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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 (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 carbon wall discharges. To assess differences in P_{th} due to the change to a Be/W-wall, a series of experiments has been conducted at JET to measure P_{th} as function of plasma density for different B_t/I_p [1]. At medium to high density a reduction in the threshold power of 30% is found, favourable for ITER. At lower density P_{th} exhibits a minimum, not observed with the current divertor in the C-wall. The density at the minimum in P_{th} scales as B_t^{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 P_{th} increases the threshold to similar values as in the C-wall. P_{th} decreases with increasing lower triangularity and increases with increasing upper triangularity. Operation with strike points on the vertical targets strongly increases P_{th} 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 Z_{eff}, 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 P_{th}, 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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Author: Dr DELABIE, Ephrem (EURATOM-FOM association DIFFER, The Netherlands)

Co-authors: Dr MEIGS, A. (CCFE, Culham Science Centre, Abingdon, UK); Dr MAGGI, Costanza (Max Planck Institut fuer Plasmaphysik); Dr SOLANO, E (Asociación EURATOM-CIEMAT, Madrid, Spain); Dr RIM-

INI, F. (CCFE, Culham Science Centre, Abingdon, UK); Dr MEYER, Hendrik (EURATOM/CCFE Fusion Association); Dr CARVALHO, I. (Associacao EURATOM-IST, Lisboa, Portugal); Dr HILLESHEIM, Jon (Culham Centre for Fusion Energy); Dr MENESES, L. (Associacao EURATOM-IST, Lisboa, Portugal); Dr CLEVER, M. (Association EURATOM-FZJ, Jülich, Germany); Dr STAMP, M. (CCFE, Culham Science Centre, Abingdon, UK); Dr BRIX, Mathias (CCFE, Culham Science Centre, Abingdon, UK); Dr HAWKES, N.C. (CCFE, Culham Science Centre, Abingdon, UK); Dr DREWELOW, P. (MPI für Plasmaphysik, Greifswald, Germany); Mrs SIREN, Paula (Association EURATOM-Tekes, FIN-02044 VTT, Finland); Dr BIEWER, T. M. (Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA); Mrs BOURDELLE, clarisse (CEA, IRFM, F-13108 Saint-Paul-lez-Durance, France.)

Presenter: Dr DELABIE, Ephrem (EURATOM-FOM association DIFFER , The Netherlands)

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