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DIAGNOSTIC TESTS, UNUSUAL EXPERIMENTS AND PERFORMANCE ON THE DIII-D GYROTRON SYSTEM

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The gyrotron complex on the DIII-D tokamak now has been completed with the installation of six 110 GHz gyrotrons in the 1.0 MW class. The rf pulse lengths have been limited administratively to 5.0 s at full parameters, 40 A, 80 kV, and over 10.3 MJ per pulse at peak power, ~3.1 MW, have been injected into DIII-D for plasma experiments. The reliability of the gyrotron performance has been 82% over a three-year period.

A direct high power measurement of the transmission line efficiency has been made. For this test, a dummy load capable of absorbing the full rf power was installed, first near the gyrotron and then, after ~90 m of transmission line, near the tokamak. The absorbed dummy load powers, normalized to the power loading of gyrotron internal components sensitive to rf production, were measured. The total efficiency averaged 74% for the 31.75 mm diam. evacuated corrugated transmission lines carrying the $HE_{1,1}$ waveguide mode past 7 miter bends. Loss in the Matching Optics Unit (MOU) was 3.3%-7.9% and a fairly large loss, ~10% was measured in the first sections of waveguide after the MOU, owing to excitation of lossy high order modes in the conversion from free space Gaussian to $HE_{1,1}$ upon injection into the waveguide.

Three materials experiments have been performed using the system. The power from one gyrotron was used to flash anneal amorphous silicon, forming aligned single crystals suitable as nucleation sites for CVD deposition of silicon leading to high efficiency photovoltaic conversion. A similar annealing of CMOS structures produced improved junctions accessing the 32 nm performance node. Finally, a gyrotron pumped waveguide loaded with naptha and Zn powder is being used to investigate the possibility of creating high velocity pellets driven by rapidly expanding gas heated by microwaves.

This work was supported in part by the US Department of Energy under DE-FC02-04ER54698.