Fast imaging of edge localized mode structure and dynamics in DIII-D

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Abstract. Fast-framing images of CIII and $D_{\alpha}$ emission in the low-field-side plasma boundary of the DIII-D tokamak [J.L. Luxon, Nucl. Fusion \textbf{42}, 614 (2002)] show that edge localized modes (ELMs) rapidly eject multiple field-aligned filaments from the plasma edge. The toroidal and poloidal mode numbers of these filaments depend on normalized plasma density, with measured ELM toroidal mode numbers ranging from \(\leq 10\) to 20 in low density plasmas and 15 to 35 in high density plasmas. In high-density plasmas with moderate collisionality \(v_{\text{ped}}^* = 0.50\), ELMs originate at the low-field-side midplane region and the ion parallel velocity in the scrape-off-layer is faster for ELMs with larger $D_{\alpha}$ divertor emission, suggesting that large ELMs eject higher temperature ions from deeper within the plasma compared to small ELMs. In low-density plasmas with collisionality $v_{\text{ped}}^* = 0.25$, the midplane and divertor ELM signals appear simultaneously, indicating that ELM behavior depends on collisionality. At all $v_{\text{ped}}^*$, ELMs drive parallel fluxes to the divertor; in addition, ELMs drive cross-field propagation of filaments, which results in plasma-wall interactions that are poloidally localized within 15 cm of the midplane. Using the wall interactions as signatures of the filaments in the scrape-off-layer, the measured poloidal width of the filament ranges from 1 to 5 cm.