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

1. Recent developments in JINR cloud services

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Abstract:

The JINR cloud based on the Infrastructure-as-a-Service (IaaS) model provides JINR users with virtual machines (VMs), i.e. a universal computing resource designed for personal usage and as a basis for multi-user services. In this paper we give an overview of the recent changes in the JINR cloud infrastructure, common cloud services and present some new service developments, namely mon-service.jinr.ru and jupyter.jinr.ru.

2. Event reconstruction based on data from micro-strip detectors of the tracking system in the BM@N experiment

Authors: D. Baranov

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Abstract:

Main detectors of the tracking system in the BM@N experiment have a micro-strip readout. The key advantage of the given detector type is to use readout electronics that are much easier to assemble through a smaller number of digital channels in comparison with, for example, pad-based or pixel-based detectors. However, this advantage is diluted by a significant shortcoming, i.e. false strip crossings (fakes) resulting from the coordinate reconstruction procedure. It considerably complicates further track finding algorithms. With an increase in event multiplicity the number of fakes increases as well. It leads to a reduction in the overall efficiency of the event reconstruction procedure.

In this report, we describe the features of the hit reconstruction procedure as a step in the complete event reconstruction based on data from three types of micro-strip detectors used in the BM@N experiment in 2017-2018: GEM, SILICON, CSC. The software implementation of simulation and data processing algorithms for the detectors is also described.

3. Design, development and testing of the Electromagnetic Calorimeter of the MPD and BM@N at NICA

Authors: B. Dabrowska
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Abstract:

An electromagnetic calorimeter (ECal) will be used to measure the coordinates and energy of electrons and photons in the MPD. The ECal will also play an important role in the particles identification and measurement of the total energy flow. To accomplish these goals, a heterogeneous calorimeter type “shashlik” was selected, made of 220 scintillation and lead plates. The radiation length of the calorimeter is 11.8X0, the energy resolution is 5% and the the time resolution is below 1ns.

4. Time-of-Flight (ToF-400) system of the BM@N experiment

Authors: A. Daribayeva
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Abstract:

The BM@N experimental setup is constructed as a spectrometer capable of detecting charged hadrons, electrons and photons in heavy-ion collisions in the energy range of the Nuclotron. To achieve these aims, the detector must include a precise tracking system and a high-performance particle identification system based on time-of-flight measurements. The time-of-flight system (ToF-400) consists of two walls installed at a distance of 4 meters from the target and placed symmetrically with respect to the direction of the beam axis.
During the 55th session of the Nuclotron, a large amount of data was collected in the BM@N experimental setup. Upon the session, Ar and Kr beams were induced to different targets: C, Al, Sn, Cu, Pb. Current work presents the information about the construction of the time-of-flight (ToF-400) system. It also includes the preliminary result of identification and estimation of the time resolution of the ToF-400 system based on the analysis of the experimental data.

5. Operation center of the JINR Multifunctional information and computing complex

Authors: A.O. Golunov, A.G. Dolbilov, I.S. Kadochnikov, I.A. Kashunin,
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Abstract:

The Multifunctional information and computing complex (MICC) at the Laboratory of Information Technologies of the Joint Institute for Nuclear Research (LIT JINR) is a sophisticated multi-component hardware-software complex aimed at a wide range of tasks related to data processing, analysis and storage in order to ensure scientific and productive activities of the Institute and its Member States. The main components of the MICC computing infrastructure are the Tier-1 and Tier-

2 grid sites of the global grid infrastructure WLCG (Worldwide LHC Computing Grid) created for processing of data from experiments at the Large Hadron Collider, the JINR cloud infrastructure and the heterogeneous computing cluster HybriLIT. An important tool for ensuring a smooth operation of computing systems of such a level in a 24/7 mode is a comprehensive monitoring of all components and subsystems of the Centre. To ensure an effective control of the MICC components, the operation center (OC) of the Multifunctional information and computing complex has been developed in the Laboratory of Information Technologies. The main functions of OC are the round-the-clock surveillance of the state of hardware components, services, the engineering and network infrastructure.

6. Cluster monitoring system of the Multifunctional information and computing complex (MICC) LIT

Authors: I. Kashunin, A. Dolbilov, A, Golunov, V. Korenkov, V. Mitsyn, T. Strizh, E. Lysenko
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Abstract:

The monitoring system of LIT MICC Tier-1 and Tier-2 was put into operation in early 2015. In connection with the development of the computing complex, the number of devices as well as the number of measured metrics increased. Thus, over time, the amount of monitored data increased and the monitoring system server performance was insufficient. The solution to this problem was the construction of a cluster monitoring system. This made it possible to distribute the load from one server to several and significantly increase the level of scalability.

7. The PHQMD model for the formation of nuclear clusters and hypernuclei in heavy-ion collisions.

Authors: V.Kireyeu[1], J.Aichelin[2], E. Bratkovskaya[3], A. Le Fevre[3], Y. Leifels[3], V. Kolesnikov[1]
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Abstract:

Modeling of the process of the formation of nuclear clusters in hot nuclear matter is a challenging task. The PHQMD (Parton-Hadron-Quantum-Molecular-Dynamics) model is a transport approach incorporating explicit partonic degrees-of-freedom (quarks and gluons), an equation-of-state from lattice QCD, as well as dynamical hadronization and hadronic elastic and inelastic collisions in the final reaction phase. An n-body quantum molecular dynamic type propagation of hadrons which allows choosing of the equation of state with different compression modulus was recently complemented with a number of routines for the formation of nuclear clusters and hypernuclei in the reaction final state.
We present first results from PHQMD on the study of the production rates of strange hadrons, nuclear clusters and hypernuclei in heavy-ion collisions at NICA energies. In particular, sensitivity of hadronic anisotropic flow harmonics on the "hard" and "soft" equation of state within the PHQMD model was investigated.

8. Neutrino oscillation analysis in the NOvA experiment

Authors: L. Kolupaeva
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Abstract:
NOvA is an accelerator experiment at FNAL (USA) devoted to studying neutrino oscillations (electron neutrino appearance and muon neutrino disappearance in both neutrino and antineutrino modes). This is one of the off-axis new generation experiments with two detectors sited at 14 mrad off the NuMI beam axis and separated by 810 km of the Earth crust.
The main goals of this experiment are the search of CP violation in the lepton sector, measurement of neutrino mass hierarchy and some oscillation parameters with better precision. The latest obtained oscillation analysis results with neutrino and antineutrino beams will be presented in this poster.

9. Short-Range Correlation measurement at BM@N

Authors: V. Lenivenko[1], V.Panin[2], M. Patsyuk[1], N. Voytishin[3]
[1]Laboratory of High Energy Physics, JINR, Dubna, Russia
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Abstract:

BM@N (Baryonic Matter at Nuclotron) is a fixed target experiment. It is the first functioning experiment of the NICA-Nuclotron-M (Nuclotron-based Ion Collider fAcility) accelerator complex. The main goal is to study the properties of hadrons and the formation of (multi) strange hyperons on the threshold of the birth of hypernuclei.
In the last physical run, which ended in April 2018, besides the main BM@N physical program, the first measurement of Short-Range Correlations in the carbon nucleus was carried out. About 20% of nucleons of nuclei at any moment of time are located in intensely interacting SRC pairs, which are characterized by a large absolute and small momentum of the center-of-mass system in comparison with the Fermi pulse. Traditionally, the properties of SRC pairs are studied in hard scattering reactions when a particle from the beam (electron or proton) interacts with one nucleon of a nucleus. In the BM@N experiment, inverse kinematics was used: a carbon ion beam collided with a liquid hydrogen target, while the nucleus, after the interaction, continued to move forward and was recorded by tracking and time-of-flight systems of the BM@N spectrometer. The properties of the residual nucleus at a beam momentum of 4 GeV/s/nucleon have never been studied before.
We will present a brief overview of the preliminary results of analyzing the data of the first SRC measurement at BM@N.

10. GOVORUN supercomputer: hardware and software environment

Authors: D.V. Belyakov[1], Yu. A. Butenko[1], I.A. Kashunin[1], M.A. Matveev[1], M. Vala[2]
[1] Laboratory of Information Technologies, JINR, Dubna, Russia
[2] Pavol Josef Safarik University, Kosice, Slovakia

Abstract:

«HybriLIT» heterogeneous platform is a part of the Multifunctional information and computing complex (MICC) of the Laboratory of Information Technologies of JINR. The heterogeneous platform consists of «GOVORUN» supercomputer and «HybriLIT» educational and testing polygon. Network infrastructure of the heterogeneous platform is based on 10GBASE-TEthernet network with

two high-speed segments of 100Gbit/s Mellanox Infiniband and 100 Gbit/s Intel Omni-Path technologies. The data network of «GOVORUN» supercomputer has been built on high performance network filesystem «Lustre» which is working over 100 Gbit/s Intel OmniPath. The MPI processes utilizes Intel Omni-Path between CPU component and Mellanox Infiniband between GPU component. The total performance is 500 TFlops for double precision and 1 PFlops for single precision.

11. Tier-1 Service Monitoring System

Authors: V. Korenkov, V. Mitsyn, I. Pelevanyuk, T. Strizh
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Abstract:

Tier-1 for CMS was created in JINR in 2015. It is important to keep an eye on the Tier-1 center all the time in order to maintain its performance. The hardware monitoring system is based on Nagios. It monitors the center on several levels: the engineering infrastructure, the network and hardware.
Apart from infrastructure monitoring, there is a need for consolidated service monitoring. Top-level services, which accept jobs and data from the grid, depend on lower-level storage and processing facilities, which themselves rely on the underlying infrastructure. There are various sources of information about the state and activity of the Tier-1 services.
The decision to develop a new monitoring system was made. The goals are to retrieve a monitoring information about services from different sources, process data into events and statuses and react according to a set of rules, e.g. to notify service administrators or restart a service.

12. Simulation of the Supernova Neutrino Signal in NOvA Detectors

Authors: M. Petropavlova
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Abstract:

Many neutrino experiments are be sensitive to the core-collapse supernova neutrino signal. However the development of detection methods and evaluation of experiment sensitivity to such signal requires a detailed simulation of supernova neutrino interactions in the detector geometry. Currently there is no common-used software for such simulation. We present a GenieSNova software package, which interfaces existing models of supernova neutrino fluences with GENIE interaction generator. This package is being developed for the NOvA experiment, however being general enough it can be easily applied to other detectors with different geometry and composition.

13. Search for multiquark exotic states at the ATLAS experiment

Authors: A. Vasyukov
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Abstract:

One of the current areas of research within the framework of the standard model are experimental searches and the study of multiquark hadrons. This poster provides an overview of the properties of the

recently discovered pentaquark states: Pc (4312), Pc (4380), Pc (4445), Pc (4457) (LHCb, 2019); and also tetraquark states Zc (3900) (BESIII, 2014-2017), Zc (4200) (BELLE, 2014). The current results and plans for furher study of these states in B-hadron decays in the ATLAS experiment at the LHC are discussed

14. Front-End Electronics development for TPC/MPD detector of NICA project

Authors: S. Vereschagin
Laboratory of High Energy Physics, JINR, Dubna, Russia

Abstract:

Time Projection Chamber is the main tracker of the Multi-Purpose Detector. The detector will operate at one of beam interaction points of the collider NICA and it is optimized to investigate heavy-ion collisions in the energy range from 4 to 11 GeV/n. The TPC Front-End Electronics will operate with event rate up to 7 kHz at average luminosity 10^{27} $cm^{-2}s^{-1}$ for gold collisions at 9 GeV/n. The electronics is based on the novel ASIC SAMPA, FPGAs and high-speed serial links. Each of 24 readout chambers will serve by 62 Front-End Cards and one Readout and Control Unit. The whole system will contain 1488 FECs, 24 RCUs which gives us 95232 registration channels. The poster report presents current status of the FEE development and results of the FEC testing.

15. GOVORUN supercomputer engineering infrastructure

Authors: A.S. Vorontsov, A.G. Dolbilov, M.L. Shishmakov,
E.A. Grafov, A.S. Kamensky, S.V. Marchenko
Laboratory of Information Technologies, JINR, Dubna, Russia

Abstract:

A complex engineering infrastructure has been developed to support the GOVORUN supercomputer, which is an expansion of the HybriLIT heterogeneous cluster. The infrastructure combines an integration of two solutions on cooling systems: the air cooling system for the GPU-component and the water cooling system for the CPU-component based on the solution of the RSC Group.

16. IT- ecosystem of the HybriLIT platform

Authors: D. Belyakov[1], Yu. Butenko[1], M. Kirakosyan[1], M. Matveev[1], D. Podgainy[1], O. Streltsova[1], Sh. Torosyan[1], M. Vala[2], M. Zuev[1]

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Abstract:

In order to efficiently use HPC-resources in solving scientific and applied problems, it is necessary to provide both computing resources and software-information environment that allows users to simplify work with the existing computing resources. Another aspect that influences the development of the software-information environment is integration of HPC-resources with applied program packages that are increasingly being used to solve complex technical problems that are necessary for JINR. All this leads to the formation of an IT ecosystem, which is not only a convenient means for carrying out resource-intensive computations, but also becomes a fruitful educational environment

allowing students to learn latest computing architectures, technologies and tools for parallel programming.

17. Using the GOVORUN supercomputer for the NICA megaproject

Authors: D.V. Belyakov[1], A.G. Dolbilov[1], A.N. Moshkin[2], D.V. Podgainy[1], O.V. Rogachevsky[2], O.I. Streltsova[1], M.I. Zuev[1]
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Abstract:

At present, the GOVORUN supercomputer is used for both theoretical studies and event simulation for the MPD experiment of the NICA megaproject. To generate simulated data of the MPD experiment, the computing components of the GOROVUN supercomputer, i.e. Skylake (2880 computing cores) and KNL (6048 computing cores), are used; data are stored on the ultrafast data storage system (UDSS) under the management of the Lustre file system with a subsequent transfer to cold storages controlled by the EOS and ZFS file systems. UDSS currently has five storage servers with 12 SSD disks using the NVMe connection technology and a total capacity of 120 TB, which ensures low time of access to data and a data acquisition/output rate of 30 TB per second. Due to the UDSS high performance, by May 2019 over 40 million events for the MPD experiment have already been generated using the UrQMD generator for a nuclear collision energy AuAu $\sqrt{s}$ = 4, 7, 9, 11 GeV. In future, other MC generators are expected to be used as well.
The implementation of different computing models for the NICA megaproject requires confirmation of the model's efficiency, i.e. meeting the requirements for the time characteristics of acquiring data from detectors with their subsequent transfer to processing, analysis and storage, as well as the requirements for the efficiency of event modeling and processing in the experiment. For these purposes it is necessary to carry out tests in a real software and computing environment, which should include all the required components. At present, the GOVORUN supercomputer is such an environment; it contains the latest computing resources and a hyperconvergent UDSS with a software-defined architecture, which allows providing a maximum flexibility of data storage system configurations.
It is planned to use the DIRAC software for managing jobs and the process of reading out/recording/processing data from various types of storages and file systems.
All the enumerated above will allow one to check a basic set of data storage and transmission technologies, simulate data flows, choose optimal distributed file systems and increase the efficiency of event modeling and processing.
The studies in the given direction were supported by the RFBR grant ("Megascience – NICA"), №18-02-40101 and 18-02-40102.