Overview of small ELM studies on AUG and TCV

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In medium sized Tokamaks like AUG and TCV it is not possible to achieve ITER relevant pedestal and separatrix conditions simultaneously. At the pedestal top future fusion devices will have a very low collisionality $\nu^*_{\mathrm{e,pedtop}} \propto n_\mathrm{e}/T_\mathrm{e}^2 \sim 0.06$, due to the expected high temperature. For efficient power exhaust the collisionality at the very edge should be high, $\nu^*_{\mathrm{e,sep}} \sim 12$, due to the expected high separatrix density [1].

While discharges matching the ITER pedestal top collisionality coincide with unbearably large type I Edge Localized Modes (ELMs) [2] (without magnetic perturbations), experiments with high separatrix collisionalities in ASDEX Upgrade [3], TCV [4] and EAST [5], exhibit small ELMs. To keep good confinement these plasmas need to be highly shaped, i.e. high triangularity, high elongation and close to double null.

In the experiment, large type-I ELMs and small ELMs can coexist. Therefore in addition to the peeling-balloning model that is used to explain type I ELMs, small ELMs have been described by a ballooning model, as they are located close to the separatrix, driven by the pressure gradient and stabilized by magnetic shear [6]. This work will further explore this shear dependence with ideal ballooning stability analyses using HELENA [7] and discuss the importance of diamagnetic stabilisation using non linear calculations from the JOREK [8] code. Additionaly the newest experimental results of the small ELM research performed at AUG and TCV will be shown. This will include scans of different plasma shapes to influence the magnetic and the $E \times B$ shear as well as filament studies with focus on size and frequency and their influence on the target heat flux. The manifestation of the small ELMs at ITER-like separatrix conditions as filamentary transport rather than large bursts offers a possible route to tolerable heat loads at high pedestal top pressure in future fusion devices. Finally first results of discharges showing a plasma startup directly into a small ELM regime, completely avoiding type I ELMs, will further display the practicality of the small ELM scenario.

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