fascination

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Science & Technology Facilities Council

WELCOME

Welcome to the autumn 2014 edition of *Fascination*.

In this edition, we bring you all the latest UK news from CERN, including how patients with lung and liver tumours could benefit from a new project between CERN and the University of Bath, and what it's like to be a CERN summer student (page 12).

If broadcaster, science communicator and physicist Professor Jim Al-Khalili could give advice to someone at the start of their science career, what would he say? Find out on page 24 as we catch up with the man himself.

The arms race against bacteria is on, and scientists are taking on the battle against antibiotic resistance using the Diamond Light Source. More about the fight to keep the world well on page 18.

Cosmic rays from space strike aircraft every few seconds as they fly through the air. But are they enough to ground a plane? Our new facility, ChipIR, has been designed to find out. Learn more on page 20.

Our Harwell Oxford campus is growing. On page 14, we give you a sneak peek of the exciting developments happening on site and what they will mean for our science.

Read our news section to find out how Rosetta has made history, how space robots invaded Tate Britain, how STFC has given a vital boost to UK nuclear physics research and much more!

Happy reading!

Best wishes,
Your Fascination editorial team

ABOUT US

Our scientific research seeks to understand the Universe from the largest astronomical scales to the tiniest constituents of matter. Providing access to and managing a range of world-class research facilities, STFC delivers fundamental insight and scientific breakthroughs in areas ranging from particle and nuclear physics to space, laser and materials science. Through our UK operations and our involvement in major international collaborations, we generate outcomes that shape societies, strengthen economies, build industries, create jobs and transform lives.

Don't miss an issue

Fascination is STFC's quarterly in-house magazine. We also produce ad-hoc themed editions throughout the year. To receive an electronic version straight into your inbox, please visit: www.stfc.ac.uk/fascination and subscribe.

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NEWS

The lives of **CERN People** caught on film in new series

A still from an episode of CERN People.
Credit: Liz Mermin

Want to know what it's like to be a particle physicist working at one of the world's largest, most respected centres for scientific research? CERN People, a new series of short films created by documentary filmmaker, Liz Mermin, and funded by STFC, takes you behind the headlines and into the lives of real particle physicists working at CERN. With a primary focus on the younger physicists you don't usually see in front of the cameras, the films shine the spotlight on what they do, their motivations, their aspirations, and what it's like when someone finds the Higgs boson before you.

Watch the films on YouTube at:
www.youtube.com/intelligentchannel
Follow Liz on Twitter: @merminfilms

Future of fast computer chips could be in graphene, says new research

STFC's Dr Emma Springate, one of the research team, with the Artemis laser.
Credit: Monty Rakusen Photography

Scientists using lasers at STFC's Central Laser Facility are a step closer to finding a replacement for silicon chips that are faster and use less energy than at present.

Graphene is pure carbon in the form of a very thin, almost transparent sheet, one atom thick. It is known as a 'miracle material' because of its remarkable strength and efficiency in conducting heat and electricity.

In its current form, graphene is not suitable for transistors, which are the foundation of all modern electronics. For a transistor to be technologically viable, it must be able to 'switch off' so that only a small electric current flows through its gate when in standby state. Graphene does not have a band gap so cannot switch off.

The research team, led by Professor Philip Hofmann from Aarhus University in Denmark, has tested the behaviour of bilayer graphene (a new material in which two layers of graphene are placed one on top of the other, leaving a small band gap to encourage the transfer of energy between layers), to discover whether or not it could be used as a semiconductor. Their results suggest that, with further technological work to reduce imperfections, it could replace silicon transistors in electronic circuits.

Graphene transistors could make smaller, faster electronic chips than are achievable with silicon. Eventually more and more transistors could be placed onto a single microchip to produce faster, more powerful processors for use in electronic equipment.

To read the full story, go to:
www.stfc.ac.uk/3257

European Astronomy Prize 2014

Aerial View of Cerro Paranal. Credit: J L Dauvergne & G Hüdepohl (atacamaphoto.com)/ESO)

Entries are now open for the European Astronomy Journalism Prize 2014.

This marks the third successive year for this popular award for journalists, journalism students and astronomy students. Run by STFC and the European Southern Observatory (ESO), in conjunction with the Association of British Science Writers and the Royal Astronomical Society, the aim of the competition is to celebrate the outstanding coverage of astronomy, and in particular, work that enthuses the audience about the importance of astronomy.

The winner will have the rare opportunity to visit the largest astronomical project in existence, the Atacama Large Millimeter/submillimeter Array (ALMA), located 5000 metres above sea level in the Atacama Desert, on the high-altitude Chajnantor Plain, Northern Chile. Comprising fifty 12-metre antennae, plus a compact array of sixteen antennae, it allows astronomers to observe and image the enigmatic cold regions of the Universe with unprecedented clarity.

Entries for the Prize must be about astronomy and related areas of technology, or about the work and lifestyles of astronomers, engineers or others working in the field of astronomy, must reflect European interests and they can be online, written or broadcast.

Entry is open to journalists, students of a recognised journalism course, students of a recognised qualification in astronomy, or holders of a recognised qualification in astronomy, whose work is published or broadcast and is accessible to the general public. You may be asked to provide proof of your status.

Entries must have been published or broadcast during the period 1 August 2014 to 28 November 2014 inclusive. Applications close on Friday 28 November 2014.

For information about how to enter and full terms and conditions, visit: www.stfc.ac.uk/astroprize

NEWS

Construction gets underway on the ESS

Latest full-size conceptual rendering of ESS.
Credit: European Spallation Source / Team Henning Larsen Architects

Construction is now officially underway on the world's biggest microscope, the £1.4 billion European Spallation Source (ESS), being built in Sweden with key British input.

"The ESS is one of the largest science and technology infrastructure projects of the decade. Using neutrons to examine the structure of matter, the ESS will help scientists in a huge array of applications – from medical research to new materials, better drugs to longer-lasting batteries, safer and more secure transport and much more," said Professor John Womersley, Chief Executive of STFC.

The UK is a major partner in the 17-nation ESS consortium, and will contribute around 10 per cent of the construction costs.

When completed early in the next decade, ESS will complement Britain's own world-leading neutron source, ISIS, at STFC's Rutherford Appleton Laboratory.

"The Swedish government recognises that British expertise developed at ISIS is going to be crucial for the successful design, construction and operation of the ESS. Sweden will help fund ongoing work at ISIS, and I'm delighted that British engineers, technicians and scientists will be able to work with their Swedish and Danish counterparts and other European partners on this exciting project" said Professor Womersley.

Professor Womersley represented the UK at the ESS Foundation Stone Ceremony, held in Lund, Sweden, on 9 October.

For more information about ESS, visit: http://europeanspallationsource.se

STFC researcher awarded Dorothy Hodgkin Fellowship

Dr Elin McCormack has been awarded the Dorothy Hodgkin Fellowship from the Royal Society, for her work on remote sensing of atmospheric electric field strength. She is one of just nine researchers selected for one of these highly competitive fellowships this year.

Dr Elin McCormack.
Credit: STFC

Dr McCormack said, "I'm delighted that the Royal Society have chosen to support my research and I'm looking forward to doing this work in the stimulating scientific environment that RAL Space provides".

Her project uses a new measurement technique that has the potential to enable the study of properties of the Earth that impact on climate change, radio propagation and health.

The Dorothy Hodgkin Fellowship scheme supports outstanding scientists and engineers at an early stage of their career. It is aimed specifically at researchers who require a flexible working pattern – such as those with young children – so is particularly popular with female scientists.

For more information about the Dorothy Hodgkin Fellowship, visit: https://royalsociety.org/grants/schemes/dorothy-hodgkin

RAL Space robots invade Tate Britain after dark

Robots designed, developed and tested by STFC's RAL Space were fitted with lights and cameras and let loose to explore Tate Britain back in August, as part of a new online live-streaming initiative, the After Dark project.

The intelligent robots can sense their way around and were originally developed for Mars rover trials and research, but in collaboration with The Workers, who created the After Dark project, this time they were used to give unique virtual tours of the Tate Britain galleries after lights out.

People from around the world logged in and joined a virtual tour with one of the RAL Space robots, and some people even got the opportunity to take control of the robot during the tour – using the on-screen buttons or the arrow keys on their keyboard to turn and move forward, look up and look down. They sensed obstacles around them and fed this information to the operator, to help them navigate.

Kim Ward, Head of Space Engineering Technology at STFC's RAL Space, said "We are delighted to have been involved in the After Dark project, exploiting the expertise of our Robotics Group. Our team often works in support of planetary exploration programmes by conducting field trials in remote Mars-like terrains like the Atacama Desert. For the After Dark project, the robot platforms used were developed as an extension of our outreach rovers."

The After Dark project ran from 13-17 August at Tate Britain, and The Workers are currently looking for new venues for the project. Keep up-to-date with the project's progress and see video footage from Tate Britain at www.afterdark.io

Night vision: an After Dark project robot with Jacob Epstein's The Visitation (1926) at Tate Britain.
Credit: Alexey Moskvin/Tate Britain/PA

STFC's I-TAC takes first prize

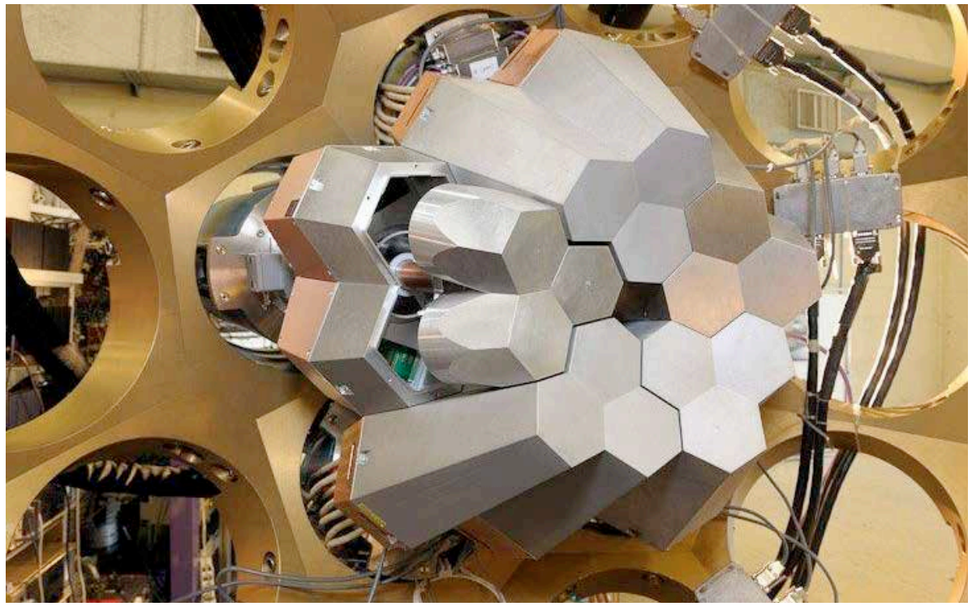
Growth Accelerator (sponsor), Debby Clucas, Karen Lee, BBC's Michael Mosley, Paul Vernon, Martin Morlidge and Zoe Hill.
Credit: UKSPA

The Innovations Technology Access Centre (I-TAC) has scooped a prestigious UK Science Park Association (UKSPA) award for having the best track record in developing and supporting start-up and high-growth businesses. The award celebrates the invaluable role that innovation centres and incubators, and their business environment, play in the growth and economic success of early stage companies.

Since it opened four years ago, I-TAC, which is part of STFC, has supported more than 60 high-tech companies and aided in the development of 46 new innovative products. It has also helped its tenant companies achieve an impressive £80 million of investment and to create over 100 new jobs.

The awards ceremony, which was hosted by science writer and BBC presenter Michael Mosely, was held on 10 July as part of UKSPA's 30th Anniversary Summit in Birmingham.

Boost for UK's nuclear physics research



AGATA 3. Credit: STFC

The UK's nuclear physics research capability will be strengthened significantly with the establishment of a new nuclear physics theory group at the University of York, thanks to a special funding award from STFC.

The award will pave the way for the appointment of a nuclear physics theory chair and a PhD studentship, in addition to a nuclear physics theory lectureship, funded by the University of York.

The move is driven by a strategic need for theory and modelling support to the UK's national experimental programme which was identified in a 2012 Institute of Physics report. Professor Bob Wadsworth, from York's Department of Physics, said: "The fact that there are only a handful of UK academics working on nuclear physics theory has been highlighted as a serious issue for the status of nuclear physics research in the UK.

"At the moment, experimental nuclear physicists working in the UK frequently need to seek support from theorists in Europe, Japan or the United States. Having more theorists in the UK will be invaluable to the UK nuclear physics community."

Professor John Womersley, Chief Executive of STFC said: "This initiative was identified as a priority, both in community consultation and by our advisory panels, which has led to STFC providing this additional funding to strengthen the UK programme in nuclear physics theory. This new collaboration between STFC and the University of York reinforces our commitment to help keep the UK at the forefront of nuclear physics research."

The new theory group will complement the work of York's experimental groups and will work closely with theory groups at Manchester and Surrey Universities, as well as other groups across Europe and beyond.

The new chair is expected to be in place by March 2015, the lecturer by June 2015 and the studentship will begin in October 2015. STFC will fund the chair position for approximately three and a half years, after which time York will take on the funding of the post.

New publications

Big data: big impact

Big data is big news at the moment – ninety per cent of all the data in existence has been created in the last two years. But how much do you know about it?

Find out what big data is, why it's useful and how it's going to impact our lives in the future with this informative brochure, combining scientific insight with real-life context.

With stories from the worlds of science and research, environment and climate, medicine and health and manufacturing and industry, the information in this brochure is just a sample of the significant social and economic impacts of big data.

To download or order hard copies, visit: www.stfc.ac.uk/1805

Accelerators: powering cutting-edge research

There are around 20,000 particle accelerators in use around the world - but what exactly are they? How do they work? And what are they used for?

Particle accelerators play an important part in our everyday lives; developing new technologies and making useful discoveries.

Produced by STFC in conjunction with the Institute of Physics (IoP), Lancaster University and The Cockcroft Institute, our accelerators brochure is an insightful guide to what accelerators are, and how and why they are used in energy, fighting cancer, medicine, security, environment, industry, the natural world and heritage.

To download or order hard copies, visit: www.stfc.ac.uk/1805

The latest UK news from CERN

Troubleshooting CERN

If an alert goes off at CERN, it will almost certainly show up on one of Chris Wetton's 15 screens in the CERN Control Centre. At the end of a busy shift, Stephanie Hills, CERN's UK Communications and Innovations Officer, caught up with him to find out how the Long Shutdown (LS1) of CERN's accelerator complex has affected his team.

CERN Control Centre. Credit: interactions.org

Chris is a member of the Technical Infrastructure Operation group, an eight-strong team that works 24/7 to monitor all the services for CERN's accelerator complex. Chris and his colleagues rely on sensitive triggers throughout the complex to send an alert as soon as any deviation is detected so that it can be fixed before anything significant goes wrong. The bank of screens is intimidating – there are screens with schematic diagrams and synoptics of the electrical network, and on others there are lines of text in different colours indicating the priority level of an alert. These can be from level zero (white/grey - information only) to three (red - requiring immediate intervention from the fire service). Fortunately there are no red lines - the screens are mostly yellow indicating level two technical issues, and after nearly 10 years in the job, Chris was able to do a quick scan across the screens and calmly assess what was going on.

"We monitor everything from the fire alarms, gas, heating and ventilation systems to the evacuation systems and automatic doors," explains Chris.

"If an alert goes off, we identity the problem, and then we try to fix it."

Sometimes an alert can be reset remotely, but often it requires the shift operator to go on site. CERN is spread across a wide geographic area and the team needs an intimate knowledge of each site, as well as each system. They maintain a detailed database with information about each system; where to find it, what it will look like, common faults and how to fix them. Sharing information is essential and there is time reserved at the start/end of each shift to pass on current information.

"Level two alerts are the most common during a technical stop when people are working on the machines. We need to know who is working where, what they're doing, and what alerts they might trigger. Most people will call us up before they start, but not always. When the accelerators are working it's reasonably calm, but at the moment, we're taking 200-280 phone calls every day." If that sounds busy, bear in mind that the screens are registering new alerts all the time.

During LS1, a number of new systems have been installed requiring Chris and his colleagues to familiarise themselves with a new set of challenges. One system problem could trigger up to 30 alerts, and some trigger more regularly than others. "It can be quite stressful when there's a big problem such as a power cut – if we're operating, everyone calls us – the physicists want to get on with their physics!"

In 2013 (during LS1), a staggering 1.8 million alerts were registered (doubling the total from 2012).

> "...we're taking 200-280 phone calls every day."

Each one had to be dealt with. During normal operations, there is one person on shift, but for LS1, the team has needed extra resources and volunteers were recruited from other parts of CERN to assist the team. The experience has given them a valuable insight into the complexities of CERN and its operations. "If we go on site to fix a problem, we're still in permanent contact with the monitoring systems via our phones," says Chris. "Night shifts and quiet times are good opportunities to get out and about around the CERN sites familiarise ourselves with where the critical systems are located."

Having such an in-depth knowledge of CERN means that the team is often seen as the first point of contact for troubleshooting any incident whether it involves the accelerator complex or not, and this can have its lighter moments; "A few days ago we took a call advising us that the sheep that graze some of the land inside the main CERN site had escaped. Sorting out livestock definitely isn't our responsibility, but actually we do have the farmer's phone number, and we did solve the problem!"

Aside from farming, Chris and his colleagues come from a variety of backgrounds – cryogenics, electrical systems, cargo ships and submarines. He himself started out as an apprentice maintaining high vacuum, RF, cryogenics and metrology equipment in a semiconductor fabrication cleanroom for Philips.

"CERN uses essentially the same technology, just on a huge scale!" says Chris. "It's the hands-on interventions that I enjoy; we've been given more responsibility and more chances to go on site in LS1 so I hope that will continue."

An international perspective for STFC apprentices

STFC apprentices, Josh Preston and Henry Russell, were on a three-week work experience placement at CERN this summer. And it was quite an eye-opener!

About to go into the final year of their apprenticeships, Josh and Henry had the option within their college course to arrange a work experience placement. After taking part in an exchange visit to the Institut Laue Langevin and European Synchrotron Radiation Facility in Grenoble last year, they thought they would aim high for a second time.

"We loved the challenge of working in a different country; the similarities, the differences and the culture. We thought we'd try for CERN," says Henry. "But we really didn't think it would happen!" adds Josh. They have spent their placements working in CERN's Beams Department. "My team is working on the electrical controls for power converters for the LHC," says Josh. "I've been designing and organising an automated test rig. It's a very sophisticated system but surprisingly easy to use."

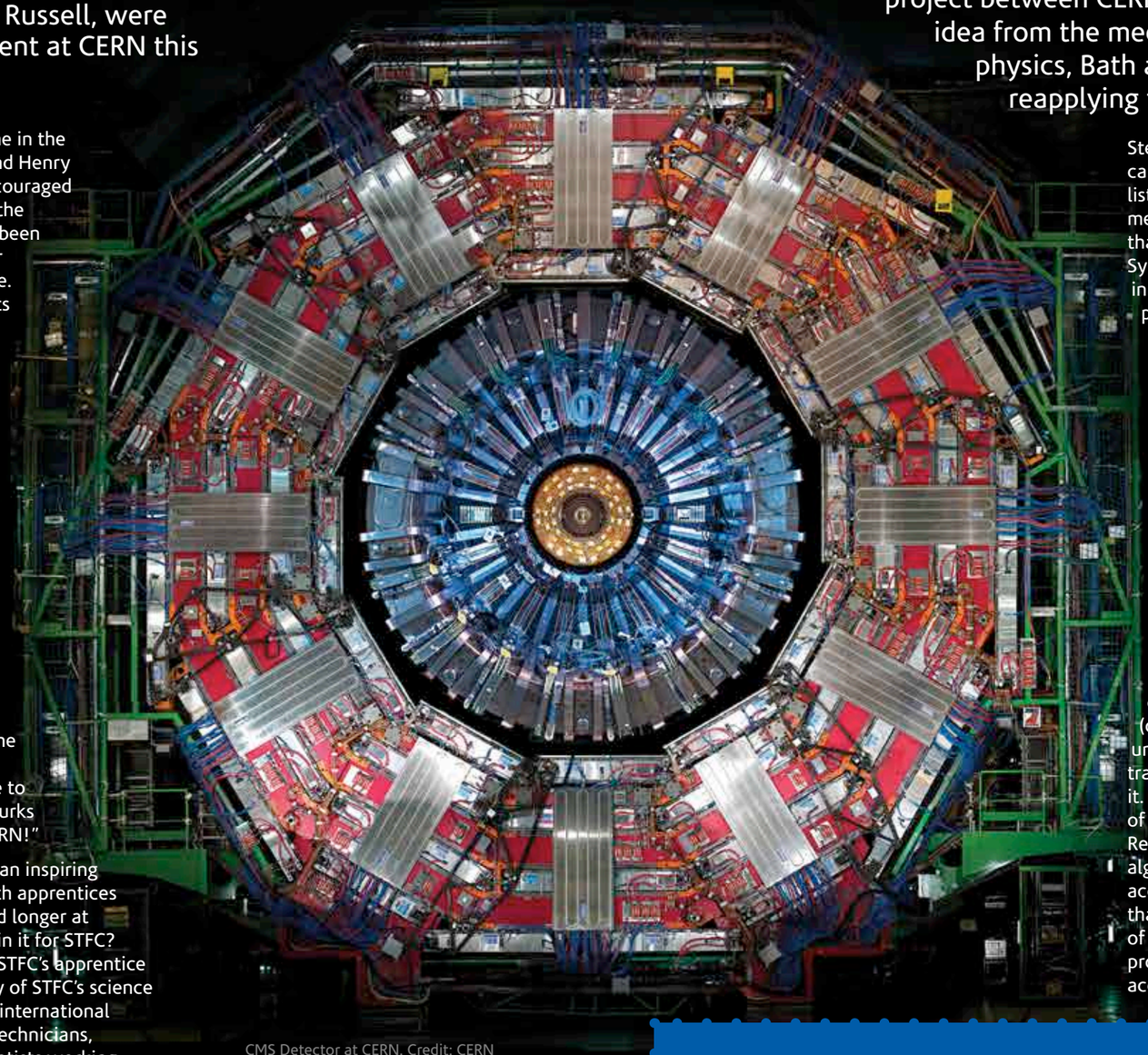
Josh's experience has given him some food for thought, "We have a similar system at STFC but we don't use it as fully as we could." He's clearly keen to use his newfound knowledge when he gets back to the Rutherford Appleton Laboratory. Henry has been working in the Beam Instrumentation workshop machining components for the LHC. "I think I could have been a bit more productive if I'd been able to speak better French – GCSE French doesn't cover technical vocab – but it's a friendly team and we've managed to communicate; we've drawn lots of pictures on post-it notes!"

"They have some nice ways of working at CERN", says Josh, "and I think there are some opportunities for us to suggest ways to improve our work when we get back."

Alongside their time in the workshops, Josh and Henry have also been encouraged to attend some of the lectures that have been part of the summer student programme. Particular highlights were lectures on the future particle accelerators; CLIC, the ILC and the Future Circular Collider. "I thought Ugo Amaldi's lecture about cancer therapy was fascinating," says Josh, "it was such a thorough explanation. It's one of the highlights of the placement."

For Henry, it was the opportunity to see CMS: "I would love to see more of what lurks underground at CERN!"

It has clearly been an inspiring few weeks and both apprentices would like to spend longer at CERN. But what is in it for STFC? John Hill manages STFC's apprentice programme, "Many of STFC's science projects are major international collaborations so technicians, engineers and scientists working together is a key element to their success. Exposing our apprentices to this international environment early in their training gives them an opportunity to develop their teamwork skills and to appreciate the importance of communication between collaborating members."



CMS Detector at CERN. Credit: CERN

Imaging a moving target

Patients with lung and liver tumours could benefit from a new project between CERN and the University of Bath. Taking an idea from the medical domain and applying it to accelerator physics, Bath alumnus Steve Hancock (CERN) is now reapplying the technique to medical imaging.

Steve's 'light bulb' moment came in 1993 when he was listening to a talk about medical imaging. He realised that protons in the Proton Synchrotron (PS) had more in common with a human patient than you might think. Delivering radiation doses accurately to lung and liver tumours is tricky because these organs are constantly moving as the patient in- and exhales. Similarly, protons in an accelerator beam swirl around rather like the effect of stirring cream in coffee, and accurate imaging that would enable fine-tuning of the beam is challenging.

However, the physics of this swirling motion (deformation) is well understood and there are tracking models to simulate it. "I tweaked the simplest of iterative ART (Algebraic Reconstruction Technique) algorithms to take into account the rapid deformation that occurs during a 'scan' of my 'patient', a bunch of protons circulating in a CERN accelerator," explains Steve.

The technique, phase space tomography, takes a series of one-dimensional profiles and reconstructs a 2D picture. It is now used in CERN's PS, Booster, Antiproton Decelerator and the Low Energy Ion Ring (LEIR) to measure precisely the very different longitudinal characteristics of the beams in those machines. It's not currently used in the LHC (Large Hadron Collider) because the proton bunches are too short, but there are plans to develop an optical version of the technique.

The technique continued to be used at CERN, but its wider potential remained untapped until last year when Steve received an alumni newsletter from his old university, "There was an article about Bath opening a new Engineering Tomography Lab. So I got in touch." Now the idea is to combine the methodology of Steve's algorithm with the fantastic time resolution (up to 100Hz) of electrical impedance.

What's new at Harwell Oxford?

Home to over 200 organisations, Harwell Oxford is a hotspot of scientific and technological excellence, with thriving clusters working in areas as diverse as healthcare, the environment and space and satellite applications - and it's growing. Here we give you a tour of what's new on campus.

Harwell Oxford, Credit: STFC

Harwell Oxford is a joint venture between STFC, UK Atomic Energy Authority and private sector partners, Harwell Oxford Developments. Harwell Oxford has plans to build on the campus's position at the forefront of scientific discovery, research and innovation to create continued growth and excellence on the world stage.

European Data Relay System

As you arrive at Harwell Oxford, you can't miss the new dish – one of three ground stations for ESA's new European Data Relay System (EDRS), which is being designed to reduce time delays in the transmission of large quantities of data. EDRS will use lasers to transmit data between satellites, so that it can be downloaded to Earth within minutes, rather than hours. This means that (for example), data from Sentinel 1a could be used for flood prediction. EDRS will use two geostationary payloads. The first is scheduled for launch in 2014, aboard host satellite Eurobird 98, with the second following it into orbit in 2015.

European Centre for Space Applications and Telecommunications

In December 2013, then Minister for Universities and Science, David Willetts MP, attended a ceremony to launch the European Space Agency's (ESA) new dedicated building. ESA's European Centre for Space Applications and Telecommunications (ECSAT) has been based at Harwell Oxford since 2009. The new ECSAT building is scheduled for completion in 2015, and will house around 100 ESA employees. Work is underway on a site in front of the iconic Diamond Light Source building. RAL Space's new Technology Centre is a little further underway, in a prominent position on Fermi Avenue, opposite the Diamond Light Source. This world-class facility will be home to five new advanced space test chambers along with extensive clean rooms and 12 Thermal Vacuum Chambers from 5m to 0.5m diameter. The current plan is for our Assembly Integration and Verification (AIV) team to commission the facilities from late 2015 onwards, depending on operational requirements.

ECSAT current progress. Credit: STFC

ECSAT future building look. Credit: ESA

New occupier on campus

At the Farnborough Air Show in July, Lockheed Martin announced it is opening a space technology office at Harwell.

Lockheed Martin has been collaborating with STFC for over a decade. The company is extremely enthusiastic about the UK's ambitious space strategy and is excited to be on campus to further strengthen its relationships with UK, European and other civil space agencies and companies.

Paul Davey of Lockheed Martin confirmed that: "Harwell's open innovation environment, combined with the breadth and depth of the research and innovation undertaken on campus lends itself to the Lockheed Martin collaborative approach, which is already established on other campuses in the United States."

Diamond's new beamline

A new beamline is under construction for Diamond. Scheduled to come into operation during the second half of 2016, the I14 Hard X-ray Nanoprobe beamline will provide two dedicated end stations. The first, a dedicated facility for micro-nano small angle scattering (SAXS), will be optimised to carry out small and wide angle X-ray scattering studies, as well as scanning fluorescence mapping with a variable focus beam. The second is a station for nanoscale microscopy, delivering a nanoprobe with the smallest possible focus, optimised for X-ray fluorescence, X-ray spectroscopy and diffraction.

New beamline constrction. Credit: STFC

More information

This is just the beginning of the planned expansion of Harwell Oxford. To find out more about the Harwell Oxford Campus, contact STFC Campus Development Manager, Mark Burrows: mark.burrows@stfc.ac.uk

EDRS Dish. Credit: STFC

Superbugs vs superdrugs

Image credit: Dreamstime.com

Bacteria are naturally developing resistance to the antibiotics we use against them. These 'superbugs' are on the rise, and for scientists at STFC, the race is on to find a solution.

Antibiotic use underpins much of modern medicine and has saved lives that might otherwise be lost to very common infections and minor injuries. According to the World Health Organisation (WHO), antibiotics and vaccines add an average of 20 years to our lives. Advanced therapies such as cancer treatment and organ transplants, which make patients particularly vulnerable to infection, depend upon the use of antibiotics.

We are in an arms race against bacteria. The 1950s and 60s were golden years, when new antibiotics were developed faster than the bacteria could develop resistance. Since then, the pipeline for new drugs has dried up. No new classes of antibiotics have been developed since the 1980s, and research on treatments to replace antibiotics is still in the early stages.

The WHO's *Antimicrobial resistance: global report on surveillance 2014* paints a chilling picture - very high rates of resistance have been found in all WHO member countries for common diseases. Patients who contract these disease-resistant strains are at risk, and their treatment costs more. Drug-resistant infections in the EU cost at least €1.5 billion each year.

Fighting superbugs with light sources

The good news is that researchers are taking on the challenge of antibiotic resistance, many of whom use STFC-funded facilities. At the Diamond Light Source, a group from the Universities of East Anglia and St Andrews recently studied 'Superdrug' bacteria in extreme detail. They pinpointed the structure of a protein responsible for creating the 'camouflage' that allows gram-negative bacteria (which cause a range of illnesses, including E-coli, salmonella and meningitis) to hide from the body's defence mechanisms as well as offering protection against antibiotics. Group leader Prof Changjiang Dong, from UEA's Norwich Medical School, said "Many current antibiotics are becoming useless, causing hundreds of thousands of deaths each year. The number of superbugs is increasing at an unexpected rate. This research provides the platform for urgently-needed new generation drugs".

In 2011, Dr Jon Marles-Wright was part of a group of scientists from Newcastle University and the Nara Institute of Science and Technology in Japan that used Diamond to identify a group of proteins that enable certain bacteria to build effective cell walls. Again, these proteins may provide a novel antibiotic target for a range of bacteria. Dr Marles-Wright said that "This discovery provides us with a highly attractive new target for drug discovery programmes".

Medical Research Council (MRC) scientists from the Research Complex at Harwell used crystallography at Diamond to uncover the structure of NDM-1, a vicious form of bacterial enzyme that is resistant to even the most powerful antibiotics.

Producing a model of bacteria such as NDM-1 enables researchers and pharmaceutical companies to develop new treatments. Professor Sharon Peacock, a member of the Medical Research Council Infections and Immunity Board, said "Identifying the structure of NDM-1 is a crucial step towards ensuring that drug development is based on a sound understanding of the mechanisms of bacterial resistance to antibiotics".

A collaboration of scientists has used the Diamond Light Source and the European Synchrotron Radiation Facility (ESRF) to understand the 3D structure produced when penicillin binds to a common disease-causing bacterium. Knowing how drugs work is an important step in improving them so that they can overcome resistance. In 2012, scientists from GlaxoSmithKline used ESRF to visualise how a new type of antibiotic can kill bacteria that have proved resistant to other treatment.

Neutrons weigh in

Light sources aren't the only facilities that can be used for antibiotic research. In 2011, funding from the Engineering and Physical Sciences Research Council allowed scientists from Kings College London to use ISIS to investigate the antibiotic Amphotericin, which has been the first line of defence against fungal infections since the 1950s. Emerging resistance to Amphotericin poses serious problems for AIDS and chemotherapy patients, but until we learn more about how it works, finding a replacement drug will be difficult.

In 2013, a collaboration of scientists from Queen Mary University of London, ISIS, the University of Toronto, the University of Szeged and Beijing Normal University used neutrons to study how penicillin goes from completely inactive to specifically active in the presence of target bacteria. Building on the successes emerging from the penicillin project, new and exciting neutron and muon beam experiments are on-going, with experiments being designed for other bioactive molecules.

Our role

Developing new antibiotics is only one of the strategies needed to tackle the issue of resistance. All across the world, patients are taking antibiotics unnecessarily, failing to complete courses of antibiotics, taking sub-standard drugs and sharing their antibiotics with others – all of which can spread antibiotic resistance.
In farming, the widespread use of antibiotics to promote growth is adding to the problem. Our use and misuse of antibiotics is driving the rise in resistance. The focus of the Longitude Prize (chosen by the public) is to encourage the development of a cheap, accurate, rapid and easy-to-use point of care test kit that will allow more targeted use of antibiotics, and a reduction in misdiagnosis and prescription.

With science, care and concerted effort, we can turn the tide against bacteria once more, and continue to enjoy the benefits of modern medicine in the future.

For more information can be found on the Diamond website: www.diamond.ac.uk

Could cosmic rays ground a plane?

UK scientists have built ChipIR, a new facility at our ISIS neutron source, to find out how neutrons from cosmic rays affect our electronic equipment.

The bombardment of the Earth's atmosphere by cosmic rays generates showers of particles, including high energy neutrons. When these neutrons in the atmosphere collide with silicon microchips here on the ground, they can cause electronic devices - such as computers, microprocessors, communications infrastructure and even medical equipment - to become unreliable, give erroneous results or fail. They can even re-programme a device's memory, or in an extreme case, completely burn out the device.

This may not be such a great problem for small inconveniences with something like a mobile phone, which you may not even notice has been affected, but when neutrons strike and interfere with microchips that are helping to pilot an aircraft, the problem is much more disturbing. In fact, at flight altitude, the potential interference from neutrons is 300 times greater than it is here on the ground.

Whilst in flight, a microchip in an aircraft may be struck by a neutron every few seconds. The central problem is that it is difficult to predict, with certainty, how an individual device or system is going to behave when it does. This is compounded by how rapidly electronics are developing - faster, smaller, more complex and efficient devices have huge benefits, but also increased risks. In order to develop the strategies and techniques required to protect electronics, we have to understand in detail what exactly goes wrong when a neutron strikes. That's where the latest instrument to be built at our ISIS neutron facility, ChipIR, comes in; it is one of the first dedicated facilities outside the USA designed to look at how silicon microchips respond to cosmic neutron radiation.

ChipIR uses high-energy neutrons from ISIS to mimic the neutrons from cosmic rays. Scientists and engineers can then trace what happens when electronic devices are flooded with neutrons – pinpointing exactly why that piece of electronic equipment is being disrupted, allowing them to overcome the problem.

In a single hour, ISIS will be able to replicate what happens when microchips are exposed to high-energy neutrons for hundreds of years of flying time.

ChipIR will dramatically increase the effectiveness of electronics testing and aims to provide Europe's gold standard for screening microchips – making planes safer and electronics more reliable. This will bring big benefits to the electronics industry, giving businesses operating in a wide range of areas the chance to use ChipIR to engineer products that are reliable, safe and resistant to neutron strikes.

Leading aerospace and electronics companies from the recent SEEDER (Single Event Effects Design for Electronics Reliability) and SPAESRANE (Solutions for the Preservation of Aerospace Electronic Systems Reliability in the Atmospheric Neutron Environment) consortium including BAE, Aero Engine Controls, QinetiQ and MBDA, have been providing advice to STFC on the ChipIR development and are have been taking advantage of the UK's new capabilities in this area at ISIS.

Minister of State for Universities, Science and Cities, Greg Clark, said: "The Government understands how vital it is to innovate and tackle the challenges that face our electronics industry. This funding is helping to develop a facility capable of putting safety critical circuits through their paces, making planes safer and the electronics on which we all depend more reliable."

ChipIR has successfully completed its first round of development testing before going in to full operation in 2015.

For more information about ChipIR, visit: www.stfc.ac.uk/3300

An easy to understand poster about cosmic rays is available on our website: www.stfc.ac.uk/3160

Image credit: Dreamstime.com

Rosetta makes history

After a decade of waiting, we have opened a new chapter in Solar System exploration. Rosetta has become the first spacecraft to make history by successfully rendezvousing with a comet.

Rosetta is now orbiting around Comet 67P/Churyumov–Gerasimenko 405 million kilometres from Earth, about half way between the orbits of Jupiter and Mars.

The success is a big win for the UK space sector, which has significant involvement in the mission.

Minister of State for Universities, Science and Cities, Greg Clark said, "Rosetta is a big mission for the UK, with much of the spacecraft built and designed here and our scientists involved in 10 of the mission's instruments.

"As the spacecraft makes history as the first to orbit a comet as it swings around the Sun, our UK Rosetta scientists and engineers will be 'on-board' for the trip of a lifetime, ready to unlock the secrets of this time capsule from the dawn of our Solar System."

Talking about the mission's success so far, STFC's Professor Richard Holdaway, said: "It's brilliant news that, after a long round-the-Solar-System journey of over six billion miles, Rosetta has finally reached its target and safely gone into an initial dance around the comet before finally reaching a stable orbit..."

On board Rosetta is a lander named Philae, which houses a suite of instruments used investigate the comet. Scientists have now identified a safe touch-down place for Philae: area J, an intriguing place which shows clues of recent activity nearby, on the head of the comet.

One of the instruments housed within Philae is called Ptolemy, an award-winning evolved gas analyser instrument the size of a shoebox, designed by teams from STFC RAL Space and the Open University. After landing on the comet, Ptolemy will collect and analyse samples of any organic material on the surface and use this to investigate the relationship with similar materials from other Solar System bodies.

As comets were formed at the same time as our Solar System, it's hoped that, through Rosetta, we will learn more about our Solar System's birth. We might find a definitive answer to the question of whether Earth's water was originally delivered by comets; we might even discover the origins of life itself.

It's not just space exploration that the Rosetta mission will benefit: technology designed for use on Rosetta is also being used in medical developments. Small UK enterprises based at the ESA Business Incubation Centre Harwell (Oxfordshire), which is managed by STFC, have been taking advantage of the technology.

Oxford Micro Medical is using technology originally developed for Rosetta to develop a breath test for detecting stomach ulcers and a stomach infection linked to cancer. And thanks to Rosetta insight, Chilton Technology is developing micro-needles for use in vaccinations, so that a significantly smaller volume of liquid will be needed.

Insect Research Systems Limited is developing technology for detecting and monitoring bed bugs in hotel rooms, and although not using technology directly applied to Rosetta, they are using many of the same philosophies and lessons learnt during the Rosetta mission; such as the same requirements for portability, ruggedness, low power and limited user interaction.

Rosetta will deploy Philae onto the comet landing site on 12 November.

For more information about ESA BIC, visit: www.esa-bic.org.uk

For more information about the mission, visit: www.stfc.ac.uk/3004

Follow the Rosetta mission on Twitter: @ESA_Rosetta

Image credit: ESA

DID YOU KNOW?

Rosetta takes its name from the Rosetta Stone, an artefact discovered in 1799, which featured inscriptions of the same words in Egyptian Hieroglyphic, Ancient Greek and Demotic – offering the first translatable script of Egyptian hieroglyphs.

The lander's name, Philae, comes an obelisk that was discovered on Philae Island, south of Cairo, by British antiquarian Sir William John Bankes, in 1815. The ancient obelisk featured bilingual inscription, featuring the names of Ptolemy and Cleopatra in Egyptian hieroglyphs. This gave historians further scope to decipher the hieroglyphs on the Rosetta Stone.

The obelisk is now kept at Bankes's Dorset Estate, Kingston Lacy, owned by the National Trust. They will have a Rosetta themed display during October half term, check their Facebook page or website for details nearer the time: **https://www.facebook.com/KingstonLacyNT**

An interview with Jim Al-Khalili

By Lisa Davies

Jim Al-Khalili is a one of the UK's best science storytellers. Professor of physics at the University of Surrey, where he's also Chair of Public Engagement in Science, Jim has a string of successful books, an OBE, a BBC Radio 4 show, and numerous science documentaries, podcasts and public lectures under his belt. He's also a referee for some of STFC's fellowships. We caught up with him to find out more about his life and career in science.

First things first, Jim, what inspired you to become a scientist?

I fell in love with physics around about the age of 14 and never looked back. Before that I guess I was no different to lots of boys: I thought I could combine lots of careers: some sort of science as a day job (inventor or marine biologist or archaeologist), then a rock musician in the evening, whilst playing professional football (for Leeds United) on the weekend. I haven't quite given up on the last two ambitions!

You do a lot of explaining, commentating and educating in your job as a science communicator – did you ever consider becoming a science teacher?

I don't think I ever thought about becoming a teacher – but now I guess that is essentially what I mostly do, whether it is lecturing to my undergraduate students at university, or through my broadcasting, public lectures and writing.

What made you choose theoretical nuclear physics?

During my undergraduate degree I did a placement year working in a research lab for a research and development company on vacuum chambers, and lots of electronics. When I once nearly electrocuted myself while cleaning out a piece of apparatus (because I'd forgotten to unplug it) I decided lab work wasn't for me and that I should probably stick to theoretical physics – and in any case I enjoyed the puzzle-solving aspect of working with algebraic equations and computer codes. So for my final year research project I chose one that was highly mathematical, and I loved it. It led me to choose a PhD in theoretical nuclear physics and I've never looked back. Nowadays the only time I venture into a lab is during my university open days.

What brought you into the public eye?

This was a very gradual process rather than one specific occasion. By the mid-90s I was doing lots of schools talks and I was also happy to explain my research to journalists and be interviewed on local radio, and so on. In 1997, I was chosen as the Institute of Physics' (IoP) schools and colleges lecturer, and my subject matter (relativity and cosmology) led to the IoP commissioning me to write my first popular science book, Black Holes, Wormholes and Time Machines (1999). My big TV break came in 2007 when I presented the three-part BBC series, Atom. But then I was already becoming quite well-known.

Jim with STFC's Head of Nuclear Physics, John Simpson. Credit: STFC

On your BBC Radio 4 show, The Life Scientific, you've interviewed some of the rock star figures of the science world. Now is your chance to namedrop: who has been your favourite person to interview?

I keep changing my mind. Many of the guests have been personal friends of mine on the sci-comm circuit, like the chemist Andrea Sella, materials engineer Mark Miodownik, neurophysiologist Mark Lythgoe and mathematician Ian Stewart. Others have been people I've admired, like Jocelyn Bell, Peter Higgs and Colin Pillinger. I also felt tremendously excited to interview James Lovelock, in his mid-90s now but still as sharp as ever. But if I were to pick one then I would probably choose the physicist, Alf Adams, who invented the strained semiconductor laser and who taught me solid state physics when I was an undergraduate in the mid-80s. He's a real working class hero and an unsung one at that, and yet his research has been fantastically important to 21st century technology.

You are president of the British Humanist Association (BHA). What does it mean to be a humanist?

Well, it is basically having faith in humankind – that we do not need a religious faith to tell us how to live our lives and treat each other. A humanist sees the importance of empathy, compassion, kindness and so on, not because God tells him or her that is how they must behave or because they fear punishment of their god if they don't do these things, but because these traits define what it means to be human. Basically, you don't need God to be good.

What led you to get involved with the British Humanist Association?

I have been an atheist and rationalist all my adult life, but never realised that I was a humanist. In fact the BHA, with whom I had no previous association, approached me out of the blue and asked me if I would be prepared to take on the role of president, after the previous incumbent, the journalist Polly Toynbee, stepped down. Only then did I realise that in fact what they stood for matched very closely my own philosophy and outlook on life, and I was honoured to accept.

Why do you think it is important to communicate science to a wide audience?

This hardly needs stating any more as everyone agrees it is vital. We live in a technological age and so many of the decisions our society has to make requires a certain level of scientific literacy in order to understand the basics of important issues like climate change, or an appreciation of risk and statistics in our everyday life decisions. But aside from that, understanding our Universe and our place in it is what defines our humanity – science is therefore an integral part of our culture and any civilised and enlightened society should be able to appreciate the wonders of the world around us in the same way we can appreciate art or music.

How much do you think science communication has moved on in the last decade?

Hugely. The UK now leads the world in the public engagement of science by about a decade. Just witness the explosion of interest in science festivals, and literary festivals now always have scientists involved – likewise the many excellent science documentaries on TV and radio and the public conversation on science online, in blogs and so on. Things were very different when I started off 20 years ago, when it was even frowned upon for a research scientist to go out and talk to the wider public. Thankfully that stupid attitude has all but disappeared.

> "The UK now leads the world in public engagement of science, by about a decade"

You're a referee for some of STFC's fellowships, which offer early career researchers the chance to establish a strong, independent research programme in the UK. Do you think the UK is a good place to start a career in science?

Absolutely. Of course we will always argue that funding for our own area of science is not enough for us to do all the research we would like to, but we should not forget the UK is still one of the world leaders in scientific research in many areas. Just consider those subjects under STFC's remit: nuclear and particle physics and astronomy. Yes, funding cuts have been made in the past few years, but this country is still a great place to work and be at the forefront of research.

What advice would you give someone in the early stages of their science career?

That depends on what drives and motivates them. Not everyone wants to spend their life doing research, others cannot conceive of doing anything else. My advice would be to follow your heart (OK, not very scientific, since your heart is just a muscle, but you know what I mean). This means you may want to move from one area of science to another, or to apply your scientific training in a different type of career. The bottom line is that I would say that there is a big world out there, so don't pass by any opportunities when they come up – take the plunge and be adventurous.

In the time your career has spanned so far, what would you say has been the biggest discovery in the physics arena?

Well, am I allowed to cheat here? The biggest discovery by physicists has to be the World Wide Web, which has transformed our lives immeasurably. More specifically, I cannot pick out one particular discovery that stands out: maybe the 1998 research in astronomy which showed, through the study of supernovae, exploding stars, in very distant galaxies, that our Universe was expanding ever-more quickly. This led to the idea that the Universe is pervaded by something called dark energy. But no one really understands yet what it is.

If you could be involved in designing any scientific experiment (with a limitless budget), what would it be?

For me, I don't think it is a matter of how much money we need to throw at the biggest problems – it's more to do with being clever enough to design the right experiment. There are plenty of unanswered big questions out there, to do with the interpretation of quantum mechanics, whether supersymmetry is correct, what dark matter and dark energy are, whether there is a unique theory of quantum gravity, what is the origin of consciousness, how life started, are parallel Universes real, was there anything before the big bang… so many questions.

How did it feel to be awarded an OBE?

Surreal. My wife called me to tell me the letter had arrived from Downing Street. At the time I was filming in the Middle East for a BBC documentary. She said I had to keep it secret, which was incredibly difficult as I was so excited.

What have you got planned for the rest of the year – will we be seeing you on our TV screens?

Yes, I am making a new two-parter for BBC4. The working title, which I think conveys what it will be about even if it changes once the film is finished, is Jim Al-Khalili's Crazy World of Quantum Mechanics. We are filming in the autumn and it is planned to air sometime before the end of the year.

My other exciting new project is a forthcoming high-end popular science book, written with my colleague at Surrey, the molecular biologist Johnjoe McFadden. It is called *Life on the Edge: the coming of age of quantum biology* and is due to be published in February 2015.

For more information about Jim Al-Khalili, visit his website: www.jimal-khalili.com

Credit: STFC

Credit: STFC

UK to build unique intergalactic GPS instrument

UK-based engineers and designers will build a unique and powerful instrument that aims to tackle some of the most compelling astronomical puzzles – such as how stars and galaxies form and evolve, and probing the structure of our own Milky Way.

Revealing our galaxy

Mapping the stars is like trying to map a forest of densely-packed trees from the inside, as the Earth is in the middle of the Milky Way's disc. But MOONS (Multi-Object Optical and Near-infrared Spectrograph), will allow astronomers to see obscured areas in the Milky Way at a distance of around 40,000 light years away, enabling them to create a 3D map of our galaxy.

MOONS will be based at the European Southern Observatory's (ESO) Very Large Telescope (VLT) in northern Chile, already the world's most productive ground-based astronomical facility.

An ambitious project

Conceived at our UK Astronomy Technology Centre (UK ATC) in Edinburgh, the team will lead the Project Office managing the multinational consortium that will construct MOONS, and will also play a vital design role for key components.

All in all, the project will cost around 23 million; and hardware alone will cost 9 million. Building such an ambitious and powerful new device – which will be about the size of a transit van – will take around 200 staff years of effort, and will harness UK ATC's world-leading expertise in fields such as miniaturised mechanics and precision optics.

Director of the UK ATC, Professor Gillian Wright, said "The team at UK ATC in Scotland have an opportunity with this project to enable all of us to understand why the Milky Way looks the way it does. This instrument will act as an intergalactic GPS to help us to navigate through the billions of stars in our galaxy and create a comprehensive map of its structure."

The UK ATC will develop the most innovative component, the individual motorised systems allowing each fibre to move rapidly into position; it will also develop the cryostat system (used to cool MOONS down to -170°C) vital to enabling the infrared observations needed to penetrate galactic and intergalactic dust clouds. The University of Cambridge will develop complex cameras capable of meeting the instrument's demanding performance requirements.

Partnerships with a range of UK equipment suppliers will also contribute across the project, helping the UK to further strengthen its cutting-edge scientific capabilities in the relevant fields.

Ground-breaking technology

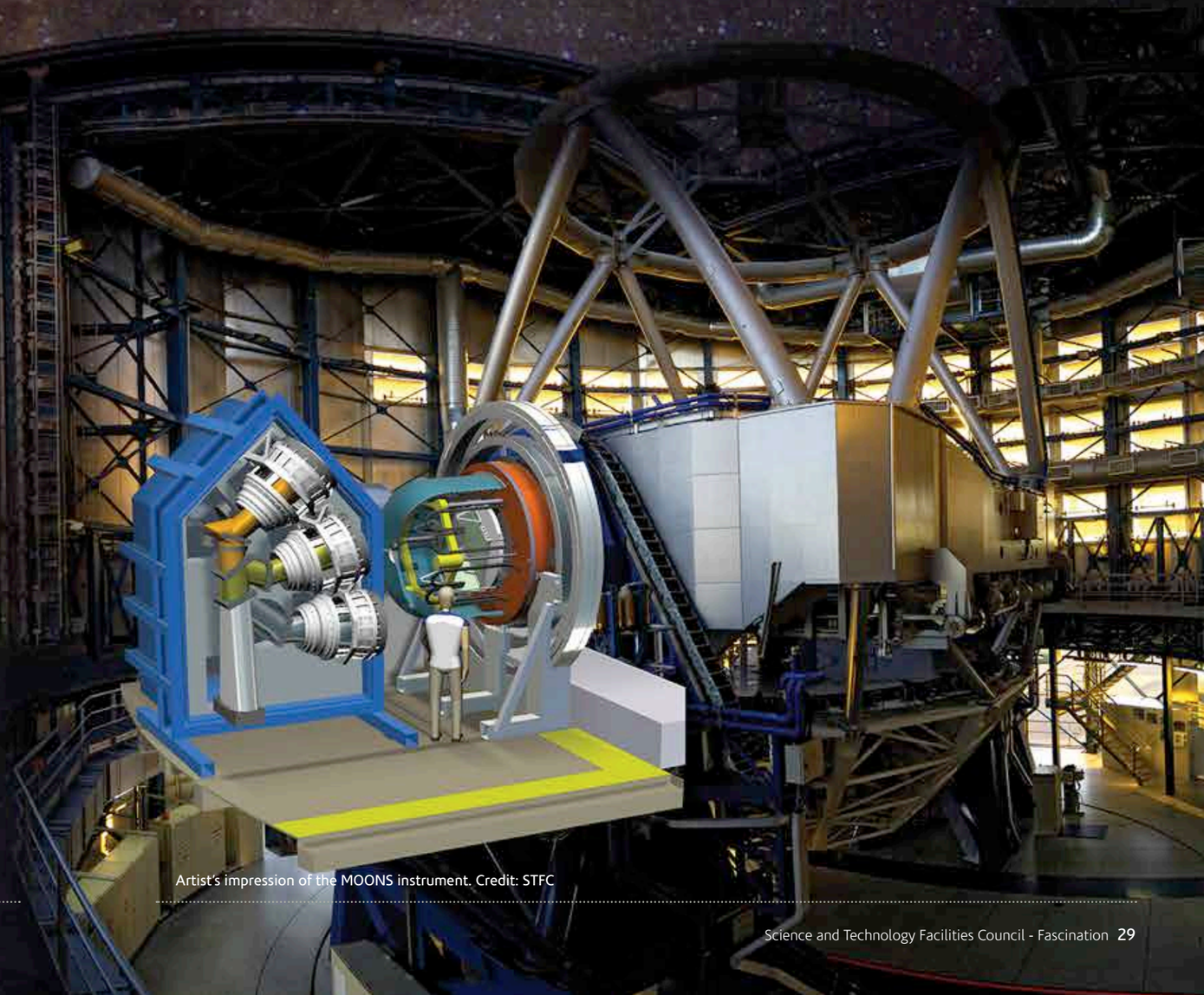
Like any spectrograph, MOONS will use the colour of light emitted by objects to reveal their chemical composition, mass, speed and other properties. Breaking new ground by simultaneously observing 1000 objects using fibre-optic cables to feed their visible and infrared light into the instrument, it will survey large samples of objects far faster than any existing instrument and conduct surveys that would be virtually impossible using today's technologies. Not surprisingly, the design will pose extraordinary technical demands. For example, each of the 1000-plus fibres will have to move into position very quickly, with great accuracy and without colliding with each other.

Paving the way to new discoveries

Once MOONS is up and running, the international consortium will receive 300 nights of observations using the instrument. In particular, this will benefit two ground-breaking projects: one to produce an unprecedented sophisticated survey of the centre of the Milky Way; the other to look far back in time at ultra-distant galaxies to uncover the secrets of their early evolution.

Professor Roberto Maiolino from the University of Cambridge, Project Scientist for MOONS, says: "MOONS will vastly expand our knowledge of the mechanisms responsible for galaxy evolution across the life of the Universe. It will be possible to characterise the properties of millions of distant galaxies – for instance, by identifying the signatures of ongoing star formation and black hole accretion – and how galaxies' evolution depends on their large-scale environment. Cambridge will play an essential role designing and assembling key optical subsystems, as well as in defining the science programme."

MOONS is scheduled to become operational by 2019.



Artist's impression of the MOONS instrument. Credit: STFC

REACHING OUT

Making science accessible and engaging is important to STFC, and we are committed to inspiring people of all ages with science. Read the latest on our outreach work…

CERN@school inspiring the scientists of the future

Students discuss the LUCID experiment at the RSSSE 2012. Credit: CERN@school

STFC provides funding to CERN@school, a project that gives school students access to CERN technology in their classroom. Helping teachers to deliver engaging particle physics lessons, CERN@school gives students the chance to get hands on and make their own particle physics discoveries; analysing raw data from ground and space-based experiments.

CERN@school provides access to data from the space-based radiation detector, the Langton Ultimate Cosmic ray Intensity Detector (LUCID), and a number of ground-based pixel detector chips (Medipix detectors) for both teaching and research purposes. It also provides the educational resources to support teachers with LUCIS data and dectector kits in the classroom.

The project gives students the opportunity to be a part of a collaboration between teachers, academics and students, and hopes to inspire the next generation of physicists and engineers.

On 8 September, the first CERN@school Research Symposium took place, supported by STFC.

Over 100 students and teachers from around the UK attended the event at University of Surrey, Guildford, to get a taste of an important part of the scientific process; the academic conference. Attendees shared their experiences of the project, presented their results and explored potential collaborations as part of the CERN@school programme. Our CEO, John Womersley, also attended the event. In his closing speech, he said: "I am sure that we have not just seen future scientists presenting here today, but future leaders.

Congratulations to you all on a remarkable achievement."

Our Public Engagement Large Award offers the opportunity of funding for amounts up to £100,000 for projects in public engagement relating to STFC science and technology. Applications close on 6 November 2014, so if you have a project you'd like us to fund, apply now! More details about how to apply and terms and conditions can be found by visiting: www.stfc.ac.uk/1839

To find out more about CERN@school, visit: www.cernatschool.web.cern.ch

Astronomical sign language introduced

Astronomical sign language at work in a planetarium. Credit: STFC

Over 90 astronomy signs have been created in British Sign Language (BSL), in a project led by STFC's public engagement team and part-funded by the Scottish Government.

The signs have been developed with Heriot Watt University and the Scottish Sensory Centre with the aim to make astronomy more accessible to Deaf audiences. The new signs cover fundamental observing terms, such as constellations, through to research topics, including Dark Matter, helping to connect the Deaf community with cutting-edge research.

Previously, BSL users have had to use finger spelling for these terms. The new signs are strong visual representations of the concepts and objects. This makes them more helpful for a variety of learners and teachers and the signs could be used widely, for example in classrooms.

On 22 August, STFC led a training day for 12 science communicators and 13 BSL/English interpreters at the Glasgow Science Centre, to introduce the new signs. The day allowed interpreters and communicators the chance to practise using the signs to deliver outreach activities.

Over the next three months, there will be a series of Deaf-accessible public astronomy events being delivered around Scotland. View the calendar here: www.roe.ac.uk/vc/public-events/special-events

For more information about the astronomy signs, visit: www.ssc.education.ed.ac.uk/bsl/astrohome

School Science Prize at Daresbury Laboratory

Over 100 Year Nine students from 17 schools entered this year's Daresbury Laboratory School Science Prize, answering the question "why do you love science?"

The standard of entries was high, and judges were delighted to see how many young people are being inspired by science and engineering subjects.

The sixteen finalists were asked to present their entries to the audience at the final on 14 July at Daresbury Laboratory, before being grilled by a panel of five judges from MerseySTEM, IBM (who also sponsored the event) and STFC.

The crowd was also treated to an inspiring talk from fellow Year Nine student, Sasha Geim, whose father, Andre Geim, has won a Nobel Prize for Physics for the discovery of graphene.

Judges crowned Natalie Clare, from Sir Thomas Boteler CE High School, Warrington, the winner following a great presentation about how science has inspired her:

"My aspiration in life is to be a dermatologist as my future career. To help other people with my own condition would make me truly happy. To find a cure for psoriasis would be my biggest goal in life, I want to be able to help people suffering. For this I would need to utilise mainly my biology but also my chemistry skills to reach my goal. I would constantly be surrounded by science as a doctor, continuing research left behind by doctors already passed, or working with doctors researching the same things as I."

Natalie received an iPad Mini, kindly donated by IBM, and the School Science Prize certificate.

Entries are now open for the Rutherford Appleton Science Prize. Visit: www.stfc.ac.uk/3345

The finalists and two of the judges. Credit: STFC

fascination

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Establishments at Rutherford Appleton Laboratory, Oxfordshire; Daresbury Laboratory, Cheshire;
UK Astronomy Technology Centre, Edinburgh; Chilbolton Observatory, Hampshire; Isaac Newton Group, La Palma;
Joint Astronomy Centre, Hawaii.

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