Report of the Space Telescope Users' Committee (STUC) Meeting, November 2004

The Space Telescope Users Committee (STUC) met on November 18th and 19th, 2004 at the Space Telescope Science Institute.

Attended: David Axon, Debra Elmegreen (Chair), Martin Elvis, Eric Emsellem, Laura Ferrarese, Patrick McCarthy, Peter Nugent, Bob O'Dell, Regina Schulte-Ladbeck, Lisa Storrie-Lombardi, Monica Tosi, Don York Unable to attend: Martin Barstow, Karen Meech

The Space Telescope Users Committee (STUC) welcomed reports on the state of the Hubble Space Telescope and the Institute from the STScI Director, Steven Beckwith; NASA HST Project Scientist, Dave Leckrone; Assistant Project Scientist, Malcolm Niedner; NASA HST Program Manager, Preston Burch; Deputy Manager of HST Operations Project, Keith Kalinowski; STScI HST Mission Office Head, Rodger Doxsey; STScI Science Policies Head, Duccio Macchetto; STScI staff scientists, Claus Leitherer, Brad Whitmore, Paul Goudfrooij, Ken Sembach, and Rick White; and STScI grants officer, Ray Beaser.

1. Observatory Status

The STUC appreciated the in-depth presentation on the status of the HST, the expected degradations with time, and alternatives for the prolongation and improvement of its performance. Except for the critical failure of STIS, all instruments are performing well. However, two fine guidance sensors (FGS) are degrading, and two gyros may fail as early as mid-2006. The batteries are following the linear degradation already mentioned at the April 2004 STUC meeting. Predictions made then are still roughly valid, leading to a critical level in ~2008.

(a) Failure of STIS

A critical failure of the side 2 electronics of STIS occurred in early August and led to a suspension of all activities with this instrument. The STIS failure affected programs from Cycle 11,12, and 13, for a total of 1163 orbits, including about 30% of all orbits allocated in Cycle 13. It is clear that this instrument was a cornerstone of HST, with a very high associated publication rate. There is now no spectroscopic capability in the UV (except for the more limited slitless grism and prism modes on ACS), for the first time since the 1970's. COS would restore medium and low resolution point-source UV spectroscopy. STIS was unique for high spatial resolution in the UV and optical, and high spectral resolution in the UV. Ray Beaser assured the STUC that funding issues involving STIS projects were being carefully considered and handled on a case-by-case basis.

(b) Advanced Camera for Surveys (ACS)

All operations are nominal. There was a new STSDAS release in early November, which should aid in calibration issues with this instrument. Learning from the STIS experience, when several weeks were needed to switch to side 2 after the failure of the side 1 electronics, the ACS team is working on a procedure to allow a fast switch from side 1 to side 2, in case of failure.

(c) NICMOS

New software was developed to correct for changes in the dark currents.

(d) Cosmic Origins Spectrograph (COS)

COS is in storage at the Goddard Space Flight Center. A 6-month test is coming up this month to verify the optical throughput, see if the gratings have degraded, and check the overall performance. A major worry is a thermal drift found in the optic select mechanisms. A decision was made to correct the problem in software rather than change the hardware. As a result of the STIS failure from an interpoint converter, similar converters in COS have been evaluated and may be upgraded. The work will be done at Ball, which would also adjust it to make it robot-friendly if there is a robotic mission.

(e) Wide Field Camera 3 (WFC3)

WFC3 passed thermal vacuum testing, which included evaluation of optical performance and stability and science performance in the IR. It had a good thermal and power profile and functioned well. Possible upgrades to the system are being reviewed following the presence of UVIS filter ghosts and some issues with the IR channel. Modifications to prepare for a possible robotic mission, such as installing gyros, are underway.

2. Servicing Mission

A set of options for possible future servicing is being considered, including installation of WFC3, gyros, and batteries, in addition to possible installation of COS and replacement of fine guidance sensor FGS3. It is encouraging that nothing is being done to preclude a manned servicing mission. Dave Leckrone invited STUC to hold all or part of its next meeting at Goddard in order to visit the clean room and see preparations for a possible robotic mission. The STUC welcomes this opportunity, since the Hubble Robotic Servicing/Deorbit Mission (HRSDM) is under serious consideration.

The STUC is pleased to see continued development of servicing plans, although the source of funding within NASA has not been identified. The Exploration Systems Directorate has expressed enthusiasm for the robotic servicing. Some funds are available to develop robotic missions within different projects, including the new exploration initiatives to Mars and the Moon. A robotic servicing mission to HST could be seen as helping these missions by substantially accelerating autonomous rendezvous and docking technologies. Successful servicing would also provide a substantial boost to NASA's image.

3. HST Scheduling

There was no glitch in the scheduling efficiency at the transition between Cycle 12 and 13, nor, remarkably, when STIS failed (also because STIS was not being used when it failed). The extra scheduling took another 30-40% of an ordinary year's scheduling effort. STUC commends the STScI staff for the efficient way they responded to the failure of STIS to minimize the loss of effective use of HST.

About 20% of Cycle 12 orbits had not been scheduled at the time Cycle 13 started; now Cycle 12 is over 95% complete. Less than 5% of Cycle 11 orbits remained at the beginning of Cycle 13. About 1/3 of Large/Treasury programs are complete. There are 25 STIS programs that could be transferred to other instruments; in addition, there are 46 new programs that were awarded time as a consequence of STIS failure. Their selection was based on upper quartile projects on TAC-ranked lists, in consultation with the TAC chair and panel chairs from Cycle 13 TAC. Replacement programs have been received and the Phase II reviews will be completed by the end of November. In terms of the science mix, Quasar Absorption Line and Interstellar Medium Science programs that were

significantly impacted by the STIS failure were primarily replaced by cosmology and stellar population studies.

4. Archival Data System and Future Data Processing

The STUC congratulates STScI staff for improvements in the data processing system to the pipeline as well as the archive. The STUC was pleased with the installation of multidrizzle in the ACS pipeline, which is supported on many different platforms. The extra compute load is well within the system capacity. Archival retrieval time is now less than 2 hours, down from 20 hours a year ago. This speed-up is due to improvements in the hardware and network architecture, with fewer and more powerful computers and simpler interconnections, as well as new software builds that significantly enhanced the overall system efficiency. The re-implementation was completed at the end of the summer. Future safestore methods of core archival data are being considered.

Further steps will be for tweakshift to allow multidrizzle to measure offsets between images directly via object identification, cross-correlation and wavelets, rather than from the pointing information recorded in the header. This will eliminate small pointing errors between subsequent orbits, and improve coordinate accuracy from the current 1-2 arcsec to 0.1-0.2 arcsec. This should be ready within 2 years at most. These efforts will stimulate an even broader re-use of HST data in the future, supporting more archival research programs. The STUC views the improved accuracy of coordinates as an important issue.

Enhanced services under consideration and development include higher level science products, faster response time, and National Virtual Observatory (NVO) compatibility, with most data retrieved from an extended archive of calibrated data and catalogs. STScI is the site for the NVO project management. NVO, in concert with international virtual observatories, provides a set of international standards for sharing data. Through the platform Aladdin, data for a given object can be extracted easily from multiple archives. The STUC applauds the continued development of the NVO. The STUC urges that the Directors of the key space telescopes (Chandra, Spitzer, HST) coordinate on archive standards and tools.

5. Archival research metrics

At STUC's request from the last meeting, the Institute reported on the statistics of Archival programs from Cycle 5 through Cycle 11. There have been 446 funded archival programs. Altogether 35% of HST papers published in refereed journals are based on archival data: 1546 archive-based out of a total of 4417 HST-based papers. The distribution of archival programs is peaked on Cycle 7 (80 programs), and the distribution of archival papers is peaked on the same cycle, with 107 published papers. STUC notes that this is probably an underestimate of archival productivity, since archival use from later cycles will grow with time. These programs, by definition, are second uses of the data, so the production of ~50% more papers than GO papers alone is a significant gain to the scientific return from HST.

6. STIS Close-out Plan

Cycle 11 and 12 calibration programs are being analyzed. Final calibration parameters will be determined and delivered. In particular, sensitivity calibration for Echelle modes will be prepared and delivered, using data collected up to August 2004. There has been a degradation in sensitivity of the Echelle modes from 1997 to 2004. Furthermore, the flux calibration has deteriorated because the groove angles changed with time. FUV-MAMA detectors have a residual dark pattern that is not corrected by the pipeline. The problem has become more pronounced during recent cycles.

Other planned activities in the pipeline areas are:

1. a spectroscopic extension of the multidrizzle program
2. CTE correction
3. improvements to the preview feature in the archive/retrieval pages
4. association of GO wavecal associations with the appropriate science spectra, so that all can be downloaded at the same time
5. update to the data handbook
6. preparation of a document summarizing issues with operation and calibration of STIS, which can be of use for other science instruments.

The STUC believes that item 1 (multidrizzle) and item 4 (wavecal) are high priority items, but that some other items may be less useful. The STUC notes that the discussion should also include whether some of the efforts expended here should be partly switched to software support efforts on active HST instruments and archive efforts, such as those discussed in section (4). STUC members Dave Axon and Don York have agreed to be involved in the STScI review and prioritization of the close-out plan.

7. Cycle 14 Update

The Call for Proposals (CP) was released in October. The proposal deadline is January 21, 2005. Panels/TAC will meet on March 13-19, and Cycle 14 observations start July 2005. There will be an opportunity to share time between HST and Spitzer (130 orbits of HST time vs. 225 hours of Spitzer time, each equal to 2 weeks of time). In addition there is a proposed new category to assess larger proposals that make use of both Spitzer and Hubble.

One major uncertainty is whether the telescope will operate in two- or three-gyro mode during Cycle 14 (see item 9). The decision will not be made until after in-orbit tests currently scheduled for February; i.e., after the proposal deadline, when critical tests to establish the feasibility of the two-gyro mode will be performed. Therefore, the PIs are asked to describe the science in the regular three-gyro mode, but also to describe whether and how the science can be done in the two-gyro mode. It will be possible to propose a separate set of targets for two-gyro and three-gyro modes. Proposals will be ranked by the TAC in two lists, one assuming a three-gyro model and one assuming a two-gyro mode. If three-gyro mode is still available at the beginning of Cycle 14, Phase 2 will be submitted in May for three-gyro mode operation and 1-2 months later for two-gyro mode operation, in case a gyro failure occurs during Cycle 14.

The STUC is pleased that the solar system panel will be expanded since it does not have a mirror panel, and that three at-large members will be included for the TAC.

8. Science Center Services

A small internal Institute survey of Science Center services for observers on Chandra, Spitzer, and HST was made to determine what worked well and what needs improvement. Users were generally satisfied with proposal software, with some minor issues. TACs were deemed to be well-run and fair. The use of parallel panels during reviews was good. Two-phase proposal systems were preferred. Users suggested having compatible proposal tools for the three institutes. The majority of survey respondents favored a "fair share" algorithmic approach for grant support, which might be considered for HST (taking into account variable overheads). The STUC comments that improvements to the Astronomer's Proposal Tool (APT) have been very helpful for planning observations.

9. Two-Gyro Science Mode

Tests and preparation for two-gyro science mode (TGS) are progressing well. Some software has been loaded. The final flight software load and on-board testing will take place in February 2005. Jitter analysis suggests that the performance of HST will be degraded less than previous models indicated; maximum jitters are expected to be up to 18-20 mas. At the moment four of the six gyros are operational. The typical gyro lifetime is 4.77 years, and one of the currently operating gyros will reach its expected 50% failure time by mid-2005; the probability of being able to continue in three-gyro mode would drop to 50% by May 2006. Various options are being considered, ranging from using 3 gyros as long as possible to switching to 2 gyros as soon as July 2005. A pre-emptive switch to TGS in mid-2005 would add some 2400 to 3000 orbits to the useful lifetime of the telescope. The estimate is that 70-75 orbits per week will be schedulable in two-gyro mode; presently 80 orbits per week are scheduled on average. The transition will be complex and could be moved around some, to complete Cycle 13 programs, for example.

The impact on science programs of the two-gyro science mode was discussed with STUC. With TGS, coronography will suffer and may not be possible both due to the inability to do multiple roll angles in a short time and to the larger PSF. Scheduling of other programs will be impacted and many programs will be less efficient. Roll angle-constrained and time-constrained observations will be more difficult and subject to the targets being in the accessible part of the sky, which will be more restricted. Guide stars will need to be brighter than 14th magnitude and single guide star tracking will not be allowed. Taken together, all of the above will have a major impact on Target of Opportunity (ToO) observations.

Studies indicate that an idle gyro does not degrade significantly, and will probably restart without incident. If February tests show that a two-gyro mode performance is worse than expected, the three-gyro mode will be kept for as long as possible. If, as hoped, the tests show that the in orbit performance is as good as current predictions indicate, the Institute and NASA will need to decide whether to deliberately use the two-gyro mode at the beginning of Cycle 14.

A decision about an early entry into two-gyro science mode, deliberately reducing some aspects of mission performance, is one of the most momentous issues to be brought to the STUC. It is significant that consideration is being given to entering two-gyro mode prior to there only being two gyros available. The extension of the HST operational life by early use of TGS is promising. This would, however, make an important change in the nature of HST operations, impacting some observing programs (such as certain coronographic or time-constrained observations). We note that several high profile HST science programs - GRBs, SNe, large surveys - may be negatively impacted by two-gyro mode operations.

On the other hand, since the TAC has to reject many highly ranked programs in every cycle, it seems unlikely that TGS operations would not be able to carry out a top quality science program. We note that Spitzer operates under constraints similar to those of two-gyro mode and that GOs are creative about designing programs to accommodate these constraints. Moreover, the ever-evolving nature of science means that a longer operational life is likely to lead to HST being able to address topics that have not yet been uncovered.

Among the STUC members, 8 of 12 favor going to a two-gyro mode in July 2005, with key concerns discussed by all regarding how the top science programs would be impacted. The continuation of the best science should be the key driver in the decision. Ultimately, it may be in the best interests of science to prolong the life of HST, which may mean that an early two-gyro mode is the best approach. At this time, STUC feels that there is insufficient information about the scientific impact to assess whether the loss of some programs would offset the gains of a longer operational life. We strongly encourage further studies of this difficult and crucial issue, and urge that the use of the three-gyro mode for Cycle 14 is not precluded until the TAC has evaluated the proposals.

The STUC agrees that there should be a November 30 email and a webpage announcement alerting potential proposers to the increased probability of going to two-gyro mode, so that proposals are sure to include a discussion of the two-gyro mode implications (as already requested in the CP); the email should re-iterate that there will be two ranked lists, one for three-gyro and one for two-gyro mode. The Two-Gyro Mode Handbook and website are up and running, and should prove very helpful for Cycle 14 planners.

10. Summary

The STUC thanks the Institute for its hospitality and congratulates the Director, the members of the STScI, and the GSFC/HST Project for their hard work during challenging times. In particular, we acknowledge and commend:

- efficient rescheduling following the STIS failure
- continued development of the two-gyro science mode
- continued development of possible servicing plans
- continued preparation of COS and WFC3 instruments
- expansion of the solar system panel and addition of at-large TAC members
- substantial improvements to the data processing system hardware and software
- STScI efforts on the NVO and making the HST archive NVO-compatible
- the new catering service at STScI!

The STUC also encourages and recommends:

- a November 30 email/webpage announcement to the community stressing the possibility of a two-gyro mode in Cycle 14 and the need for proposals to address two-gyro science
- continued study of the impact of the two-gyro mode on science and scheduling issues
- continued selection of the best science by the existing TAC process
- discussion by directors of HST, Spitzer, and Chandra to develop common software standards
- further review of STIS close-out (with Dave Axon and Don York representing STUC in the discussions, including getting updates from Paul Goudfrooij as problems are better defined)
- appointment of solar system and target-of-opportunity experts to STUC

11. Next meeting

The next meeting of STUC will take place April 4 and 5, 2005 at the Institute (and possibly partly at Goddard). Items for the agenda include, in addition to responses to the above concerns:

- discussion of NAS reports
- update on two-gyro science mode tests
- update on servicing mission development
- update on gyros and battery life expectancies and the impact on science
- update on instrument functionality
- discussion of STIS close-out prioritizations

12. Portfolio assignments

Retiring members: Debra Elmegreen, Karen Meech, Peter Nugent, Lisa Storrie-Lombardi **Incoming Chair** of STUC: Martin Elvis

Portfolios indicate the areas of primary responsibility for each STUC member. The portfolios were reviewed, and assignments made for new members as follows (changes in **boldface**):
ACS/WFPC2: Tosi, O'Dell COS: Axon, York, Schulte-Ladbeck, **Barstow** NICMOS/
WFC3 **McCarthy, Ferrarese** Proposal Handling and Scheduling: Axon, **Barstow** Software Analysis Tools: **Elvis**, Emsellem Targets of Opportunity: Elvis Solar System Issues: **Elvis**Archive: Elvis, Tosi TAC: O'Dell, York GO Funding: **McCarthy, Ferrarese New portfolio:** Two Gyro Mode: Eric Emsellem, Regina Schulte-Ladbeck