The design and implementation of Kσ-band three-beam cascaded serpentine travelling-wave tube (TWT) amplifiers are presented. In the multiple-beam cascaded TWT concept, the RF output from each interaction circuit stage is serially connected to the input of the next stage, with each stage driven by a separate electron beam. This configuration provides flexibility for gain, bandwidth, and power trade-offs in high-power, broadband applications, where size and weight are key requirements.

MAGIC-3D simulations predict that a peak power of 3.5 kW with saturated gain of 16 dB and an instantaneous bandwidth of 30% centered at 36 GHz can be achieved in a circuit length of 4.5 cm driven by three optimized 20 kV, 0.5 A beams. This three-beam cascade serpentine TWT amplifier design will serve as the baseline design for a future compact power booster. Consequently, the number of interaction gaps, pitch, and dispersion for each stage in the design are optimized to maximize the bandwidth-power product rather than gain.

A high peak power “proof-of-principle” amplifier experiment is currently being planned. The design for this amplifier will also be presented. This amplifier prototype will be driven by a three-beam (3 x 0.6 A), 20-kV gun adapted from a previous eighteen-beam, 42-kV, S-band klystron gun. The gun has been fabricated using spare parts from the 18-beam gun. Design simulations indicate a peak power of 4.4 kW and saturated gain of 22.5 dB can be achieved with a 12% bandwidth centered at 28 GHz. The small-signal gain is 29.1 dB with 18.4 dB, 6.9 dB, and 3.8 dB for the first, second, and third stage, respectively.

Circuit fabrication and cold tests are currently underway. Once implemented and tested, this “proof-of-principle” amplifier will provide valuable information to validate the design methodology and tools; a critical step toward the future development of this new type of amplifier.


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