ELECTRON CYCLOTRON CURRENT DRIVE AND CURRENT PROFILE CONTROL IN THE DIII–D TOKAMAK*

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Experiments on heating and current drive using second harmonic electron cyclotron heating (ECH) are being performed on the DIII–D tokamak using the 110 GHz ECH system. This system presently employs two MW-level gyrotrons. The antenna system is designed to produce a pair of narrow beams which can be steered in the vertical direction in order to allow the deposition location to be varied from the center of the plasma to the edge without altering the discharge parameters. Modulation of the EC power and phase sensitive detection of the temperature perturbation by ECE diagnostics is used to determine the location of the heating and to place an upper bound on the deposition width. The total power absorbed in the plasma is determined from the integrated amplitude of the profile of perturbed electron temperature or by comparison of the increase in stored energy with the increase from other heating methods like neutral beam heating and fast wave heating, at comparable power. This work shows effective heating by the ECH with good power accountability.

The profile of EC-driven current can be measured in discharges which have beam heating during the current ramp phase so that sawteeth are avoided. The ECCD current is found by subtacting the local Ohmic current density, including the back-induced current which acts to conserve the poloidal flux, from the equilibrium current density. Analysis of current drive indicates that up to 170 kA of central current has been driven by 0.8 MW of EC power, resulting in a negative loop voltage as large as –0.023 V near the axis. The ECCD co-current tends to drive the central safety factor $q(0)$ toward unity at a significantly higher rate than without the ECCD, and the effect of the current highly localized near the axis can be seen in the change of the start time of the sawteeth and on the time behavior of the internal inductance. The current drive figure-of-merit $\gamma = 0.35 \times 10^{19}$ A/W m^2, which is roughly consistent with previous determinations using the fundamental ECH (60 GHz) system when scaled for differences in T_e and Z_{eff}.

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