Effect of the divertor configuration on the JET edge radial electric field

C. Silva[1], E. R. Solano[2], J. C. Hillesheim[3], E. Delabie[4], G. Birkenmeier[5,6], L. Gil[1], C. Giroud[3], R. B. Morales[3], D. Nina[1] and JET Contributors[1]

EUROfusion Consortium, JET, Culham Science Centre, Abingdon, OX14 3DB, UK
[1]Instituto de Plasmas e Fusão Nuclear, Instituto Superior Técnico, Universidade de Lisboa, Portugal
[2]Laboratorio Nacional de Fusión, CIEMAT, 28040 Madrid, Spain
[3]CCFE, Culham Science Centre, Abingdon, OX14 3DB, UK
[4]Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6169, USA
[5]Max-Planck-Institut fur Plasmaphysik, Boltzmannstr. 2, D-85748 Garching, Germany
[6]Physics Department E28, Technical University Munich, 85748 Garching, Germany

The current extrapolations for the ITER L-H threshold power are based on a widely used multi-machine scaling, depending on density, magnetic field and machine size. However, there is a considerable scatter around the scaling law caused by hidden parameters, such as the divertor configuration. Studies in different devices (e.g. [1, 2]) have shown that the divertor configuration can vary the power threshold by up to a factor of two and may therefore have a large impact on future devices that needs to be understood.

The existence of a strong shear in the perpendicular plasma flow, $v_\perp$, caused by a radial electric field, E_r, is thought to be fundamental for the edge turbulence suppression. The origin of the $E_r \times B$ flow is still not fully understood and therefore E_r measurements are essential to better understand the link between flow shear and turbulence suppression.

Over the years, several L–H threshold experiments were performed on JET to investigate the importance of different parameters such as divertor geometry and isotopic mass (e.g. [1, 3]). Here we report on $v_\perp$ measurements obtained by Doppler backscattering in JET experiments with different outer divertor strike-point positions: tile 5 of the horizontal target (V5), vertical target (VT), and in the corner (CC) configuration (between the horizontal and vertical targets close to the pump throat). As reported before (e.g. [3]), VT and CC have similar L-H threshold, which is roughly a factor of two larger than in V5.

A deeper $v_\perp$ well is measured at the L-H transition for the VT configuration, $v_\perp \sim -3$ km/s, which is higher by a factor of about two than for V5. Furthermore, the $v_\perp$ profile for CC does not show a well ($v_\perp \sim 1$ km/s at the expected well location) indicating that the edge E_r profile results from the main ion rotation compensating the diamagnetic term. This may be explained by the existence of an edge toroidal flow most relevant for CC. As reported in [4], the corner configuration shows a stronger pedestal toroidal velocity than in the other configurations, as well as a lower neutral pressure in the main chamber. No clear correlation is seen between the shear flow and the L-H power threshold for different divertor configurations. Our results do not show evidence for the existence of a critical $v_\perp$ needed to achieve H-mode.

References: [1] C. F. Maggi et al., Nucl. Fusion 54 023007 2014; [2] P. Gohil, et al. Nucl. Fusion, 51 103020 2011; [3] H. Meyer et al., EPS Conference on Plasma Physics, P1.013 2014; [4] E. Joffrin et al., Nucl. Fusion 57 086025 2017

[1]See the author list of 'Overview of JET results for optimising ITER operation' by J. Mailloux et al. to be published in Nuclear Fusion Special issue: Overview and Summary Papers from the 28th Fusion Energy Conference (Nice, France, 10-15 May 2021)"