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EX/P4-03: L-H Transition, Pedestal Development and I-mode Studies in the ASDEX Upgrade Tokamak

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Investigations of the L-H transition in situations with a high power threshold, such as low density, unfavorable ion gradB drift or application of magnetic perturbations widen the knowledge on transition and pedestal physics. At ASDEX Upgrade, such studies yield the following results.

H-modes achieved with ECRH at low density allowed to decouple the electron and ion channels. The analysis reveals the key role of the ions reflected by a constant values of the minimum radial electric field well (E_r) over a wide range of density and T_e/T_i. This also explains the increase of H-mode threshold power (P_thr) towards low density.

Discharges with L-H transitions induced at different densities by ECRH exhibit very different reaction of the edge electron temperature and density at the transition. While T_e almost does not respond to the L-H transition, n_e increases abruptly, reflecting a strong transport change. The density increase depends mainly on the neutral gas pressure in the divertor region prior to the L-H transition. In line with the peeling-ballooning theory, the first ELM occurs at a given value of the pedestal pressure. The H-L back-transition following the ECRH turn-off happens at the same pedestal pressure, which is also that at the L-H transition.

The magnetic perturbations (MPs) used to mitigate ELMs also influence the L-H transition. At low density, the MPs do not affect P_thr, while at high density P_thr is 2 times above its usual value. For intermediate densities, the L-H transition is followed by mitigated ELMs and requires only 20% more power than the usual P_thr. The first analysis of edge profiles points towards a reduction of the ion pressure gradient induced by the MPs.

The I-mode emerges gradually from L-mode as power is increased in cases with high P_thr. It is characterized by a pedestal in both T_e and T_i, while the density profile keeps L-mode characteristics. The pedestal development suggests a self-amplification between increasing E_r shearing and turbulence reduction. Plasmas heated by ECRH or NBI at different densities indicate that the ion channel plays a key role in this process. Overall, the formation of a temperature pedestal with increasing power seems to be universal property of divertor tokamak plasmas, generally masked by the transition to H-mode.

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