

**Report of the Hubble Space Telescope Users Committee**  
**April 12 –13, 2007**

**STUC Members Present:** Barstow, M., Ferrarese, L., Garnavich, P., Green, J., Kneib, J.-P., Koo, D., Mateo, M., McCarthy, P., Nicholson, P., O’Connell, R., Renzini, A., Saha, A., Treu, T., Vestergaard, M.

**Top Level Observations and Recommendations:**

The STUC wishes to commend the Institute and the Project for their timely and adept handling of the cycle-15 observing program and cycle-16 proposal process in light of the anomaly with ACS. This was a unique challenge and the Hubble team rose to the occasion with prompt planning and careful follow-through.

The STUC is pleased to see great progress in the planning for SM4. We look forward to the installation and commissioning of COS and WFC3 with great anticipation. We are encouraged by the early indications that repair of ACS may be possible and by the maturity of the plans to restore STIS to operation. We believe that this process should continue and be given high priority in the planning for SM4. We congratulate the Hubble team for its success to date in planning for this ambitious servicing mission.

The project asked the STUC to prioritize the installation of new instruments during SM 4. The committee believes that the successful installation of both COS and WFC3 is of the highest scientific importance, but if needed, it would place a higher priority on the installation of WFC3. The STUC believes that if there are no technical reasons to do otherwise, WFC3 should be deployed with the channel select mechanism set for the UVIS channel (see attachment).

NASA Headquarters asked the STUC to assign relative scientific priorities to the repairs of STIS and ACS as part of SM4. The STUC has drafted a plan to make this prioritization and will deliver its recommendation to the Project and the Institute on, or before, May 15, 2007 (see attachment).

The STUC has drafted a letter to the Chair of the Astrophysics Subcommittee of the NAC pointing out the continued scientific impact of HST even after the loss of parts of ACS and the ongoing need for healthy guest observer and archival research grant programs. We also note that HST is poised to enter its most powerful and productive period and this is not the time to reduce support for science. We encourage the subcommittee to support efforts to develop repair plans for ACS and STIS.

The STUC sees no compelling reason why approved ACS/SBC programs should not be carried out. We encourage the Institute to look at possible schedule models that would concentrate SBC usage in a manner that would minimize the risk of further damage to the ACS electronics.

The committee has some concerns that the Institute may not have the required personnel to support HST instruments post-SM4. We encourage the Project and Institute management to examine the size of the instrument support teams from the perspective of the most optimistic outcome of SM4. We suspect that additional staff may be required.

The STUC does not believe that there is a compelling case for opening COS to replace the two low-resolution gratings. While the apparent degradation is a source of concern, the committee feels that the problem is not sufficiently well understood to warrant the risk associated with opening the instrument this close to launch.

The committee commends the WFC3 team for their perseverance in obtaining superb detectors for the IR channel. We hope that the issue with the UVIS detector is resolved soon and that the instrument team can meet the tight schedule for integration and testing prior to launch.

The STUC believes that the ST-ECF provides a valuable service to the worldwide HST user community. Their development and calibration activities benefit all users of HST and their observer support activities are important to the successful use of HST by scientists in Europe. The STUC is concerned that the ECF activities are scheduled to terminate upon the expiration of the NASA-ESA MOU concerning HST in 2010. We urge NASA and ESA to work together to extend the MOU, and the support for the ECF, until at least 2014.

#### **Other Recommendations:**

The STUC suggests that the Institute reevaluate the survey proposal category in light of the lack of successful proposals in cycle 16. It appears to the STUC that the program should either be incentivized or terminated. We would like to see this program succeed.

The STUC concurs with the proposal to move the cycle 17 deadline back a few months from the nominal January 2008 date and encourages the Institute and Project to migrate the proposal cycle back towards the original late summer deadline.

The WFC3 and COS science white papers provide good overviews of the science missions for the two instruments. The committee was concerned that there may be some inaccuracies and omissions in the current drafts and identified four people from the committee (two for each) to work with the teams to produce final versions of the white papers.

The committee is impressed with the work being done on the Hubble Legacy Archive and believes that this activity should continue to receive ample support. We believe that the HLA can become a valuable and important tool for research for years to come. The STUC felt that if there was a serious shortage of personnel that priority should be given to new data and active instruments and that archival activities can accelerate or decelerate

as other needs dictate, provided a suitable level of continuity is maintained. Mario Mateo has volunteered to serve on the HLA Board.

Parallel observing offers a means to increase the scientific productivity of HST at modest cost. We encourage the Institute to prepare for the powerful parallel capability provided by the post-SM4 instrument suite. We also encourage them to consider the optimal approach to producing scientific results in this mode. This may involve allocation of time or observing programs in a manner other than the standard TAC process. Some thought should be given to reconstituting a parallel working group.

## **Meeting Minutes**

### **STScI Outlook: (Matt Mountain)**

Mountain presented a very positive perspective on the recent developments at the Institute. He stressed that Hubble is still producing very high-level science, and highlighted three recent key science results. These include the determination of the mass and orbital inclination of a planet orbiting Epsilon Eridani using the FGS, the mapping of the dark matter distribution in the COSMOS field and new evidence that Dark Energy is an unequivocal component of the cosmic energy budget. The number of publications including Hubble observations is still growing and most of the growth appears to be driven by the archive.

Mountain summarized the ACS timeline and its recent failure. This led to the implementation of the backup proposals, and the extension of the proposal submission deadline.

The Astrophysics Subcommittee of the NASA Advisory Committee has suggested that NASA should engage STUC or other committees to evaluate the merits of repairing STIS and/or ACS during SM4. The subcommittee also suggested that Hubble's currently reduced capabilities should lead to a reallocation of grant support from Hubble to NASA's R&A programs. Mountain believes that the subcommittee is in error in suggesting that Hubble is no longer an unparalleled scientific resource and he argued that the response to the loss of ACS will require more research funds rather than less. He asked the STUC to take action on this issue. He noted that the chair of the cycle 16 TAC produced a very strong letter in support of the sustained scientific vitality of HST.

**HST Status:** (Sembach) Ken Sembach updated the STUC on the causes of the ACS failure that occurred on January 27, 2007. The failure of the side 2 auxiliary-power box (combined with the previous, unrelated failure of the side 1 electronics) has left the WFC and HRC inoperable. It was noted that there was a significant gas discharge within the instrument. It is unclear whether this has had any effect on the WFC and HRC, however, there is reason for optimism given that the SBC does not appear to have suffered from any contamination. The STUC congratulated the institute for their prompt and effective response following the failure. In particular: 1) a surprisingly small number of orbits were lost: about 50-60 (out of ~72 expected) in the week following the failure, with the

scheduling being back to full efficiency on the second week; and 2) the ACS was promptly switched to side 1 so the SBC could be operated. Of the 321 orbits using the SBC and planned at the time of the failure, about 70 have already been executed (as of April 1, 2007). Calibration of the SBC continues as planned. Calibrations relevant to data taken using the side 1 electronics (prior to the June 2006 failure) is virtually completed. Calibration of the WFC and HRC operating from the side 2 electronics is more problematic, in particular: 1) the switch from the side 1 electronics to the side 2 electronics which occurred in July 2006 was accompanied by a 4 degree drop in the temperature, which led to a significant changes in the QE and flat fields, in particular for the WFC; 2) planned data to characterize CTE effects has been lost as a consequence of the side 2 electronics failure. Calibration efforts have been prioritized and are geared towards long-term use of archival data. Items with highest priority are 1) CTE characterization of WFC and HRC, which will be made using data collected between 2004 and 2006; 2) flat fields for the WFC F850LP filter; 3) QE curve for WFC after cool down; 4) new L-flats for both WFC and HRC, pre- and post-cool down. Some planning is underway to come up with a strategy in case ACS is revived during SM4. A successful repair of the instrument will require completely new calibrations to be performed, as well as an update of all proposal tools/documentation.

#### **Two-Gyro mode: (Reinhart)**

Reinhart reported that an average of 72 orbits per week are scheduled in 2G mode (compared to ~80 in three Gyro mode). After transition to 2G mode, the initial GS acquisition failure rate has been of the order of a few percent, but a systematic increase has been noted between December 2006 and January 2007, with failure rates as high as 18%. This can be partially accounted for by the switch from GSC1 to GSC2: by including fainter objects, the latter catalogue suffers from more severe contamination from faint galaxies, double stars, variable star, etc., all of which will likely lead to acquisition failure. It is estimated that failure due to catalogue issues is of the order of 2.4%. The other notable cause of failure is drift that occurs before fine lock is achieved. Several issues related to the GSC2, in particular in the Coma cluster region, have been resolved. Other software problems (e.g. pointing errors which occurred after a successful acquisition following a failed acquisition, and failed GS re-acquisition following a small angle maneuver in the previous orbit) have been identified and corrected.

#### **Cycle 15 and 16 Update: (Neill Reid)**

The loss of ACS has been a major development in the science operations for cycles 14, 15, and 16, impacting ongoing programs, scheduling, proposal submission and review, and science programs for Cycle 16. The ACS contingency program minimized the impact of the loss of ACS on the science program of Cycle 14 and 15. Thirty five proposals were submitted and 6 (753 orbits) were selected by subset of the Cycle 15 TAC. The rapid implementation of the ACS contingency plan allowed science operations to be restored to normal efficiency with a loss of approximately 1 week of science time (~70 orbits), despite the high fraction of time scheduled with ACS. The STUC congratulates STScI for the foresight and seamless execution of the ACS contingency plan, and thanks the Cycle

15 TAC for participating in the peer review process.

Approved ACS programs for cycles 14 and 15 accounted for approximately 1600 orbits and 1200 snapshot targets. The programs were reviewed and considered for transfer to working instruments according to the procedures applied after STIS failed. The process is not yet complete; to date approximately 1000 orbits have been transferred from ACS to other instruments. Together with the 750 orbits devoted to the ACS contingency proposals, this exceeds the original ACS allocation and ensures that a full schedule can be maintained through the end of Cycle 15. As in the case of the STIS failure, terminated ACS programs will not be revived in the event of an ACS repair, but will have to compete again for time through the normal proposal process. The STUC commends the Institute for carrying out this process quickly and effectively and for giving users the opportunity to participate in the process of recovering as much science as possible.

The cycle 16 proposal cycle was also heavily impacted. ACS failed the day after the proposal deadline and accounted for 450 programs out of 747 total. The Institute responded promptly extending the deadline by two weeks within 2 days of ACS failure. The HST users community responded very positively to the extended deadline: the number of the submitted proposals exceeded the original number (+47 proposals, excluding AR and theory). Oversubscription was higher than in Cycle 15. Thanks to the joint efforts of the Institute and of the panels and TAC members, the schedule for Cycle 16 peer review was unaltered. Panels and TAC members were instructed that SM4 is not guaranteed to happen, and therefore compelling programs that are feasible with WFPC2 should be given the chance to carry out the science. However, it was also suggested to panel members to consider that in some instances the gain with WFC3 may exceed a factor of 10 in exposure time.

Two new proposal types were introduced for Cycle 16. Joint HST-Spitzer proposals were introduced to allow the community to exploit HST/SST synergy during the last cycles of SST, without introducing double-jeopardy. Only 5 proposals were submitted, with a total request below the total number of orbits/hours available for this program. Two proposals were selected by the TAC, requesting 222 HST orbits and 168 Spitzer hours. Survey programs were introduced in response to the declining execution rates of snapshots program in recent cycles, with the goal of optimizing the schedule and recovering HST orbits. Of the 29 proposals submitted, only 16 met the criteria and no survey proposals were accepted. It is unclear whether the outcome of this experiment is due to the fact that survey programs are inherently less effective than GO programs or due to the fact that the community did not have time to digest and exploit this new format. The STUC wonders whether this opportunity will be offered again in Cycle 17 and whether Survey Programs should be encouraged, for example by setting aside a separate pool of orbits, if they benefit the overall efficiency of the observatory.

The TAC considered the programs selected in Cycle 16 to be cutting edge and extremely compelling, and would support extending panel allocations by 30-40%, without further review, to fill the schedule in case SM4 slips.

The STUC commends the institute for minimizing the impact of ACS failure on cycle 16 review process. The STUC is delighted to hear about the positive response of the community to the extended deadline and that a compelling science program could be selected for Cycle 16.

The proposed Cycle 17 schedule is based on SM4 occurring in September 2008, with HST available for observations by the end of November 2008. Cycle 17 will offer the full suite of instruments, assuming SM4 is successful. The Cycle 17 deadline will be moved to the beginning of March 2008, the TAC will meet mid-May 2008, and phase-II will be ready by July/Aug 2008 (pre-SM4). Cycle 17 will run from the end of SM4 to the end of 2009. A supplemental call for proposal will be issued in case SM4 slips into 2009. The STUC endorses the current plan for Cycle 17. However, the STUC suggests that the plan be revisited at the next STUC meeting in October 2008, when more accurate predictions of SM4 launch date will be available.

**Instrument Support: (Sparks, Biretta, Keokemoer, Doxey)**

Bill Sparks reported on the progress with calibration activities for the current instruments and closeout for WFPC2. Approximately 68 orbits were allocated to calibration activities with ACS and these have been impacted by the loss of the HRC and WFC channels. Focus monitoring has been transferred to WFPC2. As WFPC2 is now a heavily used instrument its calibration plan has been modified and enhanced with greater emphasis on calibrations needed for current and upcoming observations. There is a fairly large NICMOS legacy calibration planned and the institute would like to see this completed before SM4. Some of this activity has been outsourced through the proposal process.

The institute continues to work on cross-instrument flux calibration using a set of ~50 stars tied to three DA white dwarfs with accurate model atmospheres. COS will use the common HST flux standards and WFC3 will use the ACS visible and NICMOS IR standards.

Sparks outlined the calibration plans for COS and WFC3. These will build on heritage from the STIS, ACS and NICMOS calibration plans. The STUC was pleased with the organization and progress in this area particular given the trying circumstances arising from the ACS anomaly.

John Biretta summarized the status and closeout issues associated with WFPC2. This instrument has assumed great importance with the failure of ACS in Jan 2007 and this change has significantly complicated the scope and magnitude of effort associated with this instrument. The STUC is supportive of the WFPC2 team's efforts to bring this instrument back to frontline status as a user instrument, including obtaining calibration data, attacking the principal known photometric problems in WFPC2 (the CTE issue and the WF4 anomaly), and updating user documentation to reflect new calibration methods and ensure the community has an accurate understanding of the current performance of the instrument. We understand and agree with the significant increase in Institute support to this group (from 1.5 to 5.2 FTE). Both Biretta and Rodger Doxsey implied that

the loss of ACS makes it more difficult to ensure a clean closeout of WFPC2 at SM4. However, the STUC considers this a reasonable trade given the need to maintain WFPC2 in the best possible health as it serves as the only optical imager on HST prior to the servicing mission. We warmly congratulate the WFPC2 team for its flexibility since the failure of ACS and its efforts in supporting this instrument as its usage increases by nearly a factor of 10 compared to when ACS was operational.

Rodger Doxsey presented a sobering description of the multitude of issues that have arisen in supporting HST instruments since the failure of ACS, and of the wide range of possible instrumental configurations of HST after a successful SM4. The presentation laid out a strategy in which both WFPC2 and NICMOS must be supported as prime science instruments in the period leading up to SM4 (these instruments have experienced factors of 10 and 2 increases of usage since Jan 2007, respectively). In addition, resources will eventually have to shift to preparations for SM4, then to support of SMOV operations, then normal operations on (potentially) the most powerful and varied suite of instruments every available on HST. Given the uncertainties in the schedule for SM4, the specific instrument installations and repairs that will occur, this implies preparations of a wide range of possible contingencies.

The STUC was impressed that it appears that the current instrument group feels it should be able to handle all this effectively, and we broadly agree with the prioritization of tasks: Support WFPC2 and NICMOS as active user instruments up through (and in the case of NICMOS, beyond) SM4, obtaining necessary calibration data for both instruments to ensure the best possible treatment of new data, and, ultimately, archival data for each instrument. This effort is especially impressive given the limited staffing, though the entire team seems to understand and accept the challenge of the effort. The rapid shift of programs and instrument usage after the ACS failure is to be greatly commended and bodes well for the ultimate success of this team as it addresses the new challenges. The STUC congratulates the entire HST instrumentation team for their energy, imagination, and determination in this process.

### **COS & WFC3 White Papers:** (Leitherer and Fruchter)

The STUC heard two excellent presentations on the science white papers prepared for the COS and WFC3 instruments, prepared to assess their relative merits. STUC appreciated the efforts of the white paper leaders and the teams in preparing the documents and recognized the major contributions that both instruments will be able to make to science with HST if successfully installed. There were some concerns raised that some of the science claims in the two papers were not fully supported and that some key capabilities may not have received adequate attention. Two members from the STUC were assigned to work with the two teams to produce final versions of the papers. These people are: O'Connell and McCarthy for WFC3 and Green and Barstow for COS.

It was recognized that it was necessary to provide a clear recommendation of the priority for installation of the two new instruments during SM4. After careful discussion it was agreed that, in the remote possibility that only one instrument could be installed during

SM4, the top priority would be WFC3. However, STUC wished to make it clear that this was a relative ranking of two very strong cases and the ideal result was that both instruments should be installed.

**WFC3 SOC Early Release Science:** (O'Connell, McCarthy, Whitmore)

The SOC heard presentations from Peterson and McCarthy related to the proposed early release science program for WFC3. O'Connell introduced the subject and explained the history of the SOC and the instrument. He noted that the role of the SOC had grown considerably from what was originally envisioned. The SOC has no GTO time and no grant support. The STScI Director is considering awarding some observing time to the SOC to quickly demonstrate the power of the instrument.

The STUC discussed this issue, with members of the WFC3 SOC excused and concluded that there is some value in having the WF3 team carry out a quick science program. They made three recommendations to the Director. These include: 1) drawing on community input regarding the choice of fields and targets, particularly for the  $z \sim 1$  portion of the program, 2) setting up a special pool of funds to support archival research with these data as was done for the UDF, and 3) seeking input from members of the community outside the WF3 team.

**Hubble Legacy Archive:** (Whitmore)

The goal of the Hubble Legacy Archive (HLA) is to secure an enhanced science return of the data obtained with HST on long time scales. This is especially important given the significant and ever-growing size of the HST archives; it has a strong potential of providing a significant source of data and science products for current and future science programs. It is appropriate to engage in this project at the current time while the relevant instrument/data specialized expertise is still present at STScI and ST-ECF. The current emphasis is to provide (i) easily accessible, fully calibrated non-proprietary data with improved astrometry either as individual exposures, combined images from a single visit for deeper images, and as mosaics build from data from multiple visits for a wider field of view, (ii) instrument footprints on sky survey plates, and (iii) source cut-outs of HST data. The first release (primarily individual and combined ACS exposures) is aimed for summer 2007. Second release (ACS mosaics, NICMOS grism extractions, WFPC2 images) is expected in winter 2008. The HLA is also expected to receive final data products from the Treasury Programs in the future.

The STUC is pleased to see that the HLA team has followed the STUC's earlier recommendations to prioritize data products that will be useful to a larger pool of users (i.e., fully calibrated and drizzled images with improved astrometry which are readily available on disk at STScI for fast retrieval as opposed to extended source lists of positions and photometry which often is either ill-suited or inadequate for all applications) and to utilize software, interfaces, and algorithms that are already available. The STUC is also pleased to see that the HLA team recognizes the need to actively seek user input so to provide products that users want.

The STUC commends the HLA team for providing on a relatively short timescale an impressive interactive product, that will not only be useful to users and easy to use, but which also runs relatively fast, automatically, and which does not require large efforts by the HLA team to produce. The STUC recommends that the HLA team, if at all possible, make use of the efforts of existing archival programs to recalibrate and mosaic the archived ACS images so to ease the burden of the HLA team.

Whitmore asked for a volunteer from the STUC to serve on the HLA board. This group will likely meet infrequently at the Institute, but will have regular telecons. Mario Mateo agreed to serve on the group.

### **ST-ECF: (Fosbury)**

Bob Fosbury reported on the activities of the ST-ECF. This group is co-funded by ESA and ESO with currently 14 staff members. In October 2006 it was decided to terminate its activity in 2010 date at which the original Hubble MOU between ESA and NASA was ending.

ST-ECF is conducting 4 main activities. The first is linked to software development to exploit the grism spectroscopy instruments of Hubble (NICMOS, ACS and soon WFPC3). This software have been developed so that it is easily reconfigurable depending on the instruments capabilities, and thus has potentially future application such as NICSPEC on JWST or even ground based spectrograph.

The second activity is linked to the archive activities. ST-ECF is responsible of the European Hubble archive, and is part of the Hubble Legacy Archive initiative focusing in making high-level data products for all grism spectroscopy modes of Hubble instruments. The first products will be soon release and will contain the NICMOS grism pilot project. The aim is to publish in 2010 their final HLA products.

The third activity is the European outreach, which is leaded by 2 staff members, helped by a number of trainees. This outreach contribution has very high visibility at its using almost half of the ESO data download bandwidth. It has developed the "fits liberator" a software now widely used to read fits images in Photoshop. Recently, they have produced posdcast (called hubblecast) to target the younger part of the public.

Finally, the fourth activity is the ESA/ESO coordination that has brought together group of astronomers to write reports on different science topics (extra solar planets, the Herschel-ALMA synergy, fundamental cosmology, and a 4th one is to come on galactic structure). These reports are feeding the Astronet group who is working on the European science vision for astronomy.

STUC thanks ECF for its very productive support to the Hubble project. We are however very concerned by the possible termination of this group in particular for its unique

contribution for the instrument activities (grism spectroscopy), their important HLA and the wonderful outreach contribution.

**NASA HQ Report:** (Hayes)

Jeff Hayes reviewed the overall outlook for astrophysics within NASA's program. In general the program is healthy and all of the current missions are functioning well. The projected budget for astrophysics declines gently over the next five years. There are budget issues associated with SM4 and the launch slip from spring 2008 to fall 2008 has resulted in a roughly \$40M shortfall that will need to be met within the Science Mission Directorate and likely within the astrophysics division in particular.

Hayes charged the STUC with providing a scientific prioritization in the potential repairs of ACS and STIS as part of SM4. He asked the committee for its input on this question within two weeks. The committee discussed this in considerable detail in executive session and has drafted a letter to Leckrone and Mountain on this subject. This letter is appended to this report.

**Status of the Project and Program:** (Burch, Leckrone)

Burch reported that the flight for SM4 could be as early as August 11. It is quite unlikely that the launch would move before July. We are now at L-17 months, but Johnson will not start its contracts for the detailed work for the mission until June, so there is no real chance of a launch in May 08. He reviewed the considerations in deciding which FGS unit will be replaced and reported that we are currently in good shape regarding gyros.

During SM4 new batteries will be installed. The current replacement batteries will be 12 years old at launch, the batteries on-orbit are 20 years old. The new ones are in a freezer at Goddard. A new battery procurement is underway. STIS repair appears to be coming along well and has passed a CDR. The flight timeline calls for ACS repair on the same day as the COS installation. The STIS cooling system will go in after the STIS repair. They will give some of the cooling envisioned by the aft shroud cooling system, which was not installed. Five EVAs will accommodate the task list: two new instruments, two repairs, plus house keeping. The most likely site of the ACS failure is on board 3 on side 1. The repair plan calls for removal of four boards and the installation of a new power supply. This will provide power for the WF channel. They may also be able to use the copper pads to back power the HRC. The new power supply will not have the same interpoint converter (the component that failed) and COS and WF3 will not have these either.

Leckrone reported that the goal for SM4 is to have five working instruments for the first time since 1993. This will put Hubble at its high point. ACS was getting 70% of the time in 2005, averaging 50%, STIS was between 17 and 30%. He suggested that white papers dealing with ACS+WF3 as an imaging capability, and another looking at COS+STIS as a spectroscopic capability would be helpful.

Leckrone raised an issue relating to the COS gratings. There has been a loss in throughput in two of the low-resolution gratings. The loss is in the range of about 15%, the projection is that there would be a 20-25% loss in throughput at the time of launch. G225M is going down about 1.2% per year, G285M is going down at about 4.4% per year at the worst wavelength. It is not clear if the degradation will continue after launch. If the root cause is oxidation of the Al coating it will stabilize. There are no obvious pin holes based on inspection. Polarization does not appear to be a problem either. There does not appear to be any migration of the gold undercoat. The degradation is real, but not well understood. Surface contamination from C and F appear to be involved and they may interact with polarization. He believes that he would like to swap the gratings but given the risks the project at the moment is leaning towards leaving the gratings in place. He wants to know if there is a killer application that would be lost if we went with a grating with 40-50% throughput of original value. The time scale for this decision is two months. Green thinks that the risks are high and the return modest.

#### **SM4 prioritization:** (Leckrone)

David Leckrone feels that there is a great deal of pressure to come up with a priority list. He presented a chart that lays out the process. The institute senior staff will represent the users community at the final planning and prioritization meeting. The final priority list is sent to SMD at headquarters and if accepted this leads to the final EVA timeline. The STUC will send Leckrone a letter stating our priorities for instrument installation. He asked if we could identify any significant science impact that we would lose if Hubble were out of operation for a year.

He also noted that there is a question regarding whether they continue to operate the SBC side of ACS. There is a risk to ACS reparability if side 1 fails again before SM4. He asked the STUC to comment on the issue of whether SBC should be operated or if we should stand down.

The STUC has been charged with advising on the order of installation of new instruments during SM4. Accordingly, subcommittees of the STUC have produced white papers to summarize the science to be enabled by WFC3 and COS, instruments that brilliantly exploit the key features that make HST so powerful: high spatial resolution, extremely low infrared background, and ultraviolet sensitivity. The science cases for both instruments are so compelling and complementary that it is meaningless to try to rank them in any objective way. Nonetheless, mission rules for SM4 demand that the order of installation be specified, with the understanding that the second instrument may not be installed in the very unlikely event of a mission abort after the first instrument has already been placed in HST. Ultimately, and principally due to the recent loss of ACS and the established scientific power and popular attraction of HST imaging, the STUC recommends that WFC3 be given higher installation priority in the mission rules. The STUC eagerly anticipates a successful SM4 during which both WFC3 and COS are installed, in the process maintaining HST's status as one of the most powerful astronomical tools of all time.

### **COS and WFC3 status:** (Keyes & Mackenty)

Tony Keyes reported on the current status of COS. He focused on SMOV related activities, thermal vacuum testing and calibration philosophy. The COS team and institute group are developing an SMOV plan and working on a calibration plan that uses the standard Hubble flux standards. They recently completed a delta review for their SMOV plan and updated the instrument requirements for this review. There will be a review of the overall SMOV plan in October of 2007. Thermal vacuum testing continued in Dec 2006 and reference files will be delivered to the institute in July of 2007. Keyes reviewed the essential aspects of the instrument, its performance and the new discovery space that it opens compared to STIS.

Mackenty reviewed current activities related to the development of WFC3. The instrument has been reintegrated into its flight configuration. A problem has developed with the UV VIS detectors, both the flight detector and the spare. A new set of detectors have been ordered from E2V. The problem in UVIS1 appears to be a short in a non-insulated flex lead due to a small piece of metallic debris. UVIS2 has a short on an external circuit card. The TEC appears to have lost 10 degrees of cooling power after the vibration test. This is not critical as it still meets the spec, but it is disturbing.

The IR detectors are coming along very well. Ambient testing is going on now. There will be a thermal VAC test starting in late May 2007 and another starting in Jan 2008. The WFC3 handbook is being edited by Bond. Mackenty reviewed the properties of the candidate flight detectors. The discovery metric is very good for the new devices. He reviewed the overall testing and calibration plan.

### **SM4 and Post-SM4 Operations:** (Blades & Sembach)

The STUC received a brief report on STScI support for SM4 and plans for SMOV from Chris Blades. The committee was pleased to see that work had restarted following the announcement in October 2006 that SM4 would go ahead. The plans to involve experienced staff from JHU and the construction of the design reference mission seemed very sensible. The full schedule for this STUC meeting prevented a detailed discussion of the plans. This should be an agenda item for the next STUC meeting.

The science potential for parallel programs following SM4 will be unprecedented, including the possibility of double sets of parallels with either spectrometer if SM4 is a complete success. The STUC were pleased to note that plans were being developed to improve the scheduling of parallels and optimize the science return. It was felt that a reconstitution of the "parallels working group" would be helpful.

April 14, 2007

Dr. David Leckrone  
Senior Project Scientist  
Hubble Project

Dr. Matthew Mountain  
Director, Space Telescope Science Institute

Dear Dave and Matt,

At the recent meeting of the HST Users Committee we were charged with making a recommendation, on behalf of HST users, regarding the priorities between repairing ACS or STIS during SM4. We believe that this is an extremely important decision and we are willing to make a recommendation after an appropriate amount of reflection within the committee and consultation with our colleagues. We believe that the earliest date at which we could make an informed recommendation is May 15, roughly four weeks from now.

The STUC has developed an approach to this question that involves consultation with the broader user community, focused discussion of science priorities within the committee and consideration of past proposal pressure and time allocation. We ask that the Institute prepare a set of one to two page summaries of the capabilities of WFC3, COS, ACS and STIS and that these be posted on the web no later than April 25. The STUC will then canvas our colleagues and ask them to inform us of their preferred priority and the considerations that led them to their preference, in light of the information contained in the instrument summaries and any other materials that the institute wishes to provide. The STUC will hold a telecon on May 3 to review progress with this canvassing and to discuss our own thinking. We are prepared to inform you of our recommendation in writing by the 15<sup>th</sup> of May.

We would also prefer to report to you at that time our advice regarding other items for which you requested input, and in particular, the issue of possible change-out of the COS medium resolution gratings.

I hope that you will find this time scale acceptable; we believe that a decision of this magnitude cannot be taken without time for due consideration and broad consultation.

For the HST Users Committee, I am

Sincerely yours,

Patrick McCarthy

April 14, 2007

Dr. David Leckrone  
Senior Project Scientist  
Hubble Project

Dr. Matthew Mountain  
Director, Space Telescope Science Institute

Dear Dave and Matt,

At the Fall 2006 meeting of the HST Users Committee we were charged with making a recommendation, on behalf of HST users, regarding the priorities for installing new instruments during SM4. The committee has discussed this issue extensively and we have consulted with other HST users. It is our strong desire to see both instruments deployed and we trust that both the HST Project and the Institute share this goal. There is, however, a clear consensus within the STUC that if prioritization is needed WFC3 should be ranked slightly ahead of COS. While COS will provide unique and unprecedented powerful capabilities, we are concerned that HST would not be able to carryout its core science mission without a highly capable imager. Thus we believe that the successful installation of WFC3 should be the highest scientific priority for SM4.

The committee also considered the question of the position of the channel select mechanism within WFC3 at the time of launch. If there are no compelling technical considerations favoring one position over the other, we believe that the instrument should be launch with the CSM set for the UVIS channel. If for some reason the CSM were to be inoperable on orbit we believe that the scientific interests of the HST user community would be best served by having the instrument in this configuration.

For the HST Users Committee, I am

Sincerely yours,

Patrick McCarthy

May 15, 2007

Dr. David Leckrone  
Senior Project Scientist  
Hubble Project

Dr. Matthew Mountain  
Director, Space Telescope Science Institute

Dear Dave and Matt,

The STUC has spent the past four weeks considering the issues related to priorities in the plans to repair STIS and ACS as part of SM4. We have consulted with both instrument teams and polled a broad spectrum of HST users. These discussions have reinforced the strong motivations for returning both instruments to functionality and have highlighted the vital importance of Hubble's final years of operation.

There is a compelling case that STIS brings unique capabilities to Hubble that address a broad range of science. The ability to perform spatially resolved spectroscopy in the UV and visible with the unrivaled resolution of Hubble enables studies of black holes, massive star forming regions and their outflows, stellar populations, and galaxy dynamics that cannot be matched from the ground. By observing above the terrestrial atmosphere STIS not only probes the vacuum UV, its unmatched photometric stability allows detections of the atmospheres of transiting exoplanets. The rather poor prospects for adaptive optics at visible wavelengths from the ground and the lack of any clear path to a large aperture optical/UV telescope in space makes the case for the repair of STIS all the more compelling and urgent. While COS will provide impressive gains over STIS in some areas, it is a fundamentally different instrument that was intended to complement, rather than replace, STIS.

The Advanced Camera for Surveys and WFPC2 have been the most productive instruments on HST, whether measured from data volume, archive access, publication rates or citation rates. The large field of view and great sensitivity of ACS enabled a series of surveys whose legacy value is unrivaled. Wide Field Camera 3 was originally

conceived as a backup for ACS, a testament to the importance attached to a state of the art imaging camera for Hubble. While WFC3 can carry out much of the science envisioned for ACS, it too was ultimately designed to work in concert with ACS. The power of ACS and WFC3 working together in coordination is uniquely powerful. Large area or deep multi-color surveys spanning more than four octaves of the spectrum can be carried out efficiently with this instrument combination. The value of these surveys for future studies with JWST and other NASA and ground-based facilities should not be overlooked. When Hubble ceases operations, the imaging surveys will likely constitute its most lasting legacy.

We have discussed these issues with our colleagues and fellow HST users. There is strong support throughout the community for repairing both instruments. Among those who responded to our e-mail polls, the vote totals were very close with a slight preference for STIS. We note that another barometer of community preference, proposal and usage statistics, favor ACS by a factor of two to one. This is true if measured by proposal submission or award rates, either by orbit or by number of programs. We also note that the anomalies with GHRS, NICMOS, STIS and ACS highlight the fragility of HST instruments. While we have oriented our thinking by assuming that WFC3 and COS will be installed before repair work on ACS or STIS can commence, we believe that we would be remiss if we did not consider the possibility that one or both of these instruments might fail before the end of the Hubble mission.

These considerations lead us to urge the project to continue to plan to return both instruments to operation. We ask you to continue to develop technical approaches and EVA plans with this goal. The large expenditure of public funds in the construction of ACS and STIS further argues for investment in their return to scientific productivity.

We realize that even with the best and most optimistic planning, on-orbit realities may limit us to the repair of one, or even neither, of the two instruments. If a choice needs to be made it is the view of the present STUC that the legacy and redundancy value in imaging slightly outweigh the benefits of a second spectrograph. We note that WFC3 was commissioned because the project felt that Hubble would be crippled if it were to lose its primary imaging camera. This logic is even more compelling now as we contemplate the final servicing mission. Although repairing both instruments is unquestionably our preferred outcome, scientific priority should be given to returning ACS to operation should such a decision be required.

The STUC found this task quite difficult and, while a modest consensus was achieved, the decision was by no means unanimous. The support for both instruments is strong, widely based and close to even with the committee and the broader community of HST users. The success of the upcoming servicing mission is foremost a question of engineering, planning and execution. The scientific case for repairing both STIS and ACS

is sufficiently strong that we accept that technical realities are likely to be the deciding factor in the outcome of the mission. We appreciate your dedication to Hubble and have complete faith in your commitment to achieving the most favorable outcome to the servicing mission.

Sincerely yours,

The HST Users Committee

Martin Barstow  
Laura Ferrarese  
Peter Garnavich  
James Green  
Jean-Paul Kneib  
David Koo  
Mario Mateo

Patrick McCarthy  
Phillip Nicholson  
Robert O'Connell  
Alvio Renzini  
Abhijit Saha  
Tommaso Treu  
Marianne Vestergaard

May 15, 2007

Prof. David Spergel  
Chair, Astrophysics Subcommittee  
NASA Advisory Committee

Dear Prof. Spergel,

We are writing to you in your capacity as chair of the Astrophysics Subcommittee of the NAC on behalf of the users of the Hubble Space Telescope. We would like to encourage you and your committee to reconsider its position regarding support for HST research, particularly in the interim period between the failure of the ACS and the servicing mission scheduled for late 2008. While it is true that HST has suffered a setback with the loss of ACS we believe that it remains the premiere astrophysics mission within NASA's great observatory program. The proposal pressure in cycle 16, even with the loss of the ACS, was among the highest ever and the TAC judged the quality of the proposals to be outstanding. Among the approved programs for cycle 16 were cross-disciplinary studies of obscured starburst galaxies at  $z = 2-3$ , stellar mass determinations for galaxies at  $z > 7$ , and a wide range of fundamental programs in stellar astrophysics and cosmology. The continuing high over subscription rate for HST time and the steadily increasing publication and citation rates are testament to HST's vital role in US astronomy. It is no secret that part of the reason behind HST's success is NASA's commitment to supporting guest observers, archival researchers and Hubble Fellows.

While it may appear attractive and logical to propose a temporary reallocation of support from HST science to other deserving and under-funded portions of the NASA astrophysics program, we encourage you to consider the future beyond this year's budget cycle. In late 2008 two new instruments will be installed on HST and it appears increasingly likely that one or both of ACS and STIS will be returned to operation. Even if ACS and STIS are not repaired, WFC3 and COS will provide Hubble with its most powerful instrument suite to date. In the best-case scenario HST will have four state-of-the-art instruments covering more than four octaves of the electromagnetic spectrum. We believe that it is vital that HST research be well supported in the post-SM4 era, as there will be new challenges and unprecedented new scientific opportunities. The new instruments will provide our first detailed exploration of the IGM at  $z < 1$  and will greatly improve our ability to probe dark energy by tracing SN Ia's to the highest redshifts in the near-IR, to name just two of the programs enabled by COS and WFC3. We see great risk in attempting a short-term redistribution of resources, as there are reasons to be concerned that support will not be restored at the time it is needed most, when Hubble is in its most capable state ever.

We look forward to a reduction in Hubble operations costs post-SM4 and the benefits that will accrue to other NASA astrophysics programs. A premature move to reduce Hubble operations, however, makes little sense in our opinion from either a scientific or a cost-benefit perspective. More than \$200M in public funds was invested in the development

and construction of ACS and STIS. It now appears very likely that both of these instruments can be restored to full operability as part of SM4 with only a modest incremental cost. We believe that the scientific returns from the repair of STIS and ACS would be of great value and will make Hubble more powerful and cost effective than ever. We urge NASA to aggressively prepare to service these instruments as part of SM4.

Our committee speaks for, and is an advocate for, users of the Hubble Space Telescope. We are all, however, scientists who try to see the big picture and to find balance among the many subfields supported by NASA within its astrophysics division. We too decry the diminishing support for small space science programs within university-based groups. Many of us see the impact of this problem within our institutions and groups and we share your desire to restore funding for the small PI-driven experiments. At the same time we advocate against a reduction in support for HST research. The primary beneficiaries of HST GO funds are graduate students and post-docs, young people who carry out much of the research. Hubble will remain NASA's most powerful and widely recognized scientific facility for the next several years. The support provided for guest observers is less than 5% of the total annual cost of operating HST, yet it is the only funding item tied directly to scientific research. This small fraction of the HST budget is essential to its scientific productivity and to the health of astronomy in the US. We urge you to give it the high priority that it deserves as you consider the landscape within NASA astrophysics in the coming years.

Sincerely,

Patrick McCarthy & Abhijit Saha  
For the Hubble Space Telescope Users Committee

HST Users Committee:

Martin Barstow	U. of Leicester	Patrick McCarthy	Carnegie
Laura Ferrarese	HIA	Phil Nicholson	Cornell
Peter Garnavich	Notre Dame	Robert O'Connell	U. Virginia
James Green	Colorado	Alvio Renzini	INAF, Italy
Jean-Paul Kneib	CNRS, France	Abhijit Saha	NOAO
David Koo	UC, Santa Cruz	Tommaso Treu	UC Santa Brb
Mario Mateo	U. Michigan	M. Verstergaard	Arizona