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Modelling of Transitions Between L- and H-Mode Including W Behaviour in ITER Scenarios

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The dynamics of the access to and exit from high QDT regimes in the H-mode confinement regime in ITER is expected to be qualitatively different to present experiments: neutral fuelling is much less effective, Psep/PL-H < 2.0 even in stationary QDT ~ 10 burning conditions, the density evolution determines not only PL-H but also Palpha which in turn affects dWth/dt after a transition, and plasma position control may be challenging in case of an unexpected back transition to L-mode. In addition, the presence of W may impose additional operational constraints due to possible core accumulation and increased radiation during transients (possibility of a sudden return to L-mode confinement, plasma-wall contact and/or a disruption). To determine under which conditions the transition to stationary high QDT H-mode regime and its safe termination can be achieved, how the plasma evolution to/from H-mode can be optimised, and to assess the problem of possible core W accumulation, modelling studies have been carried out with the JINTRAC suite of codes, simulating the core and core+SOL plasma evolution for the entire period of density evolution following transitions to/from H-mode in the ITER 15 MA/5.3 T and 7.5 MA/2.65 T scenarios.
Simulation scans for the L-H transition have been performed with varying target waveforms for the density evolution, applying a feedback on pellet fuelling. Depending on boundary and operational conditions, limits for the density ramp rate and/or a delay time before the application of increased fuelling could be established. Below these limits, the plasma remains in dithering conditions with Psep~PL-H for a long while before it enters a good quality H-mode regime at Psep>PL-H, leading to increased flux consumption and a significantly reduced burn duration. In extreme cases, the plasma never reaches high performance H-mode and returns back to L-mode.
The back transition to L-mode has also been assessed. The fast reduction in core energy would cause Psep to remain close to PL-H. The plasma would then not immediately reach L-mode but stay in H-mode for a while, followed by a dithering phase before the ETB completely disappears. The energy loss could become accelerated though by an immediate transition to dithering mode e.g. after a strong MHD event. Subsequent W accumulation could then lead to an immediate transition to L-mode and a disruption.

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