Study of the L-H transition at low density in ASDEX Upgrade

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The L-H transition power threshold exhibits a minimum in density ($n_{e,min}$) below which it increases as density decreases. This behaviour is clearly seen in ASDEX Upgrade and $n_{e,min}$ is around $4 \times 10^{19} m^{-3}$ under the plasma conditions of the present study. In the work presented here, we focus on the region below $n_{e,min}$ and correlate the behaviour of the L-H threshold power with edge parameters.

The value of $n_{e,min}$ allows us to explore a wide range in density, down to about $1.5 \times 10^{19} m^{-3}$ when using ECRH only. L-H transitions could not be achieved below this density with the maximum available ECRH power of 2.2 MW. Accurate edge profiles of density, electron and ion temperatures were obtained from low power L-Mode up to the LH transition while increasing the power. At low density and with strong electron heating, the electron and ion heat channels are expected to be well separated up to the plasma edge and indeed confirmed by our measurements. This has also been assessed by detailed power balance analysis in the edge. Experimentally, at the L-H transition, edge T_e and T_i are almost equal at $n_e \approx 4 \times 10^{19} m^{-3}$, but differ by a factor of up to 1.6 ($T_e > T_i$) at $n_e \approx 1.5 \times 10^{19} m^{-3}$. As density is decreased below $n_{e,min}$, the value of the edge T_e at the L-H transition increases strongly, following the high power required to reach the L-H transition. In contrast, the value of the edge T_i increases much less. Similarly, it could also be demonstrated that for a fixed low value of density, in the L-Mode, the ratio T_e/T_i increases with heating power up to the L-H transition.

Very recently, the available ECRH power has been increased to 3 MW, offering the possibility to achieve stronger separation of the electron and ion channel. New experiments are foreseen in the very near future. The contribution will report on the latest results and discuss the possible contributions to the L-H mechanism. The role of flows, GAMs and turbulence for similar plasmas is presented in a companion paper, [1].

[1] G. Conway et al., *Zonal flows, GAMs and turbulence behaviour across the L-H transition*

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