«Study of Neutrino Oscillations in NOvA experiment»

(JINR Participation)

Project extension for the period 2018-2020

02-2-1099-2010/2018 Study of Neutrino Oscillations (Project NOvA)

Authors from JINR

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Abstract

With the discovery of a non-zero θ_{13} mixing angle the neutrino physics has entered a new era of tackling the problems of neutrino mass hierarchy and lepton CP violation. Both questions can be addressed in accelerator-type long baseline experiments through the measurement of matter effects in atmospheric-regime neutrino oscillations.

NOvA is a new generation experiment studying oscillations of muon to electron flavor neutrinos. The NOvA apparatus consists of a Near Detector at the Fermilab site, where the muon neutrinos are produced by the NuMI facility, and a Far Detector placed 810 km away. Both detectors are of similar construction based on a large-volume liquid scintillator tracking calorimeter, and both are situated 14 mrad off-axis to the neutrino beam, optimizing the signal to background ratio.

The complete 14 kton Far Detector and 220 ton Near Detector have been taking data since 2014, and a number of important measurements have been performed on the basis of statistics collected so far: a ν_e appearance signal measurement has allowed for the restriction of the hierarchy-δ_{CP} parameter space, a ν_μ disappearance signal was measured confirming oscillation parameters Δm^2 and $\sin\theta$ with high precision, moreover, from the NOvA data the θ_{23} maximal mixing was excluded for the first time with ~3σ confidence level.

Continuing the data collection, and importantly, altering neutrino and anti-neutrino beams, NOvA can unambiguously resolve the neutrino mass hierarchy at >95% C.L. for over a third of possible values of δ. For other values of this CP violation parameter, NOvA will provide δ-dependent hierarchy determination plus improved measurements of θ_{13}, θ_{23}, $|\Delta m^2_{23}|$, and δ itself, which is also very important for global analysis of the neutrino oscillation data.

The JINR group in NOvA has contributed significantly to the NOvA results. The Remote Operation Center (ROC-Dubna) was developed at JINR, giving the possibility to fully participate in the data taking and quality monitoring. The JINR computer infrastructure on the basis of GRID and Cloud technologies was developed. It is efficiently used for the home-based running of jobs and is also a part of the NOvA distributed computing resources system for the use at peak loads (e.g., before conferences). The NOvA electronics test bench was set up at JINR and provided important measurements of electronics parameters used for simulation and calibration.

Members of the JINR group are deeply involved in the ongoing analyses and in the preparation of new ones. This comprises the ν_μ, ν_e, Supernova, Slow monopole, Cosmic Ray and Near Detector physics teams. They are also involved in the development of simulation and analyses software, and are serving as a Detector Simulation convener, Offline and DAQ Software Release Managers, DAQ, DDT and ROC experts, etc.

Further running of the NOvA experiment will provide very competitive data for the measurement of neutrino mass ordering, CP-violation effects, disentangling the octants of θ_{23}, among many others. There are also plans to extend NOvA data collection beyond 2020, which will further increase the physics potential of this experiment.

The JINR team is planning to continue and extend its involvement in the NOvA data taking and analyses. As a part of this work we are planning maintenance of ROC-Dubna and the hardware test bench facility, as well as a further increase of the NOvA computing power at JINR to cope with the large amount of data, and the continuation of the aforementioned analyses.

The work of NOvA at JINR attracts a lot of attention from students and young staff, which provides a good potential for growing and extending the JINR participation in this excellent physics.

The requested resources for the project from the JINR budget are: 80K$/year for Materials and Equipment and 50K$/year for visits to FNAL and participation in the conferences and other meetings.