Radio frequency current drive in DIII-D

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Abstract. Two methods of radio frequency current drive that are well suited to controlling and sustaining the current profile in burning plasma experiments have been studied in the DIII-D tokamak. Fast wave current drive (FWCD) gave centrally peaked current densities that increased linearly with central electron temperature. While high harmonic absorption of the fast waves on energetic beam ions could reduce the available power for current drive, FWCD figures of merit as high as $\gamma_{FW} = 0.5 \times 10^{19}$ $Am^{-2}W^{-1}$ were still achieved. Electron cyclotron current drive (ECCD) was shown to be localized to the region of power deposition, with a current drive efficiency that decreased as the magnetic well depth increased. The detrimental effect of the magnetic well could be mitigated by raising the electron beta. ECCD figures of merit as high as $\gamma_{EC} = 0.5 \times 10^{19}$ $Am^{-2}W^{-1}$ were measured for central deposition. The experimental FWCD and ECCD were both extensively tested against theoretical models and were found to be in excellent agreement. Validation of these predictive models of rf current drive aids in scenario development for next-step tokamaks.