Theory of multi-stream electron beam interacting with multiple transmission lines

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Abstract. We advance here a constructive Lagrangian field theory of an electron beam interacting with a slow-wave structure represented by possibly non-uniform multi-transmission line. The electron beam is represented by multi-stream electron flow. The developed analytical theory accounts for a number of electron plasma phenomena including electron-to-electron repulsion (debunching), convective instabilities, amplifying waves and more. As to potential applications such as high power microwave devices, the theory allows to identify sources of the system convective instability (exponential growth), and to evaluate the energy transfer rate to the electromagnetic radiation. In particular, the theory points to the debunching as a source of unstable backward phase velocity modes as well its combination with multi-stream features as a source of unstable multi-stream forward phase velocity modes which are almost non-dispersive.

Keywords: Traveling wave tube, microwave, electron beam, plasma, Lagrangian