ATST Quarterly News

Newsletter of the Advanced Technology Solar Telescope Project
National Solar Observatory, Sunspot, NM & Tucson, AZ
Vol. 4, No. 1: March 2008 • *http://atst.nso.edu*

NSF requests initial funds for ATST

The President's fiscal 2009 budget plan requests $2.5 million for the Advanced Technology Solar Telescope to reduce design risks and moves ATST to NSF's Major Research Equipment and Facilities Construction (MREFC) account.

The requested funds "will allow the project to contract for detailed designs of critical-path systems, notably for the building and telescope pier foundations," according to the NSF request. "The use of these funds will require a determination by the NSF Director – in consultation with the National Science Board (NSB) – that these funds are necessary to complete a construction-ready design." A significant event will be a baseline review to be held within 12 months. The review is significant in light of NSF's new "no cost overrun" policy, which requires adequate contingency for foreseeable risks, and reductions in scope to cover cost increases.

Protecting ATST from the Sun

A paradoxical challenge in designing the world's largest solar telescope is protecting it from the Sun so that it can produce the world's best solar science data. Minimizing atmospheric seeing effects—turbulent fluctuations of the index of refraction within the atmosphere along the optical path—will be a key factor in the ultimate success of the ATST.

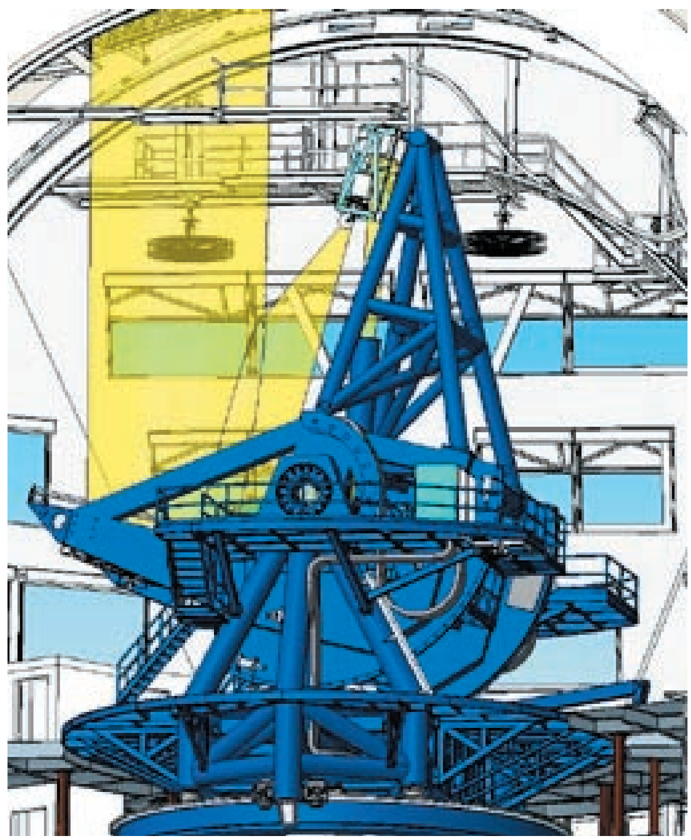
To address this challenge, the ATST design incorporates active thermal controls throughout the observatory. Our various studies and experiments have shown that if the temperatures of these components can be maintained close to or slightly below the ambient air temperature, self-induced seeing can be controlled within the error-budget allocations.

Thermal control for the enclosure starts with a shape that minimizes the surface area normal or near-normal to the Sun. In combination with a white concrete apron surrounding the base of the enclosure, this reduces the thermal load that must be removed from the carousel (the rotating part of the enclosure) by more than 50% from the baseline configuration. The carousel surface temperature is actively controlled by covering all surfaces that receive insolation with plate coil heat exchangers. Chilled heat-transfer solution is circulated through the plates to maintain the surface temperature at, or slightly below, ambient temperature.

Thermal modeling of the ATST enclosure to correctly size equipment and estimate performance has been based on covering all of the external surfaces with a white coating having a solar reflectivity of 84% and a thermal emissivity of 93%. These are typical values for white titanium-oxide or zinc-oxide paints. The properties of traditional white coatings and paints are known to degrade with time as they are exposed to the elements. The thermal coating system for the ATST is based on test results of samples weathered on the Haleakalā High Altitude Observatories site.

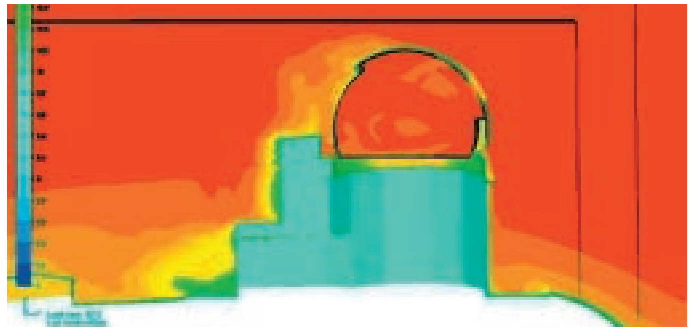
Two coatings have been identified for ATST: one for the areas that receive the most direct insolation and are nearest the light path, and a second for the bulk of the surface area. It is cost prohibitive to use the higher-performance coating over the whole facility.

The coating system for the most critical areas is AZJ-4020 white epoxy thermal-control coating manufactured by AZ Technology. Initial test results indicate a solar reflectance of just over 86% and near-normal emittance of 97% after one year of weathering. The bulk of the enclosure surface will use Energy Seal Acu-Shield, a white acrylic elastomeric coating manufactured by Advanced Coating Systems, Inc. Three-year test results reported by the Energy Star® Roof Products Program indicate an initial solar reflectance of 86%, and then 84% after three years of



An illustration of the interior of ATST shows the large cross-section available for air flow to ensure that the carousel and Telescope Mount Assembly stay close to ambient temperature. (LeEllen Phelps, NSO/AURA/NSF)

Published quarterly by the National Solar Observatory, P.O. Box 62, Sunspot, NM 88349-0062. Editor: Stephen Keil, director, NSO. Managing editor: Dave Dooling, ATST education & public outreach officer (*dooling@nso.edu*). The NSO is solely responsible for the content of this newsletter. Opinions expressed are those of the authors and not necessarily those of the NSO, AURA, or NSF. NSO operates under a cooperative agreement between the Association of Universities for Research in Astronomy, Inc. (AURA) and the National Science Foundation.



Two computer models illustrate the challenge of maintaining thermal control for ATST. The portrait at left (viewing from the north) depicts ATST at Haleakalā with the vent gates on the carousel open at morning and the telescope pointed east. While it appears serene, a computational fluid dynamics model at right (viewing from the south) depicts the resulting air stagnation on the enclosure's leeward side, with air warming while in contact with insolated surfaces. (LeEllen Phelps, NSO/AURA/NSF)

weathering. Emittance is not reported in the program, but ATST test results indicate an initial near-normal emittance of 94% and verify an initial solar reflectance of 86%.

In addition to rejecting any incident heat load, the enclosure must protect the telescope while allowing the wind to flush the optical surfaces. Toward this end, the enclosure is designed to be highly ventilated. Passive flushing is provided by 32 independently controllable vent gates, along with the carousel rear access door and the carousel entrance aperture. This provides an area of just over 200 square meters for ventilation. The active ventilation system for the carousel interior has two parts that work in tandem: fans mounted on the interior of the carousel, and exhaust fans that pull air through the floor at the base of the Telescope Mount Assembly. The fans selected for the baseline design provide 22,377 cubic feet per minute of free-air displacement using four airfoil fans. They provide an estimated one-meter-per-second breeze throughout the carousel when not competing with wind. The fan motors will be encased in a water jacket to remove waste heat.

Most recently, modeling efforts have centered on optimization of the cooling system for the lower enclosure, looking for an approach that would allow us to avoid building the utility tunnels to the nearby utility buildings, and otherwise reducing the costs and complexity of the baseline active cooling system. Thermal-mass concepts were considered for maintaining the lower enclosure surface temperatures near ambient. Two cases were developed in the RadTherm thermal modeling program to establish surface temperatures of a number of different thicknesses of concrete in different seasonal circumstances.

Winter is considered the worst case, since the Sun is lower in the sky and illuminates the walls of the lower enclosure more directly. The other case considered was intended to be representative of the most common conditions during excellent seeing at the site: Sun at 15˚ from the horizon, wind from the northeast at 5–6 meters per second, and ambient temperature of 13 ˚C. Using site-survey data for both cases revealed that significant subcooling occurs through the night. Computational fluid dynamic analyses including the effects of surface temperatures were performed to examine how this might affect the ATST optical path. The results show that any affects of lower enclosure subcooling do not extend to the optical path, and that the concept is quite effective in keeping the surface temperatures within range in the high end.

Recent and upcoming meetings

- VBI Review, TBD
- DHS Workshop, Jan. 23-24, Tucson
- OCS/DHS PDR, Feb. 5-6, Tucson
- SOC, March 12-13, Maui, HI.
- AURA Members' Meeting, April 16-19, Alexandria, VA
- Science Working Group, May 13-15, Tucson
- AAS/SPD, May 27-30, Ft. Lauderdale
- SPIE, June 23-28, Marseille, France
- Systems Design Reviews, Summer 2008 TBD
- NSF Baseline Review, Fall 2008, TBD

NSO
National Solar Observatory
P.O. Box 62
Sunspot, NM 88349-0062