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Validation of the Model for ELM Suppression with 3D Magnetic Fields Using Low Torque ITER Baseline Scenario Discharges in DIII-D[1]

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Suppression of Edge Localized Modes (ELMs) is lost in ITER Baseline Scenario discharges when the torque T_{inj} and toroidal rotation ν_ϕ are reduced. This is due to a shift in the tearing response deeper into the plasma. ELM suppression is recovered by reducing the normalized plasma pressure β_N. In H-mode plasmas, edge turbulence is suppressed in a pedestal region, leading to large pressure gradients that trigger MHD instabilities (ELMs), causing rapid heat expulsion. 3D magnetic fields are used to drive resonances that limit the pedestal width preventing the ELM. Reducing T_{inj} changes the ν_ϕ profile such that the drive shifts to a resonance deeper in the plasma, allowing the pedestal to grow again to MHD instability. Reducing β_N reduces the edge pressure, which reduces the electron diamagnetic flow and moves the drive to a resonance that is closer to the boundary, recovering suppression. In two-fluid theory, the tearing response occurs at a resonant surface where the electron perpendicular rotation $\omega_(\perp e) \sim 0$. Linear two-fluid resistive MHD simulations show that the tearing response shifts to a resonance deeper in the plasma when T_{inj} is reduced. The experimental results confirm that the tearing response occurs for a resonance where $\omega_(\perp e) \sim 0$, and suggest that the transport which limits the pedestal width is linked to the tearing response, even if any islands are predicted to be small. Although this model describes the differences between ELMing and ELM suppressed H-modes, it doesnt address the transition from ELMs to suppression, because $\omega_(\perp e) \sim 0$ is initially too deep ($\psi_N \leq$0.9, q=3) for the tearing response to limit the pedestal width. Although understanding this transition is important, ITER must apply the RMP in L-mode to avoid the first ELM. These results suggest that manipulation of the edge rotation profile will be important to optimize ELM suppression in future tokamaks.

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