



**Discovery Channel Telescope project advances** The Discovery Channel Telescope will provide a powerful tool for research, including the search for near Earth objects and addressing fundamental questions about the origin of the Solar System **Page 3**

**New project for Hobby-Eberly Telescope** Observatory Sciences has provided a software study for an upgrade to the Hobby-Eberly telescope control system to enable the telescope to be used in a project to understand the evolution of 'dark matter'. **Page 4**

## EXCITEMENT BUILDS AS THE SQUARE KILOMETRE ARRAY PROJECT ADVANCES

Observatory Sciences is looking to become involved with the Square Kilometre Array project – the biggest, most complex and most technologically innovative radio telescope ever conceived.

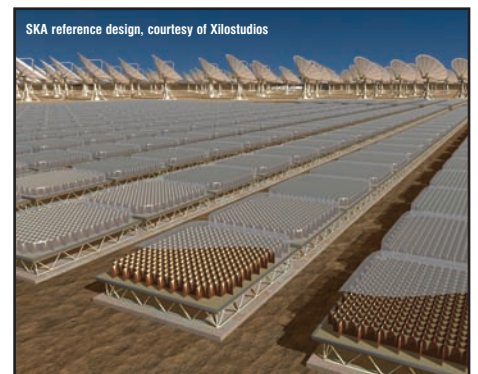
The Square Kilometre Array (SKA) will take several giant leaps forward in telescope technology, allowing it to image vast fields of view with enormous sensitivity (two orders of magnitude greater than existing facilities), observe in several directions simultaneously and independently, and cover almost the whole radio spectrum at the same time.

The project has been 'born global', with more than 50 institutions in 19 countries committing themselves to share the research and development of the telescope. A final site for the telescope has yet to be decided, but the SKA steering committee has narrowed the choice of locations to South Africa and Australia. Several of the participating countries

have "SKA Pathfinder" projects: these include ASKAP (Australia), MeerKAT (South Africa) and LOFAR (Netherlands). Some of these Pathfinder projects themselves are on a large scale: for example the ASKAP project has a budget of about AU\$ 100 million.

### Early involvement

OSL (Observatory Sciences Ltd) specialists have begun working with SKA scientists in several countries. OSL's Chris Mayer gave a presentation on telescope control at a UK SKA meeting in the Cavendish Laboratory in Cambridge in December 2008, and in February 2009 attended the International SKA Forum 2009 in Cape Town, South Africa to better understand the requirements of this huge

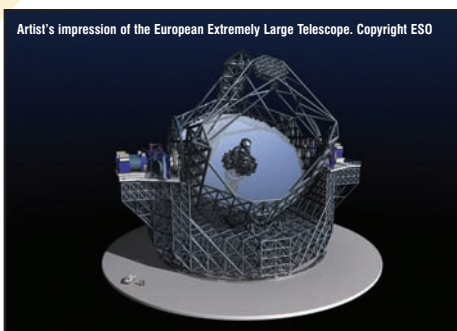


project. At the same time, Philip Taylor and Andy Foster, were in Sydney, Australia, training scientists at the ASKAP (Australian SKA Pathfinder) on EPICS software, which has been chosen as the software framework for their project.

Chris Mayer believes that this ongoing commitment and involvement, together with **Continued on page 2**

## MIDDLEWARE STUDY FOR EUROPEAN ELT

Following a study by Observatory Sciences into software options for the controls of the European Extremely Large Telescope (E-ELT), the European Southern



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

Observatory (ESO) has come down in favour of the Data Distribution Service (DDS) software for the rapid distribution of large amounts of control data required by the control system.

The scale of the E-ELT project and the complexity of the control requirements makes the choice of software framework critical. The strategy for the telescope control system has been to use commercial-off-the-shelf (COTS) and/or open source systems wherever possible to avoid expensive custom developments. In 2007, Observatory Sciences delivered a report on the E-ELT software framework and the next stage of the project has seen Observatory Sciences contracted to do a study on the use of

Data Distribution Service software in the E-ELT control system.

The Data Distribution Service is a networking middleware standard, published by the Object Management Group (OMG), that simplifies complex network programming for distributed, real-time applications. A key benefit is that it decouples individual applications from the complexity of communications, so very little design effort needs to be focused on the applications' mutual interactions. DDS automatically handles all aspects of data delivery, with emphasis on flexibility and high performance.

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# DIAMOND IS SHINING BRIGHTLY

Observatory Sciences' crucial work at the Diamond Light Source synchrotron continues, with new beamlines being commissioned.

OSL consultant Andy Foster has been leading the controls effort in the team supporting the three phase I macro-molecular crystallography (MX) beamlines at Diamond. The MX beamlines are used to solve the structure of large crystals, such as proteins. All three MX beamlines are now operational and have a full user program.

The main emphasis in 2008 was to improve the reliability and stability of the beamlines. As part of this, a major upgrade to the DCMs (double crystal monochromators) has taken place. Andy was part of the Diamond team which liaised with FMB Oxford to fit new high resolution encoders on the DCM pitch and roll axes. A second part of the upgrade involved replacing the perpendicular gearbox assembly and amplifier with a new

gearbox and micro-stepping amplifier. These two upgrades involved significant reconfiguration of the motion controller, a PMAC model from specialist Delta Tau, used to control the DCM axes. Thorough testing of the changes was performed using software developed specifically for this purpose.



Andy has also worked with UK companies Delta Tau and Micromech in the successful bid to supply Diamond with Delta Tau's next generation of PMAC motion controller. The Delta Tau Geo Brick LV was designed especially for Diamond and OSL's role was to prove that the EPICS motor control software could be used to drive the new controller. Diamond plans to use the Geo Brick LV for the remainder of the phase II beamlines and for the phase III beamlines. 



Image courtesy of Diamond Light Source

## IN CONTROL WITH LABVIEW


National Instruments' LabVIEW software is now being used in several major physics facilities, and Observatory Sciences has adopted it for a number of its current telescope control systems. OSL consultants Chris Mayer and Philip Taylor attended a meeting in Paris in February 2009 where 'big physics' applications for LabVIEW were discussed. A variety of major European physics experiment teams discussed their requirements, while National Instruments partner companies described their products.

"We have extensive experience of, and broad software expertise in LabVIEW," comments OSL consultant Philip Taylor. "It is unusual to see a project where it is not specified somewhere in the overall control scheme, and it has been integral to a number of high profile research projects. Its scope can be extended to reach into the specifications for the main control system, where currently it tends to be overlooked." 

## OSL OPENS OFFICES AT THE SUSSEX INNOVATION CENTRE

Observatory Sciences has opened new offices in the Sussex Innovation Centre, sited on the University of Sussex campus (also home to the Sussex Astronomy Centre) and has taken on new staff at the facility.

Working closely with the University, the Sussex Innovation Centre is a unique collaboration between the public, academic and business sectors, providing a thriving business incubation environment for over 70 high growth companies.

OSL consultant Philip Taylor comments: "Governments around the world have a history of investing in major infrastructure and research projects in tough times to stimulate the economy. For example, in the US President Barack Obama wants to see basic research budgets double over the next decade. Observatory Sciences is being approached for a number of new projects, and our expansion is a clear reflection of our standing and success." 

## SQUARE KILOMETRE ARRAY

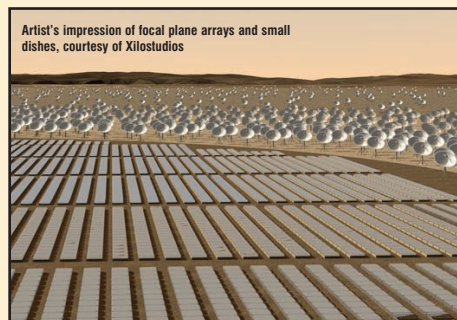
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OSL's expertise in large physics control software, puts the company in a good position to participate in the SKA. "This is a project of unprecedented complexity," he comments. "The scale of the systems that have to be modelled, the massive dataflows involved and the need for highly sophisticated distributed control present challenges on a scale no one has seen before."


The SKA will be an interferometric array of individual antenna stations, synthesising a telescope aperture with a diameter of several

thousand kilometres. A combination of receiving elements, dishes and phased array technology will be exploited to make the SKA versatile, flexible and cost-effective.

The final design is under development, but will consist of an inner core and outer stations arranged in a log-spiral pattern. The inner core will provide around 50% of the collecting area, using a centrally condensed inner array of 5km diameter to provide ultrahigh brightness sensitivity at arc-second scale resolution. Another 25% of the collecting area will be located within a diameter of 150km, with the



Artist's impression of focal plane arrays and small dishes, courtesy of Xilostudios

remainder extending to distances of 3,000km from the centre. This high angular resolution capability will allow imaging of faint emissions from the interstellar medium of distant galaxies, as well as the surface of stars and the active nuclei of galaxies. 



# CLUES TO THE ORIGIN OF THE SOLAR SYSTEM

The facilities and infrastructure for the Discovery Channel Telescope at a new site in Arizona, USA, are due for completion in 2010, with telescope control software written by OSL.

The Discovery Channel Telescope will be a powerful tool for many areas of modern astrophysics, from studies of the solar system to fundamental work in stellar, Galactic, and extragalactic astronomy. Located 40 miles outside Flagstaff, atop a cinder cone at a site known as Happy Jack, it will be among the most technically sophisticated ground-based telescopes of its size, with the work from OSL helping to deliver many of the advanced features which will optimise its performance.

## Complementary facility


The 4.2m aperture telescope, built by Lowell Observatory in partnership with Discovery Communications, will be the fifth largest in the continental United States, and will complement Lowell's four existing research telescopes sited east of Flagstaff, Arizona. The telescope is expected to be completed at a cost of \$42 million, of which \$6 million has been donated by John Hendricks – the founder and Chairman of Discovery Communications, a longstanding member of the Lowell Observatory Advisory Board, and an enthusiastic supporter of astronomy and space research.

Projects for the Discovery Channel Telescope include a survey of Kuiper Belt objects orbiting the sun beyond Neptune, comprehensive studies of comets (which in turn contain clues to the



Projects for the Discovery Channel Telescope include a survey of the composition of Kuiper Belt objects orbiting the sun beyond Neptune, surveys of the as yet little explored distant Solar System, and searches for small asteroids

origins of the solar system itself), and the formation and evolution of galaxies. The DCT, with its unique ability to switch rapidly between instruments at its Ritchey-Chretien focus, will allow Lowell astronomers and guest observers to carry out research difficult or impossible to do elsewhere.

Lowell Observatory has a proud history of scientific findings, including the discovery of the redshift of galaxies in 1912 that led ultimately to the realisation that the universe is expanding, and the discovery of Pluto in 1930. Today, 20 astronomers use the Lowell facilities to conduct research in diverse areas of astronomy and planetary science. 

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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# ESO FAVOURS DDS OPTION FOR EUROPEAN ELT

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DDS was developed for networking communications in military combat systems, but in recent years has been adopted by a number of vendors for applications as diverse as financial transaction processing, national railways and air traffic control – all applications where the networking requirements are both time-critical and data-critical.

With the segments of some of the E-ELT's mirrors being controlled at 1kHz, dealing with large amounts of critical data

in real time is a key characteristic of the telescope control system, so DDS was an obvious candidate for the network communications.

"Although it's been widely discussed, DDS has not yet been adopted for telescope control system applications, but the investigations and prototyping work that we have undertaken have shown that is an excellent solution," says OSL consultant Philip Taylor. "It ticks all the boxes by being vendor-independent, platform-neutral and real-time. We believe it could be adopted across a wide range of big science applications, from

telescopes to particle physics facilities and beyond. And the recent availability of a new open-source version of the DDS software will also promote its use."

Scheduled to be online by 2017, the E-ELT will be the world's largest optical telescope, with a primary mirror of 42m. With the potential to revolutionise ground-based astronomy, it 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 exoplanetary systems and the very first points of light in our universe. 

# INNOVATIVE SOFTWARE FOR THE HOBBY-EBERLY TELESCOPE

A software study for the upgrade of controls for the Hobby-Eberly telescope by consultants from Observatory Sciences is part of a project to help our understanding of the evolution of dark energy.

The Hobby-Eberly telescope (HET) was completed in 1997 as a joint project of The University of Texas at Austin, The Pennsylvania State University, Stanford University, Ludwig-Maximilians-Universität München, and Georg-August-Universität Göttingen, and is based at the McDonald Observatory in West Texas. Its design set a new paradigm for cost against performance, with the telescope marrying simple mechanical and optical construction principles with an innovative star-tracker mechanism, allowing overall costs to be dramatically reduced without any compromise in capability.

The telescope is a fixed elevation design with a large 11.1 x 9.8m primary mirror, made up from 91 spherically shaped segments, giving it an effective aperture of 9.2m. Elevation is fixed at 55°, so the primary mirror is stationary with



The tracker mechanism will be installed 13m above the primary mirror (photo by Thomas Sebring)

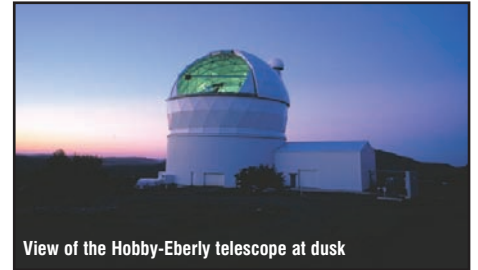
respect to gravity. The fixed elevation completely eliminates the problem of variable distortion that affects traditional telescope designs as their mount and optics are moved through all tilt angles whilst aiming at different targets. It also dramatically simplifies the telescope's supporting framework, all of which significantly reduces cost.

The trade-off however was that a new solution was required for tracking and there is restricted access to targets in the sky.

## Innovative solution


The solution for the HET had no precedent in a large optical telescope. Objects are tracked by a moving instrument package located 13m above the mirror at prime focus. As an object moves overhead, its light bounces off the large stationary mirror, and the tracking package moves to catch it, always precisely at the exact location of focus.

Now a major new project is planning to make use of the Hobby-Eberly telescope. HETDEX (the Hobby-Eberly Telescope Dark Energy Experiment) is a project designed to understand the evolutionary history of dark energy. Dark energy is the mysterious property of the universe that comprises over 70% of its total energy. We know very little about it beyond its existence, but we do understand how to study it. The goal is to



View of the Hobby-Eberly telescope at dusk

use results from HETDEX to precisely describe how the universe expands, thereby illuminating the nature of dark energy. Uncovering the patterns in the distribution of galaxies requires a survey to map out the positions of a million galaxies in a volume ten times larger than any survey to date. This cannot be done with any existing instrument on any large telescope, but it can be achieved on the Hobby-Eberly Telescope with the new VIRUS instrument installed for HETDEX.

The HETDEX experiment will require major upgrades to the hardware and software for the Hobby-Eberly Telescope and OSL, working with Patrick Wallace from Tpoint Software, has provided a software study for the upgraded telescope control system. The study was presented to the HETDEX Preliminary Design Review in April 2008. The proposal is to make use of the standard TPOINT software suite with the HET control system, despite the telescope's design being radically different from other optical telescopes. 

## FINDING A QUANTUM OF SOLACE AT OSL

Observatory Sciences has welcomed a new face to the team, with Alastair Borrowman joining the company at the end of 2008. Alastair has extensive experience in big telescope projects, and recently worked on commissioning the VISTA survey telescope now being completed at the European Southern Observatory (ESO) at Cerro Paranal in Chile's Atacama Desert.

Looking not unlike Mars with its red sand and lack of vegetation, the Atacama Desert is thought to be the driest place on Earth. The high altitude and extreme dryness make excellent conditions for astronomical

observations. It also made an excellent backdrop for key scenes in the latest blockbuster James Bond movie, *Quantum of Solace*. Increasing the drama, 007 actor Daniel Craig was on-site filming the same day the 4.1m mirror for the UK-financed telescope was delivered from Moscow.

VISTA will complement ESO's Very Large Telescope (VLT) facility and will survey large areas of the southern sky at near infrared wavelengths to study objects that are not easily seen in optical light. It will help to boost understanding of the nature, distribution and origin of known types of stars and galaxies, and

help unravel the mysteries of 'dark energy' and 'dark matter'.

Only a few days after starting employment with OSL, Alastair was on a plane to Chile to continue working on VISTA commissioning and is now looking forward to new challenges with Observatory Sciences. "This is an exciting time to be involved in big science, with new facilities constantly driving our understanding of the fundamental nature of the universe forwards," he says. "With its expertise in control software for these projects, OSL is leading from the front and I am delighted to have the opportunity to be joining them at this exciting time." 



Observatory Sciences Ltd is an independent UK-based company which provides consultancy and systems to scientific, research, industrial and technical, clients. It specialises in developing integrated systems for data collection and analysis, motion control and positioning, visualisation systems and other high performance environments. Its clients include major astronomical observatories, high energy physics experiments and other big science facilities.  
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