Power balance analysis at the L to H transition in JET-ILW

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Various investigations of the dependency of the power threshold for the L-H transition (P_{LH}) as a function of target density have been carried out at JET since the installation of the ITER-like wall [1, 2].

We find that the position of the strike points strongly influences P_{LH}, and we consider each plasma shape as a separate dataset. In some of these subsets we have clearly identified data points in the low density branch: below a certain density, $n_{e,min}$, P_{LH} increases as density decreases. For the same conditions (shape, current, field, heating system) the value of $n_{e,min}$ is considerably higher in Hydrogen plasmas compared to Deuterium plasmas. As observed in various other devices, $n_{e,min}$ also depends on toroidal field, and is affected by plasma current.

The current leading explanation for the existence of a minimum density was developed by the AUG team [3-6]. Power balance analysis before the L to H transition on AUG studies, and more recently in C-Mod [7], have shown that even if the total power crossing the 95% surface exhibits a minimum in density, this is not the case for the power coupled to the ions, which decreases proportionally to the decreasing density.

To test the model, we investigated a few NBI heated cases in JET, for which we have edge T_e and T_i measurements across the density scan. In those cases we find that T_e=T_i in the plasma edge before the transition, also when clearly in the low density branch. Uncertainties in the core Ti measurements lead us to resort to modeling to investigate if the power to the ions decreases with density in the low density branch.

In order to perform the power balance analysis of theses pulses, we have run interpretive core transport simulations with the JINTRAC code suite [8] (using the JETTO and ASCOT modules) to compute the direct electron and ion heat sources, including the radiation given by bolometry measurements. To compensate for the lack of core CX measurements of T_i, QualiKiz [9] is used in JETTO to predict electron and ion heat fluxes for radii inside rho=0.95. The predicted electron temperature profiles match the measurements quite well. The predicted T_i matches the edge CX data. We use the predicted core profiles to estimate the heat exchange term and the electron and ion heat fluxes. The computed power coupled to the ions does not exhibit a linear dependency with respect to density in the low density branch of these JET-ILW plasmas.

References:

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