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Configurational Effects of Magnetic Perturbation on Edge and Core MHD in DIII-D

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In this talk we describe how edge (ELMs) and core [neoclassical tearing mode (NTM)] magnetohydrodynamic (MHD) modes are affected (i.e., modified, suppressed or destabilized) using various configurations of magnetic perturbation coils in DIII-D. A variety of non-axisymmetric magnetic perturbations are found in modern high power tokamaks such as DIII-D. These perturbations, which are also expected to be commonplace in future tokamks, include field-errors due to multimillimeter and centimeter shifts or tilts of individual poloidal and toroidal coils, millimeter scale random shifts in all the equilibrium coils (i.e., random ensemble effects) with individual perturbation levels lying below the resolution of practical measurements, and perturbations from relatively low current non-axisymmetric coil sets designed to correct field-errors (i.e., DIII-D Correction or C-coil) or to control internal plasma instabilities such as resistive wall modes (i.e., DIII-D Internal or I-coil). Each of these produce resonant toroidal and poloidal mode spectra with resonances on rational surfaces in the core ($q \leq 3$) and boundary ($q > 3$) regions. The extent to which each of these perturbations produces islands and stochastic layers depends on its resonant mode spectrum its distance from the various resonant surfaces, the shear in the q profile near each resonant surface and the shape of the flux surfaces. Recent experiments in DIII-D have demonstrated that edge localized modes (ELMs) are particularly sensitive to edge magnetic perturbations [1]. Thus, developing a broader understanding of the interplay between these magnetic perturbations and the behavior of the ELMs at high power (low collisionality) plasma is essential for predicting both the core performance and the lifetime of plasma facing components in future fusion devices.

Experiments using the C-coil demonstrate that the ELM frequency and radial penetration depth is changed in some parameter regimes but relatively unaffected in others. Experiments using the I-coil in a toroidal mode number n=3 configuration show a wide range of ELM suppression/modification and pedestal effects depending on the poloidal mode spectrum and alignment with intrinsic errors. These results will be discussed within the context of what may be expected in future tokamaks with similar types of magnetic perturbations.

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