Performance of the Six Gyrotron System on the DIII-D Tokamak

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***Abstract*—The gyrotron complex on the DIII-D tokamak now comprises six 110 GHz gyrotrons. Five of these tubes have demonstrated 1 MW pulses 5 sec in length and one, probably due to a problem at the cathode, has generated 750 kW for 5 sec pulses. Initial factory testing demonstrated about 600 kW at 10 sec pulse length for all 5 of the high performing tubes. Typical injected rf power has been 3.2 MW with 5 gyrotrons and experiments with the full 6 gyrotron system will have about 3.8 MW injected power during 2009. Tetrode modulators are used for all the gyrotron systems. The rf beams can be directed anywhere in the tokamak upper half plane with full control of the toroidal injection angle for co- and counter-current drive and of the elliptical polarization at the injection point. The output power of the gyrotrons can be modulated at up to about 5 kHz either with pre-programmed waveforms or using real time feedback on plasma parameters derived from diagnostics with command signals routed to the gyrotrons by the DIII-D plasma control system. The system is in regular service for experiments on the DIII-D tokamak, including investigations of instability control, startup scenarios, profile control and transport. The beam transport system is about 75% efficient for 90–100 m transmission line length, with about 1 dB loss occurring in the first several meters of the lines, apparently due to mode conversion at the injection point. A series of experiments is being performed to understand the mode conversion, which is believed to be due to small angular misalignments of the rf beam at the input to the waveguide system. During conditioning for operations, one gyrotron has exhibited two different types of low frequency parasitic oscillation, one connected with reflected electrons between the gun and the cavity and the other connected with electron trajectories in the collector. These have different characteristic frequencies below 100 MHz and different dependence on the gyrotron operating parameters, which will be discussed. Spectroscopic measurements are being performed on the light emitted through the gyrotron output window to attempt to identify the source of gas evolved during the conditioning process. The system has also been used to flash anneal amorphous silicon leading to efficient formation of crystalline silicon in an effort to double the photovoltaic conversion efficiency. The results of these experiments and measurements and longer term future plans for the system will be presented.**

Topic: 10. Gyro-Oscillators and Amplifiers, Plasma Diagnostics

978-1-4244-2120-6/08/$25.00 ©IEEE.