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Suppression of Type-I ELMs with a Reduced I-coil Set in DIII-D[1]

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Recent experiments in DIII-D have demonstrated that Edge Localized Modes (ELMs) in a tokamak can be controlled with a reduced number of magnetic perturbation coils, demonstrating an important role of spectral sidebands, and showing promise of the technique for future fusion devices, where ELMs risk potentially damaging heat loads. The ELMs can be controlled with external magnetic perturbation used to regulate pressure gradients and maintain stability. The new results show that the coil currents required for ELM suppression with the reduced coil sets are comparable to what is typically required for the full set. This counterintuitive result provides an important validation of recent modeling [1,2] of the physical mechanisms involved. This modeling shows that the spectral sidebands introduced by deactivating individual coils can often increase the magnetic stochasticity within the plasma, thereby increasing transport and facilitating ELM suppression. Deactivating individual coils results not only in the reduction of the dominant n=3 component of the perturbation field, but also in a significant increase in the amplitudes of n=1 and n=2 sidebands. These sidebands may also be amplified by the plasma response. Application to ITER finds that the ITER ELM coils may be able to tolerate a loss of up to five of its 27 coils, while leaving a sufficient margin of current in the remaining coils to still meet the DIII-D ELM suppression criterion. Further, the new experiments show that the presence of the spectral sidebands does not adversely affect the plasma rotation or confinement. Both vacuum and two-fluid modeling are used to interpret and understand these results.

[1] D.M. Orlov, et al., Fusion Eng. Design **87**, 1536 (2012).
[2] T.E. Evans, et al., Nucl. Fusion **53** (2013) accepted for publication.

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