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Effect of Resonant Magnetic Perturbations on 3D equilibria in the MST RFP

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The orientation of 3D, stellarator-like equilibria in the MST RFP can now be controlled with application of an m = 1 RMP. This has led to greatly improved diagnosis, revealing enhancements in both the central electron temperature and density. Coupled to a recent advance in the V3FIT code, reconstructions of the 3D equilibria have also been dramatically improved. The RMP also inhibits the generation of high-energy >20 keV electrons that is otherwise common with the 3D state. This state occurs when the normally broad spectrum of core-resonant m = 1 tearing modes condenses, with the innermost resonant mode growing to large amplitude, reaching $\sim$ 8% of the axisymmetric field strength. This occurs in plasmas of sufficiently large Lundquist number $\sim I_p {T_e}^{3/2}$, and the duration of the state is maximized with zero applied Bt (infinite toroidal beta). As the dominant mode grows, eddy current in MST's conducting shell slows the mode's rotation. This leads to locking of the 3D structure, but with an orientation that varies randomly shot to shot, making diagnosis difficult. An m = 1 RMP can now be applied with an array of saddle coils at the vertical insulated cut in the shell. With an amplitude br/B $\sim$ 10% and a tailored temporal waveform, the RMP can force the 3D structure into any desired orientation relative to MST's diagnostics. A recent advance in V3FIT allows calculation of the substantial helical image current flowing in MST's shell, which has in turn allowed self-consistent utilization of both external and internal (Faraday rotation) measurements of the magnetic field. The ORBIT code predicts reduced stochasticity and improved confinement of high-energy electrons within the 3D structure. The suppression of these electrons by the m = 1 RMP may reflect a change to the central magnetic topology. The generation of these electrons is unaffected by non-resonant perturbations, such as m = 3. Supported by the US DOE.