UNIVERSITY OF PORTSMOUTH

Portsmouth Research Institute for Space Missions (PRISM)

Partnering with industry to make the UK a leading space nation

CASE FOR DEVELOPMENT

> Space technology is a strategic priority for the University of Portsmouth, and we are passionate about driving forward research excellence and innovation in this area. From our world-leading astrophysics and cosmology research, to our expertise in the use of satellite data for solving global challenges, at Portsmouth we aim to cover the whole range of space activities.
>
> Our new research institute, to which we have committed £5 million, will enable us to offer our data analytics, mission design, simulation and analysis specialties as services to the entire space community, and will inspire cross-disciplinary and academic-industrial collaboration.

Prof Graham Galbraith CBE, Vice Chancellor, University of Portsmouth

Cover image courtesy of images.nasa.gov

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This brochure is also available in an accessible format - please contact us: icg-admin@port.ac.uk

1. A NEW OFFER TO INDUSTRY

The UK space industry has seen extraordinary growth over the last decade, trebling in size. The industry currently generates an income of £16.5 billion annually and employs over 47,000 people. Consequently, the UK government has committed to building a highly agile space nation and making a generational leap forward in space technologies and capabilities.

A range of challenges stand in the way of achieving the ambitious national goals. The University of Portsmouth is committed to solving these challenges in collaboration with industry:

- Gap in technical skills and research skills, including access to industry-ready graduates with systems expertise, data analytics and technical skills
- Barrier of access to space for new/small companies or scientists, particularly in raising the Technology Readiness Levels (TRL) of new products
- Lack of clear path to leadership for UK Principal Investigators
- Need to develop a pipeline of sovereign missions

In partnership with both established and new organisations in the space sector, we will develop a new dedicated facility tailored to solving these challenges, breaking down barriers and boosting growth.

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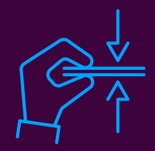
We will:



Close the space sector skills gap by developing research, teaching and training programmes to deliver what industry needs

Give industry insights into the coming advances in science and technology, through access to research expertise and horizon scanning

De-risk the process of raising TRL and broaden access to opportunities in the sector, by collaborating on the testing of new instrumentation

Feed the UK space ecosystem and build supply chain resilience by generating a diverse pipeline of large and small mission concepts

Help to facilitate new international partnerships and investment, along with increased access to grants for research and potential to generate new revenue streams

Together, we will make the UK a leading space nation.

2. VISION

Our mission is to generate the coherence in the space sector that is needed to make the UK a great space nation.

The Portsmouth Research Institute for Space Missions (PRISM) will focus on applied space research at the boundary of academic-industry work.

To this end, PRISM will contain both University research groups and industry innovation centres, and will bring together all of the University of Portsmouth's space activities under one roof. PRISM activities will be built around joint programmes that bring benefits to diverse partners, supported by bespoke facilities derived from programme requirements. Strong programmes at PRISM will form important anchors of regional (Space South Central) and national programmes.

PRISM will be formed of three key pillars, all underpinned by skills development, and all interfacing with and supporting each other:

- We will be the leading centre for **mission architecture design**
- Targeted work on **digital twins and data analytics** will build on our existing world-leading expertise
- Functional and performance **test programmes** for hardware and software will de-risk Technology Readiness Level (TRL) raising

The facility will be designed to inspire innovation, interdisciplinary collaboration, and academic-industrial engagement, as well as including new technical facilities.

PRISM represents the University of Portsmouth's commitment to space as a strategic priority. It builds on the success of our world-leading Institute of Cosmology and Gravitation, extends our critical role in supporting UK space industries, and broadens our industrially relevant and internationally renowned space-focused research and innovation.

Crucially, PRISM will develop to meet the needs of industry. We are keen to hear directly from established, emerging and aspiring players in the space sector, to understand their needs and priorities. This will enable us to tailor our activities, to deliver yet more projects and facilities to which companies in UK space do not currently have access.

Focus areas

- Industrial collaboration across the space sector
- World-leading space-focused research for now and the future
- Mission design capability as a service
- Technology test programmes
- System simulation, digital twins and data analytics
- Developing research skills for industry and academia

Benefits to the UK space ecosystem

- Stimulate growth in space-sector R&D
- Strengthen links with the wider UK ecosystem; including catapults, launch providers and other research institutes
- Enable inward investment to the UK space sector
- Access to a new set of international partners

3. OBJECTIVES & DELIVERABLES

Mission design capability as a service

Inspired by, and developed in partnership with, NASA JPL Team-X, through our Mission Design Facility we will deliver a program for the rapid development of initial concepts to mission designs.

This approach will deliver a pipeline of programmes for a wide array of missions, at different scales and levels of maturity, enabling the UK to become a leading nation in mission design.

- Mission design will be offered as a service, facilitating rapid progress on the path to a space mission for any concept, for any customer
- Access to expertise and real-time design trade-offs will increase mission reliability and support national ambitions to be a global leader in space
- Industry provision of Subject Matter Experts to the mission design process will lead to improved visibility of UK national missions to industry at the earliest stage
- Increased diversity of mission-sizes will not only enable more activity across the sector but also support growth and resilience of the UK supply chain

Image courtesy of images.nasa.gov

Widening access to space through technology development

Through a combination of rapid prototyping, digital twins and in-orbit demonstrator programmes we will facilitate the transition of space flight software from Technology Readiness Level (TRL) 3 to 6, bridging a key gap and significantly widening access to space.

Access to reconfigurable space instrumentation will allow gathering of real space-borne data for product development and testing. Combined with instrument characterisation facilities, functional and performance test programmes, full system simulations and world-leading data analytics, this service will de-risk TRL-raising of software, algorithms and sensors.

A network of industry-engaged labs working on promising future technologies, starting from the priority setting stage and making a long-term commitment to innovation and development, will also enable hardware TRL-raising activities.

We will also improve investment potential and increase the competitiveness of the UK space sector by widening access to data science expertise and facilitating new opportunities for IP generation.

Closing the space skills gap

One of the biggest risks to national ambitions in space is the skills shortage. Meeting our national and regional skills needs will require close collaborations between Further Education (colleges), Higher Education (universities) and industry. Our activities in missions and technology will generate new placement and joint-project initiatives that will allow us to recruit, train and retain significantly more talent in the space sector.

Through new research groups, courses and projects we will foster true industrial and academic collaboration and will create innovative mindsets and opportunities. We are also committed to supporting the delivery of Space Technician Degree Apprenticeships.

With industrial guidance we can tailor our delivery of research skills to produce industry-ready graduates, which have the skills currently identified as key gaps. We will also offer industry access to people, at all career stages, with in-demand expertise in systems, data analytics and space-related technologies.

Upskilling and re-skilling through Continuing Professional Development (CPD) courses will enable lifelong learning and will help retention of talent for the space sector across all career stages. The ability to host industry training for short-term projects at Portsmouth, rather than on sensitive sites, also offers greater efficiency for businesses in some fields.

4. WHY PARTNER WITH THE UNIVERSITY OF PORTSMOUTH

There are many reasons why the University of Portsmouth is best-placed to help industry take advantage of space through PRISM - from our wealth of world-leading space expertise, to our track record of successful partnerships in space-related research and innovation, to our location at the heart of the UK space sector.

The National Space Strategy recognises that academia and research institutes are a vital component to growing the UK space sector. In particular, the strategy acknowledges the contribution of universities to world-class science, nurturing talent, collaborating with industry, and unleashing innovation. Academia is also an integral part of locally-led innovation clusters working to fulfil regional space ambitions.

The most recent Size and Health report, based on an analysis of 1293 space-related organisations, found almost half are based in London and the South East, with a substantial distribution across Hampshire, Surrey, and the Isle of Wight.

The University of Portsmouth is championing regional space cluster activity and is a founding partner of Space South Central, a partnership between industry and academia, designed to:

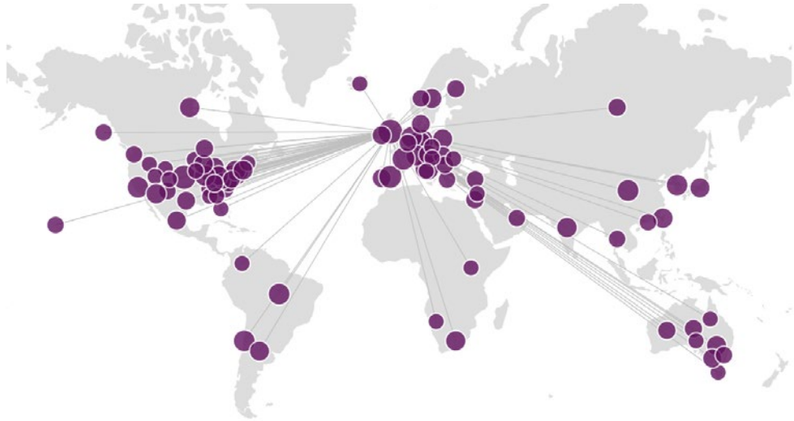
- Catalyse investment
- Deliver missions and capability
- Champion space

World-leading research: The Institute of Cosmology and Gravitation

The University is home to the Institute of Cosmology and Gravitation (ICG), a world-leading centre of space science. The ICG is internationally renowned for research excellence in cosmology, gravitation and astrophysics. It hosts 19 staff members, 25 research and outreach fellows and software engineers, 27 PhD students and a team of 4 administration staff. ICG research spans the full reach of the Universe – from early Universe cosmology, to the astrophysics of unique objects, to small satellite mission design led by our two space project managers. A dedicated research software team within the ICG explore innovative applications of astrophysics data analytics tools, and apply this expertise to a wide range of challenges, from COVID-droplet mapping to satellite imagery classification.

Our physics research is ranked 6th in the UK, with 100% of our research outputs judged to be internationally excellent or world-leading. Furthermore, ICG has successfully secured grant awards valued at £14.9M (REF period 2014-2020).

Members of the ICG play leading roles in the science requirements, design and analysis of data from many space and ground-based telescopes including major ongoing international collaborations and projects such as the Sloan Digital Sky Survey (SDSS), the Large Synoptic Survey Telescope (LSST), the ESA Euclid satellite, the Laser Interferometer Gravitational-wave Observatory (LIGO), and the Laser Interferometer Space Antenna (LISA).

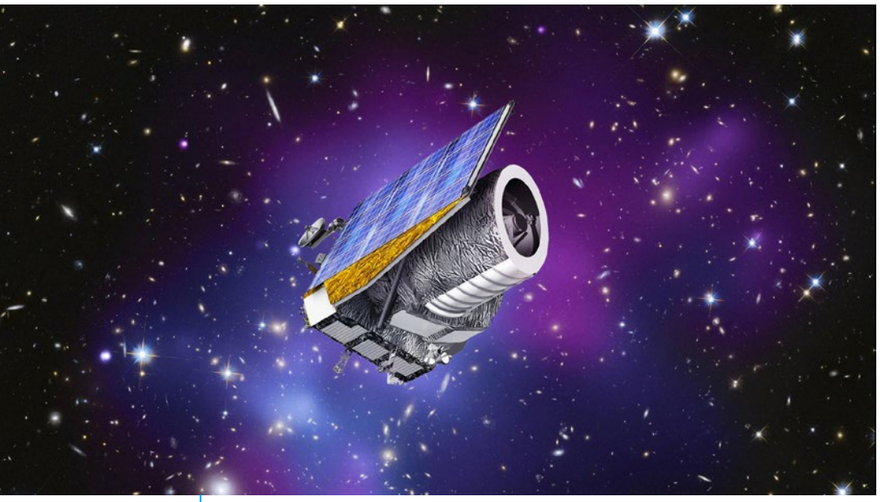


International reach of ICG collaboration

Image courtesy of images.nasa.gov

> The UK is going through an exciting period of expansion and ambition in the space sector. In Portsmouth we are surrounded by a diverse range of exciting space companies, and we would like to provide a focal point for business engagement and create cohesion in our regional space sector.
>
> One key goal of PRISM is to lower the barrier of access to space - to enable anybody to access a mission design service, for example.
>
> Portsmouth has extensive experience in applying our data analytics expertise to other fields, excellent international links and heritage in designing some of the most exciting space science missions. We will use this heritage to deliver an institute offering mission design as a service, technology development, and research skills tailored to industry needs.
>
> Such a facility is key to delivering the National Space Strategy, and we think that here at Portsmouth we are uniquely suited to developing such a facility.

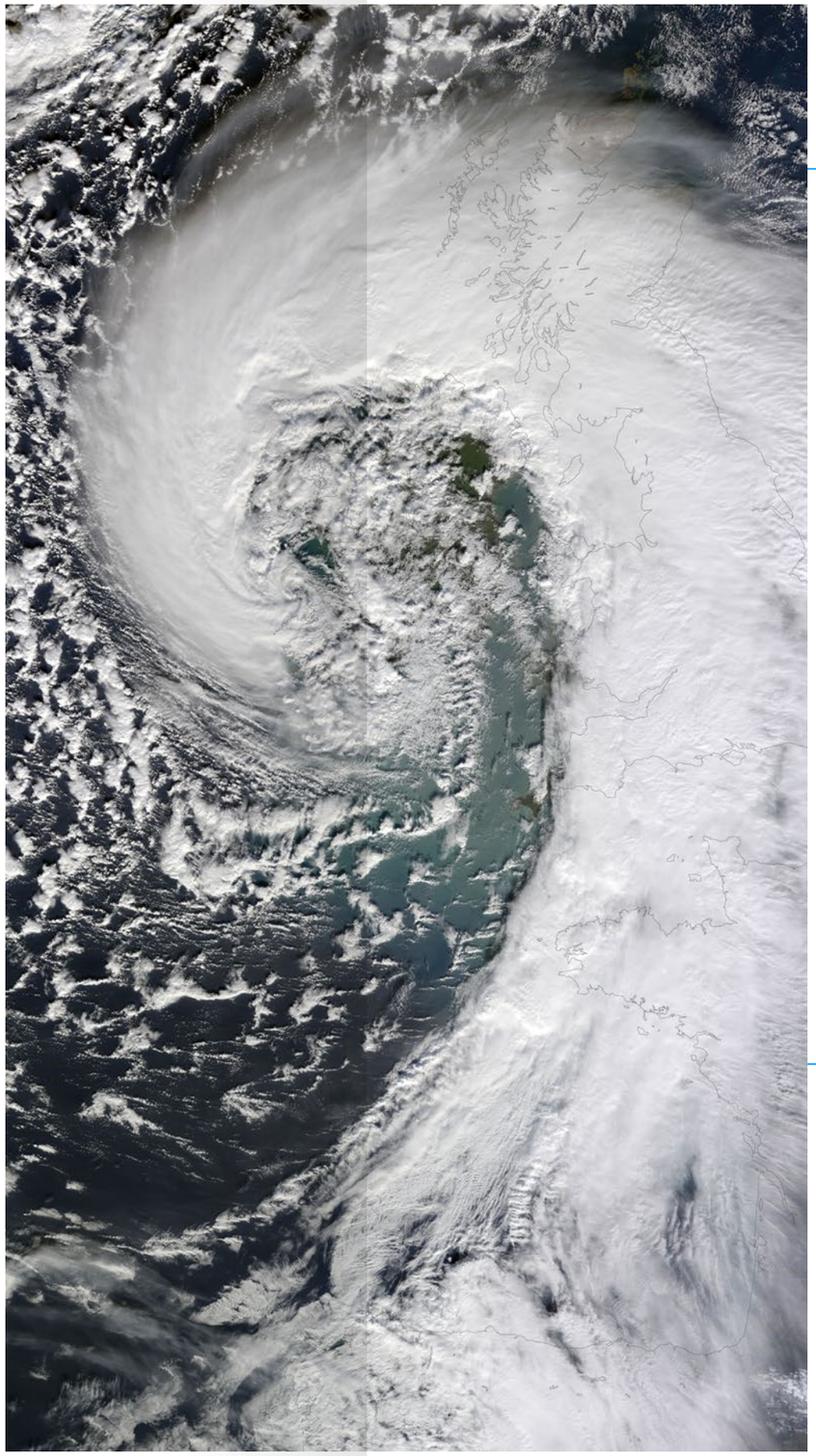
Professor Adam Amara, Director of the Institute of Cosmology and Gravitation



CASE STUDY: Euclid Mission to map the structure of the universe

Euclid is a groundbreaking ESA mission that will answer big questions about our Universe, and was originally developed by the Director of Portsmouth's ICG, Professor Adam Amara. Throughout its six-year mission, operating 1.5 million km from Earth, Euclid's 1.2 m diameter telescope will map the 3D distribution of up to two billion galaxies, up to 10 billion light-years away – around a third of the observable Universe. By revealing the Universe's large-scale structure, and its pattern of expansion, the mission will cast light on the mysterious dark energy and dark matter making up the vast majority of the cosmos.

Portsmouth has been a leading partner in this major international experiment involving 16 countries, 200 space labs and 1500 scientists & engineers. With globally leading scientists at the forefront of gravitational lensing, galaxy clustering and extragalactic astrophysics, the ICG will play important leading roles as Euclid begins to unravel some of the mysteries of the Universe.



CASE STUDY: Tackling global challenges with satellite data

The Global Earth Model (GEM) research group brings together researchers from disciplines across the University, including astrophysics, geography, geology, environmental science and biology, to work on projects involving innovative use of satellite data, and the transfer of analysis tools and methods across disciplines. Satellite imagery that shows land-cover changes has a range of applications – from urban planning and the development of guidelines on climate change resilience, through to oil pollution monitoring and policing of illegal gold mining.

The CommonSensing project, the largest Earth Observation (EO) project ever funded by the UK Space Agency (ca. £9 million between 2018 and 2022), used freely available satellite imagery to map hazardous terrain for hundreds of populated islands in the Pacific that are at risk from climate change. CommonSensing aimed to improve the islanders' resilience, using Open Data Cubes containing archives of satellite imagery and analysis-ready map layers developed by a University of Portsmouth team.

The University of Portsmouth is also one of the lead agencies delivering the SIMEX Series, the UK's largest annual international disaster and emergency response exercise. Bringing our satellite data expertise, we facilitate the delivery of this project of national importance, which addresses key global challenges.

CASE STUDY: Satellite-enabled digital insurance system for small farm-holders in Colombia

Portsmouth's Professor Richard Teeuw is leading a study on real-time data collection to inform assessments for parametric insurance. The study uses satellite data to perform farm geohazard mapping and risk evaluation of extreme weather events and the associated impacts on small scale farmers. The Portsmouth team, in collaboration with Mercari Risk Technologies (MRT), are able to utilise visible, infrared and radar satellite imagery to determine the extent of crop damage during extreme weather events. The development of a mobile app in conjunction helps to simplify the insurance process for smallholder farms and SMEs globally.

Facilities and capabilities

From enabling delivery of cross-disciplinary projects, to providing access to a rich variety of academic expertise, the University provides a wide range of other activities and facilities complementary to our space research.

Businesses involved in R&D for space hardware can access our range of material testing and characterisation facilities.

Some of our specialist laboratories include:

- Tomography
- Additive manufacturing
- Zeiss Global Centre (3D X-Ray and 3D metal and polymer printing)
- Scanning Electron Microscopy (SEM)
- Transmission Electron Microscopy (TEM)
- Mass Spectrometry
- Laser Ablation laboratory
- Rock Mechanics laboratory
- Biophysical laboratories

The University is also host to the Centre for Creative and Immersive Extended Reality (CCIXR). This facility is unique in the UK, and hosts a wealth of integrated technologies supporting virtual, augmented and extended reality, enabling innovation and providing unique opportunities to a range of business sectors. There are various ways in which the space sector could benefit from the application of the technologies at CCIXR. For example:

- Photogrammetry and volumetric capture can be used to capture hardware in 3D, so that spacecraft can be explored and worked on remotely
- Immersive technologies can assist with data fusion and validation, and training of users of satellite data
- Complex satellite data sets, such as astrophysics data, can be easily visualised

5. BUSINESS ENGAGEMENT

The University of Portsmouth plays a critical role in supporting space industries in the south-central region of England. We host ASTA Technology, the UK's only ESA-accredited provider of space engineering training, and recently held the successful Mission Space event, which promoted cohesion and partnerships in our regional space sector.

The University continues to be a lead partner of the South Coast Centre of Excellence in Satellite Applications, which promotes the many benefits and uses of satellite data and technology in the region, while supporting business growth in the space sector.

Research at the University has been undertaken with various industry partners including aerospace primes such as Airbus, BAE Systems and QinetiQ.

Some of the businesses we have engaged with:

- Satellite Applications Catapult
- Airbus
- BAE Systems
- QinetiQ
- Royal Navy
- TP Group
- Harwin
- Viridian
- PolyChord Ltd

South Coast Centre Of Excellence In Satellite Applications

The South Coast Centre of Excellence in Satellite Applications is one of three regional centres located across the UK created to help businesses and academics explore and exploit satellite technologies, to truly realise the possible.

Its mission is to develop collaborative projects, link expertise, identify and attract funding, share information, and provide network opportunities. The Centre acts as a central hub for academic and industry collaboration, building consortia, and supporting the development and funding of space technology, research and innovation.

Based at the University of Portsmouth's Technopole, the Centre hosts the region's only Space Enterprise Lab, an innovation space created for use by businesses. They are a founding partner of the UK's largest space cluster, Space South Central with whom they are using their experience and expertise to accelerate space business growth, foster an environment of innovation, grow the reputation of the south-central region and contribute to national prosperity. The Centre is also host to one of only four UK Ambassadors for the European Space Agency (ESA) Business Applications Programme.

31 Events (hosted and supported) in-person and online

166 Businesses Engaged

28 Countries Reached

£24.7m Value of Proposals Submitted

All data from Phase 2 (2019-2022)

Academic Industrial Collaboration

CASE STUDY: FLOCK - Using satellite data to reduce aviation's global warming impact

"It was a real pleasure to work with the University of Portsmouth on this challenging and important subject. They demonstrated leadership of the project and diligence in their research, and produced an excellent deliverable."

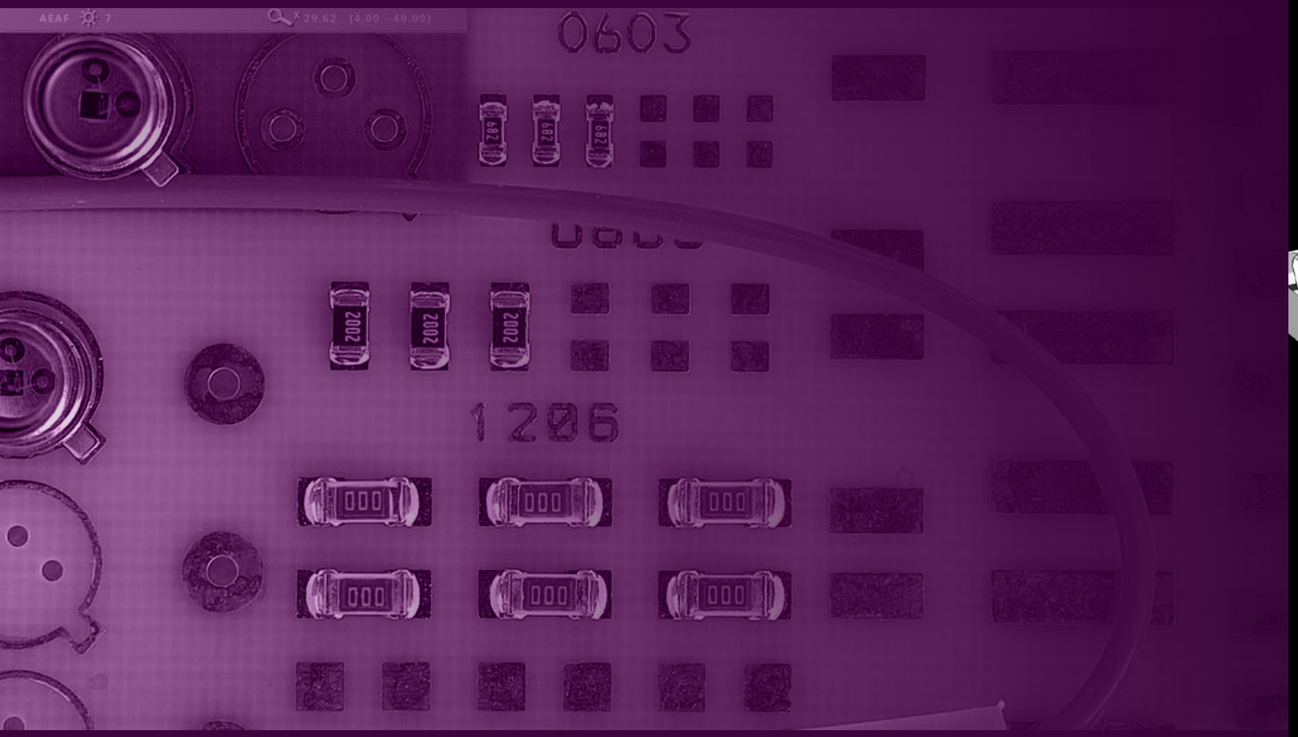
Matthew Stuttard,
Head of Space Systems Technical Strategy and R&D, Airbus

The aviation industry contributes 2% of global carbon emissions, and the global warming impact of Condensation Trails (Contrails) is equivalent to the same again. Together with PolyChord Ltd. and advised by Airbus, the University of Portsmouth has begun research into spaceborne solutions for contrail prediction and avoidance.

The preparatory study phase of the Flight Optimisation Using Contrail Knowledge (FLOCK) project was funded by the SPRINT programme.

Asta Technology Ltd.

ASTA Technology Ltd. is the only provider of ESA Accreditation for Space Technicians in the UK. Specialist staff train technicians from across the UK and Europe at dedicated on-campus facilities, supplying much-needed technical skills to companies like Airbus and BAE. ASTA has supported more than 130 businesses since it was acquired by the University in 2016, generating over £1 million in income.

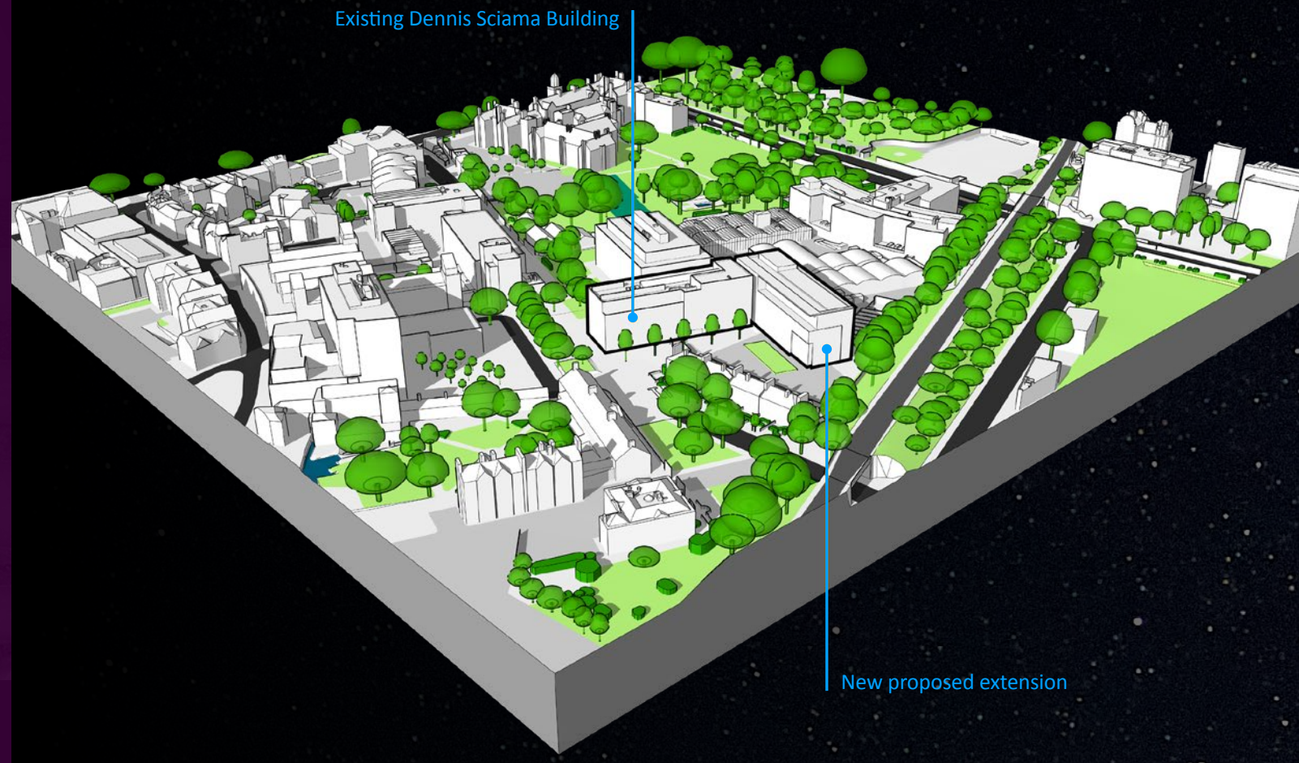


6. PRISM ESTATES CONCEPT

The proposed location for PRISM is in a dedicated new extension to the Dennis Sciama building, existing home of the Institute of Cosmology and Gravitation.

This development will be integrated into the University of Portsmouth's overall Campus Master Plan, the key aspects of which are greater density of development, sustainability, long-term adaptability, and future-proofed, fully digitally-enabled smart buildings.

The PRISM building will be technically excellent, functional, inspiring and exciting for students, staff, industrial partners and visitors, external researchers and the public.



7. WORK WITH US

PRISM sets out to help companies in the space sector deliver projects and facilities, and develop people, to which they currently have no access. We have good insight into industry ambitions, challenges and barriers – but now we need to hear from you.

Industrial partnerships will be instrumental in shaping and delivering PRISM. We welcome the opportunity to discuss the project further with you, so we can fully understand how research and innovation can deliver your goals for investment, product and talent development, and business growth.

In partnership, we will take a giant leap towards realising the ambitions of the UK Space Strategy. Together, we will make the UK a leading space nation.

Contact

Prof. Adam Amara

Director of the Institute of Cosmology & Gravitation

Royal Society Wolfson Fellow

adam.amara@port.ac.uk

linkedin.com/in/adam-amara-icg/

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