Well-directed Megawatt Flux of THz Radiation Generated by Relativistic Electron Beam in Magnetized Plasma Column with Strong Density Gradients

A.V. Arzhannikov[1,2], I.A. Ivanov[1,2], A.A. Kasatov[1,2], S.A. Kuznetsov[1,2], M.A. Makarov[1], K.N. Kuklin[1], S.S. Popov[1,2], A.F. Rovenskikh[1], D.A. Samtsov[1,2], E.S. Sandalov[1,2], S.L. Sinitsky[1,2], V.D. Stepanov[1,2], V.V. Annenkov[1,2], V.V. Glinsky[1,2] and I.V. Timofeev[1,2]

[1]BINP SB RAS, 630090, Novosibirsk, Russia

[2]Novosibirsk State University, 630090, Novosibirsk, Russia

Generation of THz radiation due to development of the two-stream instability of relativistic electron beam was observed as emission from Sun surface [1] and as a flux from a beam-plasma system at laboratory experiments [2]. Such experiments at the GOL-PET facility are carried out for the following parameters. A beam with the typical energy 0.8 MeV, current 15 kA and duration 6 μs is injected into a plasma with the diameter 6 cm, length 2.5 m and density~10^{15} cm^{-3}at the magnetic field 4.7 T [3]. First series of experiments at this set of parameters showed that emission from the beam-plasma system was mainly concentrated in a flux directed along the axis of the plasma column. Next series of the experimental studies have been focused on the influence of strong plasma density gradients on the generation of this flux. The maximum of the flux spectral power density is found to be located in the 0.2÷0.35 THz range containing the plasma and upper-hybrid frequencies. In these experiments, the increase in the plasma density gradients has been accompanied with the growth of the radiation flux power by a factor of 30 up to the level of about 10 MW. We explain the observed power increase in the presence of periodic-like density gradients by the linear mode conversion of the most unstable plasma oscillations excited at a Doppler shifted beam branch into electromagnetic waves having the same frequency in lower density parts of the plasma column.

References

1. P. Kaufmann et al. Astrophysics Journal. 603, L121–L124, 2004.
2. A.V. Arzhannikov et al., IEEE Trans. Terahertz Sci. Technol. 6, 245 (2016) DOI: 10.1109/TTHZ.2016.2525783.
3. A.V. Arzhannikov et al., //Plasma Phys. and Contr. Fusion. 2020. Т. 62. №. 4. С. 045002.

* Work is partially supported by the Russian Scientific Foundation (# 19-12-00250).