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4.51 Ultra Fast Charge Exchange Recombination Spectroscopy Detector Upgrade for Ion Turbulence Measurements

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A new actively cooled detector array and several recently implemented optimizations for the Ultra Fast Charge Exchange Recombination Spectroscopy (UF-CHERS) diagnostic on DIII-D have resulted in improved sensitivity to ion fluctuations. UF-CHERS measures carbon ion temperature (T_i) and toroidal velocity (v_θ) fluctuations associated with long-wavelength turbulence and other plasma instabilities by observing the charge exchange (CX) reaction between injected Deuterium neutrals and intrinsic Carbon impurity with 1 μ s time resolution and \sim 1 cm radial resolution. The upgrades resulted in a two-fold increase in signal levels and improved distinction between active CX and background emissions compared to a previous higher noise detector array, especially at the spectral line's edge, which are critical for curve fitting with sparse wavelength bins (8 bins/channel). T_i and v_θ fluctuations up to \sim 230 kHz have been measured with the new array. The cross-phase of Carbon density and temperature ($\ln C \times T_i$) associated with the Edge Harmonic Oscillations (EHO) in QH-mode, important to understanding increased energy confinement while allowing particle transport, were also measured. This work was supported by U.S. DOE grants DE-FG02-08ER54999, DE-FC02-04ER54698, and NSF GRFP grant DGE-1256259.

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