JET-ILW L-H transitions in Helium

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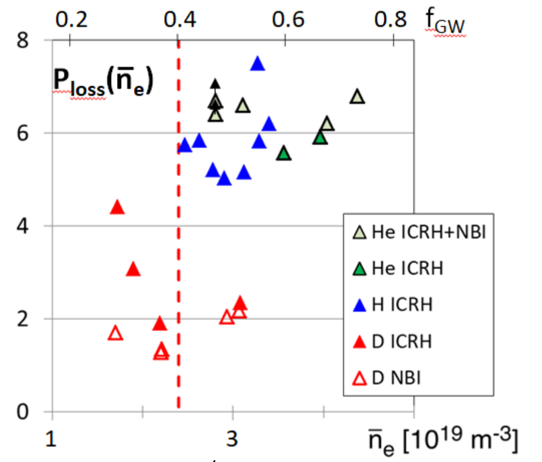
ITER plans a low toroidal field Pre-Fusion Operating Power phase with either Hydrogen or Helium plasmas in order to study H-modes as early as possible, before the nuclear phase that starts with D plasmas. A prediction of the density, n_e, at which the power required to achieve an H-mode transition is minimal, $n_{e,min}$ was made based on the AUG observations [1]: a sufficient edge ion heat flux is necessary to achieve a radial electric field (shear) to drive the L-H transition. Assuming pure electron heating in ITER, 1.5-D predictive transport modelling showed that when $n_{e,min}$~0.4 $n_{e,GW}$ the ratio of ion heat flux to total heat flux starts to saturate with increasing n_e, independent of the ion species. The model assumes P_{LH}(He)=1.4 x P_{LH}(D), while P_{LH}(H)=2xP_{LH}(D) [2].

The L-H transition power threshold, characterised by $P_{loss}=P_{Ohm}+P_{aux}-dW/dt-P_{fast}$, as a function of core averaged density, for D, H and He, in a configuration with the outer strike on the horizontal divertor tile. The data shows $n_{e,min}$,(D)~0.4$n_{e,GW}$, $n_{e,min}$,(H)~0.5$n_{e,GW}$, $n_{e,min}$,(He)~0.6$n_{e,GW}$. H has lower input power threshold than He at low densities, in part because these He plasmas have high radiation. When core radiation is removed the He power threshold drops just below the H level, with change in $n_{e,min}$. Above $n_{e,min}$(He), the D and He power thresholds align.



$P_{loss}(n_e)$ for D, H and ^{4}He plasmas with 1.8 T, 1.7 MA. Points with an upward arrow do not stay in H-mode, may have even higher threshold.

We report shape effects [3-5]. at 1.8 T, and on NBI heated transitions at 2.4 T. In all cases the increase of $n_{e,min}$ for He is robust, in contrast with earlier AUG studies [6]. As in JET-C He experiments [7], periodic clean ELMs are observed, but they could be either type III or type I.

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