ACCURATE FIELD SHAPE MODEL FOR BEAM-WAVE INTERACTION SIMULATION OF FOLDED-WAVEGUIDE TRAVELING-WAVE TUBES

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ABSTRACT

Traveling-wave tubes (TWTs) are high-power high efficiency vacuum electronic amplifiers for microwave and millimeter-wave applications. Future demands for larger bandwidths in satellite communications spark the need for the development of amplifiers in Q-band and above. The helix TWT constitutes the state-of-the-art technology for satellite applications. At such high frequencies, however, it suffers from thermal and mechanical limitations. Since the implemented delay line topology mainly dictates the bandwidth and power capabilities of the amplifier, alternatives have to be investigated.
One of them is the folded waveguide (FW) [1]. A schematic of an FW-TWT is shown in Figure 1. Distinct advantages of the FW delay line are its ease of fabrication up to the THz range and good thermal properties. It is crucial to predict the performance of a TWT featuring an FW delay line prior to actual assembly. For this purpose a beam-wave interaction simulation is necessary. In many specialized beam-wave interaction tools an equivalent circuit is used to describe the electromagnetic wave on the delay line. The waves are then represented by voltage and current amplitudes. For interaction with the particles in the electron beam tunnel, however, the electric field acting on the particles has to be specified. Static and hyperbolic axial field shapes can be applied [2], but do not yield the correct coupling to the particles, irrespective of operating frequency.
In this work a field shape model is presented that is based on the discrete waveguide model [3]. Full-wave results of the delay line's unit cell are used to synthesize an axial field shape. It is valid for any operating frequency and yields the correct coupling throughout the passband for all considered space-harmonics.

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