L-H transitions on JET with the ITER-like Wall

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The expected threshold power (P_{th}) required to access H-mode operation on ITER is extrapolated from a multi-machine scaling that is strongly weighted to a dataset of JET C-wall discharges. The changeover of the plasma facing components to Be/W has caused significant deviations from this scaling [1]. Most notable is a minimum in P_{th} as function of density, which was not observed with the current MkII-HD divertor in the C-wall JET. The density at the minimum in P_{th} scales as $B_t^{4/5}$, and decreases with decreasing plasma current. In the high density branch the threshold power is reduced by 30% compared to matched discharges in the C-wall JET, which is favourable for ITER.

A study of edge temperatures and the radial electric field derived from the force balance equation could not unambiguously identify a single critical parameter for the transition in these discharges.

The sensitivity of the L-H threshold on the plasma facing components and impurity composition has been further investigated by applying nitrogen seeding around the minimum in P_{th}. With seeding, P_{th} is increased to similar values as in the C-wall. Gyrokinetic simulations [2] attribute this to the stabilizing effect of Zeff on resistive ballooning modes, which, in the simulations, are identified as the dominant turbulence mechanism in the high density branch.

The effect of the divertor configuration on the L-H transition has been studied by varying the strike point positions while keeping a similar main plasma shape. Plasmas with the inner strike point on the vertical target and the outer on the horizontal target show a decrease of P_{th} with increasing lower triangularity. In discharges with both strike points on the vertical targets, only the monotonically increasing high density branch is observed and P_{th} is increased by a factor of 2.

The strong effect of the divertor configuration in particular has motivated the investigation of the role of the divertor conditions in the L-H transition. In the high density branch, the pressure at the strike points becomes increasingly asymmetric between inner and outer strike point as the power is ramped up in L-mode. In horizontal target discharges, this leads to detachment of the inner leg during the heating ramp, coinciding with an increase of the electron temperature at the outer strike point. The power at which this occurs becomes equal to P_{th} in the high density branch. A likely explanation for the observed asymmetries are drifts in the divertor and SOL. These could directly affect the transition by setting boundary conditions to the plasma flow or indirectly by changing the up-stream profiles.

[1] C.F. Maggi et al., Nucl. Fus. **54** (2014) 023007
[2] C. Bourdelle et al., Nucl. Fusion Lett. **54** (2014) 022001

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[+] See the Appendix of F. Romanelli et al., Proc. of the 24th IAEA Fusion Energy Conference, 2012, San Diego, USA