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Overview and Interpretation of L-H Threshold Experiments on JET with the ITER-like Wall

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The expected threshold power (Pth) required to access H-mode operation on ITER is extrapolated from a multi-machine scaling that is strongly weighted to a dataset of JET carbon wall discharges. To assess differences in Pth due to the change to a Be/W-wall, a series of experiments has been conducted at JET to measure Pth as function of plasma density for different Bt/Ip [1]. At medium to high density a reduction in the threshold power of 30% is found, favourable for ITER. At lower density Pth exhibits a minimum, not observed with the current divertor in the C-wall. The density at the minimum in Pth scales as Bt^(4/5).
The radial electric field has been reconstructed from the force balance equation before the L-H transition in the low and high density branch, but no trend has yet been found.
Subsequent experiments have focussed on the effect of the impurity composition and the divertor configuration. Nitrogen seeding around the minimum in Pth increases the threshold to similar values as in the C-wall. Pth decreases with increasing lower triangularity and increases with increasing upper triangularity. Operation with strike points on the vertical targets strongly increases Pth and leads to a loss of the minimum.
Two mechanisms are being explored to explain the observations. The first is proposed in [2], in which the most unstable modes in the high density branch are identified in gyrokinetic simulations as resistive ballooning modes which are destabilized by increasing Zeff, in agreement with the observations. A second possibility is related to changes in the recycling and radiation. Plasmas in the high density branch are partially detached but re-attach during the heating ramp. This often leads to an oscillatory (sawtooth triggered) behaviour known as divertor oscillations. Near the minimum in Pth, oscillatory L-H transitions are commonly observed. They share many characteristics with the divertor oscillations, but have a short H-mode phase. These observations suggest a link between the divertor regime and the two qualitatively very different branches of the L-H transition.

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

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