OBSERVATORY SCIENCES LTD

DISCOVERY

BIG SCIENCE SOLUTIONS AUTUMN 2018

CryoNIRSP control system software The control system software for the Cryogenic Near Infra-red Spectropolarimeter which will be one of the first-light instruments on the DKIST (currently under construction in Maui, Hawaii) is being developed by OSL . **Page 4**

TMT software consultancy contract Observatory Sciences is working on a consultancy contract for the Inter-University Centre for Astronomy and Astrophysics which is responsible for delivering the control software for the Thirty Metre Telescope **Page 3**

20TH BIRTHDAY ON TOP OF THE WORLD

The team at Observatory Sciences Ltd (OSL) has grown rapidly over the last year and now includes new young talent, coupled with seasoned project leaders and new consultants Pat Wallace and David Terrett, both of whom are highly regarded experts in the world of telescope control systems.

OSL was founded 20 years ago by specialists from the UK's Royal Greenwich Observatory in Cambridge, who realised that some of the work being undertaken at the observatory (which was closed in 1998) could continue to be done by a private company. Since then it has worked at many of the world's major optical telescope facilities as well as accelerators such as Diamond Light Source and the Australian Synchrotron.

Team visit

To celebrate twenty years of success, in October 2018 the OSL team travelled to the island of La Palma in the Canary Islands, including a visit to the observatory on the summit of the mountain, the Roque de Los Muchachos. The photograph shows us at the

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GIANT SURVEY TELESCOPE CONTROL

In late 2017, Observatory Sciences won the contract to produce the software that will control the pointing of the Large Synoptic Survey Telescope. This part of the Large Synoptic Survey Telescope (LSST) software is known as the Pointing Component. In June 2018, the Final Design Review of the Pointing Component was successfully completed following a meeting in Brighton attended by staff from the LSST project office in Tucson, Arizona as well as OSL staff and consultants. The LSST is one of the largest US federally funded projects in optical astronomy and OSL won the contract through a competitive tender.

Image courtesy of LSST Project / NSF / AURA

LSST will conduct a 10-year survey of the sky that will deliver 60 petabytes of raw image data and address some of the most pressing questions about the structure and evolution of the universe. Its 8.4m telescope uses a special three-mirror design, creating an exceptionally wide field of view, and has the ability to survey the entire sky in only three nights. The telescope must produce data of extremely high quality with minimal downtime and maintenance, so will have the world's largest (3.2 Gigapixel) digital camera. Some 20 terabytes of data will be collected every day.

The 1.2m Auxiliary Telescope will be used to measure atmospheric transmission, which relates to how directly light is transmitting through the Earth's atmosphere in a given spot, as opposed to being absorbed or scattered. This is then used to calculate a colour correction for light received by the main telescope.

This telescope was donated by Dr Edgar Smith to LSST and was previously known as Calypso when located at the Kitt Peak Observatory in Arizona. Following refurbishment, it is now being installed and commissioned at the LSST site at Cerro Pachón in Chile. OSL's Pointing Component software will be able to control both the main and auxiliary LSST

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HIGH-SPEED DETECTORS AT DIAMOND LIGHT SOURCE

OSL consultant Alan Greer is working at Diamond Light Source (DLS) in Oxfordshire UK to provide data acquisition and control software for new, high-performance detectors being developed along with collaborating institutions. The software is being developed using a data acquisition framework called Odin.


Image courtesy of Diamond Light Source

Odin will become an integral part of beamline controls at DLS, providing facilities for detectors with very high data rates. It allows the operation of multiple file writers running on different servers, working together to write a single acquisition to disk, all managed by a single point of control.

One of the first detectors using the Odin framework is Excalibur, the result of a collaboration between DLS and the Science and Technology Facilities Council (STFC), which has been implemented on the X-ray Imaging and Coherence beamline (I13) at Diamond to make use of the small pixel size in coherence diffraction imaging.

Another new project using Odin is the Percival soft-X-ray image detector. The objective of the project is to develop a back-thinned CMOS detector which outperforms present soft-X-ray image detector technology, in terms of sensor size, noise, dynamic range and frame rate. The size of this 13M pixel imager, and its 120 frames per second frame rate, impose challenging requirements for the data acquisition system.

Finally, the Tristan project at DLS is building a detector for time resolved experiments based on the Timepix3 chip. This chip (originally developed at CERN) enables a new generation of X-ray and radiation imaging technology. It has an array of electronics capable of processing individual photons. Unlike previous X-ray imaging detectors, the Timepix3 is capable of measuring simultaneously position, energy and time-of-arrival of every detected photon. Rather than collecting data frame-by-frame, the device generates a continuous stream of event data. Elsewhere at DLS, Observatory Sciences has been commissioned to prepare and present a training course on the techniques and software used by the Diamond Mapping Project, now known as Hardware Triggered Scanning.

The Mapping Project dates back to 2014, when Diamond decided to provide a unified software and hardware solution to several new and existing beamlines, in order to reduce the overall cost of ownership of these systems. The training being prepared by Observatory Sciences will ensure that these mapping techniques are more widely understood by the engineers and scientists working on the beamlines at Diamond Light Source.

NEW PERSONNEL JOIN THE EXPANDING OSL TEAM

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summit after our tours of four telescopes: the William Herschel Telescope, the Isaac Newton Telescope, the Gran Telescopio Canarias and the MAGIC Cherenkov telescope.

The group visiting La Palma included five new employees that Observatory Sciences has welcomed over the past year: Dino Tahirovic (first left in the photograph) has a doctorate in Particle Physics from the University of Ljubljana (Slovenia).

Dino's previous work included producing software for detector systems at CERN, working at Queen Mary University of London. He is now working on telescope control system software in our Brighton office.

Kieran Mulholland (second left) has a doctorate in experimental nuclear physics from the University of West Scotland. Prior to joining Observatory Sciences he was working on laboratory testing of lasers. He is part of the team based in Kirkcaldy responsible for ESO VLT software maintenance.

Thomas Ives (fourth left) was recently awarded a doctorate in Physics from the University of Edinburgh, studying swimming micro-organisms in complex fluids. He is also part of the Kirkcaldy ESO software team. Emma Arandjelovic (second right) has previously worked on control software at two synchrotron facilities (Diamond Light Source and the Australian Synchrotron) prior to joining Observatory Sciences. She is also part of the Kirkcaldy ESO software team.

Becky Williams (furthest right) has a doctorate in Astrophysics from the University of Cambridge, studying very distant galaxies to investigate the properties of these galaxies on both spatial scales and across multiple epochs. She is based at the Observatory Sciences Brighton office, working on software for the DKIST 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.

- Design and development of instrument and equipment control software
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- Training and skills transfer
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- Software commissioning and support
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OSL WORKING WITH INDIA ON TMT CONTROL SOFTWARE

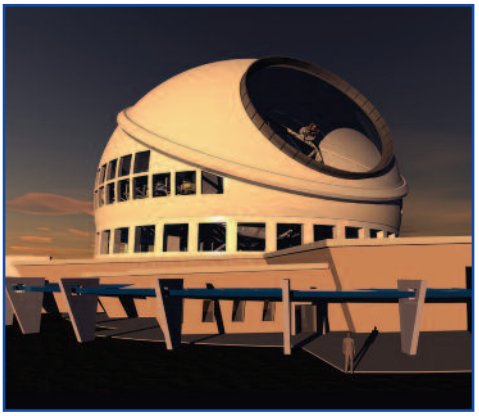
Observatory Sciences Ltd (OSL) is working on a consultancy contract for the Inter-University Centre for Astronomy and Astrophysics (IUCAA), in Pune, India, which is responsible for delivering the telescope control software (TCS) for the Thirty Meter Telescope (TMT). The TMT is one of the three giant, 30m class aperture, optical telescopes currently under development around the world.

Five years ago, OSL was responsible for the initial software design for the TMT telescope control system and the contractors selected by IUCAA (OACES, a Pune-based business division of Honeywell Automation India) are now progressing the system design towards the Preliminary Design Review scheduled for 2019.

All India TMT activities are coordinated by the India TMT Coordination Center (ITCC) at the Indian Institute of Astrophysics in Bangalore, with IUCAA leading the Telescope Control System (TCS) work.

The consultancy contract is called 'TCS domain specific consultancy' and taps into OSL's specialist knowledge of telescope co-ordinate systems and transformations and the interactions between the telescope control system and the Adaptive and Active Optics systems which will be used on TMT.

The TMT will allow researchers to see deep into space and observe cosmic objects with unprecedented sensitivity. With nine times more area than the largest currently existing visible-light telescope in the world, the TMT images will be more than 12 times sharper than those from the Hubble Space Telescope. As such it will allow astronomers to address fundamental questions from understanding star and planet formation to unravelling the history of galaxies and the development of large-scale structures in the universe.



Artist's interpretation of the TMT in early morning light. Picture courtesy of TMT Observatory Corporation

The Thirty Meter Telescope is being designed and developed by the TMT International Observatory LLC (TIO), a non-profit international partnership between the California Institute of Technology, the University of California and institutes from four other countries. A final decision is expected soon on a location for the TMT, with Mauna Kea, Hawaii the favoured site with La Palma in the Canary Islands as an alternative.

SUCCESSFUL SPIE IN JUNE

In June 2018, Observatory Sciences attended the biennial international meeting for the engineers and designers of the world's major astronomical facilities. The SPIE Astronomical Telescopes and Instrumentation conference was held in Austin, Texas and was attended by Becky Williams, Kieran Mulholland and Philip Taylor.

We had the opportunity to present our company at the exhibition and hear about new projects. With our international clientele, this event is an ideal opportunity for us to meet new as well as old colleagues.

SURVEY TELESCOPE CONTROL

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telescopes. They can be operated together so that the auxiliary telescope follows the pointing of the LSST main telescope as closely as possible. Observatory Sciences has employed two of the world's leading experts on telescope control systems as consultants for the LSST work: Pat Wallace and David Terrett, who both have extensive experience with such projects.

Pat Wallace is the author of TCSpk, the definitive software package used for large telescope pointing and David Terrett has produced TPK, a C++ class library for telescope pointing, layered on TCSpk.

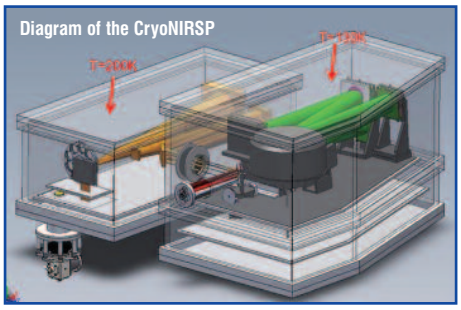
LSST's mission is to build a well-understood system that provides a vast astronomical data set for unprecedented discovery of the deep and dynamic Universe. LSST seeks to enable science in four main areas: understanding dark matter and dark energy, cataloging the Solar System, exploring the changing sky, and investigating the formation and structure of the Milky Way. LSST is scheduled to begin operations in 2022, and will conduct a 10-year survey of the optical sky. Financial support for LSST comes from the US National Science Foundation, the US Department of Energy, and private funding raised by the LSST Corporation.

OSL CONTROL SYSTEM INTEGRATED WITH DKIST

OSL is working on the control system software for the CryoNIRSP (Cryogenic Near Infra-red Spectropolarimeter) which will be one of the first-light instruments on the DKIST (Daniel K Inouye Solar Telescope) currently under construction in Maui, Hawaii.

In September 2018, Observatory Sciences consultants Becky Williams and Alan Greer visited the University of Hawaii Institute for Astronomy to integrate our control system software with the CryoNIRSP instrument hardware. The control software developed by OSL is responsible for configuring and positioning all mechanisms within the instrument (which can be as many as 15, depending on the observation) and instructing the two infra-red cameras (one for the Context Imager and the other for the Spectrograph) on how to operate.

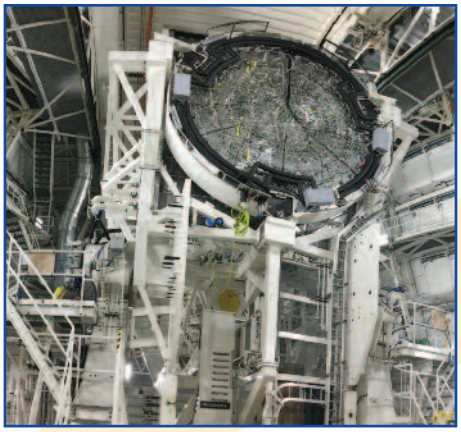
The software accommodates the configuration of three different modes for camera acquisition as well as four different observing mode set-ups including using a single camera, both in succession or two running simultaneously. The synchronisation of the mechanisms and the camera system is paramount and has proved one of the more challenging areas of the project.



The team successfully integrated the software with the instrument hardware currently available in Maui, including state of the art infra-red cameras, the polarisation modulator and a Delta Tau motion controller responsible for controlling all of the mechanisms involved in the instrument set-up (including scanning mirrors, filters, slit wheel, focus, lamp and grating). Real time motion was also successfully configured by the OSL software providing the capability to scan fields during the observation, with mechanism moves synchronised with the times the camera is not acquiring. By demonstrating the full capabilities of the control software to run several types of observation and manage all mechanisms from start to finish, the hardware integration trip was considered a complete success.

Further work continues for OSL on the CryoNIRSP project, notably involvement with the data processing side and the creation of displays to view the calibrated incoming data.

Interior shot inside the DKIST telescope dome on Maui



A YEAR OF PROGRESS ON ESO SOFTWARE

In September the European Southern Observatory (ESO) Very Large Telescope (VLT) software infrastructure release 2018 was delivered to the Paranal Observatory in Chile. This is the first VLT annual software release that Observatory Sciences engineers have contributed to, following the start of OSL's software maintenance support contract for the VLT software infrastructure in January this year.

For the 2018 release a total of 213 improvements, enhancements and bug fixes have been made, 56 of which have been the responsibility of OSL engineers, working closely with their ESO colleagues. In addition OSL engineers have also been providing software improvements and enhancements to the VLT Interferometer (VLTI) control software.

November sees OSL consultant Thomas Ives travelling to the VLT in Chile to assist with installing new software and commissioning of the New Adaptive Optics Module for Interferometry (NAOMI) to improve the VLTI, enhancing its imaging capability.

A NAOMI module will be installed on each of ESO's 1.8m auxiliary telescopes, bringing a more advanced adaptive optics system that will allow the telescopes, and the VLTI array, to see even more clearly. This will allow observations to be made in poorer seeing conditions than is currently possible with the System for Tip/tilt Removal with Avalanche Photodiodes (STRAP), which NAOMI is replacing.

INDIAN CYCLOTRON COMMISSIONED

Observatory Sciences will be returning to the Indian medical cyclotron in Kolkata in 2019 for the second and final stage of commissioning of beamline control software the company has produced.

OSL's first visit to the facility, Cyclone-30, was in early 2018 to assist with commissioning and testing at the Variable Energy Cyclotron Centre (VECC). The control software, based on EPICS and LabVIEW, was produced under contract to Danfysik of Denmark who are producing two beamlines used at the facility.

The cyclotrons produce radioisotopes for diagnostic and therapeutic use for cancer care. Cyclone-30, the biggest cyclotron in India for medical application is based on a 30 MeV beam, which is used to produce Fluorine-18 isotopes. The facility will start regular production during 2019 after the commissioning of the supporting systems and regulatory clearances. Initially the isotope will be used in Eastern India, but over time production volumes will increase allowing expansion to nationwide distribution.