SELF-CONSISTENT SIMULATION OF FREQUENCY STABILIZATION IN A GYROTRON WITH DELAYED REFLECTION

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ABSTRACT

Gyrotrons are the most powerful radiation sources in subterahertz and terahertz (THz) frequency ranges, which are widely used for various scientific applications. For many of such applications, e.g. for THz spectroscopy, high frequency stability and tunability within 1-2 GHz frequency range is typically required. Along with the existing techniques for control of gyrotron radiation, such as modulation of accelerating voltage (PID feedback control) [1], and modulation-anode voltage [2], using the partial reflection of the output power from a remote load has attracted a considerable interest in recent years since it is much simpler and faster. The influence of reflections on frequency stabilization [3]-[5], extension of the frequency-tuning band [6], and mode competition [7] was studied in numerical simulation as well as in experiments.

In this paper, we present the results of time-domain self-consistent simulation of the second-harmonic 0.4-THz gyrotron [8] with delayed reflection. This gyrotron is used for enhancing the sensitivity of NMR (nuclear magnetic resonance)/DNP (dynamic nuclear polarization) spectroscopy. For the simulations, we apply the nonstationary theory of a gyrotrons with self-consistent RF-field profile. We observe that the injection of the reflected signal leads to decreasing of the start-oscillation currents, especially for the high-order axial modes (HOAMs). Consequently, due to exciting of HOAMs, the frequency step-tunability range expands. At lower magnetic field, strong competition between the fundamental mode and forward-wave HOAMs is investigated. The effects of multistability and hysteresis is studied. The increase of frequency stability by the reflections is also demonstrated.

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