Contribution ID: **246** Type: **Poster Presentation of 1h45m**

An Electromagnetic and Structural Finite Element Model of the ITER TF Coils

Thursday, August 31, 2017 1:45 PM (1h 45m)

The ITER magnet system consists of 18 toroidal field (TFC) coils, a central solenoid, 6 poloidal field coils and a set of correction coils. The TFCs provide the required toroidal field (≈5.3T at plasma radius R=6.2m) mainly needed to confine the plasma. Since the magnets are under manufacturing, non-conformity (NCR) and/or deviation requests (DR) can be provided by the manufacturers. Fast checks on the impact of those design updates on the structural behaviour are needed before accepting their implementation. With this aim a new detailed FE model of the TFCs has been developed. It is a 3D cyclic symmetric model giving a full representation of the 2 types of coils characterizing the TF magnet. It allows computing the magnetic field during the different operating scenario and the related Lorentz forces acting on the TFCs. It also permits to simulate how the TFCs will mechanically behave during operation. Updates of the mesh can be easily implemented since the model has been built in a modular way, small sub-components of the system can be isolated and geometrically updated. This is the key feature of the model which has allowed to study in a very fast way possible NCR's and DR's. An intensive usage of the ANSYS APDL language has been implemented in such a way that the entire analysis cascade can be ran in a completely automatic way. Due to its versatility, this tool has become the reference TFCs model in the ITER community and it has been extensively used in performing additional studies simulating particular operating conditions to which the magnet can be temporarily subjected during the ITER lifetime. This paper describes the main characteristics of the model, its flexibility and analysis performance, and gives an overview of the main results it can provide considering the 15MA ITER scenario as reference.

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Session Classification: Thu-Af-Po4.02

Track Classification: B1 - Superconducting Magnets for Fusion