Hubble Project Report

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Space Telescope
Users Committee
Meeting
June 26, 2024
Agenda

- Science Highlights
- Observatory status
- Science Instrument Command and Data Handling B-Side Operations
- Budget
Galaxy UGC 12158 with Asteroid Trails

11,482 citizen-science volunteers + 19 Years of Hubble observations and 37,000 observations = 1,701 asteroid trails, with 1,031 new detections

NASA, ESA, Pablo García Martín (UAM)
Hubble’s Science is Strong and Unique

“HST continues to enable cutting edge science across scientific domains - Solar System Science, Exoplanets, Galaxies and Stellar Populations, Clusters, Large-Scale Structure and Cosmology...HST continues to be a scientific powerhouse, unique in breadth and depth. It is truly a GREAT OBSERVATORY. HST plays a key intellectual role in interrogating and challenging current scientific paradigms - driving discovery at the Frontier.” - HST Panel Findings, 2022 Astrophysics Senior Review

A Hubble Space Telescope image of the globular star cluster, Messier 4. The cluster is a dense collection of several hundred thousand stars. Hubble observations reveal evidence for an elusive invisible intermediate-mass black hole, weighing as much as 800 times the mass of our Sun, lurking at its core.
NASA’s Powerful Great Observatories program spans many wavelength bands

The original Great Observatories suite

gamma  x-ray  visible light  infrared
“In the Space Station era, the family of permanent observatories in space will open the way to new, comprehensive studies of key remaining problems in astrophysics, helping us understand:

- The birth of the Universe, its large-scale structure, and the formation of galaxies and clusters of galaxies;
- The fundamental laws of physics governing cosmic processes and events;
- The origin and evolution of stars, planetary systems, life and intelligence.

If we succeed, we will leave a legacy to rank us with the great civilizations of the past.”

- The Great Observatories for Space Astrophysics
- NASA rationale document 1986
Hubble Science is Vital to NASA’s Flagship Suite

“Hubble continues to provide key insights into the three major scientific themes of astrophysics research: (1) “How does the Universe work?”, (2) “How did we get here?”, and (3) “Are we alone?” It is expected to contribute mightily in the proposed period, providing vital synergy with JWST, Roman, and other NASA missions through its unique capabilities. Hubble will also contribute significantly to addressing the key scientific questions identified by the National Academy of Sciences Decadal Survey Astro2020, provided that it stays healthy and the over-guide budget is awarded.”

–HST Panel Report, 2022 Astrophysics Senior Review
Hubble Science is Vital to NASA’s Flagship Suite

MACS 0416 (Hubble ACS and WFC3 + Webb NIRCam)

NASA, ESA, CSA, STScI, Jose M. Diego (IFCA), Jordan C. J. D'Silva (UWA), Anton M. Koekemoer (STScI), Jake Summers (ASU), Rogier Windhorst (ASU), Haojing Yan (University of Missouri)
Hubble Remains the World’s Preeminent Optical/Ultraviolet Space Observatory

- **High demand and return:** ~1000 scientific papers a year; only ~1 in 6 observing proposals accepted
- **Unique:** Hubble’s ultraviolet/visible-light science capabilities will be vitally important and unmatched until the 2040’s
- **Groundbreaking:** Hubble provides critical insights across the entire field of astrophysics, including Solar System dynamics, stellar life cycles, exoplanets, cataclysmic phenomena, and the evolution of galaxies

Inclusive Power:
Hubble’s Innovations Include Science Selection Processes

~30% of Hubble’s Science Teams Are Now Led by First-Time Principal Investigators!
Agenda

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Observatory Status

• **Gyro-3 Performance**
  - November 2023 meeting reported August and November anomalous rate output and safing events
  - 3 safings late December 2023 – late January 2024
  - 9 safings between April 14-May 25; gyro became progressively less responsive to operational intervention
  - Transitioned to One Gyro Science on June 14, 2024; gyro-3 remains powered for maintaining insight

• **Fine Guidance Sensors (FGS)**
  - One Gyro Science requires more FGS coarse track cycles than 3-gyro control
  - Monitoring FGS compensation error performance for Servos-A and B
  - Preparing potential update for the guide star acquisition logic to reduce coarse track cycles

• **Aperture Door Test**
  - Annual tests performed since 2021 event
  - 2024 test, delayed due to gyro-3 related activities, planned for week of July 8
## Gyro Run Time Performance

<table>
<thead>
<tr>
<th>Post SM4 RGA</th>
<th>Status</th>
<th>Flex Lead</th>
<th>Total Hours 2024/152 (5/31/2024)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>Failed April 2018</td>
<td>Standard</td>
<td>43,359</td>
</tr>
<tr>
<td>G2</td>
<td>Failed October 2018</td>
<td>Standard</td>
<td>47,550</td>
</tr>
<tr>
<td>G3</td>
<td>On</td>
<td>Enhanced</td>
<td>71,911*</td>
</tr>
<tr>
<td>G4</td>
<td>On</td>
<td>Enhanced</td>
<td>142,409</td>
</tr>
<tr>
<td>G5</td>
<td>Failed March 2014</td>
<td>Standard</td>
<td>51,497</td>
</tr>
<tr>
<td>G6</td>
<td>On</td>
<td>Enhanced</td>
<td>89,523</td>
</tr>
</tbody>
</table>

G4 (Enhanced Flex Lead) – Most runtime hours on program 142,409
Mean runtime hours for the 3 Enhanced Flex Lead gyros 101,281
G6 (Enhanced Flex Lead) – 2nd most hours 89,523
G3 (Enhanced Flex Lead) – 3rd most hours 71,911*
Mean runtime hours for all 22 HST gyros 50,371
Mean runtime hours for the 8 HST Standard Flex Lead failure gyros 44,405
Mean runtime hours for the 19 HST Standard Flex Lead gyros 42,332

*One Gyro Science began June 14, 2024. G3 had 71,911 hours on May 31, 2024; remains powered on
Subsystem Reliability

HST Subsystem Reliability With Failure State Beginning June 1, 2024

[Graph showing reliability over time for different subsystems with failure state beginning June 1, 2024]
Science Instrument Command and Data Handling
B-Side Operations

- Science Instrument Control and Data Handler
  - Currently operating on Side-A following the July 2021 side switch recovery
  - Developing approach/implementation plan to enable B-Side Operations if necessary
    - Operations Concept Review held on April 5, 2023
    - System Requirements Review held on April 20, 2023
    - Critical Design Review completed April 25, 2024
    - Flight Software development expected to complete end of 2024
    - Operational capability anticipated to be available by September 2025
  - Compatible with One Gyro Science mode
## Budget

<table>
<thead>
<tr>
<th></th>
<th>FY24</th>
<th>FY25</th>
<th>FY26</th>
<th>FY27</th>
<th>FY28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post 2022 Senior Review Guidance (no NHFP funding requirement)</td>
<td>$98.3</td>
<td>$98.3</td>
<td>$98.3</td>
<td>$98.3</td>
<td>$98.3</td>
</tr>
<tr>
<td>2025 President’s Budget (includes NHFP Funding requirement)</td>
<td>$89.6</td>
<td>$88.8</td>
<td>$87.5</td>
<td>$87.7</td>
<td>$82.9</td>
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<tr>
<td>NHFP Fellows support (NOA)</td>
<td>$7.9</td>
<td>$8.3</td>
<td>$8.6</td>
<td>$8.8</td>
<td>$9.1</td>
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<tr>
<td>Comparable funding vs 2022 Sr Rev</td>
<td>$81.7</td>
<td>$80.5</td>
<td>$78.9</td>
<td>$78.9</td>
<td>$73.8</td>
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<tr>
<td>Percent Reduction</td>
<td>16.9%</td>
<td>18.1%</td>
<td>19.7%</td>
<td>19.7%</td>
<td>24.9%</td>
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- **2022 Senior Review** recommended that NASA HQ APD provide Hubble an inflation adjusted budget.
- The Project response to the post-Senior Review *flat guidance with NHFP removed*, stated that GO/AR support would be reduced beginning in FY26 due to continuing operations within the flat budget profile; PPBE-25 (FY23) communicated that GO/AR would fall to $20M by FY29; (FY23, Cycle 30 was $35.8M)
- The Project reduced the Cycle 31 (December 2023-September 2024) value to $15M
- Planning to $93.3M for FY24
- Budget environment drove Operations Paradigm Change Review and will inform 2025 Senior Review
- Anticipate OPCR feedback in July; Senior Review Call for Proposal by the Fall