



## Course Information Sheet for entry in 2018-19

### Science and Technology of Fusion Energy (EPSRC Centre for Doctoral Training)

#### About the course

The Science and Technology of Fusion Energy EPSRC Centre for Doctoral Training (Fusion CDT) programme is provided by a collaboration between five UK universities (York, Oxford, Durham, Liverpool and Manchester), several other research organisations including Culham Centre for Fusion Energy, Central Laser Facility, National Nuclear Laboratory, AWE, National Ignition Facility, ITER and Fusion for Energy, and industry such as Frazer-Nash and AMEC.

The Fusion CDT provides training from world-leading experts in a range of fusion-relevant disciplines, including materials science, plasma physics, nuclear physics, technology, laser physics, and instrumentation. It will train at least 77 PhD students in disciplines related to fusion energy over five intakes from 2014 to 2018 and for each year a significant number of fully-funded four-year PhD studentships will be available.

Other than the times when you are taking courses as part of the Fusion CDT cohort, students following the Oxford Science and Technology of Fusion Energy EPSRC Centre for Doctoral Training programme work, train and study alongside students undertaking the DPhil in Materials, together forming an Oxford cohort of research students in materials.

You will have access to a range of fusion energy facilities across the UK, including the Central Laser Facility at the Rutherford Appleton Laboratory, the MAST and JET tokamaks at Culham in Oxfordshire, advanced materials research facilities, the Orion laser and high performance computing facilities. International links provide access to many other fusion devices around the world.

The combination of world-leading experts and world-class facilities creates an outstanding training environment for the next generation of fusion scientists - the generation who may exploit ITER, NIF and other international experiments to make fusion energy a reality.

As a student on the Oxford DPhil in Science and Technology of Fusion Energy (EPSRC CDT) programme you will be part of one of the top-ranked materials departments in the world. The vibrant research school consists of around 29 academic staff, 16 Senior Research Fellows, and around 180 research students and 85 post-doctoral researchers. The department's research students are of many nationalities and come from diverse backgrounds, both graduates in the traditional subjects of materials science, physics, chemistry and engineering and also in mathematics, earth sciences and biology.

The programme is normally carried out in four years of full-time study under the supervision of an experienced member of staff. It is examined at the end of the programme by means of a written thesis and an oral examination. A wide range of exciting DPhil projects is available. The first eighteen months is a probationary period during which you undertake various taught courses specific to the Fusion CDT cohort, soon after which, subject to satisfactory progress, students normally transfer to full DPhil status. A second formal assessment of progress takes place later in the programme, normally early in the fourth year. Details of the DPhil programme, including training opportunities (academic courses, research-specific skills and generic transferable career skills) and progression requirements, can be found in the graduate course handbook.

Research interests in the department extend over most branches of materials science, as well as some aspects of solid state physics and chemistry. These include the study of a wide range of materials of relevance in advanced technological applications, including metals and alloys, composites, semi- and super-conductors, polymers, biomaterials, ceramics and materials for quantum information processing.

Much of the research is carried out in close collaboration with industry. World-leading research takes place on:

- the characterisation of materials, where there is emphasis on electron microscopy and related techniques
- processing and manufacturing of materials
- modelling of materials, where there is attention to both structures and processes
- properties of materials
- energy materials, including those for batteries, nuclear fusion and photovoltaics
- quantum information processing, which includes groups working on experimental studies, theory and modelling.

#### Fusion materials research at the University of Oxford

The plasma-facing components and breeding blanket of any future fusion tokamak will be subjected to one of the most extreme engineering environments possible. Materials will experience temperatures of up to 1200C in steady state and 3300C in transient events, and irradiation with 14MeV neutrons, causing displacement damage, transmutation giving rise to compositional changes, and internal H and He generation, plasma facing surfaces also can have high erosion rates due to interactions with the fusion plasma. Ideally, the materials should not retain tritium or themselves transmute to long-lived radioactive isotopes. For fusion to be

feasible as an economic power source, the materials must be able to survive these conditions, retaining usable thermal and mechanical properties, for five years or more.

Materials of current interest include special 'reduced activation' steels, tungsten alloys and composites, copper alloys, silicon carbide and high-temperature superconductors.

The University offers a range of projects, both experimental and modelling, on the processing, joining, microstructure, mechanical properties, and resistance to radiation damage of these materials.

Projects will use a range of specialised research techniques, usually in combination:

- advanced processing, coating and joining methods (mechanical alloying, rapid solidification, spray forming, additive manufacture, friction-stir welding)
- irradiation of materials by high-energy ion-beams, protons and neutrons.
- electron microscopy of microstructures, and radiation damage effects, including in-situ irradiations, and field-ion microscopy of radiation damage
- microanalysis by atom-probe tomography and electron-optical methods
- X-ray diffraction including use of the diamond light source mechanical testing, including micromechanics, over a wide temperature range
- computer modelling of radiation damage effects, deformation and microstructural development.

Many projects are carried out in close collaboration with the Culham Centre for Fusion Energy; in the course of projects starting in 2014 and thereafter, the CDT is expected to make use of the newly-commissioned hot cells at the Materials Research Facility at Culham Centre for Fusion Energy.

Research projects supervised by the members of Oxford staff associated with the Fusion CDT are available to applicants for the DPhil in Science and Technology of Fusion Energy (EPSRC CDT) programme. Information on available research projects can also be found at the Fusion CDT Research Areas webpage.

Further information on current research and individual members of staff at Oxford is available via the Materials Science website.

An overview of the provision for research students in the Department of Materials can be found at the Outline of Provision for Materials Research Students webpage. Also available is Guidance on Supervision Arrangements.

### **Changes to courses**

The University will seek to deliver this course in accordance with the description set out above. However, there may be situations in which it is desirable or necessary for the University to make changes in course provision, either before or after registration. For further information, please see the University's Terms and Conditions.

### **Expected length of course**

4 years

## Costs

### Annual fees for entry in 2018-19

Fee status	Tuition fee	College fee	Total annual fees
Home/EU (including Islands)	£4,260	£3,112	£7,372
Overseas	£19,915	£3,112	£23,027

The fees shown above are the annual tuition and college fees for this course for entry in the stated academic year; for courses lasting longer than one year, please be aware that fees will usually increase annually. Information about how much fees and other costs may increase is set out in the University's Terms and Conditions.

Tuition and college fees are payable each year for the duration of your fee liability (your fee liability is the length of time for which you are required to pay tuition and college fees).

Graduate students who have reached the end of their standard period of fee liability may be required to pay a termly University and/or a college continuation charge.

The University continuation charge, per term for entry in 2018-19 is £468, please be aware that this will increase annually. For part-time students, the termly charge will be half of the termly rate payable by full-time students.

If a college continuation charge applies (not applicable for non-matriculated courses) it is likely to be in the region of £100 to £400 per term. Please contact your college for more details.

### Additional cost information

There are no compulsory elements of this course that entail additional costs beyond fees (or, after fee liability ends, continuation charges) and living costs. However, please note that, depending on your choice of research topic and the research required to complete it, you may incur additional expenses, such as travel expenses, research expenses, and field trips. You will need to meet these additional costs, although you may be able to apply for small grants from your department and/or college to help you cover some of these expenses.

## Living costs

In addition to your tuition and college fees, you will need to ensure that you have adequate funds to support your living costs for the duration of your course.

The likely living costs for 2018-19 are published below. These costs are based on a single, full-time graduate student, with no dependants, living in Oxford. We provide the cost per month so you can multiply up by the number of months you expect to live in Oxford.

	Likely living costs for 1 month		Likely living costs for 9 months		Likely living costs for 12 months	
	Lower range	Upper range	Lower range	Upper range	Lower range	Upper range
<b>Food</b>	£258	£361	£2,318	£3,245	£3,090	£4,326
<b>Accommodation</b>	£536	£677	£4,824	£6,093	£6,432	£8,124
<b>Personal items</b>	£118	£263	£1,066	£2,364	£1,421	£3,152
<b>Social activities</b>	£41	£123	£369	£1,105	£492	£1,474
<b>Study costs</b>	£39	£85	£348	£765	£464	£1,020
<b>Other</b>	£22	£47	£202	£419	£269	£559
<b>Total</b>	£1,014	£1,556	£9,127	£13,991	£12,168	£18,655

When planning your finances for any future years of study at Oxford beyond 2018-19, you should allow for an estimated increase in living expenses of 3% each year.

More information about how these figures have been calculated is available at [www.graduate.ox.ac.uk/livingcosts](http://www.graduate.ox.ac.uk/livingcosts).