OBSERVATORY SCIENCES LTD

DISCOVERY

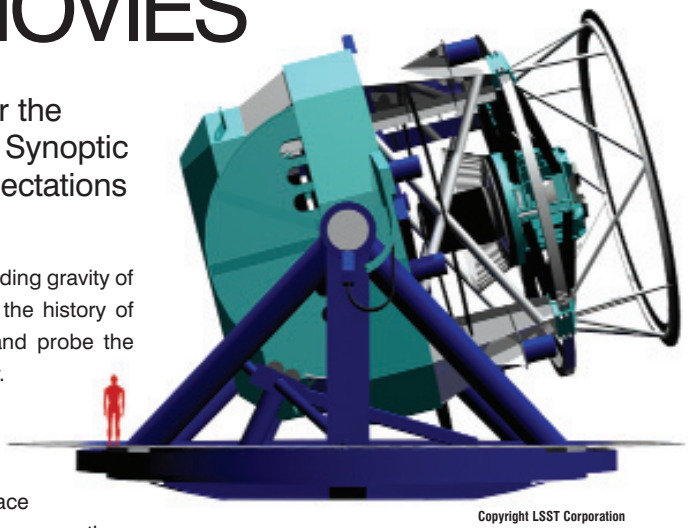
BIG SCIENCE SOLUTIONS AUTUMN 2006

Diamond begins to sparkle The new jewel in the UK's scientific crown is promising breakthroughs in many different fields of research. Observatory Sciences have been involved in the Diamond Light Source project in Oxfordshire throughout its development. **Page 2**

Unrivalled VISTA The largest ever telescope dedicated to survey work can scan the whole of the southern sky and is equipped with the world's biggest infrared camera. Software written by Observatory Sciences will control the shape of the primary mirror. **Page 3**

REVOLUTIONARY NEW TELESCOPE TO PRODUCE 'SKY MOVIES'

Observatory Sciences has completed the design study for the Observatory Control System for the innovative new Large Synoptic Survey Telescope (LSST), which is set to redefine the expectations of astronomers and scientists for observational data.



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The LSST is a US project headquartered in Arizona that is building a revolutionary new design of telescope that has a field of view 1000 times larger than that of existing large telescopes and a world-class light gathering capability. Every aspect of the project will be record breaking. The field of view, at ten square degrees, could accommodate fifty full moons.

The LSST will image an area of the sky roughly fifty times that of the full moon every 15 seconds, opening a movie-like window on objects that change or move on rapid time scales – supernovae explosions which can be seen halfway across the universe, nearby asteroids which might potentially strike Earth, and faint objects in the outer solar system, far beyond Pluto. Using the light-bending gravity of dark matter, the LSST will chart the history of the expansion of the universe and probe the mysterious nature of dark energy.

Superb images

The superb images from the LSST will also be used to trace billions of remote galaxies and measure the distortions in their shapes produced by lumps of Dark Matter, providing multiple tests of the mysterious Dark Energy. LSST will open up the 'time domain' by mapping the entire sky deeply, rapidly and continuously. It will provide all-sky maps of unimagined depth and detail, and keep doing so continuously so that changes in the universe are identified for analysis. Cosmic cartography will become cosmic cinematography, and forever change the way the heavens are viewed. The project will be partly funded by donations from private individuals and data from LSST will be placed in the public domain immediately. Multiple teams of professional scientists will be able to make

Continued on page 3

EPICS GOES PUBLIC FOR FIRST TIME

Specialists from Observatory Sciences have presented their first public training course for EPICS (Experimental Physics and Industrial Control System), the software that controls many synchrotrons and astronomical telescopes around the world.

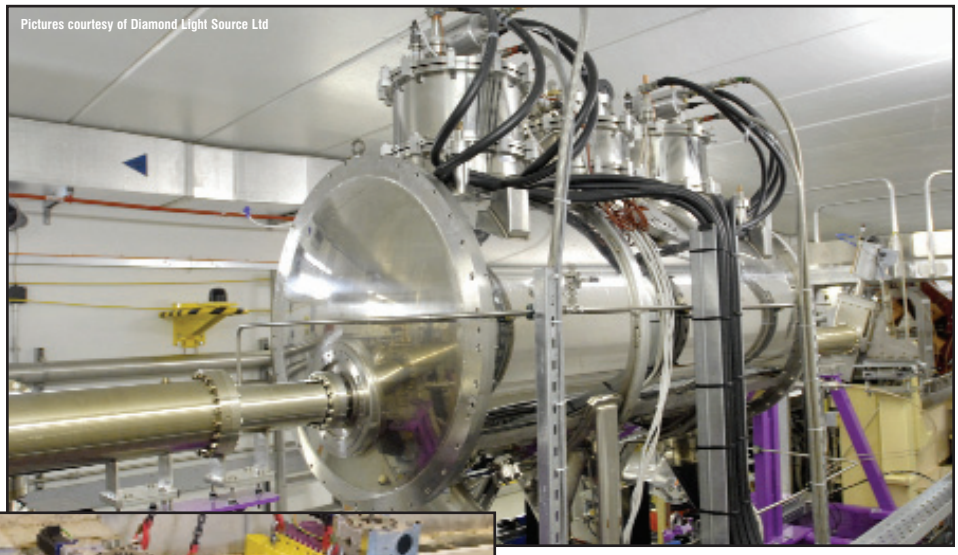
EPICS is a set of Open Source software tools, libraries and applications developed collaboratively and used worldwide to create distributed soft real-time control systems for scientific instruments such as a particle accelerators, telescopes and other large scientific experiments. Observatory Sciences is one of the leading commercial providers of EPICS software, particularly to major new scientific projects. They have used EPICS on many projects including controlling large telescopes such as Gemini as well as astronomical instruments and motion control for synchrotrons.

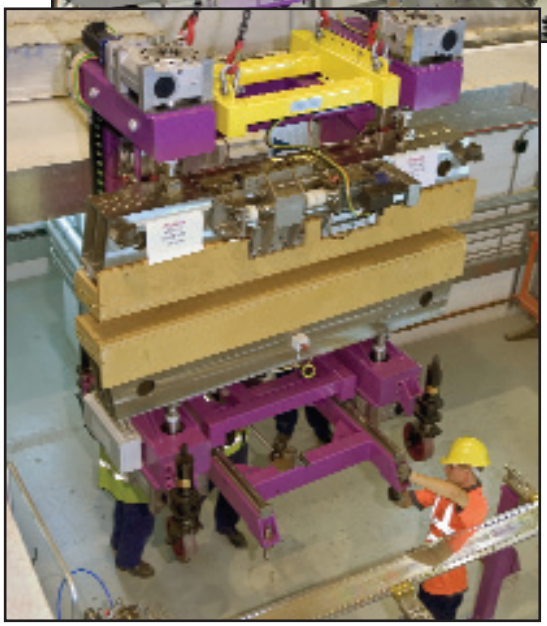
"We've run many training courses over the last five years, in locations including Chile, Australia and the Canary Islands as well as at several UK institutions," says Philip Taylor of Observatory Sciences. "But so far they have all been presented in-house for individual clients and it has been difficult for individuals or small groups to put on such courses." This first public course was held at the GANIL Heavy Ion Accelerator in Caen, France. Delegates came from GANIL itself, GSI in Darmstadt (Germany's national laboratory for heavy-ion physics), the Institute for Subatomic Research in Strasbourg France and New York's Brookhaven National Laboratory, home of the US National Synchrotron Light Source.

Observatory Sciences will also continue to run its in-house courses which provide both an introduction to EPICS as well as material for software engineers who want to be completely conversant with EPICS.

DIAMOND BEGINS TO SPARKLE

The UK's largest scientific facility built for over 30 years is now being commissioned and will come into full operation during 2007. Consultants from Observatory Sciences are now commissioning software systems at the Diamond Light Source synchrotron.





Diamond's beamlines use X-rays that are 100bn times brighter than conventional X-rays. Observatory Sciences created the software controlling the insertion devices (left).

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 were responsible for two Diamond software systems working with Micromech Systems of Braintree, Essex. The first was the girder control software which detects and compensates for any movements in the storage ring's main support structure. The second was the software for the insertion devices which generate synchrotron light which is fed to the beamlines where the scientists perform their experiments.

Significant steps

During May 2006, the first electrons orbited the 561 metre circumference storage ring and the first synchrotron light was generated later the same month. By September the system was operating at full power. Seven beamlines are now being commissioned ready to go into operation in January 2007 and Observatory Sciences is helping to commission the software used to control the beamline equipment. During the night of 12 October, Observatory Sciences consultant Alan Greer was present when Diamond's Nanoscience beamline team got 'first beam'. This is one of the most significant steps in the facility's commissioning process, and is seen as a key marker for the facility to be ready for the user community on time from early next year.

During a celebratory visit, UK Prime Minister Tony Blair said: "This shows the importance we attach to science. Our future prosperity rests more than ever before on the hard work and genius of our scientists and how we harness their research to deliver improvements in all our lives. Diamond Light Source will help us in many fields, from developing new drugs to tackling climate change."

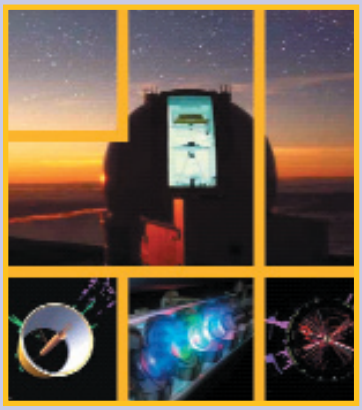
ADAPTIVE OPTICS ENCIRCLE GLOBE

Observatory Sciences consultants have spanned four continents working on the cutting-edge technology of a new Adaptive Optics system for the Gemini Observatory.

Adaptive Optics (AO) is a technology to improve the performance of telescopes by reducing the effects of rapidly changing distortions due to atmospheric turbulence, known to astronomers as 'seeing'. Adaptive Optics works by measuring the distortion and rapidly compensating for it using deformable mirrors. However, a bright reference star is needed close to the target being studied which results in only a small proportion of the sky being available for study using the original AO systems. Further developments include the use of Laser Guide Stars to produce an artificial reference star high in the atmosphere. However, the effective field of view remains small.

It is essential that Adaptive Optics be usable over a much larger part of the sky and with wider fields of view when the next generation of giant telescopes (with mirror diameters larger than 20 metres) come into operation. Multi Conjugate Adaptive Optics (MCAO) solves most of these problems. By using several guide stars and several deformable mirrors, a uniform image compensation can be achieved on a larger field using natural or laser guide stars. By probing and correcting a larger volume of turbulent atmosphere, MCAO increases the compensation performance on current 8m telescopes and opens up new possibilities for adaptive optics on future giant telescopes.

The Gemini Observatory is planning to implement a MCAO system as a facility instrument for the Gemini South 8m telescope in Chile. The »



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**
- **Data assessment and analysis systems**
- **Training and skills transfer**
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- **Facilities management and operation**
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VISTA COMES ON-LINE

Software from Observatory Sciences that controls the shape of the primary mirror worked faultlessly during commissioning of the VISTA telescope in Chile during September 2006, and the project is now scheduled to come into operation and begin scientific work during 2007. The VISTA telescope has been installed on a mountain peak at an altitude of 2600 metres, adjacent to the European Southern Observatory's Very Large Telescope at Cerro Paranal.

The Visible and Infrared Survey Telescope for Astronomy will take images in the infrared of the whole of the southern skies and is the world's largest telescope dedicated to survey work. It will be equipped with the world's largest infrared camera. The excellent image quality of the telescope is achieved by altering the figure of the 4.1 metre diameter primary mirror. The mirror is mounted on 81 pneumatic supports that can be individually adjusted to create the desired shape. Using information gathered by a wave-front sensor, the software adjusts for the varying effect of gravity as the position of the telescope changes, and also for other effects such as wind buffeting. The software from Observatory Sciences that controls this calculates a new force for each actuator up to 50 times a second. VISTA project manager Alistair McPherson comments: "Observatory Sciences provided the software on-time and the quality was first-rate."

Credit: UK ATC/Royal Observatory Edinburgh

The construction of VISTA is financed by the UK's Joint Infrastructure Fund with an additional contribution from the Particle Physics and Astronomy Research Council through a consortium of 18 UK universities led by Queen Mary, University of London.

REVOLUTIONARY NEW TELESCOPE

Continued from page 1

new discoveries in parallel, while amateur astronomers and the public will be free to view LSST images to follow developments or even make their own contributions.

The LSST has become possible because we are now able to make large, deeply curved mirrors to an accuracy thought impossible just ten years ago. The telescope uses three mirrors, an 8.4m primary, a 3.4m secondary and a 5.0m tertiary, with the first and last fabricated as a single monolith. This three stage reflection means that LSST is actually so compact that it could sit inside current generation telescope domes.

It has recently been announced that Cerro Pachón, a 2,680m high mountain peak in northern Chile, has been selected as the future site for the Large Synoptic Survey Telescope. The mountain already hosts other large telescopes including the Gemini South 8m reflecting telescope on which Observatory Sciences consultants have worked in the past.

Gemini Observatory/AURA

» system will include five laser guide stars, three natural guide stars, and three deformable mirrors configured to analyse atmospheric turbulence at different altitudes to achieve atmospheric compensation over a 1 arc minute square field of view.

Control software

OSL produced the control software for four of the subsystems that make up the Gemini MCAO:

- The Beam Transfer Optics (BTO) system, which launches the laser beam.
- The Beam Transfer Optics Diagnostics Sensor System, which provides BTO mirror corrections.
- 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.
- The Adaptive Optics Module (AOM), which contains all the optics and sensors to compensate the input beam and relay it to the instrument.

This involves OSL staff writing the software in Cambridge, UK, testing the first Laser Guide Star at Gemini North in Hawaii, and installing it at Gemini South in Chile.

In Autumn 2005, OSL was contracted by the Australian National University to provide on-site consultancy effort to complete and commission the control software for the Gemini South Adaptive Optics Imager. This is a diffraction-limited camera that will be used with the MCAO system to record extremely sharp images with resolutions similar to those obtained with the Hubble Space Telescope over similar-sized fields on the sky and at much lower cost.

ATST TELESCOPE PROJECT UPDATE

A Critical Design Review meeting at the US Advanced Technology Solar Telescope (ATST) has given the seal of approval to the Telescope Control System (TCS) designed and developed by UK-based Observatory Sciences in collaboration with the Rutherford Appleton Laboratory.

The project is run by the National Solar Observatory based in Tucson, Arizona and involves nearly all the US solar physics institutions. Observatory Sciences was the first overseas company to be brought into the project.

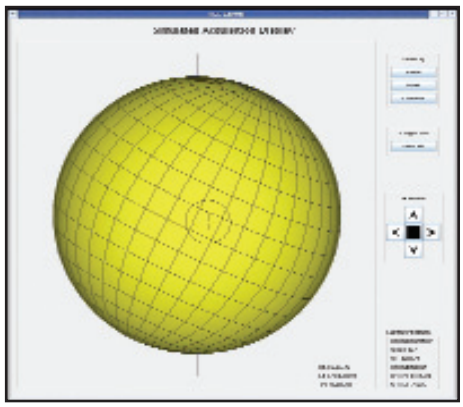
The Critical Design Review of the TCS was held in Tucson in October and was attended by Observatory Sciences consultants Chris Mayer and Alan Greer. The design of the TCS was presented to the ATST team showing how it will be built on the ATST Common Services software provided by the project office. After the software meeting in Arizona, Chris Mayer attended the Preliminary Design Review of the whole ATST project by the National Science Foundation – the funding body for the United States' big science projects.

Picture courtesy of KC Environmental, Inc.

TCS simulator

As part of its work, Observatory Sciences has produced a TCS simulator for testing the ATST control system infrastructure. The TCS uses a graphics-based acquisition control display to show an image of the sun, a coordinate system and the target location. Currently the simulator shows the image of the sun as a simple shaded disc, but when the telescope goes live, it will display a real-time data feed of the sun from the acquisition camera. The screen has hand paddle buttons to move the target location around the image. It is also possible to position the telescope on an interesting solar feature by simply selecting that feature on the Sun's image.

The simulator displays trajectory information for the mount and enclosure on a strip chart as it tracks a solar position, including offsets from the reference position. It also provides tools to look at the engineering data for the telescope components, including mount and enclosure positions and velocities, along with similar information from the coude rotator.



"With all Observatory Sciences systems we take the view that our technology should not get in the way of the users' science," says Dr Mayer. "Our aim is to hide the complexity of the underlying control systems so that solar physicists can concentrate totally on their experiments."

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

SCIENTISTS GO IT ALONE

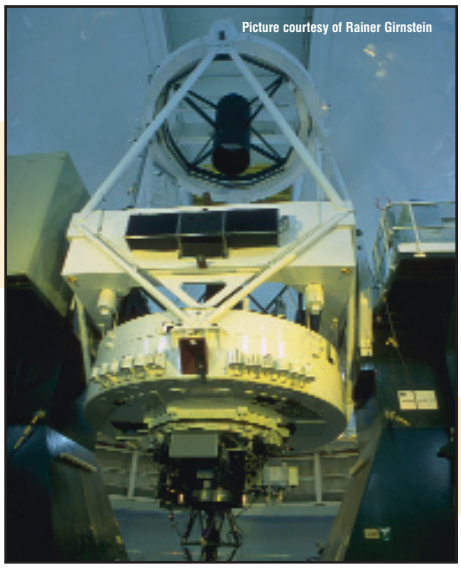
Creating one's own opportunities has become a hallmark for Philip Taylor of Observatory Sciences who, along with four others, founded the company in 1998. "We were scientists and engineers and engineers at the Royal Greenwich Observatory (RGO) in Cambridge where we had played an important part in the software used at the UK observatory on the island of La Palma in the Canaries (pictured). But the RGO was closed down and, faced with redundancy, the choice was either moving into entirely new fields or trying to find work overseas.

"For various reasons these options did not appeal, and we thought 'Here's a chance to become our own bosses. We have saleable skills and a lot of experience that many organisations would like to be able to tap into.' We also realised that few existing companies could offer this. The benefits of contracting out work rather than doing it in-house are now fully appreciated by scientific institutes and external service provision is often the preferred option."

Observatory Sciences' core product is software services for scientific projects of all sizes, including astronomical telescopes. This also transfers its skills to high energy physics research facilities and other scientific control systems. It designs, builds, commissions and maintains control system software, creates bespoke data acquisition and analysis systems, as well as providing project management and training. The client base encompasses government research and scientific bodies as well as private sector companies.

Commercial fields

Astronomy remains an important part of the business, but OSL's expertise also transfers to synchrotrons and other particle physics work and increasingly is spreading into more commercial fields too. "While at heart I will always be an astronomer," sums up Taylor, "it is very exciting to see our company spreading our skills into wider areas, gaining expertise as we do so and helping transfer new technologies to new users."



Picture courtesy of Rainer Girnstein

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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