DYNAMICS OF AXIAL MODE COMPETITION IN THE GYROTRON BACKWARD-WAVE OSCILLATOR

Department of Physics, National Tsing Hua University, Hsinchu, Taiwan

S. H. Chen
Department of Physics, National Changhua University of Education, Changhua, Taiwan

The dynamics of axial mode competition in the gyrotron backward-wave oscillator (gyro-BWO) has been investigated in theory and experiment. Because of the difference in field-shaping processes, the axial modes of the gyro-BWO each exhibit a distinctive asymmetry in field distribution along the axis. Multi-mode particle simulations reveal a consistent pattern of axial mode competition in which a fast-growing and well-established mode is subsequently suppressed by a slowly-growing mode with a favorable field profile. This is verified in a Ka-band gyro-BWO experiment. A detailed time-frequency analysis of both the simulation and experimental results further suggests that the competitiveness of a specific mode depends more on its field structure than on its initial growth rate. This perspective is expected to add a new basis for the understanding of mode competition phenomena in the gyro-BWO.


FIRST OBSERVATION OF THE CHAOTIC OSCILLATIONS IN THE K-BAND GYRO-BWO

Roman Rozental, Mikhail Glyavin, Naum Ginzburg, Alexander Sergeev
Institute of Applied Physics, Russian Academy of Sciences 603950, Nizhny Novgorod, GSP-120, 46 Ulyanova str., Russia

In the paper the results of the theoretical and experimental studies of the non-stationary dynamics of the sub-relativistic K-band gyro-BWO with external reflections are presented. The gyro-BWO is an attractive source of powerful microwave signals due to frequency tunability, which can be realized by varying the magnetic field or the beam voltage. From the other hand, in comparison with conventional Cherenkov BWO, cyclotron emission does not require slow-wave system with period less than the wavelength.

For reducing the bifurcation currents, corresponding to the transition to the non-stationary regimes, the delayed feedback, formed by the additional reflector installed at the output waveguide section was used. The transition to the periodic and chaotic oscillations regimes were obtained by the variation of the guiding magnetic field. According to theoretical considerations the gyro-BWO dynamics strongly depends on the phase of the reflecting signal, which determined by the operation frequency and, thus, by the value of the guiding magnetic field. For example, the phase variation could change the self-modulation frequency, which was observed experimentally.

The maximum output power of chaotic oscillations amounted 100 W at the central frequency near the 24.6 GHz and spectrum width of about 100 MHz. It should be noted, that gyro-BWO has a potential of increasing the operating frequency and output power with relatively high efficiency of 10-20%.


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