HST Mission Office Report

Tom Brown

STUC – 26 Jun 2024
Overview

• High scientific productivity & demand
  o Peer-reviewed papers at new record in 2023 (1056 papers)
  o Oversubscription in Cycle 32 at 6:1

• Hubble is transitioning to Reduced Gyro Mode (RGM)
  o Science observations in RGM began June 14
  o See John MacKenty’s presentation next

• Operational Paradigm Change Review
  o Call issued by HQ on March 26 to CXO and HST
  o Proposals (80-slide PPT) due April 19
  o Presentation to review panel May 8
  o No outcome yet, but high-level information presented here
  o Discussion on agenda for later today

• Hubble Mission Office changes
  o Tom Brown moving to Webb Mission Office (July 1)
  o Julia Roman-Duval serving as Interim Mission Head (July 1)
  o Helmut Jenkner retiring as HST Deputy early next year
Transition underway
- Managing erratic Gyro 3 since Aug 2023
- Increased safings mid-April 2024
- Decision to transition late-May 2024
- PIs of active programs notified June 10
- Iterating with program PIs for significant changes
- First science June 14
- Full transition should be 6 to 8 weeks
Reduced Gyro Mode

- Impacts
  - Field of regard (FoR) halved
    - 40-50% sky fraction, similar to Webb
  - Solar avoidance increased from 50° to 60°
  - Entire sky available over course of year
  - No change in data quality
    - science one-gyro since 2021
  - Max tracking/scanning speed drops from 7”/s to 5”/s
  - Limitations for objects closer than Mars
  - Reduced scheduling/orientation flexibility (e.g., no 180° flip)
  - Impacts to transients, exoplanets, and Solar System, but Hubble will still do high-impact science across the entire field

2019 RGM simulation using 2006 data

See next presentation from John MacKenty for full details
Hubble’s Unique UV/Optical Capabilities are Essential

Hubble critical to strategic questions of NASA Astrophysics Division, Astro2020, and the field:

Are we alone?
Astro2020
Worlds & Suns in Context

How did we get here?
Astro2020
Cosmic Ecosystems

How does the universe work?
Astro2020
New Messengers & New Physics
Hubble is the Bridge to the Habitable Worlds Observatory

- Hubble’s unique UV / Optical capabilities will not be replaced until launch of Habitable Worlds Observatory (HWO)

- HST science is HWO science
- HWO technology builds upon HST technology
- HST community is HWO community

Drivers of Galaxy Growth

Evolution of Elements Over Cosmic Time

Solar System in its Galactic Context

Living Worlds

https://habitableworldsobservatory.org

Advancing the Habitable Worlds Observatory Concept

Join the effort to advance the Habitable Worlds Observatory, a concept for NASA’s next astrophysics flagship mission, as recommended by the National Academies' report, “Pathways to Discovery in Astronomy and Astrophysics for the 2020s.”

The Habitable Worlds Observatory (HWO) will be a large ultraviolet, optical, infrared space telescope. It will be the first specifically engineered to identify habitable, Earth-like planets around bright stars like our Sun with a coronagraph, and examine them for evidence of life.

Developing a “Super-Hubble”

Continuing the tradition of innovation that has defined NASA’s Hubble Space Telescope, the Habitable Worlds Observatory would have a mirror large enough to find and study at least 25 potentially habitable worlds around other stars. The “super-Hubble” would reveal whether Earth-like planets are common or rare. Beyond the search for life, the telescope will be the engine to transform our understanding of the universe in the coming decades. The Habitable Worlds Observatory will follow in the footsteps of the Hubble, Webb, and Roman space telescope flagship missions, building on their technological and scientific achievements.

In September 2023, NASA formed two committees, the Science, Technology, Architecture Panel (STAP) and a Technical Assessment Group (TAG), to advance the Great Observatories Mission and Technology Maturation Program (GOMAT), including exploring the mission’s science objectives and the technologies that will enable them.
Operations Paradigm Change Review

- No results or NASA guidance yet
  - Call March 26, proposal April 19, presentation May 8

- OPCR driven by need to rebalance NASA portfolio
  - Not driven by scientific or operational performance
  - Hubble remains scientifically important and unique mission

- FY25 President’s Budget Request (PBR) of $88.9M
  - FY25 PBR includes ~$8M for NASA Hubble-Einstein-Sagan Fellowship Program
  - FY24 PBR $93.3M
  - FY24 HST congressional appropriation was $98.3M (i.e., historical value)

- Guiding principles to match FY25 PBR
  - Maintain unique UV/optical capabilities
  - Maintain essential mission ops (including standard calibrations and archive support)
  - Maintain community grants for science
  - Maintain support for broad community access, avoiding bias and inequity
Proposed changes to HST operations
- Halt WFC3/IR operations (science can largely go to Webb)
- Halt ACS/WFC operations (science can largely go to WFC3/UVIS)
- Halt high-level science products (preserve high-fidelity science data calibrations)
- Potential impacts for other instrument channels (depends upon scale of budget reductions)
- Reduce support for HST outreach
- Reduce grant funding
- Fully virtual TAC
- Grants awarded via formula instead of Financial Review Committee

Observing program impacts
- Aim to complete programs in Cycle 31 and earlier
- Cycle 32 will start in November (4 to 6 week delay) to allow for RGM adjustments
- Cycle 32 program may be adjusted to replace infeasible programs with alternatives highly ranked by TAC
- Cycle 32 GO observing notifications in early July
- Cycle 32 AR notifications and GO budget details delayed pending further NASA clarification on grant funding
Long Range Plan Status

Brigette Hesman and the LRP Team
LRP: Remaining Cycle 28-31 Observations

This is how the LRP looked in 3-gyro mode, before we began 1-gyro transition

Cycle 32 nominally started 1 October 2024 but will be delayed 4-6 weeks

Cycle 31 update

- Efficiency: through June 17, 2024: averaging 45 orbits/week over 28 weeks
  - 11 weeks of “normal operations” with average efficiency of 89 orbits/week
- Completeness: 27.2% (GO+DD), 51.0% (CAL), 30.1% (total) as of 10 June 2024

Previous Cycles:

<table>
<thead>
<tr>
<th>Cycle</th>
<th>AVG EFF (orbits/week)</th>
<th>AVG EFF (w/o downtime)</th>
<th>Downtime</th>
<th>Completeness</th>
</tr>
</thead>
<tbody>
<tr>
<td>C30 (14 months)</td>
<td>73</td>
<td>86</td>
<td>8 weeks with downtime; mostly due to Gyro 3</td>
<td>87.5% (GO+DD), 71.3% (CAL), 85.5% (total)</td>
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<tr>
<td>C29</td>
<td>78</td>
<td>84</td>
<td>4 weeks with downtime due to minor frame loss</td>
<td>96.5% (GO+DD), 100% (CAL), 96.8% (total)</td>
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<tr>
<td>C28</td>
<td>72</td>
<td>84</td>
<td>5 weeks down for side switch</td>
<td>99.2% (GO+DD), 100% (CAL), 99.3% (total)</td>
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<tr>
<td>C27</td>
<td>81</td>
<td>85</td>
<td>2 weeks with observing interruptions</td>
<td>complete</td>
</tr>
<tr>
<td>C17-26</td>
<td>80</td>
<td>84</td>
<td>33 weeks with observing interruptions</td>
<td>complete</td>
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</tbody>
</table>
LRP: Highlights – Science Impact of Gyro-3 Safemode Anomalies

<table>
<thead>
<tr>
<th>Time up prior to KFSP</th>
<th>KFSP Entry Time (UTC)</th>
<th>Return to Science SMS Start Time (UTC)</th>
<th>Downtime (days/hours)</th>
<th># of GO orbits delayed</th>
</tr>
</thead>
<tbody>
<tr>
<td>~3 mo</td>
<td>11/19/23 (23.323:20:30)</td>
<td>11/20/23 (23.324:23:00)</td>
<td>27 hrs</td>
<td>15</td>
</tr>
<tr>
<td>7 hrs</td>
<td>11/21/23 (23.325:06:58)</td>
<td>11/22/23 (23.326:21:00)</td>
<td>21 hrs</td>
<td>14</td>
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<td>20 hrs</td>
<td>11/23/23 (23.327:17:26)</td>
<td>12/8/23 (23.342:17:00)</td>
<td>15 days</td>
<td>154</td>
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<tr>
<td>20 days</td>
<td>12/29/23 (23.363:01:18)</td>
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<tr>
<td>12/30/23 (23.364:14:01)</td>
<td>1/4/24 (24.004:08:00)</td>
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<td>6 days</td>
<td>87</td>
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<tr>
<td>12 days</td>
<td>1/16/24 (24.016:13:11)</td>
<td>1/18/24 (24.018:05:45)</td>
<td>41 hrs</td>
<td>20</td>
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<tr>
<td>8 days</td>
<td>1/26/24 (24.026:02:58)</td>
<td>1/28/24 (24.028:01:30)</td>
<td>46.5 hrs</td>
<td>25</td>
</tr>
<tr>
<td>77 days</td>
<td>4/14/24 (24.105:22:05)</td>
<td>4/16/24 (24.107:06:00)</td>
<td>32 hrs</td>
<td>20</td>
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<tr>
<td>5 days</td>
<td>4/23/24 (24.114:10:00)</td>
<td>4/26/24 (24.117:03:30)</td>
<td>2 days, 5.5 hrs</td>
<td>37</td>
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<tr>
<td>2 hrs</td>
<td>4/26/24 (24.117:05:47)</td>
<td>4/30/24 (24.121:03:00)</td>
<td>3 days, 21 hrs</td>
<td>40</td>
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<tr>
<td>18 hrs</td>
<td>4/30/24 (24.122:01:00)</td>
<td>5/6/24 (24.128:04:00)</td>
<td>6 days, 3 hrs</td>
<td>70</td>
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## LRP: Highlights – Science Impact of Gyro-3 Safemode Anomalies

<table>
<thead>
<tr>
<th>Time up prior to KFSP</th>
<th>KFSP Entry Time (UTC)</th>
<th>Return to Science SMS Start Time (UTC)</th>
<th>Downtime (days/hours)</th>
<th># of GO orbits delayed</th>
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<tbody>
<tr>
<td>17 hrs</td>
<td>5/ 7/24 (24.128:21:00)</td>
<td>5/ 9/24 (24.131:04:00)</td>
<td>2 days, 7 hrs</td>
<td>22</td>
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<tr>
<td>9.7 days</td>
<td>5/19/24 (24.140:21:02)</td>
<td>5/21/24 (24.142:10:00)</td>
<td>1 day, 13hrs</td>
<td>18</td>
</tr>
<tr>
<td>42 hrs</td>
<td>5/23/24 (24.144:04:07)</td>
<td>5/24/24 (24.145:09:00)</td>
<td>1 day, 5hrs</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total Time/orbits:</td>
<td>~46.5 days</td>
<td>554</td>
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</tbody>
</table>

**Downtime for troubleshooting Gyro 3 and transition to OGS mode**

|                      | 5/24/24 (24.146:02:03)      | 6/17/24 (24.170:00:00)                 | 31 days              | 375                   |

- Downtime due to Gyro-3 safemodes = 24% (wall-clock time and percentage of scheduled orbits)
- Total of 929 orbits delayed due to Gyro-3 safemodes and RGM transition as we explored ways to preserve three-gyro science
LRP: Highlights – Exoplanet Programs

Cycle 28:
• Originally: 20 programs; 279 orbits allocated
• Currently: 2 programs, 28 orbits remain
  • 16180 (19 orbits) & 16181 (9 orbits)

Cycle 29:
• Originally: 21 programs; 403 orbits allocated
• Currently: 2 programs, 13 orbits remain
  • 16726 (5 orbits), 16875 (8 orbits)

Cycle 30:
• Originally: 14 programs; 409 orbits allocated
• Currently: 5 programs, 79 orbits remain
  • Includes 2 large programs: 17183 (HUSTLE; 18 orbits remain), 17192 (SPACE; 46 orbits remain)

Cycle 31:
• Originally: 12 programs; 269 orbits allocated
• Currently: 12 programs, 229 orbits remain

349 exoplanet orbits for all active cycles
**LRP: Highlights – Solar System Programs**

**Cycle 30:**
- 5 GO programs, **8 orbits remain**
  - 16989, Jupiter FUV aurora, 1 orbit remains
  - 17099, Ganymede, 2 orbits remain
  - 17142, Europa, 2 orbits remain
  - 17206, TNOs, 2 orbits remain
  - 17275, Jupiter, 1 orbit remains

**Cycle 31:**
- 9 GO programs (2 complete), 181 orbits allocated, **124 orbits remain**
- Large GO (17470): HST-Juno Io Campaign (122 orbits allocated)
  - 20 orbits archived; 8 orbits failed; **102 orbits remain**
  - Requested large portion of HST observations in first 3 months of cycle to coordinate with 2 Juno flybys
- **Impacted by safings in December & January so many orbits remain in program**
  - September flyby remains – unlikely that 102 orbits can be planned for this time period
- 1 GO/DD (17294): OPAL - Outer Planet Atmospheres Legacy, 41 orbits allocated, **33 orbits remain**
  - 8 orbits Uranus archived; Neptune, Saturn & Jupiter maps later in cycle
<table>
<thead>
<tr>
<th>Program #</th>
<th>(Cycle; PI)</th>
<th>Alloc (orbits)</th>
<th>Executed (orbits)</th>
<th>Planned (orbits)</th>
<th>comment</th>
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</thead>
<tbody>
<tr>
<td>16278</td>
<td>(C28; Kelly)</td>
<td>96</td>
<td>96 (100%)</td>
<td>0</td>
<td>C27 continuation; COMPLETE</td>
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<tr>
<td>16659</td>
<td>(C29; Pala)</td>
<td>118</td>
<td>93 (79%)</td>
<td>0</td>
<td>Accreting white dwarfs</td>
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<tr>
<td>16673</td>
<td>(C29; Levan)</td>
<td>22</td>
<td>0 (0%)</td>
<td>0</td>
<td>Long-term ToO; 16988 for C30; 17407 for C31</td>
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<tr>
<td>16701</td>
<td>(C29; Youngblood)</td>
<td>110</td>
<td>105 (95%)</td>
<td>0</td>
<td>Exoplanets; COMPLETE</td>
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<tr>
<td>16778</td>
<td>(C29; Williams)</td>
<td>195</td>
<td>193 (99%)</td>
<td>0</td>
<td>M31-PHAST; COMPLETE</td>
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<tr>
<td>16988</td>
<td>(C30; Levan)</td>
<td>40</td>
<td>0 (0%)</td>
<td>0</td>
<td>Long-term ToO; 16673 for C29; 17407 for C31</td>
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<tr>
<td>17069</td>
<td>(C30; Hayes)</td>
<td>119</td>
<td>107 (90%)</td>
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<td>Lyman-alpha and Continuum Origins Survey</td>
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<td>17093</td>
<td>(C30; Borthakur)</td>
<td>80</td>
<td>80 (100%)</td>
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<td>Star-forming Galaxies; COMPLETE</td>
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<tr>
<td>17112</td>
<td>(C30; Reindl)</td>
<td>130</td>
<td>127 (98%)</td>
<td>2</td>
<td>Treasury FUV Survey of White Dwarfs</td>
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<td>17115</td>
<td>(C30; Bowen)</td>
<td>96</td>
<td>84 (88%)</td>
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<td>Dwarf Galaxy Pairs</td>
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<td>17128</td>
<td>(C30; Foley)</td>
<td>105</td>
<td>105 (100%)</td>
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<td>Long-term SN ToO; COMPLETE; 17410 for C31</td>
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<td>17183</td>
<td>(C30; Wakeford)</td>
<td>122</td>
<td>96 (79%)</td>
<td>4</td>
<td>Exoplanets (HUSTLE)</td>
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<tr>
<td>17192</td>
<td>(C30; Kreidberg)</td>
<td>116</td>
<td>69 (59%)</td>
<td>34</td>
<td>Exoplanets (SPACE)</td>
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<tr>
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<td>Program (Type)</td>
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<td>Executed (orbits)</td>
<td>comment</td>
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<td>17407</td>
<td>Multi-messenger astronomy (Large)</td>
<td>20</td>
<td>0</td>
<td>Long-term ToO continuation program: 16673 (C29); 16988 (C30)</td>
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<tr>
<td>17410</td>
<td>Reducing Type Ia Supernova Distance Biases (Large)</td>
<td>30</td>
<td>0</td>
<td>Long-term ToO continuation program: 17128 (C30)</td>
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<tr>
<td>17470</td>
<td>HST-Juno Io Campaign (Large)</td>
<td>122</td>
<td>20</td>
<td>All 1-2-orbit visits; priority to Dec 2023 &amp; Feb 2024 flybys</td>
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<tr>
<td>17502</td>
<td>Star Formation and Feedback in Nearby Galaxies (Large; Treasury)</td>
<td>169</td>
<td>35</td>
<td>HST+JWST+ALMA; All 1-orbit or 4-orbit visits</td>
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<tr>
<td>17517</td>
<td>Circumgalactic Observations of Nuv-shifted Transitions [CONTACT] (Large)</td>
<td>131</td>
<td>6</td>
<td>All 1-orbit visits</td>
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<tr>
<td>17491</td>
<td>Far-UV Spectral Atlas of Metal-Poor O Stars (Large; Treasury)</td>
<td>110</td>
<td>18</td>
<td>No special requirements</td>
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<tr>
<td>17464</td>
<td>Understanding M-dwarf System Flaring (Large; Treasury)</td>
<td>88</td>
<td>53</td>
<td>Requesting visits with 8 contiguous orbits Mar – Sep 2024 for TESS &amp; GB coordination</td>
<td></td>
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<tr>
<td>17435</td>
<td>Globular Clusters Survey (Medium; Treasury)</td>
<td>61</td>
<td>37</td>
<td>All 1-2-orbit visits</td>
<td></td>
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<tr>
<td>17526</td>
<td>UV spectroscopy of Star-forming Galaxies (Medium but borderline)</td>
<td>74</td>
<td>2</td>
<td>Requesting obs in 3-orbit visits</td>
<td></td>
</tr>
</tbody>
</table>
LRP: Summary

• **Large programs:**
  - Most of Cycle 29/30 large programs are > 80% complete
  - Large programs to keep an eye on:
    - 16659 – C29 “Accreting white dwarfs as probes of compact binary evolution” - 79% complete
      - Observations that require STOP safety procedure can only be supported at ~1 per month
    - 17192 – C30 ”The SPACE Program: a Sub-neptune Planetary Atmosphere Characterization Experiment“ - 59% complete
      - Must continue to utilize as many opportunities as possible
    - 17470 – C31 “HST-Juno Io Campaign: Connecting Volcanos to the Plasma Environment” – 16% complete
      - Most of this program was due to execute December 2023 & February 2024 but severely impacted by safings

• **Status of LRP in Reduced Gyro Mode (RGM)**
  - Programs being reworked by PCs as quickly as possible
  - Less visits fell out of plan than expected
    - Expected 50% drop out but found it was closer to 10% drop out
  - Initial impressions are that the plan has limited flexibility; moving visits within the plan to create better subscription requires PC/PI rework of programs
  - Significant work left to do to make the LRP useable for RGM operations
EXPANDING THE FRONTIERS OF SPACE ASTRONOMY

STIS Update

Joleen Carlberg and the STIS Team
STIS STATUS

General Status

• STIS operating nominally (27 years in space!)
• Monitoring NUV
  • New CCD/NUV-MAMA TDS delivery for NUV wavelengths (rapid decline at 1800 – 2000 Å)
  • Tracking NUV Dark through safings
    • Long STIS safings = higher dark rates
    • Modified STIS response to safe mode = some colder than typical observations = very low dark rates

Documentation/Software Tools

• 2 STANs (Feb 2024, Mar 2024)
• 3 AAS Posters (including one intern poster)
• ISR 2024-01: Safety Acquisitions: Redundancy for non-repeatable multi-orbit STIS visits
• ISR 2024-02: Recalibration of Pre-SM4 STIS Echelle Throughputs
• ISR 2024-03: Rederivation of STIS Secondary Echelle Mode Traces

Above: Time Dependent Sensitivity (TDS) in one 100 Å bin of G230L
Monitor for Excess Cosmic Ray (CR) Rejection in CCD Data

- HST jitter can cause CR rejection algorithm to fail (STIS ISR 2019-02)
- New monitor flags datasets by comparing CR statistics inside/outside spectral extraction region
- Users can manually re-reduce data with higher rejection thresholds to improve performance
- Monitor is currently public, but not yet announced pending documentation

**STIS CR Monitor (2022)**

Last updated: 2024-05-02 17:12:59

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<th>TARGNAME</th>
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<th>OBS_TIME</th>
<th>POSTARG1</th>
<th>POSTARG2</th>
<th>PATTERN1</th>
<th>CRSPLIT</th>
<th>AVG_EXTR_FRAC</th>
<th>AVG_OUTSIDE_FRAC</th>
<th>AVG_RATIO</th>
<th>QUALITY</th>
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<td>oeq002040</td>
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</tbody>
</table>

https://www.stsci.edu/~STIS/monitors/cosmic_rays/
On-Going and Future Work (Highlights)

Coming soon...

• New Jupyter notebook on improved error estimation in low S/N regime
• Flux recalibration reference file deliveries:
  • Echelle modes: 11 more E140H cenwaves
  • First order M modes
• Data Handbook update (first since 2019)

Planned/recently begun

• Flux recalibration: more E230H cenwaves
• Charge transfer inefficiency parameter updates
• Fixing data quality flagging (CCD DQ=16 and newly recovered echelle orders)
• Supporting 2 new interns
• Supporting reduced gyro mode
WFC3 Highlights

WFC3 operating nominally

• MAST archive: 355,000+ WFC3 images
• Safings: no impact to WFC3
• PSF Image Library
  ✓ ~82 million total (UVIS + IR + WFPC2)
  ✓ New: saturated PSFs, larger cutouts
• Jupyter notebooks for GOs
  ✓ WFC3 Library transitioned to STScI’s HST notebook library
  ✓ With ACS, transitioning drizzle notebooks to STScI’s HST notebook library
  ✓ New PSF-subtraction notebook
    ePSF and PSF Image Library workflows
WFC3 Highlights

- New **UVIS/IR badpix** tables delivered to CRDS
- New **postflash** reference files for 2023 delivered
- **IR gain** monitor
  - Legacy IDL code converted to python
- **Astrometric monitoring**
  - Legacy FORTRAN code converted to python
  - Procedures streamlined
  - X,Y scales: ~0.1 pixel/2048 pix over ~14 yrs
  - Underway: updated instrument distortion correction
  - In progress: cross-check with Gaia/WCS
- **CTE monitoring** (ISR 2024-04)
  - Results nominal
  - Recommendation unchanged: ensure 20 e-/pix background
  - Coefficients on WWW

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CTE; FLC; background 20-25 e-/pix

Recommended background + pixel based CTE correction

Loss (mag/2051 pixels)

Worst-case (not used for science)

CTE, FLT, background 1-3 e-/pix

Astrometry: X scale (UVIS 1)

IR good pixels

IR bad pixels

Cold + Stable

Cold + Unstable

Hot + Stable

Hot + Unstable

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IR gain – quad 1

IR badpix tables delivered to CRDS

New **UVIS/IR badpix** tables delivered to CRDS

New **postflash** reference files for 2023 delivered

**IR gain** monitor

- Legacy IDL code converted to python

**Astrometric monitoring**

- Legacy FORTRAN code converted to python
- Procedures streamlined
- X,Y scales: ~0.1 pixel/2048 pix over ~14 yrs
- Underway: updated instrument distortion correction
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**CTE monitoring** (ISR 2024-04)

- Results nominal
- Recommendation unchanged: ensure 20 e-/pix background
- Coefficients on WWW
WFC3 Highlights

- Photometric monitoring for IR (ISR 2024-06)
  - Corrections for sensitivity changes available
  - New calwf3 code with time-dep. sensitivity under test

<table>
<thead>
<tr>
<th>Filter</th>
<th>$\lambda_p$ (nm)</th>
<th>$\bar{m}$ (%/year)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F098M</td>
<td>986.4</td>
<td>0.120 ± 0.003</td>
<td>≈ 1.68</td>
</tr>
<tr>
<td>F105W</td>
<td>1055.5</td>
<td>0.075 ± 0.006</td>
<td>≈ 1.05</td>
</tr>
<tr>
<td>F110W</td>
<td>1153.4</td>
<td>0.060 ± 0.005</td>
<td>≈ 0.84</td>
</tr>
</tbody>
</table>

Corrections for IR time-dependent sensitivity: 2009-2023

- F160W – stare mode
- G140W – scan mode
- G102 – integrated flux
- G141 – integrated flux

However...
Recent 1% increase
Preliminary: also in IR flats
Further analysis in progress

Over ~14 yrs
WFC3 Highlights

- **HST focus monitor** via phase retrieval (ISR 2024-05)
  - Portions of legacy IDL code ported to python
  - UVIS predicted at -1 micron despace in Aug 2026
  - Under analysis: can phylo method be used as monitor

- **Machine Learning** – identifying GS failures (ISR 2024-03)
  - Convolutional neural network (CNN)
  - Tested using flags from quicklook system
  - Training/validation on 2009-2022 images (no grisms/scans) with/without augmented data (flipped, rotated, cropped)
  - True positive/negative: 91%, 90%
    - False positives: typically prominent CRs
    - False negatives: very sparse fields or observing issues
  - Poor model performance using rotated augmented data
    → many GS failures have preferred direction
  - Code on github (https://github.com/spacetelescope/deepwfc3/)

**DeepWFC3: Analyzing HST/WFC3 Images using Machine Learning**
WF3 User support/documentation

- Updated Instrument Handbook (Jan 2024)
- Updated Data Handbook (Jun 2024)
- CS reviews / helpdesk
- STANs: 2024: January, March, June
- AAS meeting Jan 2024
- Overhaul of DrizzlePac ReadTheDocs (with ACS team and Data Management Division)

2024-07  “Revisiting x-CTE in WFC3/UVIS”, Anderson
2024-05  “HST Focus Monitoring”, Dressel & Rivera
2024-04  “UVIS External CTE Monitor Update”, Kuhn et al.
2024-03  “UVIS Guide Star Failure Classification with Machine Learning”, Jones & Dauphin
2023-02  “Improvements and Updates to the IR Bad Pixel Tables”, Huynh & Khandrika
EXPANDING THE FRONTIERS OF SPACE ASTRONOMY

COS Update

Marc Rafelski and the COS team
COS General Updates

- COS status updates
  - NUV Time Dependent Sensitivity (TDS) shows modest declines at most wavelengths:
    - New NUV TDSTAB delivered to CRDS June 2024 (currently processing) introducing a wavelength dependence in the TDS model, resulting in significant improvements (~5-10%)
  - FUV TDS slopes continued to steepen, ~5-6% /yr likely due to solar cycle
    - New breakpoint introduced March 2023, delivered new TDSTAB & FLUXTAB March 2024
    - FUV TDS normally ~1%/yr outside of solar maximum
  - NUV and FUV dark rate constant over the last 6 months
  - Delivered CalCOS build including y-dependent y-walk, high-voltage TDS, and bug fixes affecting the cumulative counts images and gain maps
  - Began incorporating changes to calibration programs to operate in reduced gyro mode

- Documentation since October 2023:
  - 4 STANs, 13 ISRs, AAS poster, IHB
  - HASP workshop at STScI Spring Symposium
All FUV lifetime positions and settings are being recalibrated using the new geometric+walk corrections.

The accuracy of the wavelength calibration will improve from about 1/2 resel (+/-3 pixels) to about 1/4 resel (+/-1.5 pixels).

Adding profiles to Blue Modes at LP2.

This work is expected to be completed in FY24.
COS Lifetime Investigations

- LP5 & LP6 lifetime significantly reduced due to change in use by community (frequent & long observations of very bright targets)
  - We are exploring policy changes to prevent such issues in the future
- LP7 exploration underway to determine the best location for G130M settings (~3 positions above LP6 remaining) through PSF modeling to maximize resolution
- New region identified for G160M settings between LP3-LP4 providing ~2 years of low overheads at high resolution
- Plenty of G140L life remaining at LP2, LP3, LP4, and LP5

Gain map above LP6

Sufficient gain for G160M between LP3 and LP4

G160M/1533

FUV A: HV = 178

FUVB: HV = 175
COS Spectroscopic Initiatives

- Released January 2024
- New default program and visit level coadds available via MAST Portal, HST Search form, and Astroquery
- HASP provides Jupyter notebooks to perform custom coadditions and data inspection (more coming soon)

HSLA: Hubble Spectroscopic Legacy Archive

- Started revised HSLA building on HASP to provide improved and automated cross-program co-adds along with parsing & classifying unique targets
Future Work FY24

- Finalize LP7 exploratory work
- Complete geocorr/walkcorr calibration, including new LP2 blue mode profiles
- CalCOS pipeline updates
  - Update CalCOS to handle numpy2, possibly NUV and stim bug fixes
- Finalize 3 additional Hubble Advanced Spectroscopic Products (HASP) Jupyter notebooks
- Continue Hubble Spectroscopic Legacy Archive (HSLA) revamp including both COS and STIS
- Cycle 32 calibration programs, special calibration programs, and contact scientist support
- Develop, upgrade, and document monitors, such FUV TDS and count monitor
ACS Update

Norman Grogin and the ACS Team
ACS Long-term Monitoring

- ACS continues to operate nominally (Celebrated 22yrs service in Mar’24)
  - Highly stable WFC readnoise from all amps (upper left); values unchanged for the last >1.5yrs (inset zoom)
  - WFC pixel stability monitoring (upper right) shows steady 99.8% usability
  - WFC LED post-flash intensity shows gradual 0.2%/yr decline (lower left)
  - SBC dark rate vs. temperature (lower right) has sporadic surges at >2 orbits
WFC Serial CTE Measurement and Correction

- **Serial CTE small, but growing**
  - 22 years of radiation damage has degraded the CTE of the serial registers
  - The post-readout effect is $\approx 10 \times$ smaller than Y-CTE, and the charge-trailing is X-directed, toward the amp-splits

- **Well-measured & correctable**
  - Recent WFC long-darks (1000sec) clearly show the X-trailing *(fig. at right)*
  - The Y-CTE parameterization, with suitably adjusted coefficients, works well to characterize X-CTE trailing
  - A pixel-based X-CTE correction will be added to CALACS in Summer 2024
Exploring WFC CTE Implications for Faint Sources

• Simulating WFC readout with the pixel-based CTE “forward model”
  – Large grid of faint sources distributed across WFC, to probe varying degrees of CTE
  – Readout simulated by CTE “forward model,” with realistic noise sources
  – Simulated RAWs processed with CALACS to produce FLTs/FLCs (right)

• Completeness and S/N analyses, to recommend optimal background
  – Higher backgrounds mitigate CTE charge-trailing, but add Poisson noise to photometry
  – A variety of aperture- and PSF-fitting-photometry routines were applied to the FLT, FLC, and ‘perfect-CTE’ imgs.
  – Across a broad range of faint-source fluxes (colors), both S/N and recovery completeness are now optimized at background levels of ≈30e- (dashed line), which can be reached via LED post-flash for short-/narrowband-exps.
SBC Recent Developments and Work-in-Progress

• ePSF Measurement and ePSF-Retrieval Webtool
  – 22 years of NGC 6681 monitoring (left) enable effective PSFs (‘ePSFs’) to be fit in all SBC filters
  – Resulting over-sampled ePSFs (right) are suitable for \texttt{hst1pass}; served via ACS ePSF webtool

• Towards a Time-dependent SBC Geometric Distortion in CALACS
  – Requirements: High-precision SBC \texttt{hst1pass} astrometry; proper motions from UVIS (middle)
  – Anticipated 1st determination of time-dependent geometric distortion in 2025
New ACS Documentation

- ISR ACS 2024-01 : “Evolution of Sink Pixels in ACS/WFC and Connection to Charge Transfer Efficiency” (Guzman & Ryon)
- ISR ACS 2024-02 : “The impact of CTE on point source detection in simulated ACS/WFC imaging data” (Stark & Grogin)
- ISR ACS 2024-03 : “Measuring the Column Dependence of Read Noise in ACS/WFC Bias Frames” (Guzman & McDonald)
- ISR ACS 2024-04 : “Empirical ACS/SBC ePSFs for hst1pass” (Anderson)
- Revisions to ACS Instrument and Data Handbooks to support HST Cycle 32
We welcome your feedback and thank you for your support

STScI 2024-013
Hubble Celebrates 34th Anniversary with a Look at the Little Dumbbell Nebula

STScI 2024-012
Three-Year Study of Young Stars with NASA's Hubble Enters New Chapter

Completion of ULLYSES program

Workshop held 11-14 Mar 2024

Thank you Julia and the ULLYSES team for making this program a success!