

ITER: An extremely complex machine

Magnetic and Structural Analysis with ANSYS

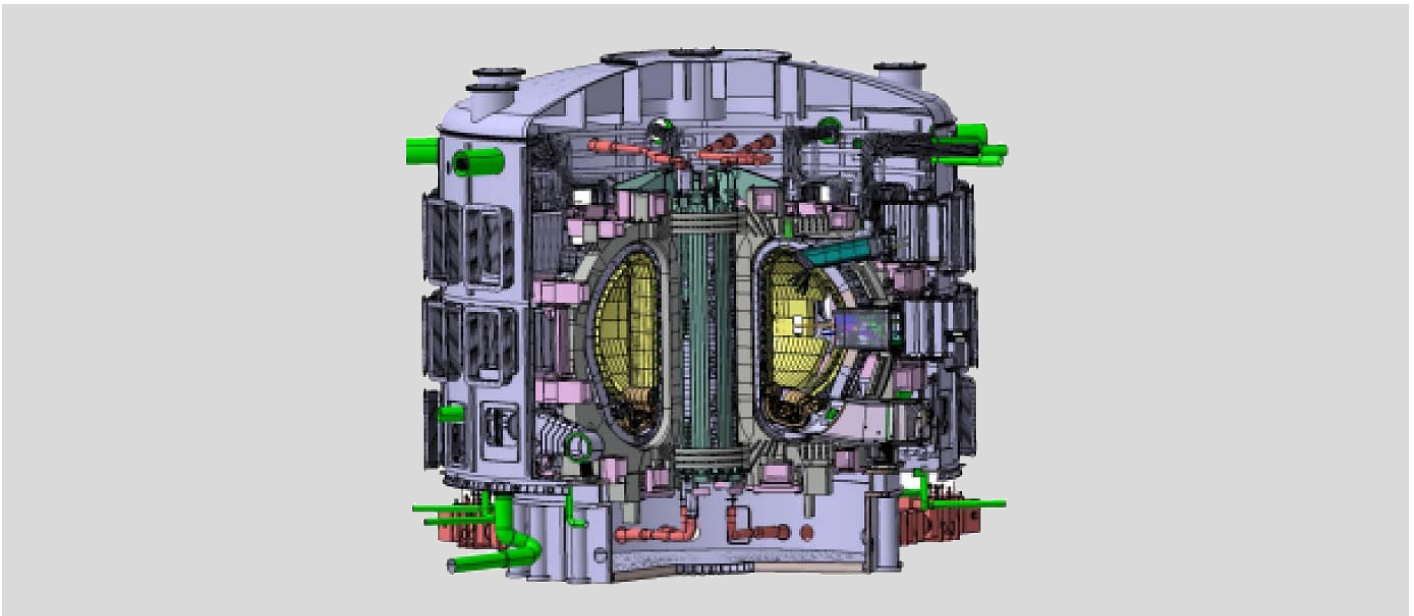


Fig. 1: Sectional view of ITER fusion reactor

Task

The International Thermonuclear Experimental reactor (ITER) is the first prototype fusion reactor to demonstrate the scientific and technological feasibility of fusion energy for peaceful purpose. One of the many technical challenges in this extremely complex machine is to confine a plasma of a few million degrees Celsius (°C) within a magnetic confinement (Tokamak concept) created by superconducting magnets, operated at -269 °C, orders of magnitude: total mass of abt. 23 thousand tons, output power 500 MW. Mass of one toroidal field coil (TF-Coil) of 360 tons, which is

equal to the take-off weight of a Boeing 747. Because of its flexibility and efficiency, the ANSYS finite element program is used within the ITER project for engineering design activities and to follow up the procurement arrangements in terms of mechanical (linear and non-linear), thermal, dynamic, and electromagnetic analyses. One simulation task is the design of the joint region of the TF-Coil. Lorentz forces on the conductors cause high stress to the supporting structure. Structural assessment of the joint region (e.g. bolts, housing) is necessary.

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Solution

- Set up of an electromagnetic model for the analysis of the magnetic field and transfer of Lorentz forces onto the nonlinear structural model considering contact and large deformations.
- Evaluation of the deformations and performing a static and fatigue assessment based on special criteria.

Customer Benefit

- Efficient process of load transfer from the magnetic field computation of the complete coil system to the detailed model of the joint region.
- Static and fatigue assessment based on their own criteria for several components, such as conductor and bolted connections.

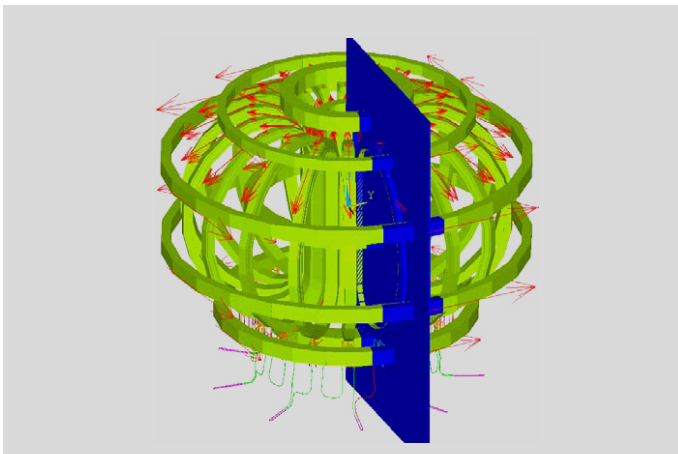


Fig. 2: Electromagnetic model of super-conducting coil system

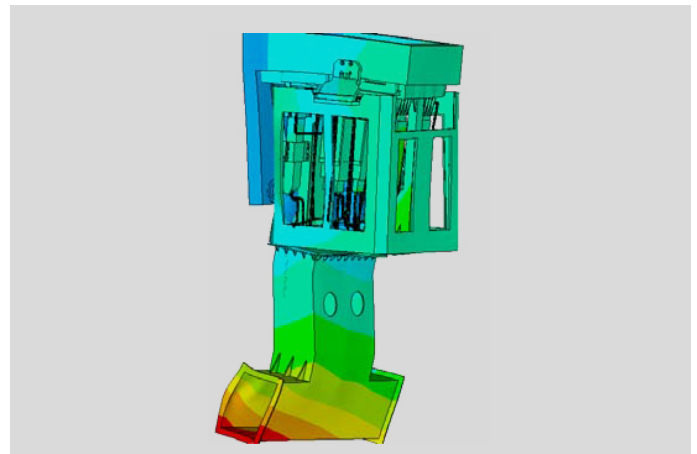


Fig. 3: Displacements due Lorentz forces

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About CADFEM

Founded in 1985, CADFEM provides everything that is required for the success of the simulation from a single source: First-class software and complete, ready-to-use systems; comprehensive

services; the latest knowledge. CADFEM is the ANSYS Competence Center FEM in Central Europe.