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ITR/P1-22: Non-linear MHD Modelling of ELM Triggering by Pellet Injection in DIII-D and Implications for ITER

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ITER operation in its high fusion performance DT scenarios (inductive, hybrid and steady-state) relies on the achievement of the H-mode confinement regime, which is expected to lead to the quasi-periodic triggering of ELMs. Extrapolation of measurements of ELM energy fluxes to plasma facing components (PFCs) in present devices to ITER indicates that, for naturally occurring ELMs (or "uncontrolled"), these will produce an unacceptably low PFC lifetime because of excessive erosion and/or superficial surface damage. Controlled triggering of ELMs by the injection of small pellets has been demonstrated in present experiments as a viable technique to reduce ELM energy fluxes. The application of this technique to ITER requires frequencies exceeding (by typically more than one order of magnitude) those of uncontrolled ELMs. Thus, significant uncertainties remain for its practical application to ITER regarding both the optimization of the pellets for efficient triggering as well as of the associated fuel throughput required by this technique.
In order to provide a firmer physics basis to the triggering of ELMs by pellet injection, and to reduce the uncertainties with regards to its application in ITER, non-linear MHD modelling of ELM triggering by pellet injection in DIII-D experiments has been carried out with the JOREK code. The modelling results show that the triggering of ELMs is associated with the pressure (and its gradient) in the pedestal region of the plasma reaching a critical value during the pellet ablation process. As a consequence, a minimum pellet size for ELM triggering (for given pellet velocity and injection geometry) has been identified. Modelling of the effect of pellet injection location (outer midplane, X-point region, high field side) and of the details of the ablation profile on ELM triggering by pellets at DIII-D, as well as of the power fluxes to PFCs during pellet triggered ELMs, are in progress and will be reported in the paper. Comparison between simulations for DIII-D and experimental measurements will be used to validate and refine modelling assumptions. Predictions of the pellet requirements for optimum ELM triggering in ITER will be carried out with the validated model and implications for the requirements and implications for pellet pacing as a technique for ELM control in ITER will be drawn.

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