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1.3 A combined interferometer/phase contrast imaging diagnostic for multiscale fluctuation measurements

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A novel combined diagnostic capable of measuring multiscale density fluctuations that extend from MHD to the lower-ETG range has been designed, installed, and operated at DIII-D. The combined diagnostic was constructed by adding a heterodyne interferometer to the pre-existing phase contrast imaging (PCI) system, both of which measure line-integrated electron-density fluctuations. The port-space footprint is minimized by using a single CO₂ laser and a single beampath. With temporal bandwidths in excess of 1 MHz, the PCI measures high- k ($1.5 \text{ cm}^{-1} < |k_R| < 25 \text{ cm}^{-1}$) fluctuations with sensitivity $3e13 \text{ m}^{-2} / \sqrt{\text{kHz}}$, while the interferometer simultaneously measures low- k ($|k_R| < 5 \text{ cm}^{-1}$) fluctuations with sensitivity $3e14 \text{ m}^{-2} / \sqrt{\text{kHz}}$. The intentional mid- k overlap has been empirically verified with sound-wave calibrations and has allowed quantitative investigation of the cross-scale coupling predicted to be significant in the reactor-relevant $T_e \sim T_i$ regime. Further, via toroidal correlation with DIII-D's primary interferometer, the toroidal mode numbers of core-localized MHD have been measured. *Work supported by USDOE under DE-FG02-94ER54235, DE-FC02-04ER54698, and DE-FC02-99ER54512.

Primary author(s) : DAVIS, Evan (MIT PSFC)

Co-author(s) : ROST, J. Chris (MIT PSFC); PORKOLAB, Miklos (MIT PSFC); MARINONI, Alessandro (MIT PSFC); VAN ZEELAND, Michael (General Atomics)

Presenter(s) : DAVIS, Evan (MIT PSFC); ROST, J. Chris (MIT PSFC); PORKOLAB, Miklos (MIT PSFC); MARINONI, Alessandro (MIT PSFC); VAN ZEELAND, Michael (General Atomics)

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