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REVIEW

"Experiment BECQUEREL at Accelerator Complex NUCLOTRON/NICA"

(Topic number 02-1-1087-2009/2020, for the period 2020-2022)

The report is based on the proposal of the Becquerel project and conclusion of the meeting of NTS LHEP (19. November 2019). The proposal provides detailed information about the present situation of the project, achieved results in the last period of 5 years, planned activities up to 2023, description of research team and detailed budget of the project.

The main tasks of the proposed project is application of the Nuclear Track Emulsion (NTE) technology to study the fragmentation of light (medium), and heavy nuclei and performing measurements with relativistic muons. Tests are planned at CERN, GSI, BNL and JINR.

Project uses NTE layers produced by company located in Pereslavl Zalessky in Russia. The thicknesses of NTE layers on glass base are 50 or 200 μm. At present, production of NTE layer (without glass base) of 500 μm started. The dimension of module is up to 10 x 20 cm^2. The spatial resolution of interaction vertex is at the level of 0,5 μm.

To reach planned tasks there are proposed two technical improvements:
1) Improve already used three precision KSM microscopes (made half a century ago by Carl Zeiss, Jena) by adding the automatic system of reading of three coordinates of tracks. This development is carried out in the Radiation Dosimetry Department (Prague) under the project "Nuclear emulsion in applied problems" within the framework of the JINR-Czech Republic cooperation program. Such system cost is about $ 5000.

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2) To buy the Olympus BX63 motorized microscope. Estimated price is $ 80 000.

NTE technology is very old. Many other techniques used in track recognition is used - Multi-wire proportional chambers, Micro-pattern gaseous detector, pixel detectors, optical TPC. An ideal directional detector would be capable of reconstructing the nuclear recoil track in three dimensions, with high spatial granularity and angular resolution and also providing information about energy of registered particles. The spatial and angular resolutions achievable with NTE are determined by size of the silver crystal and density. A super-high-resolution nuclear emulsion called the ''Nano-Imaging Tracker'' (NIT) was developed at Nagoya University (Japan) in 2010. The mean crystal size in the NIT is 40 nm. Important aspect of the whole device is quality of optical microscopes (the efficiency of the signal detection, the discrimination between signal and background). Also automatic procedure for track recognition is crucial making optical microscopy attractive. NTE covers broad range of application, such as measurement in proton therapy, detection of cosmic ray muon flux, identification of protons in laser ion accelerator experiments, detection of cold/ultracold neutrons.

The budget of the project is limited (the total budget for three years, 2021-2023, is 180 000 USD). 45 000 USD is devoted to buy small equipment and materials, 60 000 USD to cover local trip expenses and 60 000 USD for trip to abroad. The project plans to use 50 hours of working time of Nuclotron per year.

NTS LHEP discussed this project on the meeting (11 of November, 2019) and the decision of NTS is to open this project up to 2022 with highest priority.

I would like to clarify the following questions:

1) What is the comparison of the quality of NTE used with one produced by Japanese Nagpya university?

2) NTS proposed to support the project up to 2022. But proposal of project is prepared for period of 2021-2023. What is the consequence of such discrepancy for the tasks of project?

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Project includes interesting physical program, but my opinion is that it is not ambitious enough. As a result of the review, I suggest to finance realization of the project **"Experiment BECQUEREL at Accelerator Complex NUCLOTRON/NICA"** in year 2021. The support for year 2022-2023 should be discussed on the next meeting of PAC for nuclear physics.

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