

POSTER PRESENTATIONS BY YOUNG SCIENTISTS IN THE FIELD OF PARTICLE PHYSICS RESEARCH

1. LIMIT ON THE EFFECTIVE MAGNETIC MOMENT OF SOLAR NEUTRINOS USING BOREXINO DATA

A. Vishneva (DLNP)

Neutrino magnetic moment contributes to cross section of the elastic scattering leading to a change in the electron recoil spectrum which is possible to detect in low-threshold neutrino experiments. Liquid scintillation Borexino detector has a high sensitivity to magnetic properties of solar neutrinos due to its unprecedentedly low residual radioactivity level and the energy threshold on recoil electrons about 180 keV. Analyzing the Phase II data of the experiment, a limit on the effective neutrino magnetic moment has been obtained, namely, $\mu_{\text{eff}} < 2.8 \cdot 10^{-11} \mu_B$ (90% C. L.). Using this result, upper limits on magnetic moments of mass and flavour eigenstates of neutrinos have been also obtained.

2. COHERENT PION PRODUCTION IN THE NOVA NEAR DETECTOR

Hongyue Duyang (USC), Sanjib Mishra (USC), Paul Rojas (CSU), Christopher Kullenberg (DLNP JINR)

Neutrinos can occasionally interact coherently with an entire nuclear target. Such interactions can produce a single meson, which will generally have a direction that is nearly collinear with the incoming neutrino. The NOvA collaboration is performing multiple analyses to measure the cross-section for such interactions, as they can pose a background to electron neutrino appearance in long baseline experiments attempting to measure θ_{13} . Both NC (Neutral Current) and CC (Charged Current) coherent pion production are being studied, and the NC analysis will be published soon. The study of coherent neutrino interactions can give us better insight into the nature of the weak force, and in the validity of PCAC (Partially Conserved Axial-Vector Current), used to model the coherent pion production.

3. SUPERNOVA NEUTRINO DETECTION IN THE NOVA EXPERIMENT

Andrey Sheshukov (DLNP JINR), Maria Petropavlova (ISU)

Large scintillator detectors of NOvA experiment are capable of detecting a neutrino signal from the future galactic core-collapse supernova. Since the NOvA detectors were designed to study neutrino oscillations in a 2 GeV neutrino beam, detecting interacting low-energy neutrinos from supernova requires dedicated data selection and background reduction. In this poster we describe the architecture of the supernova triggering system, present the efficiency for detecting the neutrino signal depending on the supernova model and the distance to the progenitor star and consider a method to improve this sensitivity by including neutral current neutrino interactions channel on carbon nuclei.

4. SLOW MAGNETIC MONOPOLES SEARCH IN NOVA

Alexander Antoshkin (DLNP JINR and MSU), Martin Frank (USA)

NOvA far detector is well suited for finding of exotic particles due to its technical opportunities. One kind of these exotic particles are the "slow" magnetic monopoles. Measurement of the expected signals from them has been made on the NOvA test bench at JINR. It is assumed that the energy deposition of such monopoles should be sufficiently large. As a whole it promotes searches or it can limit the existence of monopoles in a wide range of parameters, previously unreachable in other experiments (MACRO, SLIM, RICE, IceCube). Special Slow Monopole Trigger has been made and implemented in NOvA DDT system. Also offline reconstruction algorithm has been developed and tested on $\sim 5\%$ of data. Technical subscription and current results are presented in this work.

5. EAST-WEST ASYMMETRY OF COSMIC RAY MUONS IN THE FAR DETECTOR OF NOVA

Olga Petrova (DLNP JINR)

The fact, that Far Detector of the NOvA experiment is located on the surface, unlike most of the neutrino detectors, allow us to study cosmic rays in there. We can measure atmospheric muon fluxes and explore their angular dependence, for example, the East-West asymmetry phenomenon. This effect is connected to the magnetic field of Earth. The Far detector site has latitude, comparably remote from the equator, and it can bring new knowledge on the subject. But this research is complicated by the fact that the overburden covering the Far detector and the rock surrounding it are also asymmetrical. Angular dependence of cosmic muon track reconstruction efficiency should be taken into account. The poster presents preliminary result of the East-West asymmetry measurement as function of muon zenith angle on the two-month data taking.

6. JINR CLOUD RESOURCES IN THE NOVA EXPERIMENT

Alexander Baranov (LIT JINR), Nikita Balashov (LIT JINR), Nikolay Kutovskiy (LIT JINR), Evgeniy Kuznetsov (LIT JINR), Oleg Samoylov (DLNP JINR), Andrey Sheshukov (DLNP JINR),

NOvA is a massive neutrino experiment in which JINR participates in many directions, including the applications of information technologies. The cloud infrastructure of the JINR Multifunctional Information and Computing Complex was extended for the NOvA experiment increasing the contribution of JINR in works on modeling neutrino events, supporting data acquisition and control, and performing physical analysis. The extension of the JINR Cloud infrastructure application scope is showed on the example of different experimental tasks.

7. HIGH ENERGY COSMIC RAY MUONS FLUX IN THE NOVA FAR DETECTOR

Anna Morozova (DLNP JINR and MSU)

It is proposed to use Far Detector of the NOvA experiment located on the Earth's surface as a Parameter for measuring the flux of high-energy cosmic ray muons (more than 100 GeV). A preliminary estimation of the signals response from such muons was carried out within single particle simulation in the NOvA Far Detector.

8. MC STUDY OF STRANGE PARTICLE PRODUCTION IN THE NOVA NEAR DETECTOR

Vladimir Allakhverdian (DLNP JINR and MSU), Oleg Samoylov (DLNP JINR)

We perform a preliminary study of strange particle production in the NOvA Near Detector. While the main goal of the NOvA experiment is to measure neutrino oscillations from muon (anti)neutrinos to electron (anti)neutrinos, the large sample of data in the Near Detector provided by the muon neutrino beam presents an opportunity to study neutrino cross-sections for different channels. In this poster we present properties for K_0 -short production in the NOvA Monte Carlo simulation. The topology of events with secondary vertices of hadron interactions is considered.

9. TEST BENCH FOR MEASUREMENTS OF THE NOVA SCINTILLATOR PROPERTIES AT JINR

Alexander Antoshkin (DLNP JINR and MSU), Nikolay Anfimov (DLNP JINR), Oleg Samoylov (DLNP JINR), Daria Velikanova (DLNP JINR and MSU)

NOvA experiment was built to study oscillation parameters – mass hierarchy and CP-violation phase in the lepton sector – in the neutrino and antineutrino beams. NOvA test bench was constructed at JINR. The main goal of this bench is to measure the NOvA scintillator properties namely α/β discrimination (results are presented in this work) and Birk's coefficients for protons and other hadrons (quenching factors). This knowledge will be crucial for recovering the energy of adronic part of primal neutrino interaction with scintillator's nuclei.

10. REMOTE OPERATION CENTER AT DUBNA FOR NOVA EXPERIMENT

Alexander Antoshkin (DLNP JINR and MSU), Nikolay Anfimov (DLNP JINR), Nikita Balashov (LIT JINR), Oleg Samoylov (DLNP JINR), Andrey Sheshukov (DLNP JINR), Christopher Kullenberg (DLNP JINR)

The ROC-Dubna, Remote Operation Center at Joint Institute for Nuclear Research (Dubna, Russia), supports the NOvA experiment located ~ 8000 km away in Fermilab (Batavia, Illinois, USA) and Ash River (Minnesota, USA). The ROC allows Russian physicists to operate the NOvA detector and monitor the NuMI neutrino beam complex. ROC-Dubna for NOvA was the first fully operational ROC outside USA. Current hardware and software setup (with all new support features) are presented in this work.

11. EVENT SELECTION FOR THE NUE ANALYSIS IN THE NOVA EXPERIMENT

Liudmila Kolupaeva (DLNP JINR and MSU)

NOvA is an accelerator experiment at FNAL (USA) devoted for studying neutrino oscillations (electron neutrino appearance and muon neutrino disappearance in both neutrino and antineutrino modes). This is one of off-axis new generation experiments with two detectors sited at 14 mrad off the NuMI beam axis and separated by 810 km of the Earth crust. The main goals of this experiment are search of CP violation in lepton sector, measurement of neutrino mass hierarchy and some oscillation parameters with better precision. The last results based on the 9e20 POT statistics with neutrino beam were obtained in end of 2017. This poster is devoted to the signal event selection in the nue appearance mode. The changes in this procedure caused the significant enhancement in statistics for 2017 analysis.

12. CONVOLUTIONAL NEURAL NETWORKS IN THE NOVA EXPERIMENT

Christopher Kullenberg (DLNP JINR)

Convolutional Neural Networks (CNN) have excelled at the classification of and object detection within images, seemingly recognizing patterns in a similar way to the human eye. This technology is now being applied to high energy physics (HEP) applications, where it has shown great promise. Given that tracking detectors effectively produce a map of energy or charge depositions within the detector, we can easily transform these outputs into an image format, and use tools already produced and tested by the computer science community to aid in event classification and reconstruction. The NOvA experiment is already applying CNNs to event classification based on overall topology, and is developing methods for improving reconstruction using neural networks. NOvA is one of the first HEP experiments to utilize these modern networks, and given the novelty of the technology, it is a very exciting field due to the massive potential for innovations and improvements in methods, offering ample opportunities for both young and experienced scientists.

13. SEARCH FOR INTRINSIC CHARM IN Z + HEAVY FLAVOUR PRODUCTION PROCESSES

A. Prokhorov (DLNP)

Processes of associated production of Z boson with heavy flavour (b and c) jets are studied in view of possible effect of intrinsic charm in proton structure function on their observables. Properties of such processes are modelled with Sherpa Monte Carlo generator and cross-checked with analytical QCD calculation based on k_T factorization approach. The modelling is able to describe existing LHC data at the $\sqrt{s} = 7, 8$ TeV energies with a good accuracy. Predictions for $\sqrt{s} = 13$ TeV energy are made, assuming with different contributions of intrinsic charm. New observables sensitive to the intrinsic charm effect and less affected by theoretical uncertainties are identified. These observables can be much promising for estimation of the intrinsic charm from future LHC experimental measurements.

14. TIER-1 SERVICE MONITORING SYSTEM

Pelevanyuk I.S. (LIT)

In 2015, a Tier-1 center for processing data from the LHC CMS detector was launched at JINR. The large and growing infrastructure, pledged QoS and complex architecture all make support and maintenance very challenging. It is vital to detect signs of service failures as early as possible and enough information to react properly. Apart from the infrastructure monitoring there is a need for consolidated service monitoring. The top-level services that accept jobs and data from the Grid depend on lower-level storage and processing facilities that themselves rely on the underlying infrastructure. The sources of information about the state and activity of the Tier-1 services are diverse and isolated from each other. The decision was made to develop a new monitoring system. The goals are to retrieve a monitoring information about services from various sources, to process the data into events and statuses, and to react according to a set of rules, e.g. to notify service administrators or to restart a service. Nowadays the monitoring system aggregates information from different sources and can determine the status of a particular component.

15. GEOMETRY DATABASE FOR THE CBM EXPERIMENT

Akishina E.P. (LIT), Alexandrov E.I. (LIT), Alexandrov I.N. (LIT), Filozova I.A. (LIT), Friese V. (GSI, Darmstadt, Germany), Ivanov V.V. (LIT; National Research Nuclear University "MEPhI", Moscow, Russia)

The paper describes the Geometry Database (Geometry DB) for the CBM experiment. The Geometry DB supports the CBM geometry which describes the CBM experimental setup at a detail level required for simulation of particles transport through the setup using GEANT3.

The main purpose of this database is to provide convenient tools for:

- 1) managing the geometry modules (MVD, STS, RICH, TRD, RPC, ECAL, PSD, Magnet, Beam Pipe);
- 2) assembling various versions of the CBM setup as a combination of geometry modules and additional files (Field, Materials);
- 3) providing support of various versions of the CBM setup. The members of the CBM collaboration may use both GUI (Graphical User Interface) and API (Application Programming Interface) tools to work with the Geometry Database.

16. NUCLOTRON BEAM MOMENTUM ESTIMATION IN BM@N EXPERIMENT

Voytishin N.N. (LIT)

The Baryonic Matter at Nuclotron (BM@N) is the first step of the realization of the Nuclotron-based Ion Collider fAcility (NICA) mega-science project. The Nuclotron facility is able to provide diverse types of beams with the kinetic energies from 1 to 6 GeV per nucleon. The BM@N experimental setup represents a complex structure which is meant to become a precise tool for the study of strange hyperon and hyper-nuclei production yields and ratios. The accuracy assessment of the main detector systems performance is one of the main tasks at the moment. The results of the beam momentum reconstruction procedure using two tracking detector systems Multi-Wire Proportional Chambers and Drift Chambers are presented.

17. BIG DATA ANALYTICS FOR DISTRIBUTED COMPUTING AND SOCIAL SCIENCES

Belov S. (LIT)

Here is described and approach of application of Big Data technologies in different fields, where the information processing could turn to be quite similar. Discussed a general schema for the analytics system and several applications: IT infrastructure monitoring for the LHC experiments, labour market analysis, social networks monitoring.

18. TOWARDS TO THE $J/\Psi \rightarrow E^+E^-$ TRIGGERING WITH TRD IN THE CBM EXPERIMENT

Derenovskaya O. (LIT), Ablyazimov T. (LIT; GSI, Darmstadt, Germany), Ivanov V. (LIT; National Research Nuclear University “MEPhI”, Moscow, Russia)

The first steps towards to the $J/\psi \rightarrow e^+e^-$ triggering in the CBM experiment is presented. The Transition Radiation Detector is most suitable for solving this task. TRD should yield reliable electron identification, a high pion suppression level, a reconstruction of trajectories of charged particles passing through the detector.

19. DEVELOPMENT OF THE MODEL AND HITS RECONSTRUCTION ALGORITHMS FOR THE MICROSTRIP SILICON DETECTOR IN THE BM@N EXPERIMENT

Baranov D. (LIT)

The silicon detector used in the BM@N experiment represents a vertex detector comprising separated silicon modules with microstrip readouts. Using the detector allows us to find primary vertices of particles collisions with high precision in the fixed target experiment. The main objective of this work is aimed at developing the geometry and program models of the silicon detector and the hits reconstruction algorithms.

20. JINR CLOUD SERVICES

Balashov N.A. (LIT), Baranov A.V., Kutovskiy N.A., Mazhitova Ye.M., Semenov R.N.

The paper reviews the main new features and development directions of the JINR cloud services: cloud.jinr.ru and git.jinr.ru. Within the framework of the first service development its new architecture is presented, which includes changes in network configuration and storage system as well as transition to another high availability configuration of the front-end nodes. Listed changes will allow considerably increase users' experience in terms of significant reduction of virtual machines deployment and migration times, and will also increase the reliability of data storage and VMs operation. The optimization of the workload distribution in the JINR cloud are considered too. The paper also contains a review of the works dedicated to the integration of the JINR Member state clouds. Regarding the service git.jinr.ru three main new features are reviewed: the Git Large File Storage (LSF) system, the GitLab Pages service and the monitoring system based on Prometheus and Grafana.

21. COLLECTION AND ANALYSIS OF RESOURCE USAGE DATA FROM THE LIT JINR CLOUD INFRASTRUCTURE

Kadochnikov I. (LIT)

JINR has an infrastructure-as-a-service cloud based on OpenNebula for providing local users with resources, as well as international cloud and GRID computing projects. Many cloud use-cases utilize cloud resources unpredictably and unevenly. The problem of optimizing resource usage arises unavoidable for both physical and virtual resources. However, the flexibility of cloud infrastructures provides a unique way to mitigate this problem by using “overcommitment”, that is giving more virtual resources than exists on the server physically.

The monitoring system for the cloud infrastructure usage was created as part of the cloud dispatcher project. It consists of monitoring agents on every physical node, a central server to collect and store data, a backup storage server and a web-interface to visualize cloud resource usage history. Agents to monitor KVM and OpenVZ hypervisors over SNMP were developed, as well as collection modules for these metrics for Nagios/Icinga2.

The information collected will aid in selecting the optimal cloud resource management strategy. Analysis of physical node load shows that implementing overcommitment and automatic migration can be very effective. Analyzing the virtual machine usage history lead to proposing a prospective strategy of grouping virtual machines into classes based on expected mean usage, and providing each class with a group of dedicated physical nodes with a fitting overcommitment ratio.

22. PHASE TRANSITION MODEL MIMICKING THE PASTA PHASE AND ROBUSTNESS OF THE PHENOMENON OF THE THIRD FAMILY OF COMPACT STARS

Alexander Ayriyan (LIT)

A simple mixed phase model mimicking "pasta" type mixed phase in the quark-hadron phase transition is developed and applied to relativistic neutron star configurations. The model is parametrized by the use of additional pressure corresponding to the impact of structural effects in the mixed phase to the critical pressure of Maxwell construction. The robustness of third family solutions for hybrid compact stars is investigated where a quark matter core that correspond to the occurrence of high-mass twin stars against a softening of the phase transition by means of mimicking the effects of pasta structures in the mixed phase. Comparing results with constraints given by the binary neutron star merger GW170817 show that at least the heavier of the neutron stars could be a member of the third family of hybrid stars.

23. CORRELATION FEMTOSCOPY STUDIES AT NICA AND STAR ENERGIES WITHIN A VISCOUS HYDRODYNAMIC + CASCADE MODEL vHLL+URQMD.

BATYUK Pavel (LHEP)

Correlation femtoscopy allows one to measure the space-time characteristics of particle production in relativistic heavy-ion collisions due to the effects of quantum statistics and final state interactions. The main features of the femtoscopy measurements at top RHIC and LHC energies are considered as a manifestation of strong collective flow and well interpreted within hydrodynamic models employing equation of state with a crossover type transition between QGP and hadron gas phases. The femtoscopy at lower energies was intensively studied at AGS and SPS accelerators and is being studied now in the Beam Energy Scan program at the BNL Relativistic Heavy Ion Collider in the context of exploration of the QCD phase diagram. In this work the femtoscopic observables calculated for Au-Au collisions in a viscous hydro+cascade model vHLL+UrQMD and their dependence on the EoS of thermalized matter are presented. Some possible opportunities to perform such studies with respect to the NICA energies are also discussed.

24. DEVELOPMENT OF EVENT DISPLAY SYSTEM FOR THE BM@N AND MPD EXPERIMENTS OF THE NICA PROJECT

GERTSENBERGER Konstantin (LHEP), MPD & BM@N Collaboration

One of the problems to be solved in modern high-energy physics experiments on particle collisions and fixed target experiments is a visual presentation of the events during the experiment run. The implementation of this task, so called Event Display, is presented for the current BM@N experiment and the future experiment MPD at the Nuclotron-based Ion Collider facility (NICA) under construction at the Joint Institute for Nuclear Research. The goals and the structure of the BM@N and MPD facilities as well as the aims of the Event Display are briefly noted. The implemented event display designed for use in offline and online modes with its options and features as well as integration with our software environments (BmnRoot and MpdRoot) are considered. The integration of ATLAS TDAQ components to transfer raw event data for visualization in the Online Event Display is shown. The examples of graphical representation of simulated and reconstructed points and particle tracks with BM@N and MPD geometries are given for collisions with different energies and particles.

25. CLUSTERS AND HYPERNUCLEI PRODUCTION WITHIN PHQMD+FRIGA MODEL

KIREYEU Viktor (LHEP)

We present new results on the dynamical modelling of cluster formation with the new combined PHQMD+FRIGA model at Nuclotron and NICA energies. The FRIGA clusterisation algorithm, which can be applied to the n-body transport approaches, is based on the simulated annealing technique to obtain the most bound configuration of fragments and nucleons. The PHQMD+FRIGA model is able to predict isotope yields as well as hyper-nucleus production.

26. STUDY OF THE GEM DETECTOR PERFORMANCE IN BM@N EXPERIMENT

MAKSYMCHUK Anna (LHEP), Kulish Elena

BM@N experiment (Baryonic Matter at Nuclotron) is aimed to study core-core (up to "gold-gold") collisions in extreme conditions. High intensity of interactions and large multiplicity of charged particles in each event cause special requirements to detectors: high spatial and time resolution, radiation loadings up to $10^6/\text{sm}^2$. As soon as triple GEM (Gas Electron Multipliers) possess all above-mentioned characteristics, they were chosen as the main track detector. Integration of GEM detectors into the experimental setup structure and study of their characteristics is a task of great importance.

27. THE DEVELOPMENT OF TOOLS FOR REAL-TIME BETATRON TUNE MEASUREMENTS FOR THE NICA PROJECT

MONAKHOV Dmitrii (LHEP)

A betatron tune measurement system was developed and tested at the Nuclotron. A white noise and chirp signals were used for transverse beam motion excitation. A custom FlexRIO digitizer module was developed which provides excitation signal generation for kicker electrodes and real-time signal acquisition from pickup electrodes. A high resolution FFT algorithm was implemented inside a NI PXI FPGA module, connected to digitizer. The measurement system is integrated with the NICA control system based on the TANGO Controls. Results and tests performed with the Nuclotron beam are presented.

28. TRIGGER ELECTRONICS FOR MPD AND BM@N EXPERIMENTS

ROGOV Victor (LHEP), Dmitriy Bogoslovski, Sergei Sergeev, Vladimir Yurevich

The described electronic modules have been developed at LHEP/JINR for trigger generation in BM@N and MPD experiments for study of highly-excited and dense baryonic matter in Au+Au collisions at energies of NICA collider and Nuclotron facility. The trigger and start detectors fast signals of MCP-PMTs and SiPMs are used as input signals for the trigger processing.

T0U is a main trigger module for the BM@N experiment. It generates trigger signal based on the beam line and target area detector signals. This module also provides both control and monitoring of the detectors and front-end electronics power supplies.

This poster presents a concept, characteristics and of the electronic modules developed for BM@N and MPD experiments.

29. TANGO WEB ACCESS MODULES AND WEB CLIENTS FOR NICA CONTROL SYSTEM

SEDYKH Georgy, Gorbachev Evgeny, Elkin Vladimir

The Nuclotron-based Ion Collider fAcility is a new accelerator complex being constructed at JINR. It is aimed to study the properties of nuclear matter in the region of the maximum baryonic density. It includes injection complex, new superconducting booster synchrotron, the existing superconducting heavy ion synchrotron Nuclotron, collider having two new superconducting rings and new beam transfer channels. NICA control system is based on Tango Controls framework - free open source device-oriented controls toolkit for controlling any kind of hardware or software and building SCADA systems. The client applications are traditionally developed using LabView or Taurus frameworks. In recent years, there has been a rapid development of web technologies. Now there is an opportunity to develop cross-platform, flexible, fast and convenient web for the control system. To achieve this goal universal tools for communication between Tango Controls and web clients are required. The most common data transmit technologies are WebSocket and REST. The report describes Tango-modules designed at JINR to provide web-access to Tango-based control system. It also gives examples of web client applications for NICA control system, using these services.

30. READOUT CHAMBERS FOR THE MPD TPC DETECTOR (NICA PROJECT)

A. Rybakov (LHEP)

The readout chambers give basic information about the particle tracks. The TPC readout system is based on the Multi-Wire Proportional Chambers (MWPC) with cathode pad readout.

The equipment ready to manufacture readout chambers in VBLHEP.

2 chambers prototype are assembled and tested. **20** chamber frames are ready to start assembly (waiting serial padplanes). The equipment is modernized, production and testing technologies are tested, prototypes are working good. Most of the materials and components purchased (ex. the serial padplanes).