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

1. **Activities of the experimental group on electromagnetic processes within the FLAP collaboration at the MT-25 microtron**

Author: Elizaveta Bushmina
Veksler and Baldin Laboratory of High Energy Physics, JINR, Dubna, Russia

Abstract:
High-energy electron beams play a critical role in both fundamental particle physics and applied research. Effective experimentation demands high-precision monitoring techniques. Among the various existing methods for electron beam diagnostics, coherent electromagnetic radiation stands out as a highly accurate approach.
The generation of polarization radiation by electron beams passing near dielectric objects has recently attracted significant interest. This effect offers dual potential: precise beam parameter measurement or the production of intense terahertz and sub-terahertz radiation. A particularly promising example is Cherenkov diffraction radiation (ChDR) [1], which occurs when relativistic electrons travel along a dielectric edge.
To investigate ChDR generation and its properties, experimental studies were conducted using a mid-relativistic electron beam at the MT-25 microtron, as part of the FLAP collaboration by the experimental group on electromagnetic processes. Targets were fabricated from both a conventional material (Teflon) and an additively manufactured one (PLA using 3D printing).
The results confirm efficient ChDR generation from both materials at the theoretically predicted angles. Furthermore, they highlight the potential of this coherent radiation for longitudinal beam diagnostics.

2. **Experimental results of electron beam intensity profiles obtained by profilometer based on the multi-angle scanning method**

Author: Elizaveta Bushmina
Veksler and Baldin Laboratory of High Energy Physics, JINR, Dubna, Russia

Abstract:
Particle beam accelerators are widely used in fundamental and applied research, driving the need for precise control of beam parameters such as energy, current, and pulse length. Accurate reconstruction of the transverse intensity profile is essential for diagnosing high-energy electron beams in fundamental science, medicine, and manufacturing. However, existing profiling methods often suffer from detector degradation when exposed to high-intensity or wide-aperture electron beams (with cross-sections of several centimeters or more), limiting their reliability for real-time measurements. To address this challenge, this paper focuses on ionization chambers due to their high radiation tolerance, sensitivity, ease of use, and real-time capabilities, and proposes investigating the profilometer based on a set of cylindrical ionization chambers for measuring the transverse intensity distribution of electron beams using the multi-angle scanning method.

The detector system was calibrated and experimentally tested on the MT-25 microtron (Dubna) with the following parameters: electron energy 7 MeV, average beam current 0.5 μA, beam divergence 5°, beryllium output window thickness 200 μm, detector spacing 10 mm, distances from the output window of 125, 320, and 420 mm, and pulse repetition rate 380 Hz. Experimental work was conducted within the FLAP collaboration.

Measured current arrays and angular dependence data were processed using custom software for angle alignment, current matching, and signal normalization to a single maximum based on calibration. Applying the inverse Radon transform, which underlies the multi-angle scanning method, enabled real-time reconstruction of 2D electron beam intensity distributions at various distances from the output window. The obtained results confirm that the proposed profilometer, combined with the multi-angle scanning method, effectively captures the spatial characteristics of the electron beam, particularly its transverse intensity distribution.

3. **Multiparticle correlations in pp-collisions at $\sqrt{s}$ = 13 TeV**

Author: Artashes Chinaryan
Meshcheryakov Laboratory of Information Technologies

Abstract:

This work is devoted to the analysis of multiparticle correlations in events with the Drell-Yan process in proton-proton collisions with the factorial moment method. This method consists in plotting the dependence of factorial moments of multiplicity distribution in the intervals of dynamical variable on the size of these intervals and allows one to exclude statistical effects related to finite particle multiplicity in events, thus exctracting genuine dynamical correlations.

The dataset collected by the CMS detector in 2017 corresponds to an integrated luminosity of 41.55 fb^{-1} at a center-of-mass energy of 13 TeV. Monte-Carlo datasets are used for comparison with experimental data. We present the calculated numerical values of normalized one-dimensional factorial moments of multiplicity distribution in a selected pseudorapidity interval and demonstrate the dependencies of these values on the parameters of theoretical calculations.

4. **Track Reconstruction in SPD Timeslices Using Graph Neural Networks with Contrastive Learning**

Author: Didorenko A.
Meshcheryakov Laboratory of Information Technologies

Abstract:

The problem of timeslice decomposition in the SPD experiment at the NICA collider consists of two stages: reconstruction of charged particle tracks with noise hit removal, and subsequent event-by-event separation of the reconstructed tracks. High efficiency of track reconstruction at the first stage is crucial, since an SPD timeslice is designed to contain from 10 to 40 overlapping events, making their separation challenging.

We propose a track reconstruction method based on graph neural networks with contrastive learning. A k-nearest-neighbor graph is built in the hit coordinate space, after which a neural network based on EdgeConv layers trained with Contrastive Loss

produces an embedding space where hits belonging to the same track are compactly clustered. Final clustering is performed using the DBSCAN algorithm. The data are obtained from the official SPD detector simulation using the SpdRoot software package. The proposed method demonstrates high track reconstruction efficiency and is promising as the primary tracking algorithm for the first stage of timeslice processing in the SPD experiment.

5. **Ultra-Fast Determination of the Primary Vertex at SPD**
Author: Maria Dima
Dzhelepov Laboratory of Nuclear Problems
Abstract:
We propose an ultra-fast, iteration-free strategy for primary vertex determination at the SPD (Spin Physics Detector) experiment. The method proceeds in two steps. First, a two-dimensional seed is obtained via a flash clustering algorithm; this seed selects a subset of tracks. For each selected track, the distance of closest approach (DOCA) to the seed is computed, and each track is linearised around its own DOCA. Since the true vertex lies in the vicinity of the seed, this linear approximation holds to within 5–10 μm precision. Instead of iterative fitting, we exploit an analytical method for vertexing straight tubes of elliptical cross section, where each tube represents the track's local error ellipsoid. The algorithm runs in under 100 ns/track on Intel Ivy Bridge (estimated at 20 ns on AMD EPYC) and achieves a resolution comparable to the current SPDroot configuration. Performance depends entirely on track selection and is therefore expected to improve as the selection is refined. This hybrid approach isolates coarse localization from precision fitting, preserving the speed required for online flash reconstruction. The selection parameters are tuned to the expected multiplicity and background conditions at SPD.

6. **Amplitude analysis of $\psi(3686)$ decays into $\pi^0\pi^0$ system**
Author: Prokhor Egorov
Dzhelepov Laboratory of Nuclear Problems
Abstract:
Glueballs, which are colorless bound states of gluons, are a part of a family of non-conventional bound states predicted by quantum chromodynamics (QCD). Their potential observation is a strong point validating the correctness of QCD. Most of the theoretical models propose that three lightest glueballs are located in the mass range of 1.5-2.7 GeV, but their direct obesrvation is extremely difficult due to the mixing with conventional quark states and overall density and complexity of the light meson spectrum. There are multiple channels suitable for the glueball search, with charmonium decay being of special interest due to glue-rich environment produced in the process, low background level and large datasets available.
We present results of model-independent amplitude analysis of the $\pi^0\pi^0$ system produced in radiative ψp decays. This analysis utilises the dataset of $(2712.4 \pm 14.3) \times 10^6$ $\psi(3686)$ decays obtained by the BESIII collaboration.

Analysis is performed in the framework of model-independent formalism, resulting in scalar and tensor partial wave contributions being obtained in a form of piecewise functions of $M_{\mathrm{inv}}(\pi^0\pi^0)$.

Minimal model assumptions are being made in the process.

The results are provided as log-likelihood scans in $M_{\mathrm{inv}}(\pi^0\pi^0)$ bins, which both minimises loss of the statistical information and accounts for relevant systematic uncertainties.

Provided model-independent description allows for subsequent development of phenomenological models via combining presented results with other relevant data sets.

7. **Constraining Heavy-Ion Transport Models with Light and Strange Hadrons in STAR BES-I Au+Au Collisions ($\sqrt{s_{NN}} = (3-27)$ GeV)**

Author: Oris Eng
Veksler and Baldin Laboratory of High Energy Physics, JINR, Dubna, Russia

Abstract:
We compare STAR BES-I data produced in Au+Au collisions at $\sqrt{s_{NN}} = (3-27)$ GeV with UrQMD, AMPT, SMASH and PYTHIA theoretical models. Midrapidity (|y|<0.5) results for invariant yields and particle ratios of $\pi^{\pm}$, p, K_s^0, Λ, Ξ and Ω, are presented as functions of collision centrality and energy. PYTHIA fails to describe strange hadrons at all energies. UrQMD and SMASH show better agreement for both light and strange hadrons. AMPT deviates from experimental data for $p_T > 2.0$ GeV and peripheral collisions (60−80%). Our work provides quantitative constrains for all models across the BES-I and future NICA experiment energy range, deepening our understanding of hadronization mechanisms near the QCD phase boundary.

8. **Leakless Cooling and Thermal Stabilization System for the MPD TPC**

Author: Alexander S. Fedotov
Veksler and Baldin Laboratory of High Energy Physics, JINR, Dubna, Russia

Abstract:
The poster presents a computer model of the leakless cooling and thermal stabilization system, together with recent results on its practical implementation for the MPD TPC. The system is designed to cool electronics dissipating more than 16 kW inside the MPD volume and to stabilize the temperature of the internal gas volume, keeping temperature deviations within 0.1 °C.

A hydrodynamic model based on the Navier–Stokes equations applied to pipe-network graphs is introduced. The model was used to identify operating regimes, select equipment parameters, and refine the operation procedure, thereby extending the standard approach to leakless cooling system design. The central engineering challenge is to maintain stable flow in branched channels under sub-atmospheric pressure, in the range of 0.1–0.9 atm, where the available pressure budget is severely limited.

The selected equipment is fully controlled by computers and programmable logic controllers and includes pneumatic control and shut-off valves, circulation and vacuum pumps, and water monitoring systems. Experimental tests confirmed the selected parameters and proper circulation through the TPC detector manifolds.

9. **Overlapped signals delimitation for HEP experiments**
Author: Dmitry Fomenok
Meshcheryakov Laboratory of Information Technologies
Abstract:
The third phase of the Large Hadron Collider's operation continues, characterized by higher luminosity and an increased multiplicity of overlapping signals.
In the cathode-strip chambers of the CMS experiment, when charged particles pass through, electron avalanches are formed, which are registered as clusters (groups of signals from adjacent strips) with charges whose distribution in space can be approximately described by Gauss functions. Often there is an overlap of clusters from closely passing particles, which can lead to significant losses in accuracy in determining their coordinates.
The currently used simple center of gravity algorithm does not provide the required accuracy for overlapped signals (the error is up to 40% of the strip width with the required accuracy of up to 5%).
To solve this problem, a sequential elimination algorithm, wavelet analysis and the use of Kolmogorov-Arnold neural networks are considered. The results of overlapped signals delimitation for all algorithms are presented and discussed.

10. **Dark matter in the two-doublet Higgs model with b-quarks in the final state**
Author: Z. Khabaev
Meshcheryakov Laboratory of Information Technologies JINR
Abstract:
A search for dark matter particles produced in association with a Higgs boson decaying to a bottom quark-antiquark pair in proton-proton collisions at $\sqrt{s}$= 13 TeV is presented. The data, collected with the CMS detector at the LHC, correspond to an integrated luminosity of 101 fb^{-1}. The analysis is performed in exclusive categories targeting both Lorentz-boosted (merged) and resolved b jet pair topologies, covering a wide range of Higgs boson transverse momentum. A statistical combination is made with a previous search using data collected in 2016 and corresponding to an integrated luminosity of 35.9 fb^{-1}. The observed data agree with the standard model background predictions. Constraints are placed on a type-II two-Higgs-doublet model featuring a heavy pseudoscalar with an additional light pseudoscalar (2HDM+a).

11. **Temperature, pressure, and gas gain monitoring system for the SPD-NICA**
Author: Daria Kirova
Veksler and Baldin Laboratory of High Energy Physics, JINR, Dubna, Russia
Abstract:
A dedicated online gas mixture quality monitor has been developed for the straw tracker of the SPD experiment at the NICA collider. The system continuously measures and logs both the pressure and the temperature of the gas mixture. It includes a reference straw detector exposed to an iron-55 radioactive source, allowing the energy spectrum to be recorded in real time. The position of the characteristic peak in this spectrum is tracked, providing a highly sensitive probe of the gas composition and the detector gain.

Any drift of the peak immediately signals a variation in the gas quality, enabling fast corrective intervention. This monitor ensures the long-term stable and reliable performance of the straw tracker throughout the experimental runs.

12. **Full-cycle production complex for Micromegas detectors**

Author: Natalia Kovyazina
Dzhelepov Laboratory of Nuclear Problems

Abstract:
At the Dzhelepov Laboratory of Nuclear Problems of the Joint Institute for Nuclear Research (DLNP JINR), the first full-cycle production facility in Russia and Eastern Europe for the fabrication and testing of advanced Micro-Pattern Gaseous Detectors (MPGDs) based on Micromegas technology has been established. The capability to conduct R&D, manufacture, and test prototypes and small batches of detectors at this facility enables JINR staff to participate effectively in major physics experiments, such as AMBER at the CERN SPS accelerator and SPD at the NICA accelerator complex.
Within the framework of the AMBER project, Micromegas detector prototypes were developed, fabricated, and tested. The results formed the basis for the collaboration's decision to adopt this technology for the upgrade of the experimental setup.
Currently, a key project is the development of the Micromegas-based Central Tracker (MCT) for the NICA SPD. The MCT will be positioned as close as possible to the beam interaction region, enhancing momentum resolution and track-finding efficiency during the initial years of SPD operation, prior to the installation of a vertex detector. To date, simulation and optimization studies of the gas mixture have been performed, establishing the primary and backup options. Furthermore, the discharge resistance of the diamond-like carbon (DLC) protective layer has been evaluated, and several prototypes with various configurations have been tested to determine the baseline parameters of the future detector. Finally, the fabrication technology has been refined, culminating in the production of the first cylindrical prototype.

13. **Longevity studies of the CMS cathode strip chambers**

Author: Dmitrii N. Kozlov
Veksler and Baldin Laboratory of High Energy Physics

Abstract:
Radiation hardness of the cathode strip chambers (CSC) applied in the CMS endcap muon system was studied. Two CSCs with different dimensions and design technologies which operating in CMS in the region of the high background rates have been exposed to a ^{137}Cs gamma source at the GIF++ irradiation facility at CERN. The accumulated charge per unit length of the CSC anode wire reached more than 1.0 C/cm for both chambers, a value more than three times higher than the expected integrated charge for the entire LHC operation period with High Luminosity (HL-LHC). The main characteristics of the CSCs periodically were studied with the SPS muon beam showing no observation of the radiation-induced degradation. The experimental results confirm the radiation hardness of the CMS endcap muon CSCs to sustain sever requirements of the HL-LHC operation mode at the energy of 13.6 TeV and instantaneous luminosity $5x10^{34}cm^{-2}c^{-1}$.

14. Numerical study of neutron and nuclear fragment production using UrQMD model supplemented by statistical multi-fragmentation model

Author: T. Q. T. Le[1,2]

[1]Institute of Research and Development, Duy Tan University, Da Nang, 550000, Vietnam

[2]Faculty of Natural Sciences, Duy Tan University, Da Nang, 550000, Vietnam

Abstract:

The Ultra-Relativistic Quantum Molecular Dynamic model (UrQMD) is widely applied for simulation of particle production in hadron-nucleus and nucleus-nucleus interactions at high energies. In our work, we show that the UrQMD model can reproduce well spectra of the high energy neutrons, and does not describe the low energy neutron spectra. In order to overcome the problem and describe the multi-fragmentations of nuclear residuals, we coupled UrQMD with the Statistical Multi-fragmentation Model (SMM) using the EoS mode of the UrQMD model. The obtained numerical results of UrQMD+SMM are in a good agreement with the experimental data on the neutron production in the reactions p+Al, Fe, Pb at 3 GeV [1] and C+C, Al, Cu, Cd at 2 GeV/nucleon [2]. Fragment mass distributions in hadron-nucleus interactions are well described. Also, fragment momentum spectra in C+C interactions at 20.5 GeV/nucleon are reproduced satisfactorily. The combined UrQMD+SMM model can be applied at design and analysis of NICA and FAIR experiments. For example, using the UrQMD+SMM model we have calculated 1 million Xe-W and Xe-Xe events at 3.3 GeV/nucleon for NICA/MPD experiment by request of users.

15. Thermometry and Thermal Status of the MPD Magnet Trim Coils

Author: Maria Medvedeva

Veksler and Baldin Laboratory of High Energy Physics

Abstract:

The MPD magnet has two resistive correction coils at the SC solenoid endcaps to trim the field and align the field lines. The Joule heating of a trim coil may affect both the coil thermal state and the ambient conditions inside the MPD volume. Therefore, this study pursued the following objectives: (i) to investigate the thermal behavior of the MPD magnet trim coils at nominal currents over a range of coolant inlet parameters and ambient conditions, assuming a non-modifiable cooling-circuit layout; (ii) to quantify the corresponding heat fluxes directed into the MPD inner volume and to identify potentially critical thermal regimes at nominal and above-nominal currents. To achieve these objectives, a 3D finite-element model of the trim coil was developed. The model included the key geometry components of the MPD magnet yoke and coil cooling circuit, and solved coupled heat-conduction and Navier–Stokes equations on a customized mesh. To validate the numerical model and ensure reliable operation of the MPD ensemble, a thermometry system was devised for the MPD magnet, together with a dedicated hardware-software platform for the configuration, readout, and handling of temperature-sensor data. Consistency between the experimental thermometry data and

the simulation results was confirmed. Potentially critical thermal regimes were found to occur only under above-nominal currents.

16. **Graph Attention Neural Network for Clustering Particle Tracks by Events in the SPD experiment of the NICA accelerator complex**
Author: Savelii Omelianchuk
Meshcheryakov Laboratory of Information Technologies
Abstract:
A Graph Attention Neural Network (GANN) for particle track clustering by events in time slices obtained at the Spin Physics Detector (SPD) of the Nuclotron-based Ion Collider fAcility (NICA) is presented. A novel approach is applied to time slice processing at high particle multiplicity and pile-up. The model is trained using a hierarchical approach and evaluated on time slices generated by the Monte Carlo technique according to the SPD experiment configuration as close as possible at the moment. The model architecture includes a graph encoder and an edge classifier, both of which use the message-passing principle and iteratively structured approach. The GANN exhibits high performance in track clustering by events for the SPD simulation, achieving 95% accuracy and 90% precision and recall.

17. **Automated Ultrasonic Welding Machine for Straw Tube Production for the SPD Straw Tracker**
Author: Sergey Romakhov
Veksler and Baldin Laboratory of High Energy Physics, JINR, Dubna, Russia
Abstract:
Straw tube detectors are widely used in high-energy physics experiments due to their low material budget, good spatial resolution, and suitability for large-area tracking systems. The SPD experiment at the NICA collider requires the production of a large number of thin-walled straw tubes with stable geometry, reliable weld quality, and reproducible mechanical properties. Ultrasonic welding of metallized PET film is one of the key technologies for manufacturing such straws, but the process requires precise control of film alignment, tension, internal pressure, welding temperature, and seam position.
A new automated ultrasonic welding machine has been developed to improve the stability, reproducibility, and efficiency of straw tube production. The system includes controlled film feeding and tensioning, laser-based correction of the film source position, precise multi-axis positioning, internal pressure regulation, automatic tube supports, pyrometer-based thermal stabilization of the ultrasonic welding head, and real-time machine vision tracking of the weld seam. The seam position is monitored by a digital inspection camera, and feedback correction is applied to keep the seam aligned with the ultrasonic welding zone during production.
The machine also provides an automated welding cycle and an integrated pressure test for checking the quality of the welded seam after production. Process parameters can be monitored, adjusted, and stored through the operator interface, supporting reproducible production conditions. The developed system forms a technological basis for large-scale

straw tube manufacturing for the SPD Straw Tracker at NICA and can be adapted for other detector projects using straw tube technology.

18. **Temperature Control via Wire Oscillation Frequency in Straw Trackers SPD**
Author: Nurzada Saktaganov
Veksler and Baldin Laboratory of High Energy Physics, JINR, Dubna, Russia
Abstract:
A method for temperature control in drift tubes (straw trackers) of the SPD (NICA) based on wire oscillation frequency is proposed. Thermal expansion of the tube changes wire tension and its resonant frequency. An experimental setup for exciting and detecting oscillations has been developed. In the range of 15–35 °C, the dependence of the squared frequency on temperature is linear; calibration yields an accuracy of ±0.3 °C, meeting the SPD requirements. The method requires no additional sensors, using the wire itself as the sensing element, and can be implemented in the standard detector monitoring system.

19. **Comparison between simulation and experimental results for laser beam positions for TPC laser calibration system**
Author: J.V. Shafarevich
Veksler and Baldin Laboratory of High Energy Physics, JINR, Dubna, Russia
Abstract:
This work provides an analysis of the results of simulations and experimental validation of laser beam propagation in the calibration system of the Time-Projection Chamber (TPC) for the MPD experiment. Precise laser calibration is essential for determining the drift velocity in the TPC gas volume, which directly impacts the spatial reconstruction accuracy of charged-particle tracks and consequently the quality of the experiment's physics results.
Ray-tracing models developed in COMSOL Multiphysics and Python were employed to analyse the impact of misalignment errors, mechanical deformations and optical element misalignments on the positions of the calibration tracks within the TPC drift volume. Experimental measurements of the positions of the laser beams were carried out using a laser tracker and a dedicated technique based on mylar screens. This enabled a quantitative comparison to be made between the simulation results and the actual geometry of the system.
The results show that the developed approach can be used to align, monitor and automate the TPC laser calibration system.

20. **Development of a control and testing system for HV power supply for the Straw Tracker SPD installation**
Author: Stanislav Shilov
Veksler and Baldin Laboratory of High Energy Physics, JINR, Dubna, Russia
Abstract:
The report will present the development of the HV-monitor device for measuring the voltage of the high-voltage power sources of the Straw Tracker detector in the SPD installation. The need for this device is justified by the requirement for additional

independent monitoring and verification of the output parameters in comparison with the internal monitoring systems of the power sources. This task is particularly important because the stability and accuracy of the high-voltage power sources directly affect the gas amplification factor in the drift tubes and, consequently, the correct operation of the detector systems.

21. **Channel Quality System for the JUNO Experiment**
    Author: Dmitrii Shpotya
    Meshcheryakov Laboratory of Information Technologies
    Abstract:
    The Jiangmen Underground Neutrino Observatory (JUNO) is an international neutrino experiment in China designed to study the fundamental properties of neutrinos. The detector contains 20 kilotons of liquid scintillator and more than 40 000 photomultipliers. To ensure high-quality data for physics analyses, continuous monitoring of detector conditions and channel performance is essential.
    The Channel Quality system is being developed to monitor the status of detector channels, namely photomultipliers, for every data run. The system is used to identify problematic channels, clarify channel selection criteria, and store information about the channel status throughout the experiment. The report will present the architecture of the system, the database model for Channel Quality and the key functions of the system.

22. **Development of Data Visualization System for the Baikal-GVD Experiment**
    Author: Dmitrii Shpotya
    Meshcheryakov Laboratory of Information Technologies
    Abstract:
    The Baikal-GVD is a large-scale deep-underwater neutrino telescope located in Lake Baikal. It is designed to detect high-energy astrophysical neutrinos and study their sources, making it an important instrument for neutrino astronomy and multi-messenger astrophysics.
    To support detector operation and data analysis, a new Data Visualization system for Baikal-GVD is being developed. The system provides a centralized web-based interface for visual inspection of detector data, monitoring information and data quality parameters. The report describes the system architecture, key functionality and a system prototype