Edge Stability Analysis for I-Coil ELM Suppressed Discharges on DIII-D*

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An internal coil system, the I-Coil, configured to produce a small n=3 magnetic perturbation resonant in the plasma edge region, was used successfully to suppress Type I edge localized modes (ELMs) without significantly reducing core energy confinement over a wide range of H-mode pedestal collisionalities on DIII-D [T.E. Evans, et al., Phys. Rev. Lett. (2004); R.A. Moyer et al., Phys. Plasmas (2005)]. At high collisionality, $\nu_e^* \sim 1$, where the H-mode phase without the I-coil was a mixture of Type I and small, possibly Type II, ELMs, the edge pressure gradient and current density were found either to evolve more slowly to the peeling/ballooning limit resulting in a Type I ELM, or to be maintained below the stability limit resulting in a discharge free of Type I ELMs. During the I-Coil phase the Type II ELMs in these discharges appeared to be enhanced in their effects and depth and thus these small ELMs may play a role in the delay or elimination of large Type I ELMs. At low collisionality, $\nu_e^* \sim 0.1$, Type II ELMs were not present and Type I ELMs were completely eliminated when the edge resonant magnetic perturbation was applied. It should be noted that the effectiveness of the I-coil in producing edge resonant magnetic perturbations was improved significantly by optimizing the poloidal phasing in the low collisionality experiments. The low collisionality ELM suppressed discharges were similar to the QH-mode in that the plasma density and impurity content do not increase as it would for ordinary ELM-free H-mode. However in contrast to QH-mode no edge harmonic oscillations, or any other magnetic fluctuations are observed. (See R.A. Moyer presentation at this conference for details on fluctuations in ELM suppressed discharges.) A range of pedestal pressures were produced by varying the I-coil current and plasma heating power at low collisionality, principally through effects on the pedestal density. Stability analysis in these cases indicates that the plasma edge was near the peeling mode limit but at pressure gradients below the intermediate n ballooning mode limit. With the I-coil off in low collisionality discharges, the pressure gradient rises to the ballooning limit and large Type I ELMs were observed.

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