From the NSO Director's Office

Steve Keil

Once again, we offer an opportunity for the community to help set the strategy and roles for the future of the National Solar Observatory. AURA has requested that NSO do some strategic planning to determine its course for the next 10 to 20 years. NSO's annual Program Plan covers the current and upcoming fiscal years, while its Long-Range Plan (LRP) addresses a five-year period, but contains a road map for the next 10 years. Both plans are available at our Web site, *www.nso.edu/general/docs*.

Key elements of the current LRP include development of the Advanced Technology Solar Telescope (ATST), with completion scheduled for 2013; completion of SOLIS over the next several months, its operation over two or more solar cycles, and its expansion into a three-station network through the development of international partnerships; operation of the newly enhanced GONG network for one or more solar cycles; and operation of current major facilities until ATST is commissioned.

Strategic planning requires us to think about the long-term role of the NSO, what its mission should be in the changing climate of astrophysics and space sciences, what economic and political factors will help shape that role, what services and facilities open to everyone on a competitive level should be operated as a national center, where NSO should strengthen its program to support solar research, and what it should not be doing. We will be discussing our planning and soliciting inputs through the various NSO advisory committees and at AAS Solar Physics Division (SPD) and other meetings, but we would also like to hear directly about your ideas for NSO's evolution and how we can better serve the solar research community. Please feel free to contact me at *skeil@nso.edu* or 505-434-7039.

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The ATST project is continuing to push toward construction readiness. During June, several talks on the status of various hardware and software designs were presented at the AAS/SPD meeting in Denver, at IAU 223 in St. Petersburg, and at the SPIE meeting in Glasgow. These provided the opportunity for the science and engineering communities to comment on the current design concepts. NSO will be issuing requests for proposals for fleshing out various subsystem designs in the next several months.

ATST has been fortunate to have Jim Oschmann as its project manager for the last few years. He quickly took the science requirements and basic telescope ideas to a fully developed concept that could be accurately costed, resulting in a comprehensive construction proposal to the National Science Foundation. Jim accepted a position with Ball Aerospace in Boulder and left the project in July. He will continue to provide support as needed to ensure his considerable knowledge is passed along. Jeremy Wagner has agreed to serve as interim project manager, and NSO is now recruiting to fill the position. If you know of strong candidates for the position, please inform them of this opportunity. Information can be found at *www.nso.edu/jobs.html*.

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The SOLIS mount and the vector spectromagnetograph (VSM) are now installed on Kitt Peak, and the other instruments will soon be ready to join the VSM on the mountain. As SOLIS gears up for operations, NSO is looking for postdoctoral candidates interested in participating in this exciting project. New data products and other information are available at *solis.nso.edu*.

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AURA's management oversight committee for the NSO, the Solar Observatory Council (SOC), has undergone a few changes this past year. Paula Szkody (University of Washington) is rotating off the SOC to serve on the NOAO Observatories Council. We would like to thank Paula for her very useful help and advice these last few years. Peter Gilman (HAO), who has been an SOC member since its inception, is also rotating off the Council but could be back under a revision of the SOC charter. Peter has provided invaluable insight and help as the NSO has established its independent program and embarked on the ATST project. He remains active on the AURA Board and we hope to continue working with him on the SOC in the near future. We welcome two newly elected SOC members, Jeff Kuhn (University of Hawaii) and Steve Kawaler (Iowa State University). Their term began July 1, and we look forward to working with them over the next several years. The SOC currently consists of five elected and two invited members. Under a proposed revision, currently being voted on by the AURA Board, the Council would have seven elected and two invited members.

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We're pleased to welcome new and returning staff members. Software engineer Lorraine Callahan has joined the SOLIS group, replacing Janet Tvedt, who transferred to the ATST project to develop common services software. Instrument maker Lou Lederer has returned to work with GONG, and Jim Mason, who worked on the ATST site survey, is now part of the GONG engineering development group. ATST Fellow Brian Robinson, from the Center for Applied Optics, University of Alabama in Huntsville, is now part of the ATST instrumentation team that is developing the tunable imaging filter system. Brian is working with Allen Gary (NASA) and K. S. Balasubramaniam on various aspects of the tunable filter optical design.

ATST

Thomas Rimmele, Jeremy Wagner & the ATST Team

The project continues to address the various design aspects of the telescope and supporting systems as we move toward a preliminary design. By the time this *Newsletter* is distributed, the project will have received preliminary input from a face-to-face review of the construction proposal held at the National Science Foundation in late August. All the while, progress has continued in several key design areas, including the software and controls, coudé lab, the thermal interface between the telescope and lab environment, the M1 thermal control, and instrumentation development.

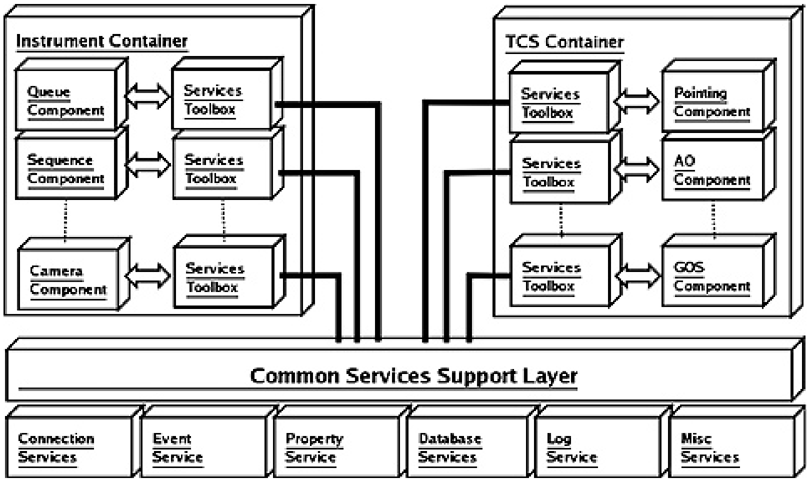

Figure 1. An illustration of two software systems that use the ATST common services to communicate.

Software

Common Services Design and Status

The "ATST Common Services" are a set of communications libraries and protocols used to send messages between the various ATST computer systems. These services also provide system developers with the necessary resources to interact with the ATST systems without the need to understand how the communications middleware really works. Figure 1 illustrates two software systems that use the ATST common services to communicate.

After a successful conceptual design last fall, it became clear that the common services package was the most important piece of ATST software and on the critical path for design and construction. Since the common services provide all of the components required for ATST software to communicate and interact, it is crucial that this system be in operation before other software systems. To support this need, the ATST software group is both designing and building the common services package. An alpha software release is expected in early 2005, with a beta release available to contractors scheduled for the following year.

Currently, the common services has a preliminary design for both the communications middleware and the communications protocols. The middleware provides the necessary software for passing messages between computers. ATST has selected Internet Communications Engine (ICE), a freely available package from ZeroC, as our middleware, and has designed interfaces using the ICEL interface design language. Tests performed on ICE's capabilities have shown performance of almost 20,000 transactions per second of typical ATST event data.

As for the ATST communications protocols, the set of commands, events, and services available to developers has been defined and described in a set of specification documents. The common services define naming, event, log, and database servers for developers to use in the ATST environment. Additional services provide generic software components and life-cycle management. The completed preliminary design effort should completely specify all of these services by the end of this year.

Contract for Control System Design

The first software-related design contract has been issued to Observatory Sciences, Ltd. of Cambridge, United Kingdom, for the ATST Telescope Control System (TCS). The TCS is one of the four principal software systems and is responsible for operation of the telescope and its many parts. Observatory Sciences is well-known in the nighttime astronomy and particle physics worlds for their real-time control expertise. Along with Observatory Sciences, Patrick Wallace and David Terrett of the Rutherford Appleton Laboratory in Oxford, United Kingdom have joined the design contract to provide their telescope pointing kernel and associated algorithmic experience.

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ATST continued

The TCS design will produce a highly accurate solar pointing model, algorithms for telescope positioning, tracking, and guiding, and interfaces to the telescope subsystems. Observatory Sciences will be working on the TCS contract for the next two years, allowing the ATST project to produce a final TCS design for the start of ATST construction.

Site Survey

The site survey efforts are currently focused on verification experiments that extend the successful cross-calibration measurements performed at the 300-meter-tall Atmospheric Technology Division (ATD) tower near Erie, Colorado (see *www.atd.ucar.edu/rtf/projects/dash04/report.shtml*). In situ measurements of C_n^2 as a function of height were compared to the C_n^2 measurements derived in a more indirect way with the SHABAR instrument, which is a vital component of the ATST site survey instrumentation. Similar experiments are now being performed at the Big Bear Solar Observatory and Haleakela sites. In situ measurements of $C_n^2(h)$ are obtained using sonic anemometers mounted on a mobile crane at 7.3 meters, 13 meters, and 23 meters above ground.

The goal is to further validate, in particular at a lake site, the performance of the SHABAR and its ability to measure the Fried parameter r_0 as a function of height over the range where the aperture of the telescope will be placed.

The Site Survey Working Group (SSWG), chaired by Tim Brown from the High Altitude Observatory (HAO), continues to be very active. Members of the group are participating in the data analysis and during frequent meetings the SSWG is monitoring the analysis of site survey data and the progress of the site survey effort. The SSWG will deliver its report on 30 September 2004. An ATST Science Working Group (SWG) meeting to review the report has been scheduled for October 13–15. The SWG will forward its site recommendation to the Project Director shortly after the October meeting.

Instrumentation

The ATST project has recently completed an optical design for a Nasmyth instrument station. We have proposed this to our instrument partners as an alternative location for coronal and UV instrumentation. This station has packaging advantages over a Gregorian platform previously studied, and the feed optics that produce the Nasmyth image introduce less instrumental polarization. The *f*/13 image at this station is formed with a total of four reflections, and is nearly diffraction limited.

In late May, the HAO hosted an ATST instrument conceptual design review/workshop at their facility in Boulder, Colorado. The emphasis at this meeting was on the system-level polarimetry components, and

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Figure 2. Comparison test of in situ and ATST measurements of seeing as a function of height underway at Big Bear.

ATST continued

the infrared (IR) and visible-light spectropolarimeters that are among the planned first-generation ATST instruments. The designs for these two instruments are being developed by our partners at the University of Hawaii Institute for Astronomy (IfA), and HAO/NCAR. There were 20 participants in all from NSO, HAO, and IfA. Good progress was made on polarimetric calibration issues, camera requirements, and specifications for the so-called Gregorian Optical Station, which houses the polarization modulators and calibration optics. The group also confirmed that the *f*/13 Nasmyth platform described above is now the baseline location for the coronal module of the near-IR spectropolarimeter.

Finite Element Analyses

Since the conceptual design review (CoDR) in August 2003, there have been a number of significant changes to the telescope structural design, most notably the new one-level, larger diameter coudé rotator; the correspondingly larger telescope pier; and the change from a Gregorian instrument rotator to one at Nasmyth. As a result, some of the finite element analyses that were presented at CoDR are being rerun. Myung Cho and Joon Lee of the New Initiatives Office in Tucson are remodeling the telescope mount, coudé lab, and pier, and expect to have preliminary results by this fall. The work they are doing will focus on static structural deflections, dynamic wind-shake effects, and modal analyses.

M1 Thermal Control Progress

The baseline for the ATST primary mirror (M1) is a 100-millimeter-thick ULE or Zerodur meniscus substrate coated with aluminum. Two competing performance issues with such a design are optical surface deformations due to gravity and wind loading, and thermally-produced image degradation, or seeing. Mirror seeing is produced when the coated side of the substrate is hotter or cooler than the surrounding air. A mirror that is hotter than the ambient temperature is particularly troublesome, since it produces rising plumes of buoyant hot air. Thus, the mirror surface temperature must be controlled to match the ambient air temperature, and since the optical beam covers the front of the mirror, the surface temperature must be controlled from the back of the substrate.

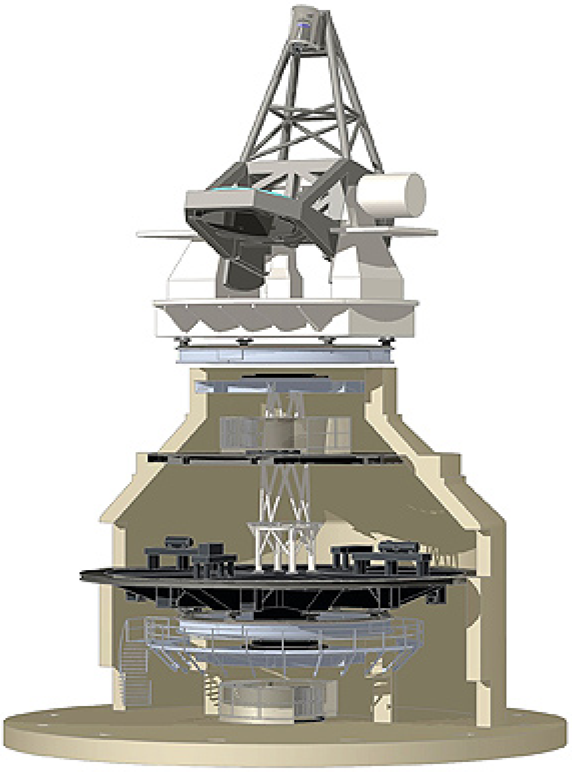

Figure 3. ATST telescope assembly.

The low thermal conductivity of ULE or Zerodur results in a time lag of hours between cooling events occurring on the mirror backside and the frontside thermal response. Since the characteristic time lag scales with the square of the substrate thickness, it is quite beneficial to use a thinner mirror. For example, a 50-millimeter-thick mirror will respond about four times faster than one 100-millimeters thick. The ATST design team is currently weighing the trade-off between the baseline 100-millimeter-thick mirror and a thinner mirror that responds to thermal changes more quickly. A thinner mirror requires an increase in the number of axial supports to maintain the current level of support print-thru, but the overall weight of the M1 assembly is significantly reduced by the thinner/lighter mirror. The final choice of thickness will be a balance of optical and thermal performance, cost, and risk.

Upcoming Milestones

The project's principal activities are focused on developing the designs to mitigate identified risk areas, preparing for design review, and the development of integrated communications designs and requirements for vendor design contracts. We are prepared to respond to input received from the August peer review of the construction proposal, and we plan to announce the final site selection by November. We are continuing our efforts to firm up potential funding partners. As reported in the last *Newsletter*, our European colleagues submitted a proposal to the European Union for adding to the current Design and Development phase in many areas and they are, at this writing, receiving responses to the various sections of that proposal. We continue to update our Web site and encourage anyone interested to visit it periodically for the latest information.

SOLIS

Jack Harvey & the SOLIS Team

After a month of diligent installation work, the SOLIS vector spectromagnetograph (VSM) resumed operation on 18 May 2004 at the Kitt Peak SOLIS Tower (KPST). We thank all of those who participated in this complex installation, and in particular John Dunlop and the mountain crew. Figure 1 shows the VSM (the rectangular housing with exposed entrance window) on the SOLIS mount.

Progress toward daily observations with the VSM has been constrained by various move-in activities. Site improvements and upgrades, along with personnel shortages and an unwanted motion of the grating, have limited observational possibilities. After the addition of an extension to the SOLIS mount at a local vendor, the mount required extra shims beyond its built-in adjustments to complete the alignment with the polar axis.

Additionally, clouds associated with summer monsoon airflow have been somewhat more frequent than average. The environmental conditions of the KPST require that the focus algorithm for the VSM be adjusted until the guider is installed. As a result, the frequency and quality of observations have been notably diminished during this period of transition. The requisite observations needed to update the focus algorithm are being collected. The guider for the VSM is still under development and some replacements of components inside the VSM are planned. The latter includes a new spectrograph entrance slit and most of the polarization calibration optics.

Several VSM data reduction algorithms were developed or improved this quarter. One new algorithm detects and corrects a varying dark bias signal from the cameras. This is presumably caused by a problem with the temperature stabilization of the detectors. Another reduction algorithm developed is a method to correct interquadrant cross talk between the four quadrants of the detectors of each camera. In addition, early observations of the chromospheric 854.2-nanometer Ca II line showed that the reduction algorithm we had been using did not adequately account for dramatic spatial variations in the core of the line profile, and a new method was devised and tested.

The magnetogram in figure 2 emphasizes features that are only manifest in the chromosphere. This figure was prepared by differencing chromospheric and photospheric magnetograms taken at different times using the old algorithm. The new reduction method produces both signals simultaneously from the core and wings of the

Figure 1. The vector spectromagnetograph mounted on top of the Kitt Peak SOLIS Tower, formerly the vacuum telescope tower. The pole that flanks the tower in the image on the left is part of a lightning protection system. (Photos by Kevin Schramm)

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SOLIS continued

854.2-nanometer line. A flat-field algorithm for 854.2-nanometer observations was also developed. A similar effort for 1083-nanometer observations is still underway and is complicated by significant fringing within the detector at this wavelength.

The Integrated Sunlight Spectrometer (ISS) will be moved to Kitt Peak by the time this *Newsletter* is distributed. During this quarter, the CCD camera of the ISS was out of service for repairs for several weeks. The camera is suspected of being vulnerable to power cycling. Work on the Full Disk Patrol was suspended during the quarter due to failures of both of its CCD cameras and a nonresponsive vendor.

The hardware for the SOLIS data acquisition and handling system was moved to Kitt Peak in mid-July. Observations can now be processed without a bottleneck of having to record data to tape. The SOLIS data archive remains in Tucson and the two systems are connected by a 45 megabyte per second data link. A small data processing system that resembles the large system on Kitt Peak is being set up in Tucson to allow software testing and the processing of accumulated data files of old observations.

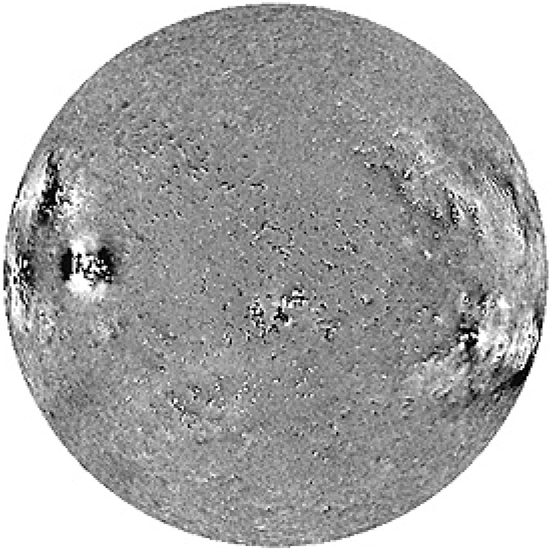

Figure 2. The line-of-sight component of the solar magnetic field processed to emphasize the chromosphere. Dark features indicate a field directed away from the observer and light features toward the observer. Note the large-scale diffuse areas near the limb, showing extended regions of horizontally oriented magnetic fields in the chromospheric component. A new reduction algorithm will show these fields more clearly.