ITER fusion alpha particle confinement in the presence of the ELM control coils and the European TBMs

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The new physics introduced by ITER operation is related to the energetic alpha particles produced in large quantities in fusion reactions. Successful operation of ITER requires that they are well confined. In this contribution, the effect of the European TBMs, ferritic inserts imbedded in the double-wall structure and ELM control coils on alpha distribution and wall power loads is simulated. These components are included in the 3D ITER magnetic field in unprecedented detail albeit without plasma shielding thus giving worst scenario predictions.

The case reported here corresponds to the 15 MA standard H-mode operation in ITER. The data received from ITER consist of the CAD drawings of the various coils (TF, PF and ECC) and the vessel components, including the first wall, the Ferritic Inserts (FI) imbedded in the double-wall structure for ripple mitigation and Test Blanket Modules (TBM) for tritium breeding, together with the EQDSK giving the plasma equilibrium. The FEM-solver COMSOL is used to first calculate the magnetization of the ferromagnetic components due to plasma current and currents flowing in the field coils. The field due to the magnetization is then added to the field integrated from the coils using the Biot-Savart law.

Thermonuclear fusion alpha population, calculated from the density and temperature profiles corresponding to the stationary phase of the ITER H-mode operation, is then simulated using the Monte Carlo –based orbit-following code ASCOT in the full 3D magnetic configuration given by the COMSOL calculations. The effect of each perturbation is assessed separately but, most importantly, the synergetic effect on fusion alpha distribution and wall power loads is evaluated. Furthermore, the structure of the magnetized components in taken into account at different levels of sophistication in order to optimize future computational efforts without compromising relevant physics.

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