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Abstract

Microwave Imaging Reflectometry (MIR) couples a multi-frequency illumination source to a shaped, 2D array of miniature, quasi-optical substrate lens antennas in order to provide a 2D image of the fluctuating electron density within a confined plasma. The successful implementation of this technique on the DIII-D tokamak is now entering its second year of operation and has obtained a wealth of previously unobtainable data pertaining to coherent modes and broadband turbulence in core and edge regions. The first measurements of 2D Alfvén eigenmode structure using this technique are presented. The poloidally spaced measurements provide the poloidal wavenumber and define a dispersion relationship for a spectrum of modes. This capability is shown to readily distinguish different eigenmodes and branches of instability, even when Doppler shift due to plasma rotation causes the observed frequencies to overlap. Furthermore, direct measurement of the poloidal propagation of unstable eigenmodes allows for comparison to the locally fitted plasma fluid rotation. This technique has been used to understand new measurements of edge harmonic oscillation (EHOs) thought to contribute to the formation of the so-called quiescent high-confinement mode, or QH-mode, on DIII-D. The incidence of diagnostic artifacts in the characterization of these long poloidal wavelengths is being explored in detail with synthetic diagnostic forward modeling techniques and the full-wave reflectometer codes FWR2D and FWR3D, revealing a correlation with non-idealities of mode structure. Planned diagnostic upgrades that will improve the quality of this data and allow for further investigation of ELM suppression and naturally ELM-free operating scenarios are also discussed.