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Fast Ion Transport during Applied 3D Magnetic Perturbations on DIII-D

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Pitch angle and energy resolved measurements as well as wide field-of-view infrared imaging show fast ion losses correlated with applied 3D fields in DIII-D plasmas. In L-mode discharges with slowly rotating n=2 magnetic perturbations, 3D field induced fast ion loss signals from separate scintillator detectors (FILDs), near and well below the plasma midplane, are observed to decay within one poloidal transit time after beam turn-off indicating they are predominantly prompt loss orbits. Beam deposition and full orbit modeling of these losses, both to the FILDs and wall, 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 different beams used. Measurements and modeling indicate total prompt loss to the wall increases with application of the n=2 perturbations by up to 7%, in these discharges, with the exact level depending on the phase of the applied 3D field. Modeling also shows negligible impact on the overall confined fast ion profile in these discharges however, it is found that localized regions of velocity space can resonate with the applied fields leading to large changes in toroidal canonical angular momentum –something potentially useful as an EP control tool. Initial application of these tools to RMP ELM suppressed H-mode plasmas show that the applied fields induce a large loss of fast ions (10%-20% of injection rate for half-energy beam ions) from the edge of the plasma and that the magnitude of the loss depends significantly on the model of the perturbed magnetic field. Calculations including the plasma response to the non-axisymmetric fields show up to a factor of two enhancement of the losses relative to those with vacuum n=3 fields alone.

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Author: Mr VAN ZEELAND, Michael (USA)

Presenter: Mr VAN ZEELAND, Michael (USA)

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