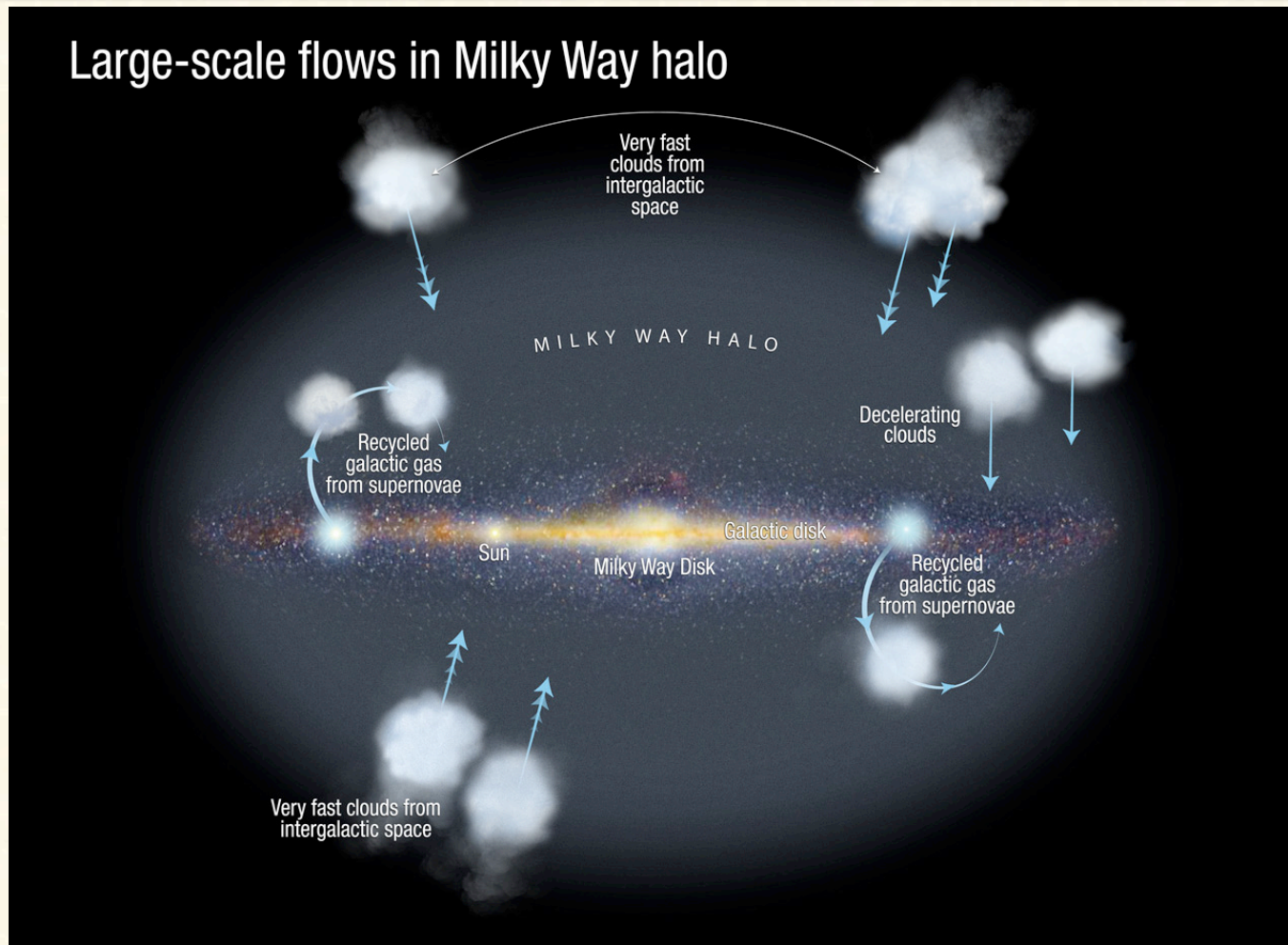
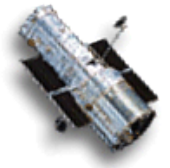
NASA, ESA, and the Hubble Heritage Team



NASA, ESA, and M. Showalter (SETI Institute)



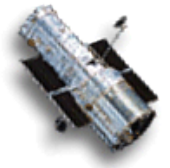
Fast Falling Clouds Fuel Milky Way Star Formation



NASA, ESA, N. Lehner, and C. Howk (U. Notre Dame)



Unprecedented Views of Supersonic Jets from Young Stars



HH47

1994

NASA, ESA, P. Hartigan (Rice University),
and G. Bacon (STScI)

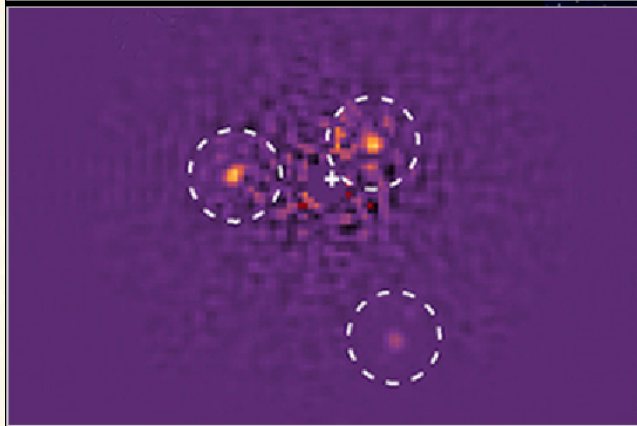
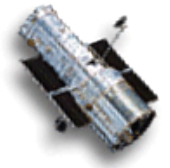


HH34 Jet

1994

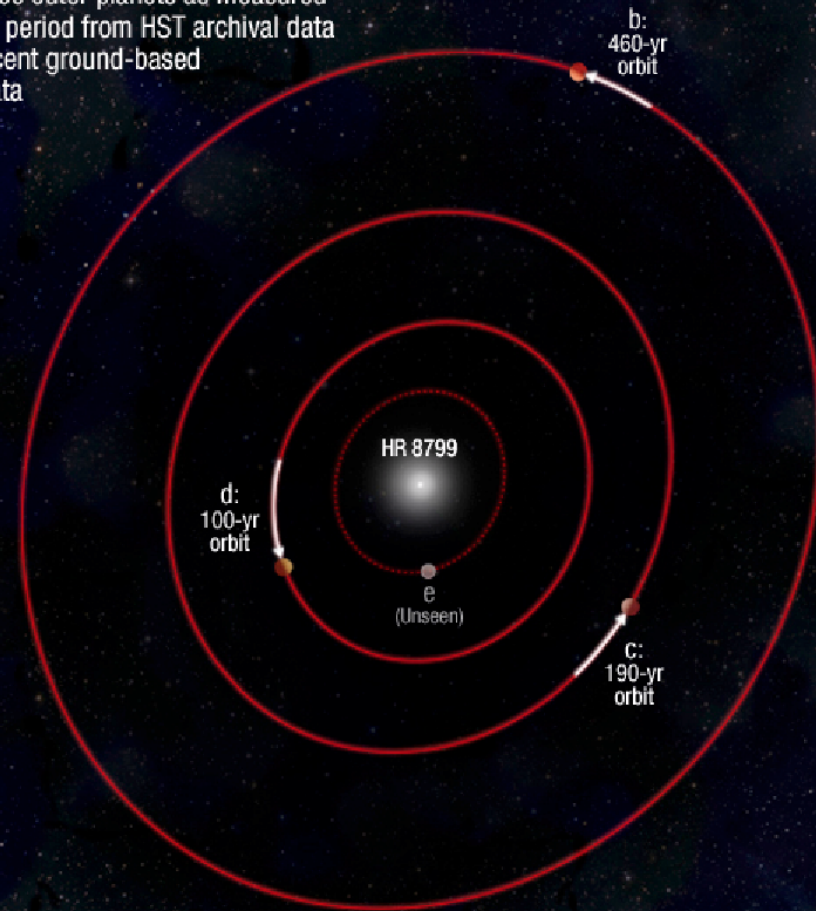


HR 8799 – A Multiple-Planet System Detected with Direct (Archival !) Imaging



HR 8799 planetary system

Motion of three outer planets as measured
over 10-year period from HST archival data
and more recent ground-based
telescopic data



R. Soummer (STScI) et al.



Light Fantastic: Laser at Inner Harbor and the Hayden Planetarium in New York show Hubble Spectra

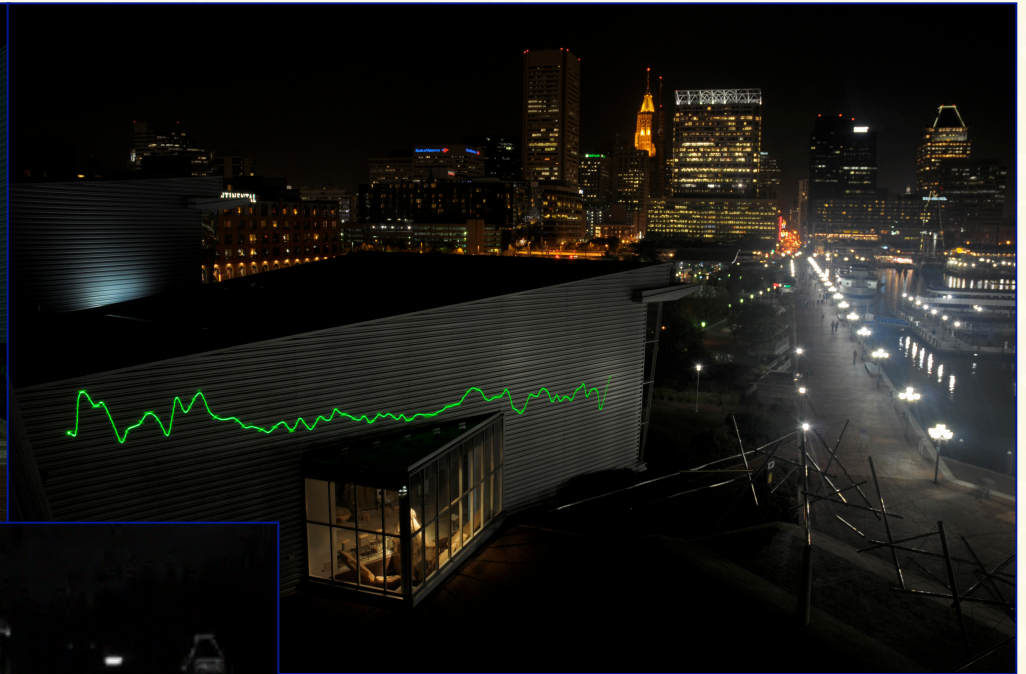
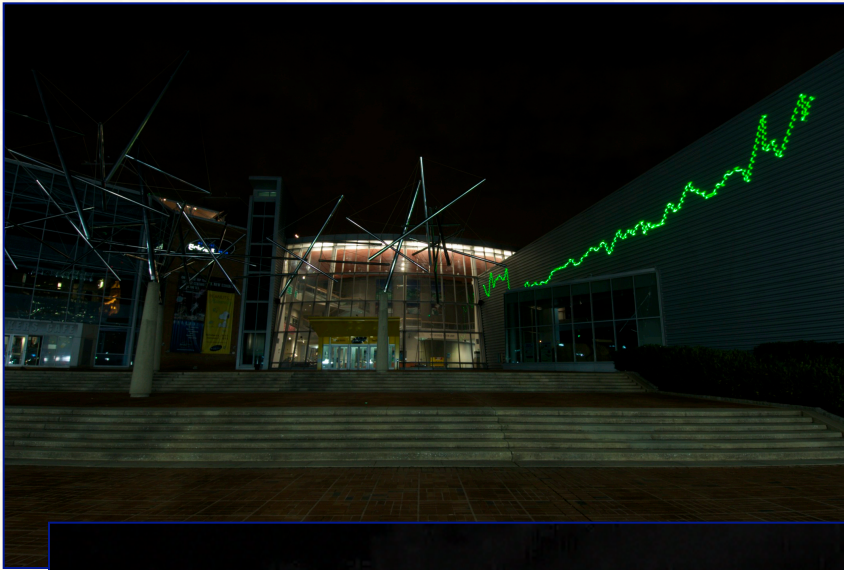
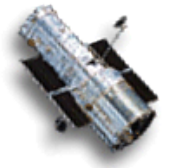
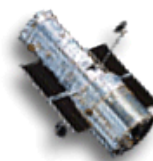


Photo credits: M. Clampin



Long Range Observing Plan

(current through week ending 11/20/11)



Cycle	Orbits	Diff from mid-Sept
17	13	-5
18	563	-143
19	3323	-76 ⁽¹⁾
Total	3899	-224

Visits not in current plan	orbits	Diff
unschedulable	166	-19
no plan windows	44	+18
C18 misc (ToO, etc)	0	-34
C19 misc	201	+13
Total not in plan	411	-22

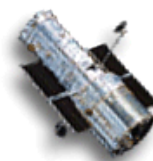
Instrument	Orbits	Diff
WFC3	2188	-67
COS	551	-48
ACS	538	-40
STIS	606	-62
FGS	14	-4
Total	3897 ⁽²⁾	-221

C18 snaps	568	-5
C19 snaps	953	-32
Total snaps	1521	-37

1. Cycle 19 calibrations still coming in.
2. Some programs have more than one SI prime.



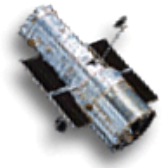
Progress of MCT, Large, and Treasury Programs



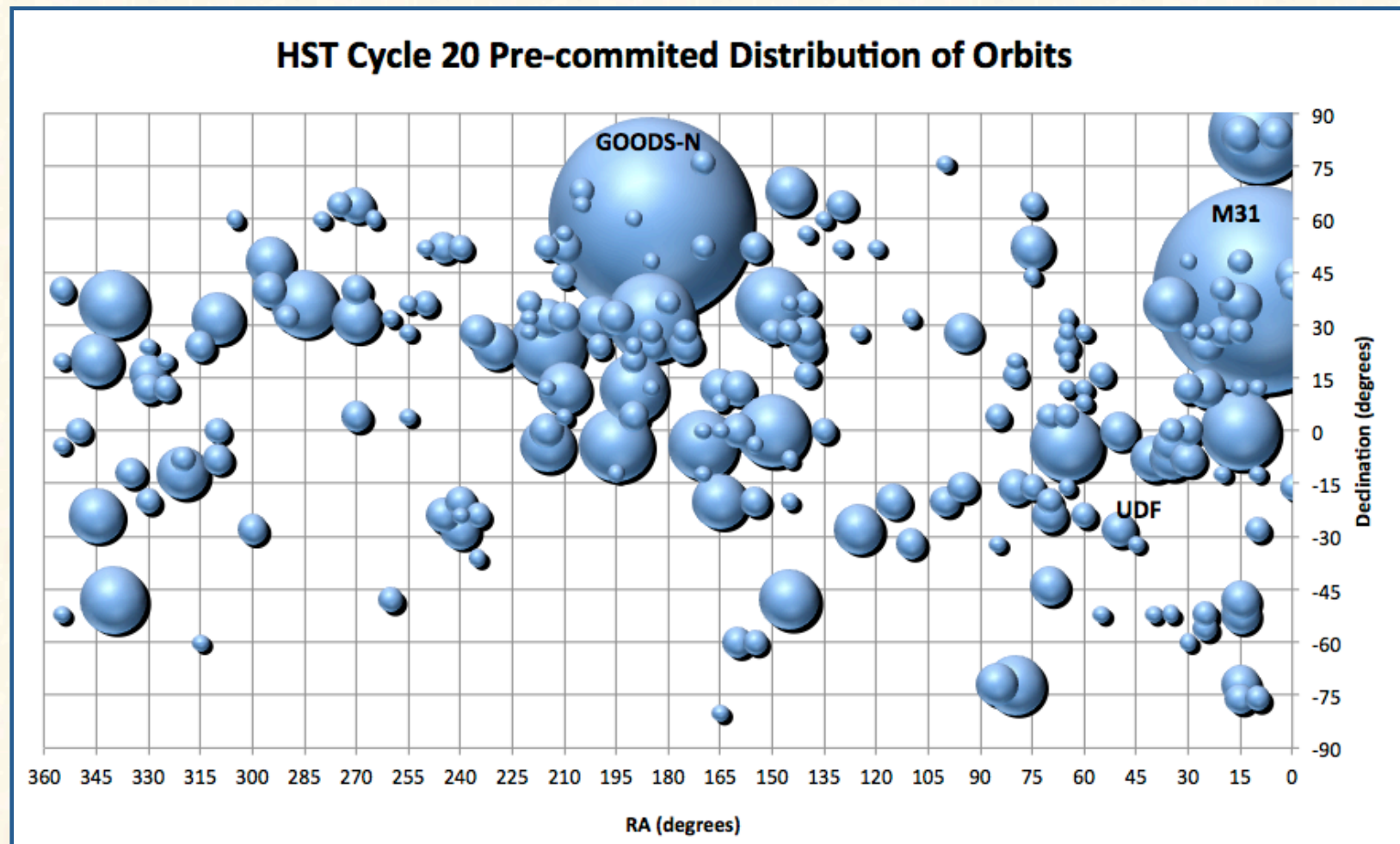
<i>MCT</i>	Total alloc	Exec/sched by 11/20/11	Planned before 9/30/12	Planned 10/1/12+	Not in plan
Dalcanton	834	353	300	120	61 (C20)
Faber/Ferg	750	310	257	67	116 (C20)
Postman	474	193	176	10	95 (C20)
Riess (ToO)	202	83	5	0	114
<i>C18 Lrg/Trs</i>					
Ayres	146	143	0	0	3
Deming	115	94	16	5	0
Tumlinson	129	106	22	0	1
Van Dokkum	248	160	86	0	2
<i>C19 Lrg/Trs</i>					
Brown	113	20	77	16	0
Ellis	128	0	128	0	0
Heckman	119	0	97	22	0
Sahu	64	8	4	0	52
Sing	124	0	30	89	5
Teplitz	90	0	90	0	0

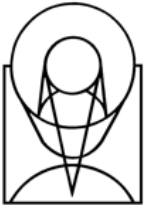


Heavily subscribed targets are concentrated in crowded RA bands

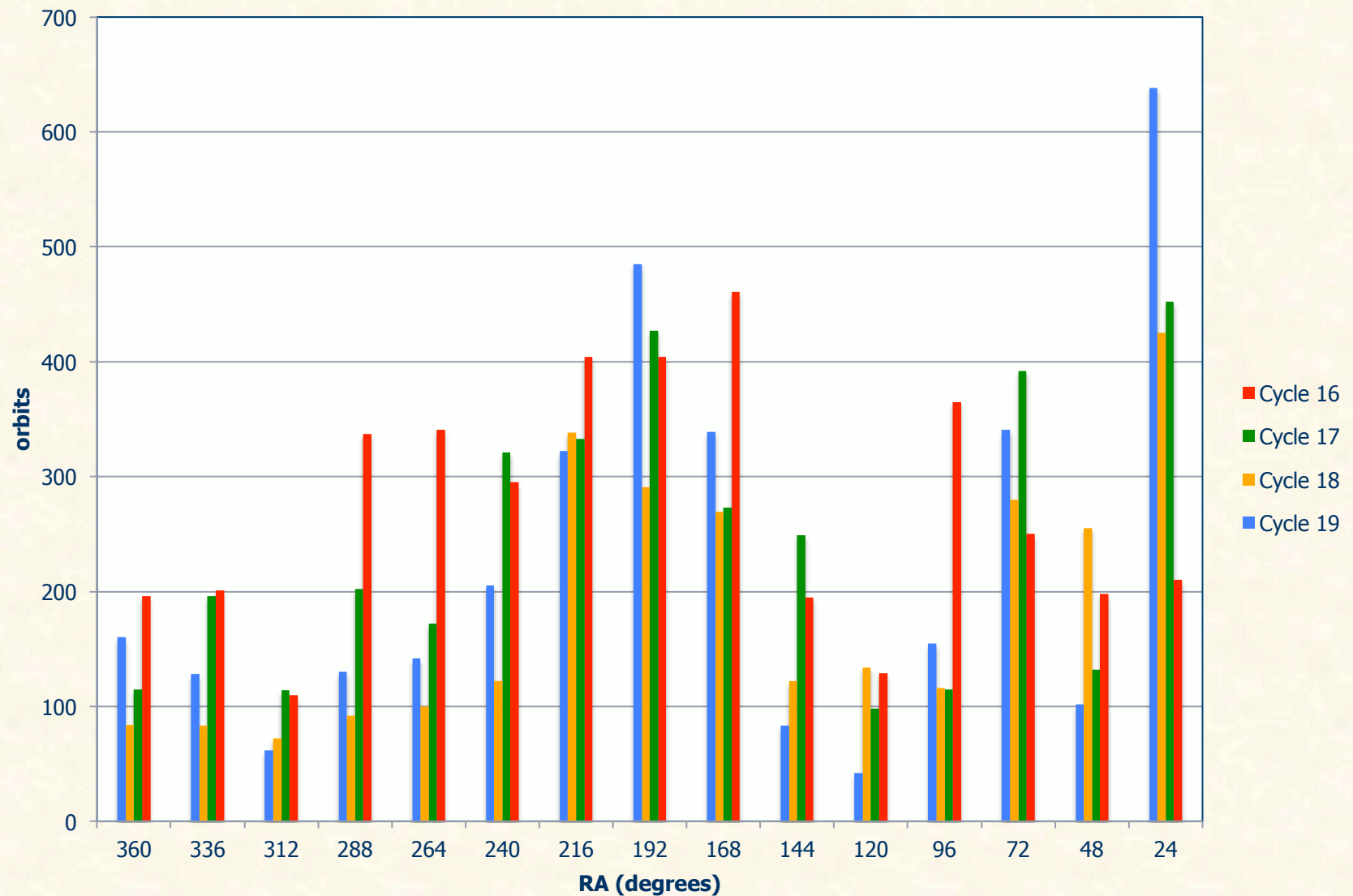
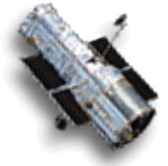


- Chart: existing commitments in Cycle 20 (Oct 1, 2012- Sep 30, 2013).
- Largest two bubbles are 140-150 orbits; all others are 30 orbits or less.



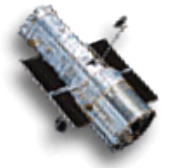


The RA asymmetry has gotten worse over the last few cycles





The Need for Limitations in Right Ascension Range in Cycle 20



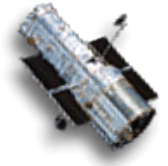
Problem: Over the last few cycles, RA asymmetry in the target distribution has gotten worse.

- Due to both MCTPs and other Large/Treasury programs looking at sources in the same part of the sky.
- **When targets are not spread \sim uniformly across the sky, there are periods of over-subscription/under-subscription through the year.**
- **Material in oversubscribed regions often gets pushed a year later.**
(Or more, depending on amount of material in over-subscribed region)

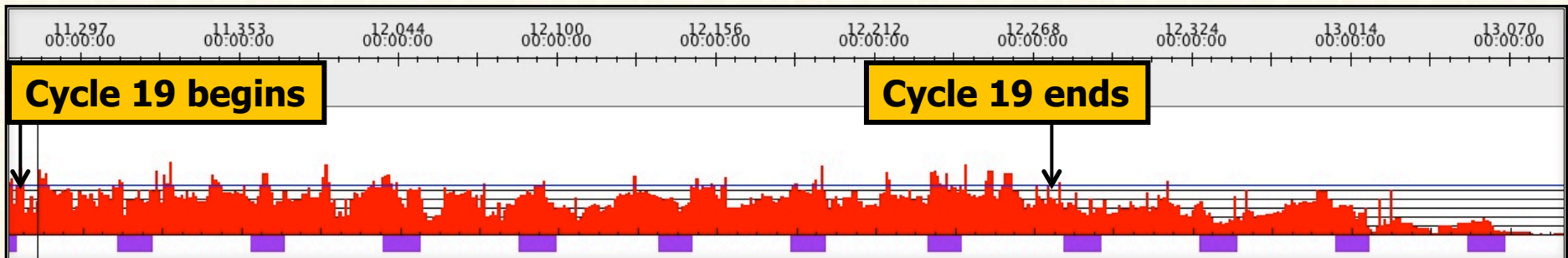
Conclusion: In Cycle 20, we need to avoid large programs in overcrowded regions of the cycle 19 tail. Claus Leitherer will address this issue in his presentation.



Cycle 19

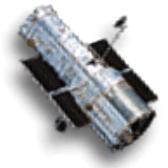


- Cycle 19 long range plan released: August 12, 2011
 - Public notification of plan windows: August 18, 2011
 - 3362 orbits planned in cycle; 860 in cycle tail after 09/30/12
- Cycle 19 nominal start date: October 1, 2011
 - Some programs started early to fill undersubscribed time
 - Cycle 17 SNAPs deactivated, Cycle 19 SNAPs activated
 - Cycle 18 TOO opportunities retired; Cycle 19 TOO opportunities available





HST Focus and Modeling Resources

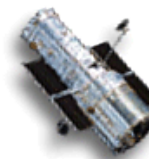
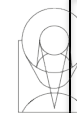


- Recent focus modeling efforts have resulted in a website consolidating all related material and services at:
www.stsci.edu/hst/observatory/focus
- Features:
 - Full discussion of HST image quality variations, measurements & monitoring, active controls, and modeling back to 1993.
 - Best temperature-based focus model thus far
 - New “Tiny Tim” PSF modeling software
 - Workflow providing web interfaces to the above tools, linking the focus model to the PSF generator
- Goal was to consolidate what we understand after 20+ years into one clearly laid-out site. “One-stop shopping.”
- Article describing this in upcoming STScI Newsletter:



HST Focus and Modeling Resources

www.stsci.edu/hst/observatory/focus



Observatory Support

FAQ

HST Focus Model

March 2011

- Interface with the [focus model](#)
- [Overview](#)
- [Input](#)
- [Output](#)
- [Performance](#)
- [Generating a PSF](#)

Overview

For a given time, this model estimates the amount of defocus at a particular camera. The model is a function of telemetered temperatures and secular terms. The temperature dependent part of the model is taken from [Di Nino et al. 2008](#) while the long-term secular trend is a more recent determination given in [Niemi et al., 2010](#). In addition to the temperature terms and secular double exponential, the model includes zero point offsets characterizing the focus offsets between cameras and channels.

HST Focus Model

Calculations of the HST focus model and measurements of the HST focus are presented. Model results can be obtained for any time range at 5 minute intervals beginning on March 9th 2003.

Measured values are available for about one hour each month. Each camera has its own operational time period, listed below, during which focus measurements were made. A comparison between measurements and the model may be chosen for the measurement time periods.

Display

- ☐ Model
- ☐ Measurement
- ☒ Comparison

Camera

- ☐ ACS / HRC.....January 22nd 2003 to January 21st 2007
- ☐ WFC2 / PC.....January 22nd 2003 to May 7th 2009
- ☐ ACS / WFC1.....January 2003 to April 2005 and August 2009 to present
- ☐ ACS / WFC3.....January 2003 to November 2006 and August 2009 to present
- ☐ WFC3 / UVIS1.....August 2009 to present
- ☐ WFC3 / UVIS2

Year: 2006 Years 2003 to present

Select Time Period

SPACE TELESCOPE SCIENCE INSTITUTE

The Institute | HST | JWST | Community Missions | Data Archives | News and Outreach

Observatory Support

FAQ

HST Focus

March 2011

- [Overview](#)
- [Monitoring & Refocusing](#)
- [Modeling & PSF Characterization](#)
 1. Estimate the focus for your observation
 2. Generate the corresponding PSF
- [Documentation](#)

Overview

HST's Cassegrain Optical Telescope Assembly (OTA) is a two mirror system, whose Primary and Secondary Mirrors are both tightly thermostatically controlled. The stable mirror temperatures, combined with a carefully designed and fabricated graphite epoxy optical truss result in a telescope that is quite stable, especially against non-axial element motions (tip, tilt, decenter).

The OTA does however experience noticeable changes in focal length as the [separation between the Secondary and Primary Mirrors](#) varies over timescales as short as an orbit and as long as the mission life ([Lallo 2006, 2007](#)). Although the Point Spread Function (PSF) delivered to the Science Instruments (SIs) is obviously very stable compared with many other observatories, these variations in focus can be measurable in the images and are considerations in many types of science analyses (e.g. [Makidon et al. 2006](#), [Sahu et al. 2007](#), [Suchkov & Casertano 1997](#)).

To mitigate these effects, active corrections are occasionally performed to maintain long term focus stability, while for shorter term variations, focus and PSF models have evolved and are available to help characterize the science.

Shortcuts

- [Focus Main](#)
- [Focus Model](#)
- [PSF Simulator](#)
- [Focus Reports](#)
- [Secondary Mirror Moves](#)

Staff Essentials

[AURA/ESA/ISSA](#)
[Research Staff List \(PDF\)](#)
[Computer Support](#)
[Conference Room Scheduler](#)
[Email List Server](#)
[Event Form \(PDF\)](#)
[Leave Requests](#)
[Procurement](#)
[ST Library](#)
[STScI Directory](#)
[STSDAS](#)
[Timecard Link](#)
[Travel Expense Report](#)
[Travel Information](#)
[Visa Information](#)
[WBS Numbers](#)

Observatory Support

FAQ

Tiny Tim HST PSF Modeling

March 2011

- Interface with [Tiny Tim](#)
- [Overview](#)
- [Input](#)
- [Output](#)
- [Performance](#)

Overview

Tiny Tim ([Krist & Hook 2011](#)) is a point spread function modeling tool which may be [downloaded](#) as a stand-alone application or run via a [web interface](#). The web tool is a more convenient & slightly simplified version. The stand-alone application allows more detailed specification of parameters, but for most purposes the web interface will be sufficiently flexible. Details of the code's operation, configurable parameters, and products are given in the [Tiny Tim User's Guide](#) while the recent updates to characterize the Wide Field Camera 3, installed in May 2009 are described by [Hook & Stoehr 2008](#).

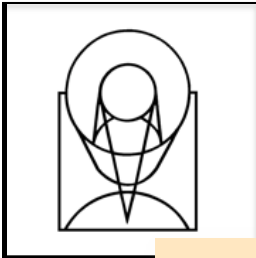
Tiny Tim Web Interface

Tiny Tim is a program which generates simulated Hubble Space Telescope point spread functions (PSFs).

Tiny Tim was written by John Krist (JPL). Early NICMOS support was provided by Richard Hook (ST-ECF/ESO), early WFC3 support as well as this webinterface by Richard Hook and Felix Stoehr (ST-ECF/ESO). See the [intro page](#) for C source code, the Tiny Tim manual, and additional documentation pertaining to WFC3.

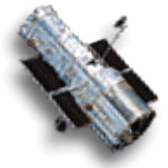
Camera	ACS - High Resolution Channel
Pixel Position	512 512
Filter	FS02N
PSF diameter	3 [arcsec]
Focus	0.0 e.g. 1.02 [microns secondary mirror despace] or 0 for default

Reset Undo



Backup - HST Focus and Modeling Resources

www.stsci.edu/hst/observatory/focus



HST Focus Model

Calculations of the HST focus model and measurements of the HST focus are presented. Model results can be obtained for any time range at 5 minute intervals beginning on March 9th 2003.

Measured values are available for about one hour each month. Each camera has its own operational time period, listed below, during which focus measurements were made. A comparison between measurements and the model may be chosen for the measurement time periods.

Display

- ☐ Model
☐ Measurement
☒ Comparison

Camera

- ☐ ACS / HRC.....January 22nd 2003 to January 21st 2007
☐ WFC2 / PC.....January 22nd 2003 to May 7th 2009
☐ ACS / WFC1.....January 2003 to April 2005 and August 2009 to present
☐ ACS / WFC2.....January 2003 to November 2006 and August 2009 to present
☐ WFC3 / UVIS1.....August 2009 to present
☐ WFC3 / UVIS2

Year: 2006 Years 2003 to present

Select Time Period

Tiny Tim Web Interface

Tiny Tim is a program which generates simulated Hubble Space Telescope point spread functions (PSFs).

Tiny Tim was written by John Krist (JPL). Early NICMOS support was provided by Richard Hook (ST-ECF/ESO), early WFC3 support as well as this webinterface by Richard Hook and Felix Stoehr (ST-ECF/ESO). See the [intro page](#) for C source code, the Tiny Tim manual, and additional documentation pertaining to WFC3.

Camera	ACS - High Resolution Channel
Pixel Position	512 512
Filter	F502N
PSF diameter	3 [arcsec]
Focus	0.0 e.g. 1.02 [microns secondary mirror despace] or 0 for default

Reset Undo

Tiny Tim Web Interface

Parameters

Camera ACS - High Resolution Channel
Pixel Position 512 512
Filter F502N
PSF diameter 3 [arcsec]
Focus -25.0 [microns secondary mirror despace]

Data

PSF distorted result00.fits
PSF undistorted result00_psf.fits
Data distorted files result00_cuts.dat, result00_energy.dat
Data undistorted files result00_psf_cuts.dat, result00_psf_energy.dat
TinyTim processing parameters.txt, input.txt, output.txt, logfile.txt

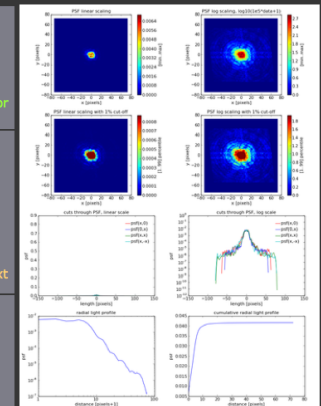
Figures

All figures on one page
PSF distorted lin_psf, log_psf
PSF with 1% cut-off lin_psf, log_psf
Cuts through the PSF lin_cut, log_cut
Light profiles radial, cumulative

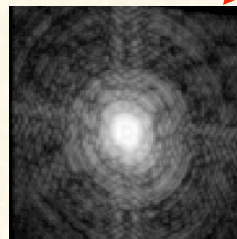
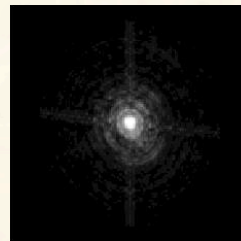
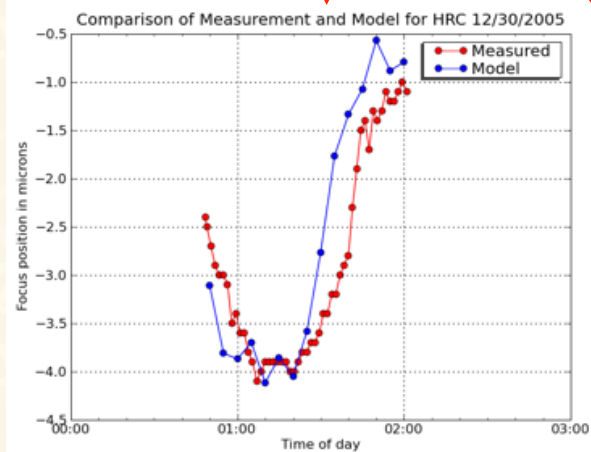
Download

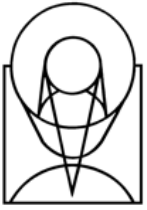
All files in one tar.gz file, including this web page

[Back to the TinyTim start page](#)

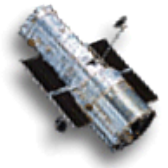


Distorted PSF





Solaris Support to be Limited



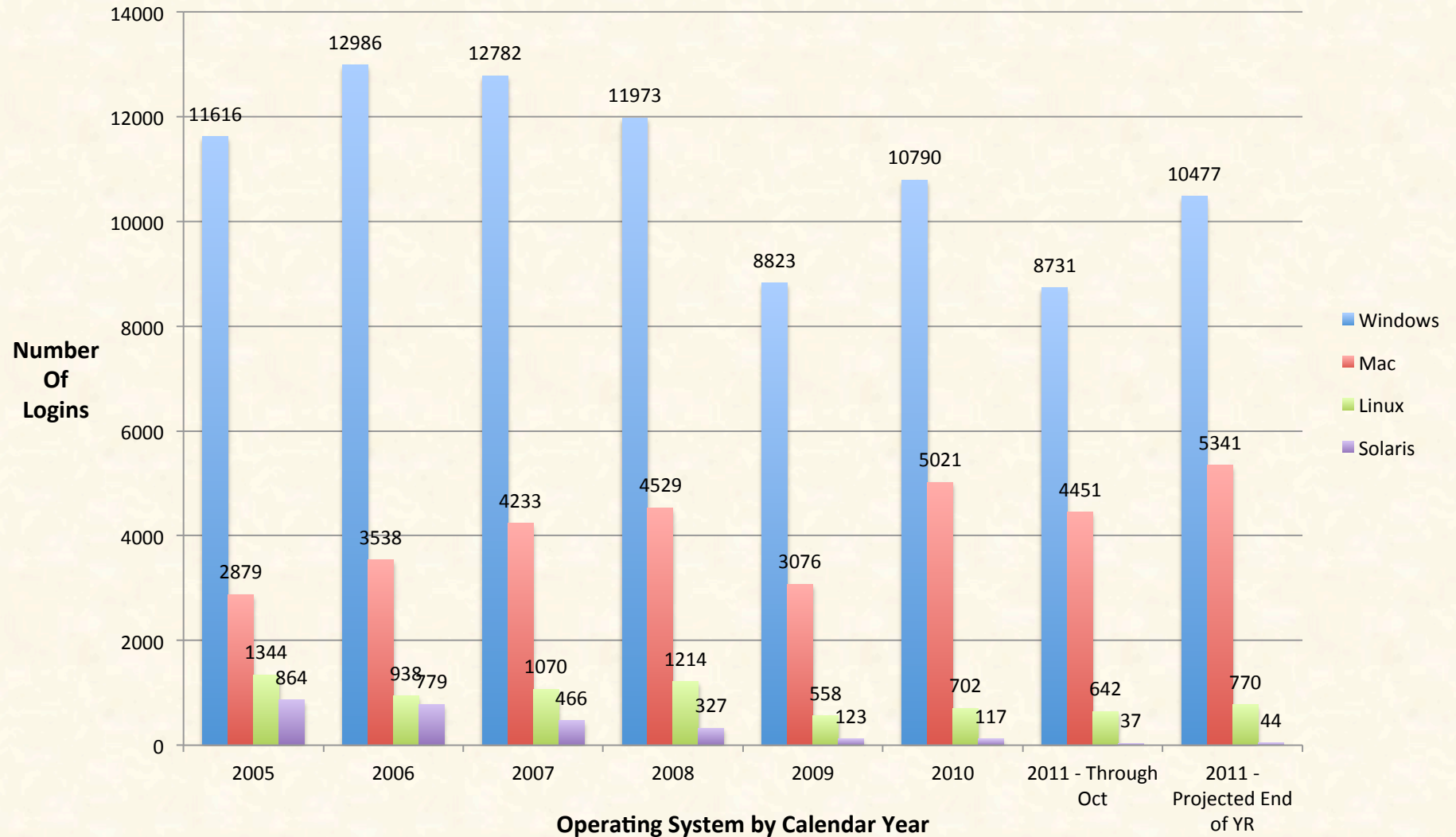
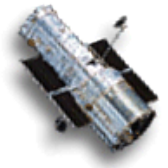
Draft wording:

- “Beginning in Cycle 20, the HST Astronomer's Proposal Tool (APT), and the Grants Management System (GMS) will no longer support the submission of HST proposals from Solaris platforms due to budgetary constraints and the limited use (<1%) of these platforms by the community during the proposal submission process. We recognize that you submitted a Cycle 19 proposal from a Solaris system and hope that this restriction does not prevent you from submitting future HST proposals. APT will continue to support other platforms in common use (list supported platforms here).”

NOTE: There were just 7 users in the past cycle (2 STScI, 2 Hawaii, 2 Rutgers, 1 JHU) .

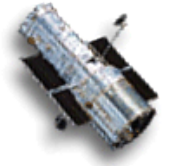


GMS External User Logins by Operating System per Year





ACS Update



A new version of CALACS will be released in Jan 2012. It will perform pixel-based CTE corrections and automatic removal of bias stripes.

The pipeline will produce two sets of products – those currently available (crj, flt, drz) and a new CTI-corrected set (crc, flc, drc).

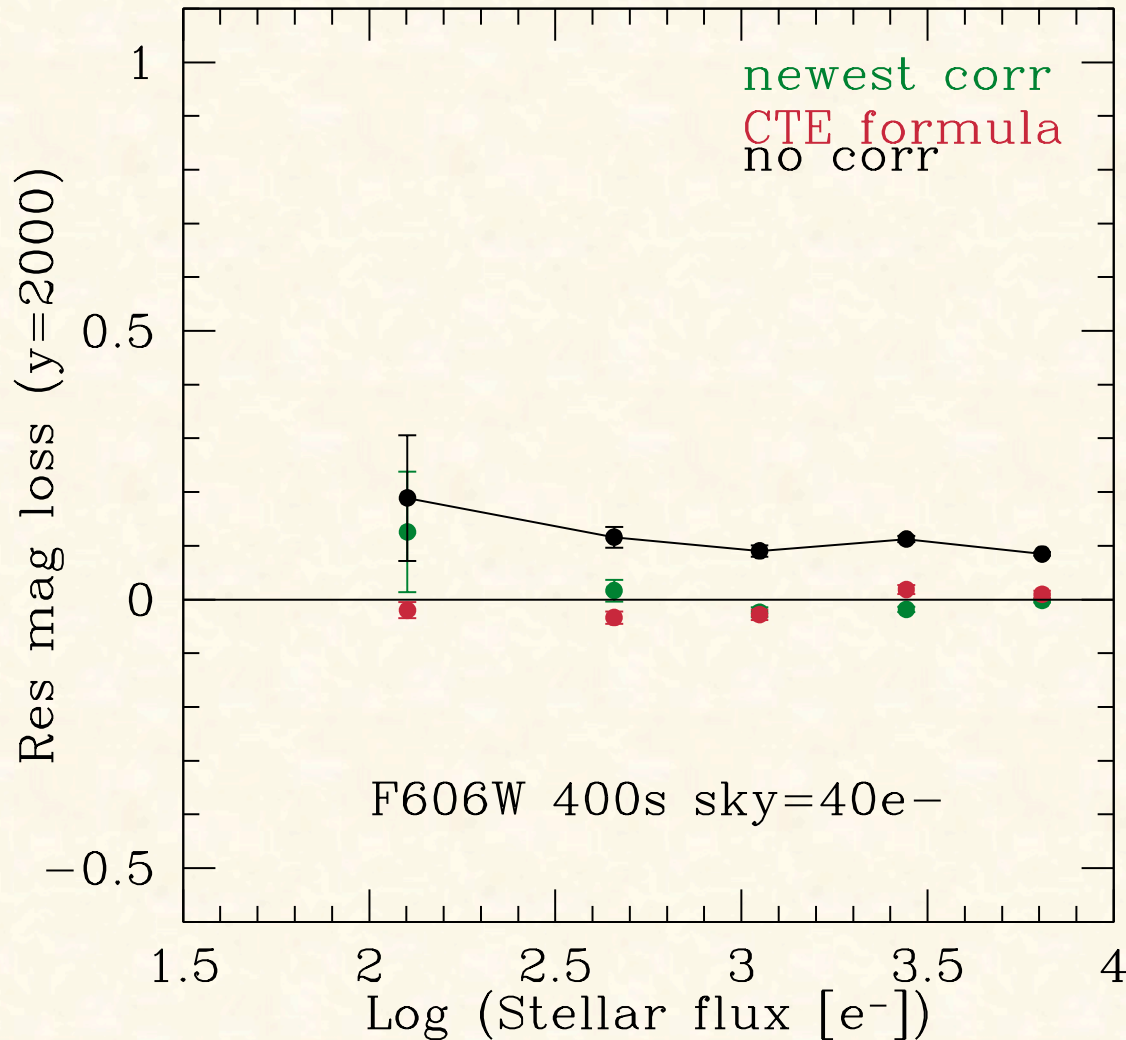
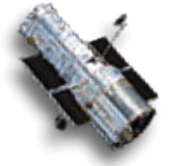
New CALACS is undergoing final testing. The CTE correction algorithm is an enhanced version of the original code written by Anderson & Bedin. It contains:

- Better correction for low signal/low backgrounds
- Empirical time dependence for worsening CTE with time (2002-2011)
- Allowance for different CTE trail profiles at -77 and -81 C detector temperatures

The new CALACS will be launched at the January AAS meeting with posters and demonstrations at the HST booth.



Comparison Between the Pixel-Based CTE Correction and Photometric Correction Formulae



For a typical ACS sky background, the new correction works very well.

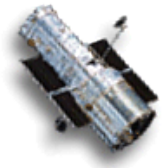
At very low flux, CTE loss becomes so large that it is hard to reconstruct the original signal.

The residual magnitude loss is determined by measuring photometry of the same stars in 47 Tuc close to and far away from the readout amplifier.



COS FUV Lifetime Adjustment

Goal: optimize COS FUV science over the next 5 years



- We are getting ready to move to a new FUV lifetime position to mitigate gain-sag effects.
 - We envision a total of 5 lifetime positions in the cross-dispersion (XD) direction.
 - The number of available positions will depend on several factors, including resolution degradation, asymmetry of the LSF, how tightly we will be able to pack the positions in XD, ...
- Preparatory work/observations to characterize the detector and optical effects as a function of XD location are almost completed.

Decision on new position by mid Dec 2011

- Work to enable new lifetime position to be started in Feb/Mar 2012.
- Science to be enabled by Jul/Aug 2012.
- Additional calibration to be performed in parallel with science over the Summer 2012.

Cross-Dispersion Direction

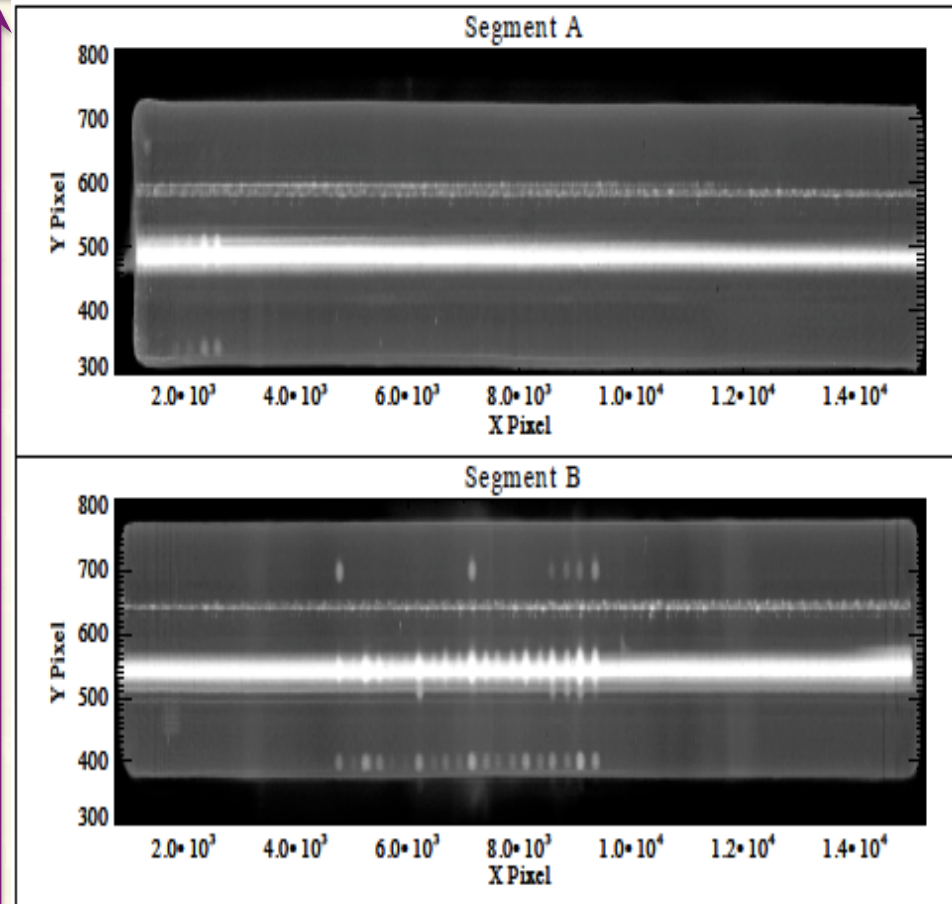
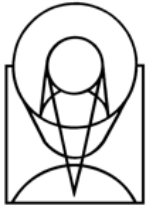
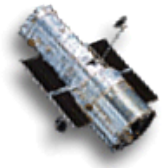


Figure 1 Cumulative count images for both segments of the COS FUV detector, constructed by coadding all FUV science exposures through July 3, 2011. The majority of the counts fall along the horizontal stripe near the middle of the detector in Y, corresponding to the nominal observing position. Also visible are the spectra from the wavelength calibration lamp, near Y=600-650. The bright Lyman- α airglow lines (4 on Segment A and 20 on Segment B) can be seen in the main spectral region, and also above and below, with the latter from the sky illuminating the aperture which is not in use. The gray scale used in this plot has been stretched to emphasize the features.

(From COS ISR 2011-05)

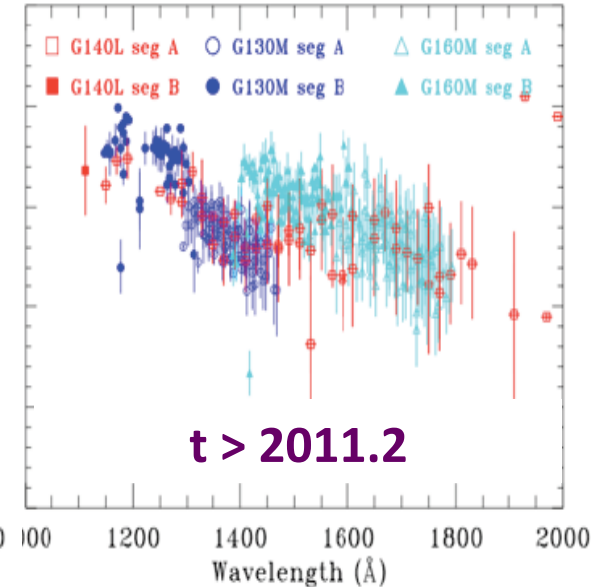
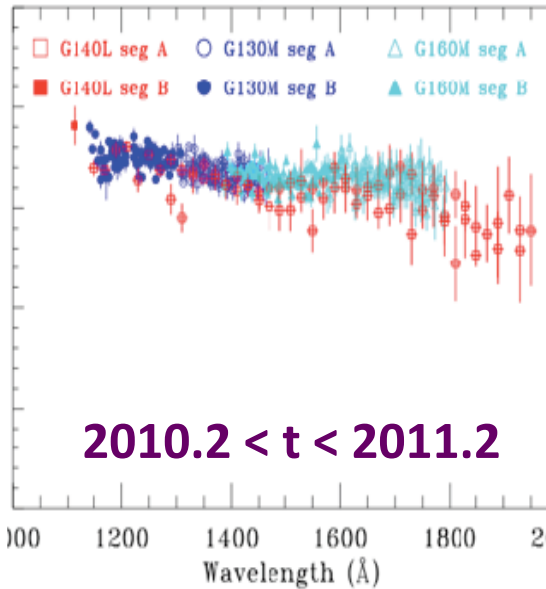
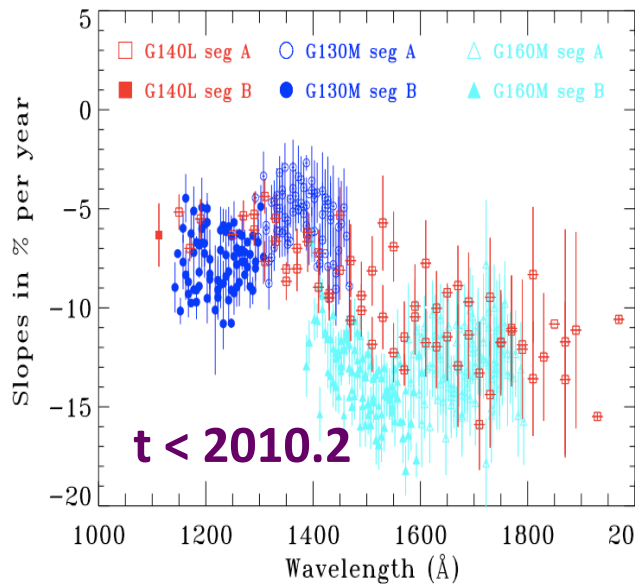
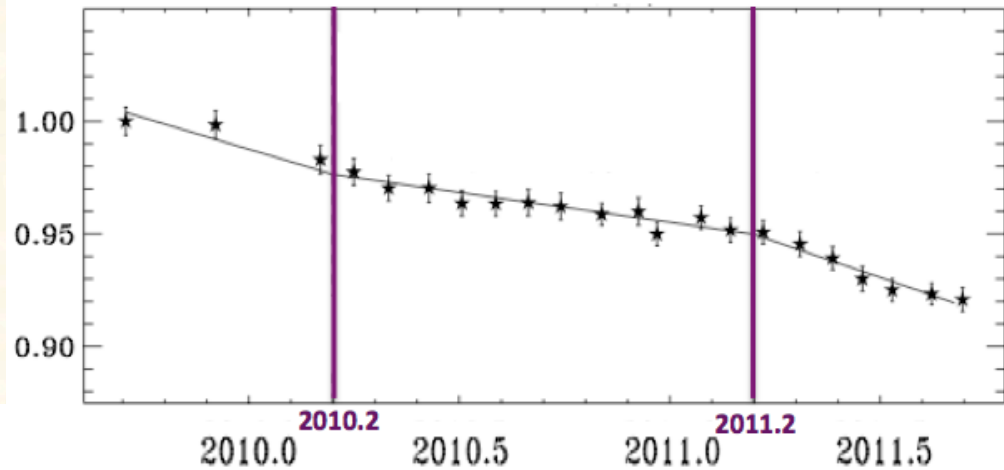


Another Break in COS FUV Sensitivity Loss



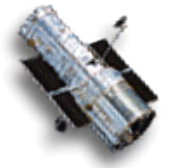
- New trends in sensitivity loss as of Mar 2011 (2011.2).
New trends are not yet included in reference files used by the pipeline CALCOS.
- Previous break ~ 1 year earlier in Mar 2010 (2010.2).
 - During that period the trend was $\sim 5\%$ loss per year at all λ , independently of grating and FUV detector segment (A or B).
- Most recent trends for the sensitivity loss have λ dependency.
 - λ dependency is also present in the initial trends up to March 2010.

Example of a λ bin for G130M: 1350–1355 Å (Segment A)

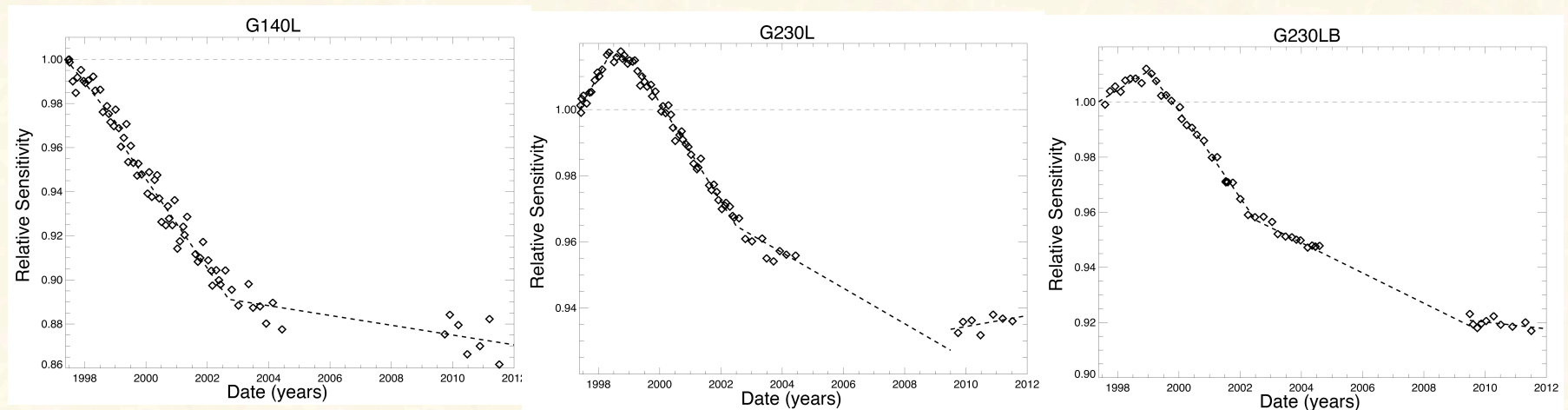




STIS UV Sensitivity Loss



Since SM4, STIS NUV sensitivity declines have slowed or stopped.



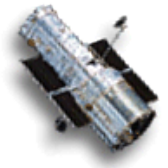
STIS NUV MAMA Dark Rates

The enhanced NUV MAMA dark rate seen after SM4 has continued to slowly decline.

- Still about $\approx 2\frac{1}{2}$ times higher than before 2004 failure.
- Further significant declines will take years.



WFC3 Status



Calibration

- Photometric zero points remain stable to $<0.3\%$ (UVIS) and $<0.5\%$ (IR).
- Stacking >3000 deep sky images improved IR flat fields by factor of 2-3 (now $<2\%$).
- UVIS flats have proven more difficult.
 - Strong breathing & position dependent PSF now properly corrected.
 - Internal reflections between CCDs and detector windows create “Flare” feature.
 - Incorporation of these aspects into Omega Cen observations improves flats.
 - Reduces residuals from 5-6% to 1-2%.
 - 10 broad filter flats now complete (7 released in August, 3 in final testing).
- IR image persistence
 - Screening of all planned observations to identify “bad actors” and to place a few hour wait after then continues.
 - Algorithm to flag (and estimate) persistence signal has been developed.
 - Requires time history tracking of all IR pixels for ~ 24 hours prior to each frame.
 - Correction files available to users upon request; MAST retrieval coming soon.



UVIS Flare

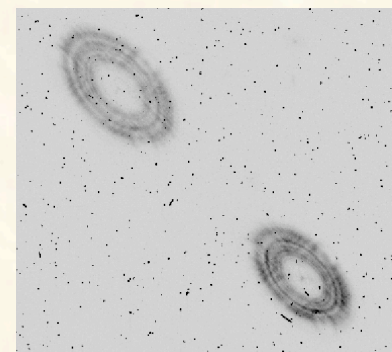
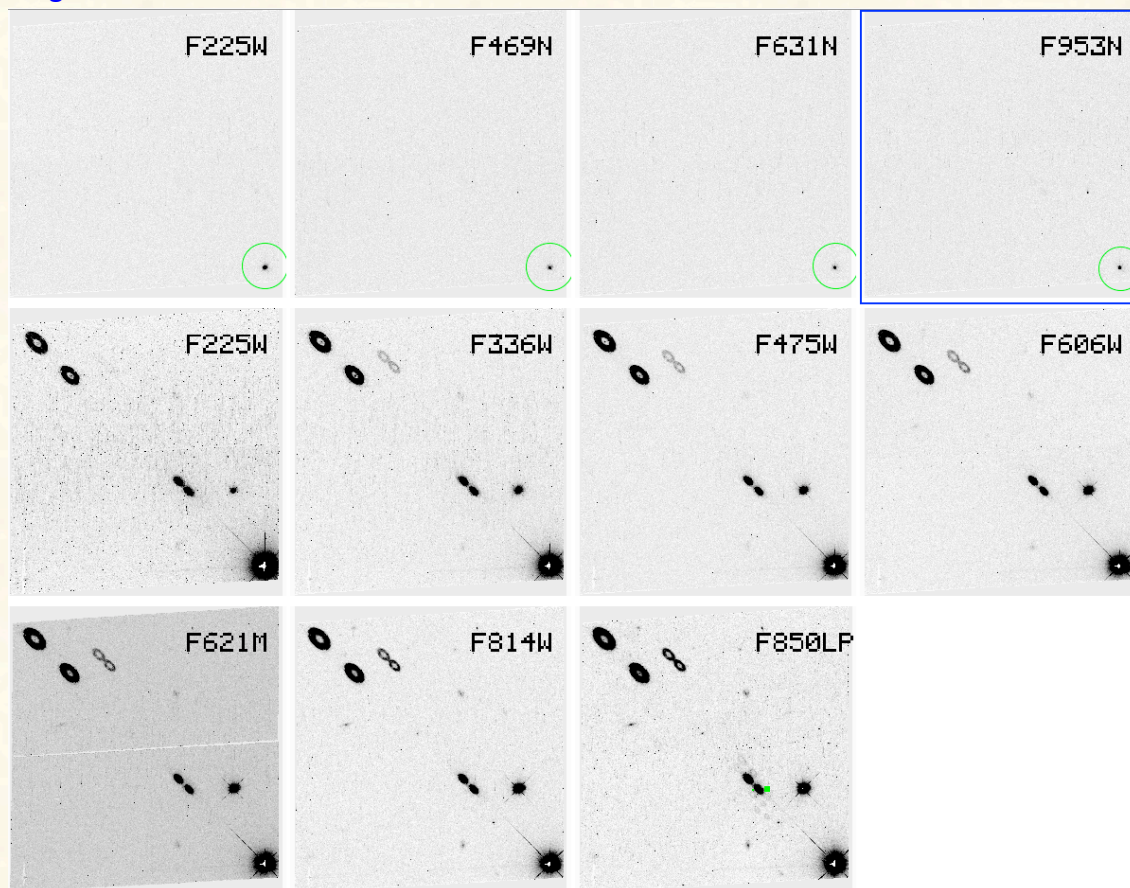
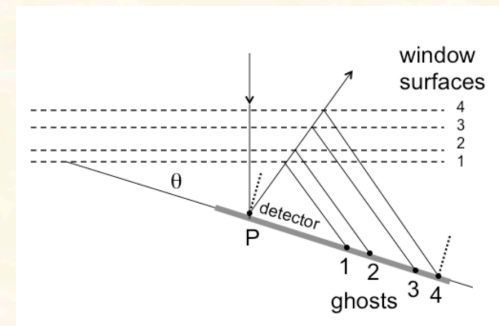
Program 12706 – Executed Oct 21, 2011



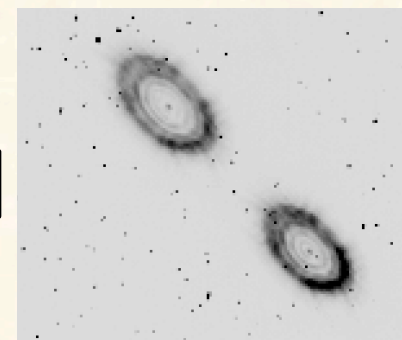
Calibration Strategy:

Short narrowband exposure to measure source brightness

Long (saturated) broadband exposure to measure strength of each ghost



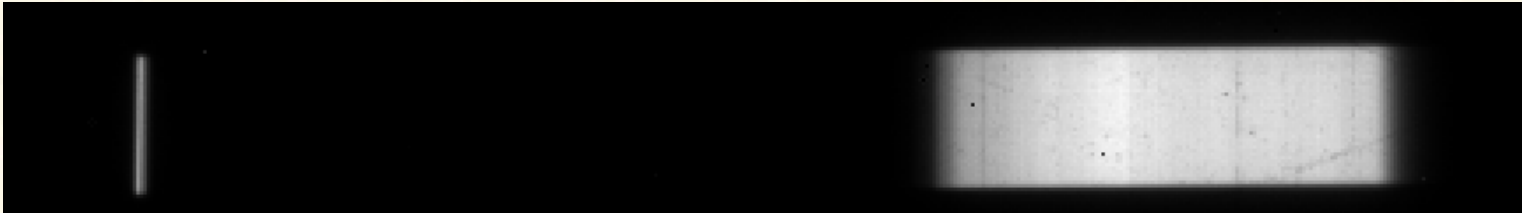
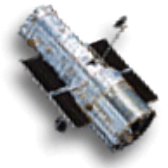
Ghosts 3 & 4



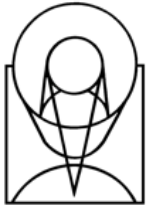
Ghosts 1 & 2



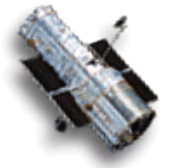
Spatial Scan Mode



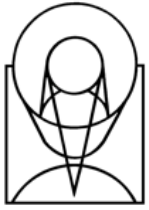
- Resurrection of Cycle 1-6 HST Spatial Scan Mode
 - Was requested by the WFC3 team to support high S/N spectroscopy.
- The original motivation was recovery of NICMOS defocussed exo-planet spectroscopic capability.
 - Advertised as Cy19 and Cy20 GO capability.
 - Test observations demonstrated 3-5x improvement in orbit utilization.
 - GO observations underway.
- Additional applications now in work:
 - IR observations of very bright sources.
 - Shorter effective exposure times combined with use of -1 spectral order to achieve >100x increase in dynamic range.
 - Ability to tie HST calibrators to Vega and other (e.g. ACCESS) bright stars --first visits scheduled for late November.



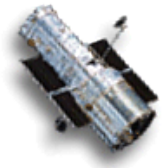
NASA 2012 Senior Review



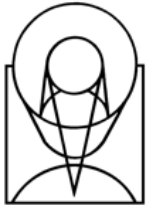
- NASA's Science Mission Directorate (SMD) periodically conducts comparative reviews of its Operating Missions to maximize the scientific return from these projects within finite resources.
- The 2012 Senior Review will assess the scientific merits of eight astrophysics missions – Chandra, Fermi, Hubble, Kepler, Spitzer, and Swift and the U.S. components of participation in Planck, and XMM-Newton.
- Performance factors include scientific productivity, future scientific potential, data dissemination, technical status, and cost.



NASA 2012 Senior Review Purpose

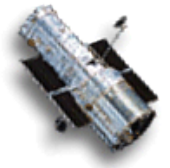


- The purpose of this comparative review is to assist NASA in maximizing the scientific productivity from its Operating Missions. NASA will use the findings from the Senior Review to:
 - Prioritize the operating missions and projects;
 - Define an implementation approach to achieve astrophysics strategic objectives;
 - Provide programmatic direction to the missions and projects concerned for 2013 and 2014; and
 - Issue initial funding guidelines for 2015 and 2016 (to be revisited in the 2014 Senior Review).



NASA 2012 Senior Review

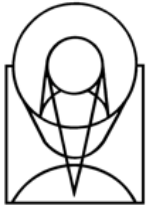
Two Initiative for the future



- We are considering two initiatives designed to enable fundamental observing programs within two key science themes in the next decade:
 - 1) Ultraviolet astrophysics
 - 2) Ultra-deep exploration of cosmic variance in the early universe

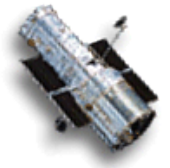
1) Ultraviolet astrophysics

- Hubble is the only mission capable of undertaking detailed observations at UV wavelengths, both now and for the foreseeable future.
- The broad diversity of UV astronomy militates against consolidation within a single large-scale program, as in the Multi-Cycle call. Rather, this initiative will be incorporated within the standard proposal call.
- Starting in Cycle 21, we will instruct panels to include the requirement for ultraviolet observations as a factor in assessing regular GO programs and SNAPs.



NASA 2012 Senior Review

Two Initiative for the future

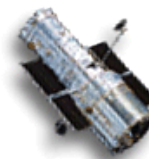


2) Ultra-deep exploration of cosmic variance in the early universe

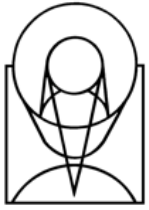
- The early universe will be a prime focus of JWST.
- At present, short-wavelength data of the required depth exist only within the UDF.
- The biggest uncertainty is now cosmic variance - observations within a single field may not include sufficient volume to provide a representative sample.
- The STScI Director will convene an advisory committee to consult with the community to identify up to four potential ultra-deep fields.
- Once identified, the field centers will be publicized to maximize the opportunity of obtaining supplementary ground- and space-based data (e.g., Chandra, Spitzer, HST, ...).
- Director's Discretionary time will be devoted to obtaining deep imaging with HST using F435W and F606W filters. (i.e., 60 orbits for each filter, a total of ~480 orbits).
- All data on these fields would be made public immediately.



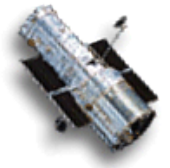
NASA 2012 Senior Review Schedule



2012 Senior Review Schedule	
Draft Call for proposals	July 1, 2011
Call for Proposals	August 10, 2011
EPO SR Proposals Due	Dec 15, 2011
SR Proposals Due	Jan 18, 2012
EPO Section Review	Jan 23 – 25, 2012
SRC Meets	Feb 28-March 2
Final Report	March 30
Guidance to Projects	April 3
Projects respond	April 23



NASA 2012 Senior Review Preparations



- STScI and HST Project are sharing work efforts for the SR proposal preparation
 - Overall proposal creation/layout (STScI)
 - Science (STScI)
 - Technical (GSFC + STScI)
 - Science Operations (STScI)
 - Mission Operations (GSFC)
 - Budget/Financial (GSFC)
 - Augmentations (STScI+GSFC)
 - E/PO (STScI)
- Expect complete draft by mid November
- Red team review in early December