Topic: EX-C

Optimization of Density and Radiated Power Evolution Control using Magnetic ELM Pace-making in NSTX

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Recent experiments at the National Spherical Torus Experiment (NSTX) have shown that lithium coating of the plasma facing components leads to improved energy confinement [1], and also the complete suppression of edge-localized modes (ELMs). Due to the lack of ELMs, however, such plasmas suffer from density and radiated power that increase throughout the discharge, often leading to a radiative collapse. Previous experiments have shown that ELMs can be controllably restored into these lithium-conditioned discharges using 3D magnetic perturbations, which reduces impurity accumulation. Here we present the optimization of the use of magnetic ELM pace-making to control the evolution of the density and impurity content. Short duration large amplitude 3D field pulses are used, so that the threshold field for destabilization is reached and ELMs triggered quickly, and the field then removed. A second improvement was made by adding a negative-going pulse to each of the triggering pulses to counteract the vessel eddy currents and reduce time-averaged rotation braking. With these improvements to the triggering waveform, the frequency of the triggered ELMs was increased to over 60 Hz, reducing the average ELM size. The optimum frequency for attaining impurity control while minimizing energy confinement reduction was determined: fairly low frequency ELMs (20 Hz triggering) are sufficient to keep the total radiation under 1 MW throughout the discharge and avoid radiative collapse, with little reduction in the plasma stored energy. When combined with improved particle fuelling the ELM-pacing technique has been successful in achieving stationarity in the line-averaged electron denisty and total radiated power, although the profiles continue to evolve.