Modulation of prompt fast ion loss by applied $n = 2$ fields in the DIII-D tokamak

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Abstract. Energy and pitch angle resolved measurements of escaping neutral beam ions ($E \approx 80$ keV) have been made during DIII-D L-mode discharges with applied, slowly rotating, $n = 2$ magnetic perturbations. Data from separate scintillator detectors (FILDs) near and well below the plasma midplane show fast ion losses correlated with the internal coil (I-coil) fields. The dominant fast ion loss signals are observed to decay within one poloidal transit time after beam turn-off indicating they are primarily prompt loss orbits. Also, during application of the rotating I-coil fields, outboard midplane edge density and bremsstrahlung emission profiles exhibit a radial displacement of up to $\delta R \approx 1$ cm. Beam deposition and full orbit modeling of these losses using M3D-C1 calculations of the perturbed kinetic profiles and fields reproduce many features of the measured losses. In particular, the predicted phase of the modulated loss signal with respect to the I-coil currents is in close agreement with FILD measurements as is the relative amplitudes of the modulated losses for the co and counter-current beam used in the experiment. These simulations show modifications to the beam ion birth profile and subsequent prompt loss due to changes in the edge density; however, the dominant factor causing modulation of the losses to the fast ion loss detectors is the perturbed magnetic field ($\delta B/B \approx 10^{-3}$ in the plasma). Calculations indicate total prompt loss to the DIII-D wall can increase with

application of the $n = 2$ perturbation by up to 7% for co-current injected beams and 3% for counter-current injected beams depending on phase of the perturbation relative to the injected beam.