FEASIBILITY STUDIES OF A 140 GHz, ≈ 2.4 MW, CW GYROTRON CAVITY

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ABSTRACT

Gyrotrons are high power millimeter wave/sub-terahertz sources capable of delivering hundreds of kilowatts of long-pulse to CW powers for a variety of Industrial-Scientific-Medical (ISM) applications that include plasma heating in thermonuclear fusion reactors, tokamaks and stellarators [1-2]. In this work, we present feasibility studies on a 140 GHz, ≈ 2.4 MW, CW, conventional cavity gyrotron, as a potential alternative for the existing gyrotron systems for W-7X type machines. This is a logical extension of our earlier work on similar gyrotron operating at 140 GHz [3-4]. During the course of these feasibility studies, we have first carried out the mode selection. Modes with eigenvalues, typically, between 65 and 85 are scanned keeping in view the basic design constraints and considerations. For the mode selection, two important rules are observed to choose a suitable mode. The first one is the mode which supports a dimpled wall quasi–optical mode converter with $\Delta m = 3$ perturbation for azimuthal focussing. For this, one should have a mode with $m/\chi_{m,p} \approx 0.5$ or $360^\circ/\varphi \approx 3$. Another consideration is better stability with respect to competing modes. The numbers indicate that the modes $TE_{28,12}$, $TE_{31,11}$, and $TE_{33,12}$ would be a good choice to work with. In the next step, mode competition is studied and the design of a conventional cavity has been designed for all the three modes. In subsequent steps, single-mode self-consistent and multi-mode time-dependent computations are carried out for cavity output power and efficiencies for all the three modes considered. Glidcop with conductivity $\sigma_{gc} = 2.23 \times 10^7$ S/m (including surface roughness and temperature) as cavity material is used for calculations All the computations are carried out with the latest version of Gyrotron Design Studio [5]. Initial feasibility design studies indicate that such an operation is very much feasible to achieve cavity output powers up to around 2.4 MW with interaction efficiencies ≈ 40 % with the selected modes. Further studies on aspects of RF-behavior are in progress at present.

References

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