OBSERVATORY SCIENCES LTD

DISCOVERY

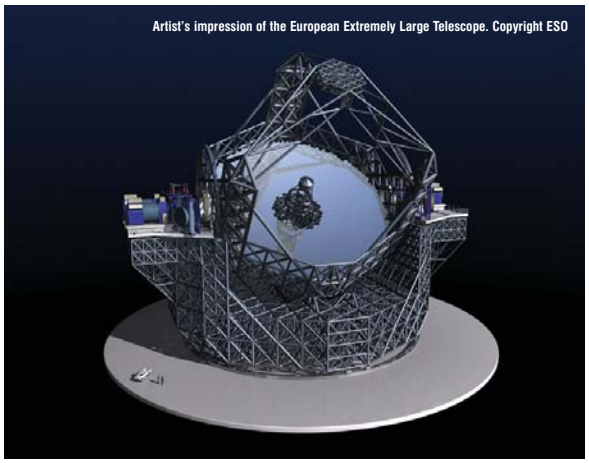
BIG SCIENCE SOLUTIONS SPRING 2008

Ultra high resolution images Observatory Sciences is producing the software to control an array of telescopes being built on Magdalena Ridge, New Mexico which will provide ultra high resolution astronomical images. **Page 2**

OSL signs TPOINT licensing agreement Observatory Sciences has signed a licensing agreement with Tpoint Software which enables it to incorporate Tpoint's state-of-the-art telescope pointing software into telescope control systems supplied by OSL. **Page 4**

SOFTWARE STUDY FOR EUROPEAN EXTREMELY LARGE TELESCOPE

Observatory Sciences has undertaken a study, under contract to the European Southern Observatory, to review software options for the controls of the European Extremely Large Telescope (E-ELT). ESO gave the green light at the beginning of 2007 to proceed with detailed design studies for this giant telescope that has the potential to revolutionise ground-based astronomy.



Artist's impression of the European Extremely Large Telescope. Copyright ESO

The E-ELT will be the world's largest optical/infrared telescope, with a primary mirror diameter of 42 metres, based on a design using new concepts specially developed for a telescope of this size. Construction is planned to start in 2010 with a budget of 850 million Euros, with the telescope completed and ready for use in 2017.

Heralding a new era for optical and infrared astronomy, the E-ELT will deliver unprecedented acuity and light gathering power to provide unique images of objects at all scales, from those in our own solar system to exo-planetary systems and the very first points of light in our universe.

Combined with its vast size, a key feature of the E-ELT will be its adaptive optics (AO) concepts, making it one hundred times more sensitive than the current largest optical telescopes, such as the 10m Keck telescopes or the 8.2m VLT telescopes. Previously, post focal adaptive optics have been built into the instruments rather than as an integral part of the telescope design itself. The E-ELT breaks the mould by embedding AO into the telescope as a baseline option.

The primary 42m diameter mirror will be comprised of 984 hexagonal segments, each

Continued on page 3

BEAMLINES BOOST AUSSIE SCIENCE BASE

Accel Instruments has brought in consultants from Observatory Sciences to assist with beamline software for the Australian Synchrotron in Melbourne. The Australian Synchrotron facility 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 for the synchrotron was achieved in July 2006 with beamlines available to external researchers from June 2007. Installation, commissioning and accelerator studies have been running across four eight-hour shifts with the beamlines available for research for the remainder of the weekly operating cycle. The team is working hard to optimise beamline performance, and it is anticipated that the beamlines will be available 24 hours per day for the new round of user experiments running from January 2008. Accel was contracted to work on the XAS X-ray absorption spectroscopy beamline. The XAS beamline wiggler was air freighted to Melbourne for installation in December 2006, closely followed by the XAS beamline itself following factory acceptance tests at the Accel facilities in Germany. Stage one commissioning began on the beamline in March 2007, with the first commissioning experiments conducted in September 2007, and the first user experiments conducted in December 2007.

Software work done by OSL for the XAS beamline included writing a Linux driver for the Delta Tau PMAC motion controller as well as

Continued on page 3

INDIAN SIGHTS ON TOP DESIGN

Observatory Sciences has begun development work on the control system software for two new telescopes which will be based in India, providing world class observing facilities in the country for ground-based optical astronomy.

The work is being undertaken by OSL in partnership with the telescope manufacturer AMOS (Advanced Mechanical and Optical Systems) based in Liege, Belgium. AMOS specialises in the design and manufacture of high precision mechanical and optical systems for the space industry and astronomical observatories.

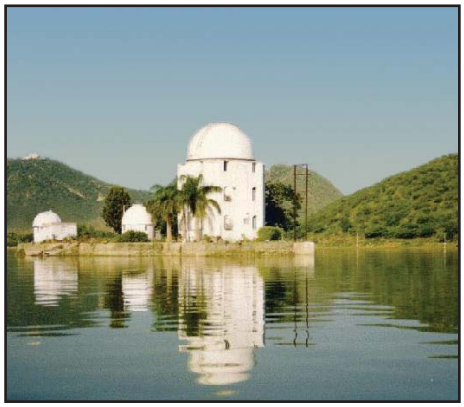
The larger of the two is the Aryabhatta Research Institute of Observational Sciences (ARIES) project for a 3.6m telescope – making it the largest in Asia – optimised for spectroscopic observations. Key requirements for the control system were to operate and control the telescope under all possible observing situations, and to provide complete computer control of the telescope with network operational capability.

To meet the image quality specification, active optics will be implemented. The primary mirror will have its shape actively driven by a set of force-controlled axial actuators. The lateral supports will be passive. The secondary mirror will be positioned in five axes to compensate for misalignment with the primary. Both active systems will use data from a wave front sensor.

The telescope will be set up at an altitude of 2540 metres at Devasthal Peak, near Nainital. The ARIES primary mirror will be produced by the Russian Lytkarino Optical Glass Factory (LZOS) in Moscow.

The second, smaller Indian telescope for which OSL is providing the control software is the Multi-Application Solar Telescope (MAST) to be sited in Rajasthan at the Udaipur Solar Observatory (USO), and which will provide a versatile tool to study the physics of solar phenomena. The new telescope will add to the existing facilities at this renowned observatory, which is one of six solar observatories in the world that together can monitor the sun 24 hours a day.

Both these telescopes' control systems will be written using the LabVIEW graphical programming language from National Instruments, incorporating positional astronomy and telescope pointing software supplied under licence from Tpoint.



(Left) Udaipur Solar Observatory. (Above right) The new 3.6m telescope will join the existing facilities at the Devasthal Peak site, situated near Nainital at an altitude of 2540 metres

SEE YOU IN MARSEILLE

June 23-28 2008 will see the biennial SPIE Astronomical Telescopes and Instrumentation event being held in Marseille, France, showcasing the latest in tools, instruments, devices and components for large ground-based telescopes, ground instruments, astronomy information technologies, space telescopes and instruments, detectors, specialised optics, materials and systems.

The theme for the conference papers at this year's event is the synergies between ground and space, focusing in particular on the complementary research goals of both ground-based and space facilities.

Observatory Sciences staff will be attending SPIE Marseille and we look forward to hearing about the latest developments in our field, and meeting new clients as well as old friends.

CONTROLLING MULTI-TELESCOPE ARRAY

Observatory Sciences is producing the software to control an array of telescopes being built on Magdalena Ridge, New Mexico which will provide ultra high resolution astronomical images.

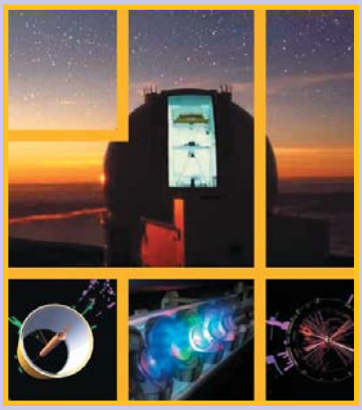
The Magdalena Ridge telescope's control system will be written using the LabVIEW graphical programming language from National Instruments, incorporating positional astronomy and telescope pointing software supplied under licence from Tpoint.

The Magdalena Ridge Observatory (MRO) is an astronomical observatory about 30 miles (48 kilometres) west of the town of Socorro, New Mexico. It is situated at an elevation of 10,600 feet (3180 metres), making it the fourth highest observatory in the world. Scheduled for completion in 2009, the site will house two main facilities: the Magdalena Ridge Observatory Interferometer (MROI) and a single 2.4 metre telescope.

High resolution images

Optical interferometry is used to combine the light beams from several telescopes to produce ultra high resolution images. The MROI array will consist of up to ten 1.4m diameter telescopes in a Y-configuration, operating in the optical and near-infrared. The telescopes will be moveable, allowing variable baselines (inter-telescope spacings) between 7.5 and 340 metres.

The facility will be used to investigate young stellar objects and planetary companion formation, to study the astrophysics of many different stages of stellar evolution, and to study the active galactic nuclei of nearby host galaxies.



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
- Systems maintenance and upgrade management
- Procurement and integration
- Facilities management and operation
- Software commissioning and support
- Project reviews

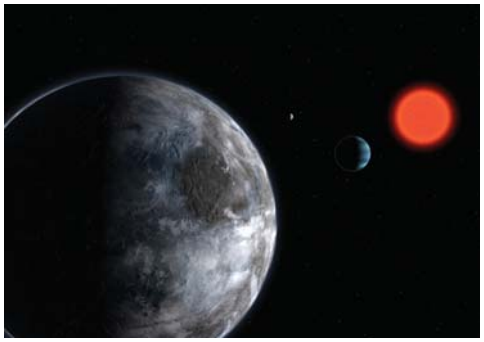
Observatory Sciences Ltd
William James House
Cowley Road
Cambridge CB4 0WX
United Kingdom
Tel: +44 (0)1223 508257
Fax: +44 (0)1223 508258
info@observatorysciences.co.uk
www.observatorysciences.co.uk

E-ELT'S ACTIVE OPTICS

Continued from page 1

1.2m in size, while the secondary mirror will be 6m in diameter. The incorporation of adaptive mirrors into the optics will be key in the imaging of distant objects. A tertiary mirror, 4.2m in diameter, will relay the light to the adaptive optics system, composed of two mirrors: a 2.5m mirror supported by some 5000 actuators able to distort its own shape a thousand times per second, and one 2.7m in diameter that allows for the final image corrections.

The scale of the E-ELT project and complexity of the control requirements makes the choice of software framework critical. "Both the VLT and ALMA software frameworks have proven themselves in use at the European Southern Observatory," says Observatory Sciences consultant Philip Taylor, "but other software solutions such as ATST software, LabVIEW, TANGO, EPICS, DDS and PVSS-2 are also options we are looking at. The final decision will be based not only on the technical and managerial challenges provided by the E-ELT, but also on the basis of delivering software that will have both a long working life and easy upgradeability."



Artist's impression of the planetary system around the red dwarf star Gliese 581. The E-ELT will be able to detect directly such a planet as a faint point of light and reveal its global properties (eg rocks versus oceans) from a low-resolution spectrum. Image courtesy of ESO

The E-ELT could be on-stream as early as 2017, and is expected to be in operation until at least 2048. The site where the giant telescope will be built will be decided in 2008 following a world-wide review of potential observing sites.

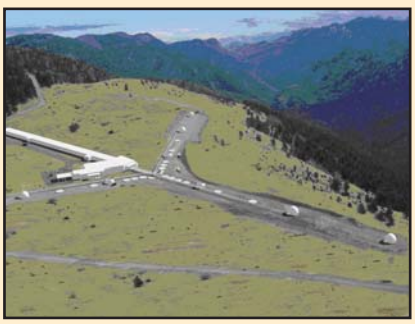
AUSSIE BEAMLINES UP AND RUNNING

Continued from page 1

cryocooler and vacuum controls software. During March 2007, on-site commissioning work was carried out in Melbourne by OSL.

Whilst the partnership with Accel on the Australian Synchrotron project is new, this is not the first involvement from OSL on the A$200m facility. When the EPICS toolkit was selected as the software environment for the system controls, consultants from Observatory Sciences travelled to Melbourne to deliver initial training on the EPICS toolkit. Based in Bergisch Gladbach, near Cologne, Germany, Accel Instruments is a specialised engineering and manufacturing company producing custom designed research and industrial equipment.

One of the leading players in its field, Accel offers a range of project management services, manufacturing technologies and engineering capabilities to companies and research facilities worldwide.



(Above) Artist's impression of the interferometer at the Magdalena Ridge Observatory. The array will consist of up to ten telescopes in a Y configuration, operating in the optical and near-infrared wavelength. Further information can be found on the Magdalena Ridge Observatory website at www.mro.nmt.edu

The telescopes making up the interferometer will be optically linked in order to produce images with unprecedented detail. And as well as being able to produce much more accurate images, a big advantage of the array is that it will be able to make these images many times faster than other existing and planned interferometric arrays.

Positioning tolerances

The facility is being designed and built collaboratively by the New Mexico Institute of Mining and Technology (NMT), the US Naval Research Laboratory, and the University of Cambridge's Cavendish Laboratory. A key aspect of the interferometer design will be the ability to meet the required positioning tolerances.

OSL is working in on the project in partnership with AMOS. The project will be completed in phases, with the initial phase being three telescopes constructed by AMOS, all of which will have near-infrared imaging capabilities. Subsequent phases will see the completion of the array of ten telescopes, and once finished the instrument will be capable of producing images of about 100 times greater resolution than the Hubble Space Telescope. The interferometer expects first light in late 2009.

AMOS has been building telescopes since 1983, including the design and delivery of the auxiliary telescopes for the European Southern Observatory's Very Large Telescope Interferometer.

SYNCHROTRON IS SHINING BRIGHT

The Diamond Light Source synchrotron is now in full operation, but the work of Observatory Sciences consultants Andy Foster and Alan Greer goes on, commissioning further beamlines at the impressive scientific facility – the largest to be built in the UK for over 30 years.

Opened officially on 19 October 2007 by Her Majesty the Queen as she celebrated her diamond wedding anniversary, Diamond Light Source is already living up to its billing as one of Europe's foremost research facilities.

Seven Phase One Diamond beamlines came into operation during 2007, used for projects that include research that could potentially lead to drugs to prevent cancer cells from spreading, studying meteorites to understand the early solar system, examining ways to improve digital storage through improved magnetic materials, and using powerful X-rays to investigate fragile ancient parchments. Research using synchrotrons in the past has led to a number of scientific breakthroughs, with biomedical achievements including finding the structure of the foot and mouth virus.

A further 15 Diamond beamlines are planned to be built in Phase Two, at a rate of four per year.

Ongoing commissioning work

Observatory Sciences consultants have been involved in the Diamond Light Source project, located on the Harwell Chilton science campus in Oxfordshire, for a number of years. As well as providing a series of on-site training courses for the EPICS software toolkit, they have been responsible for production of Diamond software systems as well as writing and commissioning software used to control beamline equipment. Now OSL consultants Andy Foster and Alan Greer are busy commissioning facilities for several new beamlines. Andy is in charge of software commissioning work on the macromolecular crystallography (MX) beamlines. Meanwhile Alan has concentrated on the Nanoscience microfocus soft-X-ray beamline for X-ray photoelectron microscopy, which can be used to study nanostructures significant for sensors, catalysts and magnetic materials and nanoscale devices.

(Above right) Aerial view of the Diamond Light Source facility. (Left) At work on the photoelectron microscope. Photos courtesy of Diamond Light Source

Much more work remains to be done at Diamond. With Phase Two beamlines scheduled for completion in 2011, a third phase may be built if funding and demand warrant. Ultimately Diamond could host up to forty cutting edge research stations.

OSL TO LICENCE TPOINT SOFTWARE

Observatory Sciences has signed a licensing agreement with Tpoint Software (owned and run by Patrick Wallace) which enables it to incorporate Tpoint's state-of-the-art pointing software into telescope control systems supplied by OSL.

The Tpoint software suite is based upon the interactive software tool TPOINT, which uses observed star positions to form a pointing model for the telescope or antenna concerned. With the TPOINT model embedded in the control system, target acquisition is swift and assured, and long-term tracking accuracy enhanced. The improvements come about not only through the continuous correction of mechanical errors such as misalignments and flexures, but also as a result of accurate mount alignment. The TPOINT tool has been widely adopted by both professional and amateur astronomers on telescopes of many different designs, including equatorial and altazimuth mounts and optical, IR and radio telescopes.

To aid the development of advanced telescope control systems, a pointing kernel software library called TCSpk is provided. This is aimed at developers of telescope or antenna control systems for professional astronomy and space applications. It uses extremely accurate and sophisticated algorithms for controlling pointing and tracking, including provision for autoguiders, tip-tilt optics and instrument rotators. TCSpk is used by scientific observatories worldwide, including the 10m Gran Telescopio Canarias, the 4.1m SOAR telescope, the 2x8m Large Binocular Telescope and the ESA 35m deep space antenna near Perth, Western Australia.

A pioneer in computerised telescope control, Patrick Wallace is recognised as the world's leading expert on precision telescope positioning, and received the Jackson-Gwilt Medal of the Royal Astronomical Society in 2004 for his "outstanding contributions to the development of precise, accurate, dependable and rigorous telescope pointing software". He set up his Tpoint Software business in 1996 in Abingdon, Oxfordshire, to develop and market the TPOINT analysis application and associated telescope pointing libraries.