Toroidal plasma response modeling for ELM control optimization via RMPs in perspective DTT plasmas

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H-mode plasma scenarios, with enhanced energy and particle confinement at plasma edge, are a viable option for fusion energy production and represent the core operational regimes for present day and next generation fusion experiments such as ITER. Good confinement however comes at the price of potentially large pressure and current density gradients in the edge region, leading to the so-called Edge Localized Modes. Type-I ELMs in particular are large bursts that can damage the plasma facing components causing large heat and particle fluxes. Applying 3D resonant magnetic perturbations (RMPs) with non-axisymmetric saddle coils is a promising method to mitigate or suppress type-I ELMs [1][2]. The DTT experiment [3], presently under realization, will be built in Frascati (Italy) with the main mission of developing reactor-relevant power exhaust technologies. ELM control is therefore of particular importance for DTT operational scenarios. Non-axisymmetric in-vessel coils are being considered for the purpose of ELM mitigation and suppression. Linear plasma response modelling [4] is exploited in this work to assess the effect of different coil geometries on ELM stability in a full power DTT scenario. Peeling-like plasma response in particular is found to be correlated with ELM control and is computed by solving single fluid MHD equations in toroidal geometry with the MARS-F code [5], which includes the effect of plasma flow. The effects on the magnetic field spatial spectrum due to the three-dimensional geometry of the non-axisymmetric in-vessel coils are evaluated with the CARIDDI code [6]. In order to evaluate the RMP effect on ELM stability, local plasma displacement in the x-point region is used as the main metric. This criterion has been correlated with ELM mitigation thresholds in MAST and ASDEX-Upgrade [7]. By taking as reference a displacement value of 3 mm at the x-point, the optimal operational space for non-axisymmetric coils in DTT is sketched in terms of coil current and phasing between independent toroidal arrays. Configurations with either two or three sets of 9 coils each are used in the model. While n=1 RMPs induce an important core response in the reference scenario, n=2,3 response shows a main peeling-like component. The effect of edge q-profile variations and comparison with other metrics is considered, such as with the Chirikov parameter criterion correlated with the RMP-induced edge stochasticity.

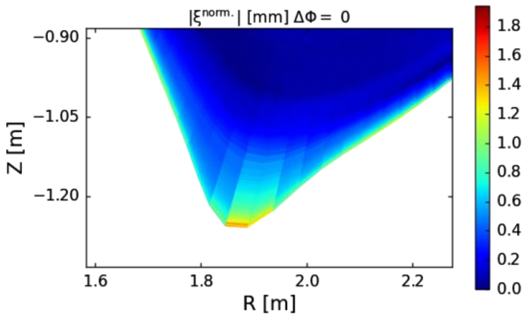

***Figure 1**: Detail of normal plasma displacement map showing the divertor region for an n=3 DC perturbation*

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