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Electron Beam Coupling to Electrical Metamaterial Structures
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Many authors over many decades have considered the coupling of electron beams to various microwave structures. These structures range from slow wave structures, such as traveling wave tubes, to dielectrics, such as the dielectric Cherenkov maser. In this presentation, we consider the coupling of relativistic electron beams to electronic metamaterials. We consider cylindrical and planar geometries and treat the electron beam as a cold, non-neutral plasma confined by an infinite magnetic field, confining motion of the electrons to the axial direction. We treat the metamaterial, which loads the cylindrical waveguide along its outer wall, using effective medium theory, considering cases of double positive, single positive, and double negative dielectrics. The presentation begins with a review of the cold structure characteristics in the absence of an electron beam and then moves to consider the coupling of the electron beam to the metamaterial. In particular we study the dispersion and small signal growth rate of this system, the frequency range of applicability, and the power handling potential of such structures. .

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