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HIGH-CURRENT PLASMA MASER PROJECT *)

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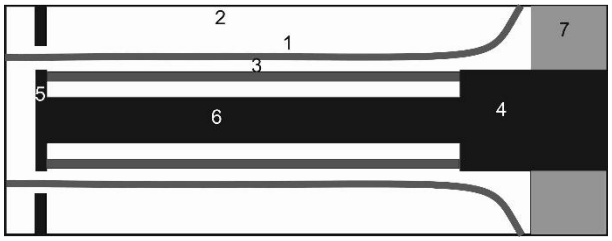
The results of computer simulation in the KARAT environment of a plasma maser - a self-oscillator of microwave pulses at a gigawatt power level with a pulse duration of up to 60 ns and a generated frequency bandwidth from 1.5 to 6 GHz are presented. The parameters of the relativistic electron beam (REB) correspond to the parameters of the pulse-periodic high-current electron accelerator "Sinus 550 80": 550 kV, 14 kA (40 Ohm), 80 ns, pulses with a frequency of 50 Hz for 1 s.

The configuration of the computational model shown in the figure corresponds to a plasma maser with a double coaxial plasma-metal waveguide. A maser of a similar design was successfully implemented in an experiment [1]. An electron beam (1) with a diameter of 9.5 cm propagates in a solenoidal magnetic field of 1 T in a chamber (2) with a diameter of 12.8 cm and settles on its walls.



Plasma (3) with a diameter of 8.8 cm is limited on the right by the central electrode of the output coaxial waveguide (4) with a diameter of 9.1 cm, and on the left by a disk (5) fixed to the electrode (4) using a rod (6) with a diameter of 6.8 cm. On the right the model is limited by the microwave absorber (7) and the end wall of the chamber (2), functionally simulating the output horn and electrode mount (4) in the experimental setup.

The configuration of a plasma maser shown in the figure with a central rod (6) on which a plasma-limiting disk (5) is fixed allows not only making the electron current equal to the optimal value for plasma masers - half the limiting transport current in a vacuum. An equally important factor is to eliminate the causes of the “microwave pulse shortening effect” inherent in all microwave electronics devices at sub- and gigawatt power levels. In experiments with microwave pulses of gigawatt power and duration of tens of nanoseconds, this effect must be specifically prevented. The main reason for the disruption of microwave radiation from plasma masers is the passage of a significant part of the reverse REB current through the plasma [2]. This kiloampere current heats up plasma electrons to ~ 100 keV within 20...30 ns, disrupts their grouping and disrupts the process of effective Cherenkov interaction with REB electrons. In the configuration shown in the figure, the reverse current of the REB does not have a path of return to chamber (2) through the plasma, therefore the main reason for the shortening of the pulse is absent.

References

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*) abstracts of this report in Russian