Referee report on the project “NOvA/DUNE”

Nowadays the neutrino physics is considered as one of the most promising subject for the discovery of phenomena beyond the Standard Model. This is mainly due to the special role, which neutrino can play as a unique neutral fermion with a very small, but non-zero mass - the fact, which was recently proved through the experimental discovery of neutrino oscillations.

It is well known that the hypothesis of neutrino oscillations dates back to the idea of Bruno Pontecorvo, who was working in Dubna. The JINR has a very long tradition of developing and studying this phenomenon. In particular, the Institute has made very valuable contributions to the neutrino oscillation experiments like: NOMAD, OPERA, Borexino, Daya Bay and others. The present proposal comprises the JINR participation in NOvA and DUNE, two top-level projects, which are continuing this remarkable list of oscillation studies.

Current goals of contemporary neutrino oscillation experiments are measurements of yet unknown parameters of this process: neutrino Mass Ordering and CP-violating phase and also improving precision of the others. This information is very valuable for understanding the neutrino sector and theory in general.

NOvA is an on-going program in this area, one of the two currently running most powerful accelerator neutrino oscillation experiments. The JINR group is involved in NOvA for many years with various contributions including detector studies and physics analyses. In particular, the team contributed significantly to the main three-flavor oscillation analysis, development of supernova detection methods, magnetic monopole searches, cosmic ray studies, etc.

Working on NOvA the JINR group has paid attention also to the development of the domestic infrastructure: Remote Operation Center for experiment control and running shifts; and the JINR MLIT Computer cluster, which allowed data analyses at Dubna and is also used for Collaboration needs.

Taking into account the JINR successful participation in NOvA and plans of experiment to continue data taking until 2026 (inclusively), the request of the project extension at JINR for three more years looks very reasonable and justified.

With the full dataset NOvA experiment will significantly improve the knowledge of oscillation parameters, however, the discovery goal (>5sigma) on the neutrino Mass Ordering most probably will not be reached. An experiment which will inherit this task using an upgraded NUMI facility and much more powerful detector is DUNE. It is developed now by the large international community as a giant Liquid Argon TPC and other cutting edge technology components.

Participation in such experiment is certainly very honorable but at the same time it is necessary to plan carefully visible contribution to the detector and data analyses.

For the physics analyses in DUNE the JINR team will obviously use an expertise gained in NOvA and for the detector construction two excellent contributions are proposed.

The Near Detector (ND) of DUNE, which is used for normalization of the neutrino flux, will also use liquid argon technique, which will have a module structure due to close position to the neutrino source and expected high rate of pileups. Collection of scintillation light in liquid argon provides good timing of events helping to deal with pileups and matching of events detected in different modules. The JINR (DLNP) group performed R&D for this system and now the development and production of the light collection system for liquid argon modules in DUNE ND is the JINR group responsibility. This includes also the front-end electronics, ADC, power supply system, signal/power lines, DAQ and slow control. The work is well advanced and prototype modules with the light collection system are tested now.

Another proposed JINR contribution is the straw-tracker of DUNE ND. This option was from the very beginning relying on the JINR (VBLHEP) group expertise gained during straw production for ATLAS, NA62, NA64 and others. It is expected that JINR will extend this expertise and keep leading scientific position due to this recognized competence. Some R&D was already carried out by the JINR group and it is proposed to have an extensive design study and prototype testing during coming years as well as special R&D devoted to the straw-tracker production technology.

Noteworthy mentioning that the straw-tracker technology is of a general interest and can be applied elsewhere. For example, NICA SPD detector is also planning to use this option.

To summarize, the proposed extension of the project looks to me well motivated and justified scientifically. The proposal is based on the existing JINR expertise and plans to extend it making visible contribution to the detector construction and physics analyses. I recommend supporting this proposal with the highest priority.

Dr. Vladimir Karjavine

Head of Department
JINR