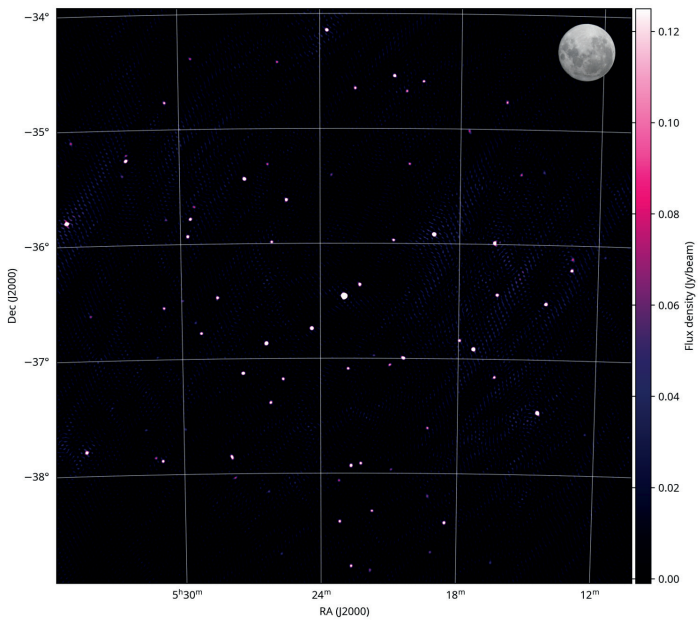
OBSERVATORY SCIENCES News

Summer 2025 ✦ Software for telescopes and accelerators

SKAO UNVEILS ITS FIRST IMAGE

Earlier this year the SKA Observatory marked an exciting milestone: the release of the first image from an early working version of the SKA-Low radio telescope currently under construction on Wajarri Yamaji Country in Western Australia. The image was produced using data from only 1024 antennas (fewer than 1% of the final planned number), and shows around 85 galaxies, each one billions of light years away from Earth. The quality of the image is impressive, and beyond what was expected at this stage of the telescope's construction. Observatory Sciences Ltd (OSL) director Alan Greer says: "Five years into our collaboration with SKAO, it is incredibly exciting to see the very first image which already demonstrates the power and potential of this unique telescope".



The first image released from SKAO's telescope in Australia, SKA-Low. Reproduced courtesy of the SKAO

When complete, the SKA-Low telescope will comprise 512 stations spread over 74km, each station containing 256 antennas. Together with its sister telescope SKA-Mid in South Africa, the pair will be the most advanced and sensitive radio telescopes on Earth. It has been estimated that the same area of the sky shown in the image above when captured by the complete set of antennas will reveal a staggering 600,000 galaxies.

OSL continues to make a significant contribution to the SKAO in two key areas: the specialised MCCS (Monitoring, Control and Calibration Subsystem) software for SKA-Low, as well as Tango control system components for both the Low and Mid telescopes. As SKA-Low has now entered a critical period of integration and testing, the MCCS team members have been working closely with the integration team based in Australia. Three OSL engineers – Alistair Child, Emma Arandjelović and Tom Moynihan – have now each spent a number of weeks working out in Perth, including visits to the integration and test facility in Geraldton.

SKA-Low Controls Manager Dr. Drew Devereux says: "Having product team members with deep expertise on hand delivers huge value to integration. From instant 'hot take' insights into root causes of bugs, to weeks-long collaborations on complex issues, the visits of Ali, Emma and Tom have exceeded our expectations when it comes to impact."

Swapping hard hats for Australian style bush hats for a change, the MCCS team visit the remote SKA-Low telescope site at Inyarrimanha Ilgari Bundara, the CSIRO Murchison Radio-astronomy Observatory, on Wajarri Yamaji Country. Credit: Courtesy of the SKAO

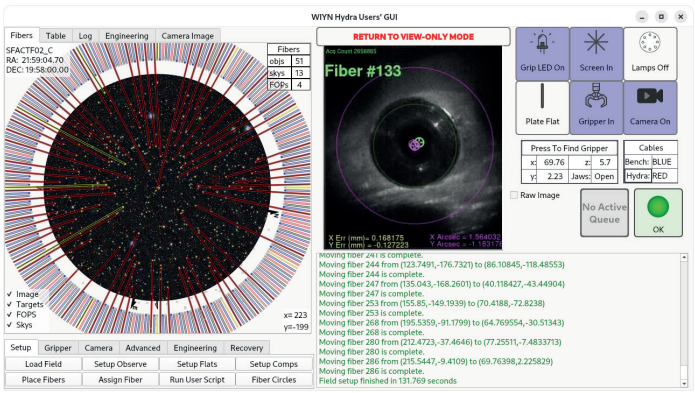
The past year has also seen members of the SKAO teams attend planning events in India, Australia and the Netherlands alongside colleagues from all over the globe. For a project such as SKAO which is distributed across many countries, timezones, and cultures, occasional face-to-face meetings such as this one have been invaluable to foster collaborative relationships and ensure the software interfaces are well defined.

Construction for both telescopes is now in full swing, and the next few years promise to bring plenty of engineering challenges as well as more 'champagne moments' as the hardware and software is scaled up.

SKA-Low antennas at the S8 station on the southern spiral arm of the SKA-Low telescope. Credit: SKAO/Max Alexander

WIYN TELESCOPE INSTRUMENT UPGRADE SUCCESSFULLY COMPLETED

Earlier this year, Observatory Sciences completed a project to upgrade the decades old control software for the Hydra instrument on the WIYN Observatory's 3.5m telescope in Arizona. Hydra is a robotic spectroscopic-fibre positioner which places up to 100 fibres across a 38cm focal plane, corresponding to precise target locations in the sky.



Screenshot of the WIYN Hydra Users' GUI, developed by OSL engineer Matt Auger-Williams.

The instrument has recently undergone several hardware upgrades, including the installation of new servo motors for positioning the fibres, as well as the replacement of the old microcontroller board with a PLC. OSL was commissioned to develop new control software to take full advantage of these upgrades.

The project included the development of a client-server architecture to interface to the newly replaced motor controller, and a streamlined, user-friendly new client interface. OSL also developed a Python-based simulator of the PLC which was used to identify improvements to the PLC logic, leading to a nearly three-fold increase in speed and improved robustness against mechanical failures. The simulator will continue to be of use during operations by scientists as they create and test observing strategies for the instrument.

The lead engineer on this project, Matt Auger-Williams, worked closely with WIYN scientists to deploy and test the new software, from daytime commissioning on the hardware to night-time on-sky operations. Matt says: "I really enjoyed the challenge of modernizing Hydra's control system to fully utilize the benefits of their recent hardware upgrades. It was particularly satisfying to see the instrument overheads reduced by a factor of three and to finally resolve hardware failures that previously could occur several times a night – the upgrades have yielded significantly more time for science observations!"

OSL ENGINEERS JOIN ESO PARANAL MISSIONS

2025 sees Observatory Sciences celebrate 8 years of working with the European Southern Observatory (ESO). The 'OSL Team ESO' engineers continue to work closely with ESO colleagues to maintain and develop the core software of ESO's Very Large Telescope (VLT) and VLT Interferometer (VLTI).

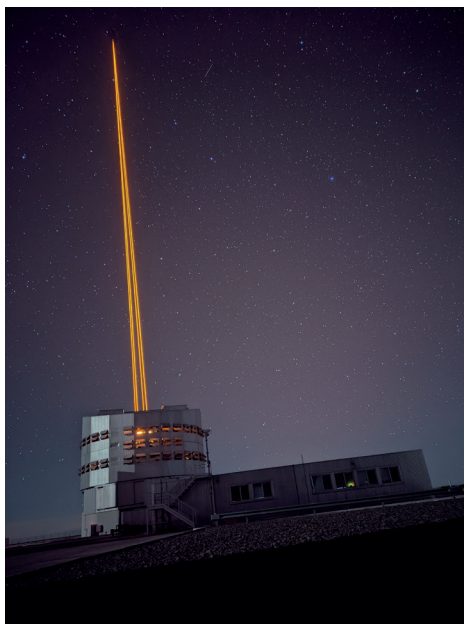
In the first half of 2025 two of the team's engineers, Matthew MacIntosh and Kieran Mulholland participated in missions to ESO's Paranal Observatory. Paranal is located 2635 metres above sea level in the Atacama Desert of northern Chile and hosts several world-class telescopes including the VLT and VLTI.

Kieran Mulholland (left) taken in one of VLT's Unit Telescopes, alongside ESO colleague Juan-Pablo Gil.

Matthew joined a team of engineers from ESO's Garching headquarters and Paranal Observatory to carry out the upgrade of the VLTI systems to the latest version of the VLT core software. This was the culmination of many months' preparation and testing in Garching, Paranal and OSL's Dunfermline office, to ensure all the many VLTI sub-systems were aligned and able to operate successfully with the new release. The thoroughness of this preliminary work paid off and ensured the upgrade mission was successful. As Matthew notes: "not everything during the mission immediately went as smoothly as we hoped, but the preparation and team's knowledge ensured when problems did occur we could quickly determine the likely problem area in the code and make the necessary fixes". He added "having the opportunity to work with fellow engineers on such a prestigious project as the VLTI at the Paranal Observatory is definitely one highlight of being a software engineer at OSL."

Kieran has been a key member of OSL's Team ESO since the first VLT/VLTI software maintenance contract began in 2018. During this time he has become the go-to software engineer for all things relating to ESO's Technical Detector Controller System (TDCS), and has recently developed an initial prototype of a camera communication library (camcom) providing simplified access to CCDs for both the VLT and ESO's new flagship Extremely Large Telescope (ELT), currently under construction 23km distant from the Paranal Observatory in Chile.

Due to his recognised expertise Kieran was requested to join a mission to Paranal organised to improve the functionality of the recently installed Wavefront Sensing (WFS) cameras for VISTA/4MOST. 4MOST is a 2nd generation instrument for ESO's Visible and Infrared Survey Telescope for Astronomy (VISTA) currently being installed at Paranal with science operations expected to start in early 2026. During the mission, Kieran helped to trace the root cause of problems impacting the functionality to a hardware fault between the VISTA telescope and the control room. After fixing the identified issue, further tests showed a vast improvement: VISTA/4MOST was able to use six technical detectors simultaneously without dropping any packets over at least several hours of testing, using high frame rates and large exposure windows. Kieran says: "I always relish the opportunity to do 'hands-on' work at the VLT. The Paranal Observatory is a very special place to work, and it's rewarding to see our software being used to enable cutting-edge astronomy".



VLT's 4 Laser Guide Star in action, part of the telescope's adaptive optics facility which measures and compensates for the distortions introduced by the atmosphere.
Photo credit: Kieran Mulholland.

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 Limited

1 New Road, St Ives
Cambridgeshire PE27 5GB

Unit 19 Pitreavie Court
Pitreavie Business Park
Queensferry Road
Dumfermline KY11 8UU

RAL Building. R1-10, R1-11
Harwell Campus
Didcot OX11 0QX

Tel: +44(0)1223 655000
contact@observatorysciences.co.uk
www.observatorysciences.co.uk

HARWELL SITE NEWS

In February 2024, the Observatory Sciences office based on the Harwell Science and Innovation Campus in Oxfordshire welcomed a new employee, George Chira. George has a Masters degree in Theoretical Physics from Lancaster University and has joined the SKAO team working on the control software for the SKA-Low telescope.

Another newcomer to the Harwell area is OSL engineer Phil Smith, who has relocated from the Cambridgeshire office to take on a 1-year contract at Diamond Light Source, the UK's national synchrotron. OSL has a long history spanning more than 15 years of providing software solutions, EPICS training and operational support to Diamond Light Source, and last year was again selected as a preferred supplier of software engineering services.

OSL engineer Phil Smith working in the Control Room at Diamond Light Source

Phil Smith has joined the High-Level-Apps team which specialises in areas such as data archiving tools, machine simulations, and accelerator feedback algorithms. Phil will be working on upgrading Diamond's virtual accelerator or "Digital Twin", a tool that simulates the Diamond accelerator.

This simulator is used by accelerator physicists as well as Controls engineers to test their software and will help in the planning for Diamond II, a project which is underway to deliver a transformative upgrade of Diamond's accelerator and beamlines. Phil comments: "I have been enjoying getting stuck in with some of Diamond's core tools which are used throughout the facility. It has also been great to work with the virtual accelerator which has allowed me to put my physics knowledge to good use."

HeXI: A WORLD-FIRST HIGH ENERGY INSTRUMENT

Andy Foster is currently working as part of the team to deliver the HeXI (High Energy Electron Crystallography Instrument) to Diamond. HeXI is one of three new projects funded by the Wellcome "Electrifying Life Sciences" grant. This new instrument will provide the means to perform high-energy electron diffraction to determine molecular structures from nanometre to micron sized crystals of proteins. The increased penetration of MeV electrons will be used to bridge the crystal gap between electron and traditional X-ray scattering based structure determination techniques.

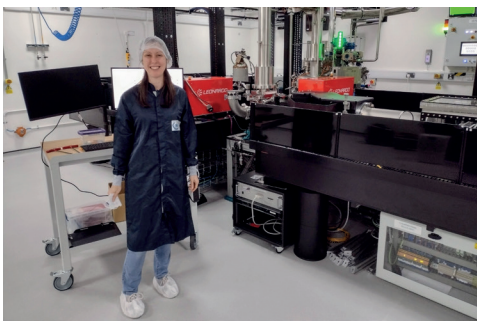
Andy comments: "This project is unlike any of the previous beamline projects I have worked on and presents some interesting new challenges. We aim to utilise the knowledge and techniques used in the Diamond Accelerator Control system, in an "electron beamline" on the other side of the ratchet wall".

Currently, the project is in the construction phase with the hutch being built later this year and components of the instrument arriving soon after that. Commissioning of those components will begin, in earnest, in 2026. Observatory Sciences are in a unique position with this project, since OSL engineers are also working with HVEE (High Voltage Engineering Europa) to help them with the design and implementation of a new EPICS control system for the electron source, which will eventually be delivered to Diamond. This collaboration has involved the design and development of the core EPICS state machine that will manage all of the individual devices within any HVEE system. This is a flexible solution that will allow the creation of state machines specific to each of their products, and its development required a solid understanding of the architecture of HVEE's EPICS control software. To support this development and forge strong relationships, Observatory Sciences consultants Ulrik Pedersen and Phil Smith have travelled to meet HVEE engineers at their Headquarters in the Netherlands.

SUPPORTING CUTTING EDGE LASER SCIENCE

The Extreme Photonics Applications Centre (EPAC), a new facility under development by the Science and Technology Facilities Council (STFC), is at the forefront of next-generation laser science. One of the scientific applications of the EPAC facility will be delivering high repetition rate laser-driven X-ray sources for imaging and industrial applications. Based at the Central Laser Facility at STFC's Rutherford Appleton Laboratory, EPAC is set to offer novel experimental techniques in the field of non-invasive imaging, with particular impact expected in areas such as materials testing and biomedical sciences.

Observatory Sciences has been proud to contribute to the development of the new EPAC facility by providing a range of specialist services. OSL has delivered tailored EPICS training courses to support the development and maintenance of the control systems that underpin the facility's complex infrastructure. OSL engineers have also been consulting on a range of topics including control and data acquisition systems architecture and implementation, drawing on their extensive experience in large-scale scientific facilities.

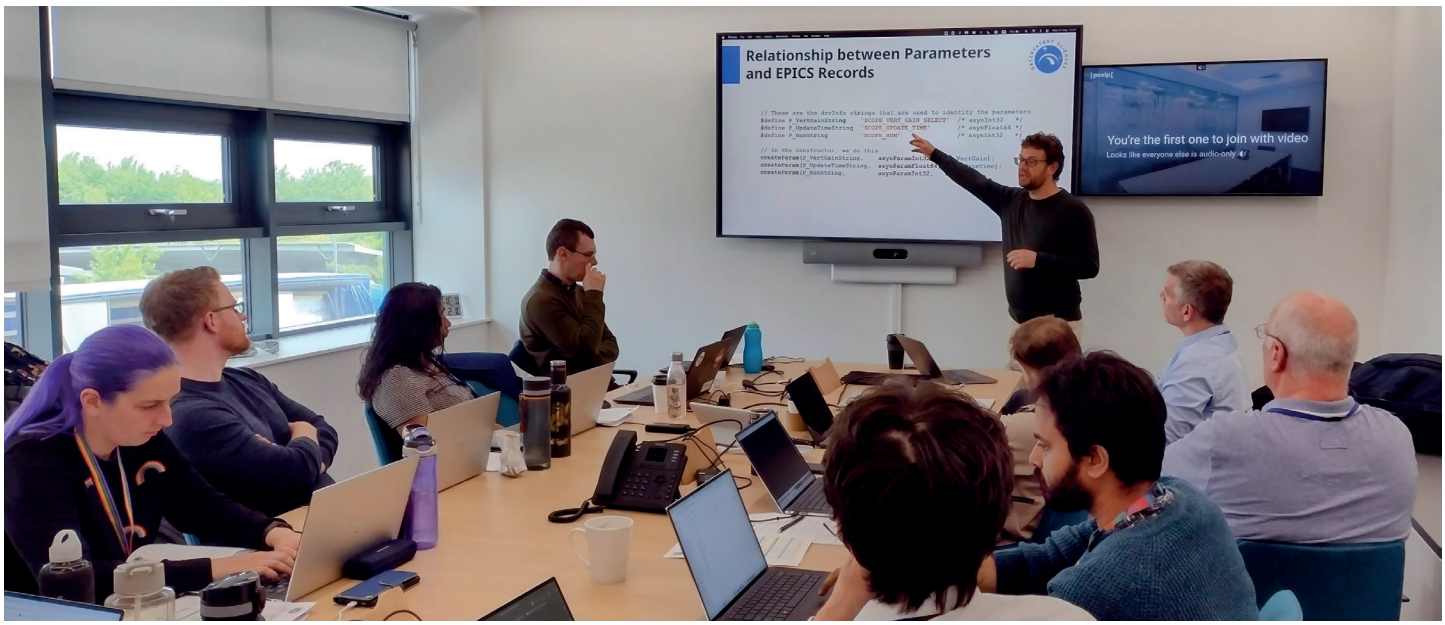


OSL engineer Emma Arandjelović visits the EPAC facility in her capacity as trainer for an EPICS programmer's course in May 2025. Photo courtesy of CLF, STFC

Ulrik Pedersen, the Principal Engineer on the project, comments: "EPAC's pioneering work in laser-driven X-ray tomography aligns particularly well with our unique expertise. Our history of involvement in synchrotron facilities around the world has equipped us with a deep understanding of high-throughput data acquisition systems – a key requirement for enabling successful tomography experiments. As EPAC moves into operational mode, we look forward to continuing our support of its cutting-edge science and contributing to the innovations that this world-class facility will enable."

EPICS TRAINING - NEW DEVELOPMENT

Observatory Sciences education and training arm of the company has continued to grow from strength to strength, delivering bespoke EPICS training courses over the last year to both Diamond Light Source and the STFC's Central Laser Facility. A further course is planned to take place in Hyderabad, India in the coming months for the Extreme Photonics Innovation Centre (EPIC), a joint UK-India initiative which is developing technology for the next generation of accelerators.



OSL engineer Ulrik Pedersen delivering an EPICS training course at STFC's Central Laser Facility. Photo courtesy of CLF, STFC

In addition, an exciting new development is underway in the form of an online course which will offer expert video tutorials to be followed at the client's own pace and convenience, with support available from OSL's highly experienced engineers. If you would be interested in receiving updates about this new offering when it becomes available, please get in touch by email to:contact@observatorysciences.co.uk.

OBSERVATORY SCIENCES MEETS UK SCIENCE MINISTER AT SKAO HQ

Observatory Sciences was recently featured in a case study by the STFC Industrial Liaison Office, highlighting the company's successful partnership with the SKAO. Subsequently, OSL representatives Alan Greer and Ulrik Pedersen were fortunate to be invited to a small, exclusive industrial exhibition held at SKAO Headquarters at Jodrell Bank. The event afforded an opportunity to meet Lord Patrick Vallance, UK Minister of State for Science, Innovation and Technology, and have a conversation with him, discussing OSL's work with SKAO and how this major contract has driven growth within the company and opened new avenues for future projects.

Lord Patrick Vallance, Minister of State for Science, Innovation and Technology meeting Alan Greer, Director and Ulrik Pedersen, Principal Software Engineer of Observatory Sciences.