Introduction: A tokamak is a device that uses magnetic confinement to study plasma. The goal of a tokamak is to use high magnetic fields to contain the plasma and produce nuclear fusion that can be used for power generation. Fusion power is a function of the magnetic field strength and the plasma performance. Recent advances in high temperature superconductors could allow tokamaks to run at higher fields, increasing the performance of the plasma to reactor levels. Research would then need to focus on improving the support systems of the tokamak. MIT’s Plasma Science Fusion Center (PSFC) and collaborators are proposing a machine, the Advanced Divertor eXperiment (ADX) that would be designed to test new technology for these systems at reactor level heat fluxes and magnetic fields. [1] COMSOL has been used to analyze the proposed ADX vacuum vessel to determine loads and stresses induced during a plasma disruption.

Stresses and Displacements above allowable for original design, but can be brought to use high magnetic fields to contain the plasma and produce nuclear fusion that can be used for power generation. Fusion power is a function of the magnetic field strength and the plasma performance. Recent advances in high temperature superconductors could allow tokamaks to run at higher fields, increasing the performance of the plasma to reactor levels. Research would then need to focus on improving the support systems of the tokamak. MIT’s Plasma Science Fusion Center (PSFC) and collaborators are proposing a machine, the Advanced Divertor eXperiment (ADX) that would be designed to test new technology for these systems at reactor level heat fluxes and magnetic fields. [1] COMSOL has been used to analyze the proposed ADX vacuum vessel to determine loads and stresses induced during a plasma disruption.

Conclusions: COMSOL Multiphysics has been used to predict the loads, stresses and displacements on the current design for the vacuum vessel for the proposed Advanced Divertor eXperiment (ADX) tokamak.

- 'mf' physics interface was used to build a cyclic symmetry model of the tokamak, including magnetic field coils and the plasma, and simulate a VDE disruption including plasma movement and current quench. This model predicts the fields, eddy currents and Lorentz forces resulting in the vessel due to a disruption.
- Forces mapped to ‘solid’ physics interfaces where stresses and displacements are calculated.
- A disruption where the plasma moves up in the vessel (VDE), before losing its current is simulated by changing which volumes carry current. Times 0-0.01s show the plasma rising in the vessel with full current (1.5MA) and times 0.01s-0.1 to show the current quench when the plasma current drops to 0.
- The changing plasma current results magnetic fields in the vacuum vessel, and these rapidly changing fields generate voltages which cause eddy currents in the conductive vessel. Fields rise slowly as the plasma moves slower towards the top of the vessel and then fall rapidly during the current quench.

References: