JINR Laboratories:

JINR comprises 7 Laboratories, each being comparable with a large institute in the scale and scope of research performed.

- Veksler and Baldin Laboratory of High Energy Physics

- Dzhelepev Laboratory of Nuclear Problems

- Bogoliubov Laboratory of Theoretical Physics
  - [http://theor.jinr.ru/](http://theor.jinr.ru/)

- Frank Laboratory of Neutron Physics

- Flerov Laboratory of Nuclear Reactions

- Laboratory of Information Technologies

- Laboratory of Radiation Biology
NICA: Nuclotron-based Ion Collider fAcity

International project in the Russian territory for research into critical states of nuclear matter under extreme conditions using high-intensity heavy ion beams.

The Standard Model — the modern picture of the World

The Big Bang Theory — the search for new states of nuclear matter

The NICA complex is aimed at the reconstruction and study of matter under extreme conditions of its phase transitions which occur at early stages of the Universe evolution.
JINR University Centre

Are you a Bachelor, a Master or a PhD student at a University of any JINR Member State or Associated Member?
You can:

- Attend JINR programme for engineers and technicians in fully equipped rooms
  Application: through the University Centre
  Selection: by national authorities

- Virtually visit JINR main scientific facilities

- Attend JINR Summer Student Programme
  6–8-week hands-on programme
  Application: through the University Centre on the web page students.jinr.ru
  Selection: by JINR Laboratories

- Use the JINR Virtual Laboratory of Nuclear Fission and the Low Energy Nuclear Knowledge Base

- Attend JINR International Student Practice
  3-week hands-on programme
  Application: through the national contact (see the list on uc.jinr.ru)
  Selection: by national authorities

- Attend our International Student Schools

The 8th International Student Summer School «Nuclear Physics – Science and Applications» (NUCPHYS – SC & APPL)
26 July – 4 August 2017
Braşov, România
Synthesis and study of superheavy elements

The SuperHeavy Elements Factory, which is based on the new high-current DC-280 cyclotron and modern efficient setups, will be the basic facility for the investigation of the heaviest nuclei.

10 new elements have been discovered at JINR over the past 60 years

Acculinna-2

Acculinna-2 fragment separator — the future of FLNR in the research of light exotic nuclei in the vicinity of the drip lines.

Nanolab

- Scanning electron microscopy
- Atomic force microscopy
- X-Ray photoelectron spectroscopy
- Equipment for sample preparation
The world’s only pulsed reactor of periodic operation. It has an average power of 2 MW and a peak power of 1850 MW. IBR-2 is one of the five world’s “brightest” neutron sources. 14 world-class neutron spectrometers, located at the beams extracted from the reactor, are available to scientists.

**Fundamental research into neutron properties**

<table>
<thead>
<tr>
<th>Neutron properties</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absence of electrostatic charge - high penetration capability</td>
<td>- the study of bulk samples; - determination of atomic scale of low energy; - determination of structure and structure transformations of molecular substances and macromolecules; - the study of the actions of chemisorption onto catalysts; - the opportunity to test a variety of materials, catalysts, high pressure cells, etc.</td>
</tr>
<tr>
<td>Neutron wavelength of thermal neutrons is comparable with atomic diameters and energy is comparable with those of electrons</td>
<td>- the study of atomic and molecular structures and dynamic processes</td>
</tr>
<tr>
<td>Presence of magnetic moment</td>
<td>- the study of magnetic properties of crystals and the fission; - the study of magnetic properties of nuclei</td>
</tr>
<tr>
<td>Nonhydrogen atomic dependence of probability of interaction between neutrons and matter on the element’s atomic number</td>
<td>- the study of high reflectivity and collective effects</td>
</tr>
</tbody>
</table>

**Examples of neutron applications**

Neutron radiography has been successfully used in paleontology.

The HEND neutron detector, constructed by the Space Research Institute of the Russian Academy of Sciences with JINR participation, aboard NASA’s 2001 Mars Odyssey spacecraft, which has been operating in the Martian orbit since 2002.
JINR Neutrino Programme

Goals and objectives of the research of neutrino properties:

- The study of high-energy neutrino properties as the only particles that can give science information about the remote parts of our Universe.
- The search for neutrinoless double beta decay that would allow drawing a conclusion about the Dirac or Majorana nature of the particle.
- The study of the transmutation of a neutrino from one kind to another, the so-called “oscillation”.

The Baikal neutrino telescope Gigaton Volume Detector

One of the three world’s biggest neutrino detectors of high energy, created by the «Baikal» collaboration.

The Baikal neutrino telescope (GVD) is part of a single research network, which, apart from producing fundamental results in the study of cosmic neutrinos, facilitates the monitoring of outer space.

The «Dubna» cluster contains 192 optical modules submerged down into the 1,300-metre depth.

The whole «Baikal» telescope will contain 27 clusters.

Central Physics Goals:

- Investigate galactic and extragalactic neutrino «point sources» in the energy range > 3 TeV;
- Investigate the diffuse neutrino flux: the energy spectrum, local and global anisotropy, flavour content;
- Investigate transient sources (GRB, binaries, etc.);
- Indirect search for dark matter;
- Investigate exotic particles: monopoles, Q-balls, nuclearites, etc.

Milestones and future of BAIKAL-GVD

First cluster of Baikal-GVD 2015

Dubna cluster event
JINR for its Partners

- Production of track membranes for water depuration and plasmapheresis
  - Different types of track membranes produced at JINR.

- Design and construction of systems for detection of explosive and narcotic substances hidden in various containers, suitcases, safes and parcels

- Design and construction of neutron detectors for investigation of novel functional materials on nanoscale
  - 2D position-sensitive gas neutron detector

- 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 spacecraft

- 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 dedicated to scientific research and the production of track membranes
JINR Computing: GRID, CLOUD, HPC

JINR Multifunctional Centre for Data Storage, Processing and Analysis.

IT infrastructure is one of the JINR basic facilities

JINR Grid Tier1 level centre — one of the 7 World centres for the CMS experiment at the LHC
- 6000+ computational nodes
- 4.2 Petabyte disk space
- 5 Petabyte tape robot
- 24/7 support

JINR Cloud Infrastructure & Utilisation

JINR Cloud infrastructure is based on OpenNebula.

Cloud is used for:
- Education and research grid infrastructure;
- PanDA polygon for the development, debugging and tests of services in the framework of ATLAS, COMPASS and NICA projects;
- Polygon on the basis of DIRAC middleware in the framework of LIT participation in the BES-III experiment;
- Cloud computational resources for BES-III;
- Virtual machines for NOVA participants;
- Hadoop polygon for big data;
- Computing resources for JINR users.

JINR Heterogeneous Cluster

Peak performance — 105.7 TFlops

The HybrILIT heterogeneous cluster enables the creation of HPC parallel applications for the solution of a large variety of mathematical resource-intensive tasks using the possibilities offered by the implemented many-core CPU and GPU accelerators.

HybrILIT-based tutorials:
- Tutorials on parallel programming techniques are regularly organised for students and young scientists from JINR and JINR Member States;
- Specialised courses by leading software developers.
Proton Therapy at JINR

- **1968**: the first treated patient
- **1974–1984**: upgrading the phasotron and construction of the Medico-Technical Complex
- **the early 2000s**: the method of conformal 3D irradiation of deep-seated tumors, where the dose distribution precisely conforms (up to millimetres) to the target shape, was worked out and successfully applied
- **2000–2016**: 1130 patients were treated with proton beam therapy at the JINR Medico-Technical Complex

Phasotron has been operating since 1949

Proton 3D radiation therapy

- more than 100 patients treated per year
- 1000 hours of proton therapy per year

Method tests

- software «TPN» developed at Loma Linda University Medical Center (USA)
- software modified to incorporate Dubna proton beams
- dosimetric measurements for the verification of algorithms

Tissue diagnostics

Research

- development of proton radiotherapy techniques
- clinical research
- dosimetry of therapeutic hadron beams
- radiobiology
- molecular and radiation genetics

Fabrication of patient-adapted devices for beam control

- profiled collimators
- boluses for the protection of the surrounding tissue

Treated diseases

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

Planning

Computation of the dose and simulation of irradiation
Bogoliubov Laboratory of Theoretical Physics

Cross-disciplinary research, theoretical physics on the basis of advanced mathematics, support of the JINR experimental programme, increasing the efficiency of scientific staff through the interplay of research and education.

International Scientific Personnel: more than 20 countries, 1/3 are young scientists

<table>
<thead>
<tr>
<th>Country</th>
<th>Theory of Fundamental Interactions</th>
<th>Nuclear Theory</th>
<th>Theory of Condensed Matter</th>
<th>Modern Mathematical Physics</th>
<th>Total (other)</th>
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</thead>
<tbody>
<tr>
<td>Russia/Other</td>
<td>54/26</td>
<td>51/18</td>
<td>37/12</td>
<td>23/8</td>
<td>220 (64)</td>
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BLTP Publications (2012–2016)

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<th>Year</th>
<th>2012</th>
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<th>2014</th>
<th>2015</th>
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<td>Journal</td>
<td>382</td>
<td>363</td>
<td>364</td>
<td>356</td>
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<tr>
<td>Conference</td>
<td>97</td>
<td>122</td>
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<td>142</td>
<td>165</td>
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<tr>
<td>Proceedings</td>
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<tr>
<td>Total</td>
<td>479</td>
<td>485</td>
<td>495</td>
<td>498</td>
<td>535</td>
<td>2492</td>
</tr>
</tbody>
</table>
JINR Social Infrastructure

- JINR Club of Scientists
- JINR Cultural Centre «Mir»
- JINR Museum

- JINR Public Library
- JINR Stadium «Nauka»
- JINR Sports Club

- Swimming Pool «Archimedes»
- JINR Tennis Courts
- JINR Yacht Club

- Resort Hotel «Ratmino»
- H&R Complex «Dubna» bld. 1
- Hotel «Dubna» bld. 3
Welcome to Dubna

- Dubna has the status as a Science town, being home to the Joint Institute for Nuclear Research, an international nuclear physics research centre and one of the largest scientific foundations in the country. The modern town was developed in the middle of the 20th century and was granted town status in 1956.
- Population: over 70,000 people.
JINR in Figures:

- **18** Member States
- **5260** staff members
- **1200** researchers
- **1000** Doctors of Science and PhDs
- **2000** engineers and technicians
- **1500** scientific publications per year
- **over 70** international conferences and workshops per year
- **800** partner universities, educational and research centres in **64** countries

Unique Park of Basic Facilities:

- **World’s Top Pulsed Neutron Source**
- **Heavy Ion Accelerators in a Wide Energy Range**
- **Megascience Project: Superconducting Collider NICA**

JINR Member States:

Associated Members: