EXPERIMENTAL DEMONSTRATION OF MULTI-MEGAWATT 95 GHz GYROTRON*

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A 95 GHz gyrotron capable of generating CW power levels in excess of 2 MW is currently under development at CPI. The gyrotron makes use of a single-anode electron gun that produces a 90-kV, 75-A electron beam for interaction with the $TE_{22,6,1}$ cavity mode. Microwave power produced in the interaction cavity is transformed into a fundamental Gaussian beam using an internal waveguide launcher and three focusing and phase-correcting mirrors. The Gaussian beam exits the tube through an edge-cooled chemical-vapor-deposition (CVD) diamond window. The spent electron beam is dissipated in a 40.6-cm diameter collector fabricated from a strengthened copper alloy. The collector nominally operates at a depressed voltage 61 kV above the cathode potential to minimize the amount of power absorbed and improve efficiency.

In the first series of experiments, a maximum output power level of 1.45 MW was obtained using a 61 kV cathode voltage, 90 kV total accelerating voltage, and 75 A beam current. Interaction and total output efficiencies were 21% and 32%, respectively. At a beam current of 40 A and the same voltage settings, an output power of 1.08 MW was measured for an interaction efficiency of 30% and a total output efficiency of 44%. Experimental evidence indicated that an oscillation in the beam tunnel region just prior to the interaction cavity was a likely cause of the lower than expected efficiency and output power at higher beam currents.

In an attempt to alleviate the detrimental effects of the oscillation, a new beam tunnel was installed on the gyrotron. No other major changes to the gyrotron were made. In a second series of tests, a maximum, output power of 1.72 MW was obtained with a cathode voltage of 70 kV, an accelerating voltage of 93 kV and a beam current of 75 A. The interaction efficiency at this point was 25% and the total output efficiency was 33%. At 45 A beam current, an accelerating voltage of 90 kV, and a collector voltage of 61 kV, an output power of 1.40 MW was obtained with an interaction efficiency of 35% and a total output efficiency of 51%. It appears that the presence of beam tunnel power still degrades the interaction efficiency at higher values of beam current, but there has been a marked improvement between the first and second series of tests, where the maximum achievable power has increased from 1.45 MW to 1.72. The operation at 1.4 MW output power with over 50% efficiency is also an important achievement.

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