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EX/3-1: Advances in the Physics Understanding of ELM Suppression Using Resonant Magnetic Perturbations in DIII-D

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Recent experiments on DIII-D have increased confidence in the ability to suppress edge localized modes (ELMs) using edge-resonant magnetic perturbations (RMPs) in ITER, including an improved physics basis of the edge response to RMPs as well as expansion of RMP ELM suppression to more ITER-like conditions. Experiments aimed at an improved physics understanding have revealed a complex plasma response in the edge region that combines aspects of ideal MHD, vacuum field penetration, and direct turbulent response to the applied RMP. New observations include RMP-induced helical displacements near the separatrix that increase with q_{95} , a displacement inversion layer in the edge temperature profile response when a rational surface associated with the largest applied RMP poloidal harmonics ($m=10-12$, $n=3$ or $m=9-11$, $n=2$) is located near the pedestal top, and nearly instantaneous changes in density fluctuations throughout the pedestal region to $n=3$ RMP amplitude variations. This complex response results in transport modifications near the q_{95} window for edge localized mode (ELM) suppression that result in $\sim 30\%$ narrower pedestal width than observed without the RMP applied. These experiments have taken advantage of DIII-D's unique capability to vary the RMP spectrum ($n=3$ from one or two internal coils, $n=2$) as well as toroidal phase variations of $n=3$ and $n=2$ RMPs for enhanced diagnostic fidelity, all done at the pedestal collisionality levels expected in ITER. In addition, RMP ELM suppression has been expanded to include the use of $n=2$ RMPs and has been robustly obtained in the ITER baseline scenario ($q_{95}=3.1$) using a single-row $n=3$ RMP.

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