JOINT INSTITUTE FOR NUCLEAR RESEARCH

science brings nations together

DUBNA | 2024

WWW.JINR.INT

THE JOINT INSTITUTE FOR NUCLEAR RESEARCH

is an international intergovernmental organization, a world-famous scientific centre that integrates fundamental theoretical and experimental research with the development and application of advanced technology and university education.

The megascience project on the construction of the superconducting heavy ion collider NICA is being implemented at the Joint Institute.

JINR plays a significant role in the implementation of the megascience project on the construction of the Baikal–GVD deep underwater neutrino telescope.

10 new elements have been discovered at JINR. JINR has a unique neutron pulsed reactor IBR–2 for research in neutron nuclear physics and condensed matter physics.

RESEARCH DIRECTIONS

Theoretical Physics

Relativistic Heavy Ion Physics

Spin Physics

Particle Physics

Low Energy Nuclear Physics

Neutron Nuclear Physics

Condensed Matter Physics

Neutrino & Astroparticle Physics

Life sciences: **Radiobiology**, **Biomedicine**, **Structural Biology**, **Astrobiology**, **Ecology**

IT & High-Performance Computing

Outreach & Education

7 JINR Laboratories, each being comparable with a large research institute in the scale of investigations performed

Frank Laboratory of Neutron Physics

flnph.jinr.ru

Veksler and Baldin Laboratory of High Energy Physics

lhep.jinr.ru

Flerov Laboratory of Nuclear Reactions

flerovlab.jinr.ru

Dzhelepov Laboratory of Nuclear Problems

dlnp.jinr.ru

Meshcheryakov Laboratory of Information Technologies

lit.jinr.ru

Bogoliubov Laboratory of Theoretical Physics

theor.jinr.ru

Laboratory of Radiation Biology

lrb.jinr.ru

Dear colleagues and friends,

The Joint Institute for Nuclear Research in Dubna is an integral part of a global family of unique international research centres. Our mission is to provide the highest quality of the scientific agenda for cutting edge research and discoveries aimed to understand the fundamental properties of matter.

The JINR Long-Term Development Strategy up to 2030 and beyond is designed to strengthen our common international scientific family. The core research fields at JINR are Low Energy Nuclear Physics, Relativistic Heavy Ion and Spin Physics, Particle Physics, Neutrino and Astroparticle Physics, Condensed Matter and Neutron Nuclear Physics, Radiobiology and Nuclear Medicine, Theoretical Physics, Information Technologies & High-Performance Computing. The foundation of the Institute is its world recognised scientific schools. Development of the idea of neutrino oscillations, synthesis of new superheavy elements, ultracold neutrons, superfluidity of the nuclear matter, postradiation recovery of cells, quantum field theory, harmonical superdimension in supersymmetry, a new generation of neutron pulsed reactors, and hyper converged heterogeneous computing cluster — these are only some of visible scientific subjects associated with modern JINR.

Our Institute and its laboratories are also setting the agenda at the forefront of innovations. To name just a few of these frontiers: novel materials and energetics, biomedicine, quantum technologies, data science, etc.

JINR is of course about basic science. No doubt that the quality of our scientific product is mainstaying on essential issues reinforcing us as a modern dynamic international intergovernmental scientific organization: worldwide scientific cooperation, science diplomacy, friendly social environment, digitalisation, innovation policy.

Our international team is diverse but united through the passion for research and sharing the value of international cooperation. The JINR Sofia Declaration signed in November 2021 highlights the value of international scientific and technological integration in solving the tasks of strengthening peace, mutual understanding, and socio-economic progress of all the countries.

JINR is open to attracting new partners and even entire regional clusters: science brings nations together. We feel obligated to use our scientific and integrating potential to promote peaceful scientific and technological progress in different parts of our planet.

Please, enjoy this brochure and become our missionary. On behalf of the JINR team I wish you pleasant acquaintance with our International Research Centre.

Grigory Trubnikov

Director of JINR

Seven-Year Plan for JINR Development (PDF)

JINR Development Strategy (PDF)

ORGANIZATION

The Committee of Plenipotentiaries of the Governments of the JINR Member States (CP), which is the supreme governing body of JINR, takes main decisions on the Institute's activities. The JINR Member States share the financing of the JINR activities and have equal rights in controlling the Institute. The Member States make contributions in the amount established by the Committee of Plenipotentiaries. The Finance Committee and the Scientific Council operate under the CP JINR.

The research policy of JINR is determined by the Scientific Council. It consists of eminent scientists from world-leading scientific organizations and universities.

The Programme Advisory Committees (PACs) are advisory bodies to the JINR Directorate and to the JINR Scientific Council in three scientific fields: Particle Physics, Nuclear Physics, Condensed Matter Physics. The Programme Advisory Committees evaluate experimental projects proposed by scientific collaborations, institutes, JINR laboratories, and individual scientists.

The Science and Technology Council of the Institute is an advisory body to the Directorate of the Institute. It aims to ensure the participation of the scientific staff of the Institute in organizing its research activities. The immediate control over the JINR activity is exercised by the Directorate.

MISSION AND GOALS

The Institute was established with the aim of uniting the efforts, scientific and material potential of its Member States for investigation of the fundamental properties of matter. Over almost 70 years, JINR has accomplished a wide range of research and trained highly qualified scientific staff for the Member States.

The concept of further development of JINR as a multidisciplinary international centre for fundamental research in nuclear physics and related fields of science and technology implies efficient use of theoretical and experimental results, as well as methods and applied research at JINR in the field of high technology through their application in industrial, medical, and other kinds of technical development. The Institute's development strategy is detailed in the Seven-Year Plan for the Development of JINR.

JINR IS A MEMBER OF 39 COLLABORATIONS AT SCIENTIFIC CENTRES AROUND THE WORLD

>900 PARTNER NETWORK ORGANIZATIONS

On 1 February 1957, JINR was registered by the United Nations.

On 24 September 1997, UNESCO and JINR signed an Agreement on Cooperation in Paris. Based on the agreement, the Institute became one of the international intergovernmental organizations associated with UNESCO.

INTERNATIONAL DIALOGUE FOR SCIENTIFIC INTEGRATION AND SCIENCE DIPLOMACY

SOFIA DECLARATION

The Declaration highlights the value of international scientific and technological integration in solving the tasks of strengthening peace, mutual understanding, and socio-economic progress of all the countries. The document was adopted on 22 November 2021, at the session of the Committee of Plenipotentiaries of the Governments of the JINR Member States held in Bulgaria.

Full text

JINR'S RANK

in the worldwide rating of **International Intergovernmental Research Organizations**

2 PERSONNEL

5 BUDGET **natural science only**

8 BUDGET

The list of the Intergovernmental Research Organizations is received from the open database of the Yearbook of International Organizations. Information on budget and staff is taken from the annual reports of the organizations.

NUCLOTRON-BASED ION COLLIDER FACILITY

SEARCH FOR NEW STATES OF NUCLEAR MATTER

Megascience project for research into the critical states of nuclear matter under extreme conditions, which occurred after the Big Bang at early stages of the Universe evolution using high-intensity heavy ion beams.

NICA covers an energy range where most important and interesting physics appears to take place — transition from hadronic to partonic effect dominance, possible appearance of first order phase transition in QCD phase diagram, transition from baryon to meson dominance in particle production.

NICA PARAMETERS

Range of nuclei:
from hydrogen to bismuth, including gold

Extracted beams:
energy — up to **4.5 GeV/nucleon**
intensity —
$5{\cdot}10^{8}$ s^{-1} for heavy ions
10^{10} s^{-1} for protons

Designed luminosity:
10^{27} cm^{-2} s^{-1} for heavy ions
10^{32} cm^{-2} s^{-1} for light nuclei and polarised protons as well as deuterons

nica.jinr.ru

Energy
$\sqrt{S}$=4–11
GeV/nucleon

Collider ring circumference
503m

JINR IN EXTERNAL EXPERIMENTS ON PARTICLE PHYSICS

Involvement in external experiments — for mutual benefit from the exchange of new scientific information and technological know-how with the emphasis on the tasks initiated or supported by JINR groups.

In LHC experiments at CERN, JINR physicists participate in analyses of data obtained and in the detectors upgrades.

Search for beyond Standard Model phenomena: CMS, ATLAS, COMET

Spin and orbital momentum composition of the proton: COMPASS/AMBER

Spectroscopy of charmed particles production in electron-positron annihilations: BES–III

Also @ CERN: ALICE, SPS, NA62, NA64

RHIC@BNL — beam energy scan made by the STAR collaboration is one of the key components of the NICA physics programme and STAR members engagement is above rubies. FAIR/GSI projects are also beneficial for NICA:

- silicon tracker technology in CBM will be implemented in BM@N and SPD experiments
- high speed electronics with PASTTRECK chip from HADES will be used for straw-tracker of SPD
- superconducting dipole magnet CBM, R&D for track gas detectors, and scintillation detectors with SiPM readout are very helpful in preparation of NICA experiments

ARIADNA beamlines

APPLIED **R**ESEARCH **I**NFRASTRUCTURE FOR **AD**VANCED **D**EVELOPMENTS AT **N**ICA **FA**CILITY

Channels for transporting charged particle beams and irradiation stations are being developed and put into operation at NICA. They are designed for research in the fields of life sciences, radiation materials science and radiation resistance of electronics, development of advanced technologies for nuclear power problems.

100%

of **dipole** and **quadrupole magnets** manufactured and tested for the project

99%

capital construction

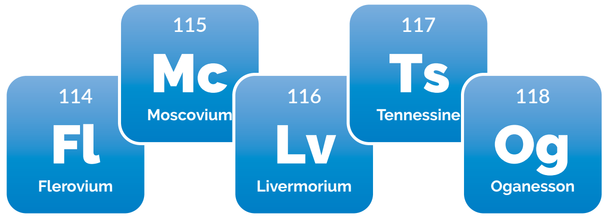
88%

overall project progress

LOW ENERGY NUCLEAR PHYSICS

In this field, JINR conducts advanced experiments on the synthesis of new superheavy elements.

The scientific programme includes experiments on the study of nuclear and chemical properties of new superheavy elements, reactions of fission, fusion, and multinucleon transfer in heavy ion collisions.



5 NEW superheavy elements **have been discovered at JINR** that conclude period 7 **of the Periodic Table**

for the past 25 years

AT PRESENT

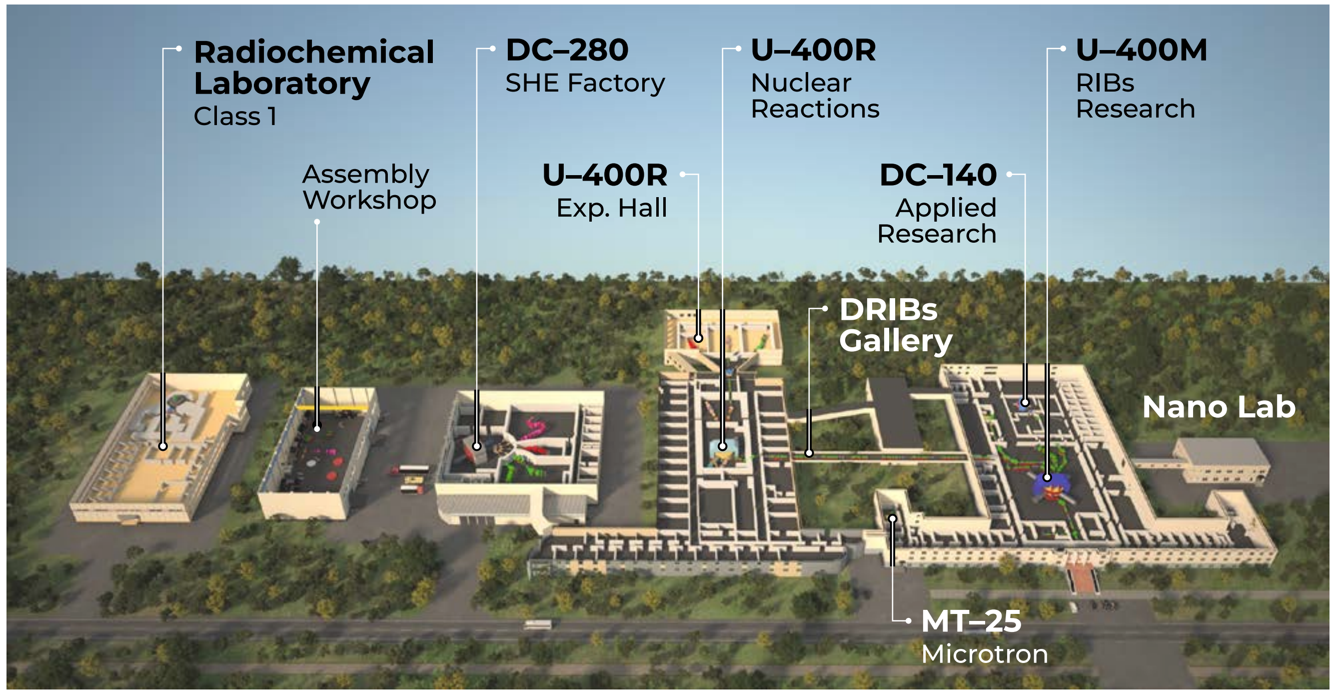
The development of works in the fields of synthesis and property study of superheavy elements is associated with the creation of a new accelerator complex called the Superheavy Element Factory (SHE Factory) based on the DC–280 specialised cyclotron. The key task of the complex is to synthesise new chemical elements with atomic numbers 119, 120, and further, as well as to study in detail nuclear and chemical properties of the earlier synthesised superheavy elements.

Record parameters of accelerated heavy ion beams have been achieved at the Superheavy Element Factory accelerator complex. The ^{48}Ca beam intensity exceeds 8 pμA. The ^{40}Ar beam at the SHE Factory has reached its designed intensity of 10 pμA.

The scientific infrastructure of the SHE Factory is gradually improving: accelerators U–400 and U–400M are developing, a new facility DC–140 is under construction for applied research in the fields of track membranes and materials science.

One of the results of global importance achieved by JINR scientists is the experimental proof of the existence of the "island of stability" of superheavy elements centred near Z=114 and N=184.

In November 2021, FLNR JINR Scientific Leader **Yuri OGANESSIAN**, after whom new element 118 was named for his pioneering contributions to transactinide elements research, was awarded the UNESCO–Russia Mendeleev International Prize in the Basic Sciences ***"to acknowledge his breakthrough discoveries extending the Periodic Table and for his promotion of the basic sciences for development at the global scale."***



BASIC FACILITY — DRIBs–III ACCELERATOR COMPLEX

SUPERHEAVY ELEMENT Factory

Strategic Research Directions:

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

SUMMARY OF EXPERIMENTS:
2020–2024

~250 new events of synthesis of superheavy nuclides

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

42 isotopes decays were studied

7 new isotopes were discovered:
^{288}Lv, ^{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
8 pμA ^{48}Ca

NEUTRINO PHYSICS AND ASTROPHYSICS

Research programme in the fields of neutrino physics and astrophysics includes a number of projects, among which Baikal–GVD is the main infrastructure and research facility.

The neutrino telescope is located in Lake Baikal 3.6 km away from the shore, at a depth of about 1,300 m. Baikal–GVD is the largest in the Northern Hemisphere and the second in size in the world.

Baikal–GVD: identification of astrophysical sources of ultra-high energy (exceeding tens of TeV) neutrinos.

Topicality: their sources are still unknown. The identification of sources will help elucidate the mechanisms of galaxies creation and evolution. This unique scientific facility is an important tool of multi-messenger astronomy, a new powerful method to investigate the Universe.

Baikal–GVD is one of the three neutrino telescopes across the world and, along with IceCube at the South Pole and KM3NeT (former ANTARES) in the Mediterranean Sea, is part of the Global Neutrino Network (**GNN**).

The Baikal–GVD Neutrino Telescope is being constructed by the international collaboration with a leading role of the RAS Institute for Nuclear Research (Moscow) and the Joint Institute for Nuclear Research.

more than **60** scientists & engineers | from **9** international research centres

Together, **Baikal–GVD and TAIGA** can provide a unique **multi-messenger observation** of the Universe integrated into the global astroparticle network.

JINR PARTICIPATION IN NEUTRINO OSCILLATION EXPERIMENTS

- Determination of CP-violating phase: DUNE
- Determination of neutrino mass ordering: NOvA, JUNO
- Precise determination of elements of the lepton mixing matrix: JUNO, DUNE

Physical properties of neutrino

- Determine whether a neutrino is a Majorana particle: SuperNEMO, GERDA–LEGEND
- Coherent elastic neutrino-nucleus scattering process at nuclear reactors: nuGEN (GEMMA)
- Sterile neutrino oscillation: DANSS

Dark matter discovery

- Existence of the dark matter particles: DarkSide, EDELWEISS
- Sources of high energy (exceeding tens of TeV) gammas: TAIGA
- Determination of nuclear matrix elements via muon capture: MONUMENT

The discovery of **gravitational waves** is one of the most remarkable discoveries ever.

VIRGO

The VIRGO experiment aims to search for gravitational waves. JINR scientists installed Institute's brand new laser inclinometers at the VIRGO Interferometric Gravitational-Wave Antenna to improve its sensitivity.

CONDENSED MATTER AND NUCLEAR NEUTRON PHYSICS

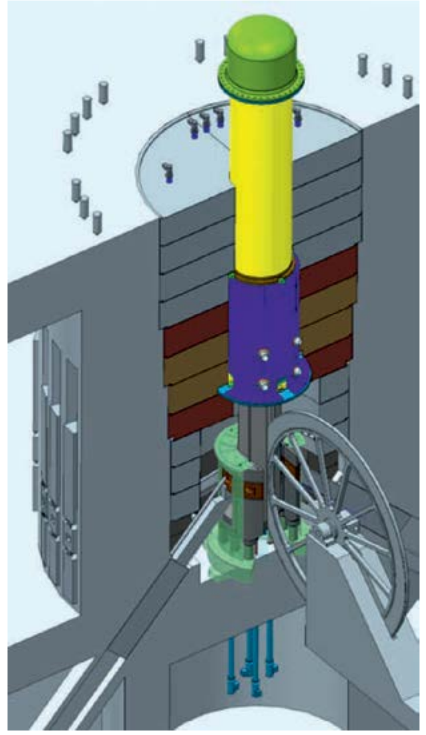
This scientific programme is implemented mainly, but not exclusively, at two basic facilities: the IBR–2 pulsed reactor of periodic action and the IREN resonant neutron source based on a linear electron accelerator.

ibr-2.jinr.ru

The **IBR–2** reactor is among top-5 "brightest" neutron sources in the world, and an international user programme is being implemented at its instruments to fulfil a wide range of tasks in physics, chemistry, biology, geology, materials science, ecology, etc. A suite of 13 high-performance instruments is available for conducting experiments, at which more than 200 experiments are carried out annually by scientists from all around the world.

Research at **IREN** focuses on nuclear data, issues related to fundamental symmetries of nuclear interactions, elementary analysis by the method of neutron resonances and applied research for the study of cultural heritage objects.

JINR is considering the possibility of creating a new neutron source of the 4th generation — the **NEPTUNE** pulsed reactor of periodic action with a power of up to 15 MW and fuel based on neptunium nitride. In combination with a modern complex of bispectral moderators, sample environment systems, and spectrometers, such a source promises to become the best in the world and open unprecedented possibilities for scientists from the JINR Member States and the entire neutron community.



Schematic view of the **4th generation pulsed reactor**

LIFE SCIENCES

RADIOBIOLOGY, BIOMEDICINE, STRUCTURAL BIOLOGY, ASTROBIOLOGY, ECOLOGY

Dzhelepov Laboratory of Nuclear Problems

- Proton therapy of cancer
- Molecular genetics
- Detectors and tomography

Laboratory of Radiation Biology

- Fundamental Radiobiology
- Radiation Neuroscience
- Clinical Radiobiology
- Mathematical Modelling
- Radiation Protection
- Astrobiology

Infrastructure for molecular, cellular and animal research

Flerov Laboratory of Nuclear Reactions

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

Frank Laboratory of Neutron Physics

- Beamlines for neutron scattering
- Structural Biology
- Ecology

Meshcheryakov Laboratory of Information Technologies

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

Veksler and Baldin Laboratory of HEP

NICA ARIADNA

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

LIFE SCIENCES

Scientific research in general and life sciences in particular have always benefited from the development of large-scale scientific infrastructures.

JINR ADVANTAGES

- Multiple radiation sources with applied channels (protons, neutrons, heavy ions, radionuclides)
- Variety of complementary instruments for structural biology studies
- Infrastructure for large-scale animal research, including on primates
- Member of International Biophysics Collaboration

PROTON THERAPY AT JINR

Expertise since 1968.

BASIC FACILITY — PHASOTRON, A CYCLIC ACCELERATOR OF HEAVY CHARGED PARTICLES

JINR worked out the method of conformal 3D irradiation of deep-seated tumours, where the dose distribution precisely conforms (up to millimetres) to the target shape.
1,300 patients underwent proton beam therapy at the JINR Medico-Technical Complex.

- **A fundamentally new method to enhance the biological effectiveness of medical proton beams and gamma-ray units has been developed and patented by LRB JINR.**
- **Worldwide unique experiments were carried out to study the effect of high-energy heavy charged particles on the brain and behaviour of primates.**
- **Computational studies of molecular and genetic mechanisms of severe brain diseases, including Alzheimer's disease and epilepsy, are in progress at LRB, FLNP, and MLIT.**
- **DLNP JINR conducts genetic research, in particular the determination of the longevity gene and the determination of the propensity to various allergic reactions.**
- **Owing to the research at IBR–2 neutron beamlines, there is a better understanding of origins of the relevant mechanisms for health protection and even its recovery.**
- **The method of neutron activation analysis is used at FLNP to help in assessing the safety of seafood, quality of wastewater treatment, environmental pollution.**

TREATMENT APPROACHES DEVELOPED FOR:

meningiomas, chordomas, chondrosarcomas, acoustic neuromas, astrocytomas, paragangliomas, pituitary adenomas, AVMs, brain and other metastases; other neck and head tumours, melanomas, skin diseases, lung carcinoma metastases, breast cancer.

- The TANGRA collaboration at FLNP JINR is developing a mobile setup based on the tagged neutron method for determining soil organic carbon (SOC) content.
- JINR in cooperation with the Space Research Institute of the Russian Academy of Sciences participates in the development and creation of neutron, gamma-ray, and charged particle detectors for spacecrafts. Thus, the HEND and LEND high energy neutron detectors work on board NASA orbiters; the DAN device on board the Curiosity rover is part of the Mars Science Laboratory.
- LRB JINR has developed and patented a novel accelerator-based technique of modelling radiation fields with continuous particle energy spectra generated by the Galactic cosmic rays inside a spacecraft in deep space.
- In 2021, JINR issued a monograph about unique findings in the well-studied carbonaceous chondrite, which fell in 1864 in France near the village of Orgueil. Most of the fossilised microorganisms (microfossils) included in the Atlas were found by LRB JINR scientists. The monograph also considers some aspects of the transfer of life in space (the theory of panspermia).
- For the first time the synthesis of prebiotic compounds has been observed after irradiation of formamide and meteorite matter with high energy hadron beams.
- LRB and MLIT, jointly with the University of Belgrade, conduct research on the development and implementation of algorithms for automation of radiobiological research.
- JINR has further plans to develop vibrational spectroscopy & microscopy: Raman and FT–IR, as well as Micro-spectroscopic study of programmed cell death — NETosis and Apoptosis.

ADVANCED INSTRUMENTS

SARRP

(**S**mall **A**nimal **R**adiation **R**esearch **P**latform)

X-ray irradiation facility designed for radiobiological studies on small laboratory animals.
This is the only SARRP system installed in the territory of Russia and Eastern Europe.

MULTIFUNCTIONAL "CARS" MICROSCOPE

(**C**oherent **A**nti-Stokes **R**aman **S**cattering)

Tasks:

- Raman, SERS, SECARS, and CARS spectroscopy and microscopy of biological objects;
- Exploration of structural and spectral characteristics of phosphors activated with various rare-earth elements;
- Plasmon-enhanced photo- and upconversion luminescence studies.

XEUSS 3.0

X-ray scattering station by XENOCS company provides study of the structure of materials and nanomaterials from atomic to nanoscale in real time with SAXS, WAXS, and USAXS methods.

THEORETICAL PHYSICS

Research in the field of theoretical physics at JINR is carried out by the Bogoliubov Laboratory of Theoretical Physics (BLTP) as well as by theoretical groups in the experimental laboratories. As one of the largest centres, BLTP acts as a “generator” of interdisciplinary studies and international cooperation, thus determining the global scientific agenda of both theoretical and experimental research.

The research topics in theoretical physics are related to fundamental problems of modern physics and those specified by the JINR basic facilities, primarily, the NICA project, as well as physics programmes of international collaborations (LHC, RHIC, FAIR, K2K, etc.). The Laboratory hosts the world’s leading experts in quantum field theory and particle physics, modern nuclear physics, condensed matter physics, and mathematical physics. Pioneering results of the studies of Dubna theoreticians have gained worldwide acknowledgement.

Theory of Fundamental Interactions	**Theory of Atomic Nucleus**
Theory of Condensed Matter	**Modern Mathematical Physics**

33% of JINR publications

230 scientists

>500 scientific papers published per year

~15 annual scientific meetings

INFORMATION TECHNOLOGIES & HIGH-PERFORMANCE COMPUTING

BASIC INSTRUMENT — MULTIFUNCTIONAL INFORMATION AND COMPUTING COMPLEX AT JINR

Development of information technologies and mathematical methods based on them, Data Processing & Storage, Experimental Data Analysis, Big Data, Quantum Computing, Machine & Deep Learning.

Network infrastructure with a bandwidth of up to 4x100 Gbit/s, distributed computing and data storage systems based on grid technologies and cloud computing, hyper-converged high-performance computing infrastructure with liquid cooling for supercomputer applications.

Telecommunication Channels:

- JINR–Moscow 3x100 Gbit/s,
- JINR–CERN (100 Gbit/s) and JINR–Amsterdam (100 Gbit/s),
- Local area network 2x100 Gbit/s,
- Distributed multisite cluster network between MLIT and LHEP 4x100 Gbit/s.

GOVORUN SUPERCOMPUTER

Hyper-converged software-defined system

Total Peak Performance: 1.7 PFLOPS for DP

Storage performance > 300 GB / s

GOVORUN KEY PROJECTS

- NICA megaproject
- Calculations of the lattice quantum chromodynamics
- Research in the field of radiation biology
- Calculations of radiation safety of JINR facilities
- Govorun is included in the unified supercomputer infrastructure based on the National Research Computer Network of Russia (NIKS)

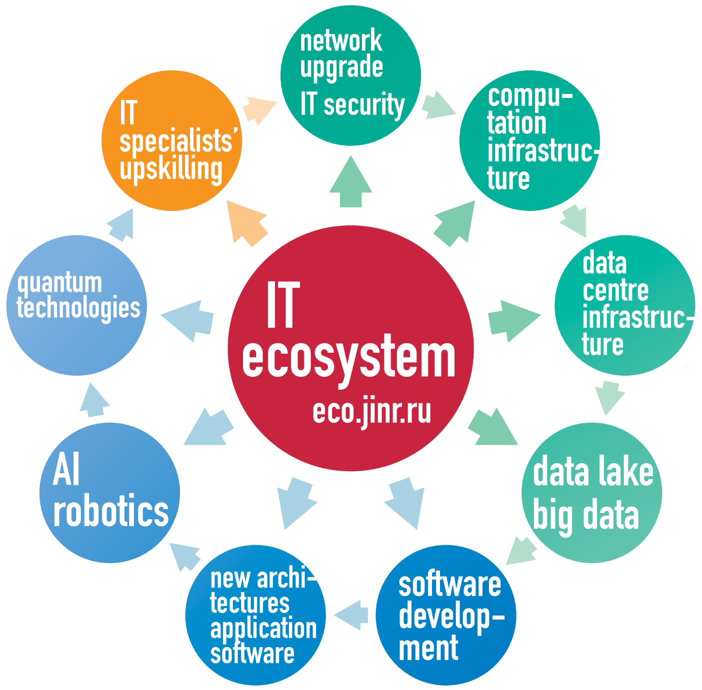
JINR is developing a unified information and computing environment, a scientific IT ecosystem that combines many different technological solutions, concepts, and techniques.

JINR GRID INFRASTRUCTURE

- Tier–1 for CMS @ LHC
- Tier–2 for ALICE, ATLAS, CMS, LHCb, BES, BIOMED, MPD, NOvA, ILC, etc.

HybriLIT Platform consists of the Govorun Supercomputer and the HybriLIT education and testing site.

A heterogeneous computing environment, based on the **DIRAC platform**, was created for processing and storing data.



JINR CLOUD INFRASTRUCTURE

- Neutrino experiments of Baikal–GVD, JUNO, NOvA
- Included in DICE — Distributed Information and Computing Environment (JINR & Member States)

EDUCATION

STUDENT PROGRAMMES
directions: **Science, Engineering, IT**

START: STudent **A**dvanced **R**esearch **T**raining
Offline. All countries. 6–8 weeks.
students.jinr.ru

INTEREST: INTErnational **RE**mote **S**tudent **T**raining
Online. All countries. 4–6 weeks.
interest.jinr.ru

ISP: International **S**tudent **P**ractice in JINR Fields of Research
"3-week introduction to JINR"
Offline. Member States only.
uc.jinr.ru/en/isp

Engineering and Physics Training
http://uc.jinr.ru/en/engineertraining

OUTREACH PROGRAMMES

Schools for Science Teachers. 1 week.
teachers.jinr.ru

Workshops, visits, lectures for foreign school students
uc.jinr.ru/ru/visit-school

Online and offline visits to the JINR labs for university and school students

edu.jinr.ru
E-learning resource

LANGUAGE COURSES
For JINR staff

AYSS 3 ANNUAL CONFERENCES

ASSOCIATION OF YOUNG SCIENTISTS AND SPECIALISTS

The Association is an active community uniting more than 1,200 young people under 35 working at JINR. It runs 3 annual conferences, as well as schools, workshops, and seminars, popularises scientific knowledge, and spreads information about JINR. Another goal of the Association is to provide help to the staff with social issues and organize social and cultural events.

JEMS TRAINING PROGRAMME

"JINR Expertise for Member States and Partner Countries"
for administrative and scientific personnel from research and educational organizations.

Excursions, lectures, round tables, networking. 1 week.

jinr.ru/jems

JINR POSTDOC PROGRAMME

The Programme provides an opportunity for talented early-stage researchers to get involved in the forefront international projects at JINR in Dubna.

BLTP JINR holds regular educational activities as part of the Dubna International School of Theoretical Physics (DIAS–TH), scientific and educational project for young scientists and students from many countries.

MLIT JINR has created an educational and research infrastructure based on the HybriLIT training and testing platform, on the basis of which training courses on modern technologies of distributed computing and parallel programming are conducted for students and specialists from many countries.

The JINR School of Information Technology is held for undergraduate and graduate students
itschool.jinr.ru

MSU BRANCH IN DUBNA

The MSU branch in Dubna has been established on the initiative of JINR. It uses the Institute's abilities as a unique international organization in the Russian Federation to establish contacts and use scientific results and best educational practices through interaction with foreign partners, participation in international projects to train personnel for fundamental research in the JINR Member States.

PHYSICS AND MATHEMATICS LYCEUM

On the initiative of JINR, a physics and mathematics lyceum named after Academician V. G. Kadyshevsky was opened in Dubna. Best teachers of Dubna and Russia work there as part of the big teacher community of the lyceum. Children from JINR Member States are among students of the lyceum.

JINR INFORMATION CENTRES

To extend and strengthen the JINR research partner network, contribute to the training of scientific staff, and popularise science, JINR builds a network of its information centres.

The JINR Information Centre is a local "Embassy" and intermediary of JINR in science and education. Information centres aim to attract potential partners, staff members, students, and schoolchildren. They initiate events to increase awareness about JINR. Eleven JINR Information Centres already operate in **Cairo** (Egypt), **Sofia** (Bulgaria), **Yerevan** (Armenia), **Vladikavkaz**, **Petropavlovsk-Kamchatsky**, **Arkhangelsk**, **Tomsk**, **Vladivostok, Irkutsk** (Russia), **Almaty** (Kazakhstan) and **Arab Atomic Energy Agency** (Tunis).

INNOVATIONS

INTERNATIONAL CENTRE FOR NUCLEAR TECHNOLOGIES RESEARCH TO BE CREATED AT JINR

Development of technologies and methods in the fields of nuclear and radiation medicine, radiation materials science, advanced training of specialists for JINR Member States in radiation biology, medical physics, materials science.

Main stages:

- Radiation biology: OMICS@LRB and neuroradiobiological studies. Radiation neuroscience. Approaches to increase radiosensitivity: pharmaceuticals, transgene systems, targeted delivery (molecular vectors) and radionuclide;
- Ion beams in broad energy range (3 MeV/nucleon to 4.5 GeV/nucleon) for innovation in life sciences, biomedicine, space exploration, radiation materials science, radiation testing of semiconductor electronics, and advanced nuclear physics technologies. Unique technologies for long-term irradiation of samples with high energy ion beams for up to several months;
- New facility with the DC–140 Cyclotron for electronic component testing, radiation materials science, track pore membrane research and production, etc. Implementation year: 2025;
- New MSC–230 Research Proton Cyclotron for R&D in beam therapy: treatment planning, radiomodificators for photon and proton therapy, flash therapy, pencil beam (10 μA, >5 Grey/litre target @ 50 ms pulse). The cyclotron is considered a pilot facility for a future medical centre. Period of implementation: 2022–2025;
- New facility: Radiochemical Laboratory Class 1 for production of radioisotopes (^{225}Ac, ^{99m}Tc) for nuclear medicine in photonuclear reactions @ 40 MeV Rhodotron accelerator. Period of implementation: 2031–2037.

JINR R&D

- Production of track membranes for water purification and plasmapheresis
- Design and construction of systems for detection of explosives and narcotic substances hidden in various containers, suitcases, safes, and parcels
- Design and construction of neutron detectors for investigation of novel functional materials on the nanoscale
- Performing reactor- and accelerator-based radiation hardness tests for electronic components of space and aviation technology and large scientific facilities

JINR EXPERTISE

- Design and construction of neutron and gamma detectors for spacecrafts
- Design and construction of superconducting magnets for large-scale scientific facilities for nuclear physics research
- Design and construction of dedicated accelerators for particle therapy
- Design and construction of accelerators for scientific research and production of track membranes

SOChI Beamline is ready (Dec 2021)

FOR NOTES

International Intergovernmental Organization
JOINT INSTITUTE FOR NUCLEAR RESEARCH

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