APPLICATION

for participation in the JINR Prize Competition 2024

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**The title of the series of articles**

«Study of the processes of generation of coherent radiations in interaction of relativistic charged particles with radiator targets and their application for accelerator beam diagnostics»

Topic 1087: "Research on Relativistic Heavy and Light Ion Physics. Experiments at the Accelerator Complex Nuclotron-M/NICA at JINR and CERN SPS," the activities " Fundamental and applied research with relativistic electron beams in the framework of FLAP collaboration" and "Investigation of deep subthreshold processes, applied and educational programs at MARUSYA set up".

**Abstract:**

The charged particle beam diagnostics are an integral part of modern accelerator facilities. Currently, the process of obtaining a license for the operation of the LINAC-200 linear electron accelerator from the supervisory authority is ongoing. An important stage of commissioning work is the preparation of diagnostic systems and measurement of electron beam parameters that will be required by the users of the facility for the planning of experiments.

The series of articles is devoted to the study of the interaction of relativistic charged particles with different radiator targets. As a result of the interaction of the field of relativistic charged particles with the radiator target, depending on the geometry of the experiment, the material of the target and its configuration, one or more types of polarization radiation may be generated: diffraction radiation, Transition radiation, Cherenkov radiation etc. These radiation types are well known and to varying degrees used for the charged particle beam diagnosis. In addition, the interaction of relativistic electrons with a radiator target leads to the generation of neutrons.

The series of articles is a set of theoretical and experimental works carried out within the framework of FLAP collaboration. The theoretical calculations and modelling results are based on the method of polarization currents, developed over many years by a theoretical group under the leadership of Professor A.P. Potylitsyn. The results obtained in experiments at CESR showed good agreement with theoretical predictions. In the experiment on observing incoherent Cherenkov diffraction radiation from colliding beams (electrons and positrons) passing in close proximity to a quartz target, it was shown that by the choosing a suitable polarization, it is possible to accurately determine the transverse beam sizes.

On the basis of the MARUSYA facility in the SPD test zone of the NICA accelerator complex, it is planned to conduct joint experiments with Tomsk Polytechnic University to observe the monochromatization effect of optical Cherenkov radiation generated by an accelerated ion beam in a radiator target with frequency dispersion. Theoretical background of the experiment is the modelling results carried out based on analytical calculations according to the polarization current method. The results obtained in the course of these studies will allow to evaluate the possibility and efficiency of using this effect as a tool for ion beam diagnostics (measurement of ion energy dispersion). Test measurements have been carried out at Nuclotron in 2023. The experimental setup has been prepared for experimental investigation of this effect during the nearest upcoming run of the LHEP accelerator complex.

During the commissioning work on the LINAC-200 accelerator, studies of coherent transition radiation (CTR) in the prewave zone from the target of finite sizes were carried out. The analysis of simulation results for experimental conditions and experimental data allowed to estimate the electron bunch duration of LINAC-200. The possibility of using coherent diffraction radiation (CDR) as a source of terahertz/subterahertz radiation is theoretically considered. To achieve maximum CDR intensity, a semi-parabolic target with a focal distance equal to the distance between the target and the collimator aperture is proposed. Modeling of the CDR spectral characteristics depending on the parameters of the accelerated electron beam was carried out.

Thus, the series of articles represents a combination of theoretical and experimental works devoted to the study of the interaction of relativistic charged particles with radiator targets and the possibility of using the resulting radiation as both a diagnostic tool for charged particle beams and a radiation source.