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MODERN GYROTRONS: ACHIEVEMENTS AND DEVELOPMENT TRENDS *)

[1]Glyavin M.Yu., [1]Denisov G.G., [1,2]Litvak A.G., [1,2]Tai E.M.

[1]*Federal Research Center A.V. Gaponov-Grekhov Institute of Applied Physics of the Russian Academy of Sciences, glyavin@ipfran.ru*
[2]*GYCOM Ltd., tai@gycom-nn.ru*

Gyrotrons are well known as sources of powerful coherent electromagnetic radiation in millimeter and sub- millimeter wavelength band.

The international ITER project is in the stage of construction and in 2024 a decision was made to increase the capacity of gyrotron complexes from 24 MW to 56 MW and, in the future, 80 MW. In the conceptual review of the DEMO project following ITER, increased requirements for gyrotrons were formulated: an increase in power by 1.5-2 times, an increase in frequency by 1.3-1.4 times, and an increase in efficiency to 60%. Such requirements undoubtedly require the solution of a number of scientific and engineering problems. Despite their rather rich history and significant results, gyrotrons continue to be the subject of intensive research.

The brightest achievements of present gyrotrons are: generations of MW power at frequencies up to 0.17 THz in CW mode with plans go to frequencies about 0.23-0.25 THz at the same power level [1,2]; different tubes with operation frequency from 0.01 THz up to 1.3 THz [3]; ability to capture frequency/phase (phased array) [4]; frequency stability better than $3*10^{-12}$ [5]; wide instantaneous gain band (10%); continues frequency tuning – more than octave [6].

The report provides a brief overview of the key results obtained by IAP RAS/GYCOM teams, present some new ideas of formation electron beams with parameters good enough for effective electron beam-microwave energy exchange, methods of mode selection and examples of most attractive gyrotron applications.

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