OXFORD SIGMA JOB DESCRIPTION

12th January 2024

Job title:	Engineering Intern
Job location:	Oxford City Centre, UK
Hours:	Full-time (37.5 hours per week)
Salary:	£24,360 (pro-rata)
Dates:	Starts July 2024 (8-week placement)
Reference:	OS-JA-INTERN-24-X

COMPANY

Our vision is to tackle energy security and climate change by accelerating the commercialisation of fusion energy. **Our mission** is to deliver materials technology, materials solutions, and fusion design services in order to assist fusion delivery.

About us: We are a small, organically grown, company owned and operated by scientists and engineers, with our roots and headquarters in Oxford. We have established ourselves as a highly respected technical service supplier for the fusion energy market, within both the private and public sectors, nationally and internationally. We are equally a research and technology development company developing novel disruptive materials and design technologies to help in the required fundamental shift for the world's clean energy future.

This internship is in collaboration with the UKAEA through the Fusion Industry Programme (FIP). The FIP targets the third pillar of the UK's Fusion Strategy, which is "commercial leadership via thriving private-sector innovation and technology transfer". A key element to achieving this is to attract and retain a diverse range of talented people working within the fusion industry. The FIP includes an Education Scheme which aims to increase the supply of highly skilled students and researchers into the sector.

UK Atomic Energy Authority

This internship position at Oxford Sigma is part of the Summer Placement Scheme and which enables students to undertake paid placements within host organisations related to the fusion industry.

Eligibility

The candidate must have the right to work in the UK

The candidate must be an Undergraduate, Postgraduate or PhD student who is still classified by their university as a student at time of placement start.

Apply

We'd love to understand more about you, and why you want to get involved in fusion.

Submit your CV and covering letter (both in PDF format) at www.oxfordsigma.com/careers/

Applications will be reviewed fortnightly, until all our spaces are filled, or until **17:00 29th March 2024** – whichever comes first.

PROJECTS

OS-JA-INTERN-24-W
Lifecycle analysis of the use of tungsten in fusion energy

The commercialisation of fusion energy offers a clean, near limitless supply of energy. In the pursuit of this goal a range of reactors have been envisioned, designed, and modelled. There is a strong argument towards smaller fusion reactors due to the reduced time of construction and capital cost of the reactor; however, quantity of structural and functional material in fusion reactors may not scale linearly with the power output. Tungsten has unique nuclear and thermal-mechanical properties that enable the element to be used as key radiation shielding for tokamaks and plasma-facing components. Tungsten also transmutes to Rhenium, Osmium and Tantalum which adds challenges to recyclability of the material. Furthermore, tungsten's lifetime in a fusion reactor is limited to between 2 – 5 years of operation based on current knowledge.

This project aims to build fusion reactor models, from large/small tokamaks to inertial confinement fusion, to determine the requirement on shielding and first-wall tungsten components. This will provide realistic estimates on the requirements in tungsten. The student will interact with Oxford Sigma's partners in tungsten mining to model the demand needs for tungsten and how this links up with a social-economical model for the mining industry. The output will directly contribute to Oxford Sigma's tungsten technology and strategy.

Student Suitability
Suitable for students studying a range of STEM subjects including but not limited to physics, nuclear engineering, materials science/engineering, mechanical engineering, chemical engineering, natural sciences, and mathematics. Applicants should have basic experience with programming in Python.

Student Responsibilities
- Be embedded into the Oxford Sigma materials team, being exposed to a range of projects.
- Performing a literature review of different tokamak designs, with a focus on dimensions.
- Construct and execute neutron transport and transmutation simulations.
- Writing up findings in a technical report.
- Presenting the findings to the Oxford Sigma reactor design team.
- Visit tungsten mines in the UK with supervision.
- Be professional and represent the company at business meetings and visits to private fusion companies and national laboratories.

OS-JA-INTERN-24-B
Materials selection for fusion breeder blankets

Breeder blankets are essential components for the successful commercialisation of deuterium-tritium fusion. Their main objective is to enable the tritium self-sufficiency, producing at least as much tritium as is burnt in the fusion reactions, while also enabling the effective harnessing of the emitted neutron energy, allowing conversion to grid ready energy. Fusion breeder blankets impose incredibly harsh environments for materials due to the high thermal, magnetic and radiation loads, and resistance to the highly corrosive molten metal medium. The selection of materials that can tolerate all these phenomena is non-trivial and it is often a compromise between the different properties.

Materials selection is a non-trivial task which will drive the economics, maintenance, and lifetime of a fusion reactor. The selection of materials is an interplay between several characteristics. Having a resource with scoring of a materials characteristics in different fusion relevant environments will enable technical non-specialists to appreciate a material's suitability beyond their specific expertise. For example, a material might be incredibly corrosion resistant and tolerate high thermal loads but have a very detrimental effect on the reactor's neutronic properties.

This project will rely on Oxford Sigma's existing extensive literature review along with our expertise on breeder blanket materials and is suitable for 1 student. The student will be exposed to a multi-disciplinary environment where different ideas/requirements must be considered, and engineering challenges are tackled in a team decision. The outcome of this project is the production of a detailed scoring matrix for fusion relevant materials, with a relative score given for their independent tolerance to each of the challenging characteristics: thermal, magnetic, radiation and corrosion.

It is expected from the student to develop a broader understanding on how different properties might impact a fusion reactor's performance as well as to become aware of the decision-making process considering several complex variables. In addition, a materials strategy roadmap will be produced for one of these materials to outline how the material can be upscaled to a commercial scale in time for fusion energy to be put on the grid.

Student SuitabilitY
Suitable for students studying materials science/engineering, mechanical engineering, physics, chemistry, and chemical engineering.

Student responsibilities

- Be embedded into the materials team at Oxford Sigma, exposed to a range of fusion materials projects.
- Perform a literature review of fusion relevant materials for breeder blankets.
- Create a scoring matrix of materials tolerance to different fusion relevant environments.
- Produce a materials strategy roadmap for a selected material of choice in fusion.
- Present the output of the project to the wider Oxford Sigma team.

OS-JA-INTERN-24-M
Making fusion materials processing accessible

Materials for fusion are often unique due to the combined physical and chemical environments. The materials in a commercially relevant fusion system will experience the coupled extremes of high energy neutron irradiation, energetic plasma particle and photon flux, and the high-temperature corrosive environment of a tritium-breeding blanket. Typical materials classes include – reduced activation structural materials; refractory metals, ceramics, and composites; high conductivity copper alloys, molten melt corrosion barriers; and the complex dissimilar materials joints where these materials meet one another.

Often the specific materials have individual requirements in their processing from raw material to finished component that are unusual or particularly challenging (for example, tungsten which cannot be melt processed). This project seeks to take the existing literature and condense the knowledge to a handbook form addressing the materials processing, and thus manufacturing, and manufacturability.

The handbook will address a growing need for ease of access to knowledge on what can and cannot be done in component manufacture to aid engineers and physicists involved in the design of components for fusion. The handbook will need to present complex materials phenomena to a technical, non-specialist audience and will focus on the use of graphical design to improve accessibility of what is otherwise the domain of niche expertise.

Student Suitability
Suitable for students studying a range of STEM subjects, with an interest in graphical design and/or UX. A materials science, or materials engineering, background would be considered advantageous.

Students will gain a broad overview of fusion materials and manufacturing, the project will support their learning and development in the interface between materials science and engineering in applying the realistic limits of material use, an area often underdeveloped in undergraduate degrees.

Student Responsibilities

- Be embedded into the Oxford Sigma materials team, being exposed to a range of projects in the manufacturing and materials space.
- From a well-known fusion materials palette, researching and identifying the key materials processing requirements of each material, and identifying their interactions with one another according to common component requirements.
- Creating a structured breakdown of the materials by their applicability and importance in a reactor and scoping different visual approaches to present their findings.
- Develop the concept for a visually appealing handbook consolidating the information found, with the assistance of Oxford Sigma's materials and manufacture team.
- Present the results to the Oxford Sigma team at the conclusion of the project. Identifying further work required to take the handbook through to publishing.

OS-JA-INTERN-24-L
LIQUID METAL CORROSION

Breeder blankets are essential components for the successful commercialisation of deuterium-tritium fusion. Their main objective is to enable the tritium self-sufficiency, producing at least as much tritium as is burnt in the fusion reactions, while also enabling the effective harnessing of the emitted neutron energy, enabling conversion to grid ready energy. Fusion breeder blankets are incredibly harsh environments for materials due to the high thermal, magnetic and radiation loads, and resistance to the highly corrosive molten metal medium. The selection of materials that can tolerate all these phenomena is non-trivial and it is often a compromise between the different characteristics.

This project will focus on analysis and concurrent modelling of novel liquid metal test facilities during their commissioning. The project will look at the current systems and their performance validation, looking at the issues that emerge and modelling improved solutions for next generation devices using finite element analysis and computational fluid dynamics as appropriate.

Student Suitability
Suitable for students studying engineering degrees.

Student responsibilities

- Be embedded into the materials team at Oxford Sigma, exposed to a range of fusion materials projects.
- Working with the lead engineer, and the issues identified within the wider programme of work. Provide analytical support and holistic problem solving to enable next generation test facilities.
- Present the output of the project to the wider Oxford Sigma team.