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P1.1047 Non-linear MHD modelling of 3-D plasma edge with Resonant Magnetic Perturbations in DIII-D and ITER.

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At present, the intensive experimental and theoretical studies of Edge Localized Modes (ELMs) physics are particularly oriented towards finding the methods of their control in ITER. ELMs potentially represent an issue for ITER divertor lifetime due to large transient heat and particle losses released in each ELM relaxation [1]. The application of small Resonant Magnetic Perturbations (RMPs) generated by specific coils demonstrated the possibility of total ELMs suppression or strong mitigation of their size [2], motivating the use of such method in ITER. The important drawback of RMP application is the complex magnetic topology at the edge and formation of 3D Scrape of Layer (SOL) leading to the splitting of the separatrix seen in experiment as helical “lobes” at the X-point. When crossing the divertor plates they form fingerlike structures (”footprints”) and non-axisymmetric heat and particle fluxes observed in many RMP experiments [3]. The 3D SOL and non-axisymmetric divertor fluxes with RMPs can represent an issue in ITER leading to local high heat fluxes (”hot spots”) in the unprotected areas, additional material erosion and fatigue stress on the divertor components.
In this work the characterisation of 3D plasma edge and divertor footprints with RMPs was done using the non-linear MHD code JOREK [4] including two fluid diamagnetic effects, toroidal plasma rotation and neo-classical poloidal friction in the model which was shown to contain essential elements for the self-consistent modelling of the non-linear plasma response to RMPs [5]. Firstly, the benchmarking of RMP model implemented in JOREK was done comparing simulation results with ELM suppression experiment on DIII-D. The divertor magnetic 3D footprints structure obtained in modelling taking into account plasma response to the realistic RMP spectrum with dominant toroidal modes N=1 and N=3 demonstrated rather good agreement with FASTCAM measurements of the divertor particle flux splitting observed in DIII-D pulse #166439 [3]. It will be shown that non-linear plasma response to RMPs can be very different compared to the vacuum fields due to the screening by rotating plasma or amplification via so called external kink/peeling response. In particular, self-consistent interplay between RMP penetration, evolution of radial electric field and electron poloidal plasma rotation taken in to account seems to be necessary elements for successful benchmarking with experiment. Secondly, the results of JOREK modelling of ITER divertor magnetic footprints and divertor fluxes with RMPs generated by In Vessel Coils (IVC) will be presented for standard H-mode scenario 15MA/5.3T. Some of the potentially possible methods of asymmetry reduction of the RMP divertor footprints such as rigid rotation or optimisation of RMP spectrum will be discussed.
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