From the Director’s Office

Steve Keil

NSO Response to the Senior Review

The report of the Senior Review commissioned by the National Science Foundation’s Division of Astronomical Sciences (NSF/AST) was released publicly on November 3 (see www.nsf.gov/mps/ast/ast_senior_review.jsp). The report is a set of recommendations that will be vetted by the national observatories and the scientific community as NSF develops an implementation plan.

The National Solar Observatory is pleased that the Senior Review report substantially affirms its long-range planning. We are ready to work with the NSF on the implementation of these recommendations, while ensuring that the solar research community—including students—can continue their advanced work, enabled by the unique NSO facilities, until the Advanced Technology Solar Telescope (ATST) is ready to conduct science.

The Senior Review report is strongly supportive of the solar community’s desire to build the ATST as the next major national solar facility to replace our aging telescopes and advance high-resolution and coronal science to the next level of scientific discovery, while revolutionizing our understanding of the interactions between the highly ionized solar plasma and the magnetic field. The report also supports NSO plans to expand SOLIS into a three-station network through international partnerships, as recommended in the decadal survey.

With strong NSF support, NSO and the solar community have devoted considerable effort to designing the ATST to meet the scientific challenges of understanding the complete spectrum of solar magnetism, along with the activities it creates that impact humankind. The Senior Review supports our plan that ATST proceed to construction in 2009, with completion in 2014, followed by other large projects such as GSMT, LSST, and the Square Kilometer Array as soon as feasible. NSO has done its homework for ATST, and as demonstrated at the NSF-sponsored Preliminary Design Review in November, we have done it extremely well.

The Senior Review report recognizes the efficiency of the NSO operational model, calling for the maintenance of current NSO staffing levels into the ATST era, and for the start of transitioning positions to ATST as soon as possible. This is reflected in NSO’s long-range planning, and the report commends NSO for acknowledging the need to give up still-productive solar facilities in order to free resources for the ATST project.

The Sun is the most significant astronomical object that we study, given the direct relevance of its output to Earth’s environment, our economy, and the defense of our nation. It is of utmost importance that the NSO and NSF work together to ensure that advanced research and solar monitoring, supported by NSO facilities, continue without interruption until the ATST is built. Thus we will work closely with the NSF to ensure a smooth transition between existing programs and those of the ATST era.

While for the most part the Senior Review report endorses the NSO long-range plan, there are some significant differences between its recommendations to NSF/AST and those called for by our community-driven plan. The Senior Review recommends that we find alternate funding sources for GONG, or plan for its closure, one year after the commissioning of the oscillation experiment on NASA’s Solar Dynamics Observatory (SDO). We are concerned that implementation of this recommendation removes a cornerstone of the NSO program, which is based upon the comprehensive study of the Sun from its core to its hot corona.

If closed on this schedule, the new high-resolution upgrade of GONG, which has enabled local helioseismology, would not complete its data collection over one solar activity cycle, nor would the new science to come from the continuous high-sensitivity magnetograms be exploited. The GONG science community has produced several compelling arguments as to why a ground-based oscillations experiment needs to continue. These points will be

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discussed with the NSF. NSO will also explore alternate funding sources to reduce the cost of GONG operations to NSF. Additionally, the NSO long-range plan calls for a phased merging of GONG and SOLIS operations into a single, efficient NSO synoptic program providing the data required to put ATST and space experiments into the context of long-term variations in solar activity.

The recommendation for GONG is similar to that for Arecibo and the VLBA. The Senior Review Committee recognized the superb science that GONG has produced, and proposed an orderly shutdown for the facility that would allow a transition to a new helioseismology experiment (Solar Dynamics Observatory), as well as the establishment of a GONG legacy database. Specifically, GONG should be closed only if a majority of its operations cost cannot be found from external agencies or partner countries. The recommendation allows for one year of overlap of GONG and SDO operations in order to perform cross-calibration of the instruments.

The report also recommends tying the ramp down of NSO's major telescope facilities to the beginning of ATST construction. NSO has planned to phase out operations at Kitt Peak and Sac Peak facilities, with final closure tied to the commissioning of ATST. This ensures that the US solar community has continuous access to state-of-the-art instrumentation supporting their research, and that the community has the necessary facilities to develop ATST technology (e.g., multi-conjugate adaptive optics, advanced multi-line polarimetry, infrared and thermal infrared instrumentation), and to develop the techniques (such as interpretation of advanced polarimetry measurements) needed to fully exploit ATST. These facilities are vital to continued training and development of the next generation of solar scientists and instrumentalists, who will be necessary to achieve the scientific goals of the ATST.

NSO plans ensure a smooth transition of personnel to ATST operations, without creating large near-term funding spikes, having already transferred considerable resources to ATST development. All current instrument programs at the Dunn and McMath-Pierce Solar Telescopes were approved on the basis of their contribution to ATST technology development and, when these are completed in the next year or two, no further instrumentation specific to existing telescopes will be developed. We will continue to work with NSF to effect this transition in the most logical fashion, without leaving a major gap in US observing capability, and in the training of the next generation of solar physicists where NSO plays a key role.

There is also a recommendation for NSO to expedite plans for the consolidation of its scientific and technical staffs.

The location of a new headquarters for NSO remains to be determined. The process that is being discussed between NSF/AST, NSO, and AURA will include a request for proposals from interested institutions followed by a thorough consideration of proposed sites. The decision to unify NSO operations is of course dependent on the timescale for ATST construction funding, which has not yet been approved.

The shutdown of NSO facilities on Kitt Peak and Sacramento Peak is part of the long-range plan put forward by NSO as we transition into the era of the ATST. The divestment of the facilities and the establishment of a new home for NSO will be a complex process entailing a search for organizations that may be interested in assuming ownership of existing facilities, possible demolition, environmental mitigation, and negotiation with potential new ‘landlords’ for the NSO headquarters. The Senior Review recommendation reflects their understanding of these complexities and encourages an early start for the preparations. The details of the transition from the existing facilities to the new one will be part of the NSF/AST implementation plan, and NSO will work closely with NSF/AST in shaping that plan.

We look forward to working with the National Science Foundation and the scientific community on the responsible implementation of the Senior Review recommendations for the National Solar Observatory. The Sun is an astronomical object of profound importance to our lives, and it is therefore vital to the nation that we continue to provide advanced capabilities for the investigation of our nearest star.

ATST Preliminary Design Review

During the first week of November, NSF held a four-day Preliminary Design Review (PDR) of the ATST, assessing its readiness to move into the construction funding approval stage. The review panel, selected by NSF, was extremely impressed with the quality of the work presented. The ATST team is to be congratulated for their dedicated and excellent efforts that form the basis for the current ATST design and plans.

Under the very capable leadership of Project Manager Jeremy Wagner, the PDR presentations established the readiness of the project to begin construction as soon as funding is secured. The team displayed great technical competence and professionalism, and were able to address all of the issues raised by the committee to its satisfaction. The team should be proud of their accomplishments, which have provided the solar community and NSF with the material to forge ahead with the realization of the ATST. It became clear to everyone at the review that ATST will be a facility with unique capabilities that should revolutionize solar astronomy.
SOLIS data showing evidence of the emerging solar cycle, and a subsequent NSO press release, caught the notice of three “science watch” news agencies, and a local news station (see the accompanying figure and solis.nso.edu/news/Cycle24.html for details). A journalist with the BBC contacted Project Scientist Jack Harvey, while he was attending the IAU meeting in Prague, to discuss the characteristics of Cycle 24 and its ramifications for space weather and communications. Highlights from this interview were included in BBC’s weekly “Science in Action” broadcast. Information from the press release also appeared in Space Daily and Space Ref: Science News as It Happens. A few additional high-latitude “new cycle” regions have been observed since the press release.

Program Scientist Carl Henney and NSO postdoc Nour-Eddine Raouafi attended the Second Ambiguity-Resolution Workshop from October 4–6 in Boulder, CO. An important goal of the workshop was to define a merit function to rate which algorithms are best suited for any given user’s requirements. Currently, the algorithm developed by Manolis Georgoulis has emerged as the clear choice for a large dataset such as that of the SOLIS Vector Spectromagnetograph (VSM), with accuracy, stability, and automated functionality. A sample set of active regions observed by the VSM and disambiguated using the Georgoulis algorithm is available via the SOLIS Web site (solis.nso.edu).

SOLIS data processing aides Jessica Goodman, Nathan Hadder, and Alex Toussaint have made good progress with various VSM-related projects. Jessica has completed processing level-2 photospheric (630.25 nanometer) longitudinal-magnetogram data. This data set has greater magnetic sensitivity—especially within sunspot umbrae—and will replace the currently available (630.15 nm) magnetograms within the year. Nathan has continued upgrades to the SOLIS database and browser interface to VSM data. Nathan also completed implementation of Jack Harvey’s new 854.2-nm processing code. The new code is currently being tested for pipeline processing. Alex has made great progress compressing VSM Stokes profile data using Hermite polynomials. Detailed analysis between the observed and fitted profiles will continue through the fall.

New feed optics were installed for the Integrated Sunlight Spectrometer (ISS) to reduce the image size illuminating the fiber that connects to the ISS. A smaller-diameter quartz fiber was installed at the SOLIS tower after the ISS moved to Kitt Peak. With the new feed optics, the ISS is no longer undersampling the solar disk. The pointing of the feed optics was adjusted during installation to co-align with the pointing of the VSM. Software and two frame-grabber boards were purchased to read out the two Full Disk Patrol (FDP) cameras. This change allows for the rapid and simultaneous display of the cameras, required for optical alignment of the visible and infrared paths needed to affix the beamsplitters to the instrument.

This equator-to-south pole subsection of a SOLIS/VSM magnetogram from 23 July 2006 shows the location and polarity of magnetic fields as light and dark patches. White indicates polarity rising out of the solar surface and black indicates polarity into the surface. An eruption of the new cycle is labeled in the lower, high-latitude part of the image. A current cycle low-latitude eruption is labeled at the top. Notice the reversed east-west orientation of the eruptions. Magnetic patterns in the northern hemisphere will be reversed, i.e., black-white near the equator for the current cycle, and white-black near the poles for the new cycle.
The Science Working Group (SWG) for the Advanced Technology Solar Telescope (ATST) held its first-ever meeting on Maui from October 17–19. The meeting in Kihei marked a clear shift in the group’s focus from the design of the ATST to the definition of detailed science needs and science cases.

“The second day’s session of science presentations was particularly interesting and useful for gauging the current state-of-the-art in solar physics research,” said SWG Chairman Thomas Berger (Lockheed Martin Solar and Astrophysics Laboratory).

The SWG was organized around status updates and reviews of major focal plane instrument designs on Tuesday, science discussions on Wednesday, and a final half-day meeting summary and assignment of action items on Thursday. Special guests included Mark Hoffman of Maui Community College, and native elder and teacher Verna Nahulu.

Wednesday’s session was targeted at detailing the science topics in which ATST will excel. SWG members were invited to prepare short reviews of science topics of their own choosing at the forefront of solar physics, followed by an outline of how the ATST instrument complement will be used to improve our knowledge of this topic. The reviews included basic instrument “observing programs” describing how solar physicists would like to see the ATST instrument array used when it comes on line, and the science data products they would find useful.

The SWG then held a brainstorming session on research areas where our knowledge of the Sun is lacking, and how the ATST might fill these gaps. Group members asked:

• What are the main questions that remain unanswered?
• How will the unique capabilities of the ATST address these questions?
• What specific measurements should ATST make?
• What ground- or space-based instruments should be used with the ATST?

The Thursday session ended with selection of four cases to be developed as clear and concise “ATST Science Programs.”

“We need to be able to explain clearly to the larger science community the ways that the ATST will be able to address specific important science questions that have relevance to the larger astrophysics and space physics community,” Berger said. “These ATST Science Programs will be important aspects of the project as it progresses through the various review and approval stages.”

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The four Science Requirements Document (SRD) programs and associated team leaders are:

- **Sunspot magnetoconvection** (SRD 3.1.7), Tom Berger (Lockheed Martin Solar and Astrophysics Laboratory).
- **Chromospheric dynamics** (SRD 3.2.2, 3.2.3), Gianna Cauzzi (Osservatorio de Astrofisico di Arcetri, Italy).
- **Coronal magnetic topology** (SRD 3.2.5, 3.2.7), Haoshing Lin (University of Hawaii).
- **Dynamics of flares and coronal mass ejections** (SRD 3.2.4, 3.3.2), Hugh Hudson (University of California at Berkeley).

The teams will prepare detailed, realistic Observing Plans for each program and show how one or more of the four first-generation ATST instruments will make specific observations in support of each. The finished plans will include the wavelengths, fields-of-view, temporal cadence, data products, and coordinated observing requirements for each topic. Each SWG member will contribute to at least one Observing Plan, with a completion deadline of February 2007, in time for reviews by the Space Studies Board or National Science Board.

SWG members were also asked to review the SRDs and Instrument SRDs for currency, relevancy, and completeness of the science presentation. The finalized SRD is to contain only cutting-edge science: several topics have either been significantly advanced, or have revealed new issues since the original case was made.

"In some sense the SRD is a ‘historical document’ already," Berger noted. "The engineers have nearly finalized the design of the telescope facility, and it is not intended that any updates or changes that we make to the SRD will result in changes to the telescope design."

In contrast, updates to the Instrument SRD science motivations are expected to impact designs to some degree. The issue of observing cadence came up repeatedly in the SWG meeting. Many of the Instrument SRDs now have maximum cadence requirements of 30 seconds or even minutes. Some presentations—especially for studying the chromosphere at high resolution—demonstrated that cadence values on the order of seconds are required to do discovery science below 0.1-arcsec resolution. Instrument designers may have to rethink mechanisms and camera requirements significantly when multi-wavelength requirements are added.

### ATST – Refinement of Enclosure Design

#### The ATST Team

Design elements of the ATST enclosure have been refined in recent months to incorporate recommendations from the Systems Design Reviews conducted in early 2006.

In response to a recommendation for further analysis of the co-rotational requirements of the enclosure and telescope, it was found that, with minor modifications to the enclosure, non-co-rotating operations are possible. A key component of the enclosure modifications is a custom carousel bridge crane, installed on double girders and set at an angle to clear the telescope in any position. The crane, along with a flange feature that allows the primary shutter to be split in two, and leave a large opening in the top of the carousel, will be very useful during construction of the telescope mount.

Exploration of weatherproofing considerations resulted in the adoption of an ‘exoskeleton’ arrangement for the carousel. As shown in figure 1, the weather-tight insulated skin is installed on the inside of the structure. The plate coil panels used for maintaining the carousel surface temperatures are mounted directly to the structure without

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**Figure 1.** The model of ATST, produced on a 3-D printer by Solid Concepts, illustrates the ‘exoskeleton’ configuration for the carousel structure, skin, and plate coil.
skin penetrations that would require detailed sealing. It is expected that this arrangement will eliminate an ongoing maintenance concern once ATST is in operation.

Tailoring the enclosure and associated thermal systems to the particular climatic and terrain conditions of the Haleakalā site has resulted in identification of a number of cost reduction strategies. The optimized thermal system includes a combination of important contributions: a white concrete apron surrounding the enclosure, which produces smaller loads; a slight change in carousel geometry, reducing exposure to insolation; a better understanding of site conditions, reducing the need for thermal treatment; and a less-expensive style of plate coil.

The project has initiated contracts with industry to review the enclosure designs and to provide independent cost estimates. Two different vendors are reviewing the technical challenges of providing the cable wrap needed to transfer the water-glycol solution across the azimuth axis for the carousel plate coil cooling system.

**Summer in Tucson from an REU Perspective**

Rachel MacDonald

“Tucson? I thought you hated hot weather!”

This was the reaction I got when I told people how I was spending my summer, but I was undeterred. I was going to participate in the National Solar Observatory’s summer 2006 Research Experiences for Undergraduates (REU) program, in Tucson, AZ.

I learned about REU programs in the spring of my first year at the University of Washington, but missed the application deadlines. After hearing about just-completed summer experiences from fellow astronomy majors during the next fall quarter, I started researching REU programs. I already had one program on my list—the National Solar Observatory, whose poster I had seen on a bulletin board. I was fascinated from the start, because I had never heard of solar observatories until then. The thought that there were entire institutions dedicated to the study of the Sun was marvelous.

I was accepted to two REU programs. I felt quite proud of that accomplishment, considering the number of students that apply for these spots every year. The first was a private observatory on the East Coast (where I have never been), and sounded interesting, but the second was the National Solar Observatory. Decision made without hesitation!

I left Seattle on a cool, rainy Monday morning, and arrived in Tucson on a hot, dry Monday afternoon. I was the last of the REU students to arrive, and I was worried at first that I would find it hard to get to know people. I had also read
Summer in Tucson from an REU Perspective continued

about other students’ summer experiences that mention psychology or personalities. I need not have worried. I have never worked with such a group of nice, easy-going people as I did this summer. There were 11 of us working in a large room for most of 11 weeks—four NSO students and seven KPNO students. As far as I know, there were no conflicts, and no major personality issues. We all just got along. We told stories, laughed together, talked about our projects, helped each other with computer problems, hung out when not at work, and commiserated about the hot, hot weather. I’m looking forward to seeing everyone again at the American Astronomical Society (AAS) meeting in January, and I hope that we all stay in contact in the years to come.

My project this summer was to look through data taken at the Kitt Peak Vacuum Telescope (KPVT), and find trends in the intensity of the umbra of sunspots (specifically, to see if there were trends tied to the solar cycle). I looked at about 3,000 sunspots from 12 years of data and found that sunspots vary in phase with the solar cycle, getting darker from sunspot minimum to sunspot maximum, and getting brighter from maximum back to minimum. My work on the KPVT data links the previously contradicting results, which came from observations during different times of the solar cycle. This is exciting work that will result in my co-authoring a paper with my advisor, Dr. Matthew Penn.

The whole summer experience was wonderful and fascinating. I learned about sunspots and the solar magnetic cycle. I also learned the programming language IDL, and how many times you can run a program and still not find all the bugs. I’ve read papers, and then later met their authors walking through the hallways at work—a little intimidating at first, but enlightening. I have also discovered how difficult it is to study the Sun during monsoon season in Arizona. More importantly, however, I’ve discovered that I love solar astronomy.

International Research Experience for (Graduate) Students (IRES)

NSO/GONG announces a summer 2007 research program for US graduate students sponsored by the NSF Office of International Science and Engineering (OISE). The eight-week program will take place in Bangalore, India under the auspices of the Indian Institute of Astrophysics (IIA). The goal of the program is to expose potential researchers to an international setting at an early stage in their careers. See eo.nso.edu/ires/ for additional information and application materials.
GONG celebrated its eleventh birthday, spanning half the nominal length of a solar “Hale” activity cycle. Long-term and stable helioseismic measurements of subsurface structures and flows have become a major component of our exploration of activity-related variations in the Sun, and the solar physics community is eager to see how the upcoming solar maximum develops, especially in light of the wide variation in predictions of its amplitude.

The past quarter of GONG activity was filled primarily with a number of international meetings, the continued development of the data processing pipeline for magnetograms in preparation for the STEREO launch, and progress on the construction of the “hot spare” instrument. We had a scare in October from the earthquake in Hawaii, but were fortunate not to suffer any damage at the Mauna Loa site.

Science Highlights
GONG scientific staff contributed 21 papers at the recent helio- and asteroseismology meeting (“GONG 2006”) in Sheffield (United Kingdom), held in conjunction with the SOHO helioseismology instruments and the new European Union network HELAS. Staff also attended the IAU General Assembly in Prague (where we had a Joint Discussion on helio- and asteroseismology); the Second International Symposium on Space Climate in Sinaia (Romania); the HELAS Local Helioseismology workshop in Nice (France); and the Solar Orbiter meeting in Athens. In November, GONG staff participated in a Local Helioseismology Comparison (LoHCo) group meeting in Boulder, CO.

Shukur Kholikov has found that an autocorrelation analysis of the low-degree time series can provide a very sensitive measurement of the “large separation,” the frequency difference between modes with the same degree but different radial order. This has revealed that the large separation varies with the level of solar activity, indicating that the depth of the upper reflection point of the modes depends on the activity. The method can also be used for time-series analysis in asteroseismology, opening a new window on the physical changes associated with stellar activity (see the accompanying figure for details).

Network Operations & Engineering
The months of July and August offered a welcome respite from site maintenance visits, following the magnetograph modulator upgrades and the Learmonth shelter swap during the previous quarter. There was considerable activity at the Tucson site, where spare items were repaired, upgraded, tested and certified for use in the network stations. The turret returned from Learmonth, after the shelter swap was overhauled and installed at the Tucson instrument. Troubleshooting and repair of failed electronics cards progressed significantly during the summer months, and has restocked the supply of usable spares. Testing and burn-in of the new waveplate amplifiers has continued, with installation imminent at some of the

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GONG++ continued

network sites. Cameras and camera power supplies are regularly under test. Adapting the real-time system to work with LTO tape drives has been successful, but this has not yet been tested with the Tucson instrument. All of this work allows for the resumption of preventative maintenance trips during the fall.

The only site visit that occurred this quarter was a preventive maintenance (PM) trip to Mauna Loa. Because the weather did not cooperate during the original installation of the upgraded modulator, and the original alignment had to be completed without sunlight, the follow-up visit to adjust and realign the modulator was useful. Data from Mauna Loa will be checked to verify proper modulator alignment. A few days before the trip began, the CCD temperature stabilization failed on the camera, and a replacement camera was added to the preventive maintenance packing list. In the end, the on-site camera was repaired in the field and the routine PM was completed on schedule.

The shelter for GONG’s Hot Spare system has been completed, with work now proceeding on the system components. The optical table support system has been completed and the table is ready for installation. The camera rotator and light feed (turret) assemblies are all nearing completion. Wiring of the power supply chassis has begun, with wiring of other chassis and the equipment rack to follow.

Data Processing, Software Development & Analysis
As of this writing, the real-time magnetogram pipeline is nearing completion. Remapped magnetograms, site-day diagnostic synoptic maps, and network-wide Carrington rotation synoptic maps are now available online.

These real-time magnetogram data products have been provided to the STEREO science team as well, supporting the mission’s coronal science. STEREO was successfully launched on 25 October 2006, and the GONG synoptic maps can be found at gong.nso.edu/data/magmap/. Full disk magnetograms, delivered every twenty minutes in near real time, can be found at gong.nso.edu/Daily_Images/.

Progress is being made in the migration of the Data Storage and Distribution System (DSDS) to Oracle 10 on the Linux platform. We can anticipate that a new DSDS GUI will be deployed before the end of the year. The GONG Web server was recently migrated from “solarc” (Sun Solaris) to “fargo” (Linux), and as a result, we are noticing a dramatic improvement in the overall performance of the Web site. The GONG Classic (1995-2001) calibrated image catalog is being migrated from eight millimeter tape to LTO media. This will preserve the data for posterity, and enable science analysis of previously unavailable meta-data stored in the FITS image header. The calibration module of the global p-mode pipeline, VMBICAL, is nearly ready to be migrated to Linux for routine processing, which should help reduce the backlog (currently at 452 site days).

Processing to date includes month-long (36-day) velocity time series and power spectra for GONG Month 108 (centered at 09 December 2005), with a fill factor of 0.87. 108-day Mode Frequency Tables are available for Month 107 and Ring Diagrams are available through Month 108. Last month, the DSDS distributed 183 Gigabytes in response to six data requests.

Staff News
We are pleased to announce that Tamara Rogers, a long-term visitor with GONG, recently accepted a faculty position with the University of Arizona Lunar and Planetary Laboratory. Tami has been working on theoretical numerical simulations of solar internal gravity modes, and will be searching for these modes in GONG data.

The team prepared a live Web page for the Mercury transit on November 8 (gong.nso.edu/mercury_transit06/latest_site_images.html). For any transit event, at least one GONG station is able to view the complete transit, while another two sites will see it at sunrise or sunset. Unlike past transits tracked by GONG, this transit was visible from Australia, Hawaii (see image), California, and Chile, which meant that staff were able to monitor the live Web page updates during regular daytime hours.