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An Overview of Work Contributing to Fusion Codes and Standards at the University of Manchester

The University of Manchester has an established and growing presence in the fusion space. We are currently a partner of the Fusion Power Centre for Doctoral Training and the lead institute of the new Fusion Engineering CDT. This demonstrates our excellent capabilities in translating from low TRL level research to a position where codes and standards can be developed. We are also part of the Dalton Nuclear Institute, the largest and most advanced nuclear research capability in UK academia, and the Henry Royce Institute, the UK's advanced materials national centre. In addition we have strong links with industry and the supply chain, from fusion start-ups to more established engineering companies. We recognise the importance codes and standards play in the development of fusion power devices.

Our research includes fundamental materials characterisation, both experimentally and through modelling. We look at materials for varied applications across fusion, including plasma facing, structural and microwaves. We have capabilities in ion irradiation of materials through the Dalton Cumbria Facility. Our experimental characterisation facilities characterise materials from the atomic scale (through our electron microscopy centre, including in situ testing capabilities (hardness, tensile tests, heating)) to large scale engineering testing (loading rigs etc). This means we are able to obtain data for fusion relevant materials across a range of scales. We also are established users of the national lab facilities at Harwell, Diamond Light Source and ISIS Neutron and Muon Source. These capabilities are essential for carrying out reproduceable testing and materials qualification.

We work extensively in the materials manufacturing space. This involves novel welding and additive manufacturing. We have experience in electron beam welding of tungsten and reduced activation ferritic martensitic and austenitic steels, as well as associated heat treatments, characterisation and modelling. We are also working on Digital Twins development and coupling our manufacturing capabilities with novel finite element models.

We have also recently began working in the tritium space and have a group looking at the influence of tritium on material properties. Materials qualification is this space will be vital going forward as we head towards the development of appropriate codes and standards.

Building on our experience in fundamental materials science, applied engineering and strong links with industry we propose the need to develop a university based miniature version of the UK's flagship Spherical Tokamak for Energy Production (STEP programme). This should primarily be built using additive manufacturing techniques. The impact is multi-fold through the following key areas: providing an avenue for training the next generation of scientists and engineers, allowing for the development of engineering standards and protocols for building a tokamak, demonstration of novel additive manufacturing techniques, a test-bed for concepts for the STEP programme and a stimulus for supply chain and economic development in the UK. This will be a vital mechanism for code and standards development as we move from an era of ad-hoc fusion device development to a unified engineering-driven approach.

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Materials data

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