Multiphysics Design of a Klystron Buncher

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Abstract

Klystron and TWT are the preferable devices where high power (kW) and microwave high frequencies with large bandwidths are desired [1].
since in these fields, solid-state devices present several lacks[2].
The design of the buncher cavity of a 130 GHz klystron is described in this paper. The proposed device can be micro-fabricated by employing such techniques over a silicon wafer [3].
In many applications, as for the sub-millimeter waves, very small beam dimension are required [4]. In this range of critical dimensions, multiple physics influencing factors, due to the heating effects and power dissipations, modify the electromagnetic behavior of the device.
In order to reduce thermal expansion of the material typical of the classical thermionic cathodes, a Carbon nanotube cold cathode is employed to produce the required beam current.
The cold cathode operates at a temperature of 35°C which produces considerable effects at the design frequency. The proximity of the buncher cavity to the electron gun, represents a critical aspect: The thermomechanical modification affects the bunching electric field, modifying the desired device behavior.
A multiphysics design approach using COMSOL has been employed to ensure the future correct operation.
By a Thermo mechanical analysis, coupling Heat Transfer (HT) and Structural Mechanics (SM) module, temperature and deformations have been determined when the heat generated by the cathode power dissipation has been diffused to the system, cooled by an opportune airflow represented in Fig. 1. Thermomechanical displacements are represented in Fig 2.
On the deformed geometry, the axial electric field of the buncher cavity has been computed through the Moving Mesh (MM) dedicated interface [5].
Scattering parameters at the input port and axial electric field of the buncher are reported in Fig. 3 and 4.
Several strategies have been adopted to obtain a simple but reliable model. The proposed approach have allowed to select the appropriate materials and shapes.

Reference

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Figures used in the abstract

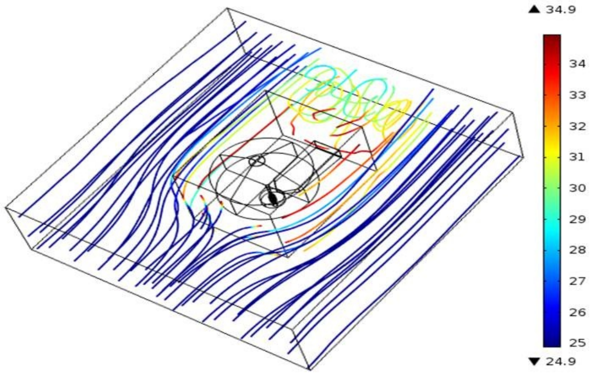

Figure 1: Airflow path with temperature distribution (°C)

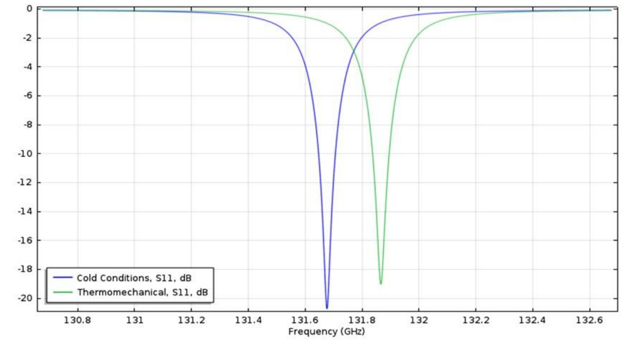

Figure 2: Scattering reflection parameters in Cold and Thermomechanical affected operation (dB)

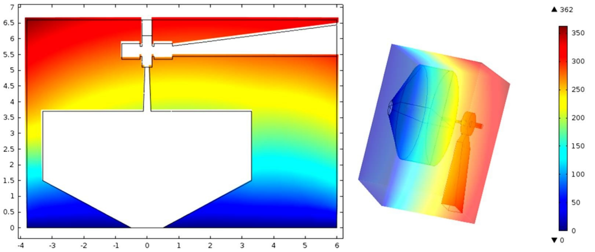

Figure 3: Thermomechanical Displacements (nm)

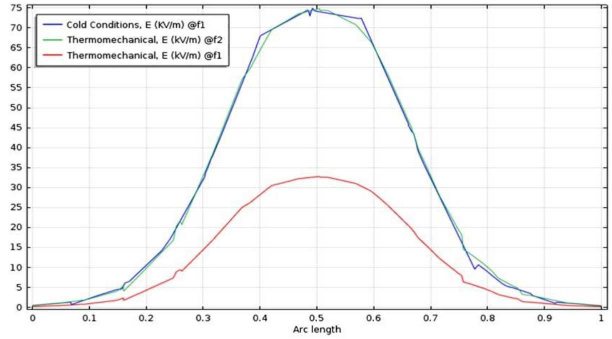

Figure 4: Bunching electric field in cold and thermomechanical operating conditions (kV/m)