

## Electron Cyclotron Heating Experiments on 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 new 110 GHz ECH system. This system presently employs two gyrotrons, a 0.75 MW Gycom gyrotron with pulse lengths up to 2 s and a 1 MW CPI (formerly Varian) gyrotron. Both gyrotrons have internal mode converters, which facilitates convenient coupling to the waveguide via a pair of phase correcting mirrors. The transmission line is windowless evacuated corrugated waveguide of relatively small diameter, 31.75 mm, which has operated with excellent reliability in extensive operation. The antenna is a pair of steerable mirrors located 70 cm above the midplane. 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. The second harmonic EC resonance strongly damps the waves, resulting in highly localized deposition. Modulation of the power in the frequency range 50 to 1000 Hz and detection of the temperature perturbation by ECE diagnostics is used to validate the location of the heating. This technique is also used to determine an upper bound on the width of the deposition profile. The total power absorbed in the plasma is determined from the integrated amplitude of the profile of perturbed electron temperature. The absorbed power is cross-checked against fiducial heating pulses using the fast wave system in the direct electron heating mode at comparable power levels. Using one gyrotron with a centrally directed ECH beam, central electron temperatures as high as 10 keV have been obtained at low density. Analysis of current drive indicates that up to 0.1 MA of central current is driven, resulting in a negative loop voltage near the axis. The effects of ECH on the toroidal rotation velocity in discharges heated with neutral beams will be described.

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\*Work supported by U.S. Department of Energy under Contract Nos. DE-AC03-89ER51114, DE-AC02-76CH03073, DE-AC05-96OR22464, and Grant No. DE-FG03-97ER54415.