INFLUENCE OF NON-RESONANT REFLECTION ON MODE COMPETITION IN A MEGAWATT-POWER GYROTRON*

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Gyrotrons are well-known as the sources of the highest power in sub-THz and THz frequency bands. However, one of the main problems is achievement of single-mode oscillation with high efficiency and stable frequency, because modern gyrotrons operate at very high-order transversal modes with dense mode spectrum, where competition with spurious modes can be dangerous. One of the efficient ways is frequency locking by external signal, which has been deeply studied in the recent years, especially after the development of two-channel quasi-optical converter in IAP RAS [1]. The drawback of this method is that one needs special driver gyrotron with extremely high frequency stability and transmission line. The other way is using the reflections from gyrotron's output window in the gyrotron with quasi-optical converter [1] for "self-locking" and frequency stabilization. The effect of the reflected wave on the gyrotron radiation spectrum was studied in a number of papers [2-4].

In this work, we studied the possibility of stabilizing the operating mode frequency under the action of a reflected wave with a sufficiently large delay and in the presence of small harmonic variations of the accelerating voltage.

We consider the numerical model of 170-GHz megawatt-power level gyrotron. Such a gyrotron was developed in IAP RAS [1]. High-order operating mode TE28.12 competes with its sideband satellites TE27.12, TE29.12. In the case of free-running oscillation mode competition can significantly affect the operating mode and achievable efficiency. We assume that the window reflects at the frequency of operating mode.

Equations, describing multimode gyrotron with reflections from non-resonant load in the fixed longitudinal field structure approximation, are given in [4]. The operating current is chosen 45A, which is typical for MW-power gyrotrons. Operating mode TE28.12 has quality factor Q = 1300. The reflection coefficient is 0.35 amplitude-wise, the delay time is equal to 9 ns. Satellites TE27.12 and TE29.12 (Q = 1300) are not affected by reflection.

Our simulations show that reflection provides stabilization of the operating mode frequency at certain interval of magnetic field due to the sufficiently long delay time. The displacement of the reflector within the wavelength leads to a slight shift in the frequencies of stable states and the values of the magnetic field at which transitions between these states occur. Such changes in the radiation frequency depending on the magnetic field and on the distance to the reflector, which are typical for sufficiently large values of the delay time and reflection coefficient, are in agreement with the theory [4]. In the presence of small harmonic variations of the operating voltage, gyrotron with reflection on the operating mode demonstrates significantly smaller variations of the radiation frequency (more than an order of magnitude) than free-running gyrotron. A similar effect we observed at frequency locking of gyrotron by the external signal [5]. Also reflection expands oscillation zones of TE28.12 operating mode and significantly increases orbital efficiency compared to the free-running gyrotron.

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