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Multiple Beam Power Grid Tubes for High Frequency and High Power Operation

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Calabazas Creek Research, Inc. (CCR), in collaboration with, Communications & Power Industries, LLC (CPI) is developing a multiple beam triode for ion, proton, and electron accelerators. Traditional, high power triodes are limited to frequencies below 300 MHz and power levels less than 100 kW. Efficiencies exceeding 70% are routinely achieved and as high as 90% have been reported. This program is developing a multiple beam triode to produce more than 200 kW of RF power.

The triode consists of a gridded electron beam source and collector in a vacuum enclosure. RF power is achieved by mounting the triode inside coaxial input and output cavities at the desired frequency. The multiple beam triode will be designed to provide RF power from 350 MHz to 650 MHz using the appropriate, tuned, resonant cavities.

The program is using the grid-cathode assembly from CPI's YU-176 planar triode [1]. Each YU-176 grid-cathode assembly provides beam power to produce 25 kW of RF power. This program is using eight assemblies to achieve 200 kW with a target efficiency exceeding 80%. An 8-beam, triode powered, RF source at 350 MHz would be approximately 36 inches long and 18 inches in diameter and weigh approximately 150 pounds. This is significantly smaller than any other vacuum electron device at this frequency and power level.

The gain is limited to approximately 15 dB. Consequently, a single beam triode-based source will serve as a driver for the multiple beam device. The cost and efficiency of the system will still exceed the performance of other RF sources at this frequency, including solid state sources.

CCR and CPI are leveraging advanced, 3D codes to simulate the beam optics and thermomechanical performance. Key issues include grid cooling, uniformity of RF electric fields on the grids, and efficiency.

1. http://www.cpii.com/division.cfm/9

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