OPTIMIZATION OF GYROTRONS WITH THE ACCOUNT FOR AFTER-CAVITY INTERACTION*

Oleksandr V. Sinitsyn, Gregory S. Nusinovich
and Thomas M. Antonsen, Jr.
University of Maryland, College Park, MD 20742 USA

Maximization of the wall-plug efficiency in MW-level gyrotrons is the task of primary importance. To do this, gyrotron developers use depressed collectors of various configurations. For example, the use of a single-stage depressed collector allows one to increase the gyrotron efficiency by about 15-20%.

Recently, a lot of attention has been paid to the role of after-cavity interaction (ACI) in gyrotron operation[1,2]. The ACI may reduce the interaction efficiency by several percent but more critical is the fact that it spoils the energy distribution of electrons in the spent beam. This reduces the efficiency of the depressed collectors.

In this paper we analyze possibilities for reducing this negative effect. In particular, we show that variations of the waveguide wall and magnetic field profiles may result in the enhancement of gyrotron performance. We present results obtained within a simple analytical theory and results of a thorough numerical analysis obtained with the help of the self-consistent, time-dependent code MAGY[3].

We have shown that by proper choice of the waveguide wall and magnetic field profiles it is possible to reduce the effect of ACI and improve the device efficiency. In particular, the wall-plug efficiency increase obtained in our simulations could be about 7%. However, these results have some limitations which will be discussed.

1. E. M. Choi, M. A. Shapiro, J. R. Sirigiri, and R. J. Temkin, "Experimental observation of the effect of aftercavity interaction in a depressed collector gyrotron oscillator," Phys. Plasmas, vol. 14, 093302, 2007.
2. O. V. Sinitsyn and G. S. Nusinovich, "Analysis of aftercavity interaction in gyrotrons," Phys. Plasmas, vol. 16, 023101, 2009.
3. M. Botton, T. M. Antonsen, Jr., B. Levush, K. T. Nguyen, and A. N. Vlasov, "MAGY: A Time-Dependent Code for Simulation of Slow and Fast Microwave Sources," IEEE .Trans. Plasma Sci., vol. 26, pp. 882-892, 1998.

* Work supported by the Office of Fusion Energy of the US Department of Energy.