Advances in the Physics Understanding of ELM Suppression Using Resonant Magnetic Perturbations in DIII-D

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Abstract. Recent experiments on DIII-D have increased confidence in the ability to suppress edge localized modes (ELMs) using edge-resonant magnetic perturbations (RMPs) in ITER, including an improved physics basis for the edge response to RMPs as well as expansion of RMP ELM suppression to more ITER-like conditions. Complete ELM suppression has been achieved utilizing n=3 RMPs in the ITER baseline scenario. In addition, RMP ELM suppression has been expanded to include plasmas with helium concentrations near 25% and the use of n=2 RMPs. Analysis of the kinetic profile response suggests that ELM suppression is correlated with the co-alignment of the $\omega_{\perp e} = 0$ location, an n=3 rational surface, and the top of the pedestal. Modelling predicts that such a co-alignment could potentially lead to island (or island chain) formation just inside the top of the pedestal, inhibiting the growth of the pedestal and thereby maintaining the ELM-free state. Detailed analysis of data obtained during toroidal phase variations of the applied n=3 RMPs have provided further evidence of an island-like structure at the top of the pedestal. In addition, nearly matched discharges with co-neutral-beam-injection (co-NBI) and counter-NBI have demonstrated the importance of the presence of the $\omega_{\perp e} = 0$ location for ELM suppression. In the counter-NBI cases, the toroidal rotation profile is such that there is no $\omega_{\perp e} = 0$ location and ELMs are not suppressed in conditions in which ELM suppression is generally observed with co-NBI.

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