DPP20-2020-000175

Abstract for an Invited Paper
for the DPP20 Meeting of
the American Physical Society

Predicting operational windows of ELMs suppression by Resonant Magnetic Perturbations in the DIII-D and KSTAR tokamaks.[1]

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A newly developed plasma response model, combining the nonlinear two-fluid MHD code TM1 and toroidal ideal MHD code GPEC, quantitatively predicts the narrow isolated q_{95} windows ($\Delta q_{95} \approx 0.1$) of ELM suppression by $n = 1$, 2 and 3 resonant magnetic perturbations (RMPs) in both DIII-D and KSTAR tokamaks across a wide range of plasma parameters. The key physics that unites both experimental observations and our simulations is the close alignment of key resonant q-surfaces and the location of the top of the pedestal prior to an ELM. This alignment permits an applied RMP to produce field penetration rather than being screened due to the lower **E**x**B** rotation at the pedestal top. The model successfully predicts that narrow magnetic islands form when resonant field penetration occurs at the top of pedestal, and these islands are easily screened when q_{95} moves off resonance, leading to very narrow windows of ELM suppression (typically $\Delta q_{95} \approx 0.1$). Furthermore, the observed reduction in the pedestal height is also well captured by the calculated collisional transport across the island. We recover the q_{95}, β_{N} and plasma shape dependence of ELM suppression due to the effect of magnetic islands on pedestal transport and Peeling-Ballooning-Mode (PBM) stability. Importantly, experiments do occasionally observe wide windows of ELM suppression ($\Delta q_{95} \geq 0.5$). Our model reveals that at low density multiple islands open at the pedestal top, leading to wide operational windows of ELM suppression consistent with experiment. The model indicates that wide q_{95} windows of ELM suppression can be achieved at substantially higher pedestal pressure with less confinement degradation in DIII-D by operating at higher toroidal mode number ($n = 4$) RMPs. This can have significant implications for the operation of the ITER ELM control coils for maintaining high confinement during ELM suppression.

[1]Work supported by US DOE contracts DE-FC02-04ER54698 and DE-AC02-09CH11466.