Energy Expertise
// Superconducting Magnets and Plasma Diagnostics

Main expertise areas

- High magnetic field measurements on Low and High Temperature Superconductors.
- Fabricating high-field superconductors.
- Computational, and theoretical understanding of superconductors.
- Development of advanced instrumentation diagnostics of magnetically confined fusion plasmas.
- Efficient handling, control and feedback of large volumes of real-time data.
- Diagnostics for MAST-U at Culham.
- Systems design for toroidal magnet field systems for cost-effective fusion energy.

Background

Fusion offers the prospect of an effectively limitless supply of energy which is relatively clean and produces no greenhouse gases. It is a non-proliferation technology with fuel taken from seawater. The most advanced fusion reactors are tokamak designs - a doughnut of plasma that is shaped, confined and controlled with magnetic fields. The plasma is sufficiently hot that isotopes of hydrogen fuse, releasing vast amounts of energy that is used to generate electricity. Our contribution to completing the road-map for fusion energy is focused on confining, understanding and controlling the plasma using large superconducting magnets and in diagnosing the physical state of the plasma using multiple real-time experimental diagnostics in order to achieve a stable source of fusion energy generation.

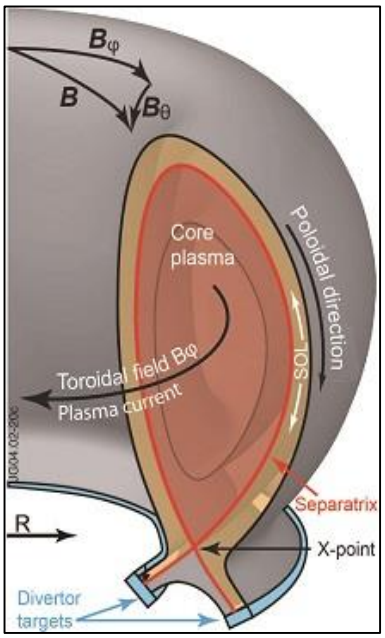
Fusion energy research at Durham has two strands:

(i) Optimization of high field superconductors within the Centre for Materials Physics and

(ii) Diagnostics and control of fusion plasmas within the Centre for Advanced Instrumentation.

Fusion research within the **Centre for Materials Physics (CMP)** is focused around measurements on high field superconductors. The research includes transport, magnetic and thermal measurements using both commercial and bespoke instruments designed and commissioned in-house. Facilities include our split-pair Helmholtz 15 Tesla magnet system with probes for making critical current measurements as a function of field, temperature and strain.

Fusion research within the **Centre for Advanced Instrumentation (CfAI)** is focused around the development of new diagnostic instrumentation for magnetically confined fusion plasmas (tokamaks), hardware-accelerated computer simulations and interpretation of fast ion diagnostics. The research includes both new optical instrumentation and methods for efficient handling of large volumes of real-time data. These areas exploit the synergies with astronomical spectroscopy and adaptive optics research.



Tokamak construction with Divertor targets for heat exhaust power extraction.

Durham University

Durham Energy Institute

ENERGY, SCIENCE AND SOCIETY

Research team

Durham staff have extensive experience in fusion energy, running research projects within the University as well as collaboratively with other partners including University of York, Culham Centre for Fusion Energy, Fusion for Energy, Siemens, Luvata, Oxford Instruments, Jefferson laboratory and Oak Ridge laboratory.

Prof Hampshire is the Director of the European Reference Laboratory for Fusion Energy. He was Editor in Chief for the IOPP journal Superconductor Science and Technology from 2007-2013. His research interests include superconductivity in high magnetic fields for MRI and fusion energy applications.

Prof Sharples is the Director of the Centre for Advanced Instrumentation. He is on the Management board for the EPSRC Centre for Doctoral Training in the Science and Technology of Fusion Energy. His research interests include advanced instrumentation for fusion plasma diagnostics and remote sensing.

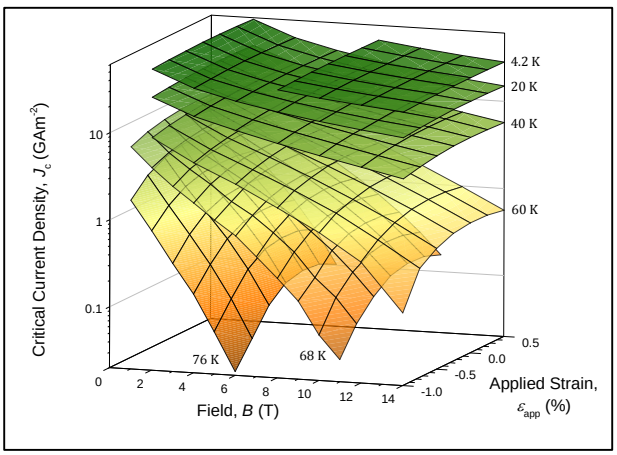
Dr Raine is a Research Fellow, manager of the Fusion Energy laboratory and winner of Harry Jones prize from the British Cryogenics Council for his PhD thesis in 2016.

Research projects

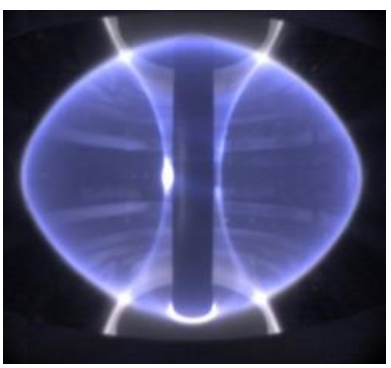
- Transport, magnetic and thermal measurements in high magnetic fields on materials that will be used in the toroidal and poloidal field coils of a fusion tokamak
- Bolometry for the MAST-Upgrade Super-X Divertor
- Plasma-wall interaction studies
- Studies of power exhaust in hot magnetic fusion plasmas
- Strain dependency of the critical current density of 2D-generation High Temperature Superconducting tapes.
- Computational studies on High Temperature Superconductors.

Postgraduate Opportunities

We welcome enquiries about PhD opportunities from prospective students. You can find details of current PhD research projects currently on offer or being undertaken at Durham University in Fusion Energy by contacting Prof. Hampshire (d.p.hampshire@durham.ac.uk) or Prof. Sharples (r.m.sharples@durham.ac.uk)



The critical current density for a High Temperature Superconductor as a function of magnetic field, temperature and strain.



A plasma inside the MAST tokamak

Contact Details:
Durham Energy Institute (DEI)
Durham University
Durham, DH1 3LE, U.K.

Tel: +44 (0)191 334 2649
Email: dei.admin@durham.ac.uk