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ITR/P1-23: Non-linear MHD Simulation of ELM Energy Deposition

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Measurements of the power deposition profile on the divertor target due to ELMs show that the wetted area during the ELMs increases significantly with the amplitude of the ELM energy losses. Taking the broadening into account in the estimates for the allowable ELM size in ITER leads to a larger operating window in plasma current (up to ˜8 MA) where natural ELMs can be tolerated. The allowable ELM sizes for the high performance DT scenario at 15 MA are very small and thus no significant broadening is expected for tolerable ELMs in this scenario.

Non-linear MHD simulations of ELMs have previously shown good qualitative agreement on features like the formation of filaments and their propagation speed and the fine structure in the power deposition profile during ELMs. The next step towards a quantitative validation of MHD simulations of ELMs is to compare observed trends in the experimental data with results from nonlinear MHD simulations. Here, the non-linear MHD code JOREK is used to study the origin of the observed broadening of the wetted area as a function of the ELM size, and to provide a physics basis for the expected ELM power losses in ITER.

MHD simulations of ELMs for JET-scale plasmas show a significant broadening of the power deposition profiles at the divertor targets during ELMs. The broadening is a function of the ELM amplitude, the dependence being in reasonable agreement with experimental observations. The broadening is due to the ergodisation of the magnetic field due to the magnetic perturbation of the unstable ballooning mode. The ergodised field shows the characteristic homoclinic tangles which lead to filamentary structures on the divertor target with multiple strike points. The broadening of the power deposition varies during the temporal evolution of the ELM itself, which is correlated with the amplitude of the magnetic perturbation.

Simulations of ELMs in the ITER 15 MA, Q=10 reference scenario, including the ITER divertor and first wall geometry, show significant broadening due to the ELM magnetic perturbation on the outer vertical target, less on the inner target. The paper will describe in detail the influence of the various MHD and transport processes occurring during an ELM on the modelled ELM heat flux pattern.

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