From the NSO Director’s Office

Steve Keil

Fulfilling the Decadal Survey Goals—A Roadmap for Solar Physics

In 2000, the Decadal Survey recommended the Advanced Technology Solar Telescope (ATST) as the top priority for ground-based solar physics in the United States. The Decadal Survey also recommended the development of the Frequency Agile Solar Radio Telescope (FASR), the expansion of the SOLIS instruments into a three-station global network, and the formation of a National Virtual Observatory. The scientific rationale for each of these facilities and capabilities is compelling, and their technological feasibility is well established. In addition to these forefront initiatives, several other major solar projects are either in progress or in the evaluation stage by other nations.

Each of these new facilities for solar physics is characterized by uniquely powerful capabilities, while in combination they can be viewed as the key components of an integrated approach to the investigation of the Sun. Fortunately, the solar physics community has long recognized the complementary nature of advanced ground- and space-based facilities with an open approach to the sharing of capabilities, data, and expertise. This recognition is even more relevant now given the funding challenges that the community faces.

In view of the revolutionary facilities on the horizon, it is timely for the solar community to develop a roadmap for our science objectives and the roles of our current and planned facilities in the achievement of these objectives. The roadmap will show a coherent and unified approach by the international solar community that, in turn, will strongly support our efforts in seeking resources. Toward this end, we would like to form an international Solar Roadmap Working Group over the next two months. I invite interested parties to please contact me (505-434-7039 or skeil@nso.edu) with opinions and ideas on how to proceed.

ATST

A large segment of the solar research community has formed a collaboration prepared to move into full-scale development, construction, and scientific utilization of the ATST. Over the past few years, the Science Working Group (SWG) has defined the science requirements for the ATST and has conducted experiments or developed models and simulations in order to understand the essential functionality of a telescope that could meet these requirements. In parallel with the SWG effort, a Site Survey Working Group (SSWG) carried out a careful site-testing program to identify a site at which the full capabilities of the telescope could be utilized to achieve the science goals. The SSWG submitted its final report in September 2004 on the properties of the three best candidate sites: Big Bear Lake, California; Haleakala, Hawaii; and La Palma, Canary Islands, Spain.

All three of the final sites offer exceptional opportunities for solar observing programs. Both Haleakala and La Palma would allow the ATST to meet its high-resolution and coronal science goals. However, the site survey data indicate that it is Haleakala that will maximize the scientific return of the ATST. Haleakala also had the largest number of hours of excellent seeing (r < 12 centimeters), the conditions from which we expect the majority of scientific breakthroughs. At the current telescope height, Haleakala has many hours of good seeing (r > 7 centimeters). Haleakala was also the best coronal site as determined by the sky brightness monitor. This will permit the ATST to observe coronal structures and measure coronal magnetic fields during extended periods of time and with uninterrupted annual coverage.

La Palma also had many hours of excellent seeing, but somewhat less than Haleakala. La Palma was also coronal but significantly less often than Haleakala, mainly due to the Sahara dust season that occurs on La Palma during the summer months. Big Bear exhibited the most stable seeing site with many hours of fair to good seeing, but few hours of excellent seeing. Big Bear was seldom coronal during the testing period and thus did not meet the coronal science requirements. The SSWG report clearly indicated that Haleakala is the best available site to enable the ATST to achieve the principal goals of observing and understanding magnetic fields at their fundamental spatial scales and at all heights in the solar atmosphere.

After a careful analysis of the SSWG final report, the ATST Science Working Group officially recommended Haleakala as the site most capable of fulfilling the science goals of the ATST. In early December, the AURA Solar Observatory Council (SOC) voted to approve our site selection and prepared a resolution for presentation to the AURA Board in support of Haleakala as the prime ATST site. The SOC also endorsed La Palma as a viable alternate site. On 6 January 2005, the AURA Board endorsed the SOC resolution, and the project is now working toward building the ATST on Haleakala.

Funding is still a fundamental issue for the ATST. We will continue to seek scientific and funding partnerships both nationally and internationally. Several international groups including the Kiepenheuer Institute for Solar Physics in Freiburg, Germany; the Institute for Astrophysics in the Canary Islands, Spain; and the Arcetri Observatory in Italy, have been active in

continued
the ATST design and development phase. In addition, 14 European institutions joined together on a proposal to the European Union Framework 6 Program for participation in the ATST project. The proposal was not selected for funding, but plans are being made to refine the proposal and pursue other funding avenues. We will also begin vigorous pursuit of partnerships in Asia.

Following an extremely positive peer review of the construction-phase proposal in the fall and an independent financial review in February of the proposed construction costs, the ATST project started its journey through the NSF Major Research Equipment Facilities Construction (MREFC) review process. This includes consideration by the MREFC screening panel, review by the NSF director, and review by the National Science Board. The project will also conduct a Systems Design Review in late March and hopes to follow it up with implementation of vendor design completion contracts for the major subassemblies.

After a careful search using several outside consultants, Jeremy Wagner has been selected as the new ATST project manager. Jeremy was serving as ATST deputy project manager and had much of the responsibility for tracking the work breakdown structure, budget, and schedule. He is intimately familiar with the project and its needs. Jeremy has experience with several solar projects and as project manager for SOLIS. He has also managed NSO Tucson/Kitt Peak operations for many years. Please join me in congratulating Jeremy on his new role as our ATST project manager. We look forward to working with Jeremy as we advance the ATST into the construction phase.

*  

SOLIS

John H. Marburger III, OSTP Director and Science Advisor to President Bush, honored the NSO (and NOAO) with a visit to Kitt Peak. He toured the new SOLIS facility and the McMath-Pierce facility, where he saw the adaptive optics system and the California State University-Northridge (CSUN)-NSO infrared camera in action. In addition, the Minority Senior Staff Assistant to the House Committee on Appropriations, Michael Stephens, visited the NSO/Kitt Peak facilities. Both these distinguished visitors expressed a thoughtful interest in the observational solar research conducted by the NSO.

In SOLIS developments, I am pleased to note that new reduction methods have been developed and implemented that correct for the strong fringe pattern present in vector spectromagnetograph observations of the important 1083-nanometer line. In addition, the integrated sunlight spectrometer will soon be in operation after completion of the fiber installation. In other developments, the Air Force Research Laboratory group at Sac Peak and the SOLIS project are exploring possible synergistic activities that will be of benefit to both programs, and I am confident that a productive collaboration will emerge from their discussions. For more information (and great pictures), see the following SOLIS update by Jack Harvey.

---

From the NSO Director’s Office continued

ATST Project Developments

Thomas Rimmele, Jeremy Wagner & the ATST Team

In early December, Deputy Project Manager Jeremy Wagner was named ATST project manager, and on 06 January 2005, the AURA Board of Directors endorsed the selection of Haleakala, Hawaii, as the best site for building the Advanced Technology Solar Telescope (ATST). The construction-phase proposal continues to progress through the review process, and the project team continues to develop ATST designs as preparation are made for Systems Design Review (SDR) in late March 2005.

Site Selection

The AURA Board’s endorsement of Haleakala as the primary site for ATST followed an earlier recommendation by the ATST Science Working Group during an October 2004 workshop in Tucson, and a resolution endorsing it by the Solar Observatory Council (SOC), which met in Tucson, 6–7 December 2004.

“The Advanced Technology Solar Telescope will be the world’s premier observatory for studying the detailed processes that occur on the Sun,” said William Smith, AURA’s president. “It is therefore appropriate that we have chosen a premier site that will host this facility.”

The recommendations followed the review of a second year of site survey data from Haleakala; Big Bear Lake, California; and La Palma, Canary Islands. If approved, Haleakala will be developed in conjunction with the University of Hawaii’s

continued
**ATST Project Developments continued**

Institute for Astronomy (IfA), which operates the Mees Solar Observatory (elevation 3,056 meters) at the site on Maui. The survey also indicated that La Palma and Big Bear would be acceptable alternatives should circumstances preclude Haleakala’s availability.

“This site recommendation is a major step forward for ATST,” says Stephen Keil, NSO director and ATST project director. “To finalize the site selection, we will consult with NSF. Once we have their endorsement, we will begin environmental impact studies and explore design issues particular to Haleakala.”

**Wavefront Correction**

Xinetics Inc. has completed the subscale deformable-mirror thermal design and analysis. The work was twofold: 1) perform a thermal and thermomechanical analysis to understand the cooling needs and parameters; and 2) address the practicality of a 5.1-millimeter actuator spacing. Xinetics was eventually able to achieve our thermal requirement while retaining the 5.1-millimeter actuator spacing design. Figure 1 illustrates one of the potential cooling concepts.

We are now working with Xinetics Inc. to develop a contract for a mechanical design with flow-works simulations in preparation for the spring review.

![Figure 1. A potential cooling concept for the ATST deformable mirror.](image)

**Software**

A Telescope Control System workshop was held in November, involving the ATST staff, Chris Mayer (Observatory Sciences Ltd.), and Patrick Wallace and David Terrett (Rutherford Appleton Laboratories). Design, interface, and operational issues were discussed for all telescope subsystems. Particular concerns were raised about the lack of a fixed guide signal, synchronization of the mount and enclosure, and movement through the zenith blind spot. Preliminary design work will be delivered by Observatory Sciences in March 2005.

The Observatory Control System (OCS) design has been extended and now implements both interactive and preplanned observations, and handles complex interactions with the ATST “virtual instrument” (VI). Configurations passed between the OCS, VI, and other systems are identified and tracked by an access identifier corresponding to the current experiment and observation. The first versions of the OCS design requirements document and interface control documents have been released.

The alpha release of the ATST Common Services continues in development, with the second release candidate available in January 2005. This release candidate implements the underlying ICE communications protocol, the ATST containers and components, and the name and event services.

**M1 Assembly**

An M1 Assembly workshop was held in early December to provide a comprehensive review of changes that have occurred since the August 2003 conceptual design review. Some of the most significant changes include increasing the number of lateral supports from 6 to 24, reducing the M1 mirror substrate thickness from 100 millimeters to 75 millimeters, and development of a “reactive” strategy for thermal control of the M1 optical surface temperature.

A detailed finite element model of the 75-millimeter-thick M1 is being developed at Hofstadter Analytical that includes the updated lateral support system and small tripods between the axial actuators and the rear surface of the M1. These tripods provide additional support points and result in a significant reduction of support print-through. This analysis will be completed soon and presented at the SDR in late March.

A “reactive” method of controlling the optical surface temperature of M1 has been developed that uses a predicted temperature profile for the day and makes corrections as needed over the observing period. It starts out with the M1 optical surface subcooled to 1°C below ambient, and then it constantly measures the ambient air temperature, averaging it over five-minute intervals. As the M1 surface temperature departs from the ambient temperature, corrections are made every five minutes. Analysis indicates that this approach, combined with the 75-millimeter-thick M1 substrate, will keep the M1 surface temperature within acceptable limits 85 to 90 percent of the time.

*continued*
ATST Project Developments continued

The Air Force is building a new mirror coating facility at Haleakala to service the 3.67-meter Advanced Electro-Optical System (AEOS) telescope. Although the ATST M1 is slightly larger, the Air Force has expressed a willingness to allow ATST to also use this facility, and ATST personnel have been working closely with their Air Force counterparts, providing detailed specifications on the ATST M1 and discussing the logistics of mirror movement, handling, and stripping/cleaning within the facility.

Enclosure

The design of the ATST enclosure continues to mature. The design requirements document (DRD) is nearing completion, and interface control documents are being generated in-house. In October, an enclosure workshop was held in Tucson. Attendees included engineers from Gemini, NSO, NOAO, and M3 Engineering. The purpose of the review was to discuss the overall enclosure design layout, thermal details, control system design, safety implications, and general contracting ideas. Many useful suggestions and ideas came out of this meeting, including simplification of the proposed control architecture, and a high priority on getting definitive soil data for foundation design.

In parallel with this, M3 Engineering was placed under contract to design and evaluate the thermal control system for the enclosure exterior. The baseline design is a “conditioned air” approach, in which chilled water is fed to fan-coil units that produce cool air that in turn is circulated within the dual-skin walls of the enclosure. A general system layout was created and costed by M3. A follow-up contract was placed to evaluate an alternate “all liquid” solution, which incorporates glycol-cooled plate-coil units that are mounted to the exterior the building. The results from this second study will be followed by a trade study to select a baseline solution from these two concepts. This solution will then be included in the enclosure DRD.

Documentation and Interface Control

The Conisio electronic document management system used by ATST was upgraded to Version 6.1 Service Pack 1 (SP1) over the 2004 holiday break. At the same time, a replication server for the Sunspot staff was configured and installed into the Sunspot network in January. The Conisio 6.1 SP1 release has significant improvements over the earlier releases, with speed of access and the ability to have multiple vaults for the same project (i.e., replication) being the high points. Conisio enables team members to easily submit a file for review, and the responsible engineer(s) to easily review and approve the file, or return it for further work. With the upgrade to 6.1 SP1 now complete, work on the automatic notifications of these state changes (which work via the regular e-mail system) for configuration and interface control has commenced.

Upcoming Milestones

Our efforts are focused on continuing to make progress on designs while preparing for the Systems Design Review. Subsystem Preliminary Design Reviews are scheduled for the Telescope Control System and the Common Services in February and March, respectively. At this writing, documentation to support the construction proposal review process is being prepared, for example, for a review in mid-March of the construction proposal Basis of Estimate. We continue to update our Web site and encourage anyone interested to visit it periodically for the latest information.
SOLIS was recently visited by John H. Marburger III, Science Advisor to President Bush (see figure 1) and later by Michael Stephens, Minority Senior Staff Assistant to the House Committee on Appropriations. Both expressed interest in the NSO program of solar research in general, and the practical applications of space weather research exemplified by SOLIS in particular. Dr. Marburger was familiar with Stokes polarimetry and wanted to know in detail about how vector magnetograms are made by SOLIS.

In an interesting "government and science" side note, the building on top of which SOLIS is now installed was formerly the home of its predecessor. This was most likely the only national astronomical facility used for research by a current member of the House of Representatives of the US Congress. Congressman Rush Holt (New Jersey), in his prior career, did research on the physics of "bright points" in the solar atmosphere. He needed to know where the bright points were located in real time to conduct a multiwavelength observational campaign. It turns out that the bright points are particularly prominent as small "dark points" in observations made with the 1083-nanometer He I line, and the predecessor of SOLIS provided the observations that he required.

The SOLIS vector spectromagnetograph (VSM) has been acquiring regular observations with the 1083-nanometer line since September 2003. A strong fringe pattern is seen in data at this wavelength due to multiple reflections in the 100-micron-thick hybrid detector in the Rockwell cameras used in the VSM. Because of this strong pattern, we thought that an elaborate reduction procedure would have to be developed to obtain useful results. In the December 2004 NOAO-NSO Newsletter, Harrison Jones (NASA/NSO) described a new method for reducing solar observations made with SOLIS using the 1083-nanometer He I line. Stimulated by this work, SOLIS Program Scientist Carl Henney attempted a very simple reduction, similar to what used to be done with the previous instrument. It worked surprisingly well and routine observations using this preliminary reduction are now being made.
available at the SOLIS Web site. Examples are shown in figures 2 and 3. A surprise in these observations is a notable increase in sharpness compared to observations made with the predecessor instrument. The reason for this unexpected improvement is not clear.

Work on calibrating the VSM vector magnetograms was continued under the leadership of Christoph Keller. During the process of measuring some of the signals that drive the polarization modulators, it appears that a connecting cable failed. This resulted in no useful vector magnetograms being made after the third week of November. Repair of this cable, and replacement of the entrance slit and calibration polarizers, is currently underway. Work on the common guider for both the VSM and full-disk-patrol instruments has continued.

The SOLIS Integrated Sunlight Spectrometer (ISS) was still being tested during the fall quarter. A fiber-optic feed bundle has been constructed and delivered by a vendor and installed in February. This will allow regular solar observations to commence using the ISS. During the quarter, we started discussions with the Air Force Research Laboratory personnel at Sacramento Peak about combining SOLIS and the Improved Solar Observing Optical Network (ISOON) activities in mutually beneficial ways.

Figure 3. Eight days of 1083-nm He I images (410 arcsec in size) that show a large active region crossing the solar disk in mid-January 2005. The active region emerged as a compact and rapidly developing bundle of magnetic flux, as suggested in the first two images. The first of at least five major flare eruptions occurred about 12 hours before the January 15 image, and the second flare occurred about five hours after the image. Similarly, the image on January 16 was made about 17 hours after and before major flares. The January 17 image was seven hours after a major flare and the January 19 image was about 12 hours after and before major flares. The complex, changing patterns of dark and light features in these images are manifestations of energy storage and violent release processes. This active region caused a severe geomagnetic storm in the Earth’s atmosphere.

Notable Quotes

“The fundamental nature of the Universe is too important to not demand a second opinion.”
—British Astronomer Royal Sir Martin Rees, commenting on two complementary results concerning the cosmology of the distant universe from the 2dF and Sloan sky surveys, during a press briefing at the American Astronomical Society meeting in San Diego, 11 January 2005.
IBIS Now Available as a User Instrument

Kevin Reardon (Arcetri Astrophysical Observatory)

The Interferometric BI-dimensional Spectrometer (IBIS) is now available to the community as a user instrument at the Dunn Solar Telescope (DST). IBIS is a dual Fabry-Perot instrument that produces high-spatial-resolution images with a spectral resolution of 25–40 milliangstroms. The instrument is fed by the recently upgraded high-order adaptive optics system on port 4. The observing staff at the DST have been through several training sessions and have produced a document describing the operational procedures.

Following its installation in June 2003, IBIS has been used successfully in a series of observing runs to look at granular dynamics, flares, and chromospheric structures. The instrument now features a white-light channel that produces a diffraction-limited continuum image simultaneously with each spectral image. This is used to align and de-stretch the separate spectral images at each wavelength in the line profile. The instrument also has been used in conjunction with G-band and Ca II K filters as well as the universal birefringent filter (UBF) setup on the adjacent optical bench. Because of its high throughput, exposure times of 20–100 milliseconds are possible at the full detector resolution of 0.085 arcsec per pixel. This makes possible both short exposure times to freeze the atmospheric seeing and studies of fainter features such as prominences.

The spectral sampling for each spectral line can be chosen based on the needs of a particular program.

IBIS can presently observe in one of five spectral channels: 1) 5896 angstroms – Na D; 2) 6302 angstroms – Fe I; 3) 7090 angstroms – Fe I; 4) 7224 angstroms – Fe II; 5) 8542 angstroms – Ca II.

In a recent collaboration with the High Altitude Observatory, IBIS was paired with a liquid crystal variable retarder to do diffraction-limited spectropolarimetry. Observations were made in the Fe I 6301-angstrom and 6302-angstrom iron lines, as well as in the chromospheric calcium and sodium lines. Further engineering will be needed to optimize the polarimetric performance and make this mode available to the community as well.

Two images obtained with IBIS in December 2004. The image on the left is a wideband white-light image obtained with the reference channel. The image on the right is a magnetogram obtained at 6302 angstroms made by summing up 32 individual magnetograms, each obtained with a 50-millisecond exposure time. The spectral resolution is degraded by the summing of the individual magnetograms, but the weak magnetic structures in the “quiet” granulation can start to be seen. The insets show a magnified version of the white-light image (outlined by box on full image) and a single snapshot magnetogram obtained with one 50-millisecond exposure. The full field of view is approximately 40 arcsec, and the tick marks on the inset images are at 1-arcsec intervals.