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Multipass Absorption of ECH on DIII-D for Polarization/Propagation Tests and High-Density Heating

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The suite of codes to model the electron cyclotron heating (ECH) profile on the DIII-D tokamak has been extended to follow the EC waves (110 GHz, second harmonic) over multiple bounces, allowing quantitative comparisons with experimental measurements in low absorption regimes for a number of purposes. First, the EC wave polarization has been checked by launching the waves radially at the centerpost tiles (see Fig. 1), where the injected X-mode component is absorbed off-axis on the first pass while the injected O-mode component is damped primarily on the second pass (at smaller radius) due to the higher electron temperature and mode scrambling [1]. Second, the injection angle for top launch ECH has been tested by placing the EC resonance so that it grazes the inboard side of the downward propagating beam on the first pass, and grazes the outboard side of the upward propagation beam after it reflects off the floor tiles. This results in a double-peaked deposition profile that can be used to constrain the poloidal launch angle by matching the multipass ray tracing code to the observed BT dependence of the two peaks. Finally, future DIII-D experiments plan to use high density plasmas (above the X-mode cut-off) for pedestal and core-edge integration experiments, and multipass ray tracing is being used to optimize second harmonic O-mode damping (single-pass absorption around 50%) for central electron heating. One option that will be explored is installing polarization-conserving reflection tiles on the centerpost to give two passes of nearly pure O-mode polarization.

Figure 1: Multipass ECH ray tracing for launched O-mode polarization on DIII-D. The carbon tiles are ˜92% reflective at 110 GHz. The modeling takes into account conversion between X-mode and O-mode at each bounce.

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References

[1] J.-Y. HSU and C.P. MOELLER, “Polarization Change of Electron Cyclotron Waves by Reflection”, GA Report GA-A18775 (1987)

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