Abstract for an Invited Paper
for the DPP00 Meeting of
The American Physical Society

Localized Electron Cyclotron Current Drive in DIII-D: Experiment and Theory[1]

Y.R. LIN-LIU, General Atomics

In recent experiments on DIII-D [1], controllable and localized off-axis ECCD was demonstrated for the first time in high temperature tokamak plasmas. Clear evidence of the non-inductive currents was seen in the measurements of the internal magnetic field by Motional Stark Effect (MSE) spectroscopy. A coupled MHD/transport simulation of the current profile evolution allows comparison between the measured MSE signals and the calculated MSE response to localized current drive [2]. The ECCD efficiency found in this way exhibits the behavior expected from theory: it decreases at larger minor radius due to electron trapping and it is highest when the ECCD is located on the high magnetic field side. Previous reports [1] of broader than expected ECCD profiles were found to be due to the finite radial resolution of the equilibrium reconstruction. Comparisons of experimental measurements with coupled ray tracing and Fokker-Planck calculations have validated crucial pieces of the physics which form the foundation of ECCD: the weakly relativistic cyclotron absorption physics, the Fisch-Boozer current drive mechanism, and the electron trapping effects in toroidal geometry (the Ohkawa effect). Collisonality corrections to ECCD using a Wiener-Hopf boundary layer model bring the theory even closer to the experiment for the off-axis ECCD cases. Finally, the synergism of the Ohmic electric field with the current drive and quasilinear enhancement provide a quantitative agreement with experiment in the higher power limit. This work is the first comprehensive validation of the theory of ECCD.

[1] T.C. Luce, et al., Phys. Rev. Lett. **83**, 4550 (1999).
[2] C.C. Petty, et al., Localized Measurements of ECCD Using MSE Spectroscopy on the DIII-D Tokamak, to be submitted to Nucl. Fusion.

[1]Work supported by US DOE contract DE-AC03-99ER54463.