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SPACE TELESCOPE SCIENCE INSTITUTE

Newsletter

Highlights of this issue:

Cycle 7-NICMOS Proposal Augmentation

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As you probably know by now, NICMOS is anticipated to have a useful lifetime of about 1.6 years, ~1/3 of the lifetime expected prior to launch. An Independent Science Review (ISR) committee met in May, 1997, to develop recommendations on the appropriate response to the shortened lifetime (see page 22). From their recommendations, STScI proceeded with a plan which will allow us to recover most of the anticipated observing time:

• Increase the allocation of observing time for NICMOS to between 40 and 50% of the total HST observing time through December 1998, the assumed end of useful NICMOS observations.

• Issue a special Call for NICMOS proposals to augment the current Cycle 7 program.

• Allow for at least limited NICMOS Camera 3 use, via special observing campaigns if necessary.

To meet the recommendations of the ISR and to have ~10% of the new Cycle 7-NICMOS programs available for scheduling in January of 1998, a highly compressed proposal review schedule was developed. The Cycle 7-NICMOS Call for Proposals was issued on July 9, 1997; the Phase I deadline was September 5, 1997; the review panels and the TAC met the week of October 5 - 10, 1997; and the Phase I notifications occurred on October 23, 1997.

To meet this ambitious schedule and to continue our Phase I process improvement, several changes were implemented, including:

• The notification for the Call for Proposals was issued by postcard and email, with the documentation was posted on the STScI Web pages. Hardcopies were mailed to libraries and institutions only, to others it was available upon request.

• Proposers were required to submit their proposals electronically; no paper copies were accepted. In the preceding review, ~80% of the programs were submitted in this fully electronic fashion.

• In place of the traditional written feedback to proposers, we provided a Comments Table based directly on the selection criteria described in the Call for Proposals. This simple Table, which is similar to those used in some other NASA reviews, focused the panelists on the key issues, provided uniform feedback across all panels, and reduced the level of effort by panelists and STScI staff, thus shortening the notification time by several weeks.

449 proposals were submitted for review, with requests for 6473 orbits from 415 GO proposals, and for 3065 targets from 34 SNAP proposals. For comparison, in Cycle 7 (September 1996), 388 NICMOS proposals were submitted for review, with requests totaling 7735 orbits from 362 GO proposals and 3345 targets from 26 SNAP proposals. In the present Cycle 7-NICMOS, proposals were received from 17 countries and from 31 states as well as the District of Columbia and Puerto Rico. 121 GO proposals totaling 1873 orbits were submitted by ESA Members as well as 5 SNAPshot proposals for 340 targets.

Following the review, 75 GO proposals were awarded a total of 1041 orbits and 8 SNAPshot programs were given 473 targets. The approved programs are listed on page 16 in this *Newsletter* as well as posted on the “Observing with HST” Web page located at:
`http://www.stsci.edu/observing/observing.html.`

The Abstract and Exposure Catalogs for the approved Phase I proposals can be found on the “Proposing with *HST*” web page located at:
`http://www.stsci.edu/observing/proposing.html.`

As noted above, the Cycle 7-NICMOS Panels and TAC met during the week of October 5 - 10, at STScI. The 49 members who reviewed the proposals among the seven sub-disciplinary panels, as well as the TAC chair, Anneila Sargent of the California Institute of Technology, and the five TAC at-large members, are listed elsewhere in this *Newsletter*. All of us owe these scientists enormous gratitude for participating in this review and for recommending the Cycle 7-NICMOS Augmentation Program to the STScI Director.

The Science Program Selection Office is always interested in hearing from the commun™ity on ways to improve the process. If you have any thoughts or comments that you would like to share, please send them to `spso@stsci.edu.`

Director's Perspective

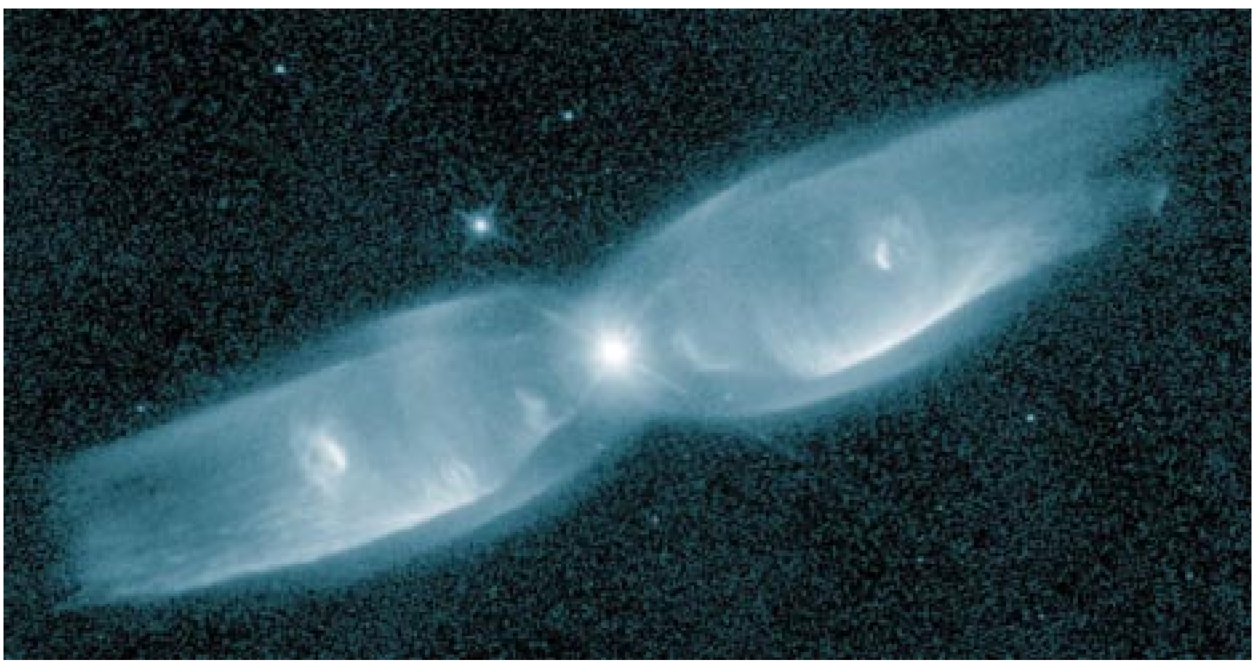
Bob Williams

The special TAC has now met and recommended the allocation of time for supplemental NICMOS programs for execution in Cycle 7 before the cryogen is depleted, amounting to 1,041 additional orbits. At the same time, the Servicing Mission Observatory Verification has also been completed, and the new instruments are now enabled for a broad range of different observing modes. The Institute is working hard on the implementation of Cycles 6 and 7 programs, and recent weekly schedules have shown NICMOS observations taking up over 50% of the available time, and STIS being scheduled more than 25% of the time, so we are already close to achieving the recommendations of the Independent Science Review in this regard. The *HST* data archive is growing rapidly with STIS and NICMOS data.

Two important events have taken place related to the long-range future of *HST*. First, the ultraviolet Cosmic Origins Spectrograph (COS), with Dr. James Green of the University of Colorado as PI, has been selected as the major new instrument to be installed in *HST* on the 2002 servicing mission, the final planned mission to service the telescope. Second, the Project has been successful in obtaining NASA acceptance of a long-range planning budget which provides for cheaper (<25% of current costs) operations of *HST* until the year 2010, i.e., five years past its previous nominal end of mission date. The Institute is collaborating with the Project on a study of how *HST* might be operated inexpensively in the era when the servicing missions are not the cost drivers that they are presently.

Extended operation of *HST* for a period of eight years without a servicing mission offers opportunities and it imposes certain constraints which are important to understand. The Project is therefore requesting a study of '*HST*'s Second Decade' which the Institute will be conducting and which will address these issues with community input and involvement. The details of the study are yet to be worked out and will be essential input for the formulation of *HST* operations and the science program after the last servicing mission and at a time when NGST and other Origins mission may also be operational.

HST Recent Release: M2-9 Planetary Nebula



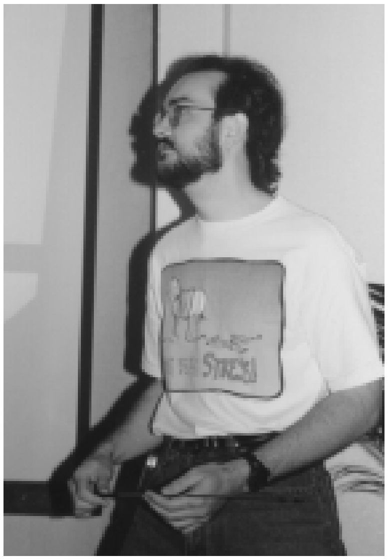
M2-9 is a bipolar planetary nebula 2,100 light-years away in the constellation Ophiucus. This WFPC2 observation was made August 2, 1997. Credits: Bruce Balick (University of Washington), Vincent Icke (Leiden University, The Netherlands), Garrelt Mellema (Stockholm University), and NASA

Christopher J. Skinner

Friends and colleagues of Dr. Chris Skinner were shocked and saddened by his sudden death on October 21st 1997, while he was visiting his parents home in Norfolk from his base at the Space Telescope Science Institute. His death at the tragically early age of 34 has cut short an outstanding career in astrophysics. Chris had been recently appointed to a Lectureship in Astrophysics in the University of Sheffield's Department of Physics and was due to take this appointment up in January 1998. Chris had been a diabetic since the age of two and it appears that it was a sudden worsening of this condition which caused his death.

Following his education in King's Lynn, Norfolk, Chris Skinner undertook a BSc Honors Degree in Physics and Astronomy at University College London (UCL), graduating in 1984. He then stayed at UCL in order to undertake a PhD research project with the infrared astronomy group. There he established his instrumentation skills and at the same time independently embarked on a separate collaborative project to analyze and model the infrared spectra of cool star dust shells that had been obtained by the IRAS astronomical satellite. He quickly revealed himself to be a talented theoretician and programmer. This unique combination of expertise in both instrumentation and in theoretical modelling was to feature strongly in his subsequent successful career as a professional astronomer.

Following his PhD in Astrophysics in 1987 and a subsequent postdoctoral appointment at UCL, Chris won an SERC personal Research Fellowship, which he elected to hold at Jodrell Bank in 1990 and 1991. There he embarked in an energetic program that made use of the MERLIN radio interferometer. In addition, he demonstrated how useful the Jodrell two-element Broad-Band radio Interferometer (BBI) could be. At the end of 1991, Chris moved to a position at the Lawrence Livermore Laboratory in northern California, where he stayed for three years. There he was responsible for operating and upgrading the Berkcam 10-micron infrared camera. At the same time he initiated many successful new observing programmes which made use of this instrument on the telescopes on Mauna Kea, Hawaii.



Chris Skinner in a typical pose with a typical t-shirt from his collection. We shall remember him this way.

At the end of 1994 he took up his position as an ESA staff member here at the Space Telescope Science Institute, where he was part of the team responsible for the successful commissioning of the infrared camera NICMOS, which was installed on the Hubble Space Telescope by Shuttle astronauts in February of 1997.

Chris worked very long hours to characterize the properties of NICMOS, helping to make it the success it has become, and contributed essential intellectual input to understanding the instrument. In his time at STScI, Chris developed strong bonds with the others working around him, and his loss is felt at a deep personal level as well as professionally throughout the Institute.

All through his professional career Chris was prolific in publishing scientific papers. These covered a large range of topics, and included infrared, optical and radio observations, as well as theoretical radiative transfer modelling of molecular lines and dust emission continua. As a result Chris has made an enduring contribution to our understanding of dust discs around main sequence stars; mass loss; molecules and dust in outflows from evolved stars; and the origin of planetary nebulae. A paper on the bipolar Cygnus Egg Nebula which he first-authored, and which appeared in the journal Astronomy and Astrophysics after his death, is representative of his strengths and creative abilities, gathering a wide range of new observational data to which he applied sophisticated axisymmetric radiative transfer modelling and great physical insight to achieve an elegant new synthesis for understanding this complex system.

Chris had a brilliant career in astronomy ahead of him. His untimely death is a major loss to astronomy. However, his loss is a deeper one for those who knew him personally. He always seemed to view life with amusement and certainly lived it to the full. His sense of the surreal was always evident — for instance, Uncle Billy's bar in Hilo was always his favorite place to repair after an observing run on Mauna Kea. Chris's interest in people and in life was also evident in the many and detailed emails that he sent to his friends and colleagues — he must have typed millions of words into this medium over the years. It is difficult to come to terms with Chris's sudden loss.

Christopher J. Skinner
June 26, 1963 — October 21, 1997.

An Amazing Summer

The OPO Amazing Space team

The Office of Public Outreach conducted its second annual Amazing Space workshop this summer, and it was indeed an amazing experience for all of us involved in the project. The Amazing Space workshop is a five-week program whose goal is to produce five online (K to 12) lesson/activities that teach fundamental scientific concepts using *HST* data to illustrate them. These lessons are intended for classroom use; therefore the topics need to fit in with the subject matter that teachers normally present to their students. We want to provide what teachers need, want, and will use. Hence, the lesson topics we choose for the workshop address National Standards and Benchmarks (guidelines that schools follow to teach certain skills and topics in certain grades). Another important program element is providing teachers with the experience of working at a scientific institute, giving them direct contact with research scientists, and exposing them to cutting edge science. As part of this experience, five staff scientists gave talks on recent science developments.

We selected 10 teachers (two elementary school, four middle school, and four high school) for the workshop from an impressive pool of applicants. Our 10 teachers came from Baltimore City, five Maryland counties, and one Virginia county. They were selected based on their curriculum development and team and World Wide Web experience.

All For One

Through experience, we discovered that successful lesson design requires a team of experts from several disciplines. Each team consisted of two teachers, a Web programmer, a graphic artist, a science advisor from the scientific staff, and a member of OPO who acted as facilitator and general resource. The teachers offered their experience in formulating lesson ideas based on their background in pedagogical principles. The scientists provided their expertise, thus guaranteeing scientific accuracy. The graphic artists and the Web programmers provided their knowledge of page layout, Web resource creation, and the use of appropriate colors, designs, and computer technology. It was an enlightening process to watch people from diverse backgrounds add their expertise to create one uniform science lesson.

Research indicates that a good lesson must be interactive and use real data in order for it to work in the classroom. An effective classroom lesson must be modular so that a harried teacher can pick part of it to use. The activity also must fit the established curriculum and conform to education standards which the teachers must meet. We use a creative process that incorporates these characteristics into our lesson/activities.

Evaluation — A Critical Part of Our Process

Since the end of the workshop, we in OPO have been working to complete the programming and graphics for the lessons. Once completed, the lessons will go through a rigorous review by a panel consisting of a scientist and teachers, as well as members of OPO's lesson evaluation

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A Quick Tour of the Lessons

The path each team took was truly unique. Here is a brief description of each lesson.

Comets, Gravity, Action!
elementary school

This activity teaches the relationship of mass and gravity. To learn the principles of escape velocity, students toss projectiles into orbit to compare the gravitational fields of the Earth, a comet, and Jupiter. Another module has the students build a virtual comet by selecting ingredients such as ammonia, dirt, methane, water, and sodium. The ingredients will determine what the comet will look like. Some comets, for example, will have an ion tail; others won't.

Star Light, Star Bright
middle school

Light is broken down into its components, both visible and invisible. A lesson highlight is the module that shows students how to look at a star and tell something about its physical characteristics - just like a scientist does. The module explores the relationship between color and temperature. Students, for example, toast a robot and observe how its color changes. They also apply the information they learned about color and temperature to real images of clusters of stars observed by the *HST*.

Amazing Summer *from page 4*

team. The lessons are reviewed for scientific accuracy, appropriate pedagogical principles, and Web design. After the initial panel review, the lessons will be pilot-tested in local classrooms, revised as necessary, and then released on the Web. Once the lessons are released, OPO will continue to collect evaluation data via the Web as well as through local classroom observations. We estimate that all of the lessons should be on the Web site by the end of November.

New Evaluation Prospects

In addition to the standard evaluation program, OPO and the University of Chicago are discussing a possible collaboration to study the long-term effects of using the Web as a teaching and learning tool. The discussions have included the possibility of using the Amazing Space lessons as part of the content provided to the teachers and students who will participate in this study. The goal of this study is to learn more about the impact of technology in the classroom and how to best design Web-based science lessons to meet the needs of teachers and students.

The 1997 Amazing Space Scientists

Alex Storrs
Comets, Gravity, Action!

Karen Schaefer
Planetary Nebulae

Anuradha Koratkar
Stars Light, Stars Bright

Dan Steinberg
No Escape: The Truth About Black Holes

Jeff Hayes & Terry Teays
How Far is Far? Determining Really Humongous Distances

If you'd like to get involved with the 1998 Amazing Space Workshop as a science advisor, please let us know.

Join the Team

You too can get involved in education! If your Web site contains information related to one of our Amazing Space lessons, provide a link to that lesson. If you are in contact with teachers through public talks, IDEAS grants, or in any other way, let them know about the Amazing Space Web site. When the lessons are posted on the Web site, please try them and let us know what you think.

Visit the "Amazing Space" Web site located at:

http://www.stsci.edu/pubinfo/amazing-space.html

Send your questions and/or comments to: amazing-space@stsci.edu

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Death of the Red Giants: Planetary Nebulae
middle school

This lesson uses exquisite *HST* images of planetary nebulae as a tool to build basic skills addressed in middle school, such as sorting and organizing. Module activities include: sorting various types of nebulae by physical characteristics, arranging them in an evolutionary sequence, and coming up with names for the strange-looking nebulae. Some of the names they suggest will be posted in the lesson, along with the names of the students and their schools.

How Far is Far? Measuring Really Humongous Distances
high school

This activity is designed for astronomy and math classes. Students measure distances by applying logarithms (they're actually useful!) as well as calculating the slope and intercept of a line. One module uses Cepheid variable stars as distance indicators and establishes the necessary numerical relationship to use periods to determine distance. They then use this relationship and *HST* Cepheid variable data to calculate the distance to clusters of galaxies.

No Escape: The Truth About Black Holes
high school

This lesson uses graphics and *HST* images to trick students into learning some physics. In one module the student calculates the escape velocity for various objects and learns how to derive the equation. Another module asks the question, How many teachers do you have to stuff into a compact car until their combined gravity is so great that none of them can walk away?" This leads directly into the concept of black holes. Another module, "Black Hole Safari," will use STIS data as they become available. High school students will be asked to explain the concept of a black hole that a seventh grader would understand.

The Cosmic Origins Spectrograph (COS): High-Sensitivity UV Spectroscopy with HST

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NASA recently selected the Cosmic Origins Spec trograph (COS) as a replacement instrument for the fourth *HST* servicing mission in 2002. COS will go into the bay currently occupied by COSTAR, which, after the 1999 servicing mission, will no longer be in use.

COS is a high-throughput ultraviolet (UV) spectrograph that is optimized to observe faint point sources. COS will be, by a large factor, the most sensitive UV spectrograph ever flown aboard *HST*. It will bring the diagnostic power of UV spectroscopy to bear on such fundamental issues as the ionization and baryon content of the intergalactic medium and the origin of large-scale structure in the Universe; the ages, dynamics, and chemical enrichment of galaxies; and stellar and planetary origins. These science programs require having the capability to obtain moderate resolution ($R > 20,000$) spectroscopic observations of faint UV sources, such as distant quasars.

We achieve high sensitivity in the UV by minimizing the number of reflections, which leads to an inherently simple spectrograph design (see Figure 1). The primary channel of COS employs a large entrance aperture, concave diffraction gratings, and a curved detector. The aperture is a two-arcsecond diameter circular field stop located on the *HST* focal surface near the point of maximum encircled energy. There is ONE reflection between the aperture and the detector. The grating has an aspheric concave surface figure specified to compensate for spherical aberration. Holographically-generated grooves provide dispersion and correct the astigmatism. Ion-etching creates a blaze that optimizes the efficiency over a narrow range of wavelengths. Two gratings, High Dispersion Channels 1 and 2, are used to cover the 1150 to 1775 A region at high resolution ($R = 20,000$ to 24,000). Each high-dispersion grating covers roughly 300 Å in one exposure. A third grating, the High Sensitivity Channel, covers the entire 1230 to 2050 Å region at lower resolution ($R = 2500 - 3500$). The three gratings are mounted on a rotating mechanism, similar in concept and function to the GHRS carrousel. The detector is a windowless microchannel-plate array, with an opaque CsI photocathode, and a double delay-line readout that has been adapted from the *FUSE* mission.

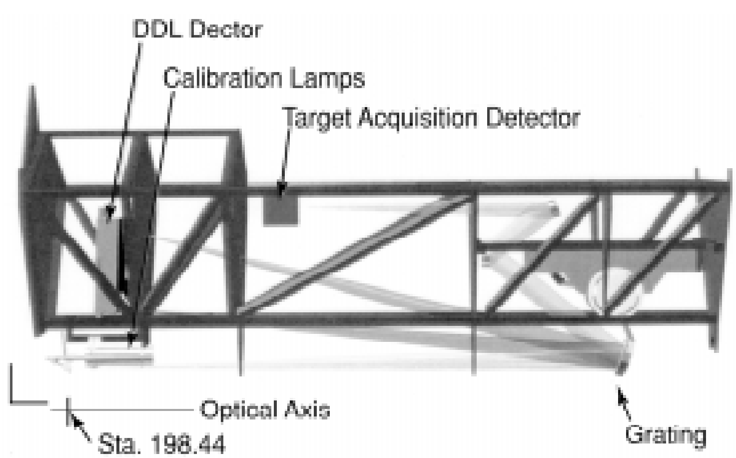
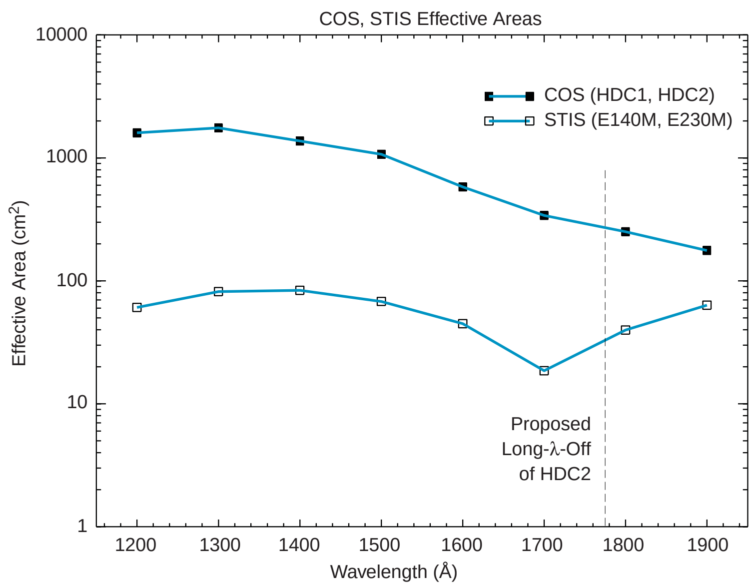


Figure 1: Schematic of the COS primary channel (as proposed). Light is received from the HST OTA through a 2-arcsecond round aperture, is dispersed by a concave diffraction grating, and finally is recorded on a curved double delay-line MCP detector adapted from the FUSE mission.

COS will build on the legacies of Copernicus, *IUE*, GHRS, FOS, STIS, and in the future, *FUSE*, giving *HST* the greatest possible grasp of faint UV targets, a capability perhaps not available from future space-based observatories for decades. COS will complement and extend the suite of *HST* instruments, ensuring that, as recommended in the "*HST* & Beyond" report, Hubble maintains a powerful UV spectroscopic capability from 2002 until the end of its mission. Combining the large entrance aperture with high-efficiency first-order gratings and a windowless detector, the primary channel of COS achieves effective areas about 18 times higher than STIS modes of comparable spectral resolution (Figure 2).

The science drivers for COS include problems of fundamental importance in astrophysics and cosmology which require the moderate resolution and high throughput of COS, and four unique capabilities of *HST*: access to ultraviolet wavelengths, large collecting area, precise pointing stability, and excellent image quality. Below we describe several scientific issues that COS observations will address.

Models for the formation of large-scale structure and the reionization of the IGM will be constrained by observing distant quasars to measure the He II Gunn-Peterson effect, the structure of the Lyman-alpha forest, and the D/H ratio in primordial clouds. COS will be capable of obtaining moderate-resolution UV spectra of hundreds more quasars and AGNs than existing UV instruments. The COS database of absorption-line systems will have high enough spectral resolution and adequate S/N to



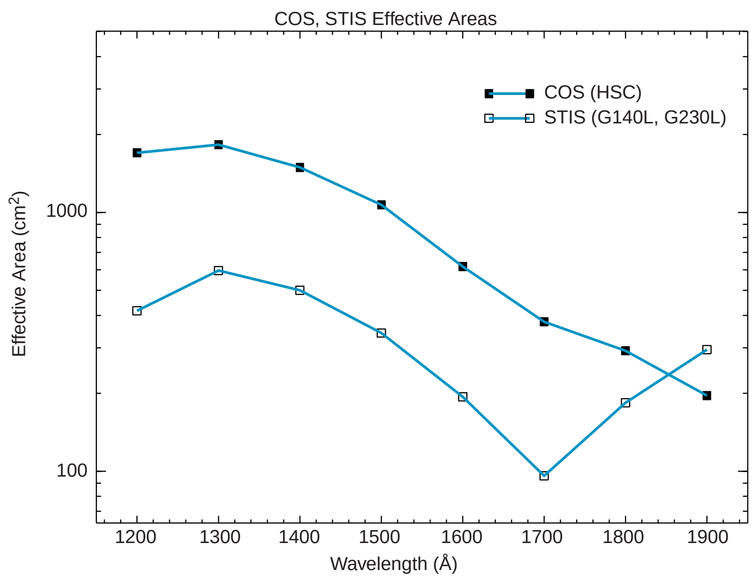


Figure 2: Effective area curves (including slit losses) for the spectroscopic modes of the primary channel of COS. Curves for STIS modes of similar spectral resolution are shown for comparison.

determine accurate column densities, abundances, and kinematics of intergalactic matter at epochs when the first galaxies were formed and the first heavy elements were synthesized.

COS will be used to determine abundances and kinematics of hot gas in galaxy halos, the impact of violent starbursts and supernovae on interstellar and intergalactic environments, and the ages of globular clusters. The numerous quasar sight-lines accessible to COS will intersect hot galaxy halos over a large redshift range. COS spectra will constrain galaxy evolution models by mapping the production of metal-enriched gas through time. COS will also observe nearby starbursting systems over a range of metallicity. These spectra will be used to model the chemical enrichment of the interstellar medium, and as templates for deriving the properties of high-z galaxies. COS UV spectra of horizontal-branch stars in globular clusters will allow significant refinement of globular cluster age estimates. which may help to reconcile the ages of the oldest stars in galaxies with the age of the Universe derived from recent measurements of the Hubble constant and closure parameter.

The origins of stellar and planetary systems will be investigated by studying the physical processes and chemical abundances in the cold ISM. For the first time in the UV, COS will observe sight-lines toward hot, embedded stars that will probe dense, molecular regions where the star formation process begins. COS data will also provide clues to the conditions and composition of the outer solar nebula. The high sensitivity of COS will allow an order of magnitude more background stars to be observed in stellar occultation studies of planetary and cometary atmospheres. COS will break new ground with direct moderate-resolution UV observations of Pluto and Triton that will be used to detect fluorescence emission from volatile gases as these bodies both undergo rare seasonal changes during the first decade of the next century.

COS will be used to observe very faint targets, taking full advantage of *HST* capabilities (large aperture, UV coatings, excellent pointing and image quality). COS is optimized to observe faint UV sources with spectral resolution high enough to determine the physical conditions in a broad range of astrophysical environments. Its design meets programmatic requirements for reliability and redundancy, and its simplicity and efficient operation ensure a high science return. With these capabilities, we anticipate a high degree of interest in using COS throughout the worldwide astronomical community.

NASA has asked the COS team to evaluate extending the wavelength coverage of COS to include the 1800 to 3200 Angstrom region by adding a secondary channel. This channel is partially to back up the STIS near-UV spectroscopic modes and also to restore the capability to observe faint targets that has been mitigated by the high background of the STIS near-UV MAMA. Our preliminary design for

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The Starburst Dwarf Galaxy NGC 5253.

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Starbursts are galaxies undergoing a major star formation event, generally in their central region. Since they are producing many massive, ionizing stars, starbursts typically have optical-infrared spectra which are dominated by the emission lines of the ionized gas. Their spectra distributions can be both bright in the ultraviolet (UV) and in the far infrared: the far infrared (FIR) radiation is emitted by the dust heated by the massive stars which are also responsible for the UV radiation.

Starburst galaxies occupy an important niche in the framework of galaxy evolution, as they are the primary site of massive star formation. A significant fraction of the star formation in the local Universe appears to occur in such high-intensity episodes (Heckman 1997); starbursts are relevant for understanding the cosmic star-formation and metal-enrichment histories (Madau et al. 1996), the nature of the high-redshifts galaxies (Steidel et al. 1996; Giavalisco, Steidel & Macchetto 1996), and of the faint blue galaxies at intermediate redshifts. However, a number of questions on the starburst's fundamental physics and evolution remain unanswered. To mention a few: How long does a starburst last (Calzetti 1997)? What is the star formation history of a burst, and what type of stellar population is left behind? What is the role of dust in determining the starburst's morphology (Calzetti, Kinney, & Storchi-Bergmann 1994)? To answer these questions, we turn to the nearest starbursts, to map their stellar populations, ages, dust content, and, ultimately, to disentangle their spatial and temporal evolution.

The dwarf galaxy NGC 5253 is an ideal laboratory for such study. This galaxy is located in the Centaurus Group, at a distance of only 4.1 Mpc from our own Galaxy (Sandage et al. 1994). A burst of star formation is currently taking place in the central ~20 arcsec region of this otherwise quiescent galaxy. WFPC2 images in *V*, *I*, Hα, and Hβ of NGC 5253 were obtained in May 1996, and supplemented with archival UV images centered at 2600 Å, in order to create a UV-optical baseline. The purpose was to study the recent star formation history of the starburst while disentangling the ages of the stellar population from the effects of dust reddening (Calzetti et al. 1997). At the distance of the galaxy, one WF pixel corresponds to 2 pc, a scale comparable with the typical size of stellar clusters (van den Bergh, Morbey & Pazder 1991). The left panel of Figure 1 shows the inner 30 x 30 arcsec of the galaxy as seen in the UV filter, while the right panel shows the same region in the *I* filter. The relative brightness of the various features (stars, clusters) is clearly different between the two bands, showing the combined effects of dust, reddening, and aging (thus reddening too) of the stellar population. The morphology of the ionized gas is shown in Figure 2.

The ionized gas emission is a tracer of the current star formation (Kennicutt 1983), while the UV emission at 2600 Å traces the star formation integrated over the last few hundred Myr, as stars as old as 100 Myr (Leitherer & Heckman 1995) still contribute significantly to the emission in this band. Longer wavelengths probe progressively longer age ranges for the stellar population (Gallagher, Hunter & Tutukov 1984). However, dust obscuration can artificially increase the age of a stellar population by making it appear redder.

In the case of NGC 5253, dust reddening was disentangled from the ages of the stellar populations by using the Hα/Hβ map as a measure for dust. For instance, the youngest stellar cluster in the center of the galaxy (a Super-Star-Cluster candidate 2 Myr old, Calzetti et al. 1997) is embedded in a dust cloud of at least 9 magnitudes of visual extinction. Without proper correction for dust reddening, the stellar continuum colors of this cluster would yield an age of about 10 Myr, in sharp contrast with the intense Hα emission. Dust obscuration is patchy in NGC 5253, implying that while some massive stars are embedded in dust, others succeeded in blowing holes in the dust blanket and can now shine through them. The net result is that this galaxy is both UV-bright and FIR-bright (as many other starbursts are). In particular, very young stellar clusters, with ages around 2 to 3 Myr and below, tend to be still inside the dusty parent cloud, while older clusters have emerged from it and are generally UV-bright. In summary, dust obscures from view the youngest bursting regions, while evolved regions suffer from moderate (though still non-negligible) extinction.

The peak of current star formation is located almost in the center of the galaxy and occupies a region only about 6 arcsec in size; the center of the peak region coincides with the position of the youngest cluster and the stellar population in the entire region is less than 10 Myr old. Here the star formation density is compatible with the maximum value derived by Meurer et al. (1997). The star formation peak is embedded in a 100 to 200 Myr old stellar population which occupies a region about 20 arcsec across. In this region, star formation is proceeding at a slower pace; its rate is between 1% and 10% of the average of the peak region. The picture of the star formation history which emerges from the starburst in the galaxy after the effects of dust are removed is a complex one. The galaxy has undergone more or less continuous star formation over the last ~100 to 500 Myr, punctuated by tremendous episodes of enhanced activity as clusters form. We are fortunate to have caught NGC 5253 in the middle of such an episode; indeed, we are witnessing the earliest stages of evolution of of a stellar cluster in the center of the galaxy.

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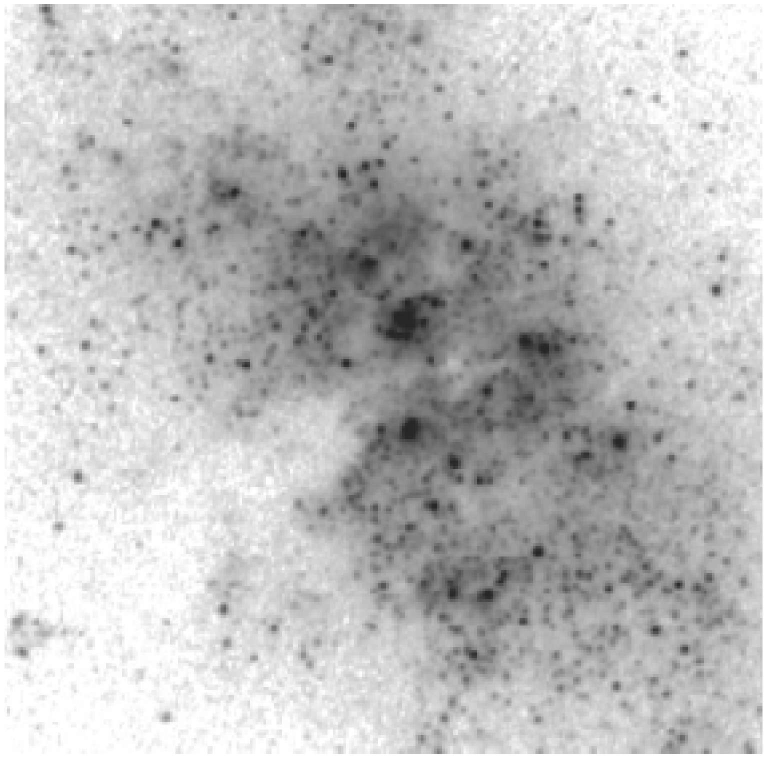

Figure 1: (left panel) The inner 30 x 30 arcsec region of NGC 5253, observed with the WFPC2 F255W (UV) filter. North is up, east is left. (right panel) The same region observed in the WFPC2 F814W (I) filter. The changes in relative brightness of the stars/stellar clusters across the region from the UV to the I filter are due to both variations in age and dust reddening.

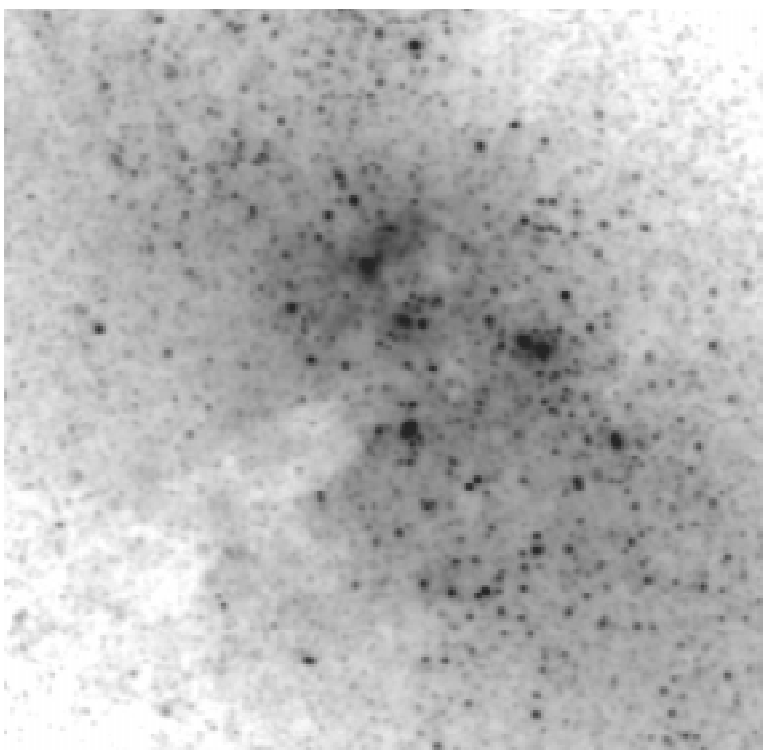

Figure 2: The same region as Figure 1, in the continuum-subtracted Hα emission (WFPC2 F656N filter). The difference in morphology between the stellar continuum and the ionized gas can be easily seen by comparing Figure 1 with Figure 2.

Instrument News

Near-Infrared Camera and Multi-Object Spectrometer

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Observations with the Near Infrared Camera and Multi-Object Spectrometer are settling into something resembling a routine. Data are being taken at a very high rate, with NICMOS observations currently occupying about half of *HST*'s schedule. The instrument continues to perform well, with cameras 1 and 2 (narrow- and medium-field, respectively) in good focus and camera 3 moving slowly towards the focus range.

Some highlights of the past couple of months include the observation of what may be the brightest star in our galaxy. This star is so big that it would fill the Earth's orbit were it at the center of our Solar System. It is so bright that it is blowing off its outer layer, which shrouds the star from direct observation at visible and ultraviolet wavelengths. It is necessary to go to the infrared to get a good look at this giant.

Nearer to home, the planets Uranus and Jupiter are featured in recent NICMOS observations. NICMOS is important for this type of observation because of the trace amounts of methane (CH4) in the atmospheres of these gas giants. In the visible spectral regions accessible to the other *HST* instruments, the methane bands are fairly weak, but bands beyond 1 micron in wavelength are much stronger. This allows the observation of clouds much higher in the planet's atmosphere; light is absorbed in a much shorter path than for the weaker bands, so only the highest clouds stand out in these images. Indeed, the images of Uranus show the highest contrast seen since the Voyager flyby in 1987. The images show the rings around these planets as well. Normally these faint rings are swamped by light from the planet, but when most of the light from the planet is absorbed by the methane in its atmosphere, the rings (which reflect the Sun's light without absorbing it) come shining through. In the same way, faint inner satellites of Uranus are easily seen in these images.

To overcome the effects of camera 3 being out of ideal focus, a "campaign" of NIC3 observations with *HST*'s focus altered is planned for the end of January 1998. The *HST* secondary will be moved to compensate for the motion of the NICMOS camera 3 detector caused by the expansion of the solid nitrogen (which cools the detector). The other NICMOS cameras, as well as the other *HST* instruments, will be out of focus during these observations, but some data will be taken in parallel nonetheless to monitor the thermal background. The final versions of the programs for this campaign have now been received at STScI.

Phase 2 submissions for successful Cycle 7-NICMOS proposals have been received as well; these are expected to be the last General Observer programs for NICMOS under the present operating configuration. These programs should enable *HST* to continue operating with about half of its observations devoted to NICMOS up to the time the cryogen is exhausted (currently, this is expected to be in late January or early February 1999).

An updated version of the NICMOS pipeline has been installed recently, which improves the cosmic ray rejection and takes care of a variety of other minor problems. In addition, we are continuing to upgrade the calibration reference files used by the pipeline as on-orbit calibration observations proceed apace.

WFPC2

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WFPC2 continues to operate very smoothly. Since WFPC2 has now been on-orbit for four years, it is interesting to consider whether there have been any long-term changes in the instrument. Below we describe two studies which show that the long-term photometry and bias jumps appear stable. In the future we plan studies of the astrometry, flat field, and CTE long-term stability.

Photometric monitoring observations are taken monthly with WFPC2 on the star GRW+70D5824. Based on these data, the possibility of a small increase (1 to 2%) in the throughput of the F814W filter was noticed last year, and mentioned in the Instrument Science Report WFPC2 97-01. Now that additional data are available, it is apparent that other filters show a similar effect, and that the change occurs as a sudden jump in February 1995. The jump is simultaneous with a change in the exposure times for the standard star observations (increased by a factor of 1.4 to 4 for the different filters). Hence, it is likely that the discontinuity is related to the well-known long vs. short exposure anomaly and/or charge transfer efficiency (CTE) problem. Apparently the throughput itself is highly stable; the throughput before and after Feb. 1995 is constant to better than 1%. An extensive set of new observations was recently made to better quantify the long vs. short and CTE effects for WFPC2; this area is our highest priority for future study. O'Dea and McMaster recently looked for long-term trends in the bias jumps. These jumps are small changes in the background level of images which are caused by spurious electronic signals during readout of the CCDs; they are usually correctable during data analysis. Interest in this subject was generated by a recent image showing an unusual series of strong bias jumps. They examined all dark calibration frames obtained between early 1994 and the present,

Instrument News

as these provide a long-term series of images with uniform properties. They found no significant evidence for any long-term change in either the frequency of the jumps, their mean / median amplitude, or in the dispersion of their amplitudes. Apparently while the jumps are sporadic in nature, their long-term properties are stable.

Fine Guidance Sensors

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FGS3

FGS3 continues to perform nominally. Astrometric observations for Cycles 6 and 7 GO proposals are being executed in a timely fashion. This includes TRANSFER function observations of close binary systems to determine relative orbits and POSITION mode observations of astrometric objects to determine the parallax and proper motions of those targets. Recently the instrument was used as both a photometer and as an astrometer to observe the occultation of a bright star by Triton, thereby providing the GO with both a light curve and the motion of Triton relative to the star.

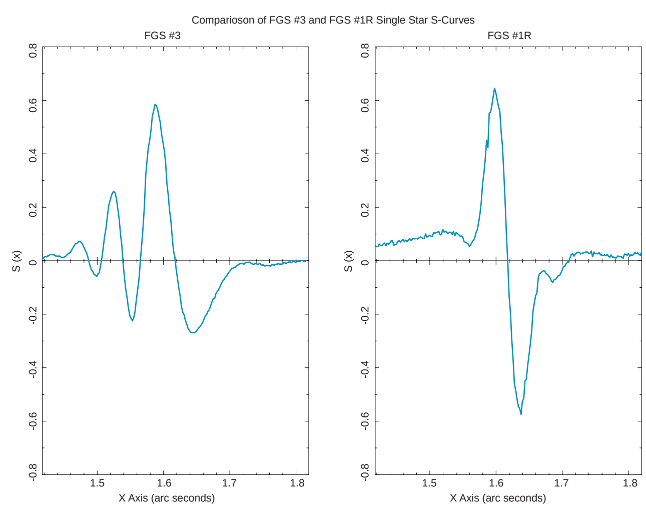
The FGS3 calibration program is well underway. To date for Cycle 7, three calibration TRANSFER function observations of blue (B-V < 0) stars have been completed, two of which appear to be single stars and therefore good candidates for the calibration reference library. (In the past, we had been frustrated to find that blue calibration stars, which on the basis of ground-based observations had been expected to be single, were actually resolved by FGS3 to be binaries and therefore not usable as reference objects). In addition to the blue star calibrations, a red calibration star has been observed, leaving five more TRANSFER function color calibration observations remaining in Cycle 7. Temporal monitoring of FGS3's interferometric fringes (S-curves) is continuing. To date three observations of a standard star have been made since April 1997, with the next due in mid January 1998. Thus far the S-curves are found to be stable to within about 2%.

Recently a special calibration test in TRANSFER mode was completed in both FGS3 and FGS1r. This test observed a known binary system at several *HST* orientations. As the telescope was rolled with respect to the position angle of the components of the binary system, the apparent angular separation between the components was measured. As anticipated (on the basis of past GO observations), the apparent separation changed as a function of *HST* roll angle at the level of 2 to 3 percent. The effect, found to be present in both FGS3 and FGS1r, is thought to be due to a small (~1%) rotation error of the Koesters prisms along each of the interferometer's axis with respect to the polarizing beam splitter within the FGS. The results of this test will allow STScI to calculate this rotation error and correct for it in the analysis of FGS astrometry data.

Other calibrations performed in FGS3 include an absolute plate scale measurement and the continued periodic observations of a standard astrometric field in POSITION mode to monitor the status of the relative plate scale and the optical distortion calibration. The data from these tests are used to maintain the FGS POSITION mode calibration database.

FGS1r

The modulation and morphology of FGS1r's interferometric fringes continue to be monitored to determine when the instrument has sufficiently stabilized (outgassed) so that it can be considered for use as a science instrument. During its first 4 months in orbit, FGS1r performed well for guiding the telescope but its S-curve characteristics were far to variable for scientific applications. During its 5th and 6th months, however, the instrument appeared to stabilize to about the 5% level. Once 2% stability has been achieved, the S-curves can be re-optimized by adjusting the articulating fold-flat #3 mirror (as was done immediately following deployment in the second servicing mission). At that point STScI will assess the scientific capabilities of FGS1r and most likely calibrate it for Cycle 8 GO science. anywhere in the *Newsletter*.



Instrument News

Space Telescope Imaging Spectrograph

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With STIS fully operational for all Cycle 7 Science, the STIS GO and GTO science era began in earnest in early October, with STIS observing for roughly 25% of the external orbits. STIS has been obtaining richly diverse science data, including high quality UV images and spectra of planets and their satellites, CCD long slit spectra of galaxy nuclei in both normal and active galaxies, MAMA first order spectra of quasars and their absorption systems, and echelle observations probing the interstellar medium, to name just a few. Meanwhile, the STIS Archival Pure Parallel program continues to populate the public archives with slitless G750L spectra and deep STIS CCD images, useful for both Extragalactic galaxy evolution and weak lensing studies as well as Galactic work probing stellar populations. The early checkout orbits of the HDF-South field (this will be described in the next Newsletter) were executed, and STIS obtained a one-orbit CCD clear image of the field centered on the quasar, as well as a one-orbit spectrum of the quasar with G230L and G430L. Our reductions of this data have been posted to the WWW. Have a look!

Roughly 30% of the very extensive STIS Cycle 7 Calibration Program has executed and that data is available in the archive for calibration analysis as well as science. The calibration analyses at STScI have focused on the basic detector performance and health-and-safety monitoring of STIS, as well as on the calibration of the first-order low resolution (so called 'L') grating modes. We continue to keep GOs aware of new developments through the regular STAN series and the postings to the STIS Instrument Pages of the WWW; check out the on-orbit performance, foibles, and calibration pages. Recent updates include information on bias level variations for the CCD, hot pixels and how to remove them, preliminary information about scattered light and its effect on line profiles and equivalent widths, slit inhomogeneities and dust specks to be aware of, etc. Also posted there are all the contributions from the Calibration Workshop held at STScI in October. And don't forget to check out the description of the FPSPLIT slits; analysis of the data from SMOV proposal 7091 designed to test out the ability of STIS MAMA's to return very high signal to noise was very successful. Signal-to-noise of over 350:1 per resolution element integrated over the point source cross dispersion profile was achieved for both the E230M and E140M modes.

We expect a to make a major update to the calibration reference files for the first-order low resolution modes in early 1998, as we complete the first basic on-orbit characterization and calibration of those modes. After that, our focus will turn to the characterization and calibration of the echelle modes, with updates we hope in April to the calibration files, and thereafter to the first-order medium resolution ('M') modes, with updates there hoped for by early summer.

We are also hard at work on modifications to the calstis software to accommodate what we have been learning through our calibration analyses, and to correct bugs in a timely manner as they are identified. We expect a major update to the calstis software by early 1998 accompanying the first-order mode calibration. At that time the pipeline will begin automatically extracting one-dimensional spectra for long-slit data, in addition to producing the two-dimensional rectified spectrum it provides now. Plans for calstis enhancements and known bugs are regularly posted to the Pipeline pages of the STIS Instrument WWW site and we point interested readers there for more details. If you are working with STIS data, don't forget to get a copy of Version 3.0 of the STIS Data Handbook, which includes substantial sections on STIS data, their calibration and analysis. If you are just getting started, we strongly recommend you try out the STIS GO Primer, which can be found under the Data Analysis Support button on the STIS WWW pages.

As if we are not busy enough keeping up with STIS, the STIS Group at STScI has also assumed responsibility for support for the `heritage' spectrographs FOS and GHRS. GOs and archival observers with questions about these instruments should send their inquiries to help@stsci.edu and we will help you out. FOS and GHRS GOs and Archival researchers will want to stay tuned to the *HST* Spectrograph's STAN, which will focus on STIS, but include information about these other instruments and their calibration as well. By the time this newsletter comes out, we are hopeful that Volume 2 of the *HST* Data Handbook, describing the retired or legacy *HST* instruments, will be out. This volume provides extensive descriptions of the calibrations of FOS and GHRS as well as instructions for working with and analyzing FOS and GHRS data. and should serve as your first reference for understanding and working with data from these instruments.

Lastly, we look forward to the January AAS in Washington, where we plan a dozen posters on the on-orbit performance and calibration of STIS, the calstis pipeline, and STScI support provided for STIS, as well as one or two on the FOS and GHRS calibration closeouts. Perhaps more importantly, we eagerly look forward ourselves to the anticipated posters and presentations of science results with STIS from the early round of GTO and GO observations. From what we've heard, we expect some smashing results! See you there.

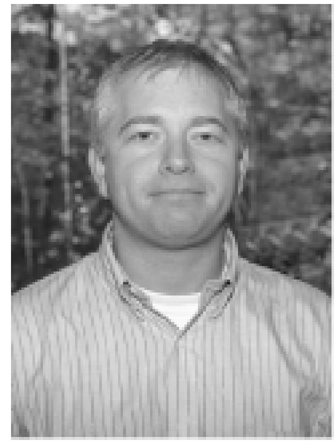
Tenure at STScI for Chris O'Dea

Christopher P. O'Dea was promoted to Associate Astronomer with tenure recently at STScI. Chris came to the Institute in the fall of 1990, into the User Support Branch, where he worked on Phase I proposals and helped establish the Space Telescope Electronic Information Service (remember STEIS?), STScI's pre-Web on-line data source. When Presto was formed in 1993, Chris joined them, and became head of the Liaison Scientist Group in 1994. That group was moved to the Science Support Division in 1995, and at that time Chris joined the WFPC2 Group, where he still is. Because of this experience, Chris chaired the User Support Coordinating Committee until this fall, when it was superseded by the Telescope Time Review Board.

Chris was born in New York City, but at the age of 3 his family moved to St. Thomas, in the Virgin Islands, from whence his mother had come. He grew up on St. Thomas and attributes his interest in science to his avid reading of science fiction, starting at age 9. The skies of St. Thomas were dark, but Chris preferred to think about the cosmos more than act as amateur astronomer. This interest led him to an undergraduate degree in physics at MIT in 1978 (he recovered from the shock of going from the West Indies to Boston), then to U. Mass. at Amherst as a graduate student. After two years of course work, Chris went to Socorro, New Mexico, to work on his thesis (radio galaxies in Abell clusters) with Frazer Owen, which he finished in 1983.

Regular readers of this space will recall that while at Socorro Chris met Stefi Baum, profiled in the previous Newsletter. They were married in 1985 while Chris was a post-doc at NRAO in Charlottesville, then they both went to Dwingeloo in 1987 as post-docs. At the time Chris joined STScI in 1990,Stefi came to Baltimore as a Hubble Fellow, then later joined the Institute staff.

Chris and Stefi have four young children, and not much spare time. In that time Chris is a soccer coach these days, and, on occasion, a home brewer.



He has a review paper titled "The Compact Steep Spectrum and GHz Peaked Spectrum Radio Sources" forthcoming in the PASP, and also suggested the following paper as an example of the problems he has worked on:

"Detection of Extended H I Absorption toward PKS 2322-123 in Abell 2597," 1994, Astrophys. J., 436, 669.

Sometimes life with HST is more interesting than we really want it to be.

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While the Hubble Space Telescope usually operates extremely smoothly, there are occasions when it "derails" and a lot of folks have to scramble to get it up and running again. Vehicle safemode entries are the most serious, but we also have occasions when single SIs safe or hang up in some way, and these also require a quick response. Each event requires the operations team at GSFC and STScI to drop what they are doing, day or night, perform a quick analysis, determine the source of the problem, and implement a recovery strategy.

There seems to be a hidden force at work which causes safing events to have a preference for holidays. So far, we have had them on New Years Eve, Fourth of July, and Labor Day. They can find other inconvenient times to occur as well. This April, while we were right in the middle of the busiest period for activation of STIS, NICMOS, and the new FGS, we had two safings within a 9 day period. The events were independent and com pletely unrelated to the new equip-ment, but added another dose of interruption and work when everyone could have used a little more sleep.

On the other hand, they have sometimes gotten folks out of boring meetings. There was one case early in the mission when we were in the middle of a telecon with the operations staff at Goddard discussing whether or not we needed to intervene with the executing command load to fix a potential timing problem, and found out at both places simultaneously that the *HST* had safed, solving that problem and ending that meeting.

On another occasion, a substantial fraction of the NASA, LMSC, and STScI operations staff were attending a NICMOS design review in building 26 at GSFC. The review had gotten to some of the particularly dry material when the *HST* went into safemode. The beepers went off in waves, first

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Editor's Note:

Editor's Note: Rodger Doxsey recently received the AURA service award at STScI for his efforts to make HST the success it is. I asked him to write about some of the experiences we have had when things don't go quite as expected.

Recent Operations with HST and its Instruments

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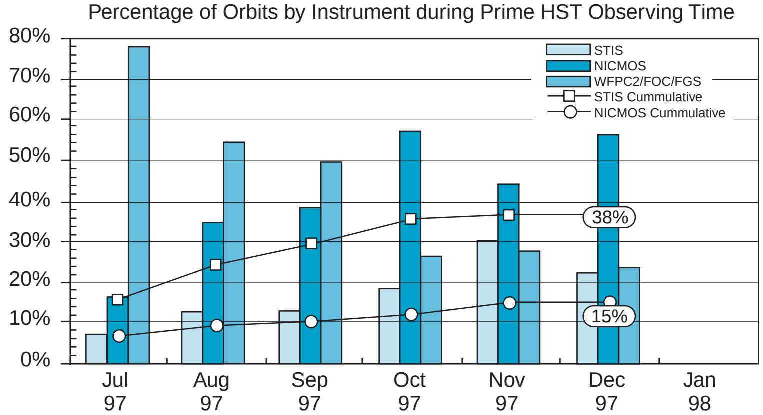
As discussed in an earlier STScI Newsletter (An Update on NICMOS July 1997), the STScI has taken actions to optimize the scientific productivity of *HST* based on recommendations from the Space Telescope Users Committee and the Independent Science Review committee chaired by Malcolm Longair. The goals were established to increase the observing time allocated to NICMOS programs to 40% and 50% of the total available *HST* observing time while at the same time utilizing the unique science capabilities of the new STIS and the existing WFPC2, FOC and FGS instruments.

These high-level guidelines have led to the development of new procedures and priorities for building the long range HST observing plan. We had to put aside our original Cycle 6/7 transition plan which ramped up NICMOS and STIS at a slower rate in order to finish Cycle 6 programs displaced by the servicing mission and subsequent verification period. Under the new guidelines, our first priority was to accelerate the flight preparation and scheduling of NICMOS observing programs. With the Phase II program updates in hand in May, we successfully started scheduling a significant amount of NICMOS observing programs in July and August as depicted in the chart (below?). Subsequent to the hard work of the STScI people involved in program development, planning and scheduling along with the cooperation and fast turnaround from many *HST* users, we have scheduled NICMOS observing in excess of 40% for the past three months with 5 weeks peaking at greater than 50%. Including the early weeks where NICMOS observing was ramping up, we have scheduling NICMOS in 38% of the prime available orbits.

We view this as an excellent forecast for being able to achieve the intended 40% to 50% NICMOS observing, especially with a specific NICMOS NIC3 campaign on the horizon in January 1998. While achieving the 40% to 50% guideline is a major step, additional observing programs were needed in order to maintain the observing levels. The special Cycle 7-NICMOS solicitation and selection activities (see page 1 in this *Newsletter)* have provided us with the needed pool of NICMOS orbits and we expect to see them start filling in the long range observing plan and flight schedules following the NIC3 campaign.

While NICMOS observing took the highest priority, it was also very important to start observing with the STIS. While the STIS Servicing Mission Observatory Verification program encountered some serious problems and setbacks with the on-orbit operation of the MAMAs, we were able to start STIS observing in July 1997, albeit at a fairly low level. Much work remained over the summer to complete the commissioning of the STIS for routine science. As the STIS commissioning activities completed, culminating in a flight software update in August 1997, our attention turned to ramping up the STIS observing program. With the current restrictions of operating the STIS MAMAs exclusively in South Atlantic Anomaly free orbits only (~5-6 orbits/day), we must routinely and regularly schedule from the STIS observing pool to avoid accumulating a significant backlog of STIS observing programs. The chart below shows the recent ramp-up of STIS observing. Our goal is to schedule STIS in at least 25% to 30% of the available orbits while NICMOS is active. Since October, we are close to meeting all of the scheduling guidelines with 51% of the time on NICMOS, 24% to STIS and 25% to WFPC2.

Percentage of Orbits by Instrument during Prime HST Observing Time



While we were working on the STIS programs, we were able to accomplish a significant amount of previous cycle WFPC2, FOC and FGS programs that were flight prepared and in the scheduling pool. In the time period since March 1997 (following the recommissioning of the WFPC2, FOC and FGS after the servicing mission), we executed almost 3000 orbits of WFPC2, FOC and FGS observations, completing all Cycle 4 observing programs, 72% of the remaining Cycle 5 programs and almost half of the remaining Cycle 6 programs. Every effort was made to get as much WFPC2, FOC and FGS accomplished while commissioning the NICMOS and STIS and accelerating the NICMOS science observing program. As of November 1, 1997, Cycle 5 is 99% complete (the remainder are driven by constraints to specific time periods) and Cycle 6 is 72% complete.

Our new procedures for programmatic balancing, along with intense calibration requirements and the NIC3 observing campaign in January 1998 has lead to an unavoidable instability

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IUE Archive at STScI

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As of mid-October, assistance for researchers using archival data from the International Ultraviolet Explorer (*IUE*) is available at the Space Telescope Science Institute. Following the advice of the *IUE* Users Committee, STScI, working jointly with the Laboratory for Astronomy and Solar Physics at the Goddard Space Flight Center (code 680), the *IUE* Project, and the National Space Science Data Center (NSSDC), developed a concept proposal for providing long-term support for the *IUE* archive in conjunction with the *HST* archive. The proposal was approved at the start of the 1998 fiscal year.

IUE was a mission to obtain ultraviolet spectra of a variety of astronomical objects. It was an international collaboration among NASA, the European Space Agency (ESA), and the United Kingdom's Science and Engineering Research Council (SERC). The satellite was launched in 1978 and continued to operate for an amazing 18 years and 9 months, well beyond its original 5-year goal. Two on-board spectrographs covered ultraviolet wavelengths from 1200 to 3350 Angstroms in both high and low resolution modes. *IUE* obtained over 104,000 spectral images of objects ranging from the Moon and Venus to quasars and AGNs. Because it was in geosynchronous orbit, it operated in real time with great flexibility. This mode facilitated a number of time variability studies with timescales from minutes to years.

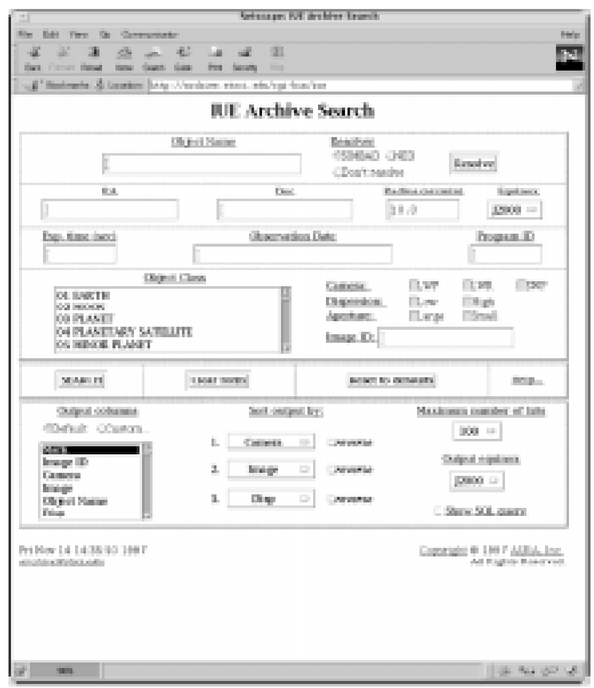
Over the years the *IUE* Spectral Image Processing System (known as IUESIPS) evolved, and much was learned about the instrument and data characteristics. Thus about 10 years ago the *IUE* Project began work to redesign the *IUE* processing system. The new system incorporated a number of changes in the processing algorithms, including the image registration, background subtraction, and extraction techniques, and new calibrations. The new system, known as NEWSIPS (for New Spectral Image Processing System), was used to reprocess all the raw data in the archive, creating the *IUE* Final Archive.

At STScI, access to *IUE* data, both NEWSIPS and IUESIPS, is provided through the same WWW and StarView interfaces used for the Hubble Data Archive. In addition, experienced *IUE* staff members are available to assist researchers. These include: Cathy Imhoff, Karen Levay, Myron Smith, and Randy Thompson, who have joined the Archive Branch and whom we welcome to STScI. The *IUE* staff will provide support for users of the *IUE* archive, organize the IUE documentation, convert much of the paper documentation into electronic form, and, working with staff at the NSSDC, assure the completion of the ingest of data from VILSPA, the European *IUE* center, into the NASA Data Archive and Distribution Service (NDADS).

The new *IUE* WWW interface is located at http://archive.stsci.edu/iue. Links are provided for users to search the *IUE* catalog, obtain help, retrieve data, and get access to *IUE* documentation and analysis software. The search page (Figure 1) allows the user to search the *IUE* catalog using a variety of parameters, ranging from target name and position to exposure time, observing date, and object class. A name resolver is also available. If this is not selected, then the object name is used in the query, which then requires a match with the name entered into the *IUE* Merged Observing Log of observations (wild card searches are also available). We recommend that searches for fixed targets be made using name resolution or positional coincidence. Moving targets' names obviously cannot be searched by position. Particularly interesting is the possibility of searching for classes of objects, ranging from planets to various types of stars to galaxies and quasars. In total, about 90 different classes of astronomical sources are available. (We warn the user that these classes have been provided by the Guest Observers so they are somewhat inhomogeneous. However, they can still be useful especially because more than one class can be selected.)

Once the search is done, the user is presented with a list of all datasets matching the query parameters. These can be marked for retrieval (the way datasets are selected for retrieval in the Hubble Data Archive), and the request is then submitted via e-mail to the NSSDC. Data can be requested in NEWSIPS and IUESIPS format and in a variety of data types.

IUE data marked in the STScI interface will be retrieved from NDADS, located at Goddard Space Flight Center. The data are stored on optical disks and accessed through an



optical disk jukebox. NDADS will retrieve the data to its staging area at ndads.gsfc.nasa.gov in the [DATA_DIST.IUE] directory. When the retrieval is finished, NDADS sends the user an e-mail message with a list of the files which were retrieved and which were not available. The data

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Cycle 7 - NICMOS Approved Programs

PI	Institution	Country	Panel	Title
Armus	Caltech/IPAC	USA	AGN	The Optical Emission Line Nebulae of High Redshift Radio Galaxies
Barnbaum	STScI	USA	CS/LMS	Environment of U Equ
Bedding	Univ. of Sydney	Australia	Galaxies	The shells of NGC 5128: debris from a recent merger
Bershady	Univ. of Wisconsin	USA	Galaxies	Searching for Old Stellar Populations in Candidate Proto-Spheroidals
Bobrowsky	OSC	USA	IM	Snapshot Survey of Proto-planetary Nebule
Borne	Hughes STX	USA	Galaxies	A NIR Snapshot Survey of Ultraluminous IR Galaxies
Buie	Lowell Obser.	USA	Solar System	Spectrophotometry of Pluto and Charon
Bujarrabal	OAN	Spain	IM	Colliding Stellar Winds: Near-IR Imaging of the Protoplanetary Nebula M192
Campins	Univ. of Florida	USA	Solar System	Observation of Two Comet-Asteroid Transition Objects
Clampin	STScI	USA	IM	Probing planetary formation around main-sequence stars: A snapshot survey
Connolly	JHU	USA	Clusters/Cosmology	The Properties of High Redshift Galaxies: A Near-Infrared Redshift Survey at 1<z<2
Dickinson	JHU	USA	Clusters/Cosmology	A complete NICMOS map of the Hubble Deep Field
Falco	Smithsonian	USA	Clusters/Cosmology	A Survey of Gravitational Lenses as Cosmological Tools II
Ferrarese	CIT	USA	AGN	A Search for Near Infrared H_2 Emission in Active Elliptical Galaxies
Freedman	Carnegie Inst.	USA	Clusters/Cosmology	Metallicity and the Cepheid Distance Scale
Frogel	Ohio State	USA	CS/LMS	Near-IR Photometry of M31's Metal-Rich Globular Clusters
Frogel	Ohio State	USA	Galaxies	The Giant Branch Luminosity Functionof M31's Bulge
Fruchter	STScI	USA	AGN	The Nature of Gamma-Ray Burster Host Galaxies
Geisler	Kitt Peak	USA	Galaxies	The Metallicity Distribution of the Globular Cluster Systems of Giant Elliptical Galaxies
Gledhill	Hertfordshire U.	UK	CS/LMS	The structure of circumbinary material in multiple T Tauri systems
Graham	U of C, Berkeley	USA	Galaxies	Infrared Luminous Stars & Stellar Population in Nearby Giant Elliptical Galaxies
Gregg	U of C, Davis	USA	Galaxies	The Stellar Population of NGC3379
Grindlay	Smithsonian	USA	Galaxies	Young and Intermediate Aged Clusters in M33 as Stellar Laboratories
Grindlay	Harvard	USA	HS/HMS	Study of Compact Binaries in the Extreme Globular Cluster Terzan 5
Hammel	MIT	USA	Solar System	Uranus Nearing Equinox: Vertical Aerosol Distribution of Atmospheric Structure
Heckman	JHU	USA	AGN	The Host Galaxies of Radio-Quiet High-Redshift Quasars
Henry	Smithsonian	USA	CS/LMS	Completing A Near-Infrared Search for Very Low Mass Companions to Stars within 10 pc
Hollis	GSFC	USA	CS/LMS	Detection of the Infrared Jet in the R Aquarii Binary System
Im	STScI	USA	Galaxies	HST NICMOS SNAPSHOT observations of
Jackson	U of Manchester, Jodrell Bank	UK	AGN	Deep IR imaging of two gas-rich radio galaxies
Johns-Krull	U of C	USA	CS/LMS	Mapping H_2 Emission Around T Tauri Stars
Jones	Liverpool John Moores U	UK	CS/LMS	IR spectra for known-mass M dwarfs
Kirshner	Harvard Obs.	USA	HS/HMS	SINS: The Supernova INtensive Study Cycle 7+: Scarlet SINS
Krautter	Landessternwarte	Germany	CS/LMS	NICMOS Study of Nova Shells
Kriss	JHU	USA	AGN	Narrow-band Imaging of BAL QSOs
Kwok	U of Calgary	Canada	IM	Near-IR Imaging and Polarimetry of Bipolar Proto-Planetary Nebulae
Lagrange	Obs.de Grenoble	France	HS/HMS	Investigating the missing link between disks around Pre Main Sequence and Main Sequence stars
Maiolino	Osservatoire Astrofisico di Arcetri	Italy	AGN	NGC 4945: Bridging the Gap Between Starbursts and AGNs
Maoz	Tel-Aviv U	Israel	Galaxies	Nuclear Rings in the IR: Hidden Super Star Clusters
Martin	U of C, Berkeley	USA	CS/LMS	An IR search for faint companionstoPleiades very low-mass stars and brown dwarfs
McCarthy	Arizona U	USA	Solar System	Grism Spectra of Centaurs and TNO's from 1-2Mum

Cycle 7 - NICMOS Approved Programs *Continued*

PI	Institution	Country	Panel	Title
Mirabel	Ser. d' Astrophysique, C.E. Saclay	France	HS/HMS	The Superluminal Source GRS 1915+105: A Runaway Black Hole?
Myers	Harvard-Smithsoonian CfA	USA	IM	HST/NICMOS Observations of the Nearest (Rho Oph) Protostellar Region
Noll	STScI	USA	Solar System	The Composition of Kuiper Belt Objects
O'Dea	STScI	USA	AGN	The Evolution of Powerful Radio Galaxies
Ortolani	U di Padova	Italy	CS/LMS	The Age of Inner Bulge Globular Clusters
Ostlin	Astronomiska observatoriet	Sweden	Galaxies	A Search For Old Stars in IZw18, Continued
Patience	U of C, LA	USA	CS/LMS	Multiplicity Survey of AlphaPersei: Studying the Evolution and Effects of Companions
Pavlov	Penn State	USA	HS/HMS	Infrared Radiation from Middle Aged Pulsars
Perlman	STScI	USA	AGN	Multi-Wavelength Monitoring of the M87 Jet
Perlmutter	Lawrence Berkeley Lab.	USA	Clusters/Cosmology	Cosmological Parameters Omega and Lambda from High-Z Type Ia Supernovae
Pogge	Ohio State U	USA	AGN	NICMOS Imaging of the Dusty CfA Seyfert Nuclei
Pottasch	Kapteyn Astro.Ins.	Netherlands	HS/HMS	The changeover from H to He rich mass loss in PN
Quillen	Steward Obs.	USA	AGN	Near-IR Cores of Radio Galaxies , Are the AGN's Moving in the Galaxies way?
Quillen	Steward Obs.	USA	AGN	The Morphology of Dense Gas in Seyferts , Obscuration and Fueling of AGNs
Quillen	Steward Obs.	USA	Galaxies	NICMOS Snap Shot Survey of Early-Type Galaxies
Rebolo	Ins. de Astro. de Canarias	Spain	CS/LMS	A Search for Giant Planets Around Very Young Nearby Late-type Dwarfs
Reipurth	CASA, Colorado	USA	CS/LMS	The Youngest Stars: CircumstellarStructure, Binarity and Origin of Jets
Renzini	ESO	Germany	Galaxies	The Initial Mass Function of the-Galactic Bulge
Roeser	Max-Planck-Institut fur Astronmie	Germany	AGN	The nature of particle acceleration in the jet of 3C 273
Rosenthal	NOAO	USA	CS/LMS	A Search for Superplanets Embedded in Beta Pic&Vega-like Circumstellar Disks
Schmidt	Steward Obs.	USA	IM	The Onset of Axisymmetry in Proto-Planetary Nebulae
Schmutz	Ins. of Astro.	Switzerland	HS/HMS	Search for ionized material around Cyg X-3
Schreier	STScI	USA	AGN	IR Imaging of the AGN Accretion Disk In Centaurus A
Schulte-Ladbeck	U of Pittsburgh	USA	Galaxies	Blue Compact Dwarf Galaxies - young or old?
Schultz	CSC	USA	CS/LMS	Near-IR Photometry of Candidate Companion to Proxima Centauri
Simon	U of Hawaii	USA	CS/LMS	A Deep Infrared Census of the W3-IRS 5 Star Cluster
Soifer	CIT	USA	AGN	NICMOS Observations of FSC10214+4724: Mapping a redshift 2.3 Quasar with 100 arsec resolution
Stanford	L. Livermore	USA	Clusters/Cosmology	A Morphological Census of z > 1 Cluster Galaxies in the Optical Rest-frame
Stolovy	Steward Obs.	USA	IM	A High-Resolution Proper Motion Study of the Ionized Gas Near Sgr A*
Tadhunter	U of Sheffield	UK	AGN	Jets, cones and the alignment effect in high-z radio galaxies
Tomasko	Lun.-Planet. Lab	USA	Solar System	Saturn's Haze Properties in the Near Infrared
Tosi	Osservatorio Astro. di Bologna	Italy	Galaxies	Starbursts: The First Generation
Urry	STScI	USA	AGN	The Two Types of BL Lac Objects: Extrema of Jet Physics
van der Werf	Leiden Obs.	The Netherlands	Galaxies	Molecular gas in the centers of Arp220 and NGC6240: nuclear accretion disks?
Vogt	UCO/Lick Obs.	USA	Galaxies	Infrared Imaging of High Redshift (0.4 <= z <= 1) Tully-Fisher Galaxies
Walborn	STScI	USA	IM	A New Stellar Generation in 30 Doradus
Warren	Imperial College	UK	Clusters/Cosmology	Deep NIC2 images of 20 high-z damped Ly-alpha galaxies
Weintraub	Vanderbilt U	USA	CS/LMS	A Search for Extrasolar Giant Planets in the Nearby TW Hya Association
Wilkinson	Jodrell Bank, U of Manchester	UK	Clusters/Cosmology	NICMOS observations of potential JVAS/CLASS gravitational lenses
Wilner	Smithsonian	USA	IM	Testing Protostellar Collapse Theory through Extinction Mapping
Yusef-Zadeh	Northwestern U	USA	IM	H_2 Observations of the Galactic Center Circumnuclear Ring
Zepf	Yale University	USA	Galaxies	Weighing the Stellar Halo of NGC 5907 with NICMOS

Cycle 7 - NICMOS TAC Panels

PANEL/PANEL CHAIR/PANELIST/AT-LARGE MEMBERS/CHAIR		UNIVERSITY/INSTITUTION	DEPARTMENT/OBSERVATORY	COUNTRY
AGN				
Panel Chair	Webster, Rachel	University of Melbourne	School of Physics	Australia
Panelists	Binette, Luc	ESOChile		Chile
	Cristiani, Stefano	ESA/Universita' di Padova	ipartimento di Astronomia	Italy
	Elvis, Martin	Harvard	Smithsonian Center for Astrophysics	USA
	Giavalisco, Mauro	OCIW		USA
	Jannuzi, Buell	NOAO/KPNO		USA
	Madejski, Greg	NASA/GSFC		USA
	Kriss, Gerard A.	Johns Hopkins University	Department of Physics & Astronomy	USA
CLUSTERS OF GALAXIES & COSMOLOGY				
Panel Chair	Schommer, Robert	Cerro Tololo Inter-Amer. Obs		Chile
Panelists	Casertano, Stefano	STScI		USA
	Rieke, Marcia	University of Arizona	Steward Observatory	USA
	Strauss, Michael A	Princeton University	Department of Astrophysical Sciences	USA
	Wright, Edward L.	UCLA	Department of Astronomy	USA
	Zamorani, Giovanni	ESA	/Osservatorio Astronomico di Bologna	Italy
COOL STARS/LOW-MASS STARS				
Panel Chair	Beichman, Charles A.	Caltech/JPL	IPAC	USA
Panelists	Hauschildt, Peter	University of Georgia	Physics and Astronomy	USA
	Kulkarni, Shrinivas	California Institute of Technology	Department of Astronomy	USA
	Legget, Sandy	UKIRT	Joint Astronomy Centre	USA
	Ortolani, Sergio	ESA/Dipartimento di Astronomia	Vicolo Dell' Osdervatorio 5	ITALY
	Stauffer, John	Center for Astrophysics		USA
	Suntzeff, Nick	Cerro Tololo Inter-Amer. Obs.	AURA, Inc.	CHILE
GALAXIES				
Panel Chair	Sancisi, Renzo	ESA/Kapteyn Astronomical Institute		Netherlands
Panelists	Calzetti, Daniela	Space Telescope Science Institute		USA
	Eisenhardt, Peter R.	Jet Propulsion Lab.		USA
	Elston, Richard	University of Florida		USA
	Graham, James R.	University of California, Berkeley	Department of Astronomy	USA
	Morris, Simon	Dominion Astrophys. Obs		Canada
	Oliva, Ernesto	ESA/Osservatorio Astrofisico di Arcetri		Italy
	Pritchet, Christopher	University of Victoria	Physics & Astronomy	Canada
	Seitzer, Patrick	University of Michigan	Dept. of Astronomy	USA

Cycle 7 - NICMOSTAC Panels *Continued*

ANEL/PANEL CHAIR/PANELIST/AT-LARGE MEMBERS/CHAIR		UNIVERSITY/INSTITUTION	DEPARTMENT/OBSERVATORY	COUNTRY
HOT STARS/HIGH-MASS STARS				
Panel Chair	Moffat, Tony	Univ. de Montreal	Dept. de Physique	Canada
Panelists	Bohannan, Bruce	Kitt Peak National Obs.		USA
	Herrero, Artemio	ESA		SPAIN
	Schaefer, Brad	Yale University		USA
	Sparks, Warren	Los Alamos National Lab.		USA
	Werner, Klaus	ESA/Institut fur Astronomie & Astrophysik	Universitat Tuebingen	Germany
INTERSTELLAR & INTERGALACTIC MEDIUMS				
Panel Chair	Dinerstein, Harriett	University of Texas at Austin	Astronomy Department	USA
Panelists	Balick, Bruce	University of Washington	Astronomy Department	USA
	Clemens, Dan P.	Boston University	Department of Astronomy	USA
	Hollenbach, David	NASA/Ames Research Center	Planetary Systems Branch	USA
	Mathis, John	University of Wisconsin-Madison	Department of Astronomy	USA
	Natta, Antonella/ESA	Osservatorio di Arcetri		ITALY
	Torres-Peimbert, Silvia	UNAM	Instituto de Astronomia	Mexico
SOLAR SYSTEM				
Panel Chair	Tokunaga, Alan	University of Hawaii	Institute for Astronomy	USA
Panelists	Festou, Michel/ESA	Observatoire Midi - Pyrenees		France
	Howell, Robert	University of Wyoming	Physics & Astronomy Department	USA
	Kostiuk, Theodor	Goddard Space Flight Center	NASA	USA
	Millis, Rober	Lowell Observatory		USA
	Young, Leslie	Boston University	Center for Space Physics	USA
TAC AT-LARGE				
TAC Chair	Sargent, Anneila	Caltech	Department of Astronomy	USA
Members-at-Large	Brown, Bob	STScI		USA
	Kleinmann, Susan	University of Massachusetts	Physics and Astronomy	USA
	Lin, Doug	University of California	Lick Observatory	USA
	Mirabel, Igor Felix	DAPNIA	Service d'Astrophysique	France
	Szalay, Alexander	Johns Hopkins University	Dept. of Physics & Astronomy	USA

The Second Decade Of HST

Report From the HST Project Scientist

David Leckrone, leckrone@stsci.edu

As part of its yearly, long-term planning of the Space Science budget, the Office of Space Science at NASA Headquarters this year has authorized the *HST* Project to plan its budget on the assumption that the mission will continue, with low-cost operations, until 2010. In other words we will no longer plan for the end of *HST*'s mission in 2005. This is wonderful news! It means that *HST* will continue in its role as the premier UV-optical astronomical observatory for a second decade. It is consistent with the recommendations of the 1996 "*HST* And Beyond" study, chaired by Alan Dressler. With the currently planned launch of the Next Generation Space Telescope (NGST) in 2007, there will be several years of overlap between the two missions, enabling coordinated research programs spanning the entire wavelength range from 1200 angstroms to 5 microns or beyond.

To create a funding "wedge" that allows a new start for NGST in 2003, with a launch in 2007, we are coordinating the budgets of the *HST* and NGST projects. We must assume that there will be only two more in-orbit servicing missions to *HST*, one in late 1999 and the last in late 2002. A mission to bring *HST* back to Earth in 2010 is sketched into our long-term plan. With a successful re-boost during last February's servicing mission, with the smaller cross-section for atmospheric drag of the new solar arrays to be mounted on *HST* in 1999, and with options for additional re-boosts in 1999 and 2002, *HST*'s orbit decay will not be an issue at least until the solar maximum around 2010-2011.

In a perfectly ordered universe, we might have been able to make the decision long ago to extend *HST*'s mission. This would have permitted an extensive, methodical strategic planning activity leading to recommendations about how to optimize the *HST* observatory for the long-term. Such a strategic plan, in turn, would have informed the Announcement of Opportunity NASA released to the community in 1996 for the instrument to be inserted on *HST* in 2002 - the final *HST* instrument. However, real life is seldom so straightforward. So, our challenge now is to create a strategic plan for *HST*'s second decade on a short time scale, with the help of the community, while constrained to "play " with the "cards" we have already been dealt. There is no time for another Announcement of Opportunity which would be compatible with the development schedule for the 2002 mission, for example. Some aspects of the planning will not require immediate action - long-term scientific observing strategies for *HST*, definition of what "low cost operations" truly entails, etc. But plans which might affect either the 1999 or the 2002 servicing missions must be completed by early in 1998. Here, I will describe to you the initiatives we have undertaken to study our (limited) options and the process by which we will reach final conclusions.

Three strategic objectives for the *HST* extended mission are clear. 1. We must do what we can during the 1999 and 2002 servicing missions to maximize the probability that *HST* will continue to function as a spacecraft until 2010. 2. We must do what we can to insure that *HST* will continue to produce top-rank science until 2010. This includes maintaining a steady flow of output that continues to be both scientifically compelling and inspirational to the taxpaying public, so that the public and political will to continue *HST*'s operation will be maintained. 3. Objectives 1 and 2 must be accomplished at relatively low cost.

The *HST* Project has been gaining experience in low-cost instrumentation and operations. Regarding instrument design and development, our approach is to use the *HST* instrument heritage that we have already paid for once, or to use new technologies that others have paid for. Examples include the Advanced Camera for Surveys (ACS) to be flown in 1999, which is costing about 60% of the price we would have otherwise had to pay for such a capable instrument, because of extensive reuse of STIS subsystem designs and spare hardware. The newly selected Cosmic Origins Spectrograph (COS), which will be inserted in *HST* in 2002, makes significant use of GHRS designs and hardware (returned from orbit last February), and also uses the delay-line detector design and grating technology already developed for the *FUSE* mission. The cryocooler for the NICMOS cooling system being considered for the 1999 mission (discussed in the October, 1997 STScI *Newsletter*), comes to us from an ongoing joint Air Force/NASA program, with the U.S. Air Force paying about 2/3 of the cost of the initial development of this exciting new technology. The Vision 2000 ground system, now under development, will provide the foundation for low-cost future operations of *HST*, using the enhanced capabilities of the new 486 spacecraft computer being flown in 1999.

As reported to the Space Telescope User's Committee (STUC) on November 25, we have initiated several small studies, of about three months' duration, to investigate relatively low-cost means to provide backup capability for the primary UV-optical imaging and spectroscopy instruments on *HST* after 2002. The STIS will be *HST*'s prime spectrograph from now until the end of the mission. It will be over 13 years old by 2010. We have asked the COS team to study several options for lengthening COS's lifetime, for making it more robust, and for extending its capabilities to provide at least a modest backup for UV spectroscopy in case one or both of the STIS MAMA channels should fail. The latter would most likely involve incorporating in COS a second, near-UV detector channel, probably using a flight-spare MAMA

Band 2 detector left over from the STIS program.

The ACS will be our primary camera to the end of the mission. As things now stand, it would be backed up by STIS imaging modes, with a very limited filter set, and by WFPC2, which will be over 17 years old by 2010 and which has a number of potential single-point failure modes, primarily in its electronics. The question we are facing is, is this sufficient insurance against the possibility that *HST* might "go blind" in a scientific imaging sense sometime between 2002 and 2010? This question motivated a NASA Headquarters request to the *HST* Project to carry out a small study, in partnership with STScI, JPL, Ball Aerospace and ESA, to investigate the technical feasibility and costs of refurbishing and updating the wide-field mode of WFPC1, using spare detectors from the ACS program, and of having it ready for flight in 2002. We now refer to such a refurbished camera as "WF3." As an ancillary activity, we are also investigating the possibility of including in WF3 an optimized coronographic subsystem with capabilities similar to those proposed in the only instrument proposal other than COS to have made it successfully through the recent scientific peer review for the 2002 *HST* instrument.

The final reports of these two studies - upgrades to COS and conversion of WFPC1 to a flight-worthy WF3 instrument - are due in December, 1997. In January, just before the AAS meeting in Washington, D.C., the original 2002 *HST* Instrument Peer Review Panel will reconvene to carry out an evaluation of the scientific and programmatic merit of these various options. On the basis of their findings, we will then organize a further community-based review of related programmatic issues and trade-offs as appropriate. A final decision about which, if any, of these options to pursue will be made by NASA Headquarters in the first quarter of 1998. Also in the first quarter of 1998, the STScI will be organizing a community-based study leading to a complete strategic plan for the Second Decade of *HST.* We expect this study to continue for several months

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(COS) from page 7

implementing the extended wavelength coverage uses flat gratings which can be scanned and a near-UV MAMA detector. A decision about whether we will proceed with the secondary channel for the near-UV will be made by NASA in early 1998.

More details about the COS instrument can be found at the COS Web site at http://cos.colorado.edu. This Web page will be updated periodically as the COS instrument capabilities and performance become better defined. As a figure of merit, we expect to obtain S/N=10 per resolution element in the R > 20,000 channels for a source with flux of 2.x10^-15 ergs per square-centimeter per second per Angstrom in 10,000 seconds.

Over the next few months, we will be developing the Design Reference Mission for COS, which will be used to gauge the *HST* ground systems resources necessary to accommodate COS operations. In order to estimate COS usage during the period 2002 to 2010, we will extrapolate our GTO science program to subsequent *HST* cycles and analyze the usage history of previous UV spectrographs aboard *HST* (GHRS, FOS, STIS). However, it would be extremely useful to us if you, the scientific community, helped us to estimate COS usage by sending potential COS observing programs to morsey@casa.colorado.edu. By doing so, you will help to ensure that a broad scientific program is represented when we calculate *HST* resources that COS will require to execute its science mission successfully.

We look forward to working with Goddard Space Flight Center, the Space Telescope Science Institute, Ball Aerospace and the scientific community over the coming years to make the COS mission a success.

IUE Archive from page 15

may then be transferred from the staging area via anonymous FTP. An e-mail message should arrive within a half hour or so of when the request is submitted, depending on the system load.

Future plans for the *IUE* archive at STScI include the possibility of previewing the data before retrieval, as currently possible for *HST* data, combined *IUE/HST* searches, placing additional documentation online, and, finally, the migration of the most frequently used data from NSSDC to STScI.

Users can also access the *IUE* Merged Observing Log of observations in Starview by selecting “Non-*HST* Data Searches” in the Welcome Page and then “*IUE*.” The *IUE* Merged Observing Log can be searched using a variety of parameters, as for the WWW pages. Retrieval of *IUE* data through Starview willbe available soon.

We plan to incorporate additional ultraviolet and optical data sets into the STScI archive in the future,including data from the Far Ultraviolet Spectroscopic Explorer (*FUSE*) currently scheduled for launch in October 1998. E-mail inquiries about the STScI data archives should continue to be directed to `archive@stsci.edu`.

Independent Science Review: NICMOS Cryocooler

September 10 - 12, 1997

1. Background

The Independent Science Review is a mechanism that permits NASA, AURA, and the Space Telescope Science Institute to seek independent scientific, technical, and managerial advice on high-level issues related to the Hubble Space Telescope Project. Previous reviews were convened in July 1996 and May 1997. These concentrated, respectively, on issues relating to the Second Servicing Mission (SM2) and an anomaly that developed shortly after SM2 in the Near Infrared Camera and Multi-Object Spectrometer (NICMOS). The reviews were conducted by senior scientists with experience with the Hubble Space Telescope or other space missions and their implementation and management.

The present Independent Science Review (ISR) was recommended by the May 1997 ISR and convened by AURA at the request of the *HST* Project. The Review was asked to consider the implications of mounting a cryocooler on NICMOS during the Third Servicing Mission (SM3), with the aim of prolonging the life of the instrument. Review Team members were George R. Carruthers, Judith G. Cohen, Robert A. E. Fosbury, Fred C. Gillett, Richard J. Harms, Martin Harwit (chair), Jeffrey Linsky, Stephan Price, and Richard J. Wainscoat.

2. The Charge to the NICMOS Cryocooler Independent Science Review Team

NICMOS, a cryogenically cooled instrument, was originally designed to operate for a period of 4 to 4.5 years. A thermal short, that developed in its dewar soon after installation on orbit, now indicates that the instrument will have a useful lifetime of only about 1.6 years, unless the short breaks, an eventuality now considered remote. Cryogenics systems experts within GSFC's Engineering Directorate have proposed an approach to cooling NICMOS to acceptable operating temperatures with a Reverse Brayton-Cycle Cryocooler, a new, high-technology mechanical cooler.

The Cryocooler Independent Science Review (CC-ISR) was charged with conducting a high-level review of the cooler as soon as possible after the completion of a Critical Design Review that was held at GSFC on September 4 and 5, 1997. The purpose was to:

• Review the cooler "in the context of all aspects of the performance of the *HST* and particularly of NICMOS, as well as the implications for the servicing mission and future instruments;"

• Examine whether the proposed technical approach appears credible;

• Determine whether the instrument will be able to perform the full range of astronomical observations originally expected of NICMOS;

• Investigate the cost of the cryocooler system, and check how the work will be funded without significant consequences to other scientifically critical areas of the *HST* program;

• Assess the implications of the cryocooler system for science operations and the performance of the spacecraft and its several instruments, and determine whether this impact is acceptable; and, finally,

• Recommend whether it is in the best interests of *HST* science to proceed with the cryocooler implementation on SM3, in 1999.

3. Two Basic Issues

The ISR decided to break down its task into two separate and independent questions:

A. The first concerns itself with the Creare Corporation's Reverse Brayton-Cycle Cryocooler alone. It asks whether the capabilities the cooler could provide the astronomical community are of sufficient significance for NASA to pursue the goal of preparing the cooler for flight and conducting an orbital test.

The ISR team was unanimous in its assessment that a reliably working, space-qualified cryocooler has long been a priority of the space community, and should be energetically pursued. It has many applications in space science, both in earth-viewing and astronomical missions. In infrared astronomy alone, cryocoolers have been considered in preliminary planning for major missions such as NGST, where a mechanical cooler could permit operations beyond the 5 micron wavelength limit, and in designs for FIRST, where mechanical coolers could provide similar advantages.

While cryocoolers for space operations have long been considered important, vibration, mechanical wear, and low efficiencies, precluded their widespread use. The Brayton cryocooler now proposed for NICMOS shows great promise. In the laboratory it has been working continuously for thirteen years, with thousands of on-off cyclings showing it to be reliable and robust.

The *HST* Project at GSFC is enthusiastic about pursuing the goal of conducting a test of a cryocooler aboard the Shuttle, in 1998. They plan to test the cooler's performance under zero-gravity conditions, and determine its cooldown rates, maximum performance, and ability to control temperature within strict bounds. This so-called "HOST" mission will also test the performance of a Capillary Pump Loop and all flight electronics components, and will assess vibration levels and general compatibility with *HST* systems.

These activities, though currently on an exceptionally fast track, carry the promise of providing the space community, and in particular the astronomy community, with a long-awaited capability of genuine importance. We endorse the approach and judge the risks involved worth the potential yields.

B. The second, more complex question asks whether this cryocooler should be installed on the NICMOS instrument on the SM3 changeout mission in 1999. To answer this in sufficient depth, the ISR examined

• The astronomical promise of NICMOS;

• The financial costs to the *HST* program of flying a cryocooler on NICMOS; and

• The risks involved in a cryocooler installation on *HST*.

These respective issues are addressed in the next three sections.

4. Astronomy with NICMOS: An Exciting Program with Great Potential

The NICMOS instrument has a number of unique capabilities which ground-based instruments will not match in the foreseeable future. Early-release observations (ERO) now in hand point to the promise of the instrument. Its current capabilities on orbit exceed a number of pre-flight expectations. It has demonstrated diffraction-limited performance at all wavelengths and significantly low scattered light levels.

A key strength of NICMOS is the low background it sees between wavelengths of 1 and 2 microns. In contrast to ground-based instruments, whose broad-band observations are hampered by the atmosphere's irregularly undulating OH airglow, the NICMOS on-orbit background is a hundred times fainter and limited primarily by zodiacal light. This difference should permit Camera 3 with its broad-band filters at 1.1 and 1.6 microns to study extremely faint extended structures 0.2 to 10 arc seconds in size, to a depth 3 to 4 times fainter than possible from the ground.

This capability will be demonstrated in the very deep observations to be made in December 1997 of the Hubble Deep Field, where NICMOS is expected to reveal the nature of faint, distant galaxies only slightly larger than 0.2 arc seconds across, at sensitivity levels never matched from the ground. Other expected results are faint detection limits on - or potentially the discovery of - brown-dwarf halos around galaxies, extended structures around quasars, stellar bridges between galaxies, and faint structures in star-forming regions, detected to unprecedented depths.

The grism mode of NICMOS offers unique advantages that cannot be achieved from the ground. Slitless spectroscopy at a spectral resolution of 200 becomes possible on orbit and appears to yield good spectra on H = 20 mag. objects in observations lasting only a single orbit. The absence of OH emission features endows NICMOS with a significant multiplex advantage in this spectroscopic mode, compared to ground based instruments restricted to the use of a slit along which at best one or two objects can be placed. The parallel mode NICMOS grism survey currently under way illustrates the potential of this capability for red shift determinations of faint field-galaxies, for low resolution spectroscopy, and for isolating samples of peculiar objects for more detailed study.

Unlike ground-based adaptive optics systems, NICMOS provides a stable, fully diffraction-limited point-spread-function. This is crucial for observations requiring a high dynamic range, and has already led to the detection of faint companions of bright stars and features around luminous quasars. Studies of surface brightness fluctuations that permit measuring cosmic distances also benefit from a stable, well-characterized point-spread-function.

The earth's atmosphere blocks observations of the spectral lines of several important atoms and molecules, making their detection difficult or impossible from the ground. Among the most important of these are the Paschen-alpha line at 1.88 microns and many water vapor features. Water vapor observations of solar system objects, evolved stars, and interstellar shocks and star-forming regions, are of particularly high interest.

The original 4 to 4.5 year lifetime foreseen for NICMOS would have lent itself naturally to a program of follow-up observations. As with any new capability, early observations often provide unexpected results that need to be verified or more deeply explored. This is only possible given enough time to carefully calibrate the instrument to fully understand its characteristics and limitations in each of its many observing modes. The reliable reduction of astronomical data cannot proceed until such instrumental parameters are well established. A thoughtfully crafted program of follow-up observations requires operation for a sufficiently long time.

It is, therefore, not only the wealth of new observations that would be increased by extending the NICMOS lifetime. An added benefit would be the validation and systematic exploration of unexpected new results made possible by an orderly sequence of follow-up observations. An extended lifetime will permit a systematic investigation of highlighted new discoveries and help the community to gain the astronomical insights this mission was intended to provide.

NICMOS promises a rich program of exciting observations that will not be matched by ground-based instruments nor, for the next few years, by any other instrument to be launched into space. The instrument's relatively recent launch has not yet permitted a complete assessment of its various capabilities, although its performance, to date, appears to match or exceed preflight expectations. A more detailed assessment should become available over the next twelve months and permit a critical analysis of the instrument's full scientific promise.

5. Costs to the HST Program

The ISR was given a presentation on the costs of preparing a Creare cryocooler for a HOST flight aboard the Shuttle and for the SM3 installation of the cryocooler on NICMOS.

Funds directly chargeable to the *HST* program were presented as roughly \$6M. The source of these monies, the ISR was told, were contingency funds earmarked for the years 2002 and rephased by NASA Headquarters. Use of these funds was presented as having no impact on operations, flight hardware, or data analysis. Additional funding was being

Independent Science Review: NICMOS Cryocooler *Continued*

provided by the Department of Defense which, in past years, was the major funder in the development of space cryocoolers.

The project pointed out that the cited costs were modest compared to the overall cost of NICMOS: $105M.

The ISR accepted these figures as presented. Time did not permit a deeper analysis, but the *HST* Project appeared sincere in its desire to minimize the costs of a mechanical cryocooler and any financial impact on *HST* science.

6. Uncertainties Surrounding a Cryocooler Mounted on NICMOS

A substantial number of uncertainties persist. Many come about from the ongoing evolution of the cryocooler concept. Others arise from a lack of information on the structural changes that may have taken place in the NICMOS dewar. The sum of these uncertainties has to be weighed against the scientific value of maintaining NICMOS operational after cryogen exhaustion. The undefined factors fall into two classes:

(A) Impact on the Overall Scientific Yield of *HST*

1. Thermal impacts on the Aft Shroud and on the other astronomical instruments on *HST*;

2. Operational restrictions resulting from the cryocooler's high power-requirements, particularly the possible restriction of operating several instruments in parallel;

3. Impact on the *HST* Pointing Control System, including jitter and potential thermal snapping' of the external radiator;

4. Electromagnetic interference and noise;

5. Contamination;

6. Costs in the development of operational software and additional costs of operating NICMOS beyond the originally anticipated lifetime;

7. Risks to *HST* hardware during the SM3 extravehicular activities, which will be on a tight time schedule;

8. Necessary reduction of contingency funding up to and beyond SM3. This could come at a cost, e.g. if the Advanced Camera System were to run into unanticipated problems.

(B). Impact on the Long-Term Scientific Yield of NICMOS

1. Current uncertainties about the degree to which the NICMOS dewar has been stressed;

2. Difficulties, to date, in determining whether the focal plane might be even further displaced after cryogen runs out and the system warms up before again being cooled, this time by the cryocooler. Related questions concern the degree to which vignetting through focal plane misalignment and displacement of the coronagraph occulting disk might affect the scientific yield of a re-cooled NICMOS.

3. Currently unresolved questions about parasitic heat losses that might make it difficult to reach the low temperature and temperature stability required for detectors and filters if NICMOS is to continue to provide the highest quality observations.

Most of these points were addressed in depth with the *HST* Project but, of necessity, remain uncertain. Without exception these factors are in flux, often varying on a day by day basis.

7. Recommendation Relating to a Cryocooler on NICMOS

Given the numerous remaining uncertainties, the ISR submits four recommendations:

1. Preparations for flight testing the Creare cryocooler on the HOST mission should proceed.

2. If a cryocooler is mounted on NICMOS it will most probably have detectors operating at a temperature roughly ten degrees higher than today. The NICMOS instrument PI team, STScI, and the *HST* project, should try to assemble whatever data can be gathered around the time of NICMOS dewar warm-up to determine the extent to which higher temperatures can be tolerated, and the extent to which an optimum set of operating temperatures might be defined as a target for later, mechanically cooled operations.

3. The ISR agrees with the May 1997 ISR's recommendation that STScI should allocate NICMOS an increased fraction of *HST* observing time, along lines that the Institute has already implemented. However, we further recommend that the selection of NICMOS observing programs should keep in mind that results obtained with the instrument now will serve as a guide to instrument designers for future missions, such as NGST. We, therefore, recommend that the Director of STScI provide discretionary time to observations that particularly stretch the envelope of capabilities and have the greatest potential for providing both new astronomical and instrumental insights. The more NICMOS can teach us about its findings through particularly challenging observations, the better informed we will be in designing successful future astronomical missions.

4. Following flight testing on the HOST mission in the early fall of 1998, a further Independent Science Review, whose membership should include the Principal Investigators of ACS, COS, NICMOS, STIS, and WFPC2, should be convened to reassess the scientific justification for flying the cryocooler on NICMOS. By this time, we should have learned far more than we know today about the status of the NICMOS dewar and optics. We should know how well the performance of NICMOS has held up in forefront astronomical observations, particularly in view of continuing advances in ground-based techniques that might conceivably reduce the advantages of observing with NICMOS from space. By the late summer or early fall of 1998, most of

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AURA CELEBRATES 40 YEARS!

Lorraine Reams, AURA Headquarters

On October 28, 1997, the Association of Universities for Research in Astronomy celebrated its 40th anniversary. A consortium of educational and other non-profit institutions, AURA was incorporated in 1957 in the state of Arizona to develop and operate national and international centers that enable merit-based research by members of the astronomical community.

This milestone event was marked by a November 18 reception with STScI staff, which was held in conjunction with a meeting of the AURA Board of Directors. Similar events were held at the National Solar Observatory at Sacramento Peak in September, and at the Tucson offices of the National Optical Astronomy Observatories and the Gemini Project in October. Observances are also planned for the Cerro Tololo Inter-American Observatory in Chile and the Gemini facilities in Hilo, Hawaii.

The Board is composed of thirteen members. Twelve are elected by the Member Representatives (1) and serve staggered three-year terms. The President of AURA is a member ex officio. The Member Representatives elect the Chair of the Board annually from among the members of the Board. The Board elects its Vice Chair.

The by-laws prescribe that at least four of the twelve Directors shall be Member Representatives, at least four shall not be Member Representatives, and at least two Directors shall come from non-U.S. institutions. Further, no more than four Directors may be non-U.S. citizens.

The Board establishes the policies of AURA, approves its budget, elects members of the Management Councils, and appoints the AURA President and the Center Directors. At their annual meetings, the Member Representatives hold the Board accountable for the effective management of AURA and the achievement of its purposes therein.

Space Telescope Institute Council (STIC)

Effective July 1, 1997, the members are:

Edwin Turner, Chair	Princeton University
Robert Millis, Vice Chair	Lowell Observatory
Cleon Arrington	Georgia State University
Tim DeZeeuw	Leiden Observatory
Richard Ellis	University of Cambridge
Gregory Geoffroy	University of Maryland
Heidi Hammel	Massachusetts Institute of Technology
Elizabeth Hoffman	University of Illinois
Garth Illingworth	University of California at Santa Cruz
Roger Malina	Laboratoire d'Astronomie Spatiale/CNRS
Goetz Oertel, ex officio	AURA
Michael Shull	University of Colorado

NEW AURA BOARD OF DIRECTORS

Effective July 1, 1997, the members of the AURA Board of Directors are:

Bruce Margon, Chair	University of Washington
Richard Zdanis, Vice Chair	Case Western Reserve University
James Hesser	Dominion Astrophysical Observatory
John Huchra	Harvard-Smithsonian Center for Astrophysics
Gloria Koenigsberger	Universidad Nacional Autonoma de Mexico
Leonard Kuhi	University of Minnesota
Morton Lowengrub	Indiana University
Jeremy Mould	Mt. Stromlo & Siding Spring Observatory
Dennis O'Connor	Smithsonian Institution
Goetz Oertel, ex officio	AURA
Robert Rosner	University of Chicago
Paul Schechter	Massachusetts Institute of Technology
Lee Anne Willson	Iowa State University

The president of each AURA member institution appoints one person to serve as its representative. Member Representatives typically are either astronomers or high-level administrators.

The STIC is a Management Council of the Board. Its members are trustees and advocates for the mission of STScI. The STIC provides stewardship and oversight, and gives support and advice to the STScI Director on important policy and management matters.

The STIC consists of nine core members, two "non-core" members, and the AURA President, ex officio. Core members are elected by the AURA Board. "Non-core"members are elected by the STIC and to add expertise not already within the core membership. Members serve staggered three-year terms. At least four of the core members are derived from the Board of Directors or the Member Representatives, or in combination therefrom. And, at least four core members come from outside the Board and Member Representatives. Management Councils elect their own Chair and Vice Chair.

NICMOS Cryocoller *from page 24*

the outstanding engineering uncertainties - in particular any uncertainties about the ability of the Aft Shroud Cooling System (ASCS) to maintain sufficiently low temperatures for optimal functioning of all instruments aboard *HST* - should have been removed. We should then have a far clearer understanding of technical concerns and potential risks surrounding the attachment of a cryocooler on NICMOS.

By the late summer of 1998, a comprehensive collection of the major observations and discoveries made by NICMOS will also be in hand. These should be made available to the ISR to be convened, independent of proprietary data rights held by individual NICMOS investigators; only with access to these data will the 1998 ISR be able to evaluate the full merit and promise of NICMOS observations and contrast these to capabilities that will be available with ground-based instruments in the post-1999 period and to the quality of observations yielded by other instruments on *HST*.

With more specific information than currently in hand, an Independent Science Review convened in 1998 will be in a position to formulate a necessary, informed judgment and reasoned recommendation on the overall scientific merits of flying a cryocooler on the *HST*.

Summary

1. The ISR recommends that the *HST* Project pursue the flight testing of a Reverse Brayton-Cycle Cryocooler on the HOST mission planned for 1998.

2. Because of the speed with which preparations for this flight test have had to be pursued, and the detailed approaches that still need to worked out, the ISR was unable to reach a reasoned decision on whether the merits of mounting a cryocooler on NICMOS outweighed the potential scientific risks to other *HST* instruments. The ISR, therefore, strongly recommends that a further Independent Science Review, whose membership should include the Principal Investigators of ACS, COS, NICMOS, STIS, and WFPC2, be convened shortly after the HOST mission is flown. The data available at that time will need to be sufficiently complete to remove current uncertainties and persuade the ISR that the scientific risks are sufficiently low and the scientific promise sufficiently high to go forward with flying a cryocooler on NICMOS aboard *HST*.

Sometimes Life *from page 13*

the technical staff, then the middle managers, then the project manager, and soon there was a parade of folks over to the control center in Building 3.

While the safings are always inconvenient for the operations staff, we have been fortunate that they have missed some of the time critical *HST* events. There were two safings in July 1993, the month of the Comet Shoemaker-Levy impact. One was just prior to the impacts, the second a few days later. A quick recovery from the first event allowed the observations to continue, but a fluctuation by a few days in the events could have lost irreplaceable observations. Safings in the day or two just prior to servicing missions can cause substantial disruption to the mission, so we have been fortunate not have had to deal with that problem.

Over 7.5 years of *HST* operations there have been 30 safemode entries, 10 during the first year. The experience gained through these events has allowed the operations staff to reduce the response time considerably, and has influenced the way new SIs are developed and operated, to reduce down time when problems occur. Each event is different, and there is a stimulating challenge to quickly determining the cause and developing a response. On the other hand, each time the beeper goes off there is a bit of dread that there may have been a serious failure, so on the whole we would all rather not have our lives made more interesting by safings.

Recent Operations *from page 14*

in the long range *HST* observing plan (LRP). At the same time, we are pleased to report that the overall *HST* observing efficiency has rebounded to the 45% to 55% level following the completion of the Servicing Mission Observatory Verification program.

The 1998 Summer Student Program at STScI

The Space Telescope Science Institute will again be host to a dozen or more undergraduate research interns in the summer of 1998. We encourage you to let students know about this opportunity. Complete information and application procedures will be available after January 1, 1998, on the Institute's web page (look under "STScI and the Astronomical Community"), or you may contact soderblom@stsci.edu. Applications will be due February 27.

The Next May Symposium: Unsolved Problems in Stellar Evolution

Mario Livio, STScI mlivio@stsci.edu

The next STScI May Symposium will take place May 4-7, 1998, and will be devoted to the topic of: Unsolved Problems in Stellar Evolution. All aspects of stellar evolution, from birth to death, will be discussed, with an emphasis on important open questions. Specifically, topics covered in invited talks will include:
Star Formation, Pre-Main Sequence Evolution, The Initial Mass Function. Brown Dwarfs, Young Stellar Objects, The Mass-Luminosity Relation, Convection and Rotation, The Solar Neutrino Problem, Evolution to Red Giants, The Importance of Input Physics and Parameters to Models, Evolution of Binaries, Mass Loss, Abundance Anomalies, Blue Stragglers, Planetary Nebulae, White Dwarfs, Supernovae, Pulsars, and Black Holes.

The list of confirmed invited speakers includes:
E. Salpeter, F. Shu, S. Stahler, B. Elmegreen, J. Liebert, J. Najita, E. Churchwell, J. Andersen, J. Toomre, J. Bahcall, P. Eggleton, A. Maeder E. van den Heuvel, R. Kudritzki, L.A. Willson, C. Pilachowski, M. Mateo, H. Bond, D. Winget, S. Woosley, R. Narayan, and I. Iben Jr.

The deadline for registration is April 1, 1998. People interested in participating should contact Cheryl Schmidt at STScI by mail:

Space Telescope Science Institute
3700 San Martin Drive
Baltimore, MD 21218, USA

e-mail: (`schmidt@stsci.edu`), or phone (410-338-4404)

The registration fee is $150 before April 1, 1998, and $170 thereafter.

For complete symposium information and electronic registration, please go to:
`http://www.stsci.edu/ftp/meetings/meetings.html`

Calendar

Cycle 8:

Call for Proposals Released	June 17, 1998 (tentative)
Phase I Proposals Due	September 11, 1998 (tentative)
Observers Notified	December 11, 1998 (tentative)

Cycle 9:

Call for Proposals Released	April 28, 1999 (tentative)
Phase I Proposals Due	July 30, 1999 (tentative)
Observers Notified	October 29, 1999 (tentative)

Meetings and Symposia

STScI May Workshop (see above)	May 4-7, 1998
Space Telescope Users Committee	May 18-19, 1998

ST-ECF Newsletter

The Space Telescope — European Coordinating Facility publishes a quarterly newsletter which, although aimed principally at European Space Telescope users, contains articles of general interest to the HST community. If you wish to be included in the mailing list, please contact the editor and state your affiliation and specific involvement in the Space Telescope Project.

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Contents

How to contact us:

First, we recommend trying our Web site: `http://www.stsci.edu` You will find there further information on many of the topics mentioned in this issue.

Second, if you need assistance on any matter send e-mail to `help@stsci.edu` or call 800-544-8125. International callers may use 1-410-338-1082.

Third, the following address is for the HST Data Archive:
`archive@stsci.edu`

Fourth, if you are a current *HST* user you may wish to address questions to your Program Coordinator or Contact Scientist; their names are given in the letter of notification you received from the Director, or they may be found on the Presto Web page (`http://presto.stsci.edu/public/propinfo.html`)

Finally, you may wish to communicate with members of the Space Telescope Users Committee (STUC). They are:

Fred Walter (chair), SUNY Stony Brook, `fwalter@sbast1.ess.sunysb.edu`
John Bally, U. Colorado
John Clarke, U. Michigan
Alex Filippenko, U.C. Berkeley
Bob Fosbury, ESO
Marijn Franx, Kapteyn Astron. Inst.
Laura Kay, Barnard College
Regina Schulte-Ladbeck, U. Pittsburgh
Ted Snow, U. Colorado
Rodger Thompson, U. Arizona
John Trauger, JPL
Will van Breugel, Lawrence Livermore

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