THE IMPORTANCE OF THE RADIAL ELECTRIC FIELD ON INTERPRETATION OF MOTIONAL STARK EFFECT MEASUREMENTS OF THE q PROFILE IN DIII–D HIGH-PERFORMANCE PLASMAS*

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In many advanced confinement regimes in tokamaks, such as negative central magnetic shear (NCS) and VH–mode, shear in the **E**×**B** flow plays a key role in suppressing microturbulence, yielding near-neoclassical ion thermal transport. The large values of radial electric field (E_r) observed in these plasmas–up to 200 kV/m also have an effect on the interpretation of motional Stark effect (MSE) measurements of the poloidal field and subsequent equilibrium reconstructions.

The presence of E_r in toroidal plasmas is a consequence of radial force balance and is given by $E_r = (Z_i e n_i)^{-1} \nabla_r p_i - \upsilon_{\theta i} B_\phi + \upsilon_{\phi i} B_\theta$, where Z_i is the ion species charge, n_i the ion density, p_i the ion pressure, and $\upsilon_{\theta i}$ and $\upsilon_{\phi i}$ the poloidal and toroidal rotation velocities, respectively. On DIII–D, with tangential beam injection in the co-current direction, the toroidal velocity term tends to dominate E_r in the plasma core. The pressure gradient term can dominate at the edge, especially in H–mode discharges. Currently, all of the terms on the right-hand side of the E_r equation are determined using CER spectroscopy measurements along with the equilibrium reconstruction. In plasmas with reduced transport in DIII–D, the **E**×**B** shearing rate exceeds the linear growth rate of turbulent modes, consistent with stabilization of turbulence by sheared **E**×**B** flow.

Including E_r in the MSE analysis becomes important when E_r is comparable to the motional term $\boldsymbol{\upsilon_b} \times \boldsymbol{B}_\theta$, where $\boldsymbol{\upsilon_b}$ is the neutral beam particle velocity and $\boldsymbol{B}_\theta$ is the poloidal field. This condition exits in most high-performance plasmas with large neutral beam injected power. The effect of E_r on the MSE measurements has been verified on DIII–D in many high-performance discharges. When E_r is neglected in the MSE analysis, equilibrium reconstructions are not simultaneously consistent with both the internal MSE data and external magnetic probe measurements; when E_r is included, the discrepancies are reduced to levels consistent with statistical uncertainties in the measurements.

Given the sensitivity of the MSE measurement to E_r, this provides an opportunity to measure E_r directly. On DIII–D, additional MSE channels have recently been added viewing along new radial sightlines to help separate the motional electric field ($\boldsymbol{\upsilon_b} \times \boldsymbol{B}_\theta$) from the background plasma E_r. field. Fitting of the E_r profile is being added to the equilibrium code EFIT, so that q(r) and E_r profiles will be available simultaneously between discharges. An overview of the upgraded MSE system along with initial measurement results will be presented.

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