Synergy in Two-Frequency Fast Wave Cyclotron Harmonic Absorption in DIII-D*

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Fast waves (FWs) at 60 MHz and at 90 MHz are coupled to DIII-D discharges for central heating and current drive at net FW power up to 3.5 MW. The primary absorption mechanism is intended to be direct electron damping in the plasma core. In discharges at B = 2 T with fast deuteron populations from neutral beam injection, 4th and 6th deuterium cyclotron harmonic absorption on the fast ions competes with direct electron damping. Previous experiments have shown that the $6\Omega_D$ absorption of the 90 MHz FWs is weaker than the $4\Omega_D$ absorption of 60 MHz FWs, in agreement with a model that includes unspecified edge losses. Recent experiments have shown that if the fast deuterons are accelerated by absorption of 60 MHz ($4\Omega_D$) FWs, adding 90 MHz power ($6\Omega_D$) can increase the fusion neutron rate by a larger increment than is obtained with 90 MHz power alone. Details of this synergy between $4\Omega_D$ and $6\Omega_D$ absorption are presented. Also, strong absorption of 60 MHz power at $6\Omega_D$ and $7\Omega_D$ (at reduced toroidal field) is observed and compared with absorption at $6\Omega_D$ at 90 MHz.

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