Measurements of the Edge Magnetic Field in DIII-D Plasmas Using a Motional Stark Effect Polarimeter

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In the DIII-D tokamak, accurate reconstructions of the internal magnetic field rely on measurements from a motional Stark effect (MSE) polarimeter [1]. The present system provides magnetic field pitch angle measurements from the high field side of the magnetic axis to the plasma edge. Recent MSE constrained reconstructions of the minimum safety factor using the EFIT code show excellent agreement with the onset of reversed-shear Alfvén eigenmodes bolstering the high level confidence in the core MSE measurement established by previous efforts. Compared to accurate the core, useful MSE measurements in the pedestal must be considerably more precise and due to the more subtle variation in the edge magnetic field, the presence of a strong electric field in discharges where pedestal measurements are relevant, and to the complex Stark-split deuterium alpha spectrum in the plasma edge. It is also important to differentiate magnetic field measurements, which MSE provides, from a direct measurement of the plasma current, which is the ultimate parameter of interest. Recent hardware modifications to the edge MSE system and new diagnostic capabilities have been implemented with a focus on improving the precision of the pedestal MSE measurement, and addressing systematic measurement errors, in particular a previously unappreciated dependence of the inferred MSE pitch angle on the mix of detected Stark states. The various implications of and reasons for this dependence are discussed. To increase the precision of the wavelength calibration and the polarization fraction of the detected deuterium alpha emission, temperature-controlled, narrow (~0.15 nm) bandpass filters were installed on nine edge MSE channels leading to a strong reduction in previously unexplained channel-to-channel offsets, and increased agreement in the measured vertical field between the edge system and other MSE arrays. The accuracy of the wavelength calibration was assessed using a new high-resolution spectrometer system. Detailed analysis of equilibrium reconstructions using edge MSE measurements will be presented.

1. C.T. Holcomb, et al., Rev. Sci. Instrum. **79** (2008) 10F518 and references therein

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