Image: © Olivier Vandeginste, http://blog.atmospheres.be

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News from the
Science and Technology
Facilities Council

Exploring & Understanding Science

fascination

Keeping Britain moving

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Science & Technology
Facilities Council

VOLCANIC ASH

Keeping Britain moving

Envisat satellite image of the volcanic ash cloud (grey plume) taken on 19 April 2010 blowing South from Iceland. Credit: ESA

While Iceland's volcanic ash cloud continues to cast its shadow across Europe most of us are becoming familiar with scenes of long queues at airports and headlines warning of the economic costs. Not so familiar, perhaps, is the significant contribution UK scientists are making to studies of the ash from the Eyjafallajokull volcano. Without accurate data on the actual ash particles in the atmosphere, the Met Office and aviation authorities can not test whether their predictions about where the ash cloud is located are correct. Real data allows these bodies to keep aircraft flying whenever safe and crucially, ensure they are grounded when the concentration of ash is dangerously high.

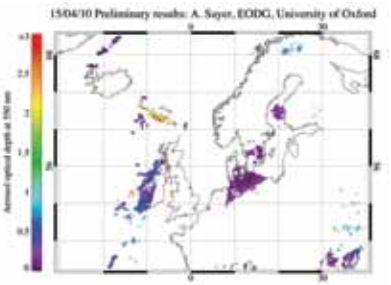
Much of this data is gathered by staff at the Science and Technology Facilities Council (STFC) and researchers funded through the Natural Environment Research Council. Using sophisticated instruments at STFC's Chilbolton Observatory in Hampshire, they have been measuring the location and properties of the ash cloud since it first entered UK airspace in mid-April.

The most important of the ground-based instruments at Chilbolton are lidars which transmit a pulsed laser beam 10-12km into the atmosphere to detect the tiny ash particles.

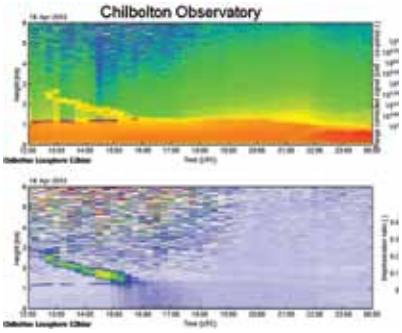
"Chilbolton Observatory has the variety of sophisticated instruments needed to make definitive measurements of the ash; in the UK it is best equipped to undertake this task," said Charles Wrench, Head of the Chilbolton facility. "We normally use the lidars for weather-related research. Since 16 April, we have used them daily to detect the shape, size, height and location of the ash particles and to see how they mix with the rest of the atmosphere. This data is vital to help verify the predictive models used by the Met Office for their forecasting."

Complementing the data from the ground, STFC and University of Oxford researchers have been studying the ash cloud from above. Using images from the European Space Agency's Envisat Satellite they are able to determine the amount and particle size distributions of the ash.

Sharing all of this significant data is the final challenge in such a situation. In response to the needs of the international atmospheric research community and the UK National Centre for Atmospheric Science, RAL's Centre for Environmental Data Archival (CEDA) has set up a dedicated database and Volcano Event Mapping Tool to share observations of the volcanic plume.



This image shows the amount of light scattered and absorbed (aerosol optical depth or AOD) by small particles in the atmosphere above Europe on 15 April 2010. It reveals information about the concentration and location of the volcanic ash particles. The AOD of the ash plume is very high (in red) compared with background marine and continental values. The AOD is calculated from satellite measurements studied at RAL's Molecular Spectroscopy Facility. Credit: A.Sayer, STFC and University of Oxford



Lidar measurements showing an ash layer descending over Chilbolton Observatory on 16th April 2010.

A breakthrough made at STFC's ISIS neutron source could lead to faster and more cost-effective methods of developing new drugs.

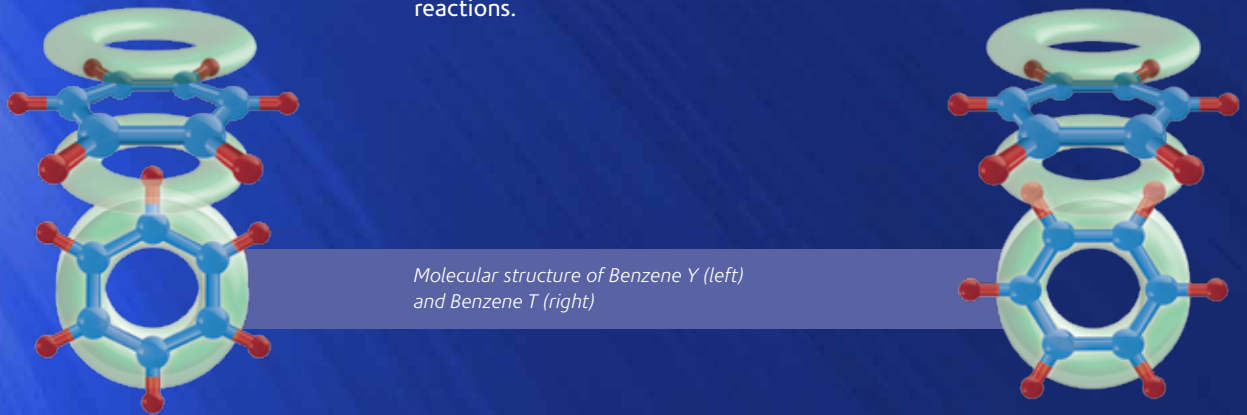
BREAK THROUGH

in development of new drugs

Scientists, led by University College London, have demonstrated how aromatic molecules arrange themselves in liquids, which turns out to be more complex than assumed when simulating these effects. Interactions between aromatic molecules - the most famous of which is benzene - are a factor in the way many important biological molecules including DNA and proteins are made up.

In the early stages of drug design, simulations are frequently used to determine the likely interaction of the drug with the target molecule. Current calculations are based on the interaction of just two aromatic molecules but new data from neutron experiments gives a more accurate picture of the way in which many molecules are orientated in the liquid and shows that this is an important factor in predicting their chemical reactions.

This discovery will have an impact ranging from basic chemistry through to our understanding of the self-assembly of biological molecules. It will in turn make drug discovery more efficient and accurate, reducing the time and cost of developing new drugs.



Molecular structure of Benzene Y (left) and Benzene T (right)

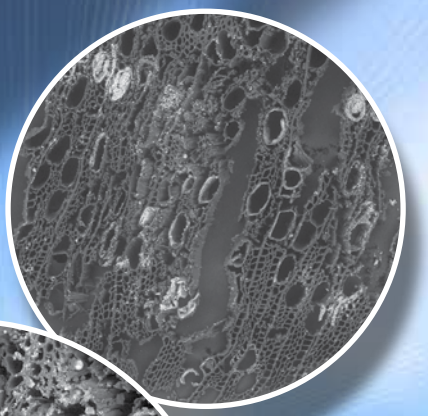
Companies see 30,000 times more clearly at I-TAC

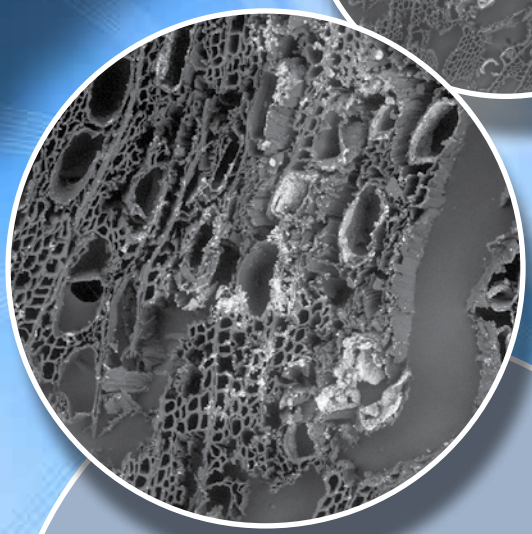
Managed by STFC, the Innovations Technology Access Centre (I-TAC) provides UK businesses and researchers with affordable and flexible access to cutting-edge scientific equipment and Laboratory space. Prior to its launch earlier this year, this had only been readily available to academic researchers and large budget companies. Backed up with specialist support from STFC's own expert scientists, participating companies benefit from flexible access to the facilities that is tailored to their requirements, as well as from the wider business support and networking opportunities offered within the Daresbury Science and Innovation Campus.

I-TAC has recently become the first centre in Europe to take delivery of Hitachi's new model of desktop Scanning Electron Microscope, the TM3000. This brand new tabletop microscope has been designed to simplify and facilitate research and observation of the microstructures of material surfaces with a magnification of up to 30,000 times, and is applicable to a host of applications and industries.

Dr Andy Smith, Daresbury Laboratory, has been using the UK's biggest microcscope, the Diamond Light Source, to look at novel conservation techniques for preserving historic marine timber artefacts, such as those recovered with the wreck of the Mary Rose.

He said: „It was great to be able to use the new I-TAC microscope to visualise some of the same specimens at high resolution. This complements the information on chemical speciation we obtained from the microfocus X-ray spectroscopy beamline at Diamond, to give us a fuller picture of the state of the timbers before and after treatment.„





The SEM images taken on I-TAC's new Hitachi TM3000 show wood cells from the tip of a Tudor arrow found on the Mary Rose. Iron from the corroded arrow tip has worked into the wood cells of the arrow and combined with sulphur from the marine environment to form pyrite nanocrystals, seen in the SEM to be lining the inside of the bigger vessels that run through the wood. The images were taken at 100x and 1200x. The SEM allows even higher magnifications which clearly show the separate pyrite grains.

Celebrating 50 years of the *LASER!*

The 16 May 2010 saw the 50th anniversary of the first demonstration of a working laser, a big step from its origins in research by Albert Einstein into quantum mechanics.

Since then, the versatile laser has not only advanced science, it has provided the basis for many of the technologies that we all now take for granted, such as high-speed internet, CDs, medical diagnostics and modern car engineering.

Scientists know that the laser has much potential still to be exploited, and lasers play key roles in many new scientific techniques being developed to address the big challenges faced in the world, such as the quest for the production of clean energy and solutions to climate change.

STFC has been driving innovative laser technology for over 30 years and, along with the Engineering and Physical Sciences Research Council (EPSRC), hosts vital laser research facilities here in the UK. Our Central Laser Facility provides an internationally leading range of laser systems for research by academia and industry. STFC also leads the European HiPER project for laser driven fusion, which could provide the basis on which future electricity power stations are built.

Scientists from STFC and Kings College London are jointly working to use lasers and microscopes to study up to a hundred proteins at once, observing how they allow cancer cells to replicate so that better medications can be developed. Funded by the Biotechnology and Biological Sciences Research Council, the aim of this research is to eventually be able to match the right medication to the right patient to improve their treatment and ultimately save lives, though for now it is still in its earliest stages.

To mark the difference lasers have made to everyday life, STFC and EPSRC have produced a booklet called 'Lasers in our lives: 50 years of impact'. To request a copy, please contact the editor.

Sun's rest linked to cold winters

After battling through the snow this year, you could be forgiven for hoping you had seen the last of cold winters for a while.

Not so, according to scientists, who say we're headed for even more frequent cold winters. They have found cold winters link to low solar activity and following the regular cycles of the Sun, we're heading into an era of just that. Whilst their research does not guarantee any given winter being cold, it suggests that planners should expect a greater number of cold winters in coming years.

Mike Lockwood from RAL who led the work said of this year's winter:

"It's been the 14th coldest in the last 160 years, yet the global average temperature for the same period was the fifth highest. We have discovered this kind of anomaly is significantly more common when solar activity is low."

The results differ from previous efforts to explain the UK's recent cold winters as they compare the most comprehensive, but regionally specific temperature data to the long-term behaviour of the Sun's magnetic field to study the differences to the average trends for the entire Northern Hemisphere.

e-Science shares LHC with the UK

On 30 March, scientists at the Large Hadron Collider (LHC) celebrated a world first after achieving the highest energies ever created by a man-made particle accelerator, with a view to answering some of the unresolved questions in physics and about the Universe.

Large-scale science facilities, such as the LHC, generate enormous quantities of data which needs to be shared and distributed around the world. e-Science shares computers, data storage and advanced software globally, enabling scientists to access extremely large databases and resources.

STFC's scientific data centre at RAL can store six thousand, million, million bytes of data. The Centre is part of GridPP - a computing grid for particle physics, specifically developed to distribute and analyse data from the LHC.

RAL is the UK's central node of GridPP – a Tier 1 Centre. Launched on the same day as the LHC's significant milestone, the Centre disseminates data via 19 regional Grids across the country to hundreds of academics in UK universities.

The benefits of the Grid network are not limited to particle physics. By enabling scientists from different organisations to share such resources, they can work on many computationally demanding problems more effectively, from trying to find drugs to treat the H5N1 flu virus, digitising mammograms to help breast cancer treatment or modelling earthquakes.

R89 building at the Rutherford Appleton Laboratory

Making space for SPACE

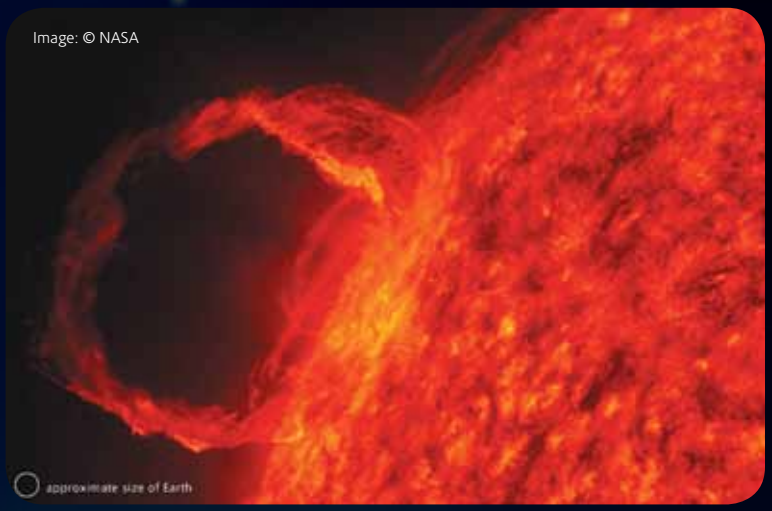


Image: © NASA

2010 is already proving to be an exciting year for the UK Space sector and the Harwell Science and Innovation Campus is at the heart of these developments.

Since the opening of the European Space Agency's first UK centre at Harwell in July 2009 and the announcement of a UK Space Agency in December, the Campus is rapidly becoming a significant cluster for space R&D, attracting key UK and overseas aerospace businesses. It is also demonstrating that it is a neutral location where some of the largest international space agencies can work together.

An International Space Innovation Centre (ISIC) is already becoming a reality with public and private sector partners. With support from SEEDA and funding from the Department of Business, Innovation and Skills' Strategic Investment Fund, STFC was able to purchase the Electron Innovation Centre on the Harwell Campus and will develop phase 1 of ISIC, focusing on Earth observation, data visualisation, security and resilience.

For the first time, the European Space Agency has awarded contracts for managing its UK Technology Transfer Network and Business Incubation Centre to the same organisation, STFC. This powerful combination will provide SMEs and start-up companies with all the support required to find new applications for space technology.

With developments happening so quickly, it seems clear that the route to the 'final frontier' will be via Harwell!


Baby stars in the Rosette Cloud
Image: © ESA

HERSCHEL

The European Space Agency has released a preview of the first results from the Herschel Space Observatory, which includes the Cardiff University-led SPIRE instrument. The new data which include images of previously invisible stardust - the stuff that all life is made from - will give us valuable new information about how stars and galaxies are made and reveal the life cycle of the cosmos. SPIRE has been designed and built by a consortium of institutes, including RAL and the UK Astronomy Technology Centre (UK ATC). The SPIRE Operations Centre, which is responsible for delivering all instrument software to ESA, and for day-to-day instrument monitoring, operation, and calibration, is located at RAL.

Image show shows a three-colour composite of a region of star formation in the constellation of Aquila around 1000 light-years from Earth and provides an insight into the way stars are forming.

not just a pretty PICTURE

It's the World Cup final – England are about to score the winning penalty and suddenly your TV picture breaks up showing only static! Scenes of jubilation you can't see … because of… the Sun!

The effects may not always be that dramatic, but solar activity can cause disrupt communication systems and that is where UK scientists come in.

They are looking at the most detailed images ever of the complex magnetic fields in the Sun's atmosphere that can mean clouds of superhot charged gas being expelled into space, causing damage to satellites that provide the vital communications links for television broadcasts, mobile phones and many other applications.

Professor Richard Harrison from RAL said:

"The images - the first to come back from NASA's Solar Dynamics Observatory (SDO) mission - look like a series of pretty pictures. But they allow us, with observations from other UK-led instruments on associated spacecraft, to predict solar storms, and therefore take preventative measures to protect satellites and communication, navigation and power distribution systems."

Technologists from RAL, working with e2v in Chelmsford, developed world leading camera systems for SDO. UK University groups from London, Sheffield and Lancashire are part of the team, operating the sophisticated cameras and interpreting the data they capture.

SDO First Light

MIRI moves to NASA

A working replica of MIRI, the pioneering camera and spectrometer for the James Webb Space Telescope, has now been shipped from RAL to NASA's Goddard Space Flight Center, bringing the Webb telescope one small step closer to embarking on its journey into space where it will produce the sharpest images yet of the farthest depths of the cosmos. MIRI, an infrared camera and spectrometer, will operate as part of the Webb telescope to observe the Universe at wavelengths that are difficult or impossible to observe from the ground. This technically challenging project is led by the UK ATC in Edinburgh.

Applying Science to

SECURITY

With stories of potential terror attacks constantly in the news, our personal security becomes a daily thought when travelling overseas. The failed Detroit airline bombing at Christmas has even more reminded us of the reality of these threats, but how is STFC helping to address these concerns?

The Security Futures Programme is identifying and co-ordinating STFC technologies and skills with the potential for defence and security applications. This approach not only helps make the world a safer place, but also exploits existing research and maximises the UK's investment in science.

STFC has established a dedicated Security Futures Lab at its Daresbury site, which is providing test and computational facilities as well as staff necessary for the development of a broad range of technologies. Rapiscan (through its subsidiary company, CXR) has been using this facility. Rapiscan Systems Ltd is one of the world's leading providers of security monitoring equipment for airports and other ports of entry.

Initially staff from STFC's Engineering and Technology Centre (ETC) provided consultancy services and then subsequently designs to realise world leading scanning technology which is already being trialled at UK airports, including Manchester, and will help ensure safe and secure travel.

Our engineers have also worked closely with CXR to design and implement additional system features to deliver improved safety. The system was finally installed in a supervised laboratory area at Daresbury for debugging and evaluation. CXR then built its first airport installed baggage scanning system, the RTT80. This programme has not only yielded a number of 'field prototype' units, but has also formed a relationship which is promoting technology development in other areas, such as accelerator systems and X-ray generators.

STFC staff are experts in many types of imaging and data analysis, so our collaboration with CXR is likely to be the first of many to help keep the British public safe.

Would like to meet spin-out companies matched with perfect partners

When it comes to successful spin-out companies and the exploitation of new, cutting-edge technologies, finding and being matched with the right individuals who can exploit these opportunities to their full potential is key.

Supported by STFC, the UK Innovation Forum (UKIF) is a new and unique organisation designed to do just this. UKIF helps British universities, institutions, research councils and government-funded laboratories find the right management who can turn their technological innovations into spin-out businesses; and gives business people who wish to create spin-outs, access to this innovative technology. The Forum will also feature panels of experts for different sectors and technologies who will provide guidance on the commercial potential of new technologies.

Created by Ian Tracey, of STFC's Innovations team, and spin-out expert Gerald Law, UKIF can already count two other research councils, 10 of the UK's leading universities, and a number of knowledge transfer networks, science parks and funding bodies as committed members. Ian Tracey explains:

"The UK Innovation Forum has been created to meet the needs of both the business community who want to be involved with spin-outs, and technology transfer offices, who are always struggling to find the right business people needed to validate their new technologies and exploit their new companies. Until UKIF we had all operated on a very local basis and will have missed out on many individuals and conversations that could have identified new areas where technologies could be useful. Now executives will be able to hear about technologies and ventures created all over the country and put themselves, and their ideas, forward."

For further information visit www.uk-if.org

The world is their oyster for STFC's PhD students

A recent survey into the career paths of STFC funded PhD students has revealed an extremely positive outcome in both science and business, in both the public and private sectors.

The survey shows that 97% of the responders who gained an STFC-funded PhD in astronomy, astrophysics, cosmology, particle physics, planetary science, solar research or space physics, were in full or part time employment, of which seven out of ten were still engaged in scientific research, either in the UK or internationally.

Interestingly, for the 27% of responders who decided not to pursue a career in academic research, the survey has shown significant alternative job opportunities in the private sector. The majority of these respondents are now employed either in the business and financial services sectors, at companies such as Barclays, IBM, BP and Goldman Sachs. These are high-value, knowledge-intensive sectors that are critical to the future competitiveness of the UK economy and there is strong demand from these sectors for people with the type of high-level computing, modelling, quantitative and transferable skills that are developed through a STFC PhD.

The survey also revealed that approximately 62% of respondents are earning a similar or greater salary than the average professional worker in the UK despite being relatively young. The implication is that many former PhD students are high-achievers in the careers they have pursued.

New funding model for big UK science facilities

The UK's seven Research Councils invest around £2.8 billion in research covering the full spectrum of academic disciplines from the medical and biological sciences to astronomy, physics, chemistry and engineering, social sciences, economics, environmental sciences and the arts and humanities. Many of these researchers require access to similar large scale experimental facilities, such as lasers, light sources and neutron sources. STFC provides many of these facilities to the UK research base, on behalf of all the Research Councils.

In March 2010 as part of a wider review of STFC, then Science Minister Lord Drayson announced that from April 2011 a new arrangement would see Research Councils UK (the strategic partnership of the seven UK Councils) working with STFC to agree the availability and support requirements for large domestic facilities (the Central Laser Facility, Diamond and ISIS). The new funding model will provide greater clarity and certainty in the funding of these facilities whilst retaining the scope for making sensible changes in the light of actual demand, A project is currently being established to implement this new funding model.

The project will run from now until 31 March 2011 and be divided into two distinct phases. Phase 1, to be completed by 31 August 2010, will focus on establishing the cost base for the facilities and the strategic planning mechanisms across the Research Councils necessary to tension facility costs against all other costs in the science base. Phase 2 of the project will run from 1 September 2010 until 31 March 2011 and establish the mechanisms that will need to be in place to operate the new funding model. During the project there will be consultation with the user community on the changes being implemented; further details of how this will be carried out will be released in due course.

ProSPECTus

A pioneering project led by the University of Liverpool with STFC's Nuclear Physics Group at Daresbury Laboratory is set to revolutionise the medical imaging process, significantly reducing the time taken to detect tumours, improving future diagnosis of cancer and the probability of successful cancer therapy.

Liverpool University student, Laura Harkness, who is working on the ProSPECTus project has been jointly awarded the Shell and Institute of Physics Award for the Very Early Career Women Physicist of the Year 2010.

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