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HIGHLY-EFFICIENT 20-MW L-BAND MULTI-BEAM KLYSTRON

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A new concept for a high-power L-band RF amplifier is described, namely a Two-Stage Multi Beam Klystron (TS-MBK) operating with 12 hollow beamlets. This configuration allows for a remarkably high RF electronic efficiency of up to 90%, with a compact electro-mechanical layout. We present a conceptual design for a 1.0 GHz, 20 MW peak-power TS-MBK; its predicted performance was determined using particle-in-cell computer simulations. The tube's efficiency—about 20% higher than conventional MBK's—is due to good bunching of its 12, 30-kV, 12-A, 2.31-μK perveance hollow beamlets; followed by 150 kV post-acceleration that results in 0.157-μK, 180 kV beamlets with a total power of 26 MW that drive the output cavity. It is notable that the required modulator for this tube needs to provide pulses of only 30 kV, since post-acceleration can be achieved using a compact and much lower cost dc power supply. Further, the post-acceleration electric field prevents electrons reflected in the collector from returning towards the cathode. One application for this tube could be as the RF source for the 3-TeV CLIC drive beam, for which about 1230, 1.0 GHz tubes supplying a total average power of 184 MW are required. Another application could be to supply the high peak and high average power to drive the emerging compact and efficient electron cyclotron resonance accelerator eCRA, producing beams for environmental remediation and replacement of radioactive sources for sterilization. The optimal operating frequency for eCRA could be about 1000 MHz, but the TS-MBK design presented here can be scaled to other L-band frequencies. The high efficiency of our TS-MBK for these applications would result in significant operating cost savings and significant reduction in waste heat from the beam collector.

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