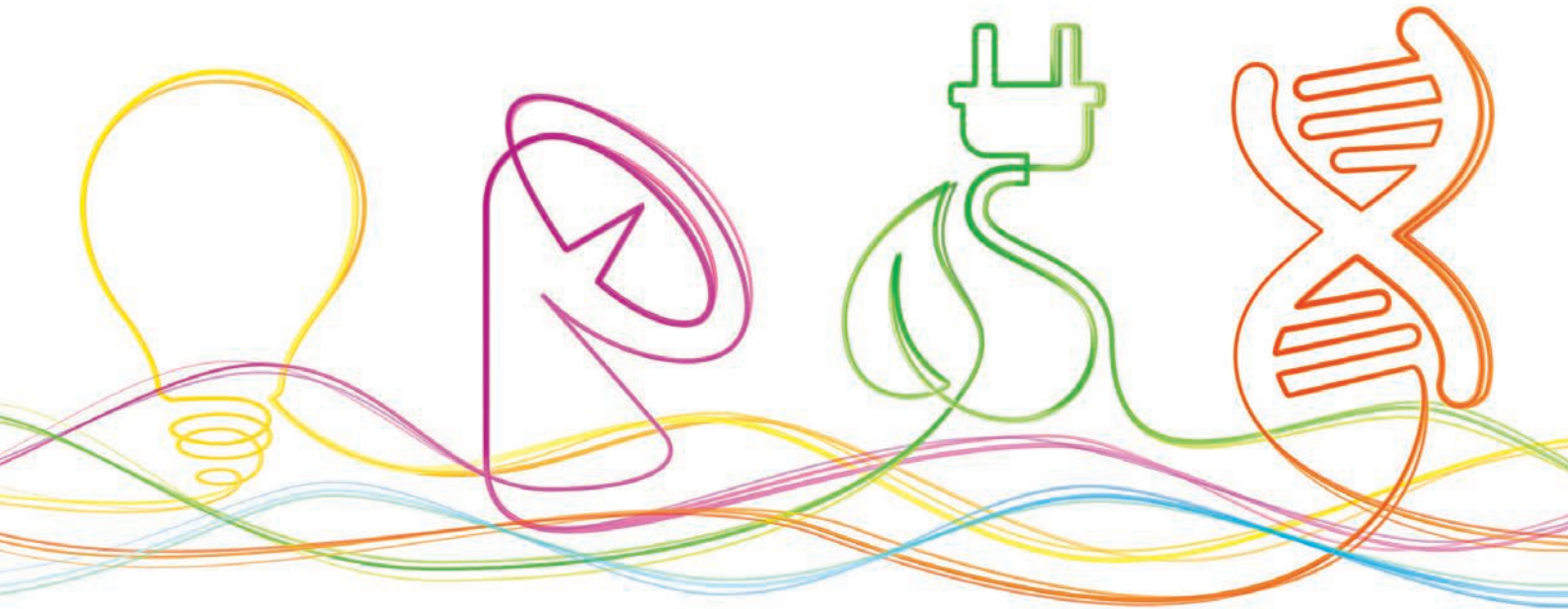


IOP BUSINESS INNOVATION AWARDS 2016

Innovative physics. Winning solutions.



The Institute of Physics is a leading scientific membership society working to advance physics for the benefit of all.

We have a worldwide membership of more than 50,000, from enthusiastic amateurs to those at the top of their fields in academia, business, education and government.

Our purpose is to gather, inspire, guide, represent and celebrate all who share a passion for physics. And, in our role as a charity, we're here to ensure that physics delivers on its exceptional potential to benefit society.

Alongside professional support for our members, we engage with policymakers and the public to increase awareness and understanding of the value that physics holds for all of us.

Our subsidiary company, IOP Publishing, is a world leader in scientific communications, publishing journals, ebooks, magazines and websites globally.

You can help us transform the future of our discipline.
Invest in physics today at **iop.org/fundraising**

Find out about our strategy for success at **iop.org/strategy**



WELCOME TO THE AWARDS

Physics has been at the heart of innovations from the light bulb to the Large Hadron Collider. Today, physics and physicists drive the success of the best and brightest companies.

The Institute's Business Innovation Awards are the only awards recognising companies in the UK and Ireland that have built success on the innovative application of physics – companies that have generated profit, secured jobs and improved efficiency across a range of sectors, from oil and gas to renewable energy, medical technologies to high-tech manufacturing.

Introduction



Professor Roy Sambles
FRS CPhys FInstP
President, Institute of Physics

The Institute's Business Innovation Awards are now in their fifth year and we are delighted to have celebrated more than 25 high-growth businesses that are succeeding through physics-based innovation.

Physics and physicists have vital roles to play in solving many of the challenges that the UK faces today. Together they lead to the development of innovative technologies that boost productivity and drive economic growth, provide advances in security and communications, improvements in energy production and use, and underpin healthcare technology.

This year's winners all provide excellent examples of the way in which physics can improve and protect lives while also forming an invaluable part of the UK economy – generating profitable turnover and providing employment opportunities. They are high-growth businesses that have made remarkable contributions across a wide variety of sectors, including: the automotive industry, healthcare, nuclear security, oil and gas, space and IT infrastructure.

An exceptional number of high-quality entries, demonstrating the strength and depth of the UK's innovative, physics-based economy were submitted from businesses of all sizes. Some innovations had already had a transformative effect, while others pushed technological boundaries, potentially catalysing future markets.

This strength in high-growth physics-based businesses is only made possible by investing in physics and physicists. If the UK is to continue to build on the success of such companies as represented here, it is essential that both the public and private sector continue to invest in physics education, research and business innovation.

I congratulate all 10 winners for their fantastic achievements thus far and I wish them even greater success in the future.

“ It is a great honour to receive this award, which is a recognition of the outstanding team at Kromek, who continues to produce world-class innovative products for the global nuclear security markets. ”

Arnab Basu MBE, CEO, Kromek

“ We’re extremely proud and delighted to have been recognised with a commendation in the IOP Innovation Awards. ”

Simon Davis, company founder and director, Aqua Cooling Solutions

“ The IOP’s commendation for our novel use of magnetism underscores our reputation for innovation as we expand into new markets. ”

Eric Mayes, CEO, Endomag

“ Ikon Science develops and implements innovative, disruptive technology. It is a great honour to receive this prestigious IOP award. ”

Martyn Millwood Hargrave, CEO, Ikon Science

BUSINESS INNOVATION AWARD WINNERS 2016

Innovation Award

Awarded to businesses for bringing new physics-based products, processes or services to market, which have had a transformative effect resulting in increased turnover, profitability and jobs.

Winners

- Ikon Science
- Jaguar Land Rover
- Kromek
- The Technology Partnership
- Ultra Electronics NCS



Commended Innovation

Awarded to businesses for outstanding innovative applications of physics that push technological boundaries or develop bespoke solutions to market challenges, opening up new opportunities for discovery or market creation.

Winners

- Airbus Defence and Space
- Aqua Cooling Solutions
- e2v
- Endomag
- Tesla Engineering



““ Jaguar Land Rover is committed to original research that improves our customers’ experiences. We are delighted to receive this prestigious award. ””

Antony Harper, head of research, Jaguar Land Rover

““ We are delighted to win this award and to lead technological advancements across the globe. Our success is due to the brilliant team at TTP, who are passionate about developing technologies and making things happen ””

Dr Sam Hyde, The Technology Partnership

““ This award recognises the passion and skill of our scientists and engineers. Their innovation captures the spirit of our business. ””

Rakesh Sharma, CEO, Ultra Electronics

““ We’re delighted to receive a prestigious IOP Innovation Award recognising our unique sensor technology and its business potential. ””

Dr Cliff Weatherup, e2v technology manager

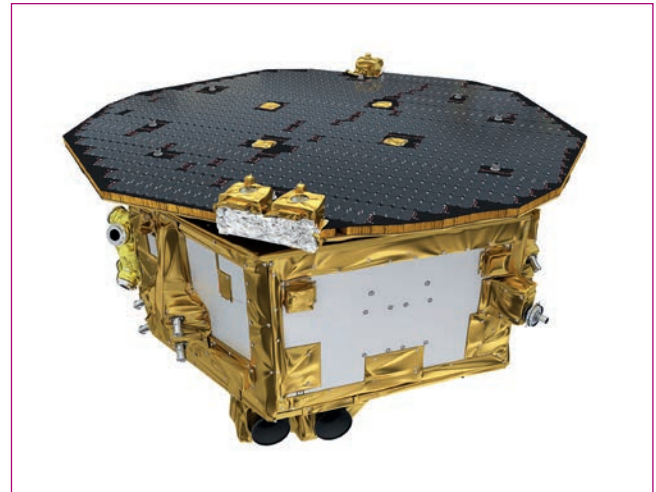
The winners

AIRBUS DEFENCE AND SPACE

For the development of the LISA Pathfinder satellite and measurement equipment that is sensitive enough to detect gravitational waves.

The Laser Interferometer Space Antenna (LISA) Pathfinder satellite was designed for the European Space Agency to test the technology needed for a planned mission (eLISA) to establish a dedicated gravitational-wave detector in space. The sensitivity of Earth-based detectors of gravitational waves is limited: they are subject to interference from seismic noise and nearby moving masses, and there is also a practical limit to their size. The LISA Pathfinder mission has successfully demonstrated that a more sensitive detector can be established in orbit.

Gravitational waves are ripples in spacetime: as they move they alter the spatio-temporal relationships between objects. This means that they can be detected by measuring changes in the relative positions and orientations of two test masses. However, for this method of detection to be sufficiently sensitive, the test masses need to be shielded from all other forces and new technology is required to accurately measure their relative positions.



LISA Pathfinder used the latest technology – inertial sensors, a drag-free control system and an ultra-precise micro-propulsion system – to minimise the extra forces on the test masses and demonstrated that they could be placed in a near-perfect gravitational free-fall. The mission also demonstrated the feasibility of laser interferometry at a frequency that is not possible on Earth. This meant that the distance of test masses 40 cm apart could be measured to an unprecedented accuracy of 0.01 nm.

The company

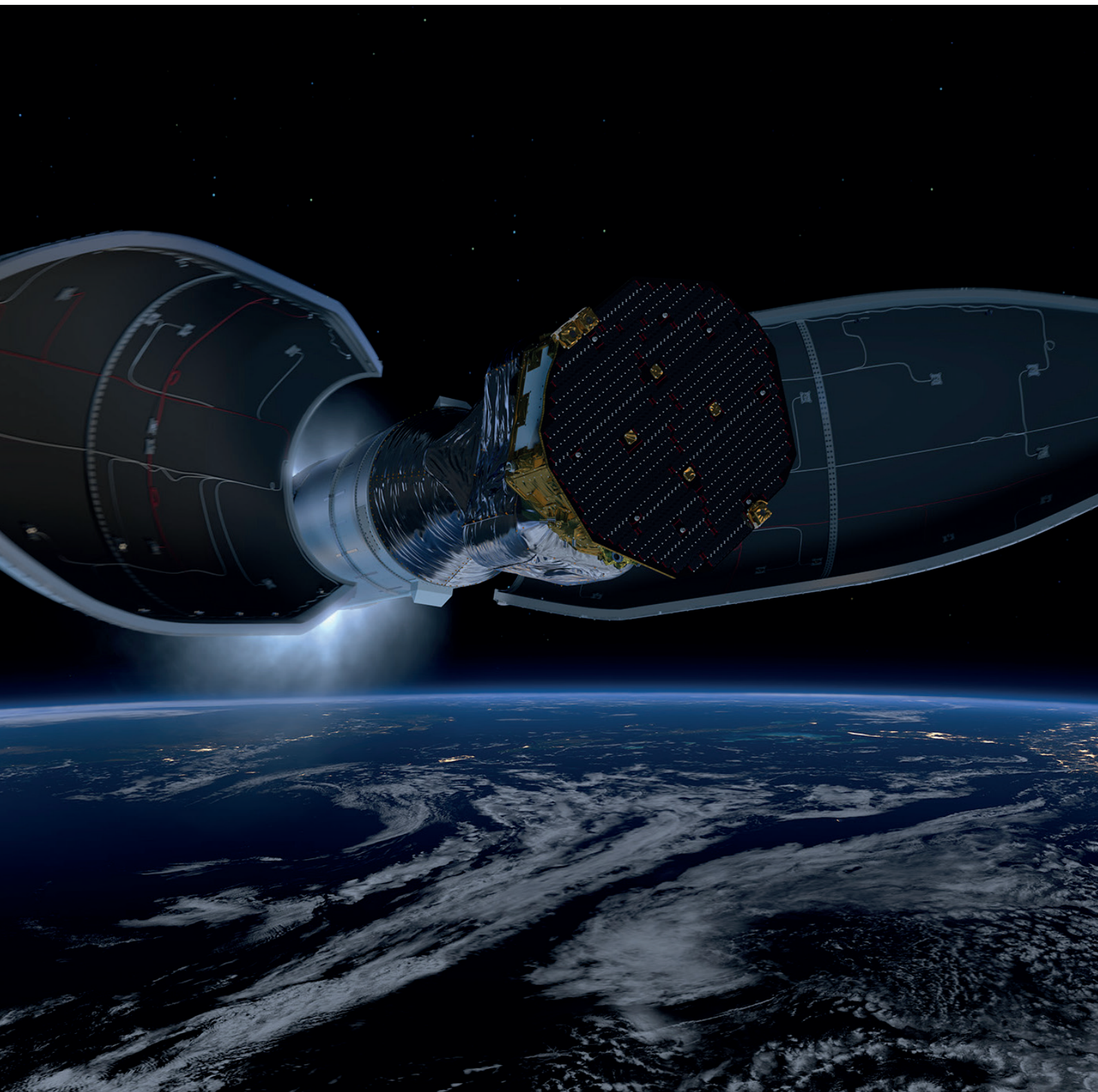
Airbus Defence and Space is a major aerospace systems provider covering satellites, launchers, transport and fighter aircraft, UAVs, communications services, and cyber-security. Airbus DS is the world's number two in the space industry with more than 40,000 employees and €13 bn in revenue.



More than

£100 m

increase in turnover



The winners

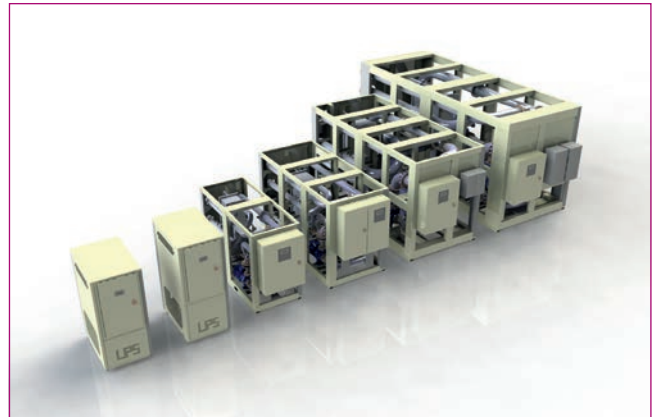


AQUA COOLING SOLUTIONS

For the development of their Leak Prevention System, which enables data centres to benefit from water-cooled data cabinets with guaranteed continuous, leak-free operation.

High-performance computing is vital to both industry and academia – powerful data centres are being used across a wide range of sectors. Data centres generate a great deal of waste heat, which leads to either very high temperatures or rooms that are inefficiently continuously air-conditioned. One solution to this problem is water-cooling, however, there can be risks involved in this approach: if a system failed, the circulating fluid would be forced out of the circuit, spraying water over the floor or the equipment. This could lead to flooding and/or damage to hardware or infrastructure, loss of data and impact on revenues and investment.

Aqua Cooling Solutions's Leak Prevention System (LPS) allows for water-cooling while removing the associated risks. The LPS uses the Venturi effect – when fluid flows through a constricted section of a pipe, there is a reduction in pressure – and the principle that water under negative pressure cannot escape through a hole or breach in pipework, hose or joint. The LPS has been designed so that, when there is a breach, air is drawn into an air separator – without affecting the negative pressure of the rest of the water in the system – enabling the rest of the water cooling system to continue to function even in the case of a breach.



Aqua Cooling Solutions have so far sold 79 units, generating around £1.7 m profit and opening up new markets in the US, Middle East and Africa. By making water cooling a viable option for data centres, Aqua Cooling Solutions is also promoting a more environmentally friendly approach of heat management.

The company

Aqua Cooling Solutions are the UK's leading specialist in industrial and commercial process-cooling solutions and associated products and services. Based in Fareham, Hampshire they provide professional industrial cooling solutions for the agriculture, automotive, computing, food/beverage, metal finishing, packaging, pharmaceutical and plastics/rubber sectors.



£1.7 m

profit generated

The winners

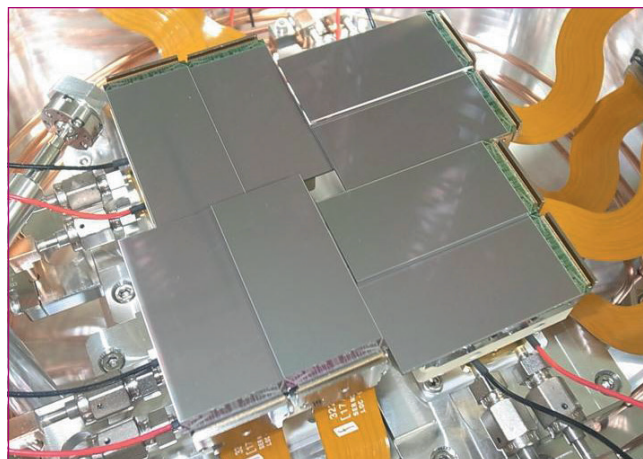
e2v

For novel CCD imaging detectors with enhanced X-ray and near infra-red sensitivity to capture more detail in biological nanostructures and remote astronomical objects.

This innovation from e2v addresses the challenge of using high-resolution imaging to capture more of the output from astronomical objects at near infra-red wavelengths. This is a particular challenge for remote objects because redshift increases with distance and so observation of these objects requires highly sensitive detectors at these longer wavelengths. Silicon sensors are also able to detect X-rays with energy of a few kiloelectronvolts (keV), but this provides limited detail when imaging molecular structures in nanomachines.

The resolution to both problems lies in increasing the depth of silicon that participates in turning incoming photons into signal electrons. However, with such deep silicon, it is possible for signal electrons to wander across pixel boundaries and make the image fuzzy. The solution is to use silicon with much higher resistivity and to apply a high-voltage bias through the depth of the pixel. The resulting electric field gathers the signal electrons and keeps them in the correct pixel. Special design features protect the output amplifiers from that high bias and guarantee reliability while achieving a five times improvement in both the near infra-red and X-ray performance.

The first customer for this technology was Riken's SACLA XFEL in Japan, where high-resolution images produced by e2v's new CCDs are used to investigate complex protein structure and cellular processes at the atomic level.

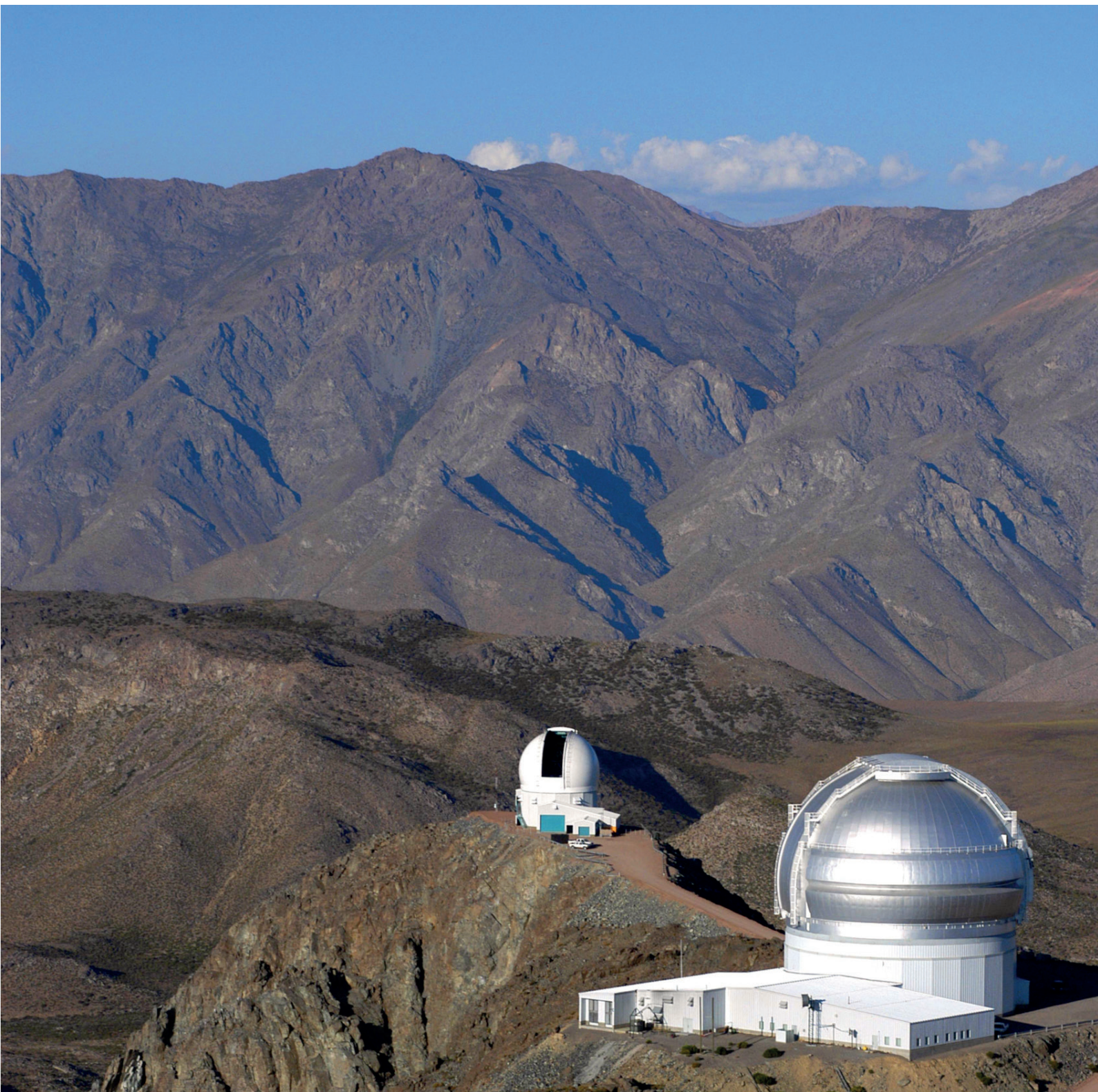


They were closely followed by the Large Synoptic Survey Telescope in Chile, where it will be used for a wide range of astronomical applications – investigating the structure of the Milky Way, the most distant quasars, and the nature of dark matter and dark energy. New applications in scientific cameras for microscopy and life science research are also emerging. It is anticipated that in three to five years this product will represent around 10% of the business unit portfolio.

The company

e2v partner with their customers to improve, save and protect people's lives. Their innovations lead to developments in communications, automation, discovery, healthcare and the environment. The company employ around 1,750 people across nine engineering locations and six sales offices in countries across Europe, America and Asia. They have annual sales of £236 m, and are listed on the London Stock Exchange.





The winners



ENDOMAG

For the development of the Sentimag System – a minimally invasive surgical guidance system for the management of cancer.

The traditional technique for locating sentinel lymph nodes involves injecting a radioisotope that is filtered out by the first nodes to drain the primary tumour and then located using a gamma-ray detecting probe. There are workflow and safety concerns using radioactive pharmaceuticals and these add to the stress and concern already felt by the patient.

Endomag has developed a unique clinical platform that uses magnetic fields to power diagnostic and therapeutic devices. Sentimag and Sienna+ form a minimally invasive surgical guidance system to address unmet needs in workflow efficiency, availability and affordability for surgical oncology. Sentimag, the foundation of the system, is the world's most sensitive handheld magnetic probe. Sienna+ is a superparamagnetic iron oxide nanoparticle that collects in lymph nodes first in line to drain from a tumour. Sentimag is sensitive enough to detect even minute quantities of the magnetic material, enabling clinicians to locate a cancer and check for any spread.

Endomag's initial focus is on improving the management of breast cancer, but clinicians have since adopted its products for other cancers including prostate, colon, endometrial and melanoma. Endomag's products have now treated more than 14,000 breast cancer patients in more than 30 countries. The company continues to develop its products for the diagnosis and therapy of other cancers.



The company

Endomag is a pioneer in the use of magnetism for minimally invasive surgical guidance. By addressing unmet needs in availability, affordability and workflow efficiency for surgical oncology, Endomag supports its mission to improve the global standard of cancer care for everyone, everywhere.



More than

14,000

patients treated

The winners

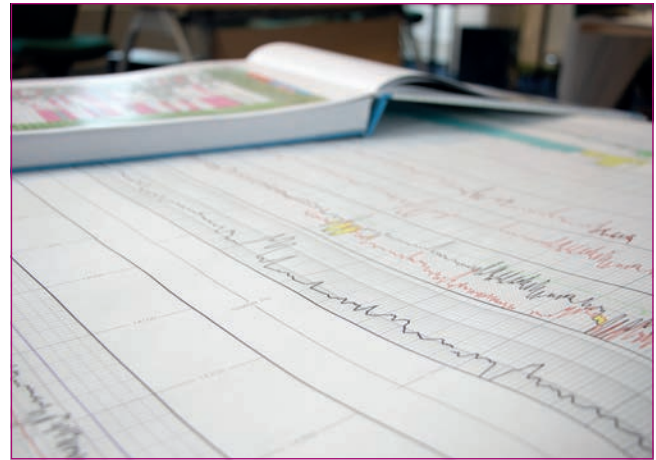
IKON SCIENCE

For the development of Joint Impedance and Facies Inversion (Ji-Fi) – a tool that accurately describes petroleum reservoirs and enables more efficient extraction.

3D seismic surveys revolutionised oil and gas exploration and production from the late 1970s, and gave geoscientists the vision of creating – from 3D seismic and well control – detailed 3D subsurface reservoir models to identify economic reservoir units.

New seismic inversion technologies evolved rapidly with the availability of increasing computer power and advances in related inversion theory. But results were inconclusive, requiring specialist interpretation, and were only partly useful in generating reliable reservoir models. Ikon Science's Ji-Fi technology delivered a step change to fully use 3D seismic data, and all available well and geological constraints.

Using more than 2,000 person-years of analysis and algorithmic development on applied rock physics, seismic forward modelling and science-rich prediction tools, Ikon took a fresh look at the seismic inverse problem. Ikon's scientists realised that rock-physics relationships, typically different for the various rock types or facies encountered, were not used effectively – or at all. By combining a more rock-physics and geological approach with new mathematical algorithms, Ikon enables usage of integrated prior regional and local geological models and analogues in the inversion of pre-stack seismic data, and is able to deliver a truly quantitative prediction of rock/fluid type and properties, and in the process deliver a step change in value.



The company

Ikon Science models and predicts the subsurface to optimise oil and gas reserves and reduce drilling costs, risks and operational uncertainty. They have created and marketed industry-leading software in collaboration with major oil companies and academia since 2001, and provide consulting services for all sub-surface decision-making.



£4.3 m

profit generated



The winners



JAGUAR LAND ROVER

For improvements to the modelling of the impact of sand and water on vehicles, enabling earlier identification of design improvements.

Jaguar Land Rover's all-terrain vehicles are expected to be able to wade through deep water and drive through deserts and sand dunes. However, this provides a substantial engineering challenge: both sand and water will damage vital components of the vehicle if they come into contact with them and are also very difficult to keep out of the vehicle.

The conventional approach to this problem involved developing physical prototypes and conducting physical tests of impact with sand and water — costing more than £250,000 per test. This approach is also very time consuming, since if a component fails the vehicle needs to be redesigned so that the test can be repeated. Jaguar Land Rover have developed state-of-the-art virtual engineering tools to model and test these scenarios without the need for physical prototypes.

The challenge was to model the physics of sand and water media upon impact with a vehicle. The optimum model uses smoothed-particle hydrodynamics, however, this approach required too much computing power, so Jaguar Land Rover combined this approach with the finite element method to develop a unique and successful approach.



The project has to date saved approximately £9 m through avoiding the necessity of physical tests. It has also enabled optimisation of the weight of certain components and fixings, saving 35–80% of the weight of these components, which translates to a saving of up to 9,000 tonnes of carbon dioxide from tailpipe emissions.

The company

Jaguar Land Rover is the UK's largest automotive manufacturer, built around two iconic British car brands: Land Rover, the world's leading manufacturer of premium all-wheel-drive vehicles, and Jaguar, one of the world's premier luxury sports saloon and sports car marques.



Saving of

£9 m

The winners

KROMEK

For the development of intelligent radiation-detection networks that can provide early warning of radioactive materials – improving the ability of security services to counter the threat of nuclear terrorism.

There are increasing concerns about public safety against potential radiological terrorist events. Such a device, deployed in a city or urban area, could render it unsafe for humans for some considerable amount of time due to nuclear contamination. In the past, photomultiplier tubes have been used to detect unusual radiation signatures – there are bulky, fragile and expensive, and were placed in specific sites that were thought to be potential targets. They do not provide the level of detection required.

As part of a US Department of Defense (DoD) programme, Kromek has developed is a compact gamma/neutron detector with wireless connectivity, allowing networking across a whole city. The devices use cadmium zinc telluride (CZT) as the detector, complemented by the use of silicon photomultiplier devices. This combination has enabled Kromek to develop high-resolution detectors compact enough to comfortably be carried by police officers and community first responders. The detectors are networked – as they are carried by police officers and first responders around a city – so they jointly build up a picture of the normal radiation levels around a city. Threats can then be detected when the radiation level differs from what is normal for a specific area.



The project has been a huge success and was given an award by the DoD. To date, 13,000 units have been sold in the US, Japan and Europe, generating turnover of more than £7.5 m.

The company

Kromek Group plc is a UK technology company and a leading developer of high-performance radiation detection products based on cadmium zinc telluride. Using its core CZT technology, Kromek designs, develops and produces X-ray and gamma-ray imaging and radiation detection products for the medical, security screening and nuclear markets.



More than

£7.5 m

turnover generated



The winners



TESLA ENGINEERING

For the development of compact superconducting magnets for medical applications, enabling the more widespread use of proton-beam therapy for cancer treatment.

The medical therapeutic application of proton beams is an exciting area that enables more effective treatment of cancer by reducing damage to surrounding healthy tissue. The beam energy is deposited over a narrower range than in other forms of radiotherapy, which limits the risk of collateral damage to vital organs. The availability of proton therapy is currently limited because of the cost and size of the superconducting cyclotron that is normally used – a conventional system requires around a football-pitch-sized amount of space for installation.

Tesla Engineering have developed compact superconducting magnet technology that enables a medical cyclotron to be mounted on a gantry – meaning that there is potential for the use of proton-beam therapy to become much more widespread. Cyclotrons combine a magnetic field with a varying electric field to accelerate charged particles. The stronger the magnet, the more compact the cyclotron. However, operating the superconducting wire in a strong magnetic field places it under stress – the stronger the magnet, the higher the stress. For this reason, conventional cyclotrons tend to be large and heavy.



Tesla uses a unique combination of electromagnetic design, materials choice, vacuum impregnation technology and mechanical modelling to develop superconducting magnets that can operate at much higher stress. These can then be used to build smaller and lighter cyclotrons, meaning that their medical applications can be made available to many more patients.

The company

Tesla was established in 1973 and designs and manufactures a wide range of top performance, state-of-the-art superconducting and resistive magnets and gradient coils for specialist applications in science, medicine and industry around the world. The company employs more than 250 people and has subsidiaries in the USA and Netherlands.



Annual magnet sales growth of

25%

The winners

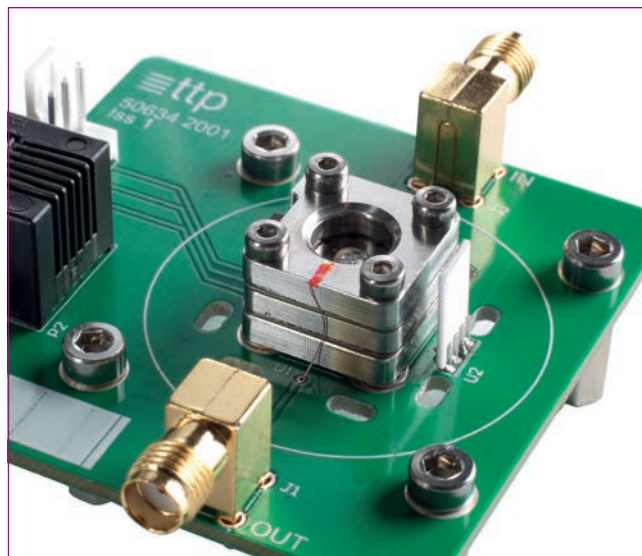
THE TECHNOLOGY PARTNERSHIP

For the development of the SonicSense acoustic gas sensor, which monitors the output of the therapeutic oxygen concentrators used in the treatment of chronic obstructive pulmonary disease (COPD).

There is a trend in gas sensors away from chemical-type devices – which offer high sensitivity but poor lifetime and troublesome signal drift – towards physical sensors that measure a property of a gas. However, the widespread use of physical sensors is restricted, as they are expensive and have a high power consumption.

The Technology Partnership's (TTP) SonicSense technology addresses both issues by turning the inexpensive piezoelectric buzzers used in doorbells or smoke alarms into an accurate, stable, low-power gas sensor. SonicSense generates and interrogates an ultrasonic acoustic resonance in the target gas; as the gas composition changes, so does the frequency of the acoustic resonance.

TTP is working with partners to commercialise the technology in a range of markets including energy, industrial safety and medical devices. For example, Philips Healthcare recognised the benefits of SonicSense technology to their oxygen concentrators, which are used to care for millions of COPD patients worldwide. Bob Murdoch, Philips's director of advanced development, explains why they chose it: "The sensor is used to monitor the purity of the oxygen concentrators' gas output and trigger an alarm if the oxygen purity is too low.



SonicSense technology offers several advantages compared to current sensors: it has a long operating life, enabling concentrators to run for tens' of thousands of hours; it doesn't require periodic re-calibration, which would be impractical in patients' homes; and the low power consumption enables concentrators to operate effectively on battery power."

The company

TTP make new technology and new products possible by the way they work. They have a commitment to world-class science and engineering and firmly believe it can have a huge impact on the commercial success of their clients.

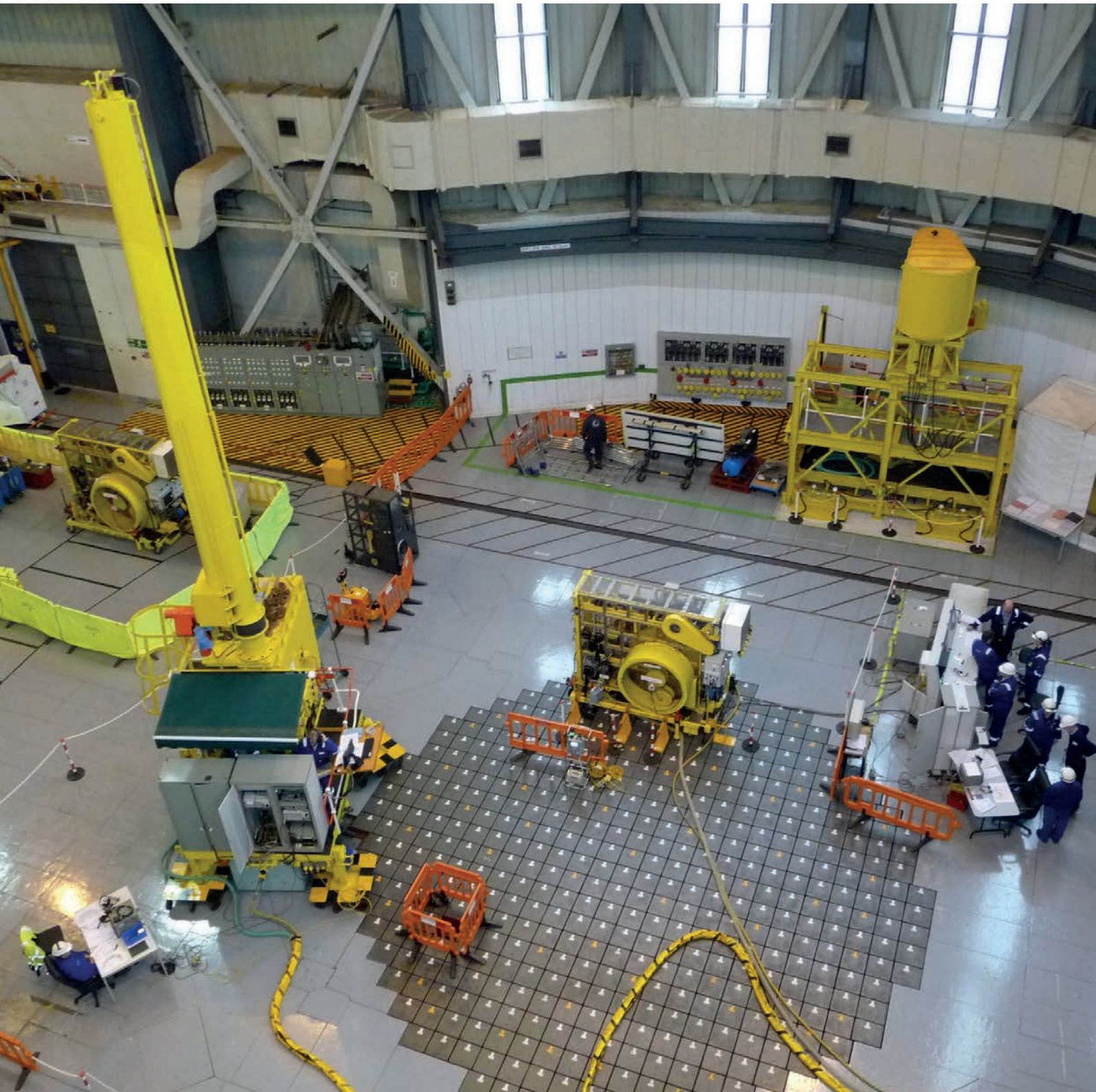


12

jobs created



The winners



ULTRA ELECTRONICS

For the establishment of a facility to design, manufacture and test neutron-flux detectors, which are critical sensors used to monitor reactor cores in nuclear power stations.

Ultra has developed a state-of-the art facility to design, manufacture and test neutron flux detectors (NFDs), including the design of specialist plant, manufacturing and test processes and training of highly skilled personnel. These critical sensors monitor and protect the nuclear reactor core, and without complete confidence in their performance, reactors are not able to operate.

NFDs present a number of extreme sensor physics challenges to be overcome, and through analysis of failure modes and device characteristics, Ultra has re-imagined the manufacturing process. The specialist plant and processes required for manufacture were predominantly designed from first principles. Challenges included ceramic materials and joining, high-temperature neutron-sensitive coating materials and methods, ultra-high vacuum processing, cleaning and measurement, and advanced fault diagnostic methods.

All stages of the manufacturing process have been designed to be as automated as possible; eliminating reliance on 'artisan' skills through a strong emphasis on measurement and setting limits. A key strategy was to develop a thermal neutron generator to perform testing on the detectors at appropriate stages of manufacture. This has greatly reduced lead times and improved quality by eliminating transport risks and testing delays.



The company

Ultra Electronics has a broad portfolio of specialist capabilities across the defence, aerospace, security, transport and energy sectors. The company has products that operate in critical environments, and succeeds by solving difficult problems through game-changing innovation and close partnership with customers.



43
jobs created

FIVE YEARS OF BUSINESS INNOVATION AWARD WINNERS

Airbus Defence and Space

Aqua Cooling Solutions

Aurox

Coherent Scotland

Displaydata

e2v

Elekta

Endomag

Gas Sensing Solutions

Gooch & Housego

Hallmarq Veterinary Imaging

Ikon Science

Jaguar Land Rover

Kromek

Magnox

MBDA UK

M Squared Lasers

Metrasens

Naneum

Silixa

Simpleware

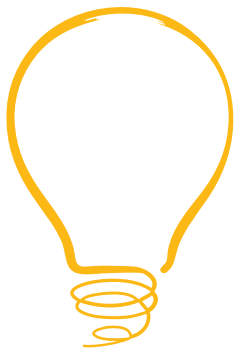
Tesla Engineering

The Technology Partnership

Tracerco

Ultra Electronics

Zephyr



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