Status Update on the DIII-D ECH System

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The gyrotron system on the DIII-D tokamak is comprised of six Communications and Power Industries (CPI) diode tubes operating at 110 GHz. Five of the six gyrotrons have been tested at 1 MW, 5 s pulses and 500–600 kW 10 s pulses and one has generated about 80% of these powers. The maximum rf power injected into DIII-D on second harmonic of the electron cyclotron (EC) resonance have been 3.5 MW during simultaneous five second pulses of all six gyrotrons. The gyrotron thermal design is adequate for 10 s pulses at 1 MW, but the pulse length is presently limited to 5 s because that duration is sufficient for the 7 s pulse durations, and prolongs the gyrotron collector service life.

Significant upgrades to the rf transmission system were made in 2010. In order to increase the total efficiency of the rf transmission, all six waveguides have been rerouted to decrease the total number of miter bends by fifteen, increasing the transmitted power by 200 kW for the entire system. The angular alignment of rf beams after the MOU focusing mirrors at the waveguide input has been revised and improved. The launcher mirrors have all been redesigned for improved heat transfer and fatigue lifetimes. Both poloidal and toroidal steering mirror motion now uses electric motors in place of air turbines, yielding higher speed poloidal scans and greater positioning accuracy.

Preparation for installation of a 7th gyrotron has been in progress since August 2010. The frequency of this depressed collector diode gyrotron will be 110 GHz, with output rf power expected to be 1.2–1.3 MW. The 8th gyrotron for the DIII-D system is in the design stage. Also a depressed collector diode tube, this gyrotron is being designed for 117.5 GHz, 1.8 MW output in short pulses with operational parameters of 10 s pulses at 1.5 MW generated.