S5-P-031801

PARAMETERS OF A PARAXIAL MAGNETIZED BUNCH OF RUNAWAY ELECTRONS*

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It has been recently demonstrated [1] that the flux of run-away electrons (RAEs) in a short (6 mm) air gap with a sharp conical cathode represents a thin divergent layer with a duration of paraxial fraction of no more than 10 ps. Behind the anode collimator with a hole diameter of 1 mm, the current and current density achieve ≈ 200 mA and ≈ 25 A/cm^2, respectively. For excitation of optically active media, radiation effect onto materials, calibration measurements, etc., these parameters can be increased by applying a strong longitudinal magnetic field limiting the transverse dimension of the RAE flow. In this case, when using an extended gas gap, by increasing the distance and time of RAEs acceleration, selecting the instant of their emission and the rate of the voltage rise, electrons acquire an increased energy at the anode. This approach has been demonstrated to obtain magnetized tubular RAE flows [2, 3], and then a conical cathode 30 mm away from the anode was used [4]. This communication presents the methods for diagnosing of a dense paraxial magnetized RAE bunch, its spatiotemporal and energy characteristics.

The instant of RAE emission is estimated from the dispersion minimum for the "delay" between a variable trigger point of the oscilloscope at the front of accelerating voltage and the front of electron current pulse [5]. A collector sensor behind a thin anode foil is used to determine the width of the RAE bunch.. In a longitudinal magnetic field of 1 – 4 T, the change in the bunch radial size requires the use of collector with a diameter of ≈10 mm. The time response of such a sensor and its prototype with a collector diameter of 5 mm was compared [1]. Data are given on the change in the bunch characteristics (amplitude - front - duration of the current pulse at half-height) depending on the recording bandwidth of the oscilloscopes which reached 60 GHz. The data show that paraxial magnetized RAE bunch has the width on the order of 10 ps. After the drift of such a short bunch behind the anode foil, the electron energy distribution was constructed by time-of-flight method. These data do not contradict the presence of a high-energy component of the bunch which was also confirmed by the method of filters that cut off slow particles.

The RAE flow is visualized by the phosphor glow which is photographed with an open shutter. This gives approximate data on the transverse structure of the bunch, since the phosphor glow intensity from the current (charge) and electron energy is not calibrated. However, visualization is indispensable when alignment the electron bunch which is required to determine the charge distribution in the transversal cross section of the bunch using anode diaphragms with the holes of different diameters. Note we are talking about the charge, since the bunch width can be comparable to or less than the time the charge drains from the current probe collector. That is, for an open collector aperture and in the presence of a small diameter collimator, different current durations will be recorded. This circumstance was considered when obtaining the dependences of the bunch current density on radius for several values of a longitudinal magnetic field. For example, at an induction of ≈ 4 T, in a central part of the bunch (0.7 mm in diameter), the current density exceeded 0.6 kA/cm^2.

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* In the part of development and calibration of a fast-response e-bunch probe, the work was supported by the RSF under Project 21-19-00260..