DOI: 10.34854/ICPAF.52.2025.1.1.205 NEUTRALIZATION OF THE KILOAMPERE REB OF MICROSECOND DURATION IN PASSING INSIDE A THIN PLASMA CORD *)

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In order to carry out research on the generation of terahertz radiation during relativistic electron beam (REB) intensive interaction with magnetized plasma [1], it is necessary to ensure neutralization of the beam magnetic field by a plasma current, it is the so-called current neutralization (see [2] and the literature cited there). The report presents the results of a series of experiments on registration of the current induced in a thin (2.6 cm in diameter) extended (about 40 cm in length) plasma cord during injection of a 6-kiloampere REB of microsecond duration into it under a condition the induction of a leading magnetic field is about 4 T. The plasma column is created by a high-current (~12 kA) high-voltage (25 kV) discharge under conditions of fast injection of hydrogen through special nozzles with use of pulse valves. The nozzles are installed at the ends of a 40 mm diameter quartz tube and inject gas into it as a rapidly propagating counter flows. The filling time of the quartz tube is about 5 ms. There are ring electrodes, providing the discharge current flow when a voltage pulse is applied, mounted in the specified nozzles. The voltage pulse is applied from a 4 µF storage capacitor through a controlled spark gap of type RU-65. When the spark gap was triggered, a gas breakdown occurred in the quartz tube. During the experiments, the following currents were measured: the current from the storage capacitor, the current in the quartz tube and the currents flowing from its ends were measured. The measurements of the currents showed that the current from the capacitor has an oscillating nature with a current amplitude up to 12 kA and a period of 16 µs with a characteristic attenuation time of 50 µs. The time dynamics of the other currents follows the changes in this current. To record the geometry of the formed plasma cord a fast optical camera was used, and its density is measured by a laser interferometer at a wavelength of 10.6 µm. In discussed experiments for injecting in plasma cord beam generated in a magnetically insulated diode of a U-2 accelerator at voltage of 0.5 MV was used. This beam after transformation and compression of its cross-section, has the following parameters at the plasma cord input: beam current of about 6 kA, beam diameter of 20 mm, pulse duration at half-height of 4 us. The REB injection was performed at different time moments in relation to the beginning of the high-voltage discharge current flow and at different conditions of pulse gas puffing that largely determined circumstances of its neutralization by plasma current.

Optimal conditions for gas puffing and discharge current passage resulting in neutralization of the REB by the plasma current, which is important for generating a flux of terahertz radiation during intensive interaction in the beam-plasma system were found based on the results of the carried out experiments.

References

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^{*)} abstracts of this report in Russian