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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 q95, 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 ~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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Country or International Organization of Primary Author

USA

Primary author: Mr WADE, Mickey R. (USA)

Presenter: Mr WADE, Mickey R. (USA)

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