Space Telescope Science Institute

ANNUAL REPORT 2006

25th year in the community

contents

Foreword

An organization's Annual Report typically summarizes what the organization is about, its composition and, most importantly, its achievements during the reporting period. The Space Telescope Science Institute, home of the science operations for the Hubble Space Telescope, the Digitized Sky Survey and the Multimission Archive at Space Telescope, future home of the Science and Operations Center for the James Webb Space Telescope, and future archive center for smaller observatories, is a complex organization. To describe all its achievements would require a volume of encyclopedic proportions.

This Annual Report is only one of the formal reports that describe the Space Telescope Science Institute (STScI) achievements throughout 2006. Complementary publications include contractual deliverables to the Hubble Space Telescope (HST) and James Webb Space Telescope (JWST) projects (which offer a detailed technical description of the work done), the Hubble Annual Science Year in Review (which highlights the science achievements of HST), the STScI Newsletter (a quarterly update of developments involving the HST and JWST instruments and ground systems, the Archive and the HST science program), and various electronic newsletters (periodic publications with specific instrument information). Finally, our Web sites provide the most current images, press releases, education and outreach materials, and general information about events and developments at STScI.

The Annual Report was approached as an audit. We list STScI's goals, its achievements, and the comments from the assessments it received (found at the end of the volume). These assessments were made by the Institute Visiting Committee, the HST annual Project Performance Assessment Panel, and the JWST Project Semi-annual Performance Evaluation Committee, as well as additional user and review committees.

STScI celebrated its first 25 years in 2006. We did not use this milestone to reflect on the past, but instead celebrated what the organization can still achieve as the science center of NASA's most productive and famous observatory, and one of the most vibrant astronomical research centers. This report reflects the work of an organization that is constantly striving to improve, to build upon its past successes, and to top its prior efforts—no matter how lauded or distinguished those accomplishments might be.

Introduction

The Space Telescope Science Institute (STScI) implements the science program for the Hubble Space Telescope (HST) and will be the Science and Operations Center for the upcoming James Webb Space Telescope (JWST).

STScI celebrated its first 25 years in April 2006. Over more than two decades, STScI has been a part of an awe-inspiring history full of both challenges and triumphs, stewards of a groundbreaking observatory whose reputation will still be celebrated long after the telescope itself is gone. Its tenure encompasses both the launch of HST and the start of NASA's next large observatory, JWST, putting it on the cutting-edge of astronomy into the foreseeable future.

This first quarter century of STScI has demonstrated that the model envisioned in the National Academy of Sciences 1976 study on "Institutional Arrangements for the Space Telescope," also known as the Hornig Report, has worked well:

- STScI is truly governed by the astronomical community.
- STScI has all essential instrument expertise in-house. Its staff answer directly to Institute management and their "customers" are unequivocally NASA and the science community. Other major astronomical observatories eventually adopted this model.
- STScI has attracted an extraordinarily high-caliber staff. Many who started their careers here have moved on to senior leadership positions throughout the astronomical community.
- STScI set the standard for a level of support and data products that are now expected of most other observatories by the astronomical community. Many other institutions adopted STScI systems outright (e.g., the Guide Star Catalog and the Digitized Sky Survey, the data processing pipeline, the General Observer proposal and observation configuration tool, the grants management system, the Hubble Fellows program, the data reduction and analysis systems, data mining tools, and others).
- The HST education and public outreach effort is arguably the most successful astronomical outreach program ever.

A further point not stressed by the Hornig Report is that the Institute model, by making science data easily accessible worldwide through an actively managed and updated archive, has resulted in a remarkable democratization of astronomical research, evolving away from just a few researchers at prosperous institutions to researchers at all institutions, large and small.

This report only describes the accomplishments of the Institute and its staff for 2006. Many other milestones reached during the past quarter of a century are listed in the timeline that runs throughout the publication. These include:

- Community-recognized leadership in conducting and administering fair and unbiased science program selection and grant management reviews and processes
- Providing the astronomy user community with enhanced tools for observation planning and timely, reliable access to data and data products
- Continued Education and Public Outreach leadership through award-winning programs and products, such as Amazing Space, ViewSpace, HubbleSite and leadership of the Origins Forum
- Reduction in observation scheduling lead time from 21 to 11 days
- Consistent, high-quality performance during the detection, investigation and resolution of instrument anomalies
- Institution of robust IT security plans and processes and development of a backup planning and scheduling capability

The HST program continues to have a major impact on the public as well as on the astronomical community. It is considered NASA's most effective science mission ever, as rated by citations in science news media, and it is routinely cited as a major reason for increased worldwide interest in astronomy.

Institute Financial and Staff Resources

	2004	2005	2006	2007
HST	$50.9M	$44.9M	$42.6M	$44.5M
JWST	$7.7M	$9.4M	$8.4M	$8.5M
Other Missions	$1.6M	$1.9M	$3.0M	$3.0M
Total	$60.2M	$57.4M	$54.0M	$56.0M

Table 1. Institute budget summary (Government Fiscal Years)

	2004	2005	2006	2007
HST	310	285	241	241
JWST	43	55	43	43
Other Missions	7	8	19	21
Indirect	77	75	79	78
Totals	437	423	382	383

Table 2. STScI Staff Summary (in full time equivalents)

STScI encountered budget challenges during Fiscal Year 2006. In order to meet the reduced funding guidelines for both the HST and JWST missions, STScI was required to implement a reduction in force at the end of Fiscal Year 2005.

However, with the reinstatement in 2006 of the final servicing mission to Hubble, and the excellent progress of JWST development, Fiscal Year 2007 is expected to stabilize the STScI budget. The HST budget is expected to stay relatively flat for a period after Servicing Mission 4 and the JWST budget is expected to increase significantly over the next few years as major ground system development starts.

In order to prepare for the increase in HST data volume after SM4, the STScI budget includes special funding allocations for network upgrades, and centralized storage and improved data backup for the desktop environment. Table 1 covers the cost of all operations at the STScI. It does not include the grant funding we disperse to the astronomical community through General Observer, Archival Research, and Education and Public Outreach programs.

AURA and STScI received a Request for Proposal to extend the contract for the HST Science and Operations Center on November 9, 2006 and submitted a response on December 19, 2006. AURA and STScI anticipate a timely negotiation process to provide a new contract by the required date of April 30, 2007.

Table 2 presents the staffing levels over the past several years at the STScI. This chart also reflects the stable environment entered in FY 2007. These staffing levels do not include post-doctoral, graduate student, or intern positions. In order to make the comparison across the years more straightforward, they also do not include the 19 FTEs from the HST Flight Operations Team, which will be removed from the STScI mid-way through FY 2007.

Staff Awards

STScI Group Achievement Awards	Perry Greenfield & Warren Hack, OPO staff, ACS recovery team, Roelof de Jong, Ralph Bohlin, Eddie Bergeron & Adam Riess
STScI Individual Achievement Awards	Maria Bertch, John Biretta, Ron Gilliland, Daniel Golombek
Aura Awards	Science Award: Mario Livio, Service Award: Tony Krueger, Technology and Innovation Award: Babak Saif, Team Award: Two Gyro Science Mode Team
GSFC Group Achievement Award	Lunar Observation Implementation Team and Babak Saif (Electronic Speckle Pattern Interferometer)
Gruber Foundation 2006 Cosmology Prize	Mike Hauser (COBE team member)
Shaw Prize	Adam Riess
International Planetarium Society Service Award	Jim Manning
Pirelli Prize	Roeland van der Marel
IAU President Elect	Bob Williams
CSC President's Excellence Award	George Chapman, Merle Reinhart and Carey Myers
OPO Awards	HubbleSite (Scientific American site of the week); Amazing Space (Scientific American.com's Science & Technology Web Award), (4Teachers.org's "4Teachers Site of the Week Award"), (Linksgiving.com's "Weekly Link Award"), selected by Yahooligans as one of the four most popular astronomy and space choices for kids ages 7–12); ViewSpace/SkyWatch (National Association for Interpretation Multimedia Award)
26th Annual Executive Stampede	Thomas Puzia (5th in Men's Division), STScI Team: Chris Burke, Rob Douglas, Mark and Elijah Giuliano, Rob Hawkins, Nicole Homeier, Thomas Puzia, Roeland van der Marel and Brad Whitmore (STScI Team placed 1st in Education Division)

WE ARE RESPONSIBLE FOR SOME OF SPACE SCIENCE'S MOST FASCINATING MISSIONS. OUR EXCITEMENT AND SENSE OF WONDER INSPIRE OUR WORK AND ALL THAT WE DO. THIS ENTHUSIASM HELPS US COMMUNICATE OUR SCIENTIFIC DISCOVERIES TO THE PUBLIC, FUELING THE IMAGINATION OF ADULTS AND CHILDREN AROUND THE WORLD.

People and Change

OUR GOALS

Attract and retain the most outstanding administrative, technical and scientific staff.

Provide an invigorating and exciting working environment.

Develop a more inclusive workplace.

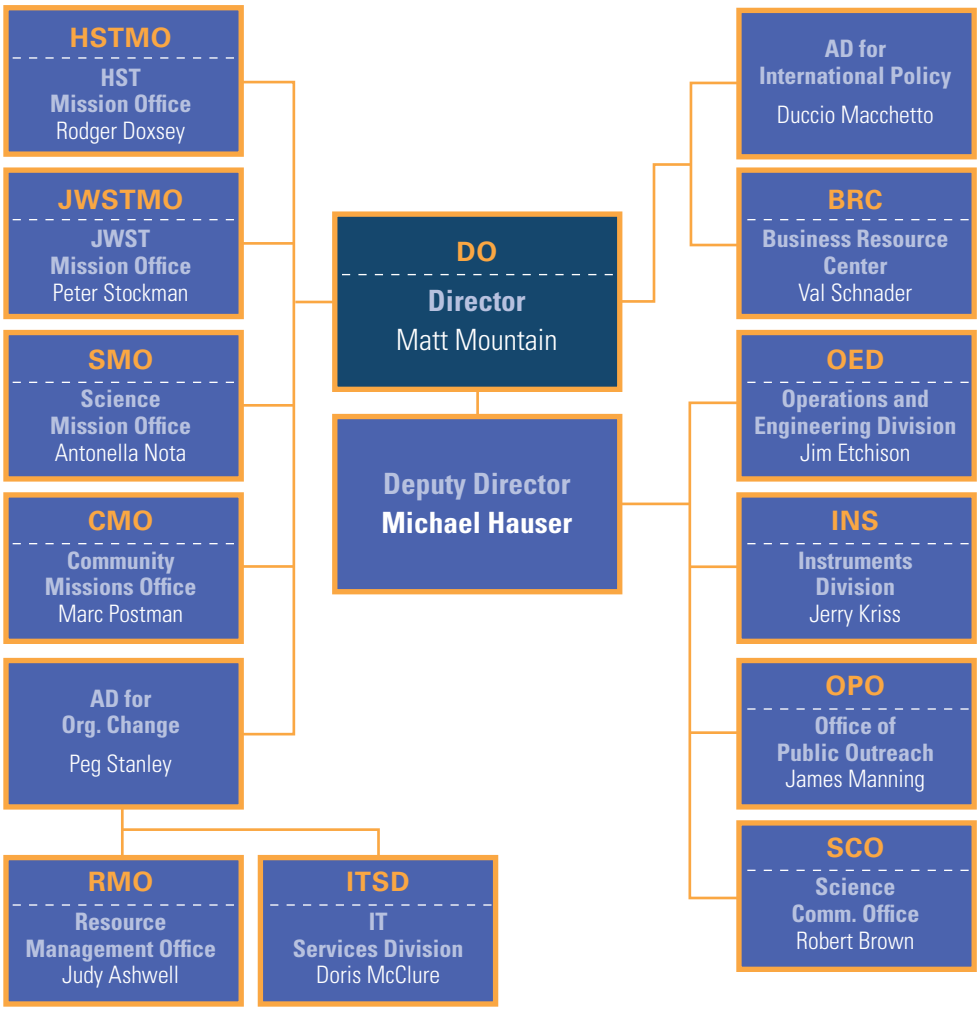
Align strategy and operations with goals and values.

People and Change

Under the leadership of its new Director, Dr. Matt Mountain, STScI has re-evaluated how we work and re-defined the values we hold as an organization, allowing us to transform our organization into one that embodies and embraces the same overarching set of guiding principles at all levels.

These changes ensure that the decision-making and routine interactions needed to accomplish STScI's work occur at the appropriate level of the organization. Three executive-level positions reporting to the Director were eliminated and their responsibilities were shifted to the other parts of the organization. Two other executive positions were created: the Associate Director for International Relations, focused on efforts to continue the NASA/ESA agreements for HST and to define the critical agreements for JWST; and the Associate Director for Organizational Change, intended to facilitate change management. These are not expected to be permanent requirements of the organization.

The overall STScI structure remains a matrix organization, with Missions and Divisions partners in achieving the mission goals. The Missions are generally responsible for the scope and requirements of the missions, including interactions with NASA and the Divisions for accomplishing the work. Experience with transferring staff between Missions and the current staffing forecasts lead STScI to retain the overall Missions and Divisions matrix and to optimize the internal structure of the Divisions. A critical philosophy in the current organizational structure is the recognition that "one size doesn't fit all" and that the flexibility and management expertise exists at STScI to handle different types of teaming and work structure arrangements.



STScI Organization

GET A GLIMPSE of the triumphs and accomplishments of the Institute's first 25 years.

DO Director's Office

The Director's Office has responsibility for overall management of the STScI—establishing policy, organization, and strategy, obtaining and managing resources—and for conducting the external relations of STScI, including reporting to oversight committees and soliciting and receiving advice from advisory groups.

RMO Resource Management Office

The Resource Management Office is responsible for direction and oversight of the planning, budgetary development and control, scheduling, quality assurance, configuration management and reporting activities of STScI.

HSTMO Hubble Space Telescope Mission Office

The HSTMO is responsible for maximizing the science return from the mission by managing the Institute activities specific to the conduct of the Hubble Space Telescope program. It develops the overall Institute plans for HST science operations and system enhancements, working with the team leads in the operating divisions. The HSTMO is responsible for establishing performance and development requirements, monitoring performance and schedules, and prioritizing the expenditure of resources. It works with the divisions and Resource Management to develop and then monitor yearly and long-term budgets. It is also responsible for establishing effective scientific, technical, and operational interfaces with the HST Project at Goddard Space Flight Center and associated contractors.

JWSTMO James Webb Space Telescope Mission Office

The JWSTMO collaborates with NASA to develop the scientific, technical, and operational vision for the James Webb Space Telescope. It manages the development of the JWST Science and Operations Center. It works with the community to ensure the best JWST observatory possible within the cost constraints of this challenging program. It works with the Institute divisions to ensure proper support to NASA, the science instrument teams, and other JWST partners, including the prime contractor, Northrop Grumman Space Technologies.

CMO Community Missions Office

CMO manages the Institute's involvement in missions and projects other than HST and JWST by facilitating new initiatives and coordinating their internal reviews. For missions arising in the community, CMO promotes new applications for Institute products, services, and operational abilities customized to meet specific mission needs, striving to maximize the scientific return of the Institute's involvements by engaging scientific and technical staff members directly in the support of community missions.

SMO Science Mission Office

SMO has specific responsibility for managing the HST time allocation process and maintaining absolute fairness and equity of opportunity to every General Observer, Archival or Theory proposer. This includes issuing the annual Call for Proposals to the astronomical community, organizing the proposal review, handling proposals for Director's Discretionary observing time, and formulating relevant policies. SMO also establishes science metrics to evaluate the success of the science program.

The contract creating STScI is signed on April 30th 1981.
Art Code is appointed interim director.
Riccardo Giacconi is appointed STScI director.

1981

SMO is responsible for oversight of the science research environment at STScI and for facilitating the optimal assignment of science staff to the missions.

The SMO conducts visitor programs to foster collaborations, to enrich journal clubs, and to support distinguished astronomers for extended visits. It manages the Director's Discretionary Research Fund and the JWST Discretionary Fund, which support staff research projects and investments in the Institute's research infrastructure. SMO conducts a spring symposium each year on a major area of astronomy, as well as smaller-scale workshops on specific scientific topics and issues and manages the Hubble and the Giacconi Postdoctoral Fellowship Programs.

INS Instruments Division

INS supports HST observers in the use of the science instruments with maximum effectiveness, providing scientific and technical advice in developing observing programs and interpreting data. It calibrates and characterizes the science instruments. It facilitates the use of new science instruments in HST, JWST and other space science missions by participating in their development, by capturing and transferring information about instrument operation and calibration to the Institute, and by coordinating the commissioning of all the instruments following a servicing mission. A small engineering team maintains engineering knowledge of the HST instruments and spacecraft, monitors health and performance of the instruments, and tracks the status of their limited-life items. STScI is expanding its service to the astronomical community by leveraging its HST experience to the JWST mission.

OED Operations and Engineering Division

OED processes and schedules the selected HST observing programs and processes HST data in the pipeline and distributes data products to the community. It maintains the operational state of the Guide Star Catalog. OED staff works with HST users to ensure the optimal translation of their scientific requirements into the technical instructions necessary to execute the observing programs, prepares the multi-year science-observing plan, which reconciles HST science program requirements and operational constraints at a high level. It then fits candidate observations into optimal weekly observing schedules with instrument calibration and engineering activities, and creates the detailed command loads that are executed by the telescope. OED is also responsible for pipeline processing of all HST data. It provides data archiving and delivery services to users. OED also operates the Multi-Mission Archive at STScI (MAST) and is an active participant in the National Virtual Observatory (NVO) program, bringing the latest in archive and data distribution expertise to the HST program.

OED is also responsible for systems engineering, commanding, and software development at STScI. Specifically, OED staff maintains and enhances the software and database systems used for science mission planning, science operations, the data processing pipeline and the archive. OED develops and maintains commanding software for the HST science instruments, develops and maintains the calibration software and tools used to reduce, analyze and archive HST data, develops and maintains the systems used by astronomers to interface with the HST systems and maintains the Grants Management System software.

ITSD Information Technology Services Division

ITSD is responsible for the Institute's computing and communications infrastructure. It develops technology-based solutions, and ensures the security and supports information systems for science operations, scientific research, and business functions. ITSD provides system management and user support services. ITSD is responsible for the production of instrument and data handbooks, Web pages, information management for engineering and business systems, and visual communications technology (Web casting and videoconferencing).

OPO Office of Public Outreach

OPO is responsible for the public outreach and education activities of STScI. OPO provides a national resource for coordination of astronomy and astrophysics content for journalists, other media professionals, and the formal and informal education communities. OPO also supports news, information and exhibit products for other NASA Origins missions.

OPO develops educational materials that address national education standards and are relevant to K–14 curricula. It also provides pre-service and in-service teacher training on the use of space science educational materials in the classroom. OPO develops and hosts a variety of Internet sites that provide first-hand information about HST and JWST to the general public and news media. The Office brings the excitement of scientific discovery and technological accomplishment to a wide audience through science museums, planetariums, libraries, and the Internet. It develops press releases, photo releases and press conferences to disseminate discoveries via print, electronic, and broadcast media.

BRC Business Resource Center

BRC provides business and administrative services to STScI in the areas of finance, human resources, accounting, contracts, grant administration, procurement, facilities management, property administration, administrative support, and staff support services. The BRC administers all HST funded grants.

SCO Science Communications Office

The SCO publishes the Newsletter and the HST Science Year in Review. The SCO conducts studies of scientific and technical issues to increase the value of space astronomy.

Diversity Initiatives

STSCI HAS A VARIETY OF PROGRAMS GEARED TOWARD INCREASING AND PROMOTING DIVERSITY IN THE WORKPLACE.

Advisory Committee on Diversity and Climate

STScI created an Advisory Committee on Diversity and Climate. The committee tracks progress on diversity and climate issues at the Institute and will meet twice a year to assess all aspects of STScI diversity, including gender, racial, religious, age, and accessibility issues for all staff. Topics include hiring and retention, equal treatment within STScI, and the overall climate toward the diverse populations within STScI. The committee reports to the STScI Director.

Education and Public Outreach

The Office of Public Outreach (OPO), as a national center for space astronomy education, has several initiatives to address how to most effectively reach and serve minorities, the underserved and the underrepresented among its target audience. These initiatives include:

- Creation of focus groups to collect data on the needs of teachers, students and the public. The focus groups help determine how HST science and educational materials can best be used to inspire and teach.
- Participation in the Council of Exceptional Children in Baltimore, Md., and the Exceptional Needs Workshop in Huntsville, Ala. Participation helps OPO learn how to make educational materials and activities more user-friendly for special-needs populations.
- Testing of Hubble-themed educational units at the Crossroads School in Baltimore, Md., and the Sundown Middle School in Sundown, Texas, and at others with high minority populations.
- Placement of science outreach materials at institutions serving populations with low socio-economic status and/or high numbers of minorities, such as the International Museum of Art and Science in McAllen, Texas. OPO also monitors the impact of these efforts.
- Interviewing of a sampling of the education and science outreach institutions currently using STScI educational materials, in order to learn how these materials are disseminated and modified for use with underrepresented groups.

Youth for Astronomy and Engineering

The Youth for Astronomy and Engineering (YAE) program, led by Tania Laguerre, engages children and teens interested in astronomy and engineering as a career. The YAE exposes participants to activities and experiences representative of the work done by astronomers and engineers. It also provides a supportive environment that encourages diversity in the astronomical and engineering community by increasing awareness to young women, minorities, and those with special needs. This year, YAE conducted a "Parent and Daughter Evening Under the Stars." Middle and high school girls, accompanied by a parent, attended a telescope-aided skywatching session and an interactive lecture from STScI astrobiologist Margaret Turnbull on "Possible Life In the Universe." The YAE also held its annual Women's Science Forum, an outreach program to high school girls, on June 17, 2006. The teens participating in the Forum enjoyed several talks by NASA and STScI employees, observed the Sun with a special telescope and conducted hands-on astronomy projects.

Hard Science/Soft Skills: Fostering Civility in the Scientific Workplace

STScI initiated "Hard Science/Soft Skills: Fostering Civility in the Scientific Workplace," an innovative speaker series focused on examining relational competence, ethics, quality of life and productivity in the scientific workplace.

"Hard-discipline" organizations, such as science, medicine, technology and engineering, present culture-specific challenges and needs when it comes to everyday workplace interaction. Speakers in 2006 ranged from Judith Martin, better known as Miss Manners, to Arthur Ciaramicoli of the Harvard Medical School, who spoke on "The Performance-Addicted Scientist: How a Lack of Empathy Can Deteriorate Work, Love and Self-Care." Other speakers included P.M. Forni ("Why Civility? Why Now?"), Marc Donahue ("Love, Hate, Fear, and Respect"), Edward Hallowell ("How to Thrive in a CrazyBusy World"), and Margaret McIntosh ("Unearned Advantages and Disadvantages as Workplace Impediments"). The series is a collaborative effort between STScI, Johns Hopkins University, the University of Baltimore and the University of Maryland School of Medicine.

The Hard Science/Soft Skills speakers, (top left to bottom right) P.M. Forni, Peggy McIntosh, Arthur Ciaramicoli, Marc Donohue, Judith Martin and Ned Hallowell.

1986

The Proposal Entry Processing Subsystem (PEPSI) is delivered.
STScI assumes responsibility for the Science Operations Ground System (SOGS).
STScI holds a May Symposium on Stellar Populations.

Caroline Herschel Visitor Program

The Caroline Herschel Visitor Program to Enhance Women & Minority Representation at STScI brings distinguished scientists from around the world to the Institute for one- to three-month visits. The program provides a stimulating and productive environment for colleagues in the community to work and lecture on their scientific projects at STScI, and offers mentoring for STScI scientists, especially women and other underrepresented groups. Visitors meet regularly with the STScI science staff, women and minority scientists, and function as members of selected short-term committees.

2006 Caroline Herschel Visitors

- Robert Kennicutt, University of Cambridge
- Jay Gallagher, University of Wisconsin
- Imke de Pater, UC Berkeley
- Judith Cohen, Caltech, Palomar Observatory
- Debra Elmegreen, Vassar College
- Francesca Matteucci, Universita di Trieste
- Monica Tosi, Osservatorio di Bologna
- Rachel Webster, University of Melbourne

Science Initiatives

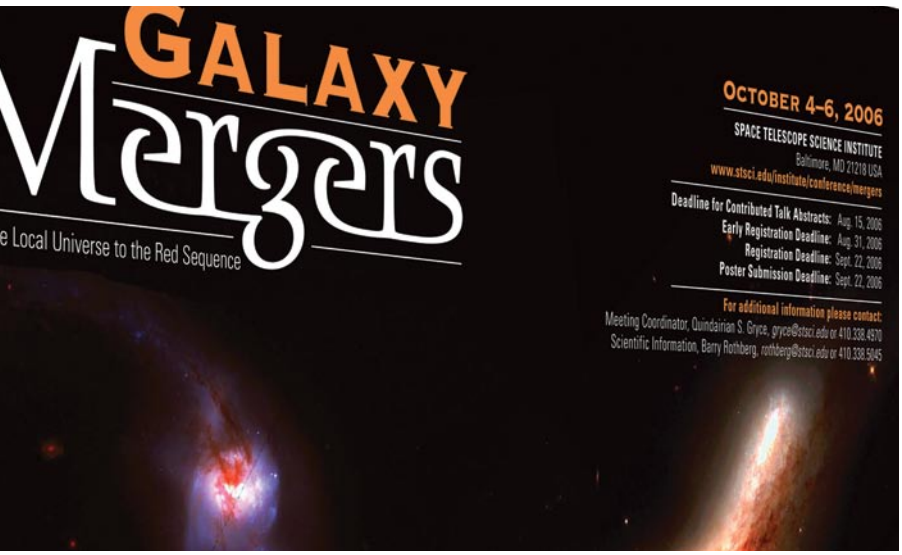
THE INSTITUTE FOSTERS A VIBRANT SCIENTIFIC ATMOSPHERE BY HOSTING A DIVERSE SET OF PROGRAMS.

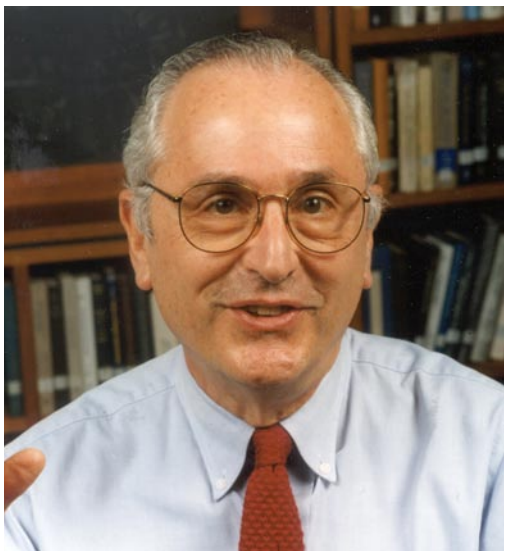
May Symposium

STScI sponsored its 2006 May Symposium, titled "Massive Stars: From Pop III and GRBs to the Milky Way." About 100 astronomers and astrophysicists from around the world attended the symposium to discuss such topics as the formation of Population III stars in the Milky Way, the formation of massive stars in other galaxies, massive stellar clusters, the evolution of massive stars, the end of life of massive stars, supernovae, gamma ray bursts, ultraluminous X-ray sources, and others.

1988

Peter Stockman is appointed Deputy Director.
The fourth Ground System Test (GST-4) is run successfully.
May Symposium: The Formation and Evolution of Planetary Systems.





John Bahcall

Mini-Workshops

STScI sponsored mini-workshops in March and October. The March mini-workshop, "The End of the Dark Ages—from First Light to Reionization," provided a venue for about 50 observers and theorists from around the world to share their views on the recent studies of ultra-deep HST observations. These observations as well as those by the Sloan Digital Sky Survey and the Wilkinson Microwave Anisotropy Probe (WMAP) deal with the little-understood epoch of time when neutral hydrogen throughout the universe completed its reionization. The October mini-workshop, "Galaxy Mergers: From the Local Universe to the Red Sequence," dealt with the current views on galaxy mergers and evolution. About 75 participants were on hand to learn how recently completed deep-imaging and spectroscopic surveys, as well as simulations, provide evidence for both gas-rich and non-dissipative mergers in early galaxy formation. The participants discussed how these competing merger pictures fit into the overall understanding of galaxy evolution.

Bahcall Lectureship

STScI and NASA's Hubble Space Telescope project established the annual John Bahcall Lectureship to honor the late astrophysicist, John Bahcall, for the seminal role he played over three decades in championing the Hubble Space Telescope. He frequently advocated for Hubble, tirelessly explaining the important ways the observatory was changing our understanding of the universe and the significant impact it had in reaching every level of society. Best known for his work on solar neutrinos, Bahcall served as president of the American Astronomical Society and president-elect of the American Physical Society.

Richard Ellis, professor of astronomy at Caltech, was the first Bahcall Lecturer. In his lecture, he described the current observational challenges in the studies of the earliest galaxies and the importance of continuing this quest in preparation for more detailed studies with the James Webb Space Telescope.

Giacconi Fellowship

In 2006, STScI renamed its Institute Fellowship in honor of the Institute's first Director, Riccardo Giacconi. Giacconi, winner of the 2002 Nobel Prize in Physics, is recognized for his support for education in astrophysics at the postdoctoral level through his founding of the Institute Fellowship Program in 1984 and the Hubble Fellowship Program in 1989. The Giacconi Fellowship Program brings outstanding young researchers to STScI, while the Hubble Fellowship Program provides support for outstanding young researchers at institutions throughout the US. Both of these programs have been highly successful in helping to launch the careers of many leading astrophysicists.

The Giacconi Fellowship is similar in the level of competition and prestige to the prize fellowships at other leading astrophysics institutions. It is for research only, on topics of the holder's choice, and carries no other duties. The research may be theoretical, observational, or instrumental. The Fellowship has a generous salary and research grant.

The current Giacconi Fellows are:

- Katherine Brand
- Chien Yi Peng
- Michael Santos

Summer Student Program

STScI runs a Summer Student Program for highly motivated college undergraduates. The 10-week program, which was begun in the 1980's by Dave Soderblom and has run continuously since 1993, selects 12 participants for immersion in a true research environment. Students have one-on-one interaction with an Institute scientist and participate directly in research, including data acquisition, reduction, and analysis. At the end of the program students present their summer's work at an informal symposium. Students attend presentations on the ways in which modern research is supported and conducted, issues related to research careers, the many and diverse activities that support the operations of HST, and preparations for the science and operations of the James Webb Space Telescope. They also listen to presentations by STScI scientists on their research.

STSCI IS A SCIENCE AND ENGINEERING ORGANIZATION WITH AN OVERRIDING COMMITMENT TO SERVICE AND QUALITY. ENABLING AND PERFORMING BREAKTHROUGH SCIENCE HAVE ALWAYS BEEN OUR GREATEST STRENGTHS.

Missions

OUR GOALS

Maximize the science program of HST.

Develop and operate the best JWST possible.

Operate a world-class archive.

Stimulate education and public outreach.

Maximize the science return of community-based astronomy projects.

Hubble Space Telescope

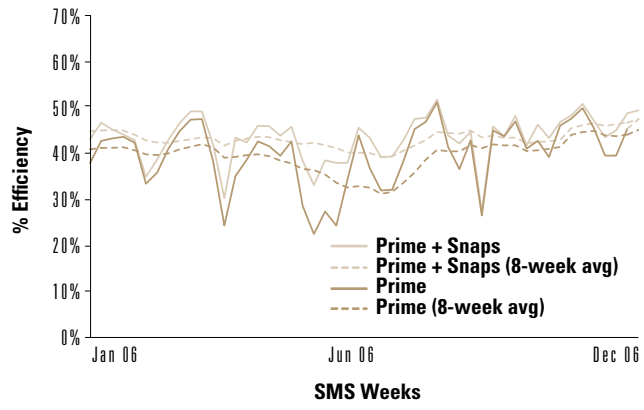


Figure 1. HST efficiency during 2006

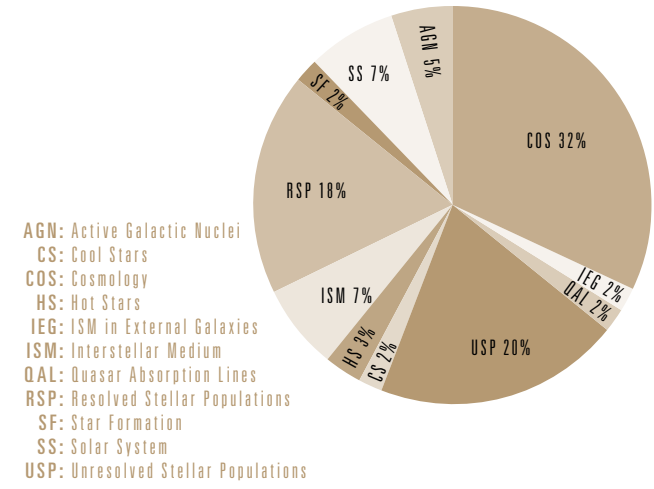


Figure 2. Distribution of the Cycle 15 orbits by science category

STScI's primary responsibility is to optimize the science program of the Hubble Space Telescope (HST). This responsibility is carried out by all involved in the Hubble program—scientists, engineers, technical and administrative staff—in organizations across the Institute. There are several major areas in which the Institute adds value to the Hubble science program. These include stimulating the best possible science program from the astronomy community via the proposal selection process, squeezing the highest possible observing efficiency from the telescope, providing timely and accurate calibration of the Hubble data, stimulating the use of the Hubble data archive for additional scientific results, providing tools to support the astronomy community's use of the telescope and the archive, and overseeing the disbursement and administration of grants.

Extending the life of HST in the face of its aging gyros has been a primary concern for the Institute. During the past year, the observatory started to operate in Two-Gyro Science Mode (TGS), and work started on the development, testing and implementation of a One-Gyro Science Mode (OGS). A study found only a small decrease in sky visibility and observable days between the modes. In addition, jitter levels, although slightly worse in One-Gyro Science Mode, are still expected to be within acceptable limits for the onboard instruments. HST is thus able to function with two gyros, and could still function in a more limited capacity with one gyro. Currently two gyros are in operation and two have been shut off to be held in reserve.

The optimization of TGS allowed a slightly higher than predicted observing efficiency. More important, it provided the ability to maintain and create an optimal long range plan of observations useful for the execution

of the Cycle 14 and 15 proposals. Despite the failure of the Space Telescope Imaging Spectrograph (STIS) in August 2004, the science productivity of the observatory remains high and Cycle 15 was as competitive as the previous ones.

Proposal selection[1]

Cycle 15 received 733 proposals, slightly more than were submitted in Cycle 14 and less than the 949 submitted for Cycle 13. The resulting oversubscription rate in requested orbits was 4.8 to 1. About 70% of all HST observing time in Cycle 14 was allocated to the Advanced Camera for Surveys.

The distribution of proposals among disciplines and larger versus smaller programs is similar to that of previous cycles, as seen in figure 2 on page 24, with a substantial fraction of Cycle 15 observations devoted to extragalactic astronomy. There continues to be a substantial oversubscription of requests for funding of Hubble archival research. The increasing size and breadth of the Hubble archive is progressively attracting more attention to its value, such that the oversubscription of Archival Research projects is comparable with General Observer programs.

Planning and Scheduling

Weekly observing schedules and command loads were created and delivered throughout the past year to provide continuous, efficient, and safe science and engineering commands to the HST observatory. All delivery schedules were met either well ahead of the procedural weekly deadlines or within sufficient margin to allow for proper product review prior to command load uplink to the spacecraft. STScI science operations staff continue to provide commendable support for spacecraft and instrument anomalies. Most notable was their work to help ensure that the telescope was returned to science operations within roughly 24 hours of entry into a spacecraft safemode or instrument suspend for three separate anomaly events.

A small hiatus in ACS observing occurred when the ACS suspended operations on June 19, 2006. ACS had been observing without major interruption since installation in HST in March 2002. A call for contingency for proposals using WFPC2, NICMOS and FGS was issued after this failure. These proposals were evaluated by the Cycle 15 TAC and kept in reserve.

An Anomaly Review Board found that the most likely explanation for the suspension was a failure within the circuitry in the Side-1 electronics of the Low Voltage Power Supply (LVPS) or the Main Electronics Box (MEB). This problem affects both the Wide Field Channel (WFC) and High Resolution Channel (HRC) CCDs. It did not affect the Solar Blind Channel (SBC) MAMA detector. The Board concluded that it would not be possible to restore full observing capabilities on Side-1, but that it would be possible to do so if the CCDs and MAMA were controlled from the redundant set of electronics on Side-2.

The Side-2 electronics and the CCD electronics boxes on ACS were powered up and ACS resumed science operations on July 4.

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[1] Regrettably, at the end of January 2007, the ACS suffered a catastrophic failure and only its Solar Blind Channel camera is working. The High Resolution and Wide Field cameras are not functioning. As of this writing, work is progressing to reassess the science programs that use ACS. This work and its conclusion will be reported in next year's publication. Less than a month after the failure, the efficiency of the observatory was again satisfactory. Measures taken included the earlier execution of some programs and the start of the execution of new contingency programs requested after ACS's side 1 failure in June 2006.

For the period from Sept. 5, 2005 to Aug. 8, 2006, the average scheduling efficiency amounted to 42.09%. This value is in line with the estimates STScI staff calculated for this first full year under Two-Gyro Science Mode operation.

Data Reduction and Analysis

PyRAF is a reduction and analysis software package developed and maintained by STScI. The fundamental capabilities of PyRAF and its use for science data analysis were the subject of tutorials offered at the Institute and at this year's Astronomy Data Analysis Software and Systems (ADASS) conference. The tutorial is now available as an online book through the PyRAF Web pages.

The MultiDrizzle software provides completely automatic registration, cosmic-ray cleaning and combination of large numbers of separate HST exposures. It now runs in the ACS pipeline as well as being available for researchers to use off-line for all the imaging instruments currently onboard HST.

Of note in the Near Infrared Camera and Multi-Object Spectrograph (NICMOS) reduction software suite was the release of SAACLEAN, which can be run on post-SAA NICMOS images to identify the amount of charge in each pixel that can be attributed to persistent flux from South Atlantic Anomaly (SAA) cosmic rays, and applies a correction based on an SAA persistence model to remove this flux from the data.

Instrument Calibration and Characterization

Calibration observations, which help determine such vital facts as precise object brightness, temperature and distance, are essential to conducting science observations. As in previous years, calibration activities took up only approximately 5 percent of the spacecraft observing time this year. All active instruments, ACS, NICMOS, WFPC2 and Fine Guidance Sensors (FGS) have participated in the ongoing program, while STIS continues to improve its calibration through the STIS data enhancement program.

A calibration outsourcing program continues as a small but relevant item in the calibration planning. If HST users wish to use the telescope in an odd mode -- for example, with an uncommon filter -- they can do so, but they need to perform their own calibration observations. The results are then kept in the STScI archive.

To enhance the science return of HST and other missions, and taking advantage of the HST capabilities in preparing for future major NASA missions, a program to provide cross-calibration material between HST, the Spitzer Space Telescope and James Webb Space Telescope (JWST) was initiated. Specifically, this project

- Establishes an astrometric field in the JWST southern Continuous Viewing Zone (CVZ).
- Calibrates faint near-IR spectrophotometric standards using A-dwarfs and K-giants to complement the existing white dwarf and solar-analog calibrators.
- Calibrates faint solar-analog photometric standards for JWST in several open clusters strategically spaced around the sky to provide continuous access to one throughout the year.

STScI staff were able to pinpoint the NICMOS anomaly discovered last year in the NIC1 and NIC2 detectors. As brighter sources are observed with NICMOS, the count rate increases faster than would normally be expected. Conversely, as fainter sources are observed, the count rate is lower than the models predicted. This anomaly produced 10%-30% errors in photometry for very faint sources. The knowledge acquired through these tests will allow for a correction to the anomaly to be implemented during Cycle 16.

WFPC2 continued to be used normally, especially as a parallel instrument. In Cycle 15, 11 proposals used WFPC2 as primary instrument. The tail of hot pixels due to Charge Transfer Efficiency (CTE) loss was explored in detail and found to be up to 200 pixels long. This discovery may be useful in improving CTE-loss corrections for Wide Field Camera 3 (WFC3), to be installed during the upcoming servicing mission. The WFPC2 team identified and developed a solution to a bias anomaly discovered in the WF4 chip. The anomalous bias was fixed by lowering the temperature of the detector.

In 2005, STScI's STIS instrument team began a STIS data enhancement program that was endorsed by the Space Telescope Users Committee and NASA. The focus of the program is to finalize the calibrations and documentation necessary to render the existing archive of STIS data in a status suitable for performing high-level and high-accuracy science. The program also includes enhancements related to STIS data retrieval from the HST archive, which will be implemented after the archival STIS data have been fully recalibrated and stored.

In response to NASA's decision to prepare for SM4, STScI resumed work on the development and ground-based testing of HST's new instruments, Cosmic Origins Spectrograph (COS) and the Wide Field Camera 3

Grants Awarded through 9/30/06 (with obligations through FY06)

1989	$1,038,133
1990	$144,801
1991	$3,313,374
1992	$11,377,362
1993	$15,545,673
1994	$16,906,230
1995	$10,601,449
1996	$19,788,368
1997	$17,955,274
1998	$21,240,639
1999	$18,943,201
2000	$18,685,619
2001	$21,108,402
2002	$21,099,550
2003	$22,369,517
2004	$25,421,259
2005	$24,670,412
2006	$19,590,494
	$289,799,757

Submitted Proposals Worldwide

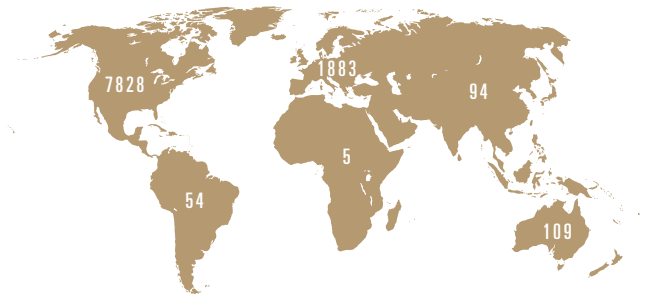


Figure 3. Astronomers from all permanently inhabited continents have submitted proposals to observe with HST.

(WFC3). Work will continue in the coming year on the last support items before on-orbit commissioning, such as the exposure time calculators, updates to the Astronomer's Proposal Tool, calibration software and Servicing Mission Orbital Verification planning.

STScI staff continues to support the development of the WFC3 in numerous critical areas, including optics, filters, detectors, and testing—in particular, the resolution of several issues with the instrument filter set and the characterization of the camera's detectors. During the past year, STScI scientists took a leading role in devising alternate alignment methodologies for the WFC3 infrared detector. They have supported the alignment of the calibration system, selections of its neutral density filters and lamps, and assessments of its performance. They also supported the analysis of the impact of dust and its removal on both the UVIS detector window and the channel select mirror. As part of both the continuation of the integrated instrument performance modeling and also the instrument lien resolution process, analysis of the deficiency in throughput seen in the IR channel was conducted.

The COS ground system development was re-started early in 2006. Updates to scheduling, proposal specification, and commanding phases of the ground system were completed to implement new operational procedures needed for correction of the COS Optical Selection Mechanism drift.

Development continued on user tools for bright object evaluation in observational fields-of-view and for exposure time calculation (ETC), which will be available to the community as part of the Astronomer's Proposal Tools (APT). Additionally, initial development of the first COS Instrument Handbook began.

Grants

STScI distributes and administers NASA grants to Hubble general observers and their co-investigators. The pool includes grants for archival and theory projects as well as the support for Hubble Fellows.

These grants support astronomers at universities, colleges and research centers, and their students and post-doctoral fellows. They also support the resources needed to analyze HST data.

STScI convenes the Financial Review Committee (FRC) to peer review the grant requests and make funding recommendations to the director. STScI developed

and maintains the Space Telescope Grants Management System (STGMS) software that allows institutions and individuals to submit and manage their grants.

Each year, around $20 million in grants pass through STScI and are distributed to the community. The table on page 28 lists the total amount of grants distributed since inception of the program for each fiscal year.

Great Observatories Workshop

STScI astronomers, along with their colleagues at the Spitzer Science Center and the Chandra X-ray Center, organized a Great Observatories Workshop that focused on the science priorities for the Great Observatories in the immediate future, particularly those that require synergistic and collaborative observational strategies. About 90 astronomers attended the workshop, which concluded with the compilation of a list of high-priority science topics in which the Great Observatories could and should make key contributions. Participants found that all the key science questions are currently being addressed by the Great Observatories, and that archival research will become increasingly important in the near future, giving rise to the need for an efficient cross-link among data archives. Participants also focused on the Spitzer Space Telescope's limited lifetime, the resulting need to streamline the proposal process for projects that require medium to large allocations, and the importance of cooperative strategies within the community to propose important science.

Hubble Science Year in Review

The Hubble 2005 Science Year in Review is a book describing the science accomplishments of HST in detail, accompanied by images and illustrations. Around 2,000 copies were distributed to all the members of Congress, policy makers in the executive branch, members of the National Academies, national agencies' managers and staff, all public schools and public libraries in the Baltimore metropolitan area, and all the astronomers that submitted a proposal as a principal investigator or as a co-investigator. Hubble Science Year In Review is a primer to the important discoveries Hubble has helped come into being and makes the case for Hubble's position as one of astronomy's most vital tools. As was the case with the first edition, the second edition of the Hubble Science Year in Review was very well received, as reflected by the comments and letters received commending the book.

Infrastructure upgrade

A project to upgrade the STScI computer networks and data storage began in 2006. The higher bandwidth and capacity is needed to handle the expected data volume increase after SM4. This network upgrade will provide increased performance to users. The centralized storage solution, which is sized to support all the work performed at STScI, is scalable so it can be extended as needed. The work included the recabling of a large portion of the STScI building and the replacement of several network switches. Data will be stored and backed up in a new centralized data deposit, easy to access by users. The data deposit is connected to a backup server that writes data to both a disk and tapes, ensuring no loss of information.

James Webb Space Telescope

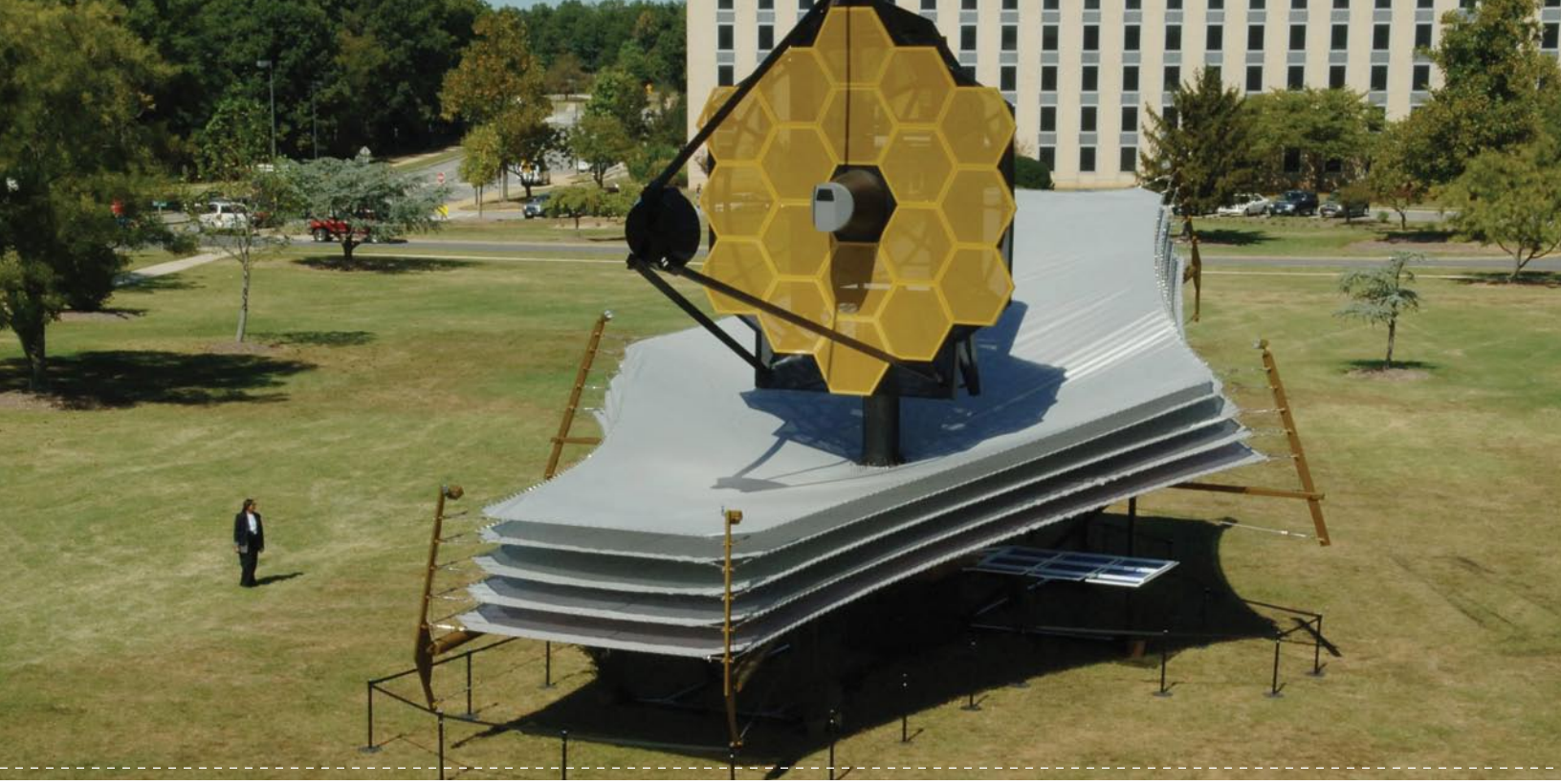
Since NASA revised the project plan almost two years ago, the James Webb Space Telescope (JWST) has remained on schedule for a launch in June 2013. The manufacturing and testing of the 18 primary mirror segments are a critical part of the plan. All of the segments have been completely machined and delivered for grinding and polishing. In January 2006, the JWST project passed another major milestone, the Systems Definition Review. Two independent review teams assessed that the design of the observatory is sound and pronounced the JWST program ready to move towards a Preliminary Design Review (PDR) in 2008. By the end of 2006, the JWST team had demonstrated the readiness of 9 of 10 mission-enabling technologies. Only the Mid Infrared Instrument (MIRI) cryocooler needed additional engineering and testing before flight-like versions could be manufactured.

As was the case with HST, NASA is partnering with the European Space Agency (ESA) in development and then operations of JWST. STScI will again be the place where this partnership will flourish.[1]

The NASA/ESA Mission Operations Joint Project Implementation Plan (JPIP) and the Near Infrared Spectrograph (NIRSpec) Joint Project Implementation Plan are being developed by STScI, NASA and ESA. The plans establish the roles of these agencies in JWST implementation and operations. The Mission Operations JPIP will include an appendix that details the provision of ESA staff to STScI for JWST operations. Building on this previous experience, we expect that a newly established partnership with the Canadian Space Agency (CSA) will be an equal and mutual success.

The project is now in a phase where the details of the flight segment design are being established. We are working with the observatory contractor, Northrop Grumman Space Technology (NGST), to analyze operations scenarios and ensure that the JWST requirements are complete. Some operations challenges have emerged pertaining to efficiently managing JWST's accumulated momentum and maintaining the observatory's orbit about L2. STScI is performing extensive analyses to determine how to schedule science

[1] By the time of this publication, the MIRI cryo-cooler had passed its testing. The formal review for technology readiness occurred in late January 2007 and concurred with the findings of the project. We will report on that meeting in the 2007 Annual Report.



observations so as to minimize the accumulation of momentum and to establish operationally defined bounds for the observatory design.

In August 2006, NGST began to test the cryogenic stability of a 1/6th portion of the backplane for the JWST primary mirror. STScI played an enabling role in this work.

A team of STScI staff, led by Babak Saif, implemented a novel measurement technique with a speckle interferometer to verify the stability of the primary mirror backplane. Saif conceived the idea two years ago, and worked with 4D Technologies of Tucson to develop the speckle interferometer, earning a second PhD along the way. This year Saif worked with Perry Greenfield, Warren Hack and Ivo Busko to build a data acquisition and processing system that acquired 10 Terabytes of data during testing of the backplane structure test article at NASA's Marshall Space Flight Center.

As a result of this work, NASA was able to show that the backplane structure (design methodology and fabrication technique) could meet JWST requirements throughout the flight environments. These include launch loads and vibration, cryogenic operations in vacuum, and thermal stability.

The success of this technique has led to new plans for its use in JWST testing. It will be used to measure the behavior of the Integrated Science Instrument Module (ISIM) structure this year, as well as for testing of the full Primary Mirror backplane structure in the future.

A portion of our time in 2006 was occupied with negotiating the revised plan for the STScI work on JWST, in order to match to the delayed launch date of June 2013. Although the launch date is 22 months later, the STScI work is not delayed an equivalent amount. STScI is integrally involved in the work of the science instrument teams, ISIM operations software development, and in supporting the Optical Telescope Element development and testing. The schedules for many of these activities were little changed. As a result, we were

1998

Steve Beckwith is appointed director.
STScI is designated as the JWST Science and Operations Center.
May Symposium: Unsolved Problems in Stellar Evolution.

faced with the challenge of continuing to keep pace with the near-term activities while contending with two years of reduced funding (FY06 and FY07). Although it has been necessary to postpone implementation of the Science and Operations Center ground systems, our scientists have continued to work with the science instrument teams on the plans for commissioning, calibrating and operating the instruments. We have also moved rapidly ahead with writing and testing the scripts that will execute on-board JWST to command the observatory. We have completed the development of the Project Reference Database, a master database of operations information, and are operating it in support of initial instrument development and testing.

STScI staff have engaged with each of the Science Instrument developer teams directly by establishing operations working groups. These groups define how the instruments are commanded and operated. One of our goals is commonality across the various instruments. Our commanding team has made considerable progress in creating the on-board scripts and the Operations Plan Executive. The on-board scripts convert high-level instructions for the science observations into detailed commands for the instruments and spacecraft. They embody the knowledge of how the instruments operate and manage the intricate interactions between the flight systems to perform the observations. The Operations Plan Executive runs the scripts and orchestrates the event driven operations paradigm for the observatory. In the past year we made deliveries of the first script builds to three of the JWST science instruments: NIRCam, NIRSpec and MIRI. We will make additional deliveries over the next two years to provide the teams with a full complement of scripts, enabling them to test the science instruments in the same way as they will be operated on orbit. Our facilities for this work took a big leap forward this year with the installation of a laboratory at STScI that houses a flight equivalent version of the ISIM computer. This lab gives us the capability to test the scripts in a flight-like environment. Our scientists have completed an end-to-end calibration budget for the four instruments and have helped define the requirements for on-board target acquisition software.

Despite delays in the schedule for developing the Science Operations Center, we did transition one of our core systems into operation this year: the Project Reference Database (PRD), the suite of tools used to manage a master database of operation information. STScI has established a central facility at the Institute that houses and controls the master data set. STScI has also provided a suite of tools for preparing and controlling local databases at the worldwide JWST development and test sites. This system will continue to be maintained and operated by STScI throughout JWST's integration, testing and operations.

The JWST Wave-front Sensing and Control System (WFS&C) analyses images of stars and computes corrective motions for the actuators on the primary mirror segments to maintain the correct optical alignment. The portion of this system that does the analysis will reside at STScI. Originally this software system was to be developed and delivered by Ball Aerospace and JPL. STScI recently took over responsibility for the JPL portion of the system and has begun designing it.

In 2006, JWST outreach efforts to the astronomical community were increased in conjunction with efforts by NASA and NGST. At the 2007 winter meeting of the AAS, we displayed a new video describing the mission as well as mirror segment models and other flight hardware. NGST provided a full-scale model of JWST just outside the meeting area. We will also provide displays at the 2007 Summer AAS meeting in Honolulu. STScI and GSFC are co-hosting an international meeting entitled "Astrophysics in the Next Decade: JWST and Concurrent Facilities" next September 24-27 in Tucson, Ariz.

Hubble Data Archive

The Hubble Data Archive continues to be one of the most used astronomical resources. In 2006, a project to replace outdated hardware, stabilizing archive systems and shortening the response time for archive users requesting data, was completed.

During the past year, 43,122 observations were processed through the STScI data pipeline and into the Hubble Data Archive. On average, users were able to access their science data from the Archive less than a day after the observations executed, including the time the data spent on the spacecraft.

The science products, reduction and analysis tools, and reference files continue to improve through the efforts of STScI staff. For instance, detectors often have deficiencies resulting from their age, such as scratches or lessened sensitivity, that can be compensated for by the effective combination of multiple files or changes in the way these reference files are created. STScI staff have worked diligently to develop techniques that best correct these detector characteristics.

The number of published papers with HST data continues to increase. More than 6,000 papers appeared in refereed journals, and more than 7,500 were published in total as of December 2006. Most notably, figure 1 shows that the yearly publications of refereed papers using HST archival data has continued to grow.

The HST Archive ingested 4.0 Terabytes of data between January and December 2006, bringing the total size of the HST archive to 30.5 Terabytes. 23.0 Terabytes of archive data were distributed.

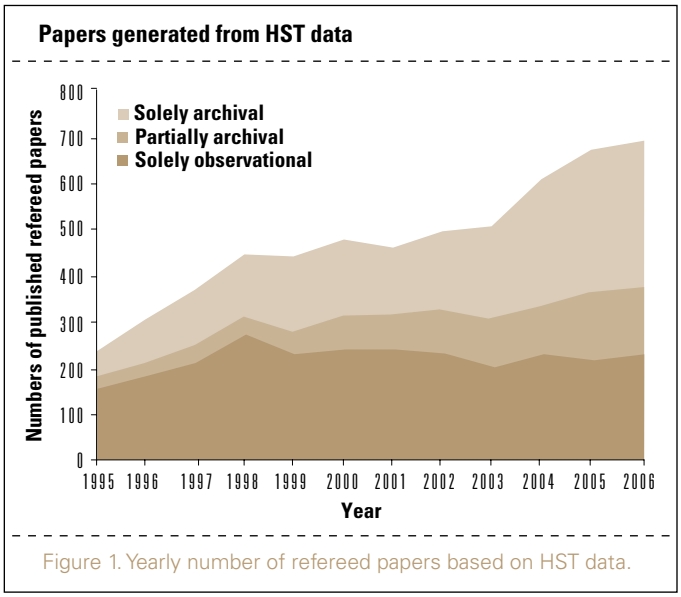


Figure 1. Yearly number of refereed papers based on HST data.

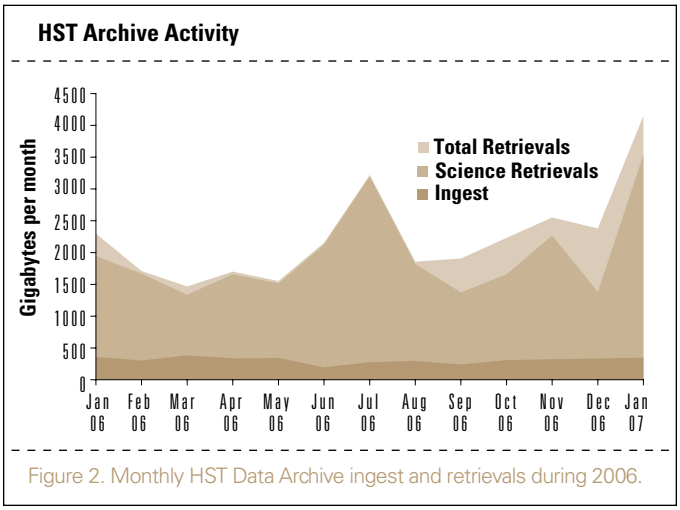


Figure 2. Monthly HST Data Archive ingest and retrievals during 2006.

2000

The PyRAF data analysis system is released.

The JWST instruments are defined and the JWST Mission Simulator is released.

May Symposium: A Decade of HST Science.

High Level Science Product Set

10 Lac (O9V) Spectral Atlas (HST/GHRS)
WFPC2 Archival Parallels (Proposal 9540)
CoolCAT - A cool-star UV spectral catalog
Cosmic Evolution Survey - COSMOS
Catalogs of B-, V-, and i-band dropout sources
HST Treasury Program on Eta Carinae
EUV Spectral Atlas of Stars (EUVE)
AGN and Quasar Spectral Atlas (HST/FOS)
Quasar Spectrum FUSE
FUSE Atlas of Starburst Galaxies
OB Stars (Galactic): FUSE Spectral Atlas
OB Stars (Magellanic): FUSE Spectral Atlas
FUSE Spectral Atlas of Wolf-Rayet Stars
GALEX Atlas of Nearby Galaxies
GEMS: Galaxy Evolution from Morphologies and SEDs
GOODS: The Great Observatories Origins Deep Survey
Grism-ACS Program for Extragalactic Science (GRAPES)
Hubble Deep Field
Hubble Deep Field South
Hubble Helix Observations
Pre-Main Sequence Stars: IUE Spectral Atlas
Hubble Space Telescope ACS mosaic images of M51
Hubble Space Telescope ACS mosaic images of M82
Ultraviolet Images of Nearby Galaxies
Quasar Spectrum HST/FOS
Spiral Galaxies
Search Field from a Search for Kuiper Belt Objects
Ultra Deep Field ACS-HRC Parallels
Ultra Deep Field - ACS-WFC
Ultra Deep Field NICMOS Parallels
Hubble Ultra Deep Field Follow-on
Wide Field Planetary Camera 2 Associations

This brings our total volume of data distributed since launch to more than 120 Terabytes.

To reduce network loads and cut the effort required to generate multiple sets of DVDs, STScI developed a process for delivering very large archival requests on external USB hard drives.

The Multimission Archive at Space Telescope (MAST)

The Multimission Archive at Space Telescope (MAST) is one of the world's most widely used data archives (see figure 3). It offers users convenient search-and-retrieval utilities for accessing 35 terabytes of data from many missions and surveys, including:

- Far Ultraviolet Spectroscopic Explorer (FUSE)
- Galaxy Evolution Explorer (GALEX)
- XMM Optical Monitor
- Orbiting Retrievable Far and Extreme Ultraviolet Spectrometers (ORFEUS)
- Extreme Ultraviolet Explorer (OEUVE)
- Ultraviolet Imaging Telescope (UIT)
- Hopkins Ultraviolet Telescope (HUT)
- Wisconsin Ultraviolet Photo-Polarimeter Experiment (WUPPE)
- International Ultraviolet Explorer (IUE)
- Copernicus
- Very Large Array-Faint Images of the Radio Sky at Twenty-one Centimeters (VLA-FIRST)
- Digitized Sky Survey (DSS)
- Guide Star Catalog (GSC)

Besides the "raw" contents of these missions data, MAST includes the collection of High Level Science Products listed in the table to the left. These very popular products, contributed by the community, are highly processed data files ready to be analyzed. Of special note is the usefulness of the Digitized Sky Survey, as demonstrated by figure 4.

Hubble Legacy Archive

STScI initiated technology studies for a project to create an HST Legacy Archive (HLA). The HLA will use available resources to add science value to the archive of HST data, and will make that data compatible with the National Virtual Observatory, a project to link the world's astronomical data together via online tools.

The Hubble Legacy Archive development project makes extensive use of National Virtual Observatory tools and infrastructure. In addition to simplifying the HLA project, this assures that HLA data products

will fit seamlessly into the NVO and be widely available through both HLA-specific and more generic NVO interfaces. The HLA will make it easier than ever to compare HST data with data from other observatories.

The HLA will be the place to find the best archival files for science. While the files in HST's archive change constantly as new information comes in, the HLA will possess the final, best files that result from the constant influx of information. The HLA will be repopulated from the current HST archive whenever significant improvements are made in the calibration or in the processing software.

Registered Users of the STScI Archive

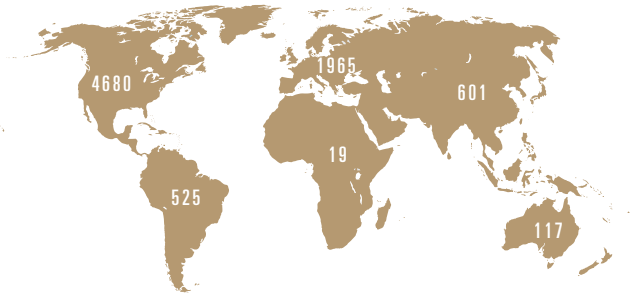
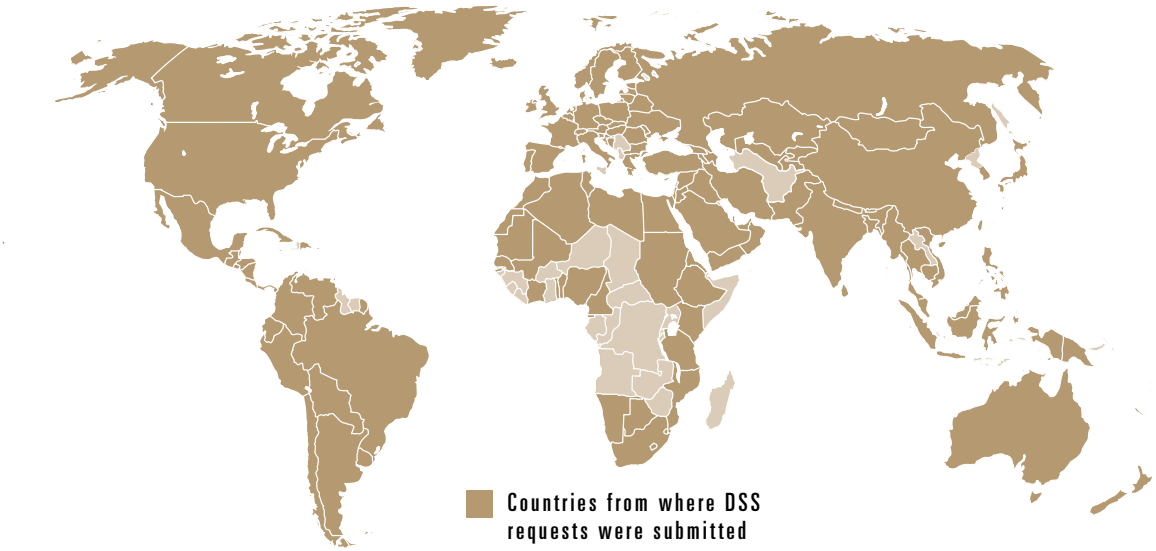


Figure 3. Number of registered users by continent.

The HLA image data will feature improved absolute astrometric accuracy based on the Guide Star Catalog II. The HLA, unlike other sources, will also allow users to download portions of HST images containing objects of interest. The HLA will include lists of objects identified within HST images.

The HLA studies are proceeding in collaboration with the European Space Agency's Space Telescope – European Coordination Facility (ST-ECF) and the Canadian Astronomy Data Centre (CADC). The ST-ECF will concentrate on including spectroscopic data within the HLA framework. The CADC will collaborate with STScI in preparing associations of images and object catalogs.



DSS Retrievals

Figure 4. Between July 2006 and January 2007, STScI received 1,112,321 requests of Digitized Sky Survey extractions from users in the 143 countries identified in the map.

“OPO is commended for outstanding results this year across its full suite of products and services, and for consistent customer-oriented focus.”

From the HST Project’s Performance Assessment Committee (PAC) FY06 letter

Bonnie Eisenhamer (STSCI) discusses space science with students.

JWST science operations center contract is signed.
HST’s IMAX movie is released.
ViewSpace is deployed.

2003

Office of Public Outreach

STScI's Office of Public Outreach (OPO) engages the public in Hubble's discoveries on a multitude of fronts, using the news media, museums, classrooms and more to disseminate a steady stream of knowledge-broadening discoveries and images.

News releases in 2006 ranged from findings on planets beyond the solar system to the first-ever image of Polaris' close companion star. Hubble helped contribute to the debate about what constitutes a planet when it confirmed that the Kuiper Belt Object Eris (formerly known as Xena) was slightly larger than Pluto. In addition, several releases on early galaxies discussed the latest ideas about the way galaxies and their central black holes form.

The winter release of Hubble's billion-pixel mosaic of the Orion Nebula provided an opportunity for a coordinated OPO effort on all education and public outreach fronts. In addition to the News team's press release and a "Hubble Minute" video broadcast on NASA TV, OPO's Formal Education group discussed the image on its Amazing Space education Web site's online newspaper, "The Star Witness." The Informal Science Education branch distributed mural-sized prints for unveiling at more than 70 informal venues, such as museums and science centers. The Online Outreach group posted to its HubbleSite Web site an explanatory point-and-click feature called an Image Tour, and introduced a utility allowing online users to zoom into and pan about the image to take advantage of its depth of detail. This utility has since been applied to all of the large images available through the HubbleSite Web site.

The Origins Education Forum group helped create a multi-mission presentation on the image and its application to a variety of science themes for Girl Scouts trainers and the Night Sky Network—a network of more than 200 amateur astronomy groups that the Origins Forum supports through content delivery and product evaluation.

A similar coordinated effort was undertaken for the "Sweet Sixteen" Hubble anniversary. The News team released a mosaic of the starburst galaxy M82, which was converted to a mural-sized print for unveiling at informal venues along with Chandra and Spitzer images of the same galaxy. The Origins team likewise keyed on the images from the trio of observatories to create a presentation for its constituencies.

The News team was adept at bringing other topics of interest to the public. The team held a media teleconference on the newly discovered moons of

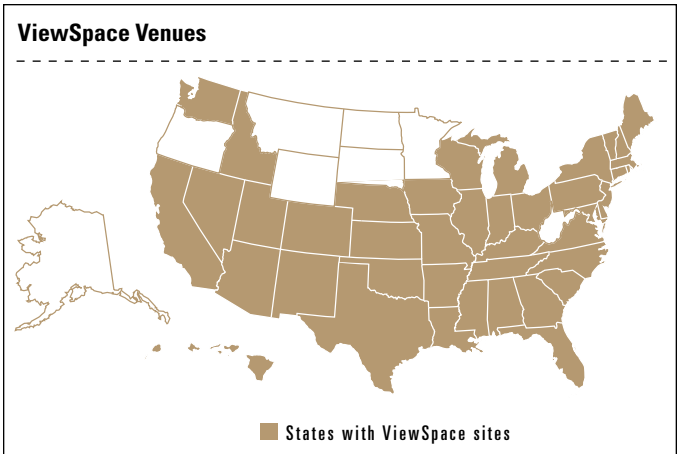


Figure 1. US map with Viewspace installations

Pluto, and reported on Hubble observations of Jupiter's new storm, "Red Spot Junior," and the breakup of Comet Schwassman-Wachmann 3. The team participated in a NASA Science Update showcasing Hubble's lunar prospecting exploits as the telescope searched for oxygen-bearing minerals on the moon in support of the Vision for Space Exploration.

The Formal Education team has continued its ambitious program of support for teacher workshops, including the NASA pre-service teacher conference, which supports teachers from predominantly minority-serving institutions. HST science data and discoveries are used by Formal Education to create the educational materials available on Amazing Space, a Web site designed for educators and students. These K-14 materials are used in classrooms in all 50 states. Amazing Space "went Hollywood" when NASA employed the site's units on comets as part of an education guide accompanying the Sony Pictures movie "Zathura."

The Informal Education branch has continued to refine its ViewSpace media display product. ViewSpace is an internet-served, permanent exhibit that provides a constant stream of images and educational presentations. More than 120 informal science education venues, libraries, and nature centers receive regularly updated ViewSpace programming on Hubble discoveries and other NASA science missions. This year, collaboration with NASA's Earth Observing Systems program has added Earth science features to the programming mix.

The Online Outreach group completed its redesign of HubbleSite, making the site more easily navigable by the 1.5 million users it receives every month. The team added "HubbleWatch," a monthly compilation of Hubble news highlights, to the podcast offerings it makes available online, and continued to develop such products as Image Tours, point-and-click explanations of popular Hubble pictures, and the backyard astronomy guide called Tonight's Sky. This year, the group posted a new special feature entitled "Black Holes: Gravity's Relentless Pull," which incorporates animations, hands-on interactive activities and articles about black holes.

The Origins Education Forum continued to coordinate the education and public outreach (E/PO) efforts of missions dedicated to the astronomical search for Origins and to partner with groups that enable the dissemination of the Origins message. The Forum continued its partnership with the Lawrence Hall of Science, providing content and evaluation services for its Great Explorations in Science (GEMS) astronomy unit. The group supported the Astronomical Society of the Pacific's Night Sky Network and worked with the Pacific Science Center's museum group, serving communities with large underserved youth populations. The team coordinated NASA mission sessions at the National Science Teachers Association Conference, and participated in meetings of the Girl Scouts, teachers of students with special needs, and Native American initiatives. The Forum established a "Beyond the Solar System" section on the Museum Alliance Web site, and partnered with the Structure and Evolution of the Universe (SEU) Forum and the Great Observatories in the development of a Braille book on multi-wavelength astronomy. The group has worked closely with its SEU counterpart this year to meld their respective mission groups into a cohesive whole.

OPO strove in 2006 to demonstrate a leadership role in service to NASA and the audiences it serves. Keynote presentations were made at the "E/PO at NASA Astronomy Centers" session of the National Research Council's Committee on NASA Astronomy Centers, and at the NASA-sponsored Societal Impact of Spaceflight Conference. The Office is taking a lead role in coordinating NASA mission efforts for the IAU-sanctioned International Year of Astronomy (IYA) in 2009, and has a representative on the American Astronomical Society's IYA Committee. And OPO co-hosted the Astronomical Society of The Pacific's Education and Public Outreach Conference in September, welcoming more than 300 of its education and public outreach colleagues to Baltimore.

National Virtual Observatory

STScI is a key player in the development of the US National Virtual Observatory (NVO), the US effort to link all the world's astronomy data together via online tools. The project will provide worldwide access to data from many different instruments at all wavelengths of the electromagnetic spectrum.

STScI is responsible for overall project management and for coordinating the NVO education and public outreach program. STScI staff are also major contributors to software development, particularly in the area of tools used to determine sky coverage and overlapping survey regions, and tools to locate data. STScI provides data standardized for the NVO, including all data collections in the Multimission Archive at Space Telescope (MAST), and many high-level products from HST and other space science missions. STScI staff have taught at three NVO summer schools for graduate students who will be using the NVO, and are contributing to a book that will fully describe the structure and capabilities of the NVO.

STScI has established a virtual observatory Web site (http://www.virtualobservatory.org) and related sites to explore the ways to integrate the power of NVO into science education.

Kepler Data Management Center

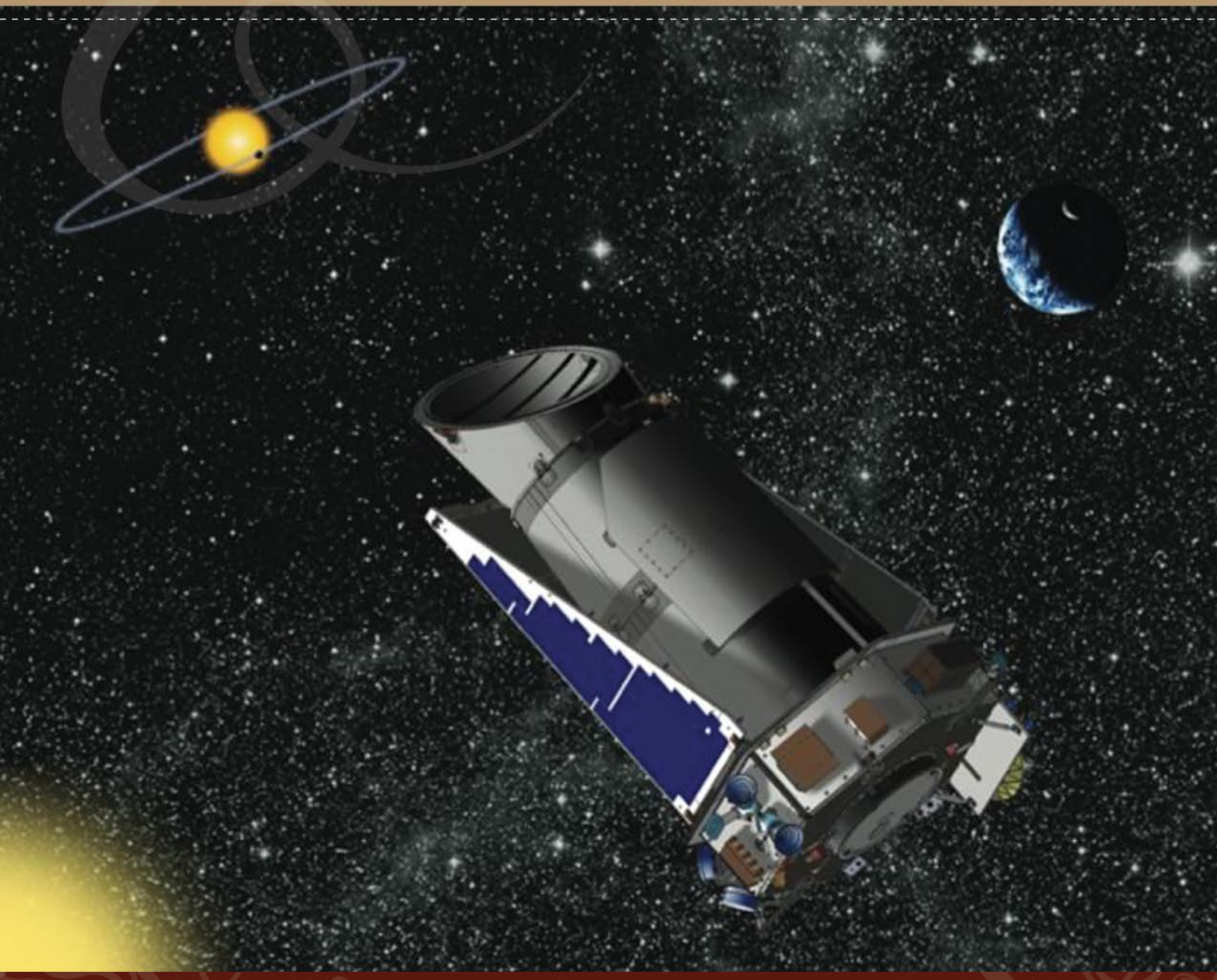
STScI is partnering with the Kepler Project to serve as the mission's Data Management Center (DMC). The primary goal of the Kepler mission is to determine the frequency of terrestrial and larger planets in or near the habitable zones around a wide range of star systems. The Kepler spacecraft will do this by detecting and characterizing photometric transit events for around 100,000 stars near the Galactic plane. Kepler is scheduled for launch in November 2008.

At STScI, the Kepler DMC will be responsible for scientific data processing, and for populating and managing the Kepler data archive, including the storage and dissemination of the light curve data.

The DMC Archive Peer Review was held at STScI on Jan. 12-13, 2006. The DMC Development Team performed a detailed walk-through of DMC documents describing what needs to be done to create the archive. The DMC Critical Design Review was held at STScI on Feb. 16, 2006. Finally, the DMC completed two builds of the data processing and archive system software. These builds provided data processing pipeline functionality, the design of the archive database tables, archive ingest functionality, and the ability to write data to the primary and backup archive.

> “It was such a pleasure [...] to see the Kepler plan to leverage the [STScI] computing infrastructure to provide their DMC. It was also a real pleasure to see a [software] development system in such good shape at CDR.”

From the Kepler Data Management Center iCDR Board Report



THE FUTURE HOLDS

more opportunities, discoveries and achievements.

TO MAXIMIZE THE SCIENCE RETURN OF ITS MISSIONS, STSCI DEVELOPS STATE-OF-THE-ART, INNOVATIVE AND CUTTING-EDGE PROCEDURES, PACKAGES AND SYSTEMS. THE KNOWLEDGE, INGENUITY AND ABILITY OF OUR STAFF EXPANDS THEIR USE TO OTHER GROUND OR SPACE-BASED MISSIONS AND PROJECTS.

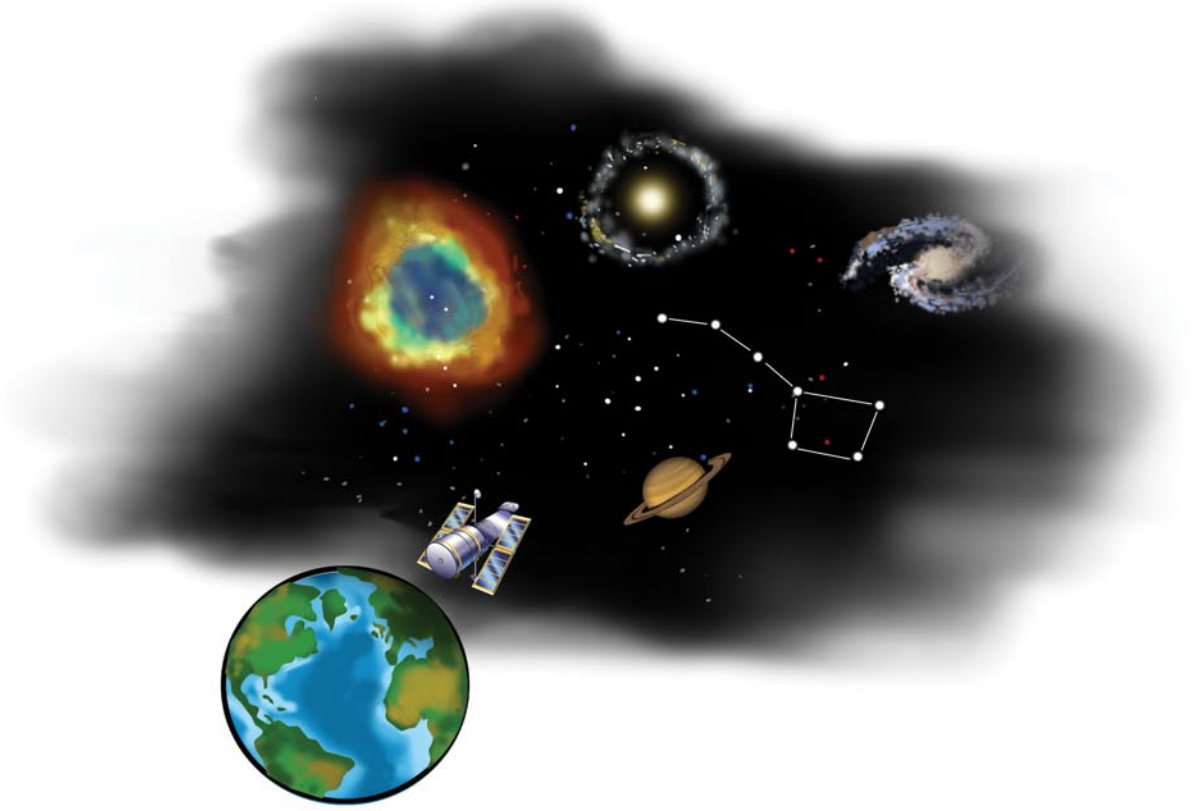
Innovation

OUR GOALS

Enable excellence in research by optimizing the science from state-of-the- art astronomical instruments.

Promote new applications for STScI products.

Foster new missions and mission concepts.



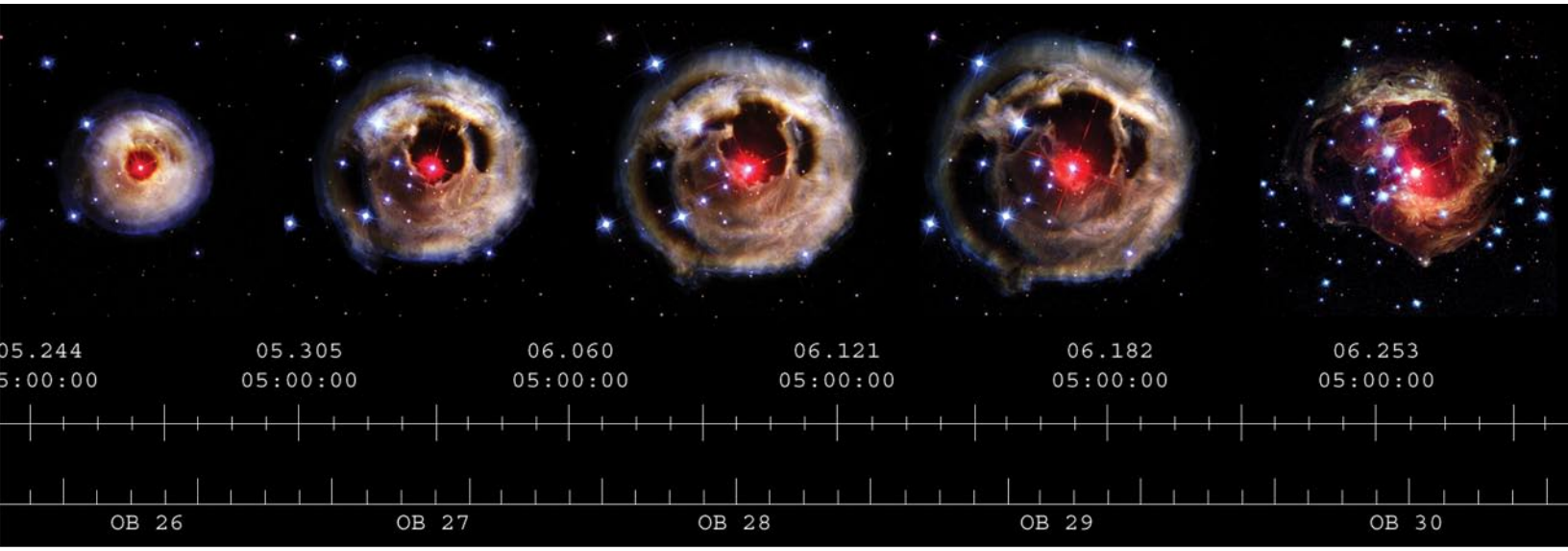
GoogleSky

STScI astronomers are collaborating with the University of Pittsburgh to experiment with methods to bring the universe to the public's computer desktops through protocols developed at Google. This collaboration aims to produce an intuitive interface, GoogleSky, that will allow users to roam through the celestial sphere mapped by the Digital Sky Survey, looking at the constellations and zooming into the Sloan Digital Sky Survey, then zooming further to objects of interest whose HST or GALEX images will appear. This interface will also connect to astronomical databases served by the Multi-mission Archive at STScI and HST press releases, and offer hyperlinks to larger collections, such as the National Virtual Observatory.

This interactive and engaging interface is not only an ideal outreach and educational tool but has the potential to flourish into a research and discovery tool.

International Workshop on Planning and Scheduling for Space

On Oct. 22–25, 2006 more than 60 technologists, researchers, and end-users of Planning and Scheduling technology from all over the world attended the Fifth International Workshop on Planning and Scheduling for Space that was organized by STScI. Planning and Scheduling technologies add value to space missions by reducing operations costs, increasing science return, and enabling new types of science. The workshop increased participants' understanding of how to improve their ability to transfer research results in computer science to applications in space science missions.



Astrophysics Enabled by the Return to the Moon

Director Matt Mountain (right) and Astronaut John Grunsfeld (left)

Scientists listen to proposals for lunar-based research.

The Space Telescope Science Institute sponsored a three-day science workshop, "Astrophysics Enabled by the Return to the Moon," including a special workshop for science writers. The workshop was organized in collaboration with Johns Hopkins University, the Association of Universities for Research in Astronomy, and NASA. Unlike a few previous meetings and studies that mostly concentrated on observatory concepts and on sites, the STScI workshop focused primarily on the science. The workshop's goal was to identify key questions in astrophysics—such as the nature of the dark energy and whether extrasolar planets are habitable.

The workshop identified important astrophysical observations that can potentially be carried out from the lunar surface. Most promising in this respect are low-frequency radio observations from the lunar far side, to probe structures in the high-redshift universe and the epoch of reionization; and lunar ranging experiments, to test a certain class of alternative theories of gravity.

Besides these, a few smaller and more limited-in-scope experiments were suggested. These included:

- A small telescope to observe the Earth, for a better characterization of Earth-like planets
- A calorimeter for the study of intermediate-energy cosmic rays
- A small, far-UV telescope to examine the structure and composition of the hot galactic medium.

Finally, attendees recommended further examination of external occulters for observations of Earth-like planets, and liquid mirrors for deep-field observations.

The workshop also highlighted the fact that observations from free space (and in particular from Lagrange points) offer the most promise for significant progress in broad areas of astrophysics. Given the impressive capabilities of the proposed Vision for Space Exploration (VSE) infrastructure, the workshop participants recommend that every possible effort should be made for the VSE not to preclude—but rather to enable—future observations from free space.

“Because of the Institute’s unique experience with Hubble—an epitome of the scientific benefits of human spaceflight and technologies developed for other purposes—it was both an obligation and a privilege for us to conduct this open, objective discussion about the possibilities for astrophysics enabled by a NASA’s commitment to return to the Moon, Mars, and beyond.”

Matt Mountain, STScI Director

STSCI IS IMMERSED IN THE COMMUNITY IT INHABITS. IT OFFERS EVENTS THAT ENRICH THE COMMUNITY. ITS STAFF MEMBERS USE LOCAL PRODUCTS AND SERVICES, AND ARE ACTIVE PARTICIPANTS IN THEIR ENVIRONMENT.

Community Involvement

OUR GOALS

Be a good community partner.

Develop community partnerships to expand our programs in the greater Baltimore area.

Engage young people to encourage their interest in science, technology, engineering and mathematics.

Public Lecture Series

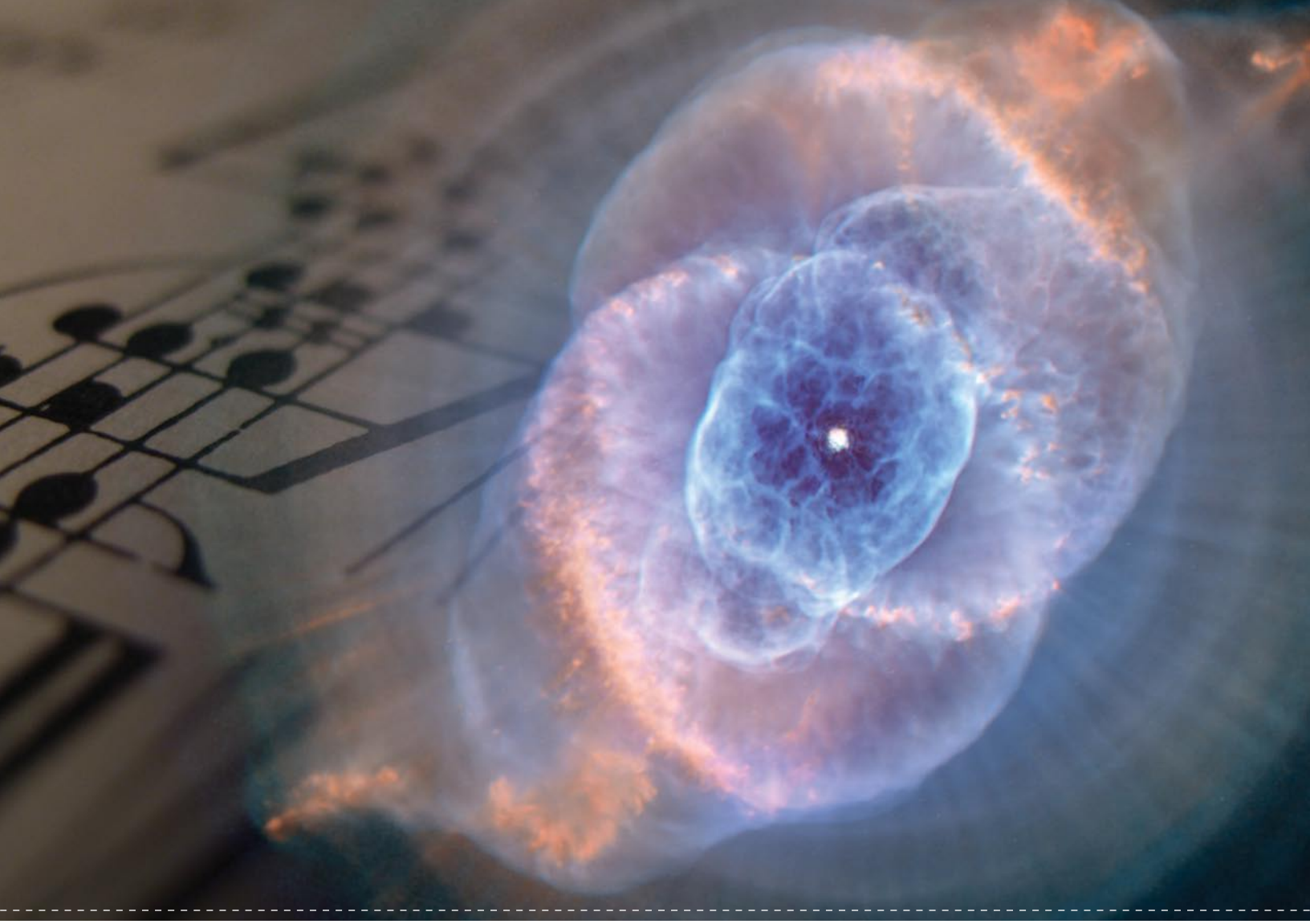
STScI conducts a monthly Public Lecture Series program organized by Frank Summers. The lectures are a well-attended series of public talks hosted in the Institute's auditorium. Each month a noted expert from the astronomical community is invited to conduct a presentation on a topic of interest to the public. Past topics have included "Giant Galaxies in the Early Universe" and "The Art and Science of Making Astronomical Images." Attendance in 2006 was approximately 1,000. The program is also broadcast over the Web via HubbleSite, STScI's Web site home for the Hubble Space Telescope.

Frank Summers (STScI) presents the Public Lecture Series.

The Meridian Speakers, (top left to bottom right) Keith Noll, Carol Christian, Wayne Rosing, Sallie Baliunas, C.R. O'Dell and Steve Beckwith.

Meridian Speeches

STScI staff, along with JHU staff, students and faculty, are invited to attend monthly Meridian Speeches, organized by STScI's Peter McCullough. Meridian speakers discuss scientific topics on a less technical level than they would in a scientific colloquium. Topics and speakers in 2006 were: "Is Pluto a Planet? The Great Planet Debate," by Keith Noll; "The Making of the Hubble Deep Field," by Steve Beckwith; "Water Footprints and Virtual Water" by Carol Christian; "A History of the Early HST" by C.R. O'Dell; "WWW.LCOG.NET: A Global Network Observatory for Extended Time Series and Transient Phenomena Observations," by Wayne Rosing; "A Millennial Sun and Terrestrial Ecosystems," by Sallie Baliunas; and "Microscope to Telescope," by David Malin.

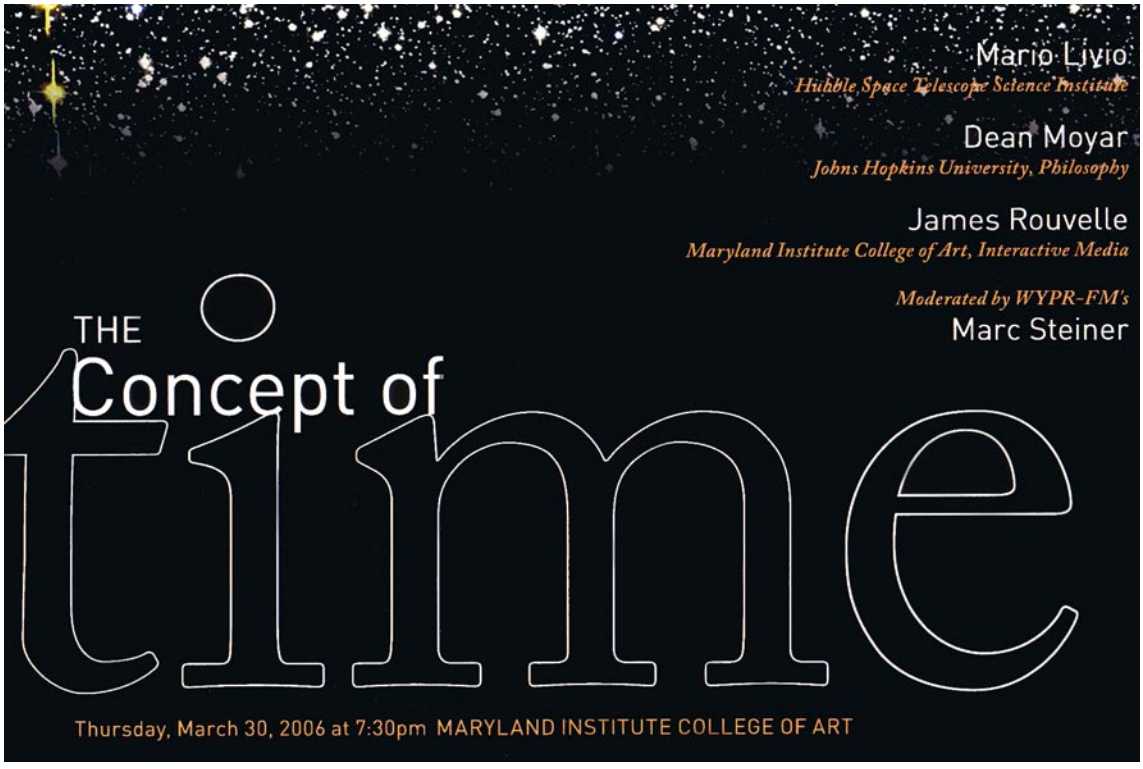


Baltimore Symphony Orchestra Explorer Series

The Baltimore Symphony Orchestra's Explorer Series couples music with multimedia presentations of science, nature and photography, offering audiences a new way to experience the symphony performance. The first concert of this year was a space odyssey that joined Hubble images and music. STScI's Mario Livio participated in the concert, supplying two presentations that helped interpret the music and images. One tied pictures of dying stars to the Tibetan myth of "rainbow bodies," a burst of colors that accompanies the death of an accomplished person. Another examined stellar and galactic birth. Livio also selected and choreographed the Hubble images that accompanied the piece of music "Rainbow Body," by Christopher Theofanidis.

Maryland Institute College of Art Lecture

"The Concept of Time," a series of presentations and discussions, was organized by STScI scientist Mario Livio at the Maryland Institute College of Art (MICA) on March 30, 2006. Dean Moyar of the Johns Hopkins University Philosophy Department presented on "Time in Philosophy," James Rouvelle of MICA on "Time in the Visual Arts," and Livio on "Time in Physics." A panel discussion with an audience question and answer period, moderated by Baltimore National Public Radio host Marc Steiner, followed the presentations. About 400 people attended.



The Invitation for The Concept of Time.

Students at Crossroads Middle School in Baltimore participate in the "Solar System Expedition" learning project taught by Frank Summers (STScI/OPO).

Speaker's Bureau

STScI conducts the Speaker's Bureau program. The Speaker's Bureau coordinates lecture requests from educational and civic organizations interested in learning about astronomy or the Hubble mission. Interested organizations can contact the STScI Speakers Bureau to request a presentation on any astronomical topic or the Hubble Space Telescope. The speakers are all volunteers from the STScI staff, who use the public outreach infrastructure for their talks and to provide useful handouts to the attendees. The Institute supplies resources and programmatic support.

Employee Recreation Committee

STScI's Employee Recreation Committee (ERC) is a self-sustaining, voluntary organization that coordinates social events and charity fundraising at the Institute. The ERC raises money for local charities through the sale of STScI- and Hubble-related merchandise. In 2006, the ERC hosted a craft sale, the traditional STScI Halloween party and costume parade, an ice cream social, and a winter holiday party. The ERC also promoted the yearly Toys for Tots campaign and a fundraising program in support of the Katrina Relief Effort.

The ERC also provides STScI staff with a number of additional benefits: discount tickets to the Maryland Science Center and other local attractions, information on discounted cellular phone plans, and a free book exchange located in the STScI Café.

Spirited Institute staff dress up for the 1993 Halloween contest.

Top painting by Melissa Dickenson, bottom painting by Karla McClintock

Painting by Patricia Bennet

STScI Art Exhibitions

STScI hosts a series of exhibits by local artists in its lobby throughout the year. This year, three Baltimore artists took advantage of the program. Each exhibit launches with a short reception, followed by several weeks of display. This year's exhibits were Melissa Dickenson's "Menagerie: A Collection of Natural Curiosities," featuring delicate, evocative paintings of flora and fauna, Patricia Bennet's flash-of-life images from a local coffee shop, and Karla McClintock's landscapes. STScI's Maria Bertch coordinates the exhibits.

2006 Assessments

HST

from the HST Project's Performance Assessment Committee (PAC) FY06 letter

- The PAC assigned an overall rating of 95 percent, directly recognizing the STScI's excellent performance over this period.
- Overall, the STSCI contributed both substantially and uniquely to maintaining HST's status as the most scientifically productive and highly regarded astronomical observatory in history.
- In 2002, an independent review committee identified serious problems associated with gender representation within the scientific ranks of the STScI. This issue has begun to overshadow much of the good work done at the Institute to date. The HST program appreciatively acknowledges the efforts made in the last few months by the current STScI Director, including a change in hiring practices and the formulation of an internal advocacy committee.

JWST

from the JWST Project's Performance Evaluation Committee letter 25 May 2006

- For this period [October 1, 2005 – March 31, 2006], AURA's overall performance was evaluated as "Very Good" with a score of 90.

from the JWST Project's Performance Evaluation Committee letter 8 November 2006

- For this period [April 1–September 30, 2006] AURA's overall performance was evaluated as "Excellent" with a score of 96 percent. We would like to commend AURA on the outstanding support provided to the new Electronic Speckle Pattern Interferometer (ESPI)
- Secondly, we commend AURA's numerous outreach activities.

Space Telescope Users Committee (STUC)

from the October 2006 Report

- We commend everyone involved in implementing the ACS recoveries, and for planning for such an eventuality well in advance of the failure.
- The STUC urges the Institute and NASA to improve the Internet bandwidth, which was raised as an issue at the 2005 October STUC meeting.
- The STUC commends the STIS group on its progress and looks forward to hearing about the completion of the final recalibration of all STIS data at its next meeting.
- The STUC commends the NICMOS team for their excellent and efficient work on identifying the current problems and providing solutions as well as for their anticipation of future needs.
- The released call for backup WFPC2/NICMOS/FGS proposals is sensible and timely. The STUC also approves of the decision of asking the Cycle 16 TAC for input on whether a new call for backup proposals will be necessary.

Institute Visiting Committee (IVC)

from the IVC 2006 Report

- The IVC finds that STScI has continued to do a superlative job in implementing the science program of the HST and has maintained it as the nation's and the world's single most productive and valuable astronomical telescope, in space or on the ground. The IVC notes particularly the Institute's great effectiveness in implementing a graceful transition to two-gyro mode operations of HST, an accomplishment of great benefit to the mission.
- The IVC finds that STScI has been effective in carrying out its assigned roles in the preparation for the JWST mission and has recently been very successful in working with the NASA-GSFC project teams and with NASA HQ.
- The IVC recommends an aggressive program by STScI management to review and revise its current internal organizational structure, to reduce the current cumbersome level of process requirements, to effectively delegate appropriate levels of authority and initiative to the internal groups charged with achieving specific programmatic goals, to develop rational and clear task priorities at the working level and to assure that adequate and realistic resources are available to carry out the critical tasks assigned to individuals and teams within the Institute.

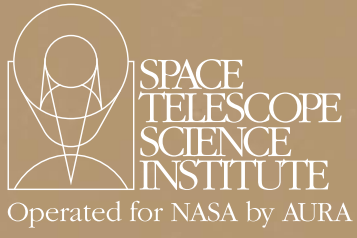
The Association of Universities for Research in Astronomy (AURA) is an international consortium of universities, educational and other non-profit institutions that operates world-class astronomical centers, one of them is STScI. AURA acts on behalf of the science communities that are served by its centers, and as trustees and advocates for the centers' missions.

AURA Board of Directors

The AURA Board establishes the policies of AURA, approves its budget, elects members of the Management Councils, and appoints the President, the Center Directors, and other officers. The Board of Directors is responsible to the Member Representatives for the effective management of AURA and the achievement of its purposes.

Space Telescope Institute Council

The Space Telescope Institute Council (STIC) provides oversight and advocacy for the Space Telescope Science Institute. In that role, the STIC recommends to the AURA Board tenure promotions, financial commitments and the recruitment and renewal of STScI's Director and Deputy Director.



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