EXPERIMENTAL RESULTS ON A HIGH EFFICIENCY 1.5 MW, 110 GHZ GYROTRON

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We report successful tests of a new cavity (named V-2005) for the 1.5 MW, 110 GHz gyrotron experiment at MIT. We achieved 1.67 MW of output power and 42 % efficiency, at 97 kV of beam voltage and 41 A of beam current in three microsecond pulsed operation in the $TE_{22,6}$ mode. The high efficiency in the newly designed V-2005 cavity results from the reduced mode competition from the competing mode, $TE_{19,7}$. These results are significantly better than earlier results with a previous cavity (V-2003) [1]. An analysis using a starting current simulation is in good agreement with the mode map measurement of the observed modes [2]. In order to convert the $TE_{22,6}$ mode to a Gaussian beam, an internal mode converter has been recently installed and is being tested currently in a depressed collector configuration. Results of operation in the internal mode converter configuration will be compared with results obtained in the axial configuration.

Recently, low-frequency parasitic oscillations, in the 100 to 160 MHz range, have been observed in these 110 GHz gyrotron experiments. The oscillations were first noticed on capacitive probes located near the microwave resonator used to measure the beam alpha (transverse to axial velocity ratio). The dependence of the frequency of oscillation on current, voltage, and magnetic compression ratio will be reported, along with the regions of I - V space in which the oscillations are observed. We will also report on: experimental measurement of the azimuthal emission nonuniformity of the MIG gun; simulation of the beam quality of the MIG gun using the MICHELLE 3-D code, including the simulation of the MIG electron beam with azimuthal nonuniformity; benchmarking of the MICHELLE 3-D code vs. other codes; evaluation of the effects on velocity spread of azimuthal nonuniformity in the MIG gun, showing that the direct effect on beam quality is very small; design, fabrication and testing in the gyrotron of a capacitive probe system divided into four quadrants to help measure azimuthal asymmetries of the electron beam; and use of the probes to measure the low frequency (100 - 160 MHz) oscillations on the beam.

References

[1] “Studies of the 1.5-MW 110-GHz Gyrotron Experiment,” Anderson, J.P.; Shapiro, M.A.; Temkin, R.J.; Mastovsky, I.; Cauffman, S.R., IEEE Trans. Plasma Science, Volume: 32, Issue: 3, pages 877- 883, (June 2004).

[2] "Experimental Results for a 1.5 MW, 110 GHz Gyrotron Oscillator with Reduced Mode Competition." E. Choi, C. D. Marchewka, M. A. Shapiro, J. R. Sirigiri, I. Mastovsky and R. J. Temkin, Physics of Plasmas (to be published, Feb. 2006).