

Electromagnetic Analysis of Transient Forces Due to Disrupted Plasma Currents on the ITER Shield Modules

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ITER is a joint international research and development project formed to demonstrate the scientific and technical feasibility of fusion power. The partners in the project - the ITER Parties - are the European Union (represented by EURATOM), Japan, the People's Republic of China, India, the Republic of Korea, the Russian Federation and the USA. ITER will be constructed in Europe, at Cadarache in the South of France. The geometry of ITER is a tokamak, in which strong magnetic fields confine a torus-shaped fusion plasma.

There are potential abnormal operating environments where the plasma currents inside the tokamak are disrupted and induce eddy currents in the shield modules. These currents interact with the large magnetic fields to produce forces in the modules which could potentially cause mechanical failure in the modules and vacuum vessel. For this reason the design and qualification of the ITER shield modules requires appropriate high-fidelity electromagnetic simulations that capture the physics of these situations. These simulations need to include an accurate representation of the disruption currents as well as an accurate electromagnetic model of the shield modules.

The purpose of this presentation is to describe the electromagnetic analysis that has been completed using the OPERA-3D product to characterize the forces on the shield modules allocated to the United States. We first describe the electromagnetic model of the system which consists of the disruption currents and the shield modules attached to the vacuum vessel. The disruption currents are represented in OPERA-3D using superposition of a large number of solenoids with independent time variation to account for the spatial and temporal variation of the plasma current and position. In addition, the simplified electromagnetic model of the shield modules will be described and discussed. Once the modeling has been described the simulation results will be presented. The force computation will also be presented and the results discussed. These forces are then used by a mechanical analysis program to compute stresses and torques on a module during the disruption of the plasma currents.

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