Active Spectroscopic Measurements of the Bulk Deuterium Properties on the DIII-D Tokamak

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Neutral-beam induced D-alpha emission spectrum contains a wealth of local plasma parameters; deuterium ion temperature, toroidal rotation and density contained in the thermal Gaussian, beam emission intensity, beam neutral density and magnetic field strength |B| contained in the Stark split beam emission, and fast-ion emission (FIDA) proportional to injected fast-ion density. An integrated fit model that accounts for each emission process individually, and the sum of the overlapping spectral features self-consistently, is being used to analyze wavelength resolved active D-alpha emission on the DIII-D tokamak. Interpretation of the spectral features is assisted by a fully three-dimensional Monte-Carlo atomic code FIDAsim [1], which produces predicted spectral features by time-dependent collisional-radiative modeling. Accurate thermal deuterium toroidal velocity measurements are determined by both atomic modeling, and a unique viewing configuration of co-current and counter-current injected neutral beams [2]. The two methods are in qualitative and quantitative agreement to the sign and magnitude of the atomic physics corrections to charge-exchange measurements. Contributions from halo neutrals to the total thermal charge-exchange emission are independently measured by sightlines adjacent to the neutral beam, and halo emission intensities display agreement with modeling of halo generation and neutral diffusion in a range of plasma conditions. Comparisons between modeling and measurements of beam neutral, thermal charge exchange, and fast ion charge exchange emission intensities will be displayed. Measurements of the bulk plasma temperature, density and toroidal rotation in deuterium plasmas will be presented which have enabled comparisons to the more commonly measured impurity ions.

[1] W.W. Heidbrink, et al., Commun. Comput. Phys. **10** (3) 2011
[2] W.M. Solomon, et al., Rev. Sci. Instrum. **79** 10F531 2008

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