# Referee report on the Project NOvA-DUNE (JINR participation)

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The report given to the Program Advisory Committee of JINR on 21 June 2023 outlines the activities of the JINR neutrino physics researchers on the NOvA and DUNE experiments in the USA, with the aim of a project extension for the years 2024-2026.

Concerning NOvA, the project has been very successful in the last decade in the study of neutrino oscillations with a long baseline configuration. The experiment runs in the USA along the NuMI neutrino beam from Fermilab. Two detectors (made of liquid scintillator calorimeters) are used, one at Ash River in Minnesota, 810 km from Fermilab, and another one only 1 km away from the neutrino production target. The science deliverables of the experiment have been excellent and concerned the understanding of the PMNS mixing matrix. The JINR group started their activities in 2014. Among their contributions, one can highlight the realization in Dubna of the Remote Operation Center (ROC-Dubna). Moreover, the JINR electronics and scintillator test benches provided inputs to simulations and calibration tasks. The JINR group is involved in several data analyses and they plan continue the effort in the next years.

The most notable aspect of this proposal is the involvement of the group in the DUNE experiment, also in the USA, currently in its construction phase. This internationally born project can be considered the ultimate neutrino oscillation detector/observatory, with a scale comparable to that of the LHC experiments and a similar cost, to be operated as a facility for decades. The setup includes four very large liquid argon TPCs placed underground at the SURF laboratory in South Dakota, hit by a neutrino beam produced thanks to the new PIP II accelerator at Fermilab. The large mass of the far detector (altogether nearly 70000 tons of liquid argon) will also provide sensitivity to a series of astrophysics subjects. The main goal of the project, however, is the discovery of the CP violating phase in the PMNS matrix and of the neutrino mass eigenstates hierarchy. The far experimental apparatus (~1300 km away from the neutrino source), as in the case of NOvA, is complemented by a near detector (ND) on the Fermilab site. This will be also centered around a liquid argon TPC detector of novel implementation (the ArgonCube concept), for which the JINR group is pioneering working from the early times with excellent results and strong commitment, despite the issues affecting the participation in person to activities in USA. The group is actually responsible for the realization of the light detection system based on two similar approaches, one of the two proposed, devised and developed by JINR.

Now the NOvA-DUNE group includes 48 heads for a total number of 27 FTEs. The average age of the team is adequate. The total number of young people is good, as well. The construction

activities for DUNE are already underway, e.g., concerning the large scale ArgonCube prototype (the 2x2 demonstrator) which is being to be assembled and operated at Fermilab. The referee appreciates that the number of researchers at the 10% FTE level is negligible. The referee also appreciates the fact the initial DUNE group has played the role of bridgehead in view of additional contributors. This is the case of the involvement in the other Near Detector set up, SAND, for which the past experience of the VBLHEP with straw tubes has been instrumental to set up an effort on some activities related to these devices in DUNE.

Anyhow, due to the current political situation, the group is wisely considering focussing on the NOvA activities and continue working on DUNE at the R&D level.

As a conclusion, the referee welcomes the continuation of the JINR initiative on NOvA-DUNE, stressing that, as soon as the external issues are solved, their effort must be ambitious and commensurate to the size and the complexity of the scientific enterprises.

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