The 4th International Symposium on Cosmic Rays and Astrophysics (ISCRA-2023)

Report of Contributions

https://indico.nevod.mephi.ru/e/iscra-2023

Contribution ID: **1** Type: **Original Talk**

A nuclear emulsion detectors for the muonography of underground structure of Holy Dormition Pskov-Caves Monastery

Tuesday, 27 June 2023 17:00 (15 minutes)

Methods for visualizing the structure of large, up to kilometer-sized objects based on recording the degree of absorption of atmospheric muons, which are called muonography, use the abundant natural flux of muons resulting from the interaction of cosmic rays in the atmosphere. In recent years, there has been an active development of muonography in various innovative interdisciplinary approaches to the study of the internal structure of natural or artificial structures, the establishment of synergy between elementary particle physics and archeology. The paper presents the first results of a study of a unique underground structure of the Holy Dormition Pskov-Caves Monastery with a long history.

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Session Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **2** Type: **Poster**

Development of 10 sq.m hodoscope made of drift tubes for cosmic ray muon registration

Tuesday, 27 June 2023 16:40 (20 minutes)

M.E.Barinov, V.V.Biryukov, A.A. Borisov, S.V.Erin, R.M. Fakhrutdinov, A.P.Filin, V.N.Gushchin, A.N.Isaev, A.S.Kozhin, A.V.Larionov, M.M.Soldatov

The 10 sq.m muon hodoscope made of drift tubes with length 3.7 m and diameter 52 mm is under development and construction in NRC "Kurchatov institute" – IHEP. Totally 768 drift tubes are grouped into 6 identical multilayers, each consisting of two tube layers with parallelly placed tubes. Tube orientation in neighbouring multilayers is orthogonal, thus the hodoscope has six X and six Y tube layers. Detailed mechanical structure, on-chamber electronic and data acquisition systems are described. Expected technical characteristics and some test results are presented.

Keywords: Muon hodoscope, Track chamber, Drift tube, On-chamber electronics, Data acquisition system.

Primary author: BARINOV, Mikhail

Presenter: BARINOV, Mikhail

Session Classification: Poster Session

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **3** Type: **Original Talk**

Systematic uncertainties of the primary astroparticle energy estimation vs zenith angle distribution of EAS event rate measured with surface array

Thursday, 29 June 2023 10:45 (15 minutes)

Systematic uncertainties in the energy estimation of EAS primaries are a source of headache for physicists and lead to elusive discrepancies in the energy spectra of cosmic rays measured with different arrays. We have found the zenith angle distribution of EAS event rate to be sensitive to these systematic uncertainties. It gives an opportunity to test different algorithms for the primary astroparticle energy estimation, to find the best of them, and tune the parameters in the model independent way. We have compared several algorithms that were in use in the Yakutsk array group, discard some of them, and derived the proper parameters assuming isotropic arrival directions of cosmic rays.

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Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **4** Type: **Poster**

New approach of explaining the missing sources of UHE neutrinos as an effect of approaching Planck length

Tuesday, 27 June 2023 16:45 (15 minutes)

In this paper a new effect have been taken into account which has ever been
used before in physics, this effect related to two different elds, Quantum physics and General Relativity. This effect takes name: Time Dilatation as an Effect of Approaching Planck Length, this effect is completely different from the gravitational time dilatation in general relativity and time dilatation due to closing to the speed of light in special relativity. The new effect becomes obvious and strong for the particles that have very high energies. Experiments in particle physics and astrophysics had got conclusion that the particles may travel faster than the speed of light in vacuum, such as MINOS experiment and Fermilab1979 in particle experiments and supernova SN1987A and Gamma Ray Bursts (GRBs) in astronomy field. And that seems violating the theory of relativity, but this theory can explain all these unusual observations easily and doesn't violating the theory of relativity.

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Session Classification: Poster Session

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **5** Type: **Original Talk**

Selection of the solar-diurnal anisotropy of cosmic rays by local and global methods

Thursday, 29 June 2023 12:00 (15 minutes)

According to the Moscow neutron monitor (NM MOSC) data, using harmonic analysis, the characteristics of the solar-diurnal anisotropy of cosmic rays (CR) on quiet days were obtained for a long period from 1965 to 2020. It has been established that the average daily CR variations at NM MOSC are almost completely described by two harmonics of the solar-diurnal anisotropy and does not contain signs of other influences. Comparison with the average daily characteristics of the equatorial component of the CR vector anisotropy, obtained from the data of the global NM network using the global survey method, showed good agreement between the results of the two methods. From a comparison of local and global results, estimates of the coupling coefficients of the first harmonic of CR anisotropy for NM MOSC was done and a new experimental method for calculating the coupling coefficients of individual detectors is proposed.

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Session Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **6** Type: **Original Talk**

On the nature of cosmic ray transport nonlocality

Wednesday, 28 June 2023 12:30 (15 minutes)

The commonly accepted CR transport theory is based on the diffusion equation, which in turn follows from the Boltzmann kinetic equation. The latter was derived for multiple collisions of particles with local formations (atoms, molecules) under the assumption of their statistical independence, more precisely, of the Poisson nature of the ISM ensemble. It is this property that is responsible for the appearance of local operators in diffusion-type equations. However, the interstellar cloud structure, coupled with its turbulent nature, is an example of a strongly correlated medium whose motion cannot be described in terms of perturbation theory. To describe it, the author proposed a generalization of the Ornstein-Zernike integral equation for the ISM correlation function (in terms of cloud concentration), which is consistent with the results of numerical MHD calculations and observation data. The important mathematical tool connecting two dynamical systems (CR and ISM) is a new 4-parameter approximation of the power spectrum of turbulent fluctuations. It is consistent with the classical power forms in the inertial interval and gives a smooth transition beyond its limits.

The report unfolds the logic of the appearance on the stage of non-local operators (fractional derivatives),
concept of fractals and multifractals. The latter also includes the mesofractal ISM model discussed in the report, which demonstrates fractal properties on small scales and transforms into a homogeneous medium upon transition to large scales. In other words, this model has asymptotic locality, and one can speak of a locality horizon beyond which the usual transfer theory becomes valid.

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Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **7** Type: **Original Talk**

Combined diffusive shock and shear acceleration in astrophysical jets

Wednesday, 28 June 2023 12:00 (15 minutes)

Acceleration of cosmic rays in astrophysical jets is investigated. Particles are accelerated at the outer bow shock and by shear flows in the jet cocoon. Applications for the origin and chemical composition of ultra high energy cosmic rays are discussed.

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Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **8** Type: **Original Talk**

Calculation of geomagnetically trapped proton flux from the PAMELA experimental data.

Wednesday, 28 June 2023 15:00 (15 minutes)

The special interest to the estimation of trapped proton intensities in low-altitude region of the near-terrestrial space environment concerns their effects on numerous robotic and manned missions. The main part of radiation exposure comes from the space region where the trajectory of mission orbit pass through the South Atlantic anomaly (SAA).
At present time, the nature of long-term magnetic trapping of protons is well established. The main sources of trapped protons are cosmic ray albedo neutron decay (CRAND) and injected solar protons. The contribution from solar protons prevail at energies <100 MeV and L>1.3, while the influence of CRAND dominates otherwise. Inelastic nuclear scattering, energy transfer to plasma electrons and ionization of the neutral atmosphere, provides the losses.
Recently the measurements of the geomagnetically trapped proton fluxes for the kinetic energy interval ranging from 80 MeV to the highest trapping energies (2 GeV) were fulfilled by the PAMELA mission at low Earth orbits (350 ÷ 610 km). Protons flux properties were investigated in detail, providing a full characterization of the particle radiation in the SAA region, including locations, energy spectra, and pitch angle distributions. To analyze data the standard approach developed in 1995 by SAMPEX team was introduced. To reconstruct the intensities of trapped particles, the effective areas, averaged over gyro phase angle, are calculated as function of pitch angle for different instrument orientations respective geomagnetic field vector. Therefore, the numerous simulations are fulfilled varying pitch angle and telescope axis orientation angles in steps (energy bins varying is separate point).
In this report, we propose another variant of trapped particles intensity reconstruction. Instead of multiple effective area calculations, the value of effective acceptance is estimated for fixed instrument orientation and pitch angle from one simulation sample (for given energy bin) of data in ordinary way with isotropic flux incidence. In this procedure, the additivity of acceptance for different regions of allowed directions is used.

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Session Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **9** Type: **Original Talk**

Astrophysical aspects of multiple fragmentation of nuclei in nuclear emulsion

Thursday, 29 June 2023 13:00 (15 minutes)

The BECQUEREL experiment is aimed at solving topical problems in nuclear clustering physics [1]. The used method of nuclear track emulsion (NTE) makes it possible, due to its unique sensitivity and spatial resolution, to study in a unified approach multiple final states arising in dissociation of relativistic nuclei. The ideas about nuclear clustering obtained in high-energy physics are important for applications in nuclear astrophysics, cosmic ray physics, nuclear medicine, and perhaps even nuclear geology. Currently, a research focus is on the theoretical concept of alpha particle Bose-Einstein condensate (αBEC) - the ultra cold state of several S-wave alpha particles near coupling thresholds. The unstable 8Be nucleus is described as 2αBEC, and the C-12 Hoyle state (HS) as 3αBEC. Confirmation of the existence of more complex forms of αBEC could provide a basis for expanding scenarios for the synthesis of medium and heavy nuclei in nuclear astrophysics.
The consideration of αBEC as an invariant phenomenon indicates possibility of its search in the relativistic fragmentation. A practical alternative is provided by NTE layers longitudinally exposed to relativistic nuclei. The invariant mass of ensembles of He and H fragments can be determined from emission angles in the approximation of conservation of momentum per nucleon of a parent nucleus [2]. Owing to extremely small energies and widths, the Be-8 and HS decays, are identified in fragmentation of light nuclei by an upper constraint on the invariant mass. Having been tested, this approach has been used to identify Be-8 and HS and search for more complex states of αBEC in fragmentation of medium and heavy nuclei. Recently, based on the statistics of dozens of Be-8 decays, an enhancement in probability of detecting Be-8 in an event with an increase in number of relativistic alpha particles was found [3]. A preliminary conclusion is drawn that contributions of B-9 and HS decays also increase. The exotically large sizes and lifetimes of Be-8 and HS allowing suggesting possibility of synthesizing αBEC by successively connecting the emerging alpha particles.
The main task of the forthcoming stage of the project is to clarify the relation between the appearance of Be-8 and HS and alpha multiplicities and search on this basis for decays of the 4αBEC [4]. In this regard, the BECQUEREL experiment aims to measure multiple channels of Kr-84 fragmentation below 1 GeV per nucleon in GSI (Darmtadt). There are a sufficient number of NTE layers, transverse scanning of which on the motorized microscope Olympus BX63 makes it possible to achieve required statistics. However, the low energy complicates the identification of HS and 4αBEC. NTE layers exposed to heavy nuclei at several GeV per nucleon will make it possible to apply well-established approaches to analysis. The acceleration of Xenon nuclei up to 3.8 GeV per nucleon and the extraction of their beam in the recent run of the NICA accelerator chain made it possible to take practical steps towards nuclear emission irradiation near the accelerator and in the area of the flagship BM@N experiment.

[1] P.I. Zarubin, Lect. Notes in Phys. 875, Clusters in Nuclei, Volume 3. Springer Int. Publ., 51 (2013); arXiv:1309.4881.

[2] D.A. Artemenkov et al., Eur. Phys. J. A 56 (2020) 250; arXiv: 2004.10277.

[3] A.A. Zaitsev et al., Phys. Lett. B 820 (2021) 136460; arXiv: 2102.09541.

[4] D.A. Artemenkov et al., Phys. At. Nucl., 85, 528 (2022); arXiv: 2206.09690.

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Session Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **10** Type: **Original Talk**

The latest results obtained on the LVD experiment

Tuesday, 27 June 2023 17:15 (15 minutes)

The LVD detector, located in the Gran Sasso Laboratory at a depth of 3600 m a.e., is designed for research in the field of neutrino physics, astrophysics, cosmic ray physics and the search for rare processes predicted by theory. The LVD experiment was built in 1991 to register neutrinos from collapses of stellar nuclei in our galaxy. The background of the detector is atmospheric muons, neutrons generated by muons in the detector material and natural radioactivity underground. The report presents the latest experimental results obtained at LVD: a limit on the frequency of supernova outbreaks, muon variations with a period of 1, 4, 10 years, and also describes the problems of studying the low-energy background underground.

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Presenter: FILIMONOVA, Natalia

Session Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **11** Type: **Original Talk**

Techniques for data analysis and primary mass reconstruction in the ENDA experiment

Tuesday, 27 June 2023 13:15 (15 minutes)

As part of the high-altitude LHAASO project, ENDA (Electron Neutron Detector Array) is being created in China. The concept of the ENDA consists in simultaneous registration of the electromagnetic and thermal neutron components (being a part of hadronic component) of the EAS. The report provides a brief overview of analytical and ML (Machine Learning) methods for shower and primary particle parameters reconstruction for simulation data. Also methods for estimation the uncertainty of such reconstruction is presented.

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Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **12** Type: **Poster**

Thermal neutron background variations monitoring using en-detectors

Tuesday, 27 June 2023 16:40 (20 minutes)

Long-term variations of thermal neutron background in Moscow, where EAS array ENDA-INR is running, are studied using en-detectors (developed in the INR RAS). EN-detectors based on the inorganic scintillation compound ZnS(Ag) + B2O3 with unenforced boron. The paper provides information about detectors stability and thermal neutron background variations including seasonal and weather effects.

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Presenter: KYRINOV, Kirill (INR RAS)

Session Classification: Poster Session

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **13** Type: **Original Talk**

Title: Progress of Electron-Neutron Detector Array (ENDA)

Tuesday, 27 June 2023 13:00 (15 minutes)

Abstract-The origin of cosmic rays can be deciphered by accurately measuring the components and energy spectrum in the knee region. Extensive air shower (EAS) studies rely on information provided by secondary high energy hadrons, which generate evaporation neutrons when they interact with matter in the environment. In the early 21st century, the electron-neutron detector (EN-detector) was developed at the Institute for Nuclear Research of the Russian Academy of Science (INR RAS). The PRImary Spectrum Measurement Array (PRISMA) project was introduced to enhance the array capabilities of cosmic ray composition separation and improve measurement accuracy. Within the framework of Chinese-Russian cooperation, at the Large High Altitude Air Shower Observatory (LHAASO) at Mt. Haizi (4400 m a.s.l.) in Daocheng, Sichuan province, China, a proposal was launched to establish the EN-Detector Array (ENDA) composed of 400 detectors in area of $10,000m^2$ to measure cosmic rays up to 300 PeV. In 2018, a cluster, having 16 EN-detectors, at Tibet University (TU) in Lhasa, Tibet, China (3700 m a.s.l.) was built to test specification of the array. Since 2019, another cluster so called ENDA-16 has started running at LHAASO, and here we give the first result of thermal neutron distribution. After gaining experience from these previous works, since April 2023, we have successfully extended ENDA to ENDA-64 composed of 64 detectors in area of $1,000m^2$ at LHAASO to measure cosmic rays from 400TeV to 20 PeV, and we will describe status of ENDA-64 and hybrid detection of cosmic ray by using ENDA and LHAASO.

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Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **14** Type: **Poster**

Extensive air showers of highest energies registered at the Yakutsk array

Tuesday, 27 June 2023 16:45 (15 minutes)

The article considers showers produced by primary particles with energies E0 ≥ 100 EeV. The showers were registered in the course of continuous long-term observations at the Yakutsk array of extensive air showers. In the present work, the mathematical processing of showers was repeated and the phenomenology of the charged component, muons with threshold thr, 1 GeV and radio emission in the region of highest energies was refined. The characteristics of cosmic rays are analyzed: the energy spectrum and mass composition determined from the Cherenkov, muon components and radio emission in the energy range 50 – 200 EeV.

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Presenter: KNURENKO, Stanislav

Session Classification: Poster Session

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **15** Type: **Original Talk**

The study of cosmic rays with energies greater than 5 EeV by radio method

Thursday, 29 June 2023 11:00 (15 minutes)

Since 1986, regular measurements of radio emission generated by air shower relativistic particles have been started at the Yakutsk array. As a result of studying the noise background on the array region, a frequency of 30-35 MHz was chosen with minimal radio noise. Showers with energies greater than 10 EeV were registered at the array. For the first time, radio emission in showers with energies greater than 100 EeV was registered at the Yakutsk array. A joint study of charged particles, Cherenkov light, and radio emission showed that the amplitude of the radio signal is proportional to the energy of the shower, and the shape of the spatial distribution of radio emission at sea level is associated with the maximum development of the shower particle cascade. Based on these characteristics, using calculations of the QGSjetII-04 model, an estimate was made of the atomic weight of primary particles that produced air showers with highest energies.

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Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **16** Type: **Original Talk**

Cosmic ray variations of magneospheric and atmospheric origin in September 2017

Thursday, 29 June 2023 12:15 (15 minutes)

Using data of ground level cosmic ray observations on neutron monitor world network, Yakutsk muon telescope complex and URAGAN muon hodoscope (Moscow), we carried out a research of magnetospheric and atmospheric cosmic ray variations over September 2017 by a modified spectrographic global survey method. We obtained time dependence of changes in the planetary system of rigidities of geomagnetic cutoff (RGC) and average mass temperature over the muon detector sites. Based on the data on the planetary system of RGCs, we calculated the parameters of certain magnetospheric current systems during the geomagnetic disturbances of September 2017 within an axial symmetric model of a bounded magnetosphere.

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Session Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **17** Type: **Original Talk**

Magnetorotational supernova neutrino emission spectra and prospects for observations by large-size underwater telescopes

Tuesday, 27 June 2023 15:00 (15 minutes)

We analyze neutrino fluxes near the surface of a protoneutron star in type II supernova explosions at core-collapse regime. For dynamoactive supernovae it is shown that effective neutrino collisions in a magnetized nucleon gas caused by the neutral current Gamow-Teller component lead to neutrino acceleration. Such an effect originates from spin-projection asymmetry in phase space volume of outer channel neutrino due to nucleon magnetic moment interaction with a field. Respective increase in a hardness of the energy spectrum is favorable for observations of supernova neutrinos using neutrino telescopes. The possibilities of detecting supernova neutrinos by large-volume Cherenkov observatories: KM3NeT and Baikal-GVD, are discussed. As is demonstrated the upper limits of the distance thresholds for such observations can be increased by a factor of 1.5 √k when employing the k-fold coincidence technique in data processing.

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Presenter: KONDRATYEV, Vladimir (ОИЯИ)

Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **18** Type: **Poster**

A technique of the calibration of optical modules inside the volume of Cherenkov water detector NEVOD

Tuesday, 27 June 2023 16:45 (15 minutes)

In recent decades, Cherenkov water (ice) telescopes such as IceCube, Baikal-GVD and KM3Net are being actively developed for research in the field of neutrino physics and astrophysics. Optical modules are the main detecting elements of such neutrino telescopes.
Calibration of optical modules of different neutrino telescopes under the same conditions is one of the important experimental problems. Such a calibration can be carried out at the Experimental complex NEVOD. Scientific installations of the complex make it possible to identify tracks of single near-vertical and near-horizontal muons, as well as to detect events with large energy deposits and to study the response of the optical modules being tested to these events.
In the report, we discuss the software and hardware complex for calibrating optical modules of Cherenkov neutrino telescopes at the Experimental complex NEVOD, as well as the possibility of its implementation for studying the characteristics of the Baikal-GVD optical module.

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Session Classification: Poster Session

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **19** Type: **Poster**

The project of the hardware and software system for storage and analysis of large amounts of data of the scientific facilities of the Experimental Complex NEVOD

Tuesday, 27 June 2023 16:45 (15 minutes)

To date, cosmic rays are the only tool that allows one to study nucleus-nucleus interactions at energies of hundreds of TeV in the center-of-mass system. Investigations of high-energy CR are carried out by detection of secondary particles of extensive air showers (EAS) formed in interactions of primary particles with the Earth's atmosphere.
Earlier studies of EAS revealed a number of unusual phenomena in the interactions of particles of high and ultra-high energies: in the measured energy spectrum of cosmic rays a number of features that today cannot be explained within the framework of a single model are observed. The key to explaining these phenomena may be the results of multicomponent studies of EAS carried out in frames of the complementary approach to the experimental data analysis.
Such studies and such an approach can be implemented at the Experimental Complex (EC) NEVOD. The complex combines six scientific facilities (NEVOD, DECOR, CTS, NEVOD-EAS, PRISMA-32 and URAN) which are launched in operation and allow one to study the same events using three components at once: electron-photon, muon and hadronic ones.
As a result of the operation of the facilities, a volumetric data stream is formed. It contains topological, trigger, coordinate, amplitude and time information about recorded events. At the same time, to solve various computational problems in order to verify the obtained experimental results and develop new methods, an impressive bank of simulated EAS and facility responses obtained using the Geant4 and CORSIKA software packages is required.
Therefore, for storing and efficient analysis of experimental and simulated events of the facilities of the Complex, a hardware and software system for storage and analysis of large amounts of data is being created. This system will be deployed on the basis of the EC NEVOD data processing center providing all the necessary operating conditions, including a backup power system, and integration into the EC NEVOD local area network. Modern DBMS will make it possible to effectively select from the total amount of events (both experimental and simulated) only those ones that satisfy certain criteria and are suitable for solving specific physical problems.
In the report, we describe the hardware and software architecture, features of the system for storage and analysis of large amounts of data of the scientific facilities of the Experimental Complex NEVOD. We also present the structures of the databases for storing data of experimental events which are already implemented and used for analysis. The prospects of the further development of the system are discussed.

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Presenters: Dr SHULZHENKO, Ivan (National Research Nuclear University MEPhI); Mr KHOMCHUK, Evgeniy (National research nuclear university)

Session Classification: Poster Session

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **20** Type: **Poster**

The data acquisition system of the coordinate-tracking detector TREK

Tuesday, 27 June 2023 16:45 (15 minutes)

The large-scale coordinate-tracking detector TREK is being constructed at the Experimental Complex NEVOD (MEPhI, Moscow). It is designed to detect high-density muon bundles of inclined extensive air showers. It will significantly expand the capabilities of the experimental complex and ensure the progress in solving the «muon puzzle».
The main elements of the coordinate-tracking detector TREK are: the drift chambers (DCs), the time-to-digital converters (TDCs), and a control computer, running DAQ software. The detector consists of two coordinate planes including 132 DCs each. The total area of the coordinate plane is 250 sq. meters. The chambers of each plane are divided into 18 clusters. Each cluster is served by its own TDC ensuring precise measurement of DC hit times, as well as periodic noise measurements. To provide synchronous operation and triggering of TDCs, the registering system of the TREK detector is connected to the System of Global Time Synchronization of the Complex, as well as to the triggering system of the NEVOD-DECOR-CTS experiment. The control and monitoring of the DAQ system, as well as TDC data read-out and storing are performed by the specially developed software.
In the talk, we describe the structure and operation principals of the TREK detector DAQ system, as well as the architecture and features of its software.

Primary authors: Mr KHOMCHUK, Evgeniy (National Research Nuclear University MEPhi); Dr SHULZHENKO, Ivan (National Research Nuclear University MEPhI); VOROBEV, Vladislav (National Research Nuclear University MEPhI); ZADEBA, Egor (MEPhI)

Presenter: Mr KHOMCHUK, Evgeniy (National Research Nuclear University MEPhi)

Session Classification: Poster Session

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **21** Type: **Original Talk**

Formation of a Forbush decrease in a magnetic cloud by the electromagnetic mechanism

Wednesday, 28 June 2023 14:30 (15 minutes)

We calculate cosmic ray intensity and anisotropy using the model of the Forbush decrease formation in a magnetic cloud by the electromagnetic mechanism for three events. The properties of the Forbush decrease are determined by solving the Boltzmann kinetic equation without particle scattering. Geometrical parameters of the magnetic cloud, such as velocity, velocity gradient, cross-section area, and angular sizes, are based on the kinematic model. The magnetic field properties and the type of helical structure near the Sun are based on the Miller and Turner toroidal model. In interplanetary space, magnetic field components are determined by the frozen-in condition. The model properties of the velocity, velocity gradient, magnetic field components, and characteristics of the Forbush decrease roughly agree with measurements in three events. There are no free parameters in the Forbush decrease formation model.

Primary authors: PETUKHOVA, Anastasia (Yu.G. Shafer Institute of Cosmophysical Research and Aeronomy); PETUKHOV, Ivan (Yu.G. Shafer Institute of Cosmophysical Research and Aeronomy of Siberian Branch of the Russian Academy of Sciences); Dr PETUKHOV, Stanislav (Yu.G. Shafer Institute of Cosmophysical Research and Aeronomy of Siberian Branch of the Russian Academy of Sciences)

Presenter: PETUKHOVA, Anastasia (Yu.G. Shafer Institute of Cosmophysical Research and Aeronomy)

Session Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **22** Type: **Poster**

Reconstruction of parameters of extensive air showers registered by the NEVOD-EAS array

Tuesday, 27 June 2023 16:45 (15 minutes)

The talk is devoted to the methods of reconstruction of parameters of extensive air showers based on the response of the NEVOD-EAS array. The NEVOD-EAS array is located in MEPhI and allows measuring deposited energy and arrival time of EAS particles. The development of reconstruction method is carried out using simulations produced by means of the CORSIKA program with the QGSJET-II-04 + FLUKA 2020.0.3 hadron interaction models. In total, we have analysed 1 200 000 showers initiated by primary protons and iron nuclei in the energy range 10ˆ15 - 10ˆ17 eV.
To reconstruct the parameters of the EAS, we have applyed two methods: least squares and maximum likelihood. The accuracy of reconstruction of the EAS core position, the age and the shower size is discussed. Results of estimation of the effective area of the array using various cuts are presented, and the accuracy of reconstruction of the shower size spectrum for different types of primary particle spectra is considered.

Primary author: YUZHAKOVA, Elena (MEPhI)

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Presenter: YUZHAKOVA, Elena (MEPhI)

Session Classification: Poster Session

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **23** Type: **Original Talk**

Bose–Einstein condensation and muon production in ultra-high energy cosmic ray particle collisions

Wednesday, 28 June 2023 17:15 (15 minutes)

Collisions of cosmic ray particles with ultra-high initial energies larger than 0.1–1 EeV with nuclei in the atmosphere lead to creation a strongly interacting matter under extreme conditions and open a wide room for appearing of the novel dynamical features for production of secondary particles. In particular, the estimations obtained for the space density of charged particles at freeze-out and its critical value within the model of certain ring diagrams allow the possibility of lasing behavior for secondary pions at least for nuclear interactions with ultra-high energy cosmic ray (UHECR) particles. The pion-lasing behavior results in the shift to larger multiplicities and, as consequence, can provide, in general, the enhanced yield of cosmic muons. The Muon puzzle is a well-known problem in the physics of high-energy cosmic rays one of the aspects of which is the muon bundle excess compared to simulations within available phenomenological models. In the present work critical value of the space particle density for onset of Bose–Einstein condensation of the boson wave-packets into the same wave-packet state is estimated with help of the improved formula obtained within model of multiparticle symmetrization for UHECR energy domain. Energy dependence of mean multiplicity of pions is evaluated for the cases of absent of the Bose–Einstein effects and for presence of laser-like behavior for pions. The possible influence of the Bose–Einstein condensation is discussed for the muon production in UHECR particle collisions with the atmosphere.

Primary author: OKOROKOV, Vitalii (National Research Nuclear University MEPhI)

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Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **24** Type: **Poster**

Ultrahigh-energy neutrino-nucleon deep-inelastic scattering and the Froissart bound violation

Tuesday, 27 June 2023 16:45 (15 minutes)

A simple formula for the total cross section \sigma_{\nu N} of neutral- and charged-current deep-inelastic scattering of ultrahigh-energy neutrinos on isoscalar nuclear targets is presented. The cross section \sigma_{\nu N} is proportional to the structure function F_2ˆ{\nu N}(Mˆ2_V/s,m_Vˆ2) (M_V is the intermediate-boson mass and s is the square of the center-of-mass energy) with an additional coefficient, which depends on the asymptotic low-x behavior of F_2: it contains an additional \ln s term if F_2 scales with a power of \ln(1/x). Hence, an asymptotic low-x behavior F_2 \sim \lnˆ2(1/x), which is frequently assumed in the literature, already leads to a violation of the Froissart bound on \sigma_{\nu N}.

Primary author: KOTIKOV, Anatoly

Presenter: KOTIKOV, Anatoly

Session Classification: Poster Session

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **25** Type: **Original Talk**

Hadronization as a key to the muon puzzle

Wednesday, 28 June 2023 17:30 (15 minutes)

The excess of muons in ultra-high energy cosmic rays (UHECR) in comparison with the results of Monte-Carlo simulations that grows with the primary particle energy is known as the muon puzzle. Since the LHC data became available, many improvements have been done to the models of hadronic interactions used in extensive air showers (EAS) simulation tools. Yet the noticeable deviation from experimental data is observed for both so-called post-LHC models: EPOS LHC and QGSJET-II-04. The focus of theoretical works that try to solve this puzzle has shifted towards the process of hadronization, i. e. when partons produced in high-energy collisions combine into final state hadrons. Some attempts were made to improve the description of particle production like core-corona effect in EPOS. But for the complete solution, further changes are required.

This study presents the detailed overview of models of hadronization used in several modern high-ene

Primary author: NIKOLAENKO, Roman

Presenter: NIKOLAENKO, Roman

Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **26** Type: **Original Talk**

High-energy magnetospheric electron flux enhancements and the parameters of interplanetary and near-Earth medium

Wednesday, 28 June 2023 15:30 (15 minutes)

Based on the data of 35-year (1987-2021) measurements of magnetospheric electron fluxes with energy >2 MeV in geostationary orbits, solar wind speed and geomagnetic activity, a catalog of electron flux enhancements was compiled in which the electron fluence exceeds $10^8\ cm^{-2}sr^{-1}day^{-1}$. The epoch superposition method performed using the GOES-13 spacecraft data shows that large electron flux enhancements are preceded by a significant increase in the solar wind velocity and the Ap index of geomagnetic activity, and immediately before the increase the relativistic electron flux decreases. Based on the calculated mean values of the electron fluences, solar wind velocity, and Ap-index of geomagnetic activity on the day of electron enhancement and on previous days, a typical behavior of these parameters during and before an electron flux enhancement was obtained. The average characteristics of electron flux enhancements and the parameters of interplanetary and near-Earth medium are calculated before large electron flux enhancements. It is shown that the greater the increase in solar wind velocity and geomagnetic activity the larger the subsequent electron flux enhancement. The density and vector anisotropy of galactic cosmic rays for 453 events of high-energy magnetospheric electron flux enhancements over the period 1996-2020 were calculated by the Global Survey Method (GSM). Some examples of these events, which are characteristic of different classes of solar sources, are considered.

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Presenter: KRYAKUNOVA, Olga (Institute of Ionosphere)

Session Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **27** Type: **Original Talk**

Investigation of the large-scale distribution of the arrival points of 1-100 PeV EAS detected at the Tien Shan cosmic ray installation

Wednesday, 28 June 2023 12:45 (15 minutes)

A set of eight scintillators with the reduced to (50-70)ns width of their output pulse signals is applied for determination of the arrival directions of extensive air showers which are effectively detected by the Tien Shan shower installation in the energy range between 1 and 100 PeV. Up to the present time, about ˜10^6 shower events applicable for deducing their directional angles were collected in 2021-2023 during the ˜5500h of the installation operation life time. Here, the statistical characteristics of these events are presented which confirm the functioning correctness of the electronic hardware and mathematical algorithms applied for the treatment of the initial measurement data. Further on, the newly obtained information on the angular distribution of the EAS arrival points is supposed to be used for a study of the large-scale anisotropy of the PeV cosmic rays on the celestial sphere by application of the difference method which has been earlier developed for this purpose in the LPI.

Primary authors: SHEPETOV, Alexander (Lebedev Physical Institute); RYABOV, Vladimir (Lebedev Physical Institute)

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Presenters: SHEPETOV, Alexander (Lebedev Physical Institute); RYABOV, Vladimir (Lebedev Physical Institute)

Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **28** Type: **Original Talk**

Reconstruction of the characteristics of a high-energy event detected by the Carpet-2 array in association with the GRB 221009A gamma-ray burst

Thursday, 29 June 2023 11:15 (15 minutes)

The Carpet-2 collaboration reports on the observation and analysis of an event with a low muon content coincident with the gamma-ray burst GRB 221009A and the transient Swift J1913.1+1946. This bright transient was observed by numerous instruments in the optical, X-ray and gamma-ray energy ranges. The redshift of this GRB is z=0.1505 (measured from afterglow observations).
The Carpet-2 array detected an extensive air shower at 14:32:35 UT (1338 s after the SWIFT trigger and 4536 s after the GBM trigger) with the reconstructed arrival direction (RA=289.51°, Dec=18.44°) , which is 1.78° from the direction towards GRB 221009A, well within the angular resolution of Carpet-2 (\approx 4.7°). This event produced zero hits in the 175 mˆ{2} muon detector of the Carpet-2 array. The reconstructed energy of the primary particle is in the range of 200-250 TeV. We estimate of the probability of the type of particle (photon or proton), its energy and detection efficiency.

Primary author: KARPIKOV, Ivan (INR RAS)

Co-author: CARPET-2 COLLABORATION

Presenter: KARPIKOV, Ivan (INR RAS)

Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **29** Type: **Poster**

The indication for 40K geo-antineutrino flux with Borexino phase-III data

Tuesday, 27 June 2023 16:40 (20 minutes)

We provide the indication of high flux of 40K geo-antineutrino and geo-neutrino (40K-geo-(ν^-+ν)) with Borexino Phase III data. This result was obtained by introducing a new source of single events, namely 40K-geo-(ν^-+ν) scattering on electrons, in multivariate fit analysis of Borexino Phase III data. Simultaneously we obtained the count rates of events from 7Be, pep and CNO solar neutrinos. These count rates are consistent with the prediction of the Low metallicity Sun model SSM B16-AGSS09. MC pseudo-experiments showed that the case of High metallicity Sun and absence of 40K-geo-(ν^-+ν) can not imitate the result of multivariate fit analysis of Borexino Phase III data with introducing 40K-geo-(ν^-+ν) events. We also provide arguments for the high abundance of potassium in the Earth.

Primary author: KARPIKOV, Ivan (INR RAS)

Co-authors: BEZRUKOV, Leonid (INR RAS); SINEV, Valery (INR RAS)

Presenter: KARPIKOV, Ivan (INR RAS)

Session Classification: Poster Session

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **30** Type: **Original Talk**

Acceptance vectors of muon hodoscope URAGAN

Thursday, 29 June 2023 12:30 (15 minutes)

Cosmic ray variations observed with ground-based detectors include variations of extraterrestrial origin, atmospheric, magnetospheric, apparatus variations, and statistical fluctuations. The method of acceptance vectors allows us to determine cosmic ray anisotropy out of the magnetosphere for studying physics of solar-terrestrial relations. The basis of the technique are coupling function method, calculations of particle trajectories in the terrestrial magnetic field, and spherical analysis.

The work presents preliminary results of muon hodoscope URAGAN acceptance vectors computing. Furthermore, the comparison of muon data with the Global Survey Method for neutron monitor network is discussed. Finally, the application of the method to investigate geoeffective events by cosmic ray data is considered.

Primary author: KUZMENKOVA, Polina (National Research Nuclear University MEPhI)

Co-authors: SUKHOVA, Polina (NRNU MEPhI); ASTAPOV, Ivan (MEPhI); BARBASHINA, Natalia (MEPhI); ABUNINA, Maria (IZMIRAN); Dr BELOV, Anatoly (IZMIRAN)

Presenter: KUZMENKOVA, Polina (National Research Nuclear University MEPhI)

Session Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **31** Type: **Original Talk**

CMS Measurements and UHECR

Wednesday, 28 June 2023 17:00 (15 minutes)

CMS measurementsm valuable for tuning CR generators are discussed.

Primary author: KHEYN, Lev (SINP MSU)

Presenter: KHEYN, Lev (SINP MSU)

Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **32** Type: **Original Talk**

The Baikal-GVD neutrino telescope: current status and development prospects

Tuesday, 27 June 2023 14:30 (15 minutes)

Currently, the deployment of the Baikal-GVD neutrino telescope is successfully underway in Lake Baikal. Baikal-GVD now comprises 96 strings with 3456 optical modules. We present the current status and plans for further deployment of the Baikal-GVD telescope and discuss issues related to the creation of a next-generation neutrino telescope in Lake Baikal.

Primary author: AYNUTDINOV, Vladimir (INR RAS)

Presenter: AYNUTDINOV, Vladimir (INR RAS)

Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **33** Type: **Poster**

Application of coupling functions to analyze energy characteristics of Forbush decreases according to URAGAN muon hodoscope data

Tuesday, 27 June 2023 16:40 (20 minutes)

The purpose of the work is to investigate energy characteristics of Forbush decreases using coupling functions according to muon hodoscope URAGAN data. A coupling function shows relative contribution of primary cosmic rays with different energies to a count rate observed by a particular detector, so it is a basic tool to study energy characteristics of various modulation phenomena, such as Forbush effects.
A coupling function of a real detector depends on an integral multiplicity of secondary particles, effective area of the detector and the spectrum of primary particles. The muon multiplicity was determined by simulations in CORSIKA software package using FLUKA and QGSJET II models.
An algorithm for determining amplitudes of Forbush decreases was developed. In the work we present results of calculations of the muon hodoscope effective energies using coupling functions. Methods for determining spectral indices of Forbush decreases by relative variations, as well as by effective energies, are implemented.

Primary author: SUKHOVA, Polina (NRNU MEPhI)

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Presenter: SUKHOVA, Polina (NRNU MEPhI)

Session Classification: Poster Session

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **34** Type: **Original Talk**

Elaboration of a model of SPHERE-3 telescope for the studies of the primary cosmic rays in 10^15 — 10^18 eV energy range using reflected from snowed surface and direct Cherenkov light from extensive air showers

Tuesday, 27 June 2023 15:45 (15 minutes)

Paper contains the first results of our attempts in the development of a model of SPHERE-3 telescope for the primary cosmic ray studies in 1-1000 PeV energy range with reflected and direct Cherenkov light generated by extensive air showers (EAS).

The aim of the work is to develop an automated method for the design of SPHERE-3 telescope, which, on one hand, will enable it to obtain the best possible estimates of EAS primary parameters and, on the other, will result in a set of rules and recommendations on how to design other detectors of the type.

Handling of samples of Cherenkov light images according to the available processing codes will give estimates of the uncertainties of the primary parameters, which integrally characterize the quality of measurements with a given version of the telescope and the procedures for their processing. As a result, the optimal version of the telescope will be selected and a general approach to the choice of its design and data processing algorithms will be developed.

A preliminary version of the SPHERE-3 optical scheme is shown as a basis for further improvement and development of optimized optical schemes that will be combined with various schemes of sensitive mosaics, electronics, trigger algorithm and off-line processing algorithms.

The description of the created database of artificial events of EAS with the generation of Cherenkov light for protons, nitrogen and iron nuclei with energies in the range of 1-100 PeV and zenith angles of 5-25 degrees according to two models of interaction and three models of the atmosphere is given.

A scheme for calculating artificial images of reflected and direct EAS Cherenkov light on the mosaic of optical sensors of the telescope is presented.

Primary authors: BONVECH, Elena (SINP MSU); CHERNOV, Dmitry (Moscow State University); Dr ROGANOVA, Tatiana (Skobeltsyn Institute of Nuclear Physics, Moscow State University, Russia); GALKIN, Vladimir (MSU); ZIVA, Maxim (MSU); LATYPOVA, Vasilisa; IVANOV, Vladimir; AZRA, Clemance (MSU); ENTINA, Elena (MSU); PODGRUDKOV, Dmitry (MSU)

Presenter: BONVECH, Elena (SINP MSU)

Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **35** Type: **Original Talk**

Kinematic description of alignment in the Pamir experiment

Wednesday, 28 June 2023 17:45 (15 minutes)

The report is devoted to the geometric and kinematic description of the azimuthal correlation of photon and hadron families, which was observed by the Pamir collaboration in emulsion experiments with cosmic rays. This effect is called «alignment», because quantitatively this feature demonstrates a deviation from the straight line of points on the emulsion film plane used for particles detection. In our approach, it is shown that a high degree of alignment is a consequence of the selection procedure for the most energetic clusters, i.e. the existence of a lower energy threshold of the gamma component in the interaction products of the target nuclei and cosmic radiation together with the law of conservation of their transverse momentum. The obtained results correct describe the maximum degree of alignment for the three points and are also close to the measurements in the Pamir experiment for the case of four and five clusters, so the proposed method looks very promising for interpretation the alignment phenomenon.

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5. R.A. Mukhamedshin, Eur. Phys. J. C 82, 155 (2022), arXiv: 2207.13558.

Primary authors: NIKOLSKII, Aleksei (BLTP JINR); LOKHTIN, Igor; Dr SNIGIREV, Alexander

Presenter: NIKOLSKII, Aleksei (BLTP JINR)

Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **36** Type: **Poster**

Monte Carlo simulation of the OLVE-HERO detector

Tuesday, 27 June 2023 16:45 (15 minutes)

A project of the OLVE-HERO space detector is proposed for CR measurement in the range 1012-1016 eV, which will include a large ionization-neutron 3D calorimeter with a high granularity and geometric factor of ˜16 m2⊠sr. Current OLVE-HERO main detector is expected to be an image calorimeter of a boron loading of plastic scintillator with a tungsten absorber. Such a calorimeter allows one to measure an additional neutron signal which will improve the energy resolution of the detector and mainly the rejection power between electromagnetic and nuclear CR components will be increased by factor 30-50. Preliminary results of modeling the threshold sensitivity from the energy of CR particles for a simplified version of the detector are presented, where the threshold value is defined by the thermal neutron number in the detector.

Primary authors: SATYSHEV, Ilyas (JINR); TKACHEV, Leonid (JINR, Dubna)

Presenter: SATYSHEV, Ilyas (JINR)

Session Classification: Poster Session

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **37** Type: **Poster**

Forbush decreases associated with coronal holes, coronal mass ejections from active regions, and filament eruptions: a comparison in solar cycles 23 and 24

Tuesday, 27 June 2023 16:40 (20 minutes)

The paper investigates the similarities and differences between Forbush decreases in solar cycles 23 and 24. The analysis was carried out for groups of events associated with different types of solar sources: coronal mass ejections from active regions accompanied by solar flares (CME1 group); filament eruptions outside active regions (CME2 group); high-speed streams from coronal holes (CH group). The distributions and relationships of various parameters were studied: the amplitude of Forbush decreases; the maximum values of the hourly decrease in the cosmic ray density, the cosmiv ray equatorial anisotropy, the solar wind velocity, the magnetic field intensity during an event, as well as the values of the solar wind velocity and the magnetic field intensity one hour before the Forbush decrease onset. The results showed that the number of events, parameter values and their relationships depend on the phase and cycle of solar activity. In the 24th cycle, the number of events in the CME1 group decreased, did not change in CME2, and increased in CH. The values of the parameters and the difference between them in different groups of events are higher in cycle 23. The magnitude of the Forbush decreases in the CME1 group in cycle 23 depends more strongly on the solar wind velocity, and in cycle 24 - on the magnetic field strength, as in the CME2 group in both solar cycles.

Primary authors: ABUNINA, Maria (IZMIRAN); Dr MELKUMYAN, Anaid (IZMIRAN); Dr BELOV, Anatoly (IZMIRAN); SHLYK, Nataly (IZMIRAN); Dr ABUNIN, Artem (IZMIRAN); YANKE, Victor (IZMIRAN); Dr OLENEVA, Viktoriya (IZMIRAN)

Presenter: ABUNINA, Maria (IZMIRAN)

Session Classification: Poster Session

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **38** Type: **Original Talk**

Forecast of strong geomagnetic storms in February-March 2023 based on measurements of fluctuations in the intensity of galactic cosmic rays

Thursday, 29 June 2023 12:45 (15 minutes)

In order to develop methods for space weather forecasting, the dynamics of fluctuations (variations with periods from several minutes to 2-3 hours) of the intensity of galactic cosmic rays (CR) during the events of strong geomagnetic storms on February 26 and March 23, 2023, which are characterized by the values Dst < -100 nT. To do this, we use 1-minute pressure-corrected registration data from the neutron monitors of the Yakutsk and Tixie Bay CR stations, 1-minute data from direct observations of the parameters of the interplanetary magnetic field (IMF) and solar wind (SW) onboard the ACE and DSCOVR spacecraft. To study the properties of CR fluctuations and SW turbulence, digital filtering methods and Blackman-Tukey spectral analysis with the Tukey spectral window are used. In this case, the maximum values of the coherence coefficients in the frequency range 1.23·10-4 - 1.67·10-2 Hz are used as the index of CR and SW fluctuations. Note that the coherence coefficient is a generalization of the correlation function to the frequency domain. Its use is due to the fact that, in contrast to fluctuation spectra, the level of which varies by orders of magnitude depending on the state of the interplanetary medium, coherence takes values ranging from 0 to 1, regardless of the level of solar activity.

It is shown that in the event in February, in contrast to the event in March, significant coherent CR fluctuations of large magnitude (about 0.8) are observed about 2 days before the start of the geomagnetic storm. An analysis of data from direct measurements of SW parameters shows that the geomagnetic storm on February 26 was caused by the passage of an interplanetary shock wave, and on March 23, by a coronal mass ejection with a magnetic cloud moving at a speed not exceeding the background SW velocity. A more detailed analysis leads to the conclusion that the presence of CR fluctuations in February is due to the presence in the SW of fast magnetosonic waves of noticeable amplitude, which can be generated by energetic storm particle flows in the region ahead of the interplanetary shock wave front. While in March 2023 the contribution of these waves to the observed IMF turbulence spectrum d id not exceed 50%, and before the onset of the geomagnetic storm, no coherent CR intensity fluctuations were observed. At the same time, high coherence values of CR fluctuations were observed in both events in the region of the disturbance itself, which may indicate an increased level of magnetosonic turbulence of the solar wind in the region of the SW disturbance itself. The results obtained here are in good agreement with the physical picture of the occurrence of CR intensity fluctuations that we have previously constructed, but further research is required to develop a method for predicting geomagnetic storms based on measurement data from neutron monitors.

We thank the NOAA and ACE Science Centers for providing the DSCOVR and ACE spacecrafts data. The work was performed using the equipment of the Unique Scientific Facility “Russian National Ground-Based Network of Cosmic Ray Stations” (https://ckp-rf.ru/catalog/usu/433536) with the support of the Russian Science Foundation (grant no. 22-22-20045).

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Session Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **39** Type: **Original Talk**

Direct comparison of muons in ultrahigh energy EASs between Yakutsk array and Auger experiment data

Thursday, 29 June 2023 10:30 (15 minutes)

The results of direct measurements of the muon density in extensive air showers (EAS) with zenith angles $\theta \leq 45^{\circ}$ and energies ${}_0 \geq 10^{17}$ eV obtained in the Auger experiment and at the Yakutsk array are considered. In both cases muons were registered by underground scintillation detectors with the same threshold energy ${}_\mu \approx 1.0 \times \sec\theta$ GeV. The measured values are compared with the theoretical values calculated within the framework of QGSjet-II-04 hadron interaction model using the CORSIKA code. They differ from each other by the factor of 1.53 ± 0.13(stat). It is shown that this difference is due to the muon density overestimation by a factor of 1.22 and the primary energy underestimation by a factor of 1.25 in the Auger experiment.

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Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **40** Type: **Original Talk**

Event reconstruction method in a hybrid muon hodoscope

Tuesday, 27 June 2023 17:45 (15 minutes)

The method of event reconstruction and obtaining of muonographs by a new hybrid muon hodoscope is considered. The design of the developed hodoscope is described. The first results of measurements, as well as the obtained estimates of the angular and coordinate accuracy of the detector are discussed.

The muonography method is based on the registration of the penetrating component of cosmic rays (muons) and makes it possible to obtain images of various objects. In order to implement the muonography method for studying large-scale objects, a new wide-aperture precision hybrid muon hodoscope was created. This hodoscope consists of two complementary recording systems - a scintillation strip detector and a drift tube detector. Alternating coordinate planes of the detectors, each with a sensitive area of 3×3 m2, are fixed in a common frame placed on a movable wheeled turntable.

To reconstruct events in the drift detector, the method of spatio-temporal clustering of signals by the drift time in the tubes is used. After the selection of hits from single cosmic muons, the search for intersections of tangent lines between the coordinate planes of the hodoscope, the reconstruction of the muon track, and the subsequent obtaining of muonographs follow. In the scintillation hodoscope, for the reconstruction of the muon track, a two-coordinate method of searching for a straight line from triggered scintillation strips is used.

Keywords: Cosmic ray muons, hybrid particle detectors, drift tubes, muon hodoscope, muonography, muon tomography.

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Session Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **41** Type: **Original Talk**

Studying muon bundles of inclined air showers in the NEVOD-DECOR experiment

Thursday, 29 June 2023 10:15 (15 minutes)

NEVOD-DECOR is the unique experiment where systematic studies of cosmic ray muon bundles in a wide range of zenith angles and, accordingly, the energies of primary cosmic rays are carried out. Impressive experimental material (more than 100 thousand events) has been accumulated over a long time period from May 2012 to December 2022. The earlier developed method of local muon density spectra allows us to compare experimental data on muon bundles with the results of the EAS muon component simulations. The analysis showed that the observed intensity of muon bundles at primary cosmic ray energies of about 1 EeV and higher can be compatible with the expectation (in frame of widely used hadron interaction models) only under the assumption of an extremely heavy mass composition. It is consistent with data of several other experiments on investigations of air shower muon content, but contradicts the available measurements of the depth of the shower maximum in the atmosphere by means of fluorescent technique, which favor a light mass composition at these energies. This probably leads to the need to revise the existing models of hadronic interactions.

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Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **42** Type: **Poster**

Coulomb pulsars are sources of cosmic rays with energies greater than 10 TeV

Tuesday, 27 June 2023 16:30 (15 minutes)

In a new capacity, Einstein's idea of the equivalence of mass and energy is confirmed. The equivalence manifests itself in similar functionality in the processes of pulsations (focusing and bounce) of "excess" energy in the generalized 2D Kepler problem and "excess" mass in the 3D Vysikaylo-Chandrasekhar problem of cumulation and dissipation of de Broglie waves in quantum stars (pulsating accretion of quantum stars) with a mass greater than Chandrasekhar's (˜ 1.46 solar masses). Such pulsations of quantum stars are due to differences in the de Broglie wavelengths of electrons and ions. This difference leads to quantum separation of charge during the collapse of a quantum star and the formation of an electric field shock wave. A new mechanism (type) of a thermonuclear reactor near the surface of charged quantum stars and dense cores of ordinary stars and planets is proposed. Acceleration of protons and electrons up to energies above 10 TeV in electric field shock waves in the nuclei of giant plasmoids – quantum stars – and their transmutation into neutrons in reactions with each other are the basis of such a mechanism. Rotation, which reveals cumulation and dissipation and structurally promotes the transfer of energy from all degrees of freedom into rotation and pulsations during cumulation, is not the only true sign of cumulation and structural spiral turbulence with hierarchical cascades of structures with energy-mass-momentum flows. The same sign of cumulation is the violation of electrical neutrality.We prove that, just as in the case of rotation, it is possible under certain conditions to form space charge jumps (shock waves of the electric field discovered by Rutherford in atomic nuclei, Gunn in semiconductors and Vysikaylo in gas-discharge plasma, see [1] for more details) and the transformation of all types of energy into electrical energy (electric field). In this case, the violation of electrical neutrality is very small, but its role in the organization of the structure of the Coulomb quantum pulsar is enormous. It is a weak violation of electrical neutrality at a level of 10-**36 that stops the gravitational cumulation of protons into stars (and even into black holes) and leads to the generation of proton or ion winds from stars [2] and even from black holes [1]. The violation of electrical neutrality at the level of 10**-18 leads to the suppression of gravitational forces, and at the level of 10-**12 - to the formation of Cosmic rays with energies up to 3·10**20 eV [1]. Simultaneous excitation in complex hierarchical dynamical systems of rotation, pulsations and violation of electrical neutrality leads to the generation of the third degree of freedom - a magnetic field. There is no need to invent a "mysterious" magnetic dynamo, but one should involve the interference of rotation and violation of electrical neutrality. The author argues that the presence of a magnetic field is an indirect, convincing sign of a violation of electrical neutrality and rotation, and, consequently, cumulation.

[1] Vysikaylo P.I. Detailed Elaboration and General Model of the Electron Treatment of Surfaces of Charged Plasmoids (from Atomic Nuclei to White Dwarves, Neutron Stars, and Galactic Cores): Self_Condensation (Self_Constriction) and Classification of Charged Plasma Structures–Plasmoids. Part I-3. General Analysis of the Convective Cumulative–Dissipative Processes Caused by the Violation of Neutrality: Metastable Charged Plasmoids and Plasma Lenses. Surface Engineering and Applied Electrochemistry. 2012, 48(1), 11–21.

[2] Vysikaylo P.I. Quantitative Investigation Nonequilibrium Inhomogeneous Plasma of the Heliosphere with Runaway Electrons IEEE Transactions on Plasma Science 2022, V.50, Issue 4, pp. 810-816. DOI: 10.1109/TPS.2022.3160189

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Session Classification: Poster Session

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **43** Type: **Poster**

Mass composition of cosmic rays with energies above 3*10ˆ15 eV according to the data of the small Cherenkov array

Tuesday, 27 June 2023 16:15 (15 minutes)

According to the long-term registration data from the small Cherenkov array of integral and Cherenkov differential detectors obtained the characteristics of air showers with energies above 3*10ˆ15 eV, including of the maximum of the development of the Xmax. The dependence of Xmax on the shower energy found and the characteristics of air showers compared with the QGSjetII-04 model. From a comparison of Xmax with calculations based on the QGSetII-04 model for a proton and an iron nucleus, a conclusion obtained on the mass composition of cosmic rays in the energy range 3*10ˆ15 – 2*10ˆ18 eV.

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Session Classification: Poster Session

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **44** Type: **Original Talk**

High Energy Ray Observatory, optimization and current status

Tuesday, 27 June 2023 15:30 (15 minutes)

The High-Energy Ray Observatory (HERO) is a space experiment based on a heavy ionization calorimeter for direct study of cosmic rays. The effective geometric factor of the apparatus is not less than 12m2sr for protons and not less than 18m2sr for nuclei and electrons. During the exposure for ~5-7 years this mission will make it possible to measure energy spectra of all abundant cosmic ray nuclei in the knee region (~3 PeV) with individual resolution of charges with energy resolution better than 30% and provide useful information to solve the puzzle of the cosmic ray knee origin. HERO mission will make it also possible to measure energy spectra of cosmic rays nuclei for energies 1-1000 TeV with very high precision and energy resolution (up to 3% for calorimeter 70 tons) and study the fine structure of the spectra. The current status of the space mission is discussed.

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Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **45** Type: **Poster**

A new method for searching for VHE muons in data from Cherenkov water neutrino telescopes

Tuesday, 27 June 2023 16:45 (15 minutes)

Measuring the energy spectrum of very high-energy muons (VHE-muons) solves many problems of cosmic rays physics and nucleus-nucleus interactions. The most promising facilities for solving this problem are gigaton neutrino telescopes (IceCube, Baikal-GVD and KM3NeT). However, VHE-muons (E > 30-100 TeV) come into the detector accompanied by muon bundles of various multiplicities. In this case, it is difficult to distinguish muon bundles of large multiplicity from muon bundles of small multiplicity with a high-energy muon. The report is devoted to the development of a new method for distinguishing such events.

The essence of the developed method is the analysis of the longitudinal profile of energy loss and the selection of events according to the exponent index of the fitting function and the magnitude of fluctuations in energy loss.
To develop and adjust the method, simulations of the energy spectrum with a power index of 2.7 were performed in the energy range of 10ˆ14 – 10ˆ20 eV via the CORSIKA program. The spectrum of EAS muons was obtained. The energy losses of EAS muons and single VHE-muons with fixed energies 10, 31, 100, 316, 1000 TeV were simulated in the PROPOSAL software package. An algorithm has been developed for the muon bundles assembling based on the spectrum of EAS muons.

Various criteria for distinguishing events based on combinations of the exponent index of the longitudinal profile of the energy loss and the residual sum of squares are discussed in the report. The results of separating events with various bins in the longitudinal profile of the energy loss of the EAS muon component are shown.

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Presenter: LISITSIN, Mikhail

Session Classification: Poster Session

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **46** Type: **Overview**

Overview on EAS neutrons: recording and simulations

Tuesday, 27 June 2023 12:30 (30 minutes)

Interest to study neutrons produced in Extensive Air Showers (EAS) is rising last years. Recent publications on this subject are overviewed and estimated. Advantages of the method to study hadronic component being the main EAS component, as well as perspectives of the method are shown.

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Session Classification: Overview Talks

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **47** Type: **Poster**

Extraction of signals from EAS neutrons detected by the URAN setup

Tuesday, 27 June 2023 16:45 (15 minutes)

On the basis of the Experimental Complex NEVOD, the URAN setup has been deployed which serves to detect the electron-neutron component of extensive air showers (EAS). This setup includes 72 scintillation detectors and covers an area of ˜10ˆ3 mˆ2. Registration of the neutron component by detectors is possible due to the ZnS(Ag) + B2O3 scintillator, where the content of the 10B isotope is 18%. When a neutron is captured by the boron isotope (10B), two charged particles are born, which cause luminescence flashes in ZnS(Ag) scintillator recorded by a photomultiplier. One of the important problems is the separation of signals caused by neutron capture in a scintillator from noise pulses. The paper presents a new algorithm for selecting signals caused by EAS neutrons capture. The algorithm makes it possible to reduce the contribution of noise pulses and increase the efficiency of neutron detection by the URAN setup.

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Session Classification: Poster Session

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **48** Type: **Poster**

Analysis of joint events by means of the ProtoTREK and the NEVOD-EAS data

Tuesday, 27 June 2023 16:45 (15 minutes)

The Experimental Complex NEVOD includes a number of large-scale facilities for detection of high energy cosmic rays, including the ProtoTREK and the NEVOD-EAS detectors. The coordinate detector ProtoTREK consists of 14 multiwire drift chambers with a total area of 13 m^2 and makes it possible to register and to reconstruct tracks of charged particles of extensive air showers (EAS). The NEVOD-EAS facility is an array of surface scintillation detectors covering an area of 10^4 m^2 which are grouped in 9 clusters; the setup registers the electron-photon component of the EAS. These detectors work independently, in particular, they have different internal clocks. The ProtoTREK is located between the detector stations of the 5th cluster of the NEVOD-EAS, therefore, the events that are registered in this cluster are considered. The work presents results of the analysis of joint events. The original method for selection of events was developed. 4814 joint events on June 10 and June 11, 2021 were found and analyzed by the difference of the angles between reconstructed directions of the EAS. Thereby, the most probable angle between the reconstructed by two setups EAS arrival directions is 3.4°.

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Session Classification: Poster Session

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **49** Type: **Poster**

Dynamics of high-energy proton fluxes in the South Atlantic Anomaly region according to ARINA and VSPLESK satellite experiments

Tuesday, 27 June 2023 16:40 (20 minutes)

This paper studies the dynamics of proton flux in the South Atlantic Anomaly (SAA) region according to ARINA (was operated on the Resurs-DK1 satellite from 2006 to 2015) and VSPLESK (which was mounted on the ISS from 2008 to2013) satellite experiments. Both spectrometers have the same scheme.
The SAA drift is determined by the position of the maximum flux of high-energy protons with energies in the range from 30 to 100 MeV at the altitude of the Resurs-DK1 satellite (about 350-600 km) and the ISS (380-420 km). Part of the time the instruments operated simultaneously.

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Session Classification: Poster Session

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **50** Type: **Original Talk**

Cosmic ray accelerator in the inhomogeneous heliosphere and its impact on the inhabitants of the Earth

Wednesday, 28 June 2023 15:45 (15 minutes)

Using the helio-sphere as an example, we have investigated the hypothesis that stellar winds or cosmic rays originate in stars and accelerate in their star spheres in electric field shock waves. We have proved that a nonequilibrium inhomogeneous giant gas discharge occurs in the helio-sphere at large values of the parameter E/N, which determines the electron temperature. This quasi-stationary discharge determines the main parameters of the slow solar wind (SW) in the helio-sphere. In connection with the development of space technologies and the exit of man into outer space, the problem of the nature of SW is acute. The Pannekoek-Rosseland-Eddington model does not take into account the important role of high-energy runaway (from the Sun) electrons and, accordingly, the duality of electron flows in the helio-sphere (from the Sun and towards the Sun). According to the alternative model formulated by us, high-energy (running away from the positively charged Sun) electrons leave the Sun and the helio-sphere, and low-energy, unable to leave the Coulomb potential well - the positively charged Sun and the helio-sphere, return to the positively charged Sun. The weak difference between the counter currents of high-energy (running away from the Sun) electrons and low-energy (returning to the Sun) electrons is compensated by the current of positive ions and protons from the Sun - SW. These dynamic processes maintain a quasi-constant effective dynamic charge of the Sun and the entire helio-sphere. Quasi-neutrality on the Sun and the helio-sphere is well performed up to 10*-36. According to experiments and analytical calculations based on our model [1]: 1) the plasma in the corona is non-equilibrium; 2) maximum electron temperature Te ˜ 1-2 million degrees; 3) Te increases from 1000 km from the Sun and 4) the role of high-energy electrons emitted from the plasma leads to a significant increase in the effective: solar charge and electric fields in the helio-sphere in relation to the Pannekoek-Rosseland-Eddington model. This is due to the absence of a compensation layer screening the effective solar charge. It does not form due to the runaway of high-energy electrons from the entire helio-sphere with high temperatures above the surface of the Sun. The runaway process of high-energy electrons forms the internal EMF of the entire helio-sphere and a giant accelerator of protons and α-particles in the SW. This process manifests itself in the generation of two counter streams of particles: 1) neutral or with a small charge (toward the Sun) and 2) in the form of high-energy electrons (escaping from a positively charged Sun) and 3) the formation of a solar wind with positively charged ions with Z/M ≥ 0.107 (from the positively charged Sun). The calculated values of the ion parameters in the solar wind are compared with experimental observations. The velocities of protons in the SW are determined by their birthplace in the helio-sphere and can exceed 1200 km/s. The influence of SW protons on the well-being of the inhabitants of the Earth is discussed.

[1] Vysikaylo P.I. Quantitative Investigation Nonequilibrium Inhomogeneous Plasma of the Helio-sphere with Runaway Electrons IEEE Transactions on Plasma Science 2022, V.50, Issue 4, pp. 810-816. DOI: 10.1109/TPS.2022.3160189

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Session Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **51** Type: **Original Talk**

Carpet-2 search of gamma rays with energies E γ ≥300 TeV from the Milky Way

Search for gamma rays with energies ≥ 300 TeV was being performed at the Carpet-2 array at the INR RAS Baksan Neutrino Observatory from 2018 to 2022. We analyzed the spectra of gamma-like events from the Milky Way region and compared it with the rest of the sky. In addition, we studied several Galactic point sources, in particular those detected by LHAASO. The results of the searches will be presented at the conference.

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Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **52** Type: **Poster**

Search for particle excess from the Cygnus Cocoon region direction during a hypothetical flare detected in the Baksan Crapet-2 experiment

Tuesday, 27 June 2023 16:45 (15 minutes)

Sources of PeV cosmic rays (so called Pevatrons) can be identified by gamma and neutrino radiation with energy more than 100 TeV due to not destroyed trajectories by interstellar and galactic magnetic fields. In particular, one of such potential sources areas is considered to be the region of the double source PSR J2032+4127 in the Cocoon nebula in the constellation Cygnus. The neutrino event with energy 150 TeV was recorded in the Ice Cube experiment in November, 2020 from the Cygnus Cocoon direction. In the Capet 2 experiment (located in Baksan gorge), there was registered a sharp increase of photon fluxes with an energy of more than 300 TeV from the same direction as Ice Cube neutrino and temporal coincidence. This flux exceeds by 4 orders of magnitude the expected intensity obtained in gamma-ray astronomical experiments and it is comparable to the EAS hadron background.
In the TAIGA astrophysical experiment, the HiSCORE wide-angle Cherenkov installation (with an area of about 1 km2 at present) is aimed at registering gamma quanta with an energy of more than 50 TeV with an angular resolution of at least 0.2 degrees. One can expect that such a powerful flare should be registered by HiSCORE array.
To check this hypothesis we have analyzed EAS events registered by HiSCORE array during 20 hr in October- November 2020 yr from the Cygnus Cocoon direction. The intensity of gamma-like particles with energy more than 200 TeV has been compared with an intensity of the nearest background region around the source. The upper limit of the expected excess flux will be presented.

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Session Classification: Poster Session

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **53** Type: **Overview**

30 years of cosmic ray research in the Tunka Valley

Tuesday, 27 June 2023 11:00 (30 minutes)

A brief history and the main results of the study of cosmic rays and high-energy gamma radiation using the Cherenkov EAS installations located in the Tunka Valley 50 km from the southwestern tip of Lake Baikal are presented. Since 1993, the important results have been got about the energy spectrum and mass composition of cosmic rays in the energy range of 1 – 1000 PeV with the Tunka-4, Tunka-13, Tunka-25, Tunka-133 installations. The spectrum indicates a significantly more complex dependence of the intensity of cosmic rays on energy than previously assumed and serves as a natural bridge between the results obtained in experiments on satellites and balloon experiments and the results of the giant international observatories Auger and Telescope Array.

Based on the experience gained, in 2014, the creation of a hybrid complex TAIGA was launched, aimed at solving a lot of tasks in the field of astroparticle physics, cosmic ray physics and high-energy gamma astronomy. In 2022, the creation of the TAIGA-1 pilot complex was completed, including 120 low-threshold wide-angle Cherenkov stations distributed over an area of 1.2 km ˆ 2, and three Imaging Atmospheric Cherenkov Telescopes. The report will present the first results of studies of high-energy gamma radiation from a number of sources.

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Session Classification: Overview Talks

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **54** Type: **Poster**

Features of Forbush decreases obtained by satellite and ground-born detectors

Tuesday, 27 June 2023 16:40 (20 minutes)

The Forbush decreases (FDs) are known as sharp drops in cosmic ray intensity, registered by different scientific equipment on Earth and interplanetary space. These events correlate with solar activity, mainly with coronal mass ejections (CMEs). CMEs spreads into interplanetary space and swap out the cosmic ray particles from the modulation region. The main features of FDs are the intensity drop amplitude and the recovery time to its undisturbed level. These parameters are characterized by a large variability of the measured values. The reasons for this variability are connected to the scale of the CMEs and with the structure and velocity of ejected solar mass in place of measurement. Also, they depend on the detector type used for observing FDs. The satellite detectors register primary cosmic rays in a wide energy range and effectuate the direct measurements of the phenomenon, whereas ground-based detectors measure the secondary cosmic rays born in the Earth's atmosphere. Ground-based detectors have larger statistics with respect to satellite experimentation but are less sensitive to different variations of cosmic rays intensity as well as FDs. To study FDs properties we use the primary flux data of CR cosmic ray particles recorded by the PAMELA and AMS-2 spectrometers for the time period from 2006 to 2019 in the rigidity range from 0.8 to 50 GV. The amplitudes and recovery time behaviors during FD phenomena were the subject of our study. The data from SOHO coronagraphs were taken for searching the CMEs responsible for the observed FDs. The amplitude values of FDs and the behavior of their recovery times were followed with respect to some parameters of solar activity and interplanetary space. The obtained results of the satellite instruments were compared with data from several neutron monitors.

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Presenter: LAGOIDA, Ilya (NRNU MEPhi)

Session Classification: Poster Session

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **55** Type: **Poster**

Modernization of mechanical attachements point

Tuesday, 27 June 2023 16:00 (15 minutes)

IACT's are one of the key parts of the TAIGA observatory and design for study of gamma rays and charged cosmic rays in the energy range of 1013-1018 eV. One of crucial components of IACT is mechanical attachment point of mirror. It's consist of: mirror, heating cable and mirror alignment actuators. This poster will present the results of the modernization of the mechanical attachment point of mirrors, such as: replacement of the heat cable with a heater, that covers the back surface of the mirror, mirror alignment automation and the production of mirrors.

Primary authors: BLINOV, Aleksandr; Mr BORODIN, Artur (JINR)

Presenter: BLINOV, Aleksandr

Session Classification: Poster Session

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **56** Type: **Overview**

Neutrino telescope Baikal-GVD: status and results

Tuesday, 27 June 2023 10:30 (30 minutes)

The progress in the construction and operation of the Baikal Gigaton Volume Detector in Lake Baikal is reported. The detector is designed for search for high energy neutrinos whose sources are not yet reliably identified. It currently includes over 3500 optical modules arranged on 98 strings, providing an effective volume of 0.6 km3 for cascades with energy above 1 PeV. We review the scientific case for Baikal-GVD, and first results from the partially built experiment, which is currently the largest neutrino telescope in the Northern Hemisphere and still growing up.

Primary author: DZHILKIBAEV, Zhan-Arys

Presenter: DZHILKIBAEV, Zhan-Arys

Session Classification: Overview Talks

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **57** Type: **Overview**

Cosmic rays data for Space Weather forecasting

Tuesday, 27 June 2023 12:00 (30 minutes)

When we speak on Space Weather we are commonly meaning the radiation and electro magnetic conditions in the near Earth space. Cosmic ray variations define directly a radiation situation. And they are also related to the variations of electromagnetic conditions in the interplanetary space and Earth's magnetosphere. This makes cosmic ray variations one of the important resources for validating the space weather state and forecasting its changes.

Primary author: ABUNINA, Maria (IZMIRAN)

Presenter: ABUNINA, Maria (IZMIRAN)

Session Classification: Overview Talks

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **58** Type: **Poster**

Project of a mobile muon hodoscope for muonography of various objects

Tuesday, 27 June 2023 16:40 (20 minutes)

At present, the method of muonography (by analogy with X-ray radiography) of the internal structure of various objects of natural or artificial origin using the natural flux of cosmic ray muons has become widespread.
To implement this method, a mobile muon hodoscope (MMH) is being developed at the NEVOD Scientific and Educational Center (MEPhI). The design of the MMH is a multichannel detecting system consisting of six single-projection planes with an active area of about 1 m2. Each single-projection plane is an assembly of two layers of 96 scintillation strips in each layer with geometric dimensions of 10 × 7 × 1000 mm3 with light collection using wavelength-shifting optical fibers to silicon photomultipliers (SiPM). The layers are shifted by half of the width of the strip relative to each other and fixed between two aluminium sheets. 32 SiPM signals are transmitted to an electronic reading system based on a 32-channel ASIC PETIROC 2A. Two adjacent single-projection planes are rotated relative to each other by 90 degrees.
In this report the features of the construction and registration system of MMH are discussed. The results of tests of a sample of a silicon photomultiplier, as well as a prototype of a single-projection plane consisting of 32 scintillation strips are presented.

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Session Classification: Poster Session

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **59** Type: **Poster**

Extending of the capabilities of the PRISMA-36 array through the introduction of a recording channel for studying neutron variations

Tuesday, 27 June 2023 16:40 (20 minutes)

Since 2012 in the Experimental Complex NEVOD (MEPhI, Moscow), the PRISMA array for studying extensive air showers by detecting neutrons has been operated. In the array the en-detectors are used to detect neutrons. The detector consists of a thin (˜ 30 mg/cmˆ2) inorganic scintillator ZnS(Ag)+6ˆLiF (the enrichment of Li with 6ˆLi isotope is 90%) and photomultiplier FEU-200, which are installed inside a light-isolating cylindrical housing (heights of 570 mm and diameter of 740 mm). In 2023, it is planned to upgrade the array by replacing the photomultipliers, integrating amplifiers, digitizing electronics and high-voltage power supply system. Also during the array upgrade, a separate recording channel will be added in the detectors to study variations of the neutron background and processes affecting these variations. In the report we discuss the results of studying the applicability of the hemispherical photomultipliers EMI 9350 and D642 for the PRISMA-36 array, as well as the scheme and operating principals of the new recording channel.

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Session Classification: Poster Session

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **60** Type: **Original Talk**

Influence of atmospheric fronts on cosmic ray muon flux

Tuesday, 27 June 2023 17:30 (15 minutes)

A new approach to the analysis of muon flux during atmospheric fronts passage is discussed. It is possible to select muons in specific planes providing different counting rate series that can reveal atmospheric waves that may accompany phenomena like the passage of atmospheric fronts. The plane includes muons from all zenith angles and some azimuth angles. This selection is made possible by the URAGAN muon hodoscope, which detects muons from all directions and records them in matrices of zenith and azimuth angles. The value in the matrix cell corresponds to the number of muons in a specific range of angles. The experimental setup consists of three supermodules that operate separately and independently from each other. It is possible to compare data from individual supermodules with each other and thus extract a useful signal. Data corresponding to the movement of atmospheric fronts above Moscow are examined. In the study, warm, cold, and occluded fronts are considered. The new approach to processing of experimental data allows us to see waves from approximately 60% of atmospheric fronts.

Primary authors: TIMAKOV, Stanislav (MEPhI); PETRUKHIN, Anatoly (MEPhI)

Presenter: TIMAKOV, Stanislav (MEPhI)

Session Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **61** Type: **Poster**

Study of cosmic ray variations in 2021-2022 based on the ENU scientific complex data

Tuesday, 27 June 2023 16:40 (20 minutes)

This work presents a comparative analysis of the time changes in the secondary cosmic ray fluxes recorded by the detector modules of the L.N. Gumilyov ENU scientific complex during the period of powerful geomagnetic disturbances on 04.11.2021 and 13-14.03.2022. Noticeable changes in the geomagnetic indices, solar wind plasma velocity and the potential gradient of the surface electric field were observed. The results of the analysis are presented, the Forbush-decreasing effect is highlighted, and the characteristics and features are considered.
The time intervals in 2021 for which an increase in the particle flux relative to the background one was also observed and registered by the ENU detectors. They are in possible association to electrified clouds, lightning activity, thunderstorms, emission of natural radionuclides, variations of the surface electric field are discussed. The main features of each recorded event are considered. It's shown that several increase events correlate with the dynamics of the surface electric field potential gradient.
This work supported by the Program-Targeted Funding Program of the Ministry of Education and Science of the Republic of Kazakhstan IRN BR10965191 "Integrated Research in Nuclear and Radiation Physics, High Energy Physics and Cosmology for the Development of Competitive Technologies".

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Session Classification: Poster Session

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **62** Type: **Original Talk**

Current status of the TREK detector for studies of cosmic ray muon bundles at large zenith angles

Wednesday, 28 June 2023 18:00 (15 minutes)

At National Research Nuclear University MEPhI, a large-scale coordinate-tracking detector TREK for the study of muon bundles at large zenith angles is under construction. The detector has an area of 250 m^2 and consists of two planes of multi-wire drift chambers.

In joint operation with the Cherenkov water detector of 2000 tons of distillated water, the TREK detector will provide on unprecedented investigation of near-horizontal flux of muon bundles generated in the interactions of ultra-high-energy cosmic rays. This research will contribute to resolving the «muon puzzle» concerning the origin of the excess of cosmic ray muons, which has been observed in such experiments as NEVOD-DECOR, IceCube and the Pierre Auger Observatory. The report presents the results of assembling and launching the inner plane of the TREK detector, the results of the gas mixture purging, the results of testing and passportization of drift chambers on the testbench. The estimates of the efficiency and the accuracy of track reconstruction will be discussed.

Primary author: TROSHIN, Ivan (MEPhI)

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Presenter: TROSHIN, Ivan (MEPhI)

Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **63** Type: **Original Talk**

The modeling of the cosmic ray particles interaction with the Earth's atmosphere during the GLE events

Wednesday, 28 June 2023 14:45 (15 minutes)

The work presents the results of calculations of the cosmic ray protons propagation through the Earth's atmosphere using the Monte Carlo method. We developed the model for this modeling with the GEANT4 software development toolkit. It uses the standard QGSP_BERT_HP class to describe the physics of the particle interactions with matter. The general results are a quantitative estimated secondary particle fluxes (neutrons, muons, electrons, positrons and photons in the wide energy region), as well as the ionization count rate in comparison only with the galactic cosmic rays. In this work we have considered three GLE events (№ 65, № 69 and № 70). Moreover, it is taken into account that there are two components in the spectrum of primary cosmic rays, prompt and delayed (in accordance with the work on assessing the features of the spectrum of relativistic solar protons using the GLE modeling technique).

Primary authors: MAURCHEV, Evgenii (IZMIRAN); Dr BALABIN, Yuriy (Polar Geophysical Institute); Dr GVOZDEVSKY, Boris (Polar Geophysical Institute); Dr GERMANENKO, Alexei (Polar Geophysical Institute)

Presenter: MAURCHEV, Evgenii (IZMIRAN)

Session Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **64** Type: **Poster**

Cutoff rigidity in the Galactic magnetic field

Tuesday, 27 June 2023 16:45 (15 minutes)

More than 80 years after the discovery of UHECRs, many questions remain about possible sources, mechanisms of acceleration, propagation, and so on. An important aspect of research is the analysis of their motion in the magnetic field of the Galaxy, which implies, first of all, model calculations. New works devoted to such an analysis appear with the accumulation of experimental observations of the field and the development of the corresponding models.
The current work is devoted to the calculation of the magnetic cutoff rigidity of cosmic rays in the Galactic field. We calculate the movement of charged particles in the Milky Way using the toolkit developed by our scientific group. The calculation is performed in a modified JF12 model. We investigate the residence time of particles with different energies in the galactic disk and construct a map of the magnetic cutoff for an observer on the Earth. The influence of the simulated sizes of turbulent inhomogeneities on the result is considered.

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Presenter: YULBARISOV, Rustam (NRNU MEPhI)

Session Classification: Poster Session

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **65** Type: **Poster**

Local interstellar spectra of electrons and positrons by demodulating fluxes from the PAMELA experiment

Tuesday, 27 June 2023 16:40 (20 minutes)

On entering the Solar System, galactic cosmic rays undergo solar modulation, which can be described with a modulation parameter defined by proton fluxes from neutron monitors. In particular, the modulation considerably distorts the fluxes of galactic cosmic-ray electrons and positrons with energies below 10 GeV. Taking into account known modulation potential, which also depends on the solar activity, there is a possibility of restoring the local interstellar spectra by demodulating fluxes from satellite experiments.
This work presents primary electron and positron fluxes obtained by the PAMELA experiment at 1 AU for different solar activity phases in 2006–2016 using machine learning methods. Also, by demodulating these spectra, the local interstellar spectra of electrons and positrons have been restored.

Primary authors: MUKHIN, Pavel; MIKHAILOV, Vladimir (NRNU MEPhI)

Presenter: MUKHIN, Pavel

Session Classification: Poster Session

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **66** Type: **Original Talk**

Study of anomalous events in the TUS experiment

Wednesday, 28 June 2023 13:00 (15 minutes)

The TUS experiment was the first detector to measure the fluorescence and Cherenkov radiation of extensive air showers (EAS) in the Earth's atmosphere from space orbit. The main goal of the TUS experiment was to search for and study ultra high-energy cosmic rays with energies E > 70 EeV. The TUS detector registered a number of unusual events, the origin of which is unclear- with an anomalously large number of active pixels . To clarify the nature of these events, a more detailed analysis has been carried out and preliminary results are presented.Various variants of the nature of the appearance of anomalous events are discussed: cosmological gamma-ray bursts (GRB), synchrotron radiation of galactic electrons in the geomagnetic field, as well as reflection in the solar panels of the satellite of fluorescent and Cherenkov radiation of out-of-aperture EASs, accompanied by lightning discharges in the atmosphere.

Primary authors: BLINOV, Aleksandr; TKACHEV, Leonid (JINR, Dubna); Mr GRINUYK, Andrey (JINR); Ms LAVROVA, Maria (JINR)

Presenter: BLINOV, Aleksandr

Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **67** Type: **Original Talk**

A new break near 10 TeV in the energy spectrum of protons according to data from space-based instruments: astrophysical interpretation

Thursday, 29 June 2023 10:00 (15 minutes)

Recent experimental data from space-based instruments of the DAMPE and CALET collaborations have shown that the energy spectrum of protons has a new feature, a break in the ~ 10 TeV region. In this energy range, the spectrum index of the observed particles varies from -2.6 to -2.9.

The purpose of this work is to establish the location zone of the sources that determine this break, the index of the proton generation spectrum in them, as well as the astrophysical interpretation of the results obtained in the DAMPE and CALET experiments.

Within the framework of the model of nonclassical diffusion of cosmic rays developed by the authors, which has break due to the propagation of particles in a sharply inhomogeneous (fractal type) galactic medium, it is shown that break in this energy range is formed by sources located at a distance of $300 - 400$ pc from the Earth. These sources, whose age is $\sim (5 - 10) \cdot 10^4$ years, generate particles with a spectrum index ~ 2.8.

The power-law behavior of the proton spectrum before and after the break, first obtained in the DAMPE and CALET experiments, confirms the conclusion made earlier by the authors that cosmic ray diffusion is nonclassical. The results of these experiments should also be considered as an indication of the need to revise the standard paradigm accepted today about the sources of cosmic rays and the mechanisms of particle acceleration in them.

Primary author: LAGUTIN, Anatoly (Altai State University)

Co-author: VOLKOV, Nikolay (Altai State University)

Presenter: LAGUTIN, Anatoly (Altai State University)

Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **68** Type: **Original Talk**

Where are the pevatrons that form the knee in the spectrum of the cosmic ray nucleon component around 4 PeV?

Wednesday, 28 June 2023 12:15 (15 minutes)

The paper discusses an approach that made it possible to estimate the distance to the nearest pevatrons, which form a break in the spectrum of the cosmic ray nucleon component of about 4 PeV. It is based on the spectra of nucleons and electrons obtained by the authors in the framework of the superdiffusion model of nonclassical CR diffusion, which have a break, on the assumption that nucleons and electrons are accelerated by the same sources and their propagation in an inhomogeneous turbulent galactic medium is characterized by the same diffusion coefficient, and also on the break in the spectrum of the electronic component in the region of 0.9 TeV, established in the DAMPE experiment.

It is shown that pevatrons, which form a break in the spectrum of the cosmic ray nucleon component of about 4 PeV, are located at distances of the order of 1 kpc from the Earth.

Primary author: LAGUTIN, Anatoly (Altai State University)

Co-author: VOLKOV, Nikolay (Altai State University)

Presenter: VOLKOV, Nikolay (Altai State University)

Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **69** Type: **Poster**

Tunka-Grande and TAIGA-Muon experiments: status, results and prospects

Tuesday, 27 June 2023 16:45 (15 minutes)

The Tunka-Grande and TAIGA-Muon scintillation arrays are part of the TAIGA astrophysical complex. This complex is located in the Tunka Valley, 50 km from Lake Baikal and is aimed at solving fundamental problems of cosmic ray physics and gamma-ray astronomy in the energy range 10 TeV - 1 EeV.
In report we present description and status of arrays, scientific programs and the main results of the Tunka-Grande array based on 7 seasons of operation: CR energy spectrum and limit on the flux of the diffuse gamma rays in the energy range 10 PeV - 1000 PeV. In addition, we provide the results of test operation of the first 3 clusters of the TAIGA-Muon array.

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Presenter: MONKHOEV, Roman (API ISU)

Session Classification: Poster Session

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **70** Type: **Original Talk**

Energy deposit of EAS cores detected by the facilities of the Experimental Complex NEVOD

Wednesday, 28 June 2023 13:15 (15 minutes)

The Experimental Complex (EC) NEVOD (MEPhI, Moscow) includes the NEVOD-EAS array, detecting electron-photon component of extensive air showers (EAS), and the Cherenkov water calorimeter (CWC), measuring energy deposit of particles passing through its operating volume.
Reconstruction of main EAS parameters (axis position, arrival direction, age and size) is performed according to the data of the NEVOD-EAS array, the clusters of which are installed around the building of the CWC. The System of Global Time Synchronization of the EC NEVOD provides timestamping events detected by the NEVOD-EAS and CWC with an accuracy of up to 25 ns, which makes it possible to select joint events in these facilities.
In this work, from all joint events in the NEVOD-EAS and CWC, we selected for the analysis only those events in which the EAS cores passed through the volume of the water detector. Since EAS cores include different types of particles, the response of CWC to electrons, muons and hadrons of various energies has been simulated in the Geant4 software package. Based on simulation, the estimates of the contribution of various components to the total energy deposit of EAS cores have been obtained. In the report we present the results of comparing simulation with experimental data.

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Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **71** Type: **Original Talk**

Development of an EAS type identification method based on an artificial neural network for the TAIGA experiment

Tuesday, 27 June 2023 15:15 (15 minutes)

The TAIGA experiment in Tunka valley is expanding the present scintillation detector array with new TAIGA-Muon detector stations. A simulation model was developed for the new stations optimization and study of the identification performance of the array together with HiScore optical stations system. The extensive air showers (EASs) were simulated with the CORSIKA simulation tool, and the detector response was simulated with the GEANT4 package. EASs induced by gamma quanta, proton and nuclei from He to Fe at energies 1 and 3 PeV have been studied. For the identification of the EAS origin, a method based on a neural network was suggested. Preliminary results show that with this method, using information from scintillation and optical detectors it is possible to achieve proton EAS suppression factor of 1000 while having gamma-quanta EAS detection efficiency about 50%. The analogous method was tested for cosmic rays element composition study. Three groups of elements – p-He, CNO and Fe could be separated with efficiencies variyng from 30 to 90% depending on the EAS type and predefined cuts.

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Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **72** Type: **Poster**

Spectrum of cosmic rays variations in 2011-2021 according to AMS-02 magnetic spectrometer onboard the ISS

Tuesday, 27 June 2023 16:40 (20 minutes)

Since the middle of the last century, cosmic ray variations have been studied using data from a ground-based network of neutron monitors. To determine the energy spectrum of cosmic rays at the boundary of the magnetosphere, knowledge of the shape of the variation spectrum is required. In this work, to determine the spectrum of proton flux variations, we used the recently published precision AMS-02 daily proton data obtained from 05/2011 on board the ISS. To approximate the spectrum of variations υ(R)= -δJ/J as function of rigidity R, the Ellison-Ramaty formula was used. Fitting parameters were obtained on the daily basis and compared with indexes of solar activity. No transformation of the spectrum was found during the polarity of the solar magnetic field reversal period. There is an anticorrelation between the fitting parameters and the number of sunspots. Alternative ways of studying the spectrum of variations are considered. At the 2nd moment there are annual quasi-periodic fluctuations. Connection of the 3rd moment with solar flares is observed.

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Presenter: SLASTNAYA, Vasilina

Session Classification: Poster Session

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **73** Type: **Poster**

High-frequency antenna cluster at the Tien Shan High-Mountain Scientific Station

Tuesday, 27 June 2023 16:45 (15 minutes)

Antenna clusters located in the Tien Shan High Mountaine Scientific Station (TSHMSS) are designed for radio detection of Extensive Air Showers (EAS) of cosmic rays. The cluster consists of 4 radio antennas, which each of them consists of mutually perpendicular arcs distributed over an area of 1700 m2. The analog part of the measuring path consists of a SALLA type antenna. These high-frequency antennas of the ”SALLA” type were used in the Tunka-REX experiment, operating in the frequency range of 30-80 MHz.
The antenna cluster works in conjunction with other installations to register SHAL. The cluster registers radio signals emitted by showers with energy above 10ˆ15-10ˆ16 eV. The purpose of the cluster is to investigate the possibilities of radio detection of the EAS, at an altitude of 3440 m above sea level, to determine the energy and elemental composition of primary cosmic rays.
Preliminary experimental data were obtained from the antenna cluster located at the Tien Shan high-Mountain Scientific Station. The experimental data were compared with the data obtained as a result of modeling in the CORSIKA package.

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Session Classification: Poster Session

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **74** Type: **Poster**

The module for positron detecting of the solid-state antineutrino detector

Tuesday, 27 June 2023 16:40 (20 minutes)

In the report we present the data on the development of a prototype of module for a solid-state detector of electron antineutrinos, which is based on a plastic scintillator for detecting positrons from the inverse beta decay (IBD) reaction. It is assumed that the complex of scintillation modules, supplemented with screens for detecting neutrons from IBD reaction using the ZnS(Ag)-6LiF (or ZnS(Ag)-B2O3) scintillation composition, will make it possible to construct large-scale detectors for monitoring antineutrino fluxes generated in a fission chain reaction. The practical application of such detectors is connected with the remote monitoring of nuclear power plant reactors, small modular reactors, including floating power plants, as well as with the solution of nonproliferation problems.

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Session Classification: Poster Session

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **75** Type: **Original Talk**

Testing the mezofractal power spectrum for ISM by comparing with numerical MHD calculations

Wednesday, 28 June 2023 15:15 (15 minutes)

For understanding cosmic ray propagation through the interstellar medium (ISM), an adequate model for the latter is needed. The ordinary diffusion approach, leading to the Brownian motion, assumes independence of ISM local inhomogeneities, such as molecular clouds and magnetic fluctuations. The long-range turbulent correlations created by magnetic force lines and gravitation forces require a special representation of these ISM properties. Pure power kind turbulent spectra occur to be too poor for this aim, and moreover, do not show acceptable agreement with last MHD calculation results. A more perspective spectra is obtained on the basis of statistical mechanics and promises to be more efficient. These include the Uchaikin-Zolotarev four-parameter mesofractal power spectrum [1], obtained by solving the Ornstein-Zernike equation using three-dimensional stable Levi-Feldheim distributions. These parameters provide its flexibility (the ability to approximate well the numerical results of various calculations) and are easily amenable to kinetic interpretation within the framework of the concept of Markov breaking chains [2].
The report shows successful applications of this spectrum to the approximation of the numerical results of two MHD calculations [3,4].

References:

1. Uchaikin, V.V.; Zolotarev, V.M. Chance and Stability. Stable Distributions and Their Applications, VSP, Utrecht, 1999.
2. Uchaikin, V.V.; Kozhemyakin, I.I. A Mesofractal Model of Interstellar Cloudiness. Universe. 2022; 8(5):249.
3. Burkhart, B.; Lazarian, A.; Ossenkopf, V.; Stutzki, J. The turbulence power spectrum in optically thick interstellar clouds. Astrophys. J. 2013, 771, 123.
4. Falceta-Gonçalves, D., Kowal, G., Falgarone, E., & Chian, A. L. (2014). Turbulence in the interstellar medium. Nonlinear Processes in Geophysics, 21(3), 587-604.

Primary authors: UCHAIKIN, Vladimir (Ulyanovsk State University); KOZHEMYAKIN, Ilya (Ulyanovsk State University); Mr LITVINOV, Vladimir (Barnaul Law Institute of the Ministry of Internal Affairs of Russia)

Presenter: KOZHEMYAKIN, Ilya (Ulyanovsk State University)

Session Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **76** Type: **Original Talk**

Solar radio bursts in the Radio Neutrino Observatory in Greenland RNO-G

Tuesday, 27 June 2023 14:45 (15 minutes)

Neutrino radio detectors are designed to target the first measurement of neutrinos beyond energies of ~10 PeV. Several such radio detectors operate in Antarctica. They are scanning the ice sheet in search of Askaryan radio emission from neutrino induced showers. The Radio Neutrino Observatory in Greenland (RNO-G), designed to monitor ultra-high-energy neutrinos in the northern hemisphere, is under construction. It currently has 7 of 35 stations with antennas inside the ice and on the surface. Antennas on the surface should also measure radio emissions from down-coming cosmic rays. The radio observatory may also be sensitive to solar radio bursts, which will be a background for cosmic rays. On the other hand, solar flares also present a unique opportunity for detector calibration. This contribution presents the results of a search for solar bursts in RNO-G data and demonstrates what calibration possibilities can be derived from solar flare data.

Primary author: MIKHAILOVA, Maria

Co-author: BESSON, David

Presenter: MIKHAILOVA, Maria

Session Classification: Cosmic rays of very high energies (> 1 PeV)

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **77** Type: **Poster**

The possibility of detecting TeV electrons and positrons of galactic cosmic rays using the Earth's magnetic field

Tuesday, 27 June 2023 16:45 (15 minutes)

Various mechanisms for the production and acceleration of positrons to energies of ~ 10 GeV and above have been actively discussed since their excess in the PAMELA experiment was first detected. To test these theoretical models, measurements of positron flux at energies of ~ 1 TeV and above are necessary. However, modern methods of registering cosmic rays do not provide an opportunity to register the fluxes of positrons and electrons separately. A promising technique is to use synchrotron radiation of positrons and electrons in the Earth's magnetic field to detect them. In this work we modeled the process of detection of positrons and electrons by this technique in the TeV energy range. Estimated registration efficiency for polar latitudes are 5-35% higher than for equatorial latitudes. Using the experimental data of CALET, DAMPE and FERMI on the total electron-positron flux of galactic cosmic rays, the expected integral detector count rate for the ROSS(Russian Orbital Service Station) and ISS(International Space Station) orbit in the energy range of 1-4.5 TeV was obtained. The high-latitude ROSS orbit provides a higher count rate. The possibility of measuring positron energies by registering synchrotron photons emitted by them was also investigated. The energy resolution was 35-45% depending on the positron energy and the minimum number of detected photons.

Primary authors: STUZHIN, Alexandr; MIKHAILOV, Vladimir (NRNU MEPhI)

Presenter: STUZHIN, Alexandr

Session Classification: Poster Session

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **78** Type: **Overview**

Cosmic rays, their role in atmospheric phenomena

Wednesday, 28 June 2023 10:00 (30 minutes)

Cosmic rays,their role in atmospheric phenomena.

Primary author: STOZHKOV, Yuri (Lebedev Physical Institute of RAS)

Presenter: STOZHKOV, Yuri (Lebedev Physical Institute of RAS)

Session Classification: Overview Talks

Track Classification: Cosmo- and geophysical aspects of cosmic rays at the ground level

Contribution ID: **79** Type: **Overview**

A new approach to determination of the cosmic ray composition

Wednesday, 28 June 2023 10:30 (30 minutes)

A new approach to determination of the cosmic ray composition

Primary author: Prof. SHAULOV, Sergey (FIAN)

Presenter: Prof. SHAULOV, Sergey (FIAN)

Session Classification: Overview Talks

Track Classification: Cosmic rays of very high energies (> 1 PeV)

Contribution ID: **80** Type: **Overview**

Cosmic ray sources in the Galaxy

Wednesday, 28 June 2023 11:00 (30 minutes)

Cosmic ray sources in the Galaxy

Primary author: BYKOV, Andrey (Ioffe Institute)

Presenter: BYKOV, Andrey (Ioffe Institute)

Session Classification: Overview Talks

Track Classification: Cosmic rays of very high energies (> 1 PeV)