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ITR/1-2: Progress on the Application of ELM Control Schemes to ITER

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High fusion performance DT operation in ITER is based on the achievement of the H-mode confinement regime with H98 ≥ 1 and an edge transport barrier that is expected to lead to the quasi-periodic triggering of ELMs. Operation of ITER with H-mode plasmas is also foreseen during the non-active (H & He) and DD operation allowing the development of ELM control schemes before DT operation.
The non-linear MHD evolution of the plasma during ELMs in ITER has been modelled with the JOREK code which shows that the non-linear MHD growth during the ELM causes a temporary ergodisation of the plasma edge leading to the appearance of striations in the ELM power flux at the divertor target. On the contrary, power fluxes to the first wall are expected to be dominated by the convection of energy by the radial propagation of plasma filaments produced during the ELM crash. JOREK has also being applied to investigate the capabilities of the ITER pellet injection system to meet the requirements for ELM control following its validation with DIII-D experimental results.
The application in-vessel coils to create edge magnetic field perturbations for ELM control and the associated power/particle fluxes to PFCs have been studied for ITER. Evaluations of the edge magnetic field perturbation by in-vessel coils show that the toroidal symmetry of the applied currents in the coils (n=3 or n=4 symmetry) can have a significant impact on the level of current required (up to 50% current level reduction) to achieve a given level of edge ergodisation. Optimization of the relative toroidal phasing of the currents applied to the 3 rows of coils shows that there is an appropriate margin (factor of ˜ 1.5 - 2) in coil current magnitude required to achieve the design criterion (vacuum approximation) for the 15 MA QDT = 10 scenario. Power and particle fluxes in the perturbed edge magnetic field have been evaluated in the vacuum field approximation and including plasma response. The application of edge magnetic field perturbations leads to the appearance of non-toroidally symmetric divertor power/particle fluxes extending up to ˜ 50 cm from the separatrix but also to a reduction of the peak heat flux by a factor of 2-3. The inclusion of plasma response decreases transport of energy/particles from the main plasma and the detrimental effects on plasma energy/particle confinement.

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