



Space Activities in Ireland **2024**

Space-related developments in Ireland supported by
the **European Space Agency** and **European Union**



Rialtas na hÉireann
Government of Ireland

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Foreword by Minister

In 2024, the Irish space industry continued its impressive trajectory, achieving significant milestones and making remarkable strides in space technology and innovation.

Highlights of the year include the launch in March of Irish company Ubotica's commercially backed CogniSAT-6 satellite which is revolutionising Earth Observation using AI to provide real-time data to end-users across a number of sectors.

2024 also witnessed the long-awaited return to space of the European Space Agency's Ariane 6 rocket. This was made possible with two state of the art technology systems from Réaltra Space Systems on board, including cameras that broadcast Ariane 6's live launch and journey into space to a global audience. A second Irish company, Nammo Ireland, provided vital propulsion technology for the Ariane 6 launcher.

This Government's ongoing investment in the European Space Agency is continuing to reap dividends for Irish companies. By the end of the year, a total of 116 Irish companies had won contracts with the European Space Agency under the National Space Strategy for Enterprise, with contracts valued at €24 million going to Irish companies, making 2024 the most successful financial year for Irish space enterprises.

As Earth Observation data remains crucial in combatting climate change, it is inspiring to witness the growing number of Irish companies developing and utilising space enabled technology and data to mitigate the impact of global warming.

2024 also saw the welcome expansion of the European Space Agency Business Incubation Centre network in Ireland. There are now seven consortium members with Atlantic Technological University, Dublin City University and Munster Technological University joining. These incubators provide technical expertise, funding and other valuable supports to space start-ups across ten incubation locations in Ireland.

I would like to congratulate the Irish Space Association on its successful first full year of operations; its support for the Irish space sector has been immensely beneficial, and I look forward to working with the Association as my Department progresses plans to develop a successor to the National Space Strategy for Enterprise.

I am also encouraged to see the educational and outreach engagement with school children continue in 2024, I'm sure many will be inspired to become our scientists, engineers, perhaps even astronauts of tomorrow.

The European Space Agency celebrates its 50th anniversary in 2025. Ireland has been a proud member since 1975 and as our relationship continues to grow, Ireland will continue to work in partnership with the Agency and its Member States for the next 50 years and beyond in space.



Alan Dillon

**Minister of State for Business,
Employment and Retail**

Department of Enterprise,
Tourism and Employment

Foreword by Enterprise Ireland

2024 was a year of extraordinary progress for Ireland's space sector, underpinned by innovation, collaboration and a growing global footprint. Irish companies continued to develop solutions at the frontier of aerospace, data science, quantum communications, sustainability, and artificial intelligence – all while deepening their participation in ESA and EU-funded programmes.

From the landmark launch of CogniSAT-6 by Ubotica, bringing real-time Earth intelligence to orbit, to Réaltra's live broadcast systems on Ariane 6, Irish technologies are enabling the missions of tomorrow. Companies like Mbryonics and ÉireComposites are shaping the infrastructure of the future through next-generation materials, communications and navigation systems.

Earth Observation solutions developed in Ireland are making a real impact on the ground – from flood mapping and biodiversity credits to climate monitoring and agricultural optimisation. The convergence of space and sustainability has never been clearer.

Enterprise Ireland is proud to support this thriving ecosystem – whether through direct engagement with ESA, our management of ESA BIC Ireland, or through international trade missions, funding partnerships and events like the inaugural Irish Space Technology Showcase.

We were also pleased to support the expansion of the ESA BIC network and to welcome new companies developing both upstream and downstream applications across sectors as diverse as healthcare, AI, semiconductors and energy.

The establishment of the Irish Space Association in 2023 and its continued growth in 2024 has added an essential voice and platform for Ireland's space community. Together with our academic, enterprise and public sector partners, we are building a connected, competitive and exciting space sector for Ireland.

Enterprise Ireland will continue to champion this growth – helping Irish companies to scale internationally, to innovate with confidence, and to play an important role in the global space economy.



Jenny Melia

**Chief Executive Officer
Enterprise Ireland**

Introduction

Despite rising global trade uncertainty and geopolitical tensions, the space technology market has continued to grow. In 2024, the market was estimated to be worth €436.69 billion and is predicted to increase to €469.61 billion in 2025. This growth is expected to continue at a compound annual growth rate (CAGR) of 7.45% through to 2034, with the market forecast to reach €896.19 billion¹.

The successful return to flight of both Ariane and VEGA marked key milestones for the European space sector in 2024. The coming years will be critical for the European space industry as the sector works to become more competitive, respond to emerging challenges, and seize the opportunities offered by NewSpace.

Ireland continues to increase its number of space-active companies which are benefiting from participation in the world's second largest space market and availing of new supply opportunities in overseas markets. In 2024, the European Space Agency (ESA) placed contracts in Ireland to the total value of €24.56 million, with industrial activities accounting for the bulk of this figure. The number of companies winning contracts with ESA continues to grow, totalling 116 at the end of 2024, including six new space-active entities. Contracts totalling €0.56m were placed with Irish research-performing organisations (RPOs) during the same period.

In line with the National Space Strategy for Enterprise 2019 – 2025, Irish companies continued to bring technology innovation to the space sector. An outstanding example was the AI-controlled CogniSAT-6 satellite – the first satellite to launch with commercial backing from an Irish company, Ubotica Technologies – and among the most intelligent and connected missions ever sent to space. The satellite featured onboard AI and real-time communications to improve Earth Observation (EO) services.

Another highlight of the year saw Réaltra Space Systems Engineering deliver its autonomous GNSS (Global Navigation Satellite System) flight system to ArianeGroup for the first flight of the new heavy-lift Ariane 6 launcher. In addition, Réaltra's VIKI video telemetry system captured striking footage of the successful launch from Europe's Spaceport in French Guiana.

2024 was another successful year for ESA BIC (Ireland), expanding significantly from five to ten incubation locations and welcoming six new start-ups to the growing family of companies developing innovative product(s) and services.

The Irish Space Association (ISA) held a series of meetings and events throughout 2024 to foster a strong network of space-active companies and researchers, sharing knowledge and information and contributing to the continued growth of this important sector.

The Irish space community, through an innovative and agile approach to RD&I, is well placed to collaborate with European partners and successfully compete in the NewSpace-driven global space market. This report showcases the diverse range of highly innovative activities undertaken by Irish SMEs and research groups in this fast-growing, dynamic and challenging sector.

1. <https://www.precedenceresearch.com/space-technology-market>

1.0

Irish technology innovations for the space and non-space sector

Irish innovation can be found in critically important areas including new lightweight structures for spacecraft, space-based decontamination solutions, and novel materials to protect spacecraft and their payloads from the noise and vibration of launch.

ATG Innovation wins 2024 JEC Composite Innovation Award

ATG Innovation won the 2024 JEC Composites Innovation Award in the Aerospace Parts category for its lattice Satellite Central Tube. The technology was developed through an ESA Future Launchers Preparatory Programme (FLPP) contract to investigate the utilisation of lattice central tubes for in-orbit transporters and last-mile delivery spacecraft for small satellites and secondary payloads. The aim of the project was to develop preliminary design solutions, assess the manufacturability of the products and perform a commercial feasibility study. The result was ~30% in mass savings and the development of a competitive commercial offering which led to a collaboration with a commercial European space company offering orbital transportation services.

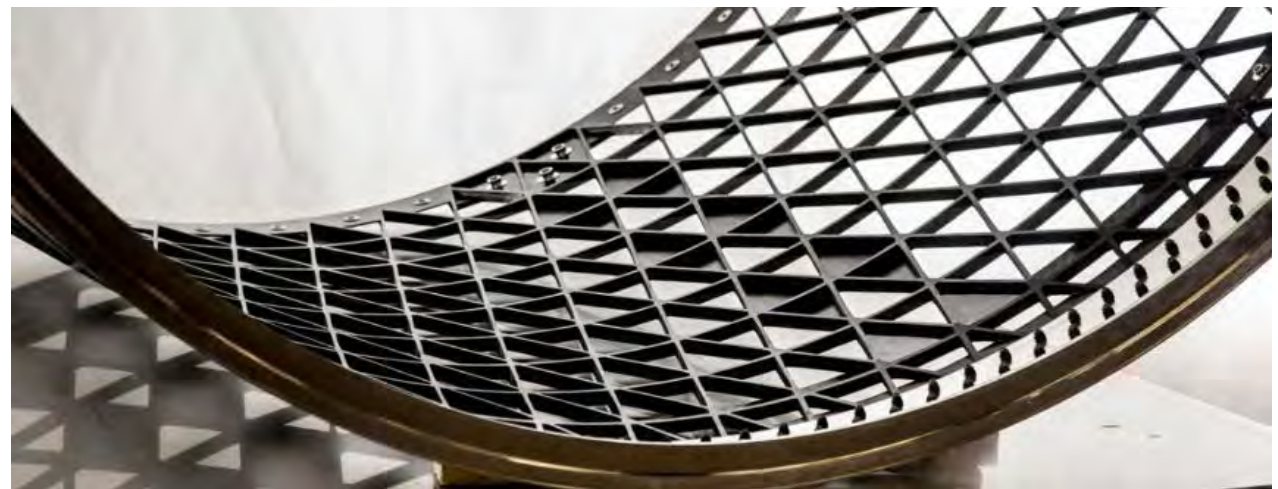


Figure 1: (Top) Brendan Murray and Kelly Matthews accept the JEC Composites Innovation Award (Aerospace Parts category) on behalf of ATG Innovation. (Bottom) ATG Innovation's Satellite Central Tube lattice technology © ATG Innovation Ltd.

Novel composite structures for advanced satellite communications

ÉireComposites is working on two space projects funded under the Irish Government Disruptive Technologies Innovation Fund (DTIF). The first, Free From Optix, is led by MBRYONICS and is aimed at increasing communication speed and security between satellites. For its part, ÉireComposites is developing high-precision composite structures for optical mirrors that maintain extremely high thermal stability in extreme space environments.

The second project, NSSPI (National Space Subsystems and Payloads Initiative) – led by UCD and ÉireComposites – will manufacture composite radar domes to enable communications from Earth to orbit.

In addition, ÉireComposites completed an ESA project to manufacture sandwich panels without using an autoclave. Trials demonstrated that large composite structures for satellites and launchers can be manufactured more cost-effectively using the new technique while still achieving the rigorous quality requirements demanded by space applications.

ÉireComposites also completed the engineering model for the stray light baffles for ESA's Altius Mission. The baffles filter stray light for the advanced optical system onboard the satellite and ensure that high-quality images can be obtained. Work is ongoing to manufacture the flight models, with a launch from Kourou, French Guiana planned for 2026.

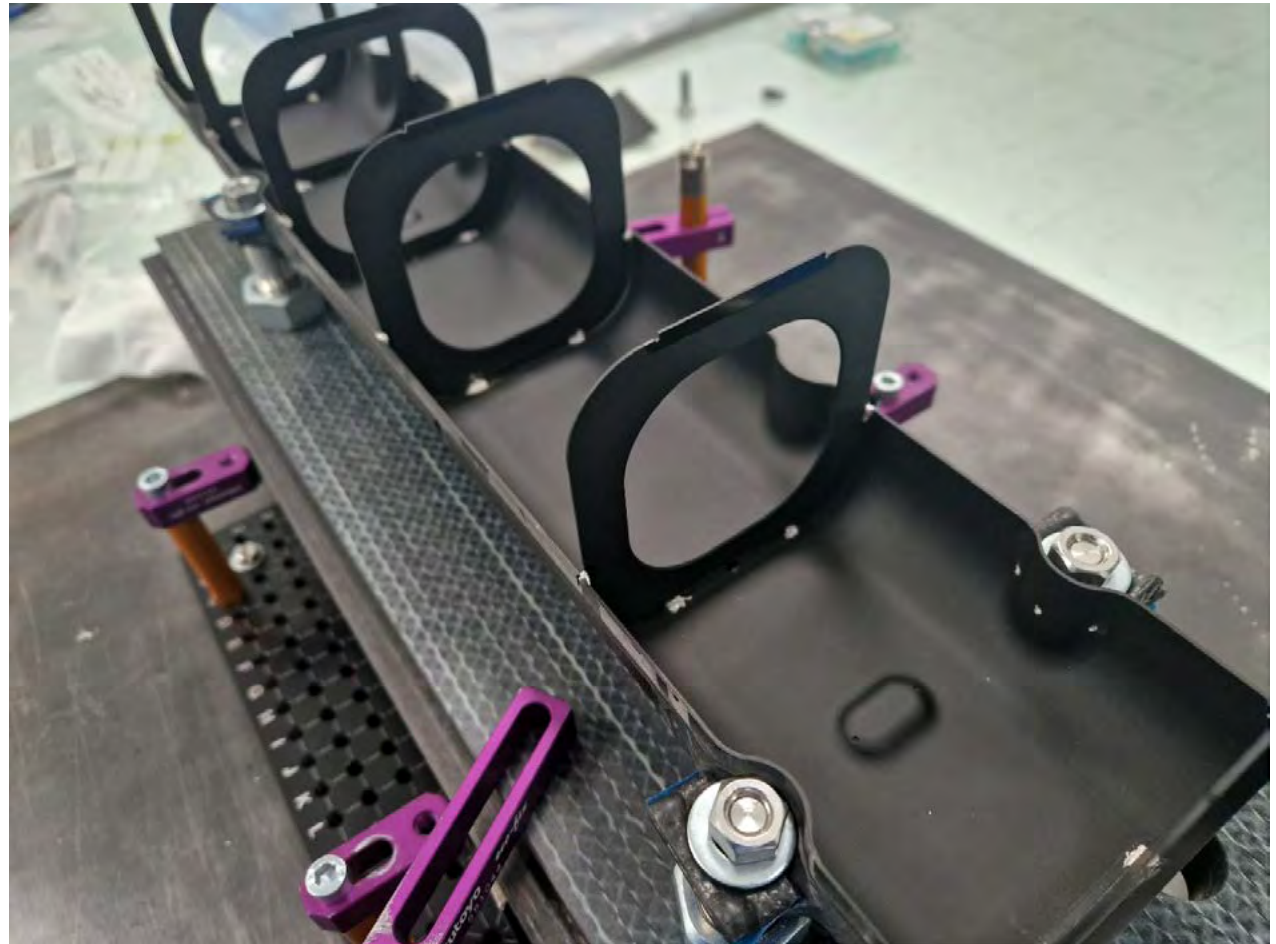


Figure 2: Partly-assembled view of the stray-light baffles © ÉireComposites

Advancing pathogen capture technology for space missions

Aquila Bioscience secured ESA funding in 2024 through the Discovery Programme to develop and validate its nature inspired biomaterial-based pathogen capture technology for biological decontamination in space. The company's innovative approach provides a non-toxic, non-flammable, biodegradable decontamination solution for space environments, mitigating microbial contamination risks while preserving material integrity. ESA expert guidance ensures alignment with planetary protection standards and space hardware constraints. Independent testing of the developed prototypes will be conducted by French company NeoVirTech.

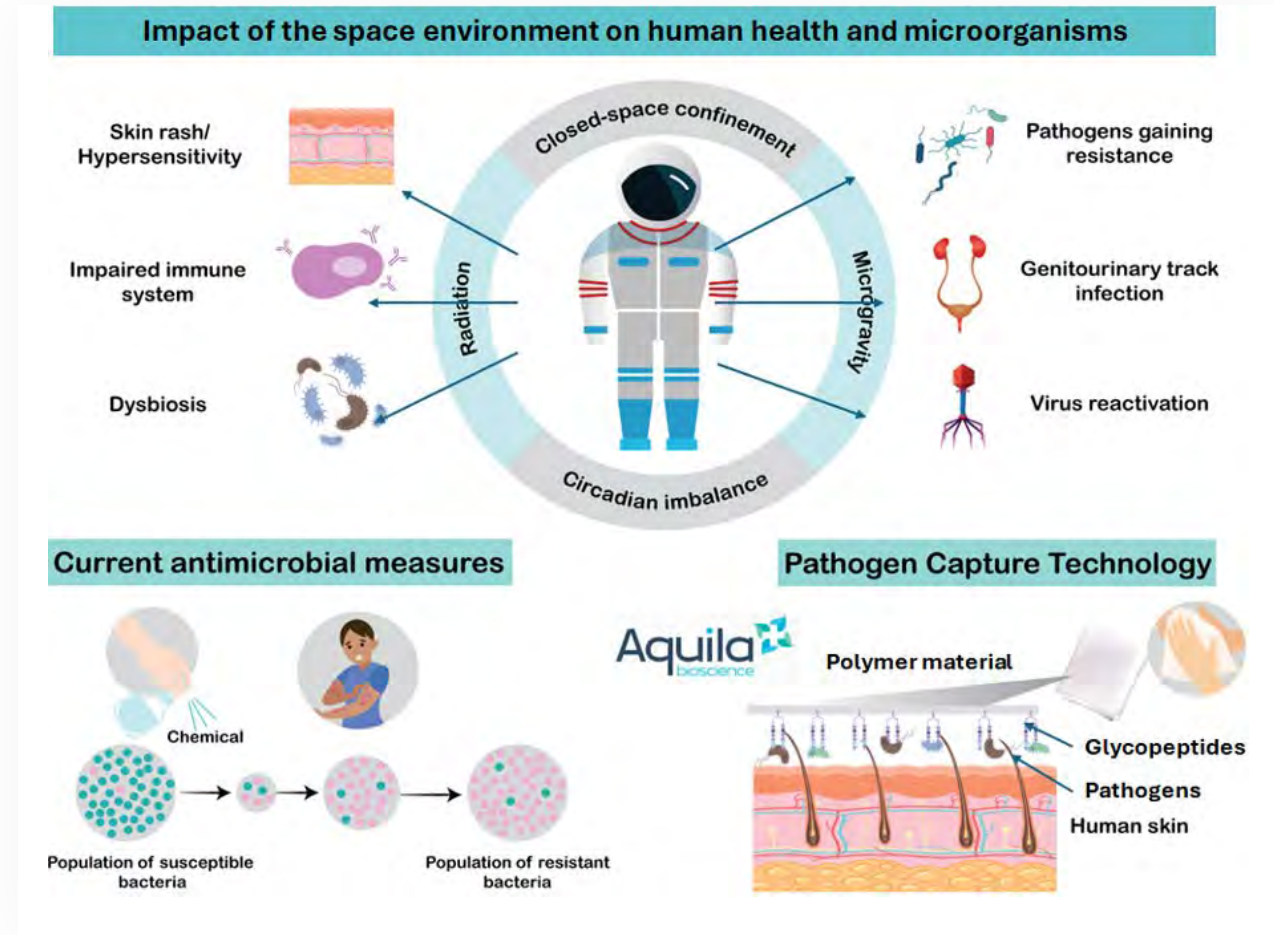


Figure 3: Pathogen Capture Technology for Space Decontamination © Aquila Bioscience

New Irish developed software suite for Lunar Gateway

Skytek have been awarded the contract to develop the Flight Data File (FDF) software suite for the Lunar Gateway space station which is planned to be assembled in orbit around the Moon. The Gateway is intended to serve as a communication hub, science laboratory, and habitation module for astronauts. The new software suite will provide Gateway operations with an innovative and integrated FDF solution to support ground operations during preparation, astronaut activity onboard the Gateway as well as potential lunar surface operations. In 2024, the initial version of the suite was deployed within ESA infrastructure to support current International Space Station (ISS) activities and in preparation for future Gateway activities.



Figure 4: Lunar Gateway in full Configuration © NASA

Lightweight acoustic protection for space



Figure 5: Lios Cofounders Eimear O'Carroll, CTO (left) and Rhona Togher, CEO (right) display samples of SoundBounce © Lios

Advanced acoustic materials specialist Lios is developing new Fairing Acoustic Protection (FAP) for launch vehicles to safeguard delicate payloads and instrumentation. The project is part of the ESA FLPP and focuses on lightweighting acoustic materials while enhancing noise and vibration attenuation.

The Lios team is focused on transforming its SoundBounce technology for FAP and its efforts so far have delivered a 60% mass reduction in prototype designs. The company is also developing world first mathematical models to analyse material response to fairing conditions during the take-off and separation stages. Beyond space, reduced-weight innovations are important for industries such as automotive, construction, and home appliances, where reducing weight lowers emissions and pollution.

Innovative micro-channel heat exchanger for reusable launch systems

ESA-funded researchers at Meath-based Confluent Research in collaboration with UK-based TWI have advanced the development of a compact, lightweight micro-channel heat exchanger (MCHX) for reusable space launch systems. This breakthrough technology is poised to improve efficiency in next-generation space propulsion systems. The novel heat exchanger is designed to withstand extreme thermal and pressure conditions, supporting high-efficiency Helium Brayton cycles cooled by cryogenic hydrogen fuel.

Utilising computational fluid dynamics and reduced-order modelling, the team optimised the MCHX for enhanced thermal performance while maintaining structural integrity. A prototype is currently being manufactured, and this will be followed by rigorous testing on a bespoke test rig, designed and manufactured as part of this programme.

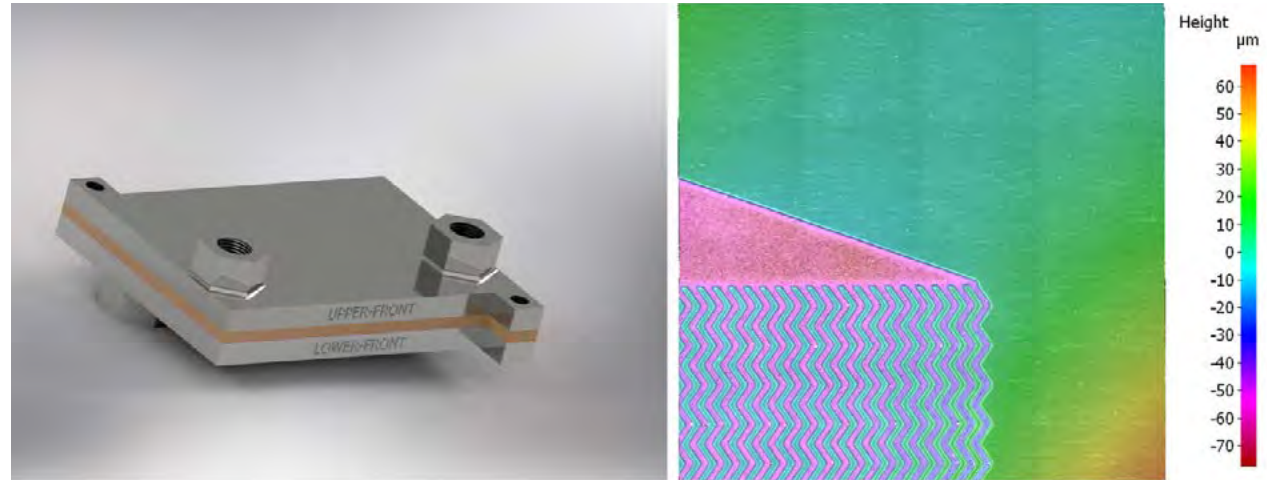


Figure 6: Prototype breadboard microchannel Printed Circuit Heat Exchanger (PCHE) design (left), and imaging of chemically etched zigzag microchannels in 100 µm thick stainless-steel shim (right) © TWI Ltd.

High-performance cooling technology for lunar applications

In 2024, Enovus Labs invented and patented Segri-COOL, a high-performance cooling technology designed for terrestrial and lunar applications. The company also created and patented the tool used to manufacture Segri-COOL. Enovus Labs plans to use Segri-COOL for terrestrial applications, with an initial focus on telecommunications and data centre cooling. Meanwhile in space, the Segri-COOL solution has been selected for a challenging deployment to the lunar south pole which is scheduled to launch in 2025.

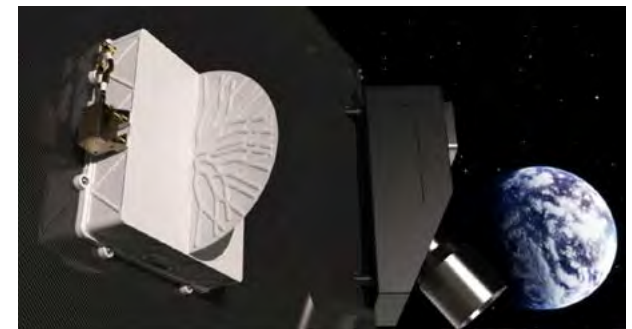


Figure 7: Segri-COOL radiator cooling an electronics box on the outside of a lunar lander located on the Moon © Enovus Labs Ltd.

STARLIGHT on... Réaltra Space Systems Engineering

Ariane's return to space captured in glorious HD

When ESA's Ariane 6 historic first mission successfully launched on 09 July 2024, the breathtaking footage of the Earth slowly disappearing beneath the rocket's flames was captured by Réaltra's cameras. The six Réaltra cameras onboard the rocket captured superb live footage from all phases of the launch, including the rocket booster, fairing and payload separations and the upper stage VINCI engine ignitions. The video images were broadcast in near real time to a global audience during the launch.



Figure 8: Ariane 6 rocket booster separation, captured by Réaltra's cameras onboard the launcher's maiden flight from Europe's Spaceport, Kourou, French Guiana © ESA/ ArianeSpace/Réaltra Space Systems Engineering

This wasn't the only Réaltra technology on board the Ariane 6, with the company's GNSS receiver telemetry system experiment payload providing precise location information for the rocket at all stages of the mission. This highly complex system was contracted, designed, manufactured and delivered in under a year.



Figure 9: Réaltra's Autonomous GNSS (Global Navigation Satellite System) flight system © Réaltra Space Systems Engineering

Ethernet in space

Also in 2024, Réaltra and Austrian partner TTTech Aerospace announced the development of a flexible ethernet switch that can be configured to enable standard electronics to communicate with the highly sensitive flight-critical communication networks of a launch vehicle. The modular system offers high-speed communication capabilities, precise synchronisation and fault tolerance for critical applications. The product aims to meet the requirements of the next generation of rocket launchers and satellites, reducing system complexity, integration and testing efforts.

Later in the year, Réaltra was recognised at ESA's Future Space Transportation Awards for its FIRST! Campaign proposal in the category for work that fosters disruptive technologies in avionics and guidance, navigation and control. Réaltra's proposal for expandable, affordable, modular time-triggered ethernet (TTE) solutions for space applications (ExAMpl) is a collaboration with Austrian based TTTech and space start-up SPiN (Space Products and Innovation). The project will commence in 2025.



Figure 10: Danny Gleeson (right; Chief Commercial Officer, Réaltra), receiving ESA's Future Space Transportation Award on behalf of Réaltra Space Systems Engineering (L-R: Thomas Maier (Senior Key Account Manager, TTTech), Stephane Dussy (Future Launchers Demonstrator Lead Project Engineer, ESA), Jonathan Rodgers (Project Manager, Réaltra)) © Réaltra Space Systems Engineering

Exo-Planet Discovery

Finally, Réaltra hit a milestone during the year when it completed the proto-flight model of its payload interface unit for ESA's ExoPlanet Finder mission (PLATO). The unit will provide high-stability, high-precision thermal control for the mission's telescopes and will be tested for space readiness and delivered in 2025.

2.0

Earth Observation, Ireland and the green agenda

The application of space technology to earthbound problems is perhaps best demonstrated in its role supporting climate action. Irish space-active companies are developing new solutions across a wide range of areas including biodiversity, carbon sequestration, climate adaptation and resilience, and wind farm siting.

How space data can support renewable energy development

Marine data specialist and Earth Observation (EO) data provider TechWorks Marine kicked off a new ESA project in 2024 aimed at expanding the use of satellite data in Europe's renewable wind energy sector. The overall goal is to develop a best practice guide for developers and operators to identify suitable sites for new wind farms by obtaining a deeper scientific understanding of the site conditions and to improve the accuracy of environmental compliance and monitoring activities. This will be achieved through strategic engagement with some of the largest wind farm developers and operators in the world, to build consensus on the way EO derived information products can and should be used in both the onshore and offshore wind sectors.

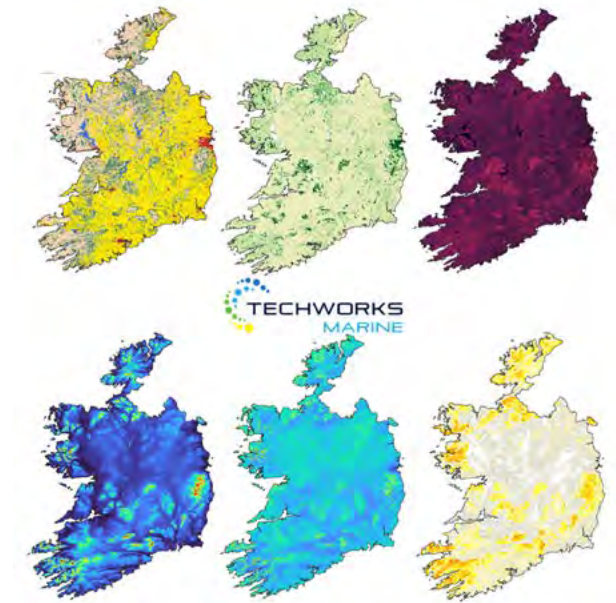


Figure 11: Satellite-derived datasets relevant to onshore wind farm site selection (left-to-right; land cover, roughness length, canopy height, elevation, wind speed at 100m, and slope). Data post-processing on imagery from Sentinel-1, Sentinel-2, Terra, Aqua, GEDI, GOES and METEOSTAT © TechWorks Marine Ltd.

Supporting high precision soil sampling

Agtech company Senus has integrated affordable, high precision GNSS hardware to improve the accuracy of its existing mobile apps for soil and habitat surveys. This will help meet the growing demand for very precise positioning in soil sampling, particularly for soil carbon programmes which require repeat measurements within one metre of previous samples.

The integration was carried out under Project EXACT, partly funded by ESA Spark. EXACT uses correction data streams from various sources, including Galileo's High Accuracy Service (HAS) via satellite, a dedicated private base station, or a commercial service over cellular networks. Additionally, the app provides real-time quality feedback and detects signs of interference. Formerly known as Farmeye, Sensus is also engaged in Project Purlieu to develop an affordable survey rig using LiDAR and cameras coupled with precision GNSS to accurately capture the structure and composition of hedgerows from the side view. An EO module follows up ground surveys with ongoing monitoring from space.

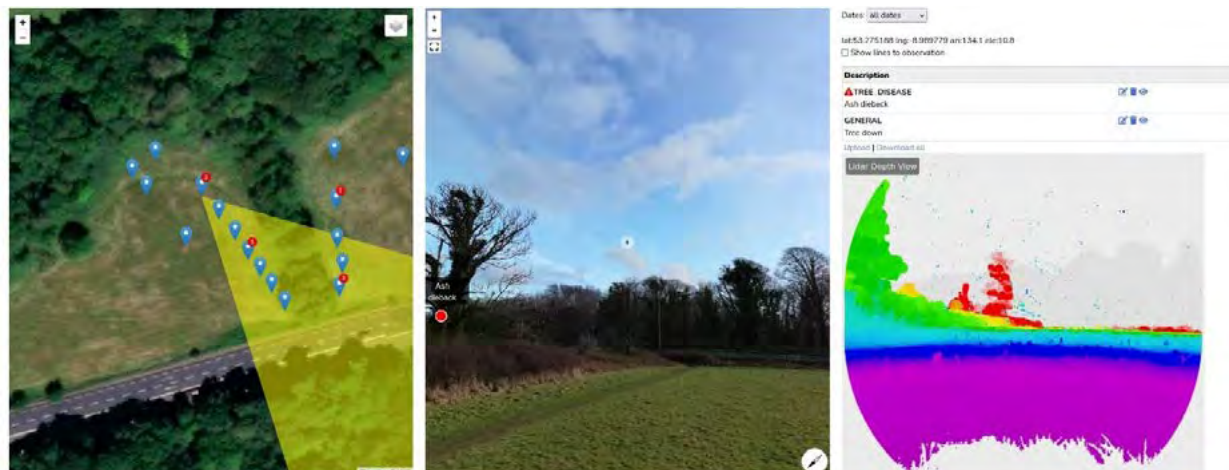


Figure 12: Purlieu (prototype) panorama visualization tool user interface, allowing virtual surveys: (left) points at which LiDAR and 360° RGB panorama images were captured (with corresponding LiDAR depth map (right), user can pan 360° and view/edit/add points of interest (middle) © Sensus

Mitigating and counteracting harsher flood conditions

In 2024, marine and EO data specialist, TechWorks Marine, launched a powerful new flood mapping programme, capable of spatial mapping any river or surface flooding in Ireland where there is a close Sentinel satellite overpass. EO satellites, in this case from ESA's Copernicus Sentinel Programme, can be used to provide valuable information on the spatial extent of floods, and how urban and rural population centres can be affected. Aided by machine learning, the now ten-year-old historical archive of Sentinel EO data can also reveal new insights on recurring flooding. The company is now working with Government agencies responsible for flood management to build advanced tools to plan, mitigate and counteract the harsher flood conditions and impacts expected in a warmer climate.

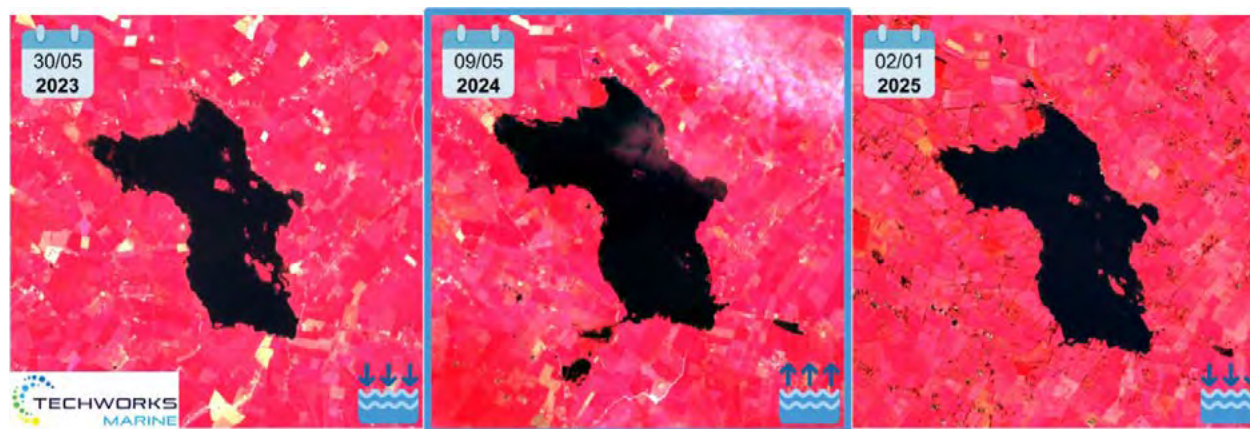


Figure 13: Modified false colour Sentinel-2 imagery showing the changing shoreline of Lough Funshinagh, as part of the CAMEO Earth Observation Platform project © TechWorks Marine Ltd.

Enabling biodiversity credit issuance

Cork-based Treemetrics, a global pioneer in forestry technology, and Qarlbo Biodiversity, a Swedish-based international specialist in biodiversity credit methodologies, have established a strategic partnership to develop a software solution for monitoring, reporting, and verifying biodiversity in forest landscapes, crucial for issuing biodiversity credits. The new tool will merge Treemetrics' forest management and remote sensing expertise with Qarlbo's proven methodologies and will utilise mobile apps, remote sensing, data mining, and satellite communications.

Using geospatial analysis and EO to accelerate climate action

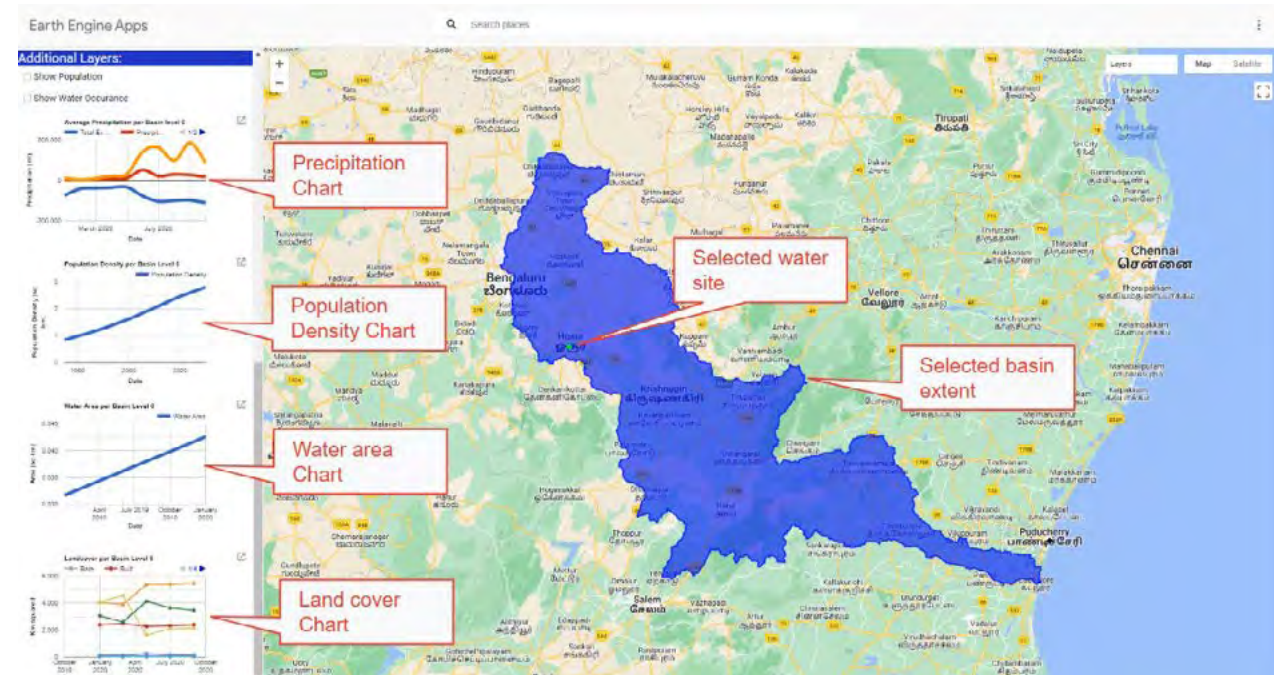


Figure 14: Lightweight Water Stewardship Google Earth Engine application developed by NGIS EU © NGIS EU

Dublin-based geospatial technology firm NGIS EU partnered with a consumer goods company to develop a water stewardship tool to help it achieve sustainability goals across its global manufacturing operations. The Google Earth Engine app developed by NGIS consolidates internal data on water consumption and production volumes with geospatial data from sources such as the World Resource Institute – these include basin levels, precipitation, water stress indicators and other factors.

This enabled the company to monitor the impact of ongoing water conservation initiatives and plan new ones, ensuring efficient resource allocation and maximising positive environmental impact. The company aims to implement water stewardship programmes in 100 highly water-stressed areas by 2030 and collaborate in those regions to address shared water challenges. The app's success has led to a second phase which will migrate the functionality to a bespoke solution integrated with the company's wider sustainability commitments.

Geoportal transforms hazard monitoring in Nepal

Mallon Technology, an Irish geospatial solutions provider, has successfully delivered an ESA Earth Observation Clinic project as part of a wider consortium with e-GEOS, Ithaca Srl and ICube-SERTIT. The project aims to mitigate climate change risks in Nepal's Hindu Kush Himalaya region. Using EO satellite data, the project conducted a comprehensive analysis of multi-hazard risks, including landslides, floods, and glacial lake outbursts. The results will support the Nepalese government in enhancing risk assessments across key river basins. Mallon Technology developed a geoportal for the project, built on its Azimap mapping software. This platform allows users to navigate and visualise EO data outputs, print maps, and analyse historical subsidence trends in the region.

Combining satellite imagery with AI and ground instruments to measure carbon emissions

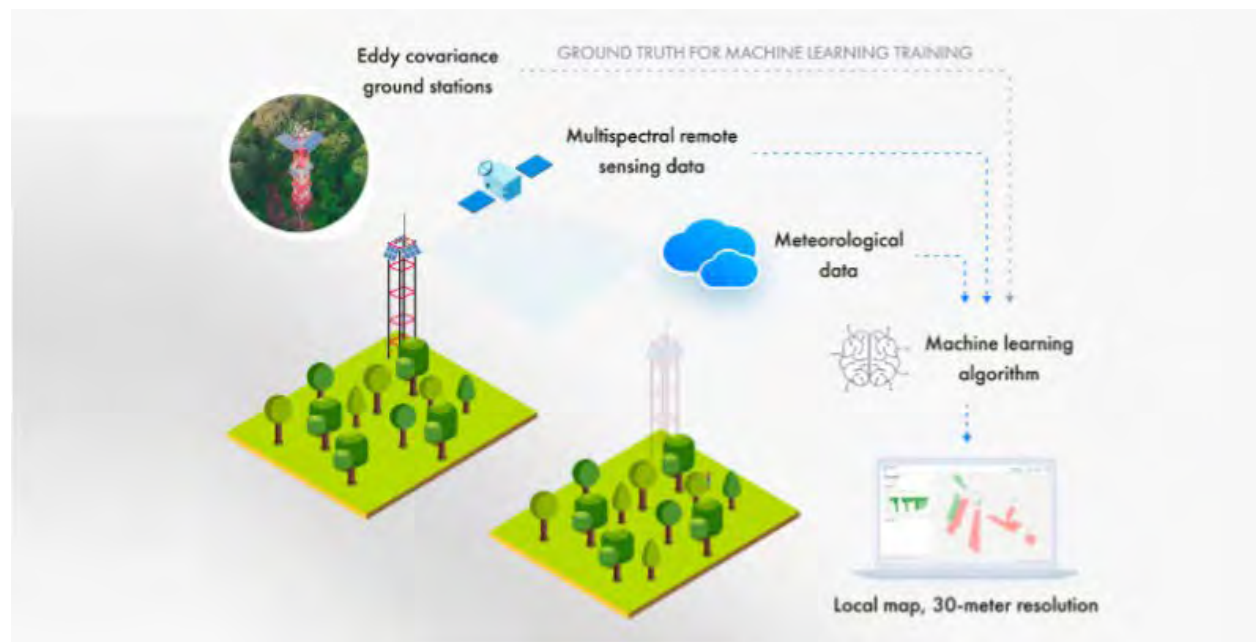


Figure 15: Schematic of CarbonSpace precision carbon monitoring, reporting and verification platform © CarbonSpace

Dublin-based CarbonSpace has developed a first of its kind artificial intelligence / machine learning-based methodology for estimating sequestration or emission of CO₂ in local ecosystems, including agricultural and natural land. The methodology uses a global network of ground gas measurement stations to calibrate measurements, while satellite imagery is used to generate sequestration or emission estimates across broad geographical regions.

The methodology is the first to provide this kind of CO₂ measurement at such high spatial (30m) and temporal (daily) resolution. The approach can combine satellite imagery from multiple satellite sources and instrument modalities, including multispectral and radar data, leading to improved accuracies. An ISO-certified version of the methodology was deployed commercially in 2024 and used in nature-based solution (NBS) projects and food and beverage supply chain monitoring across various geographies.

Supporting the archiving, exchange, and validation of satellite atmospheric products

The Irish Centre for High-End Computing (ICHEC), based at the University of Galway, provides the hardware and software infrastructure that underpins ESA Validation Data Centre (EVDC) services for European users. EVDC is an online platform that supports the archiving and exchange of correlative data used to validate atmospheric products generated by satellite platforms. These atmospheric products encompass a wide range of data on atmospheric conditions produced by satellite sensors.

EVDC serves an international community of scientists and provides registered users with access to an online interface of tools for atmospheric data processing (HARP), as well as high-performance computing capabilities, including bulk processing and scheduled processing.

Infrastructure provided by ICHEC includes systems for data storage, access, processing and analysis.

This ESA-funded initiative is led by Skytek and delivered in collaboration with international partners: NILU (The climate and environmental research institute in Norway), RHEA System S.p.A (Belgium), and BC Scientific Consulting LLC (USA).

Bringing trust and confidence to nature-based solutions



Figure 16: Proveye's platform for digital-Monitoring Reporting and Verification (d-MRV) deployed in rangelands in Kenya and Ethiopia © Proveye

In October 2024, Proveye was awarded a contract from ESA under the ARTES Business Applications and Space Solutions Programme to further develop its innovative remote sensing platform for the continuous measurement and monitoring of carbon sequestration and habitat restoration in the world's grasslands. The solution delivers trusted empirical evidence to verify activities and targets to create high-integrity nature-based credits that support farmers, project owners, buyers of carbon credits, natural capital investors, food processors and insurance firms.

In 2024, Proveye was selected as one of 15 global start-ups chosen from over 800 applicants across more than 70 countries for the Amazon Web Services (AWS) Clean Energy Accelerator. As part of the programme, Proveye will connect and collaborate with AWS enterprise customers to test and deploy its solution at scale.

Agriculture monitoring solution takes top award

The Department of Agriculture, Food and the Marine (DAFM) Area Monitoring System (AMS) won the Data Innovation Project of the Year award at the 2024 Public Sector Digital Transformation Awards. Developed by Compass Informatics in partnership with NEO BV Netherlands and EOX IT Services GmbH, the AMS uses geospatial technologies EO applications to continuously monitor c.46,000 km² of agricultural farmland and provides near-real time monitoring services for agriculture in Ireland. Machine learning algorithms combine scientifically validated input data with satellite imagery to identify patterns and assess satellite imagery for all kinds of agricultural activity. Benefits include reduced on-farm inspections, warning alerts to minimise non-compliance, and expanded monitoring capacity.



Figure 17: Compass Informatics at the PSDTA 2024 'Public Sector Digital Transformation Awards (L-R: Raghall O'Donoghue, Walter French, Vivienne Kelly, Phil Baldacchino Steward, Karen Pun, Rob O'Loughlin, Tara Sweeney, Eldar Baykiev, Paulina Furmaniak, Nick Andrews) © Compass Informatics

3.0

Navigation solutions powered from space

Millimetres count in space despite the vast distances involved. Even the slightest positioning error can fatally undermine a mission. Irish companies are at the forefront of this critically important area of space technology.

Precise positioning to unlock the secrets of the sun

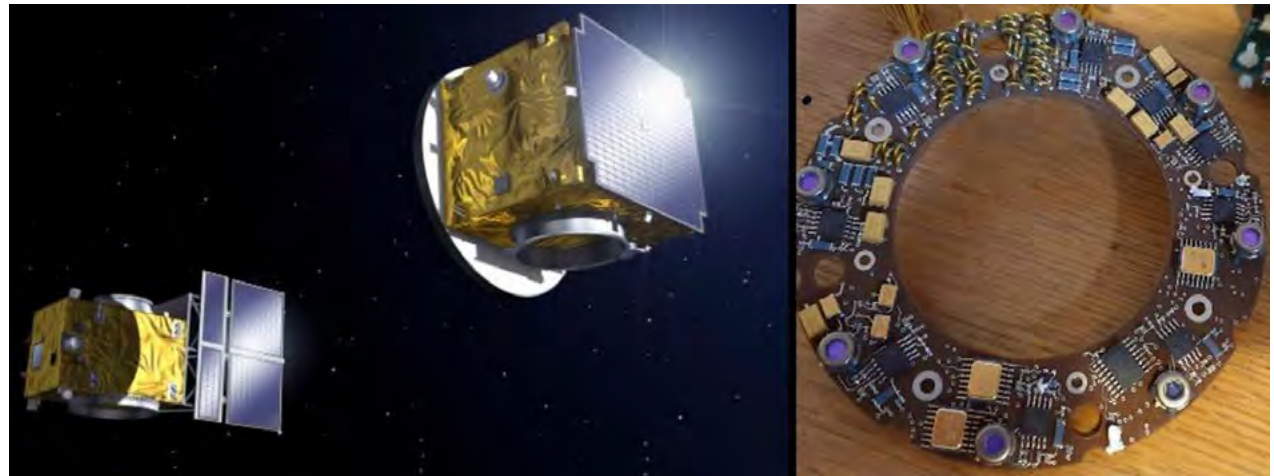


Figure 18: (left) Two spacecraft, Coronagraph and Occulter, align to create an eclipse; the SPS (Shadow Position Sensor) comprises of two sets of four onsemi SiPMs (one set as backup) and associated readout electronics. (right) onsemi's silicon photomultipliers (SiPMs) © ESA, onsemi

Silicon photomultipliers (SiPMs) developed by onsemi in Cork are helping the ESA Proba-3 space mission to unlock the secrets of the sun. The mission, which lifted off from the Satish Dhawan Space Centre in Sriharikota, India in December 2024, involves two satellites orbiting in close formation 150 metres apart, with one – the Occulter – containing a disc to create an artificial eclipse of the sun, and the other – the Coronagraph – containing a camera to capture images of the sun's corona and other data.

Housed in the camera of the Coronagraph satellite, four onsemi SiPMs measure the precise position of both satellites, enabling them to maintain formation down to a single millimetre for up to six hours at a time. The setup can create an almost perfect eclipse on demand, providing unprecedented observations of the sun's corona and its phenomena.

Figure 20: A resulting coherent radar detection image without the use of satellite navigation © Provizio

Space-tech enabled irrefutable audit trail for hazardous materials transport and storage

October 2024 saw the start of Transparency TrailBlazer – Superfy’s first project with ESA – featuring next generation anti-jamming and anti-spoofing GNSS technology, to deliver a digitally signed and authenticated end-to-end audit trail for the storage and transport of hazardous materials. TrailBlazer harnesses the power of Open Service Navigation Message Authentication, a data authentication function for the Galileo Open Service from NAVISP, to deliver an irrefutable audit trail. This is ideally suited to companies involved in the storage and transport of controlled or dangerous materials and is a cost-effective solution for manufacturers involved in the storage and transport of materials covered by the Corporate Sustainability Due Diligence Directive.



Figure 21: Transparency TrailBlazer in action – a typical deployment © Superfy



Figure 22: Transparent GNSS Taoglas antenna © Taoglas

Novel solution to satellite connectivity challenges in cars

Non-Terrestrial Networks (NTN) connectivity in automotive applications enhances vehicle communication by integrating satellite networks with terrestrial networks. This hybrid approach ensures seamless connectivity, even in remote areas where traditional networks are unavailable. However, current car design trends make extensive use of panoramic windows and roofs which leave little space to accommodate antennas.

Irish company Taoglas, with ESA support, is developing a possible solution in the form of a transparent distributed antenna which can be integrated into the glass. In addition, Taoglas was the winner of the 2024 Elektra Awards “Excellence in Product Design (High-Reliability Systems)” category for the design of its ultra-low-profile patch-in-a-patch antenna Inception, funded under the ESA NAVISP Programme. Inception is the first of its kind and allows users to move to dual band without changing the footprint, size, or height of their current single band GNSS antenna.

STARLIGHT on... Ubotica Technologies

Ground-breaking CogniSAT-6 mission successfully launched

2024 was an exceptionally busy year for Dublin-based Ubotica Technologies, with the highlight undoubtedly being the launch of the company's CogniSAT-6 satellite. Launched aboard SpaceX's Transporter-10, this was the first ever satellite with commercial backing from an Irish company. The launch was a significant step forward for Ubotica and its goal of revolutionising EO with AI-powered intelligence and real-time communications, delivering live Earth intelligence directly to users.



Figure 23: L-R: Aubrey Dunne (CTO) and David Rijlaarsdam (Director, Space System Engineering) at the 05 March launch of CogniSAT-6 on SpaceX's Transporter-10 at Vandenberg Space Force Base, California, USA © Ubotica

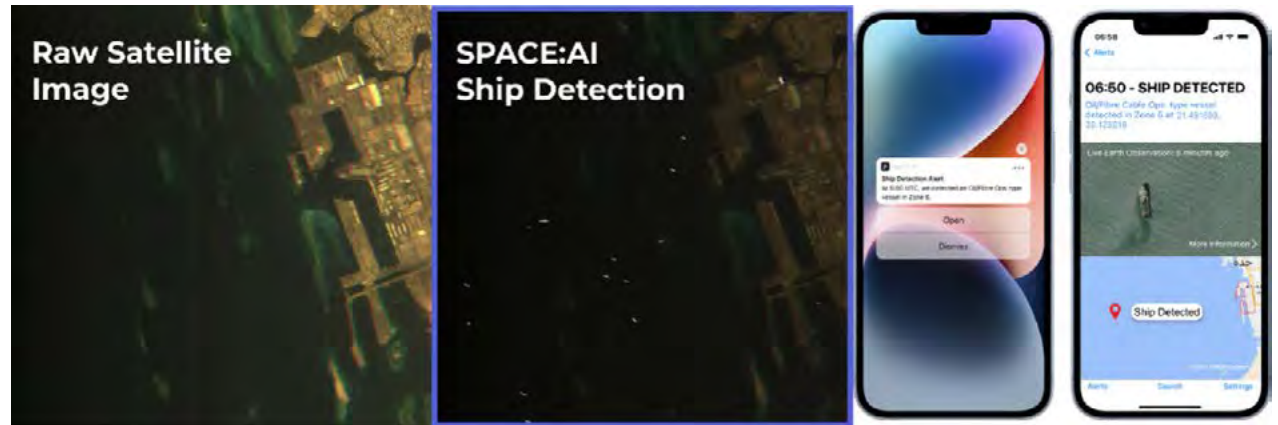


Figure 24: SPACE:AI detects and classifies all vessels near a port in 90 seconds, instantly relaying intelligence to users for real-time interaction © Ubotica

Unlike traditional EO methods, which are slow, expensive, and require all data to be downloaded to ground stations for processing that takes days, CogniSAT-6 delivers real-time insights, sending only actionable data to end users within minutes. This capability could have an important impact on climate change monitoring and security threats in the future.

CogniSAT-6 has the potential to transform numerous sectors, including precision agriculture (real-time crop insights for optimised irrigation and yields), disaster response (instant flood, wildfire, and crisis monitoring), maritime security (AI-powered vessel tracking and illegal fishing detection), energy infrastructure (monitoring pipelines, power grids, and renewables) and security monitoring (real-time threat detection and border surveillance).

NASA's Jet Propulsion Laboratory (JPL) has deployed 20 advanced AI applications on CogniSAT-6, eliminating bottlenecks associated with traditional systems and unlocking real-time insights. Ubotica and NASA JPL have collaborated for several years on AI-driven EI projects.

Fintan Buckley, CEO of Ubotica, said "AI is already reshaping life on Earth, and with SPACE:AI, we're extending that intelligence into orbit. CogniSAT-6 isn't just capturing images – it's analysing and delivering critical insights in real time, making live Earth intelligence a reality. CogniSAT-6's success would not have been possible without the unwavering support of both ESA and Enterprise Ireland."

Ubotica is also driving AI innovation in space through a number of major European research initiatives. In May, the company was selected by the European Commission for the ARCHYTAS project to develop AI accelerators for autonomous satellite collaboration. In June, it joined the EU Horizon Europe-funded MESEO project, alongside Space Primes GMV and Airbus, to enhance EO by pioneering multi-modal AI for interpreting diverse spaceborne data. Additionally, through the AGRARIAN project, Ubotica is advancing AI-powered precision agriculture to optimise crop health monitoring and yield prediction.

Finally, as a member of the DTIF-supported National Space Subsystems and Payloads Initiative (NSSPI), the company is continuing to develop cutting-edge on-orbit AI solutions to make space assets smarter, faster and more autonomous.



Figure 25: Aubrey Dunne (CTO), Fintan Buckley (CEO) and John Bourke (CFO) with a satellite model of CogniSAT-6 © Fergal Phillips

4.0

Irish companies connecting satellite communications systems

The ability of satellites and spacecraft to send data back to Earth is at the heart of the space industry. Irish companies are developing new technologies to enhance the speed, efficiency and quality of space communications.



Figure 26: O.C.E. Technology's software used for high accuracy GNSS positioning application © Romanian InSpace Engineering S.R.L.

Adding reliability to commercial components in space

NovaUCD-based O.C.E. Technology's new multicore operating system for space-grade processors incorporates a policing system for high-reliability applications to detect anomalous behaviour prior to a failure, thus allowing the application to take corrective and avoidance actions. In 2024, O.C.E. completed a successful design review with ESA for the new operating system. Microchip Technology Inc's Dublin-based development group participated in the project, ensuring that the operating system met customer expectations.

In addition, Réaltra Space Systems Engineering and O.C.E. started a development with Viasat Inc to deliver a terminal controller for Viasat's proposed constellation of optical communication satellites. O.C.E.'s multicore operating system will provide the high reliability software base. O.C.E. has also started a collaboration with the University of Ulster on the implementation of space grade firmware updates and the use of embedded artificial nervous systems for autonomous electronics fault tolerance.

Delivering spectral purity for space communications

Advanced laser diode manufacturer Eblana Photonics was awarded European Innovation Council funding in 2024 under the Mengine project to develop pure light at 1560nm. Eblana Photonics' core activity is to develop high power (~200mW) single frequency etched facet DFB laser diodes that are then micro transfer printed to silicon photonic integrated circuits to improve the spectral purity of the emitted light. Space-prominent applications for the photonic integrated circuits include satellite-to-satellite optical communications and quantum sensors at wavelengths of 780 nm.

NSC Ltd. growth rockets with new ground stations

The National Space Centre (NSC) Ltd. brought 15 new ground stations online for an expanded, multinational client portfolio during 2024. In addition, the company secured initial finance through crowdfunding for the preservation and re-purposing of The Big Dish, Ireland's landmark 32 metre antenna at Elfordstown Earthstation, for the developing market in deep space communications. This will help mitigate the sector's projected 65% shortfall in antenna capacity, as predicted by ESA. The company also launched the NSC Space Academy to deliver industry training and continuing professional development courses focused on the integration of space technologies into terrestrial use cases.



Figure 27: National Space Centre Ltd's 'Big Dish' received the first phase of remediation for preservation and re-purposing for a new future in Deep Space Communications © NSC Ltd.

Enhancing inter-planetary communications

New technology developed by Irish space communications specialist Zelinda will allow deep space probes to more than double the rate of data they can transmit. The company's broadband speed software demodulator has been integrated by Italian partners ArpSoft S.r.l into a receiver system that can combine signals from two or more ground stations.

The finished system has been installed in ESA's European Space Operations Centre (ESOC) in Darmstadt, Germany on a cluster of workstations. As well as the ability to combine signals recorded at any of ESA's four deep space ground stations, the system includes advanced turbo decoders capable of correcting any errors in the extremely weak signal from deep space probes which – in the case of Mars – can be more than 300 million km from Earth.

Assessing the suitability of RF MEMS for space

In 2024, Tyndall National Institute, in collaboration with ESA and Analog Devices Inc. (ADI), launched a project to assess the suitability of ADI's Radio-Frequency MicroElectroMechanical Switch (RF MEMS) technology for space applications. RF MEMS technology offers high performance, low power consumption and compact form factors, making it well-suited for redundancy switching as well as emerging Low Earth Orbit (LEO) SatCom applications. The design, development and manufacture of ADI's RF MEMS switches is carried out at their European regional headquarters in Limerick. The test campaign aims to provide the necessary assurance for the switches to operate in space environments, a critical first step toward industry adoption. It is hoped that this initiative will open new market opportunities for ADI's MEMS switch technology in satellite communications.

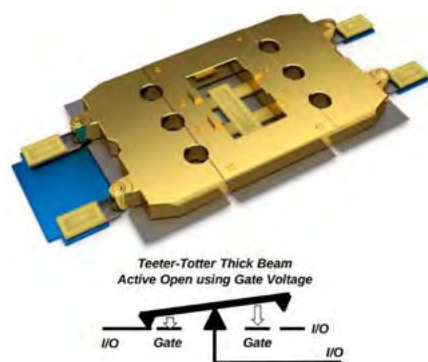


Figure 28: ADI's Gen 2 MEMS switch employs a see-saw motion and two gates for enhanced reliability © Analog Devices Inc. (ADI)



Figure 29: ST Engineering iDirect's ESA-funded COSMOS project contributed to their New Space, New Ground, Global Telecom and Cloud convergence vision for their Intuition platform © ST Engineering iDirect

Building next-gen multi-orbit satellite ground systems

Satellite communications pioneer ST Engineering iDirect's ESA-funded COSMOS (Communication System for Multi Orbit Satellite) ground segment project is focused on developing a multi-orbit satellite system. It provides valuable insights and de-risks key capabilities, including support for multi-orbit satellite systems, ensuring continued service during satellite handovers within the same constellation using make-before-break (MBB) functionality.

The project also supported high throughput and high-speed ground segment requirements for the latest high throughput satellites (HTS). Successfully completed in 2024, the COSMOS project provided valuable insights and de-risking for adding multi-orbit support to ST Engineering iDirect's Intuition product.

Irish space tech innovator opens door to 6G

Millimetre wave solutions provider Celtonn has secured a two-year contract from ESA which will see it develop a high linearity, low noise amplifier for V-Band uplink for satellite communications payloads. This will help to unlock the bandwidth required to handle the vast quantities of data involved in the evolution to 6G communications. In 2024, the company was selected to present its technology to CERN as part of Ireland's successful application to become an active member.



Figure 30: Aoife Kelly, Mark Kelly and Marie Bourke, founders of Celtonn at the company's Millimeter Wave Lab, Nexus Innovation Centre, Limerick © Arthur Ellis / Business Post

STARLIGHT on... MBRYONICS

Advancing space communication and quantum innovation

MBRYONICS continued to support the development of Ireland's space industry throughout 2024. By forming strategic partnerships with ESA, Horizon Europe and the European Innovation Council (EIC), the company demonstrated its commitment to fostering innovation and growth within the sector.

A key milestone was reached when the company was approved for an EIC Accelerator investment which will support the establishment of a significant manufacturing, assembly and testing facility for optics and photonics in the west of Ireland over course of the next five years. The MBRYONICS team worked closely with the EIC National Contact Point (NCP) team within Enterprise Ireland to secure the investment.



Figure 31: (L-R) Leo Clancy (CEO, Enterprise Ireland), John Mackey (CEO, MBRYONICS), Neale Richmond (Minister of State for Business, Employment and Retail, DETE) © Damien Eagers / Coalesce

Another notable highlight of the year was the continued development of MBRYONICS' flagship product, STARCOM, which offers advanced optical inter-satellite links and Earth links. In addition, the company secured ESA funding for the development of optical communication technologies, including progress towards deploying space-based quantum key links. These achievements, along with the successful completion of several commercial contracts, have helped to bolster Ireland's overall presence in the global space market.



Figure 32: MBRYONICS' flagship STARCOM product, offering cutting-edge optical inter-satellite links and Earth links © MBRYONICS

Another standout moment during the year saw MBRYONICS founders John Mackey (CEO), Ruth Mackey (CSO/COO) and David Mackey (CTO) being honoured with the prestigious title of 2024 EY Established Entrepreneurs of the Year.

The company's strong emphasis on collaboration has led to active engagement with industry, government and academia, creating new opportunities for MBRYONICS and has helped to position Ireland as a leader in the space industry. While the company's main focus continues to be on the development of its STARCOM product and optical communication technologies capabilities, MBRYONICS maintains its strong commitment to making a positive contribution to Ireland's future in space exploration, quantum communication and space technology development.



Figure 33: (L-R) John, Ruth and David Mackey of MBRYONICS; winners of the Established category at the EY Entrepreneur of The Year awards 2024 © MBRYONICS

5.0

Supporting the next generation of space start-ups in Ireland

Through Department of Enterprise, Trade and Employment (DETE) funding of both ESA and Enterprise Ireland, Irish start-up companies have access to the ESA Business Incubation Centre (ESA BIC). ESA BIC Ireland is managed by ESA Space Solutions Ireland (SSI) and comprises seven consortium partners – Tyndall National Institute (Lead Partner), Atlantic Technological University, Dublin City University, Maynooth University, Munster Technological University, Technological University of the Shannon and University College Dublin (UCD).

ESA BIC Ireland is part of a network of 32 ESA BICs operating across 23 ESA Member States, which were established to empower entrepreneurship and to allow local economies to benefit from space data, technologies and assets.

ESA BIC Ireland is a two-year business incubation initiative supporting high potential start-up companies that are developing a broad range of applications across the business spectrum including agritech, medical device, health and wellness, materials science, semiconductor, cybersecurity, disability support, carbon capture, sports performance and micromobility.

The centre offers technical, business and financial supports, as well as national and international networking opportunities to start-ups that have a connection with space, and which are developing either upstream or downstream applications. Incubation space is also made available at each of the consortium partner locations, thereby providing an immersive and experiential environment for founders in which to grow and scale their respective companies.

The primary supports are delivered through the provision of a structured dual-incubation model (physical or remote incubation) that includes financial supports (up to €50,000) and technical support through ESA and the consortium partners.

ESA SSI also offers ESA Spark Funding, a technology transfer funding mechanism that is designed to accelerate product development in companies that are integrating space technology with a view to developing a new market application. ESA Spark Funding provides €40,000 to companies for eligible projects that have a maximum duration of 12 months.



Figure 34: Attendees at ESA BIC Ireland National Networking Events in May at Kilkea Castle, Co. Kildare © Space Solutions Ireland

In 2024, the ESA BIC Ireland consortium expanded significantly with the addition of Atlantic Technological University, Dublin City University and Munster Technological University, doubling the number of incubation locations available to prospective space start-ups in Ireland to ten.

ESA BIC Ireland hosted two well-attended National Networking Events in 2024, both of which took place at Kilkea Castle, Co Kildare and included presentations from Luis Escudero (Technology Disruptors Manager, Directorate of Space Transportation, ESA) and Cornelius Zünd (Industrial Policy Officer, ESA).

Incubation contracts were executed with three start-up companies during the reporting year: Biota MRV, PicoGlaze and Tao Climate. In addition, six companies were selected for ESA BIC Ireland during 2024.

6.0

Space-related
Irish events
during 2024

Figure 35: The Irish LOFAR radio telescope at Birr Castle Demesne © Alison Delaney/Birr Castle Demesne

LOFAR European Research Infrastructure Consortium launched

The Low Frequency Array European Research Infrastructure Consortium (LOFAR ERIC) was officially launched at its first council meeting in January 2024. The LOFAR research infrastructure is revolutionising low-frequency radio astronomy research, resulting in multiple scientific publications in recent years.

LOFAR ERIC's founding members include Bulgaria, Germany, Ireland, Italy, the Netherlands, and Poland. The Irish LOFAR Consortium, chaired by Prof Peter Gallagher, includes DIAS, TCD, UCC, UG, DCU, UCD, TUS and Armagh Observatory and is supported by Research Ireland and the Department of Further and Higher Education, Research, Innovation and Science (DFHERIS).

Royal Astronomical Society honorary fellowship awarded to Irish researcher

Also in January, Prof Cairtriona Jackman of Dublin Institute for Advanced Studies (DIAS) was awarded an honorary fellowship by the Royal Astronomical Society for her outstanding service and leadership of planetary magnetospheric physics in Ireland, the UK and internationally – only the second Irish-based scientist to receive this honour. Prof Jackman has an extensive track record of leadership in the analysis of data from scientific missions across the solar system, including Cassini, MESSENGER and Juno and is currently a valued member of the Solar System Exploration Working Group within ESA. She founded the DIAS planetary magnetospheres group in 2020. This is now firmly established as a world-leading research team in its field.

ESA Director of Science visits Ireland

February saw the official visit to Ireland of Director of the ESA Science Programme (D/SCI) Prof Carole Mundell. The visit was organised by Irish Delegate to ESA (Padraig Doolan), UCD (Lorraine Hanlon) and Dublin Institute for Advanced Studies (Cairtriona Jackman) and hosted at DIAS Dunsink Observatory.



Figure 36: Prof. Carole Mundell (D/SCI, ESA) speaking with Prof. Peter Gallagher (DIAS) at Dunsink Observatory (top), D/SCI visit group photo outside the Main building, Dunsink Observatory (bottom) © Enterprise Ireland

Prof Mundell travelled with a senior Executive team from ESA to meet with multiple research groups from across the island of Ireland, covering topics as diverse as fundamental physics, galaxies and cosmology, heliophysics, planetary science, star formation & exoplanets and stars & stellar evolution, as well as the successful launch of Ireland's first satellite, EIRSAT-1. Around 40 senior Irish space-active scientists were given the opportunity to pitch their research to Prof Mundell and the ESA Science team.

Navigation workshop in cooperation with ESA at Enterprise Ireland HQ

Also in February, Enterprise Ireland welcomed over 50 participants to a navigation workshop at EastPoint HQ in Dublin which outlined the NAVISP (Navigation Innovation Support Programme) Element 1 workplan and Element 2 programme which address challenges in positioning, navigation and timing. Practical opportunities for the research community and industry were also highlighted. Institutional presentations were made by ESA, the Irish delegation to ESA and the SFI CONNECT Centre, as well as by danalto and Timing Solutions.



Figure 37: (top) Participants at the 2024 NAVISP (Navigation Innovation Support Programme) workshop, (bottom) NAVISP logo on display at Enterprise Ireland HQ © Enterprise Ireland, ESA

Irish delegation attends Paris Space Week

In March, a number of Irish Space companies, together with representatives from Enterprise Ireland, the Irish delegation to ESA and the Irish Space Association (ISA) paid a visit ArianeSpace and CNES (Centre National d'Études Spatiales; the French Space Agency) during Paris Space Week.



Figure 38: Representatives of Irish Space companies, IE Delegation to ESA, Irish Space Association (ISA), Enterprise Ireland and the Irish Govt. visiting ArianeSpace (left) and CNES (right) during Paris Space Week © ArianeGroup Holding (left), Enterprise Ireland (right)

The visits were organised by Enterprise Ireland's overseas French Office and the Embassy of Ireland in France (Ambassade d'Irlande en France).

Companies attending represented a broad swathe from Ireland's rapidly growing space sector, including MBRYONICS, O.C.E. Technology, Plasma Bound, PPI Adhesive Products and Réaltra Space Systems Engineering.

Ireland progresses Associate Membership of CERN

During 2024, Ireland made substantial progress towards becoming an Associate Member State of the European Organisation for Nuclear Research, CERN. A CERN Taskforce visited Ireland in April and met with Enterprise Ireland, IDA Ireland, and representatives of the Irish Space Association. The CERN Council approved Ireland's application in principle in December 2024. Associate Membership will open doors for Irish companies to compete for CERN contracts and to engage more deeply with its knowledge transfer programmes. It is expected that Ireland will join CERN in early 2026.



Figure 39: Compact Muon Solenoid (CMS) detector; one of two large general-purpose particle physics detectors built on the Large Hadron Collider (LHC) at CERN © Maximilien Brice, CERN

EUSPA delegation visits Dublin

In April, Rodrigo da Costa (Executive Director at EUSPA – EU Agency for the Space Programme) and Christina Giannopapa (Head of the Office of the Executive Director, EUSPA) paid an official visit to Ireland. The EUSPA team's morning meeting was hosted by Ethna Brogan (Director General of Civil Aviation) and Adam Monaghan (Department of Transport) and Niall Bolger (IE Delegation to ESA, Enterprise Ireland), and attended by representatives from various ministries. Discussions focused on key topics including Ireland's role in hosting an EGNOS (European Geostationary Navigation Overlay Service) facility and EGNOS V3 progress, as well as on EU Space initiatives transforming transportation and agriculture, highlighting opportunities like Horizon Europe, CASSINI and the EU Space Academy for SMEs.

In the afternoon, the EUSPA team attended the Transport Research Arena (TRA) event in Dublin, where Rodrigo emphasised EU space benefits for sustainable transport – specifically how Galileo and EGNOS support route optimisation, reduced fuel consumption and improved fleet management, while Copernicus data provides insights into road and railway conditions and weather.



Figure 40: Rodrigo da Costa (Executive Director, EUSPA) speaks at Transport Research Arena (TRA) event in RDS, Dublin © EUSPA

EU Competitiveness Council (Space)

Two meetings of the EU Competitiveness Council (Space) were held during 2024. At the May meeting, Ministers engaged in a policy debate on the proposed EU Space law while ESA's DG Josef Aschbacher gave a presentation on accelerating the use of space in Europe. A Joint EU-ESA Space Council meeting was held after the meeting where the discussion focussed on strengthening Europe's competitiveness through space.

At the November meeting, Ministers approved two sets of conclusions, one on "reinforcing European competencies in the space sector" and the other on "the interim evaluation of the EU's space programme". Ministers also held a policy debate on the future of the EU's space policy and defence synergies with a civilian space programme.

NOAA space weather scales workshop



Figure 41: Revising NOAA Space Weather Scales Workshop (Dublin, 24-25 June 2024) highlighting that space weather can impact many technologies on which society depends © NOAA

DIAS hosted a workshop on the scales used in space weather monitoring and forecasting with the US National Oceanic and Atmospheric Administration (NOAA) Space Weather Prediction Center (SWPC) in Dublin in June. The SWPC scales are the primary resource for space weather users, with over 86,000 subscribers worldwide. Space weather capabilities and users' needs have evolved since the scales were introduced in 1999. As such, NOAA has been seeking feedback on the scales to make them more valuable for users across the world and held workshops in the US, Asia and Europe in 2024.

The event was co-organised by the Assistant Director for Space Policy at the White House Office of Science and Technology Policy (Jinni Meehan) and Program Coordinator at NOAA (Bill Murtagh).

NASA Group Achievement Award for SunPy team



Figure 42: NASA Group Achievement Award for the SunPy Development Team © SunPy

The SunPy Development Team, which includes DIAS staff members, was presented with a NASA Group Achievement Award in June 2024. SunPy is a community-developed, free and open-source software package for solar physics data analysis. It aims to be a comprehensive software environment that allows solar physics researchers to carry out data analysis tasks with minimal effort.

The award was given to the team for “developing and continually improving free and reliable open-source software that supports NASA missions and the analysis of NASA’s vast archives of solar physics data”. DIAS is a co-investigator for the ESA/NASA Solar Orbiter mission and a key player in the development of software for the mission using SunPy.

Irish firms help restore Europe’s access to space

Europe’s sovereign access to space was restored in July 2024 with the successful launch of ESA’s new heavy-lift launcher, Ariane 6, from Europe’s Spaceport in French Guiana. The launch was a truly collaborative effort, involving Irish, French and international partners. Enterprise Ireland and IDA Ireland client companies were involved in ensuring a successful outcome. Nammo Ireland provided the structural supports that scaffold and connect the Core Stage Vulcain 2.1 engine and the Upper Stage Vinci engine. Réaltra Space Systems Engineering provided the video telemetry system, which captured the exciting images of the launch, as well as a new GNSS telemetry system for navigation.

The launch was celebrated at an event at DIAS, Dunsink Observatory, which was attended by many members of the Irish space community including Réaltra and Nammo, colleagues from DETE, Expertise France, as well as the Ambassador of France to Ireland, H.E. Vincent Guérend and his team from the Embassy of France in Ireland.



Figure 43: Attendees at Ariane 6 launch party at DIAS on 09 July. (L-R: Emma Jane Morgan (DETE), Danny Gleeson (Réaltra), Julia O'Malley (Head, IE Delegation to ESA), Padraig Doolan (National Delegate to ESA), H.E. Vincent Guérend (Ambassador of France to Ireland), Peter Gallagher (DIAS) © Réaltra Space Systems Engineering

Destination Earth workshop

In July, a Destination Earth (DestinE) workshop was held at Enterprise Ireland's offices in EastPoint Business Park. Destination Earth (DestinE) is a European Commission initiative to create a highly accurate digital twin of the Earth system. The project uses advanced technologies like AI, data analytics and high-performance computing to model natural phenomena and human impacts on climate change. It helps policymakers and researchers design effective climate strategies and supports the EU's goal of carbon neutrality by 2050.

The workshop featured presentations from ESA and the DestinE National Coordination Group followed by a question and answer session and bilateral discussions. The main topic under discussion was the DestinE Core Service Platform, a secure cloud-based platform for accessing DestinE data and services and offering tools for evidence-based decision-making, allowing users to customise and integrate their own data. The platform relies on comprehensive and sophisticated space-based observation data, including data from ESA's Earth Explorers, the Copernicus Sentinel series, meteorological missions and additional EO satellites.



Figure 44: Eric Monjoux (ESA's Destination Earth Project Manager) presents developments in the Destination Earth ecosystem at the July DestinE workshop at Enterprise Ireland's offices © Enterprise Ireland

15th International LISA Symposium

The Relativity Group at UCD hosted over 400 scientists and engineers from around the globe at the biennial International Laser Interferometer Space Antenna (LISA) Symposium in July. Mission scientists, members of the LISA Consortium and researchers interested in LISA science gathered at UCD for five days of presentations and discussion. The programme included 34 plenary speakers, 109 contributor talks and 148 poster presentations covering the LISA instrument, data analysis, astrophysics, fundamental physics, cosmology and theoretical waveform modelling.



Figure 45: Lead organiser Niels Warburton highlights the global reach of the LISA Symposium during the welcome talk © UCD

Irish Space Technology Showcase

The first Irish Space Technology Showcase took place in October at Enterprise Ireland's EastPoint offices in Dublin. The event was organised by Enterprise Ireland's overseas offices in France, Germany and Italy, IDA Ireland and the Irish National Delegation to ESA. Its primary goal was to bring international buyers to Ireland to explore the country's thriving space ecosystem and connect with Irish companies in the sector. Sixteen international companies, including Airbus DS, Argotec, Ariane Group, ASTECH Paris, Exolaunch, GMV, Leonardo, OHB DE, PLD Space, TAS Italia, TTTech and Viasat from Germany, Italy, France, Switzerland and Spain attended the event, meeting with 23 Irish companies. All of the Irish companies had the opportunity to pitch their solutions in a dedicated session, which was followed by pre-arranged one-to-one meetings. In total, 108 meetings were held over the course of four hours.



Figure 46: Attending the first 'Irish Space Technology Showcase' event at Enterprise Ireland's EastPoint offices in Dublin were (L-R): Andrew Vogelaar (Head of Engineering, Green Economy and Emerging Business, IDA Ireland), Julia O'Malley, (Head of Irish Delegation to ESA, Department of Enterprise, Trade and Employment), Jens Kaufmann (Head of the SME Section, ESA), Emer Higgins (Minister of State at Department of Enterprise, Trade and Employment), Cornelius Zund (Industrial Policy Officer, ESA), Charlotte Matthieu (Head of Industrial Policy and Space Economy Division, ESA), Marina Donohoe (Head of Research, Innovation & Infrastructure, Enterprise Ireland) © Enterprise Ireland

Showcasing EO technologies for sustainable city management

Compass Informatics hosted an international stakeholder meeting under the ESA Green Transition Information Factory (GTIF) programme in Enterprise Ireland's EastPoint offices in November. Attended by delegates from both private and public sectors, the event demonstrated the ways EO technologies can be used for sustainable city management. These include optimising solar power siting, measuring PM2.5 for air quality, tracking fugitive methane emissions, monitoring droughts in food-growing areas and mapping heat loss and urban heat islands effects in cities. Among those in attendance were Patrick Griffiths of ESA, Niall Bolger from the Irish National Delegation to ESA as well as project partners Prof Jan-Peter Muller and Rui Song (University College London), Yu Tao (SAIIL); Robin Cole (Earth Daily Analytics) and Rob O'Loughlin and Vivienne Kelly (Compass Informatics).



Figure 47: ESA Green Transition Information Factories – Sustainable Cities stakeholder meeting banner, featuring participants UCL, EDA, SAIIL and Compass Informatics © ESA

National Advisory Forum for Space Research established

A new National Advisory Forum for Space Research (NAFSR) was established in 2024 to set out a future roadmap for the broad spectrum of space related research and innovation in Ireland. The NAFSR arose from the need for, and importance of, a cohesive space research and innovation ecosystem in Ireland. NAFSR membership is drawn from a wide spectrum of academics, research institutes, industry representatives, and government agencies and departments. The purpose of the NAFSR is to articulate a vision of the transformative impact that could be delivered through a strategic, collaborative, and consolidated national engagement with space research and innovation that builds on current excellence and achievements, and identifies the key elements needed to turn that vision into reality.

The group is working to develop a National Strategy for Space Research and Innovation to be presented to government departments for consideration by the end of 2025. Research Ireland worked closely with the NAFSR Steering Group to develop a space research-focused survey of higher education and research institutes in the second half of 2024. The survey provided a baseline of current research and innovation activities and allowed these stakeholders to give initial input to the development of the strategy.



Figure 48: Steering Group of National Advisory Forum for Space Research pictured at first NAFSR meeting in UCD, 13 November 2024 (L-R: Lorraine Hanlon (UCD, NAFSR Chair), Niall Smith (Munster Technological University (MTU), NAFSR Deputy Chair), John Regan (Maynooth University), Caitriona Jackman (Dublin Institute for Advanced Studies), Aaron Golden (University of Galway)) © Research Ireland

Irish space industry exhibits at Bremen Space Tech Expo

In November, Deputy Head of the Irish Delegation to ESA, Conor Sheehan, along with Nicol Hoppe and Colm Foley of Enterprise Ireland, attended the Space Tech Expo Europe in Bremen, Germany. Space Tech Expo Europe is the continent's largest B2B event for the space industry, attracting over 8,000 professionals and more than 700 exhibitors annually. Irish companies exhibiting at the show included O.C.E. Technology, Réaltra Space Systems Engineering and Ubotica Technologies, among others, while Celtonn, Farran Technology, MBRYONICS, Skytek, SUAS Aerospace and Tisalabs visited. A key highlight during the event was a B2B matchmaking event which allowed Irish companies to present their innovations in a two-minute format.



Figure 49: A selection of images from 2024 Space Tech Expo Europe (Bremen, Germany), featuring attendees from Enterprise Ireland DACH Office, Celtonn, Farran Technology, O.C.E. Technology, Réaltra Space Systems Engineering, Skytek, Tisalabs and Ubotica Technologies © Enterprise Ireland

7.0

Irish Space Association: Advancing Ireland's Space Sector in 2024

The Irish Space Association (ISA), established in 2023, brings together indigenous and foreign direct investment companies, research organisations, educational institutions, and government agencies. Throughout 2024, ISA made significant strides in strengthening Ireland's position in the global space economy through strategic initiatives and partnerships both domestically and internationally.



Figure 50: (Left) Ambassador of France to Ireland, H.E. Mr Vincent Guérend, addresses attendees at ISA's "Ireland-France Space Industry Event" in May, hosted at the Residence of France, Dublin. (Right) Attending ISA's "Ireland-France Space Industry Event" was (L-R): Lisa McNamee (Doctor, RCSI), Norah Patten (Realtra Space Systems Engineering, IIAS Astronaut-003), Yvonne Kavanagh (Dir. Engineering Research & Innovation, SETU), Patricia Moore (ISA, Promethio), Marion Murphy (Managing Dir., Mallon Technology), Eimear O' Carroll (CTO, Lios) © Irish Space Association (ISA)

Engagement with France's space ecosystem deepened through ISA's participation in Paris Space Week in February, which included visits to ArianeGroup and the Centre National d'Études Spatiales (CNES), France's Space Agency. ISA's high-profile *Ireland-France Space Industry Event* in May was hosted at the Residence of France, courtesy of H.E. Mr Vincent Guérend, Ambassador of France to Ireland. In addition, a knowledge exchange webinar *French & Irish Space Ecosystem: Introduction & Cooperation Opportunities* was co-organised with Expertise France and Enterprise Ireland in July.

ISA further expanded its international network by cultivating connections with Slovakia's space sector at the Slovak-Irish Business Partnership Event in May. The potential of space medicine was explored at the American-Irish Medical Summit at the Royal College of Surgeons in Ireland in August. The Association also supported Ireland's CERN membership application by welcoming the visiting assessment taskforce in April and by coordinating Irish space-active company showcases to highlight Ireland's capabilities.

On the domestic front, ISA actively contributed to key industry discussions and events. At the Drone Summit at the RDS, ISA highlighted the crucial role of space assets in advancing drone technology. Intellectual property considerations for space technology were explored at the Dublin IP and R&D Summit at Enterprise Ireland and the Convention Centre Dublin, while, in October, cybersecurity challenges were the focus at ISA's *Strengthening Cyber Resilience in Ireland's Space Industry* event co-hosted with Space Industry Skillnet and the Collaboratory at TU Dublin Blanchardstown.



Figure 51: Patricia Moore (ISA, Promethio) and John O'Donoghue (ISA, Enbio) attending American-Irish Medical Summit in August © Irish Space Association (ISA)



Figure 52: Attendees at ISA's "Strengthening Cyber Resilience in Ireland's Space Industry" event in October (L-R: Hajar Bennouri (TU Dublin), Jack McDonnell (TU Dublin), Catherine Lenehan (Space Industry Skillnet), Mo Hassine (Tisalabs), Patricia Moore (ISA, Promethio), John O'Donoghue (ISA, Enbio), Steve Berry (Angoka)) at TU Dublin, Blanchardstown © Irish Space Association (ISA)

Investing in the next generation of space professionals, ISA participated in the National CanSat Finals in Portlaoise, where students developed miniature satellite missions. At the AvCon aviation career and talent convention, ISA engaged with 6,000 students, showcasing career pathways in aviation and aerospace, nurturing Ireland's future space innovators.

ISA's final networking event of the year – *Exploring the Intersection of Space and Medicine* – was organised in partnership with Space Medicine Ireland. Held in November at ISA headquarters in DCU Alpha, Dublin City University's Innovation Campus, the event featured Irish astronaut Dr Norah Patten and a keynote from Canadian colleague Dr Shawna Pandya, highlighting how addressing health challenges in space contributes to healthcare advancements on Earth.

Through these diverse initiatives, the Irish Space Association continues to provide a vital platform for engagement, supporting Ireland's development as an active and influential player in the global space industry. Looking ahead, ISA remains committed to fostering innovation, collaboration, and growth across Ireland's dynamic space ecosystem.



Figure 53: Attendees at ISA-Space Medicine Ireland event “Exploring the Intersection of Space and Medicine” in November. (L-R: Ronan Cunningham (INVENT, DCU), Philip Brady (Space Medicine Ireland), Patricia Moore (ISA, Promethio), Norah Patten (Réaltra Space Systems Engineering, Intl. Institute for Astronautical Sciences Astronaut), Shawna Pandya (Intl. Institute for Astronautical Sciences Astronaut) at TU Dublin, Blanchardstown © Irish Space Association (ISA)

8.0

Ireland at the forefront of space research

The breadth of Irish space research is vast, covering everything from planetary formation to studying how spaceflight affects our gut. It also includes new ways of improving satellite communications, addressing climate change here on Earth, and developing strategies to counter the negative effects of long-duration space travel on our muscles.

Next-generation space materials testing

A new generation of space materials which could be used to build future satellites, space suits and space craft are being tested in LEO conditions with input from Ireland. Placed on the Bartolomeo platform of the ISS, the composite materials will need to survive temperatures between -150oC and 120oC, space debris travelling seven times faster than a bullet, severe electromagnetic radiation, high vacuum, and atomic oxygen which erodes even the toughest materials. The project is led by the University of Bristol and is part of ESA's Euro Materials Ageing (EMA) SESAME mission. Prof Kate Robson Brown, UCD School Mechanical and Materials Engineering, UCD Vice-President for Research, Innovation and Impact and President of the European Low Gravity Research Association (ELGRA), is on the leadership team and directs the development of computational models to monitor and predict the performance of materials deployed in LEO.



Figure 54: The SESAME module (highlighted in red circle) mounted on the ISS © ESA/NASA

Positioning Ireland as international hub of space excellence

The National Space Subsystems and Payloads Initiative (NSSPI) aims to advance space technology development through collaboration, expertise and research, positioning Ireland as a recognised hub of space excellence. Led by UCD, this ambitious project has secured €7.9 million in DTIF funding and was launched in March 2024 in partnership with six industry leaders: Réaltra, Ubotica, Altera, MBRYONICS, Equal1, and ÉireComposites. An integrated software and hardware platform is currently under development. The platform will include model-based satellite design, hardware-in-the-loop satellite testing, payload integration and testing, and mission simulation tools.



Figure 55: Representatives of the NSSPI academic and industry consortium at the project's kick-off meeting in March 2024 © UCD

Shedding new light on planet formation

An international team of astronomers, with significant input from the University of Galway, has advanced our understanding of planet formation. Using the European Southern Observatory's Very Large Telescope (ESO's VLT) in Chile, the team captured images of over 80 young stars and their planet-forming discs of dust and gas. The team studied 86 stars in three star-forming regions: Taurus and Chamaeleon I – about 600 light-years away – and Orion – 1,300 light-years away. The observations demonstrate the extraordinary diversity of planet-forming discs in just three relatively small regions of our galaxy. Future advancements, such as the Extremely Large Telescope (ELT), will allow even deeper exploration of these systems. The University of Galway is contributing to the ELT, ensuring privileged access for Irish astronomers.

Exploring spaceflight-induced changes in the gut microbiome

Ireland's growing role in space life sciences research has been highlighted by a number of recent discoveries which demonstrate how understanding biological adaptations to spaceflight can advance both aerospace medicine and have significant implications for health on Earth. In the largest coordinated release of space biology discoveries in history, UCD researchers joined with others to publish the Nature Portfolio package: The Second Space Age: Omics, Platforms and Medicine across Space Orbits. As part of the package, UCD collaborated with an international consortium, to explore the microbiome effects of spaceflight.

This included analysis of the first all-civilian crew of the SpaceX Inspiration4 mission, published in *Nature Microbiology*, and a UCD-led study, published in npj Biofilms and Microbiomes, which used advanced genetics to explore changes in the gut microbiome, colons, and livers of mice aboard the ISS Rodent Research-6 mission to reveal previously unknown effects on physiology that could shape the future of long-duration space missions.

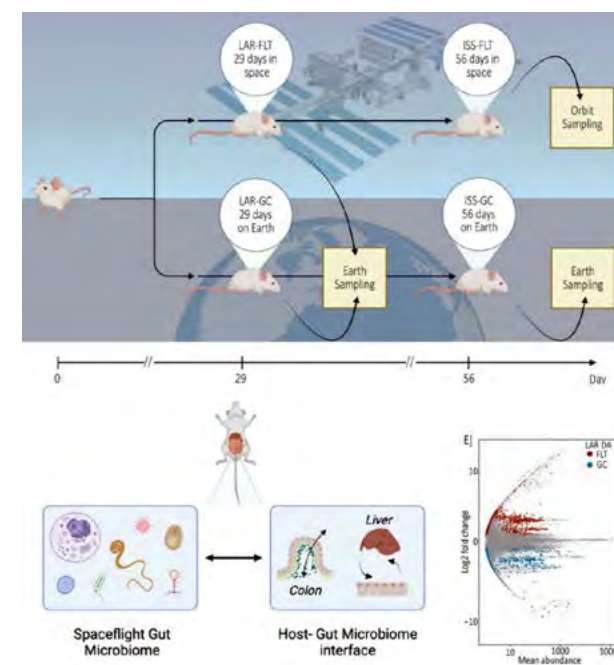


Figure 56: Rodent Research 6 mission uncovers microbiome changes associated to immune and metabolic dysfunction © UCD

New method to interpret gravitational wave data

The UCD Relativity Group is involved in a collaboration to use gravitational wave data to estimate the physical parameters of black hole systems. Working with collaborators at University of Portsmouth and University of Southampton, the group has devised a new method that simultaneously uses multiple models to analyse gravitational wave data. These waves are emitted by colliding black holes billions of light years away and release more energy than our Sun does in billions of years. The new work successfully incorporated multiple models into a single run which offers significant computational savings (up to 30% speed increase in implementation) and – more importantly – a more reliable result. The research results are expected to be published in *Nature Astronomy* in 2025.

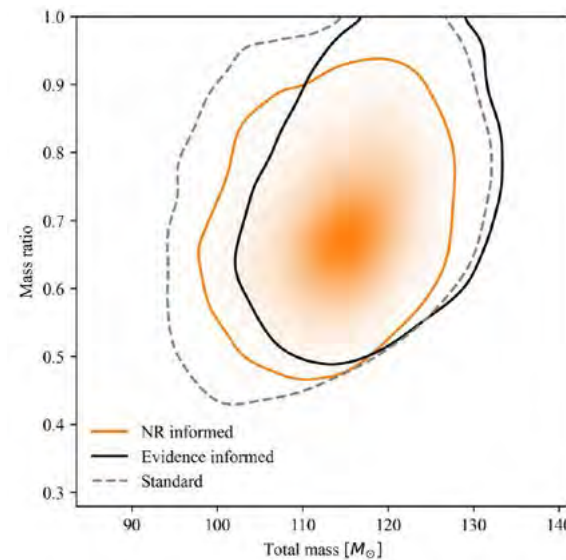


Figure 57: Estimation of the masses of the binary black hole system GW191109_010717; UCD method (orange) showing (with 90% certainty) the two black holes have unequal masses and a 70% probability that the heavier black hole is too massive for a supernova progenitor © UCD

Enhancing CubeSat communication

The WiSAR Lab at Atlantic Technological University (ATU) Donegal is involved in a project to improve the reliability of CubeSat communications in LEO. The lab has partnered with Silicon Austria Labs (SAL) on an ESA project titled “*Enhancing CubeSat Communication Through Beam Steering Antennas: Technologies and Challenges*”, which commenced in September 2024.

CubeSats, with their compact design and versatility, are vital for space exploration and communication, though they encounter communication challenges in LEO. This project analyses CubeSat communication advancements, focusing on beam-steering technologies and examines key challenges like power limitations, miniaturisation, and integration while exploring phased array systems, meta surface-based designs, and reconfigurable antennas. The project aims to develop a hybrid beam-steering system featuring a passive antenna to enhance CubeSat communications, providing adaptive and efficient connectivity in LEO.



Figure 58: Dr. Tale Saeidi, postdoctoral researcher at the WiSAR Lab, testing a component for CubeSat communication technology in collaboration with Silicon Austria Labs © ATU Donegal

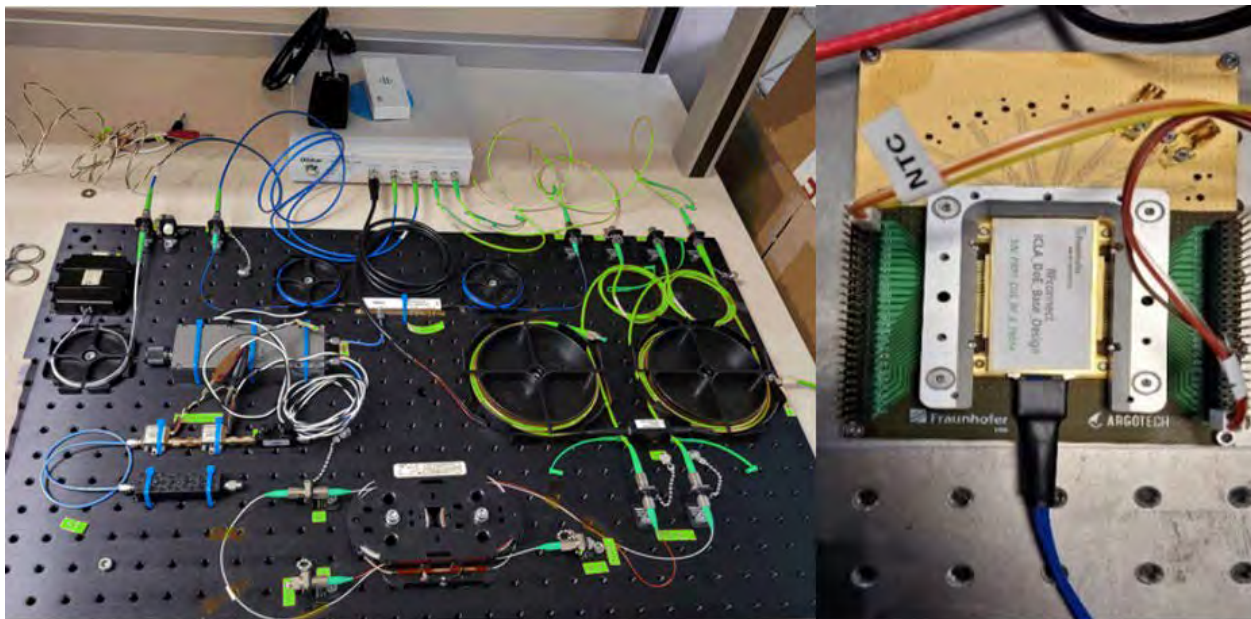


Figure 59: Benchtop setup and integrated circuit to demonstrate the use of photonic technology for generating low phase noise RF signals © DCU

Improving satellite signal generation and processing

DCU has been awarded funding by ESA to develop a microwave frequency generation unit (FGU) based on integrated microwave photonic (MWP) technologies which have the potential to greatly reduce the size, weight and power consumption of radio frequency (RF) signal generation and processing units employed for EO and communication systems on board satellites.

The project demonstrated both benchtop and integrated photonic circuits capable of generating low-phase noise RF signals that can operate across many of the frequency bands required for space applications. Key outputs were presented at the International Conference on Space Optics in Antibes in October 2024.

Energy efficient amplification of inter-satellite communications

DCU received funding from the EU Marie Skłodowska-Curie Action on Doctoral Networks for a research programme focused on training PhD students on photonic technologies for the space sector. A key achievement of the programme in 2024 was the demonstration of the use of Semiconductor Optical Amplifiers (SOA) for the energy efficient amplification of optical data signals for inter-satellite communications. SOA's can be used to amplify optical data signals with less power consumption and in a much smaller form factor than the traditional fibre amplifiers employed onboard satellites. The work carried at DCU demonstrated the amplification of a 50 Gbit/s data channel to a power level of over 200mW with minimum signal distortion and the team is working towards demonstrating powers of over 1 Watt using SOA technology.

ICHEC to advise ESA on HPC, Data and Quantum Infrastructure

The Irish Centre for High-End Computing (ICHEC) at the University of Galway was awarded funding from ESA to map pan-European high-performance computing (HPC) and quantum computing infrastructure used for data archival, access and processing services relevant to, and used in, Copernicus, DestinE and Digital Twin Earth scenarios. Also mapped were EO processors, processes, workflows and use-cases relevant for the same scenarios. The work included a study to define the requirements for the performance optimisation, set targets and HPC/cloud systems across institutional and European supercomputing infrastructures. A framework for trade-off and cost-benefit analysis was also developed, by considering parameters that represent optimisation, performance improvements achieved, processor and workflow efficiency improvements and associated costs involved.



Figure 60: Venkatesh Kannan (Associate Director (Solutions R&D), ICHEC) presenting at the July Destination Earth (DestinE) workshop at Enterprise Ireland's offices © Enterprise Ireland

New approaches to tackle muscle atrophy on the ground and in space

Research carried out by a University of Galway team in collaboration with NUIG spin-out Aquila Bioscience and Arizona State University has identified possible strategies to avoid muscle atrophy in space and on Earth. The microgravity environment in space presents challenges to our bodies, particularly affecting muscles, bones, and the immune system.

In microgravity, muscles weaken over time, leading to a condition known as muscle atrophy, a significant concern for astronauts on longer missions. University of Galway researchers and their partners published a research article "Profiling muscle transcriptome in mice exposed to microgravity using gene set enrichment analysis," in the journal *Nature Microgravity*. The authors investigated fundamental molecular changes in muscle atrophy using data from NASA's GeneLab and one of the key findings was the impact of microgravity on glycosylation—a process vital for protein stability and signalling. Alterations in glycosylation under microgravity suggest possible strategies to prevent muscle loss by targeting these pathways.

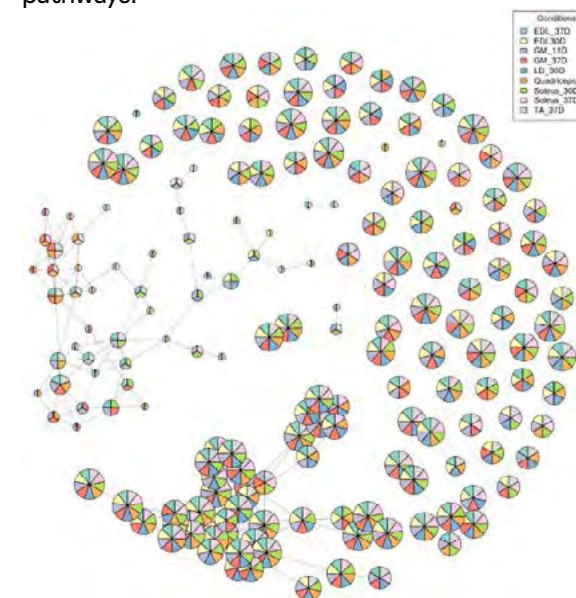


Figure 61: Cluster network generated using MoSBI online web application using gene expression data obtained from NASA's Genelab datasets for mice muscle samples © University of Galway

Irish goddess lifts off

ULAS HiPR, the University of Limerick's high-powered rocketry undergraduate team, became Ireland's first ever competitor at EuRoC, Europe's largest rocketry competition, in 2024. The team's rocket – Airmeadh – named after an Irish goddess, reached an apogee of 2.3 km. Its on-board experiment featured a custom-built AI model designed to segment and classify safe landing zones. The team launched two other rockets during the year, both at Mach-24 – an annual competition and conference in Machrihanish, Scotland for university students across the UK and Ireland.



Figure 62: (right) Morrigu, ULAS HiPR's first rocket launched at Mach-24, crafted with carbon fiber and featuring an onboard AI vision model. (top) HiPR students showcasing rockets Morrigu and Airmeadh (L-R: Conor Callanan, Karl Gilmartin, Dervla Gargan, Jay Looney, Adam Byrne) © Cyprian Gut, Alan Place



Unlocking new possibilities for advanced nanofluids

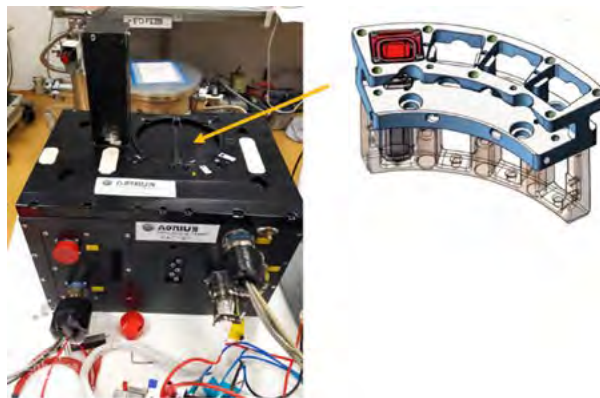


Figure 63: Test cell and sample carrier for investigation of graphene suspensions under microgravity conditions onboard the ISS © TCD

A project being carried out by researchers from Trinity College Dublin (TCD), in collaboration with Université Libre de Bruxelles and ESA, aims to unlock new possibilities for advanced nanofluid applications in thermal management, electronics, and biomedical fields, with implications for both space and Earth-based technologies. Specifically, the project will investigate the behaviour of graphene based colloidal suspensions under microgravity conditions. Currently completing baseline terrestrial experiments, the experiment is set for deployment aboard the ISS where it will analyse how the absence of gravity affects nanoparticle dispersion, stability, and thermophysical properties.

Using EO and AI to put a price on climate adaptation finance

Confirming the efficacy or otherwise of the finance deployed for climate adaptation projects in the developing world has proved challenging. Conventional approaches are both costly and time-consuming and utilise different socioeconomic based methodologies with variable degrees of success.

Researchers at the University of Galway's Ryan Institute have developed the Research Ireland-funded TAPAS (Tracking Adaptation Progress in Agriculture and food Security) using an AI-powered satellite remote sensing platform that can deliver alternative evidence-based solutions an order of magnitude cheaper than these conventional solutions and provide an independent, honest-broker means of tracking adaptation finance efficacy. The TAPAS solution utilises data from ESA's Sentinel constellation of EO spacecraft.

The Ryan Institute team has already used TAPAS to independently audit USAID's \$170 million irrigation works investment in the Senegal River Valley completed between 2010-2015, the goal of which was to make rice production more climate resilient across a 788.63 km² area. This analysis successfully identified and mapped all rice cultivation locations, tracked crop cycling patterns, monitored the region's irrigation network vitality and enabled an increase in rice yield valued at \$61.2 million to date.

New instrument for high energy astrophysics

The development of a CubeSat-compatible prototype of a Compton Telescope (COMCUBE) for high-accuracy gamma-ray burst polarimetry and multi-messenger astronomy by a team at UCD has been supported through the EU H2020 'AHEAD2020' project and Research Ireland. The prototype's performance was tested on a stratospheric balloon flight from the Esrange space base in northern Sweden in June 2024. The balloon landed on Baffin Island in Canada more than three days later, where it was recovered by helicopter.



Figure 65: Members of COMCUBE team at Esrange (L-R: Philippe Laurent, Joseph Mangan, Nicolas de Séreville, Caimin McKenna, Alexey Uliyanov) © UCD

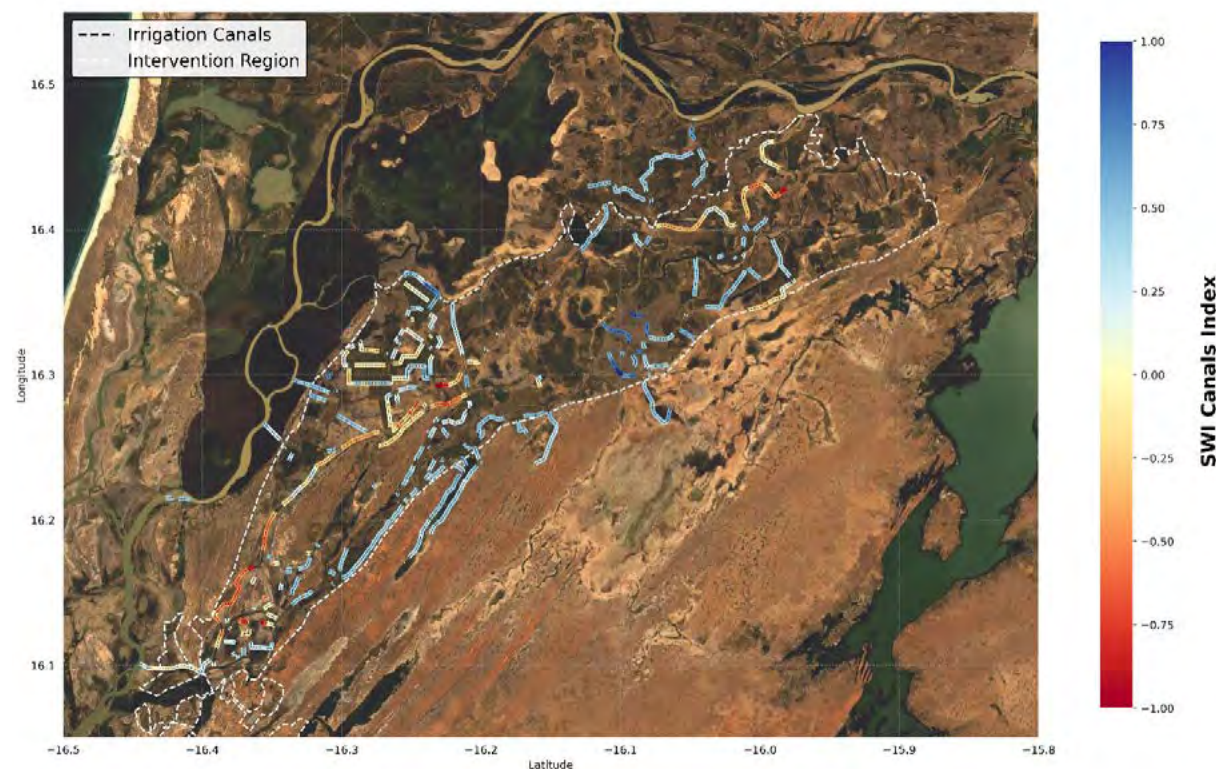


Figure 64: Sentinel-2 satellite image of the Senegal River Valley intervention area studied by the TAPAS project. Overlaid are the network of irrigation canals colour-coded according to their estimated performance activity © J. O'Farrell/TAPAS team

Exploring magnesium alloy solidification in microgravity

An experiment designed by researchers at the UCD Phase Transformation Research Group (PTRG) may pave the way for the development of improved aerospace materials and medical devices. Magnesium alloys are lightweight and high strength materials which offer potential applications in aerospace devices and medical fields. The UCD group is engaged in the development of magnesium alloys for in-situ solidification studies in microgravity. The alloys are currently being manufactured through induction melting and casting in an inert atmosphere. The experiment, slated for 2026 aboard ESA's MASER 17 sounding rocket, will use X-ray monitoring techniques to study the solidification process in microgravity as the UCD alloy sample cools from a temperature above 700°C. These findings will enhance the understanding of how gravity affects alloy solidification opening up prospects for the development of improved materials.

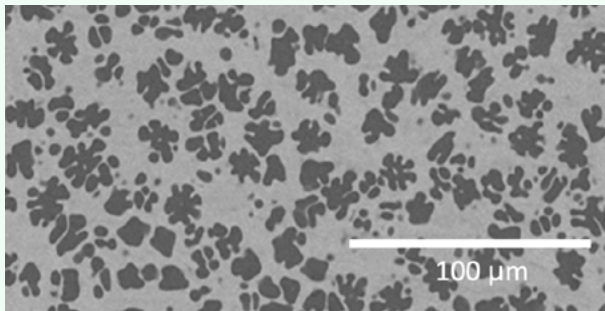


Figure 66: SEM image showing magnesium alloy microstructures recently manufactured in the PTRG lab at UCD. The dark phase are magnesium-rich dendrites, the light interdendritic phase is rich in zinc © UCD



Figure 67: Testing of mirrors for ESA's Ariel Mission in the Dublin Institute for Advanced Studies Cryogenic Lab © DIAS

Surveying the atmospheres of distant exoplanets

Components designed by DIAS in collaboration with UCD will play a key role in the first dedicated mission to survey the atmospheres of planets beyond our solar system. ESA's Ariel (Atmospheric Remote-sensing Infrared Exoplanet Large-survey) mission, due to be launched in 2029, will study the atmospheres of over 1,000 exoplanets. Using infrared spectroscopy, it will analyse their composition, climate, and formation history, helping us to understand their evolution.

DIAS, in collaboration with UCD, is responsible for designing and testing the beam splitters and mirrors that divide the light on board the spacecraft and feed it into the various instruments. These components have to be capable of withstanding temperatures as low as -240°C. DIAS was chosen to do this work because of its experience carrying out similar activity for the James Webb Space Telescope (JWST). The work has been made possible through funding from ESA's PRODEX programme with support from Enterprise Ireland.

Improving thermal control for space missions

Improved thermal control in future space missions could be made possible as a result of research carried out by TCD and the University of Pisa (U. Pisa), supported by ESA. The findings were published in Nature journal *npj Microgravity* and revealed new insights into how water droplets evaporate in space. Conducted during ESA's Parabolic Flight Campaign, the study analysed heat transfer dynamics from hyper to microgravity conditions. Results showed that evaporation rates decrease significantly in microgravity due to suppressed convection, while peak heat transfer remains at the droplet's contact line. Unlike previous studies, applied electric fields did not enhance evaporation under these conditions.



Figure 68: (left) Members of TCD research team at the Novespace Zero-G parabolic flight facility (L-R: Anthony Robinson, Michael Gibbons, Seamus O'Shaughnessy, Maxime Rouzes). (above) Droplet evaporation experimental facility and team members onboard parabolic flight campaign (L-R: Maxime Rouzes (TCD), Giacomo Saccone (U. Pisa), Seamus O'Shaughnessy (TCD), Paulo Di Marco (U. Pisa)) © TCD

Mission accomplished for EIRSAT-1's gamma-ray detector

A significant milestone was achieved by EIRSAT-1, Ireland's first satellite, on 21 August 2024, when it detected its first and second gamma-ray bursts that can signal the formation of a black hole. This achievement was facilitated by delicate fine tuning of the satellite's gamma-ray module, GMOD, during commissioning. Because the satellite's pole to pole orbit passes through regions of high background radiation, which can cause the GMOD to temporarily stop working, these zones were carefully mapped by the team and operational procedures implemented to switch the GMOD off when crossing them.

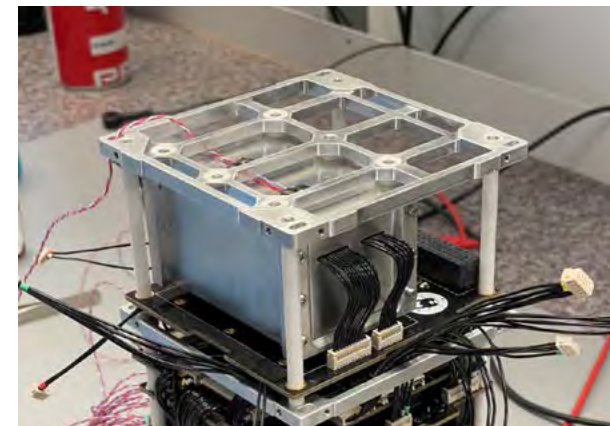


Figure 69: EIRSAT-1 GMOD FM (flight model) after integration in stack © UCD

This enabled the GMOD to detect the high energy gamma bursts of the rarer 'short' type, likely caused by the collision of two neutron stars, leading to the formation of a black hole. The distance to this burst was determined by ground-based follow-up observations to be about 2.8 billion light years.

9.0

Irish Education and
Public Engagement
with Space

Education and outreach activities are critically important to inspire the next generation of Irish space researchers and innovators.



Figure 70: Mercy Mounthawk School, Tralee Wins CanSat Ireland National Finals 2024 © Blackrock Castle Observatory

ESERO supports teachers and learners

ESERO Ireland, the Irish branch of the European Space Education Resource Office co-funded by ESA and Research Ireland, provides supports to teachers and learners. ESERO partners with the Research Ireland Curious Minds programme, MTU Blackrock Castle Observatory and Oide, the Department of Education's teacher support service, to provide continuous professional development opportunities and classroom resources. Some 2,364 teachers nationwide attended ESERO Professional Development courses in 2024.

During the year, ESA's Europe-wide, ESERO Ireland-funded 'Climate Detectives' classroom project hosted its first Irish finalists while the CanSat final was covered by Ireland's national broadcaster RTÉ. A suite of new Mission X video introductions was launched to teach students of up to 14 years of age the key elements to keeping fit and staying healthy in space and on Earth. 2024 also saw several new partnerships, including projects with Armagh Observatory and Dunsink Observatory, funded by Research Ireland's Discover Call, and a pilot 'space adventure' with Lismore Heritage Centre.

As part of Science Week in November, ESERO Ireland developed a partnership with Microsoft Dreamspace to deliver a careers webinar. Hosting and promotion by influencer Shanice Griffin gave this added appeal to students, with over 1,300 students tuning in. In addition, the Curious Minds / ESERO primary school online shows for Science Week achieved more than 5,400 views and included promotion of new Mission X resources with 1,892 unique website views.

Space Week 2024

Space Week, coordinated by Munster Technological University (MTU) Blackrock Castle Observatory (BCO), ran from 04-10 October with over 460 events nationwide reaching over 25,000 people. The week, which included a Space Week Road Trip with astronaut Steve Swanson, attracted extensive media coverage. Highlight events included the second annual Space Open Day at MTU, a celebration of the Europa Clipper launch at Galway Atlantaquaria, and the NASA Space Apps Challenge at the National College of Ireland, Dublin and Technological University of the Shannon (TUS), Midlands. School participation in Space Week remains strong, with teachers across the country availing of curriculum-aligned resources produced by BCO and ESERO Ireland.



Figure 71: Astronaut Steve Swanson with students from Dominican College, Taylor's Hill at Galway Atlantaquaria © Blackrock Castle Observatory

DIAS Dunsink Observatory outreach programme

2024 has been another exciting year for public engagement at DIAS Dunsink Observatory. The research institute ran a series of space-related events for children and the general public with public nights attracting several thousand visitors to connect with researchers and to look through the historic Grubb Telescope – the largest refractor in Ireland.

In addition, DIAS ran its very popular transition year programme twice during the year, allowing students from secondary schools around Ireland to spend a week at the observatory and connect with researchers and other students with a passion for space. A highlight of the year was the kick-off of Space Crafts, supported by Research Ireland's Discover Programme and the Fingal County Council Arts Office. Space Crafts is a collaboration between astrophysicists and artists allowing local primary school students to explore space through art and science activities.



Figure 72: Primary School students at a Space Crafts workshop at DIAS Dunsink Observatory © DIAS

Science Week 2024: SpaceFest 2024 and Solaris

SpaceFest – run by the National Space Centre (NSC) Ltd. and Greywood Arts – hosted a range of science, technology, engineering and arts events for over 4,500 visitors during Science Week in November. Workshops and exhibitions took place at the NSC Ltd's Elfordstown Earthstation in East Cork, home of The Big Dish, which housed the festival's central exhibition. COSMIC DEBRIS was an immersive multimedia journey from artists-in-residence Nicholas Carn, Kerry Guinan and artist/engineer Luisa Charles that challenged the audience to rethink our place in the cosmos and the impact we leave behind.

New for 2024, SpaceFest expanded into Cork City through dynamic collaborations on STEAM programming with leading institutions including University College Cork, the Irish Photonic Integration Centre (IPIC), Tyndall National Institute, and MTU Blackrock Castle Observatory.



Figure 73: Space Fest Cosmic Debris exhibition at National Space Centre Ltd. 2024 © NSC Ltd.

Solaris, a new creative project commissioned by Research Ireland, is a giant motorised expandable sphere which takes the audience on a journey from the birth of a star to its explosive transformation into a pulsar.

Narrated by Dara O'Briain and Prof Jocelyn Bell Burnell, the show was developed by the Axolotl collective in consultation with researchers and a team of lighting/visual designers and creatives. Premiering at Science Week 2024, *Solaris* opened in Cork's Marina Market before being taken to St Nicholas' Church in Galway City.



Figure 74: Solaris launch Event, SpaceFest 2024, Cork © Research Ireland

Glossary

AMS	Area Monitoring System
Ariel	Atmospheric Remote-sensing Infrared Exoplanet Large-survey
CERN	European Organisation for Nuclear Research
COSMOS	COmmunication System for Multi Orbit Satellite
DAFM	Department of Agriculture, Food and the Marine
DCU	Dublin City University
DETE	Department of Enterprise, Tourism and Employment
DFHERIS	Department of Further and Higher Education, Research, Innovation and Science
DIAS	Dublin Institute for Advanced Studies
DTIF	Disruptive Technologies Innovation Fund
EASN	European Aerospace Science Network
EASTRO	European Association of Space Technology Research Organisations
EGNOS	European Geostationary Navigation Overlay Service
EIC	European Innovation Council
ELGRA	European Low Gravity Research Association
ELT	Extremely Large Telescope
EO	Earth Observation
ESERO	European Space Education Resource Office

EUROSPACE	Trade association of the European Space Industry
ESA	European Space Agency
ESA BIC	ESA Business Incubation Centre
ESA SSI	ESA Space Solutions Ireland
ESO VLT	European Southern Observatory Very Large Telescope
ESRE	Association of the European Space Research Establishments
EUSPA	EU Agency for the Space Programme
FAP	Fairing acoustic protection
FLPP	Future Launchers Preparatory Programme
GNSS	Global Navigation Satellite System
GTIF	Green Transition Information Factory
HAS	High Accuracy Service
HTS	High throughput satellites
ISA	Irish Space Association
ISS	International Space Station
LEO	Low Earth Orbit
LISA	Laser Interferometer Space Antenna
LOFAR ERIC	Low Frequency Array European Research Infrastructure Consortium

NAFSR	National Advisory Forum for Space Research
NAVISP	Navigation Innovation and Support Programme
NCP	National Contact Point
NOAA	US National Oceanic and Atmospheric Administration
NSSPI	National Space Subsystems and Payloads Initiative
NTN	Non-terrestrial networks
RF MEMS	Radio-Frequency MicroElectroMechanical Switch
SiPMs	Silicon photomultipliers
SME4SPACE	Representative group for Space SMEs
SWPC	US Space Weather Prediction Center
TAPAS	Tracking Adaptation Progress in Agriculture and food Security
TCD	Trinity College Dublin
TUS	Technological University of the Shannon
UCC	University College Cork
UCD	University College Dublin
UG	University of Galway
VGDS	Verified GPS/GNSS Data Stream



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Plankton blooms swirl in the North Atlantic Ocean off Ireland in this Envisat image. © ESA



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