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Prospects for ELM Control at Lower Pedestal Collisionality with an Edge Resonant Magnetic Perturbation in DIII-D

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An edge resonant magnetic perturbation has been used in DIII-D to mitigate large edge localized mode (ELM) impulses for periods as long as 9 τ_E in discharges with moderate to high pedestal collisionality $0.38 < \nu^* < 0.85$. Since large Type I ELMs are a critical issue for next step devices due to the impulsive power loading to the divertor targets that is predicted to significantly reduce the target plate lifetime, it is desireable to extend these ELM control results to the lower pedestal collisionality where ITER is expected to operate. In DIII-D, the primary mechanism for reducing the large Type I ELMs at high ν^* is enhancement of radial transport by destabilization of Type II ELMs and/or other electromagnetic fluctuations in the pedestal. This enhanced radial transport is less impulsive than the Type I ELMs, and slows the recovery of the pedestal total pressure gradient to its critical value for Type I ELMs. The best ELM suppression is obtained for discharges with the highest pedestal densities and collisionalities $0.6 < \nu^* < 0.85$, a result that is inconsistent with expectations for an edge stochastic layer. However, similar radial transport enhancement due to small scale events or Type II ELMs still occurs in discharges with lower collisionality $\nu^* \approx 0.4$ and less effective ELM suppression. This result suggests that further optimization of the applied perturbation in lower pedestal collisionality plasmas may significantly improve the ELM mitigation. In this paper, we summarize the effects on Type I and II ELMs obtained for different discharge shapes, collisionalites, and applied magnetic perturbations, and discuss possible approaches to improving the ELM mitigation at pedestal collisionalities closer to those expected in ITER.

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