Contribution ID : **173** Type : **Poster**

Simulation of self-focused electron beam in a pyroelectric accelerator

Thursday, 1 December 2022 13:00 (15)

When the temperature of the pyroelectric single crystal changes, X-ray generation is possible. To obtain the above effect, it is necessary to change the temperature of the crystal in vacuum (pressure on the order of several mTorr). Under such conditions, an electric field arises between the grounded target and the crystal surface, which causes the field emission of electrons from the crystal surface [1]. This opens up prospects for using pyroelectric crystals as compact electron accelerators. An accelerator based on a lithium tantalate ($LiTaO_3$) crystal with a surface charge of 1200 nC is capable of generating electron beams with an energy of about 20 keV.

It was shown in [2] that due to the non-uniform charge distribution on the pyrocrystal surface, the electric field lines converge at one point. This feature allows us to suggest the possibility of the presence of the self-focusing effect in the pyroaccelerator. This hypothesis was tested using numerical simulation based on the finite element method.

It was assumed that the emission occurs from the surface of the crystal. The simulation results confirmed the self-focusing hypothesis. The dependence of the maximum electron energy on the emission point and the focal length on the radius on the crystal surface are obtained. The electron spectrum obtained is consistent with the experiment.

The simulation made it possible to elucidate the radiation characteristics, which are difficult to find experimentally. The model was verified. The trajectories of electrons and their energies agree well with experiment and theory. The theoretically predicted non-uniform charge distribution and self-focusing are confirmed. Simulated monoenergetic electron flow in a pyroelectric accelerator can be used for calibrations of different particle detectors facilities.

The work was supported by the grant from the Russian Science Foundation (project №21-72-00006).

[1] Kubankin A. S. et al. Optimal speed of temperature change of a crystal in a pyroelectric X-ray radiation source // AIP Advances. 2018.

[2] Ghaderi R., Davani F. A. Determination of surface electric charge profile in pyroelectric crystals // Applied Physics Letters. 2014.

Primary author(s) : SHAPOVALOV, Pavel (National Research Nuclear University “MEPhI”, Moscow, Russia)

Co-author(s) : OLEINIK, Andrei (Laboratory of Radiation Physics, Belgorod State University, Belgorod, Russia); KLENIN, Artemiy (Laboratory of Radiation Physics, Belgorod State University, Belgorod, Russia)

Presenter(s) : SHAPOVALOV, Pavel (National Research Nuclear University “MEPhI”, Moscow, Russia)

Session Classification : Poster Session

Track Classification : Facilities and advanced detector technologies