Large Scale Research Infrastructure and Scientific Program of JINR

International School on Nuclear Methods and Applied Research in Environmental, Material and Life Sciences
NUMAR-GOBI
30 June - 4 July 2025

JINR – international intergovernmental research organization

FUNDAMENTAL PHYSICS OF ELEMENTARY PARTICLES AND ASTROPHYSICS, ATOMIC NUCLEUS, CONDENSED MATTER, APPLIED RESEARCH IN MATERAIL AND LIFE SCIENCES, ECOLOGY

JINR is a very large multi-disciplinary research infrastructure that implements a deeply integrated model to manage global international scientific cooperation

15 member states,
5 associated member states
3 partner states (agreement on coordination with Government)
800+ partner research organizations and universities from
60+ countries and international organizations

7 laboratories, 5000+ employees from 30+countries
budget 220 M$ (2024)

2023: 2024:

JINR's position among international intergovernmental scientific organizations (IISO)

2 in terms of the number of personnel among all IISO

5 in terms of budget size among IISO in the field of natural sciences

8 in terms of budget size among all IISO

2017-2023 Scopus	JINR	JINR RIA
Total	**10 944**	
2023	1407	1754
2022	1347	1463
2021	1435	1472

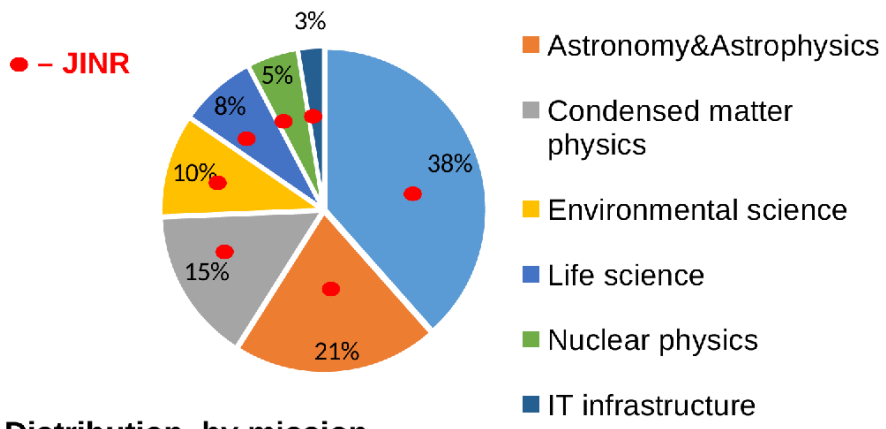
1113+1015+280+34 = 2442

https://bi.siscern.org/superset/dashboard/annual-reports/

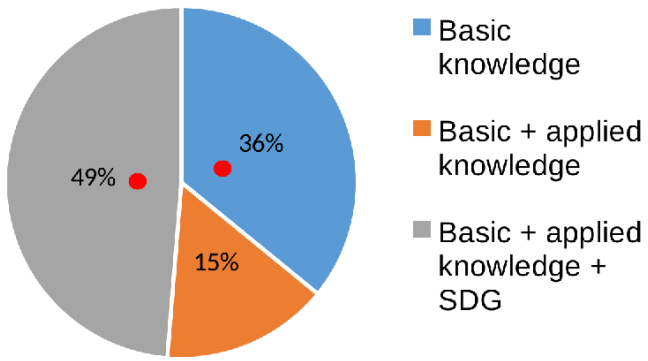
No.	International intergovernmental scientific organization	Annual budget 2023, kUS$	Personnel 2023
1	**CERN**	1 452 280	12 370
2	**JINR**	204 200	5200
3	Joint Research Centre	650 260	2 700
4	European Space Agency	8 073 593	2 547
5	ITER*	827 250	1 069
6	UNESCO	654 558	2 200
7	European Molecular Biology Laboratory	375 541	1 996
8	European Southern Observatory	329 816	750
9	European Synchrotron Radiation Facility	139 766	675
10	European Spallation Source	147 016	551
11	Institut Laue-Langevin	126 564	527
12	Square Kilometer Array	239 719	271

Global trends and JINR development

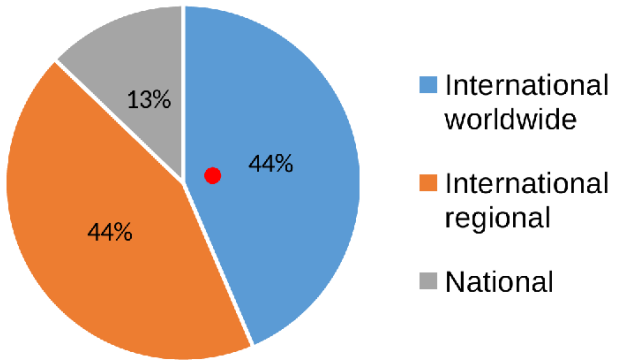
Distribution by fields of science



Distribution by mission



Distribution by international dimension



The statutory for JINR fields of science occupy a priority position in the world scientific agenda and development of a large research infrastructure.

The analysis shows that almost half of modern projects in the field of basic sciences have accompanying programs of applied research aimed at sustainable development goals (SDG).

Worldwide international dimension, the multi-disciplinary scientific program and large infrastructure projects of JINR harmoniously complement the global scientific agenda and the worldwide landscape of mega-science infrastructure, assuming, along with the main goals in the field of fundamental research, the achievement of certain SDG.

JINR research Infrastructure in the global scientific Landscape today

IUPAP Report 41

A Worldwide Perspective of Research And Research Facilities

in Nuclear Physics by the IUPAP Working Group 9

Taking beam energies of 1 GeV or greater, one has:
- fixed target heavy-ion experiments (CERN-SPS, SIS-GSI/FAIR);
- fixed target proton-nucleus studies (Fermilab, J-PARC);
- **heavy ion collider experiments (BNL-RHIC, CERN-LHC and in the future NICA);**
- fixed target-lepton DIS experiments (CERN, JLab-CEBAF);

Superheavy element search:
The future race hunting for the 119th and 120th elements **will continue at the SHE factory** at Dubna and RIKEN.

Baikal-GVD: ... the study of the flux of high-energy neutrinos and the construction of a telescope with a volume of 1 km^3...

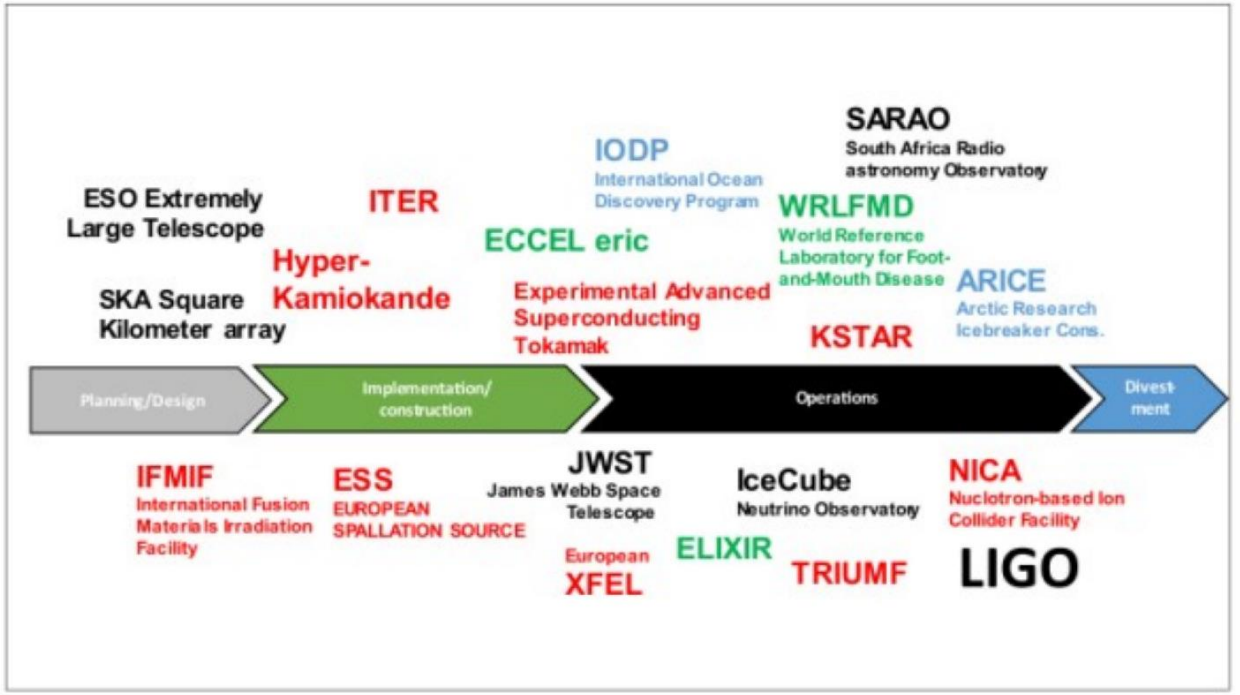
VERY LARGE RESEARCH INFRASTRUCTURES

OECD BETTER POLICIES FOR BETTER LIVES

POLICY ISSUES AND OPTIONS

OECD SCIENCE, TECHNOLOGY AND INDUSTRY
POLICY PAPERS

July 2023 **No. 153**

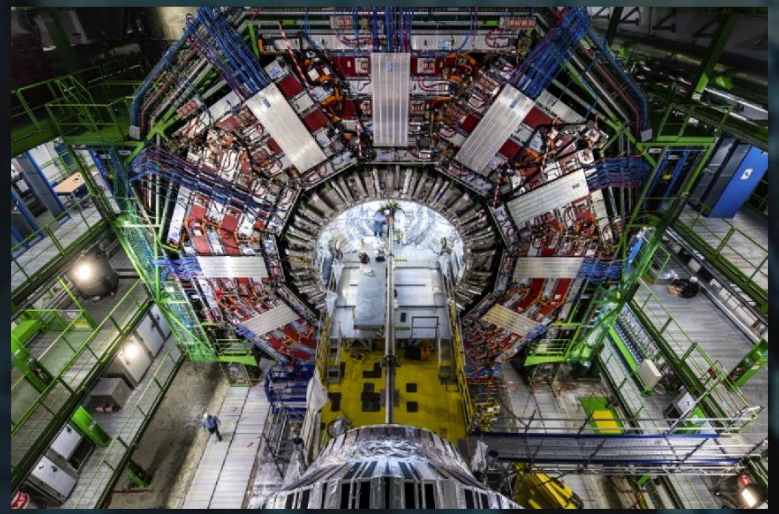


Cooperation with CERN

Scientific relations between CERN and JINR date back to 1957, were formalized in 1963. Since 1970, the traditional **CERN–JINR schools for young scientists** have given starting impulses for many scientific careers.

The **scientific contribution of JINR** to the overall CERN activities includes all areas of research and engineering. JINR has contributed to the **LHC machine** (dampers), to the experiments (**CMS**, **ATLAS** and **ALICE**) and to the WLCG, as well as to the non-LHC programme (**COMPASS**, **NA48**, **NA49**, **NA61**, **NA62** and **OPERA**). **Within CMS**, JINR initiated a collaboration scheme called **RDMS** (Russia and JINR Member States) which allowed a good coordination of the participation of these countries and made their contribution more visible. JINR has also been involved in common software development projects (**NICE**, **LabVIEW**, **EDH**) and participates in the **EGEE project**.

JINR has had the status of **Observer** in the CERN Council **since 2014**.



International Decision-making, Management and Expertise System of JINR

WG on Financial Issues at the CP

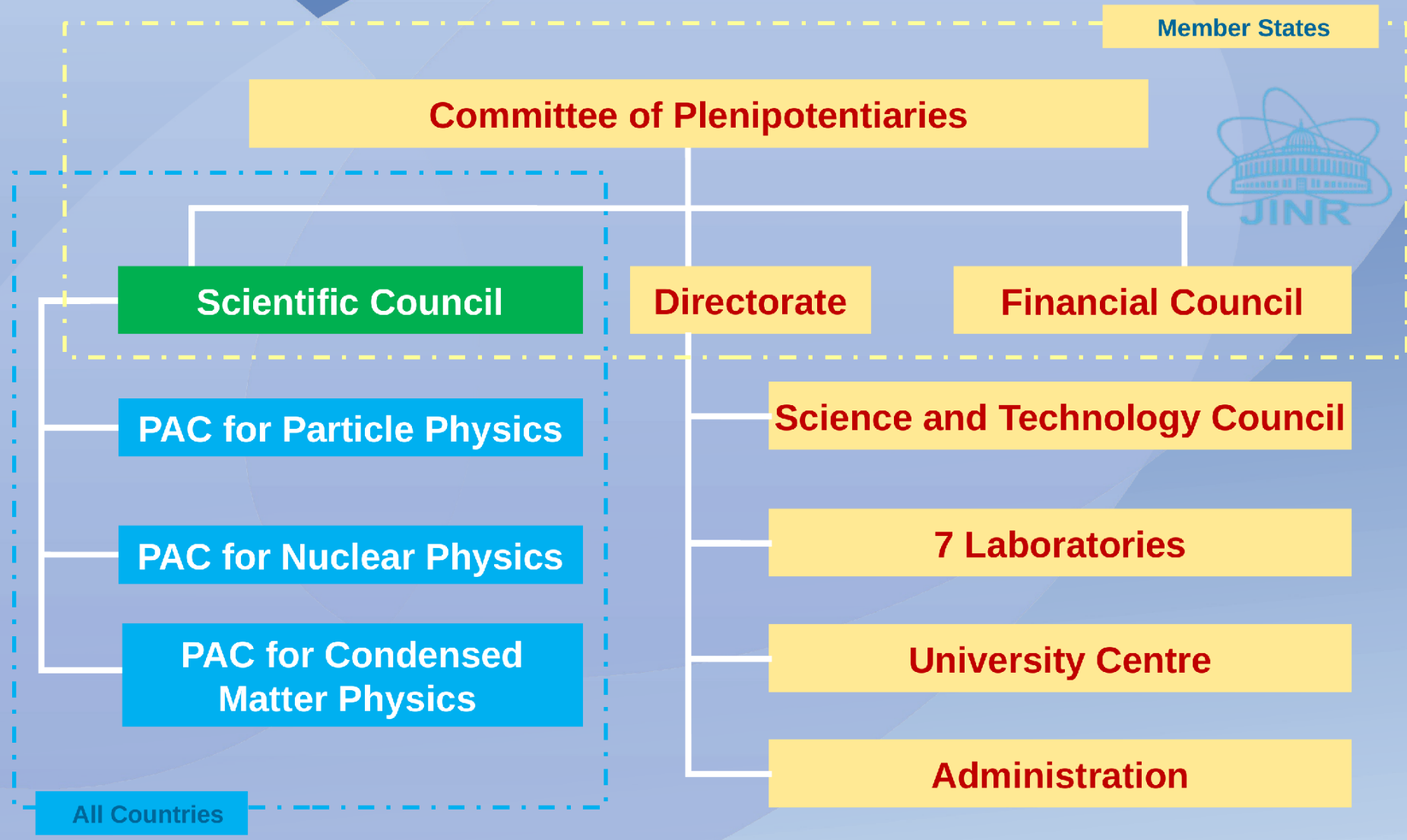
Expert WG at the CP

Expert-analytical WG at the Directorate

WG on Social Infrastructure under the Directorate

JINR Science and Technology Councils of laboratories

Technical Council



Committee of Plenipotentiaries

Each Member State has one representative in **the supreme governing body of the Institute**
and the right to one vote in the voting

JINR International Scientific Council and Program Advisory Committees

JINR Laboratories

The Bogoliubov Laboratory of Theoretical Physics is one of the world's largest institutions of theoretical physics. Research topics: fundamental interactions of fields and particles; theory of nuclear systems; theory of complex systems and advanced materials; modern mathematical physics: gravity, supersymmetry and strings. The Laboratory provides theoretical support for experimental research at JINR and in other research centres with the participation of JINR.

The Veksler&Baldin Laboratory of High Energy Physics is implementing a project for the construction of an accelerator complex of the NICA megascience class, including the upgraded accelerator Nuclotron-M, a Booster and the heavy nuclei collider and polarized particles. The megaproject is aimed at recreating and studying nuclear matter under extreme conditions that arose in nature at the early stages of the evolution of the universe and in the bowels of neutron stars.

The Dzhelepov Laboratory of Nuclear Problems — the oldest in JINR. The laboratory is mainly occupied with the research in neutrino physics and astrophysics, established by Bruno Pontecorvo. The laboratory is involved in the creation of the Baikal-GVD (deep underwater neutrino telescope on a cubic kilometer scale), which is one of the three largest telescopes in the world in terms of effective area and volume for observing natural neutrino fluxes and the largest in the northern hemisphere.

The Flerov Laboratory of Nuclear Reactions is a leading research centre in heavy ion physics, occupying a leading position in the field of synthesis and research of nuclear physical and chemical properties of new superheavy elements. The further development of this scientific direction is connected with the successful implementation of the unique project of the world's first "Superheavy Elements Factory", the basic installation of which is the new accelerator DC-280.

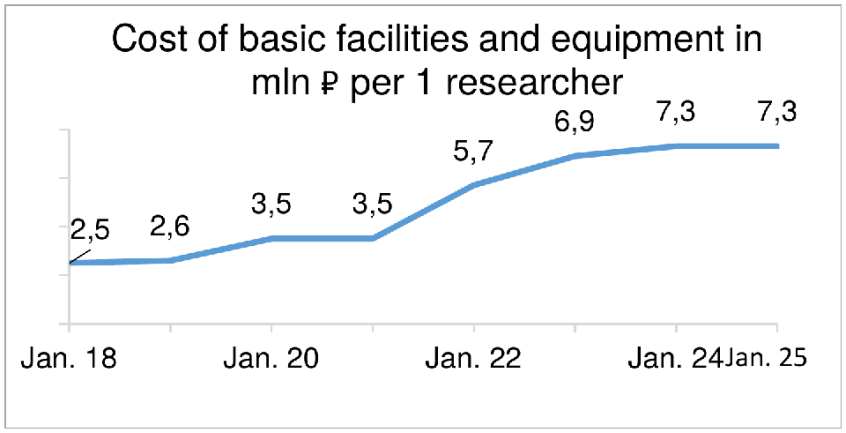
The Frank Laboratory of Neutron Physics is developing an ambitious scientific programme of studies of the neutron as an elementary particle and its application in nuclear physics, condensed matter physics and other modern trends of applied research. The main basic facility of the laboratory is the IBR-2 pulsed neutron source with a spectrometer complex, which allows us to actively develop a user programme in a wide range of areas in condensed matter physics, nuclear physics, medicine and ecology.

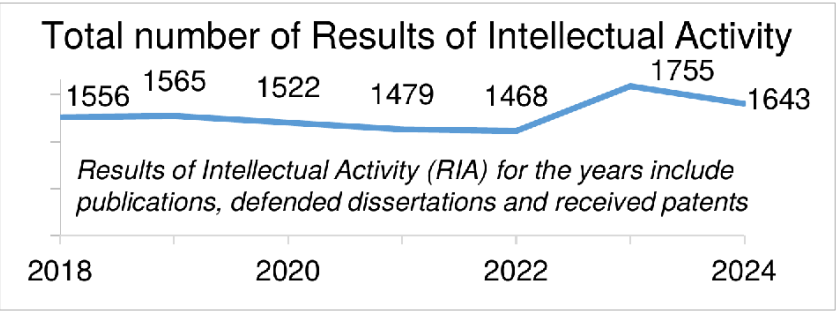
The Meshcheryakov Laboratory of Information Technologies is a world-class supercomputer centre equipped with powerful high-performance computing and information tools integrated using high-speed communication channels into global computer networks. The laboratory has created and put into operation a unique supercomputer GOVORUN — a heterogeneous computing platform for cardinal acceleration of complex theoretical and experimental research conducted at JINR.

The Laboratory of Radiation Biology develops research on radiation genetics and radiobiology, photoradiobiology, astrobiology, physics of radiation protection and mathematical modeling of radiation-induced effects. LRB is a member of the international biophysical collaboration, cooperates with scientific institutions of JINR Member States and other countries. Here, in particular, a number of studies have been carried out to assess the radiation risk of astronauts during long interplanetary flights and to develop methods of experimental space radiobiology.

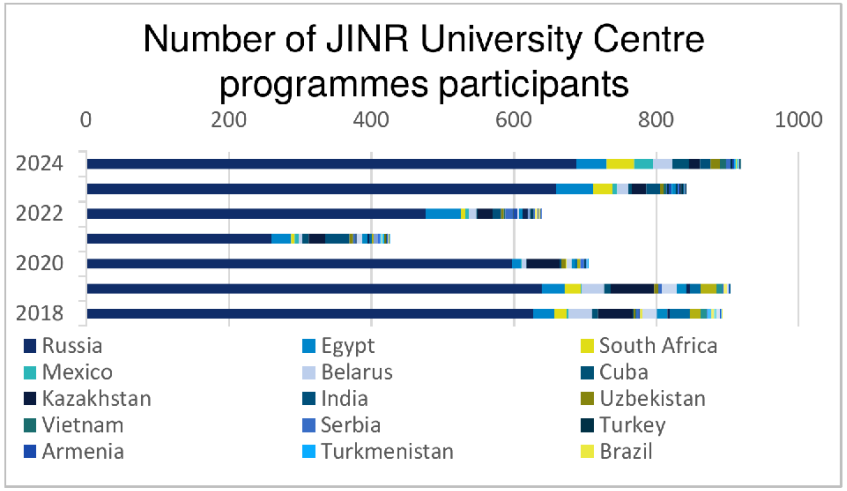
The JINR University Centre was created to implement the educational programme of the Institute, aimed primarily at training highly qualified personnel for further work and research in JINR laboratories and research centres of the participating countries. The UC has created and regularly improves conditions for the participation of students and postgraduates in the work of scientific groups of the Institute.

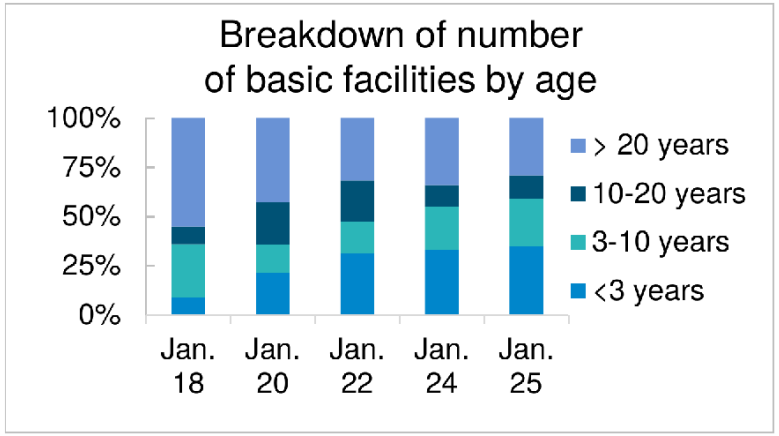
Monitoring Performance Indicators

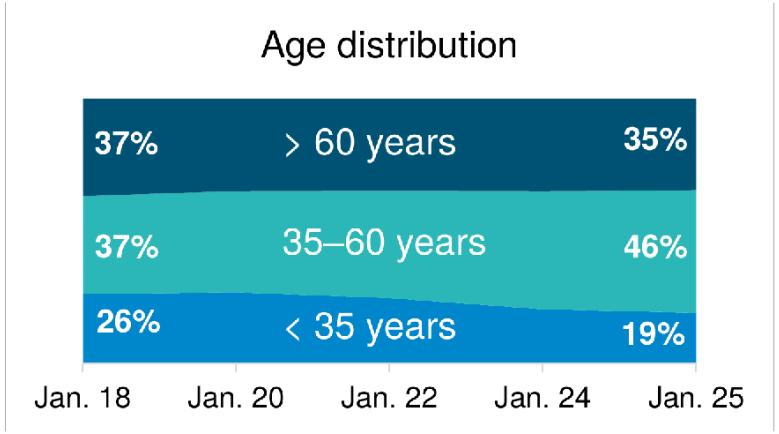


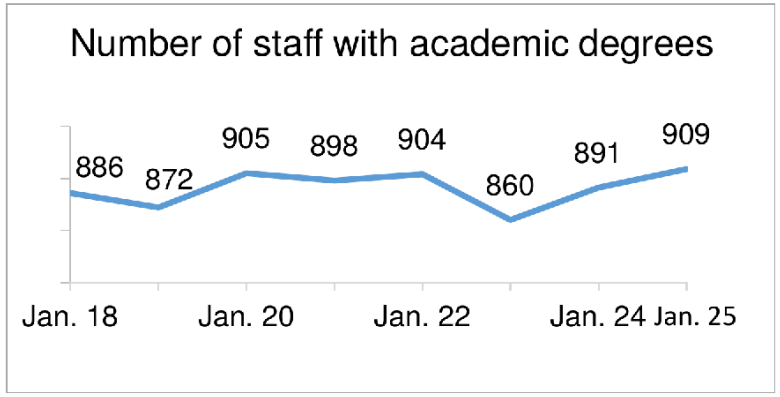


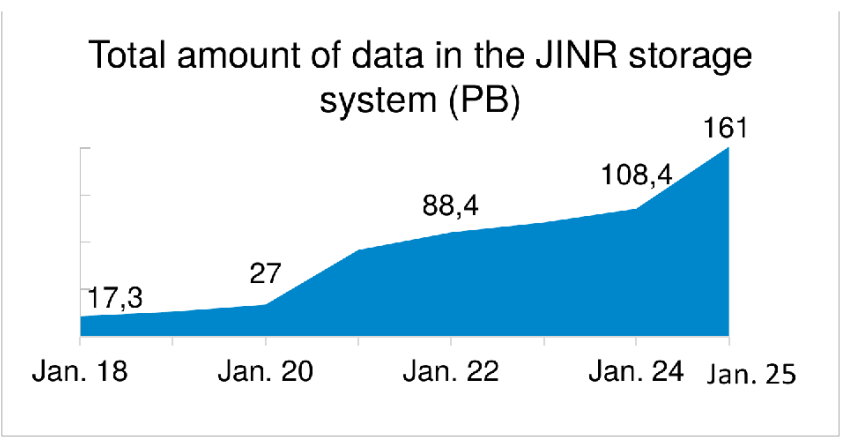
	2021	2022	2023	2024
Number of publications by Scopus	1454	1350	1419	1399

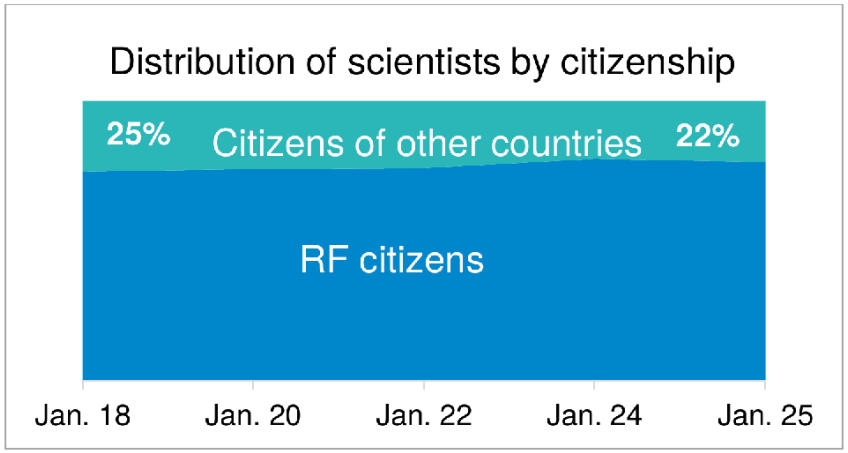


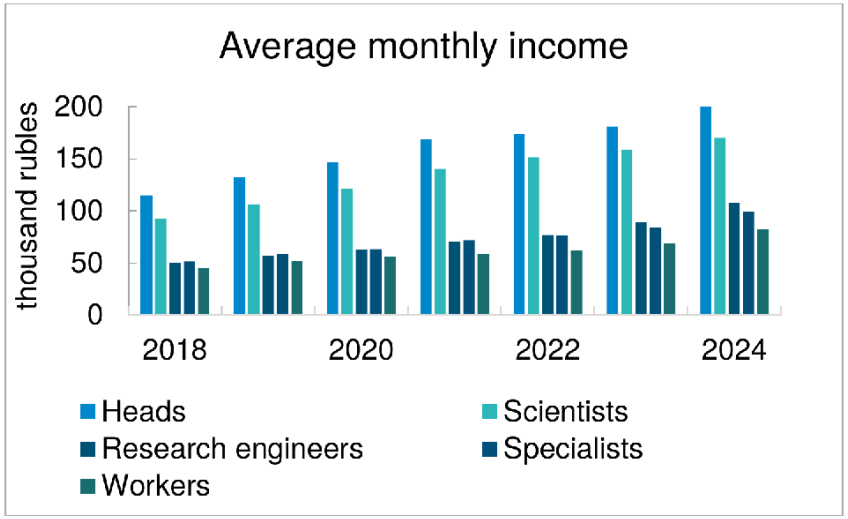












JINR Established New Scientific Journal

The Resolution of the Committee of Plenipotentiaries (March 2024) and the JINR Decree No.559 (July 2024) initiated the establishment of a new journal.

First issue with 7 articles was published in 2024

Natural Science Review, an international, peer-reviewed, full open-access journal specializing in natural and technical sciences.

JINR Scientific Leader, Academician V.Matveev is the Editor-In-Chief.

Key concepts:

- Platinum open access: free foe readers and authors;
- Online journal, no hard copy;
- 4 issues per year, English language, special issues are possible;
- Scientific articles, reviews, intellectual products, and TDR/CDR are accepted for publication;
- All expenses are covered by JINR.

Prompt publication process:

- 2 weeks for one round of review (but good quality of reviewing is a priority);
- 1 week for editing after being accepted;
- Articles are published once they appear on the website.

Website: nsr-jinr.ru or nsr-jinr.int (alias)

Multidisciplinary Complex of Large Research Infrastructures

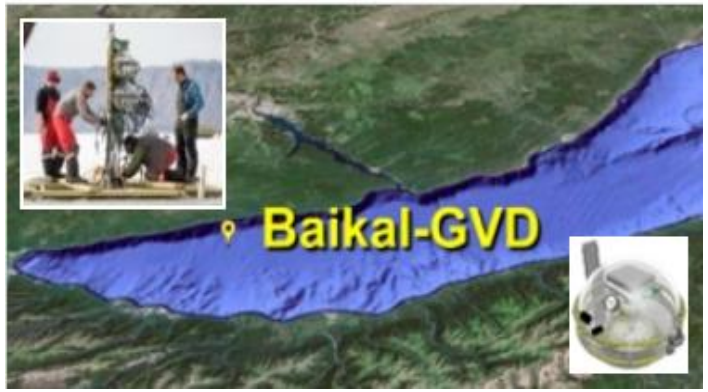
7-YEAR PLAN FOR THE DEVELOPMENT OF JINR (2024-2030)

Relativistic Heavy Ion & Spin Physics
NICA complex

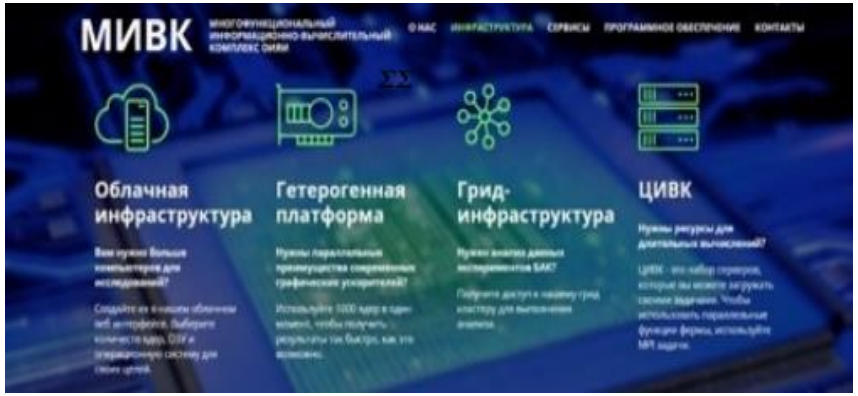
Low Energy Nuclear Physics
SHEF, DRIBS-III accelerator complexes

Condensed matter research and Neutron physics (IBR-2M reactor)

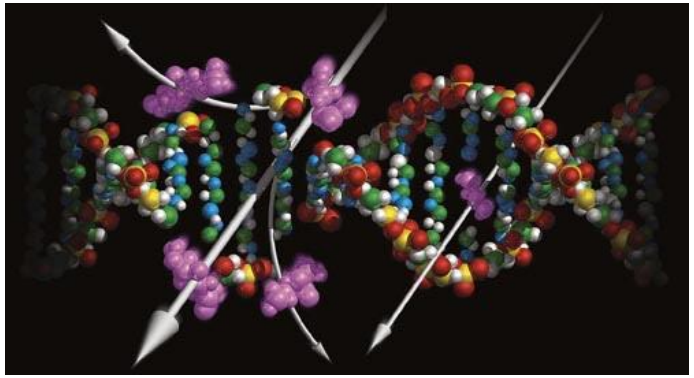
Neutrino & Astroparticle physics
Baikal-GVD neutrino telescope



IT and High Power Computing
MICC (Govorun supercomputer, GRID)

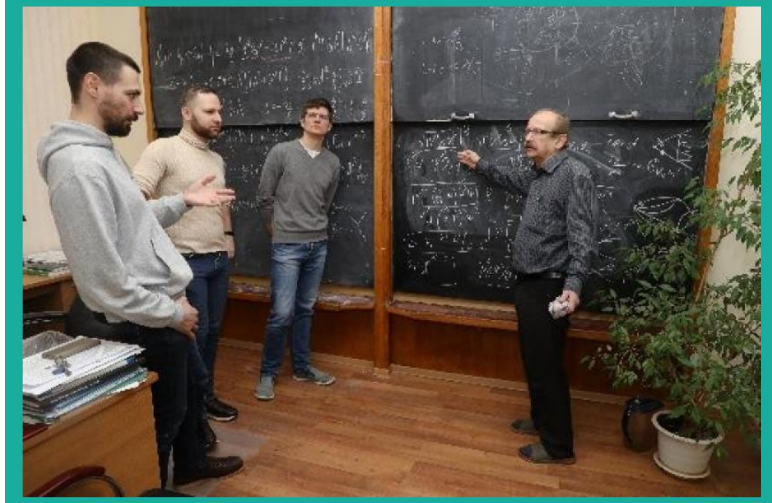


Life Sciences
Radiation biology, Proton therapy



Theoretical Physics at JINR

A unique laboratory with **230 researchers from more than 20** countries conducting multidisciplinary research.



THEORETICAL PHYSICS (Bogoliubov Laboratory of Theoretical Physics)

Theory of Fundamental Interactions

Theory of Atomic Nucleus

Theory of Condensed Matter

Modern Mathematical Physics

Interlaboratory cooperation

Research and educational project

DIAS-TH

"Dubna International Advanced School of Theoretical Physics"

VBLHEP Hot and dense nuclear matter in heavy-ion collisions

DLNP
Neutrino physics

MLIT
Lattice QCD calculations

FLNR
Superheavy and exotic nuclei

DLNP *Few-body systems, Exotic nuclei*

FLNP
Condensed Matter, New materials

FLNR
Nanoporous 2D membranes, Ion irradiation

MLIT Computational methods for nuclear physics and quantum chemistry

Human strategy:

- ❑ Attraction of leading scientists
- ❑ Attraction of young researchers
- ❑ Stimulation of scientific activity

Scientific strategy:

- ❑ Extension of international collaboration
- ❑ Keeping up with current scientific trends
- ❑ Interplay of research and education

RELATIVISTIC HEAVY ION PHYSICS & SPIN PHYSICS

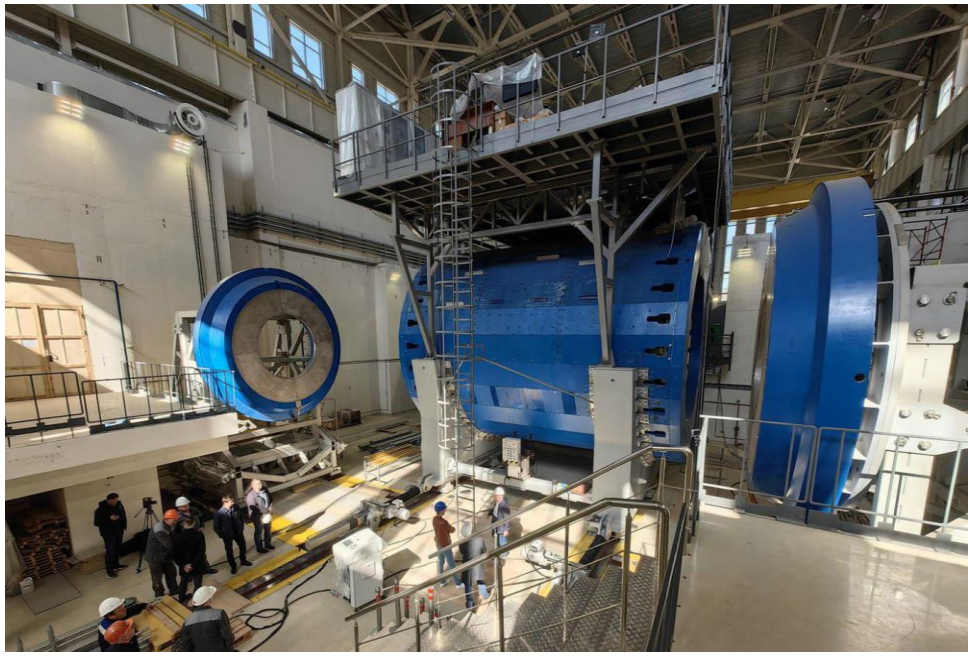
NICA **N**UCLOTRON-BASED **I**ON **C**OLLIDER **FA**CILITY

nica.jinr.ru

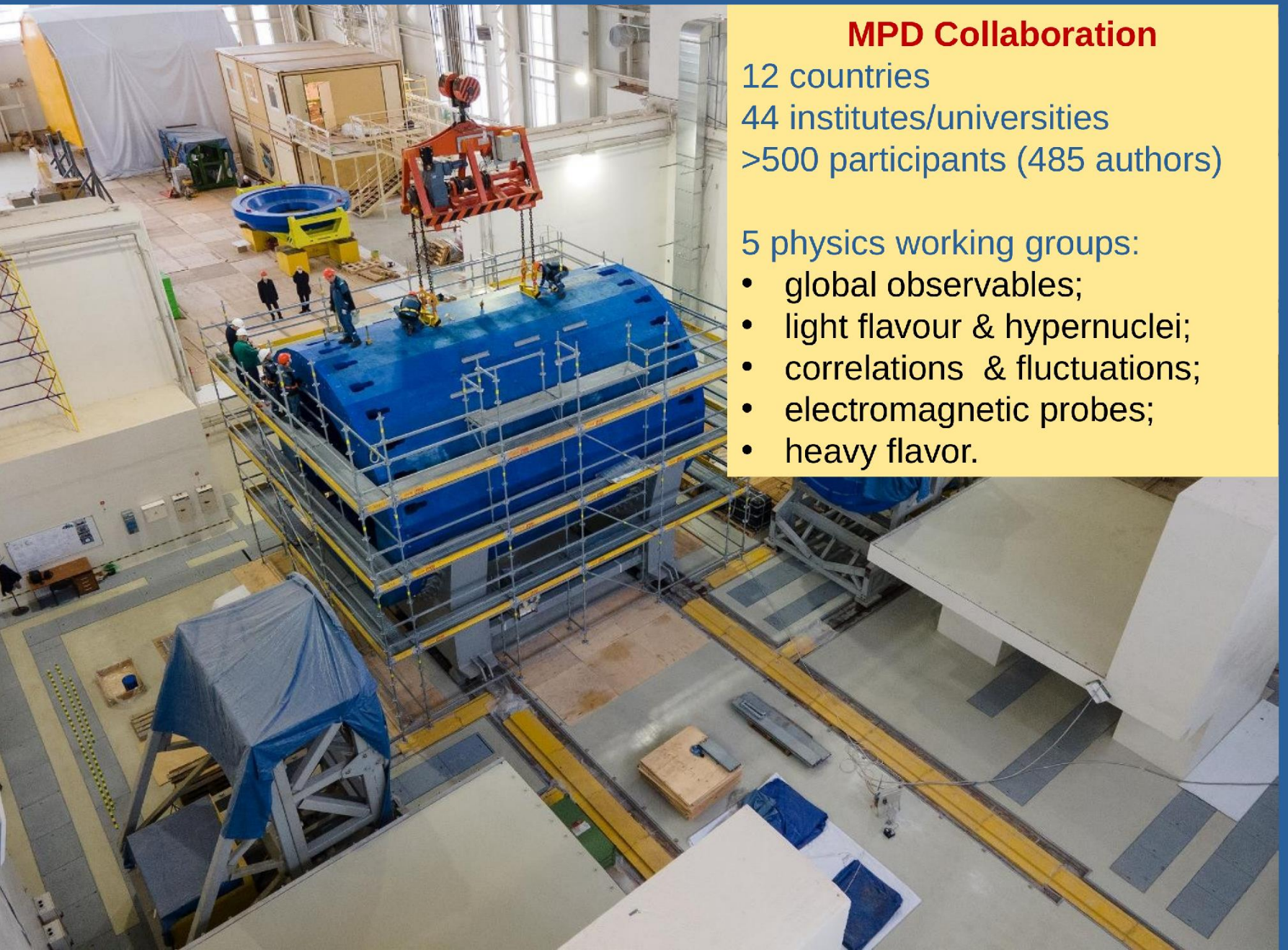
Relativistic Heavy Ion Physics and Study of nucleon structure. Near and Long-Term Future

- The timely completion of the NICA project, its commissioning and steady and efficient operation.
- Completion of the detectors: **BM@N**, **MPD** and **SPD** at NICA and successful data taking over the decades to come. JINR will make significant contribution to the basic configuration of the SPD detector.
- After several years of running of MPD, an Upgrade is foreseen, responding to an increase in luminosity of NICA. Adding detectors in the forward region as planned.
- Studies of possible future extension of NICA for acceleration of electrons, opening new physics potential via e-p and e-A collisions.

	2022	2023	2024	2025	2026	2027	2028	2029
NICA Collider commissioning		Commissioning runs						
MPD extended config. construction and opration			System design and production		Detector extended mode operation			
Consruction of NICA collider extended config.								
Prep. and start of polarized beam operation		SC-solenoids production and tests			Spin transparency mode operation			
SPD construction and commissioning	R & D, prototyping, testing			SPD systems production and assembly			SPD operation	
Nuclotron modernization	R & D, prototyping, testing			Magnets production, ring assembly			New Nuclotron operation	



International cooperation: Catalytic Role of NICA Detector Collaborations



MPD Collaboration

12 countries
44 institutes/universities
>500 participants (485 authors)

5 physics working groups:

- global observables;
- light flavour & hypernuclei;
- correlations & fluctuations;
- electromagnetic probes;
- heavy flavor.

BM@N Collaboration

10 countries
19 institutes/universities
255 participants

Extended physics programme of the ongoing experiment:

- short-range correlations;
- hyperons & hypernuclei;
- heavy ion physics, etc.

SPD Collaboration

10 countries
23 institutes/universities
~300 authors + individuals

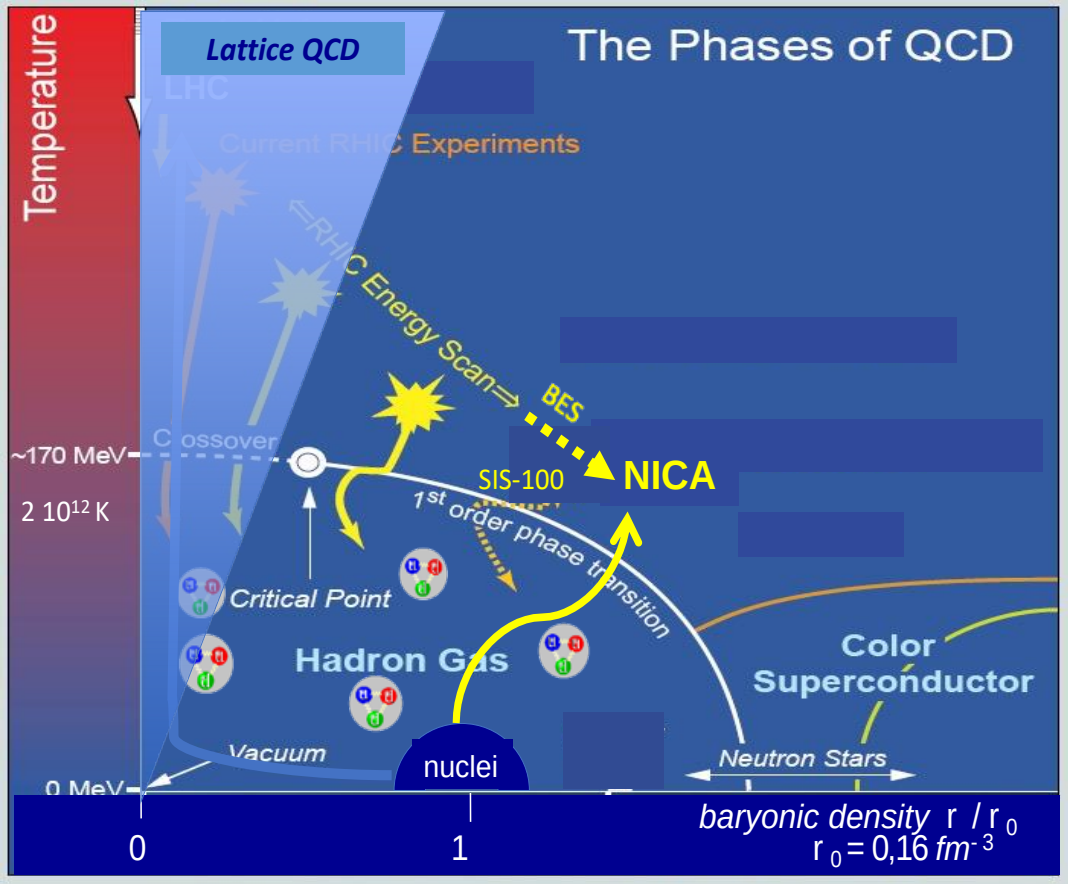
Physics goals:

- gluon content in p and d;
- charmonia;
- open charm;
- prompt photons.

BM@N & MPD

NICA

SPD



MPD covers this interesting region providing powerful combination of **large luminosity, collision energy and system size scan** (including isobars), large and consistent **acceptance,** full **centrality** range.

NICA is complementary to existing and planned world facilities (FAIR, SPS), and will be a natural and necessary continuation and significant expansion of studies at RHIC BES.

The SPD experiment is aimed at studying the properties of strong interactions in the nonperturbative region, at measuring the proton and deuteron spin structures, and at the development of a three-dimensional model of the nucleon. It is unique in its methodology, breadth of coverage and variety of tasks.

Experimental facility	SPD @NICA	RHIC	EIC	AFTER @LHC	SpinLHC
Scientific center	JINR	BNL	BNL	CERN	CERN
Operation mode	collider	collider	collider	fixed target	fixed target
Colliding particles & polarization	$p^{\uparrow}$-$p^{\uparrow}$ $d^{\uparrow}$-$d^{\uparrow}$ $p^{\uparrow}$-d, p-$d^{\uparrow}$	$p^{\uparrow}$-$p^{\uparrow}$	$e^{\uparrow}$-$p^{\uparrow}$, $d^{\uparrow}$, $^3He^{\uparrow}$	p-$p^{\uparrow}$,$d^{\uparrow}$	p-$p^{\uparrow}$
Center-of-mass energy $\sqrt{s_{NN}}$, GeV	≤27 (p-p) ≤13.5 (d-d) ≤19 (p-d)	63, 200, 500	20-140 (ep)	115	115
Max. luminosity, 10^{32} cm^{-2} s^{-1}	~1 (p-p) ~0.1 (d-d)	2	1000	up to ~10 (p-p)	4.7
Physics run	>2025	running	>2030	>2025	>2025

APPLIED RESEARCH @ NICA

The Applied Research Infrastructure for Advanced Developments at NICA fAcility (ARIADNA) will include:

(1) Beamlines with magnetic optics, power supplies, beam diagnostics systems, cooling systems, etc.

(2) Experimental zones equipped with target stations for users (detectors, sample holders, irradiation control and monitoring system, etc.)

(3) Supporting user infrastructure (areas for deployment of user's equipment, for sample preparation and post-irradiation express analyses, etc.)

Low-energy ion beams available at HILAC	Intermediate-energy ion beams available at Nuclotron	High-energy ion beams available at Nuclotron
3.2 MeV/nucleon	150-1000 MeV/nucleon	up to 4.5 GeV/nucleon
Life sciences, Radiation damage to microelectronics, Materials science, Novel relativistic nuclear technology		

Protons and ions with Z = 2 to 92

Irradiation of decapsulated microcircuits and solid materials with 3.2 MeV/nucleon ions.

Ions: $^{12}C^{6+}$, $^{40}Ar^{18+}$, $^{56}Fe^{26+}$, $^{84}Kr^{36+}$, $^{131}Xe^{54+}$, $^{197}Au^{79}$

Irradiation of capsulated microcircuits with 150-350 MeV/nucleon ions. Ions like $^{197}Au^{79+}$ are decelerated in the capsule to 5-10 MeV/nucleon.

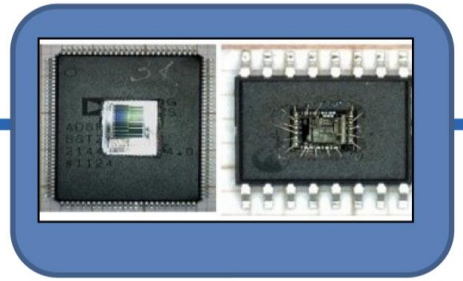
500-1000 MeV/nucleon ions be available at the target station for biological sample irradiation.

Ions: $^{1}H^{1+}$, $^{2}D^{1+}$, $^{12}C^{6+}$, $^{40}Ar^{18+}$, $^{7}Li^{3+}$

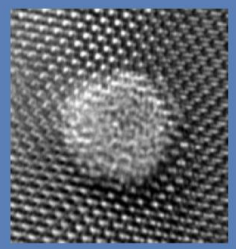
Target station will be equipped with targets from C to Pb and with the systems of beam and target diagnostics, positioning, thermometry, synchronization, radiation control, and data acquisition.

PILLARS OF APPLIED RESEARCH AT NICA

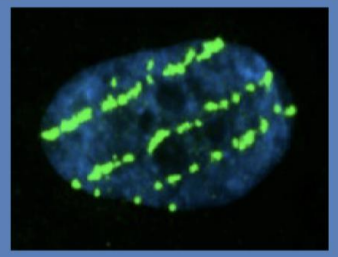
Radiation effects in microelectronics



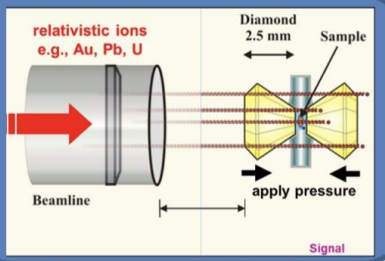
Radiation protection in space



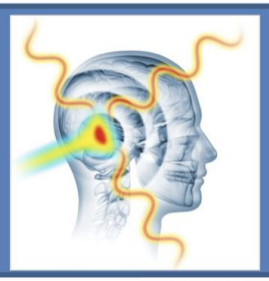
Materials research with ion beams



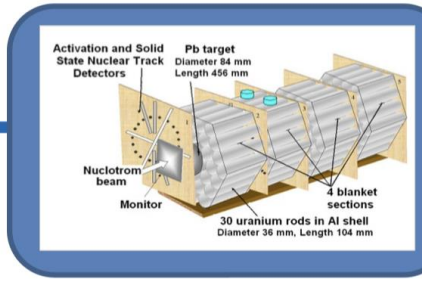
NICA



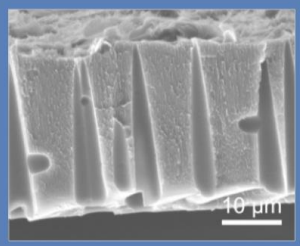
Radiation biophysics and radiobiology



Radiation therapy-related research



Novel technologies for accelerator-driven systems (ADS)



Materials in extreme radiation dose conditions

Courtesy of Dr. O.Belov

THE ENTIRE SCOPE OF RESEARCH IS NOT LIMITED TO THESE DIRECTIONS AND OPEN FOR USER PROPOSALS

NEUTRINO AND ASTROPARTICLE PHYSICS

Dzhelepov Laboratory of Nuclear Problems

Scientific directions :

– Double beta decay, neutrino nature -- Majorana or Dirac; Nuclear matrix elements

– Fundamental neutrino properties (magnetic moment, mixture with a sterile state, etc)

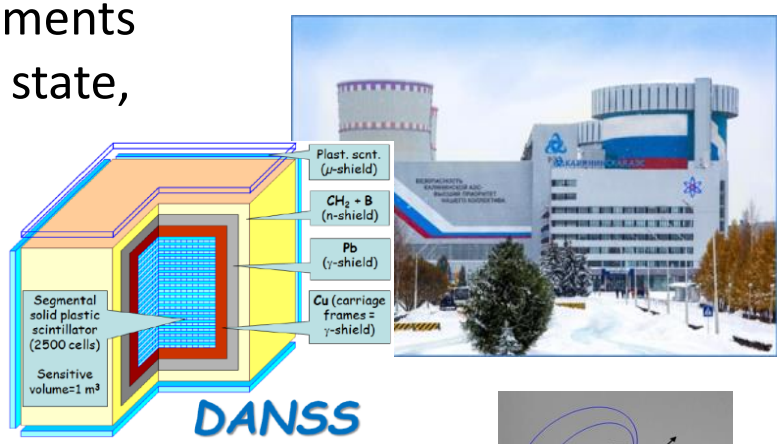
– Monitoring of nuclear reactors with neutrino detectors

– Direct and indirect search for Dark Matter

– Investigation of galactic and extragalactic neutrino sources

– Atomic processes accompanying radioactive decay

– Applied directions of research



The major aims:

– BAIKAL-GVD: Observation of ultra-high energy astrophysical neutrinos; identification of their sources and nature

– DANSS: precision measurement of the spectrum of reactor antineutrinos

– RICOCHET: New physics with precision measurements at reactors.

– vGeN: search for magnetic moment of neutrino

– LEGEND: neutrinoless double-beta decay at 10^{28} years

– Radiochemistry plus spectroscopy for astrophysics and nuclear medicine

vGeN

GEMMA-II

Edelweiss

supernemo collaboration

RICOCHET

GERDA

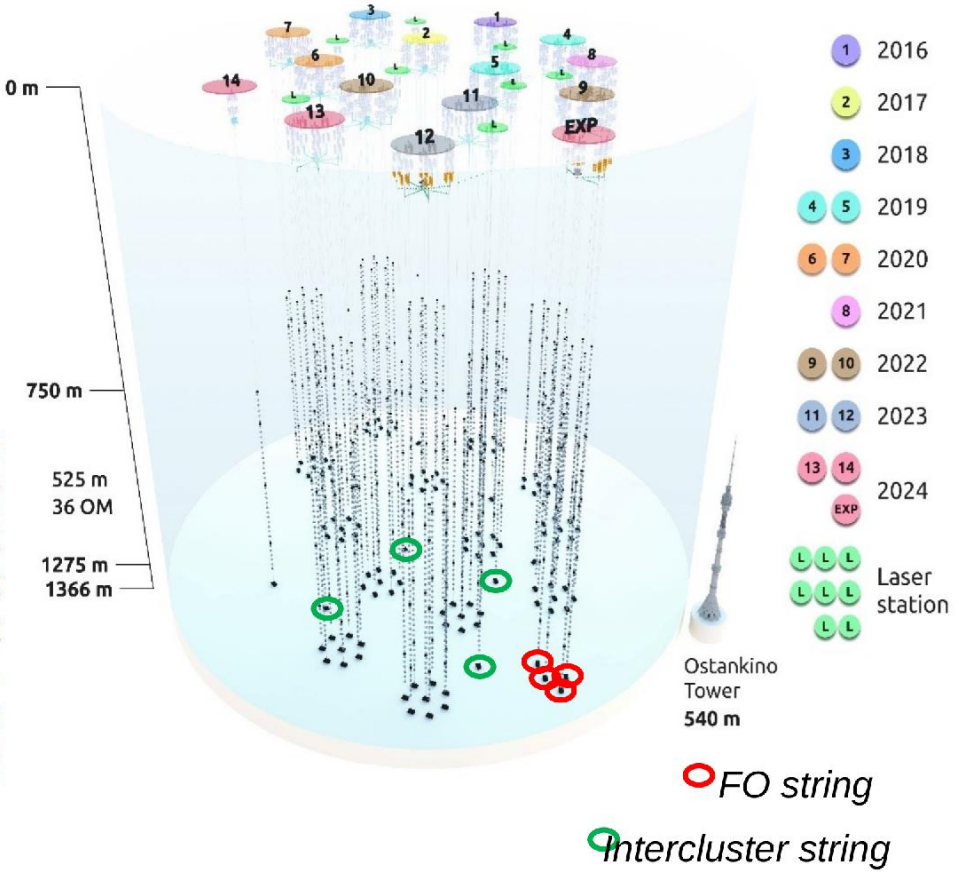
Baikal-GVD Project

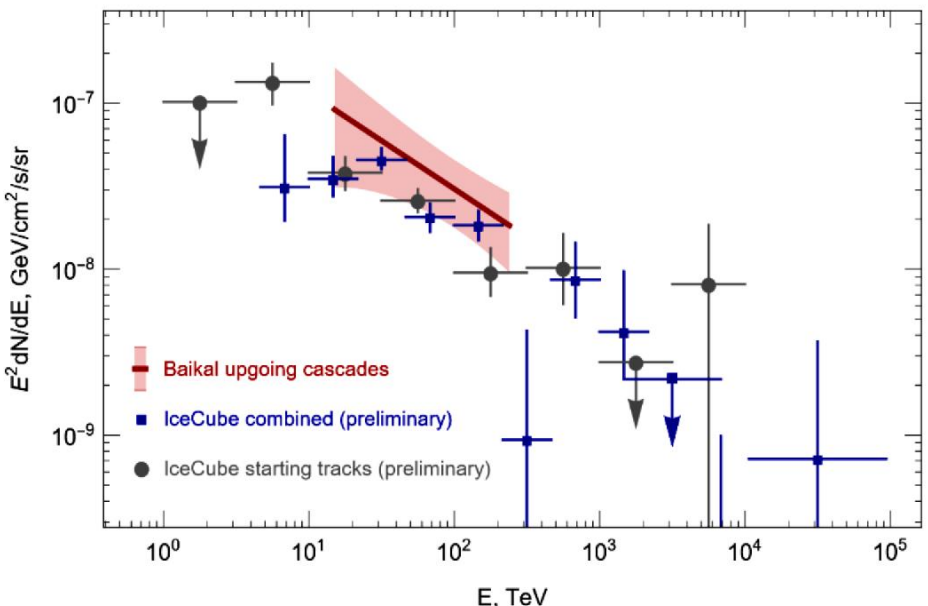
Baikal, 13 March, 2021. The ceremonial launch of the Baikal-GVD, the largest deep underwater neutrino telescope in the northern hemisphere, and the signing of a Memorandum of understanding between the Ministry of Education and Science of Russia and JINR for the development of the Baikal deep underwater neutrino telescope

Status of the Neutrino Detector Baikal-GVD

Total: 4,104 OM + 8 laser stations

- Currently, the deployment of the Baikal-GVD neutrino telescope is successfully underway. 13 full clusters are installed. The underwater structure of the installation contains just over 4,100 photodetectors;
- The production and technical base of the Baikal project ensures the deployment of **two clusters annually**;
- GVD has **developed shore infrastructure**: control centre, laboratories, workshops, deployment tools, living quarters;
- GVD is **testing ground** for the development the systems for next-generation telescope:
  - 4 strings with fiber-optic DAQ;
  - 4 inter-cluster strings.





The accuracy of determining the direction of neutrino arrival is four times as good as in the largest IceCube telescope. For the first time in an independent experiment, the existence of high-energy astrophysical neutrinos was confirmed, their flux and spectrum were measured.

Nearest plans:

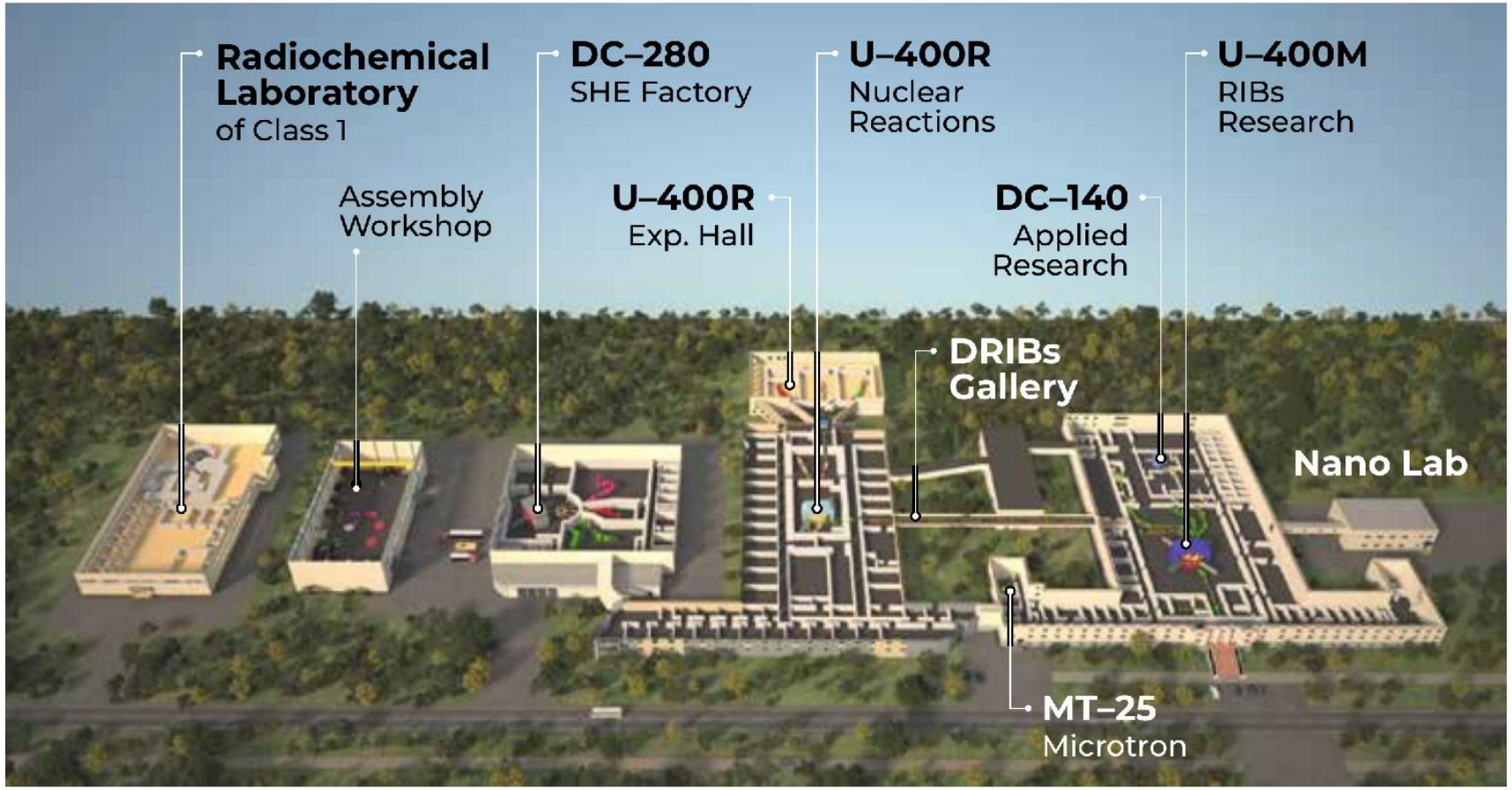
- About 700 optical modules are going to be assembled for deployment in 2025;
- The collaboration is planning to install additional 2 new clusters, 2 garlands with new DAQ system and additional inter-cluster strings in case a good external conditions (weather and ice).

On 12 February, the beam was successfully passed through the LINAC-200 sections. The inauguration will be held by Members of the JINR Scientific Council on 13 February 2025

Electron beams for various tasks

- **Particle detectors R&D** (NICA, COMET, DLNP, FLNR, Serbia, Egypt, Sarov, Novosibirsk, Tomsk)
- **Education** (JINR University Centre)
- **Electron beam diagnostics, R&D and fundamental tasks**
- **Nuclear physics experiments** (DLNP, FLNR…)
- **Applied research and Life Sciences** (LRB)

NUCLEAR PHYSICS (Flerov Laboratory of Nuclear Physics)



BASIC FACILITY — DRIBS-III ACCELERATOR COMPLEX

10 new elements have been discovered at JINR

Strategic Research Directions:

- Heavy and superheavy nuclei
- Light exotic nuclei
- Radiation effects
- and nanotechnologies
- Accelerator technologies

SUMMARY OF EXPERIMENTS:
2020–2023

240 new events of synthesis of superheavy nuclides

VS.

~100 events at all the facilities in the world, including in Dubna, since 1999

36 isotopes decays were studied

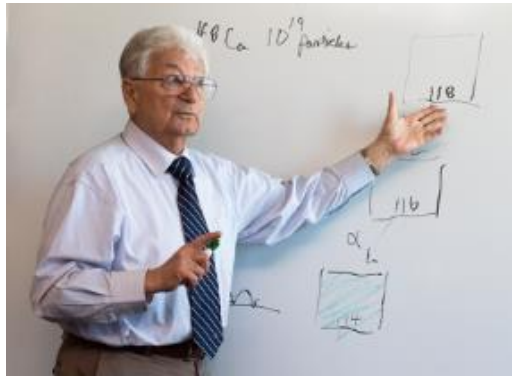
6 new isotopes were discovered:
^{286}Mc, ^{276}Ds, ^{275}Ds, ^{272}Hs, ^{268}Sg, ^{264}Lr

New decay modes:
^{268}Db (alpha-decay)
^{279}Rg (spontaneous fission)

Test of target stability up to
7 puA ^{48}Ca

Flerov Laboratory of Nuclear Reactions

Research of synthesis of new nuclei:



acad. Yu. Ts. Oganessian

Fusion:
+ any element (question of probability)
- lack of neutrons

Fragmentation:
+ very efficient and universal
- products are lighter than ^{238}U

Fission:
+ neutron-rich products
- products are much lighter than ^{238}U

Multinucleon transfer (MNT):
+ a way to unknown regions
- very, very complicated technically

Light & super light exotic nuclei, neutron-rich hydrogen (^{5,7}H) and helium (^{8,10}He) isotopes)

Courtesy of Dr. A. Karpov

Synthesis of new elements
Super Heavy Element Factory
DC-280

TARGETS:

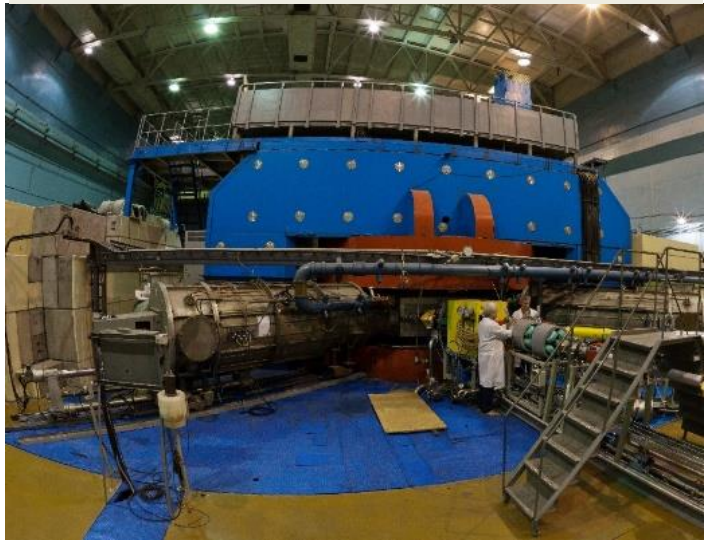
- Rosatom and ORNL (USA): *Isotopically enriched heavy actinide materials;*
- Radiochemical Lab of class 1

BEAMS:

- Production of high-intensity beams of ^{50}Ti, ^{54}Cr and others
- New ECR-28 GHz (2024)

Radioactive Ion-Beam research
Basic facility: U-400M

Ambitions: E up to 80AMeV, I x 2



In operation after upgrade

- Nucleon halo, neutron skin;
- Exotic decays: b-delayed, 2p,2n radioactivity;
- Soft excitation mode;
- New magic numbers;
- Spectroscopy of exotic nuclei;
- Cluster states;
- Reactions with RIBs;
- Astrophysical applications.

Nuclear reaction studies @ U-400R

Ambitions: up to 2.6 mA (U-beam) 10^{10-11}, smooth energy variation

Construction of new experimental hall

- **Multinucleon transfer reactions:** *Production of new isotopes of heavy,SH nuclei; Study of properties of new nuclei.*
- **Decay spectroscopy of heavy nuclei:** *actinides and light transactinides*
- **Study of fusion-fission and quasifission reactions leading to heaviest nuclei**
- **Low-energy and spontaneous fission of heaviest nuclei**
- **Study of nuclei at high excitation energies (several hundred of MeV)**

IC-100 CYCLOTRON ⇨ DC-140

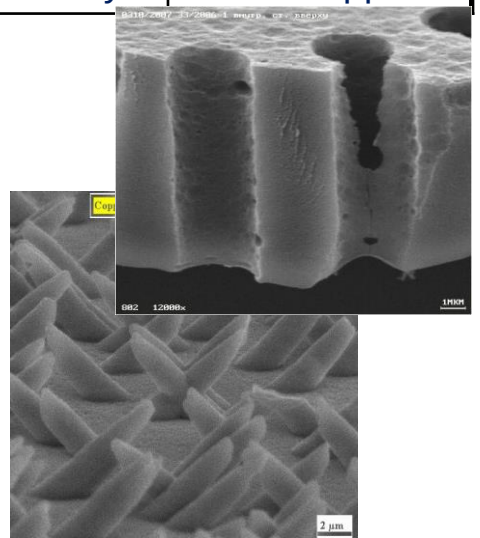
APPLIED RESEARCH

parameters	
Accelerated ions	$^{22}Ne^{+4}$ $^{40}Ar^{+7}$ $^{56}Fe^{+10}$ $^{86}Kr^{+15}$ $^{127}I^{+22}$ $^{132}Xe^{+23}$ $^{132}Xe^{+24}$ $^{182}W^{+32}$ $^{184}W^{+31}$ $^{184}W^{+32}$
A/Z ratio	5.5 – 5.95
Ion energy	0.9-1.2 MeV/A
Pole diameter	1 m
Vacuum	$5 \cdot 10^{-8}$ Torr
$^{86}Kr^{15+}$ beam intensity	$1.4 \cdot 10^{12}$ pps
$^{132}Xe^{23+}$ beam intensity	~ 10^{12} pps

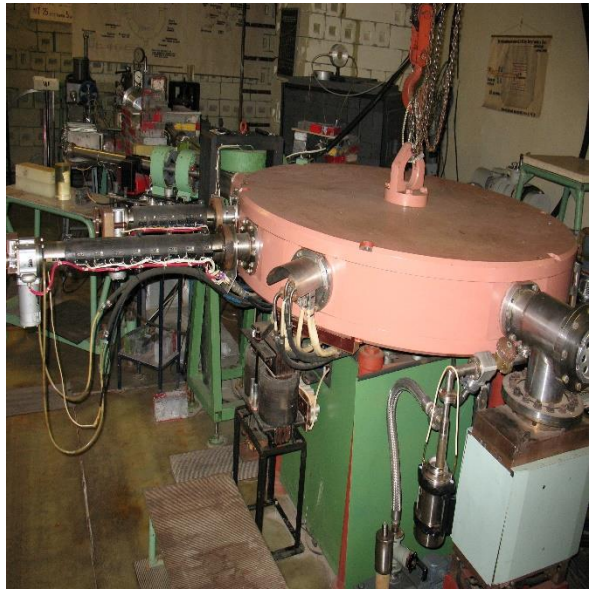
Commissioned: 1985
Reconstructed: 2002

Setups:

- polymer film irradiation unit with uniform implantation over a 600x200 mm target
- box for material science research



MICROTRON MT-25



parameters	
Energy range	5 to 25 MeV
Pulsed beam current	20 mA
γ-ray flux	10^{14} pps
Thermal neutron flux	10^{9} pps cm^{-2}
Fast neutron flux	10^{12} pps

Applications:

- γ-activation analysis
- neutron activation analysis
- isotope production for analytical purposes
- study of nuclear reaction induced by γ-quanta
- biological and genetics research
- hardness tests…

Courtesy of Dr.D.Kamanin

Laboratory of neutron physics

NEUTRON PHYSICS

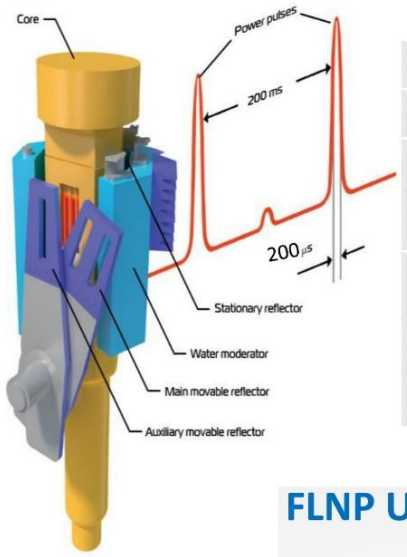
- Ultra-cold neutron physics;
  - Neutron lifetime;
  - Weak equivalence principle check. EDM?
  - Neutron quantum states in gravitational field;
- Neutron scattering for condensed matter studies
  - Diffraction at high pressure;
  - Soft matter;
  - Nanostructurized magnetic materials;
  - Energy selective neutron radiography and tomography;
- Nuclear physics with neutrons
  - Nuclear data for engineering and astrophysics;
  - Fundamental symmetries violation in neutron-nucleus interaction;
  - Applied research;

IBR-2 REACTOR
PULSED NEUTRON SOURCE
AVERAGE POWER – 2 MW
PEAK POWER – 2 GW

CONDENSED MATTER PHYSICS WITH NEUTRONS

Frank Laboratory of Neutron Physics
Лаборатория нейтронной физики им. И.М. Франка

NEUTRONS

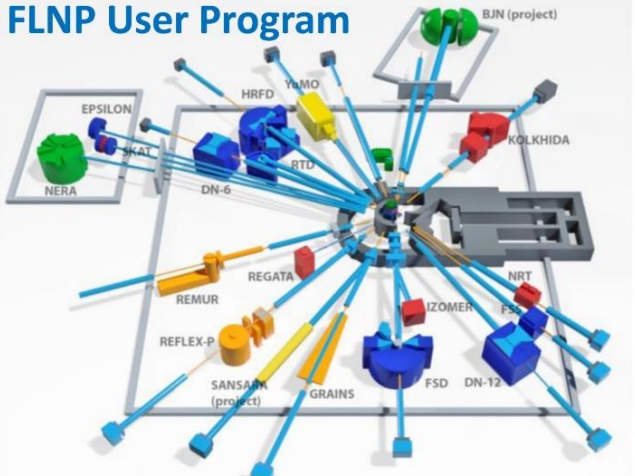


Average power, MW	1.8
Fuel	PuO_2
Pulse half-width, μs: fast neutrons thermal neutrons	 200* 340
Thermal neutron flux density from moderator surface: - time average - burst maximum	 ~ 10^{13} n/cm^2·s ~ 10^{16} n/cm^2·s

Typical Number of Operating Days per year

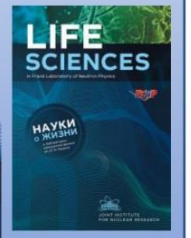
2500 h per instrument

FLNP User Program



- ▶Nanosystems and Soft Matter (YuMO, GRAINS, REFLEX, REMUR, SANSARA-project)
- ▶Atomic and Magnetic Structure (RTD, DN-6, DN-12, SKAT, EPSILON, FSD, HRFD)
- ▶Lattice and Molecular Dynamics (NERA, BJN-project)
- ▶Neutron Activation Analysis (REGATA)

Research in
– structure and dynamics of functional materials
– nanomaterials for energy storage
– materials by neutron scattering, neutron activation analysis, neutron radiography and complementary methods



http://flnp.jinr.ru

X-RAYS

SAXS/WAXS/USAXS

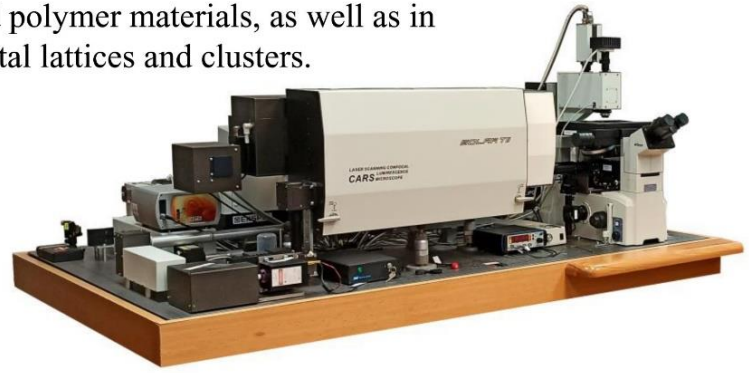
Analysis of particle size distribution, crystallization rates and lamellar structure of semi crystalline polymers. Size and shape analysis of surfactants or proteins in solutions. In situ studies of nanostructure transitions and others.

DIFFRACTOMETER

Analysis of phase composition and type of crystal structure and microstructural parameters of polycrystalline materials (films, nanomaterials and solid objects).

RAMAN SPECTROSCOPY

Analysis of nature of chemical bonds in organic molecules and polymer materials, as well as in inorganic crystal lattices and clusters.



https://ibr-2.jinr.int/

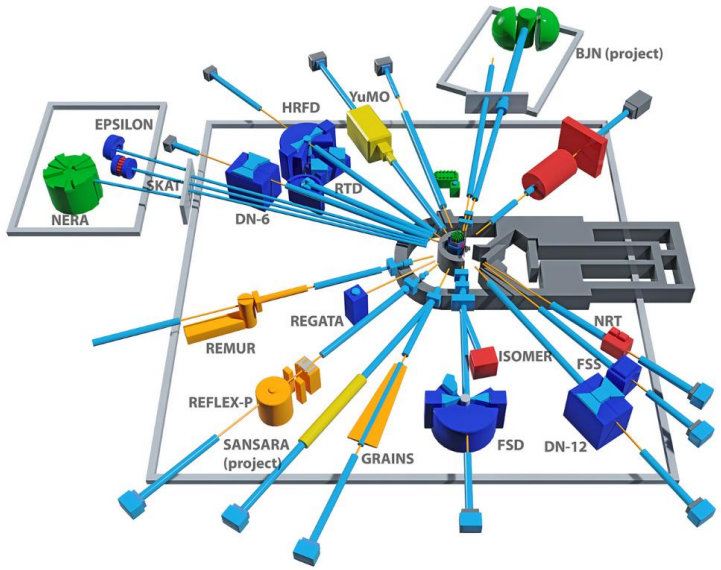
https://ibr-2.jinr.int

ATTENTION! THE OLD SITE IS LOCATED AT: oldibr-2.jinr.ru

IBR-2 User Club

Register Enter

HOME GENERAL INFORMATION FLNP VISIT IMPORTANT DATES FEEDBACK CONTACTS



News of IBR-2 User Club

2025/04/04

Dear Users,
We would like to remind you about the possibility of submitting beamtime proposals for experiments for the second half of 2025.

Submission deadline: **April 30, 2025**

IBR-2 Status: OFF

Next cycle: 13-24 of October 2025
Work schedule

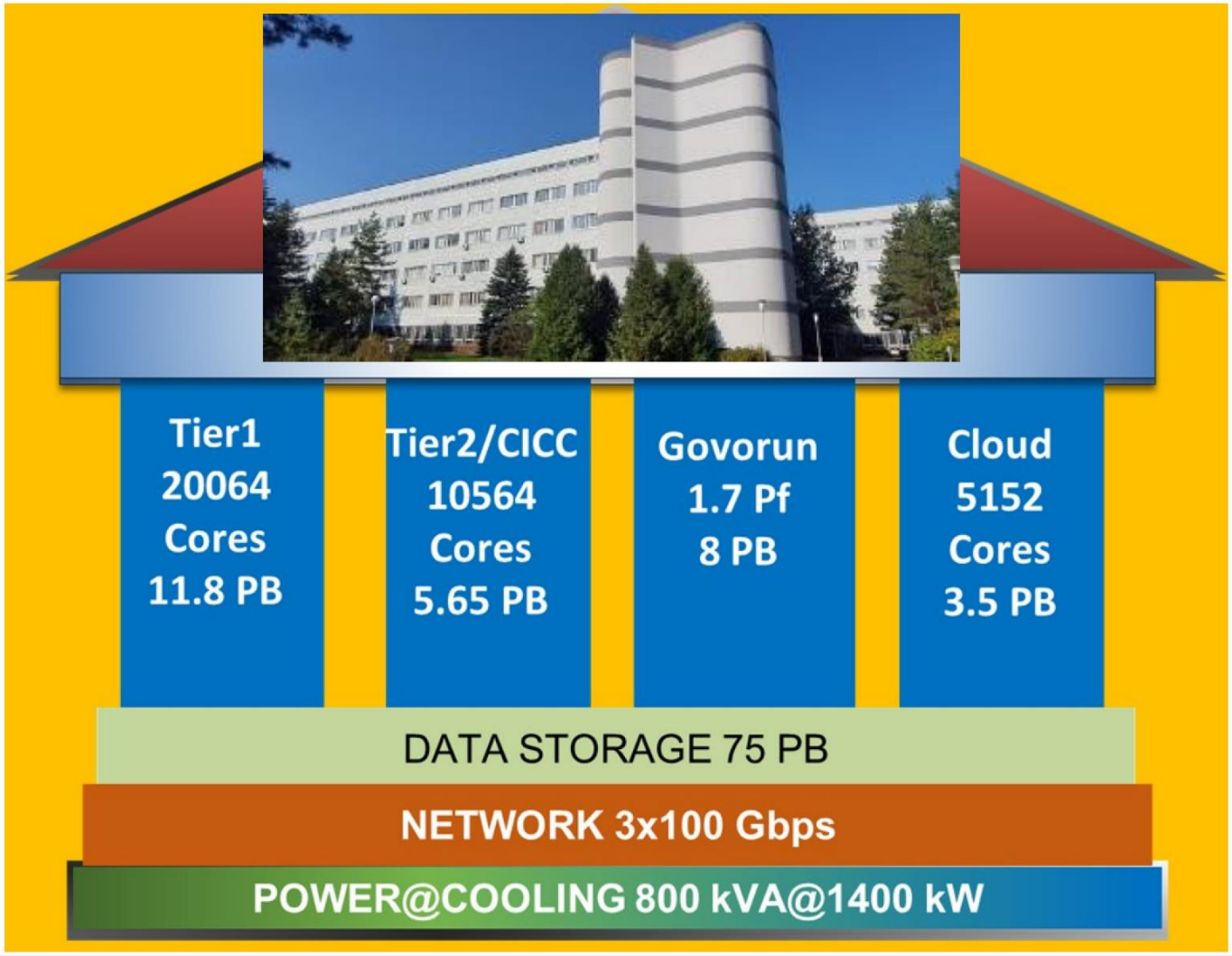
Useful information

- IBR-2 INSTRUMENTS with the list of REFERENCES and RESPONSIBLE
- CONFERENCE CMR@IBR-2
- FLNP USER GUIDE
- FLNP ANNUAL REPORTS
- FLNP DNICM LABORATORY EQUIPMENT

Information for RNF grant applicants/Информация для грантозаявителей РНФ

ОБЪЕКТ ИНФРАСТРУКТУРЫ - ИБР-2

Multifunctional Information and Computing Complex (MICC)



4 advanced software and hardware components

- Tier1 grid site
- Tier2/CICC site
- hyperconverged “Govorun” supercomputer
- cloud infrastructure

Distributed multi-layer data storage system

- Disks
- Robotized tape library

Network

- Wide Area Network
- Local Area Network

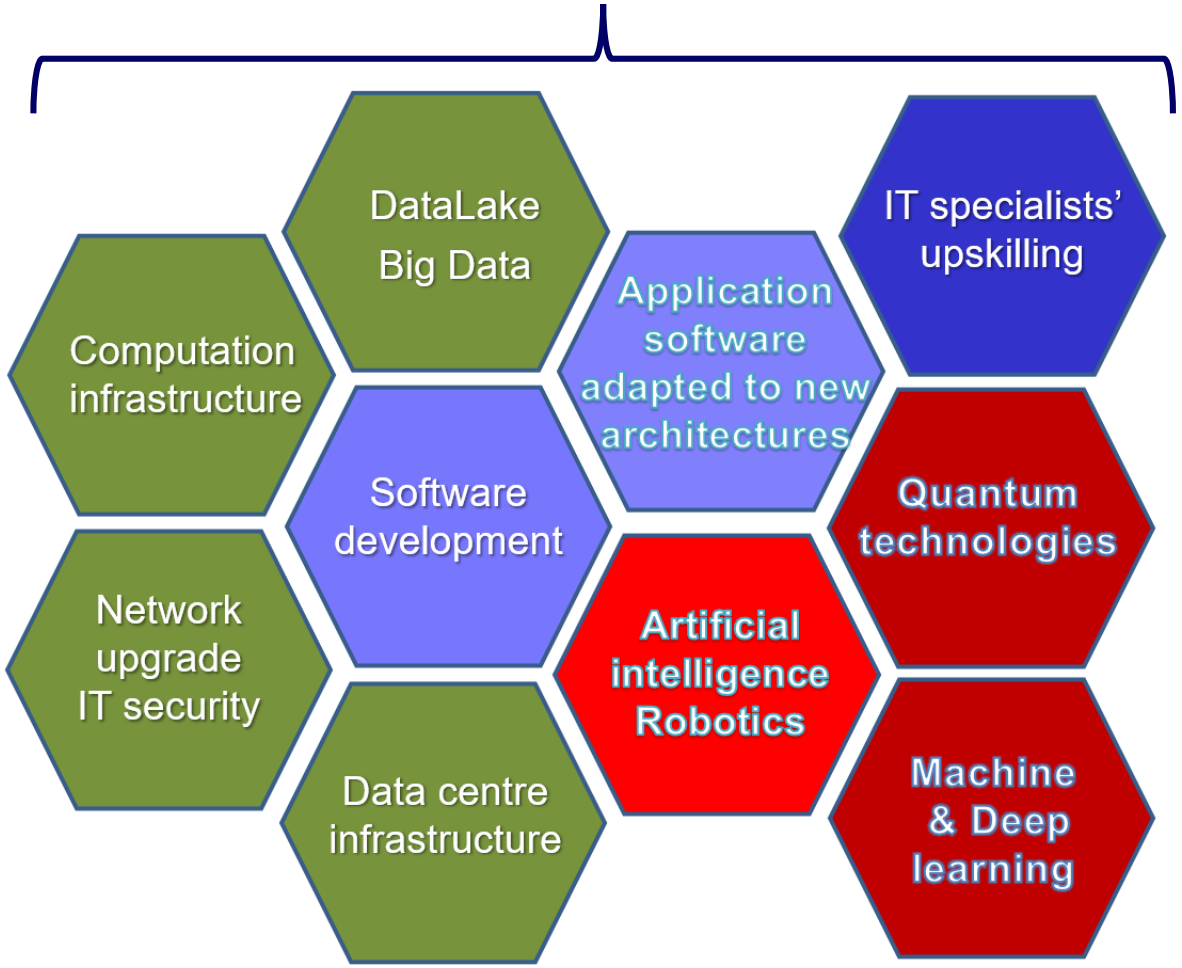
Engineering infrastructure

- Power
- Cooling

The main objective of the project is to ensure multifunctionality, scalability, high performance, reliability and availability in 24x7x365 mode for different user groups that carry out scientific studies within the JINR Topical Plan.

Strategy for Information Technology and Scientific Computing at JINR

Scientific IT ecosystem:



The coordinated development of interconnected IT technologies and computational methods

Steady implementation/upgrades of

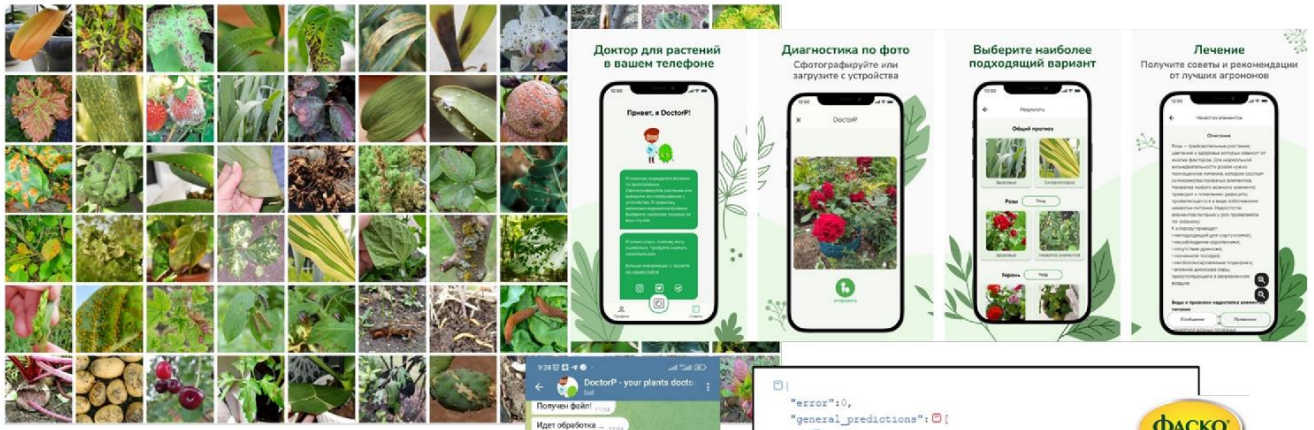
- Networking (**Tb/s** range)
- Computing infrastructure within the Multifunctional Information & Computing Complex (MICC) and
- "Govorun" Supercomputer,
- NICA Tier0-Tier1-number of Tier2;
- Baykal, NOvA, JUNO – all types of resources
- LHC@HL-LHC: Tier1 for CMS, Tier 2 for ATLAC, ALICE
- Data center infrastructure,
- Data Lake & long-term storage for all experiments.

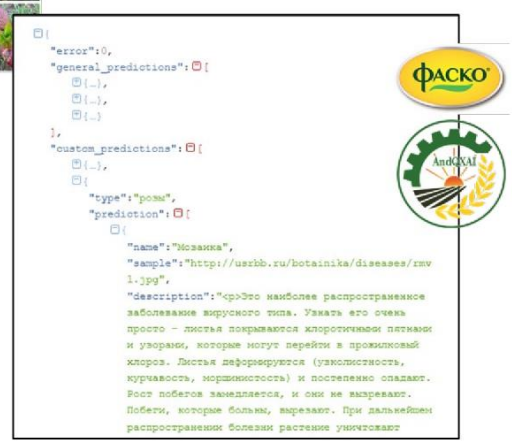
The **development of new data processing and analysis algorithms** based on

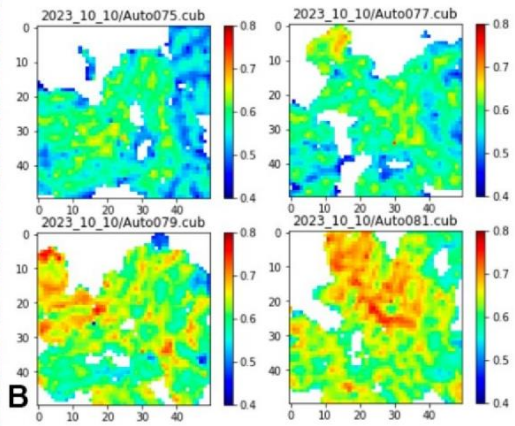
- ML/DL,
- artificial intelligence,
- Big Data
- Quantum technologies.

A variety of means will be used for IT specialists upskilling.

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.

Life Science Research

Dzhelepov Laboratory of Nuclear Problems

- Proton therapy of cancer
- Genetics
- Detectors and Tomography

Laboratory of Radiation Biology

- **Fundamental Radiobiology**
- **Radiation Neuroscience**
- **Clinical Radiobiology**
- **Mathematical Modeling**
- **Radiation Research**
- **Astrobiology**

Infrastructure for molecular, cellular and animal research

Veksler and Baldin Laboratory of HEP

- Heavy ion beamlines for space radiobiology, technologies for beam therapy

Frank Laboratory of Neutron Physics

- Analysis in the structural biology and pharmacology
- Ecology

Mecheryakov Lab. of Information Technologies

- High performance computing
- System for biological data storage and processing
- Bioinformatics, Machine Learning

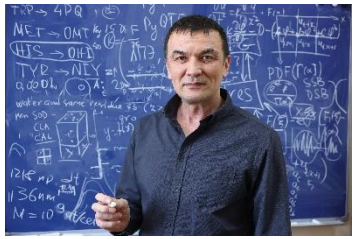
Flerov Laboratory of Nuclear Reactions

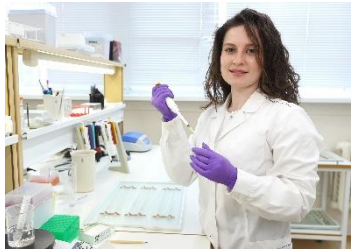
- Ion beams for cellular research
- Radionuclides synthesis for radiation medicine

Laboratory of Radiation Biology

lrb.jinr.ru

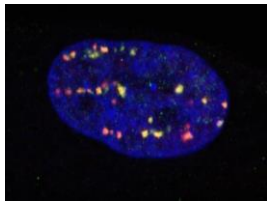
- 1959 - first radiobiological experiments
- 1978 - Biological Research Sector
- 1988 - Biological Division at DLNP
- 1995 - The Department of Radiation and Radiobiological Research
- **2005 - Laboratory of Radiation biology**



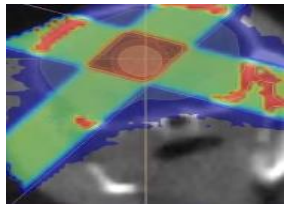


Main Research Fields:

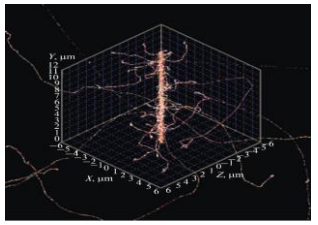
Molecular Radiobiology



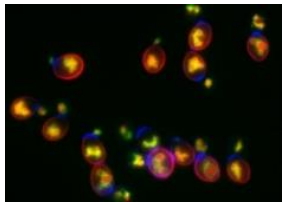
Clinical Radiobiology



Mathematical Modeling



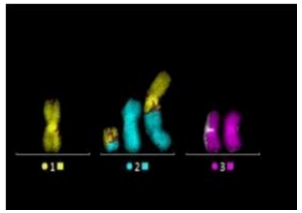
Radiation Genetics



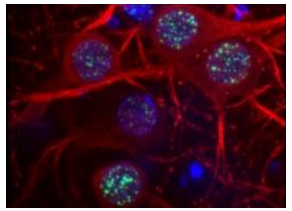
Radiation Physiology

Radiation Research

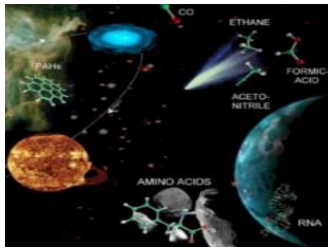
Radiation Cytogenetics



Radiation Neuroscience



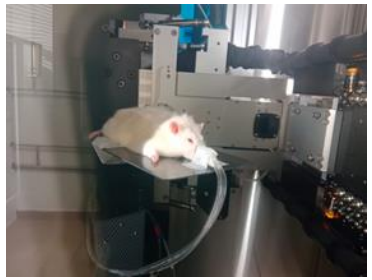
Astrobiology

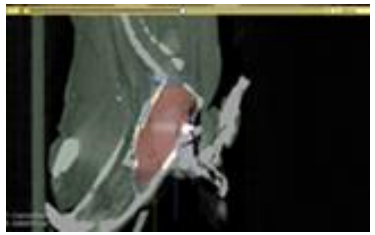


LRB Research Equipment

super-resolution microscope

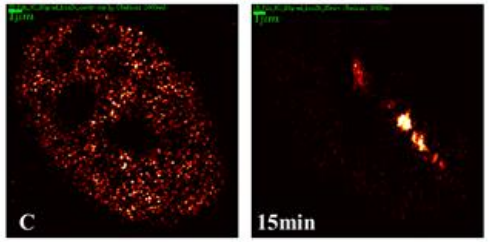
CYTEK Aurora CS
Cell Sorter | Flow Cytometer



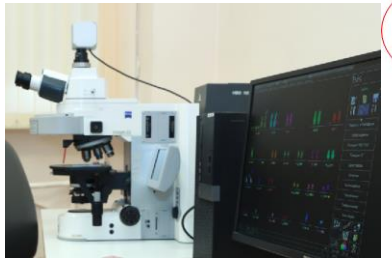


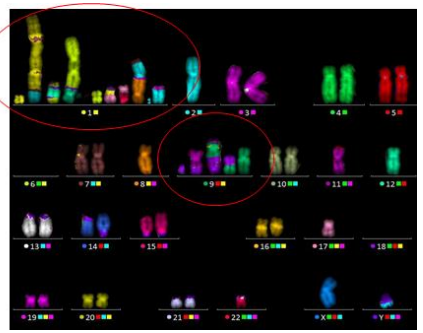
SARRP (Small Animal Radiation Research Platform)

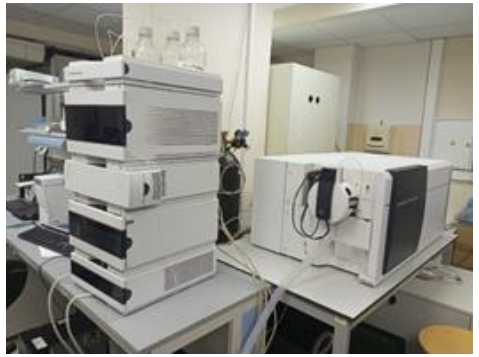
Kubtec Xcell 320



METASYSTEMS
microscopy system for mFISH







AGILENT
HPLC-MS
triple quadrupole

Vivarium (up to SPF grade cages)
Tomography Units

Scanning Electron Microscope

Innovations and applied research

The strategic goal of innovative development of **JINR “2030”**

is to become one of the leading centres of knowledge transfer among the Member States of the Institute. Such a centre should be capable of achieving significant results in compliance with their technological priorities, increasing interest in expanding applied research at the basic facilities of JINR, demonstrating the significance of the results of fundamental science for society.

The flagship initiative of the Institute in the development of **R&D infrastructure**

is the creation of the Innovative Centre for Nuclear Physics Research in radiation biology, biomedical technologies, radiation materials science, ecology, and information systems.

- **Machine learning**
  Plant disease detection platform pdd.jinr.ru
- **Hydrogen energy**
  New materials and proton-exchange membranes improvement
- **Implant development**
  Biocompatible implants for corneal transplantation
- **Proton therapy**
  New 230 MeV superconducting medical cyclotron
- **Membranes**
  Track membranes for water analysis and filtration Cassette module for immunoenzyme preparations and vaccines
- **Tomography**
  semiconductor detectors for "coloured" computer tomography
- **Carbon supersites**
  Mobile facility for measuring soil carbon content
  based on the tagged neutron method

DOKAGENE

Центр водородных технологий

Центр водородной энергетики

ГЛАЗНОЙ ЦЕНТР ВОСТОК-ПРОЗРЕНИЕ
Мировое качество офтальмологии в России

ROSATOM

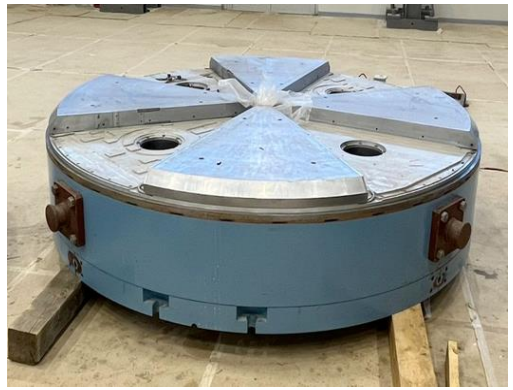
ВЛАДИСАРТ
VLADISART

Реатрек

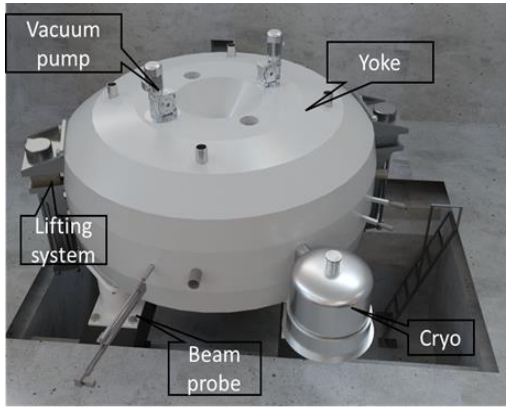
МИНИСТЕРСТВО НАУКИ И ВЫСШЕГО ОБРАЗОВАНИЯ РОССИЙСКОЙ ФЕДЕРАЦИИ

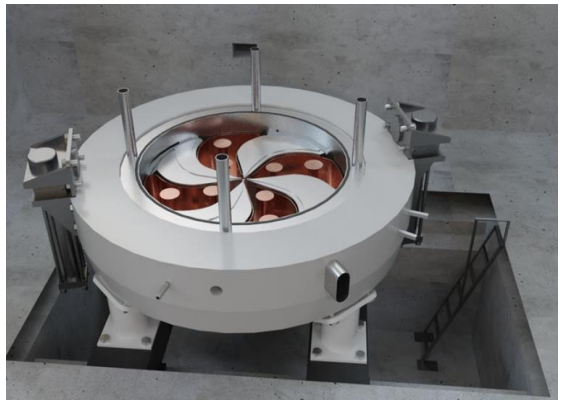
INTERNATIONAL CENTRE FOR NUCLEAR TECHNOLOGIES RESEARCH

- **Radiation Biology @ LRB**, OMICS technologies, radiation neuroscience, new approaches for radiation therapy, targeted delivery of drugs and radionuclides, radioprotectors;
- **ARIADNA.** Applied beams@NICA: radiobiological studies (400-800 MeV/n); irradiation of electronics and material science (3; 150-350 MeV/n); nuclear physics (1-4.5 GeV/n);
- **DC140 cyclotron:** Space electronics testing, radiation material science, new generation of track membranes;
- **MSC230 cyclotron:** research and beam therapy: treatment planning; radiomodificators for γ– and p- therapy, flash-therapy, pencil beam (10 μA, >5 Gr/l @ 50 ms pulse).
- **Radiochemical Laboratory Class-I** for production of radioisotopes (Ac^{225}, ^{99m}Tc), nuclear medicine R&D in photonuclear reactions @ 40MeV e-accelerator.



DC-140 (construction phase)





MSC-230 (general view)

International Training Programmes

3 stages of international student practice take place every year

About **100** project topics in the main areas of JINR research are offered to students

Over **150** students participate in international introductory practices annually

Students from **23** countries come to JINR for internships and practices

Over **30** participants in long-term student programmes and internships annually

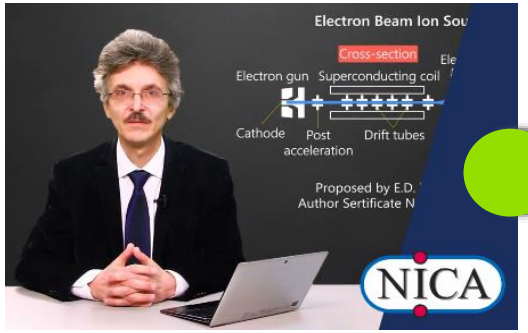
Students from **8** countries have been on excursions to JINR over the past 5 years


Programmes for students and young scientists

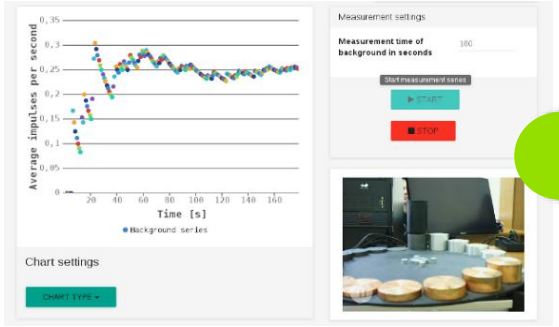
- Bachelor's, Master's and PhD theses;
- INTEREST – INTErnational REmote Student Training at JINR; Student Online Practice; **interest.jinr.ru**
- International student practices; **uc.jinr.ru/ru/isp**
- Summer Student Programme; **students.jinr.ru**
- Conferences and schools for young scientists and specialists. **ayss.jinr.ru**
- START Programme **start.jinr.ru**

Open Information & Educational Environment

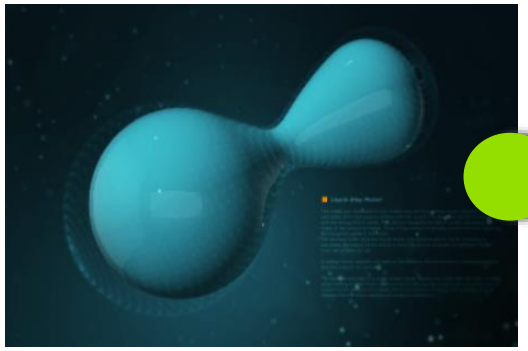
edu.jinr.ru



Video lecture courses

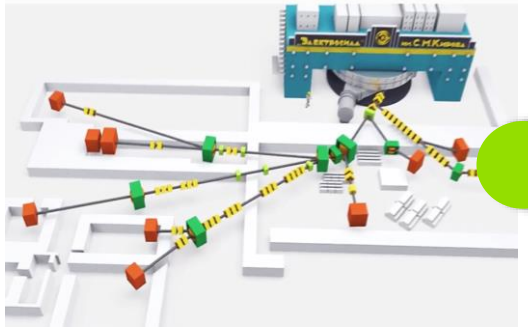


Remote practicums on nuclear physics



Virtual Laboratory for nuclear physics

Hands-on practicum



Multimedia educational resources

JINR Expositions

Information Centres in JINR and in JINR Member States

One of the instruments for the development of the Institute's international activities is the JINR Information Centres establis the JINR Member States and partner countries.

IC functions: work with students, young scientists, schoolchildr teachers, educational centres of the region, high-tech enterprises of the region, research work.

Infocentres are an excellent platform for spreading information about JINR, improving the virtual educational programmes of the JINR UC and modernizing the educational process as a whole. There are regular excursions for schoolchildren to the IC; work with teachers is constantly carried out, and a large number of educational events, the participants of which are universities, are held.

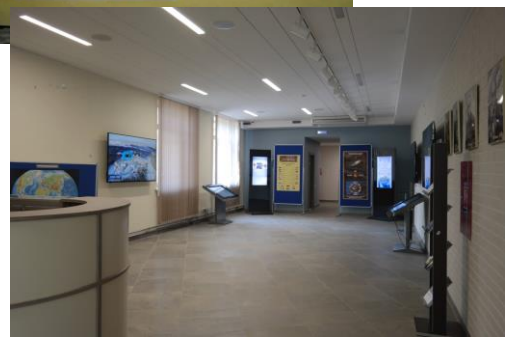
Vladikavkaz, October 2018. Opening of the JINR Information Centre at the K. L. Khetagurov North Ossetian State University

Sofia (Bulgaria), 16 September, 2021. Opening of the JINR Information Centre in Sofia University “St. Kliment Ohridski" within the framework of series of events dedicated to the 65th anniversary of the Institute and the Year of Bulgaria at JINR

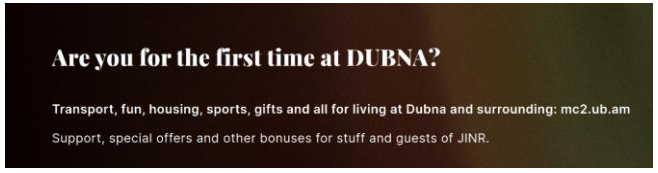
December 2020. Online opening of the JINR Information Centre on the basis of the Academy of Scientific Research and Technology (ASRT) of the Arab Republic of Egypt

Arkhangelsk (Russian Arctic), 18 March, 2022. Opening of the JINR Information Centre in Federal Arctic University

SOCIAL ENVIRONMENT



JINR Visit Centre



Unofficial guide
https://mc2.ub.am/en

JINR Club of scientists

JINR Conference Centre

JINR Cultural Centre "Mir"

JINR Stadium "Nauka"

JINR Tennis Courts

Swimming Pool "Archimedes"

Hotel Complex "Dubna"

JINR Resort "Dubna" (Black sea)

JINR Yacht Club

International Culture at JINR

Joint Institute for Nuclear Research

SCIENCE BRINGING NATIONS TOGETHER

JINR

DOSCIENCE@DUBNA