SPECTRUM RADIO-FREQUENCY OSCILLATIONS GENERATED WHEN THE PLASMOID GYRORESONANCE INTERACTIONS IN A LONG MAGNETIC MIRROR [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2020.47.1.129

Andreev V.V., Novitsky A.A., Umnov A.M.

RUDN University, Moscow, Russian Federation, [temple18@mail.ru](mailto:temple18@mail.ru)

The possibility of generating long-lived plasma bunches with an energetic electron component under conditions of gyromagnetic autoresonance in the magnetic field of an extended mirror trap in the regime of a reverse magnetic field has been shown previously [1, 2]. The aim of this work was to study the spectrum of LF and HF oscillations generated by plasma bunches created and held in the working volume of a high-frequency resonator. The registration of electrostatic oscillations in the plasma was carried out using two flat electrodes mounted diametrically opposite in the central part of the resonator in its wall region. The motion of the bunch inside the resonator leads to an induced time-varying charge on the electrostatic probe and current through the load resistor. The oscillation spectrum in the microwave range was recorded at the minimum of the magnetic induction of the mirror using a waveguide antenna. The time and parametric dependences of the frequencies and amplitudes of the recorded oscillations on various discharge conditions were recorded. Microwave signals were processed using a Tektronix RSA-6114A spectrum analyzer. Processing waveforms from electrodes using the fast Fourier transform method showed the presence of low-frequency oscillations with frequencies of 130 kHz and 450 kHz at a pressure of   
P = 1 ∙ 10-5 Torr, which are observed in the final stage of autoresonant acceleration. A comparison of the LF oscillations with the fluctuations in the intensity of the bremsstrahlung detected in the transverse direction, as well as the signals of the PMTs recorded in the region of the trap minimum, shows that they are interconnected and are observed synchronously at the moment the bunches shift to the registration region. Microwave signals (2.28 GHz and 4.52 GHz) are also recorded at a given point in time; a broadening of the spectrum is observed with increasing pressure of the working gas. Radiation at a frequency of 4.52 GHz is recorded in the trap at the end of the microwave pump pulse.

Along with the experimental study of long-lived plasma bunches generation, a three-dimensional computer simulation of this process was carried out using the particle- in-cell method. It is shown that there are fluctuations in the density of the bunch with a frequency of 70 - 82 MHz, associated with bounce oscillations of the energetic electronic component of the bunch. The spectrum of oscillations of a bunch formed after the dumping of local bunches at the center of the mirror is apparently much wider (more diverse) than those described above. The parameters of the formed bunch (density, shape, volume, energy spectra of the plasma components) vary in time, which was recorded both experimentally and in numerical simulation. For full-scale computer simulation, it is necessary to combine the excitation of oscillations with the nature of the gyroresonant interaction of the electrons of the initial plasma, taking into account the ion component and the bunch parameters dynamically changing in space and time.

This work was financially supported by the RFBR grant No. 18-29-21041.

Reference

1. Andreev V.V., Novitskiy A.A., Umnov A.M., Chuprov D.V. Instruments and Experimental Techniques. 2012. Т. 55. № 3. С. 301-312.
2. V.V. Andreev, A.A. Novitsky, A.M. Umnov IOP Conf. Series: Journal of Physics: Conf. Series 1094 (2018) 012013

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVII/Lt/ru/FE-Umnov.docx) [↑](#footnote-ref-1)