Evidence of the limiting output power in a compact MILO process

R. Cousin [1], J. Larour [1], P. Gouard [2], P. Raymond [3], A. J. Durand [4]
(1) Laboratoire de Physique et Technologie des Plasmas (LPTP), CNRS-Ecole Polytechnique, 91128 Palaiseau, France
(2) Département de Physique Théorique et Appliquée (DPTA), CEA/DAM Ile-de-France, 91680 Bruyères-le-Châtel, France
(3) Institut franco-allemand de recherches de Saint-Louis (ISL/EMW), 68301 Saint-Louis, France
(4) Thalès Electron Devices (TED), 78941 Vélizy, France

In the last decade, the MILO (Magnetically Insulated Line Oscillator) has proven to be an efficient high power microwave source (HPM). The self-magnetic field generated by the electron beam flowing along the velvet cathode surface allows high operating voltages of several hundred kilovolts. A high voltage generator delivering 500 kV matched to the MILO tube leads to microwave output powers greater than 1 GW. The current cooperative work has resulted in a 2.44 GHz 4-cell load limited compact MILO for embedded applications (volume and mass reduction).

In order to characterize the compact MILO slow wave structure, we have performed a 2D model under the EM-PIC code MAGIC and have clearly identified the four resonant frequencies. We established precise criteria responsible for the limiting output power in our compact device, based on the analysis of the external Q-factor. We compared our calculations with some cold experiments (without electrons), performed with a network analyzer, and we got very good correlations (R. Cousin et al., Rev. Sci. Instrum., 76, 124701 (2005)). The experimental analysis has shown frequencies superimposed to the 2D model, which were compared to 3D MAGIC simulations with and without electrons. In this geometry, some non-axisymmetric modes appear between the fundamental modes and the cutoff of the first order mode of the 4-cell periodic resonator. For instance, the excited mode at 2.68 GHz is responsible for a beating wave leading to a limited and unstable microwave output power. By optimizing the geometry of the 4-cell periodic resonator, we forced a stable process for a MILO oscillating frequency shifted to 2.34 GHz.