MSE Measurements of NTM Structure and Suppression With ECCD*

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Neoclassical tearing modes (NTMs) are magnetic islands that grow owing to a helical deficit in the bootstrap current that is resonant with the spatial structure of the local magnetic field. The local NTM structure has been examined on the DIII-D tokamak using direct analysis of motional Stark effect (MSE) signals by analytic methods that are not dependent upon (or even require) an accurate equilibrium reconstruction.[1] For plasmas with a rapidly rotating m/n=3/2 NTM, an axisymmetric analysis of the MSE signals yields the first explicit measurement of the "missing" equilibrium bootstrap current around the island location at q=1.5. The most dramatic case occurs when the m/n=3/2 tearing mode frequency locks to the m/n=2/1 tearing mode, resulting in a complete flattening of the pressure profile and a total loss of the pressure-driven current density between the two islands. The local helical perturbations of the MSE signals also have been analyzed for quasi-rotating tearing modes to determine the helically perturbed current density for comparison with MHD codes. When the m/n=2/1 NTM is suppressed using electron cyclotron current drive (ECCD), the measured changes in the total current density that restore the missing bootstrap current at the q=2 surface are found directly from MSE measurements. Utilizing ECCD suppression of the m/n=2/1 NTM with feedback control of the current drive location, the normalized beta of long pulse H-mode discharges has been raised above the no-wall stability limit.

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