



### PhD Project Descriptions for Fusion CDT Website

<b>Project Title</b>
<b>Innovative Fusion Tokamak System Designs using High-Field Superconductors (Computational PhD).</b>
<b>Supervisor/s</b>
Prof. D. P Hampshire (Durham)
<b>External supervisors/s and affiliation (if applicable)</b>
Application to CCFE for support has been made.
<b>University</b>
Durham University
<b>Is this project suitable for a part-time student*? Please provide detail below if this is not possible or if this is possible but with some restriction.</b>
* There are a range of possible part time participation levels, e.g. 50%, 4 days a week etc. and we encourage supervisors to be mindful of this when answering this question.
Yes, the project is suitable for full-time or part-time (e.g. 50%, 4 days a week etc.). The University and Research groups are committed to advancing equality. We aim to ensure that our culture is inclusive, and that our systems support flexible and family-friendly working, As recognized by our Juno Champion and Athena SWAN Silver awards, we recognise and value the benefits of diversity throughout our staff and students.
<b>Is this project suitable for flexible working*? Please provide detail below if this is not possible or if this is possible but with some restriction.</b>
*Flexible working could include non 9-5 working hours on a continuous or frequent basis. For example a computational project may lend itself well to mornings and evenings, this could be particularly important to students with caring responsibilities.
This is a computational PhD so we are happy to consider flexible working.
<b>Project Description:</b>
Please note the following:
<ul style="list-style-type: none"> <li>• The description should include a clear link to fusion. We recommend including a short introductory paragraph providing a high level overview of the project and context.</li> <li>• Please think about the language you are using and make it inclusive – for example, avoid words that might be perceived to have gender connotations (e.g. strong, bold, robust).</li> <li>• Please mention the training that will be provided as part of this project beyond the initial taught element and skills that might be acquired through the course of the PhD, i.e. communication, scientific writing, analytical skills etc.</li> <li>• Please try to avoid use of abbreviations – if they are used, please ensure they are defined.</li> </ul>

- Please don't include any entry requirements, such as degree classification, that are not consistent with your department's PhD entry requirements. You may wish to link to the entry requirements web page provided by your department, where available.

Please try to not exceed one page

**Background to the PhD Research Project::**

The ITER (International Thermonuclear Experimental Reactor) Tokomak that is being built in Cadarache in France is one of the most exciting scientific projects at the beginning of the 21<sup>st</sup> century (<http://www.iter.org/>). It will produce 500 MW which is about ten times the power needed to run the machine. Superconductivity is the enabling technology for this project since without it, the magnets that hold the plasma would either melt or consume more energy than the tokamak produces. Approximately one third of the cost of ITER comes from the superconducting magnets which use low temperature superconductors. After ITER, which is the last large-scale fusion energy experiment, we expect new tokamaks to be built across the world that will help enable *commercial* fusion energy (eg DEMO - Demonstration Power Plant). Both traditional low temperature and high temperature superconductors will be considered. The timescale for first-plasma at ITER (2025) means that there is a wonderful opportunity now for early career Physicists to develop new tokamak designs using high temperature superconductors.

**PhD Research Project and Supervision :**

The PhD research project will be computational. It will include a collaboration between Durham University and The Culham Centre for Fusion Energy (CCFE) developing new designs for fusion energy tokamaks. The student will focus on developing novel system designs, analysis and costing of an optimized fusion energy tokamak by considering both traditional low temperature and high temperature superconductors. This is a fabulous PhD project that is ideal for a student with a first class degree in Physics and a broad interest in materials and applied Physics. They will be expected to network with scientists throughout the world working on fusion. The PhD supervisors are: Prof. Damian Hampshire who is an experienced member of the high-field applied superconductivity and fusion energy community and a member of staff from CCFE. We will use the PROCESS code in collaboration with colleagues at CCFE.

The 4 year PhD is funded through the Fusion CDT partnership which gives an excellent exposure to many of the best Universities in the UK, an excellent taught course in fusion energy, exposure to the fusion community across Europe and the expectation that you will go abroad for at least one collaborative project in your 2nd or 3rd year. Your training in the fusion CDT means you spend about 6-8 months during the first year of your PhD at CDT partner Universities. This computational PhD is formally based at Durham, but you will need to work at Durham, CCFE and at other International fusion energy laboratories as the project requires <http://www.fusion-cdt.ac.uk/contact/>.

The PhD supervisory team will include Prof. Damian Hampshire who is an experienced member of the high-field applied superconductivity and fusion energy community and a member of staff from CCFE . The 4 year PhD is funded through the Fusion CDT partnership which gives an excellent exposure to many of the best Universities in the UK, an excellent taught course in fusion energy and exposure to the fusion community across Europe. The PhD is formally based at Durham for access to high magnetic fields and cryogenic facilities, but the training in the fusion CDT means you spend about 6-8 months during the first year of your PhD at CDT partner Universities and will include regular visits to CCFE. It will also probably involve working in an International laboratory (usually the USA, Japan or EU) for at least one collaborative project in the 2nd or 3rd year as the project requires. The Research Groups are committed to developing an environment that produces world-class science and is inclusive, flexible and family-friendly. <http://www.fusion-cdt.ac.uk/contact/>.

Skills the student will learn during the PhD:

- i) Transferable Skills.

Communication: Presentations at conferences and developing collaboration.  
Personnel: Networking skills. Working with expert senior staff, junior staff and staff providing services.  
Writing: Reports, Conference and Journal publications.  
Knowledge: Understanding magnetically confined fusion and high field superconductors.  
Research and critical thought.  
Time management.  
ii) Specialist Skills.  
High field superconductors modelled using PROCESS for fusion applications.  
Advanced computation using HPC and theoretical skills.

Please add a sentence or two about any opportunities and/or requirements for collaboration, international travel and any atypical aspects. For example:

*The project will be mainly based in York, but will require long stays particular to the US, for several weeks at a time.*

*or*

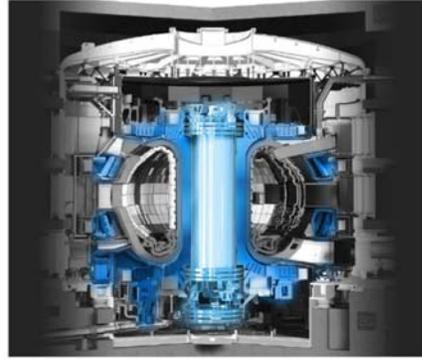
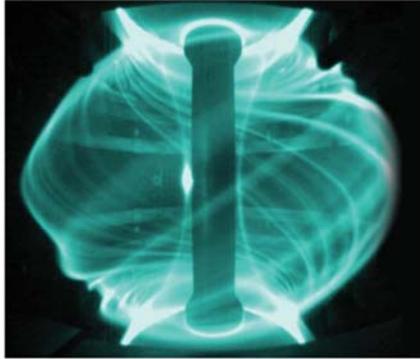
*The project will be mainly based in Oxford, but there is the opportunity for travel to conferences and collaborations with other groups.*

*The project will be mainly based in Durham University, but will include regular visits to CCFE. It will involve overseas travel to: Japan or the US for a collaboratory for 6 – 8 weeks; the USA and/or Japan and/or Europe for conferences and collaborations; Japan or France to use International High Field Facilities.*

For further information prospective applicants should contact..... (please provide name and email address)

Please contact Prof. Damian Hampshire at: [d.p.hampshire@durham.ac.uk](mailto:d.p.hampshire@durham.ac.uk) – send your CV, a covering e-mail that includes a brief explanation of why you are interested in Superconductivity and Fusion Energy and your availability for interview. Web-pages: <http://www.cfe.ac.uk/JET.aspx> and <http://community.dur.ac.uk/superconductivity.durham/personnel.html>. CCFE is the fusion research arm of UKAEA.

**Please remember to email a picture to go alongside the project description on the website to [ruth.lowman@york.ac.uk](mailto:ruth.lowman@york.ac.uk)**



*(Left) A magnetically confined plasma burning at about 10 times the temperature of the sun.  
(Right) The superconducting magnet systems (in blue) that confine the plasma in ITER: <http://www.iter.org/>*