

Electron Cyclotron Emission Imaging of MHD Activity on the DIII-D, TEXTOR, ASDEX-U, and KSTAR Tokamaks*

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Recently developed electron cyclotron emission imaging (ECEI) diagnostics on DIII-D, ASDEX-U, and TEXTOR have provided unprecedented 2-D time-resolved images (e.g., movies) of MHD modes present in tokamak plasmas, proving to be uniquely capable of characterizing phenomena over a broad range of plasma parameters, tokamak operating scenarios, and fluctuation regimes. On DIII-D, dual independently configurable detector arrays provide simultaneous 2-D images of T_e fluctuations with a total of 320 (20 vertical x 16 radial) channels. Similar systems at TEXTOR and ASDEX-U consist of 128 (16 vertical x 8 radial) channels in a single array. Receiver electronics provide a bandwidth of 400 kHz for fluctuations up to 3 cm^{-1} . First data from this diagnostic demonstrates sensitivity to coherent electron temperature fluctuations as low as 0.1%, providing excellent resolution of precursor oscillations and low-level MHD. 2-D images of Alfvén eigenmodes provide unambiguous measurement of poloidal mode structure and mode evolution in excellent agreement with ideal MHD theory. During experiments on both DIII-D and ASDEX-U, the imaged mode structure reveals poloidal asymmetries that are consistent with predicted non-ideal MHD effects. New features of the sawtooth instability have been observed on DIII-D and TEXTOR. Precursor oscillations and intermediate relaxation events have been imaged and analyzed using biorthogonal decomposition to reveal long-lived co- and counter-rotating modes which exhibit kink and tearing-like attributes. The presence of strong harmonic content in these modes reveals toroidal structure with $n > 1$. This is compared to the results of similar analyses performed on slowly rotating tearing modes imaged at DIII-D with ECEI.

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