HST Status

HST Mission Office

STUC Presentation

November 1, 2010

Last presentation: April 13, 2010

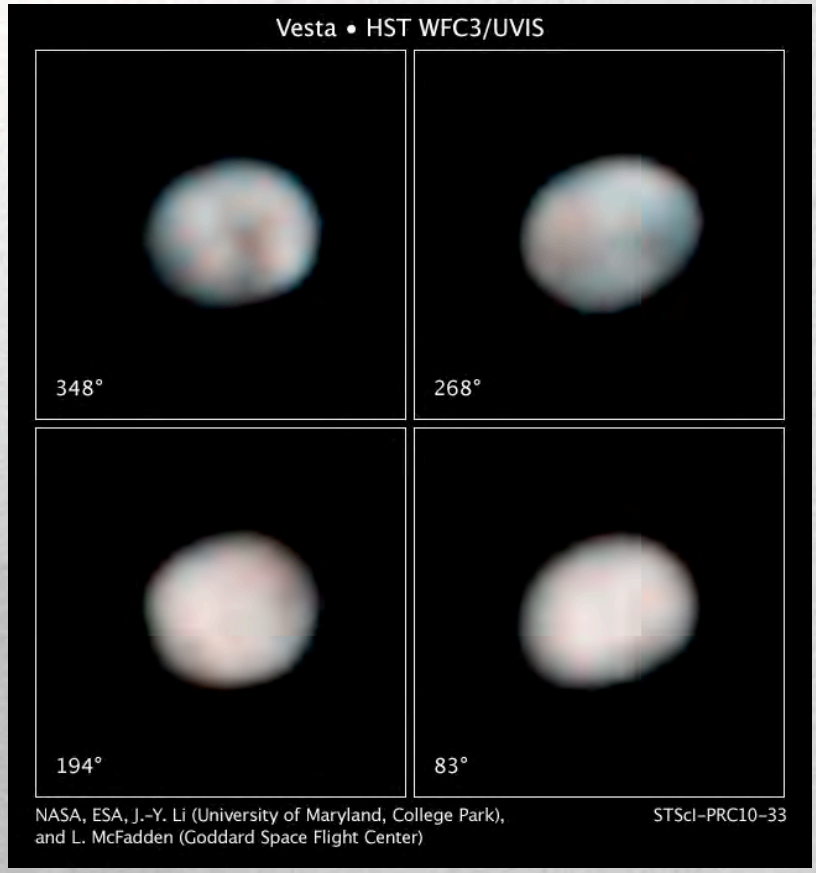
Agenda

- Highlights since last STUC meeting
  - 23 press releases since last STUC meeting
- Observatory Status
  - Scheduling
  - Calibration orbits
  - Instrument status
  - Focus
  - Exposure Time Calculator update

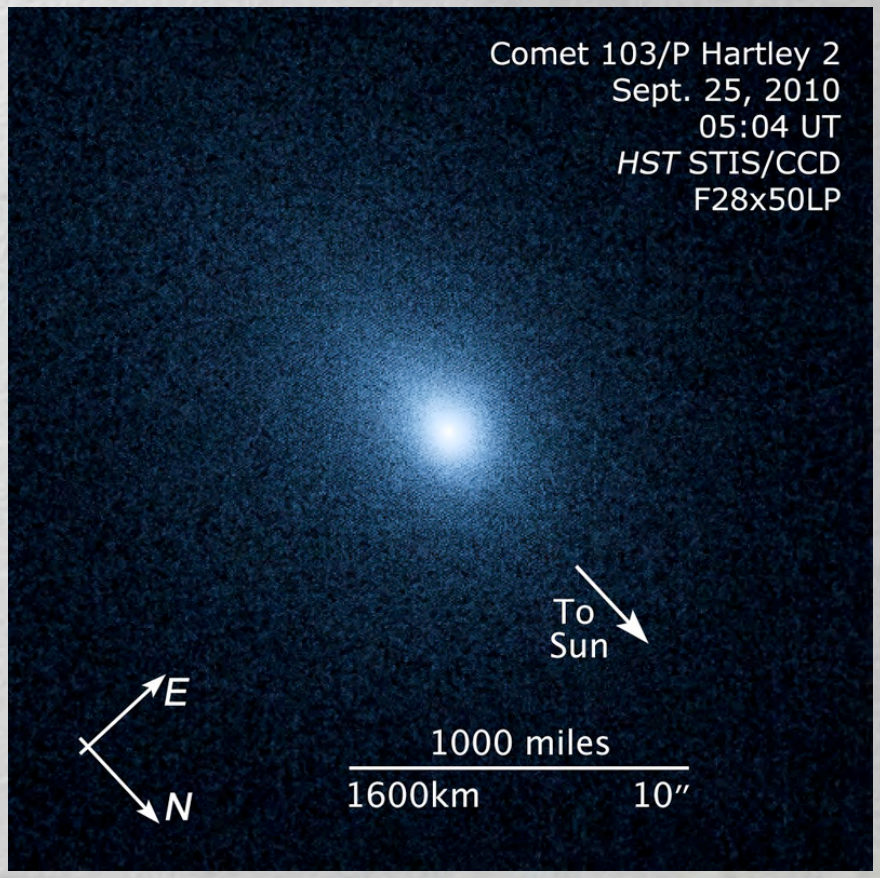
Cycle 18/19 policies and Multi-Cycle Treasury Programs will be covered in other presentations

Hardware investigations will be covered by HST Project

Solar System Mission Support



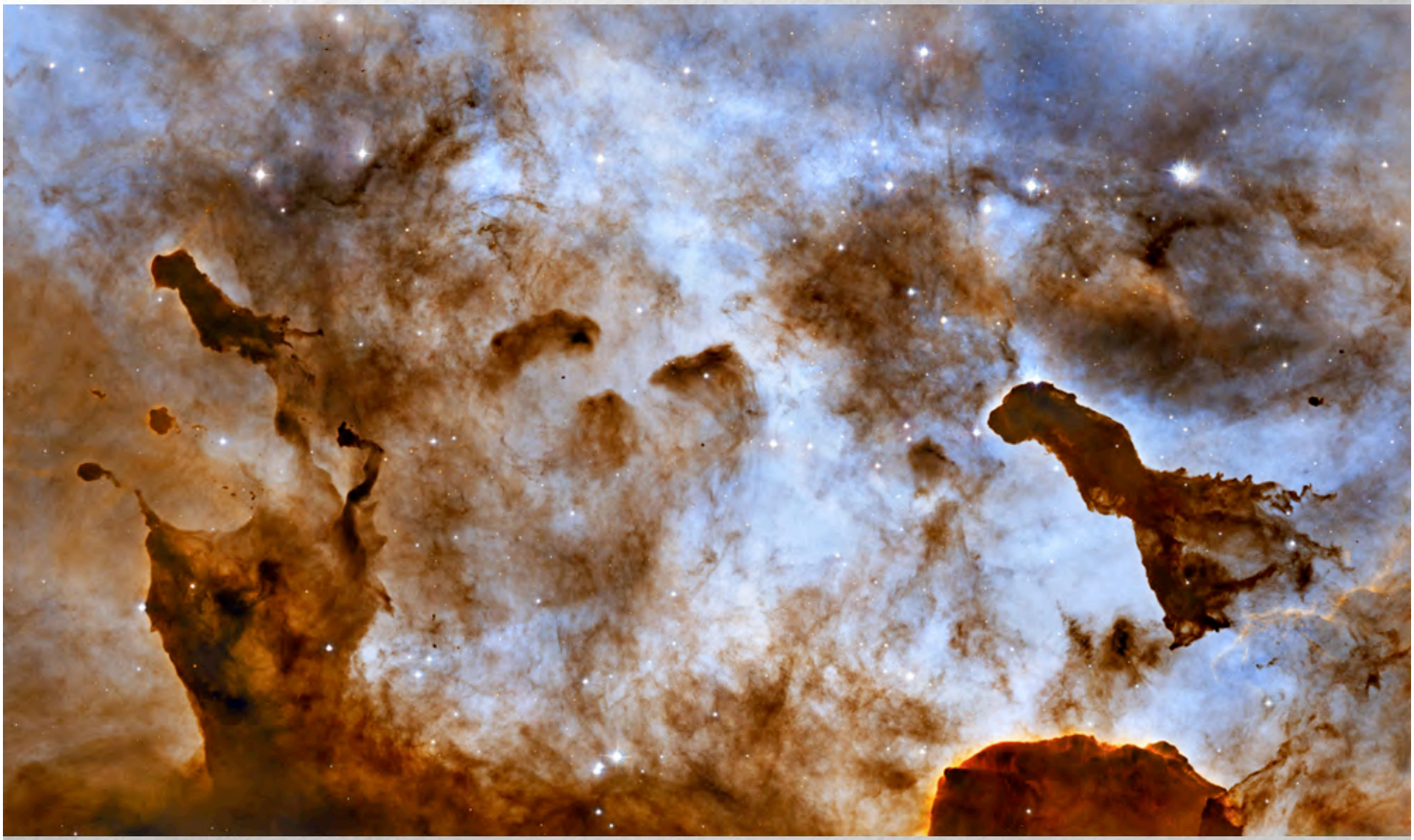
Planning for Dawn Spacecraft rendezvous with Vesta in July 2011 (STScI-PR2010-33)



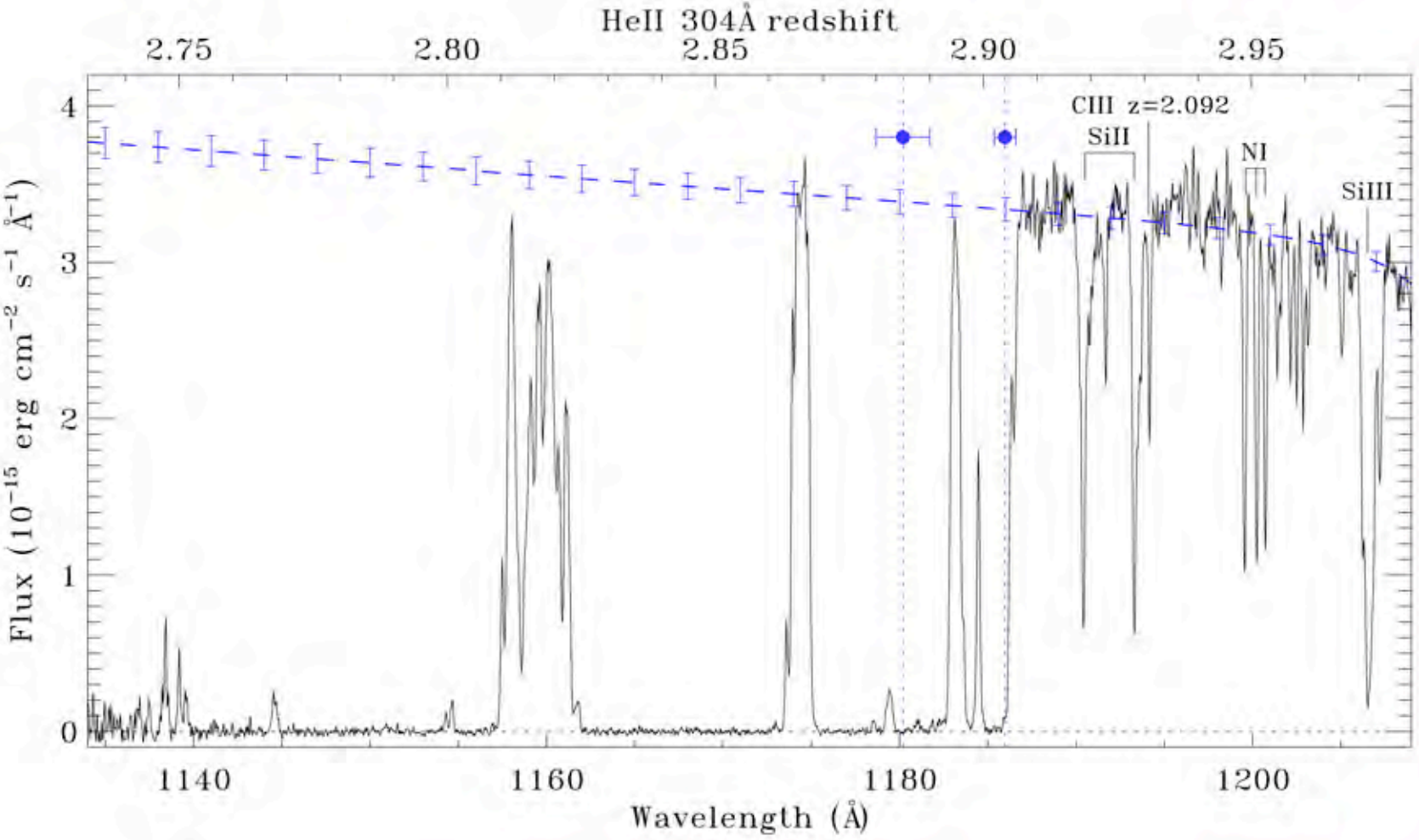
Planning for DIXI/EPOXI flyby of Comet 103P/Hartley on 4 Nov 2010 (STScI-PR2010-35)


I
V

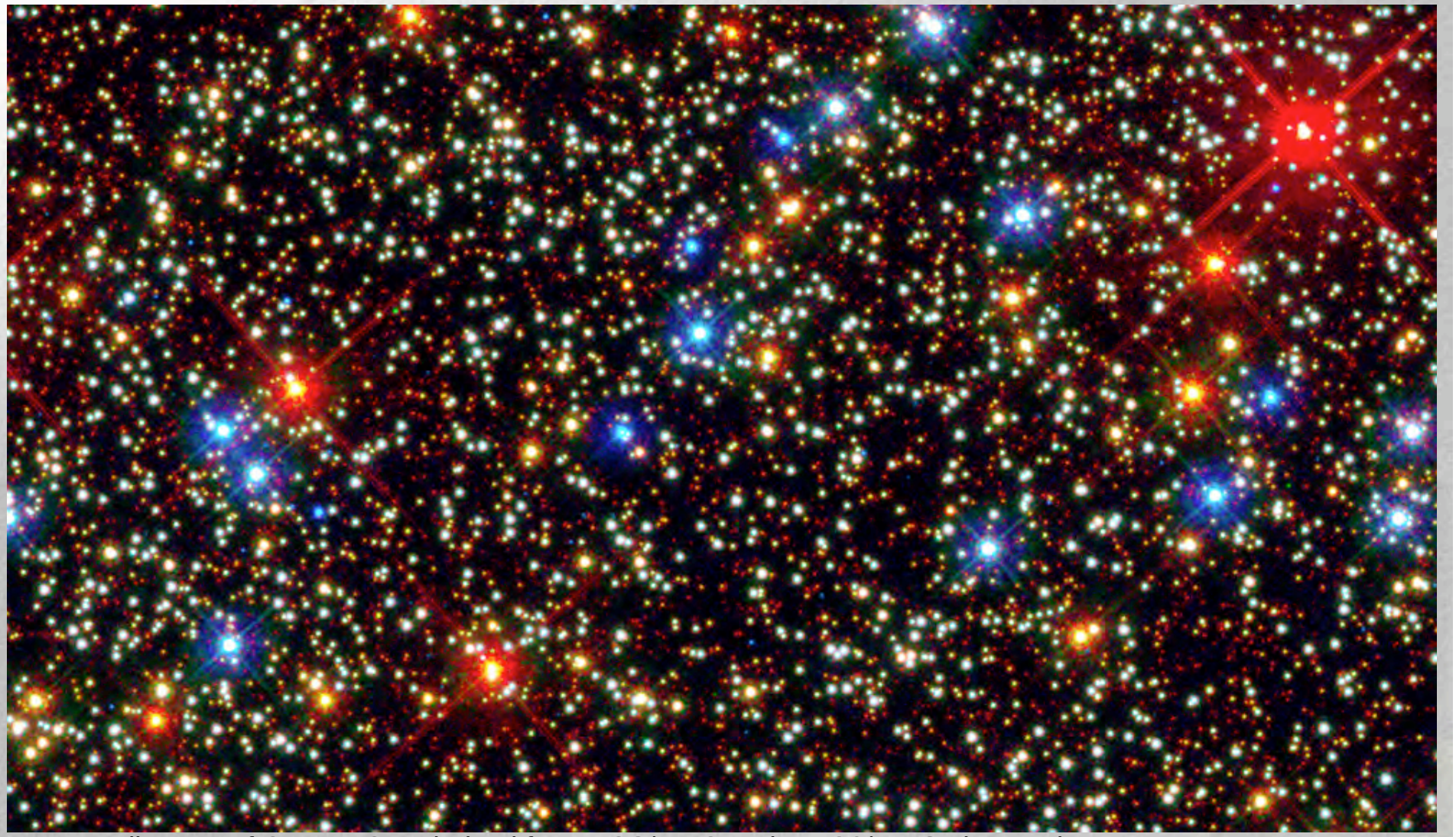
Carina Nebula



Spectroscopy



Omega Cen – Stellar Evolution



HR diagram of Omega Cen derived from ACS/WFC and WFC3/UVIS observations
J. Anderson (STScI-PR2010-28)

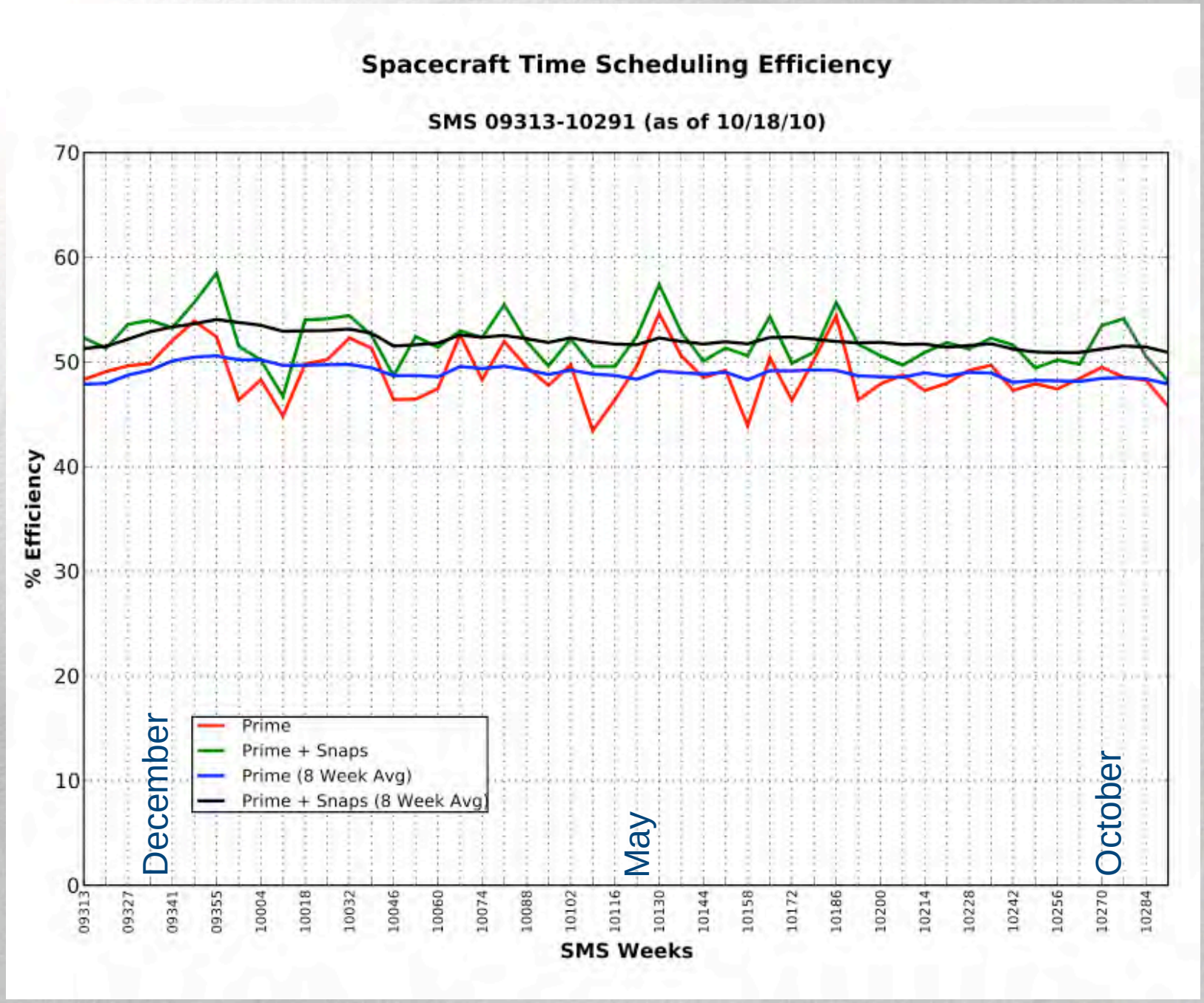
Observatory Status

- Observatory scheduling is challenging, but efficient
- Observatory subsystems continue to function well, with some minor issues of note
  - Science Instrument Command and Data Handling (SI C&DH) Unit
    - 09 Sep 2010: Science Data Formatter experienced “lock-up” event
    - 03 Oct 2010: Science Data Formatter experienced upset 90 minutes after new method of power cycling SDF input circuitry was implemented
  - Gyro 4
    - Switched to secondary gyro heater to mitigate Attitude Observer Anomaly (gyro bias disparity between day and night), which was causing guide star acquisition failures
- All science instruments (ACS, COS, FGS1r, STIS, and WFC3) are performing as expected
  - Current moratorium on STIS MAMA and ACS/SBC MAMA observations
  - FGS2r2 stability is excellent (installed during SM4)
  - NICMOS and its cooling system remain in hibernation

HST Scheduling and Long Range Plan

(D. Adler)

- Cycle 18 scheduling has been efficient
  - Averaging 84 orbits/week since start of cycle (10 wks)
  - LRP was built assuming 82 orbits/week
- Cycle 16 programs are mostly complete
  - 27 orbits remain
  - One WFC3 orbit is planned for December
  - 26 NICMOS orbits are pending
- NICMOS in the Long Range Plan
  - 46 orbits remain (42 in LRP, 4 unplanned)
  - No NICMOS observations planned in Cycle 18
- Cycle 18 runs until 30 September 2011 (13 month cycle)
  - Aligns cycle boundary with fiscal year


Spacecraft Time Scheduling Efficiency
SMS 09313-10291 (as of 10/18/10)
% Efficiency
SMS Weeks
Prime
Prime + Snaps
Prime (8 Week Avg)
Prime + Snaps (8 Week Avg)
December
May
October

Current State of the Long Range Plan

Complete through calendar ending 7 Nov 2010

Cycle	Orbits	Diff from last month
16	28(1)	-14
17	522	-99
18	3701(2)	+94
Total	4251	-19

Visits not in current plan	Orbits	Diff
Unschedulable	160	+12
No plan windows	50	-2
C17 misc (ToO, etc)	22	-5
C18 misc (ToO, etc)	130	-39
Total not in plan	362	-34

Instrument	Orbits	Diff
WFC3	1975	-42
COS	979	-19
ACS	486	0
STIS	786	+40
FGS	52	-3
NICMOS	42	-0
Total	4320(3)	-24

C17 snaps	969	-0
C18 snaps	1073	-36
Total snaps	2042	-36

Notes:
(1) All but two orbits are NICMOS
(2) Cy18 cals have been recently submitted
(3) Some programs have more than one SI prime

Recent LRP Developments (1 of 2)

- Most Cycle 18 calibrations are in the LRP
  - 245 (out of ~284) external orbits included as of 25 Oct 2010
- SI C&DH lockup on 09 Sep 2010
  - Return to science SMS started on 11 Sep 2010
  - 27 science orbits were replanned for the near future
- SI C&DH anomaly on 03 Oct 2010
  - Return to science SMS started on 05 Oct 2010
  - 20 science orbits were replanned for the near future

Recent LRP Developments (2 of 2)

- STIS MAMA and ACS/SBC stand-down
  - 13 Sep 2010 SMS was reworked to remove visits
  - Goal is to return to STIS MAMA observing on 15 Nov 2010 SMS
  - ACS/SBC return to observing expected ~ April 2011
  - 77 orbits of STIS MAMA and ACS/SBC had plan windows from mid-Sep to mid-Nov
    - Most replanned for near future, but some moved out a year

Multi-Cycle Treasury Program Progress

Proposal		Orbits			PI
PI	Title	Sched	Obs	Alloc	
12055 - 12116	A Panchromatic Hubble Andromeda Treasury - I	-	72	412	Dalcanton
12060 - 12064	Cosmic Assembly Near-IR Deep Extragalactic Legacy Survey -- GOODS-South Field, Non-SNe-Searched Visits (CANDELS)	1	16	432	Faber/ Ferguson
12065 - 12069, 12100 - 12104	Through a Lens, Darkly - New Constraints on the Fundamental Components of the Cosmos	-	-	178	Postman
12099	Supernova Follow-up for MCT	7	3	67	Riess

Replanned for this week

Status as of 26 October 2010

Cycle 17 Large Program Progress

Status as of
26 October 2010

Proposal		Orbits			PI
ID	Title	Sched	Obs	Alloc	
11359	WFC3 ERS: Panchromatic WFC3 survey of galaxies at intermediate z	Done	104	104	O'Connell
11360	WFC3 ERS: Star Formation in Nearby Galaxies	Done	110	110	O'Connell
11563	Galaxies at z~7-10 in the Reionization Epoch	1	174	192	Illingworth
11598	A Map of Multiphase Accretion and Feedback in Gaseous Galaxy Halos	-	124	134	Tumlinson
11616	The Disks, Accretion, and Outflows (DAO) of T Tau stars	-	48	111	Herczeg
11644	A dynamical-compositional survey of the Kuiper belt	1	106	120	Brown
11677	Is 47 Tuc Young? Measuring its White Dwarf Cooling Age and Completing a Hubble Legacy	Done	121	121	Richer
11697 multi-cycle	Proper Motion Survey of Classical and SDSS Local Group Dwarf Galaxies	-	43	49	Piatek
11704 multi-cycle	The Ages of Globular Clusters and the Population II Distance Scale	-	60	63	Chaboyer
11741	Probing Warm-Hot Intergalactic Gas at 0.5 < z < 1.3	-	132	137	Tripp

Cycle 18 Calibration Orbits

- Cycle 18 calibration plan has been reviewed and approved
  - Plan is lean compared to previous cycles to maximize science time available to GOs

	External Orbits	Internal Orbits
Cycle 12	423	5200
Cycle 13	316	1526
Cycle 14	320	1742
Cycle 15	532	994
Cycle 17	655	5557
Cycle 18	284	4166

ACS Status
(L. Smith)

- WFC and SBC are both functioning well
  - SBC will not be used until FSW fix to protect MAMA during SI C&DH upsets is implemented (~ April 2011)
  - No significant changes in instrument performance since last STUC meeting
- Update: Bias striping in post-SM4 images
- Update: Correction of charge transfer inefficiency using a pixel-based charge transfer efficiency code
  - See Anderson & Bedin 2010, PASP, 122, 1035

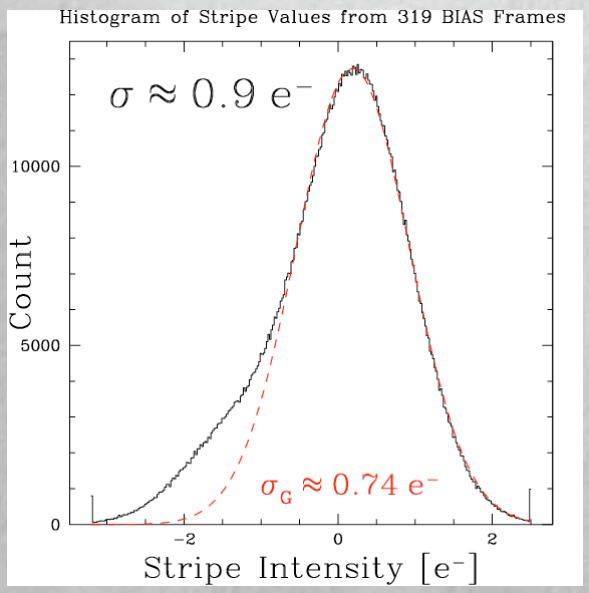
Post-SM4 Bias Striping (1/2)

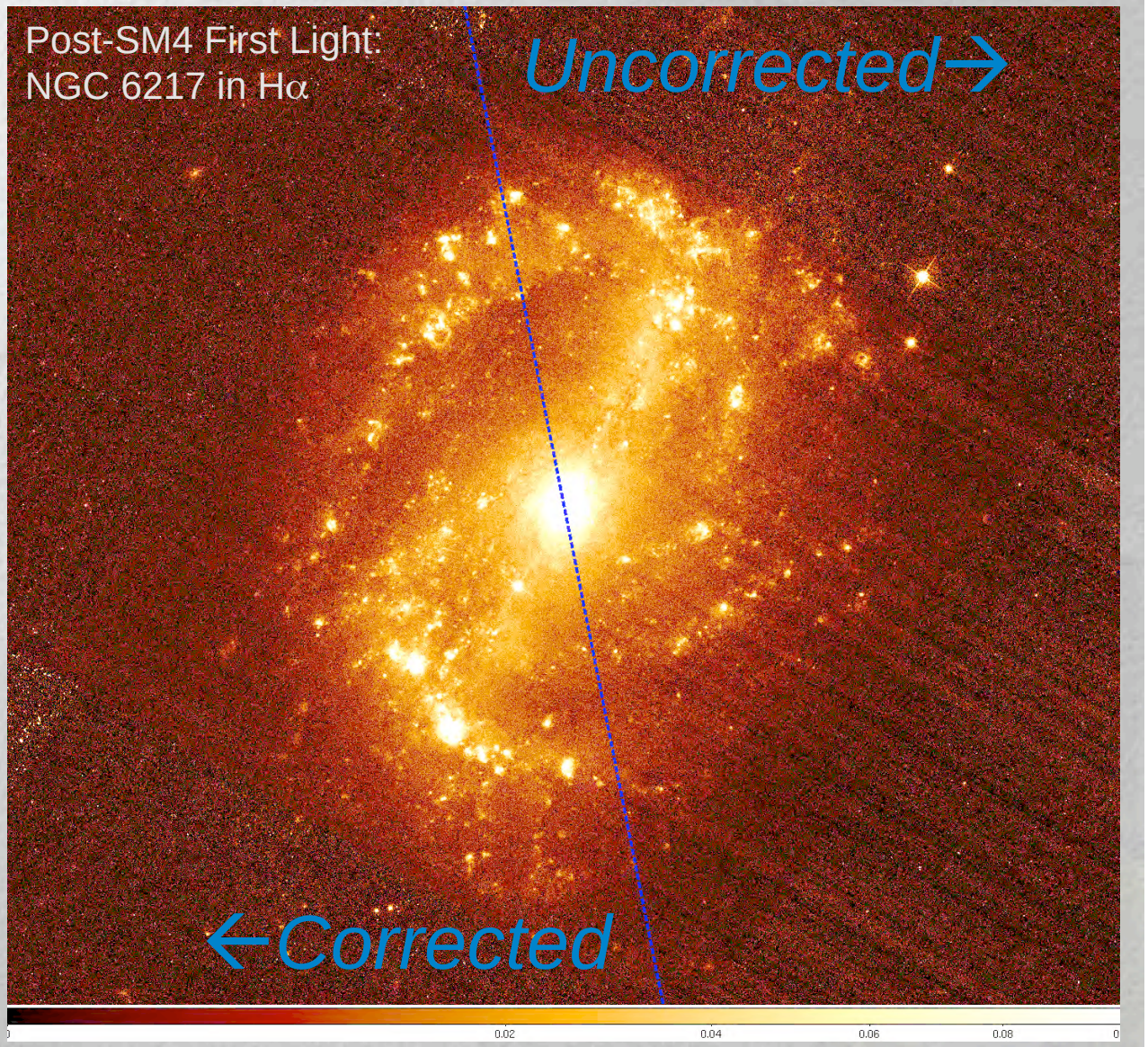
- Caused by 1/f noise on a reference voltage from the CEB-R SIDECAR ASIC installed during SM4
- Slowly varying (1 mHz to 1Hz)
  - Constant across rows
  - Constant for all 4 amps
- Stripe amplitude distribution is approximately Gaussian with $\sigma \approx 0.9$ e-; stable for >1 yr
- Mitigation via fitting within science region of image, with good-excellent results for most scenes
- Python code available now; STSDAS release soon

Post-SM4 Bias Striping (2/2)

WFC BIAS, pre-correction

WFC BIAS, post-correction

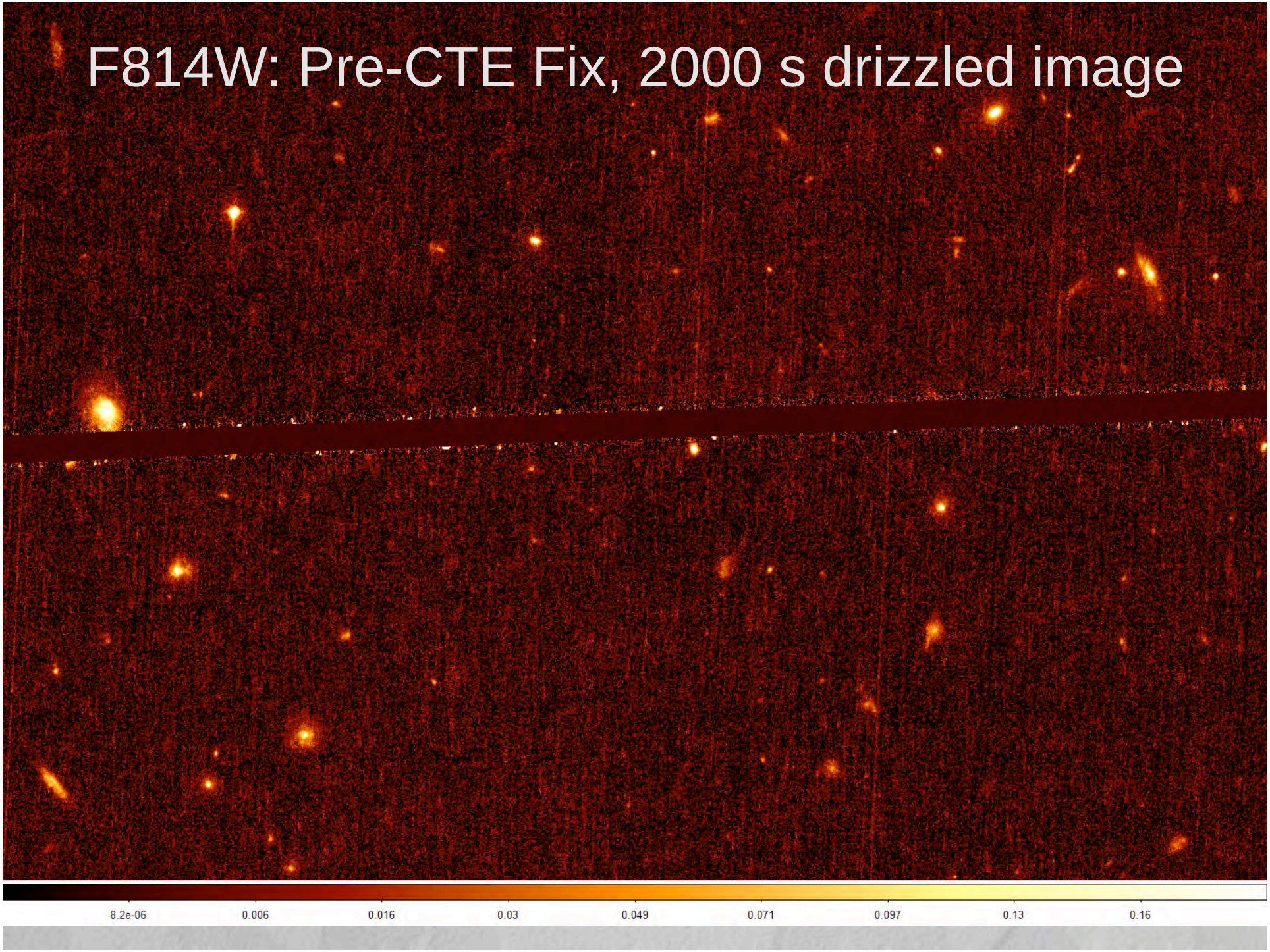




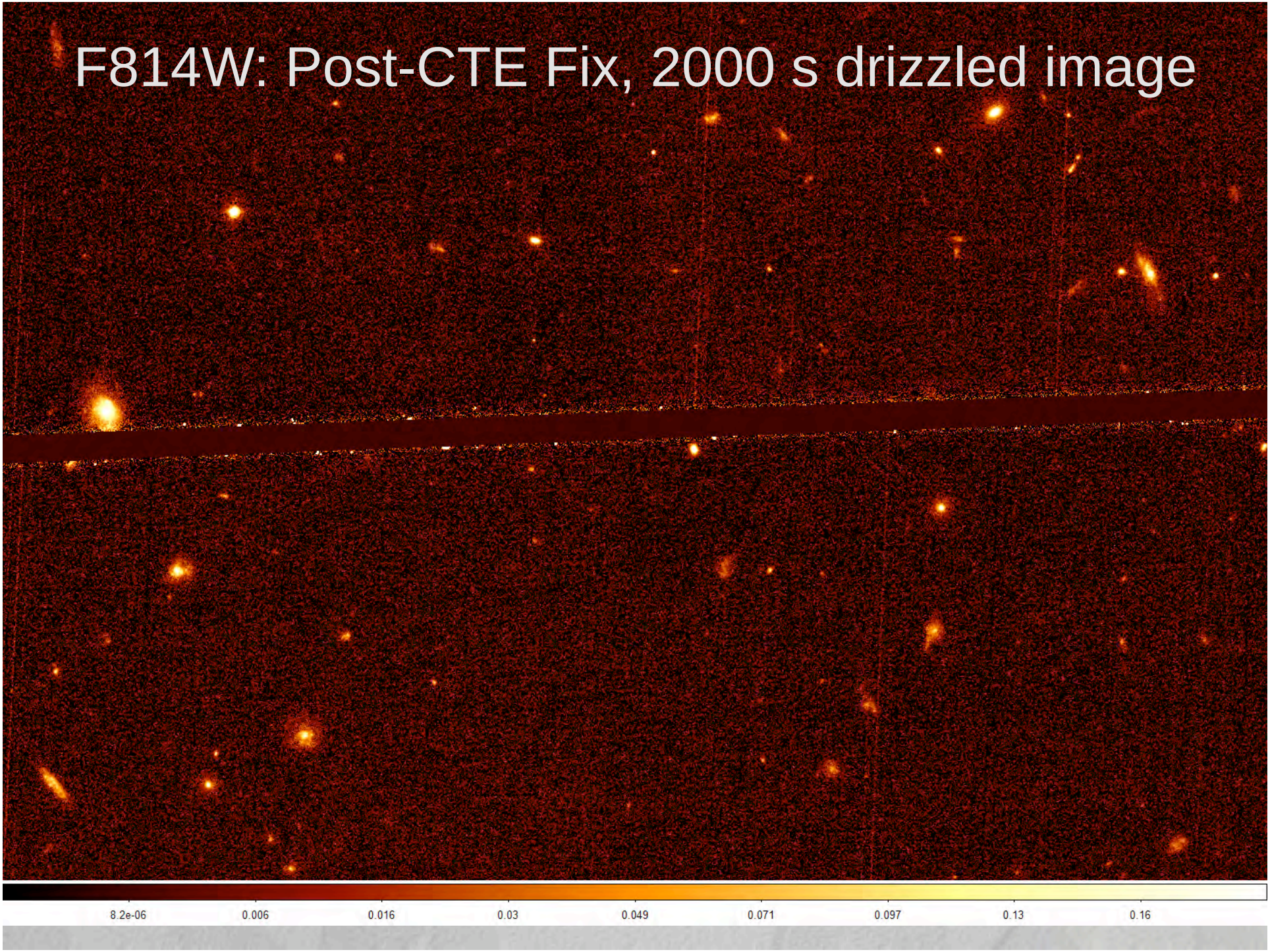
Charge Transfer Inefficiency Mitigation

- Anderson/Bedin code has been converted to Python/C and will be made public in next STSDAS release – beta version using FLT file
- Code will be incorporated in CALACS pipeline to work on RAW data and will be thoroughly tested by ACS team – available by end of 2011
- Next slides show first application to CANDELS GOODS-South ACS parallel field
  - Region farthest from amps is shown and highlights plethora of CR and hot pixel trails remaining in drizzled set of 4 combined images

F814W: Pre-CTE Fix, 2000 s drizzled image



F814W: Post-CTE Fix, 2000 s drizzled image

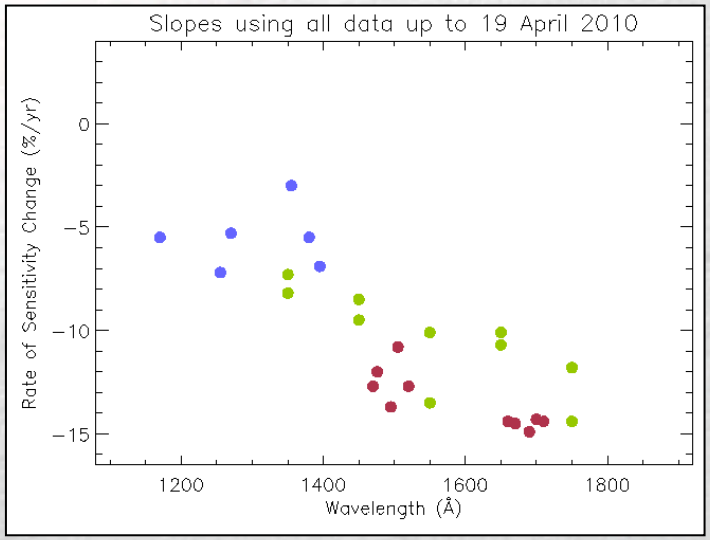


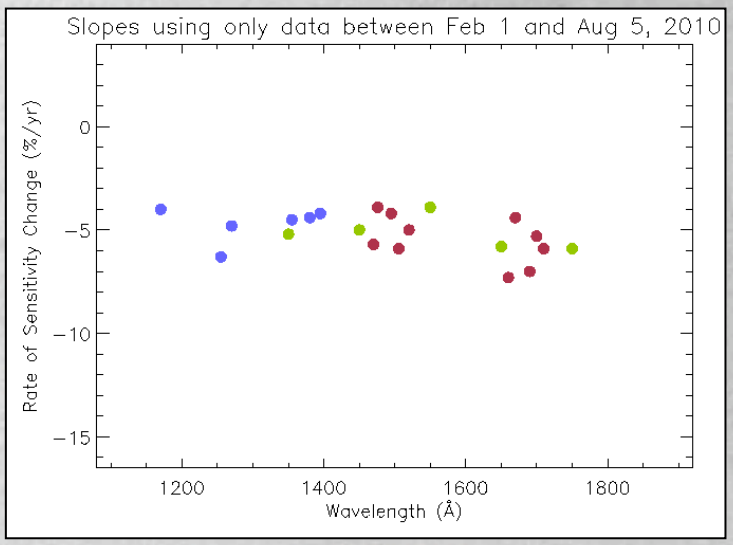
COS Status

(C. Oliveira, C. Proffitt)

- COS continues to perform well
- Highlights
  - FUV sensitivity decline is leveling off, λ-dependence weakening
  - FUV gain is sagging at detector locations illuminated by Lyα
  - NUV bare-Al grating sensitivity continues to decline on trend
  - New FUV G130M modes provide coverage down to 900 Å at reduced resolution
  - EUV response is being evaluated
  - NUV MAMA detector dark is increasing on trend
  - Flat-fielding remains an active area of work (update next meeting)

COS FUV Sensitivity

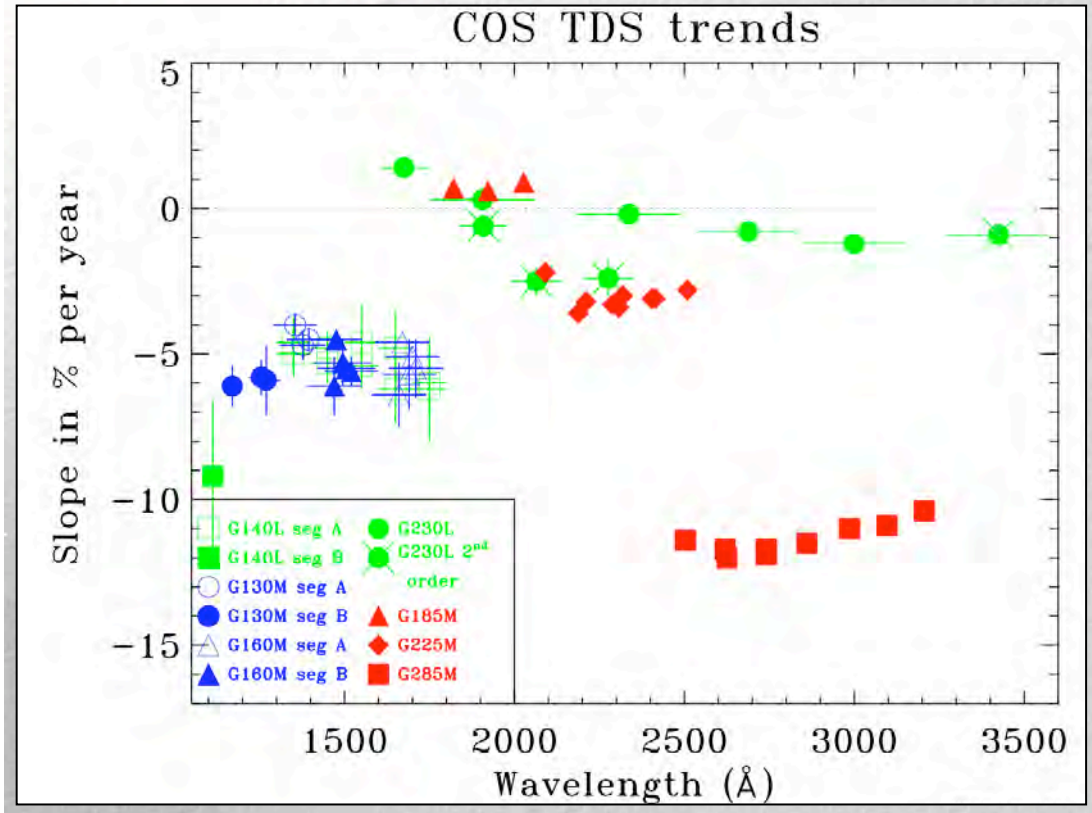




- G140L
- G130M
- G160M

- Initial data showed steep wavelength dependence, degradation up to 15%/year, and variability between the gratings and segments
  - Initial concern that degradation was due to collecting too many photons proved unfounded (degradation not isolated to regions of heaviest use)
  - Was also concern that if degradation was due to atomic oxygen, decline might accelerate as solar maximum approaches and atmospheric density increases
- Newer results show flattening of decline and less λ-dependence
  - Decline now about 5-6 %/yr with little λ-dependence

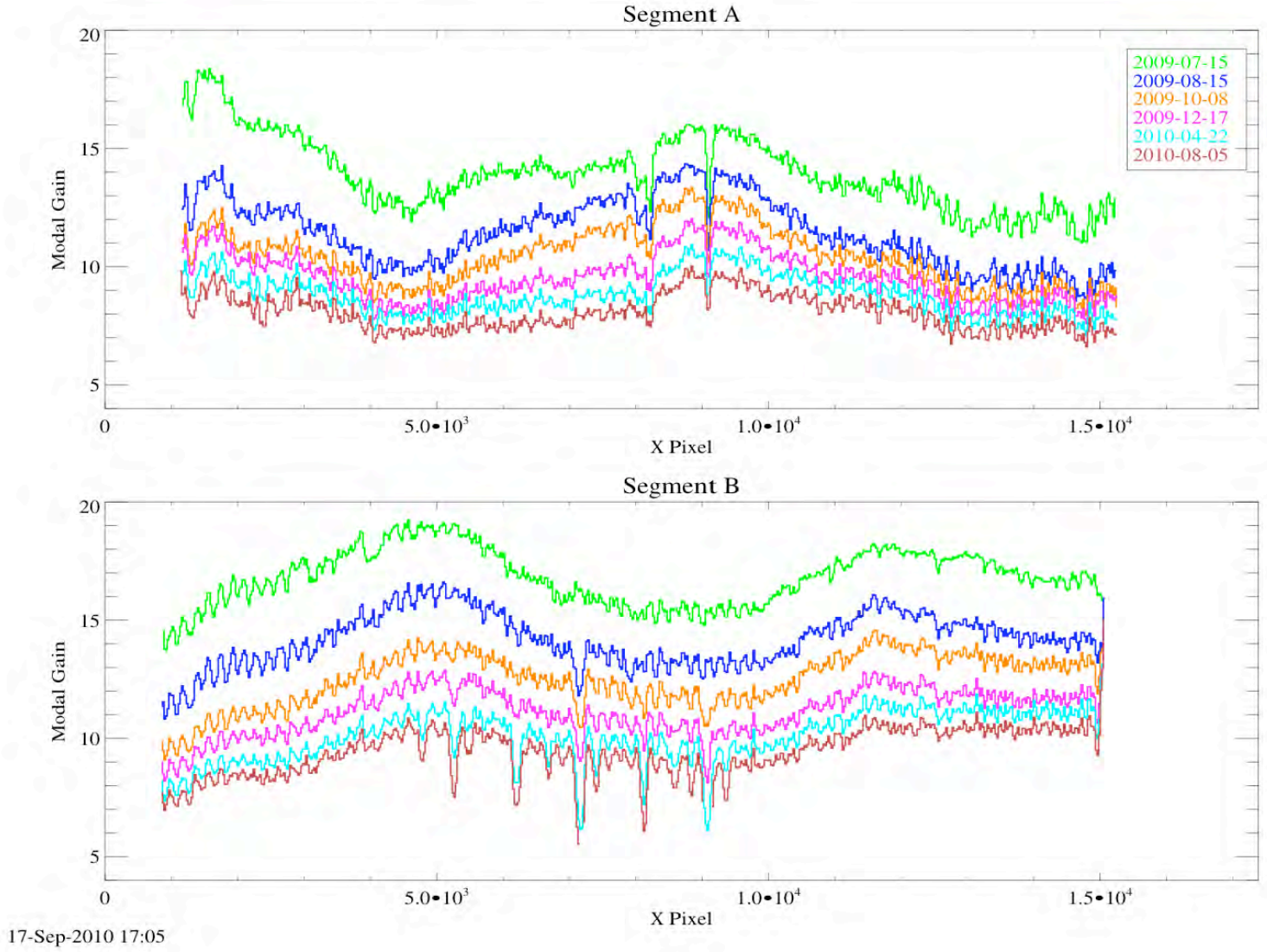
COS Sensitivity Summary



- FUV sensitivity loss rate is now approximately 5 – 6%/yr, with little λ dependence
- NUV bare aluminum gratings show linear declines over time of about 3.5 %/yr (G225M), and about 11 %/yr (G285M), with little λ dependence
- MgF_2 coated G230L and G185M gratings show little change over time, except perhaps for the 2nd order light from the G230L

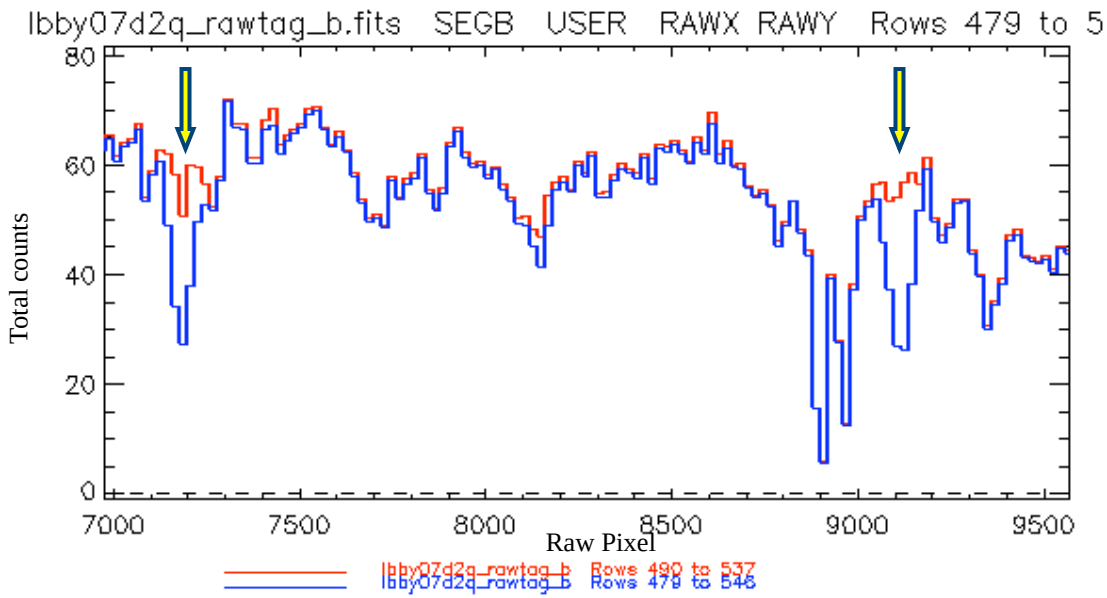
For the FUV channels, the mean slopes of the sensitivity decline are shown as a function of grating and wavelength for the period between Mar 15 and Sep 15, 2010. For the NUV channels, which have not shown any change in behavior, the slopes are fit to all data available from Cycle 17 calibration observations.

COS FUV Gain Sag (1/2)



COS FUV Gain Sag (2/2)

- Currently, the areas most heavily affected already show >30% loss: FUVB around pix 7200 (Lyα from G130M/1309/FP3) and 9100 (Lyα from G130M/1291/FP3).
- Other areas will slowly catch up.
- Each affected region has a width of ~110 pixels (width of PSA)



Red => PHA = [0,31]; Blue => PHA = [4,30] (currently used)
Data are from program11997, vis 07, G160M/1623/FP=4, bin = 20 [09/2010]
Yellow arrows mark regions where gain sag leads to a loss of counts

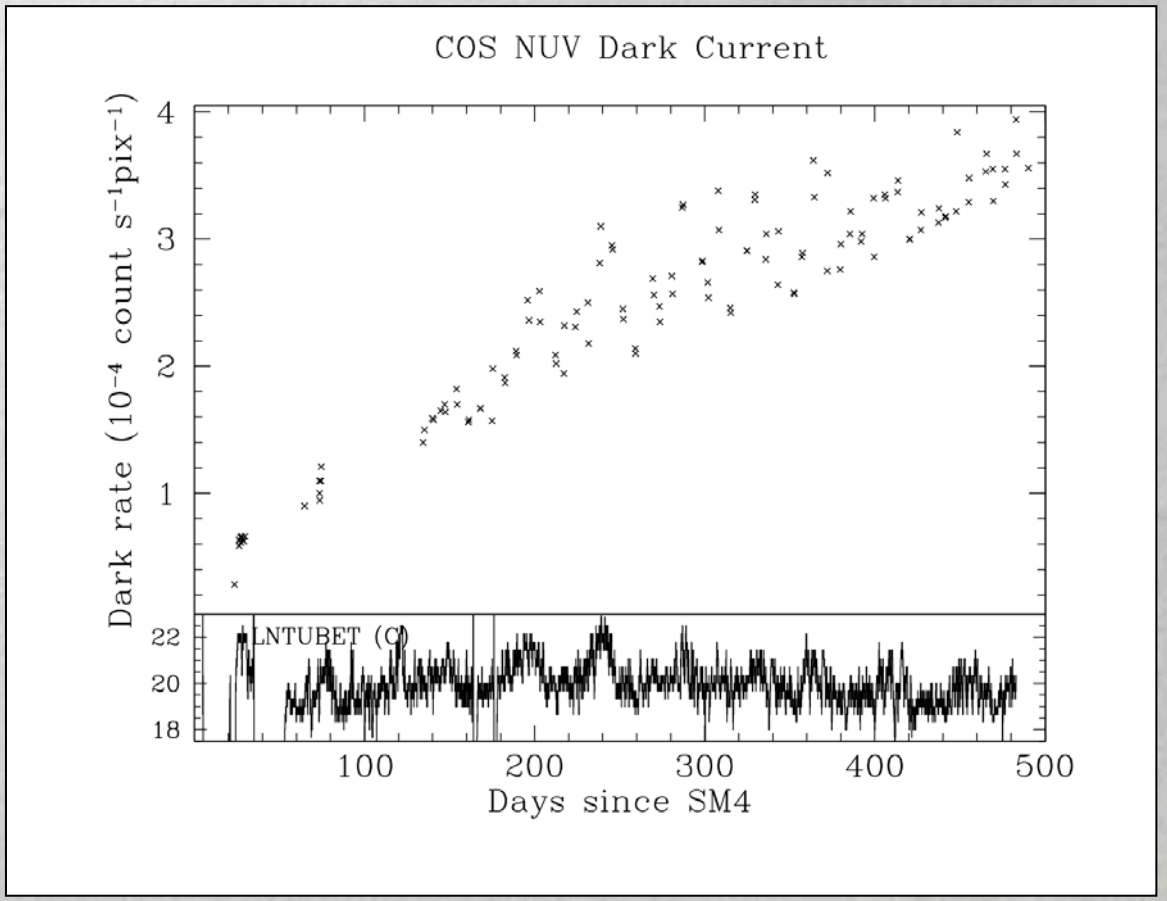
Short term solution
Open up pulse height screening range

Medium term solution
Increase HV to restore gain

Long term solution
Use other "clean" lifetime positions available

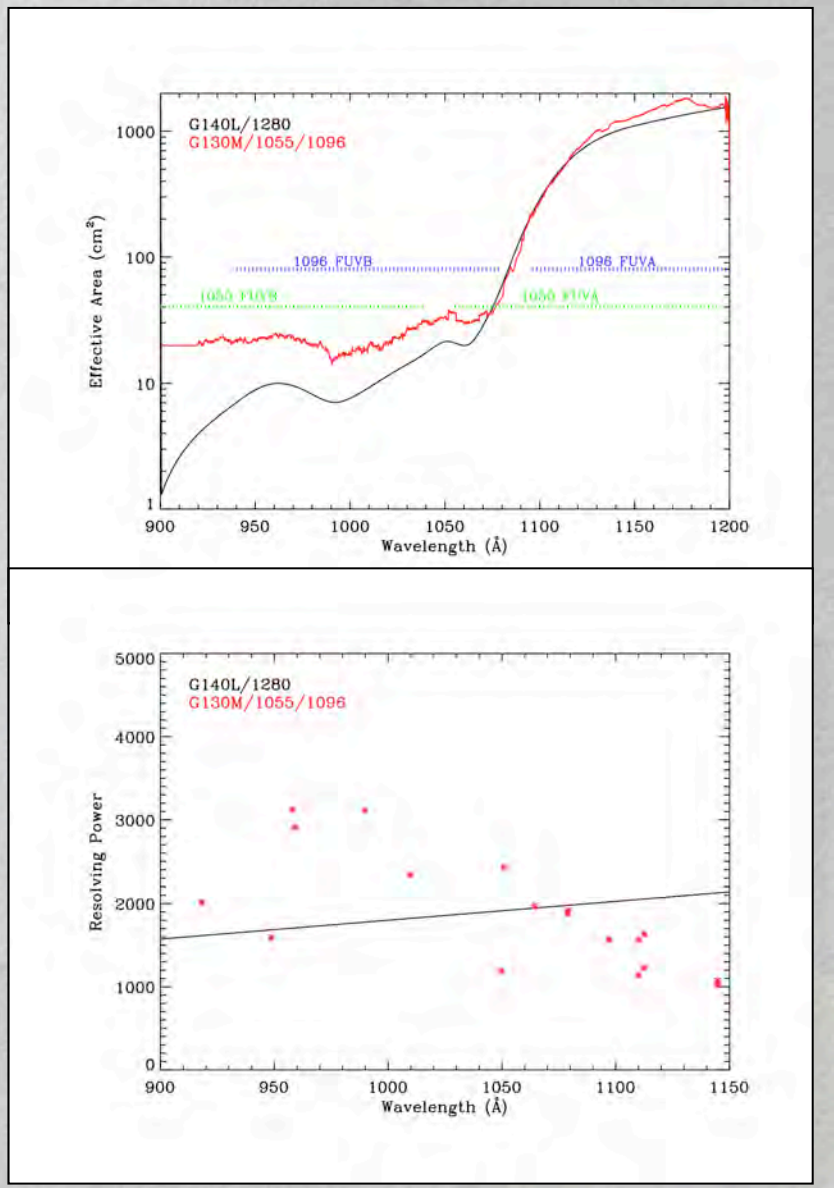
COS NUV Dark Counts

- Dark current increasing linearly with time
- Fluctuations correlated with temperature
- Monitoring continues
- Present dark current value is 3.56×10^{-4} c/pixel/s
- ETC will be updated for Cycle 19



New FUV G130M Settings

- Two new G130M central wavelength settings cover 900-1200 Å
  - λ_c = 1055 and λ_c = 1096
- A_{eff} > A_{eff} (G140L)
- R ~ 3000 – 1000, λ-dependent
- New modes implemented in Cycle 19 ETC

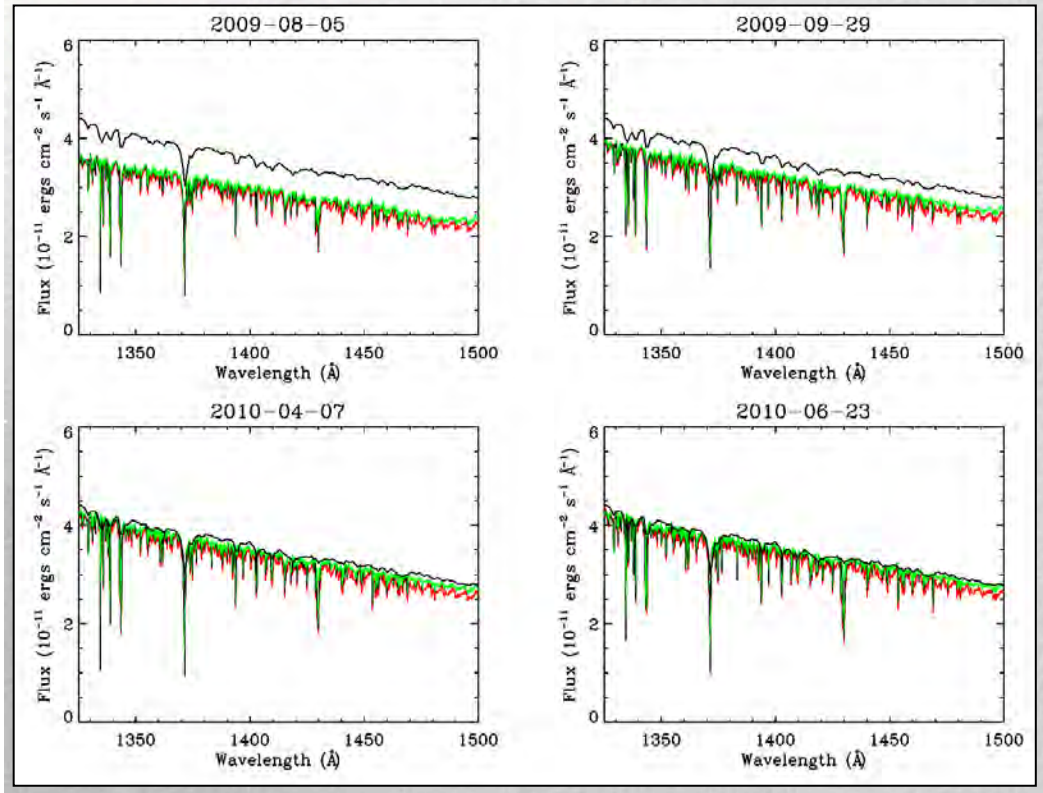


STIS Status

(C. Oliveira, C. Proffitt)

- STIS continues to perform well
- Highlights
  - Anomalous E140H throughput decline has improved
  - Excess NUV dark current seen after SM4 has continued to decline, although more slowly than at first
  - Execution of Cycle 18 CCD coronagraphic visits has begun

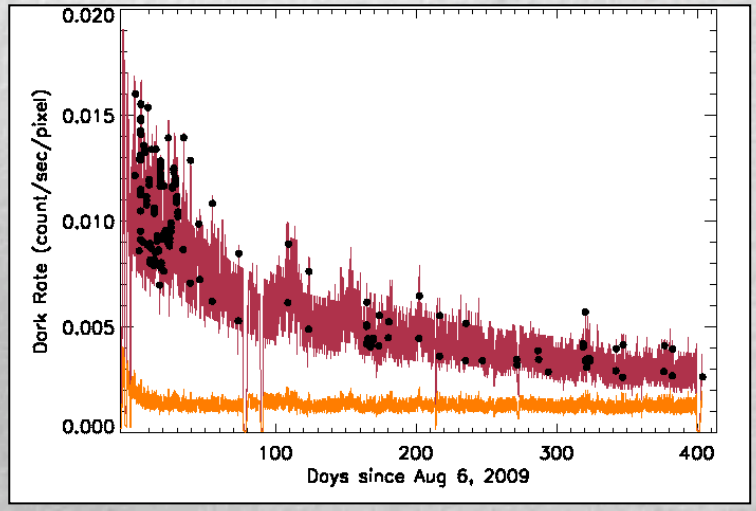
E140H Throughput



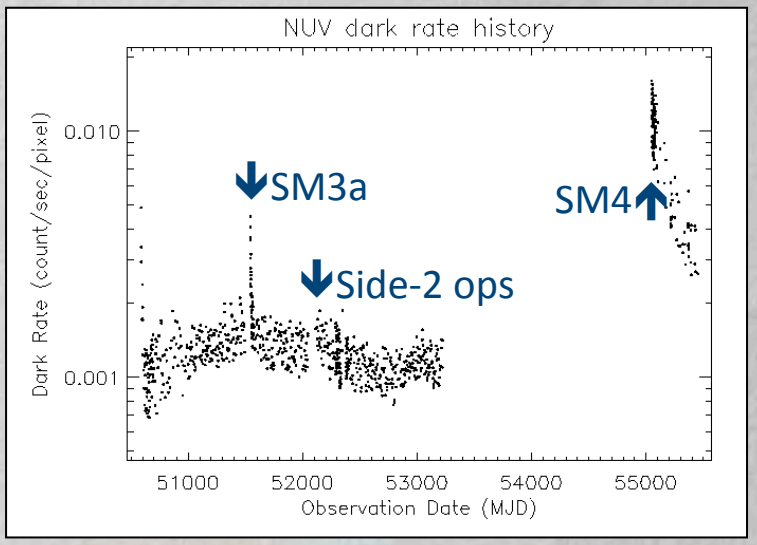
- Initial SMOV measurements showed E140H throughput was low by ~20% compared to expectations based on G140L TDS trends.
- Throughput appears to have recovered over time. Black curves at left show the low dispersion G140L reference spectrum.
- Figure at left shows effects of blaze shift (red line) and new throughput estimates (green line) that correct for blaze function changes.

NUV MAMA Dark Current

- Rate of decline has slowed
  - Level approaching ~2x pre-SM4 model
- Window will be cold while MAMAs are off
  - Temporary increase in dark current expected when operations resume on 15 Nov 2010 SMS
  - Expect excess to dissipate in ~3-4 weeks



Black dots = measured STIS dark rates
Red line = empirical model with short term temperature variations
Orange line = pre-SM4 model



Dark rates measured in STIS NUV MAMA dark exposures throughout the on-orbit life of STIS

STIS Coronagraphic Observations

- In Cycle 18 there is a significant increase in the amount of STIS coronagraphy, primarily targeting stellar debris disks
  - 12228 Schneider, 88 orbits, 4 orbits already executed
    - Probing for Exoplanets Hiding in Dusty Debris Disks: Inner <10 AU Disk Imaging, Characterization, and Exploration
  - 12281 Clampin, 12 orbits
    - STIS Coronagraphic Imaging of the Kuiper Belt Surrounding the HR 8799 Planetary System.
  - 12291 Krist, 12 orbits, 4 orbits executed (+2 today)
    - STIS coronagraphy of Spitzer-selected debris disks
- These observations require careful subtraction of residual light from the star under the wedge, and are often looking for subtle features
- STIS CCD has accumulated significant radiation damage and lacks a working temperature controller
  - STScI is working on improvements to CCD dark scaling and subtraction
  - Plans for applying pixel-based CTE corrections to STIS CCD images are being developed

WFC3 Status
(J. MacKenty)

- WFC3 is operating nominally and calibration is ongoing
  - Current dark, bias, and bad pixel reference files are available
  - Photometric zero points stable to <0.3% (UVIS) and <0.5% (IR)
  - Flat field residuals 4-6% peak-to-peak in both channels
    - P-Flats (high spatial frequencies) stable to <1% in both channels
    - UVIS star cluster generated L-flats (low spatial frequencies) near completion (2-3% p-p; ~1% rms)
    - IR star cluster and sky flats are in progress
  - Astrometric/Multidrizzle calibrations for 10 UVIS and 5 IR filters completed (0.1 pixels)
  - Key detector calibrations and trends established and monitored
    - Hot and bad pixel behaviors are as expected
    - IR count rate non-linearity calibration fairly secure: 1.1% per dex (3-5x smaller than NICMOS)
  - 57 Instrument Science Reports since SM4 detailing SMOV and Cycle 17 activities and results

WFC3 Grism Activities (1/2)

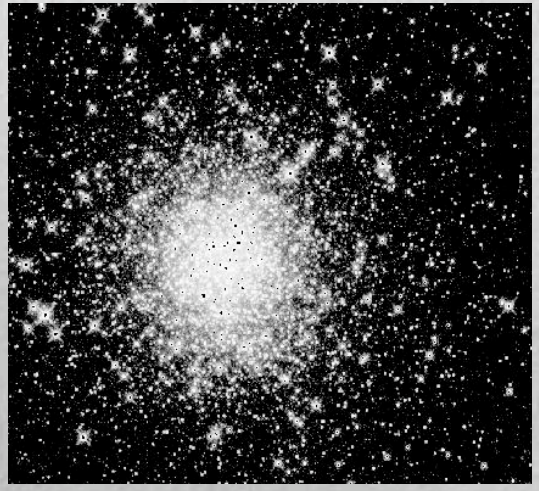
- ST-ECF support is being phased out this December, as planned
  - Excellent support over the past decade including ground calibration, simulators, user documentation and support, flight calibration, and aXe analysis software
  - Ongoing work to transfer knowledge, software, documents, and website materials to STScI
  - Completed SMOV & Cy17 calibrations support advertised performance
    - Cy18 calibration developed in-house with ECF input; improve corrections for field dependence

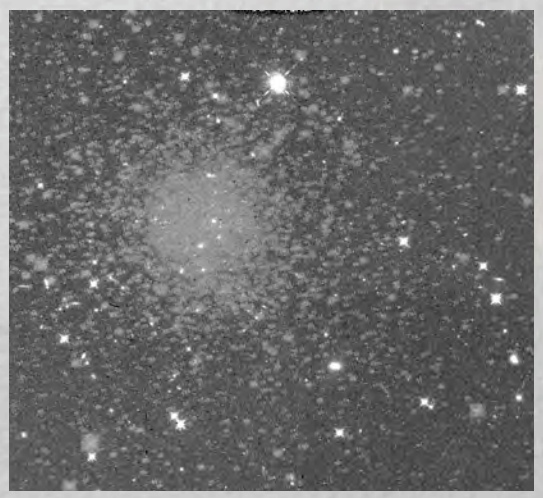
WFC3 Grism Activities (2/2)

- Cycle 18 TAC led to a large increase in number and scope of WFC3 IR grism science programs
  - WFC3 team has organized a grism subgroup, is adding staff, and is coordinating with ACS and JWST slit-less spectroscopy efforts
  - STScI and ECF are jointly organizing a grism spectroscopy workshop 15-16 Nov 2010STScI
    - Outreach to current and future observers; discussion of analysis techniques
  - WFC3 team is exploring paths to increase support for and capabilities of grism spectroscopy
    - aXe Cookbook (ECF) released 14 September 2010
    - Internal staff training in aXe reductions and generation of calibration reference files
    - Drift scans for high S/N and improved time resolution spectra of bright sources

WFC3 IR Persistence (1/2)

- Majority of WFC3/IR science and calibration programs create some level of persistence
  - Exposures to ~50% full-well generate measureable persistence signal
- Very bright sources can cause severe persistence
  - Particularly problematic are sources that illuminate many pixels
  - Limited scheduling mitigation in place and/or repeats





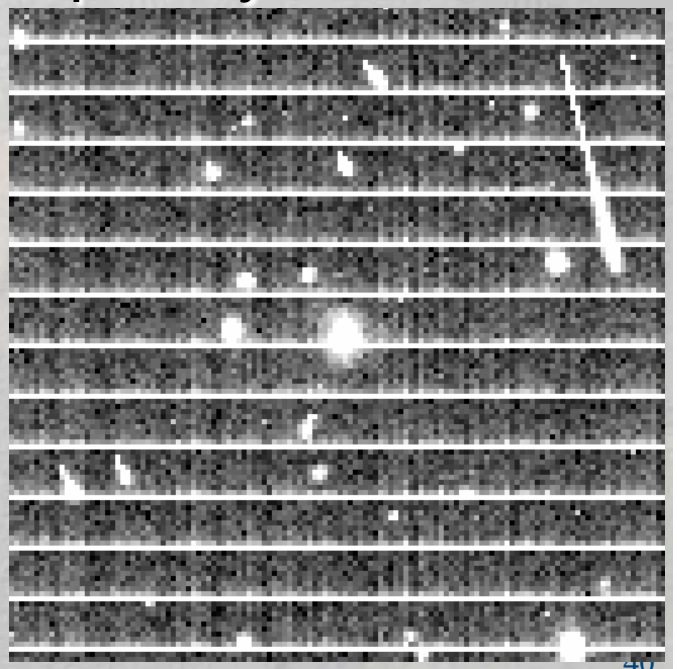
Terzan 5 and its faint ghost in a later orbit

WFC3 IR Persistence (2/2)

- Mitigation Strategy
  - GOs are required to dither IR observations (except pure parallels)
  - Working with scheduling (via CS reviews) to avoid IR observations for several orbits after observations of problem targets
  - Knox Long & Adam Riess have built prototype tools to track pixel exposure history and predict dark current
  - Knox is currently providing case-by-case support for GOs with impacted observation
    - Working to generalize this capability for all IR observations
    - Most important for parallels and detections of faint time-variable sources (e.g, SN Ia in MCT programs)
  - Exploring potential for correction as well as identification of impacted pixels

CCD Charge Transfer (1/2)

- CCDs unavoidably suffer radiation damage in space
  - Ground testing of WFC3 e2v CCD indicated susceptibility comparable to ACS WFC detectors
  - In flight WFC3 CTE is declining 2-3 times faster than ACS detectors (faint star loss 8-10%)
  - **WFC3 today is where ACS was 3 to 3.5 years after SM3b**
  - Cause strongly suspected to be solar cycle (SAA 3x at solar min; ACS also declining faster now)
- WFC3 CCDs have a charge injection capability
  - ~15,000 e-/pixel can be injected into every 1, 10, 17, or 25 rows
  - Incurs ~15-20e- noise penalty in those rows
  - Initial in-flight experiments (Sept-Oct 2010)
  - Noise in non-injected rows <5e- (mostly <4e-)
  - 10 or 17 row spacing removes nearly all CTE loss
  - Testing repeatability of injection and stability of calibration

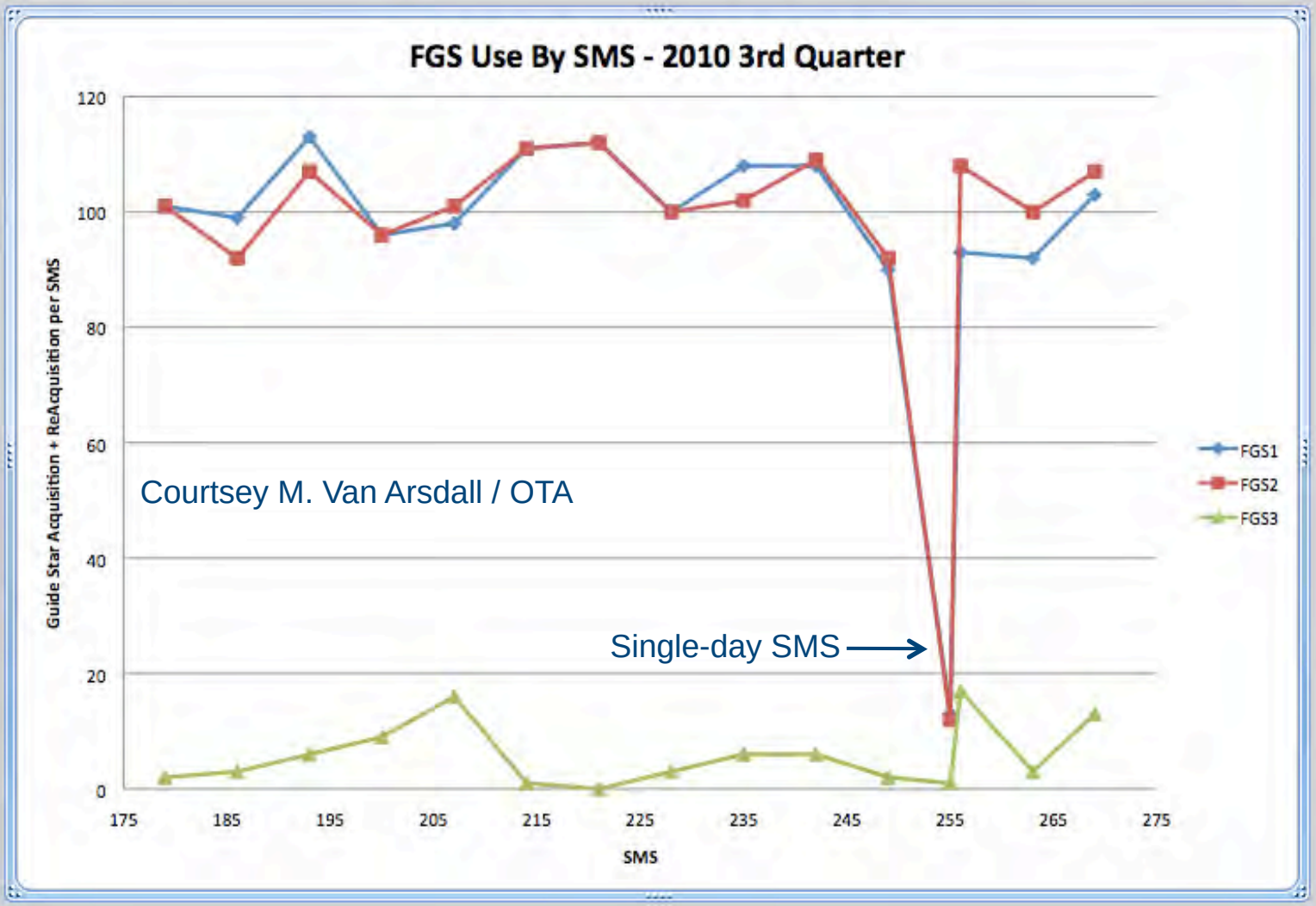


CCD Charge Transfer (2/2)

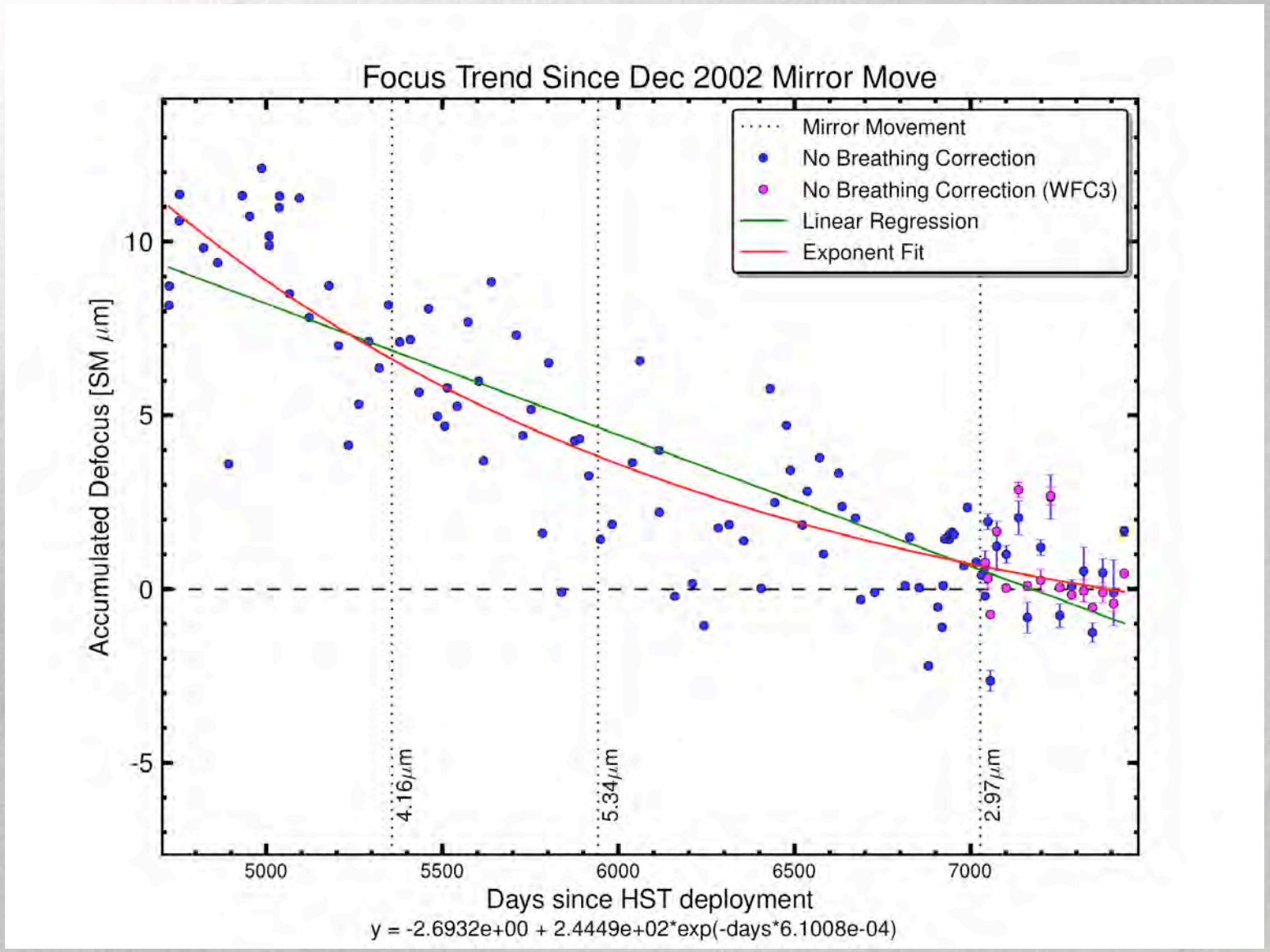
- Ongoing efforts
  - Characterize CTE and report photometric impacts
  - Prepare Charge Injection for Cycle 19 as observer option (ON/OFF)
    - Need to test calibrations and pipeline modifications
  - Explore (w/ACS group) performance of Anderson/Bedin algorithm
    - WFC3 detectors are different than ACS

Fine Guidance Sensor – FGS2R2

- SMOV4 calibrations
  - Interferometer optical alignment (AMA)
  - Scale calibration
  - Focal plane alignment
  - Photometric sensitivity (needed for guide star count rates)
- FGS2R2 has been guiding HST since summer 2009 as the roll-control FGS
- S-curves are stable
  - No need for second AMA adjustment
  - Mini-OFAD can proceed
- Final calibration will enable use as a “dominant” guider


FGS Use By SMS - 2010 3rd Quarter
Guide Star Acquisition + ReAcquisition per SMS
120
100
80
60
40
20
0
175
185
195
205
215
225
235
245
255
265
275
SMS
FGS1
FGS2
FGS3
Courtsey M. Van Arsdall / OTA
Single-day SMS

Observatory Focus



Exposure Time Calculators

- Persistent problems in Cycle 18 combined with difficulty in maintaining Java codebase
  => Mission Office decision to completely rewrite ETC
- Initial development: Jul 2009 – May 2010
- Commissioning: May – Oct 2010
- Preparation for deployment: Sep – Nov 2010
- Public release: 3 Dec 2010, with Cycle 19 Call for Proposals
  - Similar look/feel to current Java-based ETC
  - NICMOS and ACS coronagraphy not included in this release

ETC Improvements - Internal

- Inherently parallel architecture
- Size of codebase reduced from ~130K to ~13K lines of code
- Formerly dispersed instrument-related data now localized
- Direct use of ETC engine now supported (e.g., for batch use)
- Greatly simplified installation procedure

ETC Improvements - Calculations

Current improvements:

- Sampling versus interpolation
- ACS prism integration ranges and UV polarizer
- WFC3 PSF fraction

Future improvements (post-commissioning):

- Convolution
- Extended target smaller than extraction region
- STIS slit widths

ETC Improvements – User Interface

- Web pages slightly reorganized to better match workflow
- Better wavelength range information available
- More versatile plots:
  - User can specify min, max, log mode for each axis and redisplay
  - Allows zooming in to data features of interest