EPJ Web of Conferences **149**, 04037 (2017) DOI: 10.1051/epjconf/201714904037
10th International Workshop 2017 "Strong Microwaves and Terahertz Waves: Sources and Applications"

Influence of weak reflection from a nonresonant load on the operation frequency of the 28 GHz technological gyrotron

A.A. Bogdashov, G.G. Denisov, A.P. Fokin, M.Yu. Glyavin, Yu.V. Novozhilova, A.S. Sedov, A.I. Tsvetkov

Institute of Applied Physics of the Russian Academy of Sciences (IAP RAS) Nizhny Novgorod, Russia, ap.fokin@mail.ru

The frequency of the output radiation of a gyrotron can be unstable because of the fluctuations of the power supply voltage. For several applications of the gyrotrons frequency tunability or frequency stabilization are required. The usual way of frequency variation or stabilization is the control of the accelerating or the modulating voltage [1, 2]; while there exist some other ways to stabilize the frequency of the gyrotron [3] that seem to be promising. In our work we investigate the frequency stabilization of a gyrotron by weak reflection from the nonresonant load. The advantages of his method are the simplicity of reflector manufacturing and absence of complex and expensive fast-acting power supplies.

Experimental setup

In our experiment, we used the continuous wave gyrotron for technological applications with operating frequency 28 GHz at the second cyclotron harmonic. The output power was partially reflected back to the gyrotron cavity by the nonresonant reflector – the ring of the smaller inner diameter, inserted to the output waveguide. The parameters of the ring were selected in such way, that reflection coefficient was 10% for radiation power. Experimental setup allowed the step movement of the reflector in the range of several wavelengths with steps of 2 mm.

For the experiment we limited the beam current at 0.5 A to prevent the excess power reflection back into the gyrotron. The operation point was far from optimal for this gyrotron, and with accelerating voltage of 19.4 kV, the output power is about 2 kW, so the reflector parameters also will not be distorted by thermal losses.

Results of the experiment

Depending on the distance to the reflector, either the frequency stabilization or the increase of the frequency modulation can be achieved. On the Fig. 1. presented the dependence of gyrotron frequency on the magnetic field. In the region of lower magnetic fields (that correspond the optimal region for output power) the presence of the reflector changes the incline, stabilizing the frequency. The spectrum width in the experiment was reduced up to two times and the frequency tenability in range of 3 MHz was achieved.

Along with the change of the dependence of gyrotron frequency on the magnetic field, there is a considerable change of the gyrotron output power with the distance to the reflector.

This can be explained by the change of the Q-factor of the complex resonator, consisting of gyrotron resonator and the waveguide section up to the reflector. The movement of the reflector in the range of wavelength can double the Q-factor, leading to better stability of the frequency.

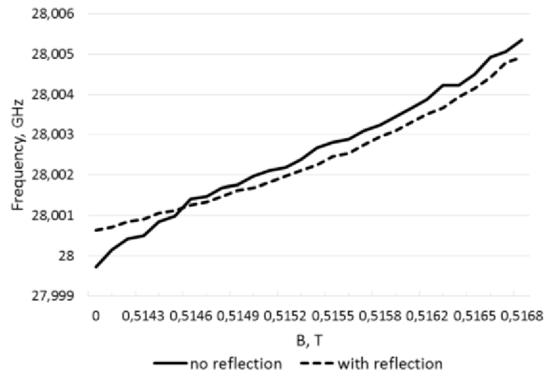

Fig. 1 Experimental dependence of frequency on the magnetic field with and without reflections

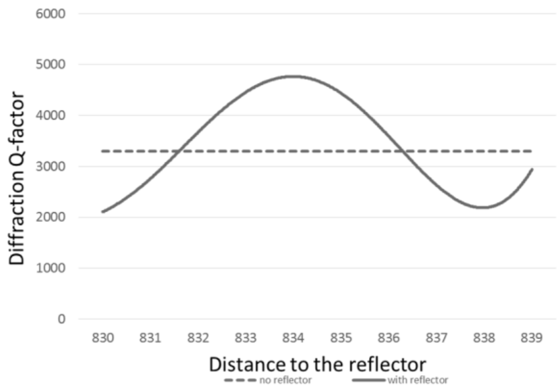

Fig. 2. Calculated dependence of diffractional Q-factor on the distance to the reflector

The movement of the operating point on the interaction length – normalized beam current plane due to the change of Q-factor explains the seeming paradox of gyrotron power increase in presence of noticeable reflection. Such mechanical tunability of frequency and power opens a new way of control over the output parameters of gyrotron radiation.

This work was supported by Council on grants of the President of Russian Federation, project # MK-3452.2017.8

References

1. *Idehara T., Mitsudo S., Ogawa I.,* Development of High-Frequency, Highly Stable Gyrotrons as Millimeter to Submillimeter Wave Radiation Sources // IEEE Transactions on Plasma Science, 2004. V. 32. №3. P. 910-916

2. *G.Yu. Golubiatnikov, et al,* Gyrotron frequency control by a phase lock system // Technical Physics Letters, 2006, Volume 32, Issue 8, pp 650–652

3. *M.Yu. Glyavin, G.G. Denisov, M.L. Kulygin, and Y.V. Novozhilova,* Stabilization of gyrotron frequency by reflection from nonresonant and resonant loads // Tech. Phys. Lett., vol. 41, no. 7, pp 628–631, 2015b.