Pedestal particle transport during the ELM cycle at ASDEX Upgrade

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Edge localized modes (ELMs) appear in plasmas with steep pressure gradients in the edge transport barrier. During an ELM crash the edge pressure profiles relax, while heat and particles are transported into the scrape-off layer (SOL) and to the divertor. Subsequently, the recovery of the edge profiles of electron density \((n_e)\), electron temperature \((T_e)\) and ion temperature \((T_i)\) occurs on well separated time scales which have different durations \([1,2,3]\). The various phases of the edge pedestal recovery are correlated with distinct signatures in the magnetic signals at the midplane \([2,4]\), changes in divertor conditions \([5]\) and changes in the SOL density at the high field side and the low field side \([6]\).

A prominent feature of the inter-ELM pedestal development is the very fast recovery of the pedestal top \(n_e\) and \(T_i\), which both occur before \(T_e\) recovers. This behaviour has been found to be universal at ASDEX Upgrade, i.e. at different collisionalities \([2]\), for different isotope species \([7]\) and also for different plasma shapes \([8]\). The pedestal density behaviour is a complex interplay of transport and sources. The divertor neutrals and the high field side high density (HFSHD) region \([9,10]\) set the separatrix density. The SOL profiles determine the transparency to neutrals and thus the ionisation source profile inside the separatrix, which influences the gradient. Last but not least instabilities in the pedestal affect particle transport.

In this work, ELM resolved data at the midplane and in the divertor are analysed for an exemplary ELM cycle. It can be shown that the timescales of the changes in the inner divertor, the HFSHD region and the main chamber neutral fluxes do not fit the \(n_e\) recovery. The fast \(n_e\) recovery can be attributed to a reduced particle flux due to the reduced gradient. The particle flux increases again correlated with the appearance of magnetic fluctuations in the pedestal, causing the pedestal top density to saturate and giving rise to an additional particle flux to the divertor.


*See the author list of “Overview of progress in European Medium Sized Tokamaks towards an integrated plasma-edge/wall solution” by H. Meyer et al., to be published in Nuclear Fusion Special issue: Overview and Summary Reports from the 26th Fusion Energy Conference (Kyoto, Japan, 17-22 October 2016).