HIGH-GAIN WIDEBAND HIGH-POWER 200-GHz MULTIPLE-BEAM SERPENTINE TWT DESIGN*

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Serpentine traveling-wave tubes (TWTs) are a class of vacuum electronic devices capable of wideband (25%), high power performance [1]. However, their bandwidth depends critically on the path length along a half-period of the serpentine waveguide (from gap to gap). At THz frequencies (200 to 1000 GHz), beam tunnel diameters well below 200 μm are required to achieve bandwidth ~20%. On this scale, fabrication issues, alignment, beam interception, and electron beam thermal effects will dominate and ultimately limit the practical circuit length and, by extension, device gain and output power. Since the gain-bandwidth product is a function of both circuit length and beam current, it is clear that the formation of an intense, well-focused beam is a key factor. Recent advances in high power THz amplifier development have shown that ~100 mA, ~ 20 kV beams with diameters of ~100 ⌠m are feasible [2]. However, even with these stringent beam parameters, we estimate that a single-beam, 220-GHz device with ~40-dB saturated gain and ~20% bandwidth would require a circuit length ~5 cm (assuming half copper surface conductivity). The long circuit length makes this device impractical, as severe beam interception will be unavoidable. We will introduce a novel, multiple-beam approach, which provides a potential means to overcome this fundamental obstacle.

In this concept, the RF output of each stage is connected to the input of the next stage driven by a different beam. To illustrate the concept, we will present the design of a threebeam 220-GHz serpentine TWT amplifier. MAGIC-3D [*ATKMission Research*] simulation results predict that the device should be capable of a peak power of 73 W and saturated gain of 42 dB over an instantaneous bandwidth of 50 GHz (23%), when powered by three 100 mA, 20 kV, well-focused electron beams. This performance can be achieved in a very compact circuit length of only 1.5 cm – a significant advantage for THz electron beam devices where issues of fabrication tolerances, beam alignment, and electron interception are of critical importance.

A detailed description of the concept and the gun and circuit designs will be presented at the conference.

1. Dohler G., *et al*., "Millimeter wave folded waveguide TWTs," *Proc. of Vacuum Elec. Annual Review (1993),* p. V-15.
2. Nguyen, K. *et al*., "Design of terahertz extended interaction klystrons," *IVEC 2010 Conference Record*

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