ELECTROMAGNETIC MODELING AND SUBSEQUENT STRUCTURAL ANALYSIS FOR ITER CORE CXRS UPPER PORT PLUG DIAGNOSTIC STRUCTURE

A. Panin, W. Biel, Y. Krasikov, O. Neubauer

IEF-4 (Plasma Physics), Forschungszentrum Jülich, Association EURATOM-FZJ, D52425 Jülich, Germany

Corresponding author: a.panin@fz-juelich.de

The upper port of the ITER vacuum vessel (VV) has to contain the core charge exchange recombination spectroscopy Port Plug diagnostic system (CXRS) that is a complex mechanical structure. The system design should be compliant with strict ITER requirements and the system has to serve full ITER lifetime with several provisioned replacements of critical parts.

The electromagnetic (EM) forces acting on the system should be carefully considered among other kinds of loads as thermal, seismic etc. The first option of the CXRS conceptual design was developed in a collaboration between Forschungszentrum Jülich (FZJ), ITER-NL, UKAEA(CCFE) in 2008.

FZJ developed the EM FE model of the ITER magnet system. The model is based on work [1] and addresses the main Port Plug features. It includes the VV, the blanket shield modules (BSM) including the diagnostic one attached to the Port Plug, the toroidal and poloidal field coils, the plasma region to model moving plasma with/without halo current as well as the main CXRS massive structures like the Outer Shell and Shielding Cassette. The 20 degree toroidal sector was modeled to allow for the Port Plug unsymmetry. The FE model is flexible to changes like different EM transients with/without halo current, change of CXRS/diagnostic BSM geometry, electrical contacts between parts etc.

The upward vertical displacement events (VDE) were studied as first priority cases and the worst ones were selected for modeling. The results of modeling made it possible to proceed in three ways:

- The EM loads on the massive CXRS components as the Outer Shell and Shielding Cassette derived directly from the EM global model have been used for design of their mechanical attachments.
- The ANSYS sub-modeling feature has been used for more detailed EM models of CXRS critical components which are located inside main massive structures.
- The “express” analyses for relatively small conducting components located inside massive structures have been performed to make a prompt choice between different design solutions. The same FE mesh is used as for the transient EM as well as for the structural analyses. No “air’ elements surrounding conducting bodies are modeled for the EM analysis (that is usually quite a challenge for complex models) and the boundary conditions derived from the global EM model are applied directly to conductive structures. Details and applicability of this approach are discussed in the paper.

Meanwhile, because of high importance of EM loads on the CXRS functionality and lifetime, FZJ launched two contracts on independent global EM CXRS modeling with the use of the same input data and assumptions but, desirably, with different modeling approaches.

At present these models are ready for benchmarking.

[1] M. Roccella, EFDA contract EFDA/03-1106 "Electromagnetic analyses of ITER blanket modules". ITER_D_2222E8