Science and Technology Facilities Council

From Knowledge to Impact: STFC Impact Acceleration Account

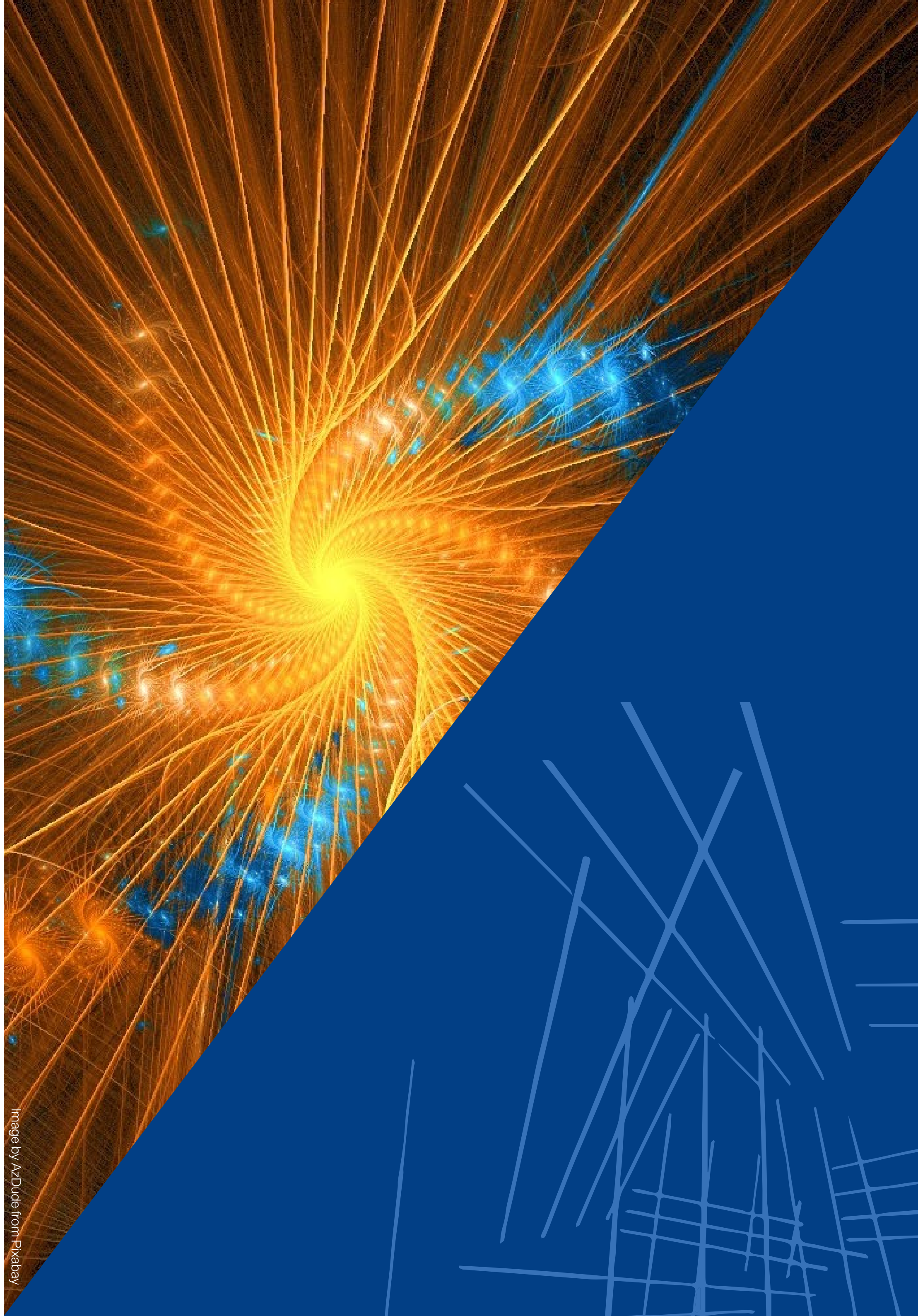

Image by AzDude from Pixabay

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STFC Impact Acceleration Account

STFC's Impact Acceleration Account (IAA), first introduced in 2014, provides responsive funding, managed at the institutional level, for the promotion and practise of innovation activities at Universities receiving significant STFC core grant funding.

The scheme is designed to promote impact and develop opportunities originating from the core STFC research and technology programme. This includes leveraging extra investment, increased industry engagement and community building activities, maximising the impact for the STFC community.

The case studies in this document highlight some of exciting projects funding thought the IAA. These studies showcase different approaches used by institutions and highlight the strengths and expertise from across the STFC community.

Credit: GettyImages

Delivering on Impact

Outputs from IAA recipients 2019/20

£2.5M STFC investment

£2.1M leveraged funding of which **£900K** from industrial partners

£3.3M continuation funding secured post IAA

4 spinouts

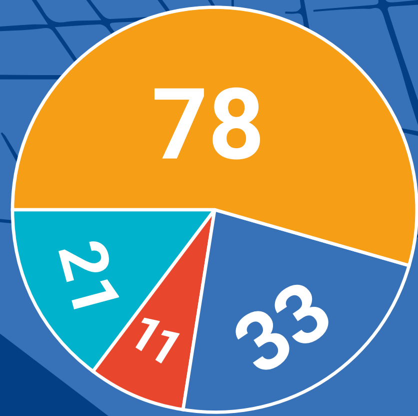
49 publications

7 patents

14 new products

80 follow on grants applied for

Funding Awarded



- proof of concepts
- collaboration events
- secondments
- *other

*Other includes: National and Local Government Engagement, Industry Engagement, Market Scoping and Analysis and Interdisciplinary Networking Events

Cardiff University *

Durham University *

Imperial College London

Lancaster University

Liverpool John Moores University

Open University

Queen Mary University of London

Queen's University of Belfast

Royal Holloway, University of London

University of Bristol

University of Cambridge *

University College London *

University of Edinburgh *

University of Glasgow

University of Hertfordshire

University of Leeds

University of Leicester

University of Liverpool *

University of Manchester *

University of Nottingham

University of Oxford

University of Portsmouth

University of Sheffield

University of Southampton *

University of St Andrews

University of Surrey

University of Sussex

University of Warwick

University of York

* Institutions which lead one of STFC's Data Intensive CDT's

Cardiff University

From astronomy to security

Investigators: Simon Doyle and Peter Hargrave (Cardiff University)

Cardiff used IAA funding to develop a proof of concept for the next generation of real-world environment scanning for airport and border security.

Using state of the art technology originally developed for astronomy instrumentation, the technology allows for the real-time scanning of individuals or vehicles to identify potentially dangerous objects or contraband.

The team have secured an additional £1M in funding, launched a spinout company, Sequestim, and a patent application has been filed.

This has since been trialled in Cardiff airport and the technology is projected to enable up to eight times the throughput of travellers through security checks, delivering vast improvements in airport efficiency, cost savings and higher levels of traveller satisfaction.

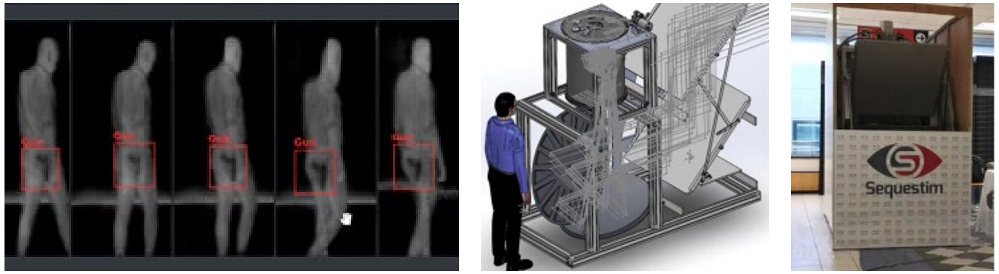
Image by rawpixel.com

The scanner's camera uses 'kinetic inductance detectors' that can help it detect the equivalent of the heat of a 100-watt lightbulb at a distance of half a million miles – twice the distance of the moon from Earth.

An image taken by the Sequestim device of a truck moving past a sensor at speeds up to 100mph clearly identifies the shapes of figures concealed in the rear of the vehicle.

The technology, pioneered by School of Physics and Astronomy researchers, could be installed at ferry ports globally, speeding up checks.

Further patents are being developed, and there are plans to secure an ECAC and TSA certificate, allowing the technology to be officially used in airports around Europe.



Left: Demonstration of our system working at Cardiff airport working at 5 frames/s. Here a mock gun has been concealed underneath a thick jacket. The system can clearly image the gun which has been identified by the AI as a threat. Centre: A CAD model of the early prototype demonstration system. Right: The demonstration system on temporary deployment at Cardiff airport.

Sequestim CEO Ken Wood and Sequestim co-inventor Andreas Papageorgiou (background) conducting trials at Cardiff Airport

"The support provided by STFC for fundamental physics and device research is core to the success of this venture. The availability of specific funds like Innovation Partnership Scheme and IAA enabled us to explore and then exploit the commercial applications of technologies originally developed for astronomy applications. In particular, the availability of IAA funding has been invaluable to enable rapid implementation of ideas that have significantly improved the commercial offering of Sequestim Ltd."

Peter Hargrave, Director of Innovation and Engagement,
School of Physics and Astronomy

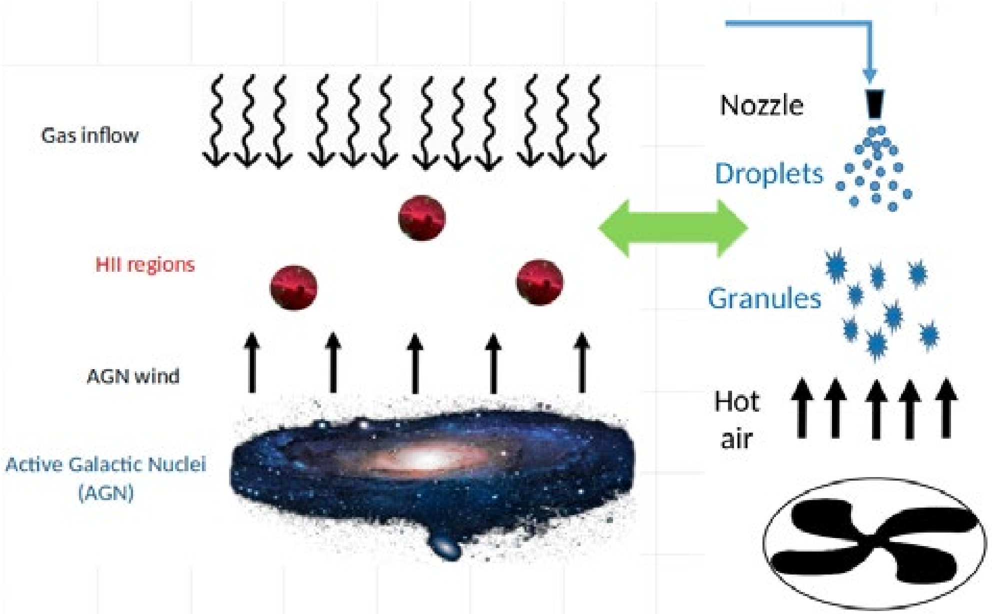
Durham University

Using galactic wind to clean your laundry

Investigators: Richard Bower, Miguel De-icaza-lizaola and Carlton Baugh (Durham University)

Researchers at Durham used the knowledge developed in the STFC sponsored Data Intensive Science CDT to develop new computer algorithms for modelling the properties of laundry powder during its manufacturing process.

Using the same computer algorithms used to make predictions on galaxy formation, the team partnered with Procter & Gamble to develop a code which can link directly to their pilot plant data and automatically create predictive models for both product quality and process performance.



The image shows a simplified analogy between the industrial spray drying of laundry powder and galaxy formation via galactic winds, and hence illustrates the link between industrial and academic research.

For more examples of projects by the Data Intensive Science CDT students, please visit: **https://ddis.physics.dur.ac.uk/highlights/**

Image by rawpixel.com

"This gave us a fresh look into how other disciplines build predictive models. The resulting algorithms have been coded into our spray drying process modelling software. Turning data into process feasibility for major Ariel washing powder upgrades can now take days instead of weeks, increasing our speed to market to delight our consumers and deliver on shareholder value."

Stefan Egan, Procter & Gamble

Imperial College London

Imperial College London

Visualising Martian landscapes in 3D from Mars rovers

Investigators: Sanjeev Gupta and Robert Barnes (Imperial College London); Gerhard Paar (Joanneum Research, Austria); Chris Traxler and Thomas Ortner (VRVis, Austria); and Matt Gunn (Aberystwyth University)

Imperial College London is involved in preparation for both the 2020 NASA Perseverance and the ESA/ROSCOSMOS ExoMars 2022 Rosalind Franklin rover missions to Mars.

The group had funding to test a terrestrial prototype of the camera system developed by Aberystwth University and test 3D tools and visualisation techniques on terrestrial datasets building on ongoing funding from the UK Space Agency. With computer engineering colleagues from Austria they developed a novel 3D visualisation software tool, called PRo3D.

Working with a number of industrial partners, IAA funding was used for development, testing and validation of additional toolkits for PRo3D. A two-day workshop was hosted to demonstrate the tool, which was attended by academia, industry and funding bodies, enabling discussions on imaging requirements for the ExoMars mission, new technical capabilities and requirements and new opportunities to improve and apply the software.

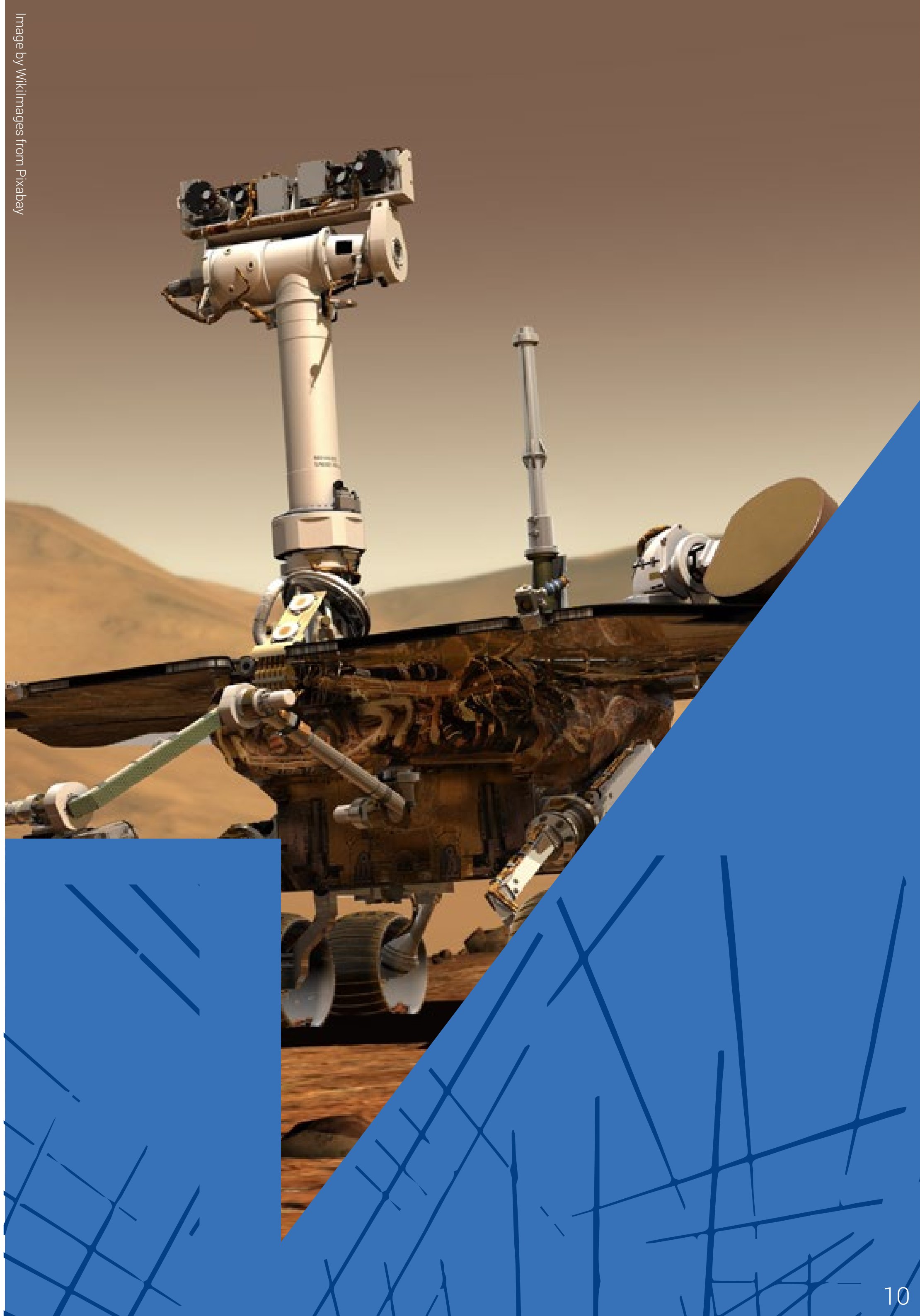
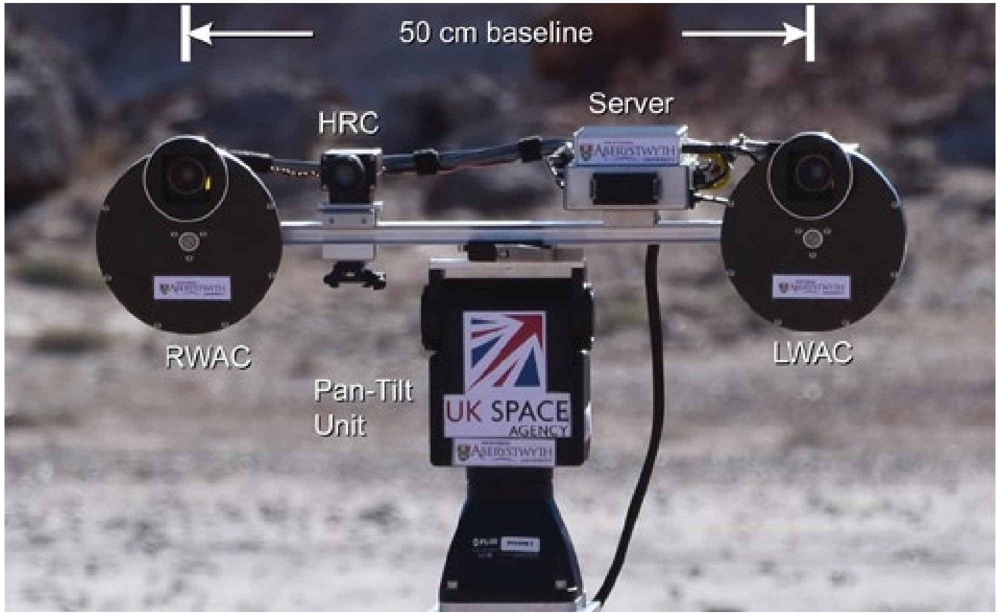


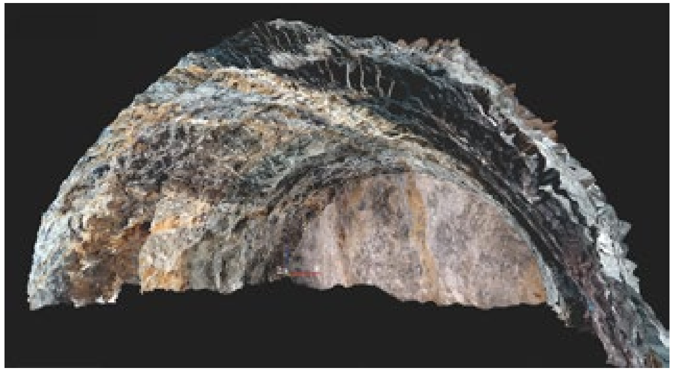
Image by WikiImages from Pixabay

The team is now planning scoping work to applying this tool to engineering geology sectors in the UK and Europe. This follows interest from an Austrian tunnel company who have seen the potential for geological analysis during tunnelling using this technology.

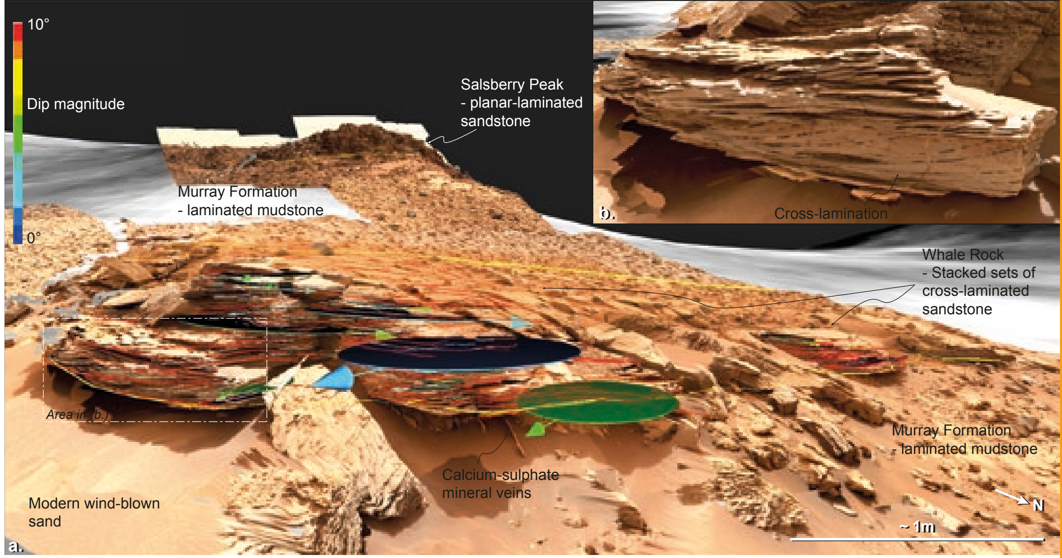


Aberystwyth University PanCam Emulator (AUPE) developed by Matt Gunn at Aberystwyth University for collection of stereo-images of rock outcrops, similar to that which will be collected by the ESA and ROSCOSMOS Rosalind Franklin ExoMars 2022 Rover PanCam at Oxia Planum on Mars.

3D View of a tunnel embrasure and face visualised with a tunnel monitoring viewer based on the same framework as PRo3D (Aardvark). Such 3D Digital Outcrop Models are collected every ~2.5 m during advance of tunnel drilling, and used for planning and assessment of rock properties, fracture styles and densities. Data courtesy of Dibit and Joanneum Research.



Credit: Dibit



Digital Outcrop Model (DOM) of Whale Rock at Pahrump Hills, Gale crater, Mars, visited by the NASA Mars Science Laboratory Rover Curiosity. It is a small lens of sandstone in a thick succession of lakebed mudstones. The complex layering was caused by migration and stacking of small dunes on an ancient riverbed, which can be analysed to understand the behaviour of the water which emplaced them.
Credit NASA/JPL/MSSS/Joanneum Research/VRVis.

> *"With the help of STFC IAA funding, our group was able to significantly enhance the capabilities of visualisation software to analyse and interpret the geology of Mars to assist the search for evidence of ancient life on Mars. Now we are looking forward to applying our tools to engineering geology problems on Earth"*
>
> Sanjeev Gupta, Professor of Earth Science,
> Department of Earth Science & Engineering, Imperial College London

Lancaster University

Supernova detectors for emergency relief

Investigator: Brooke Simmons (Lancaster University)

By taking research in extragalactic astrophysics, specifically galaxy evolution and supernova detection, and an STFC 21st Century Challenges grant looking at crowdsourcing and machine learning for disaster relief and resilience.

The team at Lancaster accelerated the development of the ‘Planetary Response Network,’ that provides change detection in Earth satellite imagery before, during and after humanitarian crises.

They worked with the charity Rescue Global, and 24 Commando Royal Engineers, who were deployed on the ground before, during and after natural disasters to make use of the outputs and was tested following Hurricane Dorian in September 2019.

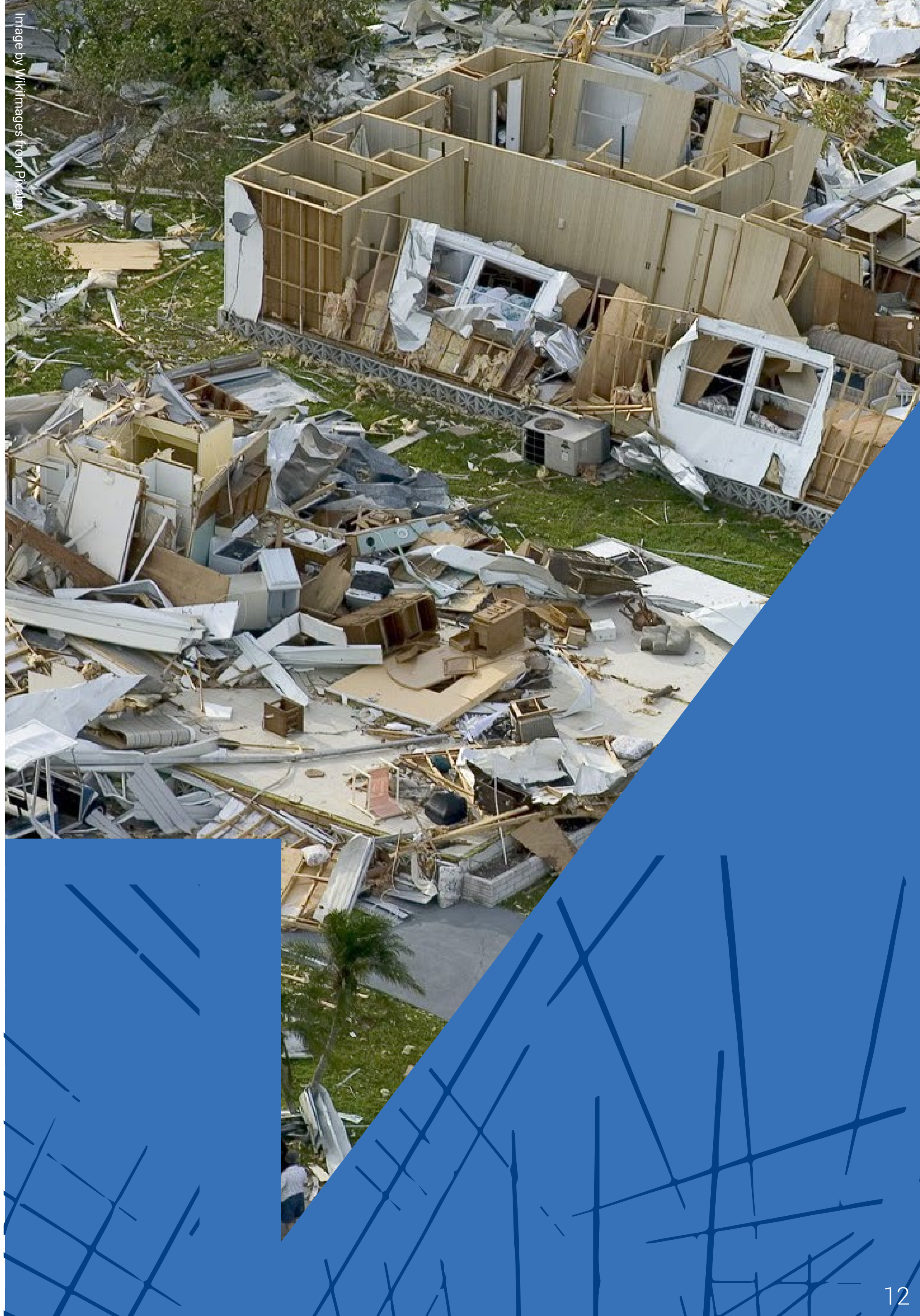
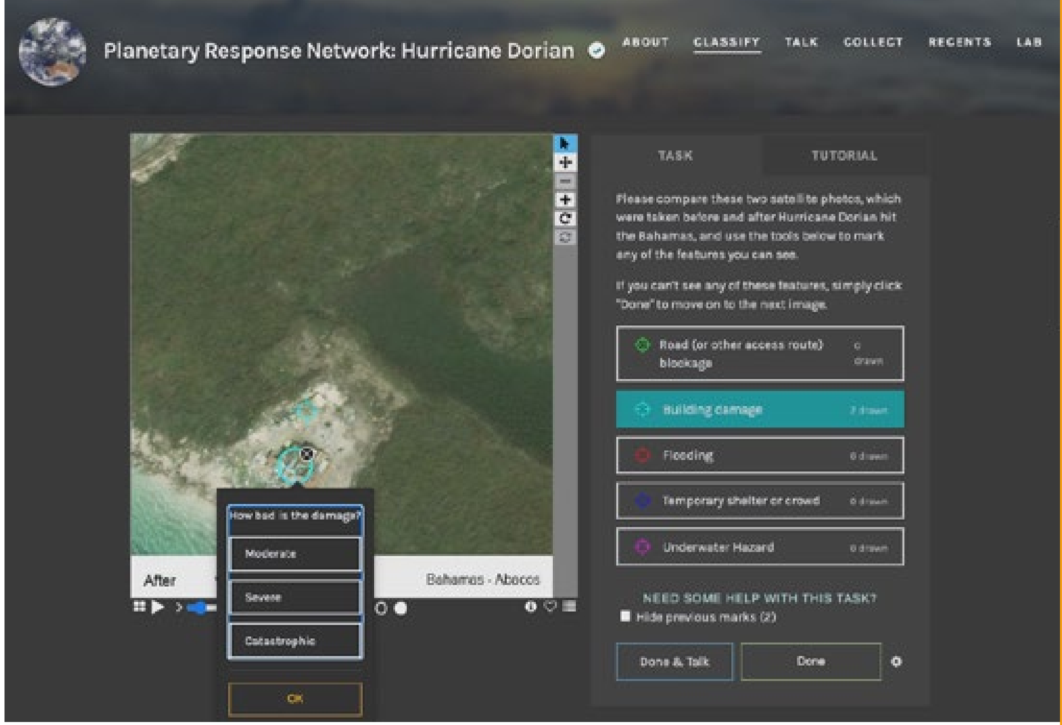


Image by WikiImages from Pixabay

The team collected 365,000 classifications from users over nine days, which represents one year of person effort, and helped the Royal Commando Marines deploy more effectively in the emergency area. The technology looks to enhance relief efforts, reducing potential wasted time by helping to understand the situation, which should help to save lives.

The team are looking into further funding and have developed a commercial partnership with 1715 Labs to further develop the technology.

More information at: **www.planetaryresponsenetwork.org**



"In the wake of the aftermath of Hurricane Dorian in 2019 24 Commando Royal Engineers conducted a trial working with the Planetary Response Network, run by researchers at Lancaster University and in collaboration with researchers at the University of Oxford. The Unit has Force Elements deployed on an annual basis to the Caribbean region to provide Humanitarian and Disaster Relief (HADR) assistance if required. Due to the fluid and complex operating environment that exists during HADR operations accurate and timely intelligence is key, particularly during the early stages of any relief operations where the prioritisation of often scarce resources is most needed. The proof of concept delivered by the Planetary Response Network has the capability to add significant value within a HADR scenario in the future. The rapid data analysis, cross-referenced with parameters that could be adjusted as required by subject matter expertise, enabled a well refined product. The ability to identify key areas of interest to prioritise forward deployed assets enables a much more surgical approach to relief efforts and significantly reduces potential wasted time on the ground building an understanding of the situation, ultimately saving lives."

Capt R Smith-Birch, Adjutant 24 Commando Royal Engineers

The Open University

AstrobiologyOU: addressing scientific, governance, societal, ethical and commercial challenges

Investigators: Geraint Morgan, Karen Olsson-Francis, Victoria Pearson and Susanne Schwenzer (The Open University)

The Open University has a track-record of translating space know-how to solving terrestrial challenges, mainly led by Dr Geraint Morgan.

Recognising the potential for Innovation, IAA funding was used by Morgan and The Open University's Astrobiology research group to support its expansion. They brought STFC-funded and other researchers, together with an external consultant, to form a multi-disciplinary team to develop and visualise their future commercialisation and innovation objectives. These objectives and implementation plan were included in a bid to Research England's Expanding Excellence in England (E3) funding scheme.

The Astrobiology group went on to secure £6.7M from this scheme with the aim to expand their capacity and capabilities; and make the UK a global leader in this area. The expansion has huge potential for industry engagement, and translational research, which will have significant economic and societal benefit.

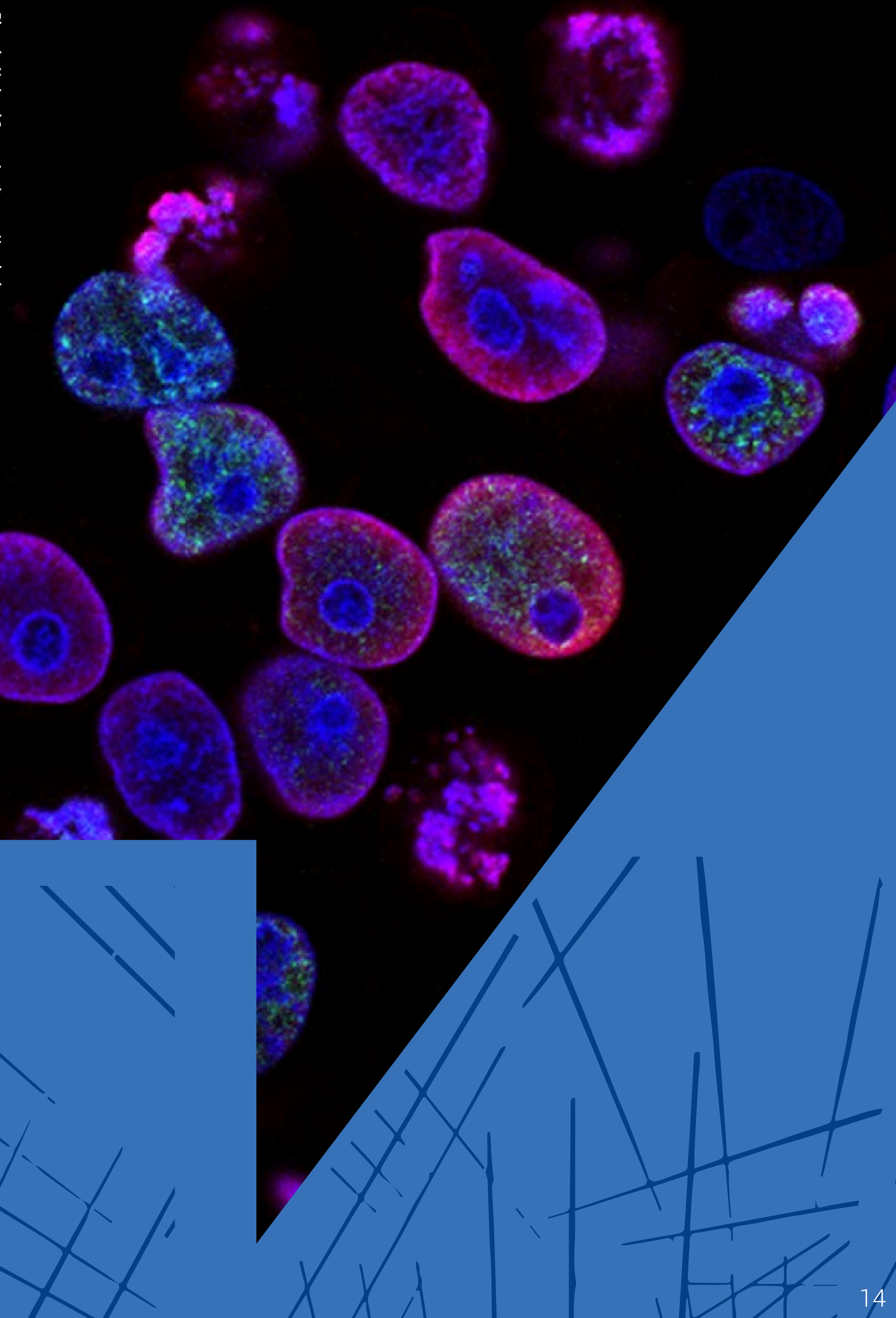
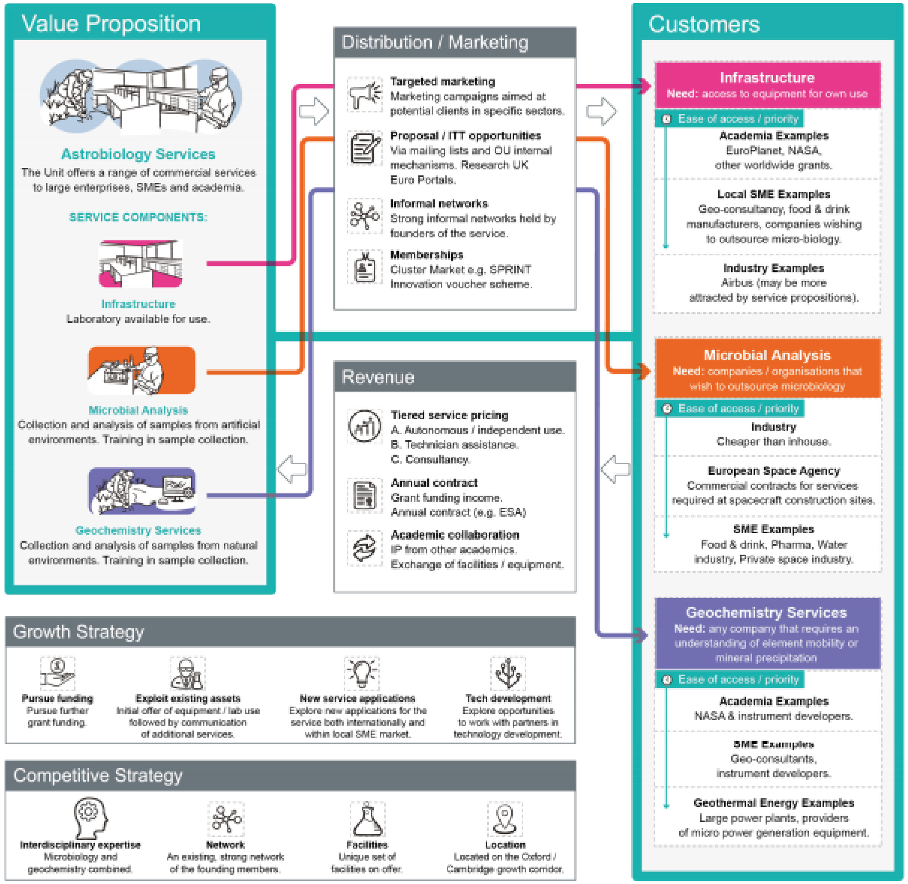


Photo by National Cancer Institute on Unsplash

The award of this prestigious E3 funding has already significantly raised the profile of (now) 'AstrobiologyOU's' research. It also provides a unique opportunity for STFC scientists to work closely with industry and other sectors of academia to develop new and innovative ideas in this space. After the successful bid, a dedicated Business Development Manager, Dr Yiannis Tsamis, was appointed for three years to develop the commercialisation strategy further. This has helped crystallise their ideas into a single, cohesive programme of work that can be easily articulated to other stakeholders, both internally and externally.

Dr Mario Toubes-Rodrigo from AstrobiologyOU presenting a poster about the group's activities and members at the Research England Expanding Excellence in England programme meeting



Visual Business Model created with Telford Consulting Ltd that illustrates AstrobiologyOU's commercialisation and knowledge exchange activities.

> *"This is an excellent opportunity to bring together several research strengths within The Open University, especially across disciplinary boundaries and with people we would not traditionally work with within science."* Professor Karen Olsson-Francis, Director of AstrobiologyOU

Queen Mary University of London

Flexible and novel radiation detectors for nuclear industry applications

Investigators: Adrian Bevan, Theo Kreouzis, and Peter Hobson
(Queen Mary University of London)

Developed from research carried out on the ATLAS experiment at the Large Hadron Collider at CERN, the team at Queen Mary University of London have worked alongside the Atomic Weapons Establishment (AWE) and Micron Semiconductor Ltd. to develop and commercialise state of the art neutron sensors.

Using IAA funding, the team at Queen Mary, led by Professor Adrian Bevan, Head of the Particle Physics Research Centre at School of Physics and Astronomy, used thin-film silicon and a polymer support to develop cylindrical sensors and organic electronics to develop novel sensors.

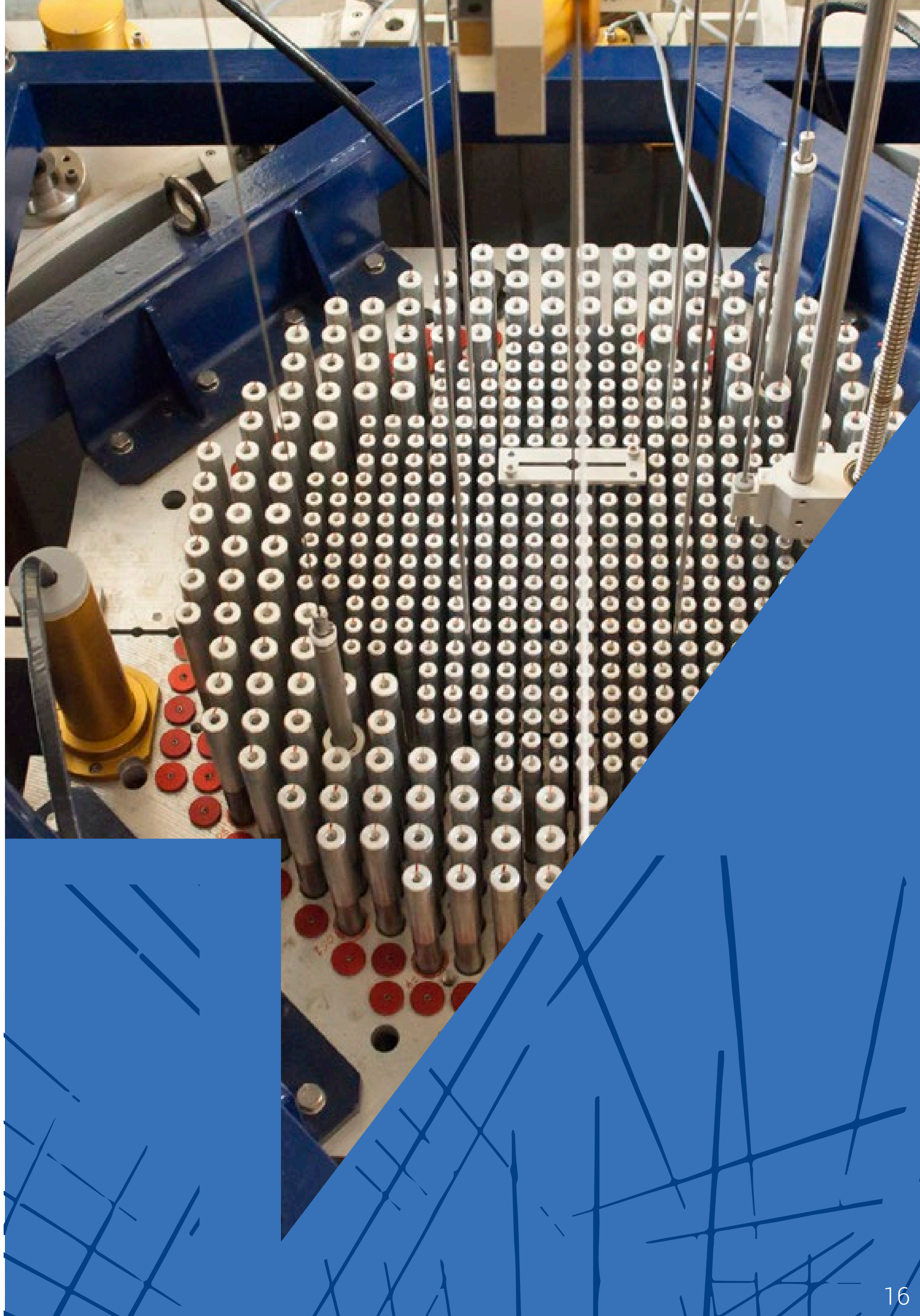


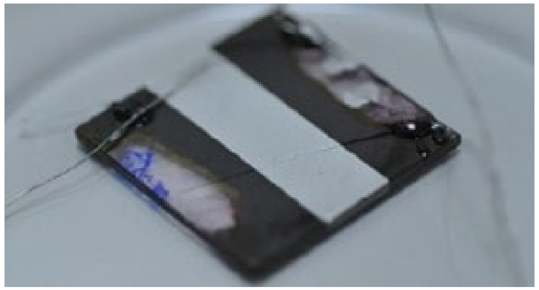
Image:Core of CROCUS, a small nuclear reactor used for research at the EPFL in Switzerland
Creative Commons cc0 license

By focussing on development of curved silicon detectors, this would open up potential uses. These detectors could potentially wrap around beam pipes, targeting the ultimate goal of zero mass support structure.

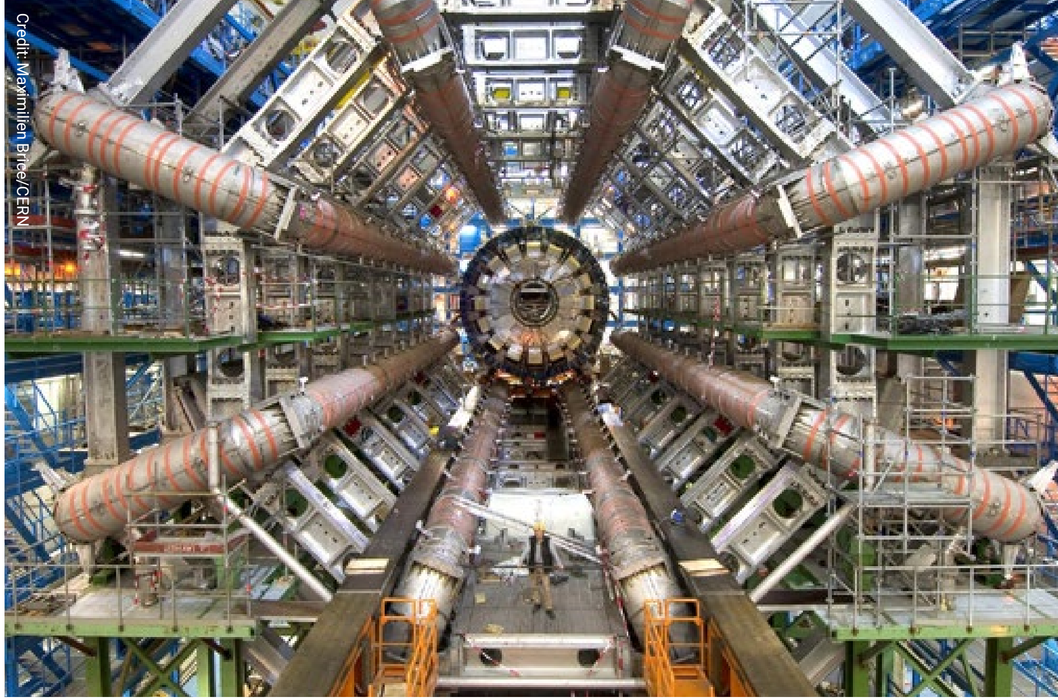
Industrial applications could include cylindrical sensors for X-ray crystallography (sensors that can be used to understand the structure of viruses, DNA and crystalline materials). These can also be deployed in devices that can be adapted to survey pipes in nuclear reactors.

The team received £100k support from Micron Semiconductor Ltd. to help develop the prototype device. The team are also working on development of novel organic semiconductor radiation detectors with £228k support from AWE, for two PhD students to aid in technology development. The team are developing the technology and are working toward licencing this technology to industry.

Self supporting mechanical sample of silicon with carbon fibre edge supports illustrating the concept of mechanical structural stability for a curved thin silicon device. The sample is 20x50mm of silicon with a thickness of 50 microns and a radius of curvature of approximately 2.6cm.



A device with four organic diodes showing the top aluminium cathode. The anodes for each diode extend from under the black organic semiconductor region into the sides of the substrate. This variant of device shows silver epoxy connections, the project now uses a purpose made socket aiding faster device testing and replaceability.



The ATLAS experiment at CERN

> *"This funding has enabled us to explore the feasibility of making a new type of particle detector. Our work could lead to improved scientific instruments and new industrial devices."*
>
> Professor Adrian Bevan, Head of the Particle Physics Research Centre at School of Physics and Astronomy, Queen Mary University of London

University College London

Twinkle space mission to study exoplanet atmospheres

Investigators: Jonathan Tennyson, Giovanna Tinetti and Marcell Tessenyi (University College London)

The Twinkle mission grew from original research activities based at UCL which involved building a scientific space mission using off the shelf components for the spectroscopic analysis of exoplanet atmospheres.

Using IAA funding, UCL developed a business case to convert initial interest from scientists worldwide, with end user engagement, which led to the formation of a company called Blue Skies Space Ltd.

The impact of this work has allowed the company to engage users and develop new contacts. Since then, the company has generated >£569k in private capital and €250k co-funding from the European Space Agency and the backing of the UK Space Agency.

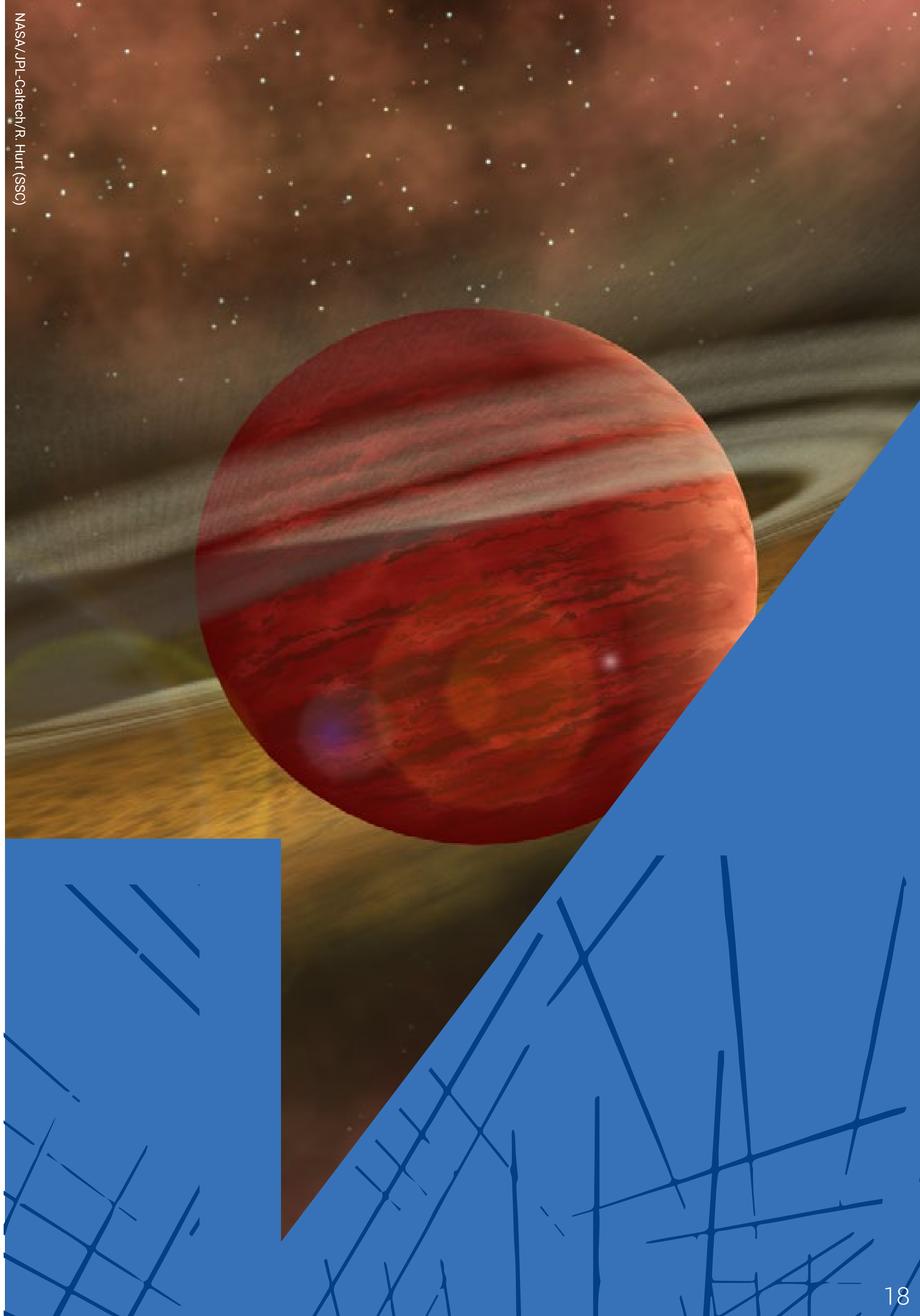


Image: In this artist's conception, a possible newfound planet spins through a clearing in a nearby star's dusty, planet-forming disc.

The project has received interest from Airbus Defence and Space and ABB to progress the technical design of the Twinkle satellite ahead of construction which is due to begin late 2020.

For more information please visit: **http://www.twinkle-spacemission.co.uk/**

Image by Reimund Bertrams from Pixabay

“We think Twinkle will be transformative on how space science data is collected and accessed globally. The service model we offer opens the door to a large number of institutions worldwide to partake in cutting edge research in a cost-effective manner. The success of Twinkle will lead to a series of scientific satellites delivered through this sustainable model.”

Dr Marcell Tessenyi, CEO of Blue Skies Space Ltd,
Senior Research Associate at UCL’s Department of Physics & Astronomy

UNIVERSITY OF LEEDS

University of Leeds

Planetary science for improved terrestrial air quality

Investigators: John Plane, Hu Li and Alexander (Sandy) James (University of Leeds)

Researchers at the University of Leeds are looking to reduce toxic emissions from diesel engines.

The fuel efficiency, responsiveness and flexibility of diesel engines has led to extensive use in vehicle fleets, off road vehicles, trains, ships and static generators. Although demand in passenger vehicles is decreasing, other applications will persist. Throughout the lifetimes of these engines the importance of cost effective, efficient catalytic treatment of exhausts will continue to increase.

Using their work on understanding the formation of phosphorus and nitrogen compounds in solar system science they have developed new low-cost catalytic materials for reducing the toxic emissions.

The LowCat material has unprecedented low temperature NO_2 reduction with simultaneous CO oxidation at high temperatures and is a significant improvement compared to currently available technology.

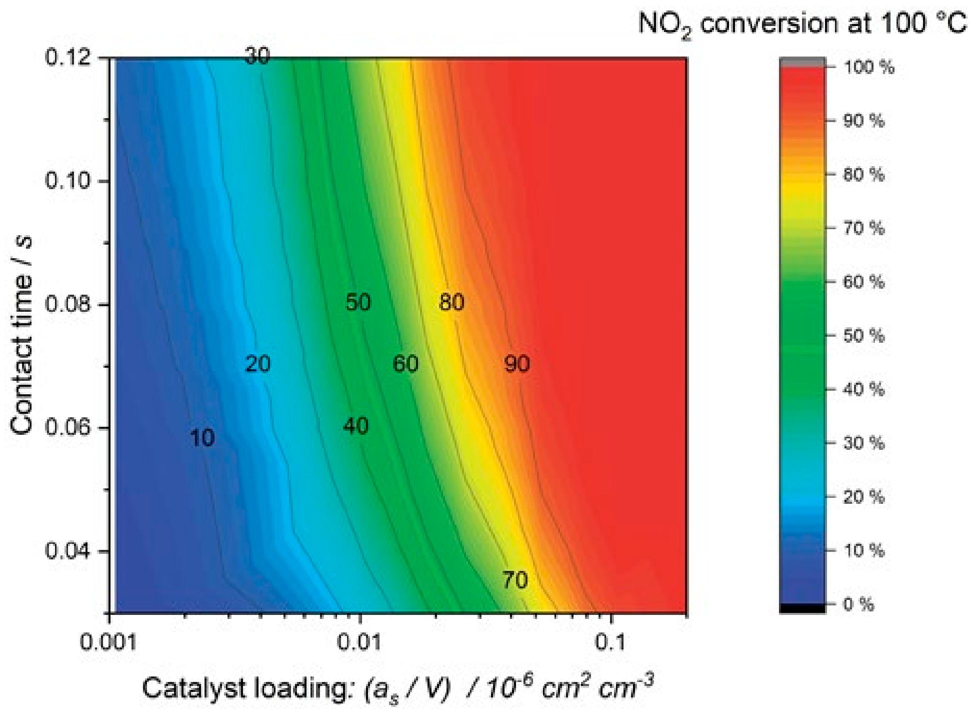
Image by Andrzej Rembowski from Pixabay

Using IAA funding, the researchers performed initial proof of concept experiments and testing together with one of the leading companies in the exhaust catalysis industry.

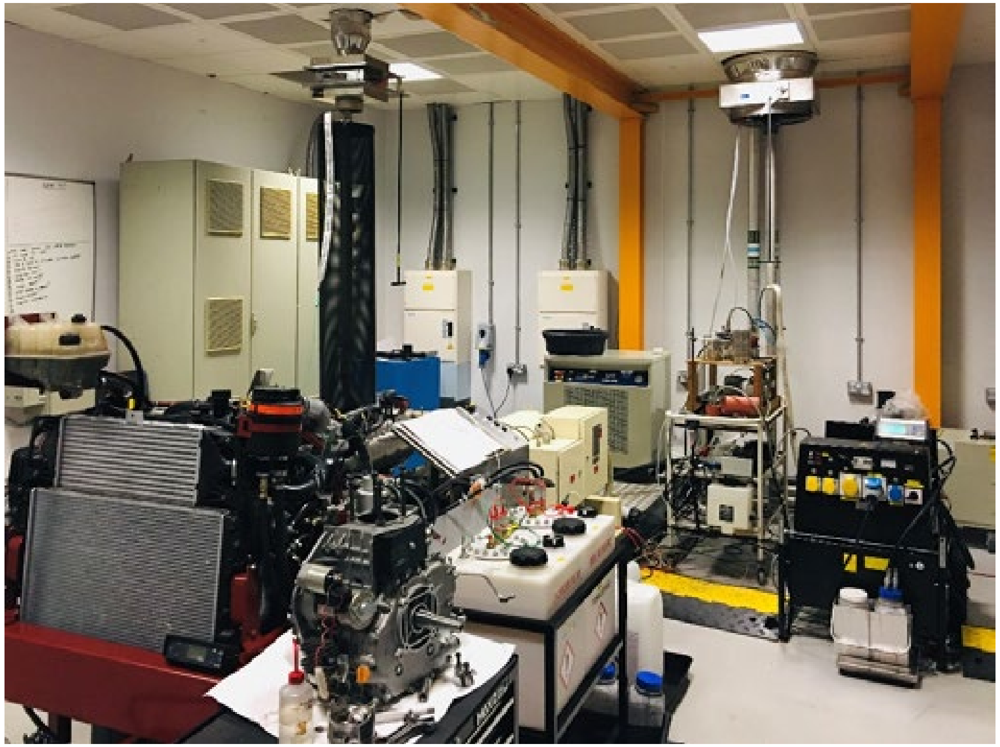
This technology now has a patent pending in the UK, alongside a number of academic publications. The work has been presented at several international conferences: Gas Kinetics 2018 (Lille, France), Inaugural meeting of the Leverhulme research centre for functional materials design (2018, Liverpool, UK) and CAT 2018 (Rome, Italy).

The team are looking to scale-up the technology which could have significant impact in the transport industry, especially in heavily polluted areas and urban spaces all over the world.

Credit: GettyImages



Predicted NO2 conversion efficiency of LowCat for different catalyst loadings and exhaust residence time.



The Engine Lab at the University of Leeds

> *"LowCat is a very exciting technology that appears to have significant commercial potential. We are already planning the next stage of development, via an application for IPS funding with our industrial partner, and we are looking forward to scale-up and prototype trials in the near future."* Simon Clarke, Commercialisation Manager, University of Leeds

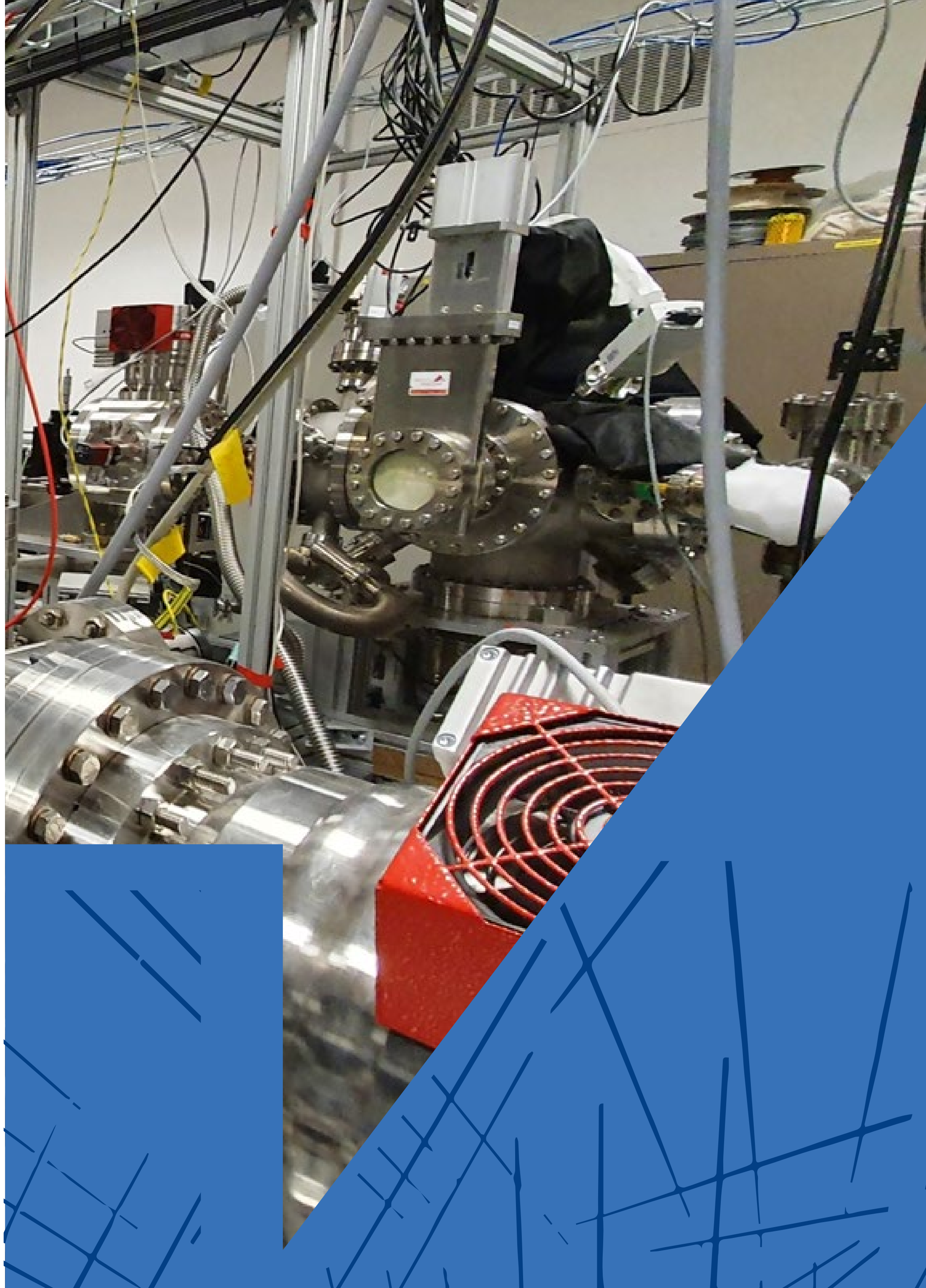
University of Liverpool

Next generation particle accelerator diagnostics

Investigator: Carsten Welsch (University of Liverpool)

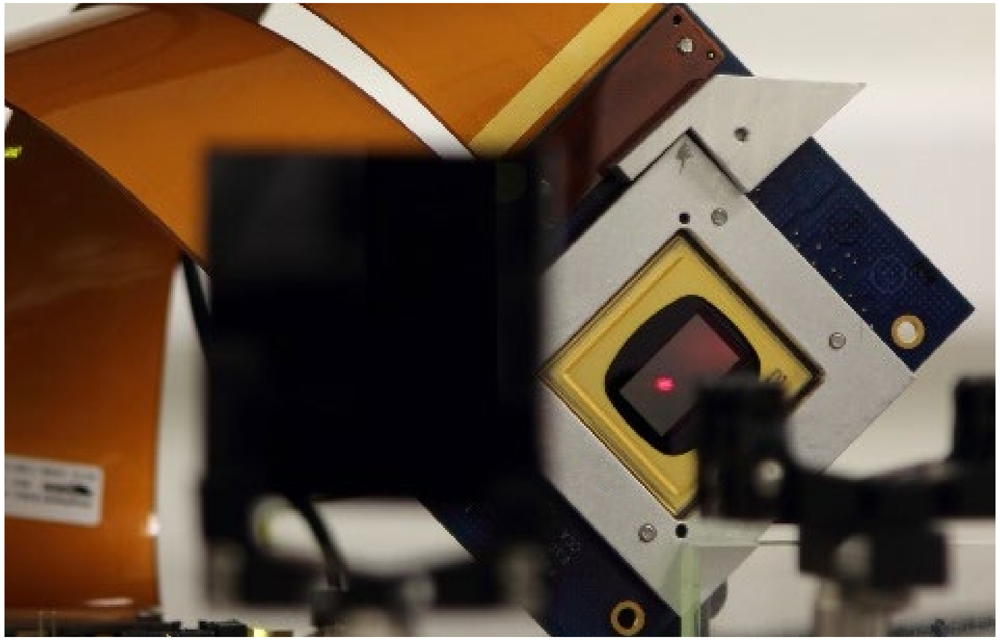
Particle accelerators are used globally to help answer some of the biggest fundamental physics questions. They also drive the development of new medicines, treat cancer, and improve progress in chemistry and environmental sciences. Developing novel diagnostic solutions for accelerator and clinical facilities, increases their output, reliability and cost efficiency.

Researchers in the Liverpool Accelerator Physics QUASAR Group have collaborated with the company D-Beam Ltd. commercialising R&D using state of the art technology from the upgrade of the Large Hadron Collider at CERN. This has produced innovative product solutions for the accelerator, healthcare and security sectors.



Gas Jet based beam monitor for the High Luminosity LHC. Image courtesy of University of Liverpool

IAA funding was used to fund a number of proof-of-concept projects in collaboration with D-Beam; these have subsequently attracted additional European Union funding for joint R&D and Follow-on-Funding from STFC. The new products are being tested at the MAX IV facility in Sweden and the STFC CLARA facility in the UK, with plans to sell to a global market in coming years. Such technology could allow the UK to become a global leader in the development and manufacture of novel beam-diagnostic systems, leading not only to greater scientific discoveries and understanding, but also to enhanced medical facilities and improved patient outcomes.



Adaptive optics sensor for beam characterisation. Image courtesy of University of Liverpool.

Optical beam loss monitor for accelerator optimisation. Image courtesy of D-Beam Ltd.

> *"The development and commercialisation of new technologies is at the forefront of our impact and engagement strategy. The IAA funding has provided us with the first building blocks in getting our ideas off the ground to develop innovative, market led, impact generating technologies in collaboration with our spin-out company, D-Beam Ltd."*
>
> Professor Carsten P Welsch, Head of Department

University of Sheffield

Cosmic rays and railway tunnels

Investigators: Lee Thompson and Patrick Stowell (University of Sheffield and Geoptic); Chris Steer (Geoptic); Jon Gluyas (Durham University and Geoptic).

Academics at the University of Sheffield have used detector technology developed for the T2K neutrino experiment (along with their expertise and knowledge) to make a new cosmic muon detector for imaging civil infrastructure.

Working alongside Central Alliance, as well as National Rail and AMCO, this technology can be used in railway tunnels to locate hidden voids and density anomalies. With this detector the team can establish the structural integrity of key infrastructure, allowing for improved public safety.

STFC IAA funding from Sheffield paired with EPSRC IAA funding from Durham provided support to help develop and test the instrumentation. The technology, now fully patented in the UK, was the basis of the spin-out company, Geoptic Ltd, which launched in November 2019.

Since then, Geoptic Ltd. have been contracted by Network Rail to survey a further three railway tunnels where hidden shafts and voids are suspected.

Image by Michael Schwarzenberger from Pixabay

This technology has applications in other areas of civil engineering and elsewhere which will be further explored as the business grows.

In 2020 Geoptic was awarded a prestigious Institute of Physics Business Start-Up award which recognises and celebrates small, medium and large companies that have excelled in innovation, delivering significant economic and/or societal impact through the application of physics.


Photo by K. Mitch Hodge on Unsplash

Credit: Geoptic Infrastructure Investigations

Muon tomography instrumentation imagining a railway tunnel

"I first started building cosmic ray muon detectors for schools outreach projects. Looking back, never at that time could I have imagined that years later we'd be using very similar instrumentation to help the rail industry look for hidden shafts and voids in railway tunnels."

Lee Thompson, Professor of Particle Physics at the University of Sheffield

UNIVERSITY OF Southampton

University of Southampton

Molegazer: Early detection of melanoma using astrophysical techniques

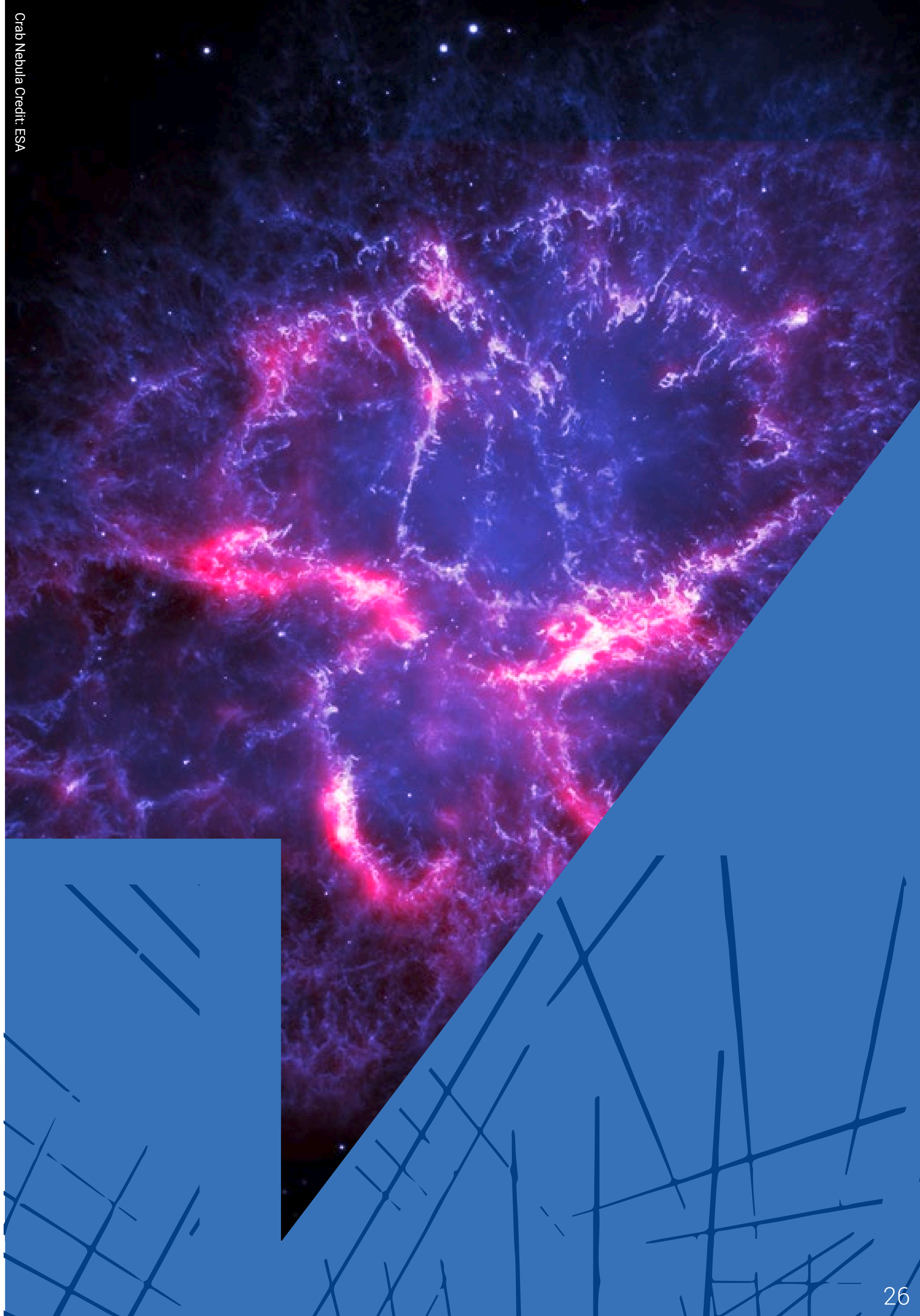
Investigators: Mathew Smith and Peter Boorman (University of Southampton); Rubeta Matin (Oxford University Hospitals NHS Foundation Trust)

Astronomical sky surveys routinely observe the sky every night, comparing each new image with a historical baseline to detect new cosmic explosions.

Images are taken over a period of time and compared to detect supernovae. In order to do this, Artificial Intelligence algorithms were developed to track changes in images. Tens of thousands of these images are taken and the supernova signature is very subtle – so it is impossible for humans to analyse them all.

Coincidentally, as part of routine care in the NHS, images covering the entire body (TBP) are regularly obtained for all patients with a high risk of developing melanoma. These are used to provide a baseline for clinicians who then visually inspect moles to determine if they have evolved into melanoma.

With similar challenges facing both astronomers and dermatologists, STFC funded researchers used IAA funding to set up the project 'MoleGazer'.

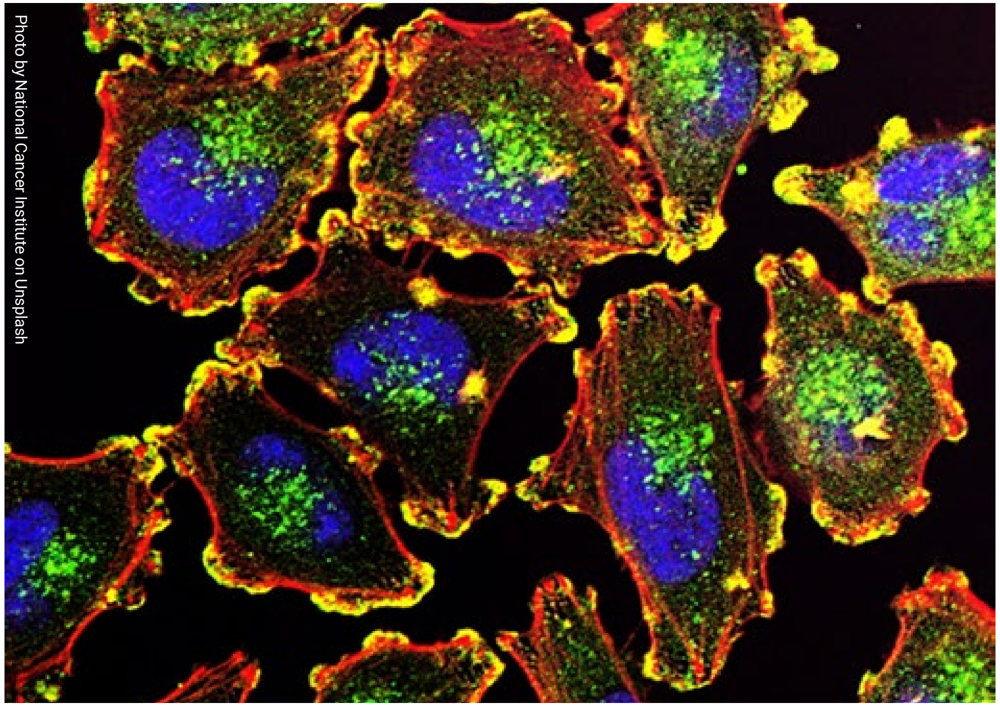


Crab Nebula Credit: ESA

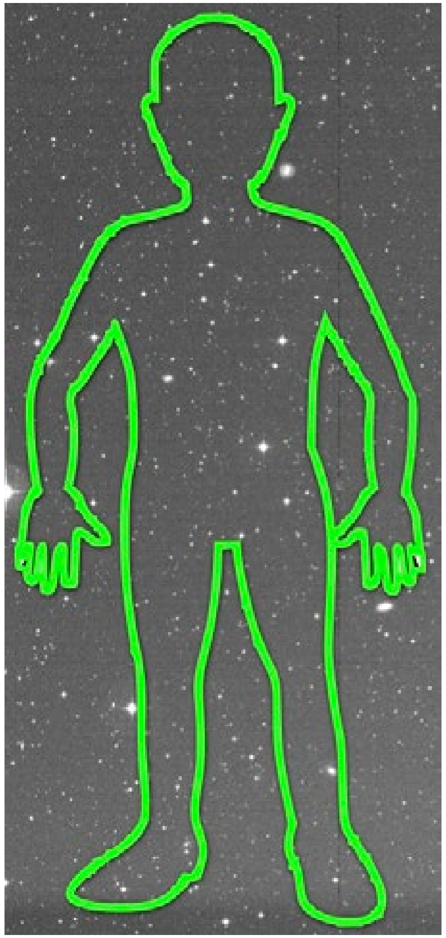
Partnering with the Oxford University NHS trust, the team tested whether these algorithms could be transposed from studying the night's sky to routinely detecting skin cancer.

This successful project showed that astronomical techniques can be used to detect, classify and track the evolution moles from routine NHS imaging. With the development of an end-to-end automated pipeline, MoleGazer has laid the foundations for AI techniques, developed in astronomy, to be used as a clinical aid in the real-time detection of skin cancer.

Using the results from this study, the project was awarded an ERC Proof-of-Concept grant of €150,000 to extend this study towards a clinical setting. Over the next 24 months, the project will routinely image 50 patients, each with a high risk of developing melanoma, every three months, to characterise and predict how moles and skin lesions evolve into melanoma.



Metastatic Melanoma Cells



"We have developed a truly interdisciplinary approach with IAA funds at Southampton. This is a great example of where an astrophysicist and medical staff have worked together, taking non-medical related research, developing this for the greater good and contributing to better health outcomes." Ruth Saw, Impact Funding Manager

University of St Andrews

University of St Andrews

Predicting space weather and eruptions from the sun

Investigators: Paolo Pagano, Duncan Mackay, Stephanie Yardley (School of Mathematics and Statistics, University of St Andrews)

Drawing from research using mathematical simulations to study phenomenon found on the Sun, the team at St Andrews developed a software package to simulate active regions and the onset of space weather.

Space weather describes how magnetic fields, radiation, particles and matter ejected from the Sun and these interact with the Earth's upper atmosphere.

Space weather poses a threat to modern society because it can cause major disruption to our technological systems, and in the most extreme cases lead to the failure and interruption of power grids, satellite electronics and radio communications. This has a significant socioeconomic impact.

The main activities of this project were to take real-time, data-driven science models and exploit them into a fully operational framework for daily use to predict space weather.

Image by PolarityFlow from Pixabay

The prototype numerical simulation software performs real-time, data-driven simulations to predict the time of eruptions on the Sun and determine the amount of energy storage and release.

The software package is currently being tested on 30 different active regions to determine its validity in predicting eruptions, upon which it will be supplied to the MetOffice for use in predicting the onset of Space Weather from the Sun.

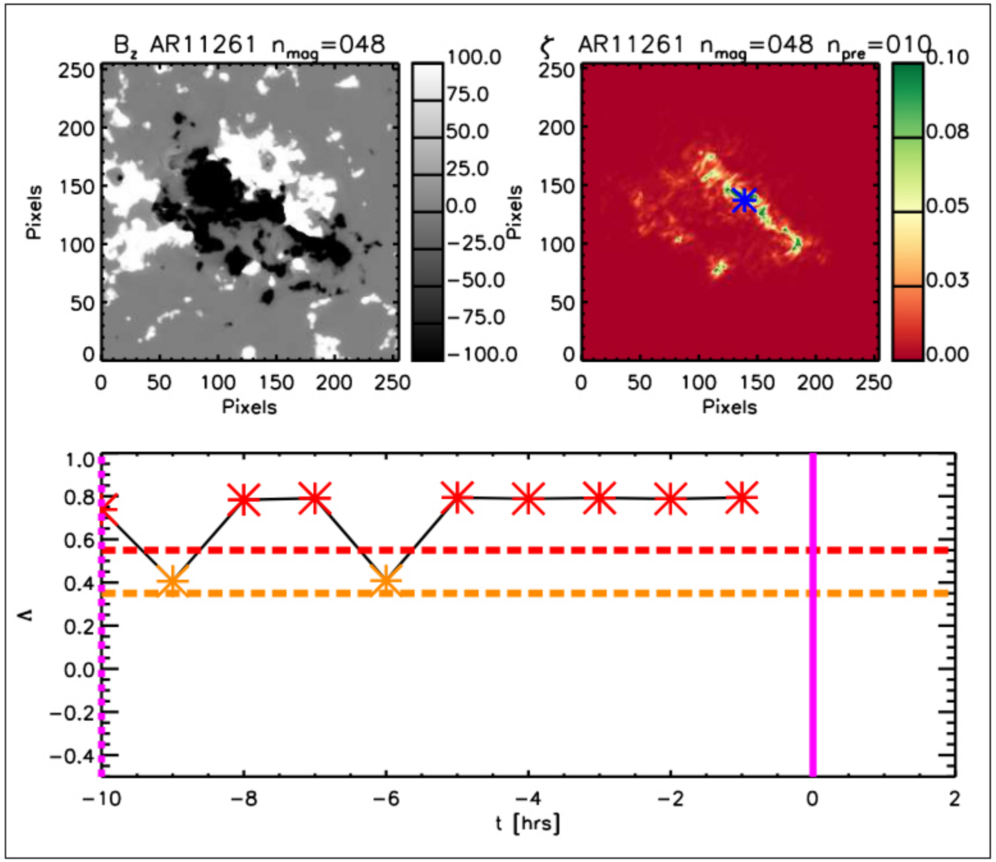
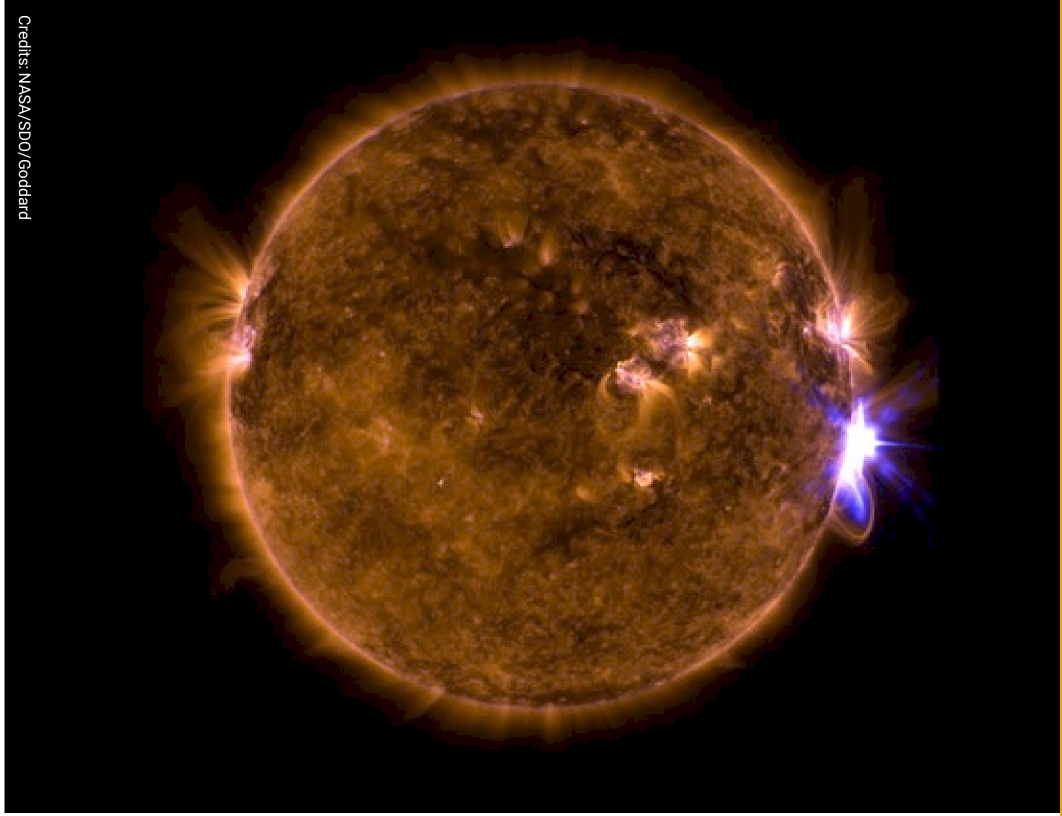


Illustration of S2WARM (St Andrews Space Weather Active Region Monitor) developed with STFC IAA funding. Top Left: Active region on the Sun. Top Right: Predicted eruption metric for active region. Bottom: Predicted eruptive state of the active region during the 10 hours prior to the actual observed eruption on the Sun (purple line). The eruptive state given by the stars is categorised as: green ~ non-eruptive, yellow ~ possible eruption, red ~ eruption highly likely. The yellow and red dashed lines separate the three predicted states of the active region



NASA's Solar Dynamics Observatory captured this image of a solar flare – as seen in the bright flash on the right side – on Sept. 10, 2017. The image shows a combination of wavelengths of extreme ultraviolet light that highlights the extremely hot material in flares, which has then been colorized.

"The STFC IAA funding has allowed us to develop one of the first physics-based models for predicting eruptions on the Sun. This work will help develop more accurate predictions of Space Weather in the near-Earth environment."

Professor Mark Chaplain, School of Mathematics and Statistics (Head of School) University of St Andrews

University of Warwick

Modelling the impact of space weather events on the National Grid network

Investigators: Sandra Chapman, Lauren Orr, and Nick Watkins (University of Warwick); Ciarán Beggan (British Geological Survey); and Jesper Gjerloev (Johns Hopkins University, USA)

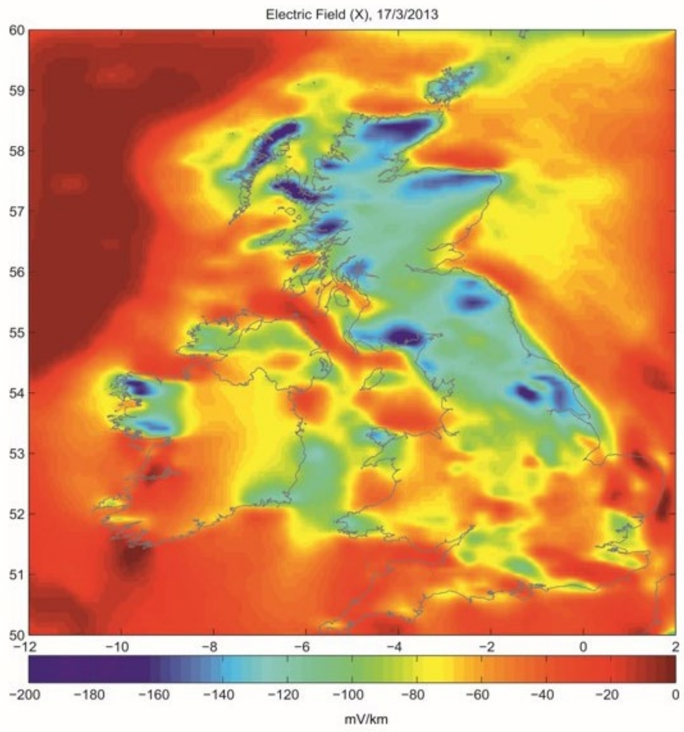
Space weather is driven by solar flares and coronal mass ejections that propagate to Earth in the solar wind. Such events can cause a variety of problems, from damaging satellites that we use for communication and navigation to disruption of flights and railway networks.

One key impact of space weather is that it can cause the magnetic field at ground level to change rapidly, inducing a surface electric field. This rapidly changing electric field causes Geomagnetically-Induced Currents (GICs) to flow through the ground through the soil, water and rocks of the Earth. These currents find their way into earthed metal networks such as power grids, pipelines, railways and undersea cables, essentially short-circuiting through the path of least resistance. GICs pose a risk to the continuous, safe and efficient operation of high voltage power transformers, which may suffer permanent or cumulative damage. UK power grid companies typically only monitor at a few fixed sites in the grid, yet there are many hundreds of expensive transformers grounded to the earth.

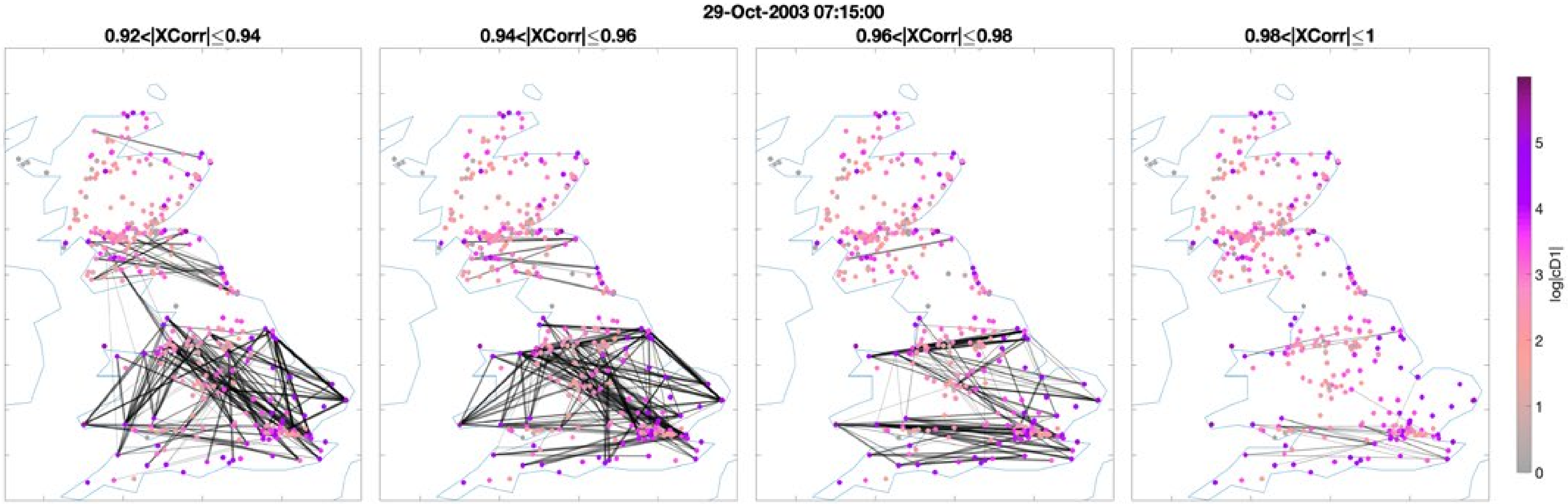
Researchers at Warwick, in collaboration with Johns Hopkins University, USA have recently developed a novel methodology based on directed networks which takes data from a multi-station magnetometer system and characterizes its response to space weather events. This work has come to the attention of the British Geological Survey (BGS), which provides space weather monitoring services, including forecasts of geomagnetic activity and near-real-time GIC simulations of its effects.

Working with the British Geological Survey (BGS), and with support from STFC (IAA fund) the team have applied this new methodology to perform a network analysis of the UK High Voltage grid. This could offer a tool where monitoring one section of the network could reliably predict the impact of space weather in other sections. These advances could help the UK Space Weather-proof existing infrastructure and potentially save billions in lost economic activity.

> *"This research will be useful as an operational aid and for understanding which substations are at risk."*
>
> Dr Ciarán Beggan (Geophysicist, British Geological Survey



Estimated surface electric field that drove GIC through the power grid during the peak of the geomagnetic storm of March 2013 [BGS]. Network response to substorm onset. We can extract basic parameters to quantify ground-based response to geomagnetic activity.



Network of GIC model output of the UK High Voltage grid during the Halloween storms 2003.

University of York

Gamma-ray imaging detectors for medical applications

Investigator: Stefanos Paschalis and Dan Watts (University of York)

Using state-of-the-art Gamma-ray detector technology, researchers at the University of York are working on new medical imaging equipment.

York receives funding to understand exotic nuclei and how they can be used to study the strong nuclear force predicted by the standard model. Using this same technology, the team have developed position sensitive scintillator detectors for medical imaging applications. The team's new detectors for positron emission tomography (PET) scanning and for imaging during proton radiotherapy, will address a number of challenges currently facing the medical imaging community.

PET scans are a type of test that create 3 dimensional (3D) pictures of the inside of your body. The PET scan uses a mildly radioactive drug to show up areas of your body where cells are more active than normal. It's used to help diagnose some conditions including cancer.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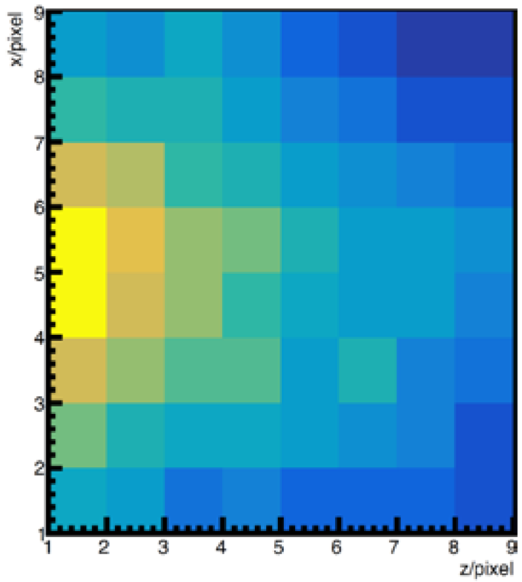
On the other hand, proton radiotherapy is one of the faster-growing cancer treatment modalities in which fast moving proton beams are used to kill cancer cells located deep inside human tissues. Advancing gamma-ray imaging technology increases the sensitivity and effectiveness of diagnostic tools and cancer treatment methods.

Using IAA funding, the group at York demonstrated that the technology could be adapted to the medical imaging sector and have subsequently been awarded £88k from STFC's Follow on fund, developed novel publications, and are working alongside the University of Manchester and Christie's hospital to further develop the technique.



A reconstructed gamma-ray beam that is entering the detector volume from the left.

Patient receiving radiotherapy treatment

> *"The IAA has helped us transform our technology for fundamental research into solutions for societal applications, and transition from pump-priming ideas to functional demonstrators."*
>
> Stefanos Paschalis, Principle Investigator and Lecturer in Nuclear Technology

Science and Technology Facilities Council

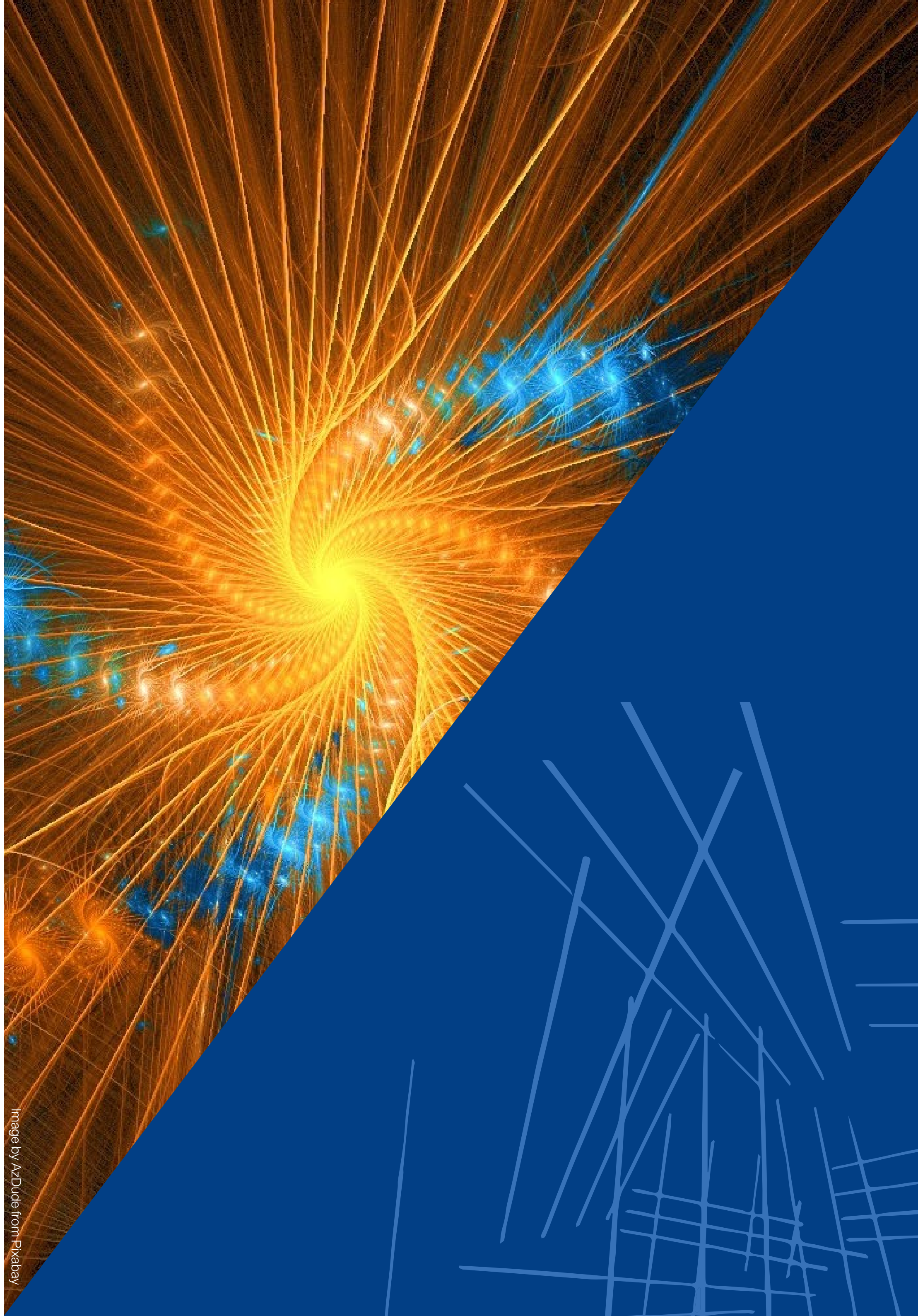


Image by AzDude from Pixabay

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