

ECE-Imaging of the H-mode Pedestal

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With 320 spatially resolved channels, a recent extension of the IF bandwidth to beyond 16 GHz (doubling the radial extent of each array), and improved video band performance for the study of turbulence and broadband fluctuations, the dual-array ECEI diagnostic on DIII-D remains the world's foremost instrument of its kind and the pinnacle of imaging heterodyne radiometry. Localized, 2D measurements of electron temperature deep within the fusion plasma core have produced breakthroughs in our understanding of phenomena such as the sawtooth crash and the formation of Alfvén eigenmodes in the presence of fast ions [1,2]. For edge fluctuations, a new method of modeling the emission from spatially inhomogeneous and optically thin plasma accounts for the presence of significant anomalous emission at frequencies below the cold-resonance of the LCFS, reproduces the experimentally observed dependence of this emission on localized perturbations within the pedestal, and reveals that it is rich in information about pedestal pressure, the dynamics of ELMs, the Edge Harmonic Oscillation of QH-mode plasmas, and the physics of ELM suppression by RMP. In particular, the identification of a finite regime between optically thick and weakly relativistic, optically thin emission, where T_{rad} is anti-correlated to temperature fluctuations, demonstrates that the narrow H-mode pedestal has a broad and structured emission spectra that may be diagnosed by heterodyne radiometry. This new understanding of how ECE, spectrally broadened by steep gradients in temperature and density, may be used to diagnose fine scale features, independent of constraints on spatial resolution, represents a significant new diagnostic capability.

- [1] H.K. Park, et al., Phys. Rev. Lett. **92** (2006) 195004.
- [2] B.J. Tobias, et al., Phys. Rev. Lett. **106** (2011) 075003.

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