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EXPANDING THE FRONTIERS OF SPACE ASTRONOMY

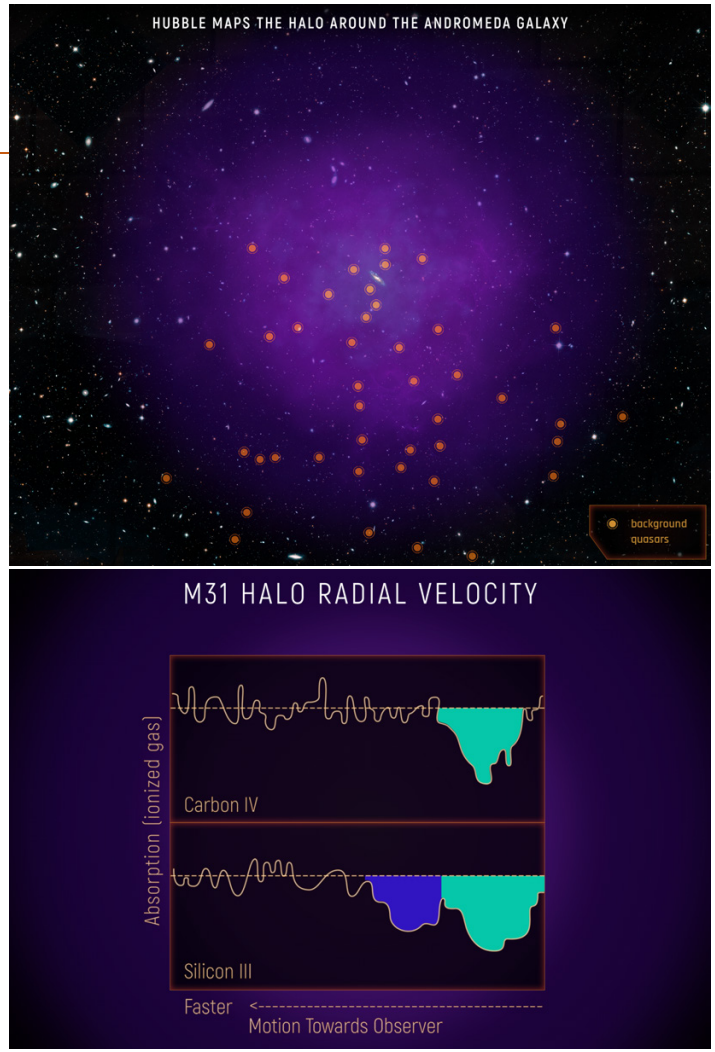
HST Mission Office Report

Tom Brown

STUC – 15 Oct 2020

Hubble Operations Proceeding Normally

- Hubble ops remote since March 16
  - Exceptions
    - Weekly delivery of the Science Mission Specification (SMS)
    - Anomaly response
  - No concerns; observatory & instruments healthy
  - Science ops at STScI continues to account for reduced efficiency in work-from-home posture
- Request for Proposal (RfP) from NASA for HST contract extension
  - Received September 24 with 3 month response time
  - Current contract runs through June 2021
  - Expecting continuation of current sci ops with no closeout
  - Proposing extension for another 5 years
- Cycle 28 underway (see Leitherer presentation for stats)
- Preparing for Cycle 29 (see Strolger presentation, and also 3 changes to CfP discussed here)
- COS 2030 lifetime extension (see Rafelski presentation)
- ULLYSES underway (see Roman-Duval presentation)



Hubble Maps Giant Halo Around Andromeda (Aug 2020)

Long Range Plan Status

(Prepared by Dave Adler)

LRP: Current Status

Cycle 28 update

- Due to an earlier-than-usual TAC, the Cycle 28 LRP was released in mid-July; it began on October 1.

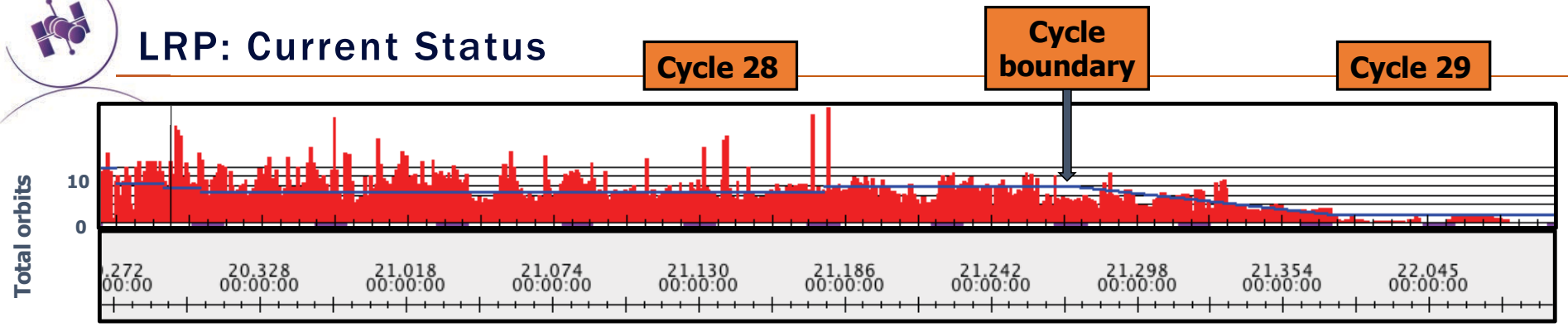
Cycle 27 averaged 85 orbits – consistent with recent cycles

- Cycle 17-23: 84 orbits/week
- Cycle 24: 82 orbits/week
- Cycle 25: 85 orbits/week
- Cycle 26: 80 orbits/week (85 orbits/week if remove three weeks of down-time due to Gyro 2 failure)

Previous Cycle Completeness – Cycles 25 and 26 are mostly done

- Cycle 25: 27 orbits remain; 23 are from the Large exoplanet programs waiting for viable windows.
- Cycle 26: 63 orbits left; 40 are from an astrometry program targeting fall 2021.
- Cycle 27: 680 orbits left; some as late as early 2022.

LRP: Current Status



- **Cycle 28 LRP: features**
  - **15 occurrences of 16-31 consecutive orbits on same target (remaining Cycle 27 and new Cycle 28).**
    - Usually exoplanets, but other science targets as well.
    - Requires LRP team to coordinate with other programs that have timing links.
  - **There is a high amount of constrained material.**
    - 795 orbits (23% of the plan) have windows of less than a week with no other opportunities for a year+.
    - Mostly exoplanets/moving targets, but also a lot of other science with highly constrained timing links.
  - **Moving targets limited to two consecutive orbits due to gyro instability.**
    - LRP team spread them out as possible.
    - Avoided overloading given week to avoid undue stress on Flight Operations Team.
  - **Some material not yet in a plannable state**
    - During LRP build process in July 2020, the LRP team left room left for this unschedulable material.
    - 2021 subscription level will go up as unplanned programs and mid-cycle programs come in.

LRP: Current Status

Constraints for discussion

- **15 occurrences of 16-31 consecutive orbits on same target (remaining Cycle 27 and new Cycle 28).**
  - Usually exoplanets, but other science targets as well.
  - Requires LRP team to coordinate with other programs that have timing links.
- **There is a high amount of constrained material.**
  - 795 orbits (23% of the plan) have windows of less than a week with no other opportunities for a year+.
  - Mostly exoplanets/moving targets, but also a lot of other science with highly constrained timing links.

- Two draft changes for the Cycle 29 Call for Proposals to address these concerns:
  - Observers are strongly encouraged to craft their programs in blocks of 6 consecutive orbits or less. If your science requires more than 6 consecutive orbits scheduled continuously, the program will proceed under a shared risk between STScI and the observer. Specifically, if the planning & scheduling team can reasonably schedule your program in this manner, it will be attempted, but if there is a problem, any subsequent attempt must be done in a series of 6 orbits or less. In Phase I, you must justify the use of a longer series of consecutive orbits, and explain the impact to your science goals if your observations cannot be scheduled in that manner, either on the 1st attempt or in the event of failure.
  - We encourage accepted programs to minimize scheduling constraints. STScI recognizes that some of the scheduling restrictions for successful programs may not be apparent to an observer using APT. If the final constraints on your program result in only one scheduling opportunity per year (i.e., falling in only one of the weekly HST schedules), that program will proceed under a shared risk between STScI and the observer. Specifically, if the observations fail, a request to repeat the observations might not be granted unless the program constraints are relaxed.


Cycle 27 statistics
(Prepared by Dave Adler)

Exoplanet Programs

- For exoplanets with tight period/phase constraints, planning windows outside the definitive ephemeris (10 weeks) are not reliable**.**
- **Cycle 25**
  - 2 programs (23 orbits) still active.
  - **deWit** (Cycle 25 Large): 94 of 114 complete. 5 visits (20 orbits) remain.
  - **Crossfield** (Cycle 25 Large): 124 of 127 complete. 1 visit (3 orbits) remains.
- **Cycle 27**
  - 11 programs: 105 of 240 orbits complete.
  - Many of the remaining visits do not yet have reliable planning windows within the definitive ephemeris.
- **Cycle 28**
  - 11 programs: 3 of 200 orbits complete.
  - Again, many do not have reliable planning windows, yet.

Solar System Programs

- ~180 orbits in Cycle 28 plan (remaining Cycle 27 plus new Cycle 28 material).

Highlights:

- **OPAL: Outer Planet Atmospheres Legacy (Simon)**
  - **Cycles 22-24:** 29 total orbits per cycle on Jupiter, Saturn, Uranus, & Neptune.
  - **Cycle 25-27:** 41 total orbits per cycle.
  - **Cycle 28:** 41 orbits planned.
    - **Uranus** done in early October; **Jupiter/Saturn** planned in July 2021; **Neptune** in August 2021.
- **New Horizons: Potential KBO targets (Porter)**
  - 58 orbits allocated; 18 in fall, rest in early spring. Observing has begun.
- **Uranus Magnetosphere (Lamy)**
  - 9 orbits of specifically-timed visits.
  - First five visits complete.

Other programs of note

- **Individual Stars as probes of Dark Matter (Kelly)**
  - 96 orbits in each of Cycles 27 and 28.
  - Six sets of 16 consecutive orbits each cycle. Precise timing required to get all visits scheduled around SAA efficiently.
  - Cycle 27; 64 done, 32 remain.
  - Cycle 28 – not yet started.
- **Reverberation in AGNs (Peterson)**
  - 198 total orbits.
  - Most sequenced to go every other day for a year.
  - Each visit has a small tolerance (+/- 12 hours) to allow scheduling around other programs.
  - Program starts November 24.
- **3D-DASH: WFC3/IR Survey of COSMOS (Momcheva)**
  - 259 total orbits.
  - Using “drift and shift” (DASH) observing technique.

Cycle 25/26 Large Programs

- **Cycle 25 –** Two exoplanets, with a few visits waiting for opportunities to allow specific period/phase.
- **Cycle 26 – T**wo programs with HOPRs timed to go in specific places.

C25/26 Program	alloc	Exec/sched by 10/18/20	Planned before 10/1/21	Planned after 10/1/21	comment
Crossfield	125	122	3	0	Exoplanet
deWit	114	89	16	4	Exoplanet; 5 not in plan
Lee	122	112	7	0	HOPRs; 3 not in plan
Teplitz	164	160	3	0	HOPRs; 1 not in plan

Large/Treasury programs

C27 Program	alloc	Exec/sched by 10/18/20	Planned before 10/1/21	Planned after 10/1/21	comment
Berg	133	127	4	0	2 not in plan
Jha (ToO)	51	50	1	0	Completed. Cycle 28 part started
Kelly	96	64	32	0	6 sets of 16-consecutive orbits
Roman-Duval	77	70	0	0	completed
Weisz	244	177	47	0	20 not in plan

C28 Program	alloc	Exec/sched by 10/18/20	Planned before 10/1/21	Planned after 10/1/21	comment
Jones	110	0	110		
Kelly	96	0	64	32	6 sets of 16-consecutive orbits
Momcheva	259	0	66	10	3D-DASH; 183 not in plan
Peterson	198	0	163	35	Reverb – every other day for 1 yr
Sabbi	84	0	66	18	GULP

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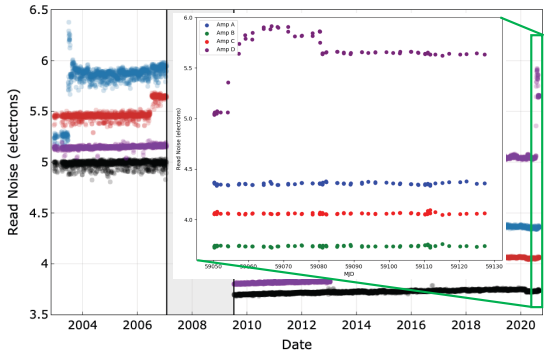
ACS Update

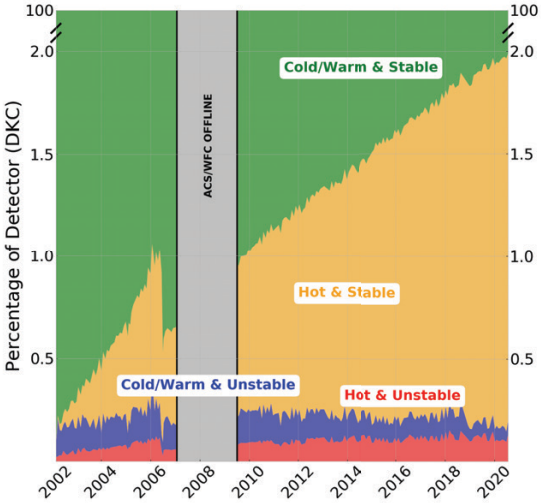
Norman Grogin, Roberto Avila, and ACS Team

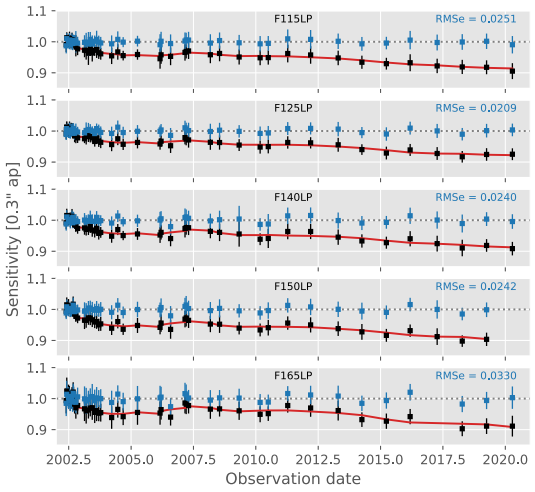
ACS Developments since the Apr'20 STUC Meeting

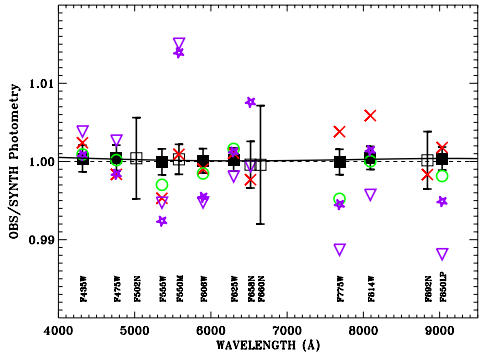
✓ ACS continues to operate nominally.

- Continued stable WFC readnoise after Jul'20 AmpD glitch (*upper left*); slow trending of WFC dark current & CTE
- WFC pixel stability monitoring (*upper right*) shows steady 99.8% usability
- Refined SBC time-dependent sensitivity model (*lower left*) reduces photometric scatter to 2-3% across all SBC filters
- New WFC throughputs: 0.1% agreement (*lower right*) b/w primary HST standards and CalspecV11 synthetic photometry









ACS Ongoing & Planned Work

- Sep'20: Delivery of CalspecV11-compliant throughputs to support Cycle 29 ETC
  - Oct'20: Delivery of corresponding IMPHTTABs (new ACS zeropoints); reprocessing w/ WFC3
- ACS/WFC spatially-dependent saturation flagging in CALACS (±10% variation seen)
- Refined WFC 'superdarks' for improved DARKCORR in CALACS
  - Traditional 1000sec DARKs suffer from saturated hotpix; 65e^- FLASH may be excessive
  - Cyc27 pilot: assessed reduced-exptime DARKs at a variety of reduced post-flash levels
  - Early Cyc28: testing fidelity of superdark using 2× more, 2× shorter DARKs (& 1/3 FLASH)
- Further support for WFC polarimetric observing
  - Sep'20: Polarization Tools added to *acstools* software suite, for expediting polarim. analyses
  - Investigation of potential new ACS operating mode: grism spectropolarimetry (6000-9500Å)

New ACS Documentation since the Apr'20 STUC Meeting

- Preparation of ACS Instrument & Data Handbooks for HST Cycle 29 (in HDox format)
- ISR ACS 2020-04 : "Accounting for Readout Dark in Superbiases II: Subarrays and Updated Readout Dark Measurement" (Ryon, Grogin, & Desjardins)
- ISR ACS 2020-05 : "Anneal Efficacy in the ACS Wide Field Channel" (McDonald et al.)
- ISR ACS 2020-06 : "Validation of Reduced Operate Anneal Mode in the ACS Wide Field Channel" (McDonald & Grogin)
- ISR ACS 2020-07 : "Unusual Horizontal Charge Overflow from Saturated CCD Pixels in the ACS WFC: Discovery and Remediation" (Cohen & Grogin)
- ISR ACS 2020-08 : "Update of the Photometric Calibration of the ACS CCD Camera" (Bohlin, Ryon, & Anderson, in prep.)
- ISR ACS 2020-09 : "Validation of New ACS/WFC Geometric Distortion Reference Files Calibrated with Gaia Data Release 2" (Hoffmann & Kozhurina-Platais, in prep.)

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COS Update

Marc Rafelski, Bethan James, and COS team

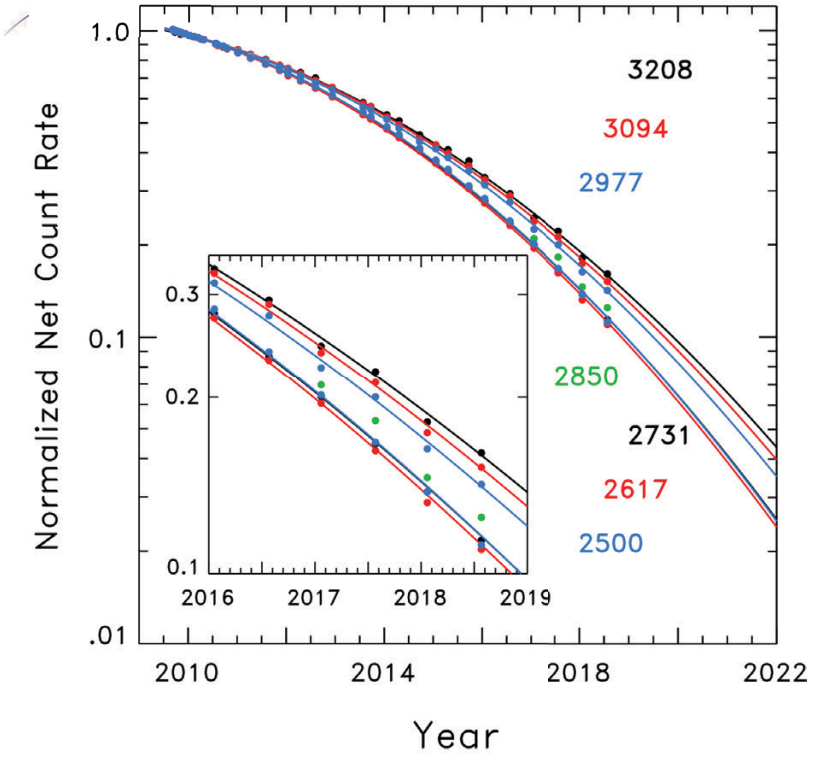
COS Summary

- COS is Operating Nominally
- HV was raised for LP4 FUVA/FUVB and at LP3 FUVA on October 5, 2020
- 2 STANS released and 8 ISRs

Authors	Title	ISR Number
B. James et al.	Summary of COS Cycle 26 Calibration Plan	2020-01
W. Fischer	Cycle 26 COS NUV Spectroscopic Sensitivity Monitor	2020-02
W. Fischer	Cycle 26 COS FUV Wavelength Scale Monitor	2020-03
W. Fischer	Cycle 26 COS NUV Wavelength Scale Monitor	2020-04
A. Fox et al.	Testing for Systematics when moving the COS Aperture Block	2020-05
R. Sankrit	Cycle 26 COS/FUV Spectroscopic Sensitivity Monitor	2020-06
D. Sahnow	Cycle 26 COS FUV Detector Gain Maps	2020-07
D. Dashtamirova et al.	Cycle 26 COS FUV Dark Monitor Summary	2020-08

NUV G285M grating

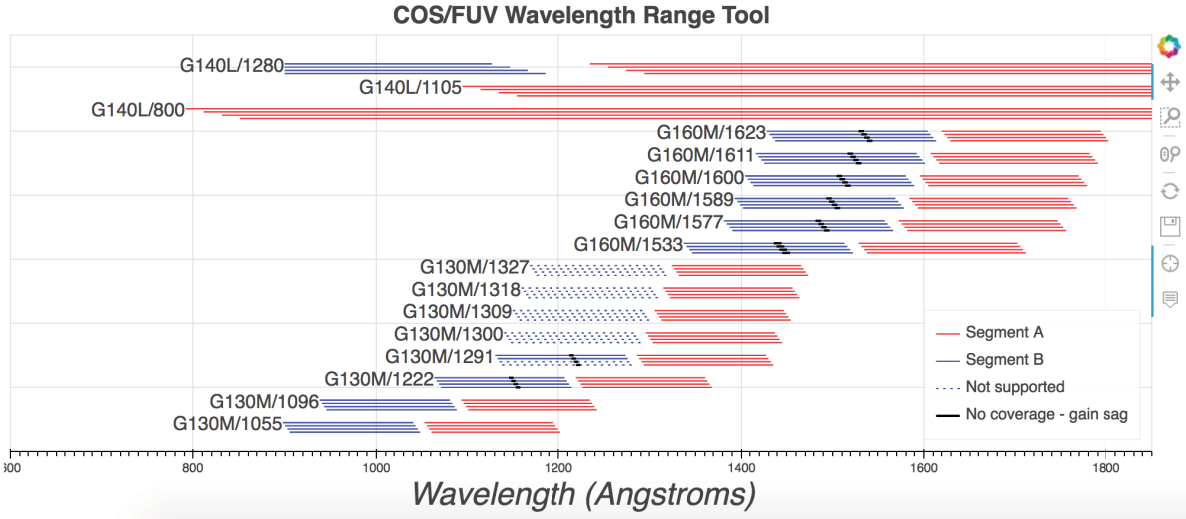
(unsupported in Cycle 29 CfP)



- G285M will be available but unsupported for Cycle 29 due to low throughput.
- Monitoring discontinued in 2018, at sensitivity loss of 85% since launch.
- By 2021 this is expected to be ~95% (but large uncertainty without monitoring).

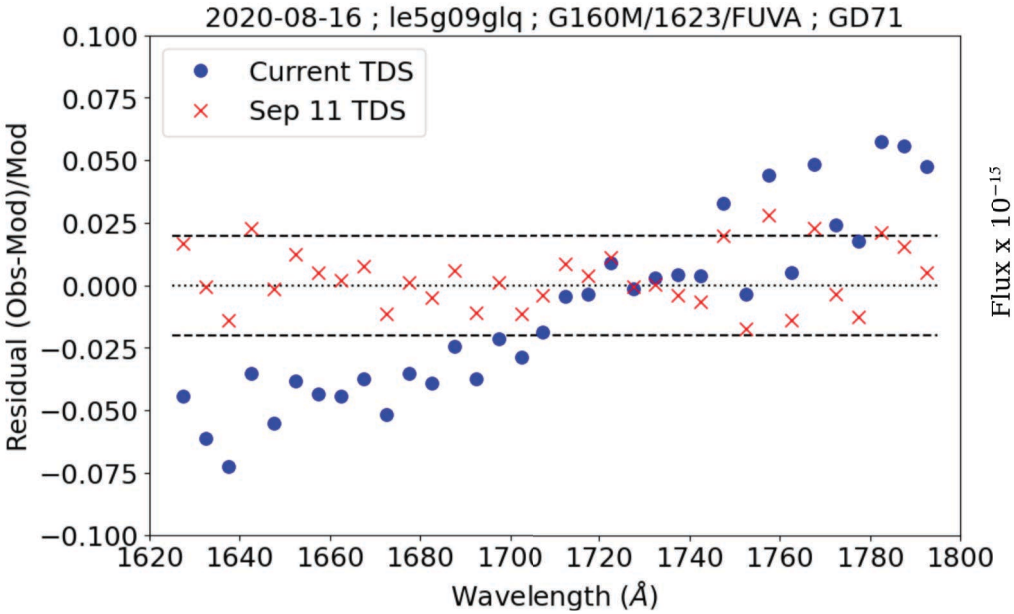
Blue Modes Recalibration Complete

(Fischer, Oliveira, Dieterich, Rowlands, Kumari, Ake, Plesha)



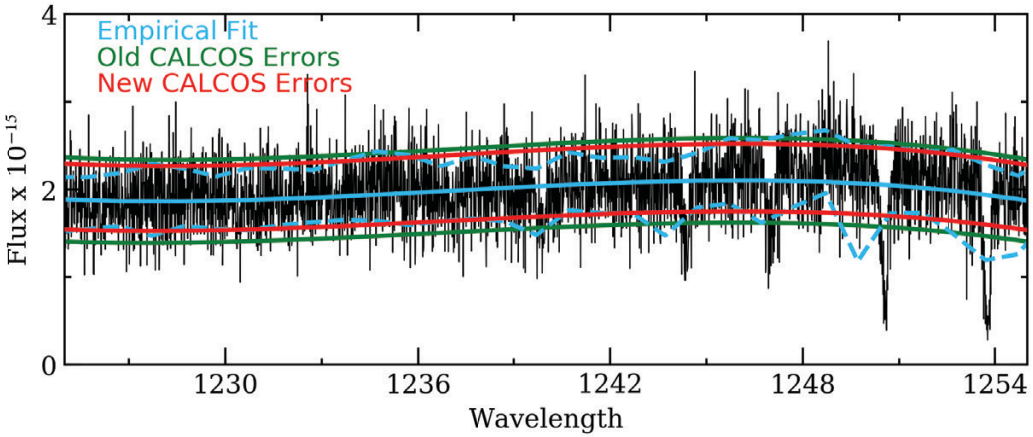
- W. Fischer, C. Oliveira, S. Dieterich, K. Rowlands, N. Kumari, T. Ake, R. Plesha
- Cenwaves 1055 and 1096 are at LP2 and extend wavelength range: 899–1196 Å, 940–1236 Å
- We improved the flux, time-dependent sensitivity, & wavelength calibrations to bring their accuracy in line with those of the other G130M modes
- New reference files have been delivered and ISRs are being written

Improved Time-Dependent Sensitivity (FUV Sankrit, NUV Fischer)



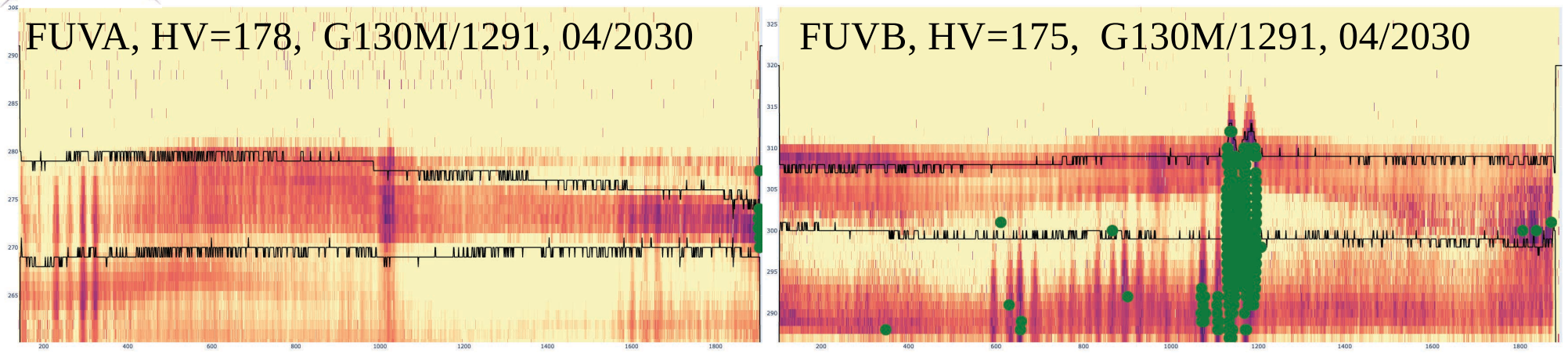
- NUV TDSTAB delivered for first time in 10 years
  - Previously off by ~10%
- New hybrid cenwave-dependent TDSTAB delivered
  - Improves TDS accuracy at short & long wavelengths
  - Monitored modes are now cenwave dependent (G130M 1291 / 1222 / 1327, G160M 1577 / 1623, G140L 1105 / 1280)
  - Unmonitored modes updated w/same methodology as in previous TDSTABS
- New breakpoint in TDSTAB at 2019.0

Corrected & improved uncertainties (Johnson)



- Corrected uncertainties: COS data previously incorrect at low SNR
- Correctly combines uncertainties in x1dsum files
- Provide asymmetric uncertainties more appropriate for low counts
- Provide all terms to determine uncertainty (counts, flat, and background)

Advanced gain modeling (Johnson)



- Each grating and cenwave has a different profile shape and needs to be modeled
- New model uses the cumulative count and extracted charge maps for each week
- Maps distribution of counts at each LP, grating, and cenwave
- Models naturally include pixel offsets, addition of background count levels, and impacts from calibration exposures
- Model is used to optimize a hybrid LP-mode of operation

Future Work in FY21

- Enable LP5
- Calibrate LP5
- Explore LP6
- Enable LP6
- Support Flight Software Update for COS LP6
- Implement new flux calibration incorporating new CALSPEC models
- Improved geometric and walk corrections

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STIS Update

Joleen Carlberg, Tala Monroe, and STIS Team

STIS Status

General

- STIS operating nominally
- New Branch Manager: Joleen Carlberg

Documentation

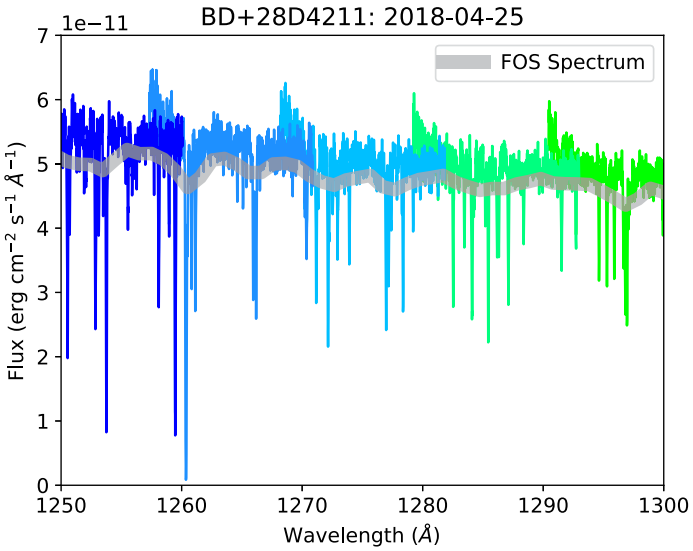
- 3 STANS published (June, July, and September 2020)

E140M – Flux Recalibration Complete

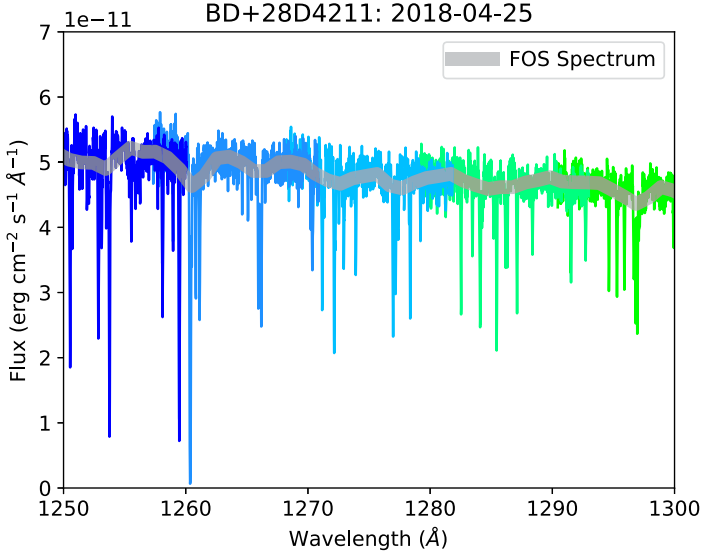
Highlights

- 5 new reference files delivered (2 RIPTAB, 3 PHOTTAB)
- Order 86 (λ ~ 1710 – 1730) newly calibrated for post-SM4 datasets
- New shapes remove edge “turn-ups” and improve absolute flux calibration

Before new reference file delivery



After new reference file delivery



CCD Defringe

Docs » defringe Edit on GitHub

defringe

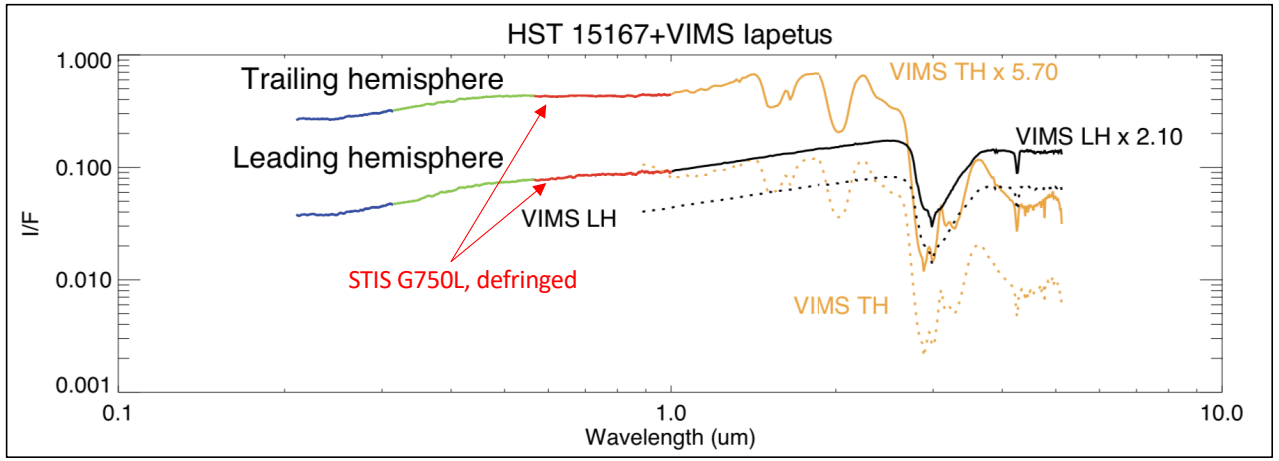
- Table of File Inputs/Outputs for the Defringe Tools
- Effectiveness of the Defringing Tools
- Routines

Guides & Examples:

- Defringe User Guide
  - Data Setup
  - 1. Normalize the Fringe Flat
  - 2. Prepare the Science File for the Defringing Correction (Optional)
  - 3. Match Fringes in the Fringe Flat Field and the Science Spectra
  - 4. Defringe the Science Spectra
  - Extraction of 1D Spectra from Defringed Science Products
- Defringe Examples
  - G750L Observation of HZ43
  - G750M Observation of AGK+81D266

Table of File Inputs/Outputs for the Defringe Tools

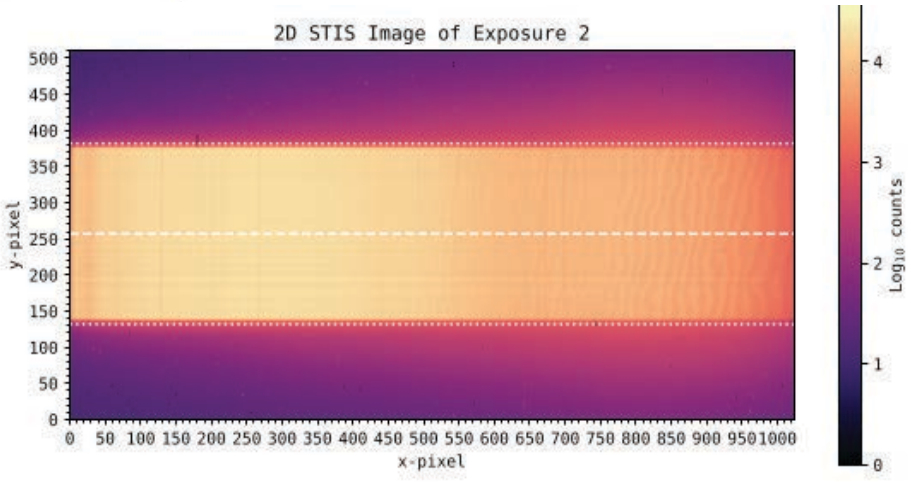
Tool	Input(s)	Output(s)
normspflat	**If do_cal is True:** [flat_file]_raw.fits, [sci_file]_wav.fits **If do_cal is False:** [flat_file]_crj.fits (G750L) or [flat_file]_sx2.fits (G750M) [sci_file]_wav.fits	[flat_file]_nsp.fits
prepspec	[sci_file]_raw.fits	**Standard Calstis Outputs:** [sci_file]_flt.fits [sci_file]_crj.fits [sci_file]_sx1.fits [sci_file]_sx2.fits

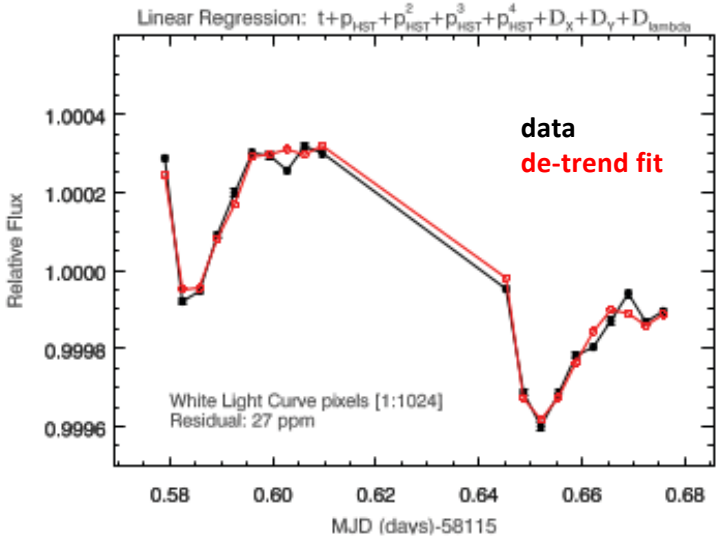


Highlights

- STIS defringe tool has been released to the community, with both step-by-step instructions and examples.
- Already, we have received feedback on its usefulness to the community. Above is a plot (shared with permission) from program 15167 showing the spectrum of Iapetus.

Spatial Scans – Analysis Complete





Highlights

- Special calibration program (15383) made 20 scans over 2 orbits of well-studied 55 Cnc to test flux repeatability compared to previous method of purposely saturating the detector
- New STIS defringe package applied to remove fringes (seen in above figure at x-pixel >~ 700). Reduces long-λ scatter by 15-20%
- De-trending analysis removes instrument systematics
- Achieved precision: 30 ppm rms residual

STIS Future Plans

Cycle 28 Special Calibration Programs

- Absolute Flux Calibration of Faint White Dwarf Standards for Cross Calibration – reobserve faint cross-calibration targets to achieve 3 independent epochs to probe potential variation
- Monitoring the 3 Primary White Dwarf Standard Stars – Biennial program to monitor primary standards
- STIS MAMA Exploration of FUV Flux Variations at Off-Nominal Detector Positions – test the achieved flux accuracy in the range of detector positions spanned by monthly offsets around nominal and D1

Future Work

- Photometric recalibration in light of updates to CALSPEC standards
- Publish results of investigation of spatial scanning for transiting exoplanet science and E140M recal
- Investigate historic coronagraphic performance, including potential evidence of CCD detector rotation
- Expand automation of routine monitors to include an echelle dispersion monitor (followed by lamp, TDS monitors)

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WFC3 Update

Sylvia Baggett, Annalisa Calamida, and WFC3 Team

WFC3 status

General

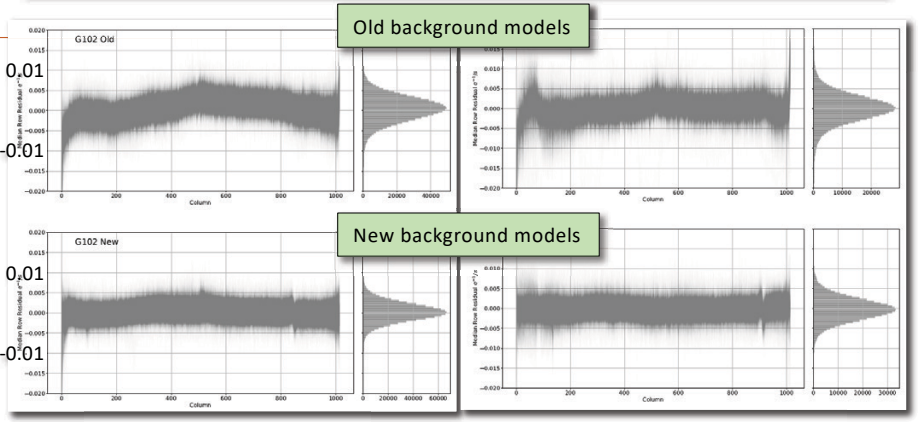
- WFC3 operating nominally
- ~ 280,000 WFC3 images in MAST archive
- Quicklook: data/instrument monitoring nominal

Completed

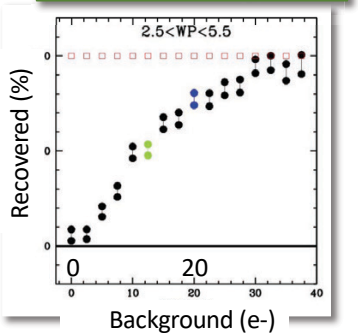
- New IR grism backgrounds (ISR 2020-04)
- Mitigating UVIS CTE loss (ISR 2020-08 + White Paper June 2020).

  → recommend 20e- background

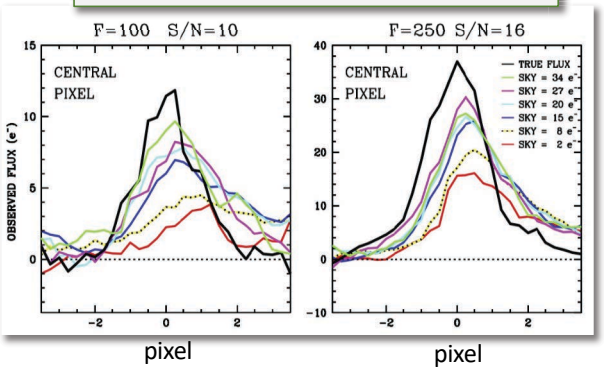
Residuals in G102 (left), G141 (right) datasets as a function of detector column



Faint warm pixels: fraction recovered vs background



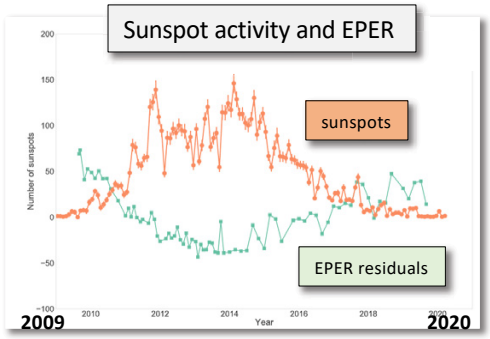
Stellar profiles as function of background

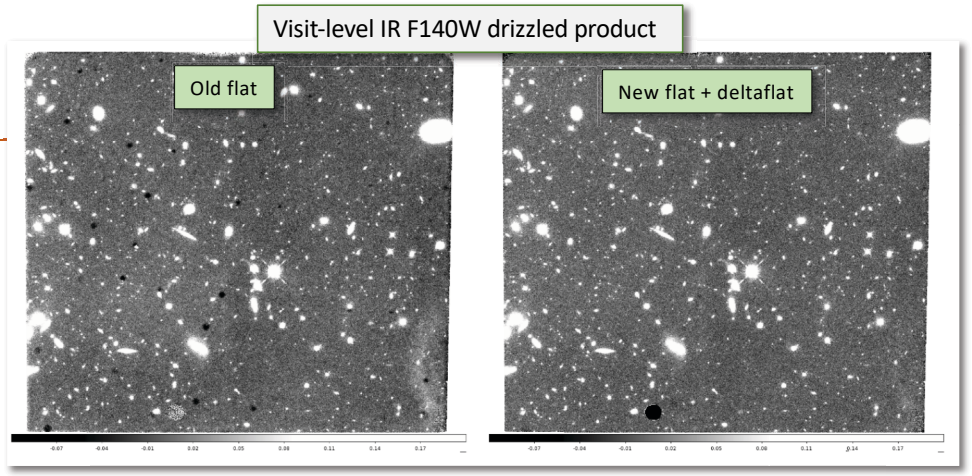


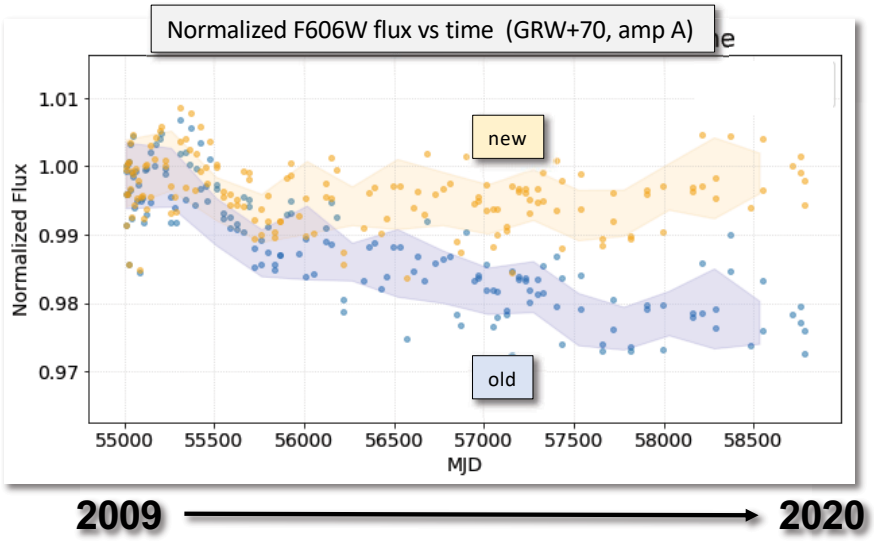
WFC3 status

Completed

- Support of GSFC Hybrid guiding mode test: WFC3 data quality equivalent to normal mode; excellent scan RMS
- Updated IR sky flats
  a) p-flats+ from 10+ years of stacked sky frames
  b) time-dependent delta flats to correct blobs
- Updated zero points account for:
  changes to flux standard SEDs + Vega (Bohlin et al. 2020)
  time-dependence of UVIS sensitivity
  new IR flatfields
- EPER analysis residuals to linear fits show anti-correlation with sunspot counts: radiation damage is higher during solar min (ISR 2020-06)

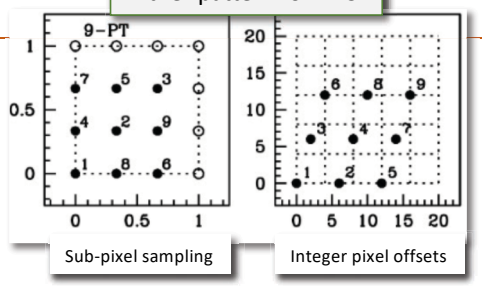




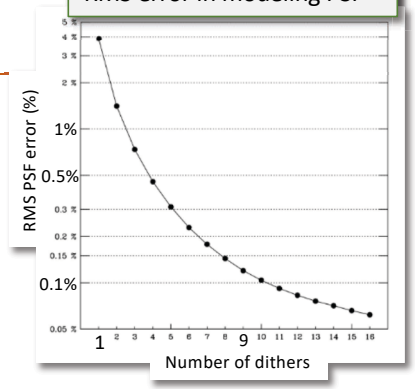


WFC3 status

Dither pattern for N=9



RMS error in modeling PSF



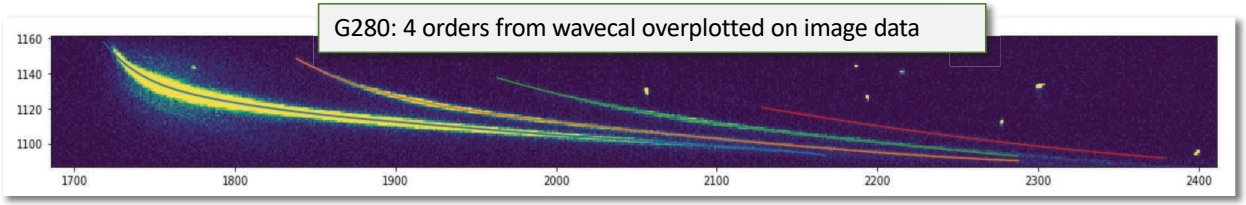
Complete

- Supplemental UVIS dither patterns for N 1 to 9 complete (ISR 2020-07).

In progress

- Completion of zeropoint/IR flatfield documentation (STAN, Newsletter article, ISRs)
- UVIS G280: wavelength calibration for 0, +/- 1,2,3,4 orders complete for both chips, full FOV.
  Flux calibration in progress.

G280: 4 orders from wavecal overplotted on image data



- Implement UVIS CTE correction into calibration pipeline
  Requires new daily-darks 2009-2020 processed with new correction
- Continue investigation into possible IR time-dependent sensitivity
- For Cycle 29 Call for Proposals, establish centralized “landing page” with archival exoplanet TSO details (targets, programs accepted, statistics, scan quality)

User support, new documentation since April

- Cycle 28 calibration plan / Phase II's submitted
- Cycle 28 Phase II Contact Scientist reviews completed
- STANs released June 2020 and July 2020; next one will be in Oct 2020
- Helpdesk support
- June 2020 AAS:
  - A new time-dependent photometric calibration of the WFC3/UVIS detector on HST (talk)
  - Filter-Dependent Sky Flats for WFC3/IR (poster)
  - Hubble's WFC3 in 2020 (poster)

- Reports

  2020-04 - The Dispersed infrared background in WFC3 G102 and G141 observations
  2020-05 - WFC3 IR Sensitivity over Time
  2020-06 - WFC3/UVIS EPER CTE 2009 – 2020
  2020-07 - Supplemental Dither Patterns for WFC3/UVIS
  2020-08 - Strategies for Mitigation of CTE Losses in WFC3/UVIS
  TIR 2020-02 WFC3 Data Quality in Hybrid Gyro Mode
  White paper June 2020: Current CTE-mitigation Recommendation

- In prep
  - WFC3/IR filter-dependent sky flats
  - WFC3/IR blob flats
  - Updated WFC3 IR Zeropoints (Bajaj et al.)
  - Cycle 29 IHB updates

Summary

Hubble continues to perform ground-breaking science

Happy to discuss any of the material in this slide package or other topics

Be safe and stay in touch