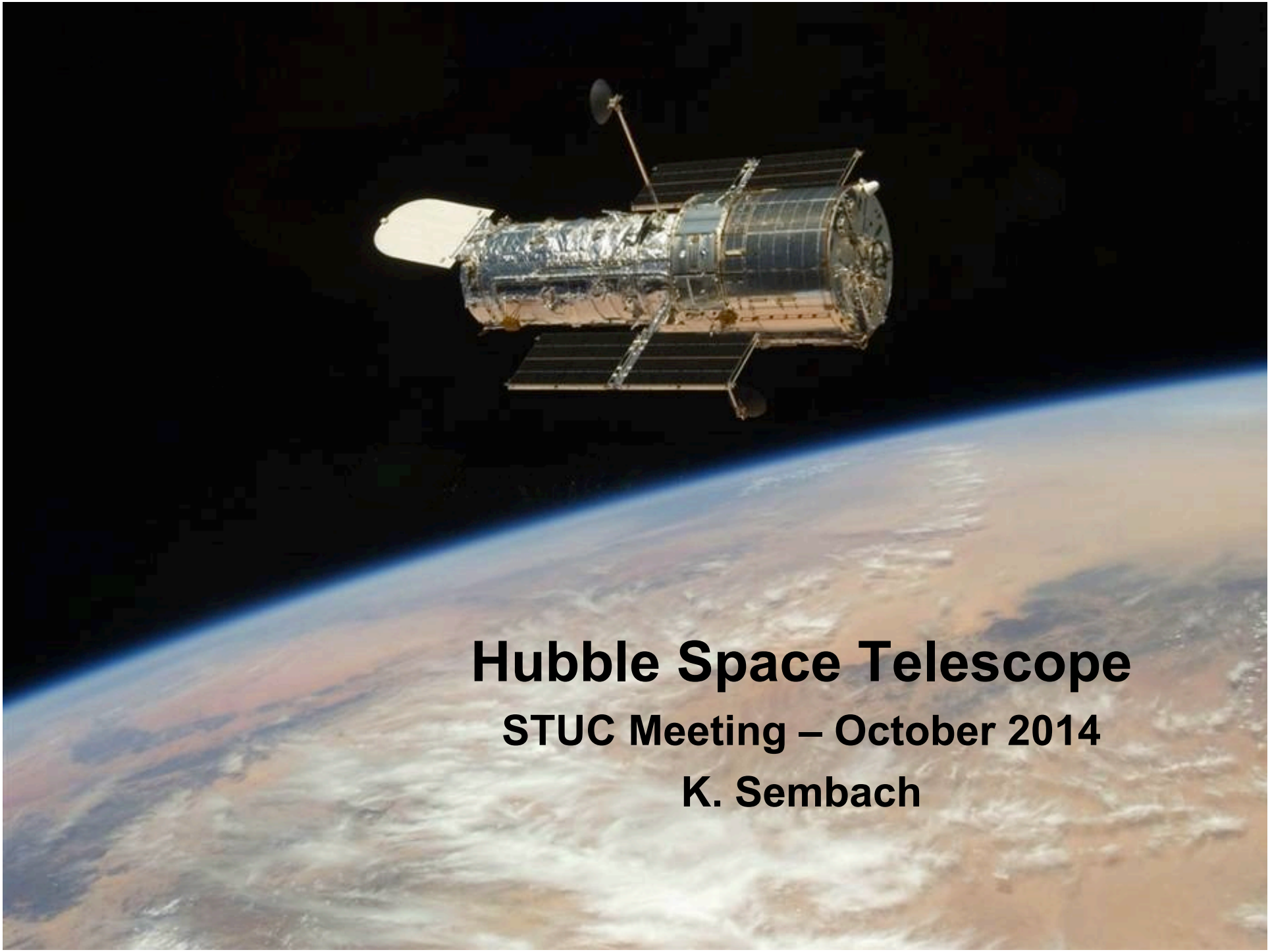
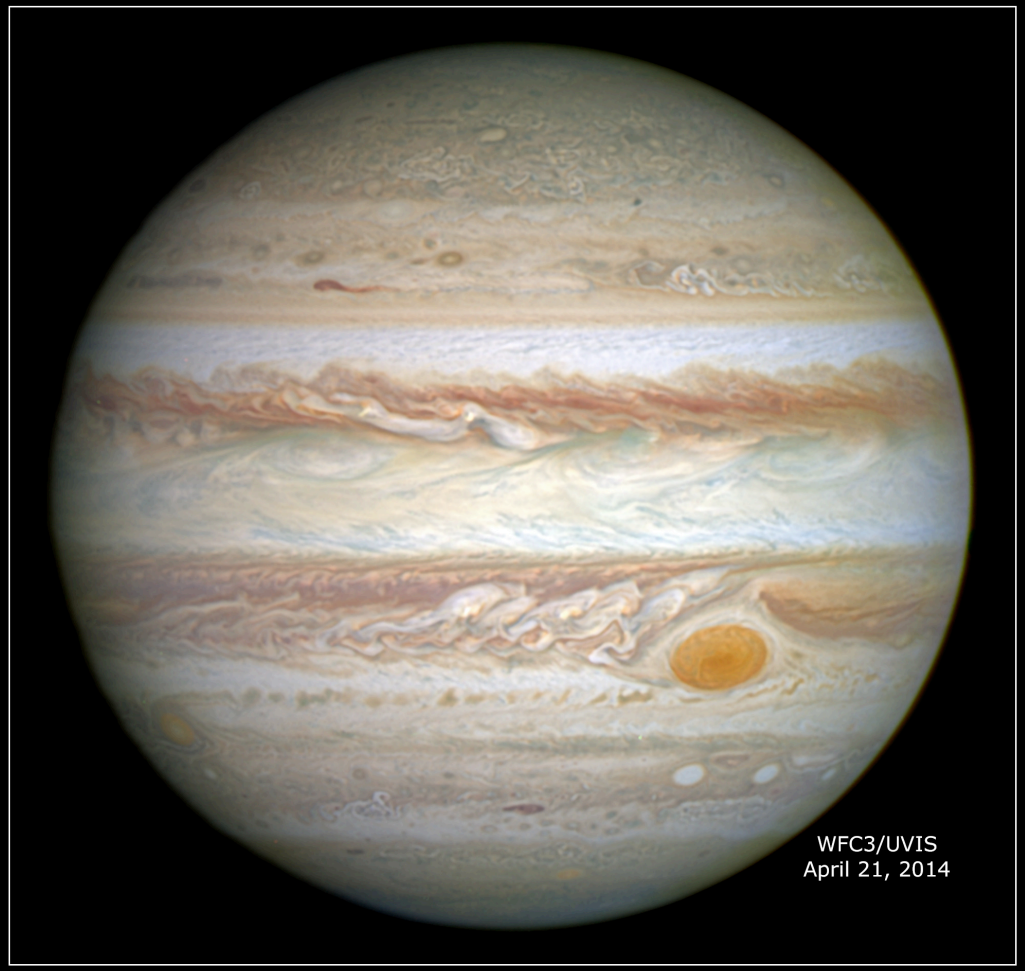


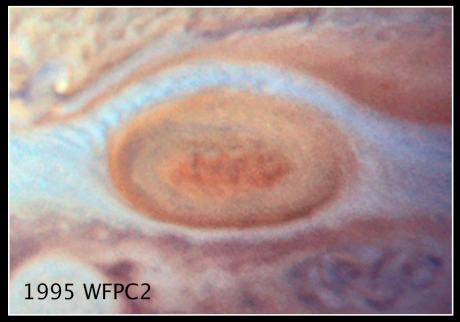
Hubble Space Telescope

STUC Meeting – October 2014

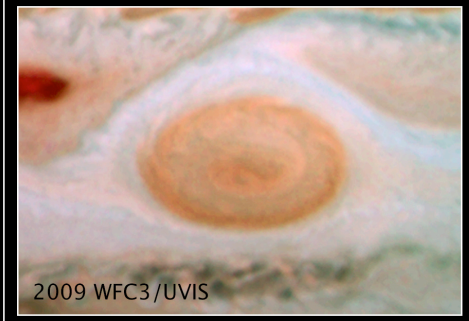
K. Sembach

Planets Near and Far

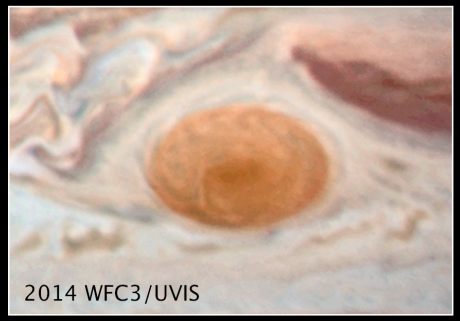




13,020 miles



11,130 miles



10,250 miles

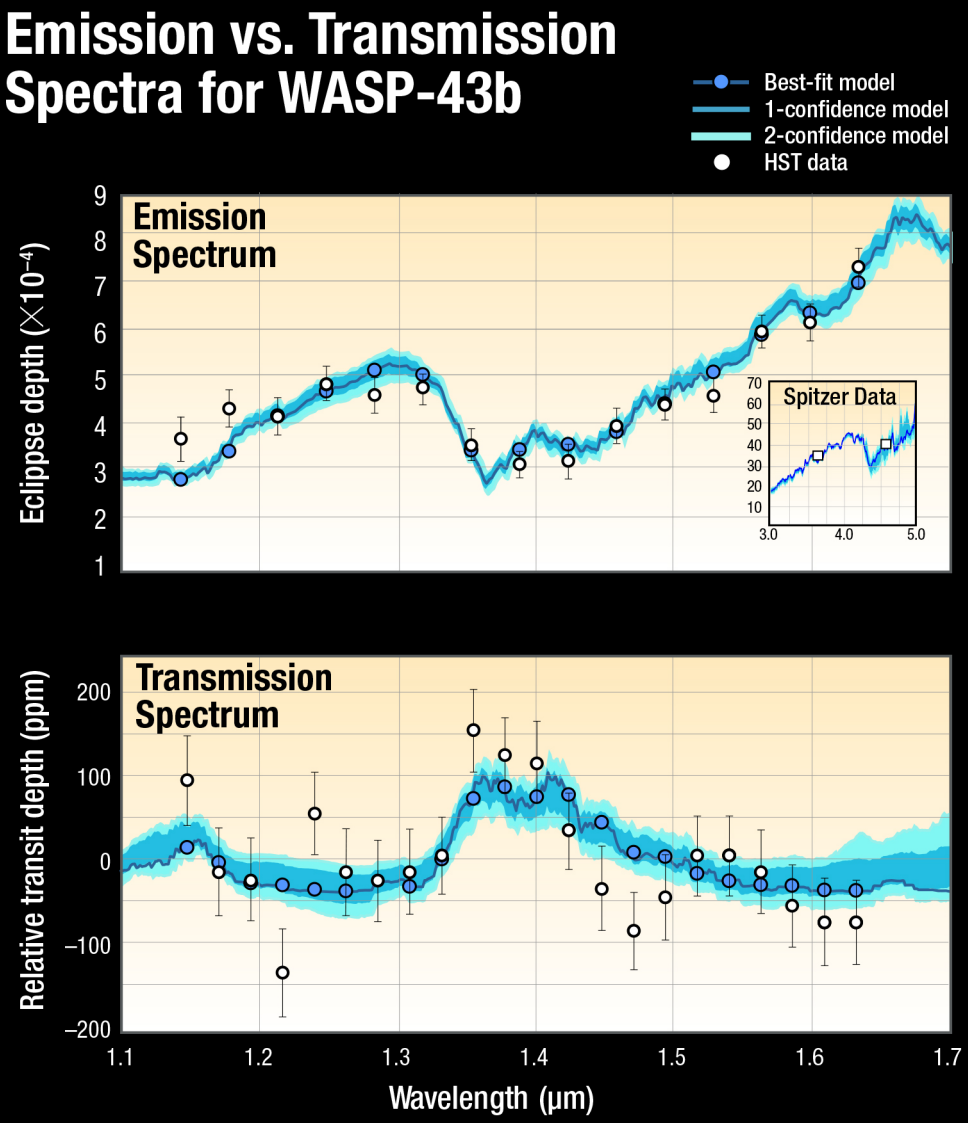
Jupiter and the Great Red Spot
Hubble Space Telescope WFC3/UVIS WFPC2

Amy Simon-Miller et al.

NASA and ESA

STScI-PRC14-24a

Planets Near and Far



Jacob Bean et al.

Current Hubble Status

- All science instruments are performing well
  - ACS, COS, FGS, STIS, and WFC3 are in use
- Gyros continue to function fine (P. Crouse)
  - No issues since loss of Gyro 5 in March 2014
- Cycle 22 has begun (N. Reid)
  - October 1, 2014 – September 30, 2015
- Frontier Fields program is in full swing (J. Lotz)
- Source Catalog v1 will be released in early 2015 (L. Strolger)
- 25th Anniversary on April 24, 2015 (H. Jirdeh, A. Nota)
  - Extensive planning underway

Cycle 23 Schedule (2015)

CP Released – Jan 7
Proposals Due – Apr 10
TAC / Panels – Jun 8-12
Phase 2 / Budgets – Jul 24
Observations Start – Oct 1

Repaired Instruments

- SM4 occurred in May 2009

Instrument	Side	Install	Activate	Fail	Op Time (months)	Repair	Op Time (months)
STIS	1	Feb-97	Feb-97	May-01	51		
	2	Feb-97	May-01	Aug-04	39	May-09	65
ACS	1	Mar-02	Mar-02	Jun-06	51	May-09	65
	2	Mar-02	Jul-06	Jan-07	6		

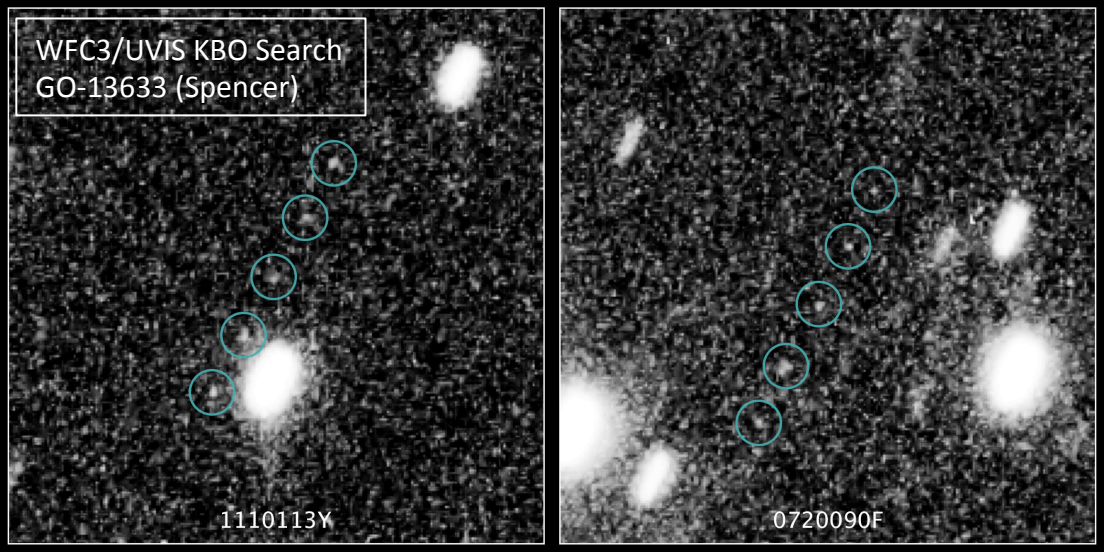
Long Range Observing Plan
(D. Adler and the Planning & Scheduling Team)

- Observing efficiency remains high

- Cycle Completeness:
  - Cycle 19 completed in March 2014
  - Cycle 20 planned to finish in October 2014
  - Cycle 21 planned to complete in June 2015

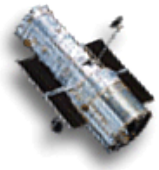
<Orbits/week> scheduled	
Cycle 21	84.0
Cycle 20	85.5
Cycle 19	83.2
Cycle 18	83.4
Cycle 17	84.0

- New Horizons KBO search in August helped filled end-of-cycle hole in long range plan



Long Range Plan

Status through calendar ending 10/12/14



Cycle	Orbits	
	May	Now
20	19	0
21	1595	396
22	69(1)	3446
Total	1683	3842

(1) Some Cycle 22 Frontier Fields and DD observations had windows opening in Cycle 21.

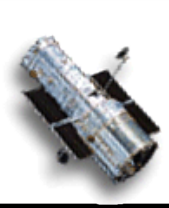
Visits not in current plan	Orbits	
	May	Now
Unschedulable	18	157
No plan windows	2	0
Cycle 20 miscellaneous	122	3
Cycle 21 miscellaneous	99	81
Cycle 22 miscellaneous	0	412
Total not yet in plan	241	653(3)

Instrument	Orbits	
	May	Now
WFC3	590	1769
COS	530	814
ACS	354	818
STIS	221	483
FGS	2	4
Total(2)	1697	3698

SNAPs	Orbits	
	May	Now
Cycle 21	494	397
Cycle 22	0	1098
Total	494	1495

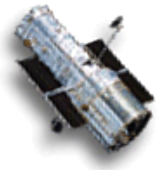
(2) Some programs have more than one prime science instrument.
(3) 118 orbits of unplanned block are due to contingency programs (e.g., side-switch)

Long Range Plan
Progress of Frontier Field Programs



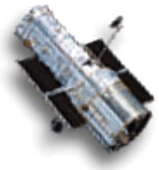
Frontier Field	Cycle	Orbits alloc	Executed or scheduled	Planned	
			< 10/12/14	< 9/30/15	10/1/15 - 9/30/16
Abell 2744	21	140	140	0	0
MACSJ0416.1-2403	21	140	140	0	0
MACSJ0717.5+3745	22	140	50	90	0
MACSJ1149.5+2223	22	140	4	136	0
Abell S1063	23	140	0	2	(138)
Abell 370	23	140	0	2	(138)

Cycle 21 Large/Treasury Programs



Program	Orbits alloc	Exec/sched by 10/12/14	Planned before 9/30/15	Comment
Ayres	230	205	22	3 not in plan
Bean	152	131	20	1 not in plan
Calzetti	154	154	0	Completed
Churchill	110	100	10	Finishes 11/14
Peterson	179	179	0	Completed
Piotto	131	126	5	Finishes 6/15
Sahu	64	60	4	Finishes 10/14
Treu	140	91	49	Finishes 1/15

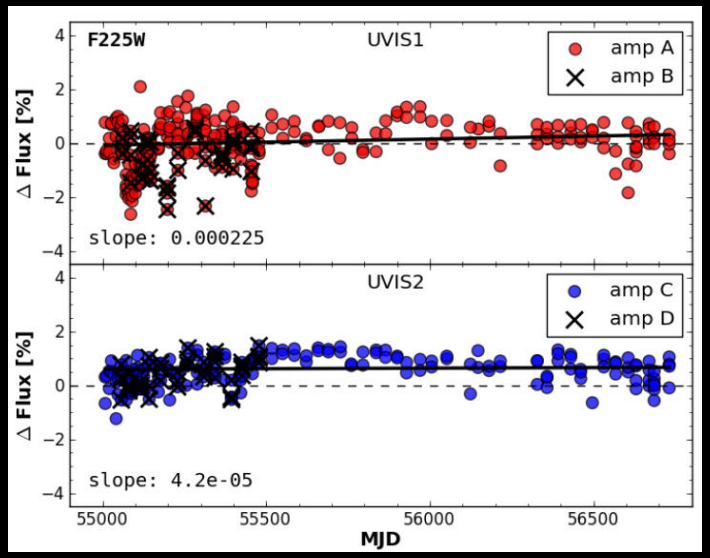
Cycle 22 Large/Treasury Programs



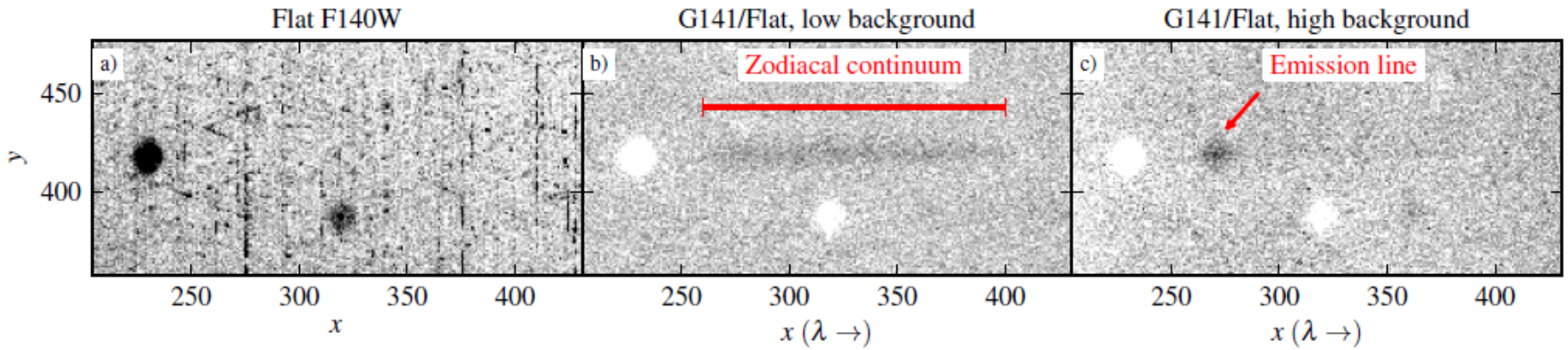
Program	Orbits alloc	Exec/sched by 10/12/14	Planned before 9/30/15	Planned after 10/1/15	Comment
Benneke	124	0	47	67	10 not in plan
France	125	10	115	0	
Freedman	132	30	85	17	
Malhotra	160	0	120	40	
Oesch	132	0	100	32	
Perlmutter (ToO)	87	2	63	0	22 not in plan
Robberto	52	34	16	0	2 not in plan
Skillman	81	17	64	0	
Spencer	194	184	10	0	Finishes 10/14
Tripp	99	0	87	12	

Cycle 22 Calibration Plan

- Plan requires ~5% of available orbits

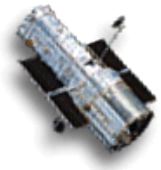


Instrument	Orbits	
	Cycle 21	Cycle 22
ACS	30	39
COS	69	44
FGS	18	2
OTA	13	10
STIS	21	21
WFC3	103	100
Total	**254**	**216**



ACS Status

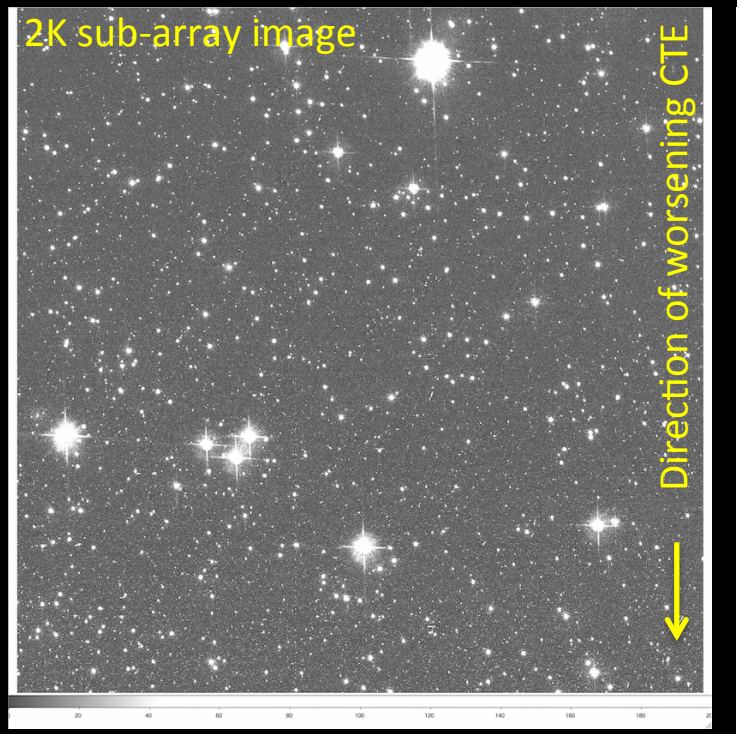
(N. Grogin and the ACS Team)



- ACS/WFC and ACS/SBC are operating nominally
- The recently approved Cyc22 ACS Cal plan newly includes:
  - Refined photometric and astrometric calibration of WFC polarizers
  - Expanded calibrations incorporating LED post-flash for CTE mitigation
- The ACS Team has been supporting the HFF implementation and data-reduction efforts. Enhanced WFC calibrations, driven by HFF requirements, are being incorporated into CALACS and AstroDrizzle to benefit the entire ACS user community.

Recent/Upcoming ACS Improvements

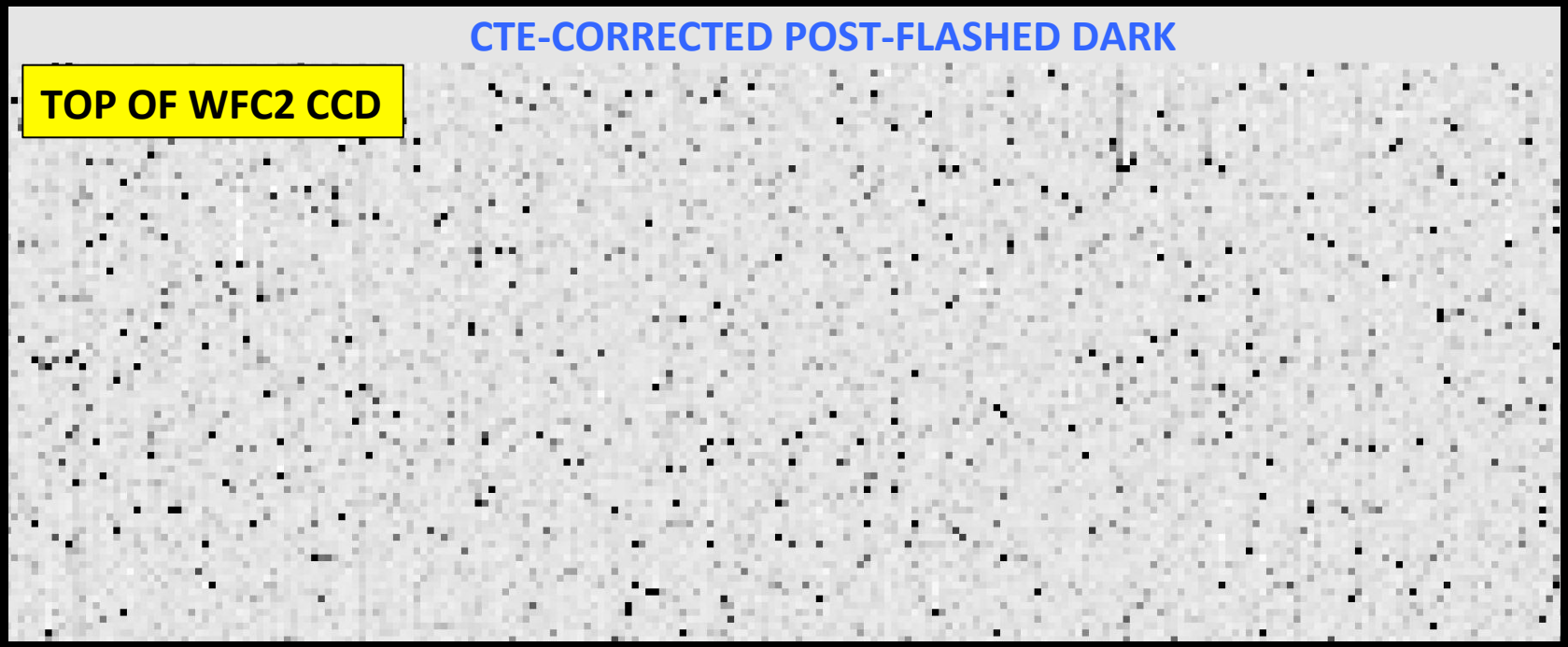
- Improved calibration information
  - Refined WFC geometric distortion solutions for BVI, motivated by HFFs
  - Updated 47 Tuc astrometric reference catalog with proper motions, to refine the geometric distortion solutions for *all* broadband filters and for the polarizers
  - Tracking the time and temperature dependencies of the SBC filters' red leak
- Improved reduction/analysis tools
  - CALACS now CTE-corrects WFC 2K sub-arrays→
  - WFC standalone reduction tool for cases where generic CALACS is insufficient:
    - Full-field bias de-striping (needed for subarrays)
    - Source-masking option for de-striping
    - Proper handling of post-flash for de-striping
    - Full end-to-end reduction incl. CTE correction
  - Scripts for precision WFC alignment and "self-cal"



ACS Calibration Highlight: Flashed Darks

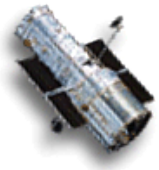
- WFC CTE is worst at the lowest background levels
  - Calibration DARKs have much lower backgrounds than do typical obs
  - ∴ Superdark "warm" pixels far from serial register irrecoverably trailed
  - ➢ Adding LED post-flash preserves warm pixels (but adds Poisson noise)

- Cyc22 ACS Cal plan now includes LED post-flash for DARKs



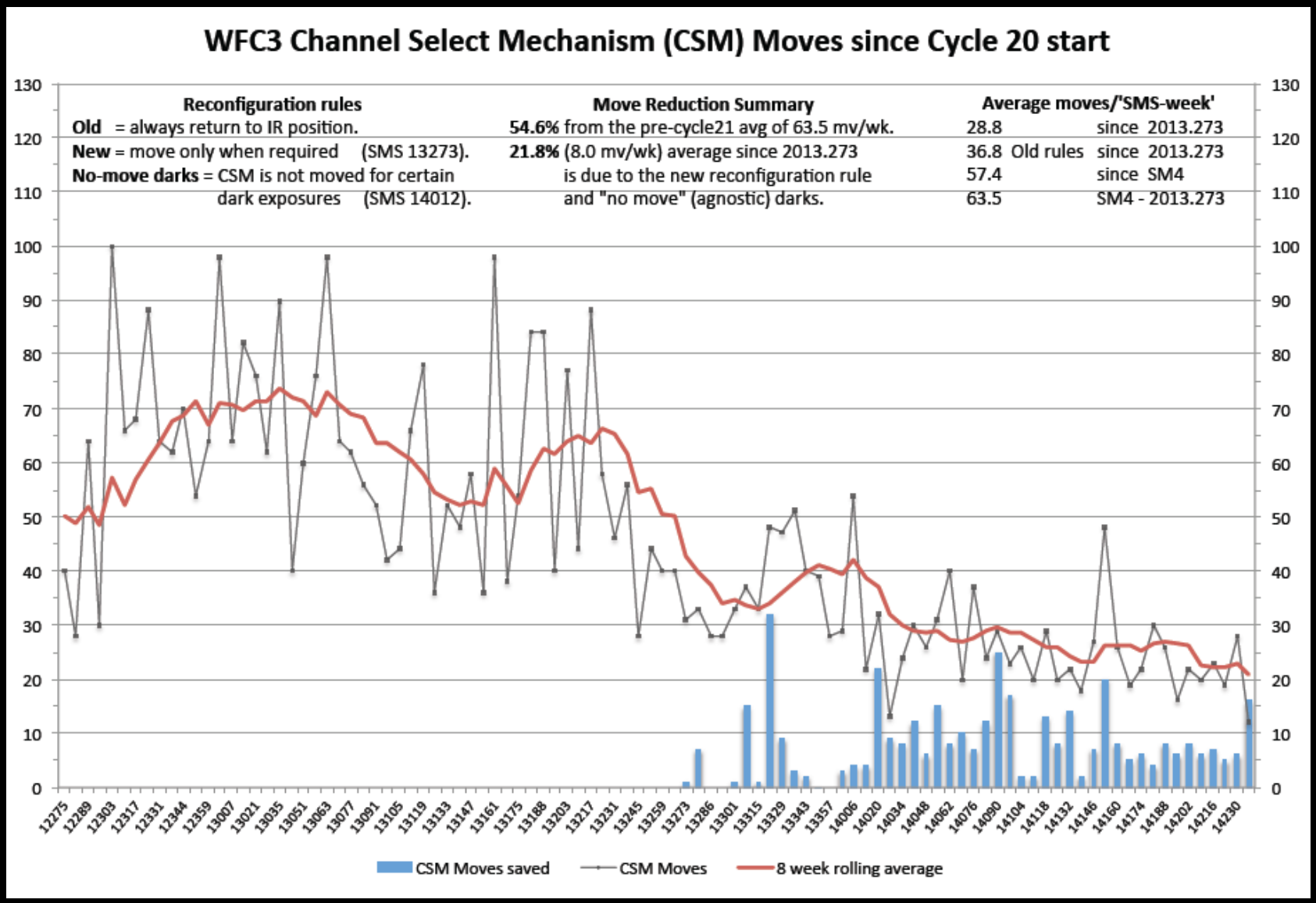
WFC3 Status

(J. Mackenty and the WFC3 Team)



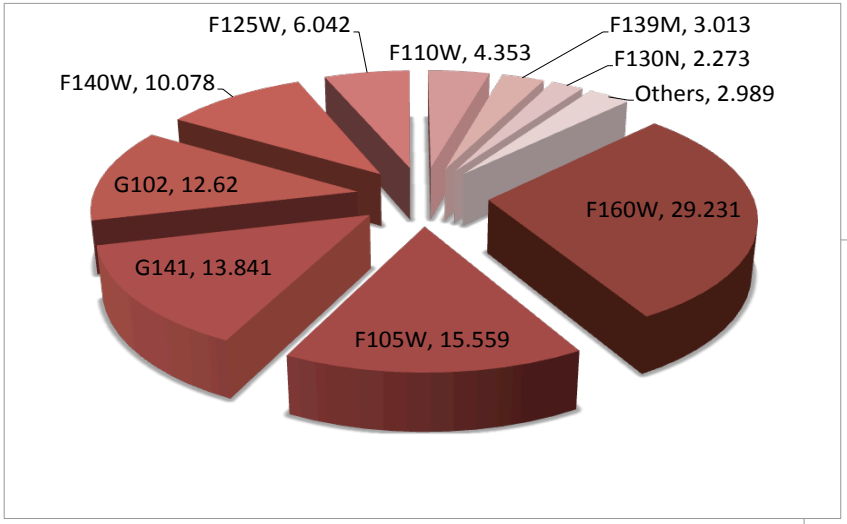
- WFC3 is operating nominally
- Photometric zero points (including UV) stable to ~1% since 2009
- Astrometric calibration is stable (dominated by HST OTA "breathing")
- UVIS CCD Detectors CTE declining as expected with radiation damage
  - Mitigation/correction methods have improved considerably
  - Pipeline correction to be implemented next summer
- IR detector shows no evolution of its performance in flight

Channel Select Mechanism Usage



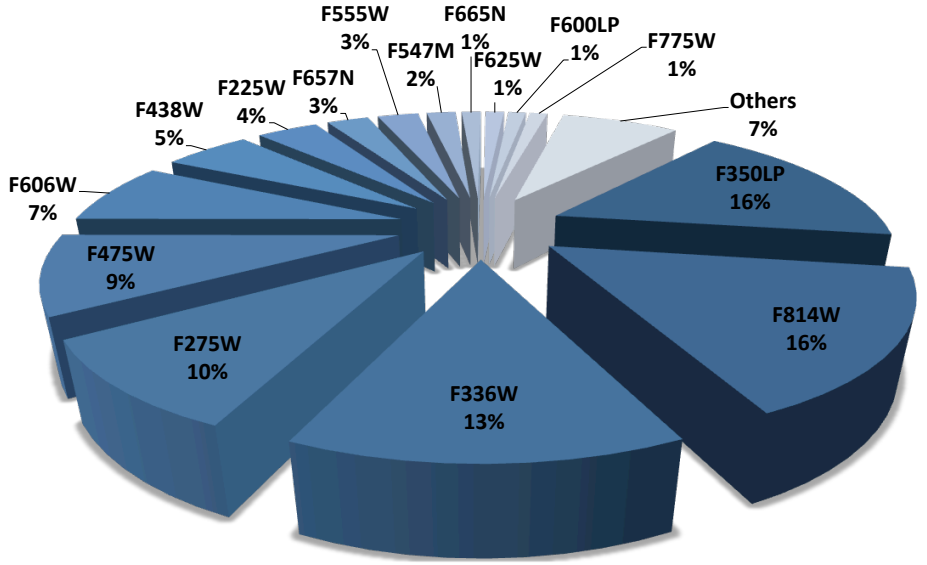
WFC3 Filter Usage in Cycle 22

IR – Percentage of Time



- 40% of the IR exposures use GRISM (=26% of IR time)
- **For the first time all the 15 IR filters are used in one cycle**
- 26% of the exposures uses spatial scan (=4% of IR time)

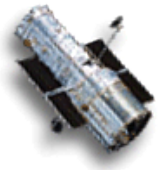
- 30% of UVIS time is used to observe in the near UV
- 67% of UVIS observations use post-flash
- 45 out of the 62 UVIS filters are used
- 2.4% of UVIS time is for spatial scan
- 0.4% of UVIS time is with G280 (10840 sec)



UVIS – Percentage of Time

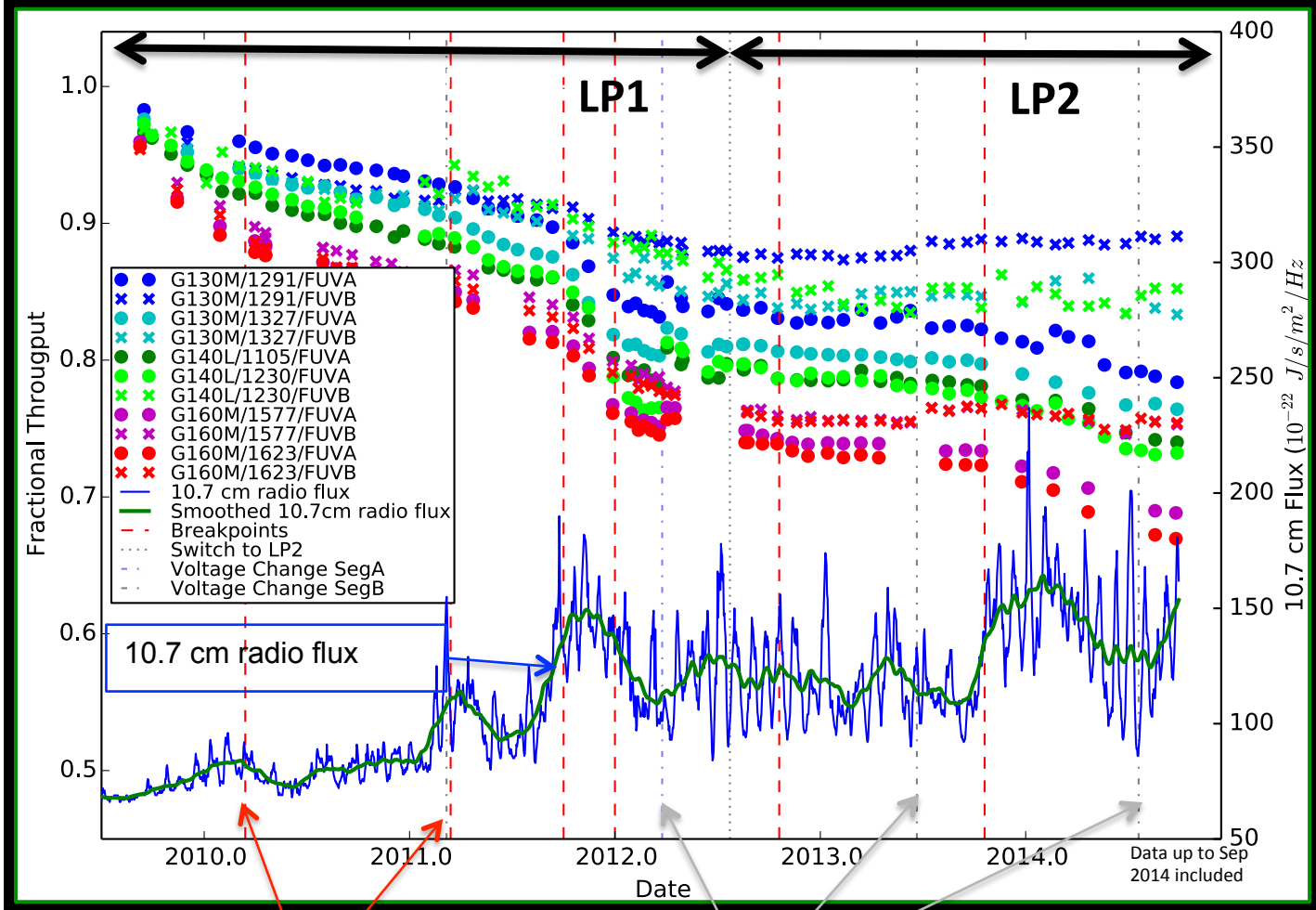
COS Status

(C. Oliveira and the COS/STIS Team)



- COS has been at FUV detector lifetime position 2 since July 2012
  - High voltage of Segment B increased on July 21, 2014 to mitigate gain sag effects
  - Plan to increase HV of Segment A in November 2014
  - HV increases are transparent to users
- Move to COS FUV lifetime position 3 is planned for February 2015
  - New FUV spectral extraction will be used
    - Uses library of spectral reference profiles to determine encircled energy contours
    - Presently deriving traces and profiles needed for new extraction
  - G130M/1055 and G130M/1096 will remain at LP2
- Expect to be at lifetime position 3 for ~3 years after move
  - Subsequent positions will have substantially degraded resolution unless major changes from how we operate now are put in place
  - Need to investigate alternative solutions over the next couple of years

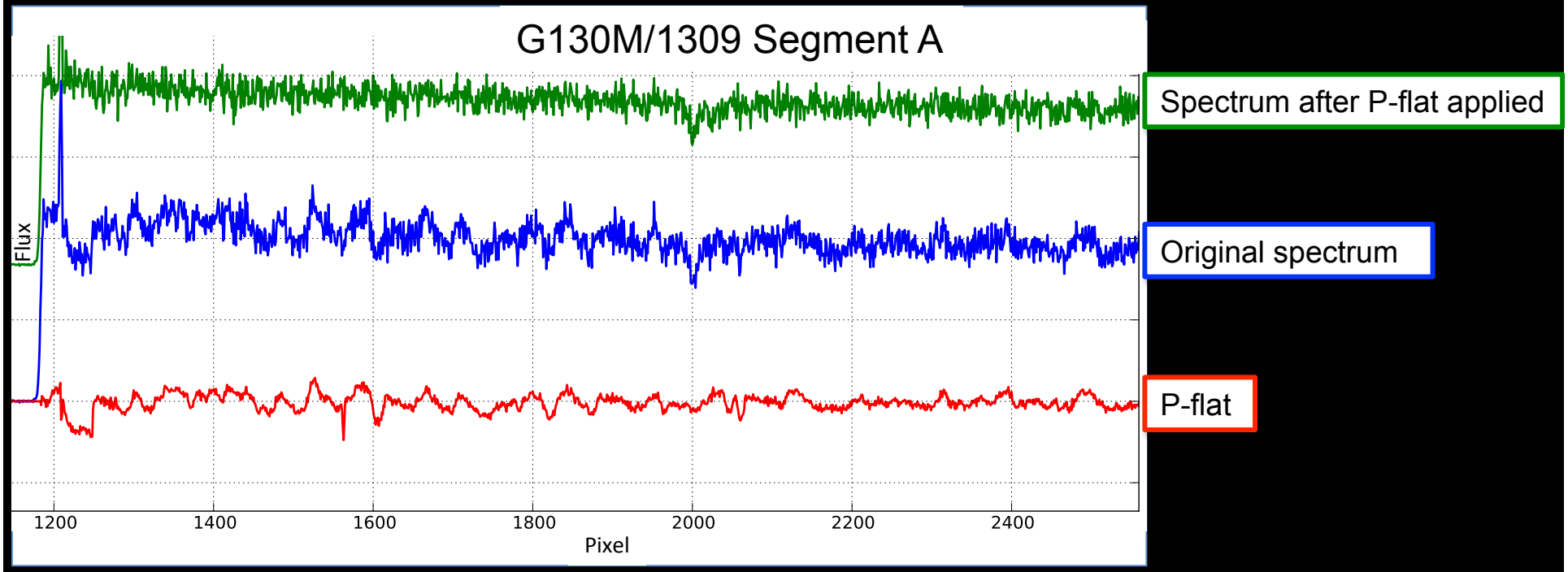
COS FUV Sensitivity



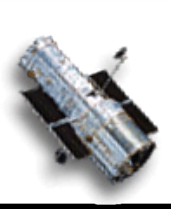
- Time dependent sensitivity slopes remained shallow during 2013
- New TDS breakpoint around 2013.8, with steeper slopes, up to ~8% per year

COS FUV Pixel-to-Pixel Flat

- 1D flat-fields (P-flats) to correct pixel-to-pixel fixed pattern noise have been developed for lifetime position 2
  - Useful mainly for high S/N observations, S/N > 30 per resolution element
  - Not yet implemented in pipeline as applicability for data obtained at positions slightly offset in cross-dispersion direction is under study
  - Available to all users on a “use at own risk” basis



COS MIRRORB/ACQ/IMAGE Imaging Target Acquisitions

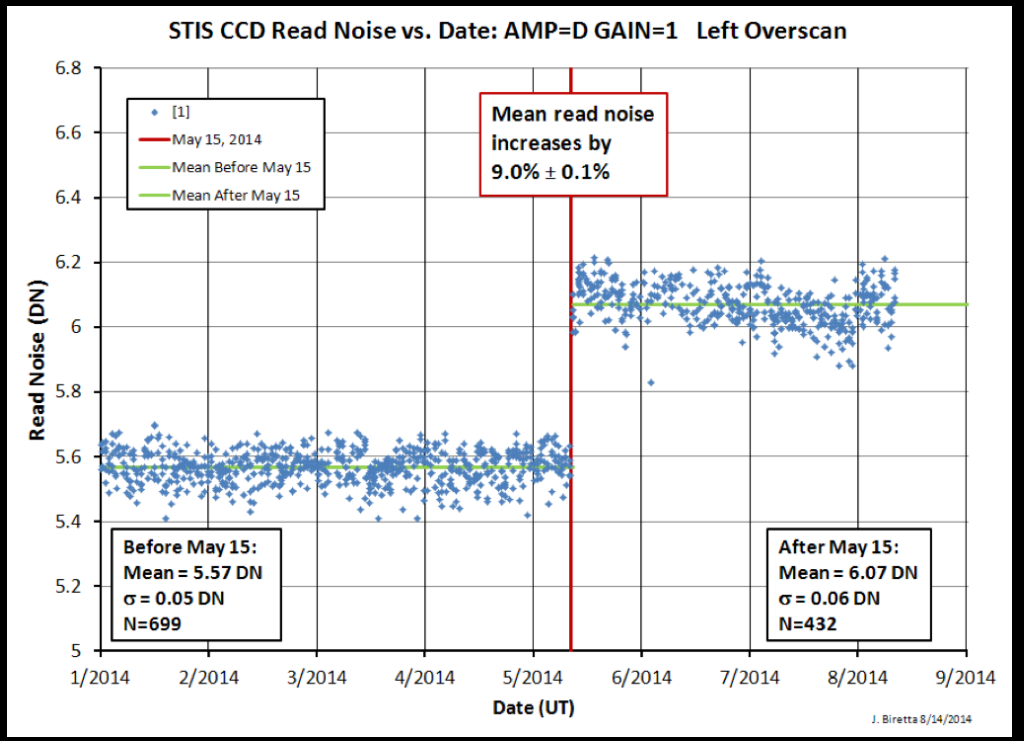


- MIRRORB/ACQ/IMAGE target acquisitions were put on hold in late July 2014
  - Help desk call identified large velocity shift (45 km/sec) between ground data and COS/G130M obs
  - Alternative acquisition options were discussed with PIs and used when possible
- Problem with lamp exposure used to find the center of the aperture
  - Leads to mis-centering along the dispersion direction and incorrect zero-point offset of wavelength scale
  - Issue is due to a combination of NUV dark current increases and secular drift of OSM
- Solution is to increase lamp current is being and recenter acquisition sub-arrays
- Expect to return to unrestricted use of COS/MIRRORB/ACQ/IMAGE on Nov 17, 2014
- In the process of evaluating potential effect on programs that executed before issue was uncovered in July 2014

STIS Status

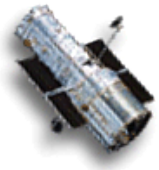
(C. Oliveira and the COS/STIS Team)

- MAMA and CCD channels are working well
- CCD Amp D read noise increase
  - Change consistent with new 2.4e$^-$ RMS noise source early in Amp D signal chain affecting both GAINS 1 and 4
  - Users warned of increase in GAIN = 1 through STAN (Aug 2014), ETC 23.1 modified
- No changes seen in Amps A or C



- No unexplained STIS events during period
- Radiation damage to early Amp D signal chain is probable cause
  - Conclusion reached by GSFC ARB that studied similar increase in 1999

Spectroscopic Legacy Working Group



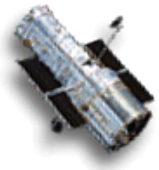
- Identify the key science areas and archival data sets that would benefit from the availability of spectroscopic HLSPs.
- Define one or more high-priority COS or STIS HLSPs that will enable the scientific community to conduct science investigations relying on spectroscopic datasets quicker, easier, or in new ways. There need not be a "one-size fits all" approach to this task. Science need/demand should drive the types of products defined.
- Develop and test algorithms necessary to create these spectroscopic HLSPs.
- Create examples of prototype HLSPs that should be produced and maintained by STScI through the end of the HST mission.

Charter

Members:

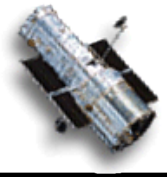
Jason Tumlinson (Chair, MESA/HSTMO)
Tom Ayres (Colorado)
Charles Danforth (Colorado)
Andrew Fox (co-chair, COS/STIS)
Ed Jenkins (Princeton)
Brian Keeney (Colorado)
Molly Peeples (COS/STIS)
Cristina Oliveira (COS/STIS)
Alessandra Aloisi (OED)
Lou Strolger (SMO/HLA)

Spectroscopic Legacy Working Group



- Draw on, and potentially combine, science-grade post-MAST processing and co-addition codes already in use
- Products to be generated will be peer-reviewed along with the algorithms that generated them by reviewers from outside STScI and the WG
- Ultimately these high-level products will be available beside the traditional MAST products
- Current status: have reviewed 3 common co-add codes for COS and STIS. Working now to reconcile their methods and derive optimal methods for workhorse modes (high priority is on COS FUV and STIS echelle modes).

Preparing APT for Java 7 End of Life



- Oracle's published roadmap has the end of public updates for Java 7 set for April 2015. After this date, OS updates could break compatibility and security issues will not be fixed.

- Upgrading APT to Java 8 will mean APT's minimum OS requirement will change:
  - We will have to drop support for Windows XP (3 submissions in Cycle 22)
  - We will have to drop support for OSX 10.7 (143 Submissions in Cycle 22).
  - Requiring OSX 10.8 or higher will mean that users will need to have a Mac purchased new from Apple in the past ~6 years

- The APT Team recommends moving to Java 8 with the October 2015 APT release

- This upgrade is in line with our previous pattern updates:
  - Java 6 came with APT 19.0 in Jan 2011 (Java 5's end of updates was Oct 2009)
  - Java 7 came with APT 21.4 in Oct 2013 (Java 6's end of updates was Feb 2013)
  - Java 8 would go out with APT 23.4 in Oct 2015 (Java 7's end of updates is Apr 2015)