Impact of plasma response on RMP ELM suppression in DIII-D

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Several DIII-D discharges with different resonant and non-resonant responses show that those with stronger kink-response, a flux surface corrugation which is driven by amplification of non-resonant components of the resonant magnetic perturbation (RMP) spectrum, are closer to the peeling-ballooning stability limit and eventually cross into the unstable region, causing edge localized modes (ELMs) to reappear. Simulations of the magnetic topology for all cases are compared. The topology consists of a kinetic equilibrium reconstruction, the RMP fields and a linear plasma response, calculated by resistive, 2-fluid MHD. It is found that the kink response is correlated to the edge current density as can be seen in Figs.1(a,b). Cases with small (blue lines), medium (green lines) and large (red lines) edge current density show small, medium and large kink displacements respectively. The findings will be cross-checked against modelled 3-D ideal MHD equilibria, using VMEC.

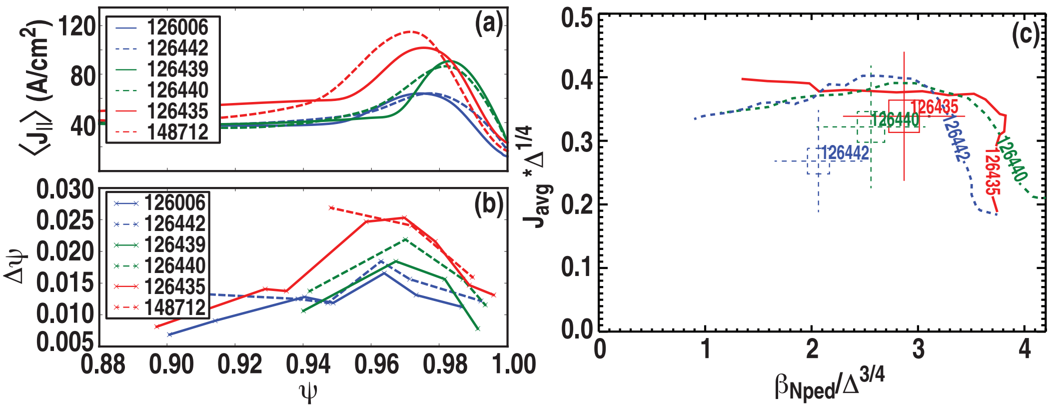

Figure 1: *(a) Parallel current density at the edge for various discharges. (b) Kink displacement, as difference of maximum and minimum normalized flux of corrugated surface. (c) Peeling-ballooning-stability simulations.*

On the other hand, screening/amplification of resonant field components is related to flows; high flows lead to increased screening in the simulations, although the islands rarely heal completely. It is found that the magnetic topology of discharges with low edge current density is dominated by islands, even with screening. With increasing edge current density the edge topology transitions from such an island dominated structure to a kink dominated structure where islands are forced to follow the corrugated surface structure. A correlation between the kink-response and the reappearance of ELMs in the presence of RMPs is found. As shown in Fig.1(c), kink dominated discharges (red lines) are much closer to the stability boundary in peeling-ballooning-stability simulations then island dominated discharges (blue lines), which are well inside the stability limit. Experimental observations are in agreement with the simulations that in the red cases ELMs are only mitigated and eventually return, while in the blue cases ELMs are fully suppressed by the applied RMP. Work supported by the US Department of Energy under DE-AC05-00OR22725, DE-FC02-04ER54698 and DE-FG02-95ER54309.