Peeling-Ballooning Stability of RMP Discharges

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The peeling-ballooning model posits that intermediate wavelength (n~3-30) MHD modes driven by the sharp pressure gradient and resulting large current in the pedestal region constrain the pedestal height and drive ELMs. Numerous peeling-ballooning stability studies of various types of H-Mode plasmas on multiple devices suggest that, in general, the plasma is stable to peeling-ballooning modes during the inter-ELM phase, and becomes unstable near the onset of standard (Type I) ELMs [eg 1-4]. However, certain types of edge oscillations, such as Type III ELMs and the quasi-coherent mode, appear to be resisitive modes which exist below the peeling-ballooning threshold.

In resonant magnetic perturbation (RMP) discharges, ELMs are suppressed via increased particle transport associated with the imposition of non-axisymmetric magnetic fields. Initial peeling-ballooning stability studies of these discharges find that, in the resonant phase where ELMs are suppressed, the pedestal remains in the peeling-ballooning stable region [3,4]. When the RMP is turned off and Type I ELMs return, the discharge becomes unstable to peeling-ballooning modes around the time of ELM onset, as expected. Here we present extensive stability analysis of a number of such discharges, exploring the impact of shape, density and q-profile.

An additional issue is the physics mechanism for small ELM-like events that can exist when the magnetic perturbation is present but is non-resonant. In this case, significant measurement uncertainties and small changes in the equilibria make analysis challenging. We approach this issue both via direct stability analysis, and via a statistical comparison with the EPED1 pedestal height model, which provides an indication of whether a set of profiles are systematically below the expected peeling-ballooning constained pedestal height.

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