135th session of the JINR Scientific Council

Director's Report: News, Science, Prospects

Academician Grigory V. Trubnikov

15–16 February 2024, Dubna

Information on the Resolution of the session of the JINR Committee of Plenipotentiaries

10 November 2023, Almaty, Kazakhstan

Chair of the Committee of Plenipotentiaries — representative of Georgia A. Khvedelidze

Session of the JINR Committee of Plenipotentiaries
10 November 2023

AGENDA

1. Results of the implementation of the Seven-Year Plan for the Development of JINR for 2017–2023. Seven-Year Plan for the Development of JINR for 2024–2030

Speaker — G. Trubnikov

2. Draft budget of JINR for the year 2024, provisional contributions of the Member States for the years 2025, 2026, 2027

Speaker — N. Kalinin

3. Results of the meeting of the JINR Finance Committee held on 9 November 2023

Speaker — A. Omelchuk

4. Recommendations of the 134th session of the JINR Scientific Council (September 2023)

Speaker — S. Nedelko

5. Changes in the membership of the JINR Scientific Council

Speaker — G. Trubnikov

6. Amendments to the Regulation on the procedure for awarding JINR annual prizes

Speaker — S. Nedelko

Having heard and discussed the report ***"Results of the implementation of the Seven-Year Plan for the Development of JINR for 2017–2023. Seven-Year Plan for the Development of JINR for 2024–2030",*** presented by G. Trubnikov, JINR Director, the Committee of Plenipotentiaries took note that, despite the difficult working conditions associated with COVID-19 restrictions and the sharp deterioration of the geopolitical situation, in 2017–2023 JINR achieved impressive results both in the development of the Institute's large research infrastructure and in scientific research based on this infrastructure.

It should also be noted that JINR has made a significant contribution to international cooperation, especially at CERN. The institute's human resources potential is steadily growing. JINR is successfully developing as an international intergovernmental scientific organization, establishing new integration ties with a wide range of countries in different regions of the world.

An undoubted achievement of recent years is the establishing and constant development of international experimental collaborations on the basis of the large research infrastructure of JINR. Overall, these achievements have created a very solid foundation for the further development of the Institute in the new seven-year period.

The CP reaffirms the importance of implementing international agreements between JINR and its partners around the world. The CP adheres to the position that for the benefit of humanity, fundamental science should not divide, but bring scientists together, regardless of their citizenship.

The Committee of Plenipotentiaries RESOLVED: to approve the presented Seven-Year Plan for the Development of JINR for 2024–2030, commended by the Scientific Council and the JINR Finance Committee.

The CP approved the Topical Plan for JINR Research and International Cooperation for 2024.

The CP approved the JINR budget for 2024, in accordance with the new expenditure structure, with the income amounting to US$ 214,124.5 thousand and the expenditure amounting to US$ 253,672.8 thousand with the closing negative balance amounting to US$ 39,548.3 thousand.

The CP approved the budget for the year 2024 on the construction and exploitation of the NICA complex of superconducting rings for heavy-ion colliding beams with the special-purpose funds of the Russian Federation, provided in accordance with the Agreement between the Government of the Russian Federation and JINR, in the amount of 1,993,342.0 thousand rubles.

Joint Institute for
Nuclear Research

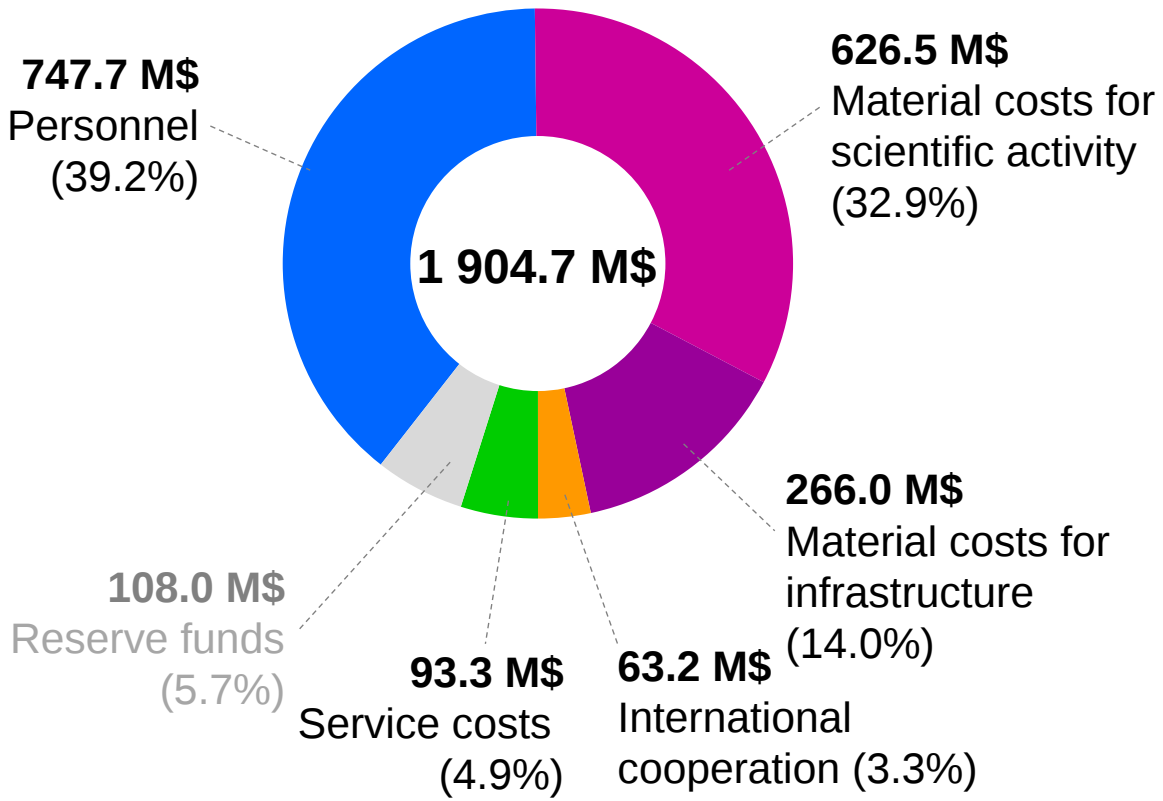
SEVEN-YEAR PLAN FOR THE DEVELOPMENT OF JINR FOR 2024–2030

JOINT INSTITUTE FOR
NUCLEAR RESEARCH

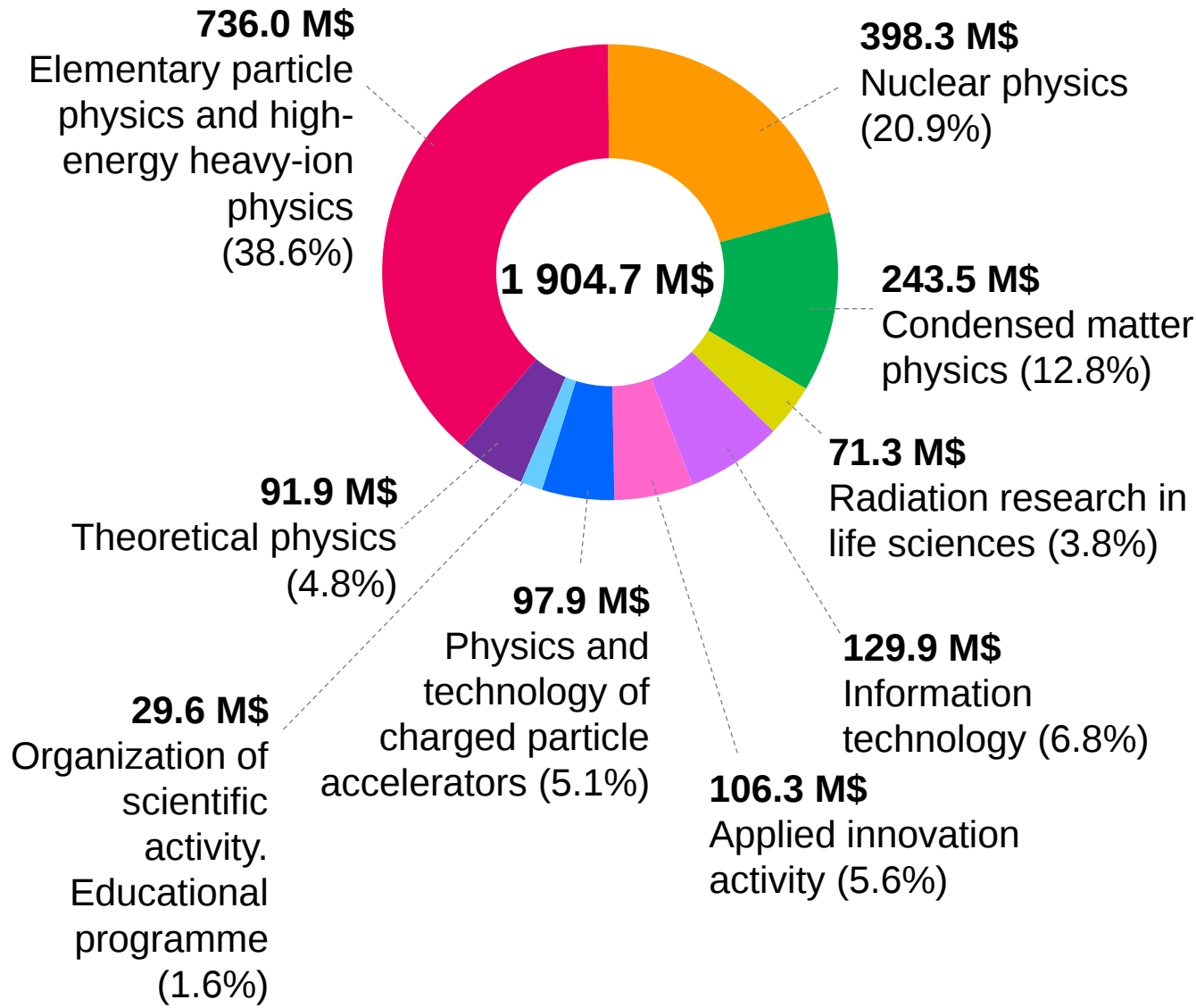
TOPICAL PLAN FOR JINR RESEARCH AND INTERNATIONAL COOPERATION

2024

Expenses of the Seven-Year Plan for 2024-2030 by types of expenses



Expenses of the Seven-Year Plan for 2024-2030 by fields of research (including overheads)



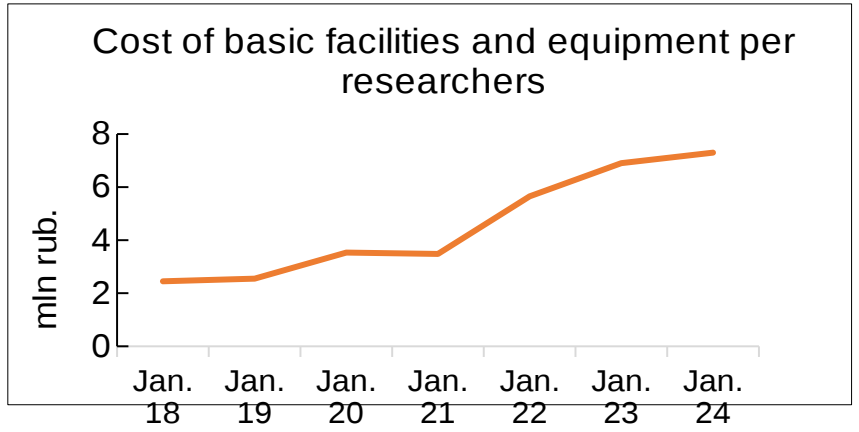
Meetings of the JINR Programme Advisory Committees

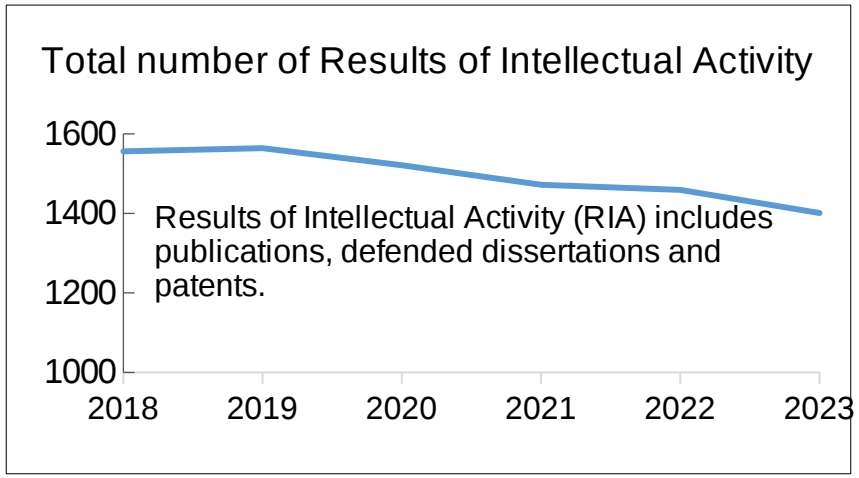
22 January, Dubna.
59th meeting of the PAC for Particle Physics
One of the central topics is the project of the NICA accelerator complex. The PAC Members reviewed reports on the progress of ongoing projects, proposals to open new and extend completed projects, and heard reports on the scientific results of external projects involving JINR. A session of poster presentations by young scientists was held.

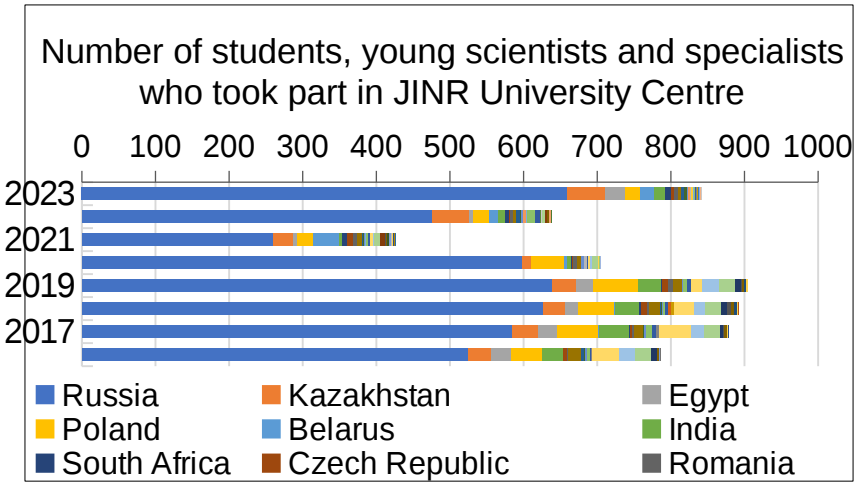
25 January, Dubna.
58th meeting of the PAC for Condensed Matter Physics
Approaches to the evaluation of JINR projects were discussed. Information was heard on the current status and plans for the resumption of operation of the IBR-2 reactor, plans for the construction of the future JINR Neptune reactor, scientific reports. A virtual poster session of young scientists was held.

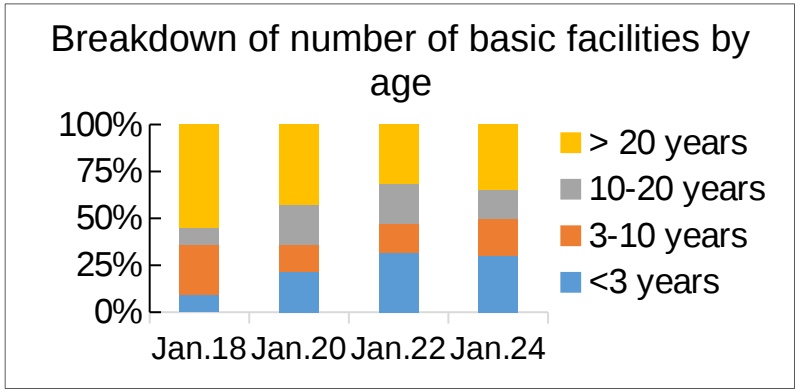
29–30 January, Dubna.
58th meeting of the PAC for Nuclear Physics
The PAC Members heard reports on the work plans of FLNP, FLNR and DLNP JINR in 2024 and scientific reports. There were reports by young scientists of FLNP. The PAC Members visited the Superheavy Elements Factory.

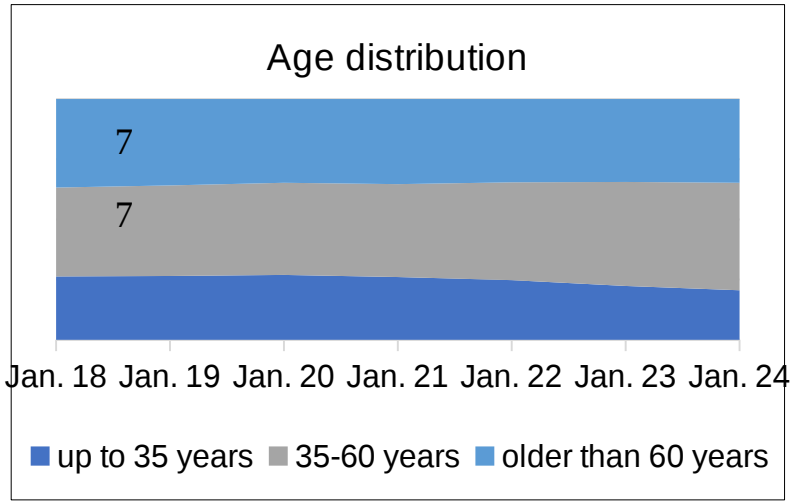
MONITORING PERFORMANCE INDICATORS

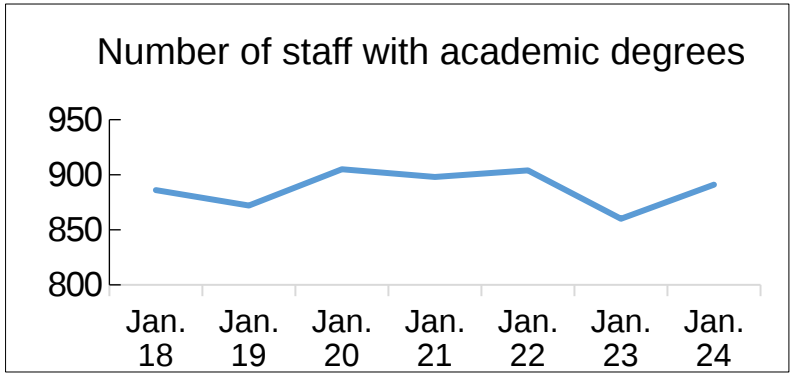


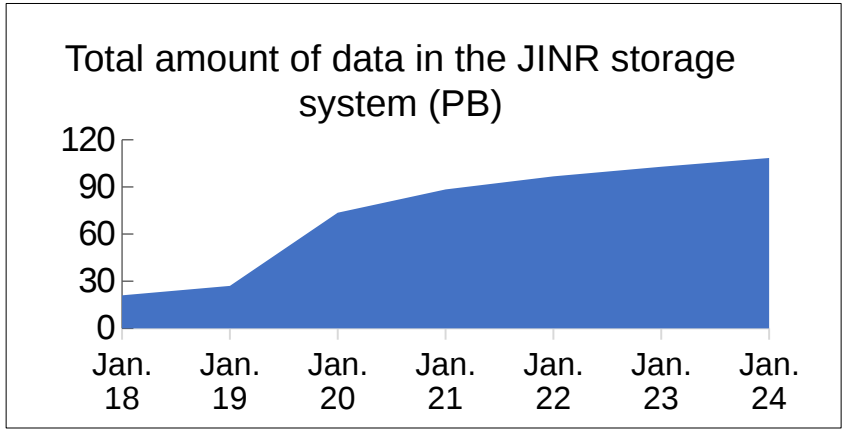


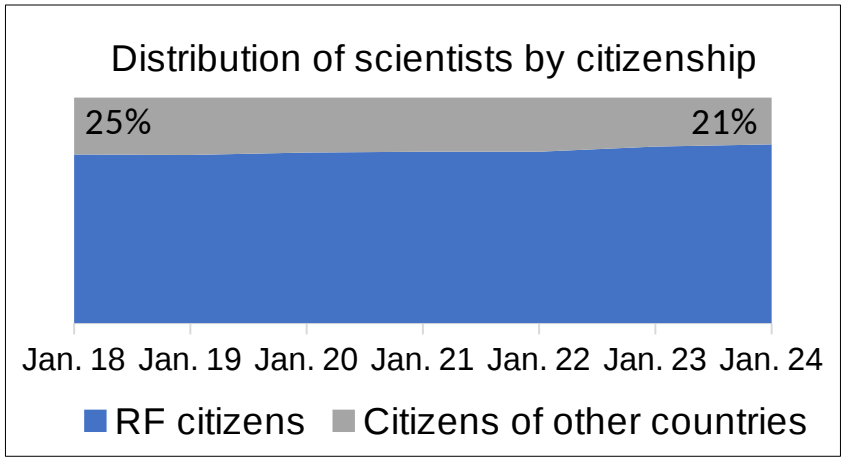


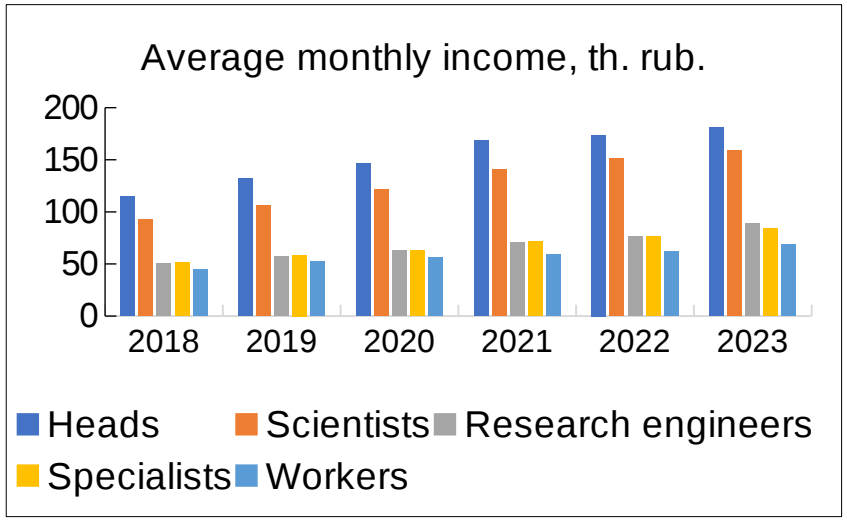












Implementation of the NICA Project

- The production and cryogenic testing of the regular elements of the collider's magnetic system are completed.
- All arc dipole magnets of the collider are installed and adjusted inside the tunnel, the production and testing of other elements of the cryomagnetic system are in the final stage.
- The magnetic cryostat and vacuum systems of the collider are being installed and tested. Elements of **RF-1** and **RF-2** systems are installed into the operation position, the annealing process and vacuum tests were conducted.
- The power supply system of the collider's structural elements is ready for commissioning.
- Preparations for the launch of a new cryogenic compressor station and a complex of cryogenic setups in building 1B are being completed.
- An educational programme is being implemented to train operators involved in the commissioning and operation of the NICA complex.

Civil construction: **99-100% is done**
Electric lighting, low current systems: **70-88%**
Heat supply, fire-fighting ventilation: **62-70%**
Refrigeration system, water cooling: **49%**
Internal 400V power supply system: **21%**

Nuclotron-Collider transfer line production started at JINR in summer 2023 and will be finished by the middle of 2024

Plans for the collider commissioning

January−May of 2024:
preparations of KRION and HILAC
for beam accumulation in Booster
Autumn 2024:
Beam run – accumulation in Booster, test of ISCRA&SIMBO
Collider technological run
Main limitations –
Completion of engineering infrastructure bld. 17
Commissioning of compressor station

2024–2025: first beam run
– Fast extraction from the Nuclotron
– Assembly of the Nuclotron-Collider beam line
– Injection into Collider
– RF & synchronization system

GPP1 Station (40.8 MW) was modernized and automated, now in operation

New compressor station will be commissioned in summer 2024

Two RF-stations are installed in the tunnel

Construction of the NICA innovation centre will start in June 2024, roadway is ready

Applied Research Infrastructure (collaboration work in ARIADNA)

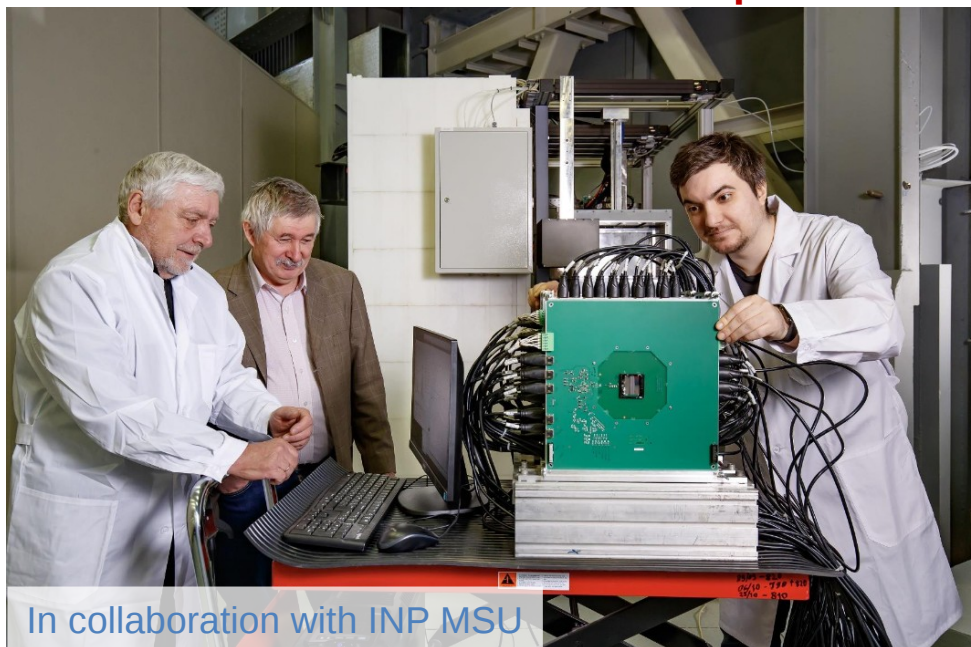
SIMBO (**S**tation for **I**nvestigation of **M**edical **B**iological **O**bjects

In collaboration with Belgorod

ISCRA (**I**rradiation **S**tation of **C**omponents of **R**adioelectronic **A**pparatus

In collaboration with ITEP and MEPhI

Particle strip detector



In collaboration with INP MSU

SOCHI station for applied research was tested with Ar beam, two other stations – **SIMBA** and **ISKRA** – are installed

ARIADNA-LS: Compelling evidence was obtained for the predominant activation of the error-free repair pathway of DNA double strand breaks (DSBs) − homologous recombination − after low-dose exposure. Scientists discovered the presence of threshold levels of radiation doses to human fibroblast cells.

Status of the MPD Project Implementation

12 Counties, > 500 participants, 38 Institutes and JINR

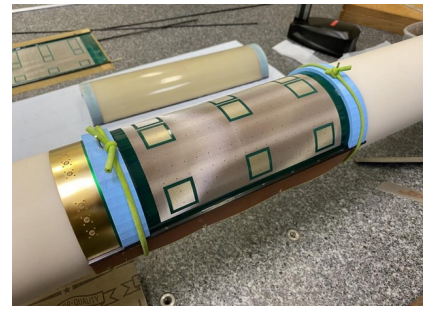
The production of all components of the MPD first-stage detector is progressing with minimal delays.

- **TPC, TOF** and **ECal** (40 out of 50 half-sectors) to be installed in 2024.
- Cooling and current supply of the **solenoid** is still critical (so far − 50°C is achieved). Further progress will rely on readiness of engineering systems in the MPD building by May 2024.
- **Magnetic field** measurements will start in June 2024 and take three months for different field configurations using the mapper produced by Novosibirsk INP.
- Installation of the **carbon fiber support frame** and detector subsystems will follow starting from September.

SPD Project

SPD collaboration:

35 institutes (+2 new), 13 MoU signed (+3 new)



First prototype of cylindrical Micromegas detector for the SPD Central Tracker

SPD Technical Design Report

- Updated SPD TDR was presented at PAC meeting in Jan, 2024
- New International Detector Advisory Committee (DAC) was called in Dec, 2023
- New DAC started to interact with the Collaboration to review the updated TDR and present a report at the next PAC session.

Work continues on building and testing detector prototypes and equipping the SPD test zone at the Nuclotron.

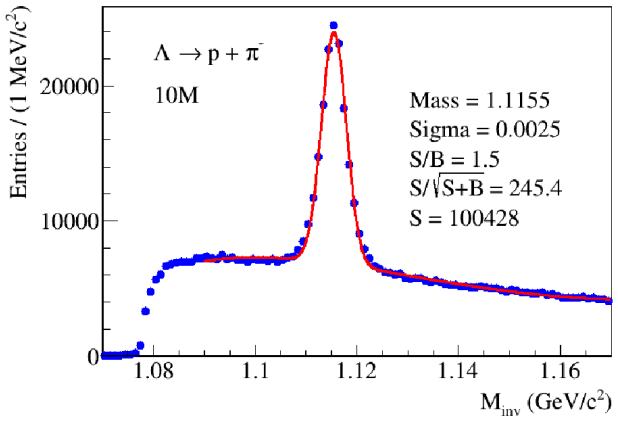
First Results of the BM@N Experiment with Xe Beam

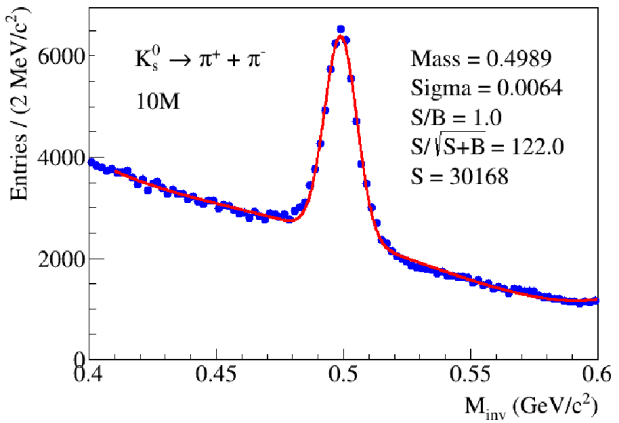
BM@N today: 5 countries, 13 Institutions, 210 participants

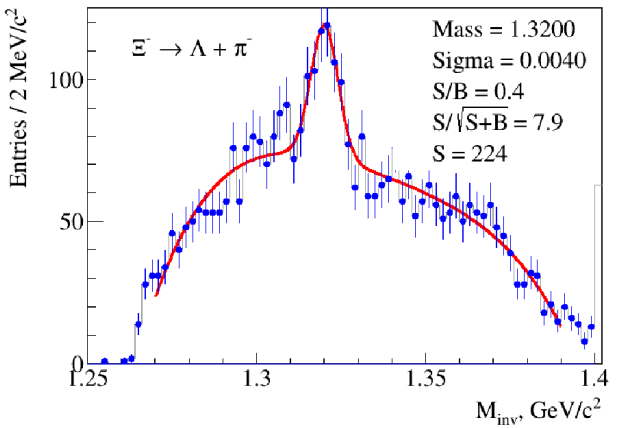
2023:

- ❑ Alignment of detectors;
- ❑ Improvement of the tracking algorithm;
- ❑ TOF calibration & pile-up correction;
- ❑ Processing of reconstructed data using DIRAC system at the MLIT Tier-1/Tier-2 computers.

Statistically significant signals of Λ- and Ξ-hyperons and K^0_s-meson were reconstructed for further physics analysis:







Finally expecting:

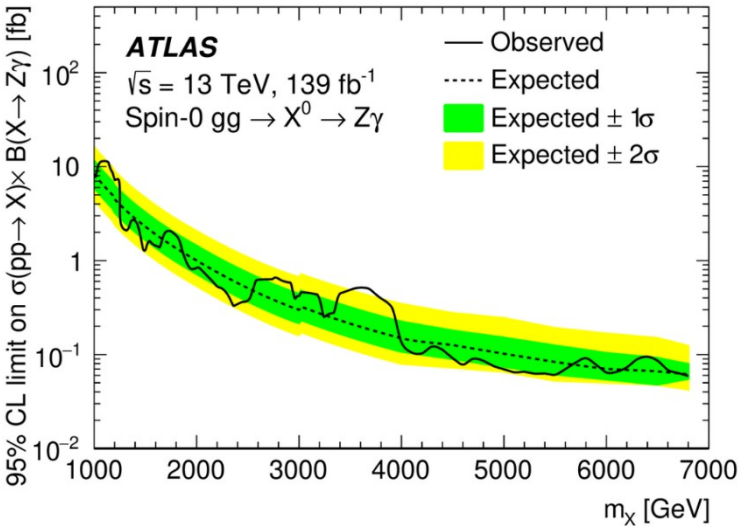
4M Λ, 1.2M K^0_s and 8K Ξ^-

First physics paper on π^+ and K^+ mesons production in Ar-nucleus interactions was published in **JHEP 07 (2023) 174**

JINR Participation in the Experiments at CERN (1)

ATLAS

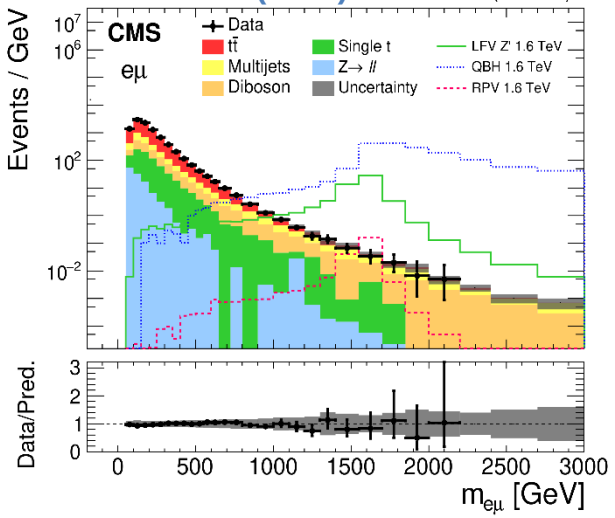
JHEP 07 (2023) 125



Upper limits are set on σ×Br(X→ Vγ) for production of heavy BSM neutral and charged bosons having spin = 0, 1 and 2 and decaying in Zγ and Wγ

CMS

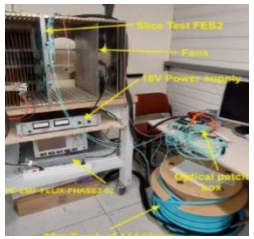
JHEP 05 (2023) 227 138 fb^{-1} (13 TeV)

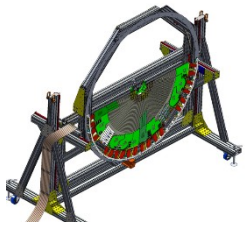


Upper limits are set at 95% CL on the product of the cross section and branching fraction for lepton flavor violating signals.

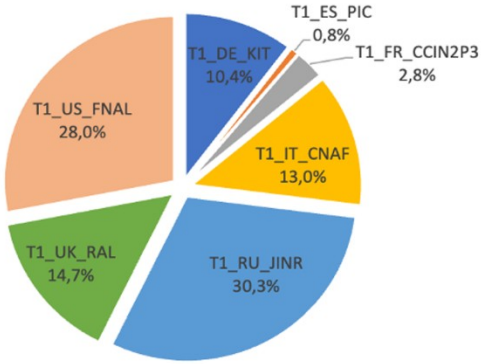
Phase-2 upgrade for HL-LHC:

- LAr Calorimeters – optical readout components – delivered
- High Granularity Timing Detector – mechanics for half-disk
- Muon Spectrometer – RPC chambers – prototypes production





Total number of processed event in 2023



The JINR Tier-1 is ranked the first place among all CMS Tier-1 centres.

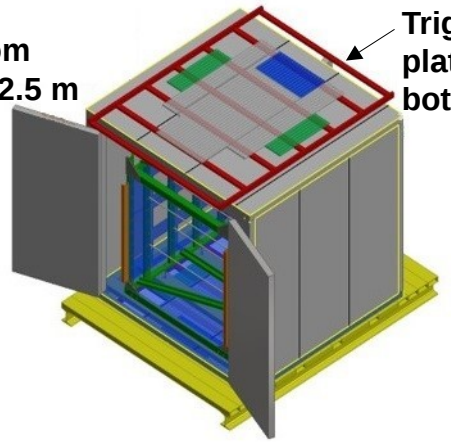
Phase-2 upgrade for HL-LHC:

- High Granularity Calorimeter:
  - 2 Cold rooms delivered to CERN in 2023
- Endcap Muon System:
  - CSC longevity tests
  - ME1/1 CSC upgrade

Cold room with cassettes rack inside.

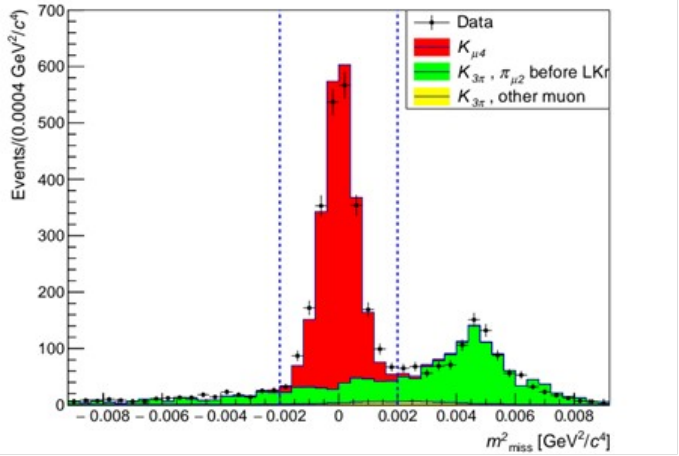
Cold room 3.1×2.9×2.5 m

Trigger scintillator plates top and bottom



JINR Participation in the Experiments at CERN (2)

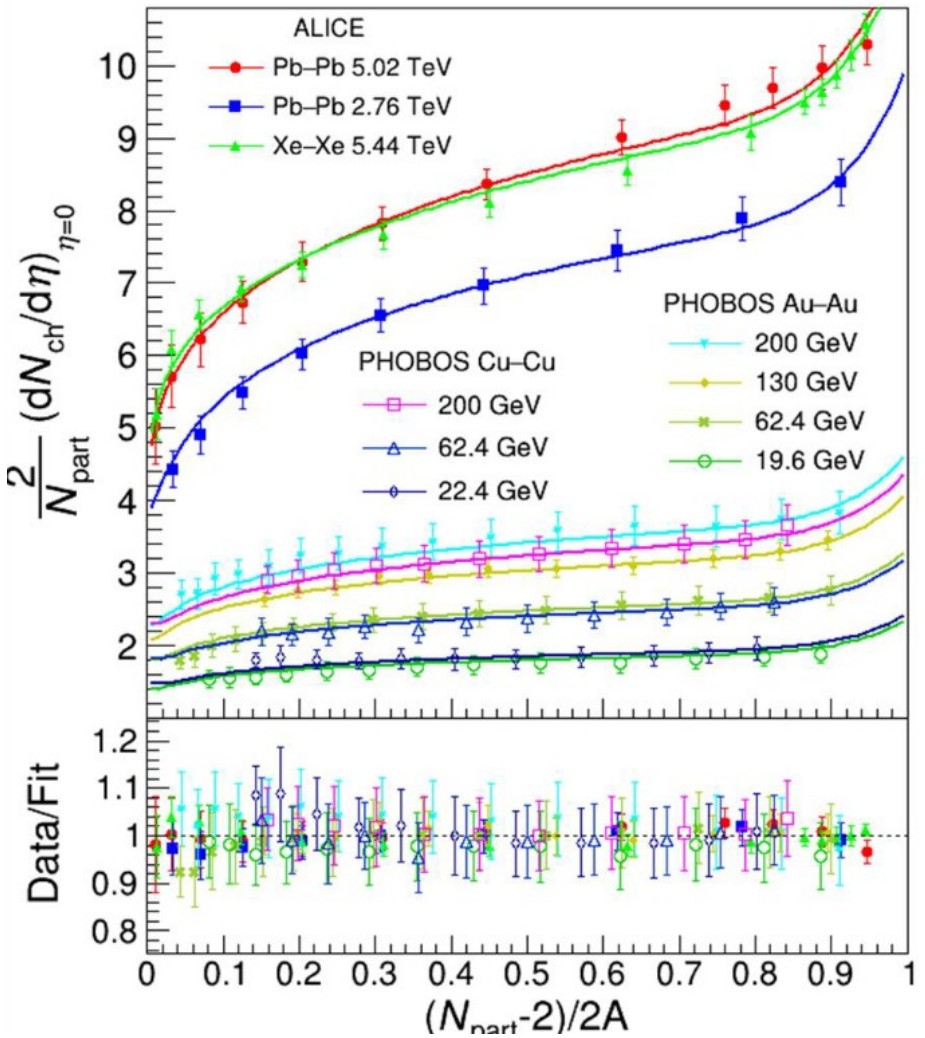
NA62



Distribution of squared missing mass

Final results of the analysis of the rare K_{m4}^{00} decay, which has never been observed earlier. The full phase space result **BR(K_{m4}^{00})=(3.4±0.2)·10^{-6}**, depending on the decay model extrapolation, is in a reasonable agreement with the R form factor prediction from 1-loop Chiral Perturbation Theory.

ALICE



Thermal model of particle production in pp and A-A collisions has been proposed.
Model consists of 3 components:

- Boltzmann-Gibbs thermal distribution
  → flow effect
- Tsallis distribution
  → resonance decays
- Power-law form
  → QCD hard processes

N_{part} – number of the participant nucleons, A – atomic number.

Calculations are in a very good agreement with experimental (ALICE and lower energy) data.

PHOS upgrade:
PWO_4 monocrystal and 3-SiPM prototype

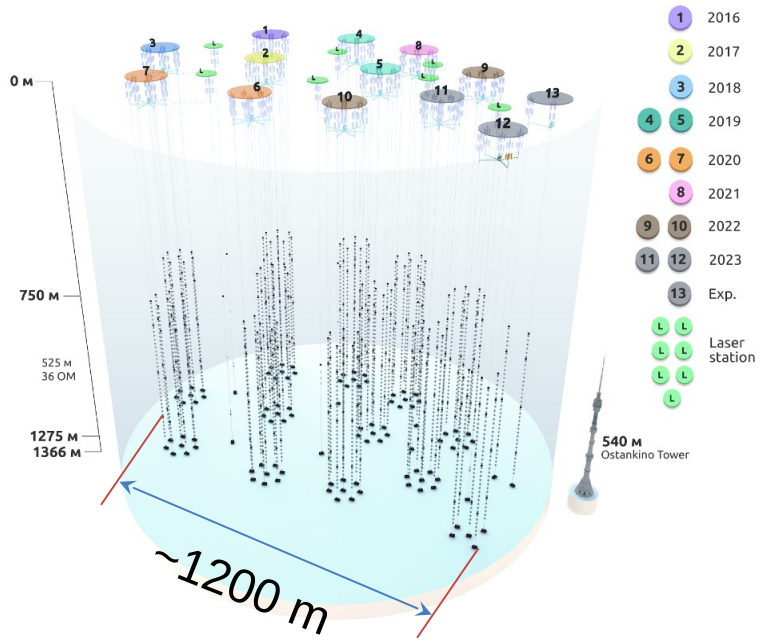
✓ Excellent time resolution of 100 ps was achieved for 2 GeV energy release.
✓ Good energy resolution, up to 2%.

Baikal-GVD Status

JINR Large Research Infrastructure

Since April 2023:

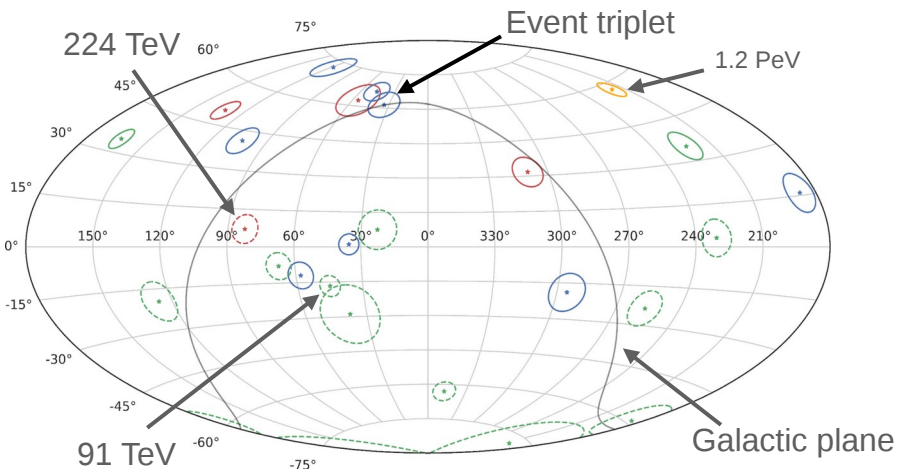
- 3456 Optical modules on 96 strings (12 clusters)
- 8 strings form a cluster – independent array of optical modules
- 36 optical modules per string
- 60 m between strings in a cluster, 250-300 m between clusters
- More than half of 1 km³ of water volume
- 384 Acoustic modules for positioning
- 72 LED beacons and 11 powerful laser sources for calibration
- About **10 astrophysical neutrinos per year**
- In 2023, 470 optical modules were manufactured for the 2024 expedition



Planned to be completed with about 6000 OM in 2027/2028

- Baikal-GVD is the second largest neutrino telescope and the first one in the Northern Hemisphere.
- Baikal-GVD has already an effective volume of above 0.5 km3 and grows every year.
- 27 neutrino candidates of astrophysical origin have been selected for period April 2018 – March 2022:
  - Significant excess of events over the expected atmospheric background is observed;
  - The null cosmic flux assumption is rejected with a significance of 3.05σ;
  - This excess is consistent with the high-energy diffuse cosmic neutrino flux observed by IceCube.
- Some events are correlated with Galactic plane.

High-Energy Cascade Sky Map



Most prominent cascade events

Best fit positions and 90% angular uncertainty regions in equatorial coordinates:

- dashed − upgoing events;
- solid − downgoing events.

Color represents energy:

$E_{rec} < 100$ TeV
100 TeV $< E_{rec} <$ 200 TeV
200 $< E_{reco} <$ 1000 TeV
$E_{rec} > 1$ PeV

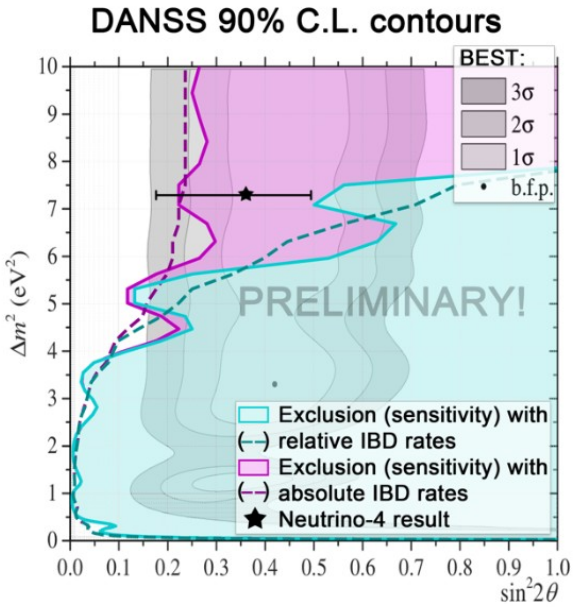
DANSS

Neutrino physics at reactors

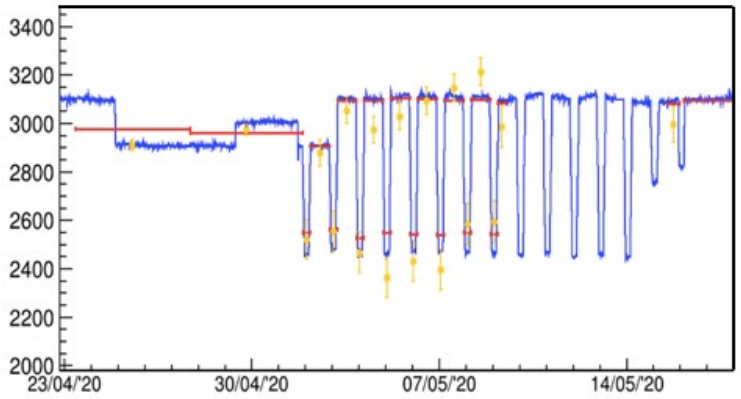
Main tasks: search for short-range active-sterile neutrino oscillations and remote monitoring of nuclear reactor core.

Status:

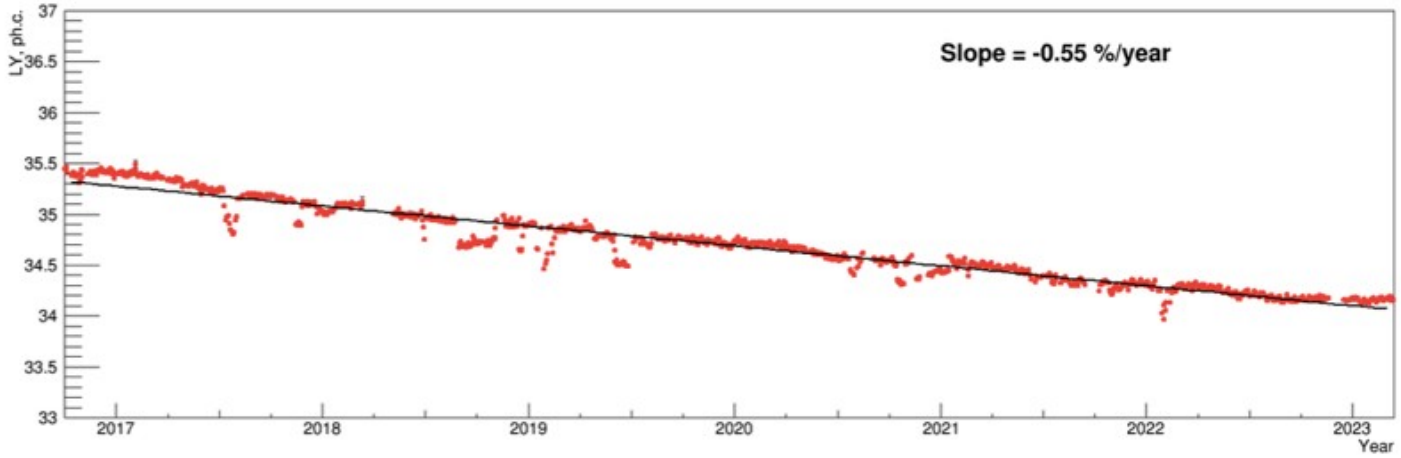
- DANSS recorded the first data in April 2016 and is still running. More than 7.7M IBD events collected.
- DANSS records more than 5k antineutrino events per day in the closest position to reactor core (distance from 10.9 to 12.9 m) . Signal to background ratio is > 50.
- We measure reactor power with 1.5% precision in two days during 7 years of operation.
- The model-independent analysis provides strong exclusion of the parameters from RAA+GA best fit.
- Resent analysis with additional information on the expected absolute reactor antineutrino count rates excludes a large part of the short based active-sterile oscillations parameter space. New analysis does not confirm NEUTRINO-4 and BEST claims. However, these estimates are model dependent.
- DANSS upgrade is planned in 2024-2025. Detector will have improved energy resolution () and 1.7 times larger fiducial volume which provides a sensitivity to scrutinize Neutrino-4 and BEST results.



Fast power monitoring



Scintillator aging



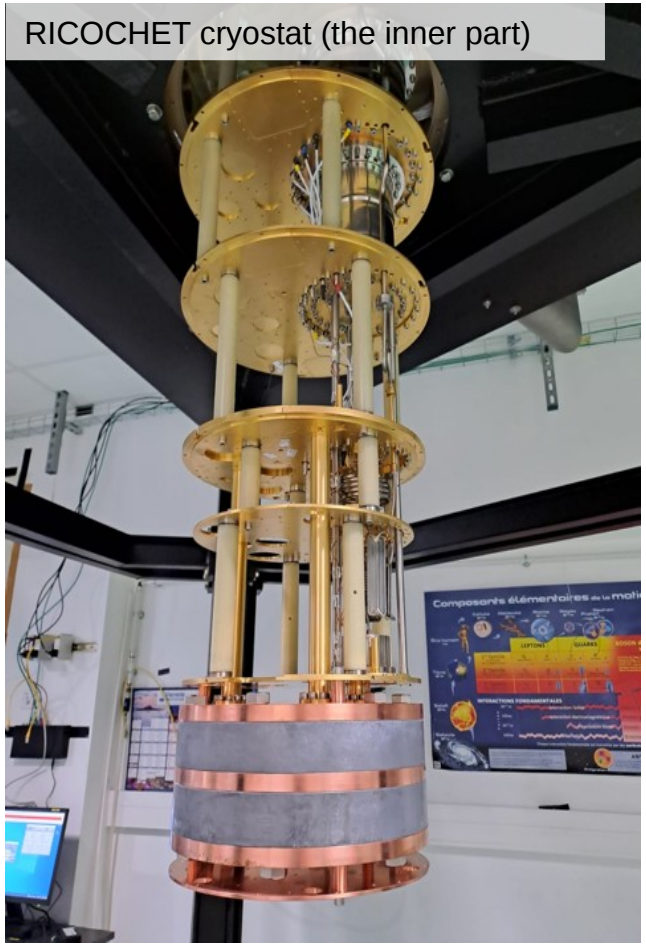
RICOCHET Experiment: New Physics with Precision Measurements of CEvNS at Reactors

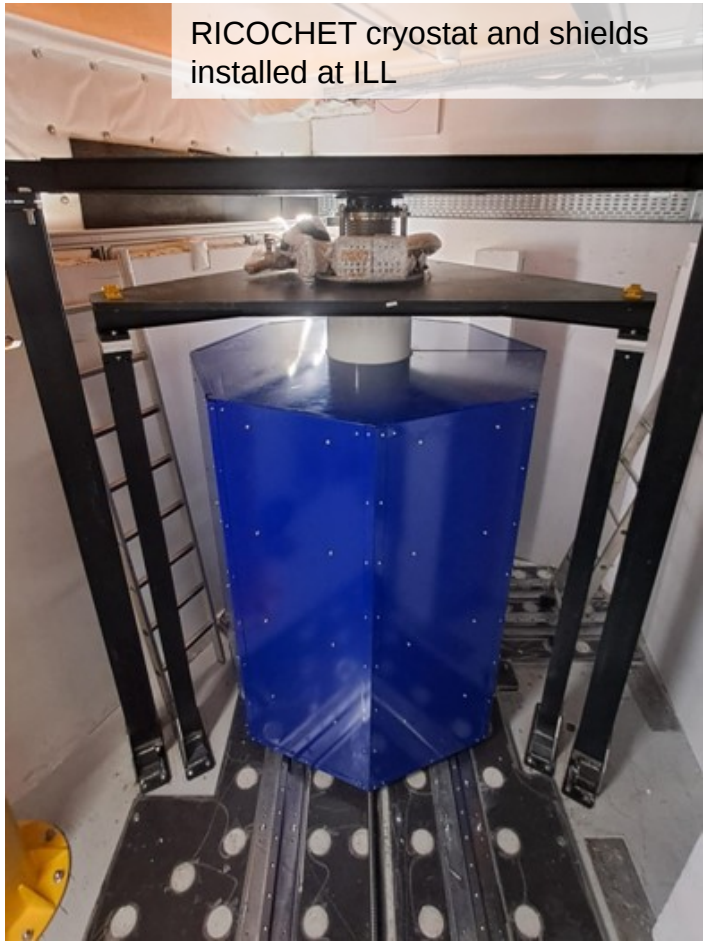
In frame of the “Investigations of reactor neutrinos on a short baseline” project, JINR participates in the international (France, USA, Canada, JINR) RICOCHET experiment which main goal is to search physics beyond the Standard Model with precise measurements of coherent scattering of reactor neutrinos (CEvNS).

Antineutrino source: ILL (Grenoble) 58 MW research reactor. Distance reactor core – detectors: 8 m.

Target: Ge detectors-bolometers with simultaneous measurement of phonon and ionization signals at ultra low energy range (from ~10 eV). Zn superconductive detectors will be added in the next phase.

Main JINR contributions: low background, low noise 3He-4He dilution cryosystem (together with IP2I, Lyon), muon veto system (together with LPSC and ILL, Grenoble), background measurements, supplementary detectors.


RICOCHET cryostat (the inner part)


RICOCHET cryostat and shields installed at ILL

- ILL background characterization done in 2021-2022: *Eur. Phys. J. C 83, 20 (2023);*
- Detectors with O(10) eV threshold: *arXiv:2306.00166 (2023) and PRL 125, 141301 (2020);*
- In December 2023 the setup was installed at ILL. First data taking is expected in coming months;
- First run will be with 3 x 33 g detectors. More detectors are in production and tests;
- About 10 significance for CEvNS is expected with 1 kg detectors already after one reactor cycle (50 days ON and OFF);
- Few percent precision needed for search of New Physics is expected to be achieved after ~2 years of data taking.

JUNO: Reactor Antineutrino Oscillations

Neutrino physics at reactors

20 kt liquid scintillator detector, 26.6 GWth reactors, 52.5 km baseline: 47 $\bar{\nu}_e$/day.
Neutrino Mass Ordering: 3σ in 6 years. Data taking: late 2024.

The JINR group significantly contributes to the detector construction and analyses preparation. Apart from already finished work on PMT tests, EMF shielding, HV design&production, etc., JINR has recently contributed to:

Satellite detector TAO

- SiPM mass-testing finished. Hamamatsu will replace unqualified arrays.
- SiPM power modules are ready.
- Cables, feedthroughs will be ready soon.
- Detector assembly: start in April at the Taishan NPP.

Developed at JINR!

Muon veto: Top Tracker

- Support structure being produced in China.
- Data acquisition software tested at IPHC (Strasbourg).
- Assembly and installation: August 2024.
- Paper: Nucl.Instrum.Meth.A 1057 (2023)

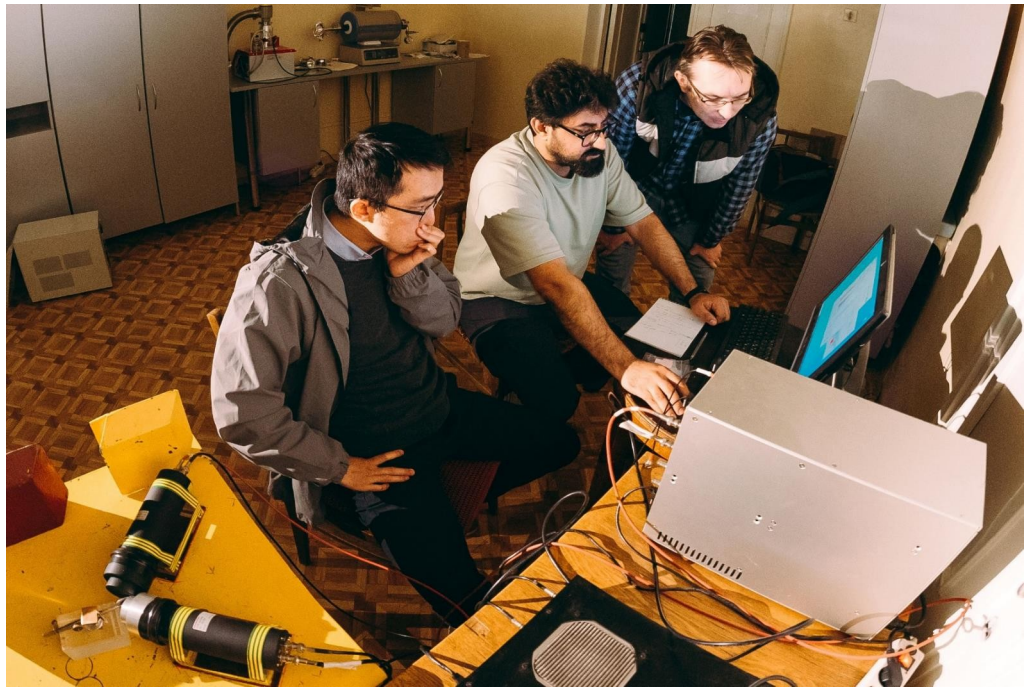
Developed at JINR!

JINR contribution to the analysis

- New comprehensive JUNO sensitivity study. JINR is one of 3 groups.
- Paper passed the collaboration review.

JINR scientists with TAO prototype

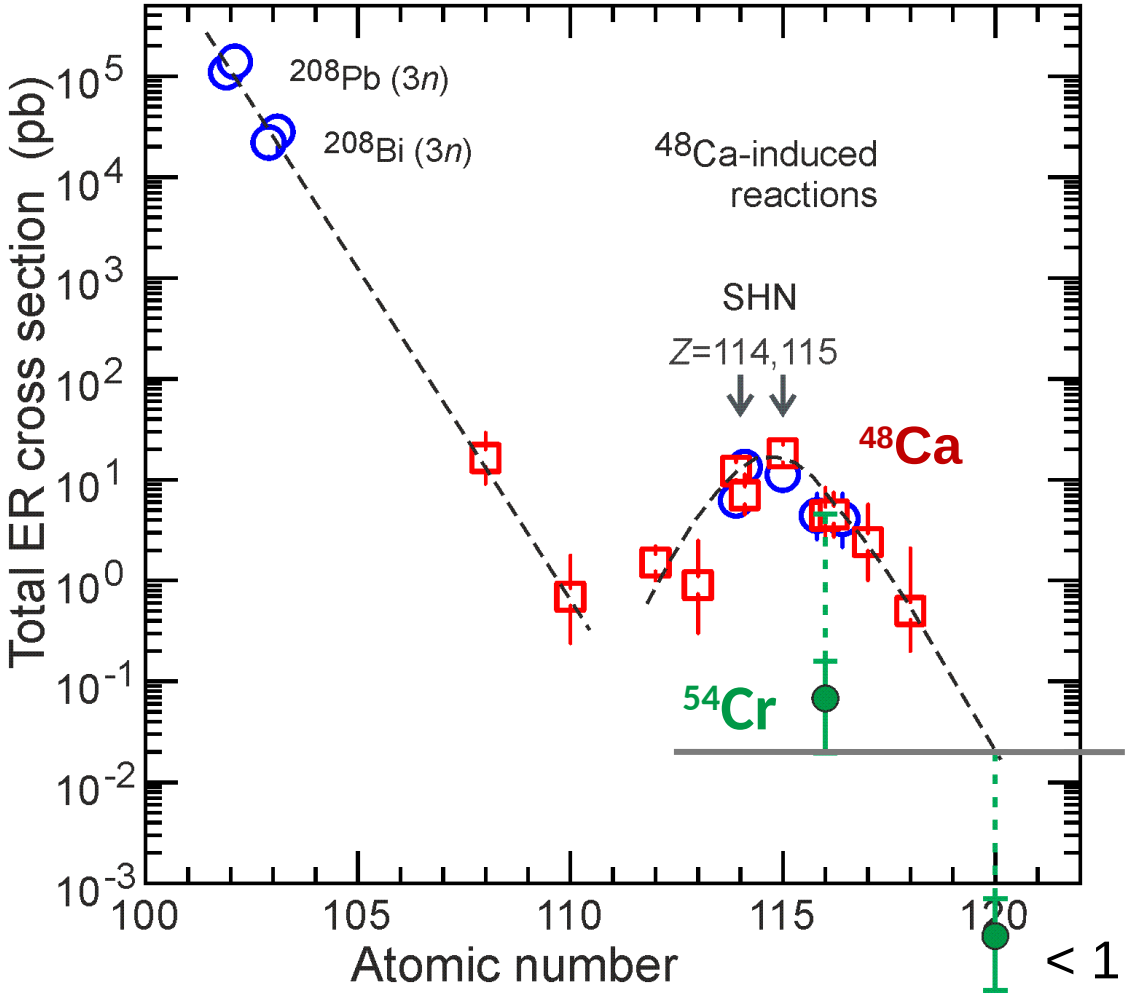
Positron Annihilation Spectroscopy



- Cooperation agreements have been signed with Vietnam and Azerbaijan, and the process of signing an agreement with Cuba has begun.
- More than 60 samples were studied by DUAL method on the beam, from Tomsk Polytechnic University, Northern (Arctic) Federal University, and from JINR Member States − Vietnam, Azerbaijan, and Cuba;

- More than 40 samples were studied using the method of Measuring the lifetime of positrons (PALS) at an autonomous source;
- Test runs of the Doppler broadening of the annihilation line method (DUAL) with two germanium detectors were performed;
- Source temperature measurement, control of longitudinal magnetic field power supplies, and switching pumps on/off were automated.

Experiments @ Superheavy Element Factory



Synthesis of element $_{116}$Lv in reaction ^{54}Cr+^{238}U

Purpose:

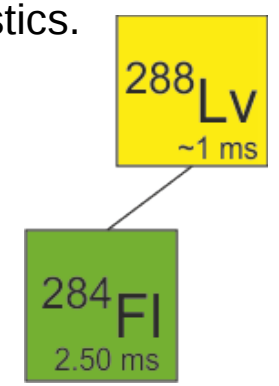
- Experience of long-term work with ^{54}Cr beam of high intensity;
- Measurement of cross sections in comparison with ^{48}Ca+^{248}Cm leading to the same superheavy element 116;
- Preparation to the synthesis of new element 120 in the ^{54}Cr+^{248}Cm reaction.

Status:

- 2 events of **new isotope** ^{288}Lv have been observed in the experiment;
- Experiment **is continued** in order to increase statistics.

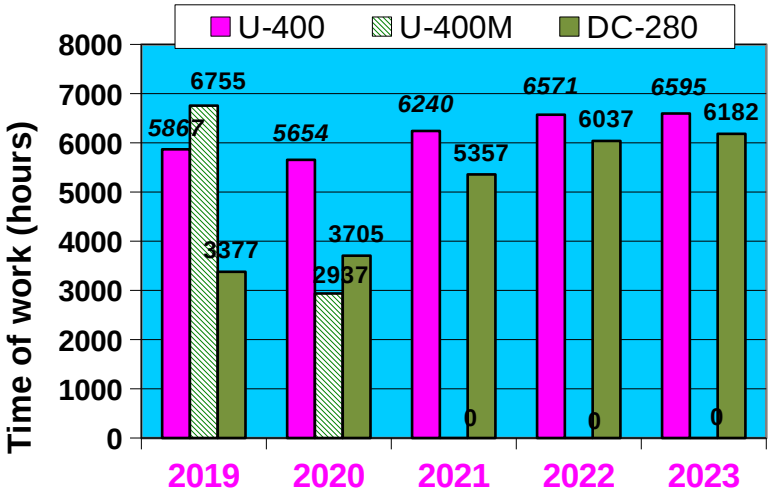
20 fb – 1 event/100 d
reachable @ SHE Factory

< 1 fb – estimate for 120 based at extrapolation of the ^{54}Cr+^{238}U experiment



FLNR Accelerator Complex
operation in 2023

FLNR accelerator complex operation (hours)	2018	2019	2020	2021	2022	**2023**
	16904	20110	15124	15065	16834	**16583**



Modernization of U-400M:
First beams – end of spring 2024

Expected beam energies and intensities after modernization

Ion	2019		Expected	
	E (MeV/u)	I(pμA)	E (MeV/u)	I(pμA)
^{7}Li	35	5	39	10
^{11}B	30	3	33	6
^{15}N	47	0.5	51	2
^{18}O	36	0.5	40	1.5
^{22}Ne	45	0.3	50	1
^{36}S	40	0.12	44	0.2
^{48}Ca	34	-	38	0.1
$^{56}Fe^{15+}$	36	0.01	40	0.1

New Experimental Hall for U-400R

JSC “Electrocentromontazh”

First pile 27.07.23

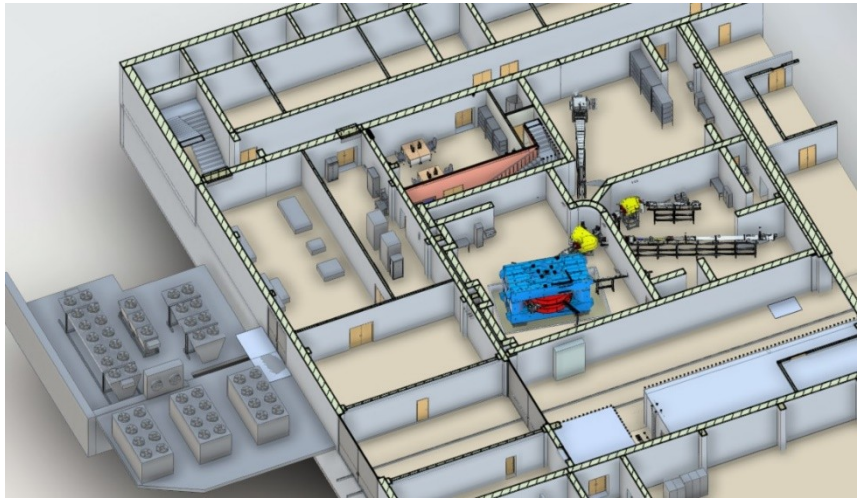
Piles:
763 pcs Ø 0.6 × 18 m
Concrete volume:
~4000 m³
Metal reinforcement:
~740 t.

Completion of the pile field 08.12.23

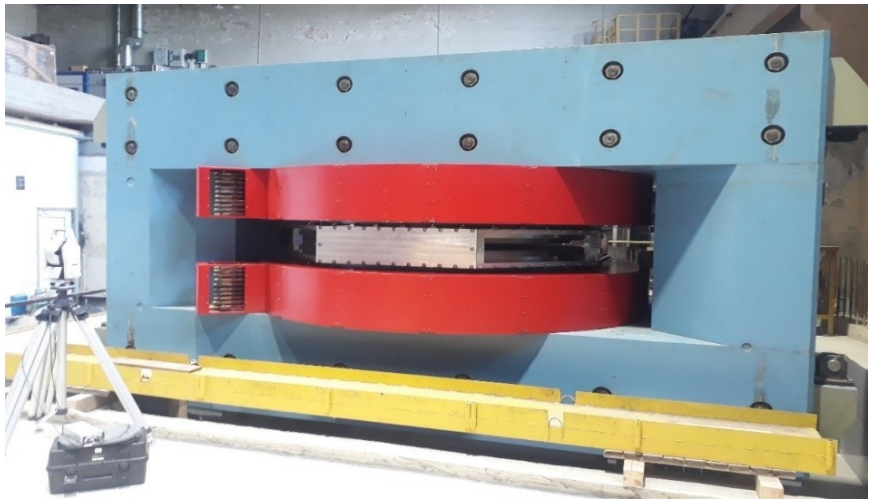
Foundation:
Concrete volume:
~2771 m³
Metal reinforcement:
~402 t.

Start of grillage pouring 21.12.23

Cyclotron DC-140: Commissioning – end of 2024



General layout of the DC-140 facility



Main magnet mounting

Engineering systems hall

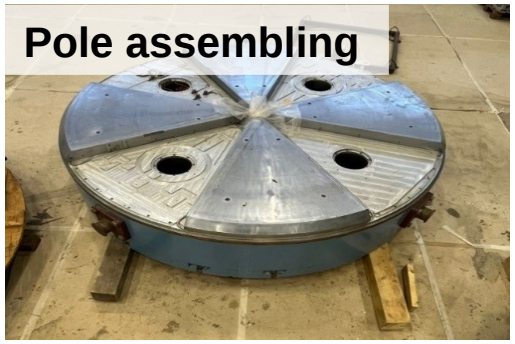
Ion source test

Vacuum chamber test

Cyclotron DC-140 elements

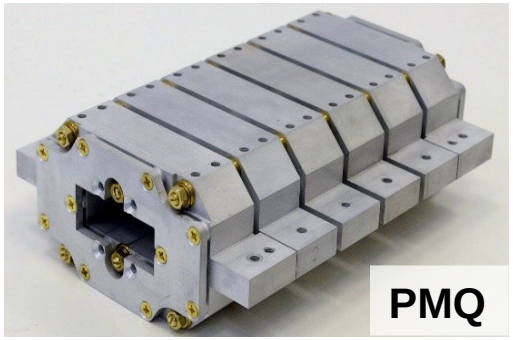
90% of the equipment
has been manufactured and
delivered at FLNR

Inflector



Pole assembling

Deflector



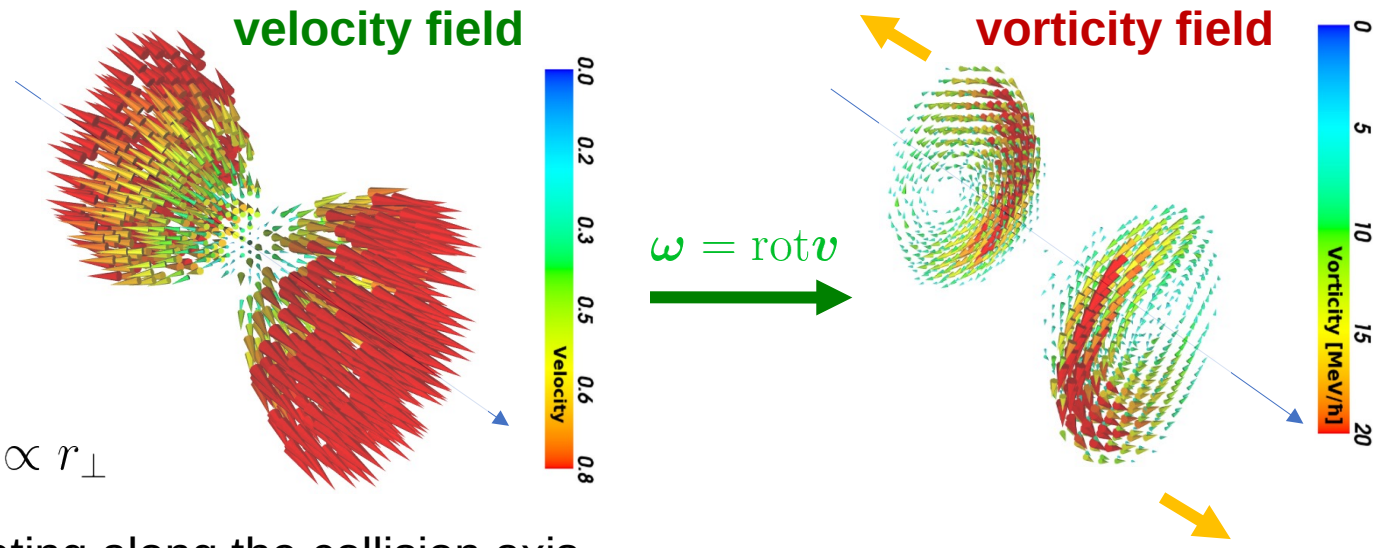
PMQ

BLTP

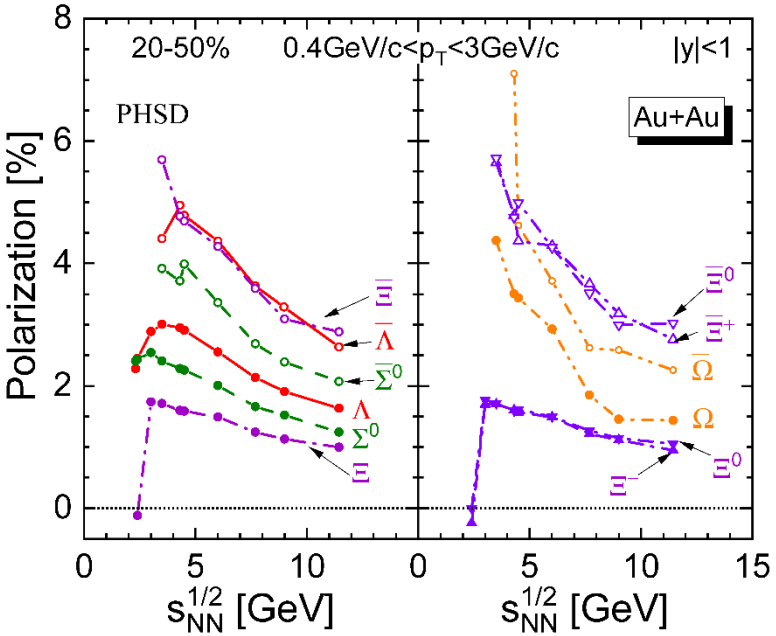
Hyperon Polarization and Vorticity in Heavy-ion Collisions

***Tsegelnik, et al.* // PRC 107 (2023) 034906.**

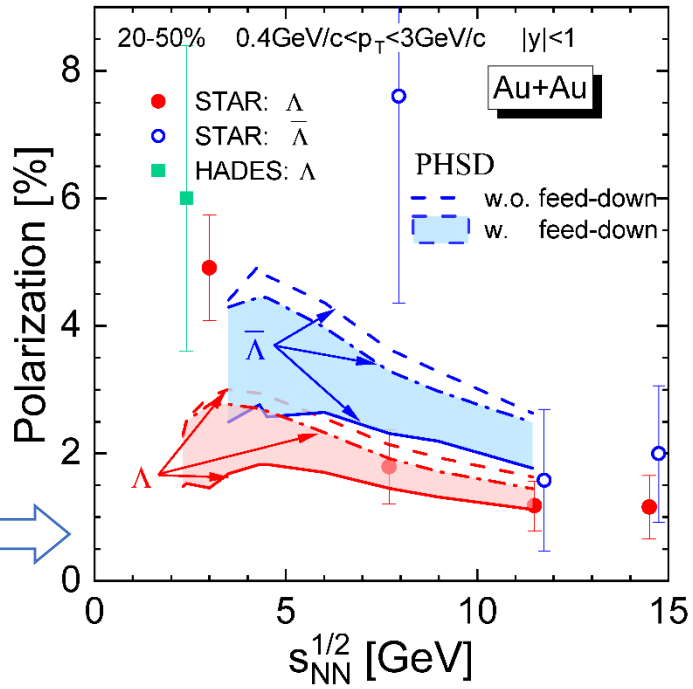
- Transport code PHSD is used to simulate particles productions and interactions in HIC
- Collective motion of particles as a *fluid* is determined
- Velocity distribution is mainly a *longitudinal and transversal Hubble* expansion $v_{\parallel} \propto z,\ v_{\perp} \propto r_{\perp}$



- Vorticity is localized in *two vortex rings* propagating along the collision axis



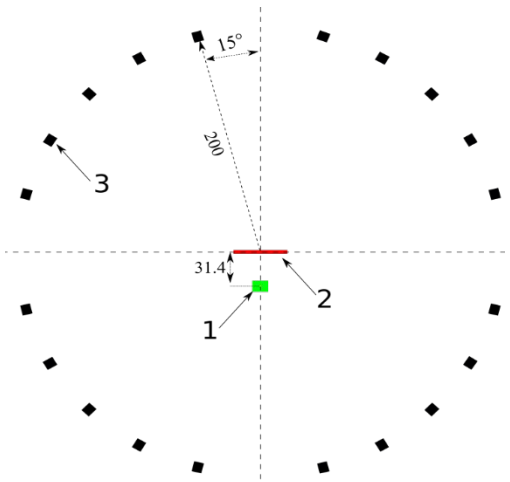
- Statistical model: fermion polarization $P \propto \frac{\hbar\omega}{T}$
  - ✓ Polarization of anti-hyperons is higher then for hyperons
  - ✓ Polarization is higher for smaller collision energies
- Feed down from hyperon decays ($\Sigma^0 \to \Lambda\gamma$, $\Xi \to \Lambda +)\pi$ reduces the observed signal
  - ✓ Experimental Λ polarization in HICs at 7.7 and 11.5 GeV are reproduced



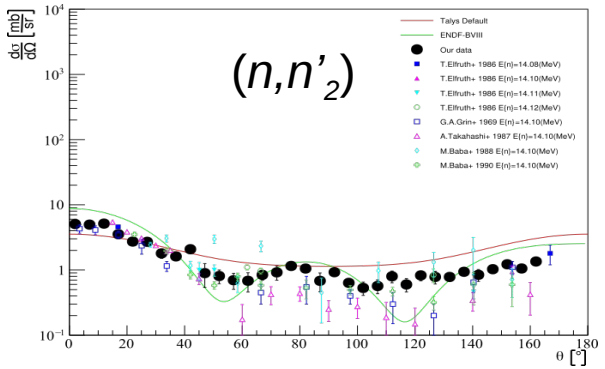
- Polarization measurements are planned in MPD and BM@N experiments at NICA

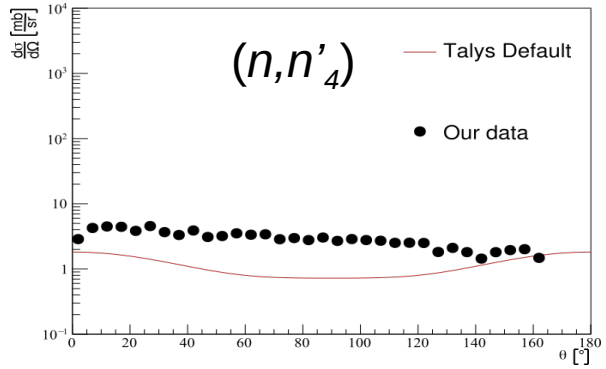
Scientific Highlights

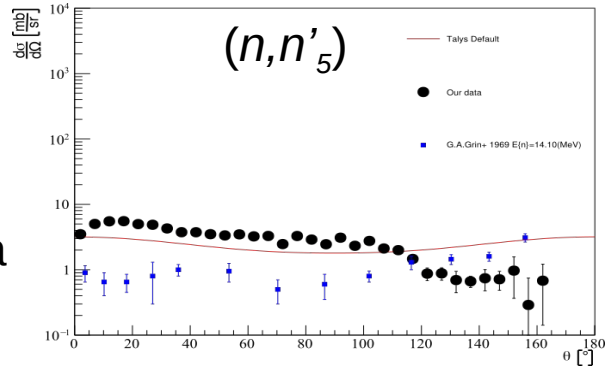
Study of reaction (*n,n'*), (*n,2n*), (*n,p*) и (*n,α*) at E_n=14 MeV using the tagged neutron method



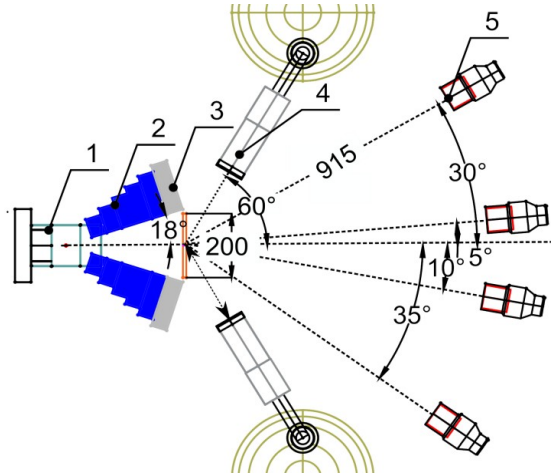
Experimental setup for measuring angular distributions of scattered neutrons. Consists of 20 plastic neutron detectors.







Data for neutron scattering on the 4th excitation level were obtained for the first time. Data for the Hoyle's state (level 2) and level 5 are updated.



Experimental setup for measuring γ-ray emission cross sections. Consists of 2 HPGe and 4 LaBr detectors. Experimental geometry was optimized using Geant4.

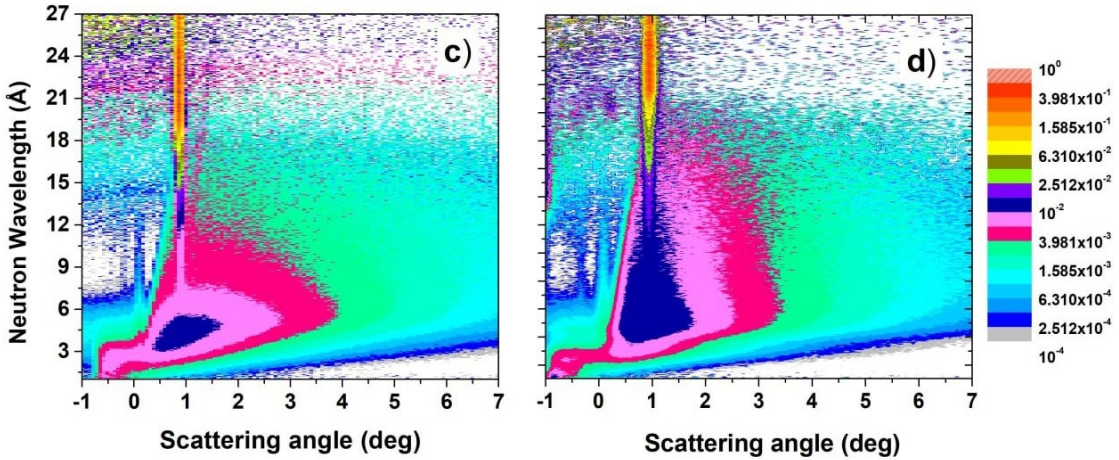
γ-transition	Our result, mb	Recommended value [INDC], mb	Range [INDC], mb
1779.0 keV ^{28}Si(n,n'),^{29}Si(n,2n')	350±20	403±20	293±28… 488±70
6129.9 keV ^{16}O(n,n	113±10	148±10	84±17… 179±22
4438.9 keV ^{12}C(n,n')	175±6	187±5	121±8… 440±80

Gamma-ray emission cross sections were measured for a number of elements. The results are consistent with the literature data.

Kopach Yu. N., Sapozhnikov M. G. // PEPAN 55, 1, (2024).

Scientific Highlights

Study the properties of advanced nanostructured reflectors for cold neutrons

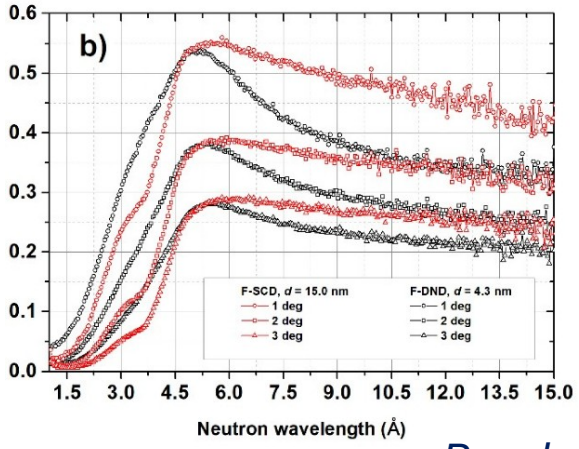


Probability of neutron scattering from the surface of a nanodiamond powder as a function of the neutron wavelength and the polar scattering angle. Nanodiamond sizes: (**c**) 4.3 nm; (**d**) 15 nm. The incidence angle of the neutron beam is 1°

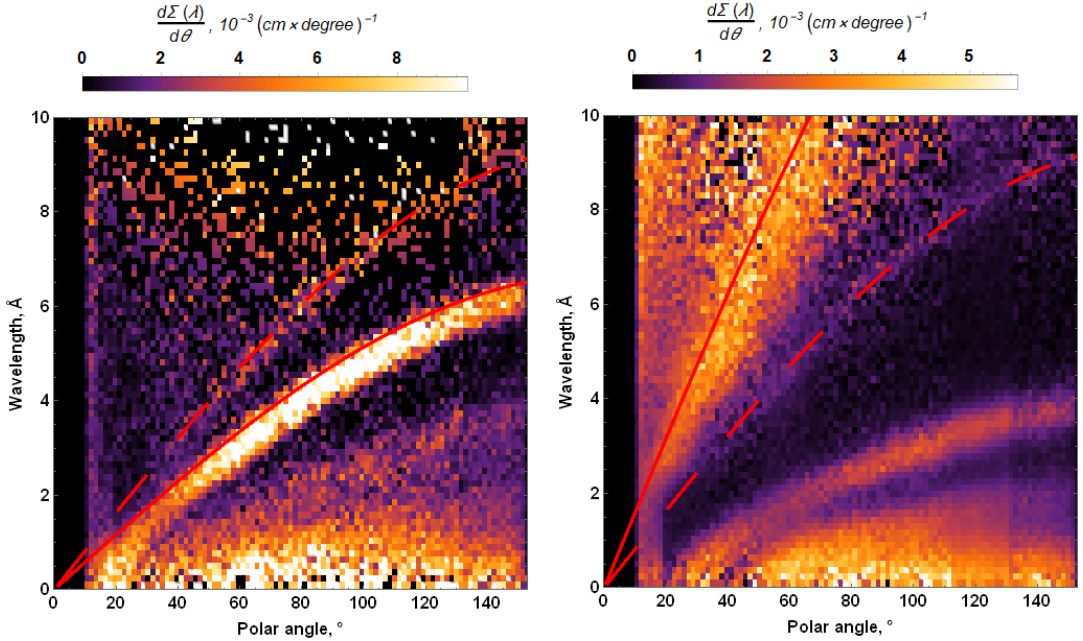
Neutron scattering probability as a function of neutron wavelength within the solid angle of the D17 detector at the ILL.

Black dots are nanodiamonds of 4.3 nm. Red dots – 15 nm.

Incident angles of 1°, 2° and 3°.



F-KS44 is intercalated graphite with a crystal lattice in which whole carbon planes alternate with whole fluorine planes.



Ordinary graphite **Intercalated graphite F-KS44**

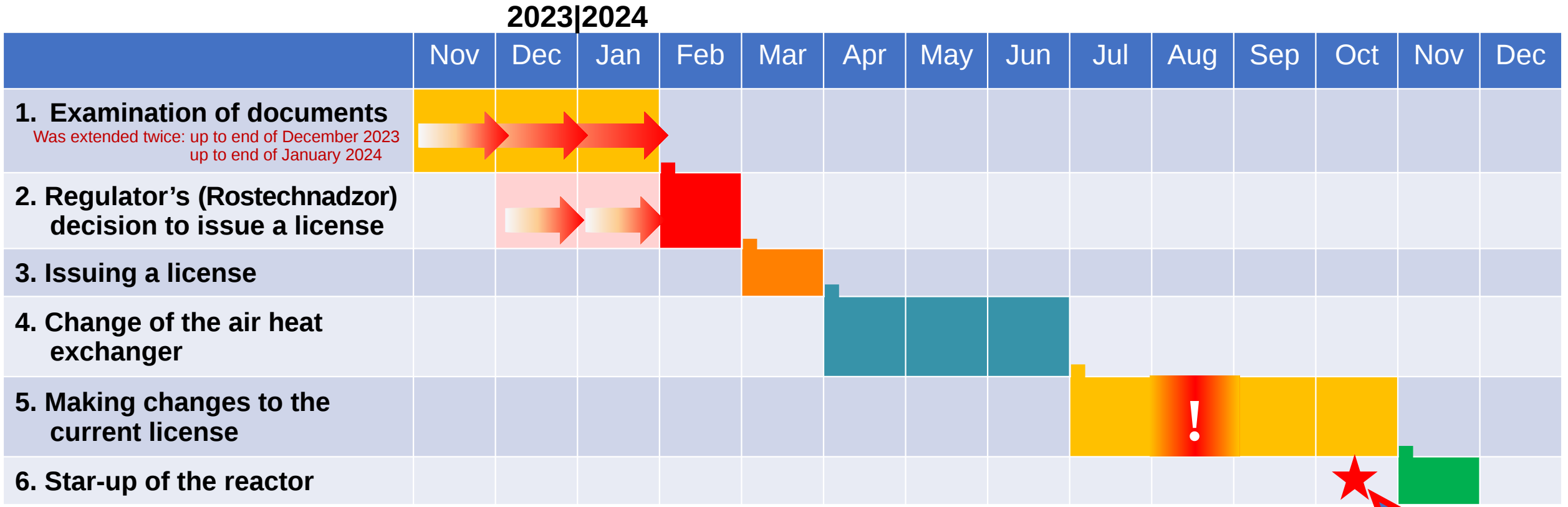
The scattering cross-section on intercalated graphite F-KS44 samples is at least an order of magnitude higher than the scattering cross-section on ordinary graphite for cold neutrons.

This makes it possible to use F-KS44 as an efficient cold neutron reflector for wavelengths of 6–15Å!

Bosak A. et al. Materials. 16 (2023)
DOI: 10.3390/ma16020703

IBR-2 Reactor

The schedule of organizational and technical work for the resumption of regular operation of the reactor (optimistic scenario).



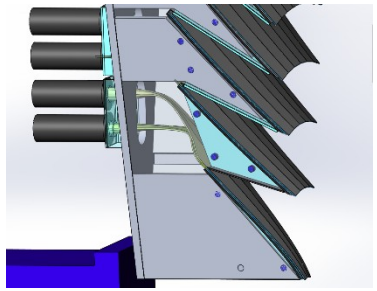
- P. 1 was started in Oct 2022. It included several iterations in papers preparation. There is no time regulation.
- P. 2 can be started only after P. 1. There is time regulation for this point: 20 working days for decision.
- P. 3 can be started only after P. 2. There is time regulation for this point : 20 working days for license issue.
- P. 4 can be started only after obtaining the license. All preparation works has been done.
- P. 5 contains stages as P. 2 and P. 3 with similar time regulation and the stage of examination of documents, which has no time regulations.

Development

Available instruments:

Back Scattering Detector (BSD)

Scintillation detectors based on ZnS(Ag)/^{6}LiF screens

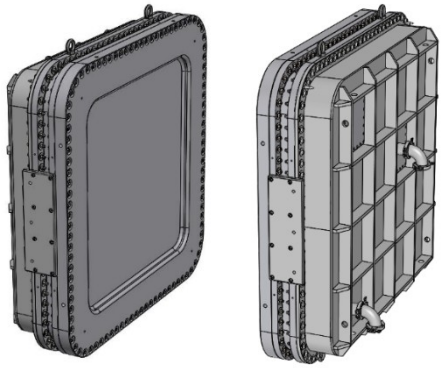


- Photomultipliers: **216** pcs
- Surface area of scintillator S >
- Total length of fibers L = **36000** m

Project of the new facilities:

SANSARA
Small-Angle Neutron Scattering/ Neutron Radiography

Large area PSD

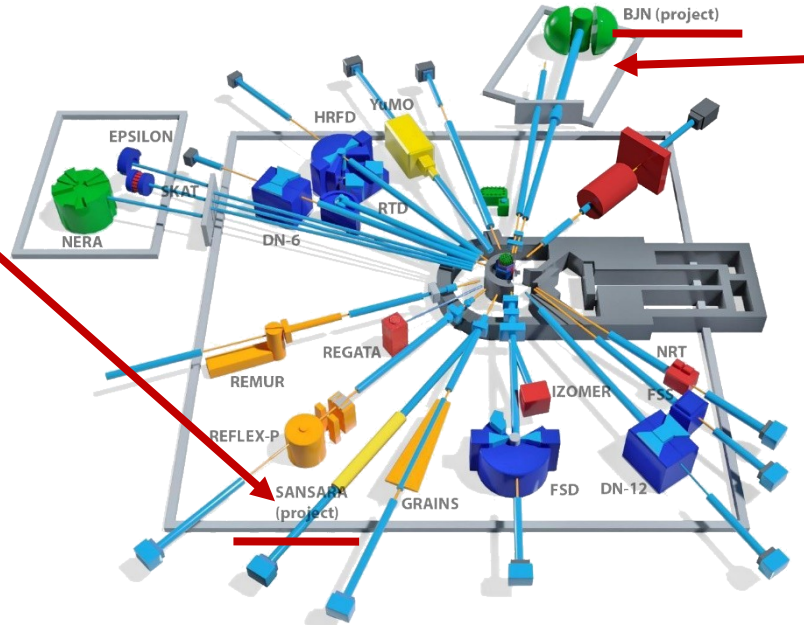


^{3}He, sensitive area 70×70 cm^{2}, resolution 5×5 mm^{2}

Vacuum tank for PSD

D = 1.6 m, L = 12 m

Manufacturing is planned in 2024



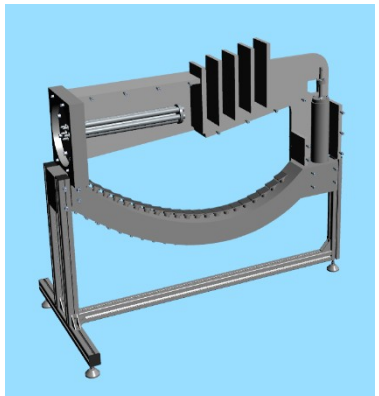
SANSARA

BJN

BJN
Inelastic Neutron Scattering in Inverse Geometry

Purchase of HOPG crystal

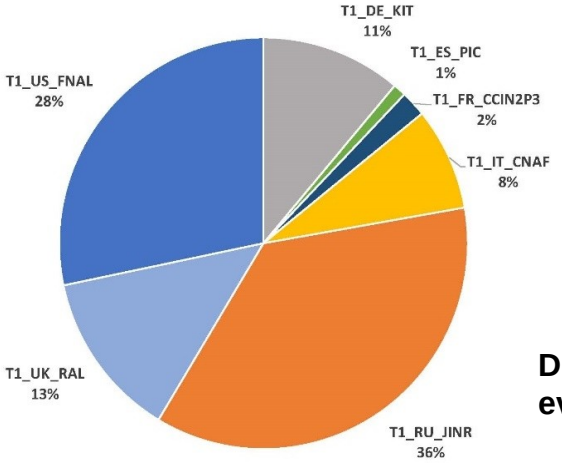
Development and manufacture of **prototype**



Produced by FrakoTertm (2023)

Delivery is planned in 2024

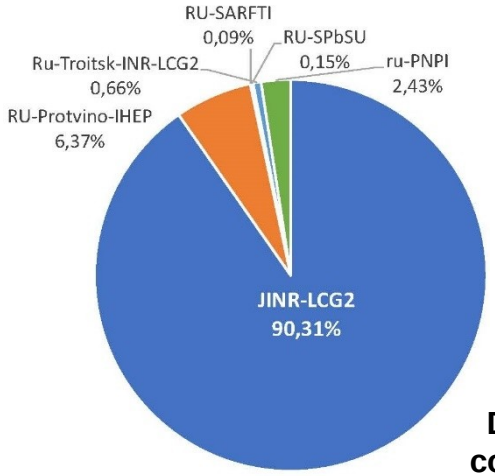
Tier1 and Tier2



JINR Tier1 for CMS is ranked first among Tier1 world centres for CMS by the number of processed events.

Tier1 is also actively used for NICA experiments.

Distribution by the number of processed events among CMS Tier1 in 2023

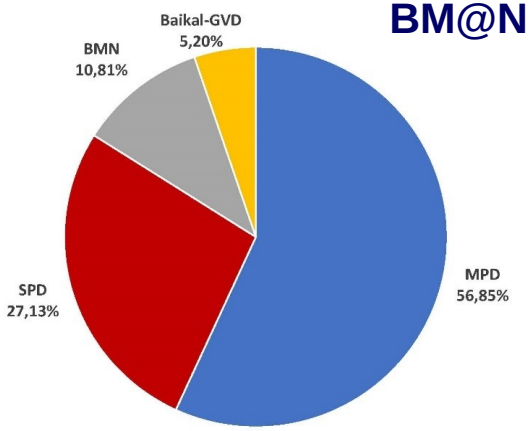


The JINR Tier2 output is the highest in the Russian Consortium RDIG (Russian Data Intensive Grid).

The Tier2 centre is used for NICA, LHC, NOvA, BES, ILC and by local users.

Distribution of RDIG jobs completed on the grid sites

DIRAC



BM@N Run 8 data processing

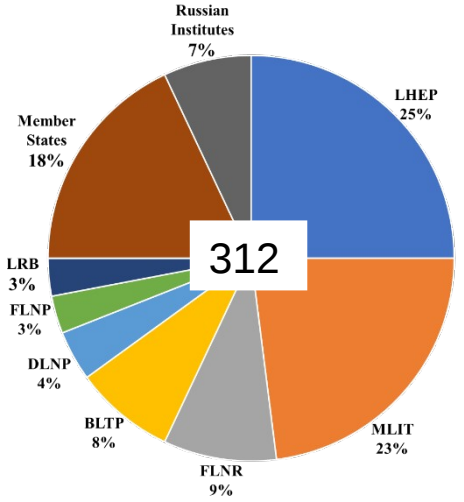
In 2023, for the first time at JINR, the complete processing of raw data from the 8th run of the BM@N experiment was performed on the distributed heterogeneous computing infrastructure integrated using the DIRAC platform.

Distribution by experiments using DIRAC

In 2023, DIRAC was employed to solve the tasks of collaborations of all three experiments at the NICA accelerator complex, as well as of the Baikal-GVD neutrino telescope.

Govorun Supercomputer

In 2023, the next stage of modernization of the Govorun SC, associated with the enhancement of the GPU component, took place.



Govorun SC total peak performance:
1.7 PFlops with double precision
3.4 PFlops with single precision
The total capacity of the hierarchical storage is 8.6 PB.

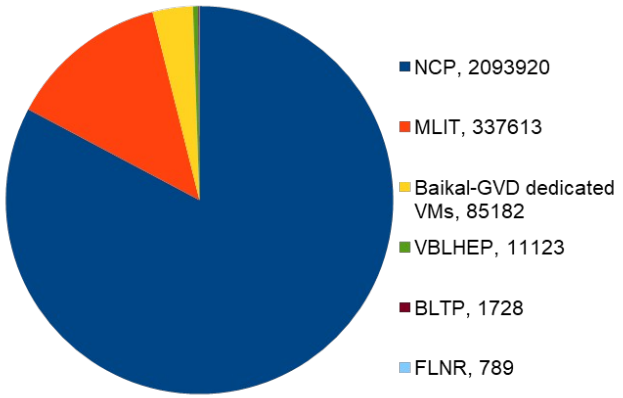
The total number of Govorun SC users is currently 312, of which 255 are JINR staff members, and 57 are from the Member States.

Cloud Infrastructure

Work done:

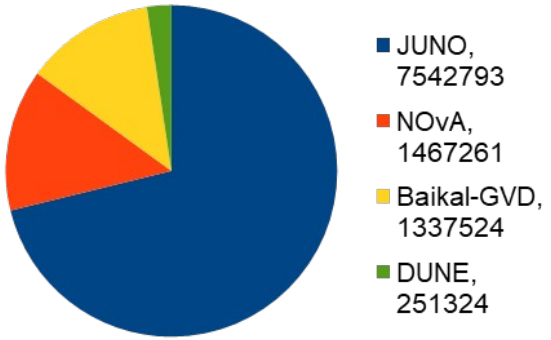
- CVMFS-based docker-container publication service to simplify user job submission on various computational resources.
- dCache storage testbed with the IAM service for token-based authentication and authorization with JINR SSO as an identity provider.
- New cloud-based service for event planning – newdle.jinr.ru.
- Increased capacity of the neutrino ceph-based storage from 1.5 PB to 3.1 PB.
- Migration procedure validation from CentOS 7.9 to AlmaLinux 9.3 for cloud servers and part of cloud-hosted services.

JINR cloud CPU resource allocation by lab and projects in 2023, CPU*hours

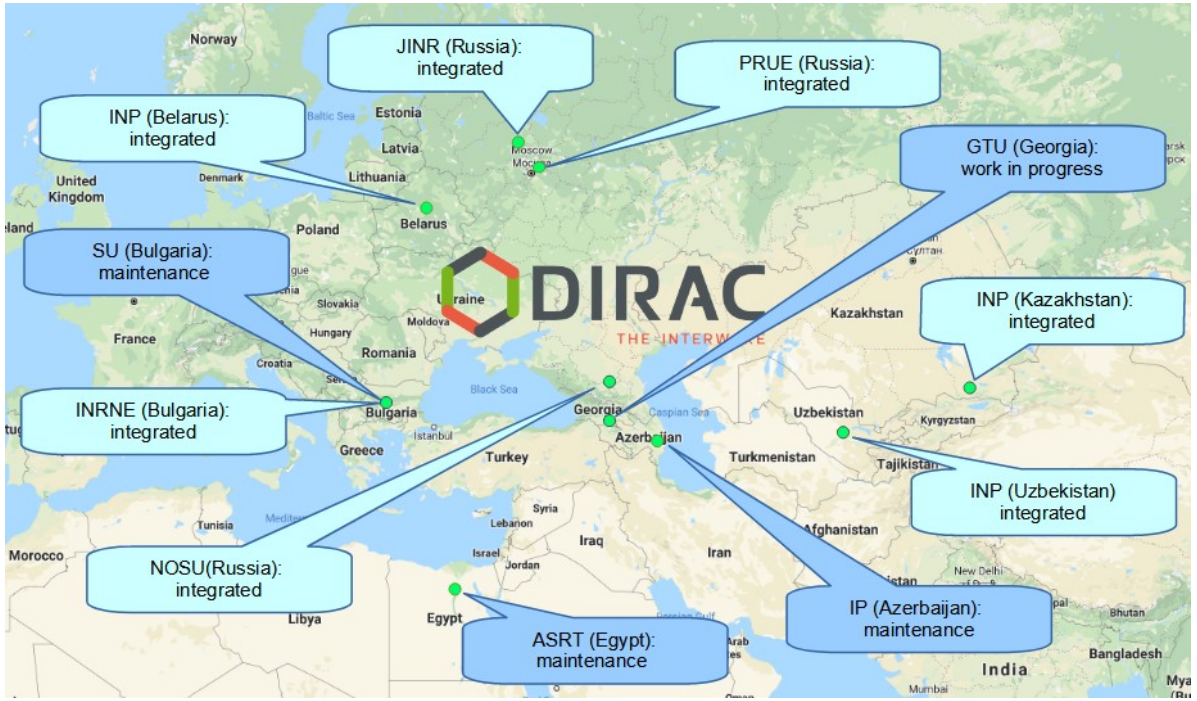


Neutrino experiments are the major users of the cloud infrastructure in 2023.

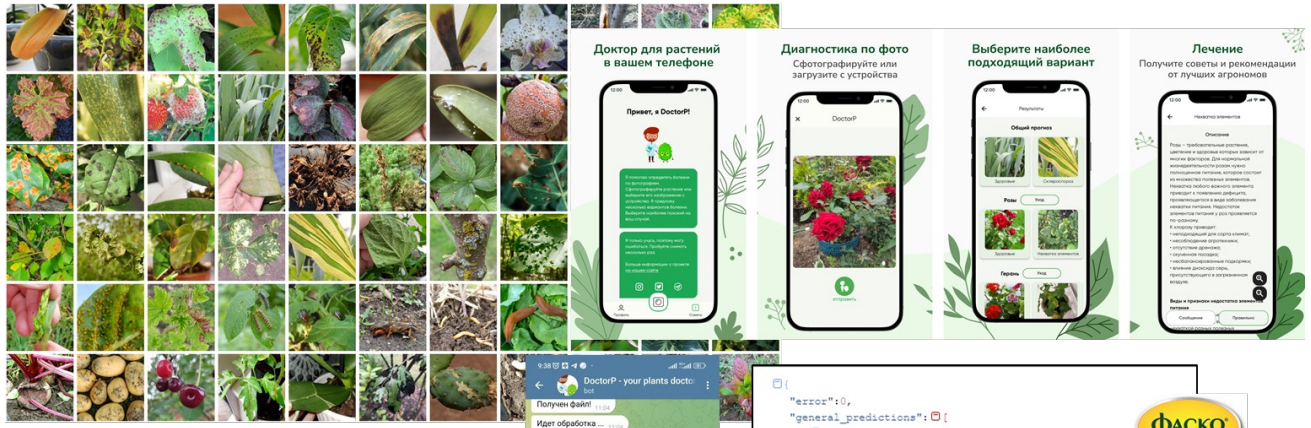
Neutrino computing platform (NCP) CPU resources consumption by projects in 2023, CPU*hours

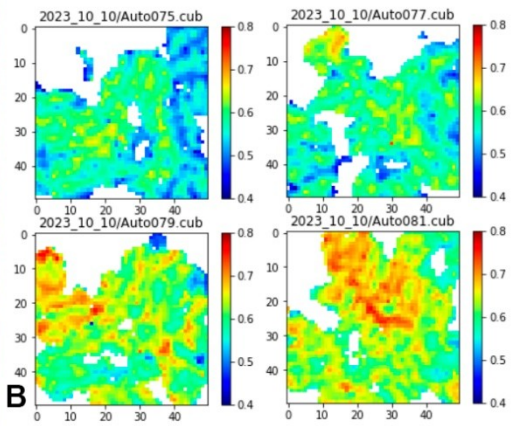


The first in the Republic of Kazakhstan and 11th JINR cloud computing cluster was integrated into the distributed information and computing environment (DICE) based on the resources of JINR and its Member States' organizations. Scientists of Kazakhstan will be able to use the resources of the INP cloud cluster within their own research and as part of cooperation with JINR, participating in the NICA and Baikal-GVD projects.



Machine Learning in Life Sciences





A platform and a mobile application (DoctorP) for detecting plant diseases and pests are being developed at MLIT JINR.

Both a general model capable of detecting 68 disease classes and specialized models for 30 ornamental and agricultural crops are available.

The database contains over 6,000 images.

In 2023, the platform has processed over 80 thousand user requests. To obtain a prediction and treatment recommendations from experienced agronomists, one just needs to send a photo showing the problem.

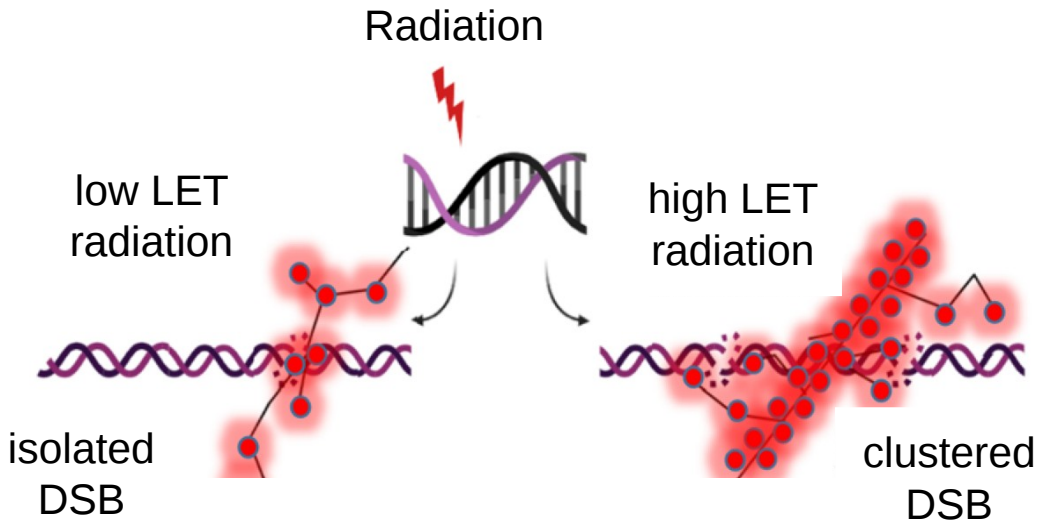
The platform can be accessed by third-party applications and services:

- Garden Retail Service (formerly Fasko),
- Andijan Institute of Agriculture and Agrotechnologies (Uzbekistan),
- Russian Agricultural Bank.

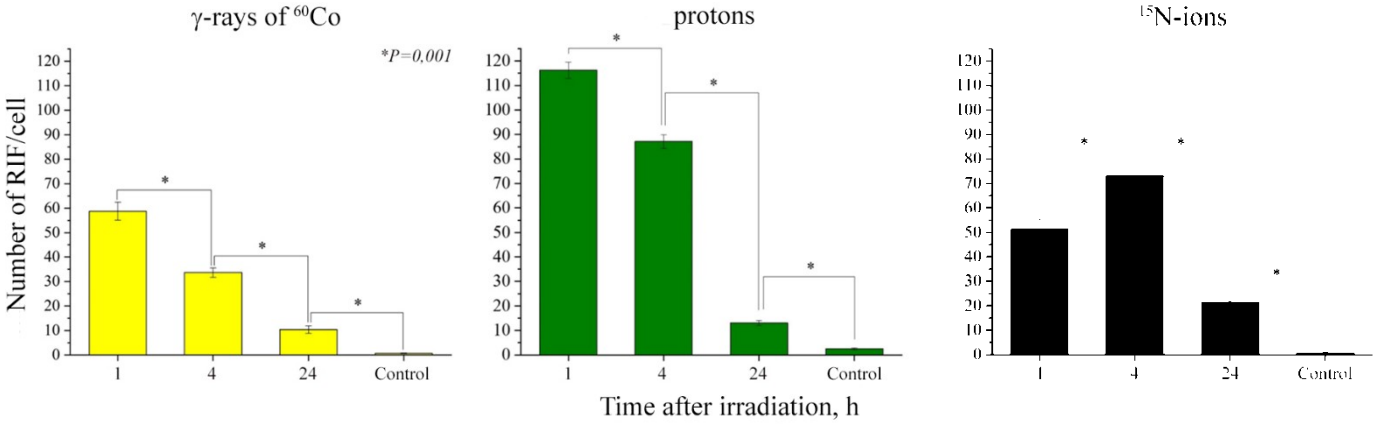
JINR School of Information Technology 2023

50 students from 11 Russian universities

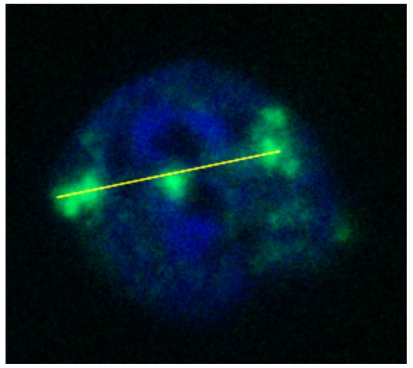
Formation and Repair of rAdiation-induced Clustered DNA Double Strand Breaks in Brain Cells



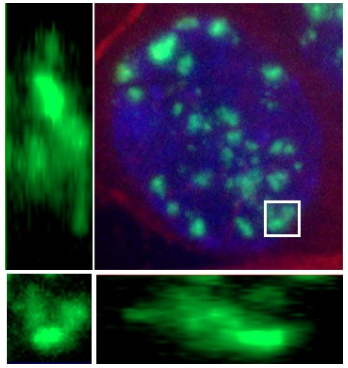
Repair of DSBs



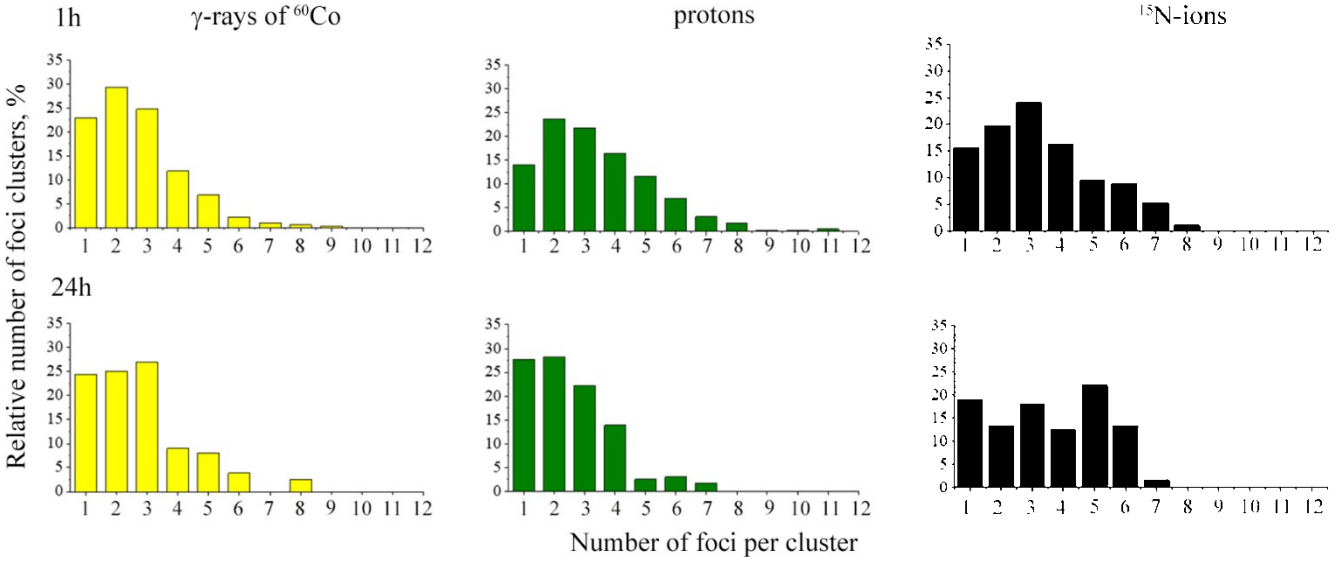
Radiation-induced foci (RIF) in a track of nitrogen ions traversing neuron cell



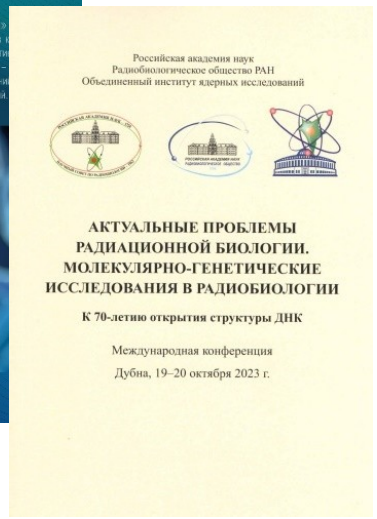
gH2AX foci cluster



Complexity level of clustered DSBs at different times



Current Problems in Radiation Biology. Molecular Genetic Research in Radiobiology
To the 70th Anniversary of DNA Structure Discovery


Российская академия наук
Радиобиологическое общество РАН
Объединенный институт ядерных исследований

АКТУАЛЬНЫЕ ПРОБЛЕМЫ РАДИАЦИОННОЙ БИОЛОГИИ. МОЛЕКУЛЯРНО-ГЕНЕТИЧЕСКИЕ ИССЛЕДОВАНИЯ В РАДИОБИОЛОГИИ

К 70-летию открытия структуры ДНК

Международная конференция

Дубна, 19–20 октября 2023 г.

Student Programmes September 2023 – February 2024

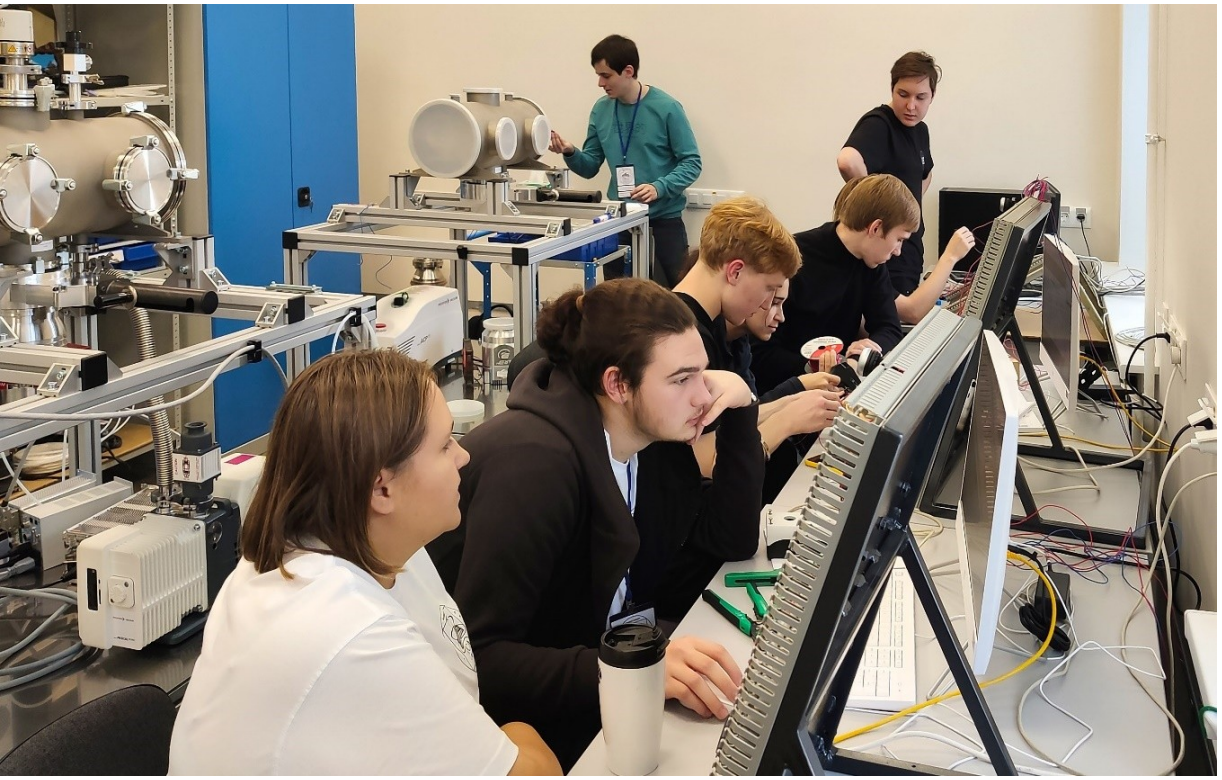
JINR-attached students, 435

School on quark-gluon matter physic

30 participants from 8 universities, November

Advanced Engineering practicum

39 students from universities of RSA and Russia



START

Summer session’23, 50 participants

Winter session’24, February-June, 26 participants

INTEREST

Wave 9, October-December, 38 participants

Wave 10, February-April, Collection of applications

Outreach Activities September 2023 – February 2024

Popular science lectures, 9, including 5 offline

Visits to the JINR laboratories for school and university students, 14, including 13 offline

Work with JINR Information Centres, 5 events

Career Days at Universities, 3 events

Science Festival NAUKA 0+

Physics Days in Dubna, November 2023

Science Through a Looking Glass at the MAYAK shopping centre, September-October

Production of Information Videos & Information Screen support

Strengthening International Cooperation

Member States

2-3 October 2023

Visit of a delegation of the National Academy of Sciences of the Republic of Kazakhstan (NAS RK) headed by President of the Academy Kunsulu Zakarya and singing of an **Agreement of Intent between NAS RK and JINR**.

1 December 2023

A JINR delegation took part in celebratory events dedicated to the **30th anniversary of the State Committee for Science and Technology of the Republic of Belarus**.

12-13 December 2023

A JINR delegation headed by Vice-Director Latchesar Kostov took part in celebratory events on the occasion of the **80th anniversary of the Academy of Sciences of the Republic of Uzbekistan**.

11 November 2023

The **10th JINR Information Centre was opened at the Institute of Nuclear Physics of the Kazakhstan Ministry of Energy**, and the **1st JINR cloud computing cluster in Kazakhstan** was launched as part of the JINR Distributed Information and Computing Environment.

23-24 January 2024

A **delegation from universities of Azerbaijan headed by Hamlet Isakhanli, the founder of Khazar University**, visited JINR. The delegation discussed matters of future cooperation with the JINR Directorate and directors of several JINR laboratories.

Strengthening International Cooperation
Member States

27-31 October 2023
Delegation of JINR headed by Vice-Director Kostov visited Egypt

The 2nd Session of the Joint Coordination Committee (JCC) on cooperation between ARE and JINR since ARE became a member state was hosted by ASRT

Egyptian Atomic Energy Authority

Zewail City of Science and Technology

National Research Center

Strengthening International Cooperation

Associate Members

23 October 2023

Dr. Rudzani Nemutudi, Deputy Director of iThemba LABS, visited JINR.

29 January 2024

JINR Director Grigory Trubnikov and iThemba LABS Director Makondelele Victor Tshivhase signed an **agreement on the establishment of a JINR Information Centre at iThemba LABS** during Dr. Tshivhase's visit to Dubna take part in the JINR Programme Advisory Committee for Nuclear Physics.

5-9 February 2024

The JINR delegation visited UniVen, UniZulu, North-West University and held a workshop at NECSA and iThemba LABS in order to join efforts in the implementation of scientific and educational nuclear physics projects.

3 October 2023

High-level meeting in Belgrade with the State Secretary of the Ministry of Education, Science, and Technological Development of Serbia Vukasin Grozdić, Senior Advisor Svetlana Bogdanović, Director of the Vinča Institute of Nuclear Sciences Snežana Pajović, and Acting Assistant Minister for International Cooperation and European Integration Ivana Vukašinović.

30 November – 1 December 2023

The **9th meeting of the JINR-Serbia JCC** took place in Belgrade.

One of the practical results of the JCC was the launch of 12 new projects.

Strengthening International Cooperation

JINR–India

17–18 April 2023

Meeting of the **Russian-Indian Intergovernmental Commission on Trade, Economic, Scientific, Technological, and Cultural Cooperation** where the parties discussed the matter of creating an India-JINR JCC.

16 October 2023

Ambassador Extraordinary and Plenipotentiary of the Republic of India to the Russian Federation H. E. Pavan Kapoor visited JINR to take part in the four-day **"India-JINR: Frontiers of Basic and Applied Research" forum** and meet with JINR Director Grigory Trubnikov.

This four-day hybrid (both online and offline) workshop, beginning on the 16th of October, 2023 covered the theoretical and experimental aspects of the studies of particle and nuclear physics, condensed matter physics, nuclear methods in life sciences, material science, IT, and some other related areas.

The workshop received an overwhelming response from both the sides, and there were 202 participants. 128 participants were affiliated to Indian institutes like VECC (Kolkata), TIFR (Mumbai), NISER (Bhubaneswar), IITs (Delhi, Bhilai, Bombay, Indore, Kanpur, Madras), NITs (Jalandhar, Patna), universities (Delhi University; Panjab University; Banaras Hindu University; Cotton University, Assam), degree colleges, and many other educational institutions representing almost every geographical region of India.

In 4 days, there were 87 presentations, 57 of which were by Indian participants.

Strengthening International Cooperation

International Organisations

23-25 October 2023

A JINR delegation headed by Sergey Nedelko, JINR Chief Scientific Secretary, participated in the 5th Meeting of the **BRICS Working Group on Research Infrastructure (BRICS GRAIN)**, which took place in Stellenbosch, the Republic of South Africa.

4 December 2023

JINR IC and VL were **officially opened** at the headquarters of the AAEA. JINR Director Grigory Trubnikov and AAEA General Director Salem Hamdi signed a Memorandum of Understanding.

On the same day, Grigory Trubnikov participated in an **AAEA Executive Board** meeting with report on the Institute's focus areas.

Strengthening International Cooperation

Strengthening Ties with Latin America

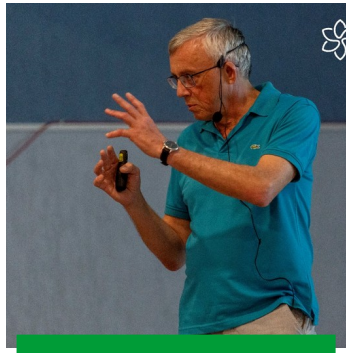
26-29 September 2023

The III Spring Meeting of the Brazilian Physical Society on Nuclear and Particle Physics

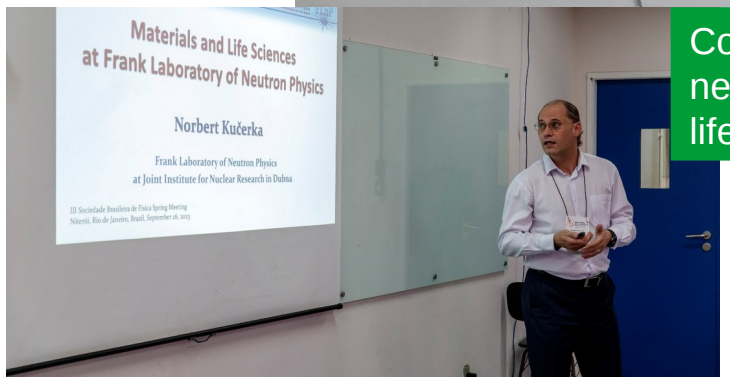
JINR participation formats:

- Invited plenary lectures
- Invited oral lectures

Current state and prospects for the development of JINR's research infrastructure



Nuclear physics



Condensed matter physics, new materials and life sciences

23 November 2023

Ambassador Extraordinary and Plenipotentiary of the Argentine Republic to the Russian Federation **Eduardo Antonio Zuain** and Second Secretary of the Embassy and Head of the Political and Scientific and Technological Departments **Luciano Javier Liendo** visited JINR. The participants discussed JINR UC's projects that are of interest to educational centres of Argentina and the possibility of holding joint events.

JINR–Cuba Meeting on Applied research and Human capacity building

29 February – 1 March 2024. Gavana, Cuba

JINR–Mexico Cooperation: Developing a Partner Network

9–13 October 2023

Congress of Mexican Physical Society. Invited plenary talks by Dr. N. Kučerka (FLNP) and Dr. D. Kamanin (UC)

17 October, National association of Universities and higher education Institutions

17 October 2023

JINR–Mexico Joint Coordination Committee (JCC) at the National Council of Humanities, Science and Technologies of Mexico (CONAHCYT)

12 October, Michoacán University

Mexican Physical Society

The JCC members identified five projects as the basis for the JINR–Mexico cooperation development:

- Strong interaction matter with the MPD in NICA-JINR;
- Magnetoresistive materials;
- Development of RUME-ECRIS to produce high-energy heavy ion beams from a single-ended Van de Graaff accelerator;
- Applications of radiation-nanoparticle, plant-nanoparticle interactions and X-ray spectrometric studies;
- Identifying DNA repair protein biomarkers associated with cancer development.

JINR Meetings on the Margins of 67th Session of IAEA General Conference

Vienna, 25–29th September 2023

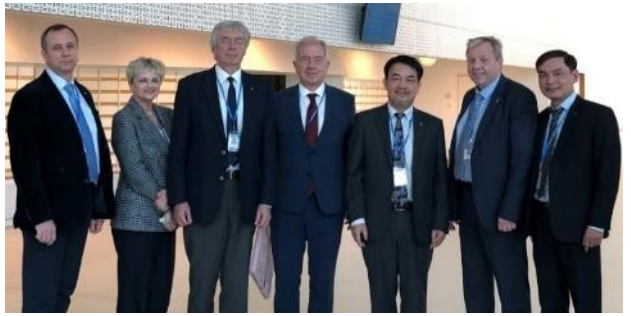
Consultations with IAEA DDG confirmed for 2024:

- JINR to host IAEA supported internships and scientific visits to Dubna;
- Joint development of on-line laboratory for nuclear education and training;
- First professional visit and training in JINR laboratories for IAEA Lise Meitner Programme cohort (second half of 2024).

Meetings with national delegations and international organizations: highlights and immediate follow-up activities

AAEA:

- official visit of JINR Director to AAEA HQ and official opening of JINR Information Centre in AAEA in December 2023;
- Planning and drafting of AAEA-JINR plan of joint activities.



Vietnam (VinAtom):

- Joint development of laboratory on nuclear science and technology;
- Opening of JINR Information Centre in Hanoi.

Argentina (CNEA):

- JINR-CNEA scientific webinar for JINR−Argentina researchers.

Visits to JINR expected from **CNEA (Argentina), CNEN (Brazil), ININ (Mexico)** and **Pakistan (PAEC)** following JINR invitation.

Awards

JINR scientist P.Shirkov, a leading methodologist of the JINR University Centre won the For Loyalty to Science All-Russian Award

Among the winners of the RAS medals for young scientists for 2022 are JINR young scientists L.Kolupaeva and E.Bushmina for their work in the field of nuclear physics.

Professor A.I.Malakhov (JINR VBLHEP) was awarded the P.A.Cherenkov Prize of the Russian Academy of Sciences

VBLHEP Deputy Director for Scientific Work H.Khodzhibagiyan − the winner of the first **Vyzov National Award** in the field of future technologies

22 September, 2023, at the 134th session of the JINR Scientific Council announced the winners of the OGANESSON Prize in Dubna.

JINR young scientists A.Nezvanov and V.Shalaev received the award of the Governor of the Moscow Region

300th anniversary of the Russian Academy of Sciences

The Russian Academy of Sciences celebrates its 300th anniversary.

It was established on February 8, 1724 by order of Peter the Great by decree of the governing Senate. So this date became the Day of Russian Science.

A gala evening dedicated to the 300th anniversary of the Russian Academy of Sciences was held at the State Kremlin Palace.

A Scientific session of the Nuclear Physics Section of the Department of Physical Sciences of the Russian Academy of Sciences, dedicated to the 300th anniversary of the RAS will be held in Dubna on 1–5 April, 2024


Thank you for your attention!