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DISCOVERY

BIG SCIENCE SOLUTIONS SPRING 2013

Power PMAC motion controller Observatory Sciences is now able to offer software for Delta Tau's new Power PMAC motion controller compatible with both the EPICS and TANGO software systems, enabing adoption of the controller at large scientific facilities. **Page 2**

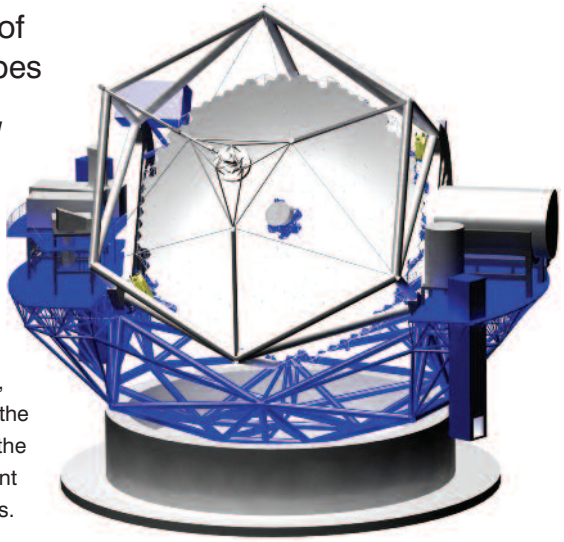
ATST TCS acceptance testing The telescope control system developed by Observatory Sciences for the Advanced Technology Solar Telescope has recently completed its acceptance testing in Tucson, Arizona. **Page 4**

CONCEPTUAL DESIGN FOR TMT TELESCOPE CONTROL SYSTEM

The Thirty Metre Telescope project will lead to the construction of one of the world's most advanced and powerful optical telescopes

The Thirty Metre Telescope (TMT) will consist of a primary mirror with 492 individual 1.45 metre segments that together measure 30 metres in diameter, providing more than eight times the collecting area of the current largest telescope. All segments will be under precision computer control so they will work together as a single mirror. When completed, the Thirty Metre Telescope will enable astronomers to study objects in our own solar system and stars throughout the Milky Way and its neighbouring galaxies, and the formation of galaxies at the very edge of the observable universe, near the beginning of time.

The TMT project, with headquarters in Pasadena, California, is a partnership formed by research universities and governments from the United States, China, Japan, India and Canada. Different aspects of the project are being undertaken by the partner countries. The



With construction of the TMT moving nearer, Observatory Sciences has been awarded a contract to undertake a conceptual design of the Telescope Control System, following work on cost and schedule reviews. Image courtesy TMT Observatory Corporation

TMT observatory control software consists of a set of software components that control the operations of the telescope, the mirrors, the telescope enclosure, and the various instruments. India is responsible for the observatory software, the data management system and the image and object catalogues.

TCS conceptual design

With the first phase of construction of the Thirty Metre Telescope moving ever nearer, Observatory Sciences has been awarded a contract to undertake a conceptual design of the TMT telescope control system (TCS). This contract follows previous work on the TMT, where Observatory Sciences consultants participated in cost and schedule reviews.

The telescope control system is responsible for the coordination and control of the various subsystems that make up the telescope, responding to commands received from the

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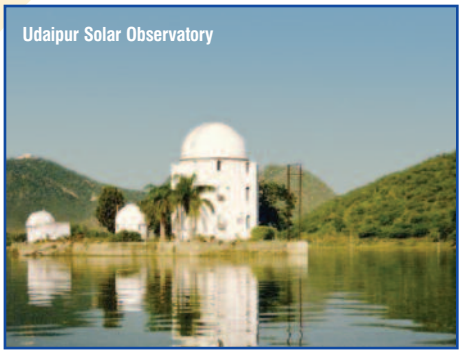
COMMISSIONING ON AN INDIAN ISLAND



Udaipur Solar Observatory

Final commissioning of the Multi-Application Solar Telescope (MAST) in Rajasthan at the Udaipur Solar Observatory (USO) in India continues after Observatory Sciences consultants Chris Mayer and Alan Greer spent January 2013 at the site commissioning the telescope control system.

Observatory Sciences began development work on the MAST control system software in 2008, along with that for another Indian telescope: the 3.6 meter aperture ARIES – the largest in Asia. The MAST telescope has now been transported to its final site on USO's island in the middle of Lake Fatehsagar in Udaipur; a special raft had to be constructed to transport the telescope to the site, and working on the island sometimes requires being rowed to work.

The telescope control system is written using the LabVIEW graphical programming language from National Instruments,

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EPICS AND TANGO OPTIONS FOR POWER PMAC MOTION CONTROLLER

Observatory Sciences is now able to offer software for Delta Tau's new Power PMAC motion controller compatible with both EPICS and TANGO

Observatory Sciences has worked with Delta Tau motion controllers for many years, and is now providing software support for its latest and most powerful system. The Power PMAC motion controller combines a computer and a motion controller in a single compact unit, making it an extremely flexible option for high-end, complex applications with up to 256 axes of control. The Power PMAC provides advanced servo and kinematic algorithms, and runs a Linux real-time operating system using the Xenomai pre-emptive real-time kernel.

Observatory Sciences is continuing its work with Brookhaven National Laboratory's Synchrotron Light Source II (NSLS-II) with the latest project for Power PMAC EPICS support. Construction of the NSLS-II began in 2009 and operations are expected to begin in 2015. The new contract follows work to produce control software for their Moveable Gap Damping Wiggler (supplied by Danfysik of Denmark) 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 ability to use the Power PMAC with both EPICS and now TANGO will enable adoption of these systems at large scientific facilities such as synchrotrons. Observatory Sciences is a recognised leader in EPICS, developing control systems and delivering EPICS training. The

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EPICS toolkit has been used on many high energy physics facilities as well as on large astronomical telescopes around the world, and EPICS software now provides the core control system for many synchrotron facilities.

The addition of TANGO software for the Power PMAC will provide another option for synchrotron motion control. TANGO (TAco Next Generation Object) is a distributed control system, based on object oriented and service oriented approaches to software architecture. It is being actively developed by the collaborative effort of a group of European scientific institutes, including Alba, Desy, Elettra, ESRF, FRM II, Solaris and Soleil.

Soleil synchrotron

The first user of Observatory Sciences TANGO software library for the Power PMAC will be the Soleil synchrotron – the French national synchrotron which provides a multi-disciplinary instrument and research laboratory. The synchrotron is currently home to a number of high profile research projects, including looking into the production of graphene semiconductor nano-ribbons. This two-dimensional crystal composed of a single layer of carbon atoms has very promising properties that could drive major advances in microelectronics.

Observatory Sciences experience with Delta Tau goes back over 15 years to work on the Gemini 8 metre Telescopes project. The Gemini mount control system, acquisition and guidance system and cassegrain rotator all use PMAC2 VME cards to provide the servo control to their motors. Observatory Sciences consultants worked with staff at the Argonne National Laboratory, Chicago, to develop and test the PMAC VME device driver. More recently, Observatory Sciences has worked with Delta Tau to integrate its GeoBrick LV controller with EPICS to provide the Diamond Light Source synchrotron with its next generation motor controller solution.

DESIGN REVIEW AS TMT BUILD MOVES CLOSER

Continued from page 1

observatory control system and from expert user interfaces. The telescope control system consists of a sequencer and status/alarm monitor, a pointing kernel, a corrections module, and several adaptors. The sequencer and status/alarm monitor provide high level control of the mount, the primary, secondary and tertiary mirrors, and the enclosure. TMT's calotte telescope enclosure is made up of a rotating base over a fixed base, a circular aperture in a cap structure mounted on an inclined track, and a cap cover, giving the observatory its distinctive appearance.

The pointing kernel converts target positions (right ascension and declination) into pointing and tracking demands in the appropriate coordinate systems for the telescope mount, instrument rotators, atmospheric dispersion correctors, instrument and adaptive optics system wavefront sensor probes, and the enclosure cap and base.

The corrections module on the TMT is responsible for the creation and management of the look-up tables that control the position and shape of the primary, secondary and tertiary mirrors as a function of zenith angle and temperature. It will also process data from the telescope global metrology system and provide appropriate position information to the other control systems.

Construction at the proposed site on Mauna Kea, Hawaii has been delayed after objections were raised on environmental and conservation grounds. But the release of a long-awaited hearing officer's report in November 2012 dismissed arguments raised by petitioners, and found that the TMT project satisfied all the key criteria for construction to begin. Hawaiian officials have now granted a permit for constuction, which could begin as early as April next year.

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.

- Design and development of instrument and equipment control software
- Technical reviews and studies of software solutions
- Training and skills transfer
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- Software commissioning and support
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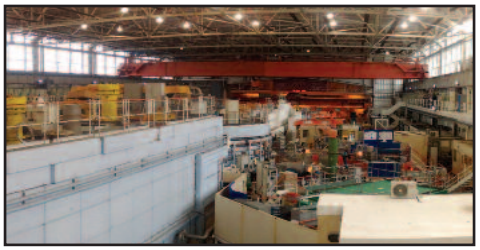
OSL DELIVERS LARGEST EPICS TRAINING AT ISIS

The ISIS project is adopting the EPICS software framework for some of its controls which will be used in conjunction with the existing National Instruments LabVIEW software

The ISIS pulsed neutron and muon source at the Rutherford Appleton Laboratory in Oxfordshire, UK is owned and operated by the Science and Technology Facilities Council. ISIS produces beams of neutrons and muons that allow scientists to study materials at the atomic level using a suite of instruments, often described as 'super-microscopes'. It supports a national and international community of more than 2000 scientists who use neutrons and muons for research in physics, chemistry, materials science, geology, engineering and biology.

In February Observatory Sciences delivered its largest ever training course on the EPICS software environment. Over five days, Observatory Sciences consultants provided EPICS training to 14 ISIS and Diamond Light Source participants. Observatory Sciences Director Philip Taylor comments: "Deploying EPICS in any facility requires a lot of knowledge and experience of best practice, and our training course was aimed at giving delegates the experience they need to enable them to make full use of its many features."

Observatory Sciences is one of the leading exponents at delivering EPICS training, and is an acknowledged expert in EPICS software which has been used on many high energy physics facilities as well as on large astronomical telescopes around the world. Observatory Sciences consultant Andy Foster will be presenting the first day of training at the forthcoming EPICS spring collaboration meeting, 29 April to 3 May, which is being jointly hosted by ISIS and Diamond Light Source. The meeting will consist of two days of training and pre-meeting sessions, followed by the main EPICS meeting on the final three days of the week. Taylor comments: "These meetings provide a chance for people from various different sites to come together and discuss their work and progress, and look at what is being done at other facilities. It also provides an opportunity to see what new tools are available."



The neutron hall at ISIS, the pulsed neutron and muon source at Rutherford Appleton Laboratory in Oxfordshire, UK

EPICS (Experimental Physics and Industrial Control System) is a set of open source software tools, libraries and applications developed collaboratively and used world-wide to create distributed soft real-time control systems for scientific instruments.

OSL ATTENDS KEY EVENTS

Observatory Sciences will have trade stands at two scientific control software meetings this year – the EPICS spring collaboration meeting and the ICALEPCS conference and exhibition (6-11 October) in San Francisco, California. Taking a trade stand at these two events enables Observatory Sciences to demonstrate its capabilities. "It enables us to showcase the role we have played in many big science projects, showing how hardware and software can be optimally combined to provide the best possible solutions for large physics facilities," says OSL Director Philip Taylor.

COMMISSIONING FOR MAST

Continued from page 1

incorporating positional astronomy and telescope pointing software supplied under licence from Tpoint. Observatory Sciences built the telescope control system on proven technology, thoroughly tested before delivery and commissioning

During OSL's commissioning visit, new features were added to the telescope control system software along with performance enhancements. As well as making solar observations, telescope pointing tests were carried out during the night and initial calibrations were performed on the guiding system.

MAST is a 50cm diameter aperture telescope built by AMOS of Belgium. The MAST telescope delivers a world class observing facility in India, providing a versatile tool to study the physics of solar eruptions. Specific science goals include investigating the topology and evolution of emerging magnetic flux regions leading to solar activities such as flares and coronal mass ejections, investigating the magnetic velocity and structure of sunspots and small scale features such as pores in the photosphere and chromosphere, and investigating the decay of sunspots and their relation to moving magnetic features.

ATST TELESCOPE CONTROL SYSTEM UNDERGOES ACCEPTANCE TESTING

The telescope control system developed by Observatory Sciences for the Advanced Technology Solar Telescope (ATST) has recently completed its acceptance testing in Tucson, Arizona

Observatory Sciences has been involved in the ATST project since 2004, and won the contract to develop the TCS software in 2010, building it using the ATST Common Services Framework to ensure that it will integrate seamlessly with other components that make up the ATST control system. The main programming languages used for the TCS software are Java and C++.

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.

Observatory Sciences is involved in several other aspects of the ATST project. Most recently, it has been contracted to provide the control software for the telescope's Primary Mirror (M1) – a 4.24m diameter, 75mm thick, off-axis paraboloid. The size is unprecedented for an off-axis mirror, presenting challenges in its manufacture and assembly as well as in its control systems. The baseline support system consists of 118 axial force control actuators mounted at the mirror back surface and 24 lateral supports along the outer edge with an active optics capability. Thermal control is also implemented to minimise temperature rise of the optical surface due to coating absorption.

(Above) Casting the ATST primary mirror: photo courtesy SCHOTT AG. (Top right) Artist's impression of the ATST; picture courtesy of NSO/AURA/NSF

M1 control system

The ATST M1 control system is being constructed by the Belgian company AMOS, which specialises in the design and manufacture of very high accuracy opto-mechanical systems for the space industry and professional astronomy. AMOS has worked ona number of high profile telescope projects and has produced high-precision diamond-turned components for a range of clients.

Observatory Sciences has also made good progress with the enclosure control system (ECS) for the ATST and has recently delivered the Beta release of the control software. 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. The ECS provides software that translates observatory tracking and slewing information into commands for the physical systems of the enclosure. As with the TCS software, Observatory Sciences has built the ECS software using the ATST Common Services Framework.

The contract for construction of the enclosure was awarded to AEC Engineering of Minneapolis, Minnesota, part of the IDOM group which is based in Bilbao, Spain. The high-level software development was subcontracted to Observatory Sciences, working with IDOM staff in Bilbao and Minneapolis.

With its background in a wide range of the telescope's subsystems, Observatory Sciences will soon be providing software quality assurance services for ATST. This will include Observatory Sciences defining software testing practices and procedures that in-house and external software suppliers will use.

NEW INFRARED TELESCOPE PROPOSED FOR TURKEY

A new 4-metre class infra-red telescope has been proposed which will be sited in North-eastern Turkey near the city of Erzurum. The Eastern Anatolia Observatory (DAG) project was accepted in January 2012 by the Turkish Ministry of Development, and in December 2012 DAG issued a Call for Information to allow it to identify companies interested in participating in a forthcoming Call for Tender to supply the telescope.

The science drivers behind the new telescope include the investigation of solar system bodies, stars and stellar evolution, as well as galaxy formation and evolution. The new telescope will have important synergies with other Turkish facilities, as well as providing additional research capability for astronomers outside of Turkey.

The telescope will be constructed at Karakaya Tepeleri, at 3170m altitude in a mountain range at a site that will protect it from weather from both the North (the colder Black Sea region) and South (the hotter Middle East and Mediterranean Sea). Meteorological parameters have been monitored that show that the site is suitable for IR observations, including low humidity and mean wind speed.