

Welcome to NICA days 2019 and IVth MPD Collaboration Meeting in Warsaw

Monday, 21 October 2019 - Friday, 25 October 2019

CZiITT



Book of Abstracts

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NICA Technical Session / 1

Average high energy neutron flux distribution in the Quinta sub-critical assembly irradiated with proton beam of 0.66 GeV energy applying the actinide spectral index method

Authors: Marcin Szuta¹; V.A. Voronko²; V.V. Sotnikov³; ELZBIETA STRUGALSKA-GOLA⁴; Marcin Bielewicz⁵

¹ *National Centre for Nuclear Research*

² *National Science Center "Kharkov Institute of Physics and Technology", Kharkov, Ukraine*

³ *National Science Center "Kharkov Institute of Physics and Technology", Kharkov, Ukraine;*

⁴ *NCBJ SWIERK*

⁵ *Nacional Centre for Nuclear Research*

Corresponding Authors: elzbieta.strugalska-gola@ncbj.gov.pl, marcin.bielewicz@ncbj.gov.pl, mszuta@cyf.gov.pl

The paper presents the results of investigations of nuclear-physical characteristics of neutron fields generated in a massive uranium target irradiated by deuterons with an energy of 0.66 GeV. 23 natural uranium samples spatially arranged in a sub-critical assembly Quinta (at the Joint Institute for Nuclear Research, Dubna, Russia), were irradiated with spallation neutrons. We have processed the experimental data based on gamma-ray spectrometry in order to reach (obtain) the number of neutron induced fissions and neutron captures in the detector foils. Applying the try and error method we have found that the neutron energy for which the ratio of the fission cross section to the capture cross section of the natural uranium from the nuclear data base is equal to the measured ratio of the spectral indexes. The retrieved distinct fission and capture cross sections for the distinct neutron energy from the nuclear data base describe the average values which enabled us to evaluate the average neutron flux and neutron fluency distribution in the assembly.

MPD Collaboration Meeting / 2

Status of the proposal for a beam-beam monitoring system for the MPD

Author: Maria Elena Tejeda-Yeomans¹

¹ *Universidad de Colima*

Corresponding Author: unidusu@gmail.com

The MexNICA collaboration proposed in 2016 a beam-beam monitoring detector system (BE-BE) for the MPD-NICA experiment. This BE-BE detector is able to provide complementary capabilities such as a trigger signal for MPD to identify and to discriminate beam-beam minimum bias or centrality events from background and beam-gas interactions. Additionally, the BE-BE detector is useful for luminosity measurements and event plane resolution studies. In this talk we present the status of the BE-BE design, the status of prototype tests and recent simulations to highlight its capabilities, relevant for the stage 2 of MPD experiment.

TeVNICA Session / 3

Particle identification based on combined information from ToF and TPC

Authors: Tomasz Zawiański¹; Adam Kisiel²

Co-authors: Marcin Bielewicz³; Daniel Dabrowski²; Nikita Dunin⁴; Marek Peryt¹; Michalina Milewicz-Zalewska⁵; Krystian Roslon²

¹ *Warsaw University of Technology*

² *Warsaw University of Technology (PL)*

³ *Nacional Centre for Nuclear Research*

⁴ *JINR*

⁵ *Joint Institute for Nuclear Reactions*

Corresponding Authors: krystian.roslon@cern.ch, daniel.dabrowski@cern.ch, marcin.bielewicz@ncbj.gov.pl, nikitadunin@live.ru, kisiel@if.pw.edu.pl, tomasz.zawislak@cern.ch, milevich@jinr.ru, marekperyt@if.pw.edu.pl

A new approach to particle identification based on four methods including:

- $dE/dx(p_{total})$

- $\beta(p_{total})$

- $m^2(p_{total})$

- $m^2(dE/dx)$

This method takes advantage of Monte Carlo data to create templates for aforementioned distributions. The templates are then used to determine given track's identity.

TeVNICA Session / 4

Implementation of algorithms for reconstruction and identification of baryons, including strange baryons, in MPD experiment

Authors: Jakub Zielinski¹; Adam Kisiel¹

Co-authors: Marcin Bielewicz²; Daniel Dabrowski¹; Nikita Dunin³; Krystian Roslon¹; Michalina Milewicz-Zalewska⁴; Marek Peryt⁵

¹ *Warsaw University of Technology (PL)*

² *Nacional Centre for Nuclear Research*

³ *JINR*

⁴ *Joint Institute for Nuclear Reactions*

⁵ *Warsaw University of Technology*

Corresponding Authors: krystian.roslon@cern.ch, milevich@jinr.ru, marekperyt@if.pw.edu.pl, marcin.bielewicz@ncbj.gov.pl, qba.zielinski@gmail.com, kisiel@if.pw.edu.pl, daniel.dabrowski@cern.ch, nikitadunin@live.ru

In experiments like MPD, that study behaviour of particles, it is important to correctly identify registered particles. One problem is the identification of particles that generate signal in detector. Second is the reconstruction of baryons, that have life span too short to reach detectors. All of this is important in studying strong interactions between different baryon types.

The presentation will start with physics motivation for the study. Next, the process of identifying baryons using MpdRoot software will be explain. The results for proton identification and lambda reconstruction will be presented. In the end will be shown first attempts at creating correlation function for proton-lambda.

TeVNICA Session / 5

Development and optimization of detector visualization and MPD data

Authors: Arkadiusz Czarnecki¹; Adam Kisiel²

Co-authors: Marcin Bielewicz³; Daniel Dabrowski²; Nikita Dunin⁴; Michalina Milewicz-Zalewska⁵; Marek Peryt¹; Krystian Roslon²

¹ *Warsaw University of Technology*

² *Warsaw University of Technology (PL)*

³ *Nacional Centre for Nuclear Research*

⁴ *JINR*

⁵ *Joint Institute for Nuclear Reactions*

Corresponding Authors: krystian.roslon@cern.ch, milevich@jinr.ru, a.czar200@gmail.com, nikitadunin@live.ru, daniel.dabrowski@cern.ch, kisiel@if.pw.edu.pl, marcin.bielewicz@ncbj.gov.pl, marekperyt@if.pw.edu.pl

To properly simulate what happens after two particles collide in a detector one needs a properly modeled geometry of said machine. For later physical analysis it is important to know exactly what are its dimensions, where is it located in space, where are the particles located, what tracks did they leave. Also knowing how to add new detector or detector parts and where to put them in the code is important as well.

TeVFeNICA Session / 6

Application of PROOF system to optimization processes of physical analysis for the MPD experiment

Author: Kacper Skelnik^{None}

Co-authors: Marcin Bielewicz¹; Daniel Dabrowski²; Nikita Dunin³; Adam Kisiel⁴; Marek Peryt²; Michalina Milewicz-Zalewska⁵; Krystian Roslon⁴

¹ *Nacional Centre for Nuclear Research*

² *Warsaw University of Technology*

³ *JINR*

⁴ *Warsaw University of Technology (PL)*

⁵ *Joint Institute for Nuclear Reactions*

Corresponding Authors: dabrowski@if.pw.edu.pl, marekperyt@if.pw.edu.pl, marcin.bielewicz@ncbj.gov.pl, krystian.roslon@cern.ch, kisiel@if.pw.edu.pl, kacske@wp.pl, milevich@jinr.ru, nikitadunin@live.ru

The aim of this project is to make processes of physical analysis faster. In everyday scientist work it is obvious that we want to have the results of our research in a few moments. Main goal of this presentation is to show how we can achieve it. Which means: basic of developing a TSelector, automatization of processes of physical analysis (from users perspective). And show results of my work: speed up, data quality, efficiency. I going to discuss nowadays benefits of using PROOF (in the simplest version), and few ideas for the future.

TeVFeNICA Session / 7

Analysis of background radiation with a scintillation counter

Authors: Kamila Kempny^{None}; Paweł Dębowski^{None}; Anna Kierznowska^{None}; Marek Peryt¹

Co-authors: Marcin Bielewicz²; Daniel Dabrowski¹; Nikita Dunin³; Adam Kisiel⁴; Michalina Milewicz-Zalewska⁵; Krystian Roslon⁴

¹ *Warsaw University of Technology*

² *Nacional Centre for Nuclear Research*

³ *JINR*

⁴ *Warsaw University of Technology (PL)*

⁵ *Joint Institute for Nuclear Reactions*

Corresponding Authors: milevich@jinr.ru, kisiel@if.pw.edu.pl, kamilakem1@hotmail.com, anna.kierznowska2@gmail.com, nikitadunin@live.ru, dabrowski@if.pw.edu.pl, marcin.bielewicz@ncbj.gov.pl, marekperyt@if.pw.edu.pl, krystian.roslon@cern.ch, pawdeb42@gmail.com

The project concerns an analysis of background radiation with a scintillation counter. It included a series of measurements in different external conditions and attitude of the device. The analysis and comparison of the results was carried out in terms of the use of the device in the NICA project. Conclusions pointed out some of device's flaws which should be taken into consideration during the final experiment.

TeVFeNICA Session / 8

Integration of the Therminator model with the MpdRoot environment

Authors: Robert Mikoś^{None}; Adam Kisiel¹

Co-authors: Marcin Bielewicz²; Krystian Roslon¹; Marek Peryt³; Michalina Milewicz-Zalewska⁴; Nikita Dunin⁵; Daniel Dabrowski³

¹ *Warsaw University of Technology (PL)*

² *Nacional Centre for Nuclear Research*

³ *Warsaw University of Technology*

⁴ *Joint Institute for Nuclear Reactions*

⁵ *JINR*

Corresponding Authors: kisiel@if.pw.edu.pl, robertmikos11@gmail.com, marcin.bielewicz@ncbj.gov.pl, krystian.roslon@cern.ch, dabrowski@if.pw.edu.pl, milevich@jinr.ru, nikitadunin@live.ru, marekperyt@if.pw.edu.pl

THERMal heavy-IoN generATOR (Therminator) is a model of Monte Carlo event generator for simulating collisions of heavy particles. The code is written in the object-oriented c++ language. In the MpdROOT environment simulations were launched for one and two events. Small code changes have been made to improve Therminator efficiency. Work is underway on the proper functioning of it on the Cluster. There are plans for the future to optimization of MpdTherminatorGenerator source and header file.

TeVFeNICA Session / 9

Integration of temperature monitoring software inside the Master and Slave 19 "RACK cabinets for the Slow Control System of the MPD-TOF detector

Authors: Monika Kutyla¹; Krystian Roslon^{None}

Co-authors: Marek Peryt¹; Michalina Milewicz-Zalewska²; Daniel Dabrowski¹; Nikita Dunin³; Marcin Bielewicz⁴

¹ *Warsaw University of Technology*

² *Joint Institute for Nuclear Reactions*

³ *JINR*

⁴ *Nacional Centre for Nuclear Research*

Corresponding Authors: marcin.bielewicz@ncbj.gov.pl, marekperyt@if.pw.edu.pl, milevich@jinr.ru, kutyla.m44@gmail.com, nikitadunin@live.ru, roslon@if.pw.edu.pl, dabrowski@if.pw.edu.pl

To avoid getting dust inside RACKs it was decided to close them as hermetically as possible and provide the closed air loop ventilation. In each cabinet there are temperature and humidity transducers, fans modules and radiators. Using RS-485 standard based on the MODBUS protocol and modules of logic outputs, fans are being switched on and off depending on temperature inside each RACK and their work time. The cabinets are working in master-slave configuration. Software is easy to adjust to load settings from database.

TeVFeNICA Session / 10

Management of the Monte Carlo simulation process in the MPD experiment on the NICA cluster

Author: Lukasz Sawicki^{None}

Co-authors: Adam Kisiel¹; Marek Peryt²; Jakub Zielinski¹

¹ *Warsaw University of Technology (PL)*

² *Warsaw University of Technology*

Corresponding Authors: qba.zielinski@gmail.com, marekperyt@if.pw.edu.pl, kisiel@if.pw.edu.pl, l.saw99@outlook.com

The presentation shows the problem of mass simulation and generation of Monte Carlo particle collisions in the MPD experiment. It contains information about the tools used and how to solve the problem, next stages of work, the current outline of the program and a summary of the amount of simulated data were described.

TeVFeNICA Session / 11

R&D of the r, ϕ scanner mechanical construction for the scintillator detector background radiation measurements

Authors: Marek Peryt¹; Maciej Czarnynoga²; Martyna Winnik^{None}; Monika Nadolna^{None}

Co-authors: Marcin Bielewicz³; Daniel Dabrowski¹; Nikita Dunin⁴; Adam Kisiel⁵; Michalina Milewicz-Zalewska⁶; Krystian Roslon⁵

¹ *Warsaw University of Technology*

² *Politechnika Warszawska*

³ *Nacional Centre for Nuclear Research*

⁴ *JINR*

⁵ *Warsaw University of Technology (PL)*

⁶ *Joint Institute for Nuclear Reactions*

Corresponding Authors: milevich@jinr.ru, dabrowski@if.pw.edu.pl, monikanadolna1313@interia.pl, martyna.wnk@gmail.com, maciejczarnynoga@gmail.com, krystian.roslon@cern.ch, kisiel@if.pw.edu.pl, marekperyt@if.pw.edu.pl, marcin.bielewicz@ncbj.gov.pl, nikitadunin@live.ru

The aim of this project is the introduction to research and development of a prototype drive system for various sensors in the r, ϕ coordinate system. The device was designed for extensive solutions, but in this case, the focus was particularly on the cosmic ray measurement system. An extremely important issue was the easiest possible adaptability to various applications, therefore the proposed solution was made mostly in the technology of aluminum profiles. The designed solution is expected to study areas up to 1m in length and 2π angle. After auspicious prototype tests and meeting the primary assumptions, the final device is assumed to examine the expanse up to 3m in length and 2π angle. The continuation and further progress of the project will consist of the manual preparation of the measuring device, software development and real cosmic ray measurements performance.

TeVFeNICA Session / 12

The prototype of an air based cooling system for the Slow Control System of the MPD-TOF detector

Authors: Anna Szumigala^{None}; Michał Maciałowicz^{None}; Krystian Roslon¹

Co-authors: Marcin Bielewicz²; Daniel Dabrowski¹; Nikita Dunin³; Adam Kisiel¹; Michalina Milewicz-Zalewska⁴; Marek Peryt⁵; Monika Kutyla⁵

¹ *Warsaw University of Technology (PL)*

² *Nacional Centre for Nuclear Research*

³ *JINR*

⁴ *Joint Institute for Nuclear Reactions*

⁵ *Warsaw University of Technology*

Corresponding Authors: marekperyt@if.pw.edu.pl, anna.szumigala@gmail.com, nikitadunin@live.ru, michal.macialowicz@gmail.com, daniel.dabrowski@cern.ch, krystian.roslon@cern.ch, milevich@jinr.ru, kutyla.m44@gmail.com, marcin.bielewicz@ncbj.gov.pl, kisiel@if.pw.edu.pl

In order to keep RACKs clean of any dust and other particles, the decision has been made to hermetically close them off from the environment. This however can lead to overheating of electronic devices inside. Due to that, a special cooling system was designed. It consists of two sets of fans, two transducers (measuring temperature and humidity) and radiators. All the elements are connected to a computer with the usage of RS-485 wires and the MODBUS protocol. The main goal of this project was to prepare, assemble and install all of the aforementioned equipment.

MPD Collaboration Meeting / 15

Extraction of multiple parton interactions from forward-backward multiplicity correlations

Author: Eleazar Cuautle Flores¹

¹ *Universidad Nacional Autonoma (MX)*

Corresponding Author: eleazar.cuautle.flores@cern.ch

Forward-backward multiplicity correlations have been studied in electron-positron, proton-proton and more recently in lead-lead collisions. For the proton-proton case, comparison of experimental results to different models reveals an incomplete understanding of the physical phenomenon associated with these correlations. In this work, we present a study of forward-backward multiplicity correlations in proton-proton collisions using the PYTHIA event generator, at LHC energies. A detailed analysis is presented with and without weak decays, splitting data samples into soft and hard QCD processes, and comparing the computed correlations for short and long range pseudorapidity

regions. Each of these regions is analyzed accounting for the effects of color reconnection and independent multiple parton interactions. We show that a combination of these effects is required to explain the latest measurements on proton-proton data. Furthermore, is shown that from measurements of multiplicity correlations is possible to extract the average number of multiple parton interactions in the event producing these correlations, and albeit model depending, to predict the strength of these correlations, not yet measured, for higher energy collisions

NICA Days 2019 General Session / 16

Status of the MPD

Authors: MPD Collaboration^{None}; Viacheslav Golovatyuk¹

¹ *Joint Institute for Nuclear Research (RU)*

Corresponding Author: viacheslav.golovatyuk@cern.ch

The status of construction of the main subsystems of MPD will be described. The start configuration of the MPD includes superconductive coil which provides homogenous magnetic field up to 0,57T, the main tracker - Time Projection Chamber (TPC) time of Flight system, Fast Forward Detector for zero level trigger and start signal of the TOF and Forward Hadron Calorimeter (FHCAL). To decrease the background from the secondaries a beryllium beam pipe will be used. Development of the integration procedure which is important part of the project will be demonstrated

MPD Collaboration Meeting / 17

visualization of online and archived equipment values of BM@N and MPD experiments

Author: Petr Chumakov¹

Co-author: Dmitry Egorov¹

¹ *JINR*

Corresponding Authors: peter.chumakov@bk.ru, degorov@jinr.ru

Centralized equipment monitoring is an integral part of physical experiments. Convenient display and subsequent extraction of the stored values from the database reduces human error probability, simplifies the process of data collection and allows it to be used in the processing data from the detectors, increasing the quality of the results.

Modern technologies and standards make it possible to encapsulate implementation complexity of monitoring systems, providing access to the user through browser or desktop applications.

This presentation discusses the utilities and tools developed by our group for the BM@N and MPD experiments.

MPD/NA61 Joint Session / 18

NA61/SHINE detector upgrade

Author: Dariusz Tefelski¹

¹ *Warsaw University of Technology (PL)*

Corresponding Author: dariusz.tefelski@cern.ch

The NA61/SHINE detector, at the CERN SPS, is undergoing a major upgrade during the LHC Long Shutdown 2 period (2019-2021). The upgrade is essential to fulfil the requirements of new open charm measurement program. It is necessary to stress that this new physics goal can be achieved only when the readout rate will be increased by a factor 10 and the resolution of the secondary vertex in the high multiplicity tracks environment of Pb-Pb events will be improved. The following elements of the experiment are parts of the upgrade: Time Projection Chambers (TPC), Vertex Detector (VD), Beam Position Detectors (BPD), Particle Spectator Detector (PSD) and Time of Flight detectors (TOF). On top of the detectors, new Trigger and Data Acquisition (TDAQ) system is being developed. In the proposed talk the progress on design and development of new detectors and TDAQ system for NA61/SHINE experiment will be presented.

NICA Days 2019 General Session / 19

Concept of the Spin Physics Detector

Author: Vladimir Ladygin¹

¹ *VBLHEP JINR*

Corresponding Author: vladygin@jinr.ru

The study of the spin effects and polarization phenomena at NICA at high luminosity (up to $10^{32} \text{ cm}^{-2} \text{ s}^{-1}$) of longitudinally and transversely polarized proton and, especially, deuteron beam collision requires the development of Spin Physics Detector (SPD) placed at the second interaction point of the collider. SPD consists of the superconducting magnetic system, inner silicon tracker, straw tube tracker, particle identification system, electromagnetic calorimeter and muon range system. The free-streaming DAQ system will allow to store about 4 MHz events. The progress in the development of different SPD subsystems is presented.

TeVNICA Session / 21

Status of the Temperature Stabilisation System for NICA-MPD

Author: Krystian Roslon¹

Co-authors: Adam Kisiel¹; Daniel Dabrowski²; Maciej Czarnynoga³; Marek Peryt²; Michalina Milewicz-Zalewska⁴; Nikita Dunin⁵

¹ *Warsaw University of Technology (PL)*

² *Warsaw University of Technology*

³ *Politechnika Warszawska*

⁴ *Joint Institute for Nuclear Reactions*

⁵ *JINR*

Corresponding Authors: kisiel@if.pw.edu.pl, marekperyt@if.pw.edu.pl, dabrowski@if.pw.edu.pl, maciejczarnynoga@gmail.com, krystian.roslon@cern.ch, milevich@jinr.ru, nikitadunin@live.ru

The Multi Purpose Detector (MPD) at Nuclotron based Ion Collider Facility (NICA), which is under construction at the Laboratory of High Energy Physics at the Joint Institute for Nuclear Research, will be studying relativistic heavy-ion collisions. Such detector consists of high amount of electronic devices. Each of sub-detectors, modules, devices, being a part of NICA-MPD produces a specific

amount of heat. Overheating may cause damage of electronics or even spontaneous combustion. Also, in case of specific sub-detectors (eg. MPD-TPC), the temperature gradient will be the main cause of measurement uncertainty (PID). This paper shows the design brief of the Temperature Stabilisation System for NICA-MPD.

NICA Days 2019 General Session / 22

Physics program of the SPD experiment at NICA.

Author: Alexey Guskov¹

¹ *Joint Institute for Nuclear Research (RU)*

Corresponding Author: alexey.guskov@cern.ch

The SPD experiment at the NICA collider aims to investigate the nucleon spin structure and polarization phenomena in collisions of longitudinally and transversely polarized protons and deuterons at \sqrt{s} up to 27 GeV and luminosity up to $10^{32} \text{ cm}^{-2} \text{ s}^{-1}$. Production of the Drell-Yan pairs, charmonia, prompt photons and high- p_T hadrons will be the main instrument to access the full set of the leading order transverse momentum-dependent PDFs of nucleons. Physics program of the experiment will be presented in details.

TeVFeNICA Session / 23

Managing large scale computing for MPD experiment

Authors: Krzysztof Dygmarowicz¹; Oleg Rogachevskiy²

Co-authors: Adam Kisiel³; Daniel Dabrowski¹; Krystian Roslon³; Marcin Bielewicz⁴; Marek Peryt¹; Michalina Milewicz-Zalewska⁵; Nikita Dunin⁶

¹ *Warsaw University of Technology*

² *Joint Institute for Nuclear Research (RU)*

³ *Warsaw University of Technology (PL)*

⁴ *Nacional Centre for Nuclear Research*

⁵ *Joint Institute for Nuclear Reactions*

⁶ *JINR*

Corresponding Authors: oleg.rogachevskiy@cern.ch, nikitadunin@live.ru, marekperyt@if.pw.edu.pl, marcin.bielewicz@ncbj.gov.pl, milewicz@jinr.ru, dabrowski@if.pw.edu.pl, krystian.roslon@cern.ch, kdygnaro@gmail.com, kisiel@if.pw.edu.pl

My main task during working in JINR was Managing large scale computing for MPD experiment. At the beginning I had to get knowledge about mpdroot program which is used to simulate Multi Purpose Detector (MPD). Another task was to collect knowledge what my team needs on clusters and what resources can I acquired in JINR. I received access to LIT cluster (Supercomputer Govroun) and to job managing software DIRAC, used to work with RDIG (Russian Data Intensive Grid). My next task was to find how to work with it and prepare instructions. Based on experience and programs from NICA cluster written by co-workers I prepared working versions on LIT and RIDG resources.

TeVFeNICA Session / 24

Data Acquisition from spectrometry and dosimetry systems using LabView environment

Authors: Urszula Dąbrowska¹; Paulina Zawadzka¹; Ewelina Kołpa¹; Nikita Dunin²

¹ *Warsaw University of Technology*

² *JINR*

Corresponding Authors: paulina.konstancja612@gmail.com, nikitadunin@live.ru, ewelina.kolpa2204@gmail.com, ula.dabrowska.95@gmail.com

Presented work could be divided into two main tasks.

One of them was to modify existing software programs for three types of detectors: SiPM spectrometer, Geiger-Mueller counter and Gamma-Scout dosimeters.

All the programming was made in LabView graphical development environment.

Another assignment was to measure radiation intensity in three different surroundings: inside the rack, inside the building and outside the building. The aim was to examine the background radiation which would be needed for correct interpretation of the data acquired during NICA experiment. All the measurements were done using dosimeters connected to computers by USB interface. All the data was compared and statistically analysed.

TeVFeNICA Session / 25

α , β , γ radiation monitoring in the working area of the MPD Slow Control electronic equipment.

Authors: Alicja Jakubowska¹; Marta Robak¹; Anita Zagrobelna¹

Co-authors: Daniel Dabrowski²; Nikita Dunin³; Michalina Milewicz-Zalewska⁴; Marek Peryt²; Krystian Roslon⁵

¹ *Warsaw University of Technology, Faculty of Physics*

² *Warsaw University of Technology*

³ *JINR*

⁴ *Joint Institute for Nuclear Reactions*

⁵ *Warsaw University of Technology (PL)*

Corresponding Authors: krystian.roslon@cern.ch, dabrowski@if.pw.edu.pl, marekperyt@if.pw.edu.pl, milevich@jinr.ru, nikitadunin@live.ru

Project focuses on α , β , γ radiation monitoring. Firstly, three Gamma-Scout detectors were tested if the measurements taken in the same location are equal within 5% uncertainty. Next, detectors were moved to three different locations. Data collected from those locations in three available working modes (detection of γ , $\beta+\gamma$ and $\alpha+\beta+\gamma$ radiation) was analyzed to determine potential influence of the rack's case on radiation levels. Also, based on received data of radioactive sources (Eu-152 and Thorium) tested using Radateh photoelectronic detector three spectrograms were generated and compared, to conclude best utility of each type of detector. Further tasks involved developing software for a self-built Geiger-Müller counter using NI myDAQ and LabVIEW environment.

MPD Collaboration Meeting / 26

Status of FHCaI

Author: Alexander Ivashkin¹

Co-author: Alexander Strizhak¹

¹ *INR RAS*

Corresponding Author: ivashkin@inr.ru

We present the current status of Forward Hadron Calorimeter (FHCAL) at MPD. It consists of two arms, each comprises 44 individual modules. The performance of FHCAL for the determination of the geometry of heavy ion collisions will be discussed.

The status of the FHCAL modules production will be reported. The approaches in the energy calibration of FHCAL with cosmic muons will be reported. The future plans for the FHCAL integration in MPD and its operation would be also discussed.

Industrial Session / 27

Development of the Intelligent Power Distribution System

Authors: Tomasz Kowalski^{None}; Rami Faraj^{None}

Co-authors: Marek Peryt¹; Marcin Birski²; Adrian Krężel¹; Patryk Okoński; Barbara Kędzierska¹; Tomasz Zalewski¹; Aleksandra Fliszkiewicz¹; Klaudia Zardzewiała³

¹ *Warsaw University of Technology*

² *University of Wrocław*

³ *Politechnika Warszawska*

Corresponding Authors: k.zardzewiala@gmail.com, marekperyt@if.pw.edu.pl, tkowalsk@mion.elka.pw.edu.pl, aleksandra.fliszkiewicz7@gmail.com, zalewskitomasz94@gmail.com, birski@gmail.com, adriankrezel@gmail.com, rami.faraj@saytech.io, okonski.patryk@gmail.com, kedzierska_barbara@wp.pl

The goal of this paper is to present further development of the Intelligent Distribution System. The system connects a number of devices to a three-phase network and balance loading of this network. The main challenge during the design process is to propose compact solution, which will be compatible with the MPD platform. Simultaneously, all necessary functionalities, i.e., circuits protection, soft-start of the system, online monitoring and remote control, are provided.

TeVFeNICA Session / 28

Development and optimization of mpdroot software

Authors: Daniel Osinski^{None}; Wojciech Żurkowski^{None}; Oleg Rogachevskiy¹

Co-authors: Marcin Bielewicz²; Daniel Dabrowski³; Nikita Dunin⁴; Adam Kisiel⁵; Michalina Milewicz-Zalewska⁶; Marek Peryt³; Krystian Roslon⁵

¹ *Joint Institute for Nuclear Research (RU)*

² *Nacional Centre for Nuclear Research*

³ *Warsaw University of Technology*

⁴ *JINR*

⁵ *Warsaw University of Technology (PL)*

⁶ *Joint Institute for Nuclear Reactions*

Corresponding Authors: nikitadunin@live.ru, oleg.rogachevskiy@cern.ch, zurkowski@outlook.com, marekperyt@if.pw.edu.pl, krystian.roslon@cern.ch, kisiel@if.pw.edu.pl, dabrowski@if.pw.edu.pl, marcin.bielewicz@ncbj.gov.pl, daniel.osinski.1996@gmail.com, milevich@jinr.ru

The main task of my project was to determine and fix errors and warnings in Mpd-Root software. Mpd-Root is a simulation and analysis framework for NICA/MPD Detectors. Due to the work which was done - warnings free, compilable software code was obtained and released. Additionally, macros included in software files were checked in context of ability to work properly.

TeVFeNICA Session / 29

α , β , γ radiation monitoring in the working area of the MPD Slow Control electronic equipment.

Authors: Alicja Jakubowska^{None}; Marta Robak^{None}; Anita Zagrobelna^{None}; Nikita Dunin^{None}

Co-authors: Marcin Bielewicz ; Daniel Dąbrowski ; Adam Kisiel ; Michalina Milewicz-Zalewska ; Marek Peryt ; Krystian Rosłon

Project focuses on α , β , γ radiation monitoring. Firstly, three Gamma-Scout detectors were tested if the measurements taken in the same location are equal within 5% uncertainty. Next, detectors were moved to three different locations. Data collected from those locations in three available working modes (detection of γ , $\beta+\gamma$ and $\alpha+\beta+\gamma$ radiation) was analyzed to determine potential influence of the rack's case on radiation levels. Also, based on received data of radioactive sources (Eu-152 and Thorium) tested using Radateh photoelectronic detector three spectrograms were generated and compared, to conclude best utility of each type of detector. Further tasks involved developing software for a self-built Geiger-Müller counter using NI myDAQ and LabVIEW environment.

MPD/NA61 Joint Session / 31

Synergy in the development of forward hadron calorimeters for NA61, BM@N, MPD and CBM experiments

Author: Fedor Guber¹

Co-authors: Alexander Ivashkin²; Sergey Morozov¹; Marina Golubeva¹

¹ *Russian Academy of Sciences (RU)*

² *INR RAS*

Corresponding Authors: ivashkin@inr.ru, marina.golubeva@cern.ch, sergey.morozov@cern.ch, fedor.gouber@cern.ch

The lead/scintillator transverse and longitudinal segmented forward hadron calorimeters will be used in the upgraded NA61 and BM@N experiments and future CBM, MPD experiments to measure centrality and reaction plane orientation in heavy ion collisions. Similar calorimeter has been already used at the NA61 experiments on the search for the critical point and the onset of deconfinement in nucleus-nucleus interactions.

The light detection in all of these calorimeters is provided by the micropixel photodiodes and signal readout is provided by sampling ADCs. At present, already constructed modules for the future CBM experiments at FAIR are used at the NA61 upgraded hadron calorimeter and at the new hadron calorimeter in the BM@N experiments.

Mutual interest in the forward hadron calorimeters developments for these experiments, including development of different approaches of the centrality determination, calibration procedure will be discussed.

MPD Collaboration Meeting for general audience / 32

Feasibility studies of femtoscopic measurements in MPD

Author: Daniel Henryk Wielanek¹

¹ *Warsaw University of Technology (PL)*

Corresponding Author: daniel.henryk.wielanek@cern.ch

One of measurements that will be performed in MPD are femtoscopic measurements. This technique makes possible to measure spatio-temporal sizes of the source that emits particles by measuring two-particle correlations.

In this talk I present results of studies pion-pion correlations obtained from simulation with UrQMD model and MPD detector setup. I discuss the track and pair selection criteria. I also discuss of precision of the femtoscopic measurements with MPD.

TeVFeNICA Session / 34

XYZ Scanner for magnetic field studies

Authors: Witold Olech^{None}; Marek Peryt¹

Co-authors: Marcin Bielewicz²; Nikita Dunin³; Krystian Roslon⁴; Daniel Dabrowski⁴; Michalina Milewicz-Zalewska⁵; Maciej Czarnynoga⁶; Filip Protoklitow; Bartłomiej Juruc

¹ *Warsaw University of Technology*

² *Nacional Centre for Nuclear Research*

³ *JINR*

⁴ *Warsaw University of Technology (PL)*

⁵ *Joint Institute for Nuclear Reactions*

⁶ *Politechnika Warszawska*

Corresponding Authors: marekperyt@if.pw.edu.pl, nikitadunin@live.ru, maciejczarnynoga@gmail.com, witold.olech@gmail.com, daniel.dabrowski@cern.ch, fprotoklitow@gmail.com, krystian.roslon@cern.ch, bjuruc@gmail.com, milevich@jinr.ru, marcin.bielewicz@ncbj.gov.pl

Topic of the presentation is XYZ Scanner. This mechanical structure should allow to place a gauge (eg. Magnetometer) in a specified point in space. In NICA project it will be used for analysis of magnetic field uniformity in magnets. Existing project is 1D scanner, designed and constructed using Bosch aluminium profiles. Motion is realised by step motors with 3D printed parts. Developed software allows to control engines. Further development trend is extending project to all dimensions.

TeVFeNICA Session / 35

Naming and numbering application development for Equipment Database

Authors: Adam Biegański^{None}; Michalina Milewicz-Zalewska¹; Jakub Mrówczyński^{None}

Co-authors: Krystian Roslon²; Adam Kisiel²; Marcin Bielewicz³; Daniel Dabrowski²; Marek Peryt⁴

¹ *Joint Institute for Nuclear Reactions*

² *Warsaw University of Technology (PL)*

³ *Nacional Centre for Nuclear Research*

⁴ *Warsaw University of Technology*

Corresponding Authors: bieganski19@gmail.com, marekperyt@if.pw.edu.pl, daniel.dabrowski@cern.ch, milevich@jinr.ru, krystian.roslon@cern.ch, kisiel@if.pw.edu.pl, kuba.mrowka1@gmail.com, marcin.bielewicz@ncbj.gov.pl

Aim of our project was to create a multi-platform application which will enable identifying and stock-taking every single component used in NICA project. To achieve that we created Windows and Android mobile application which allows user to get acquaintance with NICA coding convention and

generate or decode unique 10-character code of component given according to coding lists. Thanks to the application performing EqDb database shall become much more efficient and safer.

TeVFeNICA Session / 36

Modelling Au-Au collisions in NICA collider energy spectrum using MPD programming environment

Authors: Maja Tureczek-Zakrzewska^{None}; Marta Monikowska^{None}; Marek Peryt¹; Michalina Milewicz-Zalewska²; Adam Kisiel³; Krystian Roslon³; Marcin Bielewicz⁴

¹ *Warsaw University of Technology*

² *Joint Institute for Nuclear Reactions*

³ *Warsaw University of Technology (PL)*

⁴ *Nacional Centre for Nuclear Research*

Corresponding Authors: marcin.bielewicz@ncbj.gov.pl, krystian.roslon@cern.ch, milevich@jinr.ru, marekperyt@if.pw.edu.pl, majatureczekzakrzewska@gmail.com, kisiel@if.pw.edu.pl, marta.monikowska@samorzad.if.pw.edu.pl

The main goal of this work was to perform Au+Au collisions generated within UrQMD model for different energies of NICA beam energy range. In order to obtain events generations, as well as physical analysis MPDroot environment was used. All the work was automatized via created macros and performed at NICA cluster. Simulations were held for intermediate energies of 4,7,9 and 11GeV.

TeVFeNICA Session / 38

Implementation of THERMINATOR generator to the MpdRoot environment.

Authors: Maksymilian Odziemczyk^{None}; Filip Jakubczak^{None}

Co-author: Adam Kisiel ¹

¹ *Warsaw University of Technology (PL)*

Corresponding Authors: kisiel@if.pw.edu.pl, filip.jakubczak97@gmail.com, maksymilian.odziemczyk@gmail.com

Presentation will be about how THERMINATOR generator was implemented in the MpdRoot environment, how to use it and perspectives for the future. Results accomplished with THERMINATOR will be presented as well. If applicable, audience will be able to ask some questions.

NICA Technical Session / 40

Naming and Numbering Convention for the Equipment Database of the NICA project.

Authors: Michalina Milewicz-Zalewska¹; Tomasz Traczyk²; Marek Peryt³; Viacheslav Golovatyuk⁴

Co-authors: Daniel Dabrowski ²; Krystian Roslon ²; Adam Kisiel ²

¹ *Joint Institute for Nuclear Reactions*

² *Warsaw University of Technology (PL)*

³ *Warsaw University of Technology*

⁴ *Joint Institute for Nuclear Research (RU)*

Corresponding Authors: marekperyt@if.pw.edu.pl, viacheslav.golovatyuk@cern.ch, krystian.roslon@cern.ch, tomasz.traczyk@cern.ch, daniel.dabrowski@cern.ch, milevich@jinr.ru, kisiel@if.pw.edu.pl

In every big scientific project human influence creates disorder. For an investment as big as NICA it is crucial to organize all the elements and minimize the chaos. One of the ways to achieve this goal is to create an Equipment Database (EqDb). Each component in the EqDb will receive its individual Part Identifier. Naming and Numbering Convention is a document containing instructions for Part Identifier creation. It was based on the existing model from CERN [1]. These Part Identifiers will simplify component identification at the location.

[1] L. Betev EP/AIP, P.Chochula EP/AIT, Naming and Numbering Convention for the ALICE Detector Part Identification –Generic Scheme, ALICE-INT-2003-039, 2003

MPD Collaboration Meeting for general audience / 41

Correlation femtoscopy at NICA energies

Author: Pavel Batyuk¹

Co-authors: Ludmila Malinina¹; Konstantin Mikhaylov²; Grigory Nigmatkulov³

¹ *Joint Institute for Nuclear Research (RU)*

² *NRC "Kurchatov Institute" - ITEP (RU)*

³ *National Research Nuclear University MEPhI*

Corresponding Authors: nigmatkulov@gmail.com, pavel.batyuk@cern.ch, ludmila.malinine@cern.ch, konstantin.mikhaylov@cern.ch

The correlation femtoscopy gives possibilities to measure the space-time characteristics of particle production processes due to the effects of quantum statistics (QS) and final state interactions (FSI). Femtoscopy at lower energies was intensively studied at AGS, SPS and in the Beam Energy Scan (BES) program.

Results on pion and kaon correlation femtoscopy for the NICA energy range are shown in the work. Also, a set of auxiliary tools to perform simulation with the vHLLE+UrQMD model in a simpler manner is presented. A new package to be used for femtoscopy analysis is announced and first correlations functions got directly from the model are shown.

MPD Collaboration Meeting for general audience / 42

Short-lived resonances and neutral mesons in the physical program of the NICA-MPD

Author: Viktor Riabov¹

¹ *NRC Kurchatov Institute PNPI (RU)*

Corresponding Author: viktor.riabov@cern.ch

Short-lived hadronic resonances such as $K^*(892)^{0,\pm}$, $\rho(770)^0$, $\phi(1020)$, $\Sigma(1385)^\pm$, $\Lambda(1520)$ and $\Xi(1530)^0$ are used to study different aspects of particle production and collision dynamics in pp, p–A and relativistic heavy-ion collisions. The yields of resonances are sensitive to the competing processes of hadron rescattering and regeneration, thus making these particles unique probes of the properties of the late hadronic phase. Measurements of resonances with different masses and quantum numbers also provide insight into strangeness production and processes that determine

the shapes of particle momentum spectra.
We discuss results of the model-based studies of the influence of the hadronic phase on the measured properties of resonances in heavy-ion collisions at NICA energies. Moreover, we discuss prospects for resonance measurements in the MPD experimental setup and results of the feasibility studies obtained using Monte Carlo simulation of the detector performance.

MPD Collaboration Meeting / 43

Event simulation and reconstruction in the BM@N experiment

Author: Sergei Merts^{None}

Corresponding Author: sergey.merts@gmail.com

The BM@N (Baryonic Matter at Nuclotron) is the first experiment to be realized at the accelerator complex of NICA-Nuclotron at JINR (Dubna, Russia). The aim of the experiment is to study interactions of relativistic heavy ion beams with a kinetic energy from 1 to 4.5 AGeV with fixed targets. Status of detector setup simulation is presented including geometry description and Monte-Carlo data digitization. The main stages of event reconstruction for the BM@N experiment are described in report. Some of experimental results are shown.

TeVFeNICA Session / 45

Design and Implementation of a control and measurement system for testing the quality of Fiber Optic Tracks for the Slow Control System of the BM@N and MPD-NICA experiment

Authors: Dawid Kraśko^{None}; Marek Peryt^{None}

Co-authors: Marcin Bielewicz ; Daniel Dabrowski ¹; Nikita Dunin ²; Adam Kisiel ³; Krystian Roslon ; Michalina Milewicz-Zalewska ⁴

¹ *Warsaw University of Technology*

² *JINR*

³ *Warsaw University of Technology (PL)*

⁴ *Joint Institute for Nuclear Reactions*

Corresponding Authors: milevich@jinr.ru, dabrowski@if.pw.edu.pl, dawid.krasko@gmail.com, nikitadunin@live.ru, kisiel@if.pw.edu.pl, roslon@if.pw.edu.pl

Nuclotron based Ion Collider fAcility (NICA) require a control and measurement system to test fiber optics. The system is important to ensure a quality of fiber optic tracks. It consists of different devices for measurement of various parameters. Control and measurement system will be used to check optic cable tracks, which were connected to the network in four of Slow Control System's RACKs and all fiber optics in future.

TeVFeNICA Session / 46

Design and heat transfer simulations for the MPD-TOF detector cooling system

Authors: Agata Ptak¹; Maciej Czarnynoga¹; Krystian Roslon^{None}

Co-authors: Marcin Bielewicz ; Daniel Dąbrowski ; Nikita Dunin ; Adam Kisiel ; Michalina Milewicz-Zalewska ; Marek Peryt

¹ WUT

Corresponding Author: agataptak3114@gmail.com

Electronic devices' overheating may cause functioning problems and production of inaccurate data in the experiment's detectors. The aim of the project was to design the most optimal and efficient way of cooling the MPD-TOF detector's module, to ensure the optimal operating condition for the Front End Electronics. The work consisted of preparing detailed CAD model of the existing module and proposed cooling system, and performing CFD simulations of heat transfer inside the module.

TeVFeNICA Session / 48

Setup of the heat transfer inside the TOF-MPD detector

Authors: Jakub Zdziębowski^{None}; Krystian Idźkowski^{None}; Krystian Roslon¹

Co-authors: Adam Kisiel ¹; Daniel Dabrowski ²; Marcin Bielewicz ; Marek Peryt ; Michalina Milewicz-Zalewska ³; Nikita Dunin ⁴

¹ Warsaw University of Technology (PL)

² Warsaw University of Technology

³ Joint Institute for Nuclear Reactions

⁴ JINR

Corresponding Authors: dabrowski@if.pw.edu.pl, milevich@jinr.ru, krystian.roslon@cern.ch, nikitadunin@live.ru, idzkowskikrystian@gmail.com, kisiel@if.pw.edu.pl, zdzieblowski@opoczta.pl

Time of Flight (TOF) detector is a part of Multi Purpose Detector (MPD), crucial element of the NICA complex. The detector generates signal that carries information needed for the particle identification. Complex physical process of forming output signal requires maintaining the amplifier circuits at specific temperature. Overheating may induce major signal distortions and - in worst case - damage of the detector. To avoid that scenario, many thermal simulations were performed.

The aim of this work was to build instrument for multipoint temperature measurement inside the TOF module and collect the essential data to verify the simulations. To assemble this setup, Pt100 type RTD sensors and LUMEL SM1 modules were used. Next, in order to multiply input channels, custom multiplexer circuit were built. Afterward, specialised LabVIEW software was created for circuit control and data acquisition.

The presentation presents the design concepts, problems encountered and obtained results during the described work.

TeVFeNICA Session / 49

Quality Assurance of particle collision simulation in MPDRoot

Authors: Adam Kisiel¹; Aleksandra Mazur^{None}

Co-authors: Daniel Dabrowski ²; Krystian Roslon ¹; Marcin Bielewicz ³; Marek Peryt ²; Michalina Milewicz-Zalewska ⁴; Nikita Dunin ⁵

¹ Warsaw University of Technology (PL)

² Warsaw University of Technology

³ *Nacional Centre for Nuclear Research*

⁴ *Joint Institute for Nuclear Reactions*

⁵ *JINR*

Corresponding Authors: kisiel@if.pw.edu.pl, dabrowski@if.pw.edu.pl, milevich@jinr.ru, krystian.roslon@cern.ch, marcin.bielewicz@ncbj.gov.pl, ollaleksandra@wp.pl, marekperyt@if.pw.edu.pl, nikitadunin@live.ru

Program to analyze simulated data from .root files, which are available on PCs or NICA cluster system (2 versions) by creating histograms of:

- multiplicity
- transverse momentum
- polar angle
- pseudorapidity
- pseudorapidity in a function of polar angle.

TeVNICA Session / 50

Development of visualisation for MPD experiment

Authors: Mateusz Kowal^{None}; Adam Kisiel¹

Co-authors: Michalina Milewicz-Zalewska²; Marek Peryt³; Nikita Dunin⁴; Krystian Roslon¹; Maciej Czarnynoga⁵; Daniel Dabrowski³

¹ *Warsaw University of Technology (PL)*

² *Joint Institute for Nuclear Reactions*

³ *Warsaw University of Technology*

⁴ *JINR*

⁵ *Politechnika Warszawska*

Corresponding Authors: dabrowski@if.pw.edu.pl, krystian.roslon@cern.ch, nikitadunin@live.ru, milevich@jinr.ru, mati.ko@wp.pl, marekperyt@if.pw.edu.pl, maciejczarnynoga@gmail.com, kisiel@if.pw.edu.pl

Monte Carlo simulation plays a significant role in particle physics. Therefore, it is important that the geometry of MPD components in software needs to be as close to real as possible. Visualising simulations helps to create actual projection of detector and generated particles. The Cosmic Ray Detector reduces the amount of muons counted for analysis by detecting cosmic radiation. With given geometry and functional code it can be added to MPD simulation.

During presentation geometry of MPD will be shown as well as exemplary visualisation of collisions. The process of simulating events will be explained.

MPD Collaboration Meeting for general audience / 51

Mini Beam-Beam monitoring: a wake-up trigger detector for the TOF of MPD

Authors: Lucio F. Rebolledo-Herrera¹; Cristian Heber Zepeda Fernandez²; Miguel Enrique Patino Salazar³; Mauricio Alvarado⁴

Co-authors: Alejandro Ayala³; Eduardo Moreno Barbosa⁵; Mario Rodriguez Cahuantzi⁵; Luis Montano Zetina⁶; Marco Ayala-Torres⁷

¹ *Instituto de Ciencias Nucleares, Universidad Nacional Autonoma de Mexico / Benemérita Universidad Autónoma de Puebla*

² *Benemérita Universidad Autónoma de Puebla-MexNICA, México*

³ *Instituto de Ciencias Nucleares, Universidad Nacional Autonoma de Mexico*

⁴ *MexNICA - Universidad Autónoma de México*

⁵ *Autonomous University of Puebla (MX)*

⁶ *Centro de Investigación y de Estudios Avanzados del IPN (MX)*

⁷ *Centro de Investigación y de Estudios Avanzados del IPN, México*

Corresponding Authors: amayala@fis.cinvestav.mx, heber.zepeda@cern.ch, eduardo.moreno.barbosa@cern.ch, ayala@nucleares.unam.mx, lucioreb@gmail.com, luis.montano.zetina@cern.ch, miguel.enrique.patino.salazar@cern.ch, mario.rodriguez.cahuantzi@cern.ch, mauricio.alvarado@correo.nucleares.unam.mx

Progresses on the design of an inner mini Beam-Beam (MBB) monitoring detector to help triggering the TOF is described. This consists of a cylinder 60 cm in length and 52 cm in diameter with strips located on the surface of the cylinder along its axis consisting in arrays of 2cm x 2cm x 0.3 cm³ scintillating plastics separated by 1cm. This detector is proposed to be part of MPD and is being developed by the MexNICA group. We also show the first mechanical and structural design for mBB together with the corresponding strength and mechanical simulation results using the CAD software. Also, using MC simulations, we show the performance of the scintillating plastic squares coupled each to four SensL Silicon Photomultipliers (SiPM) sensors. These studies show the importance of sensor location on the plastic sensitive area. Finally, we describe the advances in the front-end design based on fast signals from the used SiPMs. Triggering instrumentation design for Time of Flight (TOF) detector awake is also presented along with TRB3 interfacing for fast signal processing, independent from trigger circuitry.

TeVNICA Session / 52

Heat transfer simulations for three TOF-MPD detector modules

Authors: Kacper Nowacki¹; Krystian Roslon²; Maciej Czarnynoga²

Co-authors: Marek Peryt²; Adam Kisiel²; Michalina Milewicz-Zalewska³; Daniel Dąbrowski²; Nikita Dunin²; Marcin Bielewicz⁴

¹ *Warsaw University of Technology*

² *Warsaw University of Technology, Joint Institute for Nuclear Research*

³ *Joint Institute for Nuclear Research*

⁴ *National Centre for Nuclear Research, Joint Institute for Nuclear Research*

Corresponding Author: knowacki1997@gmail.com

As is common knowledge, electronics produce heat while working. The tasks were to carry out simulations of heat transfer between three of 28 modules of MPD-TOF detector and also research a method to carry them out using results of a simulation for only one module. Simulations have been performed with a usage of CFD method.

MPD Collaboration Meeting / 53

A “vector finder” approach to track reconstruction in the Inner Tracking System of MPD/NICA.

Author: Dmitry Zinchenko¹

Co-authors: Alexandre Zinchenko²; Eduard Nikonov³

¹ JINR

² Joint Institute for Nuclear Research (RU)

³ Joint Institute for Nuclear Research (JINR)

Corresponding Authors: alexandre.zinchenko@cern.ch, eduard.nikonov@cern.ch, zinchenk1994@gmail.com

At present, the accelerator complex NICA 1 is being built at JINR (Dubna). It is intended for performing experiments to study interactions of relativistic nuclei and polarized particles (protons and deuterons). One of the experimental facilities MPD (MultiPurpose Detector) 2 was designed to investigate nucleus-nucleus, proton-nucleus and proton-proton interactions.

As one of the possible MPD upgrade steps, an Inner Tracking System (ITS) based on the next generation silicon pixel detectors [3] is being considered to be installed between the beam pipe and the Time Projection Chamber (TPC). It is expected that such a detector will increase the research potential of the experiment for both the proton-proton (high luminosity) and nucleus-nucleus (high particle multiplicity) interactions. According to the proposed design, the MPD ITS will consist of five layers of silicon pixel detectors. The main purpose of the ITS is to provide a better precision of the primary and secondary vertex reconstruction and improve track reconstruction in the MPD in the region close to the interaction point.

The existing in the MPD track reconstruction method is based on the Kalman filter in the TPC. Its simple extension to the ITS is not adequate to fully exploit the potential of the new detector, therefore such a method cannot be considered as a good tool to study ITS performance. That is why another algorithm, based on the “vector finder” approach, was developed. The talk will describe the proposed track finding algorithm for the ITS of MPD and present its performance results obtained on Monte-Carlo generated data of nucleus-nucleus collisions.

1 Nuclotron-based Ion Collider fAcility web-site: <http://nica.jinr.ru>

2 MultiPurpose Detector web-site: <http://mpd.jinr.ru>

[3] B.Abelev et al [ALICE Collaboration], J. Phys., G41 (2014) 087002

TeFeNICA Session / 54

Embedded data processing using NI MyRIO and LabVIEW for magnetic field measurements

Authors: Hanna Gałach^{None}; Nikita Dunin¹

Co-authors: Marcin Bielewicz²; Daniel Dabrowski³; Michalina Milewicz-Zalewska⁴; Marek Peryt³; Krystian Roslon⁵

¹ JINR

² Nacional Centre for Nuclear Research

³ Warsaw University of Technology

⁴ Joint Institute for Nuclear Reactions

⁵ Warsaw University of Technology (PL)

Corresponding Authors: hagonia654@gmail.com, marcin.bielewicz@ncbj.gov.pl, milevich@jinr.ru, marekperyt@if.pw.edu.pl, dabrowski@if.pw.edu.pl, nikitadunin@live.ru, krystian.roslon@cern.ch

The task concerned the improvement of operation of the magnetic field measurement system, containing the MAG3110 magnetometer. LCD screen has been connected to the system in order to display the measurement results. Data logging to the USB drive connected directly to the MyRIO system has been configured. The sensor has been calibrated.

MPD Collaboration Meeting for general audience / 55

Development of the Fast Interaction Trigger for MPD experiment

Authors: Victor Rogov¹; Vladimir Yurevich¹; Sergey Sergueev¹; Sergey Sedikh¹; Alexander Timohenko¹; Vladimir Tikhomirov¹; Nikita Lashmanov¹; Nikolay Kozlenko¹

¹ JINR

Corresponding Authors: rogovictor@gmail.com, sergei.sergueev@mail.ru, vyurevi@gmail.com

The fast triggering of nucleus – nucleus collisions and the precise TOF measurement with picosecond time resolution are important features of all experiments at RHIC and LHC colliders.

The Fast Interaction Trigger (FIT) system is an important part of the Multi-Purpose Detector (MPD) setup for study of Au + Au collisions with beams of NICA collider in the energy interval $4 \leq \sqrt{s_{NN}} \leq 11$ GeV. The main aims of the FIT are (1) fast and effective triggering of Au + Au collisions in the center of the MPD setup and (2) generation of the start pulse for the TOF detector.

The fast vertex-trigger signal, provided by Fast Forward Detector (FFD), is the main signal of the L0 trigger of MPD. The fast determination of z-position of collision point of the vertex requires the appearance of pulses with high amplitudes in both sub-detectors FFDe (East side) and FFDw (West side) and it defines the trigger efficiency. For this aim the pulses of each sub-detector are fed to sub-detector electronics unit. Two-threshold method is used to get a good time resolution, only LVDS pulses with lengths above a threshold value (corresponding to photodetector output pulses with large amplitudes) are used for production of sub-detector pulses Te and Tw. The time of generation of these pulses is defined by appearance of the first good pulse from sub-detector modules.

This presentation will cover the main design concepts, detector construction, beam test results, and the results of detector performance studies.

TeVFeNICA Session / 56

Cable tester design for NICA-MPD Platform

Authors: Grzegorz Nakielny¹; Marek Peryt¹

Co-authors: Adam Kisiel ²; Daniel Dabrowski ²; Krystian Roslon ; Marcin Bielewicz ³; Michalina Milewicz-Zalewska ⁴; Nikita Dunin ⁵

¹ Warsaw University of Technology

² Warsaw University of Technology (PL)

³ Nacional Centre for Nuclear Research

⁴ Joint Institute for Nuclear Reactions

⁵ JINR

Corresponding Authors: nikitadunin@live.ru, marcin.bielewicz@ncbj.gov.pl, marekperyt@if.pw.edu.pl, rosilon@if.pw.edu.pl, milewicz@jinr.ru, g.nakielny@gmail.com, kisiel@if.pw.edu.pl, daniel.dabrowski@cern.ch

Such big experiments as NICA-MPD come along with a lot of multi-device connections. Therefore, the results of research may depend on quality and correct connection of signal cables. In this talk a complete design of cable tester for the NICA-MPD Platform will be shown, including software, electronical, and mechanical aspects of the device. The project layout has been optimized to provide possibility to check and validate the most popular signal cables. The device assembly process has been designed to meet the requirements of application in standard RACK cabinets.

TeVFeNICA Session / 58

Conception and development of the system for the magnetic field strength measurement in the NICA-MPD PLATFORM surroundings created using NI myRIO technology

Authors: Jakub Gluch^{None}; Paulina Marikin¹; Marek Peryt²

Co-authors: Michalina Milewicz-Zalewska³; Maciej Czarnynoga⁴; Adam Kisiel⁵; Nikita Dunin⁶; Krystian Roslon⁵; Daniel Dabrowski⁵

¹ Faculty of Physics of Warsaw University of Technology

² Warsaw University of Technology

³ Joint Institute for Nuclear Reactions

⁴ Politechnika Warszawska

⁵ Warsaw University of Technology (PL)

⁶ JINR

Corresponding Authors: kisiel@if.pw.edu.pl, marekperyt@if.pw.edu.pl, maciejczarnynoga@gmail.com, kkuba53@yahoo.pl, paulinamarikin@gmail.com, daniel.dabrowski@cern.ch, milevich@jinr.ru, krystian.roslon@cern.ch, nikitadunin@live.ru

Research and development of monitoring software to measure and save data of the Earth's magnetic field for NICA-MPD-PLATFORM. Due to the presence of unwanted background magnetic fields or uniform magnets with defects in their magnetic field, that could affect measurements, it was necessary to create magnetic field monitoring system. For that purpose a system was created with use of magnetometer MAG3110 and NI myRIO. The software to collect and record magnetic field in three axes with the option of changing the frequency and number of measurements was created. The final program can also calibrate raw data.

MPD Collaboration Meeting for general audience / 59

Current status of the Time-of-Flight system of the MPD

Authors: Vadim Babkin¹; Viacheslav Golovatyuk¹; Mikhail Rumyantsev¹; Mikhail Buryakov¹; Aleksandr Dmitriev¹; Kristina Vokhmyanina²; Aleksandr Kluev³; Sergei Lobastov⁴

¹ Joint Institute for Nuclear Research (RU)

² BelSU

³ Belgorod National Research University

⁴ Joint Institute for Nuclear Research

Corresponding Authors: mikhail.rumyantsev@cern.ch, vadim.babkin@cern.ch, rinaskela@gmail.com, viacheslav.golovatyuk@cern.ch, kristinav2005@yandex.ru, aleksandr.dmitriev@cern.ch, lsp1967@mail.ru, mikhail.buryakov@cern.ch

Mass production of detectors and modules of the MPD TOF system was launched in March 2019. Currently, the production process of all elements of the Time-of-Flight system has stabilized but is passing slightly behind schedule. The report will present the reasons behind this lag, and an updated schedule will be presented taking into account the current situation.

In addition, the report will present the latest simulation results of the Time-of-Flight system with the newest detailed geometry in the MPDROOT and the status of creating service subsystems.

MPD Collaboration Meeting / 60

A MAPS based Inner Tracking System of the Multi-Purpose Detector at the NICA collider

Author: Yuri Murin¹

¹ JINR**Corresponding Author:** murin@jinr.ru

The Multi-Purpose Detector (MPD) is being constructed to study the properties of extremely dense nuclear matter formed in relativistic nucleus-nucleus collisions at NICA energies. The yields of strange and charmed particles are the important observables sensitive to critical phenomena in phase transitions of the QGP-matter at high net-baryon density. Highly efficient registration of such short-lived products of nuclear interactions using vertex silicon detectors will play a key role in the analysis of the possible onset of deconfinement in nuclear matter.

An Inner Tracking System (ITS) based on the Monolithic Active Pixel Sensors (MAPS) is under design by the emerging MPD ITS collaboration in Dubna and Wuhan. The ultra-light carbon fiber structure carries five layers of CMOS ALPIDE sensors recently elaborated by the ALICE collaboration. The two layers of the Outer Barrel (OB) are built out of 42 staves developed for the new ALICE ITS to be installed at CERN next year. The MPD ITS mainframe mechanics and the OB installation is planned to be completed in 2023. The Inner Barrel (IB) will use novel MAPS sensors of enlarged area and reduced thickness to be developed together with the ALICE collaboration within 2020-2025 and installed after the reduction of the diameter of the MPD beam pipe to optimal value of 38 mm will become possible.

The report presents the main details of the MPD ITS layout, computer simulations of the pointing resolution gained with the system, as well as a quality assessment of the MPD tracking system including ITS and Time Projection Chamber used for the reconstruction of the multi-strange hyperons and the D-mesons produced in the central Au-Au collisions at $\sqrt{s} = 9$ GeV.

TeVFeNICA Session / 61

Optimization of the gas distribution system for the MPD-TOF detector module

Authors: Andrzej Ryczek^{None}; Krystian Roslon^{None}; Maciej Czarnynoga^{None}

Co-authors: Marcin Bielewicz ; Daniel Dąbrowski ; Nikita Dunin ; Adam Kisiel ; Michalina Milewicz-Zalewska ; Marek Peryt

The MPD-TOF detector is a gas detector in which an optimized gas distribution system plays a key role. The main task of this system is to ensure an even, laminar flow of the working fluid throughout the detector volume. During the work, various variants of the gas distribution system were prepared inside the MPD-TOF detector module. Next, flow simulations were carried out for each variant using the CFD method. Based on the results obtained, the optimal option was selected.

NICA Technical Session / 62

Gas System for Test Stand TOF/MPD

Authors: Daniel Dabrowski¹; Krystian Roslon¹; Marek Peryt²

¹ Warsaw University of Technology (PL)

² Warsaw University of Technology

Corresponding Authors: marekperyt@if.pw.edu.pl, krystian.roslon@cern.ch, daniel.dabrowski@cern.ch

The Multi-Purpose Detector (MPD) being currently developed in the V&BLHEP will be used for studies of hot and dense nuclear matter, by detecting particles created in heavy ion collisions. One of the most important systems of the MPD which will be used in identification of these particles is gaseous Time-of-Flight detector, based on the mRPC (multi Resistive Plate Chambers) technology. Parameters of gas environment inside of the detector chambers have major influence on its registration possibilities. That is why ensuring right and stable working environment is crucial for proper functioning of the detector. Advanced and highly automated Gas System based on prepared

project will consist of many modules including Mixer, Distribution, Recirculation, Buffer, Purifier, Analysis.

MPD/NA61 Joint Session / 63

Upgrade of the NA61/SHINE ToF system based on a MRPCs for the NICA experiments

Authors: Aleksandr Dmitriev¹; Alexandre Malakhov¹; Iouri Gusakov¹; Mikhail Buryakov¹; Mikhail Rumyantsev¹; Sviatoslav Buzin¹; Vadim Babkin¹; Viacheslav Golovatyuk¹

¹ *Joint Institute for Nuclear Research (RU)*

Corresponding Authors: mikhail.buryakov@cern.ch, alexandre.malakhov@cern.ch, mikhail.rumiantcev@cern.ch, sviatoslav.buzin@cern.ch, aleksandr.dmitriev@cern.ch, vadim.babkin@cern.ch, viacheslav.golovatyuk@cern.ch, iouri.goussakov@cern.ch

The obsolete left-right time-of-flight system (TOF-LR) of the hadron spectrometer NA61/SHINE require upgrades due to significant ageing of scintillators, photo-multipliers, power supplies as well as the outdated readout electronics and cables. New TOF detectors based on multi-gap resistive plate chambers (MRPC) for the NICA experiments are proposed as a replacement. The progress on design and development of new TOF system for NA61/SHINE experiment will be presented in the report.

NICA Technical Session / 64

Proposal of TPC calibration laser beam position control system for NICA/MPD

Author: Tomáš Rössler¹

Co-authors: Juris Lukstins²; Miroslav Mashlan³

¹ *Palacky Univerzity Olomouc*

² *JINR*

³ *Palacky University Olomouc*

Corresponding Authors: miroslav.maslan@upol.cz, tomas.rossler@upol.cz, juris007@list.ru

In order to minimize the error in the absolute position measurement by TPC, it is necessary to account for both static and time-dependent distortions in the drift path of the ionization cloud. The time-dependent distortions can result from the changes in gas performance, in environmental variables (temperature or atmospheric pressure), or from spontaneous failures. A calibration system that can reproduce fiducial tracks is needed to monitor the TPC performance.

Laser calibration system is based on two lasers NL303HT-10FH with beam expander telescopes what provide 18-20 mm diameter output beams. Each laser creates calibration rays at a half of detector (until high voltage electrode membrane). Lasers are situated on optical tables together with mirrors, which direct initial beam to TPC detector. NL303HT-10FH laser provides vertical polarized (90%) UV (266 nm) beam. In order to align mirrors a control system of beam position should be designed, produced and aligned. There will be eight beam output channels where laser beam position should be checked while in each channel two mirrors are adjusted. This procedure will be necessary once or, maybe, few times in period of mounting of optical system. Later, in period of 7-15 years the system can be switched on for short time to check that all 8 laser beams are at the same places as they were oriented starting TPC job. To choose materials and devices it should be taken into account that all materials must be nonmagnetic and chemically stable (vapors do not cause aging of TPC readout

proportional chambers). All 8 control blocks should be removable. On the other hand, system will work without TPC personal interference in period of 7-15 years.

Our proposed solution is based on the simple visible light camera, consists of detecting and imaging component, supplemented by the luminiscent component, provided the UV laser light transformation to visible diffuse light. The luminiscent plate serves as the transparent screen, the laser beam profile image is observed by the standard CMOS camera as detector using the imaging component. Two solutions of imaging were designed, either the standard lens or the pinhole aperture. Contribution gives teoretical principles, technical designs and evaluations of advantages/disadvantages of both approaches that are important for the final decision about the control system construction.

NICA Technical Session / 65

The dosimetry protection of the MPD Electronic Equipment at the new NICA Collider –the prototype system

Authors: Arkadiusz Chłopik¹; Aleksandr Bancer¹; Marcin Bielewicz^{None}; Adam Dudziński¹; Elżbieta Jaworska¹

Co-authors: Daniel Dabrowski ²; Nikita Dunin ³; Jarosław Grzyb ¹; Michalina Milewicz-Zalewska ⁴; Marek Peryt ²; Marcin Pietrzak ⁵; Krystian Roslon ; Jacek Rzakiewicz ¹

¹ *National Centre for Nuclear Research*

² *Warsaw University of Technology*

³ *JINR*

⁴ *Joint Institute for Nuclear Reactions*

⁵ *NCBJ*

Corresponding Authors: aleksandr.bancer@ncbj.gov.pl, milevich@jinr.ru, nikitadunin@live.ru, adam.dudzinski@ncbj.gov.pl, j.grzyb@ncbj.gov.pl, a.chlopik@ncbj.gov.pl, roslon@if.pw.edu.pl, mp@euronika.eu, jacek.rzakiewicz@ncbj.gov.pl, elzbieta.jaworska@ncbj.gov.pl, dabrowski@if.pw.edu.pl, marcin.pietrzak@ncbj.gov.pl

“The prototype dosimetry system to protect NICA Slow Control electronic equipment” project was started in Dubna at the beginning of 2018. Its primary purpose is to design a prototype dosimetry system for continuous monitoring of Multi-Purpose Detector (MPD) Slow Control electronic equipment which can protect it against accidental ionizing radiation caused by the NICA collider failure or its abnormal functioning. The system will be fitted out with alarming features which can inform chosen people about crossing the safe threshold of the radiation and the electronics will be possibly destroyed by the irradiation. Then the controlled switching off of the Nuclotron-based Ion Collider fAcility (NICA) Complex can be possible. The system can also be utilized for protecting the personnel working on electronic platform near the MPD against the radiation. The presentation describes the prototype system status of hardware and software after almost two years of work. There will be also presented the plans for the future.

NICA Days 2019 General Session / 66

Is orbital angular momentum efficiently transferred to spin degrees of freedom at NICA energies?

Author: Alejandro Ayala¹

¹ *Instituto de Ciencias Nucleares, Universidad Nacional Autónoma de México*

Corresponding Author: ayala@nucleares.unam.mx

We compute the relaxation time for quark/antiquark spin and thermal vorticity alignment in a quark-gluon plasma at finite temperature and quark chemical potential. We model the interaction of quark/antiquark spin with thermal vorticity as driven by a phenomenological modification of the elementary quark interaction with gluons. We find that in a scenario where the angular velocity produced in a peripheral heavy-ion collision competes with transverse expansion, and thus is small, quarks/antiquarks take a long time to align their spin with the vorticity. However, when the angular velocity created in the reaction is large, the alignment is efficient and well within the lifetime of the system created in the reaction. The relaxation time is larger for antiquarks which points out to a difference for the polarization of hadrons and antihadrons when this alignment is preserved during hadronization.

NICA Days 2019 General Session / 67

String fusion effects at NICA energies

Author: Vladimir Kovalenko¹

¹ *St Petersburg State University (RU)*

Corresponding Author: vladimir.kovalenko@cern.ch

The multiparticle production in the relativistic collisions of hadrons and nuclei is often considered in a two-stage approach. At the first stage, a certain number of quark-gluon strings is produced, and the final particles are produced by strings decay. The formation and fragmentation of strings is implemented in various Monte Carlo generators, such as PYTHIA, HIJING, FRITIOF, AMPT, UrQMD, etc. However, a number of new and precise measurements from the SPS, RHIC and LHC experiments shows that the many observed effects don't fit into the picture of the individual, non-interacting strings.

Among the observables sensitive to the collective effects are the multiplicity dependence of the transverse momentum, forward-backward correlations and strongly intensive measures, charge and particle ratio correlations and fluctuations, strangeness and charm production.

In this work, we studied the effect of the interaction between strings in pp and AA collisions using at NICA energy range. We applied a dipole-based Monte Carlo model [1, 2], in which the interaction between strings is implemented according to string fusion model [3, 4]. The model takes into account also the finiteness rapidity length of strings, allowing at NICA energies to probe different ranges of baryon density. For the particle species discrimination, the modified Schwinger mechanism is used [5], where the effective string tension, according to the string fusion prescription, depends on the string density. The results demonstrate that the inclusion of string fusion improves the agreement of the model predictions with experimental data. We discuss the possibilities of new measurements using MPD detector at NICA.

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NICA Technical Session / 68

Beam-Beam Collisions Monitor for NICA

Authors: Grigori Feofilov¹; Anton Baldine²; Farkhat Valiev¹; Pavel Har'yuzov³; Nikodim Makarov⁴

¹ *St Petersburg State University (RU)*

² *Joint Institute for Nuclear Research (JINR)*

³ *JINR, Dubna*

⁴ *Saint-Petersburg State University*

Corresponding Authors: baldin@sunhe.jinr.ru, valiev@hiex.phys.spbu.ru, feofilov@hiex.phys.spbu.ru

The Fast Beam-Beam Collisions (FBBC) monitor, based on the application of the secondary emission detectors –the Micro Channel Plates (MCPs), is proposed for NICA experiments at JINR. Two interaction points are foreseen for beam intersections at NICA: one for heavy-ion studies with the Multi-Purpose Detector (MPD) and another one for the polarized beams for the Spin Physics (SPD) experiment. The fast MCPs with the improved performance characteristics such as low resistivity (100-500 MOhm) 6 μ channels, high efficiency of MIPs registration and high gain ($\sim 10^7$), the extended life duration, very short signals with fast rise-time (~ 0.8 ns), are proposed for the event-by-event monitoring of the beam-beam interactions. The ultra-high vacuum compatibility and the low-mass compact design allow the application of the MCP setup inside the vacuum beam-pipe. The conceptual design of the Beam-Beam Collisions detector and fast readout electronics is presented and discussed.

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NICA Days 2019 General Session / 69

MONITORING AND CONTROL SYSTEM OF BM@N EXPERIMENTAL EQUIPMENT AND PROSPECTS FOR MPD

Authors: Petr Chumakov¹; Dmitry Egorov¹; Vitaly Shutov²; Roman Nagdasev¹

¹ *JINR*

² *Joint Institute for Nuclear Research (RU)*

Corresponding Authors: vitaly.shutov@cern.ch, peter.chumakov@bk.ru, degorov@jinr.ru

Multi-Purpose Detector (MPD) experimental setup which is under construction in JINR and Baryonic Matter at Nuclotron (BM@N) have many common detectors and servicing equipment. The monitoring and control system which was developed for the BM@N experiment can serve as a good starting point for developing control system of MPD experimental hardware. Short overview and results of usage of the monitoring and control system at BM@N are presented in the report.

MPD Collaboration Meeting / 70

Study of energy distributions in FHCaI

Authors: Alexander Ivashkin¹; Marina Golubeva²

¹ *INR RAS*

² *Russian Academy of Sciences (RU)*

Corresponding Authors: marina.golubeva@cern.ch, ivashkin@inr.ru

We propose to study the angular distributions of the energy deposited in FHCAL modules. The obtained distributions were fitted by the linear function on event-by-event basis. This fit allows to extract the transverse gradient of the spectator energy in the calorimeter and also the energy carried by free spectators inside the beam hole. The clear correlations between the fit parameters are observed in full range of the collision centralities.

Assuming, that the peripheral area of FHCAL is occupied mainly by the produced particles (pions), it can be possible to subtract their energy contributions to the full FHCAL energy. It makes possible to calculate the energy of free spectators in the central collisions and to avoid the ambiguity in FHCAL energy depositions for central and peripheral events. Potentially, the developed approaches would help in the determination of the centrality of the collision with FHCAL without application of the TPC information on multiplicity.

NICA Days 2019 General Session / 71

Finding resonances, unitarity, peculiarities and traps

Author: Robert Kamiński¹

¹ *Institute of Nuclear Physics PAS*

Corresponding Author: robert.kaminski@ifj.edu.pl

Finding resonances in amplitudes parametrized by us is an old well-known but controversial issue. Despite the apparent simplicity, it can cause many serious problems and surprises. By performing an analysis of the amplitudes fitted to the data, it's easy to find peculiarities and come across traps. They are especially important when planning a precise definition of resonance parameters. The purpose of the presentation is to show what may be the effects of neglecting such problems and how to avoid them. The key here is unitarity and crossing symmetry.

NICA Days 2019 General Session / 72

Pixel detectors for the Inner Tracking System of NICA MPD

Author: Vladimir Zhrebchevsky¹

Co-authors: Dmitriy Nesterov ; Nikolai Maltsev ; Grigoriy Feofilov ; Sergey Igolkin ; Valeriy Kondratiev ; Tatiana Lazareva ; Dosbol Nauruzbaev ; Nikita Prokofiev ; Alina Rakhmatullina ; Vladimir Vechernin

¹ *Saint-Petersburg State University*

Corresponding Author: v.zhrebchevsky@spbu.ru

One of the key problems of modern relativistic nuclear physics is the study of the phase diagram of strongly interacting matter. These experiments try to answer the question of how the transition of the QGP to the hadron gas occurs. To resolve such ambitious problems of studying hot and dense baryonic matter occurring in the relativistic heavy ion collisions, a new mega set-up is currently being developed at JINR: Multi-Purpose Detector (MPD) at NICA collider 1. The main element of this MPD set-up it will be tracking system, required for the precise determination of track vertices with subsequent track reconstructions of all detected charged particles in a wide range of transverse momentum and pseudo rapidity.

The monolithic active pixel sensors based on CMOS technology are also being considered as building block for the construction of the vertex and inner tracker of the NICA MPD. These sensors were developed for the upgraded Inner Tracing System of ALICE experiment in CERN 2.

In this overview the properties and characteristics of multicomponent detector modules as basic elements for the precise determination of primary and secondary vertices together with new ultra-light, radiation-transparent carbon fiber support structures (all detector modules are mounted on these structures) will be reported. Also possible use of these technologies for the experiments SPD, BM@N and NA61/SHINE will be discussed.

The reported study was funded by RFBR according to the research project № 18-02-40075.

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MPD Collaboration Meeting / 73

MPD Yoke production status

Author: Nikolai Topilin¹

¹ *Joint Institute for Nuclear Research (RU)*

Corresponding Author: nikolai.topiline@cern.ch

Report presents problems and solutions of MPD Yoke production. There are short descriptions about production tolerances of main details, Yoke control assembly, transportation and axillary equipment production.

MPD Collaboration Meeting / 74

Full MPD Ecal. Data Base

Author: Larisa Stolypina¹

¹ *JINR*

Corresponding Author: lora_s_73@mail.ru

The report describes a database being developed to store a large amount of information about the electromagnetic calorimeter of MPD. A brief description of the manufacture of calorimeter modules is given. The advantages of using the database during the creation and operation of the electromagnetic calorimeter are shown.

MPD Collaboration Meeting / 75

The demonstrator of Cosmic Ray Detector (MCORD) for the MPD detector.

Authors: Marcin Bielewicz¹; Joanna Maria Stepaniak²; Lukasz Swiderski³; Adam Kisiel⁴; Grzegorz Kasprowicz⁴; Marek J. Peryt⁵; Maciej Rybczynski⁶

Co-authors: Martyna Grodzicka-Kobylka³; Bartosz Maksiak²; Sławomir Mianowski²; Damian Pszczel⁷; Paweł Słobczyński³; Tomasz Szczesniak³; Paweł Linczuk⁵; Daniel Wielanek⁵; Krzysztof Pozniak⁸; Wojciech Zabolotny⁹; Ryszard Romaniuk⁴; Arkadiusz Chłopik³; Aleksandr Bancer³; Krystian Grodzicki¹⁰; Adam Dudziński³; Elżbieta Jaworska⁴; ELZBIETA STRUGALSKA-GOLA¹¹; Marcin Szuta³; Krystian Roslon⁴; Zbigniew Włodarczyk¹²; Grzegorz Stefanek⁶; Paweł Kankiewicz¹³; Agnieszka Synfeld-Kazuch¹⁰; Michalina Milewicz-Zalewska¹⁴

¹ *Nacional Centre for Nuclear Research*

² *National Centre for Nuclear Research (PL)*

³ *National Centre for Nuclear Research*

⁴ *Warsaw University of Technology (PL)*

⁵ *Warsaw University of Technology*

⁶ *Jan Kochanowski University (PL)*

⁷ *National Centre for Nuclear Research; Uppsala University*

⁸ *Warsaw University of Technology, Institute of Electronic Systems*

⁹ *University of Warsaw (PL)*

¹⁰ *National Center for Nuclear Research*

¹¹ *NCB J SWIERK*

¹² *Jan Kochanowski University, Kielce, Poland*

¹³ *Jan Kochanowski University, Kielce*

¹⁴ *Joint Institute for Nuclear Reactions*

Corresponding Authors: ryszard.romaniuk@cern.ch, agnieszka.synfeld-kazuch@ncbj.gov.pl, elzbieta.jaworska@ncbj.gov.pl, kisiel@if.pw.edu.pl, marcin.bielewicz@ncbj.gov.pl, joanna.maria.stepaniak@cern.ch, pawel.sibczynski@ncbj.gov.pl, slawomir.mianowski@ncbj.gov.pl, aleksandr.bancer@ncbj.gov.pl, martyna.grodzicka@ncbj.gov.pl, krystian.roslon@cern.ch, daniel.wielanek@cern.ch, t.szczesniak@ncbj.gov.pl, adam.dudzinski@ncbj.gov.pl, bartosz.maksiak@cern.ch, wojciech.zabolotny@cern.ch, mszuta@cyf.gov.pl, marekperyt@if.pw.edu.pl, a.chlopik@ncbj.gov.pl, damian.pszczel@cern.ch, milevich@jinr.ru, krystian.grodzicki@ncbj.gov.pl, maciej.rybczynski@cern.ch, pozniak@ise.pw.edu.pl, elzbieta.strugalska-gola@ncbj.gov.pl, greg.stefanek@cern.ch, zbigniew.wlodarczyk@ujk.edu.pl, p.linczuk.1@stud.elka.pw.edu.pl, l.swiderski@ncbj.gov.pl, grzegorz.kasprowicz@cern.ch, pawel.kankiewicz@ujk.edu.pl

The article shows the present construction state of the MCORD detector (MPD Cosmic Ray Detector) demonstrator and early design status of the full MCORD detector based on the long and thin plastic scintillators with silicon photomultiplier photodetectors (SiPM) for the photon readout. Additionally we describe the analog front-end and digital electronic system based on MicroTCA crate. The Multi-Purpose Detector (MPD) is a part of Nuclotron-based Ion Collider fAcility (NICA) located in Dubna, Russia. The MPD needs an additional trigger system for better muons recognition and for rejection of cosmic ray muons. The NICA-PL consortium comprised of several Polish scientific institutions has been formed to determine goals and basic assumptions for MCORD detector.

MPD Collaboration Meeting / 76

Centrality Determination in Heavy-ion Collisions with MPD (NICA)

Authors: Petr Parfenov¹; Alexander Ivashkin²; Ilya Segal³; Arkadiy Taranenko³; Anton Truttse⁴; Artyom Anikeyev⁴

¹ *NRNU MEPhI (RU) INR RAS (RU)*

² *INR RAS*

³ *National Research Nuclear University MEPhI (RU)*

⁴ *NRNU MEPhI (RU)*

Corresponding Authors: petr.parfenov@cern.ch, ilya.segal@cern.ch, ivashkin@inr.ru, arkadiy.taranenko@cern.ch, aaanikeyev@mephi.ru, aatruttse@mephi.ru

Centrality is a key parameter for defining the collision system size in relativistic heavy-ion collisions. It provides a tool for selecting events according to cross section in a similar way in different experiments and with theoretical model calculations. The progress of centrality determination in Au+Au collisions at Multi-Purpose Detector (MPD) at the future NICA collider is presented. The choice of variables used for event classification will be discussed.

MPD Collaboration Meeting / 77

Performance studies of anisotropic flow with MPD at NICA

Authors: Arkadiy Taranenko¹; Petr Parfenov¹; Anton Anikeev¹; Anton Truttse¹; Viktor Kireyev²

¹ NRNU MEPhI

² JINR

Corresponding Author: avtaranenko@mephi.ru

The Multi-Purpose Detector (MPD) at NICA collider has a substantial discovery potential concerning the exploration of the QCD phase diagram in the region of high net-baryon densities and moderate temperatures.

The anisotropic transverse flow is one of the key observables to study the properties of dense matter created in heavy-ion collisions. The MPD performance for anisotropic flow measurements is studied with Monte-Carlo simulations of gold ions at NICA energies $\sqrt{s_{NN}} = 4 - 11$ GeV using different heavy-ion event generators. Different combinations of the MPD detector subsystems are used to investigate the possible systematic biases in flow measurements, and to study effects of detector azimuthal non-uniformity. The resulting performance of the MPD for flow measurements is demonstrated for the directed and elliptic flow of identified charged hadrons as a function of rapidity and transverse momentum in different centrality classes.

MPD Collaboration Meeting / 78

Main parameters of MPD Electromagnetic Calorimeter in Latest Geometry Version.

Author: Viacheslav Kulikov¹

Co-authors: Sergey Bulychov²; Maxim Martemianov ; Mikhail Matsyuk²; Igor Tyapkin³; A.V. Skoblikov⁴

¹ NRC "Kurchatov Institute" – ITEP, Moscow 117218, Russia

² NRC "Kurchatov Institute" - ITEP (RU)

³ JINR

⁴ NRC "Kurchatov Institute" – ITEP

Corresponding Author: kulikov@itep.ru

As part of the NICA/MPD project, a unique cylindrical electromagnetic calorimeter (ECal) is being created with a diameter of 2 m, a length of 6 m and a total weight of about 60 tons. Recently, the design of a 12-ton power frame of ECal made of carbon and glass-plastic was completed. This led to the need for a significant changes in the structure of ECal. A new program for the geometric description of ECal was created, including both the power frame and the new structure of the modules and their layout. The report is devoted to the first presentation of the main characteristics of ECal. The power frame contributes 10.9% of the radiation length in front of the ECal (in addition to 17.2% of the TOF), and also adds plastic partitions from 0.2 to 14 mm thick between the modules. This leads to an average decrease in the total ionization signal from the ECal by 10%, which weakly affects the energy resolution, which remains at 4.5% for 1.0 GeV photons, but significantly distorts the Gaussian shape of the energy response distribution due to an increase in the low-energy tail. The energy and angular accuracy of the ECal and their dependence on the photon energy and the threshold of the electronics, the detection efficiency of photons, muons and neutrons, the expected resolution in the mass of the neutral pion will be given. This work was supported by RFBR grant No. 18-02-40054.

NICA Technical Session / 79

STATUS OF THE FRONT-END ELECTRONICS FOR THE TIME-OF-FLIGHT MEASUREMENTS IN THE MPD EXPERIMENT

Authors: Mikhail Buryakov¹; Vadim Babkin¹

¹ *Joint Institute for Nuclear Research (RU)*

Corresponding Authors: vadim.babkin@cern.ch, mikhail.buryakov@cern.ch

Overview of the status of the front end electronics which planning to use with a long strips readout MRPC at the Time-of-Flight measurements in the NICA-MPD experiment.

MPD/NA61 Joint Session / 80

Particle production properties at SPS energy range - recent results from NA61/SHINE experiment.

Author: Szymon Mateusz Pulawski¹

¹ *University of Silesia (PL)*

Corresponding Author: s.pulawski@cern.ch

The research programme of the NA61 collaboration covers a wide range of hadronic physics in the CERN SPS energy range. It encompasses measurements of hadron-hadron, hadron-nucleus as well as nucleus-nucleus collisions. The latter are analyzed to better understand the properties of hot and dense nuclear matter. In this contribution recent results on particle production in proton-proton, Be+Be, Ar+Sc interactions at beam energies of 19/20A, 30/31A, 40A, 75/80A and 150/158A GeV/c will be presented as well synergies with future NICA program will be emphasised.

MPD/NA61 Joint Session / 81

Convolutional neural network for centrality determination in fixed target experiments

Author: Denis Uzhva¹

Co-author: Andrey Seryakov¹

¹ *St Petersburg State University (RU)*

Corresponding Authors: andrey.seryakov@cern.ch, denis.uzhva@cern.ch

Fixed target experiments have an unique possibility to measure centrality of colliding systems by hadronic calorimeters on the beam line. This is usually achieved by the detection of all forward nucleon spectators and accomplishes fluctuation and correlation measures with lower biases than in collider experiments. However, hadronic calorimeters have much lower resolution than multiplicity detectors that introduces additional volume fluctuation to the measures.

In this work, we present the first attempt to increase the resolution capacity of the spectator detector by implementing a convolutional neural network to the modular structure of the Projectile Spectator Calorimeter of the NA61/SHINE experiment. The data were generated in the framework of SHIELD Monte-Carlo event generator with detector response simulated with GEANT4 for the collisions of the lightest available system (⁷Be+⁹Be) and for the highest beam momentum (150A GeV/c). Two ways of determination centrality – by a number of forward spectators and by forward energy – are considered. In comparison with the classical centrality selection method, the neural net shows a significant increase of centrality selection accuracy after implementation.

MPD Collaboration Meeting / 82

MPD electromagnetic calorimeter simulation

Author: Maxim Martemianov¹

Co-authors: Igor Tyapkin²; Andrei Semenov²; Viacheslav Kulikov; Mikhail Matsyuk¹; Yury Krechetov²; Sergey Bulychov¹; Irina Semenova²

¹ NRC "Kurchatov Institute" - ITEP (RU)

² Joint Institute for Nuclear Research

Corresponding Author: mmartemi@gmail.com

In a frame of the NICA / MPD project, a unique cylindrical electromagnetic calorimeter (ECal) is being created. Recently, the design of the power frame made of carbon fiber was completed. This led to significant changes of the calorimeter structure. This report gives a brief description of the new ECal geometry, the modification of simulation procedure and the current basic parameters of the calorimeter. The ECal geometry simulation is based on the standard software of the MPD detector: MpdRoot and FairSoft. In the new version, the calorimeter consists of 38,400 "shashlik" towers with 210 layers combined from a 1.5 mm scintillator plate and 0.3 mm lead plate coated with reflective paint. The shapes of the towers are approximately a truncated pyramid with a base of 4x4 cm² and of 64 types, more accurately described by a set of trapezoids. All towers look at the point of the beam intersection, forming the so-called projective geometry. Each calorimeter module is formed of 16 towers. All modules are placed in 50 baskets with a total weight equal to 1.2 tons each. As part of this program, independent module options have been developed to use in the test measurements on cosmic ray and electron beams. This work was supported by RFBR grants № 18-02-40054 and № 18-02-40079.

MPD Collaboration Meeting / 83

Electromagnetic Calorimeter of the MPD at NICA

Authors: Boyana Dabrowska¹; Igor Tyapkin²

¹ Joint Institute for Nuclear Research (RU)

² JINR

Corresponding Author: boyana.marinova@cern.ch

ECal type "shashlik" having sampling 300 micron Pb and transverse cell size ~4x4 cm² has the ability to measure energy with the resolution up to 5% in the range of energy at NICA.

Due to not fully projective geometry of the detector (the reason is the large scatter of the interaction point), in certain cases, a correction of the hit position depending on the interaction point is needed. As an example, it is shown that using this correction when restoring π^0 can reduce the sigma in two times.

It found an easy method to calibrate calorimeter using cosmic muons.

MPD Collaboration Meeting / 84

Beauty = Truth. On the role of aesthetics in physics

Author: Tomasz Miller¹

¹ Copernicus Center for Interdisciplinary Studies, Jagiellonian University

Corresponding Author: tomasz.miller@uj.edu.pl

Modern theories of physics are elaborate, math-heavy constructions that aim to encompass the workings of the world in the largest possible scales on the one hand (relativistic cosmology), and on the deepest subatomic level on the other (quantum field theories). What they share in common is the special kind of raw, majestic beauty, which not only enthralls theorists (including Einstein and Dirac), but sometimes even drives their scientific pursuits. But what actually makes a theory “beautiful”? In order to answer this question, during this popular lecture we shall take a quick walk starting from the very dawn of (mathematical) physics all the way to the current search for grand unification. Can aesthetics really lead us closer to the truth, or is beauty a luring, but deceitful guide that should have no place in the logical and empirical method of physics?

MPD Collaboration Meeting / 85

Software developments for detectors experimental hardware

Authors: Petr Chumakov¹; Dmitry Egorov¹; Roman Nagdasev¹; Vitaly Shutov²

¹ JINR

² Joint Institute for Nuclear Research (RU)

Corresponding Authors: vitaly.shutov@cern.ch, peter.chumakov@bk.ru, degorov@jinr.ru

Big modern physics detector experiments represent a collaboration of workgroups and require wide variety of electronic equipment. All devices can be classified into two categories - Data Acquisition (DAQ) equipment and hardware that is not time-critical and can be run at low priority. But the statuses and stored data from these systems, such as high voltage systems, gas systems, temperature sensors, front-end electronics, etc. play notable part in the experiment operation and further data analysis. Monitoring, control and archiving of the values from the devices must be centralised and unified to simplify data access and interaction between detectors and subsystems.

TeVNICA Session / 86

Monitoring and stabilisation of the test laboratory environment Time of Flight for NICA - MPD - PLATFORM

Authors: Klaudia Pachulska¹; Jędrzej Kołaś^{None}; Krystian Roslon^{None}

Co-authors: Marek Peryt¹; Michalina Milewicz-Zalewska²; Daniel Dabrowski¹; Marcin Bielewicz³; Nikita Dunin⁴

¹ Warsaw University of Technology

² Joint Institute for Nuclear Reactions

³ Nacional Centre for Nuclear Research

⁴ JINR

Corresponding Authors: rosilon@if.pw.edu.pl, gosciu0987654321@gmail.com, nikitadunin@live.ru, marcin.bielewicz@ncbj.gov.pl, pachulskaklaudia0@gmail.com, dabrowski@if.pw.edu.pl, milevich@jinr.ru, marekperyt@if.pw.edu.pl

The aim of this project was to design and construct system for environmental monitoring and stabilisation inside test laboratory for MPD-TOF platform. The presentation includes schematics of proposed system design, brief description of its function, accomplished tasks and proposed plans for future development.

MPD/NA61 Joint Session / 87

Fluctuations and correlations study at NA61/SHINE

Author: Daria Prokhorova¹

¹ *St Petersburg State University (RU)*

Corresponding Author: daria.prokhorova@cern.ch

The strong interactions program of NA61/SHINE, a fixed-target experiment at the CERN SPS, focuses on the search for the critical point of strongly interacting matter. The strategy of the Collaboration is to perform a comprehensive two dimensional scan of the phase diagram μ_B-T by changing the collision energy and the system size. If in this scenario, the system freeze-out occurs in the vicinity of the possible critical point, then a region of enhanced fluctuations is expected in suitable fluctuation measures.

The talk will review the ongoing NA61/SHINE analysis on multiplicity and transverse momentum fluctuations in terms of intensive and strongly intensive quantities. Furthermore, their pseudorapidity dependence, which corresponds to a scan in the baryon chemical potential μ_B at the freeze-out stage, will be presented along with the study of the higher moments of multiplicity distributions.

The talk also discusses the approaches to corrections of the results and possible systematic problems in the analysis.

TeVFeNICA Session / 88

Software for device designed to measure radiation absorption of various materials

Authors: Maciej Marcinkiewicz¹; Michał Foltys¹

Co-authors: Marek Peryt ; Daniel Dąbrowski ¹; Adam Kisiel ¹; Michalina Milewicz-Zalewska ; Nikita Dunin ; Krystian Roslon ; Marcin Bielewicz

¹ *WUT*

Speech about software designed to control the device that measures radiation absorption of various materials. Made during Slow Control Summer Practice 2019 let user measure without the hazard of being exposed to the ionizing radiation.

TeVFeNICA Session / 89

Analyzing the thermal images taken by Fluke TiS20 thermal imager

Author: Filip Protoklitow^{None}

Co-authors: Michalina Milewicz-Zalewska ¹; Daniel Dabrowski ²; Marek Peryt ²; Krystian Roslon ³; Nikita Dunin ⁴; Maciej Czarnynoga ⁵; Marcin Bielewicz ⁶

¹ *Joint Institute for Nuclear Reactions*

² *Warsaw University of Technology*

³ *Warsaw University of Technology (PL)*

⁴ *JINR*

⁵ *Politechnika Warszawska*

⁶ *Nacional Centre for Nuclear Research*

Corresponding Authors: maciejczarnynoga@gmail.com, marekperyt@if.pw.edu.pl, fprotoklitow@gmail.com, marcin.bielewicz@ncbj.gov.pl, dabrowski@if.pw.edu.pl, krystian.roslon@cern.ch, nikitadunin@live.ru, milevich@jinr.ru

Overheating electronic elements can causes them to function improperly, because of that measuring and controlling the temperature are major factors in terms of their longevity and reliability. Measurements can be done in discrete approach by using thermometers or by taking images using thermal imager and then analyzing them. In case of utilizing second approach it is easier to measure variety of subsystems in vastly reduced time, without necessity to setup whole array of apparatuses. By writing versatile MATLAB program I was able to analyze thermal images that can be used to investigate overheating elements, mean temperature and prepare graphs that can be used in future thermal analysis such as CFD simulations.

TeFeNICA Session / 90

Design of cooling system for equipment installed in RACK's 42U 19"

Author: Bartłomiej Juruc^{None}

Co-authors: Michalina Milewicz-Zalewska¹; Krystian Roslon²; Marek Peryt³; Marcin Bielewicz⁴; Daniel Dabrowski²; Nikita Dunin⁵

¹ *Joint Institute for Nuclear Reactions*

² *Warsaw University of Technology (PL)*

³ *Warsaw University of Technology*

⁴ *Nacional Centre for Nuclear Research*

⁵ *JINR*

Corresponding Authors: milevich@jinr.ru, krystian.roslon@cern.ch, bjuruc@gmail.com, nikitadunin@live.ru, daniel.dabrowski@cern.ch, marekperyt@if.pw.edu.pl, marcin.bielewicz@ncbj.gov.pl

The subject of this work is laboratory solution of pure cooling system for equipment installed in RACK 42U 19" in conditions of forced long-term operation (20 years). The designed system is a closed system operating with liquid and air cooling medium.

The scope of work includes getting acquainted with the technical and functional requirements and designing the required structures, which include: servo drive housings, liquid cooler modules, carrier transport profiles and elements constituting a connection of the enclosure interior with the cooling system, called casing. The aim of the project is to adapt and design the required structures to the existing RACK dimensions, minimizing the complexity of individual elements and maximizing the ease of their mutual assembly.

Detailed drawings have been made for the designed elements in accordance with the applicable engineering graphics, which will then be forwarded to the manufacturer in Poland.

TeFeNICA Session / 91

Upgrade of the MPD/TOF Test Stand Gas System and Control Software

Authors: Filip Mąkowski^{None}; Daniel Dabrowski¹

Co-authors: Marcin Bielewicz²; Krystian Roslon³; Marek Peryt¹; Michalina Milewicz-Zalewska⁴; Nikita Dunin⁵

¹ *Warsaw University of Technology*

² *Nacional Centre for Nuclear Research*

³ *Warsaw University of Technology (PL)*

⁴ *Joint Institute for Nuclear Reactions*

⁵ *JINR*

Corresponding Authors: nikitadunin@live.ru, krystian.roslon@cern.ch, marcin.bielewicz@ncbj.gov.pl, marekperyt@if.pw.edu.pl, milevich@jinr.ru, dabrowski@if.pw.edu.pl, f.makolski@gmail.com

In this work gas system for MPD/TOF test stand and its control software development are discussed. Some elements of the gas instalation were modified. In order to provide proper functioning of the devices PID controllers were added. To choose proper settings of the PID controllers the Ziegler-Nichols method was used. Conducted software tests turned positive. System works properly and can be further developed.

TeVFeNICA Session / 92

Time synchronization of electronic devices in RACKs NICA-MPD-PLATFORM using GPS NI-9467-c-RIO

Authors: Kamil Chęć^{None}; Piotr Sawicki^{None}; Monika Wasilewska^{None}

Co-authors: Marcin Bielewicz¹; Daniel Dabrowski²; Nikita Dunin³; Adam Kisiel⁴; Michalina Milewicz-Zalewska⁵; Marek Peryt²; Krystian Roslon⁴

¹ *Nacional Centre for Nuclear Research*

² *Warsaw University of Technology*

³ *JINR*

⁴ *Warsaw University of Technology (PL)*

⁵ *Joint Institute for Nuclear Reactions*

Corresponding Authors: k.chec.prv@gmail.com, krystian.roslon@cern.ch, marekperyt@if.pw.edu.pl, nikitadunin@live.ru, milevich@jinr.ru, marcin.bielewicz@ncbj.gov.pl, kisiel@if.pw.edu.pl, dabrowski@if.pw.edu.pl, wasilewska642@gmail.com, psrubing@gmail.com

In order to provide the same time to every devices there is a need to construct special system. In NICA project synchronization will be managed by GPS. System designers can use this module for accurate data timesampling, system clock setting, gating data acquisition based on the arrival of the PPS and synchronizing global waveform acquisition data using the FPGA.

NICA Technical Session / 93

Optical gate of asynchronous work interruptions of the measuring system with acoustic signaling in NIMyRIO technology

Author: Tomasz Gniazdowski¹

Co-authors: Marek Peryt¹; Krystian Roslon²; Michalina Milewicz-Zalewska³; Daniel Dabrowski²; Adam Kisiel²; Jan Marian Pluta²; Maciej Czarnynoga⁴

¹ *Warsaw University of Technology*

² *Warsaw University of Technology (PL)*

³ *Joint Institute for Nuclear Reactions*

⁴ *Politechnika Warszawska*

Corresponding Authors: krystian.roslon@cern.ch, t.gniazdowski15@gmail.com, maciejczarnynoga@gmail.com, milevich@jinr.ru, kisiel@if.pw.edu.pl, daniel.dabrowski@cern.ch, pluta@if.pw.edu.pl, marekperyt@if.pw.edu.pl

Information about developed interrupting system will be presented.

Hardware configuration, technology used in project, principle of operation, software creation in LabVIEW and applicability in other electronic systems will be discussed. Also positive prototype tests will be reviewed.

TeFeNICA Session / 94

Heat transfer simulation of the BM@N -STS detector

Author: Maciej Czarnynoga¹

Co-authors: Adam Kisiel ²; Daniel Dabrowski ³; Krystian Roslon ²; Marek Peryt ³; Michalina Milewicz-Zalewska ⁴; Nikita Dunin ⁵

¹ *Politechnika Warszawska*

² *Warsaw University of Technology (PL)*

³ *Warsaw University of Technology*

⁴ *Joint Institute for Nuclear Reactions*

⁵ *JINR*

Corresponding Authors: marekperyt@if.pw.edu.pl, milevich@jinr.ru, kisiel@if.pw.edu.pl, krystian.roslon@cern.ch, nikitadunin@live.ru, maciejczarnynoga@gmail.com, dabrowski@if.pw.edu.pl

Silicon Tracking System (STS) will be part of tracking system in Baryonic Matter at Nuclotron (BM@N) experiment. Such detector consists of high amount of silicon chips, which are consuming significant electric power. Most of this power is dissipated in chip as heat, this process can cause overheating of chip or even whole detector. CFD (Computational Fluid Dynamics) thermal simulation might be used to investigate the overheating risk. Moreover results of such simulation can be used to design temperature stabilisation system

NICA Days 2019 General Session / 96

Study of ^6He - d reactions at the ACCULINNA-2 separator

Author: B.Z. Zalewski¹

Co-authors: M.C. Golovkov ; S.G. Belogurov ; A.A. Bezbakh ; V. Chudoba ; A.S. Fomichev ; E.M. Gazeeva ; A.V. Gorshkov ; G. Kaminski ; B. Mauey ; S.A. Krupko ; I.A. Muzalevsky ; E.Yu. Nikolskii ; P. Napiorkowski ; W. Piątek ; P. Pluciński ; K. Rusek ; S.I. Sidorchuk ; A. Serikov ; R.S. Slepnev ; P.G. Sharov ; N. Sokołowska ; G.M. Ter-Akopian ; A. Trzcińska ; R. Wolski

¹ *Joint Institute for Nuclear Research (RU)*

Corresponding Author: bogumil.zbigniew.zalewski@cern.ch

Measurement of reactions of ^6He with deuterium target was performed in inverse kinematics at the beam energy of 160 MeV. The measurement was performed at the ACCULINNA-2 fragment separator, Joint Institute for Nuclear Research, Russia using ^6He beam delivered by U400M cyclotron. Both energies and angles of the ejectiles were detected in a range from 30 to 80 degrees in the laboratory frame. Preliminary results of data analysis are going to be presented.

NICA Technical Session / 97

Temperature sensors for controlling the drive in NiMyRIO technology

Author: Mateusz Samsel^{None}

Co-authors: Marek Peryt¹; Michalina Milewicz-Zalewska²; Daniel Dabrowski¹; Jan Marian Pluta³; Adam Kisiel³; Krystian Roslon³; Maciej Czarnynoga⁴

¹ *Warsaw University of Technology*

² *Joint Institute for Nuclear Reactions*

³ *Warsaw University of Technology (PL)*

⁴ *Politechnika Warszawska*

Corresponding Authors: krystian.roslon@cern.ch, maciejczarnynoga@gmail.com, kisiel@if.pw.edu.pl, dabrowski@if.pw.edu.pl, matekallegro312@wp.pl, milevich@jinr.ru, jan.marian.pluta@cern.ch, marekperyt@if.pw.edu.pl

The presentation talks about the designed device, based on NiMyRio technology, which can control the motor drive using the PWM signal, based on the measurements of temperature. It presents the technological solutions used in project to get the basic functionalities and also to increase the stability of the device.

NICA Days 2019 General Session / 99

Opening of the conference and welcome by the Vice-Rector of WUT

NICA Days 2019 General Session / 100

Welcome from the Ministry of Science and Higher Education

NICA Days 2019 General Session / 101

Welcome from the Ministry of Foreign Affairs

NICA Days 2019 General Session / 102

Poland in JINR

NICA Days 2019 General Session / 103

NICA project at JINR

NICA Days 2019 General Session / 104

MPD Experiment and WUT

Corresponding Author: kisiel@if.pw.edu.pl

NICA Days 2019 General Session / 105

Signing of the Memorandum of Understanding for WUT in the MPD Experiment

NICA Days 2019 General Session / 106

QCD phase diagram at NICA - K^+/π^+ horn effect and light clusters in THESEUS Topic: Heavy-Ion Collisions and QCD Phase Diagram at NICA

Author: David Blaschke¹

¹ *University of Wrocław*

Corresponding Author: david.blaschke@gmail.com

I report on recent progress in the development of the Three-fluid Hydrodynamics-based Event Simulator Extended by UrQMD final State interactions (THESEUS) 1 as a tool for investigating signals for the onset of deconfinement and the formation of a hadron-quark matter mixed phase in heavy-ion collisions at NICA energies. I shall cover three main topics:

1. The study of the MPD detector acceptance influence of the baryon stopping signal for deconfinement in the net proton rapidity distributions for the NICAS beam-energy scan 2.
2. Extension of the particlization routine to include light cluster production (deuterium, tritium) and application to study thermal and coalescence schemes; comparison with results from NA49 at 20 and 30 AGeV as well as preliminary results from HADES at 1.3 AGeV with preliminary conclusions on the role of in-medium effects [3].
3. Development of the thermal model scheme of particlization to study the K^+/π^+ and K^-/π^- ratios as a function of the beam energy, based on the Beth-Uhlenbeck approach to Mott dissociation of kaons and pions in hot, dense quark matter at the hadronization transition [4].

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- 2 V. Voronyuk et al., in preparation
- [3] G. Roepke et al., PPN Letters 15, 225 (2018)
- [4] D. Blaschke et al., PRD 96, 094008 (2017)

MPD Collaboration Meeting / 107

Quark Matter presentation rehearsal

Corresponding Author: kisiel@if.pw.edu.pl

NICA Technical Session / 108

HIC simulations with different EoS models

Author: Hovik Grigorian^{None}

Corresponding Author: hovikgrigorian@gmail.com

We have developed and performed a Bayesian analysis for selecting the most probable equation of state under a set of constraints from compact star physics, which now include the tidal deformability from GW170817. The calculations for two-parameter family of hybrid equations of state, which produces a third family of hybrid stars in the mass-radius diagram, have been made. We are preparing to apply our Bayesian analysis method also for extension of hybrid equations of state for the symmetric matter case for the finite temperatures, which will be used for HIC simulations. The results of simulations for Rapidity Distribution and Curvature at Midrapidity as well as hadron Ratios at Midrapidity will be used in Bayesian analysis method to obtain the probabilities for the model parameters within their considered range.

NICA Technical Session / 109

Surface characterization techniques for studying heavy ion irradiation effects in materials

Authors: Andrzej Olejniczak¹; Vladimir A. Skuratov²

¹ *JINR*

² *Joint Institute for Nuclear Research*

Corresponding Authors: skuratov@jinr.ru, aolejnic@jinr.ru

The aim of the report is to present the surface characterization techniques available within the framework of the Nano-laboratory building at the FLNR, JINR. The laboratory provides state-of-the-art spectroscopy and microscopy instrumentation for research on the application of heavy-ion beams in the field of nanotechnology and materials science. The techniques available include coupled confocal Raman spectroscopy-scanning probe microscopy (STM, AFM), X-ray photoelectron spectroscopy, Auger electron spectroscopy, and Fourier transform infrared spectroscopy. The results will be presented on the example of various carbon-based materials irradiated with heavy ions in the keV to GeV energy range. A possible extension of the work reported would be to study the effects induced by slow highly charged ion beams. Such beams can be produced by electron cyclotron resonance ion sources at the FLNR or electron string ion sources developed for the NICA injection facility.

TeVNICA Session / 111

Fire extinguishing unit software development for the Slow Control system of the MPD-ToF detector

Author: Nikita Dunin¹

Co-authors: Marek Peryt²; Daniel Dabrowski³; Krystian Roslon³; Michalina Milewicz-Zalewska⁴; Marcin Bielewicz⁵

¹ *JINR*

² *Warsaw University of Technology*

³ *Warsaw University of Technology (PL)*

⁴ *Joint Institute for Nuclear Reactions*

⁵ *Nacional Centre for Nuclear Research*

Corresponding Authors: marcin.bielewicz@ncbj.gov.pl, marekperyt@if.pw.edu.pl, milevich@jinr.ru, daniel.dabrowski@cern.ch, krystian.roslon@cern.ch, nikitadunin@live.ru

Software development for a fire-protection units of the Slow Control System was set as a part of the RACK infrastructure modernization at Veksler and Baldin Laboratory of High Energy Physics of the Joint Institute for Nuclear Research. The main goal of the system, as any other fire-extinguishing systems, is to protect health and life of people and to preserve the equipment inside the RACK's cabinets. Therefore, a fire protection system should work in conjunction with an automatic gas fire suppression system.

Additionally, the system should be easy to setup and be as unnoticeable as possible during the working conditions of the amenity. It should not cause additional hazards. It is desirable for it to be easy both to install and configure, while keeping the overall costs reasonable.

The software for 2 generations of FRS-RACK extinguishing modules had been designed using the development environment LabVIEW 2016. Software is intended to read the data from the sensors of the Firesi FRS-RACK and its visualization.

MPD/NA61 Joint Session / 112

Non-standard GEM foils for gaseous detectors

Author: Magdalena Kuich¹

¹ *University of Warsaw (PL)*

Corresponding Author: magdalena.kuich@cern.ch

Gas Electron Multiplier (GEM) technology is widely used in many application in nuclear and particle physics. It offers the potential to develop new gaseous detectors with unprecedented spatial resolution, high rate capability, sizeable sensitive area, operational stability and radiation hardness. In this contribution, a brief overview of gaseous detector development at the University of Warsaw will be presented, as well as basic concepts, operational mechanisms and performance of the gas amplifier structures based on standard and non-standard GEM foils will be discussed

TeVNICA Session / 113

Heat transfer simulation of the MPD-TPC detector

Author: Maciej Czerkawski^{None}

Co-authors: Krystian Roslon ¹; Marcin Bielewicz ²; Michalina Milewicz-Zalewska ³; Daniel Dabrowski ¹; Marek Peryt ⁴; Nikita Dunin ⁵

¹ *Warsaw University of Technology (PL)*

² *Nacional Centre for Nuclear Research*

³ *Joint Institute for Nuclear Reactions*

⁴ *Warsaw University of Technology*

⁵ *JINR*

Corresponding Authors: nikitadunin@live.ru, krystian.roslon@cern.ch, marekperyt@if.pw.edu.pl, marcin.bielewicz@ncbj.gov.pl, daniel.dabrowski@cern.ch, czerkawskim@yahoo.com, milevich@jinr.ru

The main task was to make temperature simulations for MPD-TPC detector. Model of ROC from MPD-TPC detector was made in line with actual dimensions of real model in Autodesk Inventor program. Whole model was drawn with all PCBs and cooling system. Then thanks to Autodesk

CFD program were carried out calculations of model in temperature domain in case of temperature change gradient examination.

MPD/NA61 Joint Session / 114

ALICE technologies proposed for the VD of NA61/SHINE in connection to the future MPD Si tracker

Author: Grigori Feofilov¹

¹ *St Petersburg State University (RU)*

Corresponding Author: feofilov@hiex.phys.spbu.ru

In this report I would like to show, first of all, briefly, the main challenges of the Inner Tracking System (ITS) design for ALICE that were successfully met, which is proved by 10 years of operation at the LHC. Secondly, the conceptual current design of the Vertex Detector for open charm at the NA61/SHINE will be discussed for two options of Small and Large Area Detector systems (SAVD and LAVD). Status of SAVD and LAVD are to be presented. This includes both the implementation of record breaking carbon fiber technologies and MIMOSA sensors performance of SAVD and the expected future ALPIDE applications for LAVD. And, finally, some ideas on possible synergies with the future ITS for MPD are also discussed.

TeVNICA Session / 115

Heat simulations for the pxi module and rack 42u

Author: Michał Gałązka¹

Co-authors: Marcin Bielewicz²; Nikita Dunin³; Marek Peryt¹; Michalina Milewicz-Zalewska⁴; Daniel Dabrowski⁵; Krystian Roslon⁵

¹ *Warsaw University of Technology*

² *Nacional Centre for Nuclear Research*

³ *JINR*

⁴ *Joint Institute for Nuclear Reactions*

⁵ *Warsaw University of Technology (PL)*

Corresponding Authors: daniel.dabrowski@cern.ch, michalgalazka97@gmail.com, marekperyt@if.pw.edu.pl, krystian.roslon@cern.ch, milevich@jinr.ru, marcin.bielewicz@ncbj.gov.pl, nikitadunin@live.ru

During the internship in JINR has been set up a problem with the electronics heat up in the RACK cabinet. It should ensure the right work conditions, the basic parameter is temperature. For that reason it has formed a need to see the heat transfer in the RACK cabinet and also the PXI module.

NICA Technical Session / 116

Probing the QCD critical end point through multi-messenger observations of compact stars and heavy ion collisions.

Author: David Edwin Alvarez Castillo^{None}

Corresponding Author: sculkaputz@gmail.com

In order to prove the existence of a critical end point (CEP) in the QCD phase diagram it is sufficient to demonstrate that at zero temperature $T = 0$ a first order phase transition exists as a function of the baryochemical potential μ , since it is established knowledge from ab-initio lattice QCD simulations that at $\mu = 0$ the transition on the temperature axis is a crossover.

We present the argument that the observation of a gap in the mass-radius relationship for compact stars which proves the existence of a so-called third family (aka “mass twins”) will imply that the $T = 0$ equation of state of compact star matter exhibits a strong first order transition with a latent heat that satisfies $\Delta\epsilon/\epsilon_c > 0.6$. Since such a strong first order transition under compact star conditions will remain first order when going to symmetric matter, the observation of a disconnected third family branch of compact stars in the mass-radius diagram proves the existence of a CEP in QCD.

To quantify the mass twins phenomenon, I will show a recent developed EoS that features of a color superconducting chiral quark model with nonlocal, covariant interactions bearing density dependent vector meson coupling and a density-dependent bag pressure. This model allows for a scenario where the compact stars of the GW170817 event are either both hadronic, both hybrid, or simultaneously hadronic and hybrid configurations, expected to be identified through the detection of gravitational radiation produced by compact star mergers.

In order to study the information derived from compact star observations, I shall review the method of estimation of tidal deformabilities of compact stars (encoded in gravitational radiation of mergers) and present results for pure hadronic as well as hybrid stars that include the mass twins case. In particular, the recent detection of gravitational radiation from the GW170817 event shed light on the properties of the neutron star equation of state (EoS), thus comprising both the study of the symmetry energy, stellar radius and the mass twins scenario. Along these lines, at the end of my talk I shall present an analysis of star rotations aimed at probing the compact star maximum mass which turns out to strongly constrain the maximum density found in star cores.

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CAEN S.p.a.

Corresponding Author: j.givoletti@gmail.com

Industrial partner presentation

Industrial Session / 119

Present and Future CAEN instrumentation 2019

Author: Jacopo Givoletti^{None}

Corresponding Author: j.givoletti@gmail.com

MPD Collaboration Meeting for general audience / 120

FAIR-NICA Cooperation

Corresponding Author: paolo.giubellino@cern.ch

MPD/NA61 Joint Session / 121

Open charm measurements plans in NA61/SHINE experiment at the CERN SPS

Corresponding Author: pawel.piotr.staszal@cern.ch

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GBTX emulation for BM@N/MPD data acquisition systems

Authors: W.M.Zabolotny¹; Adrian Pawel Byszuk²; Marek Guminski³; Grzegorz Kasproicz⁴; M.Kruszewski¹; Krzysztof Pozniak⁵; R Romaniuk⁴; David Emschermann⁶; Christian Joachim Schmidt⁶; Wojciech Zabolotny²

¹ *Institute of Electronic Systems, Warsaw University of Technology*

² *University of Warsaw (PL)*

³ *Warsaw University of Technology*

⁴ *Warsaw University of Technology (PL)*

⁵ *Warsaw University of Technology, Institute of Electronic Systems*

⁶ *GSI - Helmholtzzentrum für Schwerionenforschung GmbH (DE)*

Corresponding Authors: c.j.schmidt@gsi.de, grzegorz.kasproicz@cern.ch, adrian.pawel.byszuk@cern.ch, marek.guminski@gmail.com, ryszard.romaniuk@cern.ch, david.emschermann@cern.ch, wojciech.zabolotny@cern.ch, pozniak@ise.pw.edu.pl

The article presents the concept and implementation of the emulation of the GBTX chip for data acquisition systems for NICA experiments.

The GBTX chip is widely used in high-energy experiments. However due to export restrictions, it can't be used in NICA. There is significant synergy in building readout chains for CBM and NICA experiments. To fully utilize this synergy, it is important to emulate the essential GBTX functionality in FPGA.

For that purpose the emulator of GBTX (GBTxEMU) has been developed.

The GBTxEMU may be implemented in cheap FPGAs including Artix 7, and enables creating multichannel data acquisition chains based on the same front-end ASICs (SMX2 developed at AGH) as used in CBM. The GBTxEMU may work with the DPB boards developed for CBM, however a dedicated, price-optimized solution is planned in the future.

International Collaborators / 123

FAIR's SIS100 Quadrupole Doublet Modules - production and supply line overview

Author: Kamil Kozłowski¹

¹ *GSI*

Corresponding Author: k.kozlowski@gsi.de

Industrial Session / 124

Rittal company presentation

MPD Institutional Board / 126

Common Fund and Publication Policy Discussion

Corresponding Author: itzhak.tserruya@cern.ch

NICA Technical Session / 127

MPD TPC Status

Corresponding Author: sergei.movtchan@cern.ch

NICA Technical Session / 128

TPC electronics cooling design status

Corresponding Author: vladimir.tchepournov@cern.ch

Industrial Session / 130

CiS Silicon detectors Development, Prototyping, Production, Test, Assembly

Author: Ralf Röder^{None}

CiS Silicon detectors Development, Prototyping, Production, Test, Assembly