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EXPANDING THE FRONTIERS OF SPACE ASTRONOMY

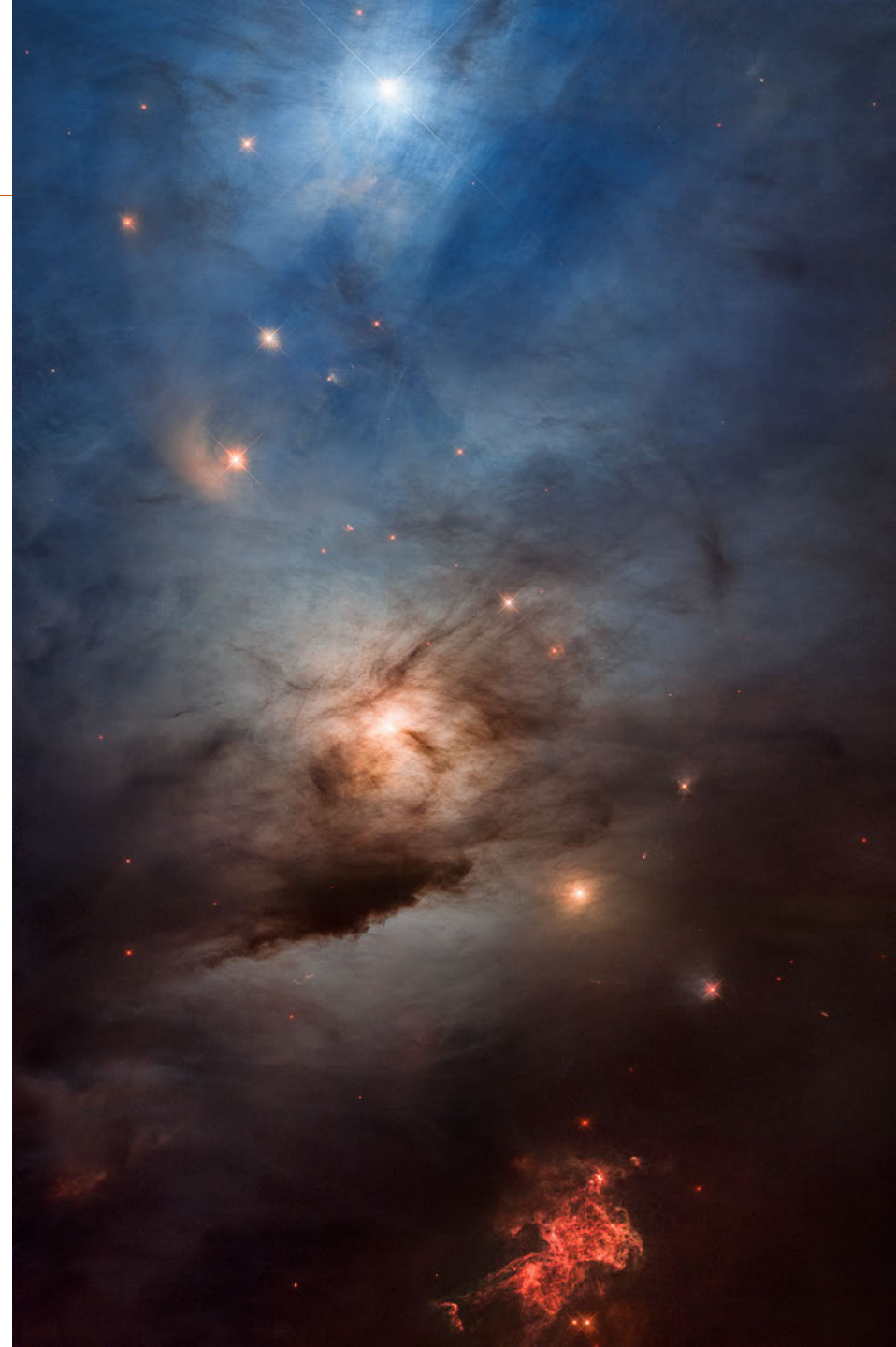
HST Mission Office Report

Tom Brown

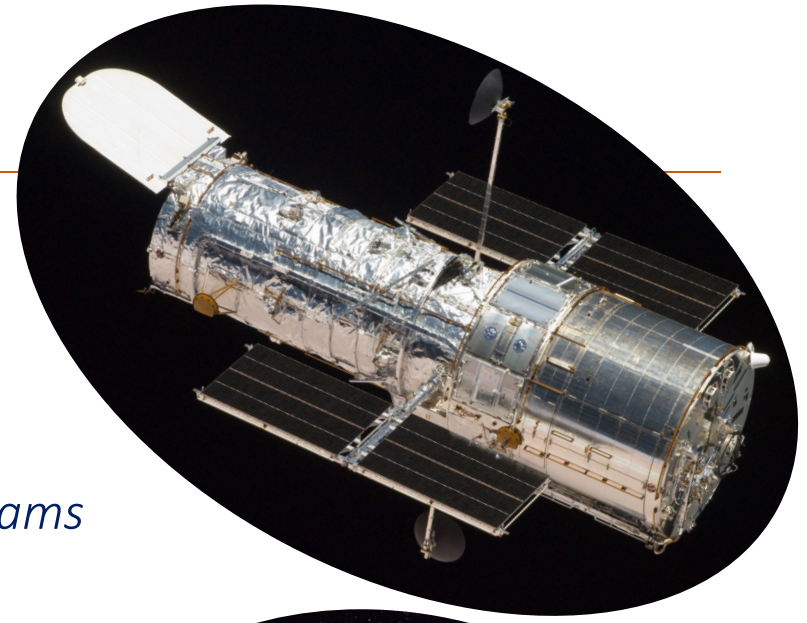
STUC – 9 May 2023

Summary

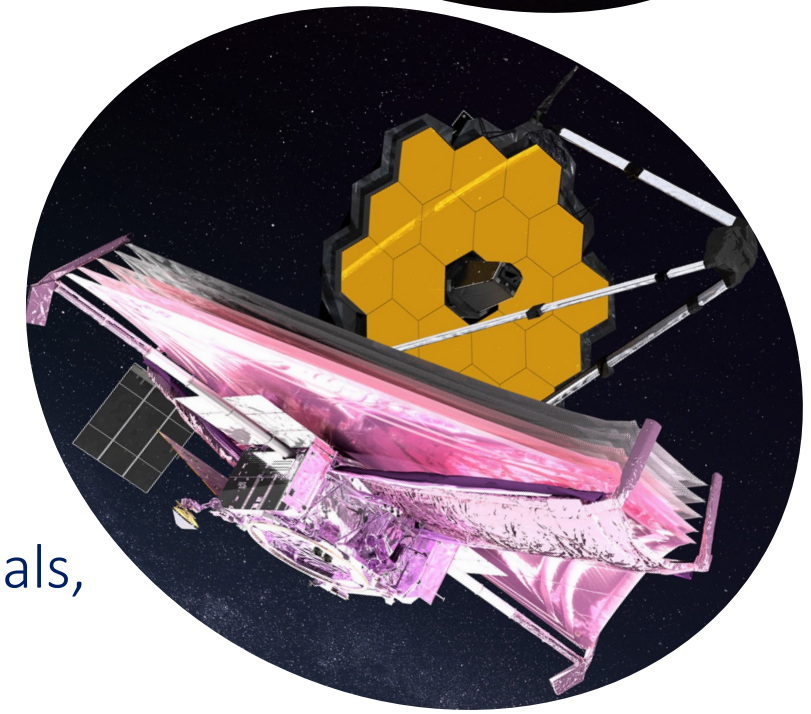
- Hubble celebrated 33rd anniversary on April 24
  - Eerie NGC1333 image (at right)
- Julia Roman-Duval began Mission Office Deputy on April 24
- Hubble & Webb working well together operationally & scientifically
  - Schedules managed to mitigate conflict between missions
- Cycle 31
  - Call for Proposals March 1, Phase I deadline May 24
  - Shortened 10-month cycle
  - New ACS spectropolarimetry and “Flexible Thursdays” ToOs
- FGS2 problems causing loss of some observations
- B-Side Operations review in April
- Grants Administration has posted example reports
- Long-range plan and Instrument support



Hubble and Webb operations



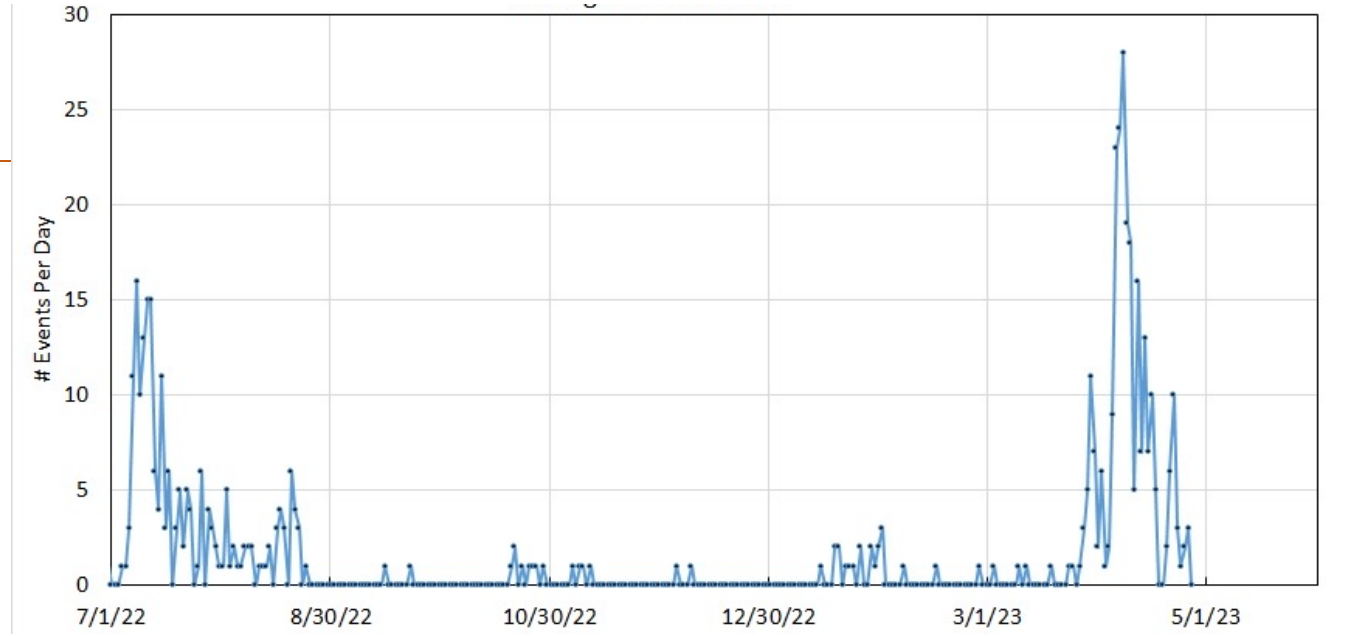
- Proposal life cycle largely relies upon shared staff:
  - Proposal solicitation & selection – shared staff
  - Planning & scheduling – shared staff
  - *Instrument calibration & contact scientists – dedicated instrument teams*
  - Data management & distribution – shared staff
  - Grants & outreach – shared staff
- **Transition from 1 to 2 missions in flight has been seamless**
- No change in response time for urgent issues (e.g., anomalies, Targets of Opportunity)
- Internally, staff supporting software builds generally shift between dedicated effort on one mission and then the other
- Externally, efforts involving the community (e.g., Call for Proposals, Time Allocation Committee) have been dovetailed to avoid overloading staff or community



Cycle 31

- Deadlines for Hubble Cycles 30 & 31 shifted to accommodate Webb Cycle 2
- Cycle 31 will span 1 Dec 2023 – 30 Sep 2024
  - Restores cycle start to October 1 for Cycle 32+
- Cycle 31 milestones
  - Mar 1: Call for Proposals
  - May 24: Phase I deadline
  - Aug 1-4: TAC discussion panels
  - Aug 7-9: TAC executive committee
  - Mid-August: notifications
  - Sep 15: Phase II deadline
  - Sep 28: Budget deadline
- Approximately 2300 orbits available to this call
- New ACS mode: spectropolarimetry
- New ToO category: Flexible Thursdays

FGS2 Issues



- FGS2 experiences periods of servo saturation events, causing lost observations
- Might be due to debris in servo and uneven distribution of lubricant
- Unclear if mitigating operations improve behavior (e.g., extended spinning to break down debris and redistribute lubricant) – usually need to wait until it settles down
- Some of these cause total or partial loss of visit
- Some of these result in no loss of science
- Latest erratic behavior covered most of April
- Worse case caused ACQ/REACQ problems in 30% of SMS
- Manually moving some observations to FGS1-3 pair during this period
- Expecting to resume normal FGS2 usage (w/exception of spatial scans & moving targets)

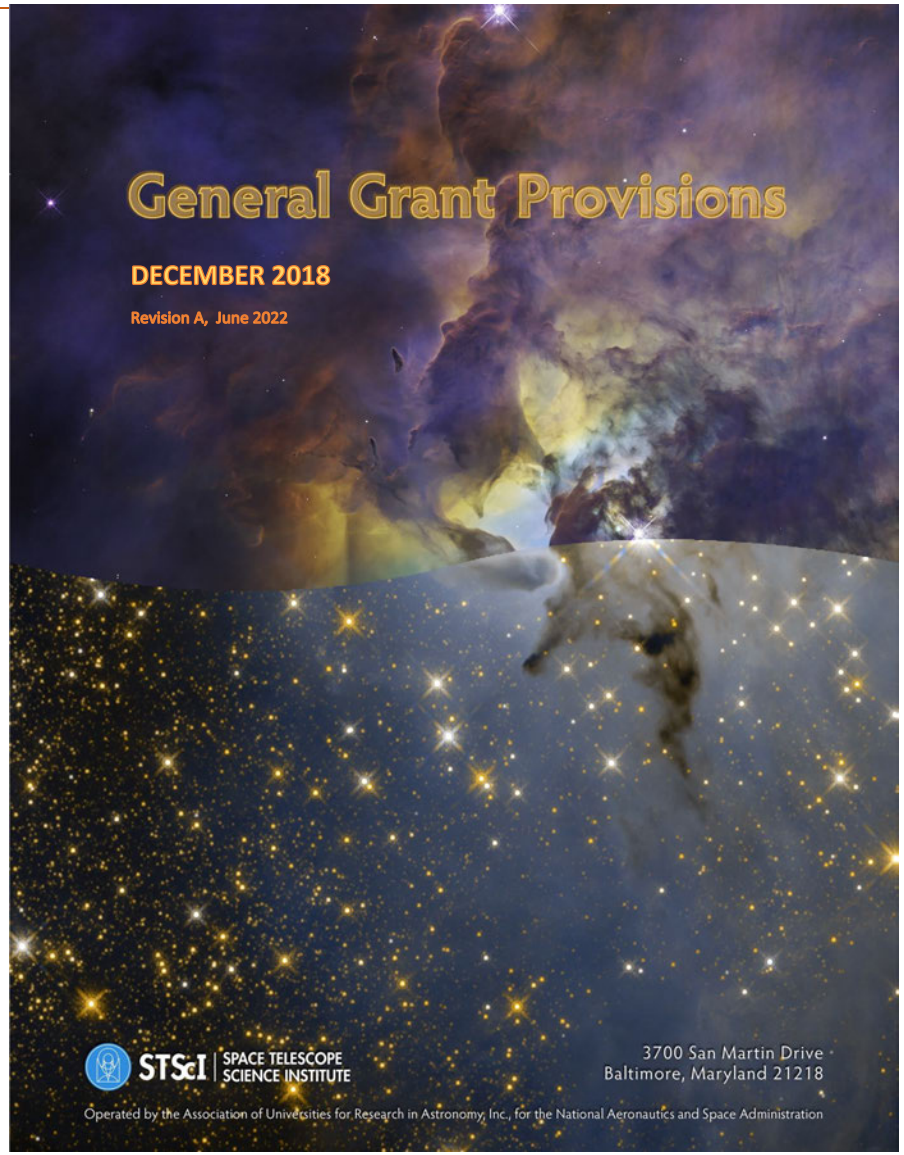
B-Side Operations

NASA Servicing Mission 4 animation
14 May 2009

- 13 June 2021 – NASA Standard Spacecraft Computer (NSSC) halted on Science Instrument Control and Data Handling (SIC&DH) System while operating on SIC&DH Side B
- Likely due to Power Control Unit (PCU) power clear circuit
- 15 July 2021 – Transition to SIC&DH Side A
- GSFC and STScI immediately began investigating the possibility of operations on Side B, by sending commands from 486 to instruments, bypassing NSSC
- Would also be applicable if similar failure occurred on Side A
- 4 Nov 2022 – Preliminary Ops Concept Review, looked promising
- 4 Apr 2023 – Ops Concept Review went extremely well

Grants update

- Discussed reporting at last STUC meeting (Oct 2022)
- Reporting requirements outlined in General Grant Provisions
  - Interim performance report: Due annually
  - Final performance report: Due within 90 days of grant end date
  - Each report includes:
    - Scope, objectives, findings, publications, comments
- Reports submitted by grant administrative PI using STGMS
- We agreed to provide example reports to guide grant holders
- Grants Administration selected & posted examples on grants site (https://www.stsci.edu/scientific-community/grants-administration)
  - 4 interim and 4 final examples
  - Checked with PI to get approval to provide these to community
  - Redacted sensitive information



Long Range Plan Status

Prepared by Dave Adler

Long Range Plan: Current Status

Cycle 30 update

- Averaging **88.6 orbits/week** over the first 31 weeks
  - Higher than typical, aided by Cycle 30 large programs that have:
    - Targets distributed across the sky
    - Lack of timing/orient constraints
  - Allows week-to-week scheduling gaps to be filled more easily before snaps are considered

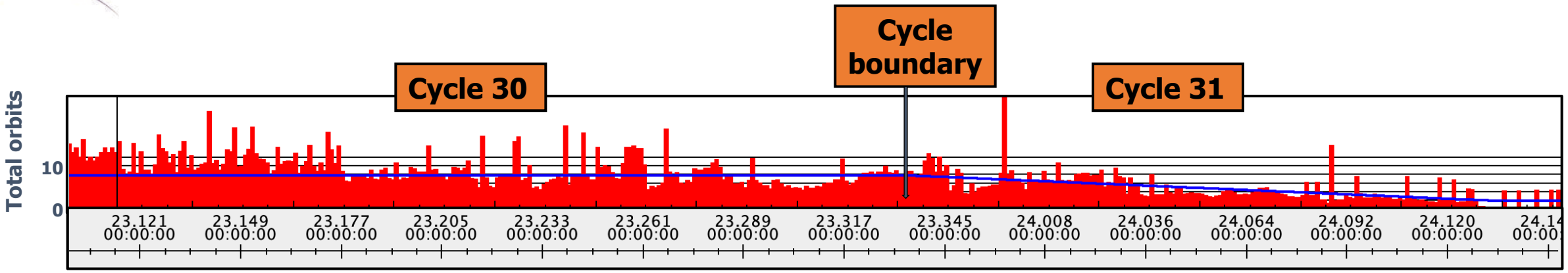
Comparison to previous cycles

- **Cycle 29** averaged **77.6** orbits/week over 53 weeks
  - Without down-time in fall 2021 (synchronization anomaly), average would be **82.1** orbits over 49 weeks
- **Cycle 28: 75.1** orbits/week with downtime in summer 2021 (SIC&DH anomaly)
- **Cycles 17-27**: averaged **80-85** orbits/week

Previous Cycle Completeness

- **Cycle 27**: 5 orbits left
  - 4-orbit HOPR from program **16039** (PI Sing, Characterizing the Outstanding Super-Earth LTT 1445Ab)
  - 1-orbit HOPR from program **15944** (PI Dupuy, The Coolest Sample of Brown Dwarf Dynamical Masses)
- **Cycle 28**: 46 orbits left

Long Range Plan: Current Status



Recent instability due to FGS2 issues

- During weekly calendar builds, scheduled visits are prepared again using FGS1-FGS3 (if possible)

Cycle 30

- Cycle 30 is 14 months long (usual Oct 1 cycle end date moved to Dec 1)
- LRP is full through the end of June 2023
  - Includes space for Director's Discretionary Programs, Targets of Opportunity, repeats of failed observations
- Subscription is a bit lower from July to the end of the cycle
  - Flexible material from cycle tail will be pulled up to keep subscription full as the need arises
  - Might lead to an increase in orbit allocation for Cycle 31 beyond the planned 2300 orbits

Long Range Plan Highlights – Exoplanet Programs

Cycle 27

- 1 program, 4 orbits remain

Cycle 28

- 20 programs, 279 orbits allocated
- 2 programs, 37 orbits remain

Cycle 29

- 21 programs, 403 orbits allocated
- 5 programs, 22 visits, 59 orbits remain

Cycle 30

- 14 programs, 409 orbits allocated
- 14 programs, 117 visits, 276 orbits remain

- **Highlights:**
  - Seeing in 3D: Unlocking the dynamical properties of a canonical exoplanet **(PI Mikal-Evans, 60 orbits - completed)**
    - Two long sequences (29 orbits in 2022 and 31 orbits in 2020, with 9-orbit repeat)
  - Mapping atmospheric dynamics at the limbs of an exceptional hot Saturn **(PI Rustamkulov, 23 orbits)**
    - Two long sequences (11 orbits and 12 orbit, still looking for workable opportunities in schedule)
  - Hubble Ultraviolet-optical Survey of Transiting Legacy Exoplanets (HUSTLE) treasury program **(PI Wakeford, 122 orbits, 44 done)**
  - The SPACE Program: a Sub-Neptune Planetary Atmosphere Characterization Experiment **(PI Kreidberg, 116 orbits – 10 done)**

Long Range Plan Highlights – Solar System Programs

Cycle 30

- 9 programs, 60 visits, 65 orbits remain
- A Combined HST and JWST Study of the Composition of the Faintest Trans-Neptunian Objects: Testing Hypotheses for the Formation of the Solar System
  (**PI Trilling, 99 orbits, nine 11-orbit visits in 10 days, complete**)
- OPAL: Outer Planet Atmospheres Legacy (**PI Simon, 41 orbits**)
  Uranus in November 2022, with Jupiter, Saturn, & Neptune in fall 2023
- DART
  - Original program in September 2022 – impact, follow-ups **(PI Li, 19 orbits - completed)**
  - Other DART programs:
    - DD: The Boulder Field in Didymos **(PI Jewitt, 16 orbits - completed)**
    - DD: Long-Term Evolution of Dimorphos's Dust Tail Created by the DART Impact **(PI Li, 9 orbits)**
    - Mid-cycle: Evolution of the DART Dimorphos Debris Field **(PI Jewitt, 15 orbits - completed)**

Long Range Plan Highlights – Other Programs

- **Cycle 29 M31 programs:**
  - Mapping Andromeda's Inner Circumgalactic Medium
    (PI Lehner, 137 orbits, completed)
  - The Panchromatic Hubble Andromeda Southern Treasury (PHAST)
    (PI Williams, 195 orbits, 182 completed)

- **Cycle 29 Reverberation program:**
  - Shedding Light on Light Echoes: Mapping the Accretion Disk and Broad Line Region in Mrk 279
    (**PI Chelouche, 50 orbits)**
  - 40 days of visits spaced every 0.7-0.9 days, with adjustments for South Atlantic Anomaly

ULLYSES

HST UV Legacy Library of Young Stars as Essential Standards (ULLYSES)

Program(s)	alloc	progs	Exec/sched by 4/30/23	Planned before 12/1/23	Planned after 12/1/23	comment
C27 Dwarf Galaxy	6	1	6	0	0	complete
C27 LMC	75	8	71	0	0	complete
C27 SMC	69	6	69	0	0	complete
C28 Galactic low-mass stars	106	7	105	0	0	complete
C28 LMC	64	6	61	0	0	complete
C28 SMC	100	6	89	0	0	complete
C28 T-Tauri	107	7	107	0	0	complete
C28 NGC 3109	9	1	9	0	0	complete
C29 LMC	114	17	88	24	0	Spring 2023
C29 SMC	36	8	36	0	0	complete
C29 T-Tauri	273	18	265	0	0	complete
C29 Sextans A	20	1	20	0	0	complete
C29 Supplement	10	2	1	9	0	Spring 2023

Large/Treasury programs

Remaining Cycle 27-28 Large Programs

C27-28 Program	alloc	Exec/sched by 4/30/23	Planned before 12/1/23	Planned after 12/1/23	comment
Kelly (c27-c28)	192	176	0	16	January 2024
Sabbi	84	79	4	0	Summer 2023

Remaining Cycle 29 Large Programs

C29 Program	alloc	Exec/sched by 4/30/23	Planned before 12/1/23	Planned after 12/1/23	comment
Pala	118	71	3	0	44 not in LRP (some ToO)
Levan	22	0	0	0	ToO; 22 not in LRP
Youngblood	110	93	12	0	Exoplanets; 5 not in LRP
Williams	195	182	10	3	M31-PHAST

Large/Treasury programs

Cycle 30 Large Programs

C30 Program	alloc	Exec/sched by 4/30/23	Planned before 12/1/23	Planned after 12/1/23	comment
Hayes	119	62	42	15	LaCOS
Borthakur	80	48	12	20	
Reindl	130	95	30	4	1 not in LRP
Bowen	96	38	26	31	1 not in LRP
Foley	105	35	3	0	ToO – 67 not in LRP
Wakeford	122	49	51	8	HUSTLE – exoplanets; 14 not in LRP
Kreidberg	116	10	69	29	SPACE – exoplanets; 8 not in LRP

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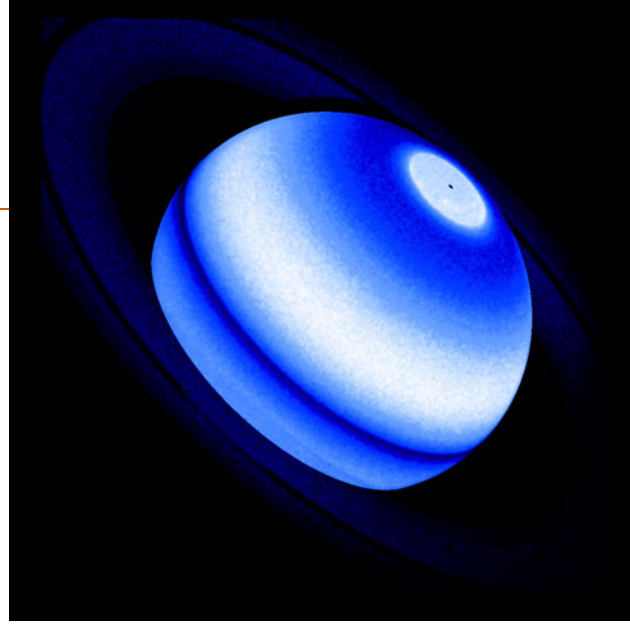
STIS Update

Joleen Carlberg, Tala Monroe, and STIS Team

STIS Status

STScI Press Release
2023-009
Lotfi Ben-Jaffel



STIS/UV imaging & spectroscopy
of Saturn
in tandem with Cassini

General Status

- STIS operating nominally (26 years in space!)

Documentation

- Published 2 STANs (Jan 2023, Apr 2023)
- ISR 2022-07: **Update of the STIS CTE Correction Formula for Stellar Spectra** (R. Bohlin and S. Lockwood)
- IHB Updates for Cycle 31

Flux Recalibration Deliveries

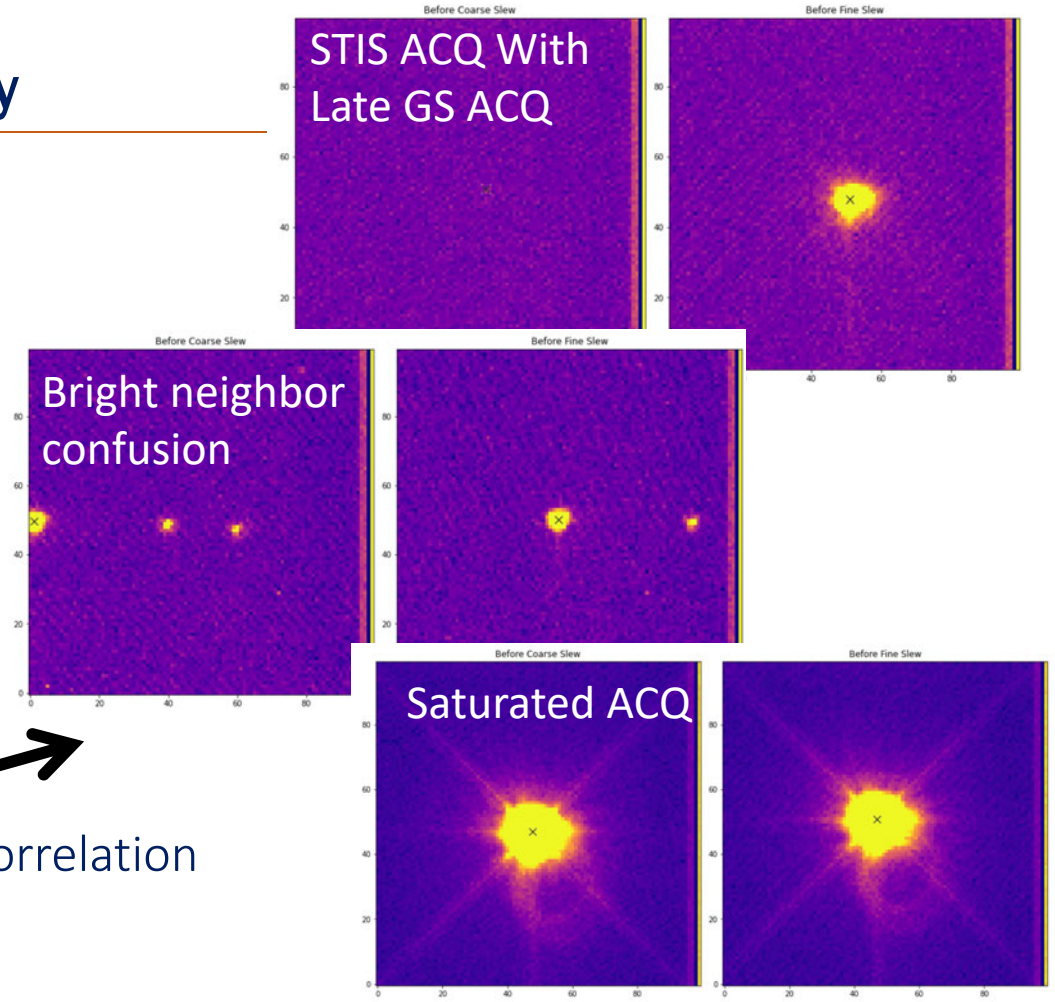
- November 2022: E230M 1978/2415/2707
  - + updated blaze shift coefficients
  - + newly calibrated ”edge” orders: 66 in λ_c2707 and 73 in λ_c2415
- April 2023: G750L

Expanding Jupyter Notebook Repository

Six new notebooks written by STIS intern (Keyi Ding)

- January 2023: Three “Walk-through” notebooks
  - Viewing different types of STIS data
  - Roles of CCD calibration steps
  - Analyzing spectral extraction regions

- April 2023: Three Analysis and Calibration notebooks
  - Analyzing target acquisition success
  - Improving wavelength zero-point with 1D spectral cross-correlation
  - Custom dark reference files



- Currently found at: https://github.com/spacetelescope/STIS-Notebooks/, but will be migrating in the coming months to a more centralized location

Highlights on On-Going Projects

- New STIS jitter monitor for easily visualizing HST pointing: https://www.stsci.edu/~STIS/monitors/jitter/

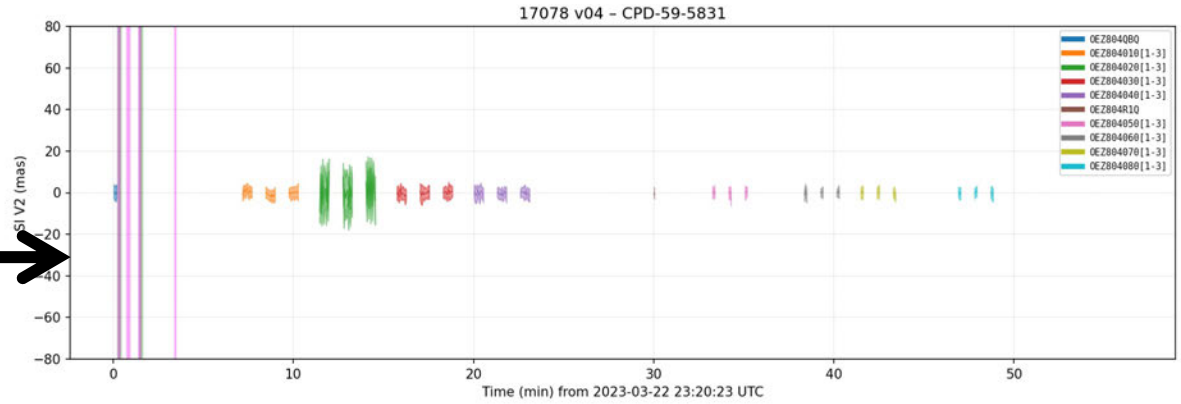
- Developing monitor to flag excessive cosmic ray rejection due to jitter
  - See STIS ISR 2019-02 for details
  - Occurs in ~20% of STIS CCD data

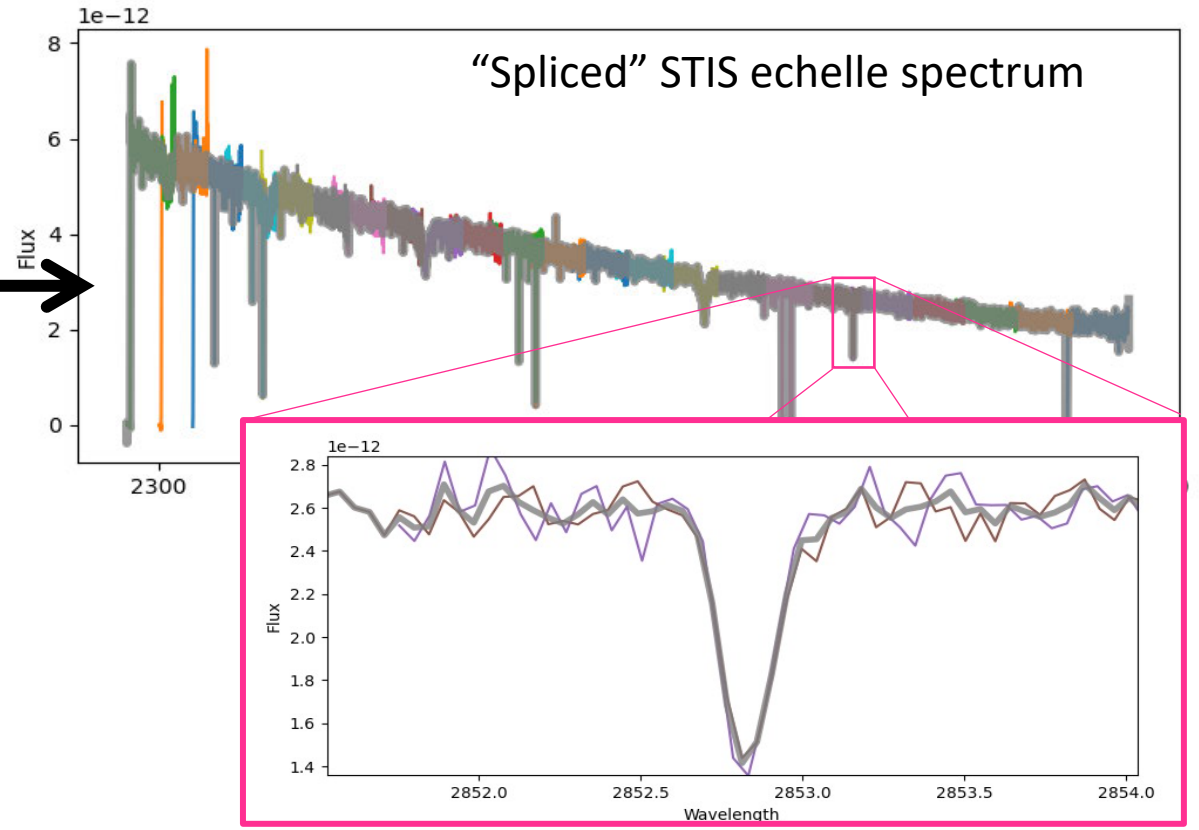
- Splice code for merging echelle orders to 1-D spectrum
  - See also Julia's update on ULLYSES and the co-addition code that will be made available, w/broader COS & STIS utility

- Cross check of L-mode time-dependent sensitivity trends with HST primary standards (ISR in prep)

- New blaze shift reference files in development (separates blaze shift coefficients from PHOTTAB reference files)

Example Jitter monitor plot





Recently Started & Future Work

Work Started:

- More flux recalibration deliveries expected in coming months (most 1st order spectroscopic modes nearly ready to go)
- CCD Working group: investigating DQ flagging/CR-REJECTION parameters
- Assess M-mode time-dependent sensitivity

Plans:

- Testing new CTE formula on wider range of STIS data and overscan correction
- Investigate lamp health
- NUV calibration (assess dark and flat field accuracy)

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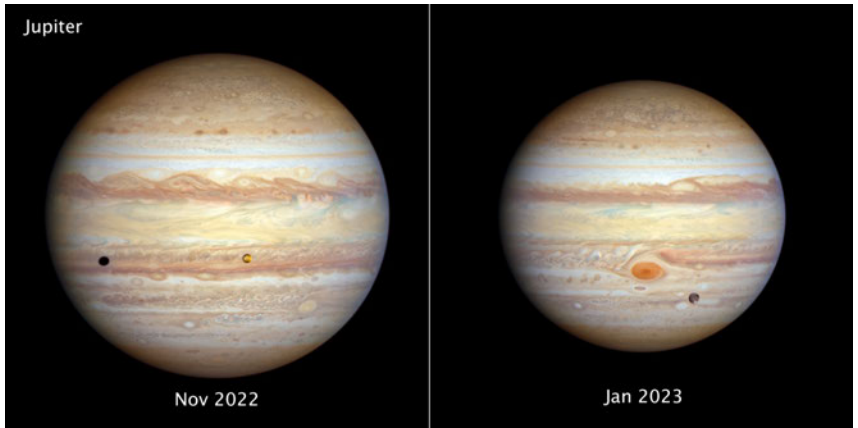
WFC3 Update

Sylvia Baggett, Annalisa Calamida, and WFC3 Team

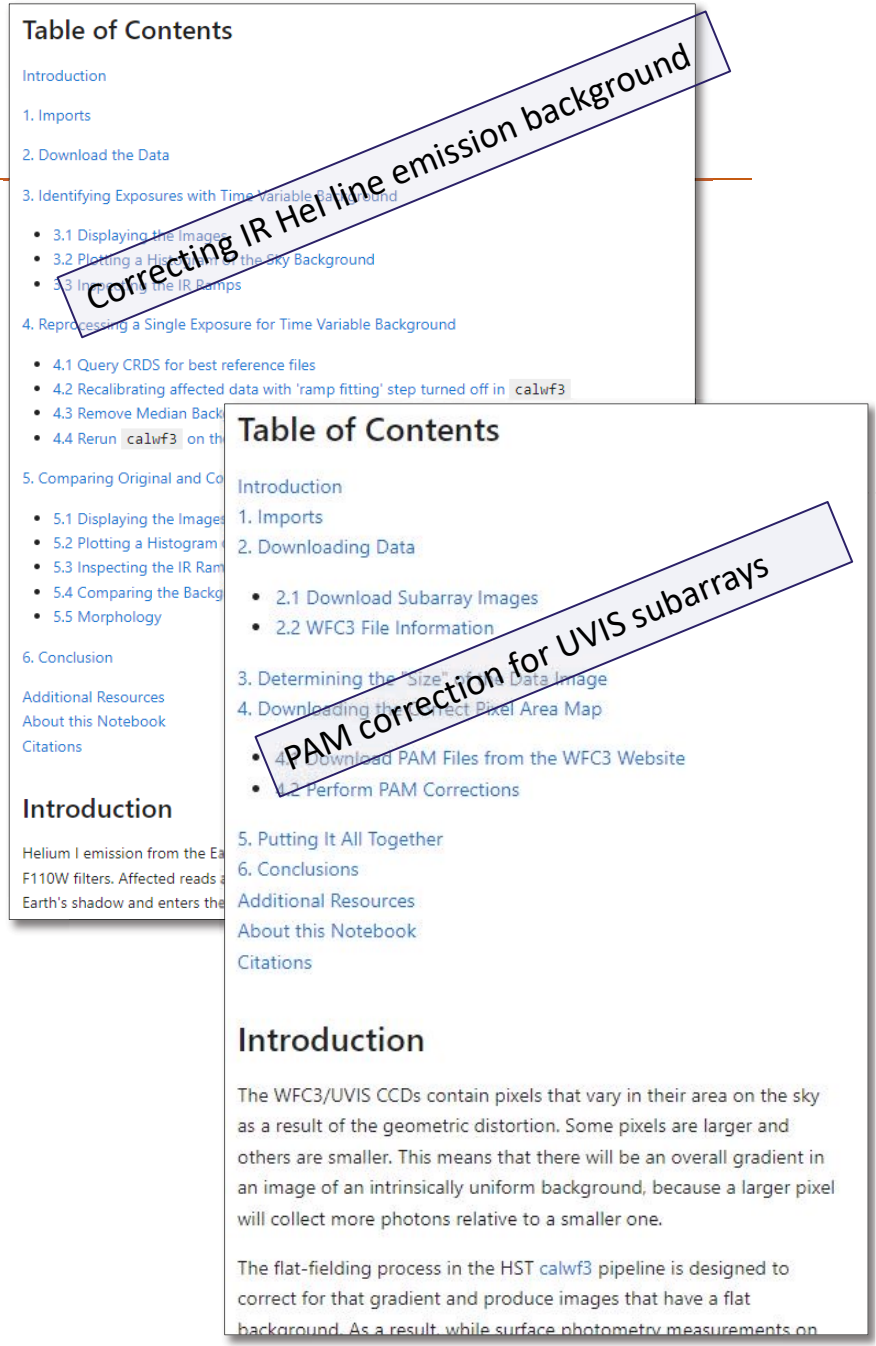
WFC3 Highlights

- **WFC3 operating nominally** – 330,000 WFC3 images in MAST
- **New HSTaxe** (v 1.0.3) release + Jupyter notebooks (incl. **G280** extraction!)
- **Four new Jupyter notebooks for GOs** (github: WFC3Library/notebooks/)
  - Time-variable background: correcting for He I emission
  - Correcting for scattered light in IR images using **two methods**
  - Pixel area map correction for UVIS subarrays
- **Support of other projects**
  - Testing of Hubble Advanced Products for **WFPC2**
  - Testing of new **Pandeia ETC** (i.e., JWST interface and engine)



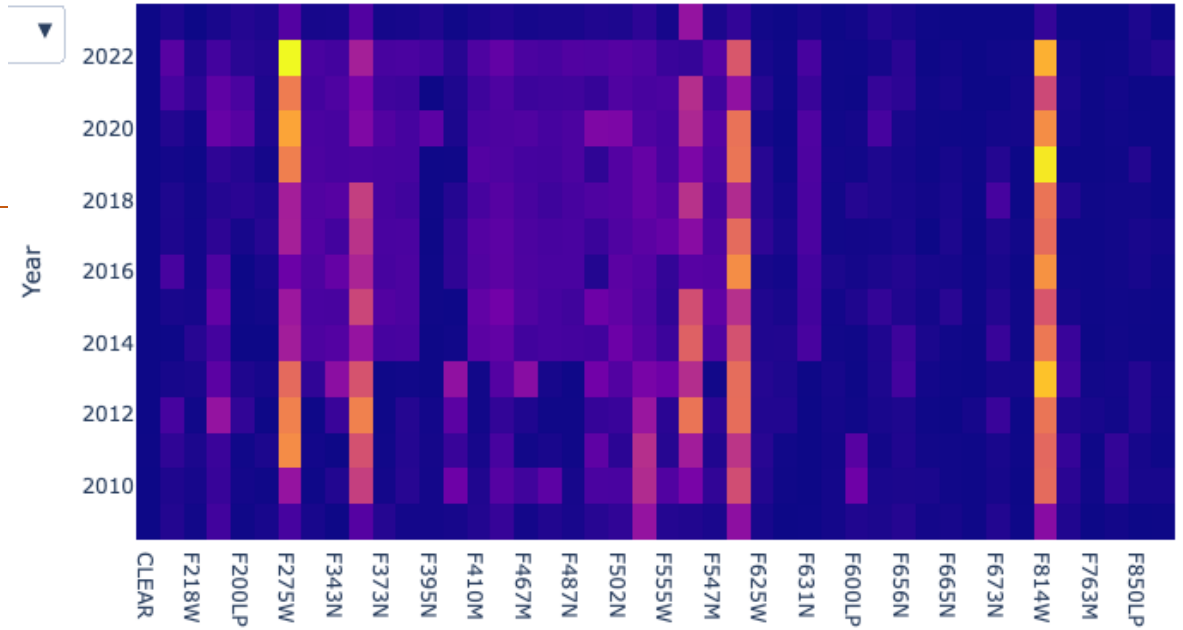
STScI Press Release 2023-007
Amy Simon

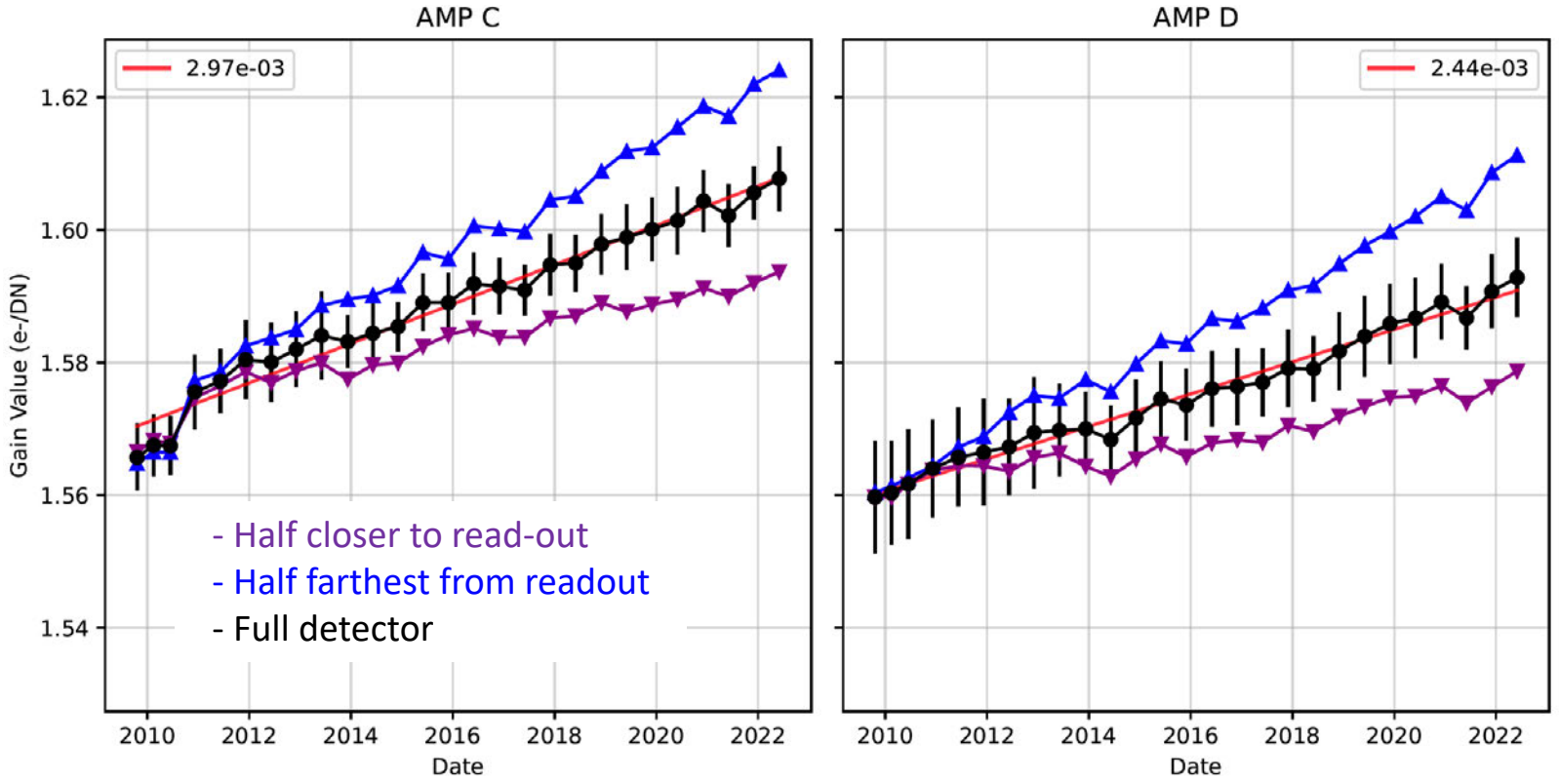
WFC3/UVIS F395N, F502N, F631N



WFC3 Highlights

- New tools and plots for the team to track detector/filter usage, guide-star failures, satellite trails, etc.
- New **time-dependent UVIS post-flash** reference files delivered (**ISR 2023-01**)
- New **UVIS Gain stability** measurements: consistent within 1-2% with past cycles and thermal-vacuum tests (**ISR 2022-08**)
    - small increase partially due to **CTE degradation**





WFC3 Highlights

IR sensitivity monitoring

1) Stare mode

- Globular clusters (external fields)
  sensitivity decline of -0.10 to -0.16 %/yr (**ISR 2022-07**)
  according to filter (and order of exposure)
- Standard star data (primary WDs + P330E)
  no clear trend due to large scatter

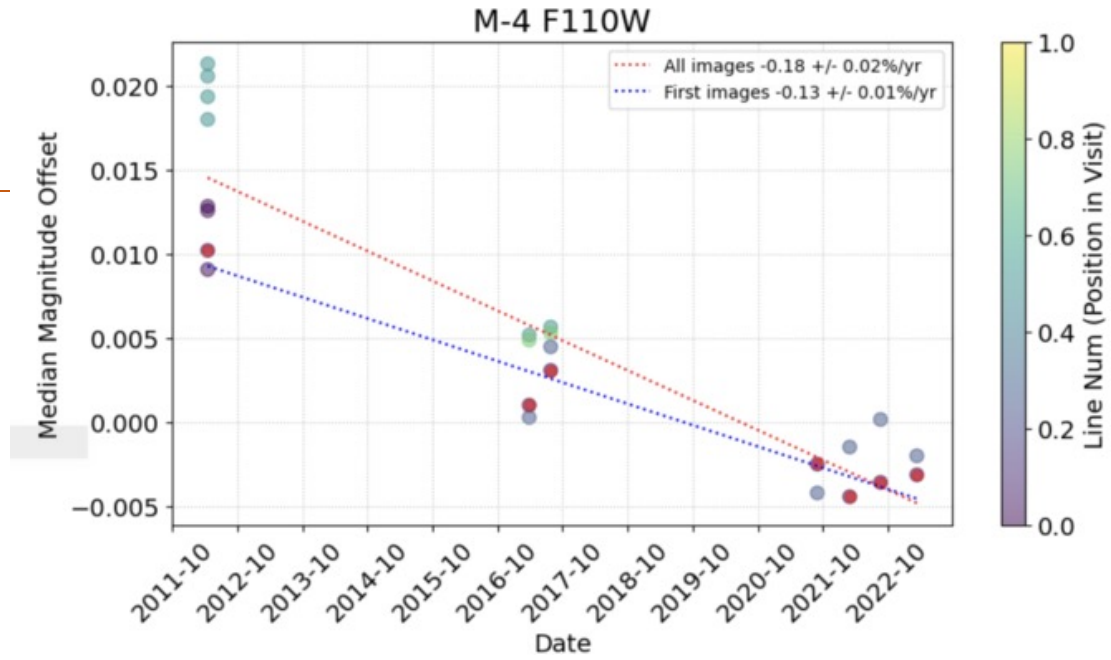
2) Scan mode

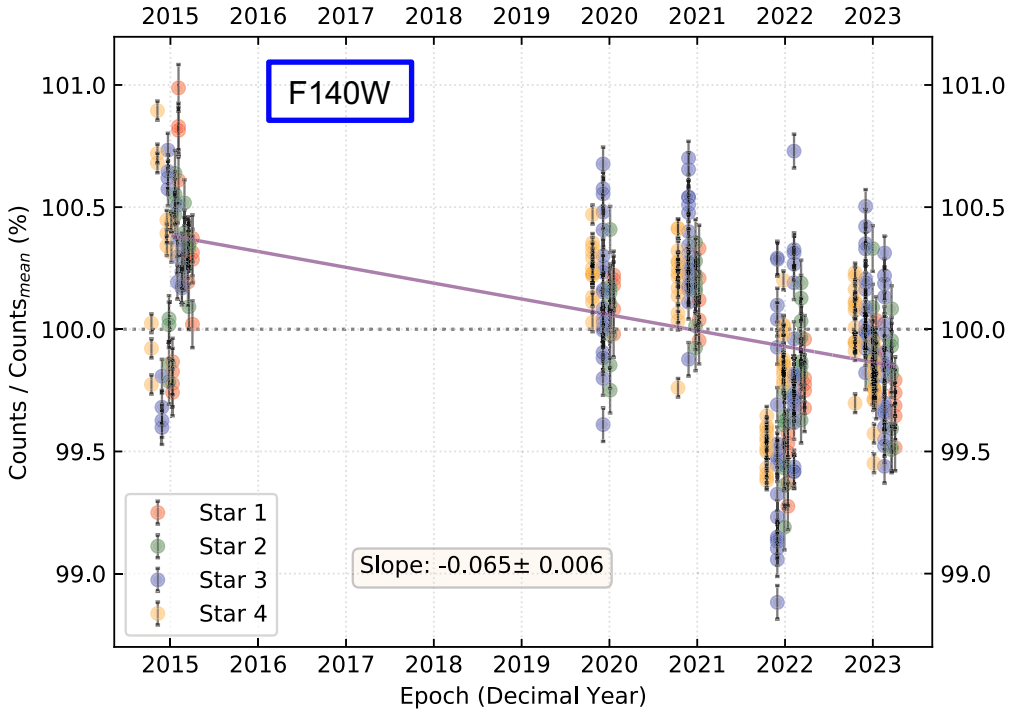
- Open cluster (M35)
  sensitivity decline of
  -0.065 to -0.15 %/yr
  according to filter (ISR soon)

Method	Slope (%/yr)
Stare	-0.10 / -0.16
Scan	-0.065 / -0.15
Grism	-0.058 / -0.11

3) Grism

- Standard star data
  sensitivity decline of -0.058 to -0.11 %/yr
  according to filter (ISR soon)

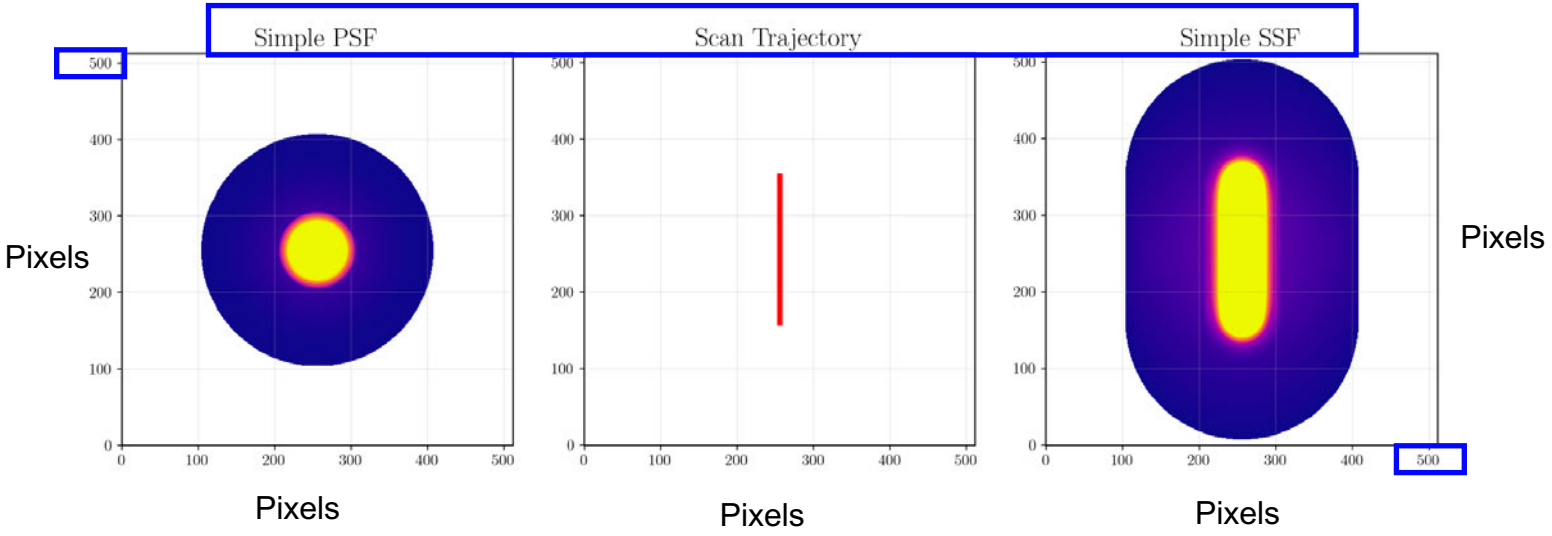


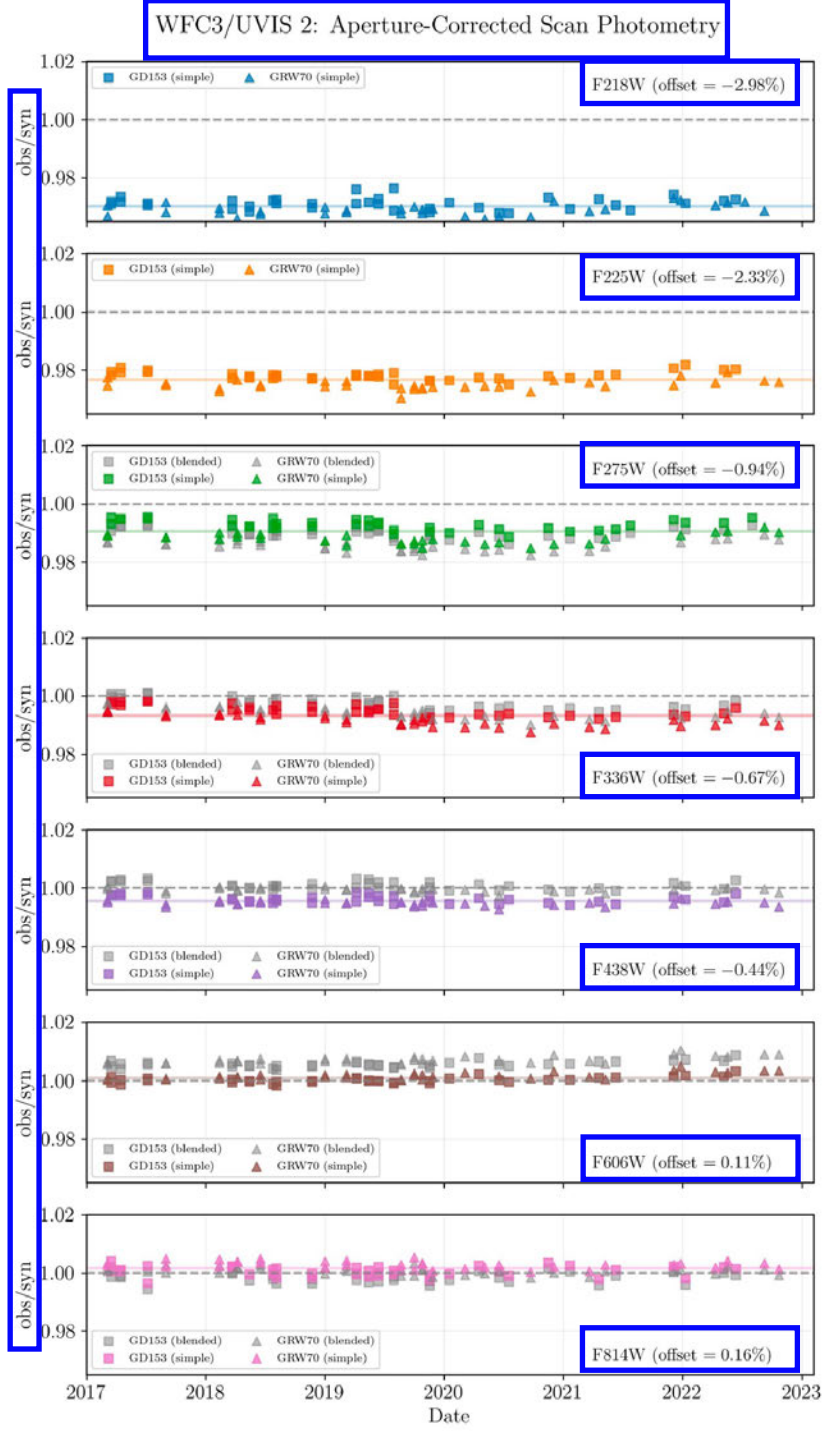


WFC3 Highlights

UVIS scan photometry

- Testing **aperture correction** for UVIS scan photometry (ISR under review)
- New calibration program (17271) to collect deep exposures to better **constrain the PSF and the "encircled" energy correction at large radii** -> fundamental to calculate UVIS scan photometry aperture corrections

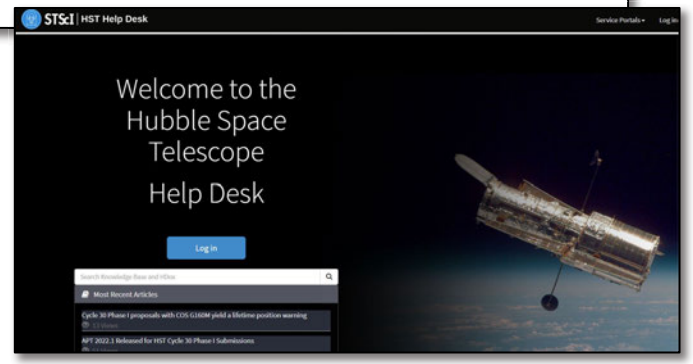




User support/documentation

- CS reviews / helpdesk
- Instrument Handbook (Jan 2023)
- STAN Jan 2023 (next one: May 2023)
- **AAS meeting Jan 2023**
- Jupyter notebooks (both external and internal)

(ISRs)



New reports

- **ISR 2023-01:** **"***UVIS Post-flash: Stability of the LED and Creation of Time-Dependent Reference Files"*
- **ISR 2022-09:** **"***TrExoLiSTS: Transiting Exoplanets List of Space Telescope Spectroscopy"*
- **ISR 2022-08:** **"***UVIS Gain Stability Results for Cycles 26 – 29"*
- **ISR 2022-07:** *"IR Photometric Stability Stellar Cluster Study"*
- **ApJ, 940,19:** *"Perfecting Our Set of Spectrophotometric Standard DA White Dwarfs"*

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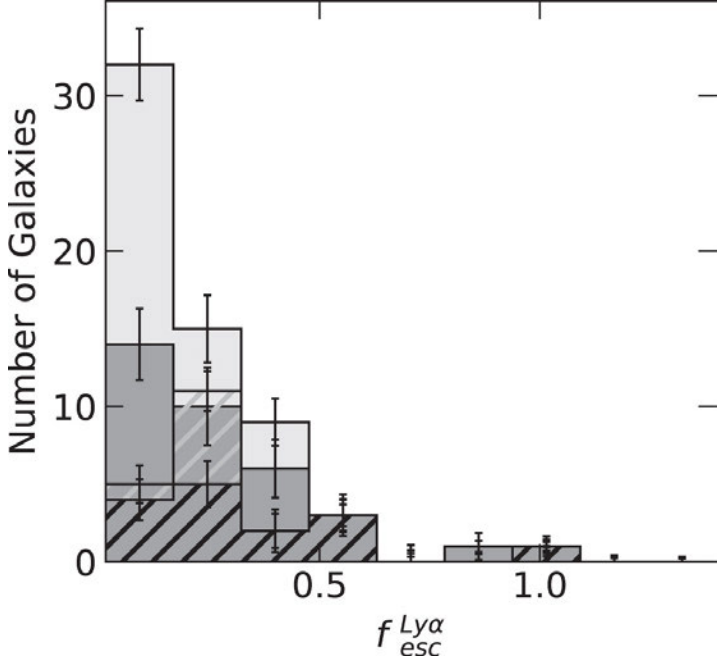
COS Update

Marc Rafelski, Bethan James, and COS team

COS General Updates

High-impact COS paper of note:
Sophia Flury
Low-redshift LyC Survey
(Flury et al. 2022, ApJS, 260, 1)

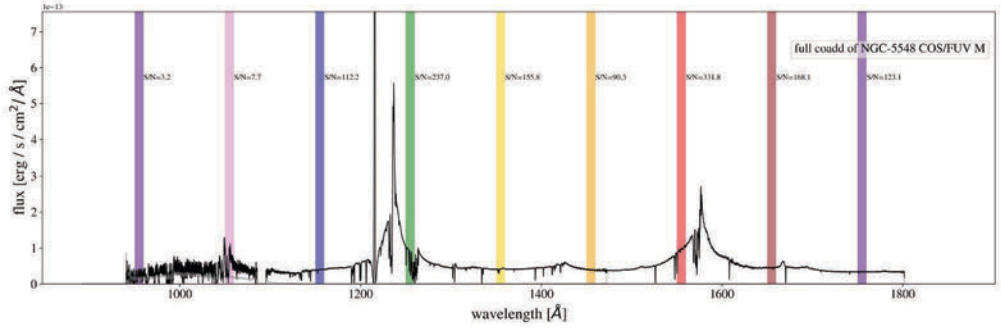
Escape fractions measured in dozens of galaxies observed with COS



- COS status updates
  - NUV time-dependent sensitivity (TDS) trends constant
  - FUV TDS slopes steepening back to ~3% /yr from low values of ~1-2% /yr
    - Steepening of TDS likely due to solar cycle
    - Reached FUV 5% flux calibration spec, update coming soon
  - NUV dark rate steady over the last year
  - FUV dark rate doubled over last year with increase in solar activity
- Updated FUV GSAGTAB to mask new gain sagged pixels at LP4 and LP5/LP6
- New Split-Wavecal monitor to ensure LP6 wavelength calibration kept accurate
- Documentation since October 2022:
  - 2 STANS, 10 ISRs, 2 AAS presentations, updates to IHB and DHB

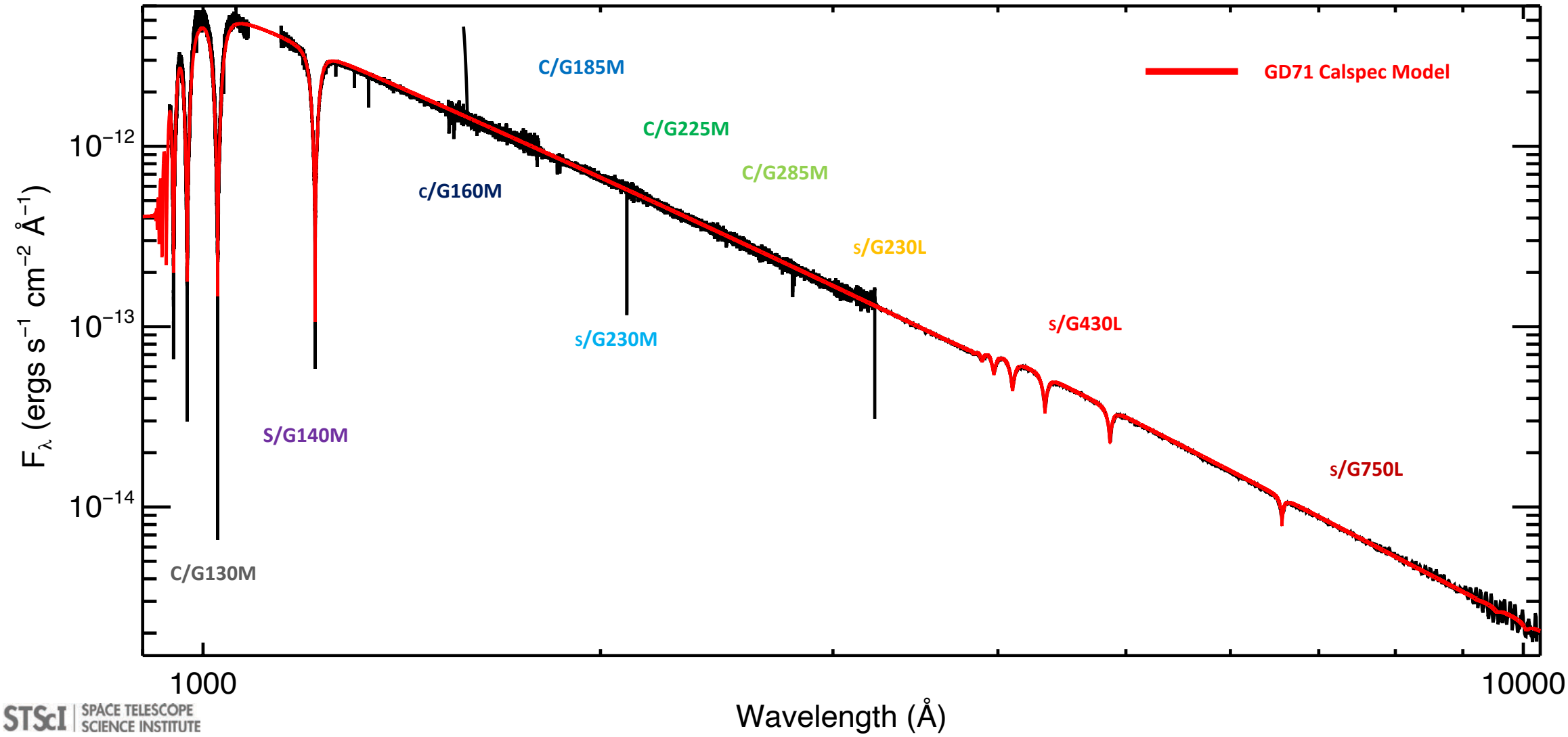
HASP: Hubble Advanced Spectroscopic Products

- Project to create automated spectral coadds of COS & STIS observations
  - Visit-level and program-level coadds in FY23 and cross-program coadds in FY24
  - After that, HASP will add visualization and target categorization
- Leverages the ULLYSES coadd code (see Julia's presentation)
- Delivered via MAST, adding new functionality for all HST users
- Custom coadditions possible through scripts and example notebooks
- Collaboration between COS, STIS, and Data Management Div. at STScI
- Sets a foundation for a revitalized Hubble Spectroscopic Legacy Archive (HSLA provided periodic releases of coadded COS data)



HASP: Hubble Advanced Spectroscopic Products

GD71—Primary HST Standard



Future Work FY23

- Update time-dependent sensitivity
  - FUV (new slope and break point) & NUV (wavelength dependence)
- Complete geometric and walk correction reference files
- Calibrate all FUV COS modes after geometric & walk correction is applied (all lifetime positions)
- CalCOS pipeline updates
  - Complete Lifetime Position 6 multiple same FP-POS fix
  - FUV high-voltage sensitivity correction (concurrent with new geo/walk flux calibration at all LPs)
- Complete Hubble Advanced Spectroscopic Products (HASP) including both COS and STIS
- Begin Hubble Spectroscopic Legacy Archive (HSLA) revamp including both COS and STIS
- Cycle 31 calibration, monitors, contact scientist, help desk, documentation
- Start work on Lifetime Position 7 exploratory with a planned start for Cycle 33

STScI | SPACE TELESCOPE SCIENCE INSTITUTE

EXPANDING THE FRONTIERS OF SPACE ASTRONOMY

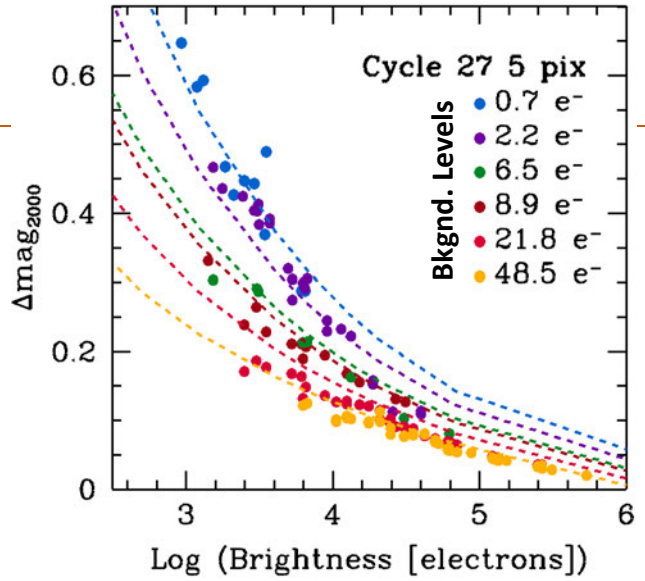
ACS Update

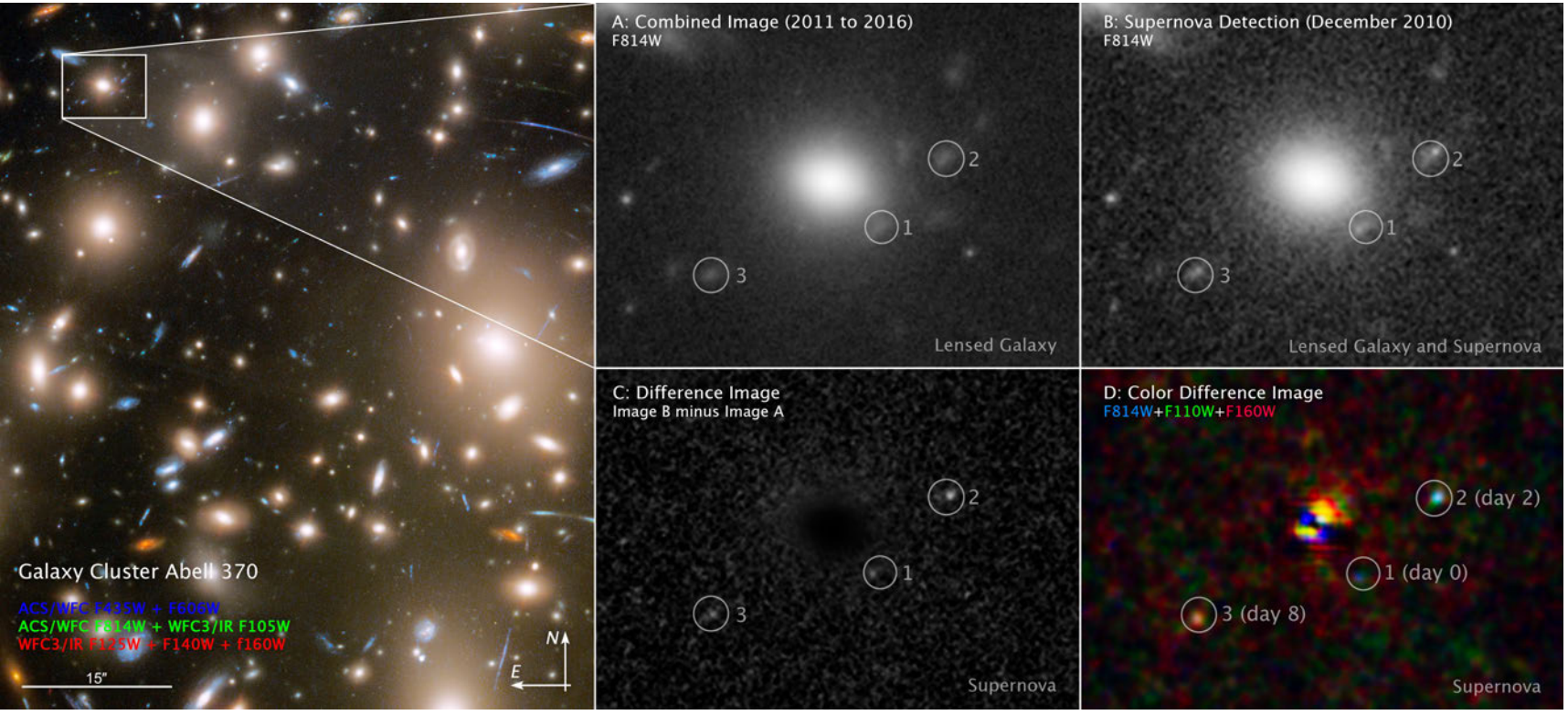
Norman Grogin, Roberto Avila, and ACS Team

ACS Highlights

- ACS continues to operate nominally
- Improved WFC aperture-photometry correction for declining charge-transfer efficiency (CTE)

New Curvilinear Phot-CTE Correction





STScI Press Release 2022-054
Wenlei Chen & Patrick Kelly

ACS/WFC + WFC3/IR imaging of Abell 370

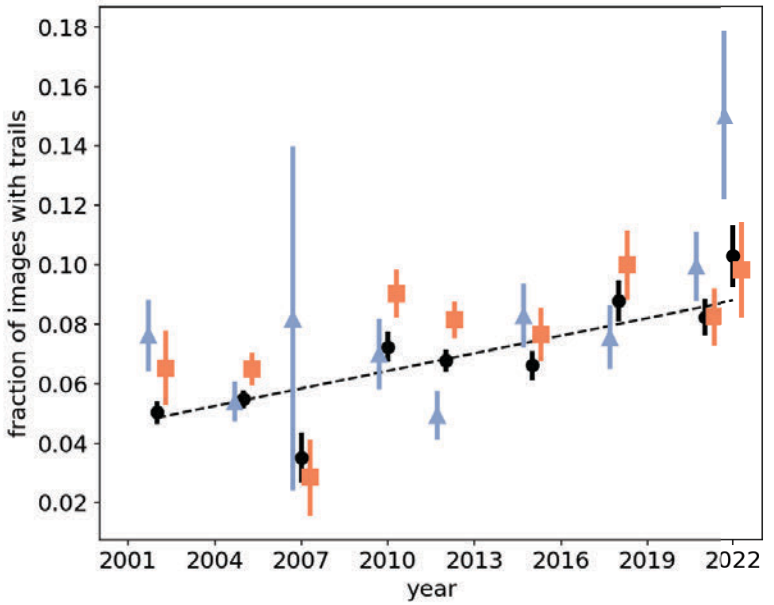
Using light path differences from gravitational lensing to capture 3 different times in evolution of supernova

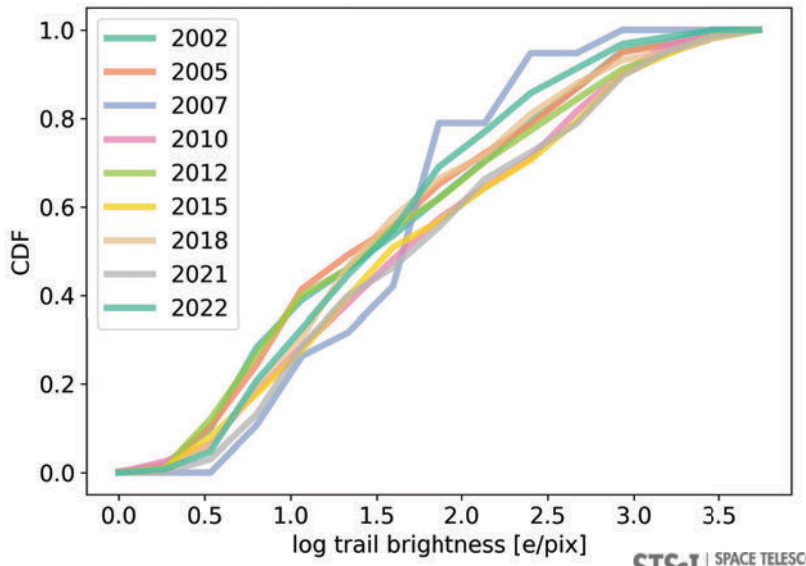
Highlights of ACS Recent & Ongoing Work

- New ACS Observing Mode for HST Cycle 31 : Imaging Spectropolarimetry
  - Crossing the WFC G800L grism and the polarizer filters for use in optical/NIR (5500–8000Å)
  - Advertised in: HST Cycle 31 CfP, ACS STAN, ACS Instrument & Data HBs, AAS242 posters, etc.
- Improved User-Tool for Identification and Masking of Satellite Trails in WFC Imaging
  - Modified Radon Transform yields much higher sensitivity to faint satellite trails than prior code
  - Across 20yrs of WFC archive: doubling of satellite-hit frequency but no evolution in trail-brightness (see figures on next slide)
- Extensive Software-Devel. Efforts, Facilitating Slitless Spectroscopy Reduction & Analysis
  - Recent release of modernized 'HSTaXe' software to support ACS G800L & other HST slitless modes
  - *Coming soon*: cutting-edge 'slitlessutils' suite, including PyLINEAR for multi-ORIENT datasets
- Refinements to WFC Dither Patterns for Improved PSF Reconstruction
  - Small adjustments to ACS-WFC-DITHER-BOX, to precisely attain desired half-pixel phase sampling
  - *Coming soon*: ISR with new sets of compact 4pt-dither POSTARGs, co-optimized for WFC & WFC3

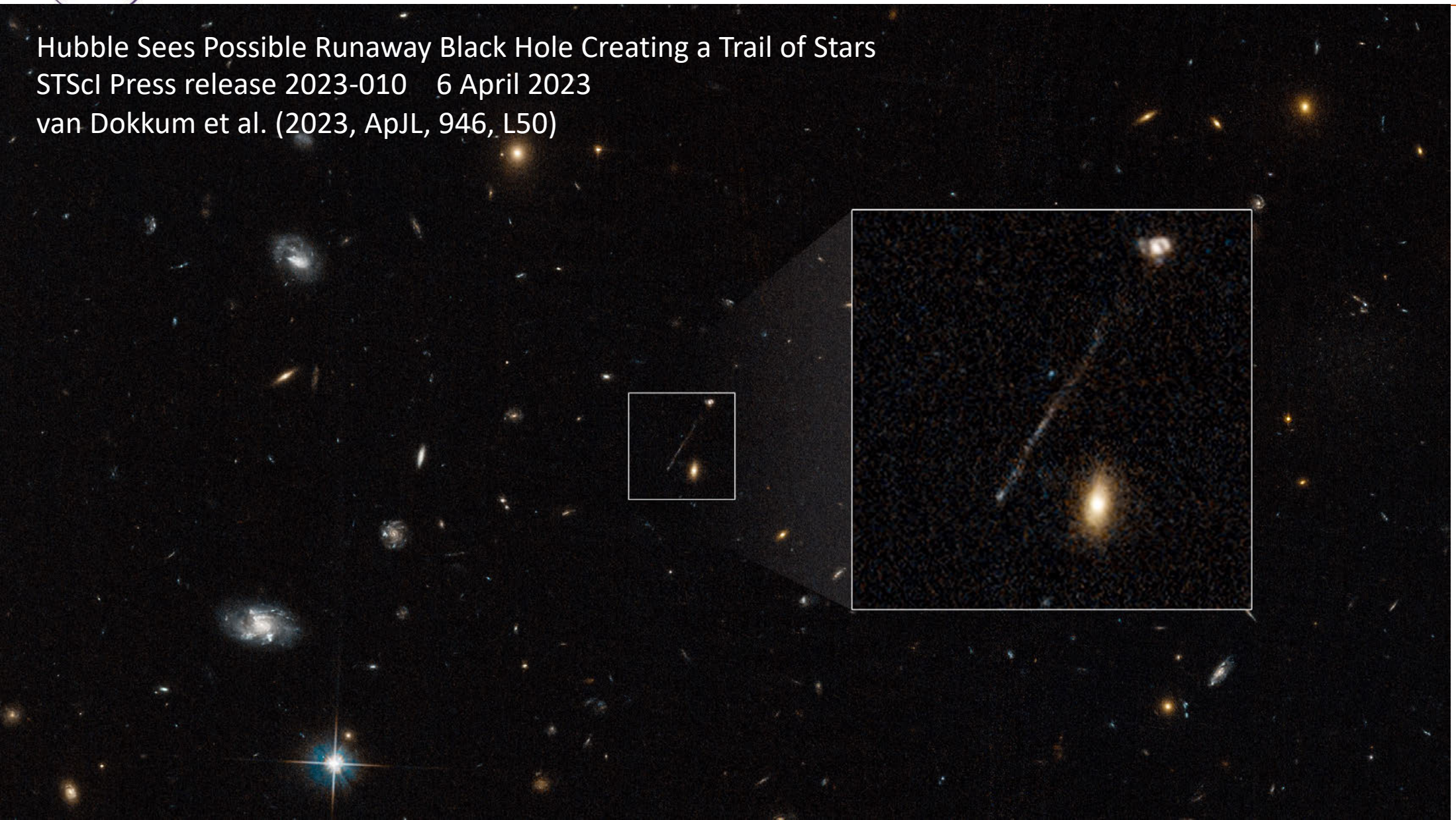
New ACS Documentation since the Oct'22 STUC Meeting

- ISR ACS 2022-06 : "ACS/WFC CTE photometric correction: improved model for bright point sources" (Chiaberge & Ryon)
- ISR ACS 2022-07 : "Fading Hot Pixels in ACS/WFC" (Ryon et al.)
- ISR ACS 2022-08 : "Improved Identification of Satellite Trails in ACS/WFC Imaging Using a Modified Radon Transform" (Stark et al.)
  - Across 20yrs of WFC archive: doubling of satellite-hit frequency but no evolution in trail-brightness
- ISR ACS 2023-01 : "Corrections to Commanding Overheads for ACS/WFC Exposures" (Ryon & Grogin)
- ISR ACS 2023-02 : "Systematic Effects in ACS/WFC Absolute Gain Measurements" (Anand et al.)
- ACS STAN (Apr'2023) : Notifications regarding spectropol., HSTaXe, and ACS documentation updates
- Revisions to ACS Instrument Handbook and ACS Data Handbook, to support HST Cycle 31





Closing Remarks



Hubble Sees Possible Runaway Black Hole Creating a Trail of Stars
STScI Press release 2023-010 6 April 2023
van Dokkum et al. (2023, ApJL, 946, L50)

Linear feature interpreted as wake of shocked gas and young stars as SMBH interacts with CGM

Closing Remarks

Alternatively (3 weeks later):
Linear feature interpreted as bulgeless galaxy viewed edge-on
Almeida et al. (2023, A&A, accepted, aXiv: 2304.12344)

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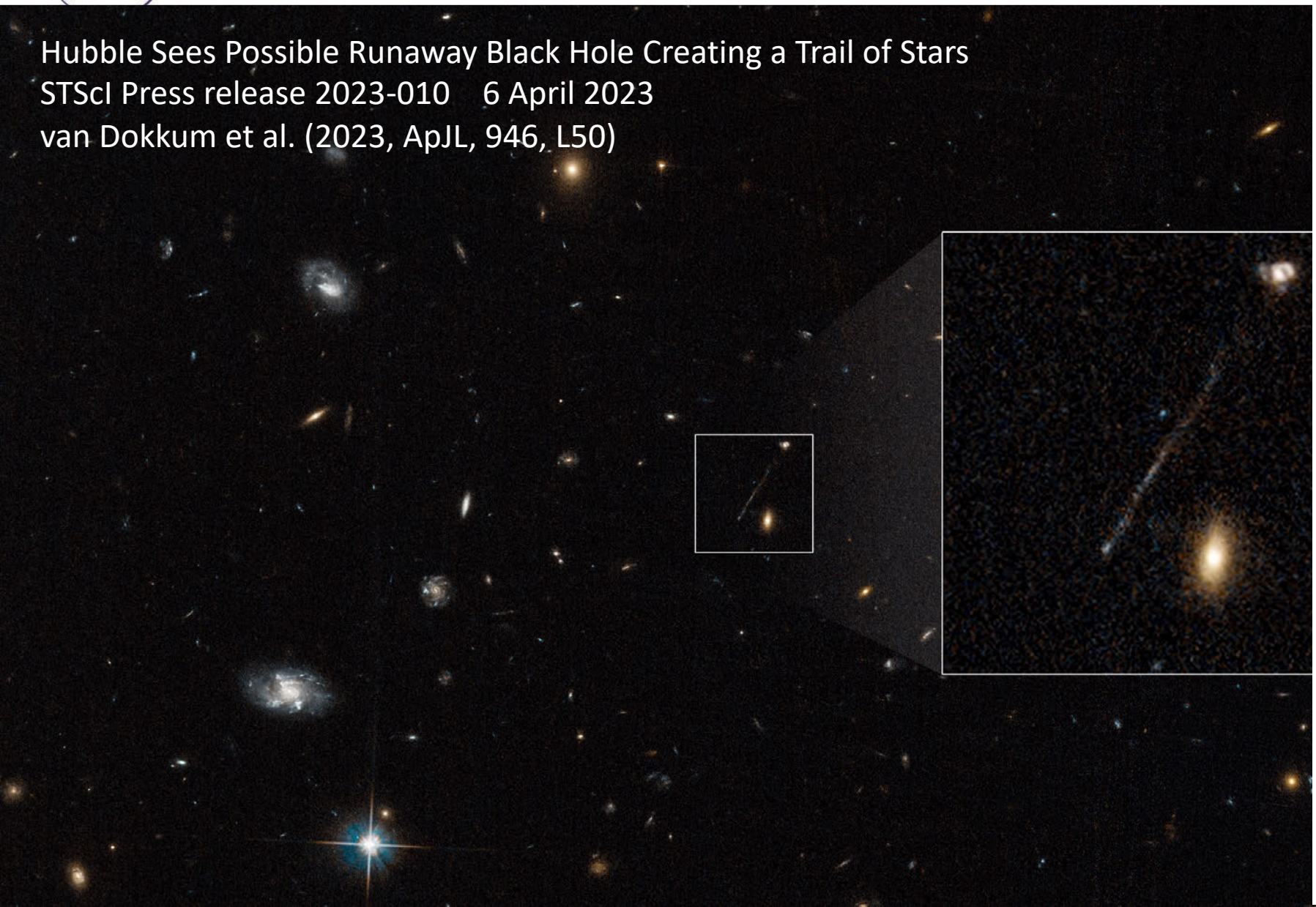

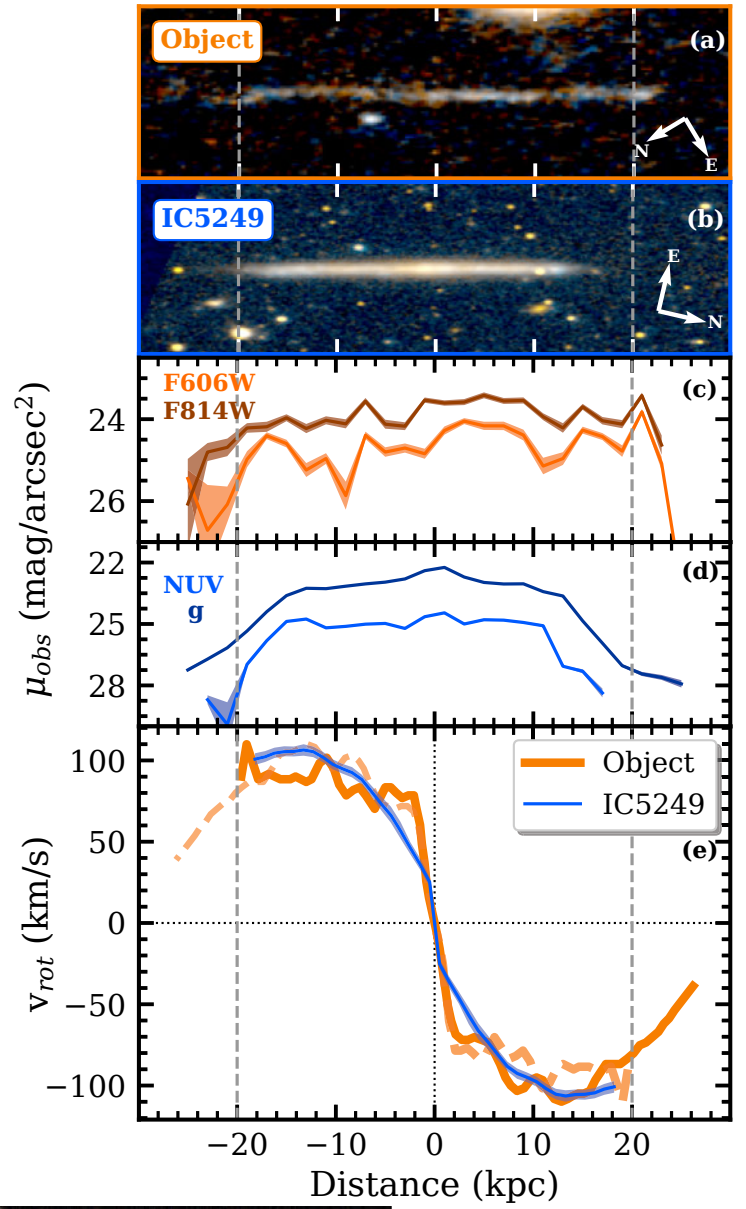

Closing Remarks

We welcome your feedback & suggestions

Thank you for your support