Inter-ELM Fluctuations and Flows and their evolution when approaching the density limit in ASDEX Upgrade

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High performance regimes (H-mode) are reached through the spontaneous formation of a transport barrier resulting from the shear-flow suppression of turbulence. The steep edge density and temperature gradients allow for large pedestal top temperature and density, thought to be necessary for ITER to achieve its fusion power targets. However these significant gradients drive instabilities such as edge localized modes (ELMs) – which appear as repetitive collapses of the edge pressure profile that may release unacceptable heat loads on the machine walls. Between ELMs, temperature and density profiles build up again on different time scales [1], raising the question of which transport mechanisms determine the profile evolution until the next ELM. Intermittent density fluctuations are observed in this inter-ELM phase, though the overall level in the edge is strongly reduced as expected. In addition to very different level and statistical properties with respect to the L-mode, the fluctuations observed using Doppler reflectometry have also a different dynamics: strong bursts, with filament-like structure, are mainly observed in the pedestal (Eₚ well) at medium to high density, often linked to radiation bursts later in the SOL and divertor. These fluctuation bursts can also be grouped in regular trains, with an apparent amplitude oscillation in a frequency range of quasi-coherent modes detected by reflectometry, similarly to what is observed in I mode [2]. The role of these fluctuations in profile recovery and clamping between ELMs will be discussed, as well as their origin as solitary structures. When the density is further increased, typically when the H-mode degrades and the ELM regime changes from a pure type I ELM to mixed type I and type III (or small ELMs) [3], the overall fluctuation level increases, keeps a strongly intermittent character in the confined plasma while the SOL becomes L-mode like. The role of these fluctuations in setting sufficiently less steep gradients to avoid large ELMs will be discussed.

*See H. Meyer et al., Nuclear Fusion FEC 2016 Special Issue (2017)