DPP19-2019-000094

Abstract for an Invited Paper
for the DPP19 Meeting of
the American Physical Society

Optimization of ELM control coil configuration for various ITER scenarios[1]

LI LI, Donghua University

Large bursts of edge localized modes (ELMs) can severely damage plasma facing components in ITER. Three-dimensional resonant magnetic perturbation (RMP) has been proposed as a promising technique to mitigate or suppress Type-I ELMs in ITER. Plasma response to the applied vacuum RMP field has been shown to play a significant role in understanding and predicting the ELM control behavior. In this work, plasma response is computed for five plasma scenarios, covering the pre-nuclear and nuclear stages of ITER exploration. The plasma response, computed by MARS-F based on a resistive full magneto-hydrodynamic model in toroidal geometry, is used to construct both linear and quasi-linear figures of merit, such as the plasma displacement near the X-point of the plasma separatrix and the toroidal torque distributions along the plasma minor radius. These figures of merit are then utilized to optimize the RMP coil configuration, such as the coil phasing, for the purpose of (i) achieving the best ELM control in various ITER scenarios at the given coil current level, and (ii) avoiding plasma core flow damping by RMP whilst allowing sufficient field penetration through the plasma pedestal region. The optimal coil configurations between the two high-Q deuterium-tritium (DT) scenarios (at the same plasma current of 15 MA and magnetic field of 5.3 T but different fusion gains, Q=5 and 10) are predicted to be similar. Such optima also hold for other ITER scenarios with similar edge safety factor q95˜3, but are substantially different for the half-current full-field (7.5 MA/5.3 T) scenario. Toroidal torque density optimization, including the Maxwell and Reynolds stresses as well as the neoclassical toroidal viscosity, reveals a generally strong coupling of torque contributions between the plasma core and edge. The best decoupling is achieved by emphasing the role of the two off-middle rows of ELM control coils and de-emphasing the role of the middle row coils in ITER. Initial value MARS-Q quasi-linear simulations are also performed to investigate the effect of RMP fields on the plasma momentum and particle transport.

[1]Work performed in collaboration with ITER IO (Nuclear Facility INB no. 174)