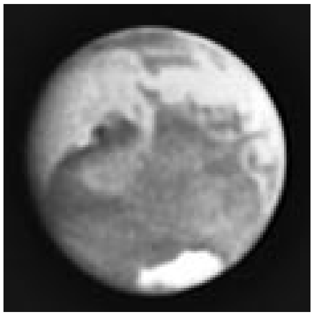
NOAO-NSO Newsletter

Issue 75

September 2003



Kitt Peak was featured on the NBC-TV "TODAY Show" national morning program on August 12, with Tucson amateur astronomer David Levy live inside the Kitt Peak Visitor Center Observatory describing how to see the planet Mars from your backyard.

Cloudy weather blocked a live feed of a Mars image from the observatory's 20-inch telescope just before show time, but a tape of the red planet from August 9 had been prepared in advance for such a situation, and the event was very successful. The image of Mars shown above was taken at the same telescope by Adam Block, lead observer for Kitt Peak public nighttime programs (who is shown in the photo below to the left of Levy. One of the satellite TV broadcast crew technicians is at right.)

Notable Quote

"Did you read the science headline in today's *New York Times?*
'Astronomers Report Evidence of "Dark Energy" Splitting the Universe'"

"My first question: Why is this on page A13 instead of the front page!?! Aren't you scared? I'm scared!"

—David Letterman, wondering aloud at the awesome implications of this New York Times story, on his late-night TV talk show, 24 July 2003

Credit: CBS

Have you seen an interesting comment in the news or heard one during a NOAO-related meeting or workshop? *Please share them with the Newsletter Editor (editor@noao.edu).*

On the Cover

This image of Jupiter was obtained as part of a systems check for the Gemini Near-Infrared Imager (NIRI) instrument.

The planet was imaged by NIRI at a wavelength of 1.69 microns, highlighting darker regions in the Jovian atmosphere that are rich in methane. The bright areas, particularly near the equator, are regions where high ammonia cirrus clouds block our view of the lower atmosphere.

The resolution in this image is 0.35 arcsec (without adaptive optics correction), showing the excellent image quality delivered by the Gemini North telescope and NIRI. Two of Jupiter's Galilean moons are visible: Europa is the bright "star" to the right of Jupiter, and Io is the bright spot projected against the equatorial cloud bands toward the right edge of the disk.

The image was also used for a contest in which a Canadian elementary school student selected Jupiter as a target for Gemini.

Image Credit: Gemini Observatory

The *NOAO-NSO Newsletter* is published quarterly by the **National Optical Astronomy Observatory**
P.O. Box 26732, Tucson, AZ 85726

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The NOAO Survey for Ionization in Neutral Gas Galaxies

Patricia Knezek (WIYN), Gerhardt Meurer (JHU) & the SINGG team

Cosmological evolution is mapped using tracers of star formation, yet the true amount and distribution of ongoing star formation in the local universe is still poorly determined. One reason is that most studies of star formation focus on samples that are biased toward galaxies with high star formation rates and/or high stellar content. Is our understanding of star formation in galaxies severely biased as a result?

To address this question, Gerhardt Meurer (Johns Hopkins University) and a team of 18 other astronomers are carrying out a NOAO survey program known as the Survey for Ionization in Neutral Gas Galaxies (SINGG). The goal of the survey is to provide a measure of the star formation rate (SFR) density of the local universe based on the potential for star formation (i.e., the presence of an interstellar medium), rather than on the ongoing star formation rate. Thus, the sample is drawn from the HI Parkes All Sky Survey (HIPASS).

Since the resulting sample is free from optical biases, the survey is well suited to addressing such questions as "If fuel for star formation is present, does star formation always occur? If it does, what form does it take?" Other goals for the survey include determining how the HII region luminosity function varies from galaxy to galaxy; examining the SFR distributions as a function of morphological type, galaxy mass, and environment; providing a morphological survey of star formation properties such as bursts and galactic winds; determining gas consumption timescales; and, ultimately, creating a reference Hα survey of the local universe for the astronomical community.

The sample consists of approximately 500 galaxies that evenly sample the HI mass distribution from $\sim 2\times10^7$ to 7×10^{10} M_{sun}. The lowest ($<10^8$ M_{sun}) and highest ($>3\times10^{10}$ M_{sun}) mass bins are volume limited. For all other bins, the closest galaxies have been selected to maximize the spatial resolution. The galaxies are imaged in *R* and *Hα*,

A montage of six representative galaxies from the SINGG sample. Shown is the continuum-subtracted Hα emission (seen largely as bright knots over the galaxy disks) superposed on the R-band image (the smooth, underlying component). Note the diversity of the amount and location of star formation.

continued

Ionization in Neutral Gas Galaxies continued

primarily with the CTIO 1.5-m telescope, using custom-built 35 Å FWHM filters, as well as standard NOAO 75 Å filters. Since the CTIO 1.5-m telescope is now dedicated to spectroscopy, the survey will be continued with the CTIO 0.9-m telescope.

Some interesting results have already emerged. One primary result is that nearly all the HIPASS targets have been detected, and there are no firm nondetections among the extragalactic HI sources. Apparently, wherever significant neutral gas exists, stars form. The optical morphology of the sample includes low surface brightness galaxies, giant spirals, mergers and interacting galaxies, starburst galaxies, and residual star formation in early disks. Many of the highest HI mass systems (>$10^{9.5}$ M_{sun}) turn out to contain multiple Hα emitting galaxies. Preliminary results suggest that starburst galaxies comprise approximately 15 percent of the sample, and that galactic winds are common.

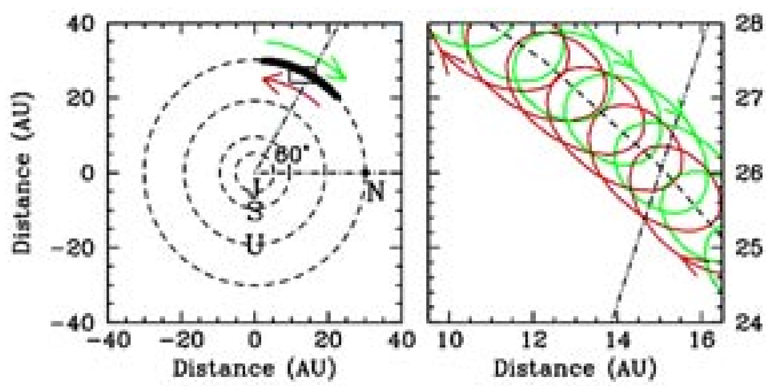
The survey has also detected a number of faint unresolved emission sources located as far as 30 kpc from the host galaxy. A recent follow-up study (Ryan-Weber et al. 2003, in preparation) on 13 of these "Emission Line dots," or ELdots, has confirmed that five of the ELdots are at velocities consistent with the host galaxies. The five ELdots are found in three systems, two of which have tidal HI features. The Hα luminosities are consistent with an ionizing flux of only a few O stars in each ELdot. If these stars formed in situ, they represent atypical star formation in the low density outer regions of galaxies. Although the calculated star formation rates are low (~3×10^{-3} M_{sun} /year), if it is continuous, this may provide a way to enrich the intergalactic medium. Further information on the survey, including publicly released data, is available at *www.stsci.edu/ftp/science/singg*.

Resonant Kuiper Belt Objects Discovered by the Deep Ecliptic Survey

Eugene Chiang, University of California at Berkeley

Since the discovery of minor planet (15760) 1992 QB_1 (in 1992 by David Jewitt and Jane Luu), we now know that the space just beyond Neptune's orbit is populated by tens of thousands of asteroid-sized bodies bound to the Sun. These Kuiper Belt Objects (KBOs) are survivors from the era of planet formation, during which the outer solar system was crowded with gravitationally interacting, physically colliding bodies interspersed among the nascent giant planets. From a dynamicist's point-of-view, KBOs furnish a remarkable ensemble of test particles whose orbits record the history of events during that formative time.

Discovering KBOs and accurately measuring their orbits is the ongoing mission of the Deep Ecliptic Survey (DES), a NOAO survey program that is being carried out using the Mosaic imagers on the Mayall and Blanco



Trajectory of 2001QR322, the first Neptunian Trojan discovered by the Deep Ecliptic Survey (Chiang et al. 2003), in a quasi-Neptune-centric frame. The left-hand panel displays a bird's-eye view of the outer solar system, with the giant planet orbits shown schematically. The dark tube of points lying on Neptune's orbit marks the computed path of the Trojan. The Trojan shuttles back and forth as indicated by the red and green arrows. Each shuttling, or libration, takes about 10^4 years to complete. The small inset rectangle is magnified in the right-hand panel to show the fast corkscrewlike (epicyclic) motion. Each corkscrew takes about one orbital period of Neptune, or about two hundred years, to complete.

continued

Resonant Kuiper Belt Objects continued

4-m telescopes. Begun in 1998 under the direction of Bob Millis of Lowell Observatory, the team now includes members from the Massachusetts Institute of Technology, the Institute for Astronomy in Hawaii, the University of Arizona, the University of Pennsylvania, and the University of California at Berkeley. DES has already discovered the most KBOs of any survey to date, but by the time the survey is complete (around 2005), it will have examined over 1,000 square degrees of sky near the ecliptic, down to *V*=24, and cataloged approximately 500 KBOs with precisely measured orbits.

DES has recently found that the Kuiper Belt is replete with "resonant KBOs" (objects whose orbital periods are nearly perfectly commensurate with that of Neptune). For example, "Plutinos" occupy the 3:2 resonance; they orbit the Sun three times, on average, for every two revolutions of Neptune. Resonances afford KBOs dynamical stability for reasons analogous to those that protect a pair of dancers from stepping on each other's toes. Plutinos were known to exist prior to 1998, but since then DES has reported that occupied resonances include the 5:4, 4:3, 5:3, 7:4, 9:5, 2:1, and 5:2 resonances. Rigorous testing for resonance membership is made possible using orbit fitting and integration software developed at the University of California at Berkeley and Lowell Observatory.

Resonant KBOs strongly support the notion that Neptune was once mobile, and that it was gently propelled to greater heliocentric distances by several AUs via the gravitational scattering planetesimals. As Neptune migrated outward, resonances swept across the primordial belt, capturing planetesimals. The preponderance of resonant KBOs is the most direct evidence we have that planetary migration (which is also invoked to explain the orbits of close-in extrasolar planets) is a real phenomenon.

In a related development, DES has also reported the discovery of the first Neptunian Trojan—an object that is in a 1:1 resonance with Neptune. The famous Jovian Trojans occupy two clusters that lie along Jupiter's orbit, displaced forward and backward of Jupiter's longitude by 60 degrees. Neptune was long thought to carry its own retinue of co-orbital Trojans. This belief was finally vindicated by the DES discovery of an object about 130–230 km in diameter that co-orbits with Neptune, remaining nearly 60 degrees ahead of it.

Extrapolations based on the amount of sky surveyed by DES to date indicate that Neptune's Trojans are likely to rival, and even exceed, Jupiter's set in both number and mass. Neptunian Trojans were likely captured as the host planet accreted the bulk of its mass. Their existence points to a relatively placid growth period for Neptune during which it was not scattered violently to and fro across the solar system, contrary to some recent speculations.

Signatures of Large-Scale Coronal Eruptive Activity, Associated Flares, and Propagating Chromospheric Disturbances

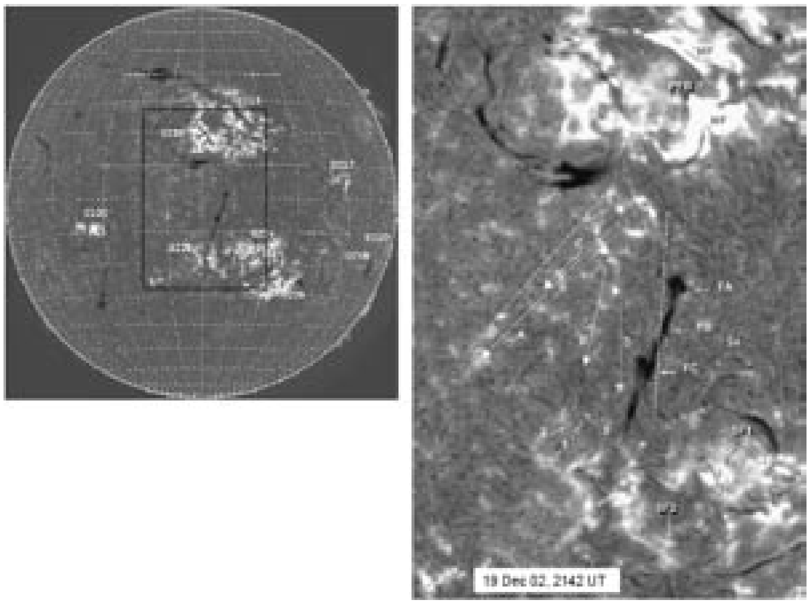
Donald F. Neidig (AFRL/VSBXS), K. S. Balasubramaniam, Alexei Pevtsov (NSO), Edward W. Cliver (AFRL/VSBXS), C. Alex Young (EER Systems, NASA/GSFC), Sara F. Martin (Helio Research) & Alan L. Kiplinger (University of Colorado)

Analyses of multiwavelength data sets obtained on 19 December 2002 at approximately 21:50 universal time show evidence of a large-scale, transequatorial coronal eruption associated with simultaneous flares in active regions in both hemispheres. The coronal manifestations, based on the SoHO Extreme ultraviolet Imaging Telescope (EIT), Large Angle and Spectrometric COronagraph experiment (LASCO), and Transition Region and Coronal Explorer (TRACE) images, include a large coronal dimming, an opening/restructuring of magnetic fields, the formation of a transient coronal hole, and a halo coronal mass ejection (CME). In the chromosphere, Improved Solar Observing Optical Network (ISOON) Hα images show distant flare precursor brightenings and several sympathetic flares.

Originating near the main flare is a rapidly propagating (800 km/s), narrowly channeled disturbance that is detectable through the sequential brightening of numerous preexisting points in the Hα chromospheric network. This disturbance is not a chromospheric Moreton wave, but it

continued

Coronal Eruptive Activity continued



Left: Limb darkening subtracted full-disk ISOON Hα image obtained on 19 December 2002. Right: A region of large-scale disturbance, across multiple active regions. PFB: Preflare brightening; arrows indicate the propagation direction of disturbances A, B, C, and D, with speeds of 800 km/s, as measured by sequentially brightened network points in a time sequence. These disturbances move the filaments at locations FA, FB, and FC, partially erupting the filament at FC. Sympathetic flares are seen in the southern hemisphere at SF1 and SF2. SoHO/MDI magnetograms show that the brightened network points are all of same polarity. The coronal manifestations of this large-scale event include transequatorial loops and coronal dimming, as observed by SoHO/EIT. These and similar events recorded by ISOON show that such large-scale coronal eruptive events trigger near-simultaneous surface activity separated by distances on the same scale as the coronal structures involved in the eruption.

does produce a temporary activation of a transequatorial filament. This filament does not erupt, nor do any of the other filaments in the vicinity. Michelson Doppler Imager (MDI) magnetograms show that the brightened network points are all of the same polarity (the dominant polarity among the points in the disturbance's path), suggesting that the affected field lines extend into the corona, where they are energized in sequence as the eruption tears away.

Three other similar eruptive events (nontransequatorial) that we studied, while less impressive, show most of the same phenomena, including distant sympathetic flares and a propagating disturbance showing close adherence to the monopolarity rule. Two of these events include filament eruptions near the main flare. We conclude that the observations of these four events are consistent with large-scale coronal eruptive activity that triggers nearly simultaneous surface activity of various forms separated by distances on the same scale as the coronal structures themselves. A filament eruption at the main flare site does not appear to be a necessity for this type of eruptive activity.

Design and Development of a Thirty-Meter Telescope

Jeremy Mould & Stephen Strom

AURA's New Initiatives Office (NIO) is proposing to carry out the design and development (D&D) phase of a project aimed at building and operating a Thirty-Meter Telescope (TMT). When complete, the TMT will be able to image and analyze galaxies at their birth, when the first stars formed in the Universe and started the processes that resulted in the world on which we live. A TMT will provide detailed views of stars and solar systems in the process of formation, and directly observe planets in orbits around other stars.

Our proposed program builds on the results of two thorough, independent feasibility studies: one undertaken by the University of California and Caltech, and the other by AURA's NIO. The proposed D&D phase will use the results of the two feasibility studies as the starting point to define the TMT system architecture. It will proceed to address key areas of technical, cost, and schedule risk to advance technologies crucial to enabling TMT and its instruments, and then to develop a Preliminary Design.

In accomplishing these D&D phase objectives, we propose to combine, in a public-private partnership, the talent and experience embodied in the institutions responsible for designing and building the four largest telescopes in the United States. We plan to do this by assembling an integrated, colocated project team to follow a design-to-life-cycle cost philosophy and management principles appropriate to a project of ultimate cost approaching $700 million.

In accomplishing these D&D phase objectives, we propose to combine, in a public-private partnership, the talent and experience embodied in the institutions responsible for designing and building the four largest telescopes in the United States.

Completing the D&D phase will require $70 million. The funds ($35 million) requested by AURA from the National Science Foundation (NSF) represent the public half of the total needed to complete the D&D phase. We propose to invest these federal dollars in multiple programs to advance key technologies—detectors, durable coatings, adaptive optics (AO) components, large format gratings—that are essential to meeting D&D objectives. These technologies will also be of significant benefit to existing large telescopes and to other ongoing programs exploring next-generation telescope concepts. We plan to engage the community broadly in the technology development program via solicitations open to all community groups.

NSF investment now will ensure: (1) a strong community voice in shaping the design and operating modes of this flagship facility, (2) public access to the TMT in proportion to invested funds, and (3) a facility that will be available to the US community early in the era of the James Webb Space Telescope (JWST). Additionally, since the TMT has the power to address questions that engage the imagination of the public as well as scientists, it offers a superb platform from which to stage and develop educational and public outreach activities.

The NIO's proposal takes a major step forward toward meeting the goal set by the Decadal Survey: to build a TMT that will be ready early in the JWST era, and to do so by combining federal and private resources. We see a historic opportunity to shape the direction of US astronomy in the 21st century by ensuring that the best minds in the community are engaged in developing the TMT design and making use of it a decade from now.

Technology Development: The Driving Force

Achieving the scientific goals of the TMT will require instruments of unprecedented power and sophistication, ranging from spectrographs that can observe thousands of galaxies or stars simultaneously to coronagraphs that enable characterization of extrasolar planets fainter than their parent stars by seven orders of magnitude or more. Exploring imaginative concepts matched to TMT science opportunities and advancing the most promising to conceptual designs are fundamental elements of the D&D phase.

It is essential that these activities proceed as an integral part of the design of the overall observatory system to enable telescope, AO, and instrument designs that result in optimal system performance. TMT instruments will be of a scale and complexity comparable to particle accelerator or spacecraft experiments, with estimated costs between $20 million and $50 million each, compared to the $5 million to $10 million instruments now populating the focal planes of Keck and Gemini.

The figure on page 9 shows the moderate- to high-resolution (MTHR) optical spectrograph envisioned by the California Extremely Large Telescope (CELT) team for possible future deployment on the TMT. The perspective is looking down the optical axis of the 30-meter primary mirror with the MTHR spectrograph mounted on the side at the telescope's Nasmyth

continued

Design and Development of a TMT continued

focus. To demonstrate the enormity of this instrument, the Gemini telescope is shown to scale; *the size of this one instrument is nearly the same as the entire Gemini telescope!* The MTHR camera mirrors, at a little under two meters in diameter, are larger than many telescope primaries used today, while the grating in this instrument would measure ~1.0×3.5 meters and actually consist of a mosaic of 40 of the largest individual gratings available today. Such a grating mosaic would dwarf any such system ever built.

Extremely Large Telescope (ELT)-class instruments thus represent a huge leap from instruments built to date. They will demand considerable investments in time and technology if they are to be realized. For Keck or Gemini, time from design concept to delivery on the telescope ranged from five to seven years. Given the even longer timescales anticipated for TMT instrumentation development—from the design phase through technology development to construction to commissioning—investment must begin quickly in order to have instruments in place at first light, a decade hence.

lower-cost components, while enabling the design of instrumentation for other ELT programs. As an example, the near-infrared detectors needed for an ELT imager must have per-pixel cost and system noise performance comparable to modern CCDs. Once developed, they can be mass-produced and used not only for the TMT, but also to populate very large focal planes for wide-field imagers on smaller telescopes with complementary science objectives.

Similarly, the proposed microelectromechanical systems (MEMS)-based deformable mirror technology development will have broad applications in other ELT and non-ELT astronomical instrumentation. Our proposed investment in MEMS as an integral part of the high-performance coronagraph will drive the unit cost below the estimated $1,500-per-actuator cost of conventional deformable mirrors, enabling not only high-performance AO on the TMT, but also the extension of high-Strehl imaging into the visible for existing telescopes (as one example).

INSTRUMENT	SCIENCE APPLICATION
MCAO NIR Imager	Stellar populations
NIR Deployable IFU Spectrometer	Assembling galaxies
NIR Coronagraph	Detecting planets
Near/Mid-IR Imager and Spectrometer	Planet-forming environments
Wide-Field GLAO Optical Spectrometer	Assembling galaxies
High-Resolution Optical Spectrograph	Stellar abundances
Multi-object Optical Spectrometer	IGM structure and composition

TMT instrument applications

In selecting the technology development for the D&D phase of the TMT, NIO (1) mapped science goals to instrumentation requirements; (2) identified key component or technology developments needed to achieve instrument goals; (3) identified targeted studies or prototype developments needed to inform design choices for candidate first-light instruments; and (4) contacted a wide range of private sector vendors and university research groups to illuminate the development programs needed and the associated costs for advancing key technologies, components, or design studies.

Investments of this kind are not only critical to timely completion of capable first-light instruments for the TMT, but will also enhance instruments on current-generation telescopes by providing access to higher-performance,

Among the technology development areas NIO will pursue during the coming four years are: Optical Detectors, Near-Infrared Detectors, Mid-Infrared Detectors, AO WaveFront Sensor Detectors, Fiber Systems, Silicon Grisms, Mosaic Gratings, VPH Gratings, Integral Field Units, Large-Format Cryogenic Filters, SolGel AR Coatings, Optical Nulling, and MEMS. These technologies will find multiple uses in a suite of TMT instruments (see table). More details about this technology development program will appear in subsequent issues of the *Newsletter*.

Site Testing: Another Critical Path Item
NIO is undertaking a comprehensive site evaluation program aimed at exploring a wide range of potential sites

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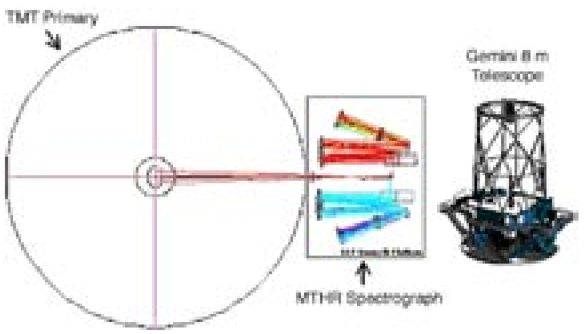
Design and Development of a TMT continued



An example of a possible ELT-class instrument. The MTHR spectrograph would provide a high-resolution optical spectroscopy capability from the Nasmyth platform, together with a massively multiplexed medium-resolution facility. For scale, the Gemini 8-meter telescope is shown next to the MTHR spectrograph.

for the TMT, from Hawaii to the southwest United States/Mexico to northern Chile, and from altitudes ranging from 2,000 to 5,500 meters. The data set from this program will not only provide the basis for selecting an optimal site for the TMT, but will also provide information critical to other groups currently evaluating potential sites for next-generation telescopes. This proposed program builds on extensive investments made over the past two years by AURA–NIO and the CELT partners in service of ensuring that site selection be made no later than fall 2007.

Over the past two years, CELT and the NIO have developed procedures, and where necessary, procured instrumentation, to allow evaluation of these sites. Final selection and weighting of the criteria for site selection and the final choice of candidate sites will be established formally at a Site Testing Methodology Review. The main site selection activities are proceeding in the following order:

- Compilation and analysis of existing databases, both global and site-specific
- Remote sensing evaluations; derived statistics for prospective sites
- Wind flow and boundary-layer turbulence studies for prospective sites by means of computational fluid dynamics (CFD)
- Procuring, setup, and commissioning of site testing equipment at prospective sites; this includes meteorological stations, differential image motion monitors, and atmospheric turbulence profile monitors
- Recording meteorological and seeing data for extended periods at multiple sites
- Data reduction and evaluation leading to selection of a site for the TMT

Throughout this process, archival results and new conclusions will be stored in a form that allows objective evaluation and subsequent decision making, facilitating use for ELT projects other than the TMT.

The following sites are being evaluated, in a campaign that will continue for approximately three years:

- Mauna Kea (two locations)
- Three undeveloped sites in northern Chile, including a high-altitude site in the Chajnantor region
- San Pedro Martir
- Las Campanas

Uniform data (meteorological, seeing, and atmospheric turbulence) are being gathered and analyzed for all of these sites, so that a data set will be in place to guide an informed choice that takes into account astronomical, engineering, and cost data. These data will be ingested into the established site database and made available publicly to benefit all prospective ELT programs.

Frontier Science Enabled by a Giant Segmented Mirror Telescope

Jeremy Mould

"Frontier Science" is the title of the first report of the Giant Segmented Mirror Telescope (GSMT) Science Working Group (SWG). Chair Rolf Kudritzki and Vice-Chair Steve Strom issued the report on June 30 after the SWG's first year of study of the Decadal Survey's GSMT.

The evolution of the Universe from the dawn of known physics to the formation of atoms has been made plain by the Wilkinson Microwave Anisotropy Probe (WMAP) spacecraft mission. The GSMT will pick up the story from the formation of the first structural seeds manifest in the gas at the most distant observable reaches of the Universe. It will follow it through the appearance of the first stars and pregalactic forms, through 13 billion years of sometimes violent evolution of these galaxy building blocks, to the grand elliptical and spiral galaxies that populate the nearby

continued

Frontier Science continued

universe, like our Milky Way. The GSMT will reveal the process of the birth of planetary systems surrounding newborn stars, and their evolution to mature planets orbiting around neighboring suns.

In the words of 2002 physics Nobel Prize winner Riccardo Giacconi, 21st century astronomy is uniquely positioned to study "the evolution of the Universe in order to relate causally the physical conditions during the Big Bang to the development of RNA and DNA." This is the opportunity that now presents itself to astronomy with a new ground-based telescope of unprecedented power: the GSMT.

The SWG finds that GSMT will, for the first time, permit direct observations of hundreds of extrasolar giant planets; the disks from which planetary systems take form; the building blocks of galaxies and the process of galaxy assembly; the earliest evolution of chemical elements heavier than helium; and, the emergence of large-scale structure as mapped by galaxies and intergalactic gas during the first billion years following the Big Bang. The SWG further reports that

- This telescope will have the light gathering power and angular resolution to open up discovery spaces that virtually assure the uncovering of unanticipated phenomena,
- From extensive analysis carried out by several groups, a 20-meter to 30-meter telescope can be built for a cost within the envelope estimated by the most recent National Academy of Sciences Decadal Survey (*Astronomy and Astrophysics in the New Millennium*), i.e., approximately $700 million,
- While there are significant technical challenges to building telescopes of this size, there appear to be no show-stoppers,
- In order to reap the enormous potential synergy between the James Webb Space Telescope (JWST) and a 20-meter to 30-meter telescope, it is essential to initiate major design and technology development efforts immediately,
- Private consortia are open to public-private partnerships to design, build, and operate a next-generation telescope,
- Federal investment now in a major technology development program targeted at key areas can advance multiple design programs, and ensure a strong public voice at all stages in developing next-generation telescopes.

At the conclusion of this powerful report, the SWG urges the NSF to seize the moment and provide funding for advancing key technologies, noting that the US community appears poised to embrace a new paradigm: public-private partnerships to advance flagship research facilities.

The members of the GSMT SWG are Betsy Gillespie and Jill Bechtold, University of Arizona; Michael Bolte, University of California at Santa Cruz; Ray Carlberg, University of Toronto; Matthew Colless, Australian National University; Irene Cruz-Gonzalez, UNAM Instituto de Astronomia; Alan Dressler, Observatories of the Carnegie Institution of Washington; Terry Herter, Cornell University; Paul Ho, Center for Astrophysics and ASIAA; Rolf-Peter Kudritzki (Chair), Institute for Astronomy, University of Hawaii; Jonathan Lunine, University of Arizona Lunar and Planetary Lab; Claire Max, Lawrence Livermore National Laboratory and University of California at Santa Cruz; Christopher McKee, University of California at Berkeley; Francois Rigaut and Doug Simons, Gemini Observatory; Chuck Steidel, California Institute of Technology; and, Steve Strom (Vice-Chair), NOAO. Scientific support at NOAO was provided by Sam Barden, Robert Blum, Arjun Dey, Joan Najita, Knut Olsen, Stephen Ridgway, and Larry Stepp.

AURA Signs Letter of Intent with CELT Development Corporation

On June 11, AURA and the California Extremely Large Telescope (CELT) Development Corporation signed a Letter of Intent representing a first step toward a public-private partnership for the design and development of a Thirty-Meter Telescope. The CELT Board of Directors and the Association of Universities for Research in Astronomy (AURA) are working together to merge the CELT project with the US national effort in large telescope design and construction. The intent is to form the first public-private partnership for a giant telescope for the US astronomical community. Matching proposals for a joint four-year development program have been submitted to private and federal funding agencies.

AURA's New Initiatives Office (NIO)—a partnership of NOAO and Gemini—prepared the proposal for the NSF. NIO's approach emphasizes the technology development that is on the critical path for GSMT, as described in greater detail in the previous article of this *Newsletter.*

On its Web page (*www.aura-astronomy.org/nv/nuresult.asp?nuid=67*) AURA describes the status and prospects of their involvement, answers some questions, and provides a forum to receive your comments and input.

This is a milestone in implementation of the Decadal Survey, and builds on two feasibility studies, one by the CELT partners, and the other by NIO. The CELT study was initiated in the fall of 2000, and the GSMT program was formally started in January 2001. Although the two teams shared information through their public Web sites and occasional meetings, their studies were conducted independently. Each

continued

Frontier Science continued

study represents two years of effort at a cost of $2 million. The CELT effort resulted in the production of a two-volume *Greenbook* (see *celt.ucolick.org*) in May 2002 describing their technical studies and telescope point design. The NIO effort resulted in the production of the Web-based *GSMT Book,* released in March 2002 and updated in November 2002 (see *www.aura-nio.noao.edu*).

Together, the CELT and AURA NIO point design efforts involved scientists, engineers, and program managers responsible for designing and building four of the world's largest telescopes and their instrument complements: the pair of 10-meter Keck telescopes and the 8-meter Gemini twins. The teams also include significant expertise in astronomical adaptive optics, ranging from the practical experience with operating systems at Keck and Gemini to the modeling expertise at Gemini and the Center for Adaptive Optics (CfAO).

The goals of the next merged phase—the design and development (D&D) phase—are to advance a 30-meter telescope design to the Preliminary Design Review stage, and to develop key technologies that would be on the critical path if a prompt decision were made to proceed to construct a telescope of such capability. We look forward to reporting progress to the community as the fund-raising proceeds and the D&D phase goes forward.

Women in Astronomy II—Thoughts for NOAO and NSO

Richard Green, Pat Eliason, Patricia Knezek, & Nicole van der Bliek

Caltech hosted a meeting on June 27–28 to address the status of women in astronomy 10 years after the meeting that led to the Baltimore Charter. Speakers from a variety of disciplines examined employment statistics, as well as studies from behavioral psychology and sociology. Breakout groups facilitated further discussions leading to community-based action. A summary and posting of contributions can be found at the Web site for the Committee on the Status of Women, linked from the AAS home page.

This article contains our personal reflections on ways that we can interpret and apply the perspectives from the Women in Astronomy II meeting to the scientific and professional culture at NOAO and NSO. We recognize that any changes can have a broad impact in at least two ways. First, NOAO and NSO share resources, including space and personnel, both internally and with other affiliated institutions like Gemini, SOAR, and the WIYN Observatory. Second, NOAO and NSO maintain a high visibility within the international astronomical community. We acknowledge that some issues discussed at the Pasadena meeting are broader than one institution's policy and practice; we highlight our awareness of them as well, even if we cannot offer immediate ways of addressing them.

Diversity

NOAO and NSO must reaffirm our endorsement of the value of a diverse scientific and technical workforce. Our mission specifically includes leadership for partnering in the development of major national projects, implementation of new technologies in major instruments and software programs, and provision of state-of-the-art observing facilities. *All* of these activities are team-oriented, a major sociological change in astronomical activities. That change emphasizes the value of multiple perspectives, the need for productive cooperation, the ability to build and maintain a cohesive team, and effective interaction with a broad segment of the astronomical community. Gender diversity within the staff is expected to contribute to enhancing those values. As an example, behavioral psychology studies indicate that female scientists are more likely to seek to build consensus and to create "win-win" situations.

The National Science Foundation (NSF) has recently emphasized its second criterion for evaluation: broader impact. Assuming that the distributions of innate ability are similar among gender- or ethnic-based crosscuts of our country's population, scientific research should be attracting the best and the brightest as a uniform fraction by gender and underrepresented minority. The way to accomplish that utopian goal in fact is to work toward a research community that "looks like" America.

In the meanwhile, NOAO will continue to pursue affirmative action and equal employment opportunity for scientific staff in the sense that it is understood by the federal compliance officers: aggressively recruit to assure that every "short list" is populated with the same fraction of qualified underrepresented applicants as the pool of those eligible to apply; assert standards of performance excellence in research and service (without subtle bias, as discussed below); and choose the clearly superior candidate. Only in less clear-cut cases may the longer-term question of staff balance appropriately enter into making the actual decision.

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Women in Astronomy continued

Further thoughts on attracting and maintaining a more diverse scientific workforce are presented below.

Snapshot of NOAO and NSO Scientific Staff
Van der Bliek et al. presented a poster at the meeting that analyzed three snapshots of the entire scientific staff from statistics provided by Sandra Abbey and the Human Resources staff. The raw numbers of female scientists, irrespective of tenure-line status or source of funding, employed by and through NOAO and NSO are:

	NOAO	
1993	3 out of 52	(6%)
1998	6 out of 58	(10%)
2003	5 out of 49	(10%)

	NSO	
1993	0 out of 17	(0%)
1998	1 out of 19	(5%)
2003	5 out of 20	(20%)

On those three snapshot days (June 1 of the given year), there were at most three senior female scientists (Astronomer with tenure, Scientist or Senior Scientist), out of approximately 26 total in NOAO; currently there is one. In NSO, there were no senior female scientists out of an average of eight. The fraction of female postdocs is similarly limited:

	NOAO	
1993	1 out of 10	(10%)
1998	2 out of 12	(17%)
2003	0 out of 7	(0%)

	NSO	
1993	0 out of 3	(0%)
1998	0 out of 0	(N/A)
2003	0 out of 1	(0%)

The bottom line is that the fraction of female scientists at NOAO has been approximately constant at 10 percent over the last 10 years. American Institute of Physics (AIP) statistics presented at the meeting show that the fraction of female astronomy faculty is 14 percent averaged over 38 departments.

Two conclusions are apparent: a serious effort at the recruitment of female applicants, resulting in representation on nearly every short list, has not increased the fraction of female scientists in NOAO; the organization would need additional women on its scientific staff to be consistent with the national average. NSO does show a significant increase in the fraction of female scientists at the junior level in the most recent snapshot.

Climate
In the autumn of 2002, AURA asked all the female scientific staff at NOAO to fill out a questionnaire on gender issues. A small group of male staff ("matched" in number, location, job title and length of service) served as a control sample. Most responses were indistinguishable by gender: concerns were expressed about service overload, inadequate time for research, and potential inability to attract top candidates without improvement in those issues. Both groups felt they were treated fairly with respect to colleagues. The women were more concerned about the level of diversity of the NOAO scientific workforce and about the need for more infrastructure for family support.

An interpretation of the survey on attitudes combined with the employment statistics is that there are no red flags in terms of working environment, but we should continue to be attentive to developing and maintaining a climate that fosters the perception and reality of equal opportunity for success and advancement. The Women in Astronomy II meeting tangentially addressed the question of what constitutes a favorable working environment for women. Presenters did paint a picture of favorable interactions, particularly in group settings: a respectful hearing of ideas, drawing out contributions from less assertive participants, and maintaining a noncombative style of discussion and resolution. The overall benefit of a favorable climate is making that aspect of the organization a positive when candidates consider job offers, and in subsequent retention of female scientific and technical staff.

Gender Bias
A number of speakers with behavioral and social science expertise illustrated graphically that all of us have built-in preconceptions related to gender, no matter how objective we think we are. Experiments with samples of undergraduates and faculty illustrated that men are perceived to be taller, more leaderlike, more effective presenters, and more skilled researchers. The responses to images, recordings, and documents had distributions favoring males, and they were indistinguishable by gender, i.e., both men and women favored men. Another study sent identical job applications to hiring committees under the name Joe or Jane Smith. The committees judged the application more favorably when the applicant was perceived to be male. The speakers left the strong impression that carefully executed experiments demonstrate conclusively that we are subject to strong gender bias in our judgments.

How should we conduct employment actions such as hiring and promotion in a way that explicitly recognizes these biases and approaches more closely true fairness in evaluating individual accomplishment? An important aspect of the behavioral psychology characterization can be taken explicitly into account: men tend to be more self-promoting and women more self-critical. In that case, going back to basics in evaluation makes sense. Committees must read the primary

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Women in Astronomy continued

scholarship and impose their own sense of its worth relative to hiring and promotion decisions. We can explicitly recognize that "impact" in terms of invited talks and wide dissemination of results through personal contacts is both personality dependent and gender-linked. In a service-oriented institution such as ours, we should also be cognizant of the qualifications we want for our staff with respect to their likely service role, and weigh those qualifications accordingly. Without sacrificing quality, we can be conscious of the preconceptions we bring to the table and work to distinguish accomplishment from style.

By extension, we can also consider these differences in behavior in advertising for open positions. The cartoon sketch of gender-based reaction is that women would be less likely to apply for a position with a list of very specific qualifications if they felt they lacked key credentials, whereas men would be less reticent. Attracting the best female applicants in the pool for a given year may require listing a more general set of qualifications for the service component, and continuing our practice of actively recruiting female candidates that we think have the necessary qualifications.

An interpretation of the survey on attitudes combined with the employment statistics is that there are no red flags in terms of working environment, but we should continue to be attentive to developing and maintaining a climate that fosters the perception and reality of equal opportunity for success and advancement.

A Fundamental Issue

A recurrent theme of the meeting was the conflict between the apparent, although ill-defined, demand for all-out effort to achieve professional success versus the desire to start and maintain a healthy family life or in general to achieve a balance between work and nonwork activities. It was noted that this conflict exists across the community, although family responsibilities tend to fall more heavily on females. The standard of competitiveness and achievement in today's research community mitigates against "having it all." An institution like NOAO will be judged externally by its effectiveness in promoting community development priorities, by the competitiveness of the observing opportunities it offers, and by the research output and quality of its scientific staff. It would take a major infusion of resources on a national scale to enable lower expectations for individual productivity while maintaining the same level of institutional accomplishment. Our budget history suggests that such a direction is unlikely.

Internal best effort is likely to be more focused on mentoring and setting clear expectations, especially for the more junior scientific staff. A standard of competitive excellence must be met, but in order to accommodate obligations to young families, it may not need to be exceeded, particularly if it is clearly defined. Mentoring can aid in focusing energy toward effective service and research productivity in a way that benefits both the scientist and the organization.

Afterword

For NOAO and NSO, we can claim that the Women in Astronomy II meeting promoted two outcomes. It reinvigorated the discussion about the career paths of female scientists within our organization and the discipline as a whole. It also served to raise our consciousness about attitudes and approaches to hiring and evaluation. Our success may be measured by our ability to maintain "quality without compromise" (as the seal on one food product declares proudly), while feeling that we as staff members are judged fairly on the basis of ability and accomplishment.

Guest Column

Finding Our Place in the Cosmos

Astronomy doesn't produce technological spin-offs; in fact, we are massive consumers of technology. Astronomy doesn't contribute to the defense of the Nation; though, to borrow the late Robert R. Wilson's words to Congress about Fermilab, it is an activity that makes the Nation worth defending. Astronomy doesn't contribute to the economic output of the Nation; in fact, it is a relatively expensive activity.

So what's the point of astronomy? The two biggest questions that humankind can ask—"How did we get here?" and "Where are we going?"—are within its province. Our place in the Cosmos—and the light that astronomy can shed on it—sparks the imagination of everyone, from school child to politician, from biologist to high-energy physicist, from philosopher to film maker.

Over the past two decades we have learned much about our vast and complex Universe. The opportunities at hand for further progress are stunning, and I believe, unprecedented. We are poised to make major advances in our understanding of how the Universe began, of how the chemical elements, galaxies, stars, and planets formed, and even of our cosmic destiny.

I think it is a safe bet to predict that one way or another, we will find evidence for life beyond our planet within the next 30 years.

We can trace the history of the Universe back to within a few microseconds of the Big Bang, a time when it was just a hot quark soup. We have a full accounting of the constituents of the Universe today—4 percent baryons (only 0.5 percent in stars!), 26 percent exotic dark matter (with 0.1 percent to 5 percent in neutrinos), and 70 percent mysterious dark energy. We also know that the Universe is spatially flat (uncurved) and that the expansion is speeding up, rather than slowing down. We are beginning to amass evidence that the Universe went through an earlier period of cosmic speed up, called inflation.

The questions ripe for answering include, "What is the dark matter?" "What is the nature of the mysterious dark energy?" and "Did the largest structures in the Universe began as quantum fuzz, as predicted by inflation?" Even the question of how the Universe came to be is coming within the realm of science.

Because the early Universe takes us back to a time when particle energies were far greater than those available today at the most powerful accelerators, and because the most basic features of the Universe we observe today—its composition, spatial curvature, and the structures that exist—were shaped by its earliest evolution, astronomical observations provide a unique window to study the very nature of matter, energy, space, and time.

The Hubble Deep Field took us back to the time when galaxies like ours were forming, and Keck and other ground-based telescopes have begun to reconstruct the history of galaxy formation. The Sloan Digital Sky Survey has discovered the most distant quasars, and the Chandra X-ray Observatory has imaged their central black hole engines in X-rays. Rapidly improving infrared capabilities, on the ground and in space, are revealing the birth of the first galaxies, and the WMAP satellite found the footprint of the first generation of stars in their ionization of the intergalactic medium. The distribution of dark matter in galaxies, cluster, and on even larger scales is now routinely imaged by measuring how it distorts the images of distant galaxies, and the same technique will be used to study the effect of dark energy on the expansion rate of the Universe.

With the ambitious projects astronomers have in mind—from the James Webb Space Telescope to the Giant Segmented Mirror Telescope—it is likely that within the next decade we will begin studying in detail the formation of the first stars and galaxies.

It is hard to match the excitement of cosmology, but in the past ten years planetary science has come close (okay, maybe even matched or exceeded it). With extrasolar planets now outnumbering planets in our own solar system by 10 to 1, we can starting addressing the big questions: "Where is our nearest neighbor?" and "How common are planetary systems that can support life?" The study of extrasolar planets thus far has brought more surprises than answers, along with many new questions. It has also created new opportunities for exciting interdisciplinary work with biologists. I think it is a safe bet to predict that one way or another, we will find evidence for life beyond our planet within the next 30 years.

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Finding Our Place in the Cosmos continued

These great opportunities for discovery are laid out in two recent National Academy studies: the McKee-Taylor Decadal Survey and the Quarks to Cosmos study that I chaired. The reports discussed the tools necessary to realize the science. These include a wide-field space telescope (SNAP), a giant (30 meters or larger) ground-based telescope (GSMT), a space-based gravity wave detector (LISA), a large-aperture, wide-field ground-based telescope for weak lensing studies (LSST), and new cosmic microwave background experiments optimized for studying polarization.

While identifying opportunities and prioritizing projects is a familiar decadal exercise in astronomy, both reports had something new and very important to say: *To realize the grand opportunities before us and to achieve our ambitious goals, we will need to change our culture and the way we operate, going beyond our traditional habits.*

More than ever before, ground- and space-based astronomy must be coordinated. Astronomical research is now supported significantly by three federal agencies—DOE, NASA, and NSF—and cross-agency cooperation and coordination is essential. Likewise, astronomy is supported by both public and private funds, and the two sectors must work as partners rather than as adversaries. Projects in astronomy are becoming larger, and international partnering, cooperation, and coordination will not only become more common, but will be more necessary.

The working style in astronomy must evolve. Targeted "astronomy experiments" (like the Sloan Digital Sky Survey and the MACHO project) will become more commonplace. The line between physics and astronomy has become thinner and fuzzier, and astronomers and physicists will need to work together. Astronomers will also have to use all the windows on the Universe available, including gravitational waves and particle accelerators. The virtual observatory of archived observations and its data mining will rival fresh observations in their power to probe the Universe and answer deep questions. Some existing facilities will have to be closed to make room for new facilities. As our discoveries go beyond what can be shown in a beautiful optical image that speaks for itself, we will have to work harder to convey the meaning and excitement of these discoveries to the public.

Astronomy is changing, but its fundamental attraction has not. It still has a unique power to engage the public and inspire the next generation of scientists and engineers, and not just astronomers. More than any other science, astronomy is an ongoing adventure to understand our place in the cosmos, one in which both scientists and the public alike can share in the excitement.

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(Starting October 1, Michael Turner will serve for two years as the Assistant Director for Mathematical and Physical Sciences at the National Science Foundation)

Announcement of Opportunity
Blanco Instrumentation

In the near future, NOAO plans to make an Announcement of Opportunity to solicit proposals for building a new instrument for the Blanco 4-meter Telescope. The contribution of the external institution or consortium would be rewarded with substantial guaranteed observing time (up to about 30 percent per year). We are anticipating that this new instrument would be ready for installation in the 2007–2008 time frame. The Announcement will be made on the NOAO (*www.noao.edu*) and CTIO (*www.ctio.noao.edu*) Web pages.

Gemini Observing Opportunities for Semester 2004A

Taft Armandroff

The NOAO Gemini Science Center (NGSC) invites and encourages the US community to submit proposals for Gemini observing opportunities during semester 2004A. Gemini observing proposals are submitted and evaluated via the standard NOAO proposal form and Telescope Allocation Committee (TAC) process. Although the Gemini Call for Proposals for 2004A will not be released until September 1 for the US proposal deadline of September 30, the following are our expectations of what will be offered in semester 2004A. Please watch the NGSC Web page (*www.noao.edu/usgp*) for the Call for Proposals for Gemini observing; this will unambiguously establish the capabilities that one can request. Several important new instrumental capabilities are expected to be offered in semester 2004A, as described below.

Gemini North

- The GMOS-North optical multi-object spectrograph and imager will be offered in 2004A. Multi-object spectroscopy (optionally with nod-and-shuffle mode), long-slit spectroscopy, integral-field unit (IFU) spectroscopy, and imaging modes will be available.
- The NIRI infrared imager/spectrometer will be offered in 2004A. Both imaging mode and grism spectroscopy mode will be available.
- GMOS-North and NIRI will be offered in both Queue and Classical modes. It is expected that Classical will only be offered to programs lasting three nights or longer (see the 2004A Call for Proposals).
- Michelle is a mid-infrared (8–25 micron) imager and spectrograph for shared use between Gemini and the United Kingdom Infra-Red Telescope (UKIRT). Observing modes include direct imaging and long-slit spectroscopy with spectral resolutions of approximately 200, 1000, and 30,000. Michelle was delivered to Gemini Observatory in late 2002. A period of characterization and commissioning of Michelle is presently underway, after which Michelle is expected to be available for scientific use. As of late July, we believe that the imaging mode of Michelle, and possibly the low-resolution spectroscopy modes, will be included in the 2004A Gemini Call for Proposals.
- The Altair adaptive optics (AO) system is undergoing commissioning in its natural guide-star mode. During 2004A, it is expected that Altair will be offered for scientific observations. As of late July, the AO-enhanced infrared imaging mode of Altair using NIRI is expected to be offered in 2004A.

Gemini South

- The Phoenix infrared high-resolution spectrograph will be offered in 2004A.
- The GMOS-South optical multi-object spectrograph and imager will be offered during 2004A. GMOS-South Commissioning and System Verification have been proceeding successfully during semester 2003A. The imaging, long-slit spectroscopy, multi-object spectroscopy, and nod-and-shuffle modes of GMOS-South are expected to be offered in 2004A. GMOS-South will be offered in both Queue and Classical modes. It is expected that Classical will only be offered to programs running three nights or longer (see the 2004A Call for Proposals).
- The T-ReCS mid-infrared imager and spectrometer will be available in semester 2004A. In April 2003, the University of Florida delivered T-ReCS to Gemini South, and first light was achieved on June 2. The imaging mode will definitely be offered in 2004A; please check the Gemini Call for Proposals regarding the availability of T-ReCS spectroscopic modes in 2004A.
- The Acquisition Camera will be available for Quick Response in 2004A.

Detailed information on all of the above instrumental capabilities is available at: *www.us-gemini.noao.edu/sciops/instruments/instrumentIndex.html.*

The percentage of time devoted to observations for science programs is planned to be 70 percent for semester 2004A, both at Gemini North and South. This percentage is up from the 55 percent (Gemini North) and 60 percent (Gemini South) planned for 2003B.

We remind the community that US Gemini proposals can be submitted jointly with collaborators in another Gemini partner; a collaboration simply submits proposals in each relevant partner country, explicitly noting how much time is requested from each Gemini partner. Such multipartner proposals are encouraged because they access a larger fraction of the available Gemini time, thus encouraging larger programs that are likely to have substantial scientific impact. In order to facilitate multipartner proposals, the United States accepts Gemini proposals both with the standard NOAO proposal form and with the Gemini Phase I Tool (PIT).

T-ReCS at Gemini South: First Light and Beyond

Charles M. Telesco, University of Florida

To an astronomy instrument builder, there are few things more exciting than the arrival of the completed instrument at the observatory, and the sight of it attached to the telescope and ready for observations. That excitement is exceeded only by the thrill of seeing the first on-sky images on the acquisition monitor. Starting in April 2003, the University of Florida's Thermal Region Camera and Spectrograph (T-ReCS) development team, working closely with the Gemini Observatory staff, experienced a crescendo of activity and excitement that culminated in our acquiring the first on-telescope/on-sky images and performance numbers. I would like to share briefly my view of some of the early commissioning activities and progress as we approach full science operations.

After extensive acceptance testing at the University of Florida in November 2002 and February 2003, T-ReCS was shipped to Cerro Pachón in April 2003. Lab testing at Gemini South during May then verified pre-ship performance. Finally, at 9:00 P.M. on June 2, T-ReCS made 8.8-micron images of the star γ Cru, thus achieving first light. Although the seeing was unsteady that night (typically about 0.7 arcsec), we could often see diffraction rings in the stellar images. Since then, we have continued to characterize T-ReCS on the telescope and worked to integrate it into the full observatory control system. Since T-ReCS is the first facility instrument to use the full-up chopping secondary-mirror system at Gemini South (our instrument OSCIR was used as a test bed to support Gemini's initial use and shakedown of the chopper in both the north and south), special care must also be taken to implement and test in final form all telescope-system observational modes needed by T-ReCS. I'm pleased to note that this arduous process, which requires close and continuous cooperation between T-ReCS and Gemini personnel, is moving ahead well.

T-ReCS is first and foremost an imager. It uses the Raytheon 320×240-pixel arsenic-doped silicon blocked-impurity-band detector, with peak sensitivity in the 8- to 25-micron wavelength range. With 0.089-arcsec pixels, the point-spread function at 8 microns is Nyquist sampled, and the array field of view is 21×28 arcsec. All lab and telescope tests demonstrate that the T-ReCS image quality is excellent, and meets all requirements for low-distortion and diffraction-limited performance.

The first nonstellar image obtained with T-ReCS was that of Mars in early June at 12.8 microns, which was shown on the Gemini Web page (see also *www.astro.ufl.edu*).

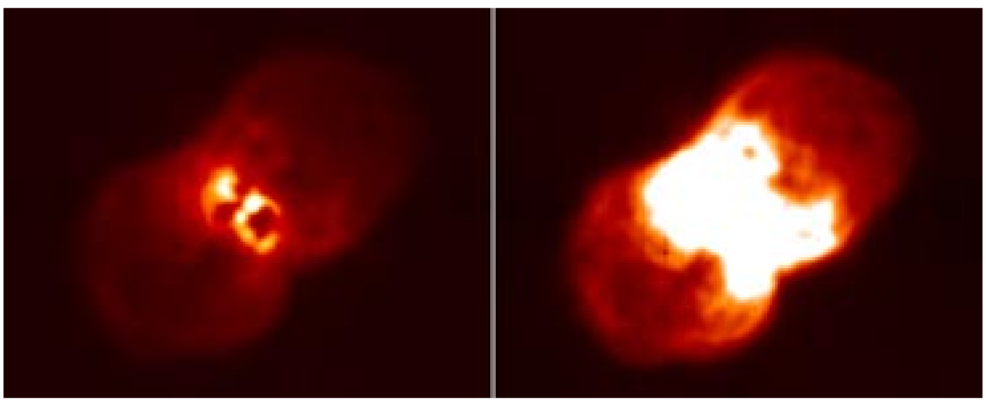

Figure 1. *A raw image of η Carinae obtained with T-ReCS at 12.8 microns. The image was obtained with the Gemini secondary mirror chopping, but without the telescope nodding. The image is displayed linearly at two different stretches and is clipped to eliminate structure below that shown in the source. The left-hand display emphasizes the bright inner structure, whereas the right-hand display shows the outer structure that is nearly three orders of magnitude fainter than the core region.*

A wealth of detail is apparent in the processed image, with a clear correspondence of features, such as Olympus Mons, evident between the T-ReCS infrared image and visible ones made by the Mars Global Surveyor. More recently, on July 13, we obtained the 12.8-micron image of the very bright infrared source η Carinae (see figure 1). The image, obtained while chopping the secondary mirror but not nodding the telescope, is displayed with linearly scaled brightness levels at two different stretches. The left-hand image emphasizes the core structure, while the right-hand image emphasizes outer dust emission that is nearly a thousand times fainter than the core emission. Except for clipping of the faintest structure, the image is essentially raw, and some artifacts are apparent.

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T-ReCS at Gemini South continued

Complex, state-of-the-art detector devices invariably have peculiarities, and the T-ReCS detector is no exception. We and other groups who have tested and/or are using this same device see a variety of artifacts, and several techniques have been developed to eliminate or minimize them. (We are grateful to Ulli Kaeufl of ESO, the Subaru COMICS team, and the Michelle team at ROE-ATC for sharing their results and ideas with us.) Some severe field structure is eliminated by referencing the integration ramp voltage to several other on-chip voltages ("correlated sampling"). The disadvantage of using this so-called four-point sampling mode, however, is that it increases the minimum on-chip integration time to roughly 25 milliseconds, whereas with nonreferenced (single) frames, the chip and electronics permit on-chip integration times as short as about 6 milliseconds. Usually, one will use the four-point sampling mode, but under some conditions it may prove useful to observe with the single-read mode. As part of the full commissioning, we are mapping out the complicated phase space of integration times, chop frequencies, and other system parameters that permit optimum operation of T-ReCS under the range of observational conditions encountered at Gemini South.

Another artifact seen by us and others is a line of dark, regularly spaced spots that radiate out from a bright source along one axis of the array. The brightness of these "cross-talk" spots is typically 0.1 to 0.4 percent of the primary source brightness. We believe that, for those observations where it matters, it may be possible to effectively eliminate these spots by appropriately processing the images, an approach that we are beginning to explore at the University of Florida. Finally, we note that the detector device has a somewhat elevated intrinsic noise, which we are still in the process of characterizing and minimizing. Even with this excess detector noise, we are finding that, based on limited initial on-sky tests, the system photometric sensitivity in the imaging mode is within a factor of two of the target sensitivity.

T-ReCS is also a low-resolution grating spectrograph, providing roughly R=100 in the 10- and 20-micron atmospheric windows and R=1000 in the 10-micron window. At the time of this writing we are just beginning to characterize the spectrographic mode on the telescope. Our initial observations have not revealed any surprises, but much work remains before the system is fully characterized on the sky. Among the many issues that we must still address is the accuracy of the flat fielding using real, on-sky observations in this mode. T-ReCS has been designed with an external (ambient temperature) wheel containing a black surface to be used as a reference surface for both imaging and spectroscopic modes, which our experience with OSCIR suggests should make flat-fielding straightforward. A cold internal polystyrene sheet, which has a highly structured absorption spectrum in the mid-infrared, can be inserted into the beam to assist in wavelength calibration. Basic characterization of the spectroscopic mode will continue throughout semester 2003B, even while full science operation progresses using the imaging mode.

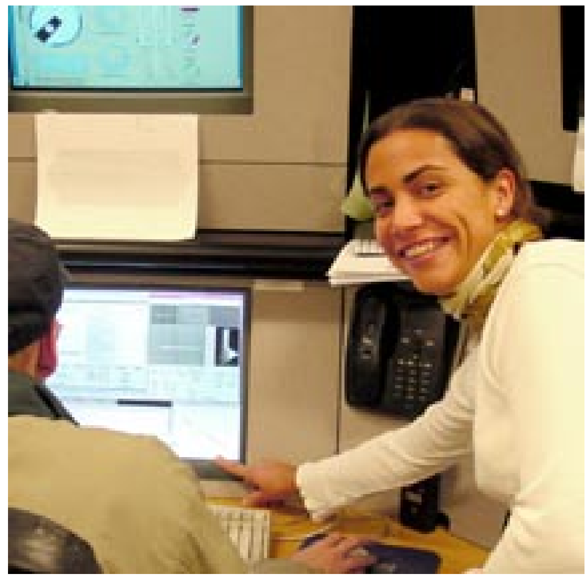

Figure 2. *University of Florida graduate student Cynthia Gómez Martín looks over Gemini astronomer Tom Hayward's shoulder as the first spectrum is obtained with T-ReCS.*

We anticipate that T-ReCS and Gemini will be prepared to carry out the community's scheduled science programs beginning in early 2003B. We are moving rapidly to complete the tasks associated with making T-ReCS the outstanding instrument the Gemini community wants and deserves. I particularly want to emphasize that the successful deployment of a major instrument like T-ReCS depends critically on establishing a harmonious and virtually seamless relationship between the instrument development team and the observatory staff. I am extremely pleased, as I hope Gemini Observatory is, with how effectively the University of Florida and Gemini have worked together to bring this project to completion.

It is a pleasure to acknowledge my T-ReCS colleagues at the University of Florida: Latif Albusairi, Dan Cawlfield, David Ciardi, Richard Corley, Jim French, Kevin Hanna, David Hon, Jeff Julian, Roger Julian, Danny Karrels, Tom Kisko, Naibi Mariñas, Cynthia Gómez Martín, Chris Packham, Robert Piña, James Radomski, Francisco Reyes, and Frank Varosi.

Reminders about Gemini Observing Proposals

Taft Armandroff & Dave Bell

For Gemini observing proposals for semester 2004A, we wish to remind proposers about several important procedural issues. Attention to these issues will help the NOAO time allocation committees (TACs) and the NOAO Gemini Science Center in evaluating and implementing the proposals.

- The Gemini Call for Proposals will specify a right ascension (RA) range for semester 2004A (see the "Instrument Calendar" in the Gemini Call for Proposals). There will be a general RA range, and there may be more restrictive RA ranges for certain instruments (because, for example, certain instruments may not be available until part way through the semester). Please check that all your targets fall within the RA range of the requested instrument.

- Gemini proposals require specification of the observing conditions for cloud cover, image quality, sky brightness, and water vapor. Think carefully about what observing-condition bands should be specified in your proposal. Specifying the conditions too tightly reduces the probability that your program will be approved and executed. Also, please explain your choice of observing-condition bands in your proposal's "Technical Description."

- Include the required overhead time in your request. The rules for calculating overheads are given in the "Performance and Use" sections of Gemini's instrument Web pages.

- For GMOS multi-object spectroscopy, pre-imaging with GMOS is required for mask fabrication. Please be sure to clearly include the observing time needed for this pre-imaging.

- Please list only one "run" per instrument in your proposal. If portions of your program require different instrument configurations or dates, please describe these requirements in the text of the "Technical Description" for the run. For instance, pre-imaging and multi-object spectroscopy with GMOS should be included in a single "run."

- If your observing program is being proposed jointly with another partner country, be sure to enter both the total time requested from all partners and that requested from the US TAC. Also, please specify who is the overall international contact for the multipartner program. Fields are available on the NOAO Web proposal form and Gemini's Phase-I Tool for supplying this information.

- If you plan to use Gemini's Phase-I Tool, be sure to read and follow the guidelines available at *www.noao.edu/noaoprop/help/pit.html*.

NGSC Webcast on 2004A Gemini Observing Proposals

The NOAO Gemini Science Center uses several channels for communicating observing opportunities on the Gemini telescopes to the US community. Starting in September, we plan to experiment with a new tool: Webcasting.

NGSC will hold a Webcast for the US community on September 17 at 10:00 A.M. MST. We will briefly review the Call for Proposals for semester 2004A, highlight new observing capabilities, and then take questions from the community.

In order to connect to the Webcast, or to download the necessary software, visit *www.noao.edu/usgp*.

You are encouraged to send your questions on Gemini observing capabilities and the 2004A proposal process, before or during the Webcast, to *usgemini@noao.edu*, or phone them in to 520-318-8421.

Gemini Next-Generation Instrumentation Planning

Taft Armandroff

The International Gemini Observatory began a process in early 2002 to identify the key science drivers for Gemini in the period 2008–2010. These key science questions, to be identified by the Gemini partner communities, would lead to a set of required observations that will guide future instrument development at Gemini.

Representatives of the Gemini communities at the Aspen meeting on science and instrumentation.

The NOAO Gemini Science Center (NGSC) organized a workshop for the US community, "Future Instrumentation for the Gemini 8-m Telescopes: US Perspective in 2003," on May 30–31 in Tempe, AZ. The goals of this US meeting were to:

- Explore important science questions that will be addressed via Gemini next-generation instrumentation in the period 2008–2010
- Identify, in general terms, the observing capabilities required to address these science questions

The participants in the Tempe meeting worked hard and defined high-impact scientific questions for Gemini to address in 2008–2010. These scientific investigations were justified and placed in context. The participants envisioned Gemini playing a substantial role in the key science questions of the day. The report of the workshop, compiled by Bob Blum, Karl Glazebrook, Michael Meyer, Jeff Valenti, Rosie Wyse, and Taft Armandroff, is available at *www.noao.edu/usgp/Tempe_Report_7-8.pdf*.

Gemini subsequently held an international science and instrumentation planning meeting in Aspen, CO, at the Aspen Meadows Conference Center on June 27–28. Fifty-seven delegates, who were selected by the international organizing committee, participated. Twenty-eight of the delegates were from the United States.

Both the Tempe and Aspen meetings were organized around four science-themed breakout groups:

- Stars, the Solar System, and Extrasolar Planets
- Star Formation Processes and the Interstellar Medium
- Structure and Evolution of the Milky Way and Nearby Galaxies
- Formation and Evolution of Distant Galaxies and the High-Redshift Universe

The Aspen delegates were creative and passionate in their proposed use of Gemini to address key problems in astrophysics. Groundbreaking science programs were proposed to study the evolution of the Universe through the investigation of dark energy and reionization. How dark matter and feedback control the formation and evolution of galaxies was another major theme. Finally, the delegates sought to define programs to understand the physical processes that lead to star and planet formation. Powerful new observing capabilities are needed to achieve these science goals, from a high-contrast adaptive optics system, to an infrared high-resolution spectrograph with unprecedented wavelength coverage, to a wide-field optical spectrograph with very large multiplexing (to list just a few).

The next steps in the process of defining next-generation Gemini instrumentation are now occurring. A report of the science goals endorsed by the Aspen delegates is being written. NGSC and the NOAO Major Instrumentation Program are investigating preliminary specifications and rough costing of the instrumentation required to achieve the Aspen science goals, as are groups at the Herzberg Institute of Astrophysics in Canada, the UK Astronomy Technology Centre, and Gemini. The Gemini Science Committee will discuss the Aspen science case and these instrument specifications at its meeting in October, formulating a recommendation on future Gemini science and instrumentation. Finally, the Gemini Board will consider the Gemini future instrumentation program at its November meeting.

NGSC Instrumentation Program Update

Taft Armandroff & Mark Trueblood

The NGSC Instrumentation Program continues its efforts to provide innovative and capable instrumentation for the Gemini telescopes in support of frontline science programs. This article gives a status update on Gemini instrumentation being developed in the United States, with progress since the June 2003 *NOAO/NSO Newsletter.*

NICI

The Near Infrared Coronagraphic Imager (NICI) will provide a 1- to 5-micron dual-beam coronagraphic imaging capability on the Gemini South telescope. Mauna Kea Infrared (MKIR) in Hilo is building NICI, under the leadership of Doug Toomey.

The NICI Team is well along in the fabrication/procurement phase of the project. Most of the optical and mechanical parts have been fabricated and acceptance tested. Most of the electronics boards are undergoing testing. Overall, 62 percent of the work to NICI final acceptance by Gemini, which is planned for December 2004, has been completed.

Cabinet of small NICI parts awaiting instrument assembly.

Completed parts of the NICI dewar and radiation shields.

FLAMINGOS-2

FLAMINGOS-2 is a near-infrared multi-object spectrograph and imager for the Gemini South telescope. It will cover a 6.1-arcmin-diameter field at Gemini's standard *f*/16 focus in imaging mode, and will provide multi-object spectra over a 6.1×2-arcmin field. It will also provide a multi-object spectroscopic capability for Gemini South's multiconjugate adaptive optics system. FLAMINGOS-2 is being built by the University of Florida under the leadership of Richard Elston (Project Scientist), Steve Eikenberry (Co-Project Scientist), and Roger Julian (Project Manager).

Detailed design work continues on FLAMINGOS-2, with recent progress in the areas of optical and mechanical design. A Critical Design Review for FLAMINGOS-2 will be held on August 20–21 in Gainesville, FL.

continued

NGSC Instrumentation continued

GNIRS

The Gemini Near-InfraRed Spectrograph (GNIRS) is an infrared spectrograph for the Gemini South telescope that will operate from 1 to 5 microns and will offer two plate scales, a range of dispersions, as well as long-slit, cross-dispersed, and integral-field modes. The project is being carried out at NOAO in Tucson under the leadership of Neil Gaughan (Project Manager), Jay Elias (Project Scientist), and Dick Joyce (Co-Project Scientist).

GNIRS has been undergoing a series of diagnostic cold cycles, followed by adjustments and fixes since December 2002. As of mid-July, GNIRS is in its fifth full cold cycle. The issues that have been addressed during these cold cycles are typical for Gemini instruments, and include light leaks, detector operating temperature, detector alignment, flexure compensation, image quality, and on-instrument wavefront sensor functionality. Gemini and NOAO began GNIRS pre-shipment acceptance testing on August 11. Once Gemini agrees that all of the GNIRS pre-shipment performance tests have been successfully completed, GNIRS will be shipped to Gemini South.

The Gemini Near-InfraRed Spectrograph (GNIRS) shown with NOAO and Gemini staff who played a role in its construction and testing.

NOAO 2004A Proposals Due 30 September 2003

Todd Boroson

Proposals for observing time for semester 2004A (February–July 2004) with the Gemini North and South telescopes, the Cerro Tololo Inter-American Observatory (CTIO), the Kitt Peak National Observatory (KPNO), and community access time at the Hobby-Eberly Telescope (HET) and the Keck I and II telescopes are **due by Tuesday evening, 30 September 2003, midnight MST.**

Proposal materials and information are available on our Web page (*www.noao.edu/noaoprop/*). There are three options for submission:

- **Web submissions**—The Web form may be used to complete and submit all proposals. The information provided on the Web form is formatted and submitted as a LaTeX file, including figures that are "attached" to the Web proposal as encapsulated PostScript files.

- **E-mail submissions**—As in previous semesters, a customized LaTeX file may be downloaded from the Web proposal form, after certain required fields have been completed. "Essay" sections can then be edited locally and the proposal submitted by e-mail. Please carefully follow the instructions in the LaTeX template for submitting proposals and figures.

- **Gemini's Phase-I Tool (PIT)**—Investigators proposing for Gemini time **only** may optionally use Gemini's tool, which runs on Solaris, RedHat Linux, and Windows platforms, and can be downloaded from *www.gemini.edu/sciops/P1help/p1Index.html.*

Note that proposals for Gemini time may also be submitted using the standard NOAO form, and that proposals that request time on Gemini plus other telescopes **MUST** use the standard NOAO form. PIT-submitted proposals will be converted to LaTeX at NOAO, and are subject to the same page limits as other NOAO proposals. To ensure a smooth translation, please see the guidelines at *www.noao.edu/noaoprop/help/pit.html.*

The addresses below are available to help with proposal preparation and submission:

Web proposal materials and information	*www.noao.edu/noaoprop/*
Request help for proposal preparation	*noaoprop-help@noao.edu*
Address for thesis and visitor instrument letters, as well as consent letters, for use of PI instruments on the MMT	*noaoprop-letter@noao.edu*
Address for submitting LaTeX proposals by e-mail	*noaoprop-submit@noao.edu*
Gemini-related questions about operations or instruments	*usgemini@noao.edu* *www.noao.edu/gateway/gemini/support.html*
CTIO-specific questions related to an observing run	*ctio@noao.edu*
KPNO-specific questions related to an observing run	*kpno@noao.edu*
HET-specific questions related to an observing run	*het@noao.edu*
Keck-specific questions related to an observing run	*keck@noao.edu*
MMT-specific questions related to an observing run	*mmt@noao.edu*

Update on the SMARTS Telescopes at CTIO

The SMARTS Consortium now operates three small telescopes at Cerro Tololo Inter-American Observatory (CTIO): the 1.5-meter with Cass Spectrograph, the 1.3-meter (ex-2MASS) with Andicam in queue-scheduled mode, and the 0.9-meter with the usual SITe 2K imager. The Montreal 2K IR Imager CPAPIR will replace the RC Spec on the 1.5-meter from April through the end of the 2004A semester for a dedicated survey by a consortium member. A small amount of time with this instrument may be available for service observations at the beginning and ends of nights during this period. A new 4K imager on the 1.0-meter telescope may also become available sometime during the 2004A semester. Please check the NOAO Web site in September for the latest information on resources available for proposals by the general community in 2004A.

Community Access Time at the Keck and HET Observatories

Todd Boroson & Dave Bell

As a result of awards made through the National Science Foundation's Telescope System Instrumentation Program (TSIP), 53 nights of classical observing time are available for allocation to the general astronomical community on the two 10-meter telescopes of the W.M. Keck Observatory on Mauna Kea. These 53 nights are being allocated over five semesters, with 12 nights to be scheduled in 2004A. The nights will be divided evenly between the two telescopes and distributed over lunar phases. All current facility-class instruments and modes (which excludes interferometry) are available. Any scientist may propose without regard to nationality or preferred access through other channels. For additional information, see *www.noao.edu/gateway/keck/*.

About 16 equivalent clear nights of community-access queue observations per year are available on the Hobby-Eberly Telescope (HET) at McDonald Observatory, under a six-year agreement with the National Science Foundation. During 2004A, about 43 hours are expected to be available for integration and set-up time. Available instruments include the High-, Medium-, and Low-Resolution Spectrographs. For the latest information on HET instrumentation and instructions for writing observing proposals, see NOAO's HET Web page at *www.noao.edu/gateway/het/*.

There are 162 nights of observing time on the 6.5-meter telescope of the MMT Observatory being allocated to the general community under an agreement with the National Science Foundation. These nights are being allocated over a period of at least six years. Due to a large backlog of programs that were awarded time in previous semesters that have not yet been scheduled, no new MMT proposals will be accepted for the upcoming 2004A semester.

A New Era in Data Access

Todd Boroson

The NOAO Science Archive (NSA), serving data primarily from the NOAO survey programs for the past 18 months, is about to enter a new phase of development. Work is now focusing on the goal of making all raw data from NOAO-granted time available to the community after a proprietary period. This entails the development of new capabilities for the NSA itself so that access can be regulated, as well as the creation and installation of a new software network—the Data Transport System (DTS)—that will enable the automatic flow of raw data from the instruments into the archive. Auxiliary benefits from this new system include the ability for observers to retrieve their data at any time from the archive, and replacement of the save-the-bits tape storage. Copies of the data will be maintained in two places, Tucson and La Serena, and the two copies will be synchronized regularly.

continued

New Era in Data Access continued

NOAO has long had a data rights policy, but now that there is a mechanism for providing access, it has been necessary to clarify some aspects of it. The policy states that the nominal proprietary period is 18 months from the date of the observation. Observers may offer a shorter period in their observing proposal or they may request a longer period from the NOAO Director with appropriate justification in their proposal. All calibration data and metadata (information describing each observation) will have no proprietary period and will be made immediately accessible through the NSA.

It is expected that raw data will start flowing to the NSA sometime in the next year, and observers will be notified when the system begins its operation.

The NOAO Survey Program in 2003

Tod R. Lauer

The NOAO Survey Program continues to support large observational surveys using NOAO telescopes. The Survey Program was initiated in 1999 to allow for observational programs that uniquely required extensive allocations of telescope time to address problems that were poorly addressed by the more standard allocations of time awarded in the regular Time Allocation Committee (TAC) process. A key aspect of survey programs is their generation of large uniform data sets that are likely to be of strong interest to the community, beyond the goals of the survey programs themselves. A condition for the award of survey time is that these data sets be made publicly available.

As of spring 2002, NOAO had awarded time to 15 survey programs through four annual calls for proposals, on topics ranging from deep cosmological "blank-sky" surveys to searches for Kuiper Belt Objects. A full list of the programs can be found at *www.noao.edu/gateway/surveys/programs.html*. The large majority of programs have made heavy use of the Mosaic cameras at the CTIO and KPNO 4-meter telescopes, but there has been substantial use of the smaller telescopes as well, particularly with the FLAMINGOS infrared instrument. Overall, the survey programs use approximately 25 percent of the total telescope time available from NOAO facilities (the Gemini 8-meter telescopes are not available through the Survey Program).

Survey programs may span several semesters, as is required to achieve the survey goals stated in the original proposal. Total run time is limited to five years, although most surveys request a shorter program length. The complete time allocation needed is requested in the original proposal; however, as this does not allow for instrument failures or weather losses, the survey programs had been allowed to apply to the annual Survey TAC for augmentation time. In practice, no survey was able to complete their program within the time span and allocations originally proposed. Unfortunately, the reasonable desire to offer augmentation time to already existing surveys does limit the resources that can be offered to newly proposed surveys.

Thus, in 2003 we decided to focus completely on older surveys rather than trying to fit in any new programs within the limited margin between time already allocated for existing surveys and the total resources available to the program. The task of the 2003 Survey TAC was thus to evaluate the progress of the ongoing surveys and to adjudicate their requests for augmentation time. This latter task was also proscribed by a new policy to limit the availability of augmentation time to those surveys approaching the final year of their original time span. Previously, the ongoing surveys could request augmentation time on an annual basis from the Survey TAC. In practice, the Survey TACs generally were not interested in awarding augmentation time until such a time as the surveys were close enough to completion that the need could be most clearly evaluated.

In 2003, six of the seven surveys eligible for augmentation were awarded some (but not always all) of the augmentation time requested. Five additional older surveys are also now considered to be completed. We are presently evaluating the total resources that will be available to new surveys starting in the second semester of 2004, and will be preparing a new call for proposals for release by December 2003.

Meanwhile, the existing surveys have been highly productive at generating the uniform data sets that they proposed. NOAO has initiated an ongoing process to make this data available to all interested parties through the NOAO Science Archive at *archive.noao.edu/nsa/*. The forms available at this page allow the search of data by a variety of parameters, and transfer images from NOAO via FTP. Several interesting data sets are already available, and the offerings will be augmented as the survey programs continue.

Observing Request Statistics for 2003B Standard Proposals

	No. of Requests	Nights Requested	Average Request	Nights Allocated	DD Nights (*)	Nights Previously Allocated	Nights Scheduled for New Programs	Over-subscription for New Programs
GEMINI								
Gemini North	65	107.63	1.66	39.68	3	0	39.68	2.71
Gemini South	58	107.04	1.85	39.03	0	0	39.03	2.74
CTIO								
CTIO 4-m	83	268.5	3.23	103	7.5	2	101	2.66
CTIO 1.5-m	6	34	5.67	45	0	13	32	1.06
CTIO 1.3-m	12	59.98	5	29.31	0	0	29.31	2.05
CTIO 0.9-m	15	97	6.47	65	0	4	61	1.59
KPNO								
KPNO 4-m	81	241.05	2.98	91.5	0	0	91.5	2.63
WIYN 3.5-m	46	134	2.91	42.25	1	7.5	34.75	3.86
KPNO 2.1-m	27	135.2	5.01	100	0	0	100	1.35
WIYN 0.9-m	8	34	4.25	26	0	0	26	1.31
Keck/HET/MMT								
Keck I	12	18	1.5	6	0	0	6	3.00
Keck II	19	32	1.68	6	0	0	6	5.33
HET	4	7.25	1.81	5.25	0	0	5.25	1.38
MMT	8	20	2.5	11	0	0	11	1.82

*Nights allocated by NOAO Director

KPNO Instruments Available for 2004A

Spectroscopy	Detector	Resolution	Slit	Multi-object
Mayall 4-m				
R-C CCD Spectrograph	T2KB/LB1A CCD	300–5000	5.4'	single/multi
Cryocam/MARS Spectrograph	LB CCD (1980×800)	300–1500	5.4'	single/multi
Echelle Spectrograph	T2KB CCD	18000–65000	2.0'	
FLAMINGOS	HgCdTe (2048×2048, 0.9–2.5µm)	1000–3000	10'	single/multi
WIYN 3.5-m				
Hydra + Bench Spectrograph	T2KC CCD	700–22000	NA	~100 fibers
DensePak[1]	T2KC CCD	700–22000	IFU	~90 fibers
SparsePak[2]	T2KC CCD	700–22000	IFU	~82 fibers
2.1-m				
GoldCam CCD Spectrograph	F3KA CCD	300–4500	5.2'	
FLAMINGOS	HgCdTe (2048×2048, 0.9–2.5µm)	1000–3000	20'	

Imaging	Detector	Spectral Range	Scale ("/pixel)	Field
Mayall 4-m				
CCD Mosaic	8K×8K	3500–9700Å	0.26	35.4'
SQIID	InSb (4-512×512)	JHK + L (NB)	0.39	3.3' circular
FLAMINGOS	HgCdTe (2048×2048)	JHK	0.3	10'
WIYN 3.5-m				
Mini-Mosaic	4K×4K CCD	3300–9700Å	0.14	9.3'
WTTM	4K×2K CCD	3700–9700Å	0.11	4.6'×3.8'
2.1-m				
CCD Imager	T2KA CCD	3300–9700Å	0.305	10.4'
SQIID	InSb (4-512×512)	JHK +L(NB)	0.68	5.8' circular
FLAMINGOS	HgCdTe (2048×2048)	JHK	0.6	20'
WIYN 0.9-m				
CCD Mosaic	8K×8K	3500–9700Å	0.43	59'

[1] Integral Field Unit: 30"×45" field, 3" fibers, 4" fiber spacing @ *f*/6.5; also available at Cass at *f*/13.

[2] Integral Field Unit, 80"×80" field, 5" fibers, graduated spacing

CTIO Instruments Possibly Available for 2004A*

Spectroscopy	Detector	Resolution	Slit
4-m			
Hydra + Fiber Spectrograph	SITe 2K CCD, 3300–11000Å	300–2000	138 fibers, 2" aperture
R-C CCD Spectrograph	Loral 3K CCD, 3100–11000Å	300–5000	5.5'
Echelle + Long Cameras	SITe 2K CCD, 3100–11000Å	60000	5.2'
1.5-m			
Cass Spectrograph	Loral 1200×800 CCD, 3100–11000Å	<1300	7.7'

Imaging	Detector	Scale ("/pixel)	Field
4-m			
Mosaic II Imager	8K×8K CCD Mosaic	0.27	36'
ISPI IR Imager	HgCdTe (2048×2048, 1.0–2.4μm)	0.3	11'
1.5-m			
CPAPIR	Hawaii II 2K IR	0.88	30'
1.3-m			
ANDICAM Optical/IR Camera	Fairchild 2K CCD	0.17	5.8'
	HgCdTe 1K IR	0.11	2'
1-m			
Direct Imaging	4K CCD	0.29	20'
0.9-m			
Cass Direct Imaging	SITe 2K CCD	0.4	13.6'

Gemini Instruments Possibly Available for 2004A*

GEMINI NORTH	Detector	Spectral Range	Scale ("/pixel)	Field
NIRI	1024×1024 Aladdin Array	1–5μm R~500–1600	0.022, 0.05, 0.116	22.5", 51", 119"
GMOS-N	3-2048×4608 CCDs	0.36–1.1μm R~670–4400	0.072	5.5'
Michelle	256×256 Si:As IBC	8–25μm R~200, 1000, 3000	0.10 img, 0.18 spec	~25"×25"
Altair (fed to NIRI)	1024×1024 Aladdin Array	1–2.5μm	0.022, 0.05, 0.116	22.5", 51", 119"

GEMINI SOUTH	Detector	Spectral Range	Scale ("/pixel)	Field
Phoenix	512×1024 InSb	1–5μm R≤70000	0.1	14" slit length
T-ReCS	320×240 Si:As IBC	8–25μm R~100, 1000	0.09	28"×21"
Acquisition Camera	1K×1K frame-transfer CCD	BVRI	0.12	2'×2'
GMOS-S	3-2048×4608 CCDs	0.36–1.1μm R~670–4400	0.072	5.5'

* Please refer to the NOAO Proposal Web pages in September 2003 for confirmation of available instruments.

Keck Instruments Available for 2004A

	Detector	Resolution	Spectral Range	Scale ("/pixel)	Field
Keck I					
HIRESb/r (optical echelle)	Tek 2048×2048	30k–80k	0.35–1.0μm	0.19	70" slit
NIRC (near-IR img/spec)	256×256 InSb	60–120	1–5μm	0.15	38"
LWS (mid-IR img/spec)	128×128 As:Si BIB	100, 1400	3–25μm	0.08	10"
LRIS (img/lslit/mslit)	Tek 2048×2048	300–5000	0.31–1μm	0.22	6×7.8'
Keck II					
ESI (optical echelle)	MIT-LL 2048×4096	1000–6000	0.39–1.1μm	0.15	2×8'
NIRSPEC (near-IR echelle)	1024×1024 InSb	2000, 25000	1–5μm	0.18 (slitcam)	46"
NIRSPAO (NIRSPEC w/AO)	1024×1024 InSb	2000, 25000	1–5μm	0.18 (slitcam)	46"
NIRC2 (near-IR AO img)	1024×1024 InSb	5000	1–5μm	0.01–0.04	10–40"
DEIMOS (img/lslit/mslit)	8192×8192 mosaic	1200–10000	0.41–1.1μm	0.12	16.7×5'

HET Instruments Available for 2004A

	Detector	Resolution	Slit	Multi-object
LRS (Marcario low-res spec)	Ford 3072×1024			
	4100–10000Å	600	1.0"–10"×4'	13 slitlets, 15"×1.3" in 4'×3' field
	or 4300–7400Å	1300	1.0"–10"×4'	
MRS (med-res spec)	2-2K×4K, visible	5000–20000	1.5" or 2" fibers	9 objects (not offered in 2004A)
	1K×1K HgCdTe, near-IR	5000–10000	(synth long-slit)	
HRS (high-res spec)	2-2K×4K 4200–11000Å	15000–120000	2" or 3" fiber	single

From the CTIO Director's Office

Malcolm G. Smith

Activity in La Serena in support of site-survey work in Northern Chile for the Giant Segmented Mirror Telescope (GSMT) and other large telescopes has now begun to involve visits to potential sites and communications with the pertinent Chilean authorities.

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Construction work has begun on a stretch of basic road in support of site testing work on "El Peñón"—a possible site for the Large Synoptic Survey Telescope (LSST) a few hundred meters from the Gemini South building, in the opposite direction from the Southern Astrophysical Research Telescope (SOAR).

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The Municipality of La Serena has put out a Call for Bids to change out its 13,000 street lamps for ones that comply with the "Norma Luminica" DS686—the Chilean national legislation that demands essentially "astronomy friendly" lighting in the 2nd (Paranal/VLT), 3rd (Las Campanas/Magellan), and 4th (La Silla/ESO, Pachón/Gemini South/SOAR, Tololo/NOAO South) regions of Chile. The bids are to include maintenance of this lighting system, which ensures that better quality lamps (IP65)—that exclude dust and insects—will almost certainly be used.

This would seem to be the most visible step yet in actually controlling the spread of light pollution near international observatories in Chile. Under this legislation, compliance is required by no later than 2005. However, a significant concern is that the bid seems to allow the use of polycarbonate transparent covers instead of glass. Though initially cheaper, these covers lose transmission quite quickly over time. In the short term, the current legislation may seem good for our observatory, but it does no good if the end result is a series of complaints about poor street illumination. An information campaign has been launched to try to address this issue before the bid process is completed.

The top three panels show the panoramic monitoring of 2 A.M. lighting curfew results in La Serena. The three panels across the bottom show the light pollution from legally permitted lighting for sporting events, a weakness of "Norma Luminica" DS686.

The photo here shows the current status of compliance in La Serena with sections of the Norma Luminica that require illuminated signs to be switched off after 2 A.M.

Fortunately, the sky over Cerros Pachón and Tololo is still sufficiently dark that movies have been made from Tololo of the setting zodiacal light near the major, coastal population centers low in the west.

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Interest is beginning to emerge in the community for the development of even wider-field instrumentation for the Blanco 4-meter telescope. Such development will be a natural next step following the stabilization of telescope operations at SOAR (see the related articles elsewhere in this *Newsletter*). Reports will be given in future issues of the *Newsletter* as details become clearer.

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The SMARTS consortium is settling into the operation of its three telescopes on Cerro Tololo and is pressing for additional partners to allow the fourth SMARTS telescope to come into operation for the consortium partners (which include NOAO's users).

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The Michigan Curtis Schmidt telescope has now come back into full operation under a NASA grant to the University of Michigan to track orbital debris.

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We are looking forward to the selection of the next director of CTIO, who is scheduled to take over the leadership of NOAO South on 8 November 2003. I asked to step down from the post after a satisfying decade of service to NOAO as director, and I will continue to support AURA's efforts in Chile.

CELT-AURA Site Testing for the Thirty-Meter Telescope

Alistair Walker & Bob Blum

The California Extremely Large Telescope (CELT) project and the AURA New Initiatives Office (NIO) are collaborating on a site-testing program for a 30-meter telescope. As part of this program, NIO has installed weather-stations at three sites in Northern Chile and operates a fourth with Cornell University on an additional site. These sites were selected through an evaluation process using initial topographical criteria, followed by remote sensing–based cloud and water vapor analyses, and detailed wind-flow simulations. The next step is to install a Differential Image Motion Monitor (DIMM) at each site to measure the seeing, which we are almost ready to do for the first site.

The DIMM telescope dome.

Around the end of the year, the DIMM will be replaced by a combined Multi-Aperture Scintillation Sensor (MASS) plus DIMM. The MASS produces low-resolution turbulence profiles and seeing for the free atmosphere (see *www.ctio.noao.edu/~atokovin/profiler*), and the DIMM provides the integrated seeing through the whole atmosphere. The difference between the two gives a measure of the seeing produced by the layers closest to the ground. Production MASS/DIMM units, being developed in a collaboration between NIO and the Sternberg Institute, will be installed at several sites around the world by a number of groups working on a variety of telescope projects.

The photo shows the fully robotic DIMM telescope inside its dome, mounted on a 3.5-meter tower, together with solar panel arrays, satellite communications dish, and electronics box, all installed for tests on Cerro Tololo. This photo was taken just after installation in July by a team including Matthias Schoeck and Warren Skidmore (University of California at Irvine), Peter Aniol (Halfmann Teleskoptechnik GmbH), and Paul Gillett (NIO), together with Edison Bustos, Manuel Martinez, Javier Rojas, and Gale Brehmer (CTIO). After ensuring that the DIMM is operating reliably, and the results are consistent with those produced by the Tololo DIMM, the system will be moved to the first site to be tested in Northern Chile.

SOAR Status

Steve Heathcote & Victor Krabbendam

As anticipated in the last *Newsletter,* figuring of the SOAR primary mirror was successfully completed at the beginning of June, and work on the integration and final testing of the entire optical system is now well advanced at the Danbury, CT, plant of contractor Goodrich Aerospace. The results obtained to date confirm that the optical system performs as expected and will meet SOAR's very exacting specifications. Progress continues on track for delivery of the completed optical system to Chile by the end of September.

At the same time, another key component of the SOAR optical system, the calibration wave front sensor, was put through its paces on the telescope. Developed by Adaptive Optics Associates of Boston, MA, this device includes a Shack-Hartman type sensor to measure the distortions in the wave front delivered by the telescope optics to the focal plane. This measurement enables calculated adjustments to the 120 primary mirror actuators, and the position and tilt of the secondary mirror, necessary to produce the sharpest possible images. In order to test this system in advance of the

continued

SOAR Status continued

arrival of the real SOAR optics, an auxiliary telescope with a six-inch diameter objective lens was used to feed starlight to the Calibration Wave-Front Sensor (CWFS). This same feed telescope will be used in the coming weeks to feed light to the first SOAR instrument, the Optical Imager, which is nearing completion at CTIO.

In a tense but well-orchestrated maneuver, the SOAR primary mirror is carefully installed on its active support system for the first time. Here it is possible to appreciate the thinness (10 centimeters) of the 4.3-meter diameter ULE glass face sheet. The 120 electromechanical actuators attached to the blue reaction structure maintain the correct surface figure as the telescope points around the sky.

The Calibration Wave-Front Sensor with its associated electronics (the two black boxes) mounted at one of the bent Cassegrain foci of the SOAR telescope. The gray cylinder in the background is a mass simulator that soon will be replaced by the SOAR Optical Imager.

These activities allow us to ensure that all the hardware and software components of the telescope, as well as the first light instrumentation package, are functioning properly, and that everything is ready for installation of the optics as soon as they arrive. As a result, we expect that the final integration steps will go smoothly and quickly, allowing us to achieve SOAR first light around the turn of the year and to be ready for the first shared-risk science use during the second part of the 2004A semester.

Developments at "El Peñón" and Cerro Pachón

Hugo E. Schwarz

"El Peñón," a potential site for the Large Synoptic Survey Telescope (LSST) near Gemini South, has been equipped with a meteorological station that sends its data to Tololo by radio modem. The station is fully independent, and runs off solar power. We have added a Doppler wind meter to test this type of instrument under realistic conditions. In recognition of the site's probable high quality, funds have been made available for putting in a road to the top of El Peñón, allowing us to develop the site further with a seeing and turbulence monitor (MASS/DIMM) and possible other instrumentation to best determine the characteristics of the site. Work on the road started in late July, and we hope to have the El Peñón real-time weather data available on the Web soon.

Work has begun on both PASCA and CASCA, the Pachón and Las Campanas mountain equivalents of the Tololo all-Sky Camera (TASCA). PASCA will be located about 115 meters from SOAR on the Gemini side of the road. A collaboration has begun with Gemini to further develop and test the aircraft detection and beam-collision avoidance software needed for the operation of sodium lasers on Cerro Pachón. For more information, contact *hschwarz@noao.edu* or *jsebag@gemini.edu*.

KPNO/KITTPEAK
NATIONAL OBSERVATORY

Technical Activities for the Summer and Autumn

Richard Green

Though we are not planning to make any submissions to the *Guinness Book of World Records*, the maintenance and upgrade activities on Kitt Peak may very well be setting a new record for duration and number of tasks performed. Major maintenance activities are being carried out for the Mayall 4-meter, WIYN 3.5-meter, and the 2.1-meter telescopes. In addition, KPNO engineering, facilities, and mountain technical groups will be supporting the installation of the Synoptic Optical Long-Term Investigations of the Sun (SOLIS) instrument suite at the Kitt Peak Vacuum Telescope facility during the month of September. The final work at WIYN will not be completed until mid-October this year.

The 4-meter received the first major overhaul, starting in mid-July. The technical challenge was a transmission lube and brake job for the declination drives. The symptom being addressed was a noticeable difficulty in getting the telescope to move after initial power-up in declination, particularly in cold weather. The culprit was one of the two brakes in the system, but it was not a routine maintenance issue. A well-kept secret of the KPNO 4-meter is that the declination drive mechanism was added as a design "afterthought." One of the gearboxes and brake assemblies is essentially inaccessible without disassembling the telescope. The weldment and gears comprise a six-ton unit, which has to be extracted sideways (and reengaged with no line-of-sight access). Indeed, the inaccessible brake was gummed up with 20 years of dried lubricant. It now sports new pads, has been regapped, both gearboxes have been thoroughly cleaned, and the gears have been lubricated and reengaged. New access panels also have been cut in the horseshoe to ease future maintenance efforts.

During that challenging operation, several minor maintenance items were also addressed. The dome shutter gearbox was flushed and refilled with a special oil. The pneumatic clamp system for the Cassegrain rotator was refurbished with new valves. And the Great White Spot was replaced. Its nautical cloth had begun to shred in the dry and windy conditions. Its replacement has metal panels with a highly reflective coating, rated at 99 percent from the ultraviolet through to the near infrared. Mosaic recommissioning includes a careful examination of the new flat-fielding properties.

The gearbox and brake refurbishment went well and met the planned schedule, so the primary mirror was removed and re-aluminized as well. A long telescope commissioning period was planned to allow measuring new force maps for the 4-meter active support system (4MAPS) and integration of the secondary tilt control to remove the coma term at *f*/8. The new wavefront camera will be a major improvement in recording wavefronts at the Cassegrain focus. Full achievement of this plan depends, however, on gaps in the monsoon cloudiness, which are always an unknown.

The 2.1-meter is also receiving a much-needed refurbishment. The long run of multiconductor cabling had gotten snagged and damaged sometime in the last year, leading to multiple peculiar symptoms. As an interim solution, much of the functionality was restored via the large number of spare conductors within the cable. The cabling is being replaced this summer, and a more reliable counter-weighting scheme is being implemented to keep the cables from jumping their tracks. In addition, the oil delivery system for the RA bearings received major preventive maintenance. The schedule is tight for full replacement, checkout of all telescope functions, and restoration to science operations in late August.

Meanwhile, the WIYN 3.5-meter telescope had begun to experience difficulties with its azimuth motion. Increased torques were recorded from the azimuth drive motors, and more frequent drive trips were encountered. Charles Corson led an effort of careful diagnosis and elimination of possible causes, including (again) sticky lubricant. In the end, the culprit seemed to be a degradation of (at least one of) the four azimuth bearings, which are high-precision, custom-fitted parts. The manufacture, assembly, and interfacing of new bearings turned out to be very technically challenging. The WIYN shutdown to accomplish that task is taking place in two parts. An exploratory effort was planned to fill a week in August, overlapping the maintenance and refurbishment of the T2KC bench spectrograph detector. An actual full replacement for all four bearings is planned for the second week of October, by which time the high-precision bearing parts will be delivered from the manufacturer and locally assembled and remachined for installation.

Low downtime during scheduled observations depends on major behind-the-scenes efforts like these. We are grateful for the efforts of all the skilled individuals in Tony Abraham's KPNO engineering group, John Scott's and Mike Hawes' mountain facilities group, Jim Hutchinson's mountain electronic maintenance team, and Skip Andree's instrument support for the sustained hard work required to make these multiple shutdown efforts successful. Please take a look also at the following safety report to gauge the scope of fire prevention activities on the mountain this year.

Fire Prevention Efforts at Kitt Peak

Chuck Gessner & Richard Green

Considerable effort was made last summer to reduce the risk of wildfire damage on Kitt Peak. In 2003, we made additional significant progress.

Kitt Peak managers met with Fire Management Officer Guy Acuna of the Tohono O'odham Nation and Wildland/Urban Interface Specialist Curtis Heaton from the US Fish and Wildlife Service. Mr. Heaton has been a tremendous help in advising us about fire regulations and resource agencies. We agreed that the best short-term approach was to provide defensible space around critical structures by trimming trees and removing undergrowth vegetation and nonnative plant species. The tenants were invited to participate, and MDM, the Southeastern Association for Research in Astronomy, and the University of Arizona have all played an active role.

After this summer's tragic wildfire and the loss of forest land and homes in the Santa Catalina Mountains, we are even more committed to a long-term program of reducing the fuel load of brush on Kitt Peak.

We are also grateful to Tohono O'odham Nation Cultural Affairs Manager Peter Steer for the development of a Tohono O'odham Nation Categorical Exclusion Checklist, complete with signatures from the Nation's chair and environmental manager. This document allowed us to take prompt action just prior to the peak fire season by stating that the planned clearing was unlikely to impact any environmentally or culturally sensitive areas. Landscaping contract work was successfully completed in early July.

This year's additional fire risk mitigation efforts at Kitt Peak included:

- The 5,000-gallon tender with the fire fighting foam machine was readied.
- Mountain facilities staff retrofitted and readied a 500-gallon "buffalo" trailer with pump to be used along with another 500-gallon trailer.
- Staff constructed "portable sprinklers" and hoses for use on endangered buildings.
- Kitt Peak management met with Tohono O'odham Nation Department of Public Safety (DPS) on June 16 to ensure that Kitt Peak is their priority location. Tohono O'odham Nation DPS has toured Kitt Peak's facilities and fire fighting capabilities and has been provided updated emergency information including maps, contact information, and GPS coordinates of structures.
- Kitt Peak management are working with the Tohono O'odham Nation fire department and the Bureau of Indian Affairs (BIA) to put into place a long-term strategy for hazard fuel reduction and a wild land–urban interface that would allow BIA funding for fire mitigation, which will protect both the Tohono O'odham Nation and the research facilities on Kitt Peak.

After this summer's tragic wildfire and the loss of forest land and homes in the Santa Catalina Mountains, we are even more committed to a long-term program of reducing the fuel load of brush on Kitt Peak. A successfully completed environmental study should allow sensible management of steeper slopes and chimney-like canyons to further reduce the fire threat without compromising soil stability or habitat. Although you will find the former "natural" look of the summit area somewhat altered when you return to observe, we're sure you understand and appreciate the need for such changes in the interest of long-term, safe operations.

From the NSO Director's Office

Steve Keil

It is my pleasure to report steady progress on projects and science capabilities this past quarter at the National Solar Observatory (NSO). The first full-disk magnetogram has been obtained with the SOLIS vector spectromagnetograph (VSM). This first image indicates that the VSM will indeed improve the quality of solar magnetic field measurements. The VSM has been at the GONG farm in Tucson for testing and debugging and will soon be joined there by the full-disk patrol (FDP) instrument. When debugging and cross-calibration are complete, the two instruments, along with the integrated sunlight spectrometer (ISS) and their mounts will be installed at the Kitt Peak Vacuum Telescope (see page 40).

✷

Adaptive optics (AO) has become a staple to feed both imaging and spectroscopic instruments at the Dunn Solar Telescope (DST). A number of exciting instruments are being fed by the new high-order AO system (76 degrees of freedom) and the older, low-order system (24 degrees of freedom). The low-order AO system, which we plan to upgrade in the near future, presently feeds the narrowband tunable filters and the horizontal spectrograph (which includes the Advanced Stokes Polarimeter). Recently, scientists from the Arcetri Observatory installed their Italian BI-dimensional Spectrometer (IBIS) at the DST. IBIS is also fed with the low-order AO-corrected beam. We intend to make the system available to users early next year. The Diffraction-Limited Stokes Polarimeter (DLSP), which is fed by the high-order AO system, is nearing the end of its Phase II development.

✷

On the Advanced Technology Solar Telescope (ATST) front, a miniworkshop to discuss enclosure concepts and instrument efforts was held in May at the High Altitude Observatory, followed by teleconferences to discuss the results of the meeting with the Science Working Group and potential design reviewers (see page 37). Thermal tests of existing vented and unvented domes were conducted to get an idea of how venting would help during the day. Installation of sky brightness monitors at all of the ATST test sites was also completed. Several talks presenting updates on AO, instrumentation, and ATST efforts were presented at the August SPIE meeting in San Diego.

✷

NSO continues with its strong commitment to supporting graduate education and attracting students to solar physics research. New Jersey Institute of Technology (NJIT) graduate student Klaus Hartkorn did extensive work at NSO under the supervision of Thomas Rimmele, receiving his PhD this May with a thesis on high-resolution studies with the DST and AO. Thomas is also advising a second PhD student jointly sponsored by NSO and NJIT, Jose Marino, whose thesis is on developing techniques for using the AO wavefront sensor to obtain the instantaneous point spread functions of AO-corrected images so they can be fully restored. Dave Byers from Utah State University is working on a PhD, supervised by K. S. Balasubramaniam, assessing methods of predicting solar activity based on surface flows. Michael Eydenberg, also supervised by Balasubramaniam, just completed his Master's thesis at the New Mexico Institute of Mining and Technology on the inversion of stokes profiles using principal component analysis. In addition to all of this, NSO has created an ATST graduate student fellowship to support work on narrowband, tunable filter designs for the ATST using Fabry-Perot filters. The candidate for this fellowship, Laura Allaire, a graduate student at the University of Rochester, spent the summer at Sunspot, familiarizing herself with various design aspects of the current filters.

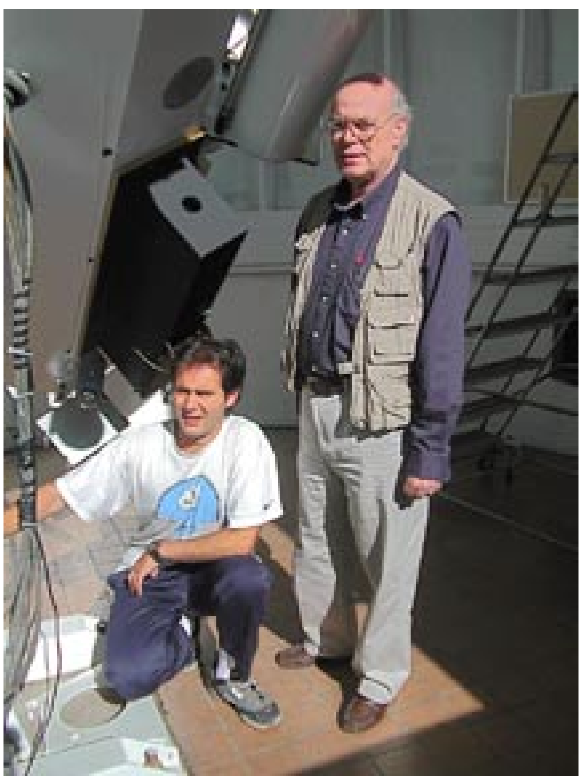
NSO also had another busy and successful summer with six undergraduates (three at each site) and three high school teachers as part of the 2003 Research Experiences for Undergraduates (REU) and Research Experiences for Teachers (RET) programs. NSO fosters close interaction among our undergraduate and graduate students, teachers, and the scientific and technical staff. In addition to research projects conducted at the respective sites, the teachers and students (including the KPNO summer students) exchanged site visits that included the traditional stopovers at the White Sands National Monument and the Very Large Array in Socorro, NM. Information about individual summer projects is available at the NSO Educational Outreach Web site (*eo.nso.edu*).

Magneto-Optical Filter System Achieves First Light

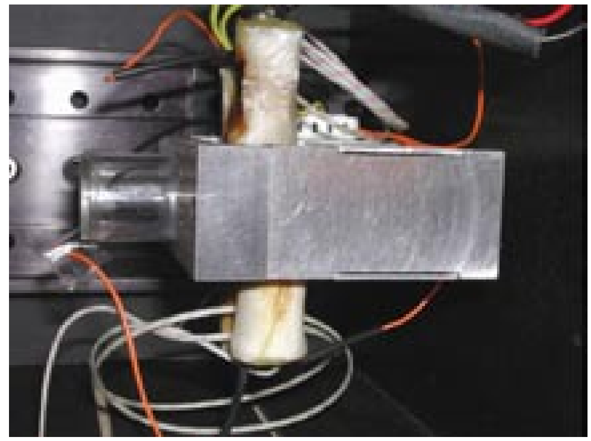
Dick Altrock (Air Force Research Lab) & Dave Dooling

Alessandro Cacciani of the University La Sapienza of Rome, Italy, has achieved "first light" at Sacramento Peak with his magneto-optical filter (MOF) system designed to image the Sun in sodium-D lines. Cacciani is a National Research Council Senior Associate, funded by the US Air Force, working at Sacramento Peak during 2003. He is assisted this summer by Ludovico Cesario, a graduate student from La Sapienza.

Sodium emits and absorbs yellow light at two narrowly separated lines at 588.995 and 589.592 nanometers. Also called the Fraunhofer D lines in the solar spectrum, they are formed in the lower chromosphere and are among the strongest in the solar spectrum. Cacciani is working to measure velocities and magnetic fields in the solar atmosphere. These can allow detailed studies of the buildup of energy in active regions that lead to flares or coronal mass ejections.



Alessandro Cacciani (standing), and Ludovico Cesario, both of University La Sapienza, with the MOF system (black box) mounted on the spar of the Hilltop Dome at Sac Peak.



Close-up view of the MOF filter unit mounted at the Hilltop Dome. The quartz container for the sodium vapor protrudes at left center from the magnet housing.

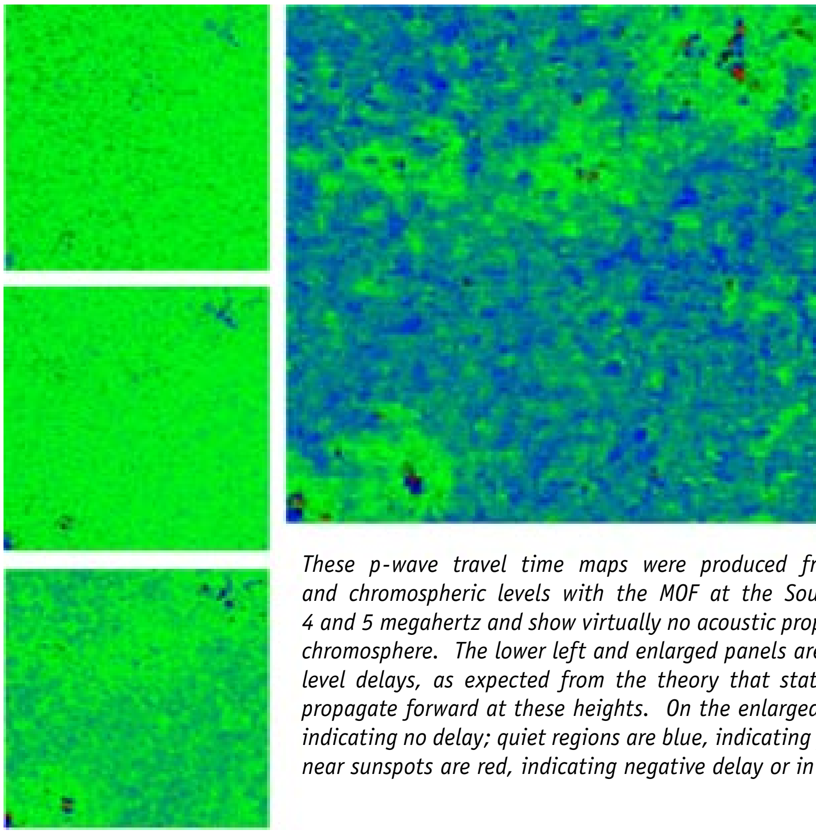
The MOF is a very narrowband filter that uses sodium vapor as a depolarizing element between two crossed polarizing filters. It takes advantage of the Zeeman and related effects to achieve stable and efficient transmission bands. The selection of the band's shape depends on the magnetic field imposed on the vapor and on its optical depth.

"At Sac Peak we have installed the first element of a chain that will be able to produce Doppler and magnetic maps of the Sun," Cacciani explains. "That is, we have at the moment a single sodium MOF to provide images on the core of the two D lines. With this first element we will study the linear polarization behavior in the center of the two D lines separately and in different locations on the Sun."

When the system is ready, the MOF will detect Doppler and magnetic signals simultaneously. Cacciani plans to use the MOF with the Dunn Solar Telescope and its low-order adaptive optics system to study the covariance of magnetic and Doppler signals. This would provide clear evidence of Alfven wave emissions from sunspots. He also plans a second system operating in the potassium line at 770 nanometers. This will capture data from the photosphere. This two-level detector was first used at the South Pole during the last Antarctic observing campaign in collaboration with former NSO staff member, Stuart Jefferies, who is now at the Maui Research and Technology Center.

continued

Magneto-Optical Filter System continued



These p-wave travel time maps were produced from Dopplergrams taken at photospheric and chromospheric levels with the MOF at the South Pole. The upper left panels refer to 4 and 5 megahertz and show virtually no acoustic propagation from the photosphere into the low chromosphere. The lower left and enlarged panels are at 6 and 7 megahertz and show different level delays, as expected from the theory that states that only high frequency p-waves can propagate forward at these heights. On the enlarged panel above, magnetic regions are green, indicating no delay; quiet regions are blue, indicating positive delay or escaping waves; and areas near sunspots are red, indicating negative delay or in-going waves.

ATST Design Progress

Jim Oschmann & the ATST Team

The highest priority task for the Advanced Technology Solar Telescope (ATST) project—the enclosure trade study—was completed in June following several meetings and debate. The result was a decision to pursue the "hybrid" design, while taking into account the technical issues raised by the reviewers. Other recent activities include the Conceptual Design Review (CoDR) that was held in late August, completion of the optical fabrication studies, preparation of Request for Proposals (RFPs) to bring outside contractor experience onboard, and organization of the construction-phase proposal efforts. The enclosure trades and several other aspects of our recent work are summarized here.

Enclosure Trades

To support the selection effort for the general type of enclosure that the project would pursue, a small workshop was held in Boulder, CO, with the ATST co-principal investigators and some of the project instrument groups. The presentations from this meeting were posted on the Web, and follow-up discussions with members of the CoDR committee and the Science Working Group were also held. The result of these meetings and our internal discussions

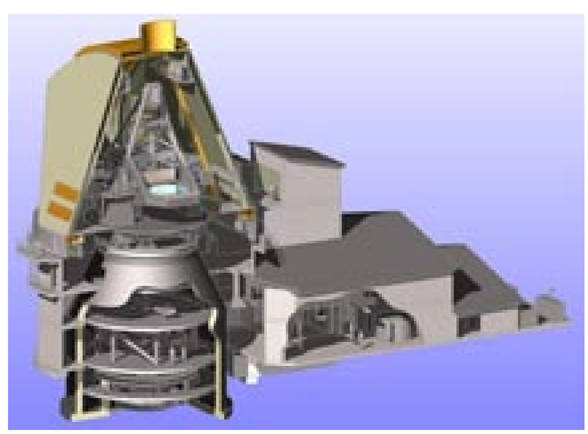


Figure 1. ATST enclosure concept.

continued

ATST Design Progress continued

was a decision to pursue the "hybrid" ventilated dome. This enclosure concept is shown in figure 1.

While the decision to pursue this design was largely supported by these meetings, concerns—based on experience about having any type of enclosure—were expressed. The project takes these concerns seriously and will address them as we move forward with the hybrid concept. Examples of the challenges with this design include the ability to cool the exterior skin of the structure and to maximize the amount of passive ventilation that can be achieved. Cooling plans are being worked in more detail and studies are underway with potential suppliers of domes. In addition, an outside study has been initiated for a computational fluid dynamic (CFD) analysis to better assess the passive ventilation properties of the dome. The first-cut results of this CFD modeling were presented at the August CoDR.

Thermal Considerations

Thomas Rimmele and Nathan Dalrymple completed measurements of dome seeing at Big Bear this summer with the help of the staff at Big Bear Solar Observatory. Although the data are still being analyzed, some first-order conclusions were obtained. The largest effect observed was a degradation in seeing with an increased temperature difference between the ambient air and the air within the dome. With respect to the dome temperature differences, the measurements resulted in effects consistent with the expectations based upon Nathan's modeling of the Big Bear dome. We are also looking at the wavefront sensor (WFS) measurements to get the spatial distribution of the local seeing that was generated. These measurements will be used to help assess error budget estimates for the adaptive optics use of ATST. This is a valuable addition to our base of modeling and testing from dome temperature and lab seeing tests.

Telescope and Facility Design

The three-dimensional models have been translated into finite-element (FE) models for the telescope, pier, coudé lab, and interface to the ground, using placeholder soil properties. Jeff Barr is gathering the correct soil properties for the six ATST candidate sites to update the model. With line-of-sight models incorporated in the FE models, analyses can provide an indication of the magnitude of windshake, as well as the amount of protection required for a given level of performance. This will help identify critical aspects of the design, and focus our optimization efforts. The current design, situated on loose soil, is dominated by global telescope and pier rocking and translation. This same soil-dominated performance effect has been witnessed on various existing telescopes and is not a surprise. It is also very difficult to improve upon, so the range of performance will vary at the different sites. The protection provided by the enclosure and the ability to adjust wind effects on the telescope structure will affect how we operate in various conditions at the different sites. It will be equally important that the foundations of the enclosure and any other surrounding buildings are sufficiently isolated from the ATST pier. This will minimize the transfer of vibrational energy from wind striking these other structures and propagating through the soil into the pier. This has been a consideration in most recently-built large telescopes. The effect of vibrational energy is amplified as one tries to increase the telescope height above the surrounding terrain.

The static gravity deformations of the telescope are being fed into alignment and active optics studies. This will provide initial dynamic range requirements for the active primary and secondary, and will determine if further active control of the feed optics or improvements in the structural design are needed.

Optics

The primary mirror fabrication studies were completed in May. All vendors were confident that their proposed methods for manufacturing and testing would lead to a successful primary mirror effort. The methods and risks varied, but no significant problems were identified with our baseline mirror configuration. Some vendors recommended further work to quantify some design aspects in more detail. The estimates of time were largely consistent with our proposed schedule, though some advance work may be required. Cost estimates covered a large range, depending upon the level of development required and the experience of the vendor. We are assessing how this information will be incorporated into our overall plans.

Ron Price has been working on requirements for the optical assemblies, and we now have contractors on board to help review these requirements and approaches. He and Nathan Dalrymple are also extending the thermal control consideration for the optical assemblies.

Instrumentation

The optics that feed the coudé labs have evolved to include a smaller collimated beam, as well as configurable feeds that allow for multiple, simultaneous instrument use. A beam reducer relays the 200-millimeter pupil into each lab at a 100-millimeter size. Ming Liang is investigating various transmitting optics that can provide changeable plate scales, thereby providing telecentric, flat focal planes to feed the spectrographs. The High altitude Observatory (HAO) and the University of Hawaii Institute for Astronomy (IfA) are converging on designs for the visible and infrared (IR) spectropolarimeters. We also intend to explore reflecting-type options, but wish to have at least one example of a multiple instrument arrangement for the CoDR.

continued

ATST Design Progress continued

The interfacing option mentioned above is concentrating on *f*/20 and *f*/40 options to feed fixed instrumentation, allowing for two plate scales. The new interface option allows for insertion of dedicated beam splitters, allowing flexibility of instrument location. In addition to the work at HAO and IfA, Allen Gary (NASA/MSFC), K. S. Balasubramaniam and Gil Moretto (NSO), and Thomas Kentischer and Michael Sigwarth (Kiepenheuer Institute) have been making progress on a visible tunable filter system design. The team has also been helped with the addition of Laura Allaire (University of Rochester), a graduate student under the supervision of R. Boyd and J. Thomas. The initial optical design of the tunable visible filter system comprises three cascaded Fabry-Perot etalons, 200 millimeters in diameter in a *f*/300 telecentric configuration. Additional studies of the proposed filter system will include the optimization of spatial and spectral ghosts, surface quality and mounting of large etalons, polarized ray-tracing, and thermal stability and drift.

Under the leadership of Haimin Wang, the New Jersey Institute of Technology team is investigating the near-IR tunable filter system. In its present concept, this system will be a combination of a tunable Lyot-type filter and a Fabry Perot. Don Jennings (NASA/GSFC) is leading an effort to develop a concept for a far-IR spectrograph.

Controls and Software

Bret Goodrich and Steve Wampler are continuing to evaluate methods of implementing a common infrastructure for the ATST control and software communications environment. The choice of candidates for communications is narrowing to 1) adapting a form of the Atacama Large Millimeter Array (ALMA) control system; and 2) a Networking Delivery Data Service (NDDS)-type system from Real-Time Innovations (RTI). The goal is to have an easy-to-implement, but flexible, system that can be interfaced to a variety of other software and hardware platforms, including LabVIEW and EPICS.

Systems Engineering

Rob Hubbard has completed the main top-down system-level error budgets. His efforts have focused on the three highest priority budgets, all of which bear on delivered image quality: 1) diffraction-limited performance in the visible spectrum with closed-loop active and adaptive optics; 2) best-case seeing-limited performance in the near-IR using closed-loop active optics only; and 3) coronal imaging where no wavefront feedback is available. We are now adding initial bottom-up estimates where they are straightforward, as well as some statistical analyses for things such as windshake and seeing effects. The top-down error budgets are available on our Web site. Analyses performed to date were presented at the CoDR in August.

Sensitivity and tolerance analyses of major optical and mechanical interfaces have been initiated. This work examines interactions between the mechanical design, optics, and error budget constraints for the various modes of operation. An initial optical-alignment plan is also being discussed, and will be documented soon.

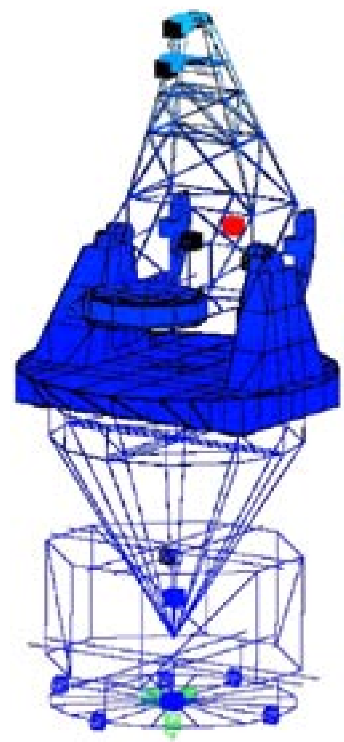


Figure 2. Finite-element model of the telescope system.

Photon Engineering is working to complete some diffractive-based stray light analysis. They have completed most of the geometrical analysis, and their interim report is available on the Web. Their analysis supports the latest work from the University of California at San Diego, and leads us to conclude that stray light is not a large driver of enclosure concept decisions.

Upcoming Milestones

The project's upcoming major milestones include site selection in October, completion of the construction phase proposal at the end of this calendar year, and moving into the preliminary design stage at the beginning of the new year. Keep an eye on our Web site for the latest developments. It promises to be a very busy fall/winter period.

SOLIS

Jack Harvey & the SOLIS Team

This is an exciting time for the SOLIS project. The major instrument, the 50-centimeter aperture vector spectromagnetograph (VSM) has frequently been pointed to the Sun since late May. This was very tentative at first, as heating of the optics by the *f*/6 Ritchey-Chretien telescope was a natural concern. The active cooling system does its job well, and even after all-day operation and outside temperatures exceeding 110°F, the optics maintain temperatures as expected. The spectrograph entrance slit receives flux of about 300 times normal sunlight and it remains unfazed. Presently installed at the GONG testing site at the Campus Agricultural Center of the University of Arizona, the SOLIS mount and VSM look somewhat strange in such a flat, farm environment.

As with any new major instrument, there are many commissioning issues that have to be addressed. One significant surprise was an inability to rotate the grating as far as needed to reach all of the spectrum lines to be observed. This problem was addressed by duct-taping a plastic sheet "bubble" around the base of the VSM, which was pressurized with HEPA-filtered, air-conditioned air, allowing the back of the spectrograph to be opened by brave "bubble-men," who diagnosed and fixed the problem. As expected, there is flexure of the optical system during the course of the day as the gravity vector changes. There are servo systems built into the grating cell to compensate for this flexure, and tests are ongoing. The instrument was also opened to install light traps near the telescope focal plane to reduce scattered light in the spectrograph.

An instrumental surprise was etalon fringing at 1083 nanometers within the silicon image-sensing layer of the hybrid silicon-on-CMOS interim camera detectors. This layer is more than 0.1 millimeters thick, and we expected absorption to minimize any etalon effects. This was not the case, and the team is modeling the fringes following ideas in a paper by Malumuth et al. (*PASP* **115**, 218, 2003). There are no fringes at the other VSM wavelengths.

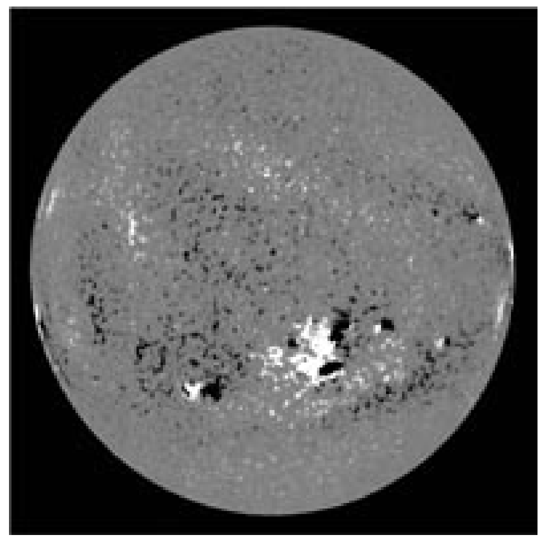


Figure 1. The first full-disk magnetogram obtained with the VSM (8 August 2003). The display saturates at ±150 gauss and the solar image was scanned in 11 minutes.

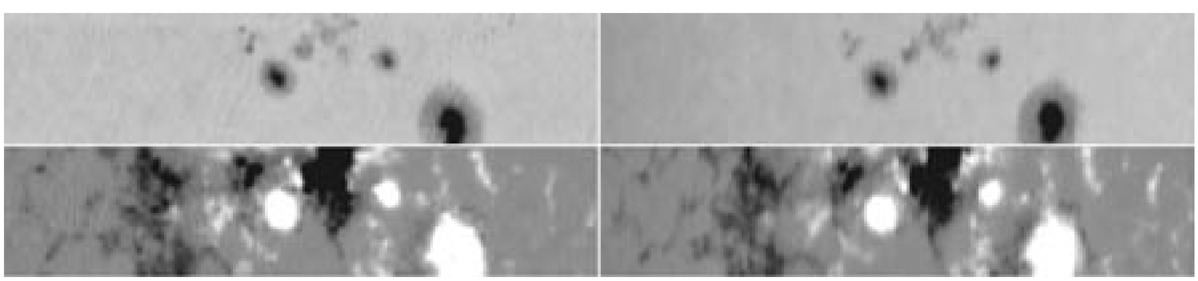


Figure 2. A solar active region observed in poor seeing on 1 July 2003 with the new SOLIS vector spectromagnetograph (left) and the old spectromagnetograph (right). The area shown is about 110x500 arcsec. The top row is intensity and the lower row is the line-of-sight component of the magnetic field. The VSM observation is a crude manual scan consisting of only 20 1-arcsec–high lines across the solar disk, spaced every 5 arcsec and interpolated to fill in the gaps. Single exposures of the polarized solar spectrum were reduced using a primitive algorithm. The noise in this observation (~5 gauss) should be reduced by a factor of ~10 in regular observations.

continued

SOLIS continued

As of this writing, we have not completed a full-disk scan with all systems properly adjusted. A variety of software and hardware issues have prevented us from reaching that major milestone.

Figure 1 shows the first full-disk magnetogram obtained with the VSM. This was obtained with the telescope in less than best focus and without the benefit of a flat-field calibration. The geometry is not fully corrected and image tracking was unguided. In spite of these limitations, the noise level is low, and this first image indicates that the VSM will provide a significant improvement in the quality of solar magnetic field measurements. Figure 2 shows a crude, uncalibrated hint of the potential of the VSM.

It is a high priority to compare VSM measurements with simultaneous ones using the old spectromagnetograph. This will allow the existing 29-year database to be connected to forthcoming SOLIS data. Since the old and new instruments use different spectrum lines, some differences are expected (e.g., the dark ring around the large sunspot in figure 2). Once a month's worth of comparison observations are available, the old instrument will be shut down and the Kitt Peak Vacuum Telescope building will be made ready for installation of SOLIS. The detailed schedule depends on the availability of KPNO mountain staff.

Work on the remaining SOLIS instruments is slow because most people are working on the VSM. The full-disk patrol (FDP) instrument was moved from its basement assembly area to the lab formerly occupied by the VSM. This allowed sunlight to be fed into the FDP using a rooftop heliostat. Good images have been observed using the 1083-nanometer He I and 656.3-nanometer H I lines. When the guider is installed and used to drive the FDP active mirror to stabilize the badly jiggling solar image (due to building vibration of the heliostat), much better images will be obtained.

NASA Sun-Climate Task Group

Jack Eddy

Exploring the nature and extent of the impacts of solar variability on regional and global climate is a targeted research element in NASA's Living with a Star (LWS) Program. The National Solar Observatory (NSO) has been involved in the solar and stellar physics aspects of that endeavor from the inception of the program, initially through contributions to a NASA workshop and a subsequent report on Sun-Climate Connections held in Tucson in the spring of 2000, and through on-going research that addresses both solar and stellar variability.

This year, I joined the NSO staff as a visiting scientist with grant support to assist NASA in refining the focus and definition of the Sun-Climate portion of the LWS Program, in part through service on the NASA Targeted Research and Technology Task Group led by Jack Gosling (Los Alamos National Laboratory). I also established and now chair an interdisciplinary Sun-Climate Task Group with representation from solar physics, atmospheric physics and chemistry, climatology, paleoclimatology, and physical oceanography to examine needs and priorities in the context of the overall climate question. Other members are Gerard Bond (Lamont Doherty Geophysical Observatory), Ray Bradley (University of Massachusetts), Wally Broecker (Lamont Doherty Geophysical Observatory), Lennard Fisk (University of Michigan), Rolando Garcia (National Center for Atmospheric Research), Charles Jackman (NASA Goddard Space Flight Center), Judith Lean (Naval Research Laboratory), Gerry North (Texas A&M University), George Reid (University of Colorado), Michael Schlesinger (University of Illinois), Steve Schneider (Stanford University), George Withbroe (George Mason University), Michael Prather (University of California at Irvine), and David Rind (NASA Goddard Institute for Space Studies). Eleven of the fifteen members of the group met in Tucson in late May with four representatives from NASA Headquarters and NASA Goddard Space Flight Center (Dick Fisher, Lika Guhathakurta, Chris St. Cyr, and Don Anderson) to discuss and develop elements of a report that will be completed this year.

NASA Sun-Climate Task Group Meets in Tucson. Front row, left to right: Chris St. Cyr, George Reid, Michael Schlesinger, Len Fisk, Michael Prather, Lika Guhathakurta, Charley Jackman. Back row: Dick Fisher, Jack Eddy, Rolando Garcia, Gerard Bond, David Rind, Judith Lean. (Also participating were George Withbroe and Don Anderson.)

GONG

John Leibacher

From time to time, GONG has the occasion to take advantage of a unique, nonhelioseismic opportunity, and the Mercury transit of 7 May 2003 was one such opportunity. Cliff Toner spearheaded the transit observations, and Jean Goodrich and Chirag Shroff successfully captured the real-time images seen by three of GONG's instruments (Learmonth, Udaipur, and El Teide). The images were relayed to the NSO/GONG Web pages, which Ruth Kneale and Caroline Barban prepared for the event. The site had over 250,000 hits during the event, and Dave Dooling captured the hoopla in a National Solar Observatory (NSO) press release.

Timing and triangulating such transits allowed 18th century astronomers to make some of the earliest accurate measurements of the Earth-Sun distance, long before the advent of radar or space probes. Today's ability to observe the events in near real time via the Web led Michele Gerbaldi (Institut d'Astrophysique in Paris, Maitre de Conferences at the University of Paris-Sud, Orsay) to propose the unique educational effort of linking GONG observations with the 18th century transit expeditions to stimulate student interest in the science and math. The real-time link from GONG to Professor Gerbaldi's classroom and the world transmitted flawlessly. Development of an educational CD-ROM planned around the entire event is in the works, and should be available on the Web as well. Cliff Toner has been working on the data to further refine our knowledge of the angular orientation of the network (see figure 1).

Next year's meeting, GONG 2004/SoHO 14, is being organized by Yale University and will be held 12–16 July 2004 in New Haven, CT. For more information, contact Sarbani Basu at *sogo04@astro.yale.edu*.

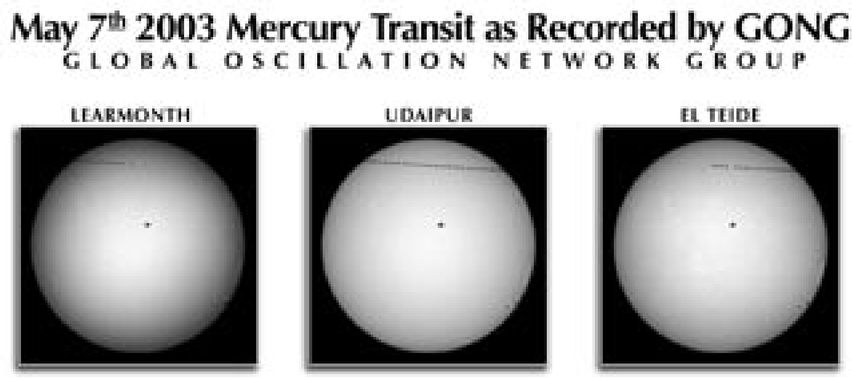


Figure 1. The transit of Mercury on 7 May 2003 was visible at three GONG sites. The transit was in progress when the El Tiede instrument began observing, Udaipur saw the entire transit, and Learmonth collected about 3.5 hours of the event before the Sun set. Included here is an excerpt from the press release, "Mercury Transit 2003: GONG Network Records Transit of Mercury; Ready for Venus," which is available, along with images and other transit sites and educational links, at gong.nso.edu/mercury transit03/: "GONG's global network of telescopes captured and relayed images of the transit of Mercury across the face of the Sun on May 7, providing people worldwide with a safe, front-row view of the event. 'The network worked extremely well with clear skies at all three sites, and the data transmission back to Tucson was great!' said Dr. John Leibacher. 'We transmitted just one image from each site every 15 minutes, and a few were missed, but it looks like we'll have very close to 100% when the dust has settled.' . . . Dr. Cliff Toner said, 'Success with the Mercury transit sets the stage for next year's Venus transit, which will allow more accurate calculations because Venus is farther than Mercury from the Sun.'" The data will be used to verify the absolute angular orientation and image scale for these three instruments. It may also be useful in estimating the upper limits of our image distortion.

Operations

The GONG prototype instrument at the University of Arizona (UA) farm had originally been envisioned as a "ground simulator" for devising solutions to field problems, the development of new technologies, and also as a spare western-US site at a longitude between Cerro Tololo and Big Bear. Due to aging components, failures in the field systems have resulted in the prototype instrument being compromised. Since the development of the GONG+ instrument, it has been used to provide emergency spares for actual field systems and, as a result, it has lost much of its usefulness as a prototype and engineering site for the testing and certification of fixes and modifications, as well as a test bed for any possible new capabilities. George Luis has joined the GONG team to address reestablishing the GONG farm engineering site to a full-up working system. George has been working as an electrical engineer for SOLIS, and we are very happy to have him on the team. In addition to restoring

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GONG continued

the engineering site and working with the operations team, George will lead the planning of an additional shelter/instrument at the GONG farm that will serve as a field-swappable spare to address many of the issues in the transition to long-term continuous operations.

In the second quarter of 2003, two preventive maintenance trips took place. The first was to Cerro Tololo in May. Most of the work was routine except for the replacement of the Lyot Filter/Michelson Interferometer assembly. As we reported in the March 2003 *Newsletter*, the ADP elements in the Udaipur instrument's filter assembly have reacted with moisture in the air, bonded to the neighboring calcite elements, and turned cloudy at the interface. As a result, the filters at all of the sites will be rebuilt and replaced to prevent future failure.

The second site, El Teide, was visited in June. The interferometer was replaced, and the Uninterruptable Power Supply (which was failing to sustain the instrument during power dropouts) was repaired. At the end of March, a replacement CPU board and a DLT drive for the on-site SUN workstation arrived in Udaipur. The new items were quickly installed and, instead of halting approximately once per day and requiring a power-cycle reboot, the workstation began operating normally. This problem did not stop data collection, but did compromise our ability to monitor the instrument.

A major improvement at the Udaipur instrument was the implementation of an ISDN connection to Tucson. At present, this is the network's only special-purpose connection, as it is relatively expensive and our typical present usage requires only a modest bandwidth. The ISDN connection has greatly improved our day-to-day monitoring of the system. There continues to be some variation in the output of one of the four camera channels at Udaipur. The output variation has been known for some time, but has not been particularly detrimental. Unfortunately, this has changed over the last few months and the output data is no longer stable. The remedy will be to replace the camera when the instrument comes back up after the monsoon. The instrument has also failed to guide for extended periods of the day. This could be related to a parameter (which can be affected by particularly hazy atmospheric conditions) that assists the guider to lock onto the Sun. At the same time, the utility power and the GONG generator were not operating properly, so the site was taken off line for about two weeks. By then, the arrival of monsoon weather precluded further analysis of the guider performance. A maintenance team will be visiting India in October.

Figure 2. George Luis (left) and Sudhir Gupta are taking a closer look at the GONG light-feed. George has recently joined the GONG team to reestablish the GONG farm engineering site to a full-up working system. Sudhir, from the Udaipur Solar Observatory, was in Tucson participating in an intensive, hands-on training program for maintaining and trouble-shooting the GONG instrument.

During the last week of April and the first two weeks of May, the Learmonth, Udaipur, and El Teide instruments were switched from the normal observing mode into a calibration mode to determine the camera rotator orientations for the Mercury transit on May 7. Ideally, this would require sacrificing one day of observations at each of the three sites. However, because of undesirable weather and intermittent problems with the calibration observations, more time was required to get the needed data. Fortunately, all of the test measurements were made and the transit images were obtained at all three sites (see figure 1).

Data Management and Analysis

We would like to welcome two new members to the GONG staff: Irene Gonzalez-Hernandez and Shukur Kholikov. Shukur joins us from the Ulugh Beg Astronomical Institute in Tashkent, Uzbekistan and will be in charge of the time-distance and acoustic holography portions of the GONG pipeline. Irene has returned to helioseismology after an interlude as a programmer in a London financial

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GONG continued

institution. She will take over the ring-diagram pipeline, which Thierry Corbard installed. In addition, Anna Malanushenko has returned as a summer student and is continuing to work on farside imaging with Charlie Lindsey.

During the past quarter, the DMAC produced month-long (36-day) velocity time series and power spectra for GONG months 75 and 76 (ending 1 November 2002), with fill factors of 0.77 and 0.86, respectively. The Data Storage and Distribution System (DSDS) distributed 300 gigabytes in response to 26 data requests.

The ring-diagram and image-merging portions of the GONG++ pipeline have been undergoing improvements in the area of interpolation and restoration. Thanks to the Local Helioseismology Comparison (LoHCo) team activities, differences were found between ring-diagram results using GONG data processed through the Arizona (NSO/GONG) pipeline and GONG data processed through the California (Stanford) pipeline. The differences were in the number of modes fitted, the apparent frequency gradient across the disk, and artifacts in the ring diagrams.

Irene Gonzalez-Hernandez, Cliff Toner, John Bolding, Rachel Howe, and Rudi Komm tested several combinations of image restoration, as well as *sinc*, Fourier, and spline interpolation in both the image merge and the remapping and tracking modules. They found that the most consistent and best results were obtained using nonrestored, *sinc*-interpolated, merged images, and by using the spline interpolator in the remapping stage. We are thus adopting this combination as the initial standard GONG ring-diagram processing. We will, however, continue to investigate and develop fitting methods that can exploit the increased information content of the restored merged images. The completion of this testing means that we will be able to begin producing flow maps on a regular basis.

The SoHO/MDI group at Stanford University hosted the second LoHCo Group workshop on April 30. The workshop materials can be found on the Web at *gong.nso.edu/lohco/* along with the poster presented at the AAS Solar Physics Division meeting in June. Doug Braun at Colorado Research Associates hosted the third workshop in Boulder, CO, July 28–30. The LoHCo group has made good progress on the comparisons between data sets (GONG, MDI, and Mt. Wilson) and between the ring-diagram and time-distance methods.

Using the *V-I* multispectral fitting method that she developed, Caroline Barban has obtained intriguing pictures of the physical amplitudes and phases of the solar background components. The quantities are not at all random and have very clear signatures as a function of temporal frequency, but little dependence on degree. This implies once again that the source of the oscillations is near the surface. The detailed shapes of the curves will be used to constrain physical models of the excitation.

One remaining baseline processing issue is the full implementation of the high-time-coverage magnetogram capability. The current magnetograph modulator suffers from a rather slow switching time, which compromises the ability of the instrument to produce a reliable zero-flux point. Richard Clark has been working with Jack Harvey on the correction of the GONG+ magnetogram zero error. The accurate determination of the zero-point is important for two scientific uses. The first is the study of magnetic field changes associated with flares for which a zero error of 1 gauss is sufficient. The second is the study of slow-changing, large-scale fields used to infer the coronal magnetic field for which the zero error greater than 0.1 gauss is likely to be detrimental. The former has been achieved but the latter has proven to be very difficult. Although the continuous magnetograms are considered a by-product of the helioseismic data collection and processing system, their community value continues to rise, and therefore it is important to continue to investigate this issue. The limiting factor appears to be the noise level of the calibration magnetogram obtained at the start of the day.

At this point, it appears that further improvement can only be accomplished by modifying the instrument itself. Since this would take some time, a two-pronged approach has been established: GONG will make the once-an-hour magnetograms available to the community with the understanding that the zero-point is within 1 gauss, and upon request, once-a-minute magnetograms with the 1 gauss zero uncertainty will be prepared for selected time periods. Efforts to determine the zero-point to a tolerance of 0.1 gauss will resume at a later date as a research project. Richard has returned his focus to the automated rejection of bad images during the calibration process. He is running a suite of tests on a large amount of incoming data and will compare the results with those of Greg Ladd's visual inspection procedure, but we look forward to the automation very soon.

Clear Skies and Challenging Observing Projects: The 2003 TLRBSE Summer Workshop

Doug Isbell, Stephen Pompea & Steven Croft

Eighteen competitively selected science teachers spent two weeks in early July at Kitt Peak National Observatory, as the culmination of an intensive teacher enhancement and retention program designed to bring active astronomical research into the classroom.

The second full year of NOAO's Teacher Leaders in Research Based Science Education (TLRBSE) program featured two new observing projects, which were aided by five clear nights of observing time on three of Kitt Peak's major nighttime telescopes, plus two days at the world's largest solar telescope

The teachers, who had to complete a challenging on-line Distance Learning course before even making it to Arizona, also received training on how to be an effective mentor to novice teachers. Each of the TLRBSE participants, who hailed from all across the country from Alaska to Puerto Rico, will be expected to mentor three teachers in their area to help retain them in the field during their challenging early years in the profession.

The four astronomical research projects covered these topics:

- Searching for novae in the massive nearby spiral Andromeda galaxy (M31), using the WIYN 0.9-meter telescope on Kitt Peak. Participants took images of sections of the Andromeda galaxy that can be compared with earlier photos of the same regions to identify the transitory signal of these bright stellar outbursts. These outbursts occur when mass is transferred between two stars in a binary system, causing the surface layers of one star to ignite explosively from the fusion of hydrogen nuclei. The research objective of this TLRBSE project is to characterize the different types of novae, the rate of novae outbursts in galaxies of various sizes and shapes, and the distribution of binary and white dwarf stars in M31.

- Searching for Active Galactic Nuclei. Participants used the historic 2.1-meter telescope on Kitt Peak to obtain spectra of these deep space beacons, which include radio galaxies and oddballs like BL Lacertae objects. The research objective of this TLRBSE project is to characterize the environment of the early universe.

continued

Figure 1. 2003 TLRBSE summer workshop participants and NOAO staff at Kitt Peak.

WORKSHOP ATTENDEES

Sherry Brown (Edmonds Woodway High School, Edmonds, WA)
Harlan Devore (Cape Fear High School, Fayetteville, NC)
Velvet Dowdy (Graves County High School, Mayfield, KY)
Steve Harness (Kingsburg Joint Union High School, Kingsburg, CA)
Joan Kadaras (Westford Academy, Westford, MA)
Tim Lundt (Burchell High School, Wasilla, AK)
Kathy Malone (Shady Side Academy, Pittsburgh, PA)
Ivy Merriot (Abaetern Academy, Bozeman, MT)
Thomas Morin (Belmont High School, Belmont, NH)
James Myers (Warren Central High School, Bowling Green, KY)
Brian Rogan (New Jewish High School, Waltham, MA)
Gary Sampson (Wauwatosa East High School, Wauwatosa, WI)
Elba Sepulveda (CROEM, Mayaguez, PR)
Marty Stuart (Bozeman High School, Bozeman, MT)
Dwight Taylor (Goldenview Middle School, Anchorage, AK)
Karin van Klaveren (Golden West Middle School, Fairfield, CA)
Thomas Vinng (Desert Mountain High School, Scottsdale, AZ)
Diedre Young (Cornerstone Community Christian School, Kelso, WA)

TLRBSE Summer Workshop continued

- A new TLRBSE project designed to characterize a common but poorly understood group of variable stars whose basic composition is similar to the Sun. Participants used the coudé feed telescope on Kitt Peak to obtain spectra of a class of irregular variable stars known as RV Tauri stars. These variables, which vary in their output on a measurable timescale, are thought to be in the process of changing from giant stars to white dwarfs by ejecting shells of material. Although many of these stars have been well-studied photometrically, their spectroscopic (compositional) features are not well known. The research objective of this TLRBSE project is to obtain a spectroscopic record that can be used to unravel the details of change in these rapidly evolving objects.

- A new TLRBSE project on multiwavelength solar imagery and spectroscopy. Participants used the gigantic McMath-Pierce Solar Telescope on Kitt Peak to obtain infrared spectra across sunspot groups to observe Zeeman splitting. The spectra were used to create magnetic field profiles across the sunspot groups, which were then combined with images of the Sun at wavelengths ranging from infrared to X-ray to help unravel the evolution of these groups and how they vary from one to another.

Although the participants spent most of their time on their own projects, most teachers had an observing experience on all four telescopes.

With all the clear nights, the TLRBSE participants were also able to make a number of additional observations. For example, the teachers used the 0.9-meter telescope to take multicolor images of several objects of educational interest, including planetary and diffuse nebulae and nearby galaxies. These images will allow students to construct their own enhanced color images of these familiar objects.

"It was a joy to work with such a dedicated, talented, and hard working group of science teachers," said Stephen Pompea, program director for TLRBSE at NOAO Tucson. "They encountered all of the challenges of astronomical research in their work at Kitt Peak National Observatory, and they performed admirably. It was a pleasure to have them as research colleagues."

The 2003 TLRBSE participants will attend the April 2004 meeting of the National Science Teachers Association in Atlanta as part of their continuing commitment to the program.

Now in its second full year following an earlier incarnation known as RBSE, TLRBSE is an inquiry-based Teacher Enhancement Program for middle school and high school teachers funded by the National Science Foundation (NSF).

The TLRBSE program also publishes an ongoing peer-reviewed journal with science results from its student-teacher research groups, who will continue to receive data from Kitt Peak throughout the year. TLRBSE will continue to expand with a new class of teachers in early 2004, for which recruiting will begin in September. See *www.noao.edu/outreach/tlrbse* for further information.

continued

Quotes from 2003 TLRBSE Teachers

"I felt from start to finish that I was a valued professional."

"[The astronomers] were especially trusting in letting us operate the telescopes and assisting in observatory operations—I felt a real sense of acceptance from them."

"This program has all the components needed to meet their objectives of training mentors and doing actual research. One of the best I have ever been involved in."

"There were some logistical flaws but the staff corrected [them] quickly. This was hands down the best workshop I have attended."

"Content-wise, the Distance Learning course was good preparation. It hit the right areas."

"I felt like I was a graduate student-cranking data, taking down and setting up the telescope. I can't believe [the astronomer] trusted us [to do all these things] but that was true of all the staff."

"This is an excellent program. It was a great experience being around astronomers and learning to use scientific instruments. Also, sharing information about astronomy and education issues with other teachers is very helpful."

"I had the experience of being an astronomer, and being able to tell my students about that is invaluable."

"I've attended almost every workshop there is for science teachers and TLRBSE is, by far, the very best one I've been to."

TLRBSE Summer Workshop continued

We strongly encourage you to find teachers in your area who might be interested in applying for the program.

We would also like to thank NOAO and NSO staff members Patricia Knezek, Frank Hill, Christoph Keller, Carl Henney, and Claude Plymate, among many others, who contributed their time and expertise to the preparation and performance of the workshop.

Figure 2: NSO staff scientist Christoph Keller observes TLRBSE teacher Ivy Merriot as she takes flat fields for her group's observations with Keller's infrared spectrometer at the McMath-Pierce Telescope Facility during the summer workshop.

NSO and KPNO 2003 REU Attendees

NSO 2003 Research Experiences for Undergraduates (REU), Research Experiences for Teachers (RET), and Summer Research Assistantship (SRA) Program participants. Back, from left: Thomas Haxton (REU, University of Chicago), Ludovico Cesario (Grad SRA, Universita La Sapienza, Italy), Francisco Virgili (REU, Michigan State), K.S. Balasubramaniam (NSO REU/RET Site Director), Mark Janoff (REU, Swarthmore College), Charles Baldner (Undergrad SRA, Maccalester College), Sebastien Deroche (Grad SRA, EESO-France), Jesse Miner (Undergrad SRA, State University of New York at Stony Brook), Matt Dawson (RET, Brockton High School), and Linda Stefaniak (RET, Allentown High School). Front, from left: Sarah Jaeggli (REU, University of Arizona), Anna Malanushenko (Undergrad SRA, St. Petersburg University, Russia), Cheryl-Annette Kincaid (Undergrad SRA, University of North Texas), Victoria Astley (REU, Florida Institute of Technology), and Laura Allaire (Grad SRA, University of Rochester). Missing from photo are Steven Olmschenk (REU, University of Chicago) and Travis Stagg (RET, West Valley High School-Fairbanks).

KPNO 2003 Research Experiences for Undergraduates (REU) participants. Left to right: Meredith Hughes (Yale University), Kevin Schlaufman (Penn State University), Amy Bender (University of Illinois at Urbana), Jennifer Connelly (Dickinson College), Mia Bovill (University of Maryland), and Tuan Do (University of California at Berkeley).

The REU/PIA Programs at CTIO

Alan Whiting & Nicole van der Bliek

In a control room high in the Chilean Andes, three astronomers are guiding the motions of a large telescope and the actions of a sophisticated electronic detector attached to it. They have just finished collecting light from a supernova, whose careful measurement may help to determine the motion of the whole universe, and in a moment, after observing certain standard stars to establish the night's calibration, they will look at the bubble of tenuous gas blown by a dying star. This is not an unusual night at Cerro Tololo Inter-American Observatory (CTIO), but these are unusual astronomers. They are undergraduate students from schools in the United States and Chile. One of them is now making the decision about which standard will give the best data for the fate of the Universe.

This is a scene from the recently concluded 2003 CTIO Research Experiences for Undergraduates (REU) and Prácticas de Investigacíon en Astronomía (PIA) activities. For ten weeks La Serena was host to five US and two Chilean undergraduates, teaching them about astronomical research by having them perform it at an international institution boasting cutting-edge instrumentation and science.

The programs are a living example of the international character of our science. US students, English-speaking and a long way from home, lived and worked together with Chileans (who were in a foreign environment in a different way). Coping with differences of language and culture was every bit as important a learning experience as mastering the intricacies of observational astronomy.

Lara Pierpoint (UCLA) starts an exposure on the CTIO 0.9-meter while Abner Zapata (Universidad de Concepcion) watches carefully.

Image of the barred spiral galaxy NGC 1097 constructed from data taken by Rebecca Wilcox (University of Washington), Lara Pierpoint (UCLA) and Abner Zapata (Universidad de Concepcion). Supernova 2003B is the star just to the left of the smaller elliptical galaxy at upper right.

Though the students are no longer at CTIO, their part in the program is not finished. At the January 2004 AAS meeting in Atlanta, GA, they will meet again to present their work as poster papers (and take their place in the more general astronomical community).

The preparations for next year's program are already underway and we are soliciting applications for 2004. The application deadline is 1 October 2003. The program is open to US citizens or permanent residents who will be enrolled as full-time undergraduate students through January 2004. Please check the CTIO REU Web page (*www.ctio.noao.edu/REU/reu.html*) for application materials and the latest news about our 2004 program, as well as for more information about the CTIO REU program, projects, and participants from previous years.

Please direct inquiries to *ctioreu@noao.edu*.