Physics of the Boundary Plasma During ELM Control with Resonant Magnetic Perturbations in ITER Similar Shaped Plasmas on DIII-D*

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Suppression of large Type-I edge localized modes (ELMs) by n=3 resonant magnetic perturbations (RMPs) from an internal coil (I-coil) was extended to ITER similar shape (ISS) plasmas at the ITER pedestal collisionality, $\nu_e^* \sim 0.1$, providing data to guide ITER RMP coil design decisions. The maximum observed ELM size was correlated with several ordering parameters including the pedestal beta and the width of the edge region where there is strong overlap of the magnetic islands (vacuum field calculations). Field line tracing showed differences in the fraction of pedestal field lines with short connection length to the targets between strong RMP cases with ELM suppression and ELMing cases with weak RMP. Complete ELM suppression was achieved in a narrower q_{95} operating window and required ~20% greater I-coil current than for comparable plasmas with lower δ shapes, but a substantial reduction of the energy loss per ELM was seen over a wider q_{95} operating window with higher frequenxy ELMs. In ELM-suppressed plasmas, peeling-ballooning stability analysis showed that the pedestal operating point was in the stable region near the peeling unstable boundary, consistent with previous low ν_e^* results at low δ. The applied RMP reduced the pedestal pressure gradient ∇p^{TOT} to achieve edge stability. The plasma response to pellet injection confirmed that effective pedestal particle confinement is reduced ~2x during ELM suppression. Core and pedestal impurities did not increase during ELM suppression in the ISS plasmas. The resonance window in q_{95} for ELM suppression was expanded either by increase of the n=3 RMP strength or by adding n=1 perturbations in combination with sufficient n=3 RMP. ELM size reduction was seen with n=1 perturbations alone and with a combination of n=2 and n=4 modes in the perturbation spectrum.

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