An in depth look into the physics of ELM triggering via vertical kicks through non-linear MHD simulations

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Triggering of ELMs via vertical plasma position oscillations was first reported in the TCV tokamak. These vertical oscillations often called "vertical kicks" were used for ELM frequency control in the type-I ELM regime in ASDEX Upgrade and are routinely used for ELM control at JET [1]. The conjectured mechanism destabilizing ELMs during the vertical motion was an increase in the edge current pushing the pedestal to the peeling-ballooning unstable region.

In order to clarify the physics basis behind this ELM control approach and its potential for application in ITER, we make use of the non-linear MHD code suite JOREK-STARWALL. We have simulated for the first time the processes of vertical plasma movement and ELM destabilization in an integrated and self-consistent form. Our simulations show that initially stable plasmas are destabilized by the application of a vertical motion, where the unstable modes present a peeling-ballooning structure in the linear phase. Plasmas with lower pedestal currents require larger vertical displacements to trigger ELMs, which confirms the hypothesis of the increased edge current as the ELM triggering mechanism. The origin of the current induced during the vertical motion is also analysed, revealing that it arises from the compression of the plasma cross section due to its motion through an up/down asymmetric magnetic field. In the case of single null plasmas compression occurs when the plasma moves vertically towards the X-point, with the velocity of the movement playing only a minor role. The presentation will describe modelling of JOREK-STARWALL of ELM triggering with vertical “kicks” for JET-C plasmas [1], comparing quantitatively code predictions with experimental results, and its application to triggering of ELMs in ITER 7.5MA/2.65T plasmas.

[1] De la Luna, E., et al. "Understanding the physics of ELM pacing via vertical kicks in JET in view of ITER." *Nuclear Fusion* 56.2 (2015): 026001.

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