OBSERVATORY SCIENCES LTD

DISCOVERY

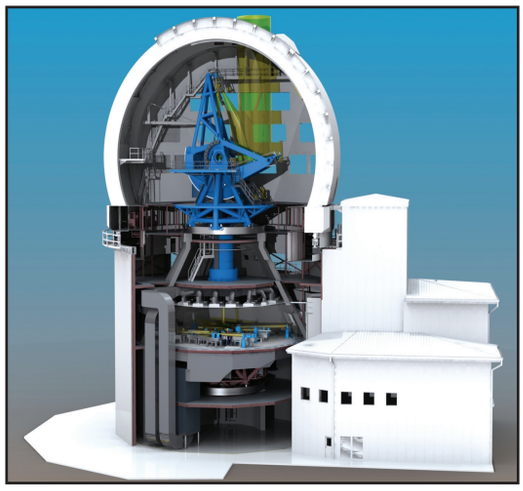
BIG SCIENCE SOLUTIONS SPRING 2011

NSLS-II damping wiggler Observatory Sciences has won a contract to produce control software for a moveable gap damping wiggler at Brookhaven National Laboratory's National Synchrotron Light Source NSLS-II facility. **Page 2**

ATST enclosure control system The software for the enclosure control system will be written by Observatory Sciences, providing protection for the telescope mount assembly and allowing the enclosure structure to point, track and slew with the sun. **Page 4**

CONTROLLING THE WORLD'S LARGEST SOLAR TELESCOPE

Observatory Sciences wins TCS software contract for ATST



Cutaway view of the ATST observatory facility. Picture courtesy of AURA/NSO/ATST.

Observatory Sciences is to develop the software to control the Advanced Technology Solar Telescope (ATST), under a contract from the US Association of Universities for Research in Astronomy (AURA).

The OSL contract covers the production of the ATST telescope control system (TCS) software. The role of the TCS is to point and track the telescope in a range of coordinate systems, to monitor thermal loads on the telescope, to perform scans and offsets coordinated with other observatory activities, to monitor and control the adaptive optics systems, and to provide interactive control for the observatory operators.

At the heart of this is multi-axis control of the servo drives in the telescope mount, which positions the telescope and uses feedback from a variety of sensors to set the altitude and azimuth of the telescope to observe the sun accurately. Many telescope subsystems are coordinated by the software, including the dome, cooling systems, primary and secondary mirror positioning and wave front sensor systems.

The TCS software will be built on the ATST Common Services Framework, which provides a common development platform for all the software, communications and configuration operations. Building the TCS on the Common Services framework ensures that it will work seamlessly with all the other

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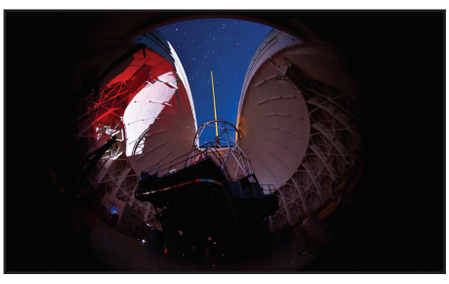
NEW GEMINI CONSTELLATION OVER CHILE

In January 2011 a new era in high-resolution astronomy began with the successful propagation of a 5-star sodium laser guide star "constellation" in the skies over the Gemini South 8m telescope at Cerro Pachón in Chile. This first propagation of the Gemini South telescope laser system marked the beginning of on-sky commissioning for the next-generation adaptive optics system called GeMS or the Gemini Multi-Conjugate Adaptive Optics (MCAO) System. GeMS will allow relatively wide-field imaging at extremely high resolution over an exceptionally large portion of the sky.



Fish eye view of the Gemini South Laser propagating into the zenith during the first night of on-sky laser operations.

During February 2011 OSL consultant Philip Taylor visited Chile to work on a further development of GeMS: the laser bench beam stabilisation (LBBS) system. The LBBS is a fast tip-tilt mirror control system which runs a closed loop servo at 100Hz. Feedback information to stabilise the laser beam is provided by a spot position detector. The control software was written by Observatory Sciences and after initial testing of the system by OSL and Gemini staff, the LBBS is now undergoing final commissioning at the telescope.

Multi-conjugate adaptive optics (MCAO) compensates for the effects of rapidly changing distortions due to atmospheric turbulence by sampling the turbulence and constructing a model of how the atmosphere is distorting the starlight. Laser guide stars produce an artificial reference star high in the atmosphere. By using several laser guide stars and several deformable mirrors, the system can provide uniform image compensation over a relatively large (~1 arcminute square) field of view. MCAO increases the compensation performance on current 8m telescopes, but it also provides a way forward

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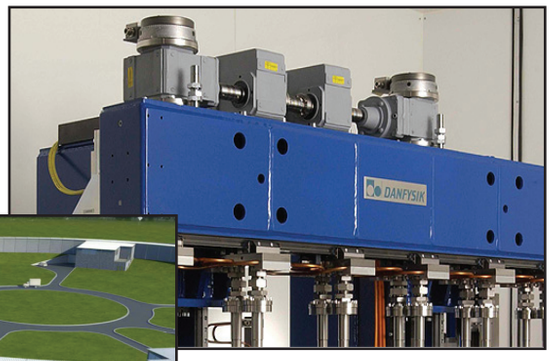
OSL WINS CONTRACT FOR WIGGLER SOFTWARE AT NSLS-II

Observatory Sciences is to provide control software for the National Synchrotron Light Source II damping wiggler



BNL awarded the contract for the production of six damping wigglers to accelerator specialist Danfysik of Denmark, with Heason Technology of Horsham, Sussex working with Observatory Sciences to develop the motion control system. Top picture courtesy of Danfysik. Lower picture courtesy of NSLS, Brookhaven National Laboratory.

Brookhaven National Laboratory's new synchrotron, the National Synchrotron Light Source II (NSLS-II) is the successor to the existing NSLS. Construction of NSLS-II began in 2009 and operations are expected in 2015, with total cost estimated at $912M. Designed to help address the critical scientific challenges of the future, NSLS-II facility will consist of a state-of-the-art, medium-energy electron storage ring (3GeV), producing X-rays some 10,000 times brighter than the existing NSLS facility.

Observatory Sciences has recently won a contract to produce control software for an NSLS-II insertion device called a moveable gap damping wiggler which will be deployed to reduce the emittance from the ring as well as provide a broadband, high intensity source of X-ray radiation.

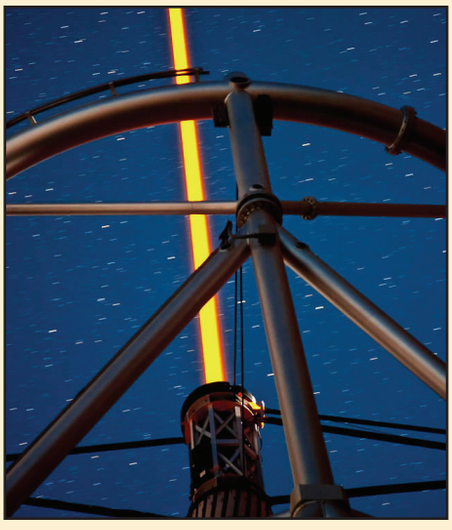
The New York based Brookhaven National Laboratory awarded the contract for the production of the six damping wigglers to accelerator specialist Danfysik of Denmark in November last year, with Heason Technology of Horsham, UK working with Observatory Sciences to develop the motion control system.

Observatory Sciences will use EPICS software to control the system. The software will run on a standard PC running Debian Linux. The EPICS system will drive four motor axes using a Delta Tau 'GeoBrick' motion controller, interfacing with Danfysik's advanced permanent magnet insertion device. Delta Tau is a Heason Technology manufacturing partner, and has also worked with Observatory Sciences on a number of synchrotron projects, including beamline motion control for Diamond Light Source.

Science goals for NSLS-II

One of the goals of the NSLS-II project is to investigate the potential for clean, affordable energy. It will enable highly reactive gold nanoparticles to be imaged in situ, inside porous hosts and under real reaction conditions. It is hoped that this work will lead to new materials to split water with sunlight for hydrogen production and harvest solar energy with high efficiency and low cost. The facility will also explore how to assemble nanomaterials into structures, will investigate new materials for making faster, cheaper electronics that consume less power, and will study how materials become high temperature superconductors, holding out the possibility of materials that are superconducting at room temperature.

The NSLS-II facility will accommodate at least 58 beamlines, using 27 straight sections for insertion-device sources and 31 bending-magnet wiggler sources, with additional beamlines possible through canted insertion devices and multiple branches.



GEMINI SOUTH LBBS SYSTEM

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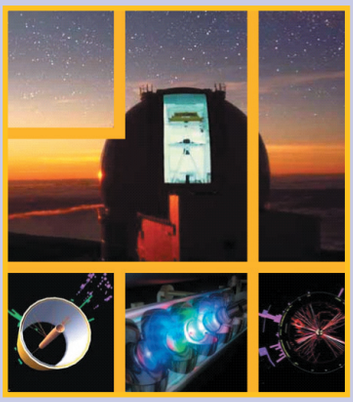
for adaptive optics on the very large telescopes of the future now being planned. The goals of these giant telescopes will be achieved only if they are coupled with efficient adaptive optics systems allowing them to actually realise their unprecedented angular resolution.

Observatory Sciences staff have been involved with the Gemini adaptive optics project from the earliest stages of its development, producing the control software for four of the subsystems that make up the MCAO system. These include: the beam transfer optics (BTO) system, which transfer the laser beam from the laser system to the laser projector; the beam transfer optics diagnostics sensor system, which provides information on the laser beam centering and pointing before projection on the sky; the MCAO slow focus wavefront sensor (SFO) which computes the slowly varying focus corrections from a natural guide star that the laser guide star (LGS) cannot provide; and the adaptive optics module (AOM), which contains all the optics and sensors to compensate the input beam and relay it to the instrument.

Close up view of the new laser propagating from the Gemini South telescope.



Observatory Sciences provides full project management and support services for public and private sector clients. This can reduce the learning curve at project implementation and achieve crucial savings in time and manpower.

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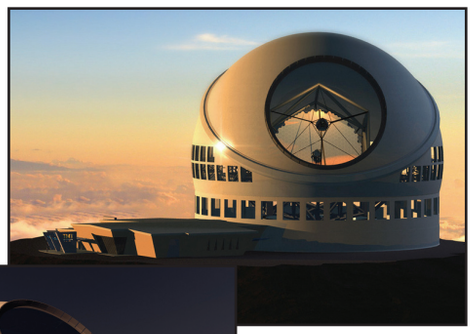
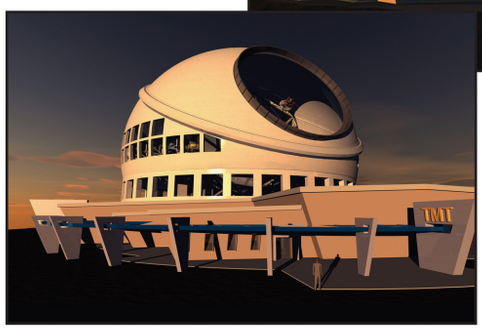
TMT PROJECT ADVANCES TOWARD CONSTRUCTION

Consultants from Observatory Sciences have participated in a cost and schedule review at the TMT

The next generation of optical telescopes will be the largest optical telescopes ever to be built and promise to open a new window onto the universe. But construction of these giant telescopes, many times larger than previous generations, come with major implications for costs, with the timescale to completion expected to run to over a decade.





(Above) Artist's impression of the TMT on Mauna Kea. (Left) Interpretation of the TMT in early morning light. Pictures courtesy of TMT Observatory Corporation.

In January 2011, Observatory Sciences consultant Chris Mayer travelled to the Thirty Meter Telescope (TMT) project headquarters in Pasadena, California to participate in a cost and schedule review, lending his expertise to one of the world's largest astronomical projects. Once operational, TMT will be one of the most advanced and powerful optical telescopes on Earth.

TMT will consist of a primary mirror with 492 individual 1.45 metre segments, together measuring 30 metres in diameter, and providing more than nine times the collecting area of the largest of the current generation optical telescopes. All segments will be under precision computer control so that they will work together as a single mirror. When completed, the TMT will enable astronomers to study objects in our own solar system, stars throughout the Milky Way and its neighbouring gal-axies, and forming galaxies at the very edge of the observable universe, near the beginning of time. In July 2009, the TMT Observatory Corporation selected Mauna Kea on the Big Island of Hawaii as its preferred construction site. The final build cost is estimated in the region of US$1 billion. Construction entered its early phase thanks to a $200 million pledge from the Gordon and Betty Moore Foundation. Matching gifts from the California Institute of Technology and the University of California are expected to bring the total to $300 million. More information on the TMT project is available at www.tmt.org.

OSL ATTENDS ICALEPCS 2011

Practical solutions will be the watchword when Observatory Sciences attends the ICALEPCS 2011 conference and exhibition, 10-15 October. "As well as the conference there will be a trade exhibition featuring controls suppliers such as Delta Tau UK and Hytec. Software and hardware can be combined to provide optimal solutions for large physics facilities," says OSL Director Philip Taylor. ICALEPCS is the International Conference on Accelerator and Large Experimental Physics Control Systems, this year hosted at European Synchrotron Radiation Facility, Grenoble.

SUN SPOTS AND SOLAR CYCLE

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components that make up the overall ATST control system. The main programming language to be used for the TCS software will be Java.

World's largest telescope

When completed in 2017, the ATST will be the largest telescope in the world dedicated to observing the sun, with unprecedented abilities to view solar detail and allow scientists to learn even more about the sun and solar-terrestrial interactions. ATST's 4m primary mirror will feed an advanced array of instruments designed to study the sun at wavelengths from near ultraviolet to far infrared. High order adaptive optics will correct blurring of solar images by the Earth's atmosphere, allowing scientists to observe features with unprecedented sharpness.

OSL Director Chris Mayer comments: "Although the primary aims of the project are scientific, studies such as mapping magnetic fields around the sun relate to sun spots and the solar cycle. This knowledge will help predict variability, advance understanding of climate change, and teach us more about solar flares which can affect both aircraft and satellites."

Observatory Sciences has been involved with the software for the ATST since 2004.

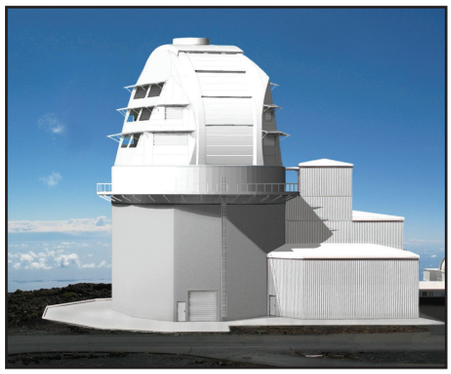
CONTROLLED ENCLOSURE MOTION SYSTEM IMPROVES SOLAR SEEING

Observatory Sciences has won a further contract to produce software for the Advanced Technology Solar Telescope (ATST), to be sited on Haleakala on the Hawaiian island of Maui

In addition to providing the ATST Telescope Control System (TCS) software, Observatory Sciences will also now be developing the ATST enclosure controls, designed to protect the telescope assembly.

The enclosure control system (ECS) provides software and hardware that translates observatory tracking and slewing information into commands for the physical systems of the enclosure. As with the TCS software, the enclosure control software will be built on the ATST Common Services Framework software provided by the project office. This provides a common development architectural framework for software communications support, configuration-based control operations, the container/component architecture, controllers, toolboxes and services.

The ATST enclosure is a complex structure integrating a number of mechanical sub-systems, including the azimuth and shutter tracking mechanisms, motors, drives and cable wraps. In addition to protecting the telescope mount assembly, these allow the enclosure structure to move so that it can point, track and slew with the sun. This is important as the thermal loads from the sun's radiation need to be minimised such that the heat does not impact on the telescope's imaging capability.



Rendering of ATST looking south. Image courtesy KC Environmental Inc.

High level software

The contract for construction of the enclosure was awarded to AEC Engineering of Minneapolis, Minnesota, part of the IDOM group. Based in Bilbao, Spain, IDOM is a major company in the field of professional services in Engineering, Architecture and Consulting. The high-level software development has been subcontracted to Observatory Sciences, working with IDOM staff in Bilbao and Minneapolis.

"In many respects this is more an engineering project rather than a scientific project, but it uses the same basic software that we're using for the TCS system," says Alastair Borrowman, who is leading the development work at Observatory Sciences' Cambridge headquarters. "Our high-level software will use the ATST Common Services Framework software to control the enclosure via an Allen-Bradley Programmable Automation Controller (PAC)."

The ATST is a project of the United States National Solar Observatory, which is operated by the Association of Universities for Research in Astronomy, Inc (AURA) under a cooperative agreement with the National Science Foundation.

BEAMLINE UPGRADE FOR SYNCHROTRON

Observatory Sciences consultant Andy Foster is working on-site at the Australian Synchrotron is Melbourne, upgrading and improving the software for the X-Ray Absorption Spectroscopy (XAS) beamline.

OSL consultants have been involved with the facility from its early days, initially delivering training on the EPICS toolkit that was selected as the software environment. Later, in 2007, OSL consultants were again brought in, this time working with Accel Instruments GmbH, to assist with beamline software. Software work done included writing a Linux driver for the Delta Tau PMAC motion controller as well as cryocooler and vacuum controls software. OSL also provided on-site commissioning.

XAS beamline

The XAS beamline consists of a collimating mirror, liquid nitrogen cooled double crystal monochromator and dual toroid refocusing mirror, with the X-rays provided by a 1.9T wiggler insertion device.

This beamline is an important facility for the Australian Synchrotron. Such beamlines are in high demand around the world for applications in the biological, chemical, earth, environmental, engineering, materials and physical sciences. The technique complements protein crystallography studies, and the two are frequently used in combination to determine challenging structures.

Examples of research being carried out on the XAS beamline include identification of therapeutic target sites, such as the metal-binding sites that may be responsible for some of the pathological effects of Alzheimer's disease, and characterisation of ion-implantation-induced disorder in semiconductor substrates, with application to electronic and photonic device fabrication.

The Australian synchrotron is a 3GeV third generation synchrotron, and is a significant addition to the country's science infrastructure, providing researchers with access to world-leading technology not previously available in Australia. First light was achieved in 2007, and research began in June 2008.