DEVELOPMENT OF A 19 KW CW, L-BAND KLYSTRON FOR THE CONTINUOUS ELECTRON BEAM ACCELERATOR FACILITY

M.E. Read, A. Mizuhara, G. Miram, L. Song, and R.L. Ives, Calabazas Creek Research, Saratoga, CA, 95070-3753

Abstract

This document describes the design of a klystron for the RF system upgrade of the Continuous Electron Beam Accelerator Facility (CEBAF) at the Thomas Jefferson National Accelerator Facility. The klystron will produce 19 kW of saturated CW power at 1497 MHz with an efficiency of 59%.

DESIGN PARAMETERS

The design parameters of the klystron are shown in Table 1.

Table 1. Klystron parameters.

Frequency	1497 MHz
Saturated Power	19 kW (max)
Operating Power	15 kW
Power Range	50% - 100%
Voltage	18.8 kV
Current	1.76 A
Small Sig. Gain	56 dB
3 dB Bandwidth	5.8 MHz
Efficiency	59%

CIRCUIT DESIGN

As shown in Figures 1 and 2, the klystron will have 6 "race-track" cavities, one of which operates at the second harmonic to enhance the bunching. Design of the klystron follows conventional procedures plus the use of 2.5D and 3D codes for calculating the performance. The output power and gain, as calculated using MAGIC, are shown in Figure 3.

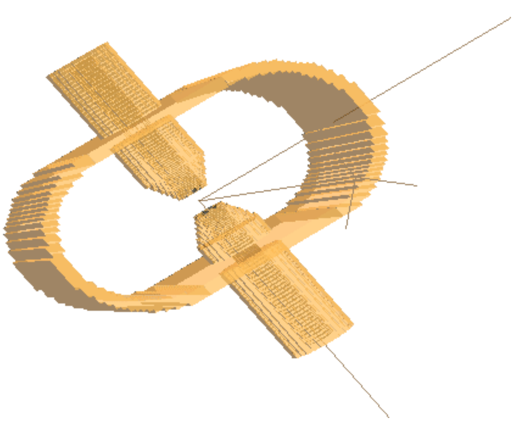

Figure 1. Race-track cavity.

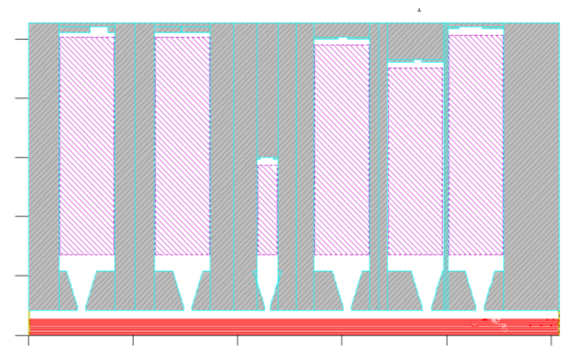

Figure 2. Cross section of the cavities and beam (crosshatch represents surface covered with loss coating).

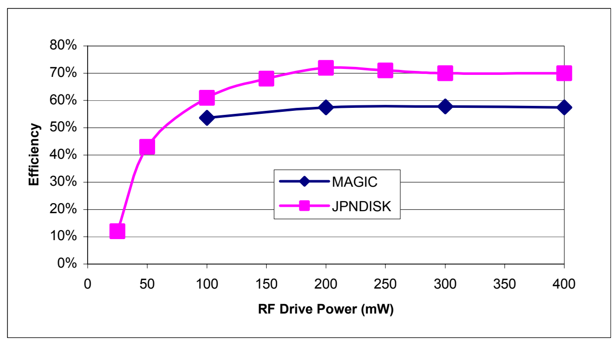

Figure 3. Output power and gain of the klystron, as calculated using MAGIC.

Figure 3 compares the results of the MAGIC simulation with those of the large signal code JAPANDISK. The efficiency predicted by JAPANDISK is about 10% higher than predicted by the more accurate MAGIC simulation. This is about the same difference observed between the efficiency predicted by other similar large signal codes and that obtained in actual operation.

ELECTRON GUN

The beam is generated using an immersed Pierce gun in a solenoidal magnetic field. Figures 4 and 5 show predicted performance of the gun using the 2.5D computer code TRAK. The design includes a modulating anode to reduce the current when less than the maximum power is required from the tube. This insures that the efficiency drops only to 47% at ½ the maximum operating power.

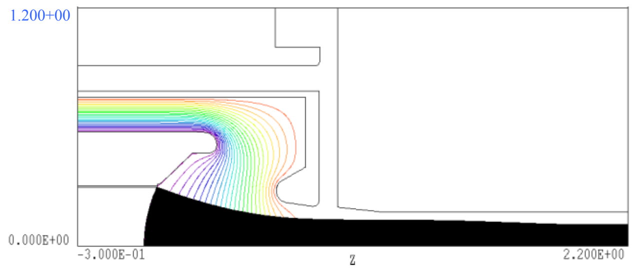

Figure 4. Electron gun for the klystron.

Reliability is critical since the tube is for use in a large accelerator. consequently, conservative values were used for the gun electric fields, the cathode current density and the collector power density. These are 83 kV/cm, 1 A/cm^2, and 500 W/cm^2, respectively.

STATUS

The tube design is complete, and a solid model of the klystron is shown in Figure 6. As soon as additional funding is approved, two prototype klystrons will be built and tested. These will then be delivered to the Thomas Jefferson National Accelerator Facility.

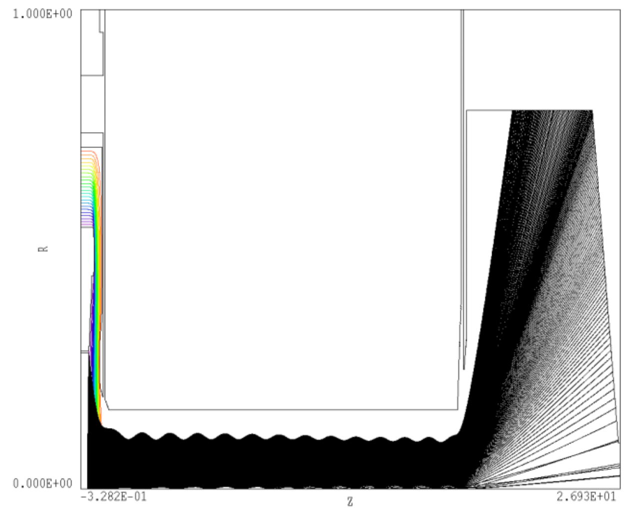

Figure 5. Beam for the klystron. The radial scale is enlarged to show detail. The scallop amplitude is 6.4%.

ACKNOWLEDGEMENT

This work was funded by the U.S. Department of Energy Small Business Innovative Research grant number DE-FG03-02E83378.

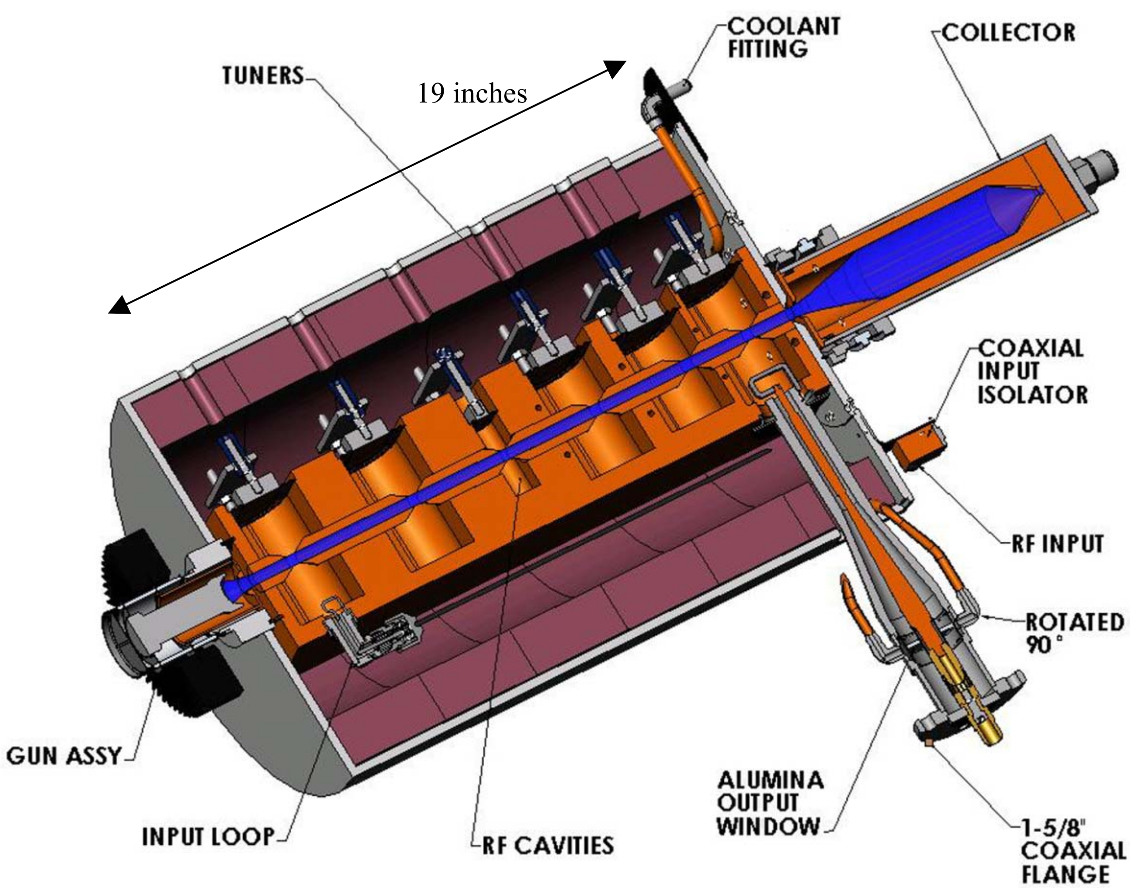

Figure 6. Solid model of the klystron.