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Control of Neoclassical Tearing Modes in DIII-D[1]

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The development of techniques for NTM suppression or avoidance is crucial for successful high beta/high confinement tokamaks. Neoclassical tearing modes are islands destabilized and maintained by a helically perturbed bootstrap current and represent a significant limit to performance at higher poloidal beta.[2] The confinement-degrading islands can be reduced or completely suppressed by precisely replacing the "missing" bootstrap current in the island O-point as first demonstrated in the Asdex Upgrade tokamak[3] or by interfering with the fundamental helical harmonic of the pressure.[4] Implementation of such techniques is being studied in the DIII-D tokamak in the presence of periodic q=1 sawtooth instabilities, a reactor relevant regime. Radially localized off-axis electron cyclotron current drive (ECCD) must be precisely located on the island. In DIII-D the plasma control system is put into a "search and suppress" mode to make either small rigid radial position shifts of the entire plasma (and thus the island) or small changes in toroidal field (and thus, ECCD location) to find and lock onto the optimum position for complete island suppression by ECCD. This is based on real-time measurements of mode amplitude. This experiment represents the first use of active feedback control to provide continuous, precise positioning. An alternative to ECCD makes use of the six toroidal section "C-Coil" on DIII-D to provide a large non-resonant static m=1, n=3 helical field to interfere with the fundamental harmonic of an m/n = 3/2 NTM as suggested in Ref. 3. While experiments show success in inhibiting the NTM if a large enough n=3 field is applied before the island onset, there is a considerable undesirable plasma rotation decrease due to n=3 "ripple".

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[2]O. Sauter et al., Phys. Plasmas **4**, 1654 (1997).
[3]G. Gantenbein et al., Phys. Rev. Lett. **85**, 1242 (2000).
[4]Q. Yu et al., Phys. Rev. Lett. **85**, 2949 (2000).