HST Status

HST Mission Office

STUC Presentation

April 13, 2010

Last presentation: November 12, 2009

Agenda

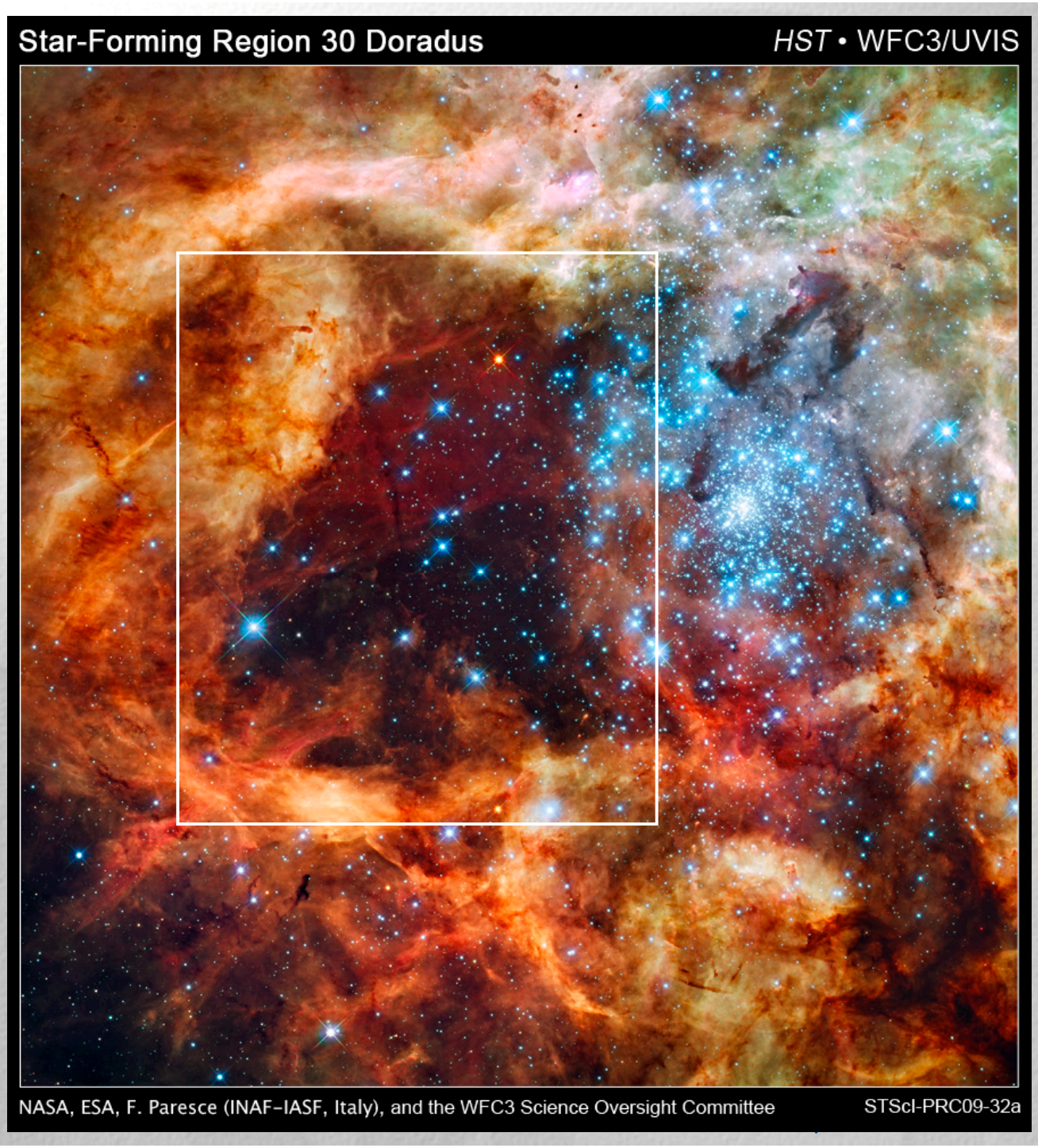
- Highlights since last STUC meeting
- Instrument status
- NICMOS status
- Cycle 17 Long Range Plan

Cycle 18 and MCTP will be covered in other presentations

Baffling Boxy Bulge ("News Nugget") - NGC 4710

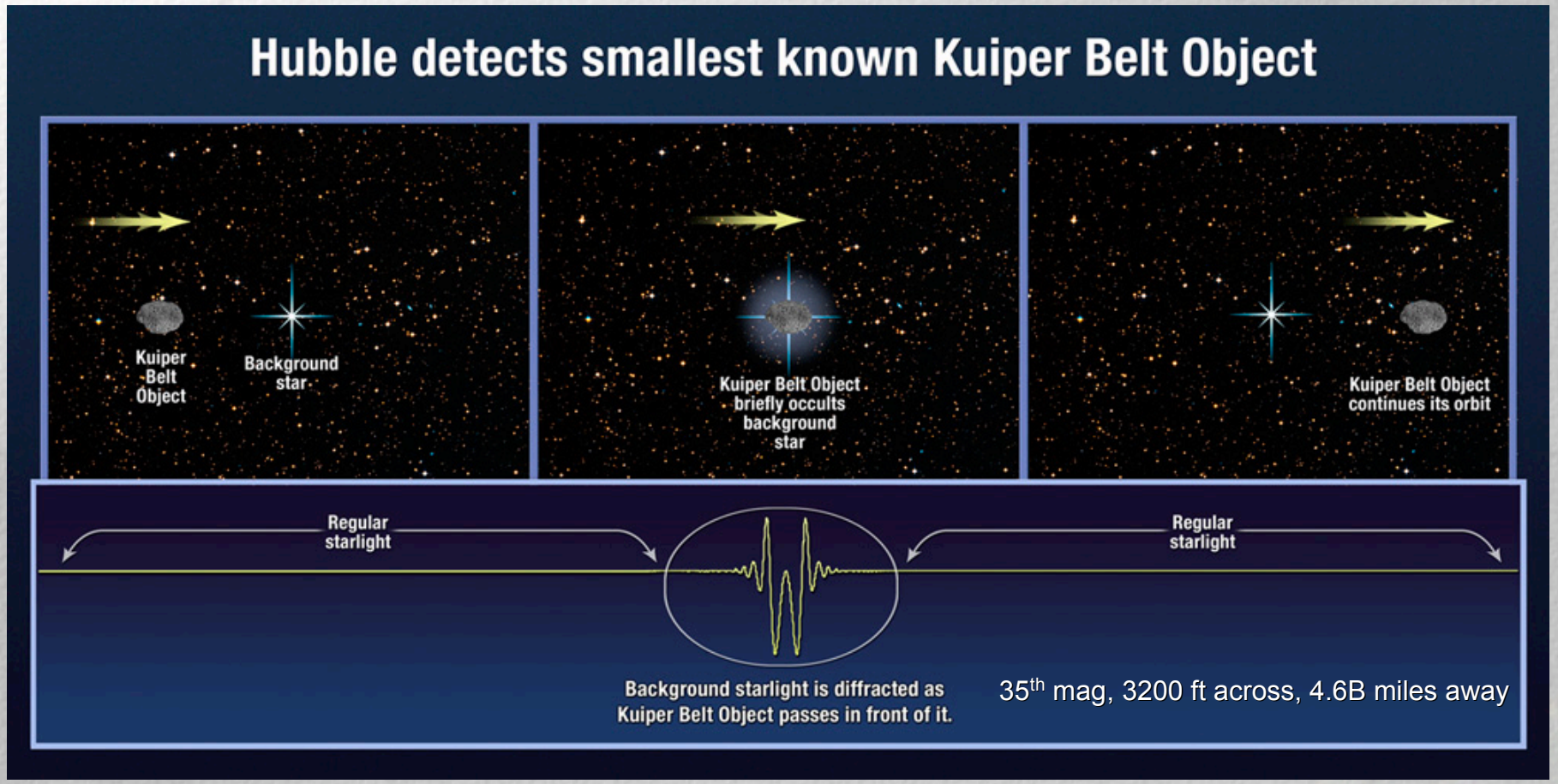
NASA, ESA, and P. Goudfrooij (STScI)

STScI-PRC2009-030



Hubble's Festive View of a Grand Star-Forming Region

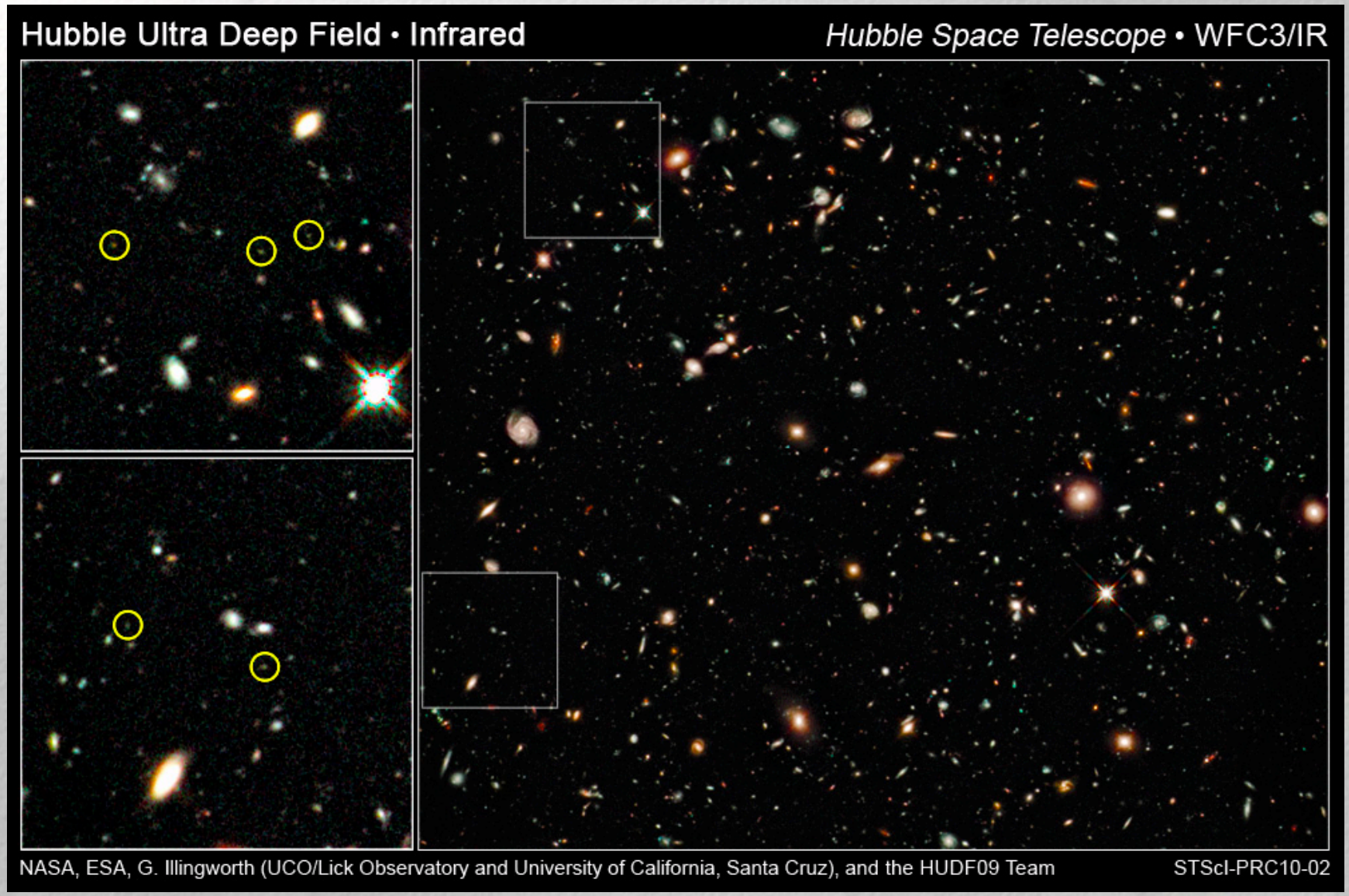
Hubble Finds Smallest Kuiper Belt Object Ever Seen



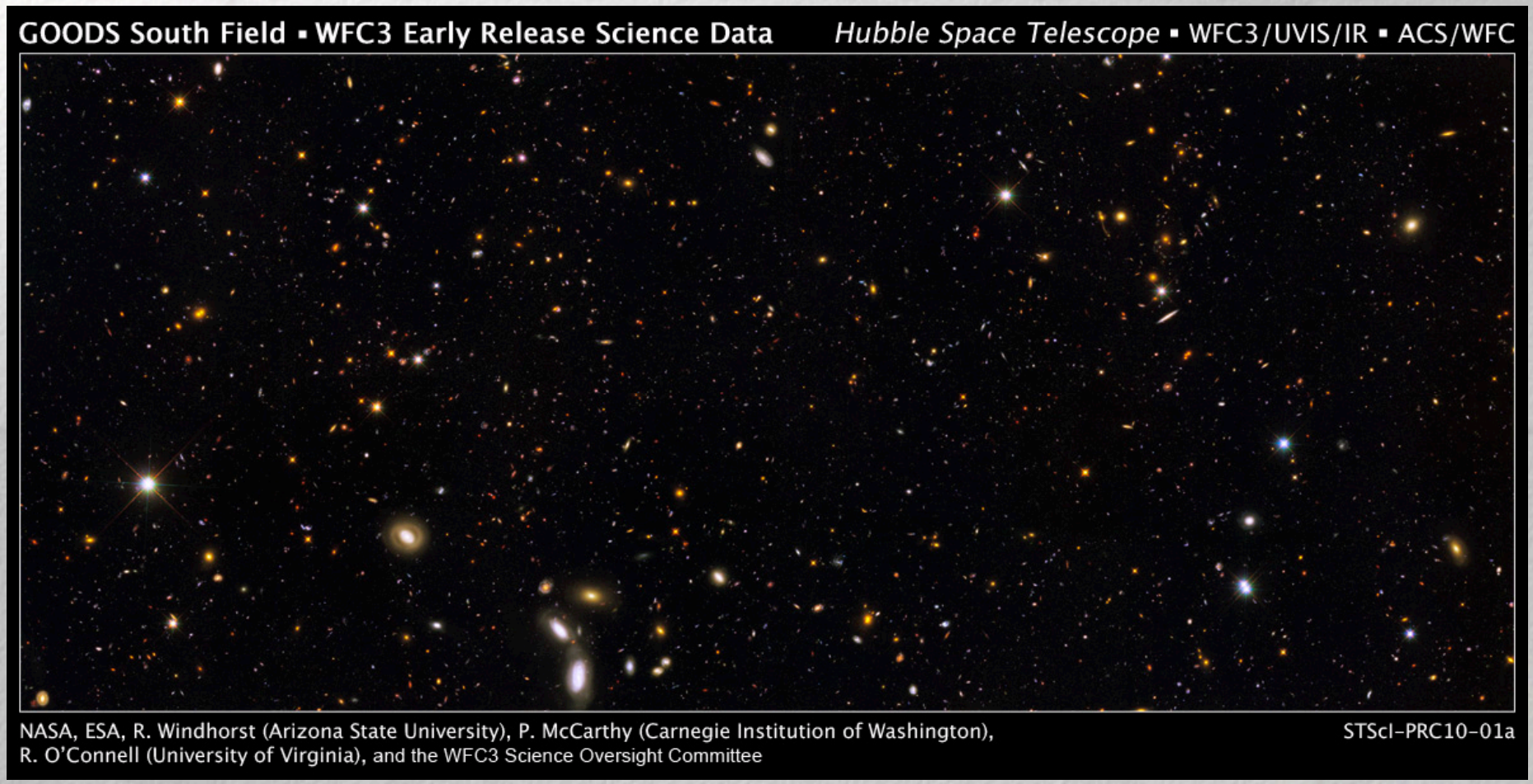
NASA, ESA, and H. Schlichting (Caltech)

STScI-PRC2009-033a

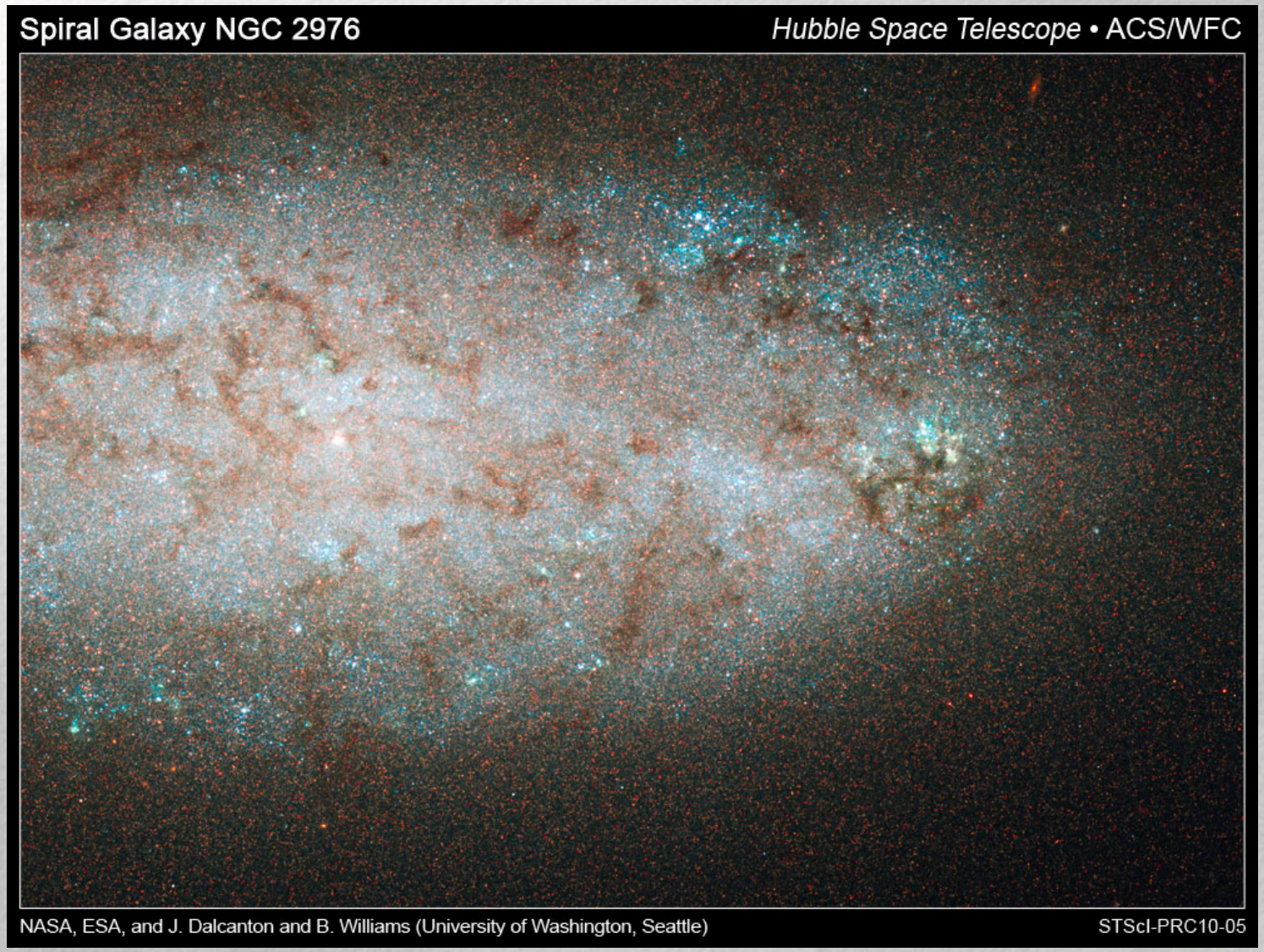
Hubble Reaches the "Undiscovered Country" of Primeval Galaxies



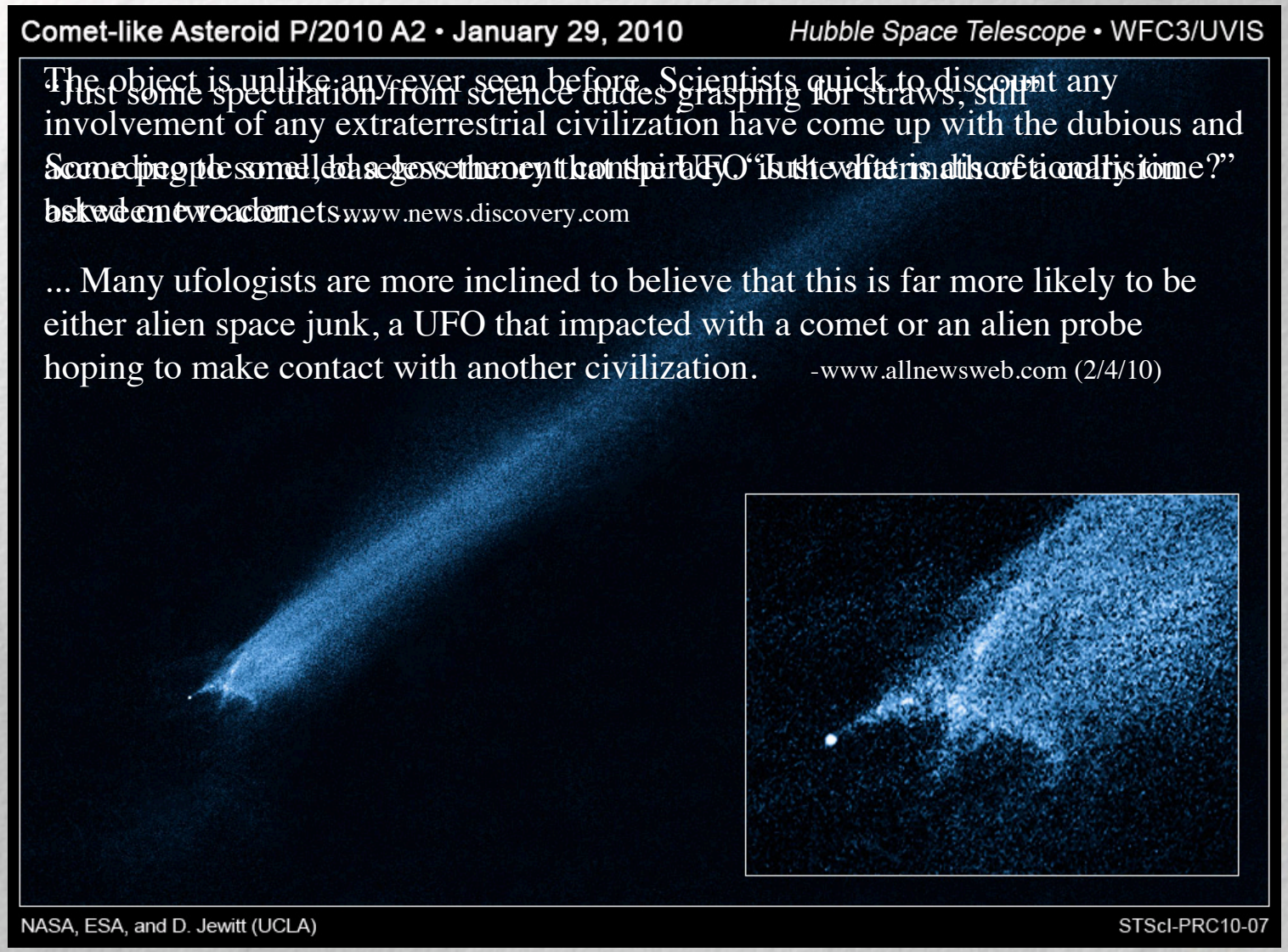
Galaxy History Revealed in This Colorful Hubble View



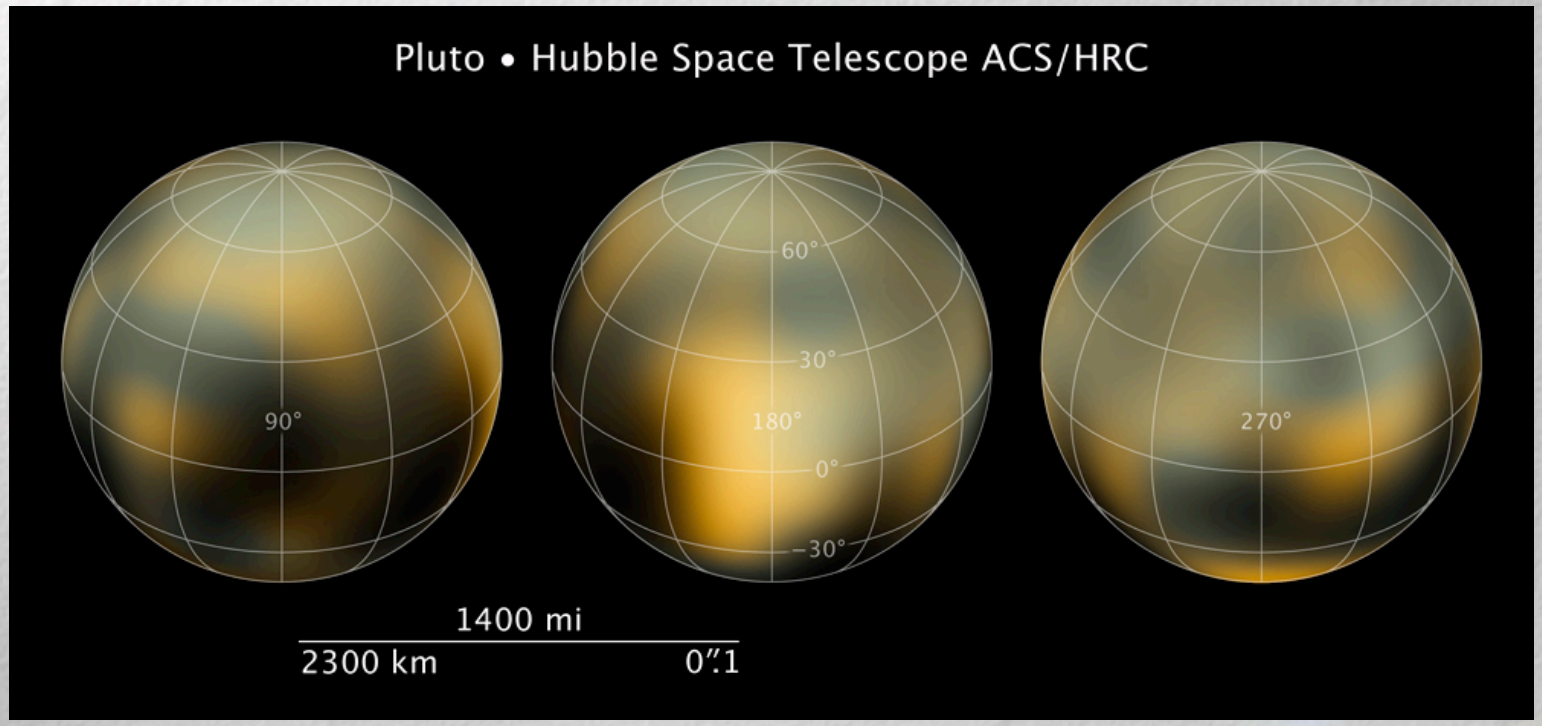
Hubble Catches End of Star-Making Party in Nearby Dwarf Galaxy



Suspected Asteroid Collision Leaves Odd X-Pattern of Trailing Debris

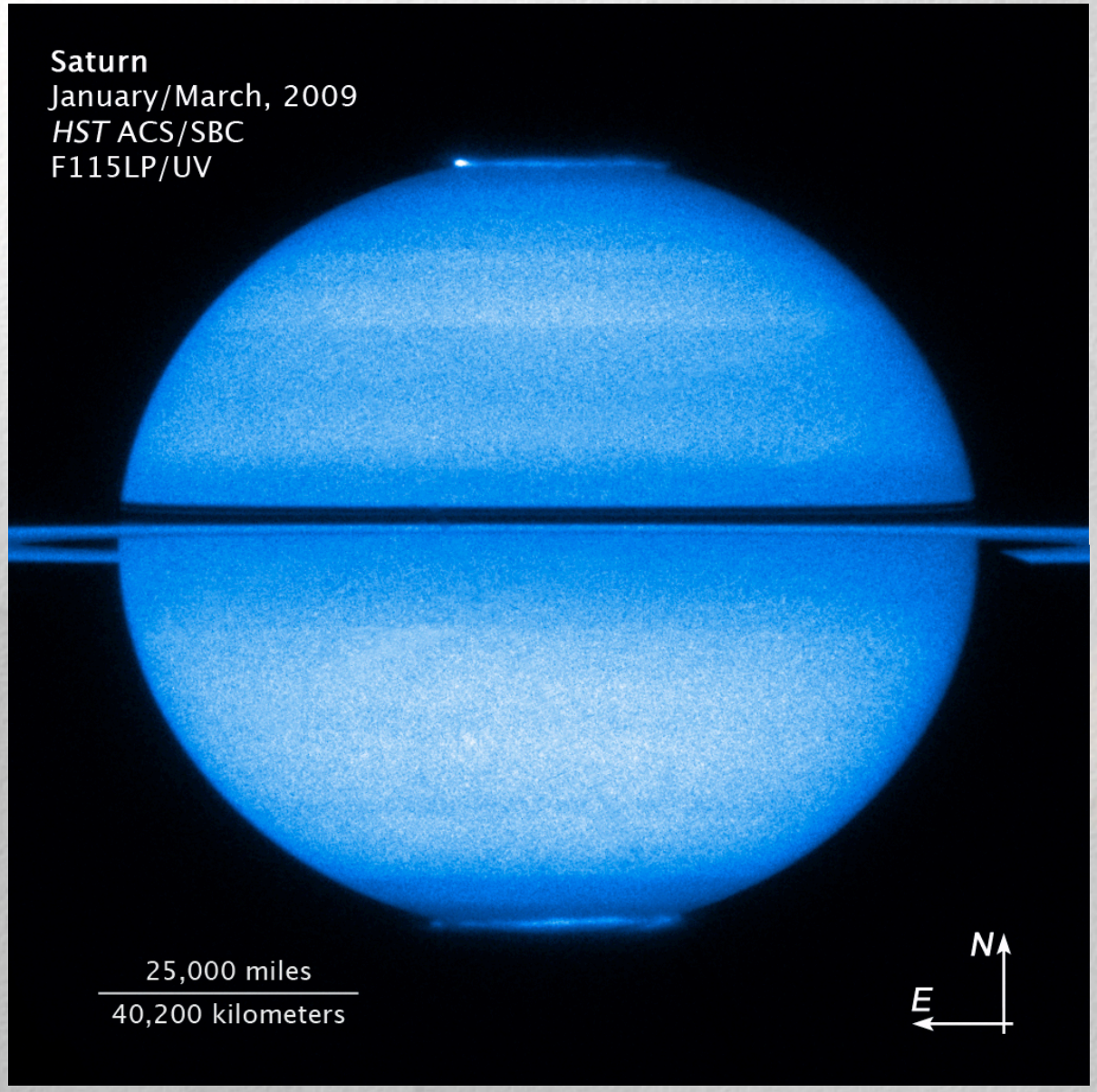


New Hubble Maps of Pluto Show Surface Changes



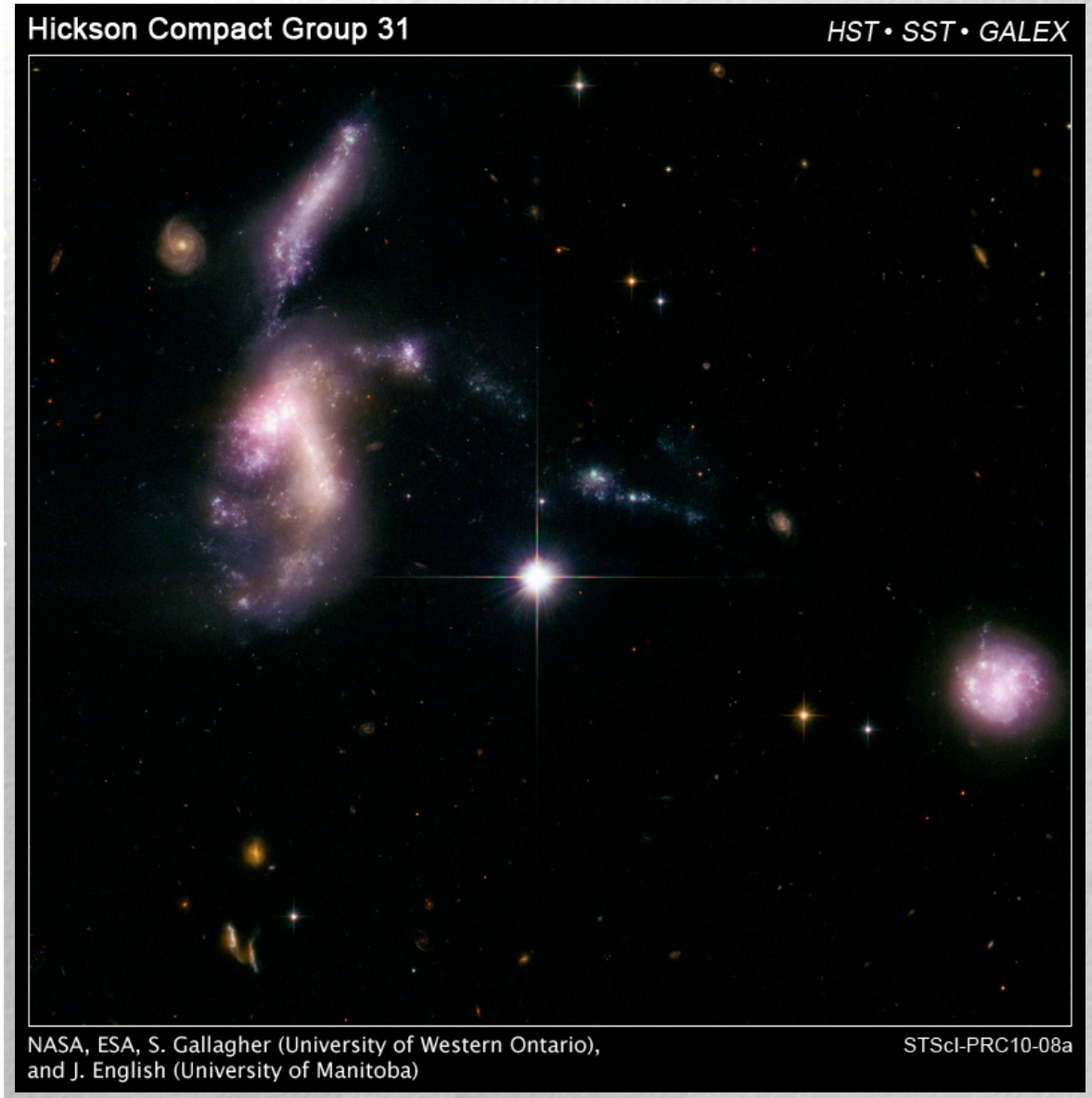
NASA, ESA, and M. Buie (SWRI)

STScI-PRC10-06a



Hubble Captures Saturn's Double Light Show

NASA, ESA, and Z. Levay (STScI)
STScI-PRC10-09



Jurassic Space:

Ancient Galaxies Coming Together After Billions of Years

Exploring the Carina Nebula by Touch

NASA, ESA, and M. Mutchler (STScI)
STScI-PRC10-11

Happy 20th Birthday Hubble!
April 24

Instrument Status

- All operational instruments (ACS, COS, FGS1R, STIS, and WFC3) continue to function well
  - Following charts contain some highlights
- Servicing Mission Observatory Verification (SMOV) is complete
  - SMOV Closure Review held at STScI 18 November 2009
  - Results documented in numerous Instrument Science Reports
    - Available on STScI instrument websites
- Early science and calibration results presented at AAS
  - Approximately 80 calibration/science posters
  - Special session “Science with the New HST”
    - Extremely well attended (several hundred people)
- Interim Cycle 17 calibration review complete
- Calibration workshop - 21-23 July 2010 at STScI

Hubble Observer Social Network

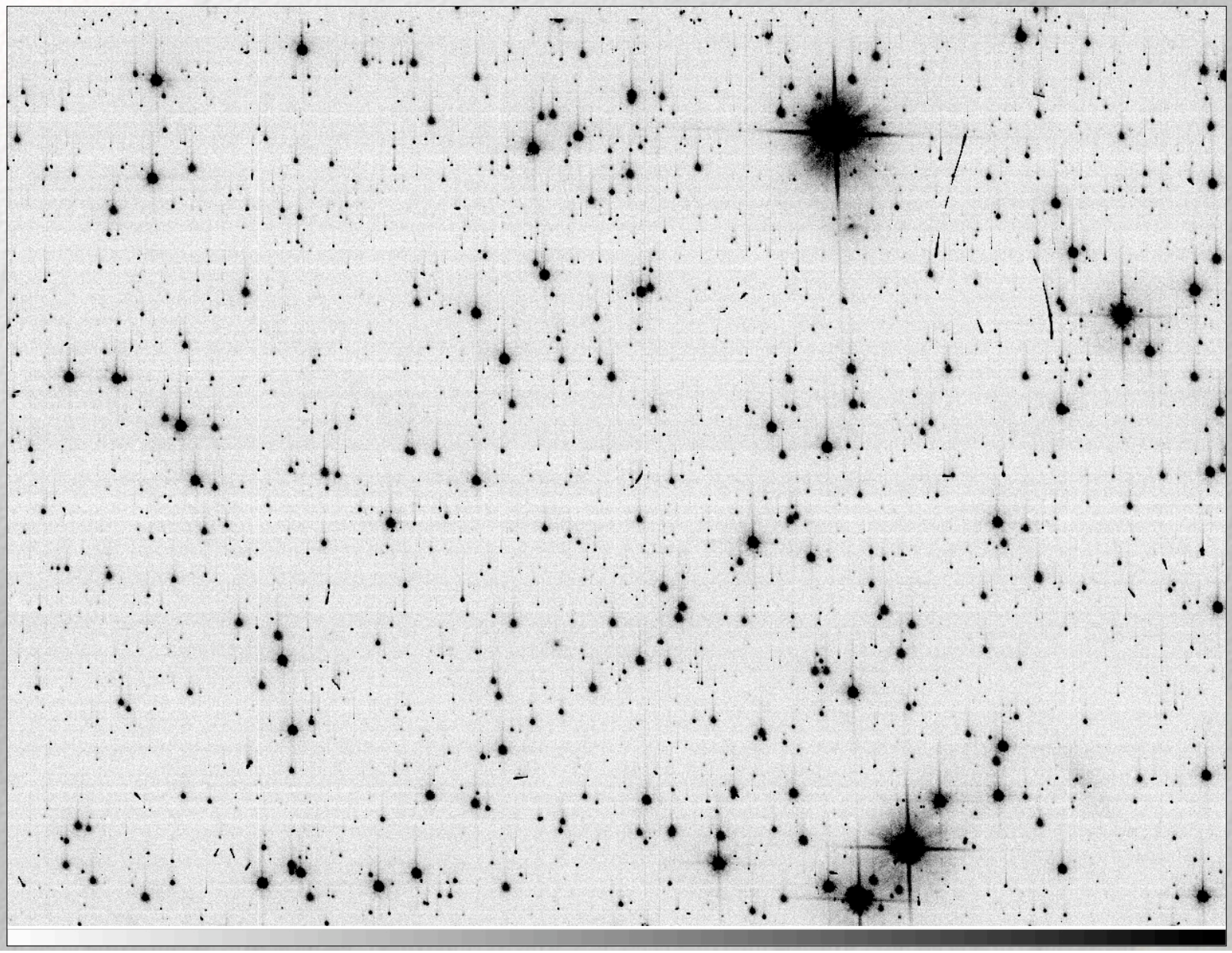
- Facebook/Twitter presence
  - Launched after Cycle 18 Phase I deadline
  - Timely information for Hubble Observers
  - Currently 750 ‘fans’
  - Does not replace existing web presence or email distributions
  - http://www.facebook.com/pages/HubbleObserver/276537282901

ACS Status

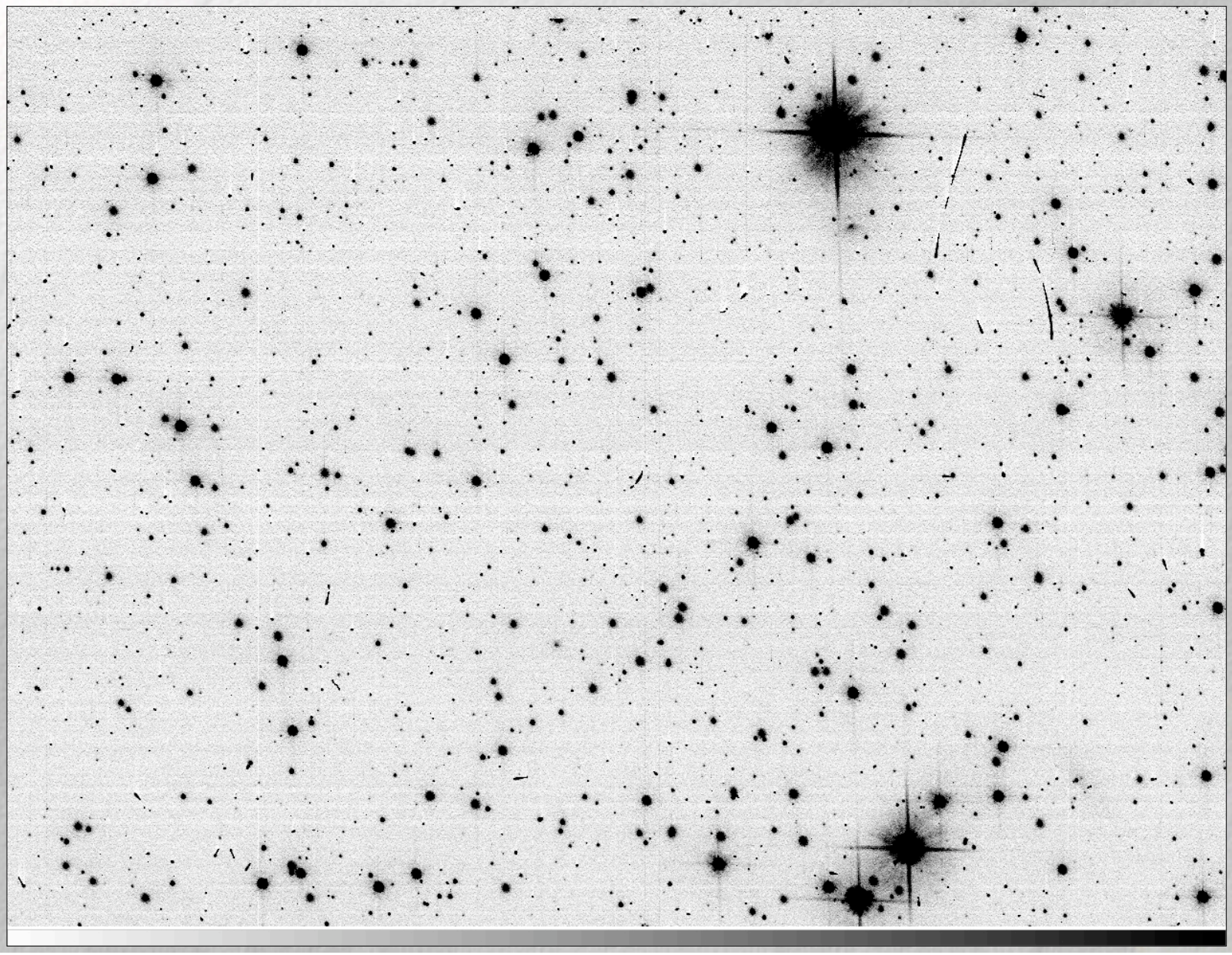
(L. Smith, D. Golimowski)

- SBC and WFC are working very well, no major issues
  - WFC geometric distortion correction needs a minor update
- ACS team has been investigating pixel-based charge transfer efficiency (CTE) correction
  - Using code from R. Massey et al. (2010, MNRAS, 401,371)
  - Using local code (Bedin & Anderson)
  - Testing is currently underway - initial results for post-SM4 data of 47 Tuc are impressive
- GSFC/DCL has been investigating on-orbit CTE mitigation via charge injection before science exposures
  - Noise much lower than shot noise from pre-flashing
  - Already implemented with e2v CCDs in WFC3/UVIS
  - Successfully demonstrated in DCL using irradiated engineering-grade SITe CCDs and ACS Build 5 flight spare with CEB-R; tests continue

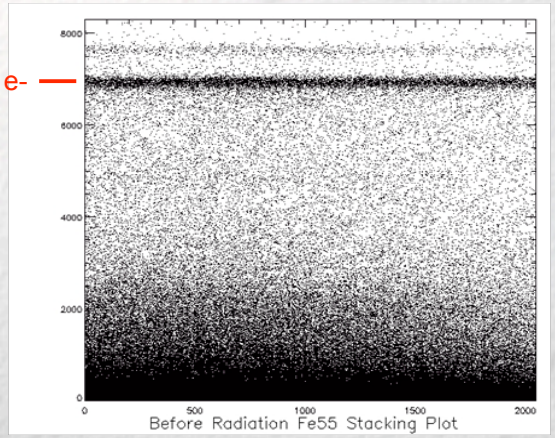
47 Tuc: post-SM4 image

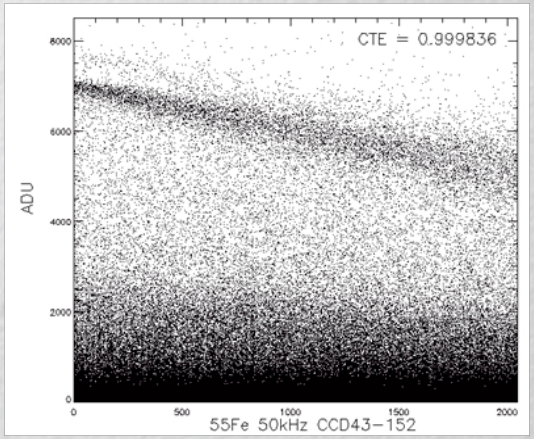


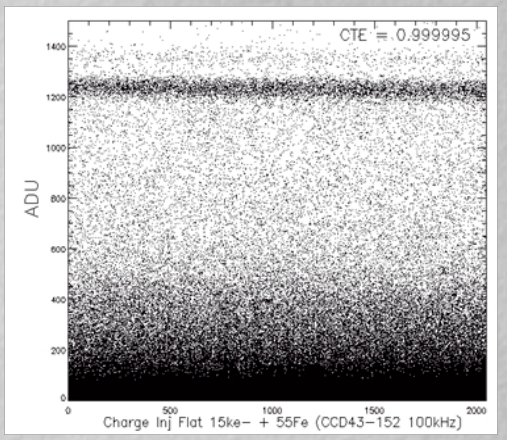
47 Tuc: post-SM4 image, CTE corrected

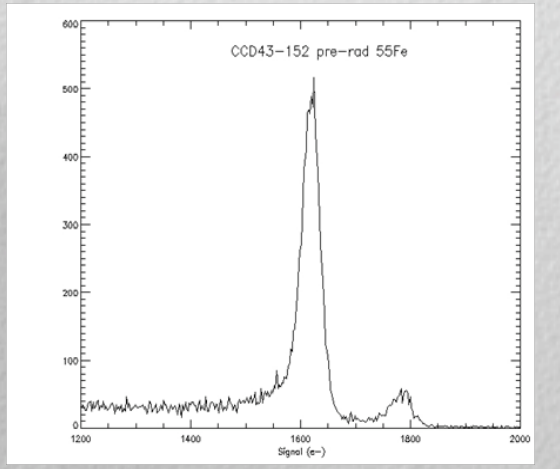


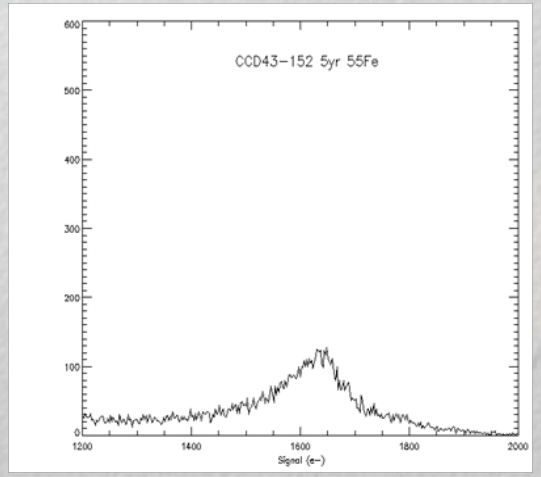
Charge Injection in e2v CCD

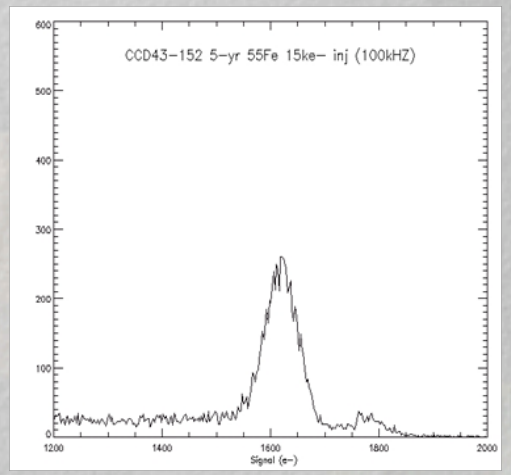












Before radiation
CTE = 0.999995; σ = 3 e-

After 5 yr radiation
CTE = 0.999836

After 5 yr + charge injection
CTE = 0.999995; σ = 10 e-

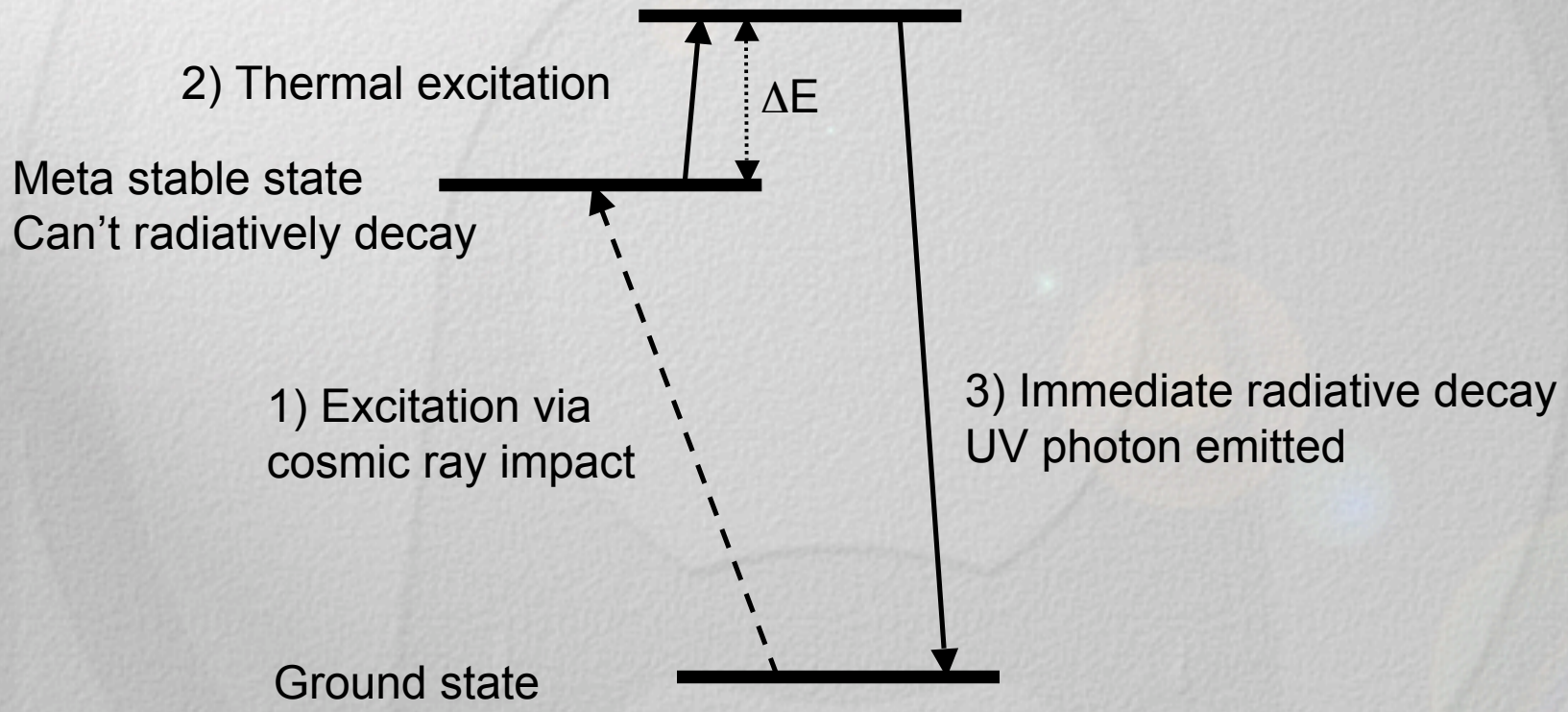
STIS Status

(A. Aloisi, C. Proffitt)

- STIS is working very well
- STIS team continues to monitor instrument performance
  - Throughputs for most modes follow extrapolation of 2003-2004 behavior very closely
  - E140H and E230H throughputs are somewhat lower and more variable
    - Focus change after SM4 may have had an impact (5-20%)
    - Additional echelle monitoring to be obtained in April and June
    - Changes in echelle blaze function are being remeasured at all CENWAVEs
    - Throughput updates should be available soon
  - NUV dark rate
    - Excess dark current seen after SM4 is declining more slowly now than it was initially after SM4
    - Believed to be due to phosphorescence in the NUV detector window
      - Depopulation of meta-stable states

STIS NUV Window Phosphorescence

- NUV MAMA dark rate dominated by de-excitation of meta-stable states in window.
  - Cosmic ray impacts during SAA populate these states



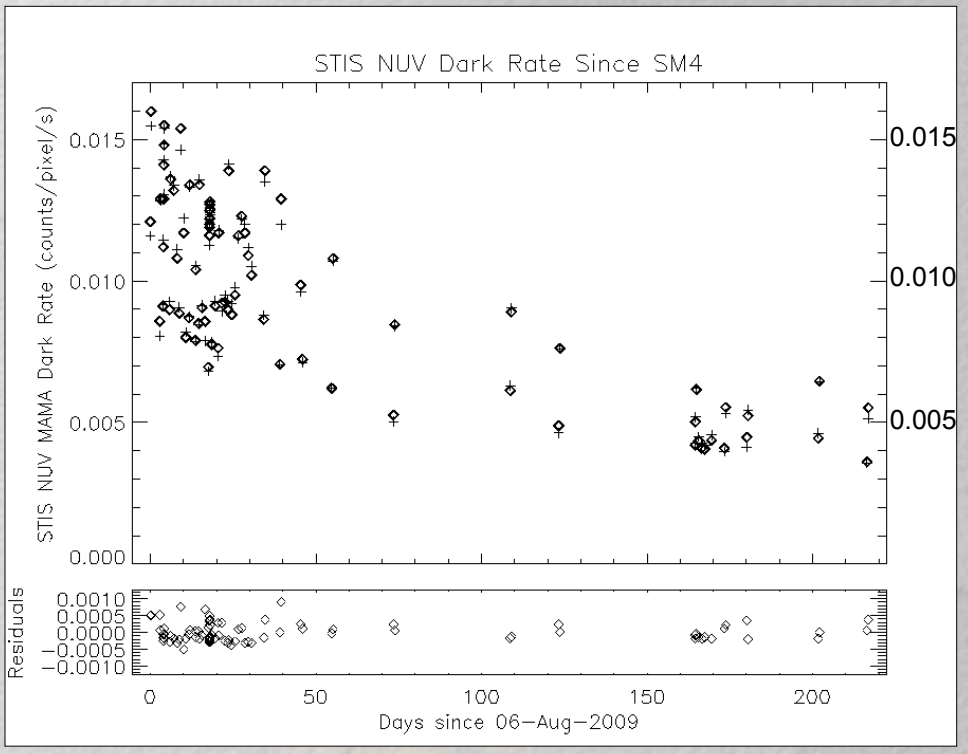
STIS NUV Dark Count Rate

- Empirical fit to post-SM4 STIS NUV dark data
  - allow for short term variations with tube temperature
  - longer term secular changes with time
  - Adopt two independent terms

$$A_1 e^{-E_1/T}\, e^{-t/\tau_1} + A_2 e^{-E_2/T}\, e^{-t/\tau_2}$$

  - Find good fit if τ_1 ~ 40 days and τ_2 ~ 400 days
  - Current mean dark rate

    ~ 0.0044 counts/pixel/s
  - Further decline will be slow; ≥ 400 d time scale



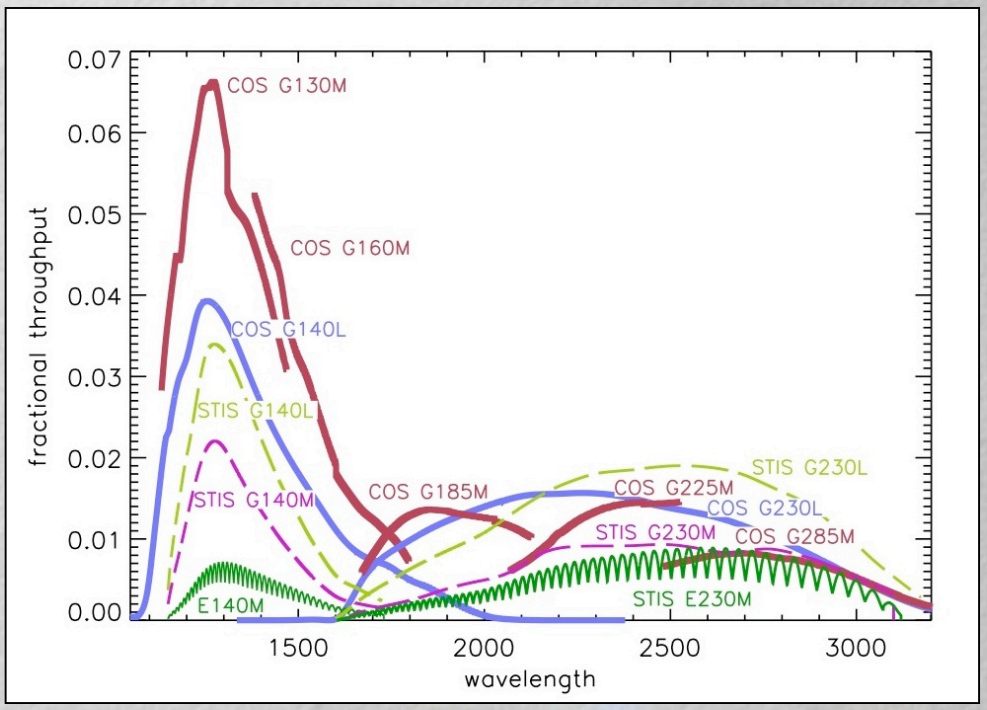
Upper Panel: diamonds show observed STIS NUV MAMA dark rates; +'s show best fit

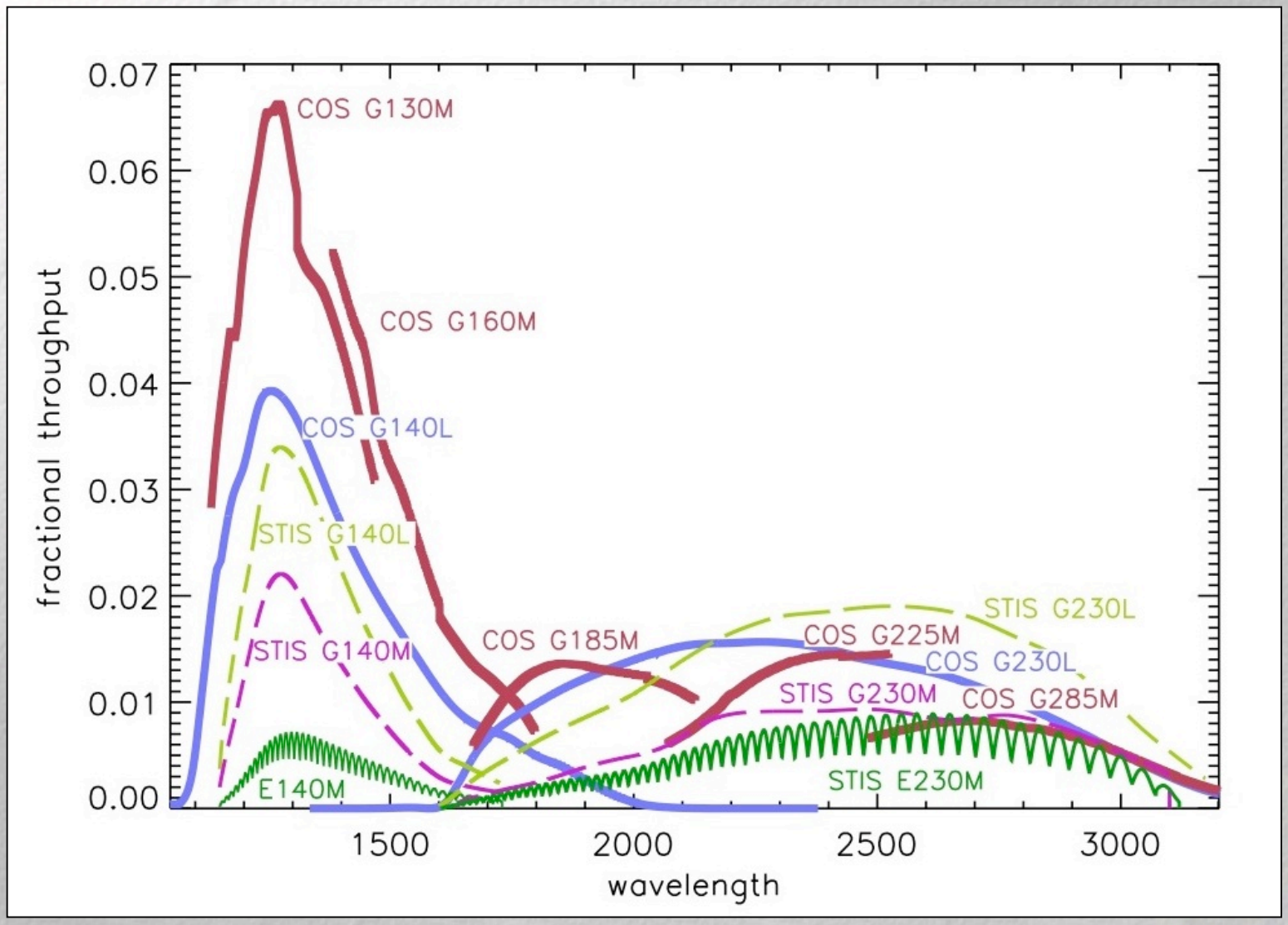
Lower Panel: residuals of (observed rate – fit)

COS Status

(A. Aloisi, C. Proffitt)

- Overall, COS is working well
  - GTO team and GOs are really pleased with their data
- Sensitivity is superb
- A few unexpected issues:
  - Bare aluminum NUV gratings G225M & G285M continue to decline in sensitivity on orbit
  - FUV channel is showing larger than expected on-obit time dependent sensitivity losses
  - COS NUV detector dark current is increasing with time




0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
fractional throughput
1500
2000
2500
3000
wavelength
COS G130M
COS G160M
COS G140L
STIS G140L
STIS G140M
E140M
COS G185M
STIS G230L
COS G225M
COS G230L
STIS G230M
COS G285M
STIS E230M

COS NUV Time Dependent Sensitivity

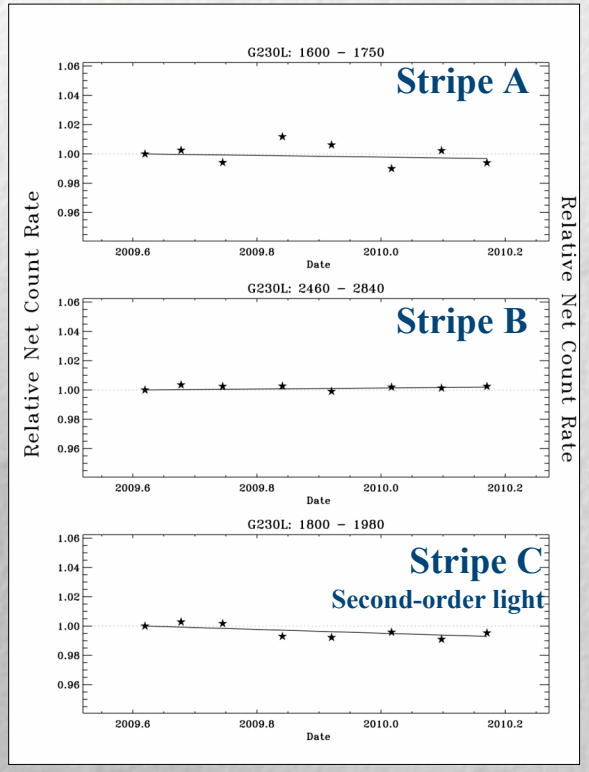
- COS sensitivity is monitored routinely
  - Internal PtNe lamp observations (every 6 months)
  - External observations of spectroscopic standards
    - Monthly: G230L, G225M, G285M
    - Quarterly: G185M

- NUV bare Aluminum grating sensitivity continues to decrease
  - Declining sensitivity was expected to arrest in orbit if due to buildup of oxide layer
  - Rate of decrease is somewhat larger than what was seen on the ground
    - ~3% per year for G225M (vs. 1.6%/yr prior to launch)
    - ~10-12% per year for G285M (vs. 4.5%/yr prior to launch)

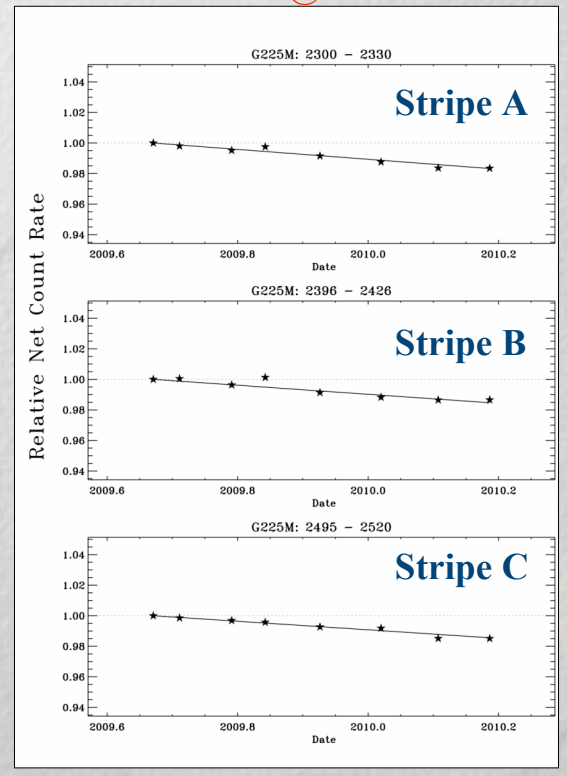
- NUV bare Aluminum gratings are used infrequently
  - G225M: 0.7% of COS time in Cycle 17
  - G285M: 2.7% of COS time in Cycle 17

COS NUV Time-Dependent Sensitivity External Source Results

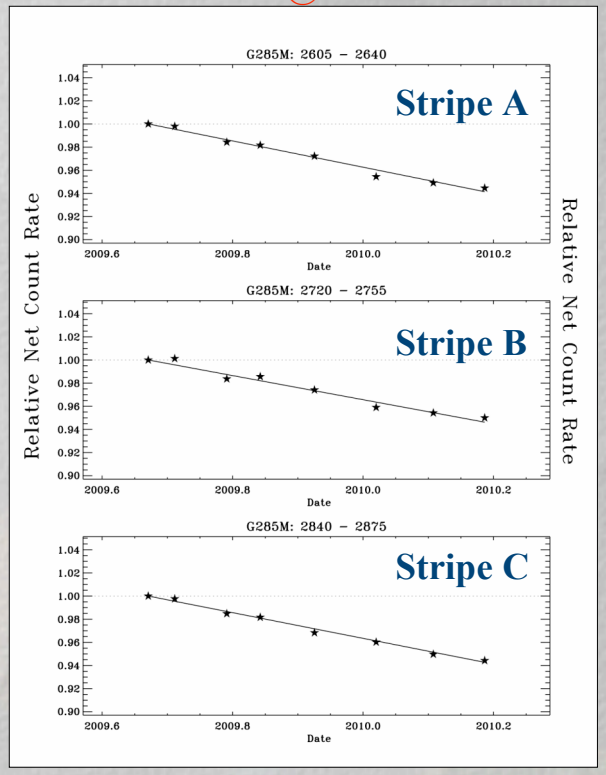
WD1057+719
G230L @ 2635 Å



G191B2B
G225M @ 2410 Å



G191B2B
G285M @ 2739 Å

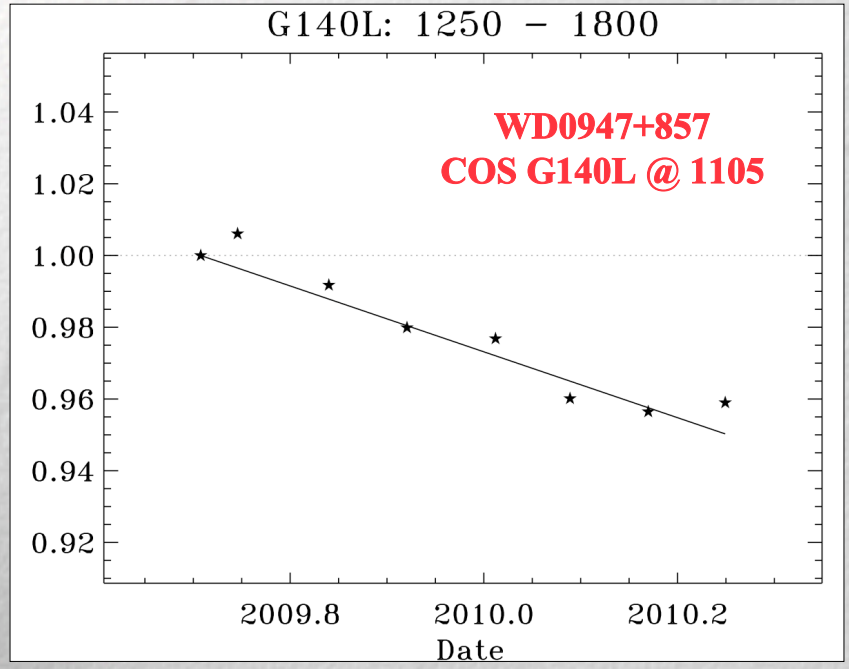


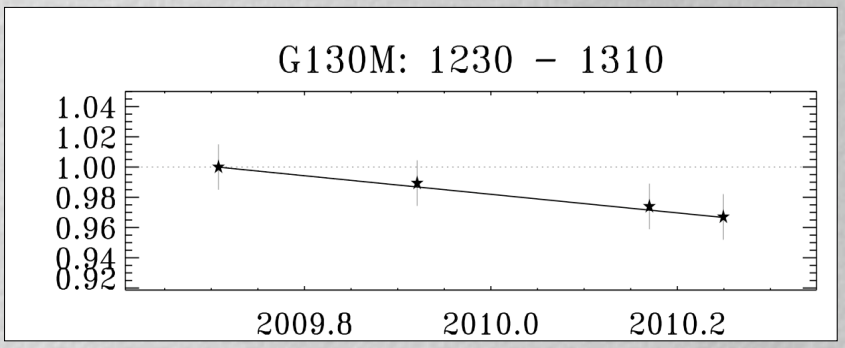
- Rates of sensitivity change for external targets:
  - G225M ~ –3% per year
  - G285M ~ –10 to –12% per year
  - G230L: 1st order changing by ≤ 1% per year, may be larger changes in 2nd order
  - G185M changing by ≤ 1% per year (only 3 epochs measured)

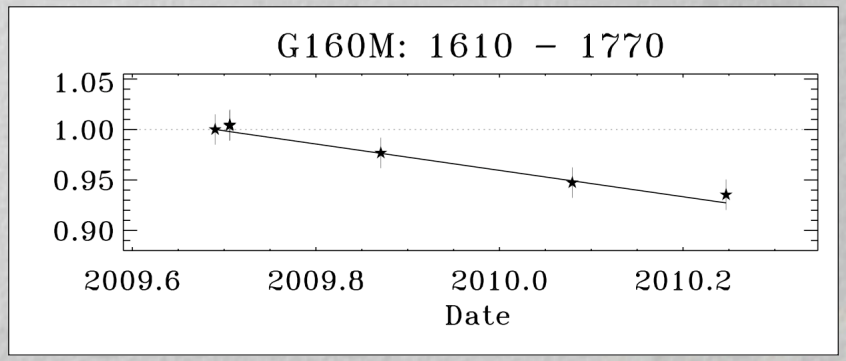
COS FUV Time Dependent Sensitivity

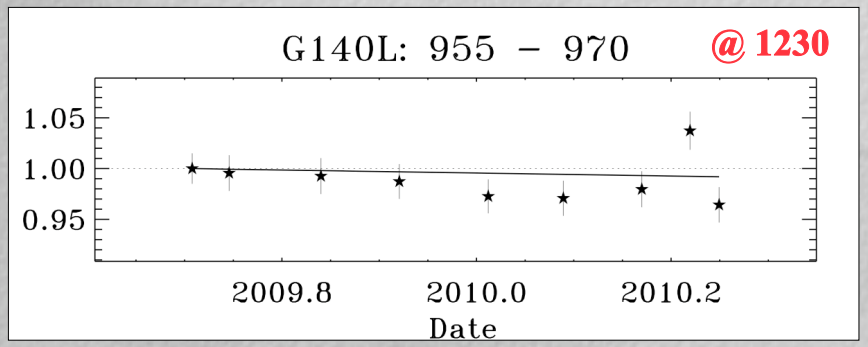
- FUV sensitivity is also decreasing with time
  - 3-13% per year @ 1300-1800 Å in G130M, G160M, G140L modes
    - STIS degradation at similar wavelengths was ~2% per year after SM2
  - Losses increase with increasing wavelength
    - Probably not typical H-C contamination
  - Consistent with degradation of detector photocathode (CsI)
    - But mode of degradation is as yet undetermined
  - Degradation does not appear to be localized to regions of the detector that are most heavily used (i.e., not photon-induced)
    - Checks done at non-standard detector positions show throughput to be essentially identical to that at the standard position
    - Areas heavily illuminated by geo-coronal Lyα show no extra degradation
    - Losses correlate better with wavelength than with either position on the detector or number of photons collected

COS FUV Time-Dependent Sensitivity External Source Results



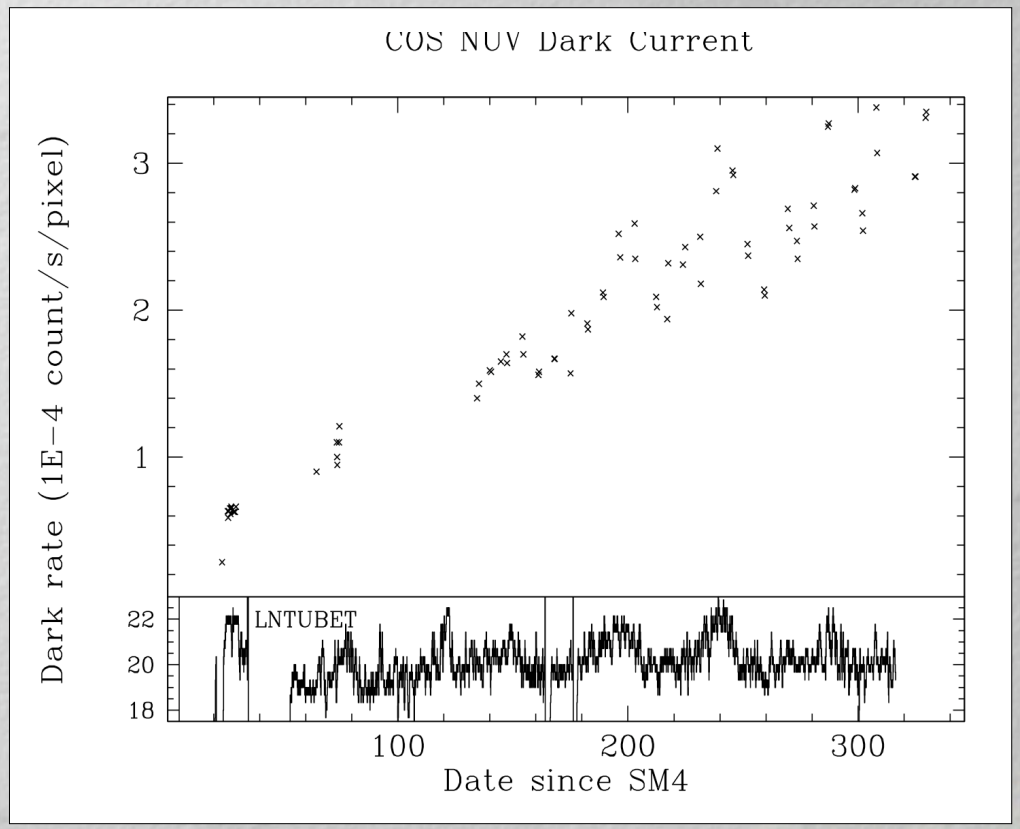






COS NUV Dark Counts

- Prelaunch expectation for COS NUV detector dark rate was 3.7e-4 counts/s/pixel
- Initial on-orbit measurements were much lower; ~ 6e-5 c/pixel/s
- Has been increasing ~ linearly with time since then
  - Now about 3e-4 c/p/s
  - Little evidence of leveling off
- Some correlation with tube temperature
- Possibly related to on-going population of meta-stable states in detector window (similar to STIS NUV MAMA detector).
  - Still much lower than the historical (1.3e-3 c/p/s) or current (4.4e-3 c/p/s) STIS NUV MAMA dark rate

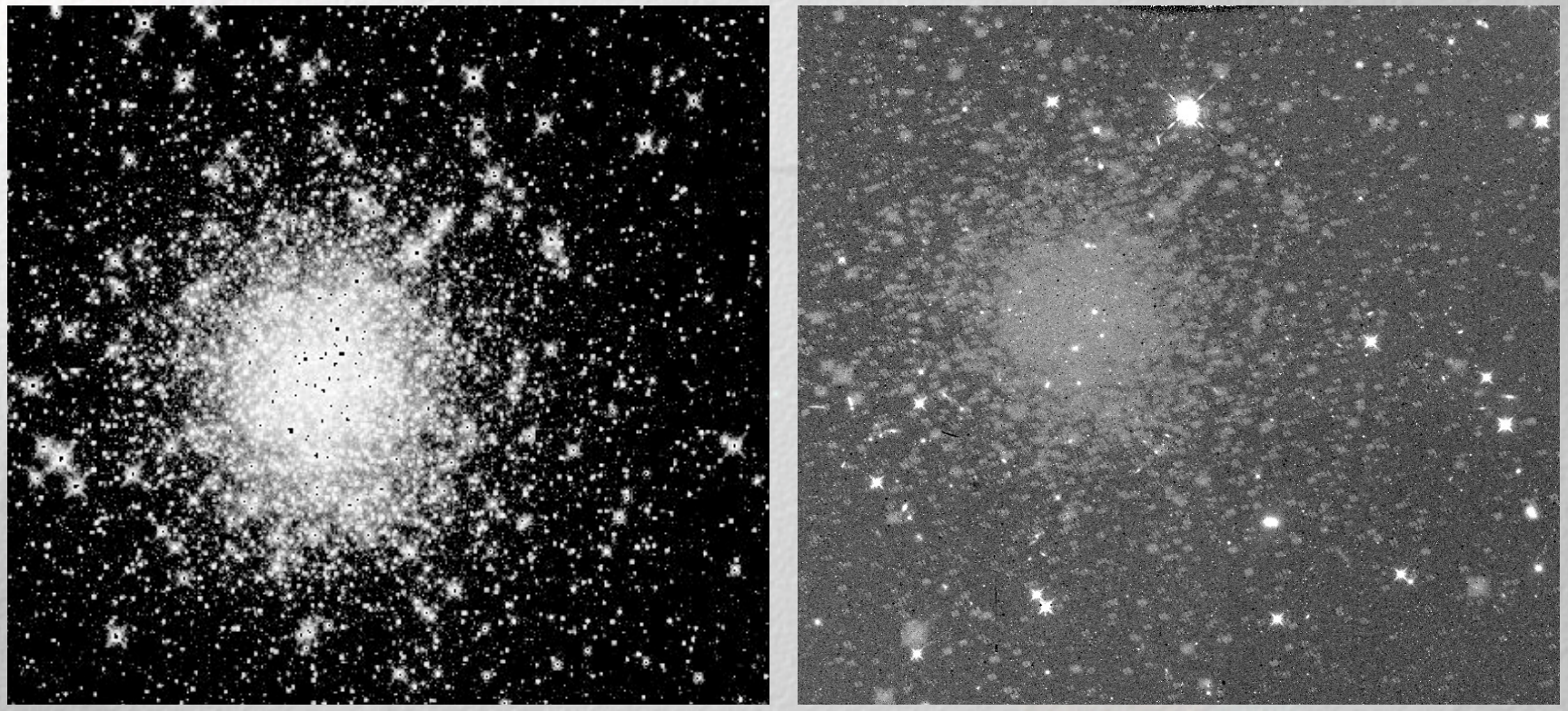


WFC3 Status

(J. MacKenty)

- WFC3 is working very well and is being monitored closely
- Photometry
  - Instrument is very stable (<<1%) and 10-15% above pre-launch expectations
  - Shortest exposures (0.5 sec) have true exposure time of 0.482 sec
  - Flat fields low spatial frequency correction(s) being developed (3-4%)
- Rate dependent non-linearity
  - Decline in response at lower count rates is estimated at ~1.1%
  - Same effect in NICMOS is ~3-6%
  - WFC3 value relies on NICMOS bootstrap - will try to verify independently
- IR Persistence
  - Significant residuals from bright sources
  - Top 10 offenders (brightest sources) identified in Cycle 17 observing program
  - Global identification and possible correction being explored
- Grisms
  - ECF has initial calibrations of all IR grisms (nominal)
  - Working with ECF to transfer grism knowledge/software/documentation to STScI by summer

WFC3/IR Persistence



Terzan 5 and its faint ghost in a later orbit

NICMOS Status (1 of 3)

- NICMOS Cryo-Cooler System (NCS) was restarted successfully on 31 July 2009
  - NICMOS SMOV was proceeding smoothly and science observations were to commence near the end of November
- On 3 November 2009, the NCS safed during an SI C&DH lock-up.
  - Cold restart deemed “dangerous” to NCS
  - Decision made to allow NCS to warm up before restart
  - NCS Neon purge planned to remove moisture in circulator loop
    - Risk assessment and procedure investigation initiated
- On 24 November 2009, HSTMO and DO met with HSTP to discuss orbit cost and science benefit of purge
  - Okay given to proceed with preparations for purge
  - Guidance given on purge parameters (number of FHST cycles, accept number of orbits of downtime, etc)

NICMOS Status (2 of 3)

- Project briefing for NCS purge on 20 January 2010
  - STScI recommended postponing NCS purge and restart indefinitely
    - Observatory level risks were not yet quantified to our satisfaction
      - FHST HV cycling
      - Possible hydrocarbon contamination of Ne (became known after briefing)
      - Possible unknowns
      - Consequences of damaging observatory are enormous
    - HST Interim Project Scientist, GSFC Operations Scientist, and GSFC Observatory Scientist agreed
  - Action taken by STScI to solicit community input on NICMOS science promise in post-SM4 era
    - STUC was briefed and asked to consider science value of NICMOS
    - STUC received input from U.A. (Schneider and collaborators)
    - STUC solicited input from colleagues
- STUC conclusion
  - No compelling science justification for near-term NCS restart

NICMOS Status (3 of 3)

- HSTP and STScI met on 1 April 2010 to discuss the forward plan for an NCS purge
  - Observatory risk assessment presented by GSFC
    - Bottom line: Risk to observatory is very low, but not zero
    - Details will be presented to STUC tomorrow
  - Cost (orbit) assessment presented by STScI
    - Recommendation: Purge should be deferred (perhaps indefinitely)
    - Selected charts from that meeting follow this slide
- In the meantime, NICMOS and the NCS are being monitored and maintained like any observatory asset that may need to be used in the future

Pending NICMOS Program Details

- GO-11123 (Bourke-80%) – 2 orbits NIC2 Pa-alpha – Proplyds
  - 10 orbit program – did H_2 for 8 orbits on RCW-38 in May/Jun'08
- GO-11136 (Liu-54%) – 13 orbits NIC1 multi filters - Brown dwarf binaries at L-T transition
  - 28 orbit program – did 7 of 13 targets (1 to 3 orbits per target)
- GO-11164 (Weintraub-80%) – 2 orbits NIC2 H_2 - T Tauri Disks
  - 10 orbit program – did 8 of 10 targets (sci/cal pairs—have 3 of 5 pairs done)
- DD-11512 (Swain-67%) – 5 orbits NIC3 defocus K grism – Exoplanets
  - 15 orbit program – did 2 of 3 visits to HD-209458 (5 orbits each)
  - *Published result: 2009, ApJ 704, 1616: CH_4, H_2O, CO2*
  - *Published result: 2009, ApJ, 707, 24: temperature and abundance retrieval*
- GO-11545 (Davies-76%) – 7 orbits NIC3 H, K, Pa-alpha – young clusters
  - 29 orbit program – did 22 of 29 targets
  - *Published result: 2010, ApJ, 708, 1241: photometry of GLIMSPE9 stellar cluster*
- GO-11622 (Knutson-0%) – 16 orbits NIC3 defocus K grism – exoplanets
  - 16 orbit program – four 4 orbit visits for GJ-436b eclipse (Neptune mass planet)
  - Search for H_2O and methane from 1.4 to 2.5 microns
- GO-11740 (Pont-50%) – 8 orbits NIC3 defocus H grism & 8 orb STIS/CCD – exoplanets
  - HD 189733 hot jupiter (no NICMOS observations yet) – broad spectral coverage
- DD-11799 (Perlmutter-40%) – 9 orbits NIC2 – calibration for faint sources
  - 15 orbit DD/Cal program to explore NICMOS rate dependent non-linearity
  - Initial results presented at January 2010 AAS meeting

Pending Program Summary

- Eight NICMOS GO/DD programs remain
  - 6 have partial NICMOS data, 2 have no NICMOS data yet
    - 5 programs probably have sufficient data to write a paper
    - 2 programs have already produced refereed papers
- Orbit cost
  - **62** orbits are required to complete the science observations
  - **33** external orbits of commissioning (SMOV)
    - Assumes NICMOS stability for all systems external to dewar
    - Assumes detector properties are known well enough to resume calibrations
    - Could be reduced to 24 orbits with increased risk to filter wheels
  - **26** external orbits of post-SMOV calibration are needed to complete the pending science observations
    - Assumes these observations can be scheduled in a single 3-4 month period
  - Purge is expected to require less than 16 orbits of observatory downtime
  - **~121 external orbits are required to complete pending science observations in addition to however many orbits of downtime are incurred for the purge**

Cycle 18 Proposals

- STScI received 872 GO proposals requesting 23,096 prime orbits and 7616 parallel orbits for Cycle 18
  - This is the 2nd highest number of orbits ever requested
  - Anticipated oversubscription is at least 9:1 (by orbit)

- NICMOS proposals accounted for ~2.9% of requested orbits
  - 31 proposals
  - 666 prime orbits (best estimate at this time)

- Assuming NICMOS proposals fare as well (no worse, no better) than others, average subscription of 9:1 suggests ~60 NICMOS orbits will be recommended for approval by the Cycle 18 TAC

- STScI will instruct the Cycle 18 TAC to judge NICMOS proposals on their scientific merit alone, without regard for condition of the NCS

- Cycle 18 TAC will rank NICMOS proposals along with all other proposals for Director's consideration

NCS Purge Cost/Benefit

- STScI discussed NICMOS science value and completion levels of the pending NICMOS observations with the STUC. A consensus recommendation to defer an NCS purge, perhaps indefinitely, resulted from those discussions.

- NICMOS offers some unique science capabilities, some of which may not be replicable in the foreseeable future, but some of which may be available on JWST or ground-based AO-assisted telescopes in 3-10 years.

- The science case for completing the pending NICMOS observations now is neither compelling nor urgent enough to recommend an NCS purge/restart in the near-term.
  - In an era when HST observing time is in extremely high demand, the orbits required to purge the NCS and complete the pending NICMOS observations are better used to conduct science with the other HST instruments.

- The STScI Director will weigh the Cycle 18 TAC's (May 17-21) assessment of the scientific ranking of NICMOS proposals in the recommended proposal pool, and determine the merits of an NCS/NICMOS recovery at a later date.

Cycle 17 Long Range Plan

(D. Adler)

- Weekly orbits counts are higher than planned
  - Averaging 84.0 orbits/week since end of SMOV (36 wks).
  - LRP was built assuming 80 orbits/week
- High rate may not continue through whole cycle
  - Early subscription is always higher due to greater selection pool, and availability of high flexibility visits
  - But high subscription has continued past the halfway point of the cycle due to a good mix of visits and ability to schedule around SAA
- Cycle 17 tail
  - Tail has been reduced from 835 to 760 orbits since start of cycle
    - Typical cycle tail is ~600 orbits
  - Includes 35 orbits of NIC GO (remainder is not yet in LRP)
  - Includes supplemental Cycle17 cals (62 orbits) added recently

Current State of the Long Range Plan

Cycle	Orbits	Change from last month
15/16	77	-7
17	2148	-293
Total	2225	-300

C16 snaps	42	- 1
C17 snaps	1100	-27
Total snaps	1142	-28

Instrument	Orbits	Change
WFC3	901	-161
COS	712	-66
ACS	263	-28
STIS	346	-21
FGS	33	-5
NIC	35(2)	-23
Total	2290(3)	-304

Visits not in current plan	Orbits	Change
unschedulable	60	+3
no plan windows	68	0
Miscellaneous (ToO, etc)	531	+204
Total not in plan	659(1)	+207

Notes:
(1) Includes Cycle 18 MCTs
(2) Some NIC cals removed
(3) Some programs have more than one SI prime

Long Range Plan

- Highlights
  - Cycle 15 is complete
    - Last three orbits observed 16 January 2010
  - Cycle 16 is almost complete
    - Only 2 active visits scheduled after end of Cycle 17 (31 August 2010)

- Current Work
  - Cycle 18: 2400-2600 orbits available for TAC
    - Cycle 17 tail, GTO, MCTP impacted total
  - Incorporate MCTP into LRP
  - Perform Cycle 18 large/treasury impact analysis