OBSERVATORY SCIENCES News

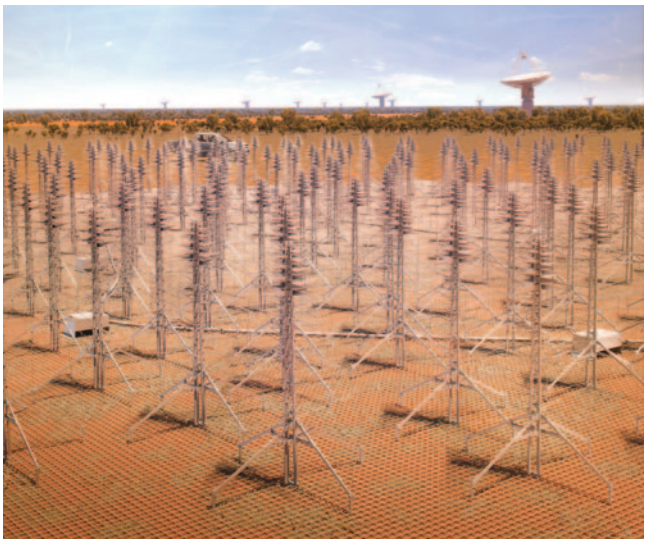
Spring 2022 + Software for telescopes and accelerators



# SKA CONSTRUCTION BEGINS

Observatory Sciences Ltd (OSL) has increased the size of its team working with the Square Kilometre Array Observatory (SKAO), which has now progressed into its construction stage to build the world's two largest and most complex networks of radio telescopes, which will acquire unprecedented amounts of data.

The two SKA telescope arrays, located 9,000km (5,600miles) apart in Western Australia and South Africa, are made up of hundreds of dishes and field stations. In Australia, there will be over 130,000 antennas by the end of construction, which must operate together and feed petabits of real-time data to central supercomputer control systems.



**Artist's impression of the SKA-Low telescope in Australia. These dipole antennas, which will number 131,072, will survey the radio sky in frequencies as low as 50Mhz. In the background are dishes of the ASKAP radio telescope, an SKA precursor. Credit: SKAO**

## Fundamental questions

The SKAO, established in January 2021, is the world's second intergovernmental organisation to be dedicated to astronomy. Headquartered in the UK on the grounds of the Jodrell Bank UNESCO World Heritage Site with sites in Australia and South Africa, the SKAO is tasked with building and operating the two largest and most complex radio telescope networks ever conceived to address fundamental questions about our universe. The SKAO already harnesses the talents of hundreds of scientists around the world and expects to spend around €2bn to complete construction by 2030 and run the observatory until then.

"This project has been many years in the planning," says Alan Greer of OSL. "We have recently signed a new eight-year framework contract to provide software to the SKA Observatory, extending and expanding on the work that we have been doing for the SKA Organisation since 2020."

The OSL team will initially be working on the Monitor, Control and Calibration System (MCCS) software for the SKA-Low telescope.

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# CONFERENCES AND FACE-TO-FACE MEETINGS BACK ON THE AGENDA

After nearly two years of travel restrictions due to the Covid-19 pandemic, 2022 should once again see Observatory Sciences staff attending face-to-face meetings. In April, we plan to attend a meeting in Geneva, Switzerland, organised for the European Southern Observatory's industry suppliers of the Extremely Large Telescope (ELT) instruments.

In February OSL attended a virtual conference to promote Pan-European Partnering in Big Science, at which European industrial suppliers to large scientific facilities will be able to network with potential commercial partners and hold one-to-one meetings. All being well, this will be followed by a face-to-face Big Science Business Forum in Granada, Spain in October 2022.

Across the Atlantic, astronomy's movers and shakers from around the world are gearing up for

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# LONG-TERM SOFTWARE DEAL AS ESS PROJECT PROGRESSES

As construction of the European Spallation Source (ESS) progresses, its partnership with Observatory Sciences has been extended and expanded through a new five-year framework agreement to provide software services.

When in full operation in late 2027, the ESS will be a world class science and technology infrastructure facility focused on the understanding of materials and development of new solutions for health, the environment, clean energy, IT and more. It is based around the most powerful linear proton accelerator ever built, a five-tonne, helium-cooled tungsten target wheel, 15 neutron instruments and a suite of laboratories in Lund, Sweden. All of this is done in close collaboration with a supercomputing data management and software development centre in Copenhagen, Denmark.

This 13-nation European project was first mooted over 20 years ago and once on-stream, two to three thousand guest researchers will carry out experiments at ESS each year. Most of the users will be based at European universities and institutes, although there is a commitment to also have significant numbers of representatives from industry.


European Spallation Source. Credit: Perry Nordeng / ESS

Construction began in 2014 and hundreds of scientists and engineers from over 40 research institutes around Europe are now working to design and build the advanced technical equipment of the facilities so that they maximise its research potential. “With so many diverse users and projects it is vital that quality and management systems are in place from day one,” says Philip Taylor of OSL. “By standardising on the open-source EPICS software framework, ESS will ensure consistency across all of their equipment which will promote operational efficiency and easy integration.”

OSL signed its original framework agreement with ESS in 2016, so has been involved throughout the planning and early construction stages. “It’s exciting to know that they will soon be moving to the operational phase,” says Taylor.

## NEW PROJECTS DRIVE GROWTH

2022 looks set to be the busiest year yet in the two-and-a-half decade history of Observatory Sciences, and the company plans to expand accordingly. Philip Taylor, one of the founding directors, says: “We have doubled in size over the last five years, are recruiting new members of staff each year and are actively seeking more, as major projects are quickly ramping up.

“We also have several new clients coming on stream. In parallel we have just been awarded a Growth Grant from local government, to support our expansion.”

To further its development, OSL has announced that it has been accredited to ISO 9001:2015, the most up-to-date and widely recognised international standard for quality management systems. Previously accredited to ISO 9001:2000, OSL knows that good management systems are at the heart of all successful Big Science projects.

OSL was founded in 1998 by five scientists from the UK’s Royal Greenwich Observatory, who recognised the need for a responsive and flexible company that could efficiently meet the software needs of big science facilities. Since then it has worked on major scientific projects around the world, including Gemini Observatory, Diamond Light Source, European Southern Observatory, DKIST Solar Telescope, Large Synoptic Survey Telescope and the Square Kilometre Array.

## OSL TO DEVELOP MONITORING, CONTROL AND CALIBRATION SYSTEM FOR SKA-LOW TELESCOPE

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The MCCS is a complex monitoring and control software system in charge of the overall data acquisition of the telescope. It is designed to configure and constantly monitor and calibrate the antennas so that they all work together with one another and with the beam forming equipment. To simplify this the antennas’ signals are collected in groups of 16, then a field-programmable gate array splits the combined signal into 384 frequency bands, performs complex gain calculations and recombines them to create multiple virtual beams from each field station.

“OSL had been in contact with the SKA Project for many years. With the SKA Observatory now established as an intergovernmental organisation and construction finally underway, we have now committed four full time staff to work on the software and are ready to add more as and when the need arises,” said Alan.

Once operating, the SKA will provide unrivalled scope in observations, exceeding the sensitivity, resolution, and survey speed of the best radio telescopes around today. With the recently-launched James Webb Space Telescope covering the infrared and far infrared spectrum and the suite of extremely large optical telescopes being built over the coming decade to capture visible light, the SKA will perfectly augment, complement and lead the way in scientific discovery and innovation.

# NEW CONTRACT SIGNED FOR TANGO SOFTWARE SUPPORT

Observatory Sciences has signed a framework agreement with the European Synchrotron Radiation Facility (ESRF) to provide software development effort for the TANGO community. TANGO is the open source device-oriented controls toolkit for use with synchrotrons, lasers, physics experiments and SCADA systems, originally developed at ESRF.

Based in Grenoble, France, ESRF is an international research institution supported by a network of industrial partners. It is based around a state of the art particle accelerator, which each year is used by about 3500 scientists who collectively represent 25 or more countries. It originally developed TANGO for its own on-site use, but also made it freely available to other institutions. The TANGO software framework is now developed and used by a range of scientific facilities around the world who together form the TANGO Collaboration. A Tango Controls Steering Committee makes strategic decisions about core developments in the Tango collaboration.

A TANGO device server implements the network communication and links to a configuration database and clients. Device servers and clients can be written in Python, C++ or Java. OSL has had a long involvement with TANGO software, using it to develop new custom software solutions for scientific control applications. Projects range from support for single pieces of hardware to complex control systems and graphical user interfaces.

"TANGO provides an interface for monitoring and controlling device servers running on multiple platforms distributed over a network," says Phillip Coles. "For example, we are using TANGO in our work with the Square Kilometre Array project and have also used it to control accelerator equipment supplied by Danish scientific instrument maker Danfysik."

## Complex control systems

TANGO is popular for Big Science projects where the control systems may comprise thousands of separate computers, networked to myriad different field controllers and other equipment. Users find it is easy to develop new functions and features to suit specific needs, and the software is put into the public domain so that others can use them too.

TANGO is expected to serve the needs of the research and technological communities for at least the next 20 years, as one of the standards for scientific distributed control systems. "It has grown from a modest start to become potentially one of the most powerful tools in control systems development," says Phillip Coles, "and OSL is now part of the TANGO core development community".

# CONFERENCES PLANNED FOR 2022

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the SPIE Astronomical Telescopes + Instrumentation Conference 2022, which it is hoped will be the first face-to-face meeting of its kind since the conference in Austin, Texas in 2018.

Scheduled to take place in Montréal, Canada, 17-22 July 2022, this should be the first major meeting OSL will attend since the pandemic so effectively shut down major gatherings of all kinds. The event marks a return to Montréal for this conference, which was previously held there in 2014.

Regular attendee Philip Taylor of Observatory Sciences, says: "Conferences and the face-to-face interaction they enable are the life-blood of science and research based sectors, so the live version of SPIE has been sorely missed."

## Presenting papers

In the past OSL has presented papers at SPIE and had display stands in the exhibition hall, and plans to do so again at the Montréal event.

"This SPIE conference can attract up to 2000 delegates and 50-100 exhibiting companies, so it's a great shop window for us, a rare opportunity to meet both existing and prospective clients from all over the world as well as learning a lot from the conference presentations," says Taylor.

# OSL TO CREATE LINAC EPICS DAQ

A Spanish company has contracted Observatory Sciences to create EPICS data acquisition software for the profile measurements of a LINAC being built under the responsibility of the CEA (Alternative Energies and Atomic Energy Commission) at the SNRC (Soreq Nuclear Research Center) in Israël.

The French research organisation IRFU (Institute of Research into the Fundamental Laws of the Universe) is responsible for the control systems for the new LINAC.

Barcelona-based Proactive R&D is a scientific services support company that specialises in astrophysics instrumentation, beam monitoring and control, experiment design and set up, large experiment infrastructure integration, cryogenics and high vacuum facilities. It was looking for a partner organisation to undertake the software elements of its work and chose Observatory Sciences based on their previous track-record of working with IRFU.

## Remote testing

"Our contract is to create EPICS data acquisition software for the SEM-Grid device being built by Proactive R&D. The system uses CAEN data acquisition hardware including a VME/USB hardware bridge that allows a standard USB computer connection to be used.


Credit: Proactive R&D

The standard IRFU EPICS control software has been adopted which we have installed and tested remotely on-site in Spain" says OSL's Philip Taylor.

A SEM-Grid is a diagnostic device used to characterise the properties and behaviour of an accelerator beam (profile and position). When particles hit a surface, secondary electrons are liberated, escaping from the surface which induce a proportional current. To determine the profile of the beam, individual wires or ribbons interact with the beam; this is called a Secondary Electron Emission grid (SEM-Grid) or harp. Each of the wires has an individual current-to-voltage amplifier.

The Proactive R&D data acquisition system will measure the voltage on each of the 49 horizontal and vertical SEM-Grid wires. A pair of CAEN data acquisition boards will be used to measure the voltages on the 98 separate channels.

"A system like this is designed to acquire a lot of data from multiple channels in parallel," explains OSL's Aya Yoshimura. "Our software is designed to ensure that all the required diagnostic data from the accelerator is captured from the data acquisition system and displayed immediately. The graphical user interface enables the desired beam profile data to be located and acquired to reveal patterns or developing trends. This means the engineers commissioning the accelerator will be able to fine-tune the system efficiently."

All the software work has been done remotely from the UK without the need to visit Spain, which has often been difficult due to Covid travel restrictions.

# DELIVERING EPICS TRAINING IN 2022

Observatory Sciences is to deliver a number of EPICS software training courses through 2022 and beyond. The courses will be to train software developers with the widely used and highly capable EPICS (Experimental Physics and Industrial Control System) software framework.

While some of the courses will be on-site, many will be virtual so that delegates from distant and diverse locations can attend simultaneously and safely whilst continuing to observe Covid-19 travel and meeting restrictions.

Two of the EPICS training courses will be for BESSY, a research establishment in Berlin. Founded in 1979, BESSY now operates BESSY II, a third generation synchrotron radiation source which provides researchers from all over the world with a universal tool for studying solar cells, materials for solar hydrogen production, quantum materials, proteins, meteorites and archaeological finds.

"BESSY has been using the EPICS software framework for many years, but will benefit significantly from the support and training course we offer," says OSL's Andy Foster.

Another long-time user of EPICS, Diamond Light Source which is located on the UK's Harwell Campus in Oxfordshire, will host another OSL training course early in 2022. OSL have regularly provided EPICS training courses for Diamond since 2002 and have now trained scores of software engineers involved in this cutting-edge facility, which is one of the UK's largest scientific projects.

There are also plans for courses for other groups and organisations which use EPICS. For instance, the new Fusion Technology Facility being built by Jacobs in Sheffield, which will play a key role in developing nuclear fusion, will adopt EPICS.

"After Diamond and BESSY, we have more courses in the pipeline, and we are also looking at how best to organise virtual courses, which will remain popular in the future" says Andy Foster. "We have a suite of course modules from which we can pick-and-mix to create custom courses to meet the precise requirements of particular organisations."