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High-resolution radial interferometer-polarimeter for magnetic field and density fluctuation measurements in fusion plasmas

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Development of the Radial Interferometer-Polarimeter (RIP) for the DIII-D tokamak is reviewed. RIP adopts the three-wave technique for simultaneous measurement of the line-integrated Faraday effect and electron density [1, 2, 3]. Three radial chords are located at or near the plasma midplane so that the Faraday effect directly provides a measurement of the equilibrium and fluctuating radial magnetic field, quantities that play an important role in plasma transport. 650 GHz solid-state sources and diode mixers are used, enabling fluctuation measurements up to 10 MHz [4]. A correlation technique to improve phase resolution is implemented by using two independent mixers for each chord [5], thereby reducing polarimetric and interferometric noise to ~0.01 Gauss/sqrt(kHz) and ~1x1013 m-3/sqrt(kHz), respectively. RIP has measured rich phenomena in DIII-D plasmas, including but not limited to magnetic field evolution during the sawtooth crash [6], detection of core magnetohydrodynamic modes not seen by external magnetic coils [7], confinement-correlated broadband magnetic fluctuations [8], and energetic particle-driven fluctuations near ion cyclotron frequency [4]. These measurements will serve to better understand and optimize high-performance fusion plasmas.

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