Aerospace expertise to fusion cooling

Technology that optimises the heat flow through the wall of a tokamak is vital to the design of future, fusion power stations. Professor Peter Ireland’s group (Department of Engineering) has considerable experience in the cooling technology used in jet engine hot stage components. An exciting collaboration between Oxford, CCFE and Rolls Royce on heat transfer enhancements for fusion power plant divertors has resulted in a jointly supervised, EPSRC funded, Industrial CASE studentship.

“The space at the Culham Innovation Centre was exactly what we needed with both clean room facilities and office space.”
Dr Rimas Juskaitis, Visiting Researcher, Department of Engineering and Managing Director, Aurox

Opening up 3-D microscopy

Aurox, a spin out of the University of Oxford, has built on the pioneering research of the Scanning Optical Microscopy Group (Department of Engineering Science) to create affordable 3-D optical microscopy. Their flagship product has been taken up by two international suppliers; Carl Zeiss Microimaging GmbH and Andor Technologies. As a result of this work they were awarded the Queen's Award for Enterprise 2012 and the Institute of Physics Innovation Award 2012.

“The University of Oxford attracts world-class researchers who engage in healthy debate and its opinion is respected by policy makers. Being part of this environment has been enormously beneficial for my work.”
Dr David Ward Senior Visiting Research Fellow, The Oxford Institute for Energy Studies and Head of Power Plant Technology Unit, CCFE

The Socio-Economic Impact of Fusion

Oxford and CCFE are also trying to understand how fusion energy, when available, could fit into the wider energy market and to identify the socio-economic impacts. Dr David Ward was seconded, part time, for a year from CCFE to the Smith School of Enterprise and Environment as a Visiting Fellow. A diverse mix of academics passed through the Smith School while he was analysing future energy supplies, including the UK’s 2020 energy targets.

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Industry and academia create a safer, smarter dating technique

ISIS Instruments Ltd, a scientific instrument design and prototyping consultancy set up by Oxford graduate Dr Christian Bradley, has worked with Dr Jean-Luc Schwenninger (Research Laboratory for Archaeology & the History of Art) to develop an improved optically stimulated luminescence reader. It is more portable, with state-of-the-art low-light imaging and can use a novel X-ray source for sample irradiation. The applications of this technology range from scientific dating, through radiation dosimetry, to authenticity testing for museums and private collections.

Funding from outside the UK

Research on fusion at the Culham site attracts over £50 million per annum from outside the UK, largely from the EU.
The international reputation of the University of Oxford as a leading research institution is maintained by enabling high-calibre academics to conduct cutting-edge research. This requires access to state-of-the-art facilities and collaborations with centres of expertise around the world. Culham Science Centre (CSC), in Oxfordshire, is a unique facility comprising Culham Innovation Centre (CIC), Culham Science Centre (CSC), in Oxfordshire, is a unique facility comprising Culham Innovation Centre (CIC), commercial technology organisations and Culham Centre for Fusion Energy (CCFE). It hosts the Joint European Torus (JET), the world’s largest magnetic fusion experiment, which is helping to shape the future of energy production. We are working together to tackle some of the key materials and engineering challenges to making a nuclear fusion power station a reality.

Located only nine miles apart, and with significant overlap of research interests, movement between the University of Oxford and CIC occurs at all levels. For example: undergraduate students on summer placements; graduate students recruited by CCFE; Culham employees studying for DPhil’s or giving University lectures; University academics locating or giving university lectures; University academics locating their spin out companies in the CIC; and Professor Sir Christopher Lewellyn-Smith, the former Culham Director, is now the Pro-Vice Chancellor (Research, Academic Services). These connections are enabled by the connections between the University and CIC, commercial technology organisations and Culham Centre for Fusion Energy (CCFE). It hosts the Joint European Torus (JET), the world’s largest magnetic fusion experiment, which is helping to shape the future of energy production. We are working together to tackle some of the key materials and engineering challenges to making a nuclear fusion power station a reality.

New posts to support plasma research

The Department of Physics’ commitment to plasma physics is demonstrated by the appointment of two new University Lecturers, one of which is funded by CCFE, and strong attendance at the joint seminar series at Culham. “Plasma physics is a major research theme in the department. Our partnership with CCFE generates the synergy required to understand physics processes in real fusion plasmas so making an important step towards optimizing the performance of power generating tokamaks.” Dr John Mather, Head of Department of Physics.

Developing research leaders of the future

Micro-mechanical testing techniques developed by Dr David Armstrong during his Ph.D at the Department of Materials demonstrated the potential for any engineering material. Using micro-mechanical testing techniques developed in Oxford, with the support of CCFE, has allowed us to understand the effects of radiation damage and to accelerate the development of plasma-facing tungsten alloys. Dr David Armstrong, Royal Academy of Engineering Research Fellow, Department of Materials, is also applying these same techniques to samples from the spallation source at ISIS, Harwell Oxford, to help increase its longevity, and is looking forward to analysing them at the new Materials Research Facility in Culham.

Working together to create new National facilities

The University of Oxford and CCFE are both founding partners in The National Nuclear User Facility (NNUF), the creation of which was a key recommendation of the Government’s 2012-13 review of nuclear energy R&D, chaired by Sir John Beddington. The other founding partners are Imperial College, the National Nuclear Laboratory and Dalton Cumbrian Facility of Manchester University. Scientists at the University of Oxford have been ideally placed to work with CCFE designing their contribution to NNUF. This provision of new equipment and infrastructure will enable research on radioactive materials by academia, industry and national laboratories.

Large collaboration from small beginnings

Professor Steve Roberts’ (Department of Materials) and Dr Sergei Dudarev’s (CCFE) interactions began when CCFE funded one research student to work with their respective experimental and modelling groups. An EPSRC-funded collaborative modelling project on radiation damage followed, which CCFE matched with experimental funding for Oxford. The experiments were very successful, energising transmission electron microscopy research and starting atom probe work on fusion materials within the department. This has led to a collaboration on a large Materials for Fusion and Fusion Power EPSRC Programme grant with 3 CCFE CASE students, 2 Rolls Royce CASE students, 1 CCFE Junior Research Fellow, 15 other students and 7 post-docs.

Professor Roberts is also part of the team from Oxford and CCFE who are heavily involved in developing a bid for funding for a source of high energy neutrons (FANIR). This will provide vital information on materials’ response to the type of neutron bombardment they will experience inside a nuclear fusion reactor. The data generated will support accurate modelling and inform the design of future fusion power plants.

Materials Department

“The long-standing relationship with CCFE is driven by the real engineering and metallurgical challenges we present us with. The joint projects form an important part of our research portfolio, and have led to the development of novel techniques that we now exploit in collaborations with other external partners.” Professor Chris Govey, FIMMM, FirstTP, Head of Department of Materials.