ANALYSIS OF STABILITY AND HIGHER-ORDER MODE INTERACTION FOR A SHEET-BEAM COUPLED-CAVITY SLOW-WAVE STRUCTURE

Paul B. Larsen, David K. Abe, Simon J. Cooke,
Baruch Levush
Naval Research Laboratory, Code 6840
4555 Overlook Avenue S.W.
Washington, DC 20375, USA

Thomas M. Antonsen, Jr.
University of Maryland, College Park, MD 20742, USA

Sheet-beam coupled-cavity slow-wave structures (SWS) are inherently 3-dimensional with complicated electric fields and overmoded dispersion. To perform initial analyses of the beam-wave interaction, we have modified existing 1-dimensional cylindrical-beam models to accommodate the sheet-beam geometry. Here we discuss the models, assess the accuracy of approaches, present results of stability analyses, and describe beam interactions with higher-order modes (HOMs) in the structure [1], some of which overlap the fundamental mode in frequency.

A linear theory has been developed for use with sheet beam structures that yields a cubic dispersion relation analogous to the Pierce model for cylindrically-symmetric traveling-wave structures. In addition, we have modified standard cylindrical coupled-cavity simulation tools by changing the space-charge interaction and the field profile to appropriately reflect the elongated beam-tunnel.

We start a simplified analysis of the HOM interaction by monitoring each crossing of the beam-line with the various modes of the dispersion diagram. For each forward wave intersection we find a gain estimate assuming a uniform length of the SWS. For each backward wave intersection we find a maximum stable length for a uniform section of the SWS. These are used as estimates for the interactions with the various modes allowed in the dispersion diagram.

We will present several methods of suppressing interactions with higher-order-modes. The first goal is to shape the cavity appropriately to reduce the interactions of HOMs, while also maintaining the desired operating frequency, bandwidth, and the interaction impedance of the fundamental. The next step is to consider selective loss coating or lossy dielectric insertion – these losses are placed judiciously to suppress unwanted modes, but minimally affect the desired mode.

Finally, we design an internal sever that sufficiently absorbs the transmitted modes of a signal, allowing increased stability for a high-gain amplifier.

1. Larsen, P.B., Abe, D.K., Cooke, S.J., Levush, B., Antonsen, T.M., Myers, R.E., "Characterization of a Ka-Band Sheet-Beam Coupled-Cavity Slow-Wave Structure," IEEE Trans. on Plasma Sci. (submitted).

---

* This work was supported by the U.S. Office of Naval Research.