HST Status

Ken Sembach

STUC Presentation
October 18, 2007
Outline

- Recent gyro failure
- Recent NICMOS safing
- Cycle 16 long range plan
- Instrument status
  - STIS, ACS, WFPC2, NICMOS, FGS
  - COS and WFC3 covered in separate presentations
- Staffing for SM4
- Lunar initiative support
Gyro 2 Failure

- HST entered zero-gyro sun-point safe mode at ~7 PM EDT on August 31, 2007
- Gyro 2 failed on-board sanity check on counts
  - HST responded as expected
  - Eventual failure of Gyro 2 was anticipated
    - HST had reached approximate date of 50% probability of 4 working gyros
  - Most likely cause: flex lead failure
    - Corrosion of thin electrical wire ("traditional" flex lead, no silver plating)
    - Corrosion a function of current, diffusion rates, wire inhomogeneities
    - Had improved fluid and fluid fill process (pressurized nitrogen vs. air)
  - Restart of Gyro 2 was deemed infeasible (failure permanent)
- Gyro 6 was powered on at ~2 AM EDT on September 1, 2007
  - Gyro 6 had been turned off early in its lifetime
  - Gyro 6 shows some bias drift (noise)
  - Gyro 6 bias is settling slowly (1-2 months expected)
Gas-Bearing Gyroscope
Gyro Status

- Full complement of gyros (6) was replaced during SM3A in December 1999

- Gyro run times as of August 31, 2007
  - G2 57315 hours - failed, 31-Aug-2007, flex lead
  - G4 53505 hours - operational, turned off 28-Aug-2005
  - G1 45578 hours - operational, powered
  - G3 33197 hours - failed 29-Apr-2003, rotor restriction
  - G5 16126 hours - failed 28-Apr-2001, rotor restriction
  - G6 12547 hours - operational, powered
  - Mean time for flex lead failures is 41800 hours

- All 6 gyros (3 rate sensing units - RSUs) are slated to be replaced during SM4 during EVAs 1 and 2.
Gyro Lifetime Estimates

Chart below shows approximate gyro failure probabilities assuming a gyro failure in July 2007 (close to time of Gyro #2 failure)

Predictions from Helen Wong (Aerospace Corp) as communicated to Art Whipple (HSTP)
One-Gyro Mode Preparations

- One-gyro mode is in an advanced stage of preparation, work begun in mid-2005

- One-gyro mode is expected to perform as well as two-gyro mode
  - Target availability should be similar to two-gyro mode
  - Jitter expected to be slightly larger than in two-gyro mode, but still very good

- Current plan is to power on Gyro 4 if either Gyro 1 or Gyro 6 fails prior to SM4

- Gyro 2 failure has not significantly altered one-gyro work schedule
  - On-orbit test currently planned during week of January 28, 2008
Impact to Science

- Safing occurred near end of week (late Friday)
  - ~25 orbits of science deferred

- Health and safety SMS loaded September 1, 2007 (Saturday)

- Science SMS loaded September 2, 2007 (Sunday)
  - All WFPC2
    - Time-critical WFPC2 orbits from previous week were rescheduled
  - No NICMOS orbits because of unrelated NICMOS safing event
    - ~20 orbits of science deferred with no NICMOS during WFPC2 anneal cycle

- The team here and at GSFC did a great job to allow a speedy recovery!
NICMOS Safing

NICMOS entered safe mode at ~11 PM EDT on September 1, 2007
- NICMOS was in SAA/Operate mode as a result of previous HST safing
- No NICMOS activities at the time of event

Cause: Single event upset (SEU) affecting the engineering data buffer, a CPU register, or a memory location
- Appropriate response to empty A/D FIFO is to safe instrument
- “Verified” on VSTIF ops bench
- Recommended action was to recover from safe mode

NICMOS was brought up to SAA/Operate mode
- Telemetry nominal
- Normal engineering data process functioned as expected

Buffer box temperatures were raised to nominal values
- Had been running cold due to NICMOS inactivity
- Brief transition to Operate and back to SAA/Operate to refresh buffer box telemetry

NICMOS science resumed with SMS loaded September 9, 2007
# Cycle 16 Long Range Plan

<table>
<thead>
<tr>
<th>LRP built</th>
<th>Complete through</th>
<th>Total orbits</th>
<th>Through 08.220</th>
<th>08.220 – 08.255</th>
<th>08.255 – 09.068</th>
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<tbody>
<tr>
<td>July 7</td>
<td>07.203</td>
<td>4470</td>
<td>3375</td>
<td>349</td>
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<tr>
<td>Aug 16</td>
<td>07.238</td>
<td>4052</td>
<td>3040</td>
<td>277</td>
<td>735</td>
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<tr>
<td>Sep 10</td>
<td>07.267</td>
<td>3764</td>
<td>2793</td>
<td>236</td>
<td>735</td>
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<tr>
<td>Oct 10</td>
<td>07.295</td>
<td>3576 (1)</td>
<td>2661</td>
<td>229</td>
<td>686 (2)</td>
</tr>
</tbody>
</table>

## Post-SM4 Instrument Breakdown

<table>
<thead>
<tr>
<th>Instrument (prime)</th>
<th>Orbits (08.220–08.255)</th>
<th>Orbits (&gt;08.255)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FGS</td>
<td>6</td>
<td>21</td>
</tr>
<tr>
<td>ACS/SBC</td>
<td>36</td>
<td>210</td>
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<tr>
<td>WFPC2</td>
<td>124</td>
<td>0</td>
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<tr>
<td>NICMOS</td>
<td>87</td>
<td>455</td>
</tr>
<tr>
<td>Total</td>
<td>229 (3)</td>
<td>686</td>
</tr>
</tbody>
</table>

Notes:
1. - new to the LRP: 140 orbits of Cycle 16 calibration
2. - 49 orbits moved forward to fill under-subscriptions
3. - 24 orbits have both NIC and ACS prime
Cycle 16 Tail

WFPC2 prime visits past 08.220 (SM4)

- Programs that will be less than 10% complete at SM4:
  - Leave post-SM4 visits alone; they will be converted to WFC3.

- Programs greater than 90% complete at SM4:
  - Leave post-SM4 orbits alone; program considered complete. PI can appeal for reinstatement of orbits to TTRB.

- Programs between 10-90% complete at SM4:
  - Move forward if possible.
Important Cycle 17 Dates

- CP release: December 3, 2007
- Phase I deadline: March 7, 2008
- TAC/Panel meetings (at STScI/JHU): May 12-16, 2008
- Phase II deadline: July 3, 2008
- SM4: August 7, 2008
- First science observations: SM4 + ~4-6 weeks (TBD)
- End of Cycle 17, start of Cycle 18: January 1, 2010
HST Instrument Teams

- New team structure put in place within INS in late April 2007 (new since last STUC meeting)
- COS and STIS combined into single team
- ACS and WFPC2 combined into single team
- Team leads:
  - ACS+WFPC2: Marco Sirianni
  - COS+STIS: Alessandra Aloisi
  - NICMOS: Anton Koekemoer
  - WFC3: John MacKenty
  - Telescopes: Roeland van der Marel
SMOV & Cycle 17 Preparations

■ SMOV
  ◆ Activities defined, and activity descriptions written
  ◆ HST Project review of SMOV plan held on October 12, 2007

■ Instrument Handbooks under revision for Cycle 17
  ◆ ACS - completed
  ◆ NICMOS - in final review
  ◆ STIS - nearing completion
  ◆ COS & WFC3 - in progress (first handbooks)

■ ETC testing underway
STIS Status

October 2007
STIS Data Enhancement

- All STIS data have been reprocessed ~ 120,000 data sets
- Associations were redefined for 1654 datasets to allow these science datasets to use GO-specified wavecals during calibration
  - Re-associations for 336 data sets waiting for an OPUS software update (expected late October)
  - A few other problem data sets to also be rerun after update
- OTFR has been turned off for STIS
  - Static archive now used to satisfy data requests
  - Retain ability to recalibrate and update static archive if future calibration improvements needed
    - Anticipate only limited updates
- OTFR will be turned on for data obtained post-SM4
  - Improvements (like the association updates) will be included
STIS Documentation

- Complete revision of STIS Data Handbook published in July 2007

- New STIS Instrument Science Reports:
  - ISR 2007-04: wx2d: A PyRAF Routine to Resample Spectral Images
    L. Dressel, 22-Aug-2007
  - ISR 2007-03: Time Dependent Trace Angles for the STIS First Order Modes
    L. Dressel, 17-Aug-2007
  - ISR 2007-02: Changes in the STIS FUV MAMA Dark Current
    C. Proffitt, 06-Aug-2007
STIS Repair

- Flight hardware manufactured
  - LVPS-2R replacement card (2 flight copies)
  - MEB replacement cover
- Hardware undergoing functional and environmental testing
- STIS Cooling System dropped from SM4
  - Minimal benefit for EVA time and resources required
- Aliveness and Functional tests to be run for a repaired STIS during SM4 have been defined
ACS Status

October 2007
ACS-Repair

- **Goals:**
  - Restore WFC functionality under side-1 (LVPS failed in June 2006) by replacing the 4 WFC CEB cards with a new module (CEB-R) powered by a new LVPS (LVPS-R)
  - Restore HRC functionality by backpowering the existing HRC CEB (success depends on the status of the existing wire harness within ACS)
  - Requirement: do no harm to SBC

- ACS-R passed CDR on Oct 3-4, 2007
ACS-R Schedule Highlights

- Testing with the first engineering module of CEB-R and ACS flight spare CCDs will start on October 25, 2007
- Flight LVPS-R ready mid-January 2008
- Flight CEB-R ready early March 2008
- Servicing Mission Ground Testing (SMGT) at end of February 2008 (possibly a second test with fully flight-hardware)
- Thermal vacuum testing - April 2008
- Shipment to KSC - June 9, 2008
- Launch - August 7, 2008
ACS - STScI Activities

- Support ground calibration and identify areas where science operations may need modification (commanding, proposal preparation, data processing)
- Define and support the functional test to be executed during SM4
- SMOV planning and on-orbit re-commissioning
ACS SMOV

- Sixteen calibration activities executed during SMOV will be complemented by Cycle 17 calibration programs
  - Activity descriptions have been completed and reviewed

- Cycle 17 will contain a new “CCD optimization program” that may allow the possibility of reducing the noise of the WFC CCDs.
  - This program will be executed promptly if the noise measured during the SM4 Functional Test is not satisfactory.
  - Unless needed immediately, new readout modes will be deferred until Cycle 18
    - Full characterization is necessary to determine the impact on noise, CTE, cross-talk, etc.
ACS Documentation

- **New Instrument Science Reports**
  - **ISR 2007-02: WFC Zeropoints at -80C**
    J. Mack et al., 03-May-2007
  - **ISR 2007-03: ACS CCDs UV and Narrow-band Filters Red Leak Check**
    M. Chiaberge and M. Sirianni, 16-May-2007
  - **ISR 2007-04: ACS/WFC: Differential CTE Corrections for Photometry and Astrometry for Non-Drizzled Images**
    V. Kozhurina-Platais et al., 08-Jun-2007
  - **ISR 2007-05: Detection of Optical Ghost in the HST ACS Solar Blind Channel Filter 122M**
    K. Collins et al., 04-Jun-2007
  - **ISR 2007-06: Photometric Calibration of the ACS CCD Cameras**
    R. Bohlin, 12-Jun-2007
ACS Documentation

- New Instrument Science Reports (continued)
  - ISR 2007-07: Calibration of ACS/WFC Absolute Scale and Rotation for Use in Creation of a JWST Astrometric Reference Field
    R. van der Marel et al., 05-Jul-2007
  - ISR 2007-08: Variation of the Distortion Solution of the WFC
    J. Anderson, 18-Sep-2007
  - ISR 2007-09: Two astrometric fields for UV observations (ISR 07-09)
    J. Maiz-Apellaniz, 05-Sep-2007
  - ISR 2007-10: ACS Polarization Calibration - Data, Throughput, and Multidrizzle Weighting Schemes
    M. Cracraft and B. Sparks, 20-Aug-2007
  - ISR 2007-11: Calibration of Ramp Filters Using the ACS Grism
    A. Fruchter, 18-Sep-2007
WFPC2 Status

October 2007
WFPC2 Status

- WFPC2 continues to perform well and is operating nominally

- The third temperature reduction of the WFPC2 replacement heater occurred in August 2007
  - Mitigates the effects of the WF4 anomaly
  - One additional adjustment is planned for February 2008
  - ISR2007-01: Temperature Reductions to Mitigate the WF4 Anomaly
    W. V. Dixon et al. 18-Apr-2007

- Dolphin 2004 CTE correction formula validated for data taken in 2007
  - The extrapolation works remarkably well
  - Andy Dolphin has been awarded an archive outsourcing program in Cycle 16 to review the formula with data taken after 2004
  - The WFPC2 team is in close contact with Dolphin and does not plan an independent revision of the formula

- Closeout plans have been defined
  - Most WFPC2 data has already been obtained (modulo remaining Cycle 16)
WFPC2 Reprocessing

The following improvements are being made to CALWFPC2 to support the final reprocessing of all WFPC2 data for the static archive (starting Spring 08):

- **UV throughput correction**
  - A new keyword will contain the correction to apply to the zeropoint to take into account the time-dependent UV contamination

- **WF4 photometric correction (completed)**

- **WF4 bias streak removal**
  - Algorithm is being tested

- **CTE warning**
  - A new keyword will contain the amount of CTE loss expected for a point source in the middle of the chip with a given signal level

- **Pydrizzle**
  - For each image, the pipeline will produce a new geometrically corrected 4-chip mosaic in the FITS image format.
NICMOS Status

October 2007
NICMOS Status

- NICMOS has been on-orbit for 10 yrs, post-NCS 5 yrs
  - >100,000 datasets in archive
  - Continues as major science instrument in Cycles 15/16
  - Expanded effort to characterize instrument as fully as possible

- Calibration:
  - Expanded normal calibration program (additional flats, darks)
  - Special close-out calibration programs (photometry, grism, distortion)
  - New reference files being delivered (time-dependent flatfields, etc)

- Software:
  - Completed: SAAclean, Staypuft, count-rate-dependent non-linearity
  - In progress: calnica improvements, temperature from bias
  - Near-term: pedestal correction, amp glow persistence, electronic shading
Expanded NICMOS Calibration Programs

- **Cycle 16 normal calibration programs expanded:**
  - Improved flatfields:
    - All filters, all 3 cameras
    - Multiple epochs to enable time dependence
  - Substantially expanded darks (400 orbits):
    - Cover all widely used SPARS/STEP readout sequences and timing patterns
    - Repeat observations across ~20 epochs
    - Improves temperature-dependent darks, reduce reliance on synthetic darks

- **Special “legacy” calibration programs**
  - Improved photometric non-linearity calibration in all cameras
  - Photometric cross-calibration
  - Revised geometric distortion
  - Improved grism calibration across entire detector
Special “legacy” Calibration Programs

- Spectrophotometric standards
  - Grism spectroscopy of primary and secondary standards
  - Imaging of grism standards to provide cross-calibration with WFC3, JWST, other future missions

- Improved grism calibration
  - Grism zeropoint/dispersion are only well characterized at nominal position
  - To improve legacy science value, characterize across entire detector:
    - Evidence suggests that errors up to a few pixels exist
    - Can be readily calibrated by placing targets at different locations on detector

- Geometric distortion
  - Evidence for changes of ~1-2 pixel since the last geometric distortion measurements (pre-2002)
  - Observe astrometric standard field (NGC1850), aim for <18mas accuracy
NICMOS Calibration Software Work

- SAA-impacted CR persistence
- Electronic ghosts ("Mr. Staypuft")
- Amplifier glow
- Electronic shading
- "Supershading"
- Bright object persistence
NICMOS Documentation

- Completely updated website
- New Instrument Science Reports
  - **ISR 2007-001: Removing Post-SAA Persistence in NICMOS Data**
    E. Barker et al., 15 May 2007
  - **ISR 2007-002: NICMOS Time Dependent Flat-fields**
    T. Dahlen et al., 29 Jun 2007
  - **ISR 2007-003: NICMOS Focus Update**
    H. McLaughlin and T. Wiklind, 29 Jun 2007
  - **ISR 2007-004: NICMOS Cycle 15 Baseline Calibration Plans**
    N. Pirzkal et al., 16 Jul 2007
FGS Status

October 2007
FGS

- FGS3 is exhibiting gradual degradation related to coarse track cycles on a servo bearing
  - Lifetime is limited by this degradation
- For several years we have been biasing guide star selections away from FGS3 after the observing calendar is built
  - Reduced FGS3 usage by about 1/3
  - Currently use FGS3 for ~26 acqs per week
- Preparing a process to avoid using FGS3 unless necessary
  - Should reduce usage to ~15-18 acqs per week
- OTA group at GSFC is also looking into reducing coarse track cycles for secondary stars
  - Plan is to use FGS3 only as secondary, not as primary
STScI Staffing for SM4
Staffing Trend

The graph shows the staffing trend from FY96 to FY08. The x-axis represents the fiscal years, starting from FY96 to FY08. The y-axis represents the total FTES without FOT and OPO. The bars are color-coded to distinguish between Total FTES and w/o FOT and OPO. The peaks and troughs are marked with labels for SM2, SM3A, SM3B, and SM4.
Staffing Trend

- SM4 will be carried out with a substantially smaller overall staff than previous SMs
- Major areas with fewer staff:
  - Software maintenance and test
  - Operations
  - Engineers (2 vs. ~6-8)
  - Commanders (2 vs. ~6-8)
- Instrument support will be stressed
  - All 5 instruments affected
  - No WFC3 IDT team
## Current Staffing for HST Instruments

<table>
<thead>
<tr>
<th>Team</th>
<th>Instrument Scientists &amp; Engineers&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Data Analysts&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Total&lt;sup&gt;1&lt;/sup&gt;</th>
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<tbody>
<tr>
<td>COS&lt;sup&gt;2&lt;/sup&gt;</td>
<td>3.9</td>
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<tr>
<td>WFC3</td>
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<td>2.5</td>
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</tr>
<tr>
<td>ACS&lt;sup&gt;3&lt;/sup&gt;</td>
<td>1.5</td>
<td>3.0</td>
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<td>HST Observatory</td>
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<tr>
<td><strong>Total</strong></td>
<td>26.2</td>
<td>11.8</td>
<td><strong>38</strong></td>
</tr>
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<sup>1</sup>Entries are FTEs, and do not include research time.

<sup>2</sup>The COS+STIS team shares personnel that work on both instruments.

<sup>3</sup>The ACS+WFPC2 team shares personnel that work on both instruments.
## Expected Staffing in August 2008

<table>
<thead>
<tr>
<th>Team</th>
<th>Instrument Scientists &amp; Engineers&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Data Analysts&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Total&lt;sup&gt;1&lt;/sup&gt;</th>
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</thead>
<tbody>
<tr>
<td>COS&lt;sup&gt;2&lt;/sup&gt;</td>
<td>5.5</td>
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<td>STIS&lt;sup&gt;2&lt;/sup&gt;</td>
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<td>1.0</td>
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<tr>
<td>WFC3</td>
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<tr>
<td>NICMOS</td>
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<td>HST Observatory</td>
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<td><strong>Total</strong></td>
<td><strong>31.5</strong></td>
<td><strong>15</strong></td>
<td><strong>46.5</strong></td>
</tr>
</tbody>
</table>

<sup>1</sup>Entries are FTEs, and do not include research time.

<sup>2</sup>The COS+STIS team shares personnel that work on both instruments.

<sup>3</sup>The ACS+WFPC2 team shares personnel that work on both instruments.
Strategy for Increasing Support

- Our subcontract with JHU provides 3.0 FTE.
  - Comprises 6 half-time scientists with FUSE and ACS experience.
  - All personnel in place and contributing.
- Recruiting 3 new DAs for HST support.
- Recruiting 4 Term-hires, Visiting Scientists, or permanent staff.
  - Final mix depends on qualifications of the applicant pool.
  - 1 Term-hire position filled, to start in November.
  - 19 term-hire and 4 Visiting Scientist applicants being vetted by the Science Recruitment Committee.
  - Permanent staff recruitment ad open until December 1.
  - Goal is to have new term hires in place by early 2008.
- Recruiting 4 ESA positions, 3 for instrument support.
  - SRC has created a short list of 9.
Strategy for Increasing Support

- Will adjust staffing among instruments as appropriate
  - Results of TAC (May 08) will show relative use of instruments after SM4
  - Results of on-going hardware development may drive some changes
  - Results of SM4 itself may affect priorities and distribution of staff
Lunar Initiative Timeline

- 10-Oct-2007: Call for white papers issued
  - Day after A. Stern’s DPS announcement
  - HST website updated accordingly
- 31-Jan-2008: White paper deadline
  - Lunar Advisory Group (LAG) reviews and ranks white papers
- 31-Mar-2008: LAG report to STScI Director
- 01-May-2008: Technical report to STScI Director
  - STScI and HSTP preliminary technical assessment
- 08-Aug-2008: SM4 begins
- 01-Sep-2008: Call for lunar science proposals issued
- 15-Nov-2008: Lunar science proposal deadline
- 21-Jan-2009: Lunar science proposal review
- 01-Feb-2009: Proposers notified of review results
- 15-Apr-2009: Phase II submissions
- Cycle 18: Proposals implemented
Lunar Initiative Support

- **User Information Report** to be released with Cycle 17 CP
  - To help proposers understand what lunar observations are possible within current operations framework

- STScI and HSTP will work together to determine what operational changes may be needed to support future lunar observations
  - Work will have to be scheduled to avoid conflicts with SM4
  - Initial assessment after white papers are submitted
LCROSS

- **LCROSS** (*Lunar Crater Observation and Sensing Satellite*)
  - Goal is to determine whether water ice exists in permanently shadowed regions - polar crater site
  - Scheduled for lunar impact in January 2009
  - Uses Earth-departure upper rocket stage to impact lunar surface
    - Impact creates an ejecta plume subject to solar UV radiation
    - Plume to be observed by LCROSS and Earth-based telescopes
    - LCROSS passes through plume and also impacts surface 10-15 minutes later

- **HST observations**
  - Goal is to observe OH 3085A emission and possibly hydrocarbons
  - Orbit 1: Timed to observe impact (STIS/CCD?)
  - Orbits 2+: To observe transient OH exosphere over several hours