Plasma boundary shape control to regulate ELMs

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The pedestal plays a crucial role determining the confinement in a tokamak plasma. Consequently, a fusion reactor should have as high pedestal pressure as possible. However, the ELMs triggered by the instabilities cause peak heat fluence on the divertor that scales with the pedestal pressure [1]. In a burning plasma this will exceed the material limits. One operating regime, called quasi-continuous exhaust (QCE) operates with high pedestals but without large ELMs. It is characterised by having the foot of the pedestal being limited by ideal ballooning modes that keeps the plasma from reaching the ELM triggering peeling-ballooning modes.

This work demonstrates a novel method of modifying the plasma boundary shape to achieve the stability conditions required for the QCE, namely making the foot of the pedestal ballooning mode unstable while not affecting the peeling-ballooning mode stability. We show the modelling result for JET and MAST-U like plasma profiles and show how the actual shaping for the required perturbation to the plasma shape could be produced in the STEP tokamak fusion reactor using external poloidal coils.

[1] T. Eich et al. Nucl. Mat. and Energy, 12 (2017) 84