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SUB-TERAHERTZ GYROTRON BASED ON THE USE OF EXTERNAL FREQUENCY-TUNABLE MIRROR*

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For spectroscopic applications, compact sources of continuous coherent radiation of the sub-terahertz frequency range with relatively high (tens of Watts and higher) power are required. Important requirements for such sources are a narrow-band spectrum of the output radiation and, simultaneously, the possibility of smooth broadband frequency tuning, which would make it possible to obtain a spectral picture in a frequency band of at least a few percent. The most attractive sources for terahertz spectroscopy are gyrotrons (electron cyclotron masers based on selective excitation by weakly relativistic electron beams of high-Q quasi-critical modes of open cavities). However, the use of such operating modes in gyrotrons significantly limits the possibilities of frequency tuning.

We describe a project of a frequency-tunable sub-THz gyrotron. To ensure smooth broadband frequency tuning, we propose to implement a scheme based on excitation of different far-from-the-cutoff axial modes of an irregular cavity. The change of the operating mode provides the change of the operating frequency. The selective excitation of each of the modes is provided by reflecting part of the output signal from a narrow-band mirror, which is located outside the gyrotron window (that is, outside the vacuum zone) and “tuned” to the frequency of the excited mode (Fig. 1). The absence in an irregular cavity of high-Q modes that could be excited without external reflection is principally important. In this situation, the frequency of the excited mode is easily changed by mechanical change of the frequency of the external mirror (or even replacing one mirror with another).

The idea of the system shown in Fig. 1 arose after analyzing results of the experiment with a 30 keV/0.7A / 0.39 THz large-orbit CW gyrotron [1]. As a development of this work, we present a design and results of preliminary simulations of large-orbit gyrotrons at the fundamental (the frequency is close to 140 GHz) and the second (~280 GHz) cyclotron harmonics. Simulations predict selective excitation of different axial modes in a wide (~10%) frequency band with a relatively high efficiency of the electron-wave interaction (20-35%).

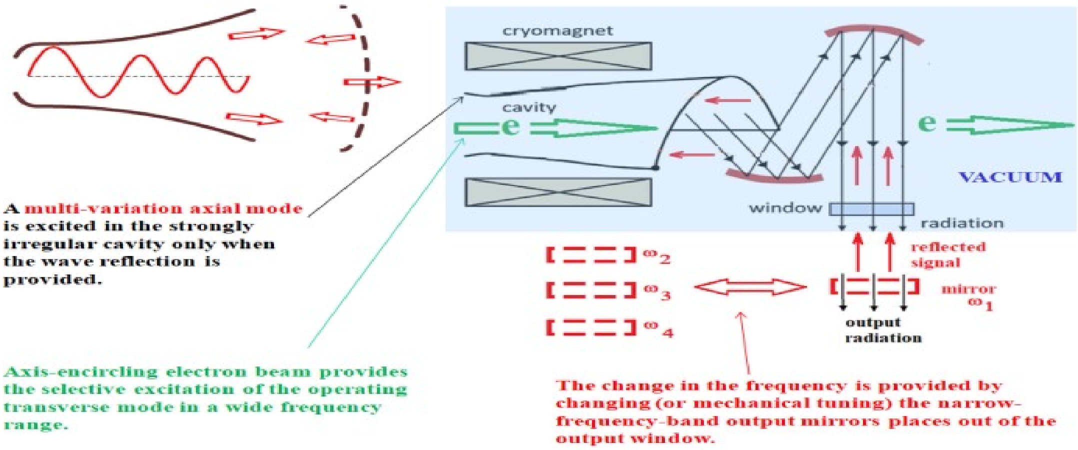

Fig.1. Schematic of the gyrotron with reflections of the excited wave from the external frequency-tunable mirror.

REFERENCES

[1] Yu.M. Guznov, Y.K. Kalynov, I.V. Osharin, A.V. Savilov, “Competition of Spurious Fundamental-Harmonic Oscillations in the Horn Section of a High-Harmonic Gyrotron,” IEEE Trans. Electron Devices, vol. 69, p. 325, 2021.

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