Perspective

Matt Mountain, *mmountain@stsci.edu*

Coming in as the new Director of the Space Telescope Science Institute in September has been an exciting and challenging responsibility. So much happens at the Institute everyday. The normal activities include ensuring that the *Hubble*'s enormously complex scheduling algorithms produce a seamless flow of observations from this building to the telescope orbiting the earth every 90 minutes.

They include stewarding its unique data through pipeline reduction and back out to the community, assessing proposals (almost $20M dollars in grants are dispersed and managed from here), and organizing myriad meetings to allocate resources, obtain advice from the community, and support our communities with calibration workshops and scientific sessions. On top of this "normal stuff," the summer of 2005 was frenetic with planning, re-programming, and testing of the two-gyro pointing mode. This amazing intellectual and technical *tour de force* has breathed new life into *Hubble*. And all this was just on the *Hubble* side of the house.

In other parts of 3700 San Martin Drive, the *James Webb Space Telescope* group, in close collaboration with our colleagues at the Goddard Space Flight Center (GSFC), are planning how make this exciting new telescope as productive as *Hubble*. Their summer wasn't idle either: *Webb* underwent extensive re-planning; the Institute co-chaired the Science Assessment Team (SAT) looking at *Webb*'s scientific promise; and the Science Working Group (SWG) came to town.

Along other corridors in this building, and just a step across the road to the Johns Hopkins University, active groups are supporting archival research with MAST and the future National Virtual Observatory. Others are supporting future NASA missions, like *Kepler*, *SIM*, and *TPF*. As I explore the second and ground floors, I find the Institute's famous Office of Public Outreach, which has produced the *Hubble* images and educational programs that have so affected the nation. Most of us have seen these wonderful NASA pictures, which flow from *Hubble* through these OPO offices, on the walls of our children's classrooms.

Of course, this entire ensemble of activities is engulfed in the frenzied buzz of visitors, seminars, meetings, and workshops—the vital signs of a vibrant scientific life pervading this exciting organization.

As always, the future of *Hubble* is closely coupled to the health of the Shuttle. The tragedy of hurricanes Katrina and Rita has put considerable and understandable pressure on NASA's activities. The media reports on the enigmatic insulation problem remind us that the Shuttle is a fragile system that should be used only for unique purposes of high national interest. Fortunately for science, Michael Griffin, the NASA Administrator, puts servicing *Hubble* in that category, stating on multiple occasions that he wants to carry out the next servicing mission (SM4) if the first two Shuttle flights after the *Columbia* tragedy go as planned. He repeated this reassurance even after the recent *Discovery* mission revealed continuing issues with the foam insulation on the external tank. NASA's enthusiasm for *Hubble* seems undeterred even by the prospect of a greatly reduced flight rate prior to the Shuttle retirement in 2010, which will impact the completion of the *International Space Station*. Recent media descriptions of NASA scenarios with as few as 10–12 further Shuttle flights still include plans for SM4.

Mr. Griffin recently simplified the future of *Hubble* by removing the requirement for SM4 to deliver a de-orbit module for the controlled reentry of the observatory at the end of science operations. This decision was possible because current estimates of reentry dates are now far in the future. The de-orbit module could have imposed difficult constraints on the mass and volume of the remainder of the payload on SM4, as well as impacts on safety, schedule, and NASA finances.

The current vision for SM4 is now the same as planned for many years and endorsed by numerous community stakeholders, including the Decadal Survey and the recent review of NASA's strategic roadmap by the National Research Council. As for all previous *Hubble* servicing missions, the cost of the Shuttle flight itself will be borne by the human spaceflight program, not the science program. The schedule and cost to the science program are now reliably predictable, based on similar servicing efforts on four previous occasions. The mission could fly in late 2007 or early 2008, and the remaining costs are probably less than $300M, spread over 3–4 years. With the new two-gyro mode, *Hubble* should continue full science operations until 2008—and remain recoverable until at least 2010—even if science operations cease temporarily.

The challenges of building a uniquely powerful, diffraction-limited, six-meter, deployable, cryogenic telescope—otherwise known as *Webb*—which is destined to orbit L2 in the next decade, had many of us working quite hard over the summer. The accompanying article by Giavalisco and Stockman summarizes *Webb*'s challenging financial circumstances. NASA's response was to instigate a number of independent studies, one by a Science Assessment Team (SAT), whose conclusions are described

in interim and final reports, which can be found at www.stsci.edu/*JWST*. Quoting from the introduction of that report:

> In April, the JWST Project received a Not to Exceed Estimate (NTE) from Northrop Grumman Space Technologies (NGST) for ~$300M of additional funds needed to complete the *JWST* development. A portion of this increase is due to the delay in officially designating the Ariane 5 rocket provided by the European Space Agency as the official launch vehicle. Other portions relate to changes in accommodating the Integrated Science Instrument Module (ISIM) and additional requirements for the Integration and Test program (I&T). In addition to this increase, which impacts the already cost-constrained fiscal years of FY06 and FY07, the Project had identified another ~$200M in additional funding requirements. These were evenly split between ISIM and science instrument increases and programmatic impacts (full-cost accounting taxes and NASA HQ drawbacks from previously approved budgets). The total increase, $500M, could not be addressed within the Science Mission Directorate budget, and necessitates at least a one-year slip in launch readiness (~$300M in additional project cost). In the light of these increases, NASA HQ has added an additional $250M to restore the appropriate percentage of program contingency. The total increase, ~$1B, is almost equal to the ~$1.5B of previously estimated cost for reaching launch readiness. While some increases had been anticipated for the challenging *JWST* program, the scale and early timing of this increase threatens the Universe division's planned science program. This situation has forced NASA to review the *JWST* program to seek major cost reductions. Equally important, NASA and its international partners must be convinced that future increases can be controlled.
>
> As a first step, NASA requested that the Project and Science Working Group (SWG) review the potential savings of reverting to the minimum mission as outlined in the Formulation Authorization Document (FAD): a 4-m class primary mirror, reduced near-infrared (NIR) capabilities, and no mid-infrared (MIR) capabilities. The results would be negligible savings (~$200M), since much of the money has been committed and devastating impacts on the science goals (< 50% of the *JWST* science goals could be studied). This clearly shows that the financial increases were neither due to increased complexity of the science instruments, nor can they be significantly addressed by the wholesale removal of major scientific capabilities and reductions in primary mirror area. However, relaxing some key science requirements and simplifying corresponding aspects of the mission, its manufacture, and integration & test (I&T) plans hold great promise to provide significant reductions in cost and future increases.
>
> In June 2005, NASA HQ created the Science Assessment Team (SAT) to provide an independent analysis of the science goals of the *JWST* mission. The SAT is charged with re-evaluating and prioritizing the scientific capabilities of the mission and reporting its recommendations to NASA HQ, the *JWST* Project, and the SWG. NASA HQ and the Goddard Space Flight Center have organized and charged other groups to evaluate the technical and financial status and plans of the *JWST* Program.

Importantly, the SAT unanimously reaffirmed *Webb* "as the highest priority facility for the US and the international community to advance astrophysical understanding." Since the formulation of the program in 1999, "the case for *JWST* and its unique capabilities has grown in strength and astronomical significance." Recognizing the substantial cost overruns and the potential for future cost growth in such a challenging mission, the SAT did recommend a number of significant simplifications based on recommendations from the Project. In particular, the potential advances in ground-based facilities led the SAT to give its highest priority to imaging and spectroscopy over the wavelength range 1.7–28 μm. Full details of these recommendations can be found at **http://www.stsci.edu/JWST/project_highlights/SAT_report_final.pdf/**.

SAT Membership

Dr. C. Matt Mountain, Co-Chair
Dr. H. (Peter) Stockman, Co-chair
Dr. Roberto Abraham
Dr. Alan Dressler
Dr. Kathryn Flanagan
Dr. Robert Gehrz
Dr. Malcolm Longair
Dr. Christopher McKee
Dr. Sara Seager

The technical state of *Webb* is excellent. The Project is approaching the transition into detailed design and development. Three of the science instrument teams have successfully completed preliminary design reviews—the one for the Near Infrared Spectrograph will be held in February 2006—and have ordered and are receiving many of the long-lead items, like detectors, optical benches, and optics. The Optical Telescope Element is under construction. Brush Wellman has delivered 20 beryllium billets for the primary mirror segments to Axsys Technologies, where they will be diamond-turned (Fig. 1). The production lines in the Axsys and Tinsley polishing facilities are ready and working on the first blanks and engineering unit.

Figure 1: The final eight Be blanks prior to delivery to Axsys Technologies for diamond-turning (credit: Brush Wellman).

The *Webb* Project has accepted all the SAT recommendations and is re-planning. It is taking steps to ensure the readiness of key technologies over the next 12–18 months. The aim is to ready *Webb* for launch in mid-2013. We at the Institute are working closely with the Project to do our part in ensuring *Webb*'s readiness and ultimate success. For us, *Webb* is a worthy successor to *Hubble*. It will have a unique role in the next decade, advancing astrophysical and cosmological understanding, building on the achievements of *Hubble* and the discoveries from *Spitzer* and other space-based and ground-based facilities.

It's been an interesting first few months at the Space Telescope Science Institute. Ω