



# ESA ACTIVITIES IN IRELAND 2020



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



Riailtas na hÉireann  
Government of Ireland

# Introduction

Ireland has been a member of the European Space Agency (ESA) since 1975. In that time, it has participated in a number of high-profile ESA missions supported by technologies developed by Irish industry and research communities.

In recent years, the scope of Irish involvement in space-related activities has increased substantially, with over 80 Irish companies and a growing number of research teams actively involved in space-related developments supported by ESA, and by Enterprise Ireland.

In 2020, ESA activities in which Irish companies and researchers were involved ranged from ESA science missions (including the Solar Orbiter mission to the Sun), space transportation, human spaceflight and Earth observation (EO) to bringing a number of technology innovations to the space programme and the growing commercial space market. Irish companies also became increasingly active in developing space-based solutions to address a range of issues here on Earth, including healthcare, in particular the response to the Covid-19 crisis, and environmental monitoring and climate change.

This report describes some of the significant activities supported by ESA in Ireland in 2020.



**Cover photo:** Artist's impression of the Solar Orbiter spacecraft. © ESA



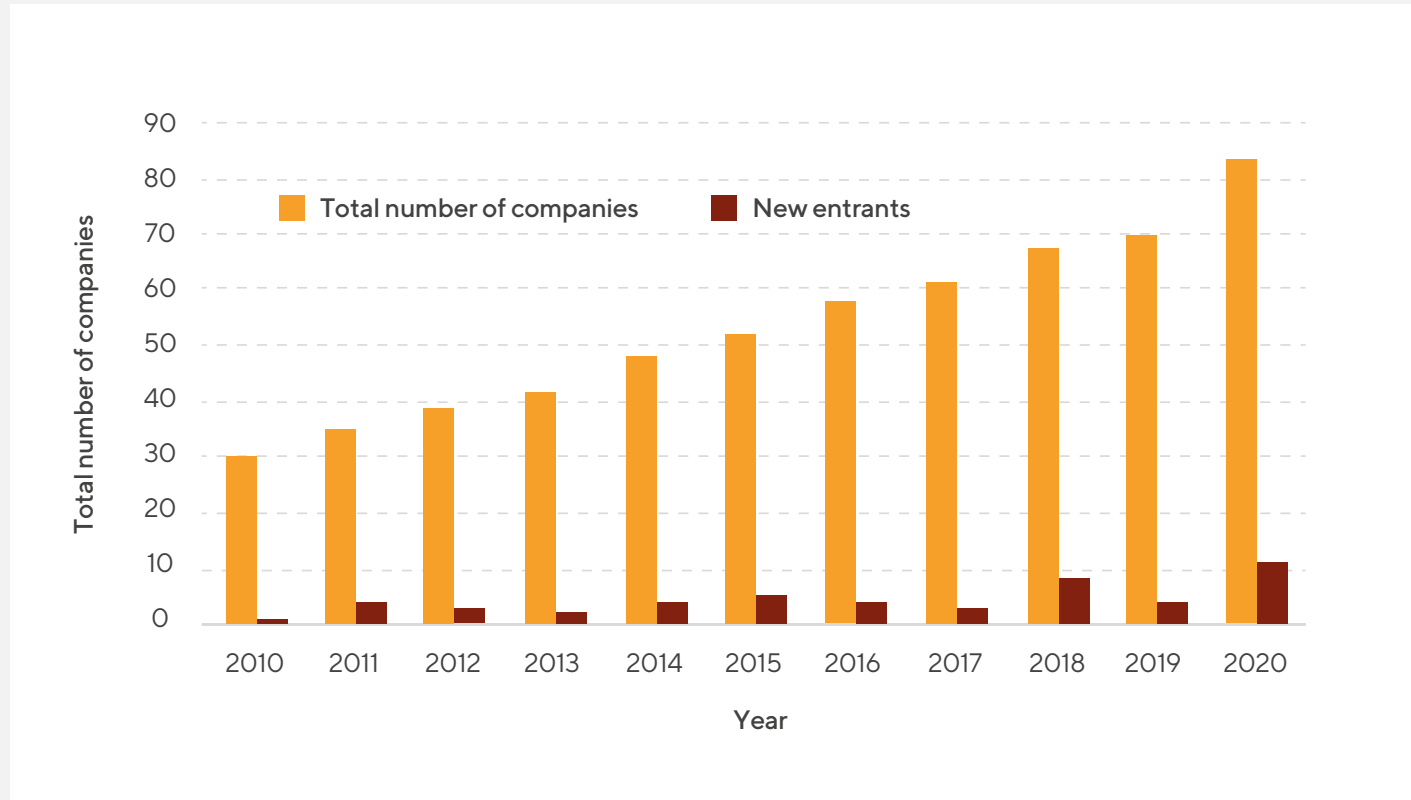
# Space: A growing opportunity for Irish companies

2020 saw record growth in the number of Irish companies engaging with ESA support programmes, with 13 new companies securing their first ESA contract; this is the highest number of new-entrant Irish companies recorded in any given year to date.

Overall, ESA placed contracts with a combined value of €11.5 million with 28 Irish companies in 2020. When the companies' own funding contribution is included, the value of industrial research and development (R&D) associated with ESA contracts was €14.7 million.

A further €1.5 million in ESA contracts was placed with 10 Irish universities and research institutes involved in a range of strategic research activities.

When averaged over the period 2018–2020, the total value of ESA contracts placed in Ireland per year was €16.7 million, with Irish industry accounting for €15 million of this total.



ESA supported a diverse array of industrial activities in Ireland, ranging from the development of highly innovative technologies for the space programme, such as satellite optical communications, to the development of satellite solutions in response to the Covid-19 pandemic and environmental monitoring in support of the Climate Action Plan.

**Figure 1:** Total number of companies active in ESA programmes, including subcontractors and ESA Business Incubation Centre (ESA BIC) companies

## Irish space innovation in response to the Covid-19 outbreak

In response to the ESA Announcement of Opportunity 'Space in response to Covid-19 outbreak', supported through the ESA ARTES Business Applications Programme, three Irish companies secured lead roles in developing solutions based on the use of satellite systems.

**React 2:** A virtual command centre is being developed by Dublin-based software and space technology company Skytek and its industrial consortium, which includes Irish and Italian health authorities and hospitals. The React 2 platform is providing information on the current state of local outbreaks to hospitals, ambulance services, and many other healthcare providers, to help coordinate emergency responses. Using a satellite-enabled system, data will be transmitted securely and reliably to users – even if they are in remote and rural areas. Notifications will be generated when suspected case numbers exceed a certain level. The information will help decision-



*Figure 2: PMD Solutions' RespiraSense monitor. © PMD Solutions*

makers quickly understand where outbreaks are worsening, so that healthcare support and medical supplies can be directed to areas most in need.

**Corona-RS:** A Cork-based medical device company PMD Solutions is working with its partners, including Beaumont Hospital in Dublin, to develop the patient-monitoring system Corona-RS. It will be used by doctors to keep a close eye on patients in the community who

are suffering from the effects of Covid-19 and other respiratory illnesses. If patients suffer respiratory failure at home, it is critical that they be admitted to hospital as quickly as possible. By using a remote monitoring system, information on respiratory health can be sent from a body-worn sensor to the healthcare provider via an intermediate device.

The Corona-RS system includes a wearable respiratory rate monitor called RespiraSense. The monitor's sensor uses 5G technology to maintain continuous connectivity. The sensor's location is tracked using the EU's Galileo satellite system, thus enabling critical information on the patient's health status to be sent directly to medical professionals. An early trial at Beaumont Hospital demonstrated that the Corona-RS system could identify patients at risk from suffering respiratory failure 12 hours earlier than is normally possible.

**BlueBridge Technologies** is, with ESA support, developing a hand-held device to monitor the spread of Covid-19.

The device, called Respr, will measure a user's lung function, breath temperature, and saturated oxygen levels. These data are then shared via mobile phone networks, using the EU's Galileo satellite system to monitor the progress of the virus in real time. Respr will be able to provide real-world information in real time to the experts advising on important decisions in the battle to restrict the spread of Covid-19 and other communicable diseases.

BlueBridge Technologies has partnered with Actuate Technologies, an American firm, to commercialise the new technology when it becomes available. The Irish firm has already built a prototype device and it expects commercial production of the device to begin in early 2022. BlueBridge Technologies, founded in 2006, is a certified medical device designer in a highly regulated market, and has previously developed software and devices for some of the largest firms in the world, including Medtronic, Novartis, Abbott, and Boston Scientific.

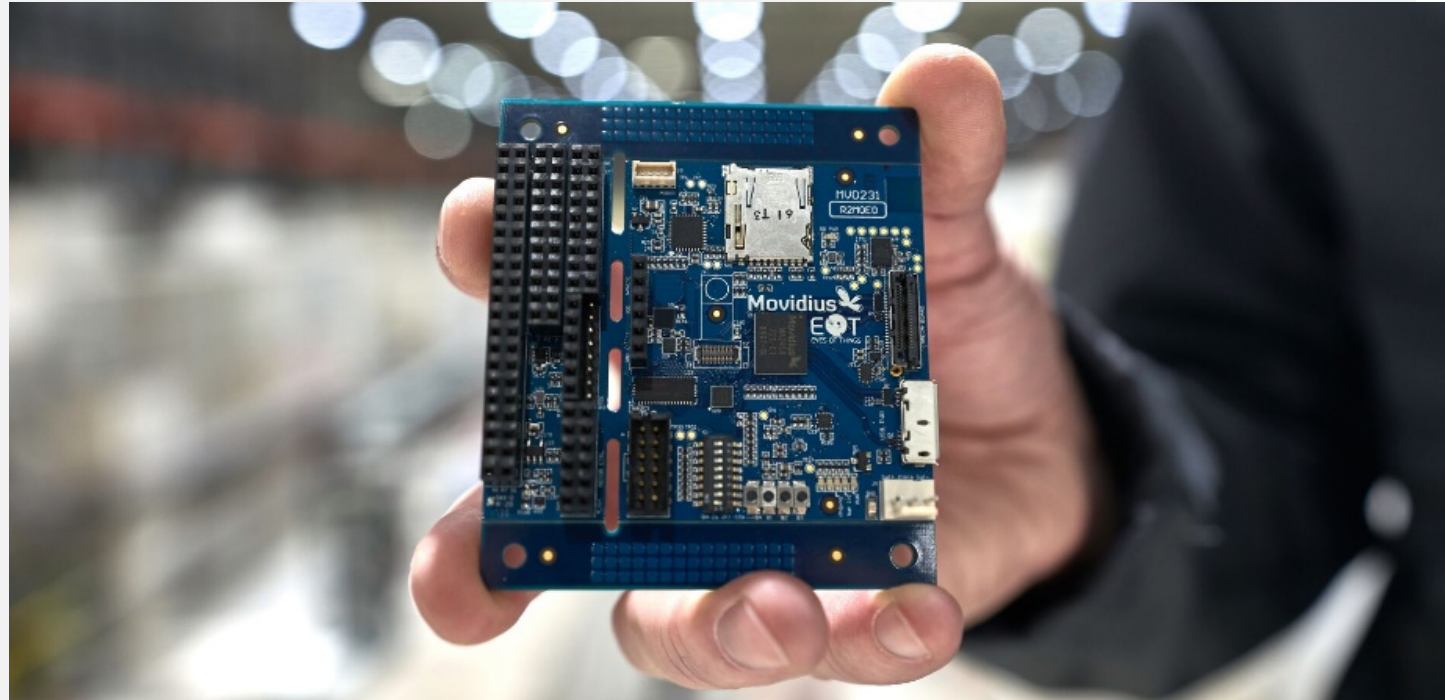


**Figure 3:** BlueBridge Technologies' Respr device. © BlueBridge

## Satellites applying artificial intelligence to Earth observation

In 2020, **Ubotica Technologies** secured an ESA contract to incorporate its artificial intelligence (AI) technology to enable the first-ever hardware-accelerated AI inference of EO images on an in-orbit satellite.

This technological achievement took place on board  $\Phi$ -sat-1, ESA's AI demonstration CubeSat, which was launched on a Vega launch vehicle. Data downlinked from the satellite have shown that the AI-powered automatic cloud detection algorithm has correctly sorted hyperspectral EO imagery from the satellite's sensor into cloudy and non-cloudy data.  $\Phi$ -sat-1 is part of an ambitious and groundbreaking programme, funded by ESA and supported by Enterprise Ireland, for the demonstration and validation of state-of-the-art deep learning technology applied in-orbit for autonomously processing EO data.



**Figure 4:** The Intel-Movidius Myriad 2 Vision Processing Unit, which is at the heart of  $\Phi$ -sat-1 mission. © CERN/M. Brice

The successful application of the Ubotica CVAI™ AI technology, which is powered by the Intel-Movidius Myriad 2 Vision Processing Unit, has demonstrated real on-board data processing autonomy, thus laying the foundation for the path to advanced deep learning applied to satellite data at source. Decision-making on board  $\Phi$ -sat-1, rather than on the ground, has been shown to enable pre-filtering of EO data, so that only relevant images with usable information are

downlinked to the ground, thereby improving bandwidth utilisation, and significantly reducing aggregated downlink costs.



## Irish involvement in planetary defence mission

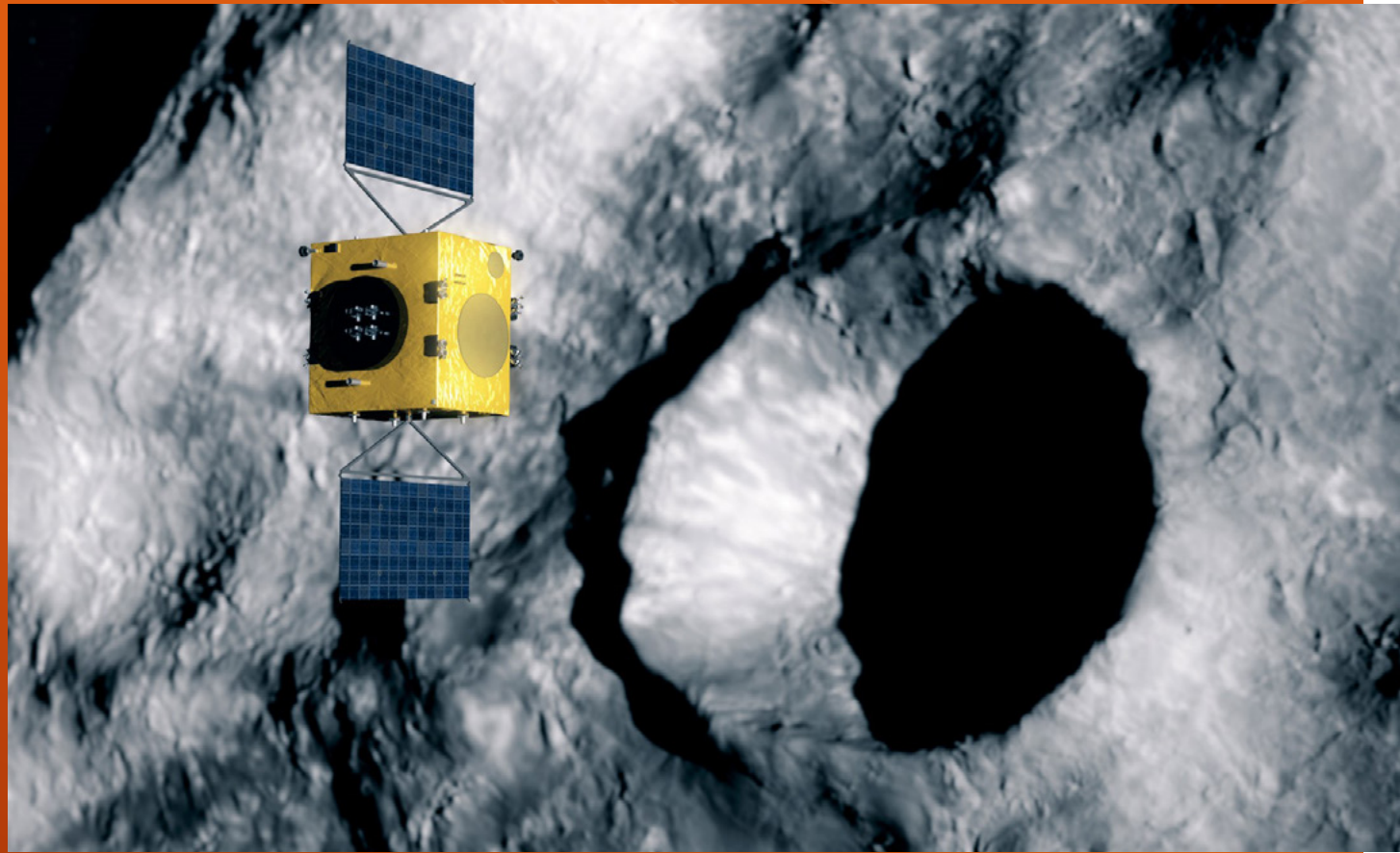
Dublin-based InnaLabs secured an ESA contract to adapt its ARIETIS-NS, a radiation-tolerant gyroscope, in partnership with German company OHB and GMV (Spain) for Hera, a planetary defence mission to support deep-space navigation.

Hera (named after the Greek goddess of marriage) will go alongside NASA's Double Asteroid Redirect (DART) spacecraft, humankind's first probe to rendezvous with a binary asteroid system called Didymos.

Hera is Europe's contribution to an international planetary defence collaboration among European and US scientists called the Asteroid Impact and Deflection Assessment (AIDA). The DART spacecraft – due for launch in July 2021 – will first perform a kinetic impact on the asteroid's moon, Dimorphos. Hera will follow up with a detailed post-impact survey to turn this grand-scale experiment into a well-understood and repeatable asteroid deflection technique.

Mission scientists are hoping that the force of the DART impact with the asteroid will be enough to deflect it out of its orbit. If Hera finds that deflection has indeed occurred, it means that any future asteroid threatening Earth could be pushed on to a safe path. InnaLabs' ARIETIS-NS

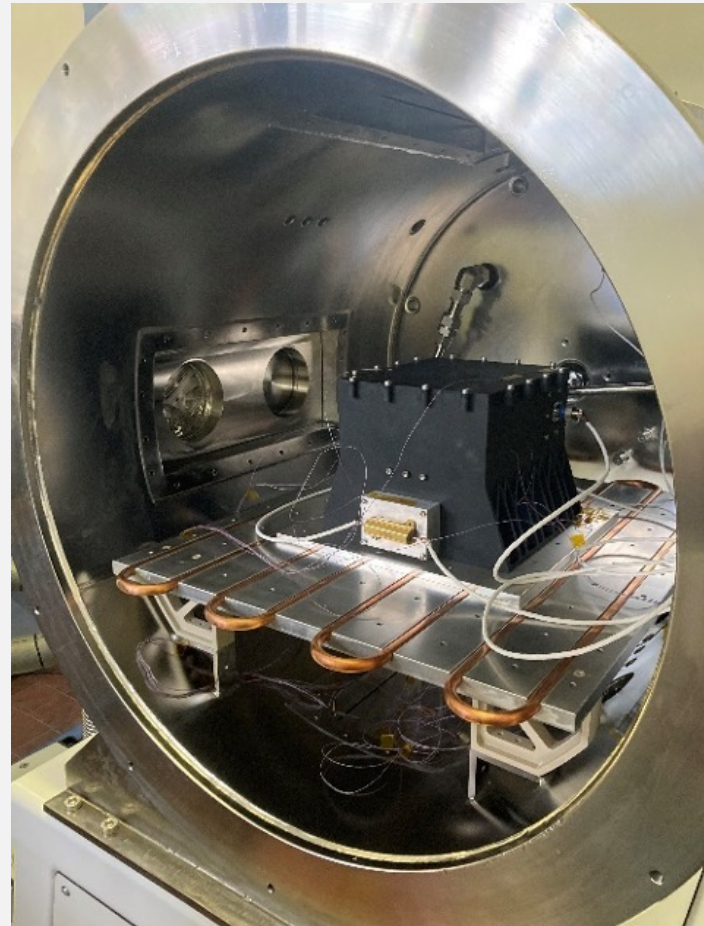
is based on InnaLabs' proven and qualified COTS (commercial-off-the-shelf) Coriolis Vibratory Gyroscope (CVG) technology and will be primarily used to support deep-space navigation.



**Figure 5:** Artist's impression of the Hera spacecraft. © ESA

## Irish companies supporting access to space

In December 2020, **Réaltra Space Systems Engineering** (a division of Realtime Technologies Ltd) designed, built and delivered the space-qualified video telemetry kit (VIKI) to ArianeGroup in Bremen, Germany for integration on the Ariane 5 launch vehicle that will carry the historic NASA Webb Telescope into orbit. The VIKI from Réaltra will provide live video streaming from the Ariane 5 rocket during the Webb Telescope launch phase, for broadcast to a global audience. Thermal vacuum chamber testing of the VIKI system was undertaken by **Enbio** in a chamber it developed in-house to meet the growing demand for space qualification testing of electronic systems in Ireland.



**Figure 6:** Réaltra Space Systems Engineering's VIKI undergoing testing in Enbio's thermal vacuum chamber. © Réaltra Space Systems Engineering

**ATG Innovation** won a Future Launchers Preparatory Programme (FLPP) contract to assess the performance, cost, and manufacturing process for a grid-stiffened interstage for small launchers. This technology could have application on a number of launch vehicles currently in development in Europe and further afield.

**Lios**, the Dublin start-up formerly known as Restored Hearing, secured its first contract with ESA to develop its advanced acoustic material, SoundBounce, for use in the next generation of European space transportation vehicles. Founded in 2009 by Rhona Togher and Eimear O'Carroll, Lios has developed technology that can protect people from avoidable hearing damage by using novel metamaterials for hearing protection.

In partnership with ESA, Lios is attempting to protect launch vehicle payloads, such as satellites and delicate instrumentation, from the high levels of acoustic noise and vibration they are subjected to during space flight. Lios will work towards improving the acoustic environment within the launch vehicle fairing – the nose cone that protects the payloads on their way into orbit. SoundBounce can reduce weight and enable an increase in the size and mass of satellites, giving



the European space transportation industry an advantage in the increasingly competitive space market.

By developing and qualifying SoundBounce to meet the demands of the space sector, the start-up expects further opportunities to arise in other sectors that require high levels of reliability, such as the automotive and aircraft industries.

**InnaLabs** was awarded a contract for the development and qualification of an accelerometer for the Vega C launch vehicle's NAVIGA inertial navigation system, which will allow global navigation satellite system-based/hybrid navigation. The system may also be used on the Space Rider vehicle, ESA's planned uncrewed orbital spaceplane.



**Figure 7:** Lios founders Eimear O'Carroll and Rhona Togher. © Lios

# Technology development for science missions

ESA's Solar Orbiter spacecraft was successfully launched in February 2020 to its orbit around the Sun. The spacecraft incorporates technology developed by Irish companies **Enbio** and **CAPTEC**.

Enbio's surface-coating technology is being used on the spacecraft heat shields, antennae, and the housing for highly sensitive instruments, in order to protect the spacecraft from extreme radiation.

CAPTEC provided the independent validation of the spacecraft's critical software. In addition, the **Dublin Institute for Advanced Studies** is co-investigator on the Solar Telescope Imaging X-Rays (STIX) instrument, one of six scientific instruments that will observe the Sun and send imagery to Earth. Four other instruments will measure the solar wind, including electrical and magnetic fields associated with it.

Irish companies **InnaLabs** and **Réaltra Space Systems Engineering** continued to develop technologies for ESA's PLATO mission.

InnaLabs was awarded a contract to develop a high-accuracy 3-axis accelerometer which could have a potential application on the PLATO platform, where it would measure the spacecraft's acceleration in three dimensions.

Réaltra Space Systems Engineering continued its work on developing the Payload Interface Unit (PLIU) for controlling the temperature of the spacecraft's 26 cameras. In fact, controlling the temperature allows the cameras to be focused very precisely. To reach the high optical precision required, the focal length of each PLATO camera will be adjusted through very slight temperature shifts, causing it to expand or shrink. Changing the temperature by just 0.1 °C using a trio of camera heaters (which will be controlled by Réaltra's PLIU) will adjust its focusing length by 1 micrometre – one thousandth of a millimetre. The company successfully concluded the PDR (Preliminary Design Review) milestone after close technical evaluation of the PLIU design documentation and test result inputs, a very significant milestone. Réaltra will now proceed with the detailed design and build of the EQM (Engineering Qualification Model).



**Figure 8:** The Solar Orbiter spacecraft before launch, clearly showing the black heat shield on top. The heat shield was coated by Irish company Enbio. © ESA, S Corvaja.



**Figure 9:** A PLATO camera mounted inside the VTC-1.5 Space Simulator for testing, using liquid nitrogen to keep it around -80 °C. © ESA, Matteo Apolloni.



## Bringing technology innovation to the space sector

High-tech start-up **PixQuanta** was awarded a contract by ESA which will enable the cutting-edge light-sensing technology company to increase the market readiness of its novel 3D imaging solutions.

PixQuanta's revolutionary light-sensing technology offers major performance and cost-saving benefits. Major markets include 3D consumer applications, such as depth-sensing interactive augmented reality (AR). Additionally, PixQuanta's technology is important for advanced driver-assistance systems (ADAS) for driving and parking in automotive applications, thus providing a crucial route to the holy grail of a safe autonomous vehicle.

In the medtech sector, PixQuanta will enable ultra-low-dose X-ray imaging, reducing radiation exposure to the lowest possible physical limit. In

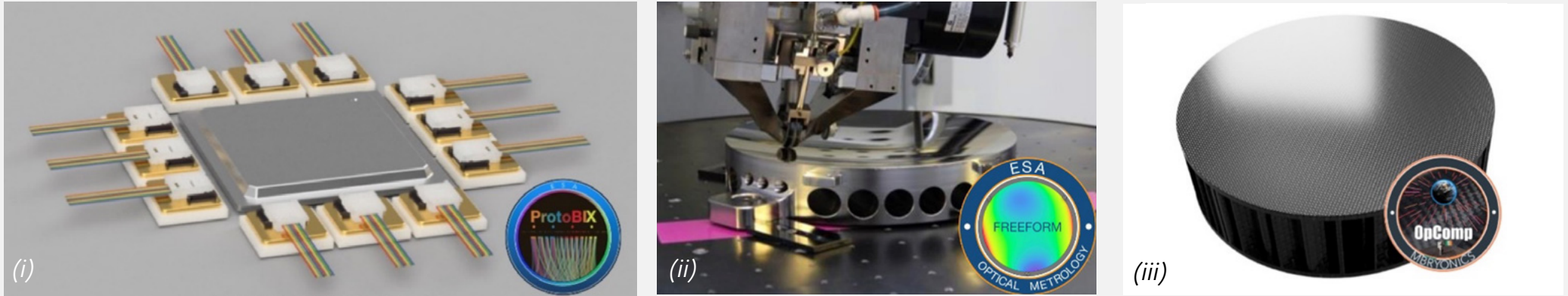
the space market, the application potential for LiDAR (light detection and ranging) is enormous, and includes activities as diverse as mapping space debris, and rendezvous and docking.

In 2020, Galway-based **Mbryonics** won three technology development activities in highly competitive ESA tenders. Mbryonics targeted these specific activities as they align with the company's strategic objective to be the world's leading provider of satellite all-optical communications payloads for the emerging constellation and high-throughput satellite (HTS) market. The design requires low size, weight, power, and cost solutions that can be manufactured in volume through the development of smart manufacturing solutions and series production lines, while providing an order-of-magnitude increase in performance.

All three developments are vital to enable next-generation satellite communications solutions in low Earth orbit and geostationary orbit for data-intensive applications such as 5G, satellite broadband, remote sensing, and EO, as well as highly miniaturised optical terminals for optical mesh networks and optical links to ground.



**Figure 10:** From left to right: Peter Smyth, Commercial Director, Tyndall National Institute; Peter Finnegan, Manager, ESA BIC Ireland; and Kevin O'Neill, CEO, PixQuanta following the announcement that PixQuanta's medical, VR and automotive applications were being commercialised under a new ESA contract. Photo: Gerard McCarthy



**Figure 11:** i) Concept illustration of an application-specific integrated circuit with ProtoBIX co-packaged silicon photonics high-speed serial interconnects; ii) An example of the machining process (polishing of off-axis aspherical mirrors) for which Mbryonics will provide inline metrology through the ESA-funded FreeForm project. © Fraunhofer IOF, published in "Fabrication method for large off-axis aspherical metal mirrors", EUSPEN 2014; and iii) illustration of a carbon-fibre reinforced plastic mirror © Mbryonics

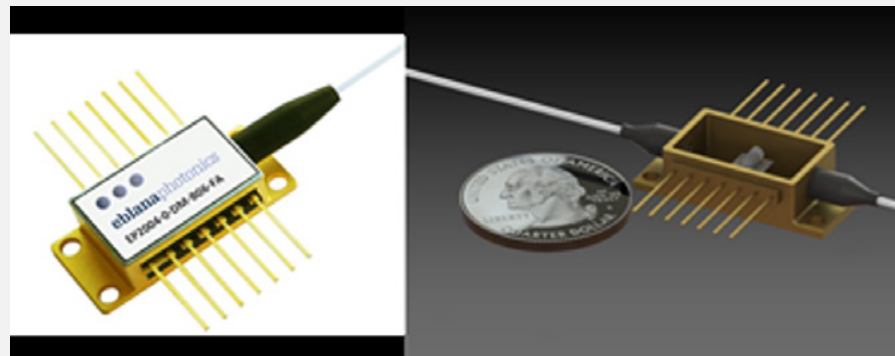
These contracts enabled Mbryonics to hire nine additional highly skilled engineers; to develop new intellectual property; to advance its smart manufacturing facilities for optical and photonics space systems; and to grow its business into adjacent and new (non-space) high-value market sectors.

**Eblana Photonics**, working with a Swiss-based industrial partner MicroR systems, École Polytechnique Fédérale de Lausanne (EPFL), and **Dublin City University** (DCU) embarked on an ESA co-funded development of a novel narrowband laser source for next-generation satellite systems. The need for smaller and more precise lasers is a universal demand across almost every market where lasers are an important technology. In addition to the space segment applications of optical atomic clocks and LiDAR, there is a range of ground segment markets that require compact and precise laser systems.

The long-term goal is to reach a space-qualified laser system for use on next-generation space-based optical atomic clocks. However, the commercial success of the programme does not rely on that end target. After completion of the project, a laser system will be ready for ground-based optical atomic clocks. This is an excellent

first target market, with a low entry barrier due to the need for advanced technology based on the properties of the new system.

DCU is playing an important role in the project by testing the spectral linewidth of the lasers developed by Eblana Photonics which will be used for laser diode optimisation.



**Figure 12:** Left, a discrete mode diode laser from Eblana Photonics; right, a rendering of an optical microresonator in a butterfly package coupled to an optical waveguide. © Eblana Photonics



## Using satellites for environmental monitoring and the Climate Action Plan

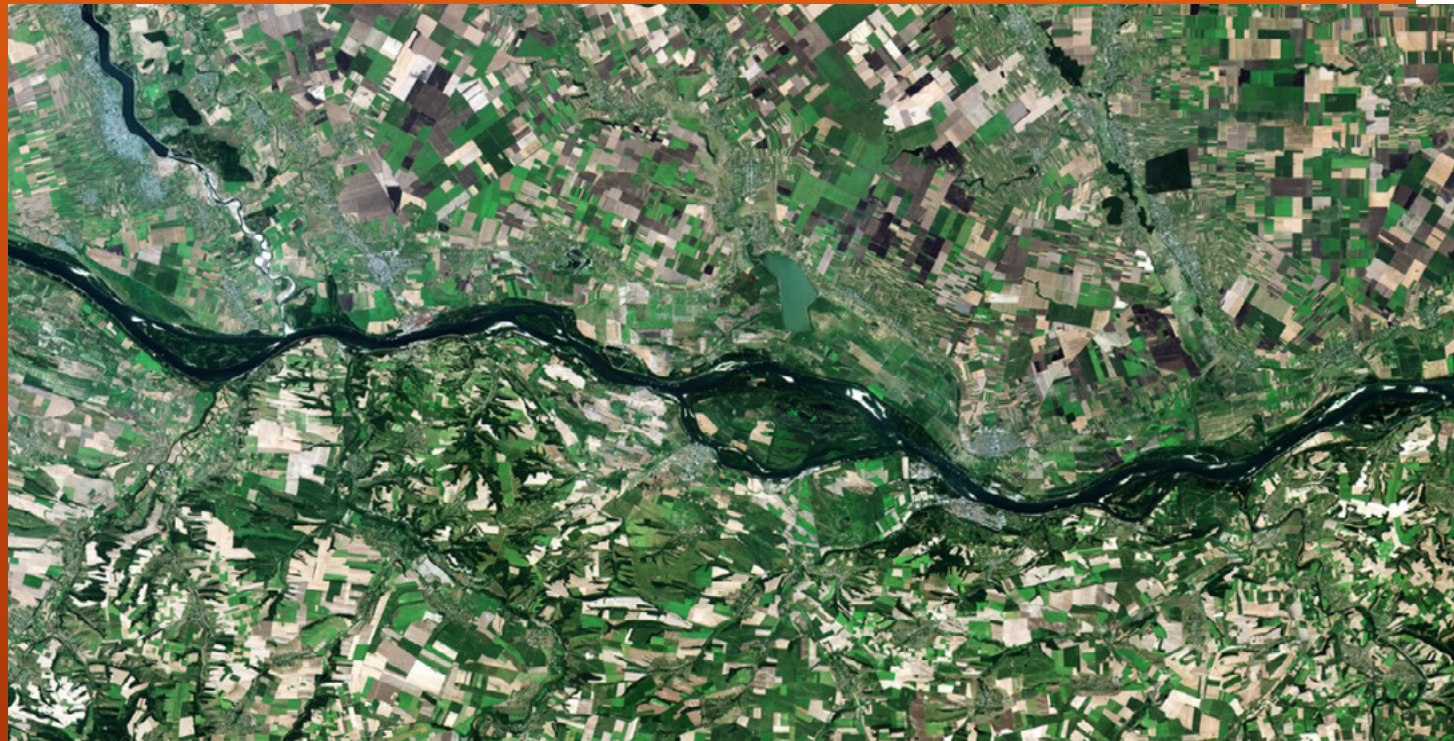
**Davra**, founded in 2012, is a pioneering Internet of Things (IoT) company that helped coin the term Application Enablement Platform (AEP). Its platform has been used to create solutions in areas as diverse as connected transportation, smart cities, connected products, manufacturing, utilities, oil and gas, healthcare, mining, and remote working.

In 2020, Davra commenced a project with ESA to develop novel methods of monitoring mine industry tailings storage facility (TSF) integrity by amalgamating terrestrial IoT ground sensor data with EO data. Davra will, with ESA support, develop a means of employing AI and machine learning (ML) in providing near-real-time views of TSF perimeter changes. The solution monitors TSF hydrological and geological changes in order to provide more comprehensive datasets, which can be used to forecast potential physical breaches or environmental regulation breaches in the storage dams.

Irish EO and geoscience company **The Icon Group** won a contract from ESA to develop the Danube Environmental Risk Assessment Platform. The new platform is expected to be used by port authorities, environmental groups, fishing and farming organisations, and the United Nations (UN), as well as regional and national authorities.

The Icon Group will develop new space imaging technology to work with cloud-based applications to detect, monitor, analyse, and characterise the sources of environmental problems across 20 European Union (EU) member states. The Icon Group will work in conjunction with the EU's Copernicus Programme, which is an EO satellite system coordinated and managed by the European Commission in partnership with ESA, EU member states, and other agencies.

**Figure 13:** The Danube river forming the border of Romania to the north and Bulgaria to the south, as captured by Sentinel-2A on 26 July 2015. © Copernicus Sentinel data (2015) / ESA







**Figure 14:** An illustration of spatial and temporal variations of structural displacement of the Buzău River valley dam, a non-rigid (embankment) type dam that is designed to flex under stress.

Tipperary-based **Woodco Renewable Energy Ltd** was awarded a contract by ESA to support smart sanitation in South Africa by combining terrestrial technologies with space-based capabilities in communities where improved sanitation measures are being deployed.

The main goal of the Space for Sanitation project is to harness the latest IoT technologies, AI technologies, and space-based technologies to provide an early warning system for likely outbreaks of disease. By combining the data streams from a wide variety of terrestrial and space-based sensing technologies, the platform will produce actionable insights, including new insights not readily available from any single source. For example, the system can monitor

the impact of illegal dumping of faecal sludge in water courses, as well as the flow of waste and its interaction with the local environment and local populations.

Project partners include Biomass Controls PBC; Water Research Commission; Duke University Center for Water, Sanitation, Hygiene and Infectious Disease (WaSH-AID); IBM; Mindseed; iPoint; University of KwaZulu-Natal; and eThekweni Municipality among others.

Cork-based company **Treemetrics** secured an ESA contract to develop a new platform to enable the production of forest certification and carbon verification standards. Consumers globally are demanding products that are sourced from producers and suppliers who work in harmony with nature. Treemetrics, with the support of ESA, has begun developing a platform to support the easier adoption of forest certification and more transparent auditing of management practices that will use the latest satellite imagery from the Sentinel satellite global constellation. The leading global forest certification standards organisation PEFC International will partner with Treemetrics to ensure that the system meets the needs of its certificate holders internationally.



**Figure 15:** A commercial forest as seen through the 'eyes' of a 3D laser scanning system developed by Treemetrics. © Treemetrics



**Geo Aerospace Ltd**, a Kildare-based start-up and first-time ESA contractor, secured an ESA Kick-start contract to investigate the use of satellite systems for the monitoring of critical infrastructure, including power grids, to meet regulatory requirements and respond to severe weather events. A follow-on demonstration project is planned.

ESA also supported a number of EO-related activities involving Irish universities including:

The Baltic+ SEAL project, involving **University College Cork**, has been framed as a laboratory to test advances in altimetry data processing to estimate coastal sea level. The project activities will also demonstrate the use of these new regionalised products by conducting an examination of Baltic Sea regional sea level trend, calculating a new mean sea level map, and producing an experimental high-temporal resolution grid. The released dataset consists of multi-mission along-track data, gridded monthly sea level and mean sea surface temperature. Further possible exploitation of the dataset includes a wide range of opportunities – from supporting local ocean circulation research to storm surge monitoring.

**NUI Galway** and **University College Dublin** are participating in the ESA-supported AIREO project to investigate the application of AI techniques in the use of satellite EO data. The approach will include:

- Reviewing current initiatives, activities, techniques, tools, practices, and requirements for preparing, using, and sharing AI-ready EO training datasets
- Setting up an AIREO network of stakeholders and practitioners in the AI/ML, EO data science communities, as well as a network of people from other relevant science disciplines
- Capturing community requirements and developing specifications for AIREO datasets by using existing formats and standards, and also developing best practice guidelines for preparing, using, and sharing AIREO training datasets.

AIREO specifications, best practices and datasets will meet FAIR (findable, accessible, interoperable, reusable) data principles and will involve building on relevant community initiatives.

**Maynooth University** is participating in the ESA HYDROCOASTAL project, using Sentinel-3 and Cryosat satellite radar altimetry for coastal zone and inland water measurements. New synthetic aperture radar (SAR) and interferometric SAR (InSAR) processing algorithms for the coastal zone and inland waters will be developed, implemented, and evaluated through an initial test dataset for selected regions. Based on the results of this evaluation, a processing scheme will be implemented, in order to generate global coastal zone and river discharge datasets. Case studies will then assess these schemes in terms of their scientific impact.

## Space supporting commercial business applications

**Robotify**, a virtual robotics platform founded by two former Dublin City University students, has won a contract with ESA worth over €450,000.

The contract will see the Dublin-based start-up provide robotic simulations for businesses in the agriculture, oil and natural resources, large infrastructure, and large infrastructure, freight, and remote testing sectors, using real-time satellite imagery from the Sentinel-1 and Sentinel-2 satellites that orbit Earth.

Instead of having to conduct on-site testing, for example, an engineer working remotely on a mining project in western Australia could configure their robot using its Simbotify engine, and then download the latest data from the Sentinel satellite toolkits to trial the efficacy of their autonomous robots' performance across a multitude of terrains.



**Figure 16:** Adam Dalton and Evan Darcy of Robotify.  
© Robotify



**Figure 17:** Tester updating the firmware of a telematics device used in Rentalmatics' SaaS-based real-time tracking system for car rental companies' fleets.  
© Rentalmatics

Dublin-based **Rentalmatics** has built a telematics-based operating system for car rental companies that allows their staff to automate, visualise and manage their car rental operations. Rentalmatics' goal is to reduce the cost of rental operation while providing new opportunities to car rental companies. Rentalmatics' software as a service (SaaS) system uses telematics devices installed in vehicles that rely on satellite positioning for fleet tracking, cellular data for data transfer, and on-board accelerometers to capture certain vehicle events, such as collisions, which may occur while the vehicle is being rented. This allows the rental company to fully visualise and manage the life cycle of each vehicle in its fleet.

With ESA support, Rentalmatics is now in the process of creating an additional product: Contactless On-demand Rental. This new product will transform the rental experience from counter-centric to app-centric. It will use a combination of AI, analytics, telematics and process automation to achieve this transformation, all rental procedures will be contactless, requiring no staff to be present.



**MinFarm Tech**, a recently established Irish company and subsidiary of MinFarm Bia AB (Sweden) secured an ESA contract to develop and deploy lost-cost satellite-based IoT solutions for the smart agriculture, mining, energy, and utilities sectors operating in remote locations where there is no cellular coverage or grid power available. Specifically, MinFarm Tech's products and services are enabling tangible operational improvements in large agricultural projects in remote regions of Southeast Asia and South America. The ESA-funded activity is being undertaken in partnership with satellite service provider Inmarsat. The opportunity to develop advanced features for optimising and managing IoT deployments over existing satellite networks like Inmarsat IsatData Pro will enable MinFarm Tech to develop its core technology, which is the foundation of its value proposition to customers and industry partners, thus supporting the company's projected future growth in Ireland.



**Figure 18:** The MinFarm MF 400 product.  
© MinFarm Tech

## Supporting new space start-ups (ESA BIC)

In 2020, the ESA BIC consortium welcomed Peter Finnegan as manager of the ESA BIC.

The ESA BIC approved five new company start-ups in 2020 (GeoAerospace, ProvEye, waytoB, AutoPlan and Geckos United), as well as one technology demonstrator project (Microchip), and it now is well on course to realise its commitments for the first five years of activity.

Five of the ESA BIC participating companies successfully closed funding rounds in 2020, with a combined value of €3.8 million.

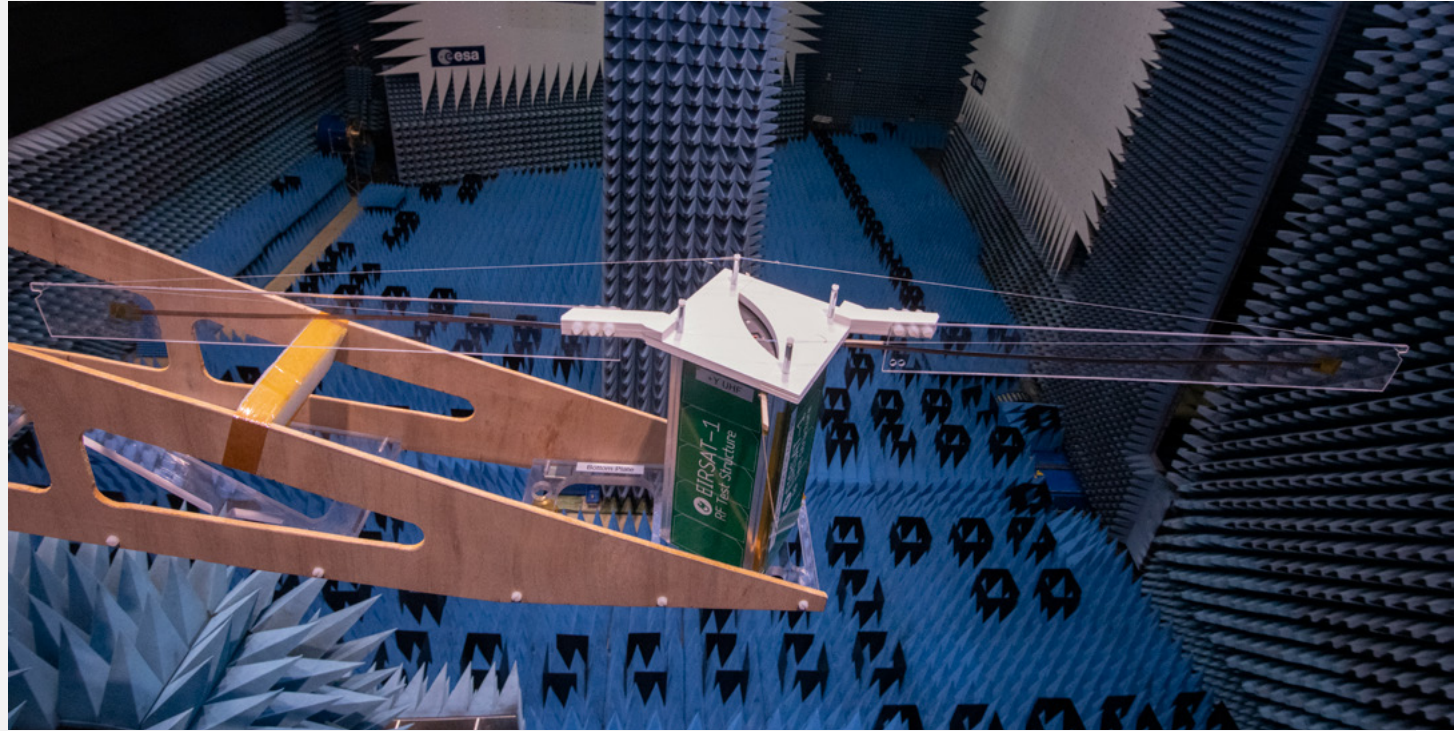


**Figure 19:** ESA BIC centres across Europe. © ESA

## Space science research

There was a notable increase in the number of space-related research activities undertaken by third-level institutions in collaboration with industry – a trend that is expected to continue into 2021.

Testing of Ireland's first mission in space, the Educational Irish Research Satellite 1, or EIRSAT-1, took place at ESA's Hertz antenna test chamber. The spacecraft is being built by students and staff at **University College Dublin**, as part of ESA's Fly Your Satellite! programme and with the support of the PRODEX Programme. EIRSAT-1 is smaller than a shoebox, but it has the complexity of a standard space mission. A number of Irish companies are also using the mission to perform in-orbit validation of their technologies, with ON Semiconductor (Ireland) providing the sensor for the gamma-ray detector, Enbio producing novel surface coatings for a heat transfer experiment, and Realtime Technologies building some of the satellite's printed circuit board assemblies.



**Figure 20:** EIRSAT-1 undergoing testing in ESA's Hertz antenna test chamber. © ESA, P de Maagt

**The Dublin Institute for Advanced Studies** (DIAS) is participating in the ESA-supported 3D Earth project. The goal of this project is to establish a global 3D reference model of the crust and upper mantle based on the analysis of satellite gravity and (electro-) magnetic missions in combination with seismological models, and to analyse the feedback between processes in Earth's deep mantle and the lithosphere. Selected case examples will provide the

possibility to test these approaches on a global and regional scale. This will result in a framework for consistent models that will be used to link the crust and upper mantle to the dynamic mantle. This model is called Winterc and is expected to be a new global Earth interior reference model for the top layers down to approximately 450 km.



**Other research contracts awarded to third-level institutions in 2020 include:**

| Institution  | Description   | ESA Programme    |
|--|---|------------------|
| Dublin City University (with Eblana Photonics)       | Compact optical clock laser   | GSTP             |
| Dublin City University                               | Novel countermeasures to prevent physiological decline during bed rest  | PRODEX           |
| Dublin Institute for Advance Studies                 | STIX instrument continued scientific and technical support  | PRODEX           |
| Maynooth University                                  | Sentinel-3 SAR image altimetry  | EOEP             |
| NUI Galway (with Mbryonics)                          | Metrology for optical free-form surfaces  | Basic Activities |
| NUI Galway   | Fine-structure of laser radiation in the far-field  | CTP General      |
| Trinity College Dublin                               | Convection and interfacial mass exchange  | E3P              |
| Trinity College Dublin                               | Hydrodynamics of wet foams  | E3P              |
| TU Dublin  | Wound healing in space  | E3P              |
| Tyndall National Institute (with NUI Galway)         | Mems-based nanoparticle storage and release system for quantum physics platform   | CTP General      |
| University College Cork                              | Atlantic regional initiative  | EOEP             |
| University College Dublin (with Thales Alenia Space) | Dust removal for optical surfaces   | Basic Activities |
| University of Limerick                               | Chemical compatibility and wettability of various materials with various working fluids for two-phase and heat pump systems | Basic Activities |

## Space for primary and secondary education

### ESERO Ireland 2020 highlights

Adaptation proved to be an important word for ESERO Ireland in 2020. Due to the Covid-19 pandemic, most of the work programme was adapted for digital delivery. A positive aspect of this change is that digital delivery removes geographical barriers to participation in events/projects.

Over 1,400 primary and secondary teachers participated in ESERO Ireland professional learning experiences in 2020. These were run in partnership with projects and organisations such as the SFI Discover Primary Science & Maths programme, Blackrock Castle Observatory, I-LOFAR, Sustainable Energy Authority of Ireland, and Junior Cycle for Teachers. A highlight was the online summer course for primary school teachers entitled “Discover Climate and Space” which ran during July and August, with 160 primary school teachers participating.



Space Week went virtual in 2020 and had a reach of over 83,000 people, with a mix of school and public events. It was funded through the SFI Discover Programme and was managed by Blackrock Castle Observatory.

New space scientists and engineers are profiled monthly on the ESERO Ireland website ([www.esero.ie/career-profiles](http://www.esero.ie/career-profiles)). Some of these also featured at the three ESERO Space Careers Roadshows, which were attended by over 2,000 Transition Year students. Senior Cycle students also had an opportunity to have space scientists and engineers visit their classrooms through the ESERO Space goes to School virtual programme.

ESERO Ireland and Science Foundation Ireland partnered with the Irish Girl Guides (IGG) and Blackrock Castle Observatory to launch the



**Figure 21:** Irish Girl Guides showcasing the first IGG Space Badge, with the aim of helping Ladybirds, Brownies and Guides to understand their place in space. While earning their badge, the girls use many science, technology, engineering, and maths (STEM) resources and also develop their scientific skills, such as problem-solving, teamwork and creativity, while having fun and engaging in space- and astronomy-related activities. © ESERO.

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# EU space activities

The EU space programme regulation establishing the 2021–2027 space programme was agreed in December 2020. Text proposed by Ireland, recognising the need to develop capacity in member states with an emerging space industry, was retained in the agreed text. Securing a mechanism to enable this commitment will be an important piece of work commencing in 2021.

In place of face-to-face Competitiveness Council meetings to discuss space-related issues, which could not take place due to the Covid-19 pandemic, the European Commission held two informal video conference meetings during 2020. At the first meeting, on 29 May 2020, the Minister of State for Training, Skills, Innovation, Research and Development, John Halligan, represented Ireland in a policy debate on how improved evaluation of the socioeconomic impact of space programmes can contribute to better policy-making and environmentally sustainable industrial development.

The Minister of State for Business, Employment and Retail, Damien English, represented Ireland at the second meeting of space ministers on 20



**Figure 22:** The ESA Council meeting at ministerial level. © ESA - S. Corvaja

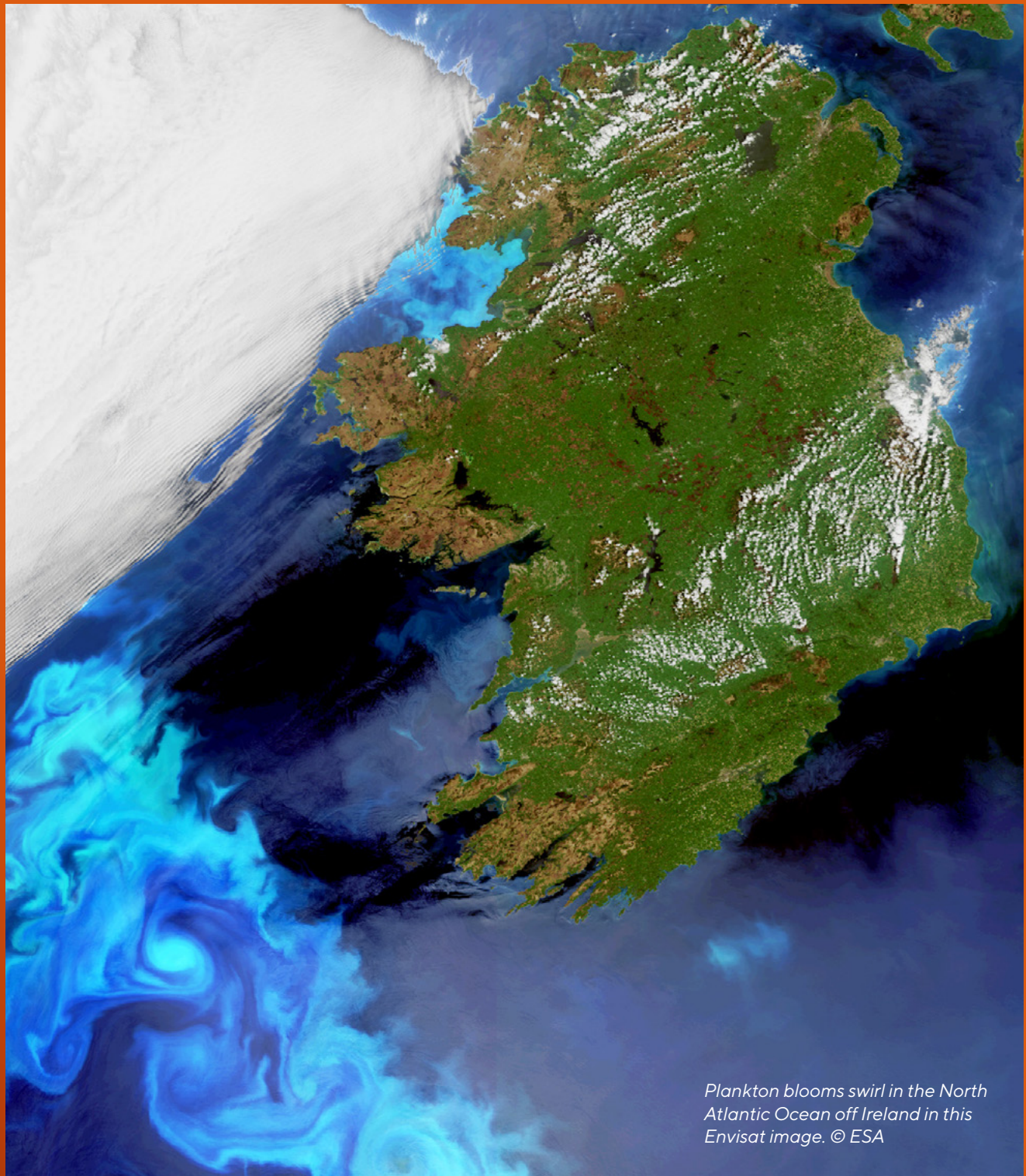
November 2020. A joint EU-ESA Space Council took place on the same day. Among the topics discussed were actions that Europe can take to build a globally competitive European space economy; European space autonomy, security and resilience; and enhancing European space cooperation. The Commissioner for Internal Market, Thierry Breton, also attended the meeting, where he announced a new €1 billion European space fund to boost start-ups and small and medium-sized enterprises (SMEs).



**Figure 23:** Minister Damien English attending the virtual joint EU-ESA Space Council meeting.



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



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