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P2.144 FE Analyses of Eddy Currents in W7-X Plasma Vessel

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Wendelstein 7-X (W7-X) is a fivefold optimized stellarator in operation in Greifswald, Germany. W7-X Plasma Vessel (PV) consists of five modules made with 17mm thick steel and having 254 openings for ports, necessary for cooling, heating and diagnostic purposes. Both ports number and their structures are different in each PV module.

During rare plasma disruption, the plasma bootstrap current rapidly vanishes and consequently eddy currents are generated in all electrically conducting components in plasma vicinity. The evaluation and analysis of these eddy currents are of major interest, because of the electromagnetic loads resulting from current interaction with the magnetic fields created by the magnets system and the plasma.

This paper focuses on the evaluation of the eddy currents induced in the W7-X PV components due to the exponential decay of the bootstrap current in the plasma (time constant 140ms). This task was accomplished by means of a PV 3D FE model. Due to the complexity of the geometry of the structure analysed, special emphasis was put on modelling issues such as elements type, mesh density and excitation representation. In first phase of the activity, the PV structure was modelled without ports, which were included in a subsequent phase. A procedure to allow quick and easy introduction or exclusion of ports from EM analyses was devised and implemented. In this way, the influence of these structures on the eddy currents could be evaluated efficiently.

Peak value of total eddy current running around the PV structure in absence of port structures turns out to be in the order of 20kA. Furthermore, results indicate that the presence of the ports leads to a relatively minor decrease of this value, in the order of 5%.

The paper presents also few examples of the PV FE model re-use for the analysis of W7-X in-vessel components.

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