Fast imaging of transients and coherent MHD modes in DIII-D

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Abstract. A fast framing camera is used to image plasma waves and instabilities in the DIII-D tokamak [J.L. Luxon, Nucl. Fusion **42**, 614 (2002)] in unprecedented detail, including tearing modes (TMs) and sawtooth crashes. To image core magnetohydrodynamic (MHD) activity, the fast camera detects visible bremsstrahlung emission ε_B in moderate to high density plasmas. For coherent MHD activity such as TMs, high-resolution 2D images of mode amplitude and phase are obtained by Fourier filtering each pixel's time series at the mode frequency. Images of $m/n = 2/1$ TMs show that inside the $q = 2$ surface, the camera measurements are in excellent agreement with an analytic model of a 2/1 island superimposed on the equilibrium ε_B profile. Direct comparison of the measurements to a NIMROD simulation shows significant discrepancies, most likely due to artificially high-density diffusion used in the code for numerical stability. The first visible-light images of transient sawtooth crashes show the structure and location of the perturbed emission from an $m = 1$ precursor oscillation, and show that during the nonlinear crash phase the instability extends to more than half the plasma minor radius.

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