Durham University

IN COLLABORATION WITH SPACE NORTH EAST ENGLAND

UKRI Science and Technology Facilities Council

Pioneering space science

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Inspiring the extraordinary

Durham University has a global reputation for excellence. We partner with ambitious organisations of all sizes, helping your business to innovate, compete and grow by connecting you to our academic experts and leveraging our extensive networks.

Pioneering space science

From scholars of old to trailblazers of the new, our unique history means we have been at the forefront of space science for centuries, pioneering our understanding of the cosmos and conducting world-leading research in technologies for space exploration and communications.

With an outstanding reputation in space science, our researchers have collaborated on projects for over 30 years with an array of commercial partners and government agencies, including the UK Space Agency, European Space Agency (ESA) and NASA.

Space-based telescopes

Our expertise extends to the development and utilisation of space-based telescopes. We have been actively involved in missions such as the James Webb Space Telescope, Hubble Space Telescope and the European Space Agency's Euclid mission. These missions have provided unprecedented views of distant galaxies and cosmic phenomena, advancing our understanding of the universe's history and composition.

Our Centre for Advanced Instrumentation developed the unique NIRSpec Integral Field Unit (IFU) at the focal point of the James Webb Space Telescope for full-field spectroscopy of distant galaxies.

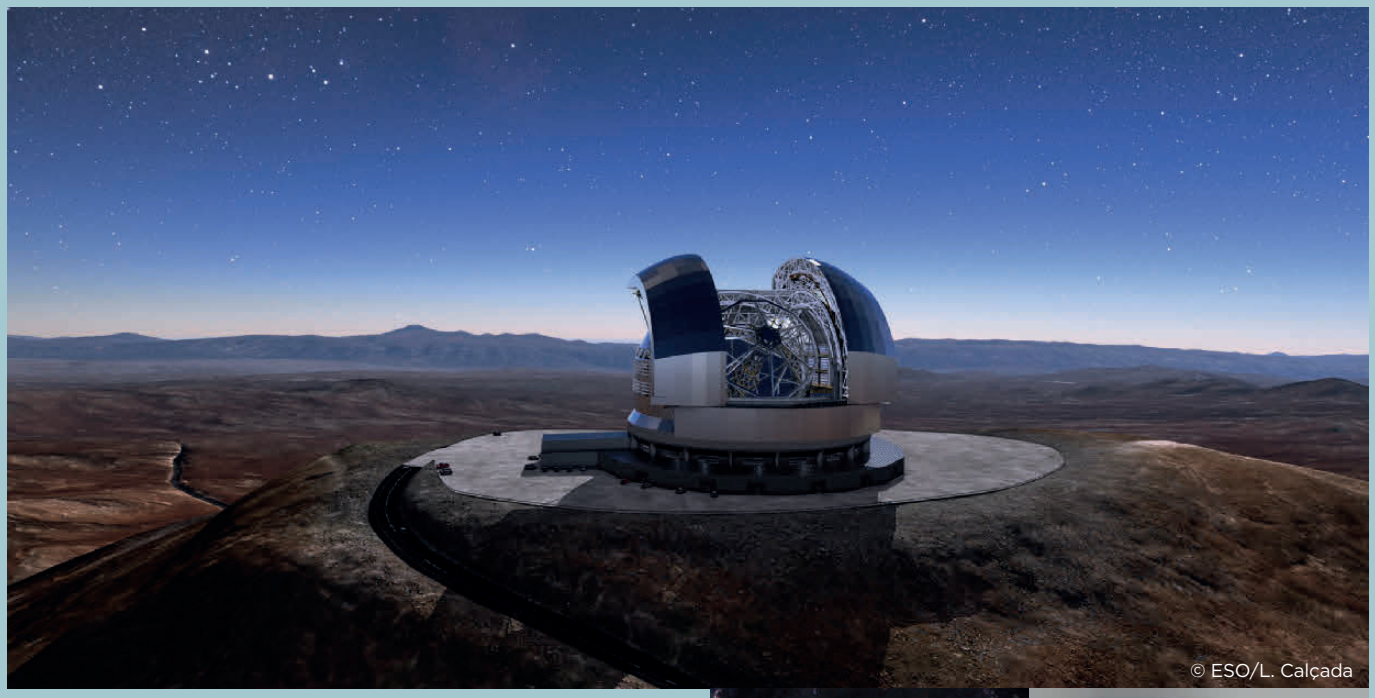
Precision optics technology and applications

We are a world-leading ultra-precise optics manufacturer, offering a wide range of services for optical parts design, manufacturing and testing. We have developed unique capabilities in optical design, integration and machining that enable previously impossible projects to become reality.

We can offer a wide range of metrology and testing capabilities including optical interferometry, non-contact 3D profilometry, surface roughness characterisation and precision CMM measurements. The metrology service can be offered as part of the total system design service or as a standalone metrology service for the precision measurement of customer produced parts.

Astrophysics and cosmology research

Together, our Centre for Advanced Instrumentation, Institute for Computational Cosmology and Centre for Extragalactic Astronomy are at the forefront of astrophysics and cosmology research. Their work has contributed to ground-breaking discoveries revealing insights into dark matter, dark energy, and the formation of galaxies and cosmic structures.



Case studies

Extremely Large Telescope (ELT)

Our astronomers and instrument scientists are developing key optical components and adaptive optics technologies for the next generation of Extremely Large Telescope (ELT).

- HARMONI is an integral-field spectrograph that is capable of observing the smallest spatial scales that the ELT can observe and providing thousands of spectra across a narrow field of view.
- MOSAIC can observe over 200 objects simultaneously across a very wide field of view, to undertake large surveys and sample large numbers of faint objects to provide a more complete understanding of the types of galaxies that exist in the universe, and how they've evolved over time. This same technology can be used to provide high-bandwidth and stable free-space laser communications between the ground and space, facilitating globally secure connectivity.

Our engineers are also producing two cutting-edge slicer-based IFUs for the METIS instrument, a first-generation system designed to provide full-field infrared spectroscopy, from objects in our solar system to distant active galaxies.

ALIGN Prototype optical communications CubeSat

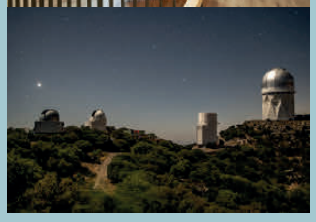
Autonomous Laser-based Inter-satellite Gigabit communications Network (ALIGN)

We are partnering with e2E, Smart Sentry and Northumbria University to develop a new laser-based optical system for satellite communications capable of being housed in a CubeSat.

The ALIGN mission, due to be launched in 2025, will carry the FOCUS (Freespace Optical Communication Unit for Space) payload and will demonstrate interlink communication at rates higher than 1Gb/s.

Ways to work with us

We work with organisations of all sizes and in all sectors. The depth and breadth of our research allows us to take a creative and multi-disciplinary approach to developing innovative solutions. Some ways of working with us are:



Contract and collaborative research

Collaboration is at the heart of our partnerships. We work with you to understand your needs and challenges, co-developing projects to help you stay ahead of the competition.

Consultancy

Our professional and confidential consultancy services give you access to our world-leading researchers to work on developing projects, providing proof of concept for new products or services, and streamlining your processes.

Knowledge Transfer Partnerships

Knowledge Transfer Partnerships (KTPs) are a leading programme by Innovate UK that brings together a company, an academic team and a high calibre graduate to work on an innovative project. We will support your business with an academic lead and recruit a graduate to work on your specific R&D need.

Recruitment, placements and internships

We work with organisations to support you with recruitment into early career roles such as graduate jobs, work-based placement years and summer internships.

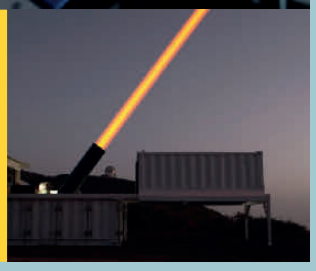
We're especially keen to support SMEs to access talent from Durham University, and we run a series of events and activities throughout the academic year allowing you to meet and recruit our students.

Continuing Professional Development (CPD)

We deliver a range of accredited and non-accredited short courses, masterclasses, summer schools and bespoke corporate executive programmes.

durham.ac.uk/business-gateway

Scan the QR code to find out more.



Case study

Advancing free-space optical communication networks

Researchers at Durham University are working with Viasat to understand atmospheric turbulence in free-space optical (FSO) communications. This research will support delivery of a robotic telescope for turbulence characterisation, as well as link performance modelling.

> **We're excited to collaborate with Durham University and their leading work on free space optics. We are committed to investing in key research and development for satellite technology, and Durham University was a clear choice, given their leading-edge work on free space optics. The results of their innovative research will be influential in the satellite communications industry, as we collaborate and bring their work from the lab to the marketplace.**
>
> **Dr Anton Monk**
> CTO for Wireless Initiatives, Viasat

Atmospheric turbulence measurement

Drawing on existing academic expertise, researchers at the University's Centre for Advanced Instrumentation developed the concept of the Shack-Hartmann Image Motion Monitor (SHIMM), a device capable of measuring atmospheric turbulence in near real-time, 24 hours a day, even in strong turbulence conditions.

To commercialise the idea, the University approached long-term industrial collaborator Lumi Space, whose emerging technology to remove space debris from orbit also relies on atmospheric turbulence monitoring.

Lumi Space is building a user-friendly interface and detailed instructions to allow a non-expert to confidently use the device – opening up the technology for potential use by Viasat and others in the sector.

The SHIMM prototype will be used by Viasat to collect data and model the optical channel to support potential ground station design, as well as support operational decision-making such as network switching between ground stations based on atmospheric conditions.

> **Researchers at Durham University offer technical expertise that cannot be found elsewhere. We have been collaborating closely on a multitude of projects for several years and hope this will continue to be fruitful long into the future.**
>
> **Dr Hira Virdee**
> Founder & CEO, Lumi Space

Centre for Advanced Instrumentation (CfAI)

Our Centre for Advanced Instrumentation (CfAI) is a leading research hub for cutting-edge instrument development in the fields of astronomy, space science, and related disciplines. It is renowned for its expertise in designing, building, and utilising advanced instruments for some of the most challenging scientific missions and experiments.

Our work often involves pushing the boundaries of what is technologically possible, resulting in innovations that have broader applications beyond astronomy. These advancements benefit various industries, including healthcare, telecommunications, and manufacturing.

- Astronomical instrumentation
- Adaptive optics
- Spectroscopy
- Photonics technology
- Freeform optics
- Gamma-ray astronomy
- Biophotonics
- Space science and instrumentation
- Fusion diagnostics
- Kinetic inductance detectors
- Free-space optical communications
- Space surveillance and tracking

Instrumentation excellence

We develop highly specialised instruments for space telescopes, ground-based observatories, and other scientific platforms. These instruments are crucial for capturing data, conducting observations, and performing experiments in various fields, including astrophysics, cosmology, and planetary science.

Space missions and ground-based observatories

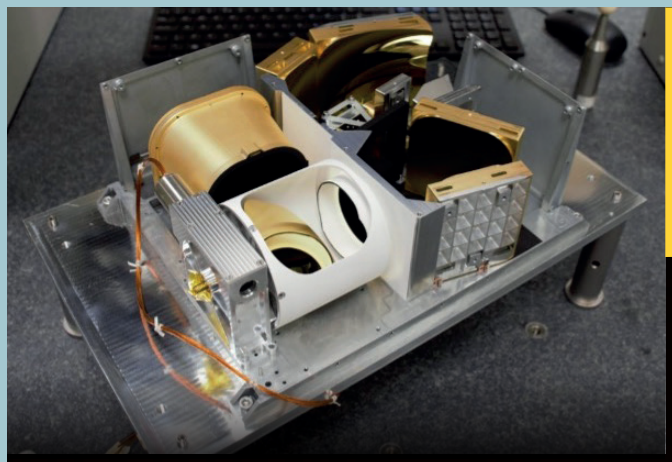
Our researchers and engineers have contributed to missions led by ESA and NASA, including designing and building instruments for space observation and exploration, such as for the James Webb Space Telescope, the ExoMars Trace Gas Orbiter, and Lunar Trailblazer, as well as for next-generation ground-based observatories and instruments.

Customised solutions

We pride ourselves on developing tailored instrumentation for specific space missions and research projects, ensuring that our partners get precisely what they need to achieve their objectives.

State-of-the-art equipment and facilities

We provide access to advanced research facilities and laboratories, enabling our partners to work with cutting-edge equipment and resources.



All-aluminium freeform optical system for the Lunar Thermal Mapper (courtesy Oxford University).

Case study

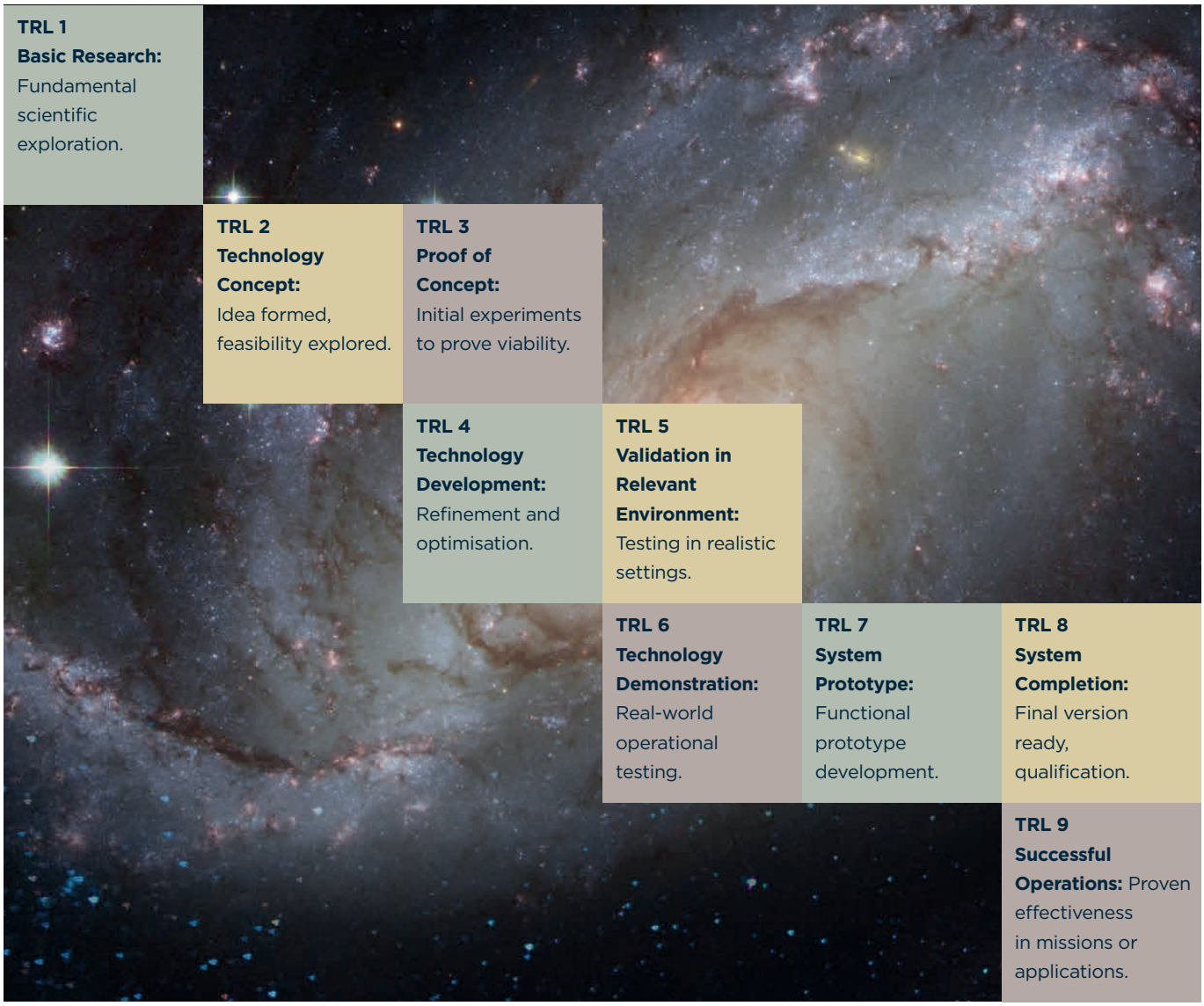
Lunar Thermal Mapper

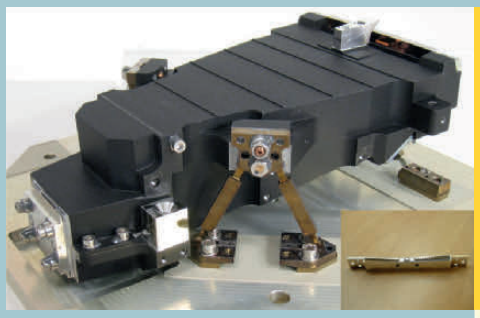
CfAI has participated in the development of the Lunar Thermal Mapper (LTM) infrared multispectral imager in collaboration with Oxford University and RAL Space on the UK side, and NASA, JPL Caltech, and Lockheed Martin on the US side.

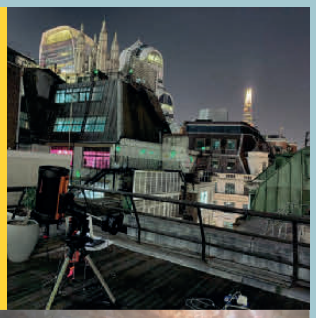
The LTM is an instrument of the Lunar Trailblazer (NASA SIMPLEx small planetary science mission) which will detect and map water on the lunar surface. CfAI has provided the five aluminium freeform optics of the LTM, and it is expected to be launched in early 2024.

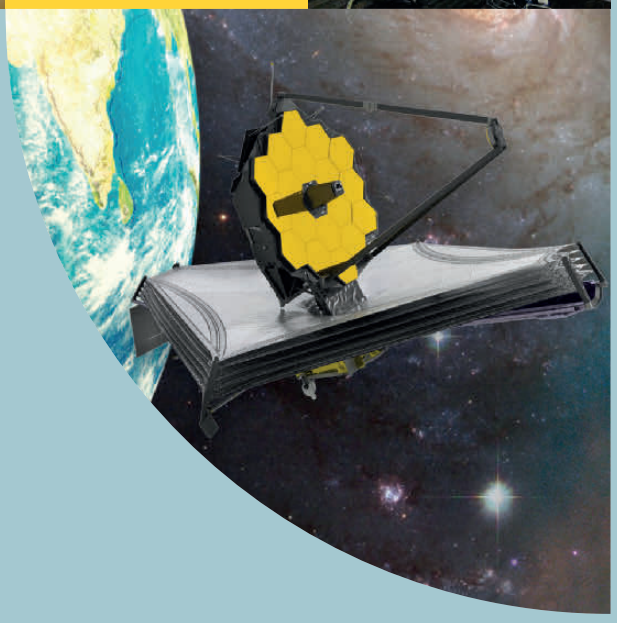
Explore our projects: innovation to commercialisation

We have expertise in advancing technology and innovation across different Technology Readiness Levels (TRLs).









TRL1

Atmospheric Science – we develop instrumentation and modelling to understand the complex dynamics of the Earth's atmosphere, focusing on optical turbulence.

Partners: ESO

Funder: UK Research and Innovation (UKRI), Science and Technology Facilities Council (STFC)

TRL 2

Our researchers led a project to develop a new hyperspectral imager to remotely map the moisture content in crops and soil using unique freeform diffractive grating manufactured at CfAI.

Partners: Ecometrica, Phase Photonics, Newcastle University, Satellite Applications Catapult.

Funder: Engineering and Physical Sciences Research Council (EPSRC)

TRL 3

Novel manufacturing and metrology techniques for freeform optics in CubeSat payloads. Our researchers are looking to apply the novel metrology technique Speckle Angular Measurement (SAM), and the Ion Beam Polishing method both developed for x-ray mirrors at Diamond Light Source to improve the surface quality of complex freeform aluminium mirrors for space.

Partners: Advanced Manufacturing Research Centre (AMRC) and Diamond Light Source (DLS)

Funder: UK Space Agency

TRL 4 & 5

Shack-Hartmann Image Motion Monitor (SHIMM), a device capable of measuring atmospheric turbulence in near-real time.

Partners: Lumi Space and Viasat

TRL 5, 6, 7, & 8

Autonomous Laser-based Inter-satellite Gigabit communications Network (ALIGN)

We are partnering with Northumbria University, e2E and Smart Sentry to develop a new laser-based optical system for satellite communications capable of being housed in a CubeSat.

TRL 8

Calibration and characterisation of ESA Sentinel-4 geostationary remote sensing satellite.

TRL 9

James Webb Space Telescope – NIRSpec IFU

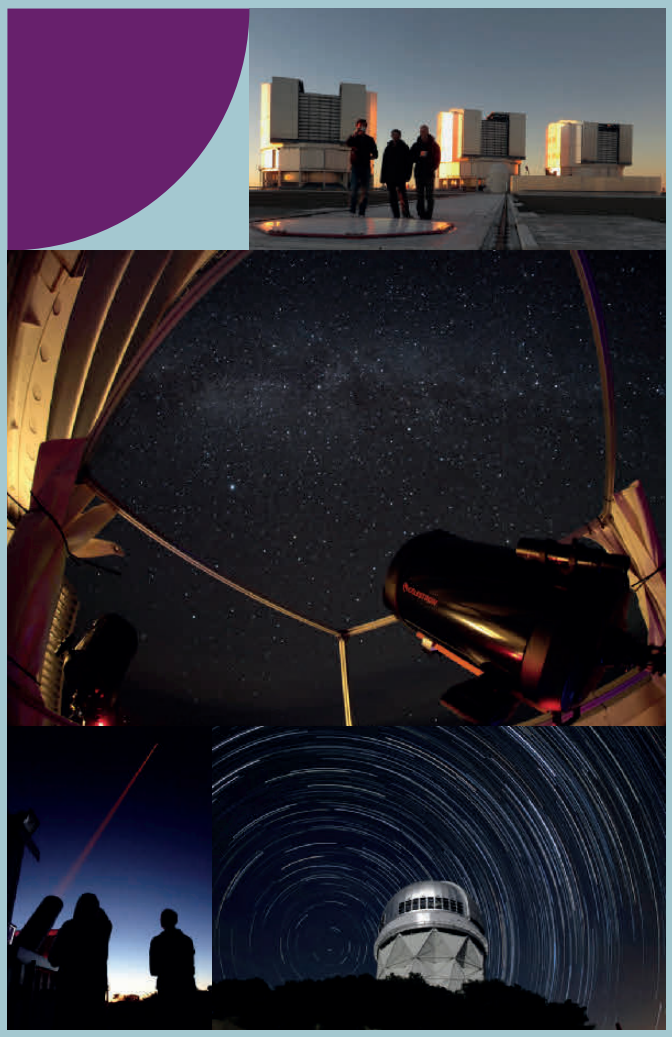
CfAI in collaboration with Surrey Satellite Technology produced diamond machined optics for the NIRSpec IFU, a key subsystem for the James Webb Space Telescope, used for the analysis of light from faint galaxies emitted over 10 billion years ago.

ESO Very Large Telescope (VLT) – KMOS

The K-band Multi Object Spectrograph (KMOS) is a second-generation instrument designed for operation on the VLT. The key feature of KMOS is its ability to perform Integral Field Spectroscopy in the near-infrared bands for 24 targets simultaneously.

SALT HRS (Southern African Large Telescope High Resolution Échelle Spectrograph)

SALT HRS is a high-resolution, high-efficiency spectrograph for the 11m SALT telescope in Sutherland, South Africa. The mechanical design, manufacture, assembly and testing have been handled by CfAI.



Case studies

VeriEarth Ordnance Survey data platform

Natural England and Durham University have teamed up with Ordnance Survey to leverage its geospatial data to produce a carbon model to protect wetlands in northern England to help meet net zero targets. The VeriEarth Ordnance Survey data platform will be used to provide transparency on the effectiveness of nature-based restoration and protect against greenwashing.

The Solar Activity Monitoring Network (SAMNET)

The Solar Activity Monitoring Network (SAMNET) aims to build a worldwide network of automatic observatories to provide 24-hour coverage of the solar magnetic field. In 2022, Durham University and collaborators at Sheffield University designed, built, and installed a new prototype SAMNET instrument at the Gyula Bay Zoltán Solar Observatory in Hungary. This new prototype provides a measurement of the solar magnetic field across the full solar disk every few minutes and represents one of the first steps towards building a worldwide network of monitoring stations.

James Webb Space Telescope

We have been involved in the scientific development and engineering of key components for the James Webb Space Telescope and our scientists were among the first to use the new instrument for research purposes.

In collaboration with Surrey Satellite Technology, we produced diamond machined optics for NIRSpec IFU, a key subsystem used for the analysis of light from faint galaxies emitted over 10 billion years ago..

Durham University Responsible Space Innovation Centre

For a sustainable future in space

We're forging a new era in space; our Responsible Space Innovation Centre is linking world-leading research, impactful partnerships, and industry-relevant training to ensure we have a sustainable future in space.

World-leading research

The Centre is an internationally recognised hub of excellence in space research. It is founded on the principle of open, rigorous and independent research to grow the capacity and capabilities of space applications while protecting the space environment for future generations.

Our vision encompasses not only the pursuit of cutting-edge technologies but also the holistic understanding of space and its broader societal, ethical, and environmental impacts. Through responsible multi-disciplinary research, in areas such as novel sensors, environment modelling, machine learning, governance and operations, we aim to address the complex challenges and opportunities of space exploration.

Industry engagement

By fostering collaborations and partnerships with national and international organisations, we aspire to lead the way in shaping the future of space research and governance.

Our core partners include the European Space Agency (ESA) and the Satellite Applications Catapult. Planning is underway for a range of joint research projects, training initiatives, access to facilities, and participation in space missions.

Education and training

We are committed to creating a pipeline of industry-relevant trained employees by nurturing talent and providing opportunities for education and practical experience.

Aligning closely with our partners to address the technical and digital skills needs of the sector, we are equipping a new generation of enthusiastic, creative and sustainability aware space professionals with the knowledge and expertise needed to excel in this rapidly evolving field.

Scan the QR code to find out more.

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