Experiments with and Simulations of a Reflex Triode Vircator

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Microwave sources based on the virtual cathode oscillator (vircator) principle have a potential for compact high-power microwave (HPM) pulse generation. The reflex triode type vircator studied at FOI consists of a cylindrical cavity and two planar electrodes. It is directly powered by a compact 20 stage 400 kV/400 J Marx generator. The generated microwave radiation is extracted via a waveguide into an anechoic chamber equipped with field probes (cf. T. Hurtig et al., Initial Results from Experiments with a Reflex Triode Powered by a Marx Generator, 15th IEEE International Pulsed Power Conference, Monterey, USA, 2005).

Parametric studies have been performed to characterize the reflex triode, with variation of parameters such as the anode-cathode gap distance, the electron emitter surface area and the driving voltage amplitude. Results are analyzed and compared to simulations. Equivalent electric circuit simulations of the Marx-vircator system provide diode currents, microwave frequencies and pulse lengths in rather good agreement with experimental data. Three-dimensional particle-in-cell (PIC) simulations of generated microwave radiation and its extraction through the waveguide give radiated electromagnetic fields which qualitatively agree with the experiments.

One observation in the experiments is a distinct non-uniform electrode erosion on the far side of the electrode surfaces as seen from the Marx generator connection. This results from the fact that the accelerating electrons are subjected to a Lorentz force due to the non-symmetric current path through the reflex triode geometry. This phenomenon is readily observed in the PIC-simulations and emphasizes that simple one- or two-dimensional models may be of limited use in characterizing the behavior of the electron beam and plasma in a reflex triode configuration. The inhomogeneous electron beam possibly also manifests its presence in some of the experimental results with a small emitter area.