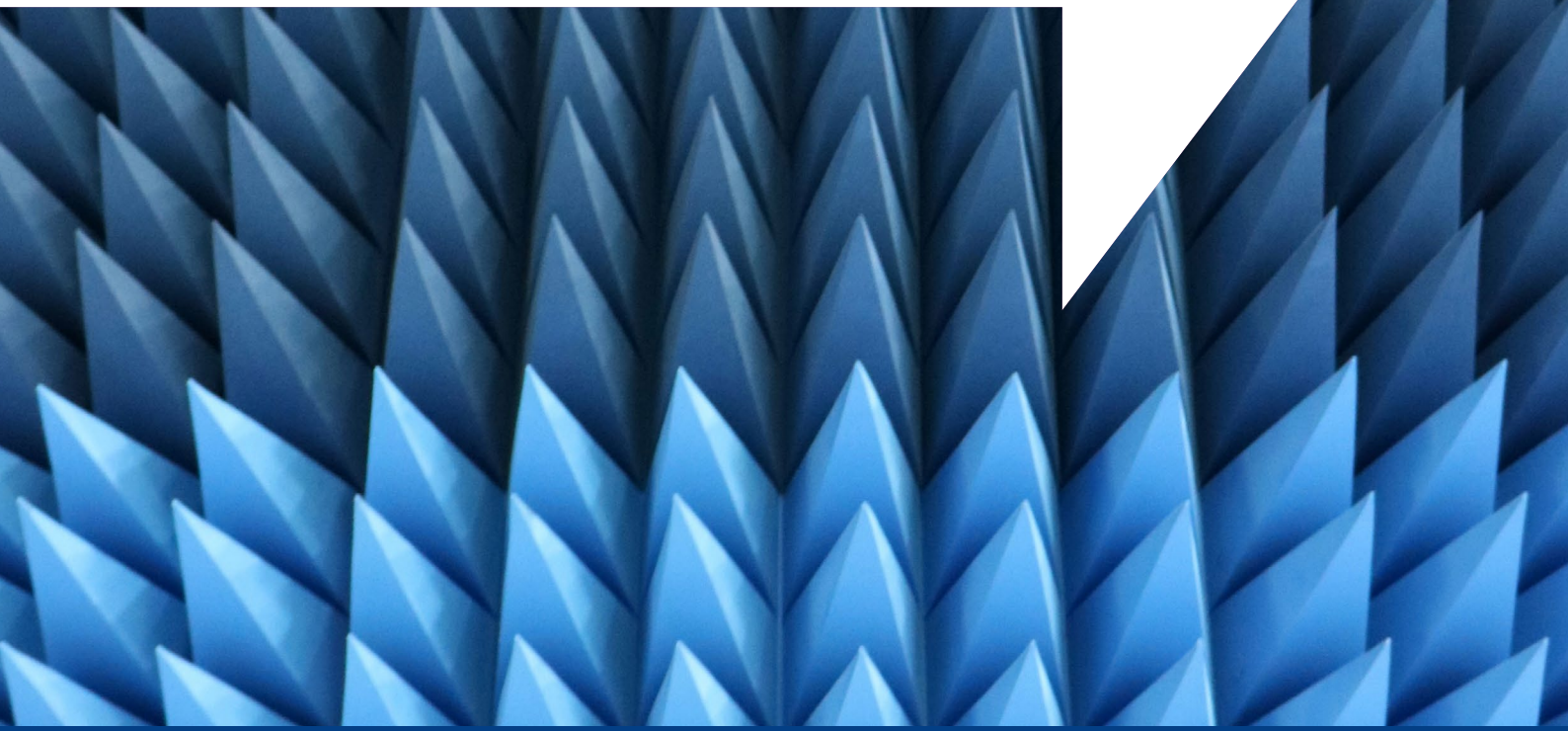
Science and Technology Facilities Council

RAL Space

RAL Space
Highlights 2023



Front cover image: Inside the anechoic chamber in the National Satellite Test Facility. Credit: STFC RAL Space

Inside cover image: NGC 346, the brightest and largest star-forming region in the Small Magellanic Cloud, captured by the Webb Telescope's Mid Infrared Instrument. Credit: NASA, ESA, CSA, N. Habel (JPL), P. Kavanagh (Maynooth University)

Welcome from Dr Sarah Beardsley

At RAL Space, we're not ones for resting on our laurels. We are innovators and improvers. The case studies highlighted here demonstrate the ways in which we are working at the cutting edge to support our communities in space and Earth sciences.

By bridging the gaps between science and technology, RAL Space teams lead the way at every step. From fundamental research challenging the way we think about the origins of dark energy, to deploying ever more sensitive astronomy instrumentation - we have been charting the course for space scientists to discover more about our Universe.

Closer to home, we have been providing tools and services to address some of the major challenges facing our planet by contributing to climate monitoring missions. We have also been working to ensure the sustainability of our own sector through our space surveillance and tracking activities.

Our new and improved facilities contribute to the strategic capabilities of the space sector. The National Satellite Test Facility, which welcomes its first customers in 2024, enables satellite manufacturers to build bigger satellites and test them efficiently right here in the UK.

In a topic close to my heart, we are also aiming to improve young people's first experiences of science by using the excitement of our work and missions to inspire them.

It is our innovative thinkers who make this all happen. And they work at all levels of our organisation, from our senior scientists through to project managers on our graduate scheme. Our people are at the core of our ability to do things that have never been done before. I am delighted to celebrate them here.

As a national laboratory we aspire that what we do today, will benefit everyone tomorrow. I invite you to read on, to discover how we're achieving this and how our work could benefit you.

Dr Sarah Beardsley, Director STFC RAL Space

4 Visual inspection of a printed circuit board in the laboratory. Credit: STFC RAL Space

RAL Space – Science driven, technology enabled

As the UK's national space laboratory, we are dedicated to making our world a better place through collaborative efforts with our community.

For more than six decades, our activities and facilities have played a pivotal role in cutting-edge scientific research across disciplines including climate science, space weather and astronomy.

Our mission is to leverage our expertise in space and to address future societal issues, stimulate economic growth, and deepen humanity's understanding of our place in the Universe.

We are committed to ensuring that the UK is at the forefront of space-enabled science, data, and enabling technologies, by:

- Supporting community access to advanced instruments, facilities, data, services, and expertise.
- Nurturing creative talent, inspiring scientific, technical, and engineering research excellence.
- Providing exceptional underpinning capabilities that empower solutions with real-world, quantifiable impact.

RAL Space is an integral part of the Science and Technology Facilities Council (STFC) and is the space hub for UK Research and Innovation (UKRI).

Tracking Aeolus' historic re-entry

Chilbolton Observatory's 25-metre antenna is one of the UK's leading locations for space situational awareness. Two radars sit behind "the Dish": the world's largest fully steerable meteorological radar, the Chilbolton Advanced Meteorological Radar (CAMRa), and the Chilbolton Advanced Satellite Tracking Radar (CASTR). The latter has been in operation since 2010, and the Observatory has provided valuable tracking data to the UK Space Agency's Space, Surveillance and Tracking team for many years.

In July 2023, the UK-built Aeolus satellite made history when mission controllers successfully guided its return to Earth – the first time such a re-entry manoeuvre has been attempted.

Aeolus took to the skies in 2018 as part of the European Space Agency's (ESA) Earth Explorer programme. The mission was equipped with state-of-the-art instruments to measure wind profiles from space for the very first time, advancing our understanding of global wind patterns to improve weather forecasting and climate research.

The spacecraft was built and launched before regulations were put in place for 'end of life' disposal, meaning that there had been no plan to deorbit Aeolus when it was built. However, ESA's Space Operations Centre in Germany were able to use remaining fuel to steer Aeolus during its return to Earth. This mitigated the already low risk of falling debris causing damage on Earth and provided useful data to inform future satellite re-entries.

Chilbolton Observatory received the request from the UK Space Agency to track Aeolus on 20 July 2023 and worked tirelessly to ensure readiness before Aeolus' re-entry. From July 26 to 28 they successfully tracked the satellite — a task no other sensor in the UK could perform during the re-entry process.

Working with the UK Space Agency, the team optimised the data, which were subsequently shared with ESA and the Inter-Agency Debris Committee (IADC). The data also included specific analysis on the risk to UK airspace provided to the Civil Aviation Authority.

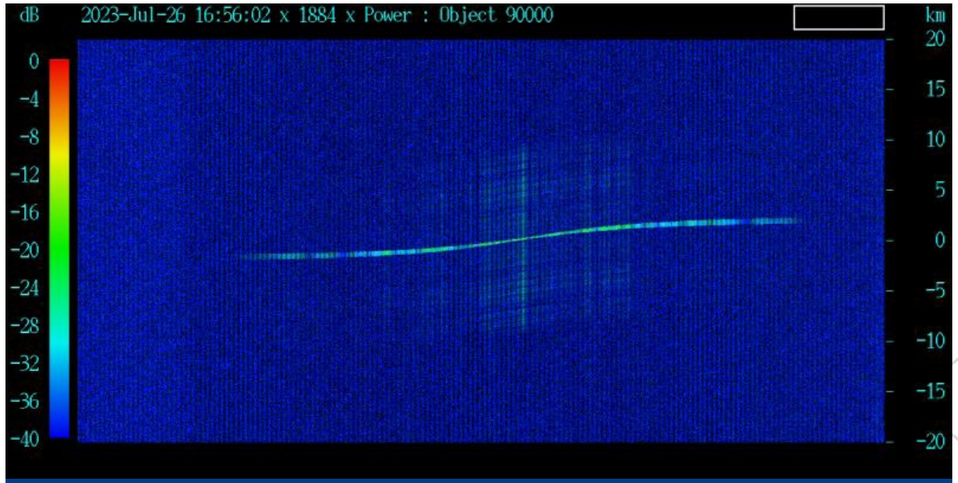
Satellites play an important role in many sectors, from Earth observation and climate monitoring to communications. However, with more than 8,000 operational satellites and more than 30,000 pieces of trackable debris in orbit, the ability to operate safely in space is growing increasingly challenging.

The assisted re-entry of Aeolus is a milestone for the space community, proving that this is a feasible way to dispose of end-of-life satellites. Data collected by sensors like CASTR will provide valuable information to analyse the projected final re-entry of these spacecraft.

Dr Emal Rumi, Senior Research and Development Engineer at Chilbolton Observatory, emphasises the significance of the endeavor in ensuring safe operations in space:

"This controlled re-entry was the first of its kind, making history and paving the way for similar procedures in the future. I'm proud that we could be part of this milestone and showcase CASTR's capabilities in support of the UK's space surveillance and tracking programme"

Chilbolton Observatory's 25-metre antenna. Credit: STFC RAL Space



Data from CASTR tracking Aeolus. Credit: STFC RAL Space

Paradigm shifting research casts RAL Space cosmologist into the limelight

Astronomy Group Leader Dr Chris Pearson was cast into the media limelight when he co-authored a paper that could help change our fundamental understanding of physics and the workings of nature.

Led by the University of Hawaii alongside colleagues in nine countries, the paper proposed that supermassive blackholes at the centre of ancient galaxies are the likely source of dark energy, the mysterious and poorly understood phenomenon that makes up 70% of the Universe.

Published across two papers in The Astrophysical Journal and The Astrophysical Journal Letters, the potentially paradigm shifting paper – which was met by the physics world with a healthy blend of excitement and scepticism – demonstrated the first observational evidence that the continued growth of black holes in long-dormant distant galaxies is cosmologically coupled to the expansion of the Universe.

If the theory holds-up to further measurements and examination, it'll change our understanding of black holes by removing the need for a physics-busting 'singularity' at their centre. This would mean that nothing new needs to be added to our picture of space to account for dark energy.

As Chris put it at the time: "If the theory holds, then this is going to revolutionise the whole of cosmology, because at last we've got a solution for the origin of dark energy that's been perplexing cosmologists and theoretical physicists for more than 20 years."

Unsurprisingly, the news of a possible seismic shift in our understanding of the Universe was met with delighted interest by the media and the public, with the press release alone being read nearly 140,000 times on the specialist research and technology news website, Phys.org.

Interviews and articles quickly followed, with Chris appearing in New Scientist, the Guardian, the Daily Mail, the Economist, and dozens of other outlets all over the world. Such was the interest in the story that Chris was soon taking to the airways on the BBC's flagship Today Programme to explain the new findings to an audience of millions.

Away from the glare of the mass media, Chris also took part in an in-depth interview with Universe Today, which has since been viewed over 100,000 times, and has been invited to give a number of academic and public talks on the research.

Whilst time and further observation will help confirm whether Chris and his colleagues' theory of cosmological coupling is the definitive explanation for the 'missing 70%' of the Universe, the paper's publication did conclusively prove that, when it comes to cutting-edge physics, the general public's fascination for the latest discoveries remains as strong as ever.

x2 RAL Space papers are cited almost twice as often as similar publications

77 papers published with a RAL Space author or co-author in 2023

One of the galaxies observed in the study, NGC 1277 is an ancient galaxy, 240 million light years away in the constellation of Perseus. At the centre of the galaxy lurks a supermassive black hole.

Credit: NASA/ESA/Hubble

The CEDA Archive

The Centre for Environmental Data Analysis (CEDA) supports atmospheric, Earth observation and near-Earth environment research communities through the provision of data management and access services. CEDA develops tools and services to aid data preservation, curation, discovery, and visualisation; all of which add value for the world-wide user community.

Data in the archive covers climate composition and numerical weather prediction as well as various Earth observation datasets, including airborne and satellite data and imagery. CEDA's main goal is to ensure that atmospheric and Earth observation data are made available and accessible to fully realise their reuse potential.

The CEDA Archive forms part of the Natural Environment Research Council (NERC) Environmental Data Service – a network of data centres covering all aspects of environmental science.

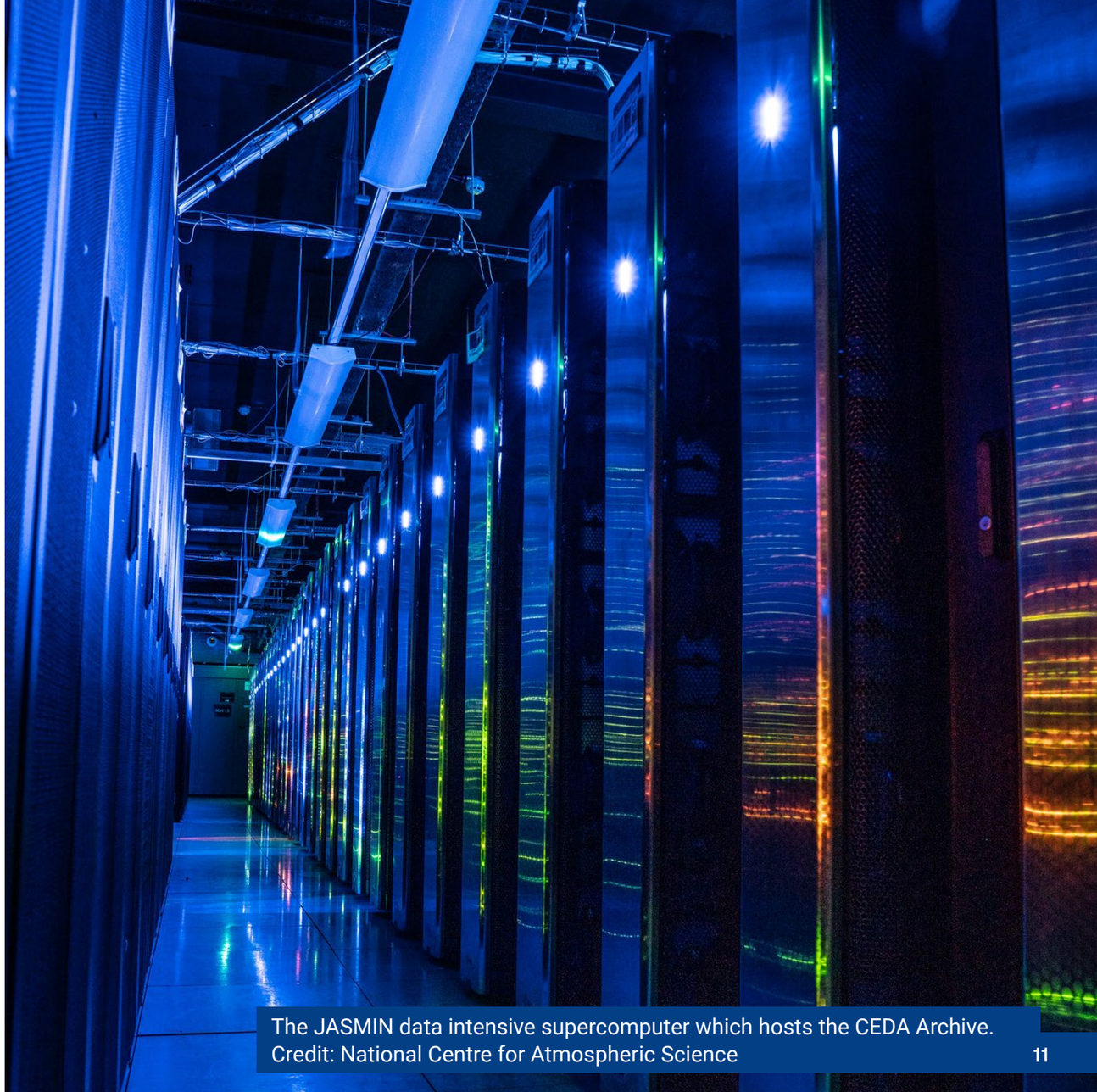
Annual CEDA Archive Deposits: April 2022 to March 2023	
Total volume deposited	4.26 Pb
Total number of files deposited	22,952,884
Total number of datasets deposited	2274

The Archive now holds over 20.3 Petabytes of data in 345,417,850 files.

Annual CEDA Archive Usage: April 2022 to March 2023	
Total number of users/distinct IP addresses	155,698
Total data downloaded	1.11 Pb
Total number of accesses	82,586,951
Datasets accessed	6079

Summary figures for usage by CEDA consumers during the reporting year.

(1 Petabyte = 1,000,000 Gigabytes.)



The JASMIN data intensive supercomputer which hosts the CEDA Archive.
Credit: National Centre for Atmospheric Science

Exploiting quantum physics in the search for elusive cosmic phenomena

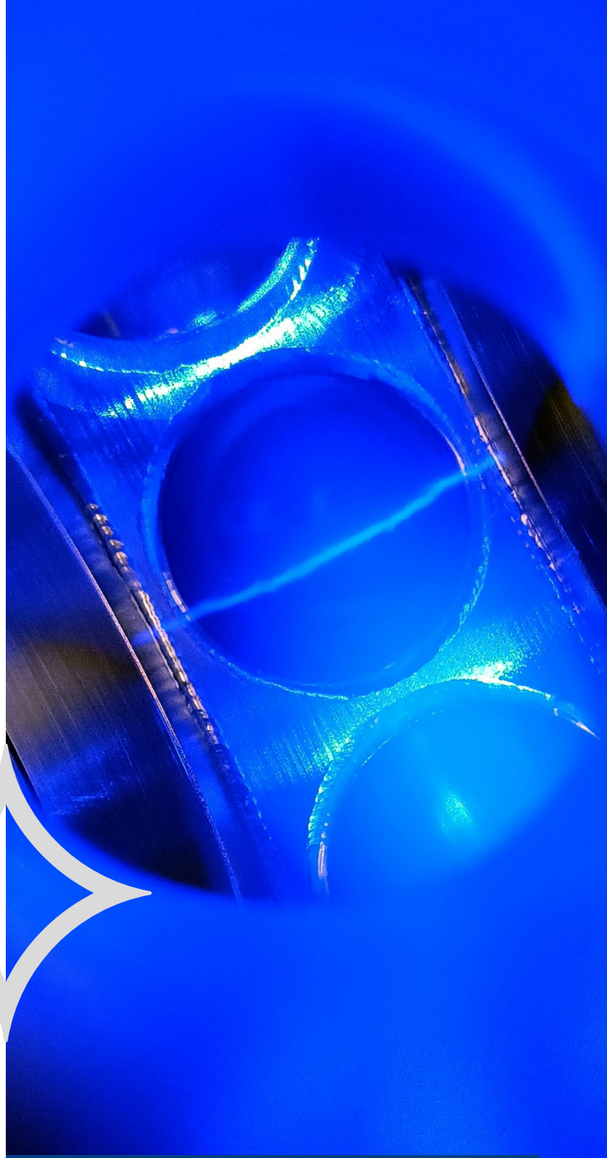
Our Quantum Sensors group are part of the Atom Interferometer Observatory and Network (AION), established to search for dark matter and mid-frequency gravitational waves. Dr Anna Marchant and Dr Mark Bason from the team tell us more about the project.

Historically, the development of astronomy has been linked to the development of optics. For example, the development of the Dutch telescopes led to detailed studies of our Moon and those of Jupiter. Nowadays, astronomers explore a vast part of the electromagnetic spectrum in the pursuit of new insights, and in the last 10 years, they have had a new tool at their disposal.

Interferometry is a way of carrying out extremely sensitive measurements using the interference of waves. AION aims to use the interference between wave-packets of laser-cooled atoms to search for gravitational waves and dark matter. By carefully measuring the difference between two atom interferometers separated by a long vacuum tube, they hope to see small wobbles as gravitational waves, or coherent dark matter fields, pass through the detector.

Our team has been working on the development of an ultracold strontium atom source for the interferometer. Because strontium is a solid at room temperature, it has to be heated to around 450°C to produce a gaseous vapour. The atoms in the gas are then laser cooled in two stages, first using blue light and then red. In this process, an atom travelling towards a laser beam can absorb some of the laser light, giving the atom a tiny kick in the direction of the laser beam. Doing this thousands of times, the net effect is a slowing down of the atom as it is pushed backwards by the laser beam. This slowing down is equivalent to making the atoms colder. Doing this with multiple laser beams, the atoms are effectively pinned in all directions and, by adding a magnetic field, can be trapped where the beams intersect.

The goal of this first round of development is to produce the largest possible cloud of atoms, at the coldest temperature, in the fastest time. The first stage of cooling is now complete with the atoms successfully confined in two-dimensions, ready to be transferred into the second chamber of the vacuum system where they will undergo full, three-dimensional cooling. In this next stage, the temperature of the atoms will be reduced to a thousandth of a degree above absolute zero. Cooling and subsequently trapping the atoms like this is essential for us to use them in experiments like the one we're developing with AION. There are still more cooling stages to come but the colder we can get the atoms, the more sensitive our instrument becomes, hopefully allowing us to observe gravitational waves and other exciting cosmic phenomena.



Laser-cooled strontium atoms in the lab at RAL Space, as seen through a vacuum viewport. Credit: STFC RAL Space

Meet our team: Anna Marchant, quantum sensors research engineer

I'm part of the RAL Space Quantum Sensors group where we're developing quantum technology and its applications. This includes using atom interferometers to implement gravity gradient sensors for Earth observation, as well as using quantum technology to answer fundamental physics questions about gravitational waves and dark matter. In practice, this involves days full of lasers and vacuum chambers, running experiments and trying to find the best solution to various technical challenges.

My background is in ultracold atoms. I did a PhD in quantum gases, focussing on those with tuneable interactions, and from there I went on to work in several postdoctoral positions in the UK and the US. I heard about a place in Oxfordshire trying to put a particular type of quantum gas, a Bose-Einstein condensate, into space – and here I am!

There's a huge amount of variety in my work, from considering atomic physics phenomena that need to be accounted for in any particular experiment, to puzzling over the best way to mount optics or detectors. Particle physics collaborations are often known for their huge facilities and in the future, the current detector project we're working on will need to move to a larger scale facility to build the next generation 100m tall detector. However, for the current stage of the project, all our equipment is on site at RAL Space, meaning we can access it whenever we want. This is a huge advantage.

Working at RAL Space not only surrounds you with a huge number of amazing people doing incredible things but also connects you with an even bigger network of world leading experts that you get to call colleagues. There is so much exciting science going on that it can be difficult to decide which direction you want to go in, but hearing about other people's experiences and interests has been really helpful for me.

Anna Marchant working on a laser setup in the laboratory. Credit: STFC RAL Space

RAL Space spin-out supports mission to Jupiter's moons

Teratech Components Limited, a spin-out from RAL Space, is on its way to Jupiter as part of a mission to learn more about the gas giant's origins and moons.

Launched on 14 April 2023, ESA's Jupiter Icy Moons Explorer, JUICE, embarked on its eight-year journey to Jupiter, where it will make detailed observations of the gas giant and three of its icy moons – Ganymede, Callisto and Europa. The discovery of liquid water beneath the surface of these moons and of certain key minerals might mean that they could harbour extra-terrestrial life beneath their cool, hard surfaces. Ganymede has further sparked scientists' interest as it is the only known moon in the Solar System to have its own magnetic field.

Also on their way to Jupiter are three diodes that were developed at the Rutherford Appleton Laboratory by RAL Space spin-out, Teratech. These diodes make up part of the detectors installed on JUICE's Submillimetre Wave Instrument, which will investigate the temperature, structure, composition, and dynamics of Jupiter's atmosphere, as well as the exospheres and surfaces of the icy moons. From this data, scientists can further determine the origins, chemical history and evolution of the Jovian system.

Teratech's Schottky Diode technology was originally developed for space applications, including in astronomy and Earth observation. However, as costs have reduced, it has since opened up to a range of commercial applications.

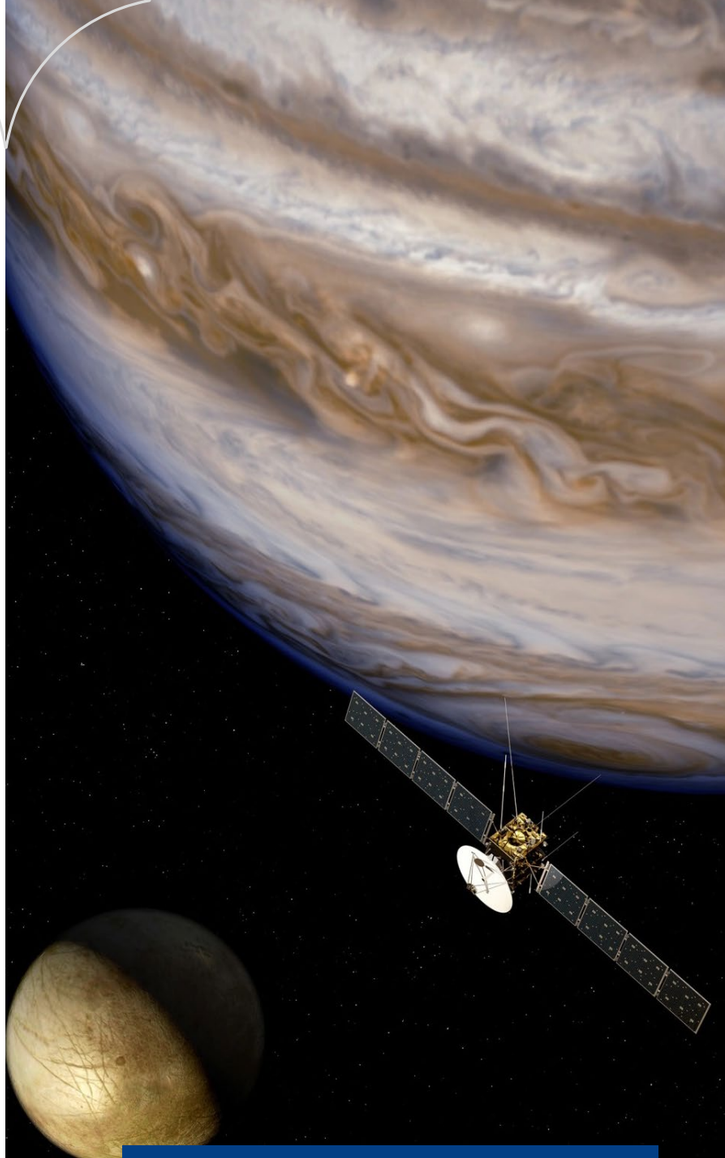
Teratech's diode manufacture laboratory, based at RAL Space. Credit: STFC RAL Space

"Teratech's' journey from STFC spin-out to a mission to Jupiter, is really exciting news for this pioneering company.

It is also a perfect example of how STFC's world leading technology, teamed with the right business support in the early days, and in this case, Teratech's location alongside RAL Space at the Harwell Campus, are all key to helping a company flourish.

I look forward to hearing the results of this ground-breaking mission, knowing that Teratech is playing a truly critical and valuable role in its success."

Dr Massimo Noro, Director of Business Development at STFC



Artist's impression of the JUICE spacecraft at Jupiter, with the moon Europa at lower left. Credit: ESA / AOES

Supporting tomorrow's climate satellites

Studying the Earth from space helps us gather valuable information on climate change, including data on greenhouse gases and temperature. At a time where countries around the world are striving to meet climate targets, satellite data is crucial to monitor progress. Satellite technology is also revolutionising the way we forecast weather events, with upcoming missions set to advance this further.

MicroCarb and MetOp - Second Generation are just two examples of climate missions that RAL Space teams and facilities have helped ready for launch.

MetOp – Second Generation (MetOp-SG)

MetOp-SG is a series of six meteorological satellites developed by the European Space Agency and EUMETSAT, which will be launched in three successive pairs.

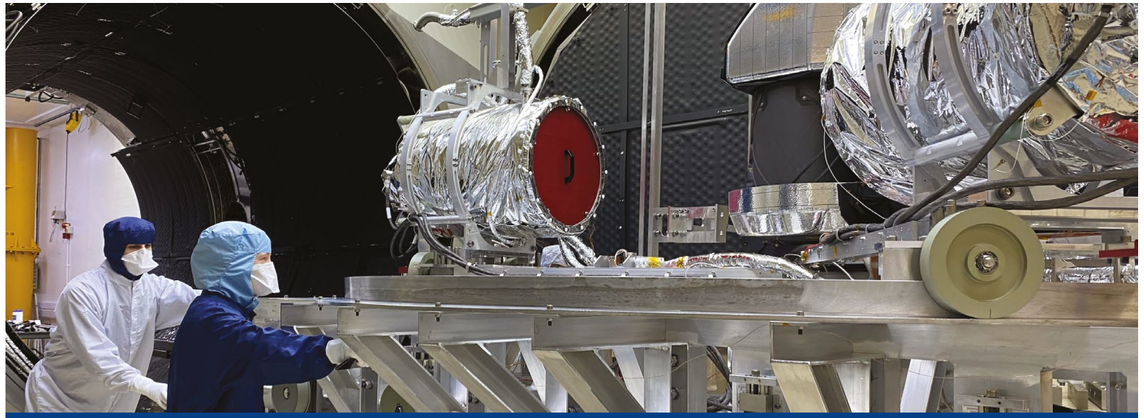
Compared to their MetOp predecessors, the MetOp-SG satellites will have a wider range of payloads providing increased observational capability, thanks in part to RAL Space's state of the art millimetre-wave technology. RAL Space delivered a total of 20 millimetre-wave receivers for MetOp-SG's Microwave Sounder (MWS) and Microwave Imager (MWI) instruments.

RAL Space also hosted Airbus Defence and Space UK to complete successful calibration and characterisation campaigns for all three MWS instruments. These tests, supported by RAL Space ground support and calibration equipment, built and supplied under contract to Airbus Defence and Space UK, will ensure that the instrument's measurements are as accurate as possible while operating in space.

The final MetOp-SG instrument tested was Sentinel-5, which will fly on board as part of the European Union's Copernicus programme. The RAL Space team worked closely with customer and prime contractor for the Sentinel-5, Airbus Defence and Space, to prepare the instrument for thermal vacuum testing.

One of the final MetOp-SG receivers in the laboratory at RAL Space. Credit: STFC RAL Space

The RAL Space and Airbus teams marking the beginning of Sentinel-5's test campaign. Credit: Airbus Defence and Space



One of the MWS flight models leaving the chamber at RAL Space. Credit: STFC RAL Space

MicroCarb

The MicroCarb satellite will be the first European mission dedicated to characterising sources and sinks of the main greenhouse gas – carbon dioxide – on a global scale.

RAL Space has supported Thales Alenia Space UK in preparing the satellite for space. Since arriving in the UK from France in December 2022, the satellite has undergone vibration, shock, and thermal vacuum tests in our facilities.

Previously, RAL Space designed and built MicroCarb's Pointing and Calibration System (PCS), which feeds the light reflected from Earth into the instrument. The PCS will allow the instrument to point at specific targets on the ground, such as cities, to take local measurements of carbon dioxide emissions from urban areas.

MicroCarb is a joint mission between the UK Space Agency and the French Space Agency, CNES.

MicroCarb undergoing vibration testing. Image credit: CNES / Benoit Cerantola

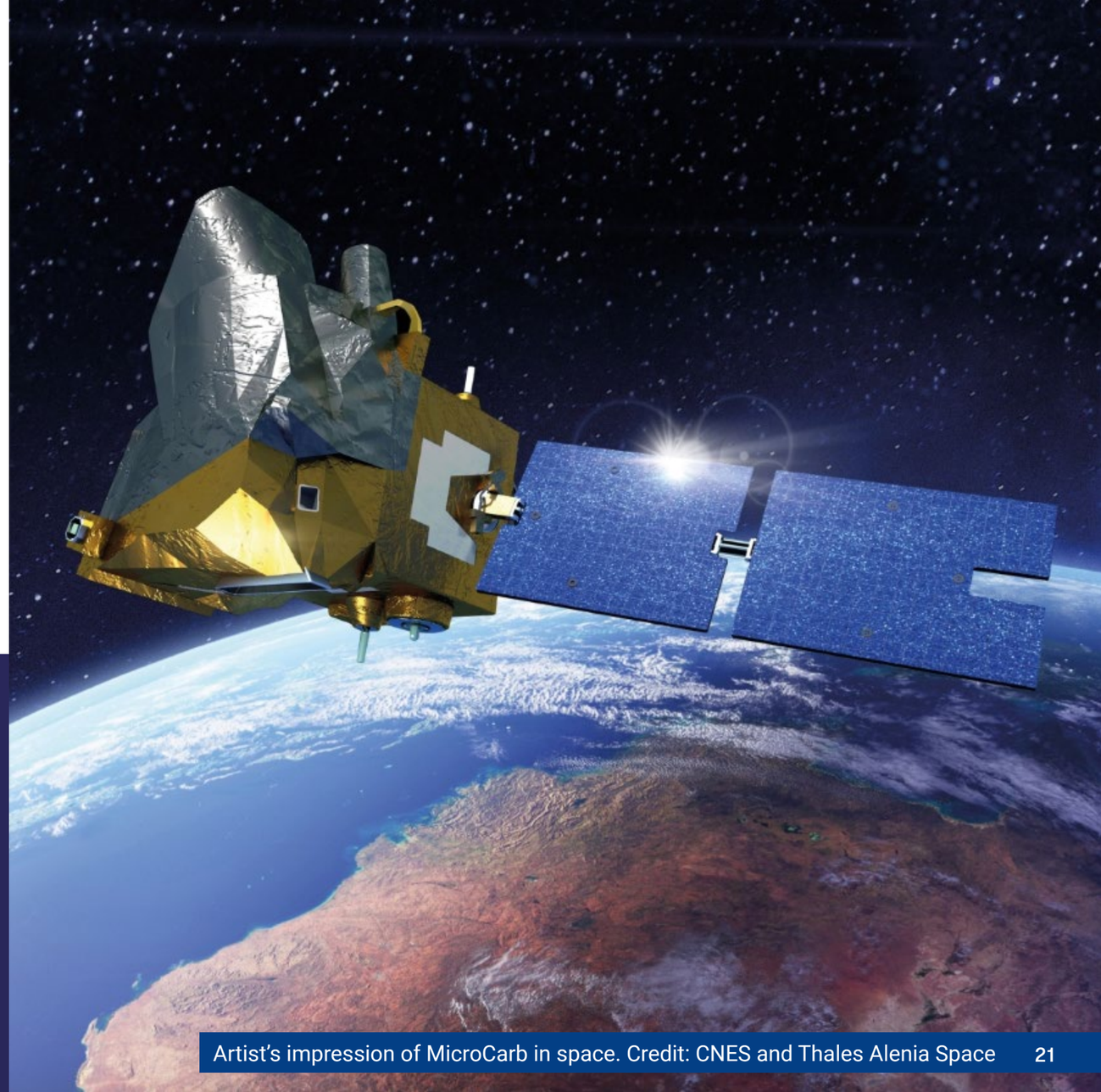
Environmental test

Thermal vacuum chambers
54 test campaigns completed

Facilities
4.7/5 star rating from
27 facility users

Dynamics
64 test campaigns completed including
9 shock test campaigns

Community
4 universities
3 internal projects
4 primes
8 SMEs



Artist's impression of MicroCarb in space. Credit: CNES and Thales Alenia Space

Step change for UK space capabilities as NSTF prepares for first users

If you were in one of the few cars driving down the A34 in June 2020, you may have been met with an unusual sight – a large convoy of lorries hauling the shrouded segments of the UK's largest space test chamber.

The 96-tonne chamber was on the final leg of its journey from its manufacturer in Italy to RAL Space in Harwell, and was one of the largest road movements ever seen in the UK, barely squeezing onto the two-lane highway as it made its way north from Portsmouth harbour.

So large was the chamber when it was assembled that the building it was to be housed in had to be constructed around it.

Three and half years, 900 tonnes of steel, and 3000 cubic meters of concrete later, the chamber now sits at the heart of the National Satellite Test Facility (NSTF), the UK's new purpose-built facility for testing large, next-generation satellites.

The NSTF marks a step change in capabilities for the booming UK space sector, giving it a one-stop-shop for all its testing requirements on home soil for the first time.

Born out of a 2015 Facilities Gap Study from the UK Space Agency, the NSTF gives the industry what it said it needs most – a single, central location, that is capable of testing very large-scale satellites and offers companies an alternative to similar facilities in the USA and mainland Europe.

The site features the complete suite of test facilities needed to put a satellite up to seven tonnes through its paces, ensuring that it will not only survive its time in space, but it'll also get there in one piece.

The thermal vacuum chamber – large enough to fit a double decker bus – tests the spacecraft against the extreme temperatures of space.

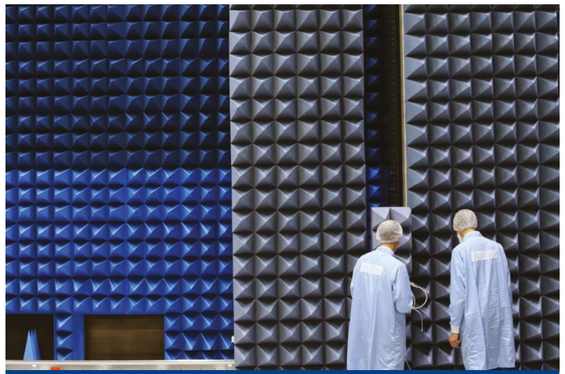
Meanwhile, the Dynamics Hall will be used to put the satellite through the violent conditions of a rocket launch, simulating the bone-shattering vibration and noise of take-off, and the hard thump of the payload uncoupling from its ride.

The Electromagnetics Chamber, an imposing cavern of 44,000 inwardly pointing blue spikes, creates the ideal conditions for testing a satellite's antennas, and can have the oxygen levels lowered to the equivalent of being 3000 metres above sea level to reduce the risks of fire.

Since its conception, the site has risen to stand as a testament to hard work, ingenuity and ambition of the UK space sector.

With final preparations now underway, the NSTF represents the UK's capability to not only compete with other space-faring nations, but to drive the whole industry forward towards unleashing its huge potential.

The NSTF main hall.



Inside the electromagnetics chamber.

The NSTF's large space test chamber.

RAL Space vibration facilities.
Credit: STFC RAL Space

Operational excellence

Isabel Martinez Chaquea, Quality and Safety Group Leader, reflects on her role, her teams' recent successes, and the importance of quality assurance in the space sector.

Quality assurance has always been part of my career path. Early in my career, I joined the quality assurance team for a pharmaceutical company in South America, and I really enjoyed applying best practices to my work and learning how to solve problems to improve the final product. After coming to the UK, I moved around different industries from pharmaceutical, medical devices and testing laboratories to eventually join RAL Space, which was a complete change of environment but one that brought me closer to my mechatronics engineering and control systems background. I soon learned that ensuring quality is particularly important for the space sector because it's extremely difficult to recall, repair, or even inspect anything once it's out in space.

At RAL Space, Quality Assurance (QA) covers many things, but our primary focus is to implement quality standards that meet industry and customer expectations. We are involved in developing quality processes and procedures, facilitating investigations, solving problems, and monitoring the performance of our quality management system. My team translates rigorous standards into a practical framework, weaving them into our day-to-day operations to ensure that our products are manufactured to the highest quality and that we deliver test services that meet tough requirements for space projects.

A recent milestone for our team, and for RAL Space, was the certification of our facilities and environmental testing services according to the European Space Agency (ESA) standard for test centres (ECSS-Q-ST-20-07C). This places RAL Space as the only test centre in the UK certified by ESA. Close collaboration between our QA and Environmental Test teams was instrumental in meeting this demanding set of requirements, and the resulting certification means that we can validate our operations against a renowned benchmark of excellence. We are striving for the same high level of certification for the new National Satellite Test Facility (NSTF).

Regular audits, monitoring and performance evaluations are undertaken by our QA team to ensure that processes consistently meet stringent requirements, which vary depending on facility and project phase. For example, very small particles can be very damaging to space hardware at certain stages of a project, with early stages often requiring our highest cleanliness level – ISO 5 – to protect sensitive optical and electronic components. When the product is integrated, with all sensitive components closed and sealed, cleanliness level can be more relaxed. In the NSTF, we'll be housing and testing complete satellites, so the cleanrooms there will run at ISO 8 – a relatively low cleanliness level. However, we do recognise our customers' need for flexibility, and are able to run these cleaner if needs be.

Quality standards span all areas of the organisation, so my team and I see a bit of everything at different stages of product development and test campaigns. This diversity is one of the most rewarding aspects of my job. Being part of a sector that makes a real difference to humankind is something that is also very appealing to me, and being part of an industry that cultivates an inclusive and open culture, there are always opportunities to contribute and learn from each other. We need a wide range of skillsets to bring awe-inspiring projects together.

Isabel Martinez Chaquea

Engaging our local community

RAL Space works with the local community in Oxfordshire to run events that support families in need, inspire young people and raise their aspirations in science, technology, engineering and maths (STEM).

In the most deprived state schools 78% of teachers report that the cost-of-living crisis would increase the attainment gap at their school[1]. The longer that pupils live with socioeconomic disadvantages, the less likely they are to stay in continuous education or employment[2] and polling current university students from all backgrounds showed that 28% are less likely to finish their degree because of the crisis[3].

Visiting families seeing themselves in infra-red. Credit: Didcot Railway Centre

RAL Space tailors school workshops and public events to the local community. Activities range from hands-on experiments about spacecraft insulation to support curriculum learning, to demonstrations of our technicians' and scientists' projects to highlight local employment opportunities, potential career routes and support available to young people.

To make children's first experience with science fun and informative, we collaborated with the Didcot Community Partnership which runs events for families in need and provides food and resources. Our ambassadors brought exciting, enriching activities about space exploration and gave children an opportunity to meet role models. 99% of attendees enjoyed the event and 88% said they would like to learn more about science in future.

1. Cost of Living 2022, The Sutton Trust, 2022
2. The long-term consequences of long-term disadvantage, FTT Education Datalab, 2022
3. Cost of Living 2023 – University Students, The Sutton Trust, 2023

Schools engagement in 2023

36% of our audiences were from backgrounds underrepresented in STEM

17 events that reached **1800** students from the most deprived areas in the UK

83% of students are more likely to consider pursuing STEM

Anna Ward and Alex Koala from RAL Space at Didcot Railway Centre's Science Fun Day. Credit: Didcot Railway Centre

Graduates

23
people currently on the STFC graduate scheme in RAL Space

4
graduates completed their training in 2023

2
industrial placement students working in RAL Space

Apprentices

3
apprentices have undertaken 4-month placements at RAL Space

2
newly recruited apprentices have joined RAL Space

1
graduating apprentice joined the RAL Space team permanently

Meet our team: Aman Sandhur, graduate project manager

As a child, I had two loves – dinosaurs and space. Needless to say, I followed my passion for the cosmos. I studied a degree in physics and philosophy and after graduating, I joined the Royal Observatory Greenwich as an astronomy presenter, delivering shows within the planetarium to visiting schools and the public. However, I wanted to be more involved in the technical side of things, so I applied to the Science and Technology Facilities Council's graduate scheme here at RAL Space.

As a graduate project manager, I'm learning the essentials of the profession and its importance within the space industry. Without careful management, a project can easily fall behind, inflate in cost, or even worse – both! A skilled project manager will oversee a project's schedule and resources, helping to ensure a project's timely and successful completion.

One of the best parts about working here is the people. I'm surrounded by friendly, experienced, and intelligent people, and I'm very fortunate that I'm learning so much from my colleagues. I share an office with a couple of engineers, and although I didn't study engineering myself, I've been learning a lot about different engineering processes going on here at RAL Space. These insights will hopefully prove invaluable towards developing my own project management style.

I value the fact that I'm actively involved within the space industry – it's my dream job. I'm now at the forefront of the latest and greatest innovations, especially within my assigned team, the Disruptive Space Technology Centre, where we are making some exciting progress in quantum communications.

However, space isn't just physics and engineering. There are so many different disciplines and professions involved in the development of our multi-faceted projects, so my advice for those considering a career in this sector is to cultivate a specialised skillset that can then be applied to one of the many areas involved within the industry.

Over the years, I've found that it can be easy to overload oneself with targets, goals and expectations. At times, I've found my ambition leading to intense amounts of stress. My hard-won lesson is that at times, it's best to just slow down and assess your situation – your passions, your interests, your drivers. And be creative, because there is more to life than just obsessively charging towards your goals.

Enhancing radio astronomy at the Sardinia Radio Telescope

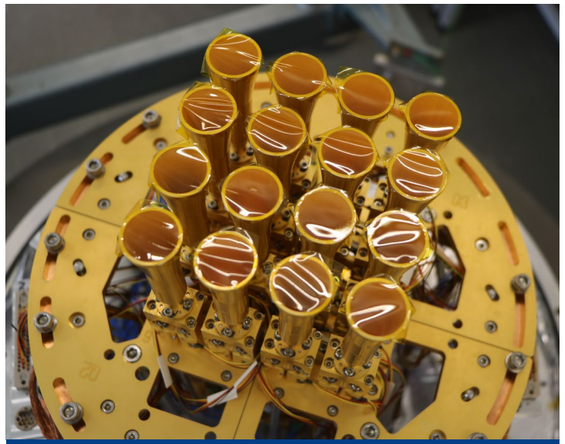
RAL Space successfully installed a powerful new tool to observe distant galaxies and enhance space weather forecasting.

The 64 metre single-dish Sardinia Radio Telescope (SRT) has played an important role in astronomical discovery since its construction in 2012, including work which has advanced our understanding of black holes.

RAL Space has installed a new millimetre wave instrument, the Cryogenic Array Receiver for Users of the Sardinia Observatory (CARUSO) which will maximise the information contained within the radio signals the SRT receives. This will enable scientists to detect and study even fainter radio signals coming from galaxies, pulsars and black holes.

Unusually, the instrument can look directly at the Sun without components being damaged. This allows it to operate in solar observation mode which will have a valuable role in the prediction of space weather. Improved forecasts could prevent harm to satellites in space and power distribution networks on Earth.

CARUSO was developed by RAL Space and partners from the University of Manchester and STFC's Technology Department.



CARUSO's 16-pixel array.
Credit: STFC RAL Space

Wider upgrades at the SRT

CARUSO is one of four new receivers delivered to the Sardinia Radio Telescope as part of a project funded by the Italian Ministry of Universities and Research.

"With the new cutting-edge instrumentation and infrastructural updates of the Sardinia Radio Telescope, we will be able to really go much further in the study of the Universe in radio waves. A choral work that has seen all the 'souls' of INAF - scientific, technical-engineering and administrative - collaborate in the best possible way to achieve this important milestone."

Marco Tavani, President of the Italian National Institute of Astrophysics (INAF)

Teams from RAL Space and INAF next to the Sardinia Radio Telescope. Credit: STFC RAL Space

Science and Technology Facilities Council

RAL Space

For more information, please contact:

RALSpaceEnquiries@stfc.ac.uk

STFC RAL Space
Rutherford Appleton Laboratory
Harwell Campus
Didcot
Oxfordshire
OX11 0QX

www.ralspace.stfc.ac.uk