S3-O-045201

DESIGN AND EXPERIMENTAL TESTING OF W-BAND PLANAR SURFACE-WAVE OSCILLATOR DRIVEN BY SHEET HIGH CURRENT RELATIVISTIC ELECTRON BEAM *

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In [1, 2] a surface-wave oscillator (SWO) of planar geometry have been described. In this configuration the use of a planar waveguide with one corrugated wall and open along the x axis (Fig. 1a) makes it possible to provide mode selection in two transverse coordinates. In this case using of sufficiently wide (on the wavelength scale) sheet relativistic electron beams can provide monochromatic radiation with a power of several tens of megawatts in the short-wavelength part of the millimeter range.

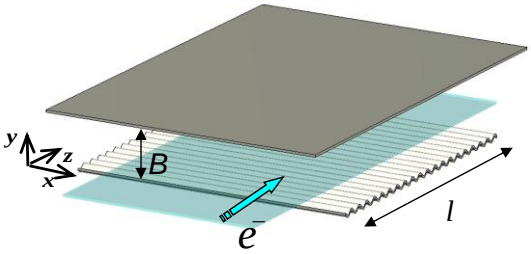

Fig.1. Schematic of the interaction space of SWO driven by a rectilinear sheet electron beam.

This paper is devoted to theoretical and experimental studies of W-band planar SWO. In simulation we use both the quasi-optical approach [2 – 5] and direct 3D PIC modeling. The research parameters were chosen close to the parameters of the experiments currently being carried out on the basis of the "SINUKI" accelerator (IAP RAS, N. Novgorod). The oscillator is designed for the operation frequency 75 GHz. The device is driven by 20 mm wide sheet electron beam with a thickness of 1 mm and current 1 kA and electron energy 0.7 MeV. A sinusoidal-profile grating with a period of 1.6 mm, a groove depth of 0.46 mm, and length of 20 periods was assumed. A modeling of the nonlinear dynamics showed that the use of an "open" electrodynamic structure with the transverse width of about 20 mm leads to the establishment of a stationary single-frequency π-mode regime with the output radiation power 40 MW.

In the experiment, the sheet electron beam was injected from a blade cathode and guided by uniform 3 T magnetic field. 1 kA sheet beam with transverse dimensions of 20 × 0.7 mm2 was obtained. The beam was aligned parallel to the grating surface in order to minimize the distance between the beam and grating, as well as to minimize the beam interception. The microwave generation with a frequency of about 75 GHz was registered by microwave detector; measured pulse duration was about 4 ns. The output power measured by the calorimetric method was about 25 MW which is in a satisfactory agreement with the theoretical predictions. The important specific of the experimental set-up is the use of high efficient side wall absorber for realization of open edge configuration.

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* The work is supported by Russian Federation program "Development of equipment, technologies and research in the field of atomic energy use in the Russian Federation for the period up to 2024" (IAP RAS Project No. 0030–2021-0027).