Simulation and experimental validation of creep–fatigue interaction in fusion reactors (UKAEA)

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The UK is the only country in the world with extensive experience in long term operation of high temperature reactors. Capitalising on the knowledge and expertise, the UK is well positioned to lead international efforts to design and build the high temperature components of a fusion reactor. However, the loading profile of a fusion reactor is different from that of a fission reactor. While a fission reactor experiences only a few hundred major cycles with long dwells in its lifetime, a fusion reactor is expected to see thousands of cycles a year. This will make the damage mechanism from which fusion reactor components suffer, unique. To design and assess the safety of high temperature component under such brutal loading regime, significant research is required to establish both micromechanical, and their micromechanical consequences of creep and fatigue damage interactions. This project is aimed at simulating this creep fatigue interaction using finite element modelling and validating the model using advanced experimental techniques.

This project is linked to joint work by UK Atomic Energy Authority and University of Bristol on EERA-JPNM (European Energy Research Alliance Joint Programme on Nuclear Materials) on Design Life60+. The work will be carried out in a newly modernised well-equipped high temperature mechanical testing facility at University of Bristol in collaboration with experts at EDF Energy and other researchers in The Solid Mechanics Research Group (SMRG). SMRG is also a regular user of UK major facilities such and Diamond Light Source and ISIS Neutron and Muon Source.

Based in the Department of Mechanical Engineering at University of Bristol (UoB), SMRG focusses on industrially-relevant research in support of low carbon energy sector in the UK. Since 2008 SMRG has had research partnership with EDF Energy, who are responsible for operating the existing fleet of UK nuclear power plants. The research has recently expanded to close collaboration with UK Atomic Energy Agency (UKAEA) at Culham Centre for Fusion Energy. This has broadened the facilities and SMRG's structural integrity activities to include fusion as well as fission. SMRG currently has eight academic staff and approximately 20 students and research staff.