Summary

Hubble operates at the highest levels of scientific performance and productivity

- Executing Cycle 25 observing program
- Instruments performing nominally
- Monitoring Gyro 2 performance
- Few and minor anomalies over last 6 months
Science Productivity Sets New Record

- Over 900 refereed publications based on HST data in 2017
- Over 15,500 to date
Monitoring Gyro 2 Performance

Gyro Rate Bias History (2017, 2018)
Monitoring increased jitter

- Jitter has increased slightly since last summer
- Requirement for jitter is $\leq 7$ mas
- Little impact at current level
- Analysis shows that observations with certain (small) apertures will be affected once average jitter exceeds 10 to 15 mas
Gyro 2 (continued)

Guide Star Reacquisition Failures Mitigated

- Due to large Gyro 2 rate bias shifts, Guide Star reacquisitions tended to run long, usually by only a few seconds
- Tweaks to the flight software and to the planning and scheduling software eliminated this issue by providing ~35 seconds more time

Forward Plan

- Preserve overall gyro lifetime to the extent possible
- Once Gyro 2 fails or performance falls below well-defined levels, Gyro 6 will be switched on
  - Acquisition failures lead to ~10% losses over a two-week period
  - Jitter exceeds ~10-15 mas and leads to the postponement of too many small-aperture programs
- Stay in 3-gyro mode as long as possible to optimize observing efficiency and field of regard
- Drop into 1-gyro mode when only 2 gyros remain operational and use them sequentially
Anomalies

Solid State Recorder 3 (SSR-3)

- Stopped receiving telemetry on 01/09/2018, after an increase in uncorrectable errors over the previous weeks to months
- Recovered by power cycling the next day
- Data storage had been switched to SSR-1, so science loss was minimal

SI C&DH Lockup #12 on 01/19/2018

- Routine recovery within ~20 hours

ACS suspend on 03/16/2018

- Single-event upset during SAA passage, as has been seen before on ACS and STIS
- Recovery after ~20 hours

In all cases, the flight operations and science operations teams performed excellent joint work and responded quickly to keep HST as productive as possible
Cycle 25 Update and Long-Range Plan (Dave Adler)

Cycle 25 averaging 83.8 orbits/week over first 29 weeks
- Cycle 17-23: 84 orbits/week
- Cycle 24: 82 orbits/week (83.2 over first 29 weeks)

Previous Cycle Completeness
- Cycle 22: Finished in January 2018
- Cycle 23: 8 orbits remain (7 from C23 large program Apai).
- Cycle 24: ~190 orbits remain, mostly complete by mid-2018.
- Cycle 25: ~3600 orbits remain (due to 1200+ more orbits accepted in Cycle 25).

Cycle 26 starts October 1, 2018, but...
- Cycle 25 material fully subscribes plan into February 2019; tail of material into September 2019.
- Less material to be accepted in Cycle 26 (up to 2100 orbits) – medium/large/coordinated programs.
- August 17 phase I deadline; October TAC; November phase II deadline; added to LRP in December.
“Spikiness” in distribution mostly due to exoplanet visits waiting for plan windows.

- As before – can’t plan exoplanets accurately far into future.
  - Windows beyond predictive ephemeris (>10 weeks) have unstable/unreliable plan windows.
  - Exoplanets are “stored” late in cycle; potential spots checked weekly, pulled forward as possible.

Second set of mid-cycle programs (< 100 orbits) will be added soon

- 67 programs/434 orbits requested.
High percentage of time-constrained science limits LRP flexibility

- ~20% of science visits in cycles 24/25 have timing constraints of a few orbits or less.
- Creates conflicts between science programs.
- Results in fewer flexible visits later in the plan that can be moved forward to fill schedule gaps.
- LRP group now builds templates of constrained visits in advance to identify conflicts early in the process.
Exoplanet Programs: Highlights

- **Sing** (Cycles 24/25 Large): 398 of 498 orbits complete.
  - 55 orbits planned for the next 10 weeks
- **Benneke** (Cycle 24 Large): 67 of 78 orbits complete.
  - One in April, other in December
- **deWit** (Cycle 25 Large): 41 of 114 complete.
- **Crossfield** (Cycle 25 Large): 13 of 127 complete

450 orbits of exoplanets with period/phase constraints remain in the plan

- **Cycle 24**
  - 100 orbits of Sing
  - 18 orbits from three other programs
  - Most non-Sing done by summer if windows hold.
- **Cycle 25**
  - 300 orbits in plan
  - 31 orbits aren’t schedulable and don’t have windows.
LRP: Statistics

Planetary Programs: Highlights

• Jupiter
  – Visible until late September, then in solar exclusion until late January 2019.
    ▸ Grodent (Cycle 24 Large): 136 of 151 orbits done.
    ▸ Wong (Cycle 24 Medium): 39 of 45 orbits done.

• Europa Cycle 25 mid-cycle campaign
  – Roth: 8 of 55 orbits done.
  – Sparks: 8 of 30 orbits done.
  – deKleer: 5 of 10 orbits done.

• OPAL: Outer Planet Atmospheres Legacy
  – Cycles 22-24: 29 total orbits per cycle on Jupiter, Saturn, Uranus, Neptune.
  – Cycle 25: 41 total orbits
    ▸ Uranus: 8 orbits in October 2017
    ▸ Jupiter: 13 orbits in April
    ▸ Saturn: 12 orbits in May
    ▸ Neptune: 8 orbits in September.
## Large/Treasury Programs

<table>
<thead>
<tr>
<th>C23 Program</th>
<th>alloc</th>
<th>Exec/sched by 4/29/18</th>
<th>Planned before 9/30/18</th>
<th>Planned after 10/1/18</th>
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<td>Apai</td>
<td>112</td>
<td>105</td>
<td>7</td>
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<td>June 2018 finish</td>
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* - exoplanet visits not planned, “in the bullpen” until the LRP group can pull them forward.

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<th>C24 Program</th>
<th>alloc</th>
<th>Exec/sched by 4/29/18</th>
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<th>Planned after 10/1/18</th>
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<tr>
<td>Benneke</td>
<td>78</td>
<td>67</td>
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<tr>
<td>Bielby</td>
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<tr>
<td>Grodent</td>
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<tr>
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<tr>
<td>Shkolnik</td>
<td>130</td>
<td>99</td>
<td>9</td>
<td>22</td>
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<td>Sing</td>
<td>498</td>
<td>398</td>
<td>70</td>
<td>30*</td>
<td>Two cycles</td>
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<td>Suzuki (ToO)</td>
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### Large/Treasury Programs

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<th>C25 Program</th>
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<tr>
<td>Crossfield</td>
<td>127</td>
<td>13</td>
<td>61</td>
<td>53*</td>
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<td>Jansen</td>
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<tr>
<td>Krauss</td>
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<td>Riess</td>
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<tr>
<td>Shapley</td>
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<td>39</td>
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<tr>
<td>Steinhardt</td>
<td>101</td>
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<td>12</td>
<td>89</td>
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<tr>
<td>Suzuki (ToO)</td>
<td>70</td>
<td>1</td>
<td>0</td>
<td>21</td>
<td>Second cycle of SUSHI</td>
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<tr>
<td>deWit</td>
<td>114</td>
<td>41</td>
<td>8</td>
<td>56*</td>
<td>9 not in plan</td>
</tr>
</tbody>
</table>

* - exoplanet visits not planned, “in the bullpen” until the LRP group can pull them forward.
Streamlining Science Operations

- The Call for Proposals for Cycle 26 specifies that all special requirements be justified in Phase I.
- Phase II deadlines will be strictly enforced to streamline budgeting process and provide a more stable LRP.
- No limits for proposals with special requirements are imposed in Cycle 26.
- It may be necessary to impose such limits in the future, as e.g. Chandra has already done.

- See John MacKenty’s presentation.

In the era of flat budgets, it becomes harder and harder to maintain a stable LRP that contains lots of highly constrained programs.
Hubble Spectroscopic Legacy Archive (HSLA)

Paule Sonnentrucker
Next Release: May 2018 – COS Only

- **1074 newly released COS FUV data & associated co-added products added in last 12 months**
- FUV Blue Modes included (G130M/1055/1096/1222): **New!**
- FUV co-adds now include LP3, LP4 in addition to LP1 and LP2 (updated λ solutions): **New!**
- **248 newly released COS NUV data products added in last 12 months**
- NUV co-added products now available (updated λ zero points): **New!**
- Redesigned Target product page with FUV & NUV co-add “Quicklooks”, when relevant: **New!**
- Failed Visits excluded from all co-adds when relevant: **New!**
- HSLA naming convention matched to Hubble Source Catalog (HSC) for cross-referencing: **New!**
- Welcome page with updated feedback email and “Acknowledgements” & “Caveats”: **New!**

In The Works:

- STIS echelle E140M + E230M data & co-added products inclusion: Summer 2018
- Access points: STIS instrument page when first products delivered, Mast Portal: **under review**
- PASP paper to advertise COS FUV HSLA improvement and COS NUV expansion
- Feasibility study for HSLA inclusion in “standard” archive maintenance & update operations
HSLA Update • Product Page: COS NUV Co-additions

Current COS/NUV HSLA: April 2017 Release

- HD187691

Programs ID & Info

Individual exposure
Legend: flux in black, errors in grey, both smoothed over 6 pixels, 0 < 1 m/s. SNR = median flux/err, per -1 m/s, in shaded window.

Setting Distribution (Cenwave, FP-POS)

Single exposure panels only

New COS HSLA Release: May 2018

- HD187691

Programs ID & Info

Individual exposure
Legend: flux in black, errors in grey, both smoothed over -1 m/s. SNR = median flux/err, per -1 m/s, in shaded window.

Setting Distribution (Cenwave, FP-POS)

Co-added Spectrum

NB: NUV ops remained at LP1
Space Telescope Imaging Spectrograph (STIS)

John Debes
STIS Status/Completed Work

Status:
• STIS’ status is relatively unchanged since last STUC Meeting
• Monitoring focus or jitter effects for any low level impacts, alerting community to areas with larger impact (i.e. small slits)

Completed Work:
• Blazefix Tool Released 1/18; Newsletter Article to be published
• Bias level increased in flight software for ACQ/IMAGEs
• NUV Flat program tweaked to protect against lamp fading
STIS Ongoing Work

- Significant user support (Several rapid ToOs, M dwarfs, UV SNAPs, Europa)
- Cycle 26 Calibration program preparation
- IRAF Replacement Efforts- STIS Hack Day, close collaboration with Software Engineers at STScI
- Documentation in progress
  - ISR Enclosed energy Investigation of STIS spectroscopic modes
  - ISR on Binary Offset Effect (i.e., Boone et al., 2018)
  - ISR on STIS Target Acquisitions
  - ISR on Wavelength solutions for STIS modes
- Pre-SM4 data re-calibrated; final regression testing finished by May
- HSLA Support via echelle PHOTTAB updates and team feedback
- Improving Data Quality Flag support for Dithered Spectroscopy (update to CalSTIS)
Future Work

- Commissioning Transiting Exoplanet Spatial Scan spectroscopic modes
  - Observations completed
  - Initial analysis in time for Delta-26 Phase I deadline

- E140M Flux Recalibration Program
  - Observations Completed
  - Used to correct blaze function shape changes
Completed STIS Documentation

- STIS ISR 2018-01 A Python Script for Aligning the STIS Echelle Blaze Function
- STIS ISR 2018-02 FUV-MAMA Geometric Distortion Solution
- STIS Instrument Handbook
- STIS Data Handbook
Cosmic Origins Spectrograph (COS)

Cristina Oliveira
COS Work – Since Last STUC Meeting

Calibration Improvements

• LP4 move in October 2018 was successful
  – All calibration reference files implemented before LP move
  – LP4-related documentation almost completed
• FUV Time Dependent Sensitivity updated
  – New breakpoint in 2015.5 : shallower slopes for all modes
  – TDS calibration accurate to +/-2%
• Gain sag reference file updated
  – Important given that observations at LP3 are continuing, concurrently with LP4 observations
• New COS/FUV LP3 + LP4 dispersion solutions have been implemented: +/-3 pix residuals

Community and User Support

• Decreased S/N requirements for COS target acquisitions using Imaging mode
  – From 40 to 20 for PSA TA; from 60 to 30 for BOA TA
  – Especially useful for programs observing M-dwarfs, where both flare and quiescence states are cleared

New COS/FUV Modes: G160M/1533 and G140L/800

• G160M/1533: continuous wavelength coverage between G160M and G130M/1222
• G140L/800: continuous wavelength coverage in Segment A from 800-1800 Å, and low astigmatic height between 800 and 1100 Å
• New modes included in APT and ETC 26.1; will be fully supported for Cycle 26 observations
**COS Work – Ongoing**

**New COS/FUV Modes: G160M/1533 and G140L/800**
- Special programs executed to determine focus that optimizes resolution
- Programs to calibrate the new modes are being developed and will execute over the next few months: wavelength, flux, and spectral extraction

**COS Performance Monitors**
- SI monitors transitioned to Python 3
  - These include TA monitors
- New monitors are being developed
  - Hotspot
  - Post-anomaly monitor

**COS Calibration**
- Cycle 26 calibration plan is being developed
- Geometric distortion correction ongoing
- X-walk correction implementation (from look-up table)
- 1 Gyro mode evaluation report produced and special handover programs to follow
  - Special handover targets selected so that impact of sky visibility issues in COS calibration program can be mitigated
Evaluate Possible FUV/LP5 Position
- Evaluate feasibility of having another COS/FUV lifetime position, LP5, at ~ +5”
- Complicated by light leak

Evaluate S/N requirements for other TA strategies
- Evaluate feasibility of decreasing recommended S/N for dispersed light TA (FUV & NUV)
- Important for M-dwarfs, but also beneficial for all other programs

Implement cenwave-dependent FUV TDS
- FUV TDS depends also on cenwave (only Seg and \( \lambda \) dependence implemented)
- Will improve accuracy of G160M flux calibration, especially after staying at same LP for a long period of time (start diverging with each breakpoint)

Update NUV TDS reference file
- Slope of NUV TDS for G285M is shallower than currently implemented in reference file
- Slope of ~ -11% per year has lead to very low throughput
COS Documentation – Since last STUC meeting

Published
ISR 2018-01: Cycle 24 COS FUV Detector Gain Maps – D. Sahnow
ISR 2018-02: Cycle 24 COS/NUV Fold Distribution – T. Wheeler
ISR 2018-03: Cycle 24 COS NUV Dark Monitor Summary – M. Fix
ISR 2018-04: Cycle 24 COS FUV Dark Monitor Summary – M. Fix
ISR 2018-07: The Spectral Resolution of the COS FUV channel at Lifetime Position 4 – A. Fox
ISR 2018-08: The Spatial Resolution of the COS FUV channel at Lifetime Position 4 – A. Fox

In Preparation for release soon
COS Data Handbook – M. Rafelski et al.
Wide-Field Camera 3 (WFC3)

Elena Sabbi
WFC3 Completed Projects

USER support
- Transition to new Help Desk
- New version of Data Handbook
- Testing of Jupyter notebooks to replace IRAF with python
- Jupyter notebook to drizzle large mosaics with Gaia

UVIS channel
- Filter-based geometric distortion solution for all the full frame broad, medium and narrow band UVIS filters

IR channel
- IR dark stability monitor and dependences
- Persistence model
- GRISM support: update of “aXe” & release of the multi-orientation spectra extraction software “LINEAR”
WFC3 Ongoing Projects

User Support
- Calibration plan for Cy 26
- Instrument Handbook (minor update)
- Primer + call for proposals

Detectors
- Detector monitor – WFC3 is performing nominally

<table>
<thead>
<tr>
<th>UVIS channel</th>
<th>IR channel</th>
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<tr>
<td>CTE calibration update</td>
<td>ZP stability</td>
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<tr>
<td>UV filters color terms</td>
<td>Time dependent bad pixel table</td>
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<td>Time dependent ZPs</td>
<td>Improved flat fields for imaging and GRISMs</td>
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<td>PSF library – yearly update</td>
<td>Geometric distortion stability</td>
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<tr>
<td>Focus monitoring</td>
<td>Short term persistence</td>
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</tbody>
</table>
**WFC3 Future Projects**

**User support**
- Support for CY26 & Mid Cycles (CS reviews, Help desk)

**IR channel**
- Improve the Up-the-Ramp fitting for IR channel data
  - Jupyter notebook for DASH observations
- Non-linearity calibration (New data just arrived)
- IR PSF library
- Persistence characterization in exoplanet observations (Data expected in August)

**UVIS channel**
- L-flat interpolation validation
- Geometric distortion calibration for full frame very wide filters and Quad filters
**WFC3 Publications**

**WFC3 Data Handbook**
Gennaro et al. 2018, Version 4.0, (Baltimore: STScI)

**Linear: A novel algorithm for reconstructing splitless spectroscopy from HST/WFC3**
Ryan, R.E., Jr., Casertano, S., Pirzkal, N. 2018, PASP, 130c, 450

**ISR 2018-03: Persistence in the WFC3 IR Detector: Intrinsic Variability**
Knox S. Long, & Sylvia M. Baggett 29 Mar 2018

**ISR 2018-02: Comparing the ACS/WFC and WFC3/UVIS Calibration and Photometry**
S.E. Deustua and J. Mack 12 Mar 2018

**ISR 2018-01: Accuracy of the HST Standard Astrometric Catalogs**
V. Kozhurina-Platais, N. Grogin, E. Sabbi 19 Feb 2018

**ISR 2017-24: A Predictive WFC3/IR Dark Current Model**
wfc3_telemetry.txt
Ben Sunnquist, Sylvia Baggett & Knox S. Long 12 Dec 2017

**ISR 2017-23: WFC3/UVIS: Bias Reference Files Analysis**
M. McKay, S. Baggett 07 Nov 2017

**ISR 2017-19: Aligning HST Images to Gaia: a Faster Mosaicking Workflow**
V. Bajaj 13 Nov 2017
Advanced Camera for Surveys (ACS)

Norman Grogin
ACS: Continued Good Performance

WFC Read Noise Monitoring

- Minor CCD Particle Contamination Event (May’17)
  - Two ~opaque irregular ‘flecks’ of 10-20pix extent; added to BPIXTAB

WFC Dark Current Monitoring

Maintaining Smooth Trend-Lines
ACS: Recent Accomplishments

- **CALACS Updates in 2018.1 Pipeline Software**
  - Every anneal interval: Sink Pixel detection and DQ-array flagging
  - Inclusion of ‘readout dark’ contribution to ERR array
  - Retention of long-term-stable warm/hotpix in DQ array
  - Minor refinements to Gen2 pixel-based CTE correction

- **SBC Dark Current vs Temperature**
  - Warmup/Cooldown curves recently characterized with 16yrs’ data
  - Possible new best practices for scheduling, & new aper. location

- **Improved LED Flash Reference File**

- **Transition of ‘Gap-filler’ SubSNAP to GOs**
ACS: New Initiatives

- Planned Refinements to CALACS for 2018.3 Pipeline Software
  - DARKTIME fix, incorporating empirically derived commanding-overheads
  - High Dynamic-Range WFC Superdarks, leveraging 0.5sec darks since 2015
  - Gaia DR2 refinements to the WFC Geometric Distortion solution
  - Update to the WFC Bias Shift correction

- Empirical WFC PSF Estimation Tool for GOs (akin to WFC3/UVIS tool)

- Astrodizzle worked-examples with ERR weighted WFC drizzling

- Updated webtools for WFC Zeropoints and Pixel-Area Maps

- Revised L-flats for WFC, based on 16yrs of 47 Tuc monitoring
ACS: User Documentation

• Recent ACS Additions (Nov’17-Apr’18):
  • 2018-02 : “Updates to Post-Flash Calibration for the ACS Wide Field Channel” (Miles)
  • 2018-01 : “Accuracy of the HST Standard Astrometric Catalogs w.r.t Gaia” (Platais et al.)
  • 2017-13 : “Accounting for Readout Dark in ACS/WFC Superbiases” (Ryon et al.)
  • 2017-11 : “A Flat-Field Correction for F435W” (Bohlin et al.)
  • 2017-10 : “A Comparison of the ACS/WFC and WFC3/UVIS Photometric Calibration” (Deustua et al.)
  • 2017-09 : “ACS/WFC Sky Flats from Frontier Fields Imaging” (Mack et al.)
  • 2017-07 : “Improving the Pixel-based CTE-correction Model for ACS/WFC” (Anderson)
  • ACS Data Handbook (version 9.0; Lucas et al.)

• Upcoming ACS Additions (May-Jun’18):
  • “Mitigating Elevated Dark Rates in SBC Imaging” (Avila et al.)
  • “A Minor Contamination Event in May 2017 Affecting the ACS/WFC CCDs” (Hoffman et al.)
  • ACS Instrument Handbook for Cycle 26