REFEREE REPORT

on the project

Studying neutrino properties in accelerator experiments

Neutrino physics is a field of research which has a great importance for our understanding of Nature. Neutrino experiments attract attention of physicists all over the world and involve thousands of people in international collaborations.

The accelerator neutrino experiments possess a number of advantages compared with other methods. Many parameters are under control in these experiments: energy spectrum of the beam neutrinos is known, change from neutrino to antineutrino beam is possible, background is reduced due to synchronization of the data with the accelerator pulses. Not all of these features are available in the reactor or cosmic neutrino experiments.

Accelerator neutrino experiments may give an answer to principal questions: what is the neutrino mass ordering, and what is the CP violation phase? The answer could come from study of the neutrino oscillations in long-baseline neutrino experiments. At present only rather weak limits are set for these quantities.

The JINR physicists have a long story of participation in accelerator neutrino experiments, the first of them being “Neutrino detector IHEP-JINR” in 1980s in Protvino. Then JINR has made an important contribution to experiments NOMAD (CERN) and OPERA (CERN/LNGS). The current project combines several state-of-the-art experiments, NOvA, T2K, DsTau and FASER, facilitating exchange of ideas and methods of analysis.

Each of these experiments has its own peculiarities and specific tasks but any of them will give a valuable information about the properties of neutrino. NOvA and T2K are studying three-flavor oscillations at long bases using off-axis neutrino beams from Fermilab and J-PARC, respectively. Their results on the neutrino and antineutrino oscillations will provide more precise data on neutrino mass ordering, CP violation phase δ_{CP}, neutrino mass splitting Δm^2_{32}, and the mixing angle θ_{23}.

The JINR group joined the NOvA collaboration in 2014 and since then has made serious contributions in hardware, software, oscillation analysis and other physics analyses. It is worth noting the creation in JINR a Remote Operation Center (ROC) that allowed the JINR scientists to participate in real time in data taking of the experiment. The JINR scientists are also involved in management of NOvA occupying positions of conveners and experts in different fields.

The JINR group has been participating in the T2K experiment since 2020 and contributed to upgrade of the near detector and to analysis of some selected processes. Joint analysis of the NOvA and T2K data, which has started already, will add new knowledge because both experiments complement each other in the oscillation analysis due to different baselines.

The FASER experiment, which uses neutrino from LHC, can cover unexplored until now region of very high energy neutrino, up to a few TeV. Neutrino of such (and even higher) energies were available only in the cosmic ray large-scale facilities (Baikal-GVD, IceCube, KM3NeT/ARCA). The cross sections of neutrino interaction of all flavors measured at FASER would give a valuable input to these cosmic neutrino experiments as well as for astrophysics and for search of BSM physics.

The NA65 (DsTau) experiment aims at tau neutrino study. The JINR group participates in NA65 since the beginning of the experiment in 2019, and contributed to data collection, to physics analysis, simulations and development of the software.

The main contribution of the JINR team to all the above experiments will be done in physics analyses, though some works on instrumentation are also planned.

All together, NOvA, T2K, FASER and NA65 are the world-class neutrino experiments, in which JINR has a quite visible position. The results, which are expected to be obtained, are of fundamental character, and for JINR it is very important and prestigious to be among the creators of these results.

The JINR team in the current project is rather large (24 FTE) and well-balanced including both senior and junior scientists. Traditionally, also the PhD and diploma students take part in research of the group.

The experience of the group in neutrino physics experiments is well recognized. The resources requested in the project look reasonable.

I recommend approving the project “Studying neutrino properties in accelerator experiments” with the first priority.

Doctor of science

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