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3.3 Active spectroscopy measurements of the deuterium temperature, rotation, and density from the core to scrape off layer on the DIII-D tokamak

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Main-ion charge exchange recombination spectroscopy (MICER) [1] uses the neutral beam induced D-alpha spectrum to measure local deuterium (D) temperature, rotation and density, plus neutral-beam parameters. An edge MICER system consisting of 16 densely packed chords was recently installed on DIII-D extending the MICER technique from the core to the pedestal and steep gradient region of H-mode plasmas where the D and commonly measured impurity properties can differ significantly. A combination of iterative collisional radiative modeling techniques and greatly accelerated spectral fitting algorithms allowed the extension of this diagnostic technique to the plasma edge where the steep gradients introduce significant diagnostic challenges. The system was operational for the 2017 DIII-D campaign and acquired data for a wide range of plasma conditions uncovering large temperature differences between D+ and impurities near the separatrix, inwardly shifted C6+ density pedestals, and strong co-Ip D edge rotation. The measurements and analysis demonstrate the state of the art in active spectroscopy and integrated modeling for diagnosing fusion plasmas and the importance of direct D measurements. [1]B. Grierson, RSI, 2012 Work supported by US DOE under DE-FC02-04ER54698 and DE-AC02-09CH11466

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