“JINR Research Programme - Present Status and The Long Range Strategy of JINR development up to 2030”

Victor Matveev (JINR, Dubna)
2018 European School of HEP
Saint Petersburg, 07/09/2019
1. About JINR, shortly
2. Big questions of physics
3. Major JINR research projects
4. On JINR Long Range Strategy
5. Conclusion remarks
JINR is the International Intergovernmental Organization joining 18 Member States and 6 Associate Members, located in Dubna in 120 km to the north from Moscow.
JINR today

18 Member States (incl. 5 from EU):
Azerbaijan
Armenia
Belarus
Bulgaria
Vietnam
Georgia
Kazakhstan
Cuba
DPRK
Moldova
Mongolia
Poland
Russia
Romania
Slovakia
Uzbekistan
Ukraine
Czech Republic

Nearly 5000 stuff

About 780 research partners in 62 countries

6 Associate Members (incl. 3 from EU):
Hungary, Germany, Egypt, Italy, Serbia, SAR
JINR is the Multidisciplinary Research Center
Basic science and Innovative applied research
Modern Educational programmes

Particle and High Energy Physics
  Relativistic Nuclear Physics
  Neutrino Physics and Astrophysics
  **Nuclear Physics**
  Super Heavy Elements and Exotic Nuclei
  **Condensed Matter Physics**
  Studies on the beams of the Pulsed Neutron Sources
  Radiobiology and Astrobiology

**Information technology and the High Performance Computing**
**Theoretical Physics and Mathematical Physics**

**Fundamental Problems of the Life Sciences**
  Nuclear Physics methods in Life Sciences
  Cosmic Medicine and Radio Ecology
  Hadron Therapy of the oncology deceases
JINR Budget “1993–2017” => “2017-2023”
JINR priority research programmes: recent highlights
JINR Research Programme

Particle and High Energy Physics
Relativistic Nuclear Physics
Hadron Matter Physics
Fundamental Physics community celebrates the great success of Standard Model: Higgs, flavor physics, rare decays etc, and seems nothing else up to the Plank scale, if not the neutrino oscillations, dark matter and energy, and what is more - getting photo of the black hole shadow and detecting the gravitation waves.

We have to look for New Physics beyond the SM !
We need New Physics paradigms after Higgs and Gravitation waves discoveries

LIGO-Virgo, GW170104

Black Hole M87 Shadow

Standard Model of Particle Physics
Physical Cosmology
Theory of Big Bang and evolution of Early Universe
Physics of Dark Matter and Dark Energy
**NICA (Nuclotron based Ion Collider fAcility)**

- Development of accelerator facility for HEP @ JINR,
- Construction of Collider of relativistic ions from $p$ to $Au$
- and for polarized protons and deuterons

with energies up to $\sqrt{s_{NN}} = 11$ GeV ($Au^{79+}$) and $= 27$ GeV ($p$, $d$)
**Heavy ion collisions**

**Particle Physics:** Most of discoveries in last decades have been obtained through research guided by the Standard Model. But the phenomena of the quarks and gluons confinement and deconfinement still require better understanding.

**Relativistic Nuclear Physics:** Physics studies driven by already existing experimental data trends in high energy heavy ion collisions and by basic principles of the general physics - classic hydrodynamics and thermodynamics and others.

**New experimental data** in the less explored region of QCD phase diagram at the maximally achievable at laboratory high baryon density of the quark-gluon media are highly needed and could lead to:

- Observation / discovery of the principally new phenomena;
- Development of theoretical models of quark-gluon matter (deriving the EoS)

⇒ RHIC (BNL), LHC (CERN), FAIR (GSI), NICA (JINR)
Searching for “Phase Transition” in Heavy Ion Collisions

Heavy-ion collisions can be described on the language of thermodynamics (temperature, baryon density, EoS, “chemical potential”, “phase transitions”, etc.)
QCD phase diagram - Prospects for NICA

Energy Range of NICA
- unexplored region of the QCD phase diagram:
  - Highest net baryon density
  - Onset of deconfinement phase transition
  - Strong discovery potential:
    a) Critical End Point (CEP)
    b) Chiral Symmetry Restoration
  - Complementary to the RHIC, FAIR, CERN & Nuclotron/NICA experimental programs

NICA facilities provide unique capabilities for studying a variety of phenomena in a large region of the phase diagram
Experiments of the Heavy Ion collisions

→

Astrophysics in laboratory and
Early Universe in Laboratory
Au+Au collision at $\sqrt{s}=11$ AGeV event
Simulated within MpdROOT

Core of Neutron Stars reaches density several times nuclear density

The Neutron Star
Strange quark star

Highest density matter in the universe
$M = 1\sim2 ~ M_\odot, ~ R \sim 10\sim20 ~ \text{km}$
$\Rightarrow$ Density of the core $= 3\sim10\rho_0$ ($1\sim3$ Btons/cm$^3$)
$\rho_0$: nuclear density

Various forms of matter made of almost only quarks

Strange Hadronic Matter
High density nuclear matter with hyperons (strange quarks)

Nuclear “Pasta”
Nuclear + Neutron Matter
Neutron Matter
Superfluid
Quark Matter
Deconfined quarks
Color superconductivity
NICA Complex: mega-science project at JINR

26 March, 2016
NICA cornerstone ceremony
Structure of the NICA / Nuclotron Complex

- BM@N
  - Nuclotron ring (c=251.5 m)
  - Booster (c=210.9 m)
  - Injection Complex
  - Extracted beam

- Collider ring (c=503 m)

- SPD
- MPD
  - Collider
  - E-cooling

- Center NICA
- Applied research area
Nuclotron (45 Tm)
injection of one bunch of \( \leq 2 \times 10^9 \) ions, acceleration up to 1 - 4.5 GeV/u max.

Booster (25 Tm)
1(2-3) single-turn injection, storage of \((2 \div 4) \times 10^9\) ions, electron cooling, acceleration up to 578 MeV/u

Linac LU-20
Ion sources

Linac HILAc

Fixed Target Area

NICA facility elements – present status (2019)

Stripping (80%) \(^{197}\text{Au}^{31+}\) \(\rightarrow\) \(^{197}\text{Au}^{79+}\)

Collider
\(L \geq 10^{27} \text{ cm}^{-2}\text{c}^{-1}\)

BR@N

IP-2
SPD

IP-1
MPD

work in progress
assembly
commissioned / existing
**Nuclotron:**

Superconducting synchrotron, put in operation in 1993 and modernized in 2010-2015

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Nuclotron</th>
</tr>
</thead>
<tbody>
<tr>
<td>type</td>
<td>SC synchrotron</td>
</tr>
<tr>
<td>particles</td>
<td>( p, d, \text{nuclei} )</td>
</tr>
<tr>
<td>injection energy, MeV/u</td>
<td>( 5 ( p, d); ) 570-685 (Au)</td>
</tr>
<tr>
<td>max. kin. energy, GeV/u</td>
<td>( 12.07 ( p); 5.62 ( d); 4.38 (Au) )</td>
</tr>
<tr>
<td>magnetic rigidity, T m</td>
<td>25 – 43.25</td>
</tr>
<tr>
<td>circumference, m</td>
<td>251.52</td>
</tr>
<tr>
<td>cycle for collider mode, s</td>
<td>1.5-4.2 (active); 5.0 (total)</td>
</tr>
<tr>
<td>vacuum, Torr</td>
<td>( 10^{-9} )</td>
</tr>
<tr>
<td>intensity, Au ions/pulse</td>
<td>( 1 10^9 )</td>
</tr>
<tr>
<td>transition energy, GeV/u</td>
<td>7.0</td>
</tr>
<tr>
<td>RF range, MHz</td>
<td>( 0.6 -6.9 ( p, d); 0.947 – 1.147 )</td>
</tr>
<tr>
<td>spill of slow extraction, s</td>
<td>up to 10</td>
</tr>
</tbody>
</table>
The first run with $^{12}$C beam from Nuclotron has started on **March 3-17, 2019:**

- $^{12}$C beam 4 GeV/u;
- Hydrogen target;
- time 324 hours;
- 20M events recorded (19Tb).
The first heavy ion run at BM@N in the FTE hall has started on March 22, 2018:

- $^{40}$Ar beam 3.2 GeV/u;
- targets: C - Pb
- 20M events already recorded.
**Booster**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Booster</th>
</tr>
</thead>
<tbody>
<tr>
<td>type</td>
<td>SC synchrotron</td>
</tr>
<tr>
<td>particles</td>
<td>ions $A/Z &lt; 3$</td>
</tr>
<tr>
<td>injection energy, MeV/u</td>
<td>3.2</td>
</tr>
<tr>
<td>maximum energy, MeV/u</td>
<td>600</td>
</tr>
<tr>
<td>magnetic rigidity, Tm</td>
<td>1.6 – 25.0</td>
</tr>
<tr>
<td>circumference, m</td>
<td>210.96</td>
</tr>
<tr>
<td>cycle for collider mode, s</td>
<td>4.02 (active); 5.0 (total)</td>
</tr>
<tr>
<td>vacuum, Torr</td>
<td>$10^{-11}$</td>
</tr>
<tr>
<td>intensity, Au ions/pulse</td>
<td>$1.5 \times 10^9$</td>
</tr>
<tr>
<td>transition energy, GeV/u</td>
<td>3.25</td>
</tr>
<tr>
<td>RF range, MHz</td>
<td>0.5 -2.53</td>
</tr>
<tr>
<td>spill of slow extraction, s</td>
<td>up to 10</td>
</tr>
</tbody>
</table>

*Start of commissioning at the end of 2019*

**Electron Cooling System**
- 2 RF stations (Budker INP) - installed

*tunnel is ready*
The Collider

45 T*m, 4.5 GeV/u for Au$^{79+}$

Double aperture magnets:
dipole & quadrupole prototypes

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ring circumference, m</td>
<td>503.04</td>
</tr>
<tr>
<td>Number of bunches</td>
<td>22</td>
</tr>
<tr>
<td>r.m.s. bunch length, m</td>
<td>0.6</td>
</tr>
<tr>
<td>$\beta$, m</td>
<td>0.35</td>
</tr>
<tr>
<td>max. int. Energy, Gev/u</td>
<td>11.0</td>
</tr>
<tr>
<td>r.m.s. $\Delta p/p$, $10^{-3}$</td>
<td>1.6</td>
</tr>
<tr>
<td>IBS growth time, s</td>
<td>1800</td>
</tr>
<tr>
<td>Luminosity, cm$^2$ s$^{-1}$</td>
<td>$1 \times 10^{27}$</td>
</tr>
</tbody>
</table>
NICA Physics: three detectors at IP-1,2 and FTE hall

Baryonic Matter at Nuclotron (BM@N)

the fixed target experiment
at the NICA FTE hall

Stage I 2017

MultiPurpose Detector (MPD)

at the NICA Collider, IP-1

Stage I 2019

Stage II 2022

Project of the SPD (Spin Physics Detector) at the NICA Collider, IP-2,
CDR is under preparation
**Multi Purpose Detector @ NICA**

**MPD Collaboration:**
- JINR, Dubna;
- Tsinghua University, Beijing, China;
- GSI, Germany
- MEPhl, Moscow, Russia.
- INR, RAS, Russia;
- PPC BSU, Minsk, Belarus;
- WUT, Warsaw, Poland;

**Foundation of collaboration April, 2018**

---

**expression of interest:**
- CERN;
- DF, US, Mexico;
- ICN UNA; Mexico;
- DF, CIEA del I.P.N, Mexico;
- FCF-M UAS, Sinaloa, Mexico;
- FCF-MB UAP, Puebla, Mexico;
- PI Az.AS, Baku, Azerbaijan;
- ITEP, NC KI, Moscow, Russia;
- PNPI NC KI, Saint Petersburg, Russia;
- CPPT USTC, Hefei, China;
- SS, HU, Huzhou, Republic of South Africa.
Magnet production: at ASG (Genova) & Vitkovice HM

- $B_0 = 0.5$ T, ~ 900 t
- The first SC coil winding has started
- All yoke elements and support structure are produced; control assembly at HM Vitkovice will start soon
Magnet fabrication: *ASG (Genova) & Vitkovice HM*

**yoke control assembly at HM Vitkovice**

**final assembly in the MPD hall - Autumn 2019**

- winding machine
- cryostat
- trim coil
Time Projection Chamber

**TPC Prototype**

**Sketch of TPC**

- HV-electrode ~ 28 kV
- ~ 110 000 readout channels

**Project status:**
- basic R&D finished, (cont. alternative RO Ch.);
- assembly workshop in preparation (readiness – 2019)

Works are going in accordance with the schedule

**Leaders:** S. Movchan, Yu. Zanevsky
TPC assembly tools, cooling & laser calibration system
**Time of Flight system (TOF)**

**Fast Forward Detector (FFD):**

*production stage*

**Provides:**

- $T_0$ for TOF,
- beam adjustment & collision L0-trigger

**mRPC – TDR has been prepared,**

*ready for mass production*

---

**The achieved time resolution is better than required**

\[ \sigma_{\text{FFD}} = \frac{54}{\sqrt{2}} = 38 \text{ ps} \]

\[ \chi^2 / \text{ndf} = 23.76 / 17 \]

- Constant: \(1143 \pm 18.1\)
- Mean: \(-0.001697 \pm 0.000680\)
- Sigma: \(0.05421 \pm 0.00052\)

\[ \sigma_{\text{PR}} = \frac{89}{\sqrt{2}} = 63 \text{ ps} \]

\[ \chi^2 / \text{ndf} = 1.31 / 11 \]

- Mean: \(0.08862 \pm 0.00044\)

---

**Calorimetry**

**ECAL – TDR - in preparation**

$L \sim 35 \text{ cm} \ (\sim 14 \ X_0), \ \text{Pb+Scint.} \ (4 \times 4 \ \text{cm}^2)$

read-out: \ WLS fibers + MAPD

**Energy resolution** \ 2.5\% $/ \sqrt{E}$

**Zero Degree Calorimeter (ZDC):**

TDR stage

**ZDC coverage:** \ $3.2 < |\eta| < 4.8$

$Pb$-scintillator sampling (5$\lambda$)

Read-out: fibers + AvalanchePD

\[ \sigma(E)/(E) = 53\%/\sqrt{E} \text{(GeV)} + 10\% \]

**Preparation for tests with electron beams at DESY (December'13)**

**ZDC provides required resolution**
cooperation with **CBM/FAIR, ALICE/CERN**:  
- manufacturing the **ITS** carbon fiber space frames for **NICA (BM@N & MPD)& FAIR**;  
- construction of **ALICE type (MAPS) ITS**

**Inner Tracking System**

**ITS MPD layout**

workshop for detector assembly & test was put in operation in **2015**

<table>
<thead>
<tr>
<th># layer</th>
<th>R0 mm</th>
<th>Active l, mm</th>
<th>N of staves</th>
<th>N of chips / layer</th>
<th>active area, cm²</th>
<th>number of pixel cells,</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24,4</td>
<td>542,4</td>
<td>12</td>
<td>216</td>
<td>889,9</td>
<td>113 246 208</td>
</tr>
<tr>
<td>2</td>
<td>42,0</td>
<td>542,4</td>
<td>22</td>
<td>396</td>
<td>1 087,7</td>
<td>207 618 048</td>
</tr>
<tr>
<td>3</td>
<td>60,0</td>
<td>542,4</td>
<td>32</td>
<td>576</td>
<td>1 582,1</td>
<td>301 989 888</td>
</tr>
<tr>
<td>4</td>
<td>107</td>
<td>1477,5</td>
<td>12</td>
<td>2 352</td>
<td>4 845,1</td>
<td>1 233 125 376</td>
</tr>
<tr>
<td>5</td>
<td>156,5</td>
<td>1477,5</td>
<td>18</td>
<td>3 528</td>
<td>7 267,7</td>
<td>1 849 688 064</td>
</tr>
<tr>
<td>6</td>
<td>206,5</td>
<td>1477,5</td>
<td>24</td>
<td>3 920</td>
<td>9 690,2</td>
<td>2 055 209 960</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td></td>
<td>10 988</td>
<td>25 362,7</td>
<td></td>
<td>5 760 877 544</td>
</tr>
</tbody>
</table>

**D. Gross in the workshop**

stand for beam tests of boards with sensors – **in operation**
Workshop for microstrip detector assembly & test

CBM-MPD Consortium

Leader: Yu. Murin

The clean workshop has started operation in 2015.

CERN & JINR have signed MoU for manufacturing the STS carbon fiber frames for NICA (BM@N & MPD) and FAIR (CBM).

The project is supported by the CREMLIN grant (framework of HORIZON-2020).
Existing and future HI accelerators

Fixed target: L-limited by detectors
Colliders: scale of $L$, in cm$^{-2}$s$^{-1}$

- SIS-300 (FAIR)
- SIS-100 (FAIR)
- NICA (JINR)
- SPS (NA-49/61, CERN)
- AGS (BNL)
- RHIC (BNL)

FAIR – NICA co-operation agreement

$\sqrt{s_{NN}}$, GeV for Au+Au
BARYONIC MATTER DENSITY FRONTIER

NICA is included in the ESFRI ROADMAP-2016 and in the NuPECC Long Range Plan 2017 - Perspectives in Nuclear Physics

Main Research Infrastructures in Particle and Nuclear Physics

PARTICLE PHYSICS

NUCLEAR PHYSICS

COMPLEMENTARY PROJECTS

ESFRI ROADMAP 2016

STRATEGY REPORT ON RESEARCH INFRASTRUCTURES

PL Roadmap 2016

NuPECC"
The kick-off meeting on formation of the MPD and BM@N Collaborations took place in Dubna on 11-13 April, 2018.

detailed information about the meeting can be found at: https://indico.jinr.ru/conferenceDisplay.py?confId=385
“Team for the future of NICA”

Attracting students and young staff from the member states to work for NICA
Grant support for initiative teams of physicists from Russian Institutes, Universities and scientific organizations

Russian Foundation for Basic Research

An open competition:
Fundamental properties of the baryon and quark-gluon matter phase transition – mega-science project “Complex NICA”

Period of the grant: 3 years
Maximal grant size: 6 M roubles/year
Minimal grant size: 3 M roubles/year

97 proposals were submitted.
According to independent evaluation, 36 projects were supported.

Results at: http://www.rfbr.ru/rffi/ru/rffi_contest_results/o_2083349
**NAUKA” NATIONAL PROJECT**

Decree of the President of RF № 204 on 7 May, 2018

**TIMELINE:** 01.10.2018 – 31.12.2024

**GOALS AND TARGETS:**

1. Ensuring the presence of the Russia among the 5 leading countries engaged in R&D in priority areas of science and technology development.

2. Ensuring the attractiveness of employment in Russia for Russian and foreign leading scientists and distinguished young researchers.

3. Advanced increase of internal R&D expenditures using all possible sources in comparison with the growth of the gross domestic product of the country.

**Budget of the “NAUKA” National Project**

- Development of the scientific and industrial cooperation: 215,0 млрд руб.
- Development of the advanced infrastructure for R&D in Russia: 350,0 млрд руб.
- Development of the human resources for R&D: 70,9 млрд руб.

**SUPERVISOR**

T. GOLIKOVA
Deputy Prime Minister of Russia

**HEAD**

M. KOTYUKOV
Minister of Science & Higher Education, Plenipotentiary of Russia at JINR

**ADMINISTRATOR**

A. MEDVEDEV
Deputy Minister of Science & Higher Education

**TIMELINE:**

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>Establishing 4 world-class international mathematical centers. Establishing 3 world-class genomic research centers. Beginning of international research at the megascience facility of the International Center for Neutron Research (based on the PIK high-flux reactor).</td>
</tr>
<tr>
<td>2021</td>
<td>Establishing 3 world-class research centers for R&amp;D in priority fields of scientific and technological development.</td>
</tr>
<tr>
<td>2022</td>
<td>Holding of 29th World Mathematical Congress (St. Petersburg) Beginning of international research at the megascience facility “The complex of superconducting rings on colliding heavy ion beams – NICA”.</td>
</tr>
<tr>
<td>2024</td>
<td>The operation of 3 national bioresource network centers. International research at megascience facilities “The 4th generation synchrotron radiation source (ISSI-4) and the Siberian Ring Photon Source (SKIF) (first stage)”. Translation support tools will be formed and the systems of technology transfer as well as research protection, research management and intellectual property issues will be organized that ensures a rapid transition of scientific results to the practical application stage. The developed technologies will be implemented into organizations operating in the real sector of the economy. A set of measures will be formed on orientating government customers to purchasing the high-tech and innovative products developed on the basis of Russian technologies.</td>
</tr>
</tbody>
</table>
Nuclear Physics at Low energies
Physics of Super Heavy Elements
Neutron reach or Exotic nuclei
Physics of extreme strong Coulomb fields
Ac. G.N. Flerov, JINR Lab. of Nuclear Reactions under his name

Lab. founded in 1957

FLEROV LABORATORY of NUCLEAR REACTIONS
Ac. G.N. Flerov, JINR Lab. of Nuclear Reactions under his name

Lab. founded in 1957

FLEROV LABORATORY of NUCLEAR REACTIONS

Yu. Oganessian
New lands
Search for new Island of Stability

Predicted 50 years ago
In Dubna and Frankfurt

Island of Stability
Shoal
Peninsula
Continent

New lands

Neutron number

Log T_{1/2} s

1 µs 1 s 1 h 1 y 1 My

100 110 120 130 140 150 160 170 180 190

120

110

100

90

80

70

60

50

40

30

20

10

0

-10

-20

-30

-40

-50

-60

-70

-80

-90

-100

-110

-120

-130

-140

-150

-160

-170

-180

-190

Pb

Th,1

F1

Og
# D.I. Mendeleev’s Periodic table of elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Symbol</th>
<th>Atomic Number</th>
<th>Mass Number</th>
<th>Electron Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boron</td>
<td>B</td>
<td>5</td>
<td>10.81</td>
<td>1s²2s²2p¹</td>
</tr>
<tr>
<td>Carbon</td>
<td>C</td>
<td>6</td>
<td>12.011</td>
<td>1s²2s²2p²</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>N</td>
<td>7</td>
<td>14.007</td>
<td>1s²2s²2p³</td>
</tr>
<tr>
<td>Oxygen</td>
<td>O</td>
<td>8</td>
<td>15.999</td>
<td>1s²2s²2p⁴</td>
</tr>
<tr>
<td>Fluor</td>
<td>F</td>
<td>9</td>
<td>18.998</td>
<td>1s²2s²2p⁵</td>
</tr>
<tr>
<td>Neon</td>
<td>Ne</td>
<td>10</td>
<td>20.18</td>
<td>1s²2s²2p⁶</td>
</tr>
<tr>
<td>Aluminum</td>
<td>Al</td>
<td>13</td>
<td>26.982</td>
<td>1s²2s²2p⁶3s¹</td>
</tr>
<tr>
<td>Silicon</td>
<td>Si</td>
<td>14</td>
<td>28.085</td>
<td>1s²2s²2p⁶3s²</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>P</td>
<td>15</td>
<td>30.974</td>
<td>1s²2s²2p⁶3s²3p³</td>
</tr>
<tr>
<td>Sulfur</td>
<td>S</td>
<td>16</td>
<td>32.06</td>
<td>1s²2s²2p⁶3s²3p⁴</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Cl</td>
<td>17</td>
<td>35.45</td>
<td>1s²2s²2p⁶3s²3p⁵</td>
</tr>
<tr>
<td>Argon</td>
<td>Ar</td>
<td>18</td>
<td>39.948</td>
<td>1s²2s²2p⁶3s²3p⁶</td>
</tr>
<tr>
<td>Gallium</td>
<td>Ga</td>
<td>31</td>
<td>69.723</td>
<td>1s²2s²2p⁶3d¹⁰4s¹</td>
</tr>
<tr>
<td>Germanium</td>
<td>Ge</td>
<td>32</td>
<td>72.630</td>
<td>1s²2s²2p⁶3d¹⁰4p²</td>
</tr>
<tr>
<td>Arsenic</td>
<td>As</td>
<td>33</td>
<td>74.922</td>
<td>1s²2s²2p⁶3d¹⁰4p³</td>
</tr>
<tr>
<td>Selenium</td>
<td>Se</td>
<td>34</td>
<td>78.977</td>
<td>1s²2s²2p⁶3d¹⁰4p⁵</td>
</tr>
<tr>
<td>Bromine</td>
<td>Br</td>
<td>35</td>
<td>79.904</td>
<td>1s²2s²2p⁶3d¹⁰4p⁶</td>
</tr>
<tr>
<td>Krypton</td>
<td>Kr</td>
<td>36</td>
<td>83.798</td>
<td>1s²2s²2p⁶3d¹⁰4p⁷</td>
</tr>
<tr>
<td>Cadmium</td>
<td>Cd</td>
<td>48</td>
<td>112.41</td>
<td>1s²2s²2p⁶3d¹⁰4p⁶4d¹</td>
</tr>
<tr>
<td>Indium</td>
<td>In</td>
<td>49</td>
<td>114.82</td>
<td>1s²2s²2p⁶3d¹⁰4p⁶4d¹¹</td>
</tr>
<tr>
<td>Tin</td>
<td>Sn</td>
<td>50</td>
<td>118.71</td>
<td>1s²2s²2p⁶3d¹⁰4p⁶4d¹¹5s²</td>
</tr>
<tr>
<td>Antimony</td>
<td>Sb</td>
<td>51</td>
<td>121.76</td>
<td>1s²2s²2p⁶3d¹⁰4p⁶4d¹¹5p³</td>
</tr>
<tr>
<td>Tellurium</td>
<td>Te</td>
<td>52</td>
<td>127.60</td>
<td>1s²2s²2p⁶3d¹⁰4p⁶4d¹¹5p⁴</td>
</tr>
<tr>
<td>Iodine</td>
<td>I</td>
<td>53</td>
<td>126.90</td>
<td>1s²2s²2p⁶3d¹⁰4p⁶4d¹¹5p⁵</td>
</tr>
<tr>
<td>Xenon</td>
<td>Xe</td>
<td>54</td>
<td>131.30</td>
<td>1s²2s²2p⁶3d¹⁰4p⁶4d¹¹5p⁴</td>
</tr>
<tr>
<td>Mercury</td>
<td>Hg</td>
<td>80</td>
<td>200.59</td>
<td>1s²2s²2p⁶3d¹⁰4p⁶5d¹⁰6s²</td>
</tr>
<tr>
<td>Thallium</td>
<td>Tl</td>
<td>81</td>
<td>204.38</td>
<td>1s²2s²2p⁶3d¹⁰4p⁶5d¹⁰6s¹</td>
</tr>
<tr>
<td>Lead</td>
<td>Pb</td>
<td>82</td>
<td>207.2</td>
<td>1s²2s²2p⁶3d¹⁰4p⁶5d¹⁰6s²6p²</td>
</tr>
<tr>
<td>Bismuth</td>
<td>Bi</td>
<td>83</td>
<td>209.0</td>
<td>1s²2s²2p⁶3d¹⁰4p⁶5d¹⁰6s²6p³</td>
</tr>
<tr>
<td>Polonium</td>
<td>Po</td>
<td>84</td>
<td>(209)</td>
<td>1s²2s²2p⁶3d¹⁰4p⁶5d¹⁰6s²6p⁴</td>
</tr>
<tr>
<td>Radon</td>
<td>Rn</td>
<td>85</td>
<td>(222)</td>
<td>1s²2s²2p⁶3d¹⁰4p⁶5d¹⁰6s²6p⁴7s²7p⁵</td>
</tr>
</tbody>
</table>

- **Flerovium** (Fl, 114)
- **Moscovium** (Mc, 115)
- **Livermorium** (Lv, 116)
- **Tennessine** (Ts, 117)
- **Oganesson** (Og, 118)
11 of 18 elements discovered during last 60 years were first synthesized in Dubna
2019: International Year of the Periodic Table of Chemical Elements (IYPT)

In support of

United Nations Educational, Scientific and Cultural Organization

International Year of the Periodic Table of Chemical Elements
Inauguration of the International Year of the Periodic Table of Chemical Elements

DG of UNESCO  Ms. Audrey Azoulay

Nobel Prize Laureate  Ben Feringa

IYPT Opening ceremony at UNESCO, 29 January 2019, Paris

Yu.Ts. Oganessian
Physics of SHE – testing the triumph of the Mendeleev Periodic Law connecting the chemical properties of elements with their atomic numbers.
Commissioning of the Super Heavy Elements Factory

DC-280 cyclotron: (26 December 2018-first test beam)

SHE Factory building

Gas-Filled Recoil Separator
The new cyclotron of heavy ions DC-280

<table>
<thead>
<tr>
<th>Ions</th>
<th>Intensity of ion beams</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{20}$Ne</td>
<td>$1 \cdot 10^{14}$</td>
</tr>
<tr>
<td>$^{48}$Ca</td>
<td>$6 \cdot 10^{13}$</td>
</tr>
<tr>
<td>$^{50}$Ti</td>
<td>$3 \cdot 10^{13}$</td>
</tr>
<tr>
<td>$^{70}$Zn</td>
<td>$2 \cdot 10^{13}$</td>
</tr>
<tr>
<td>$^{86}$Kr</td>
<td>$3 \cdot 10^{13}$</td>
</tr>
<tr>
<td>$^{100}$Mo</td>
<td>$2 \cdot 10^{12}$</td>
</tr>
<tr>
<td>$^{124}$Sn</td>
<td>$2 \cdot 10^{12}$</td>
</tr>
<tr>
<td>$^{136}$Xe</td>
<td>$2 \cdot 10^{13}$</td>
</tr>
<tr>
<td>$^{208}$Pb</td>
<td>$1 \cdot 10^{12}$</td>
</tr>
<tr>
<td>$^{238}$U</td>
<td>$1 \cdot 10^{11}$</td>
</tr>
</tbody>
</table>
Gas-Filled Recoil Separator  GFS-II
Opening of the SHE Factory building and DC-280
March 25, 2019
Status of the Factory of Superheavy Elements:
Programme of Day-1 experiments at the SHE Factory

Synthesis of new element 120

\[ ^{249}\text{Cf}(^{50}\text{Ti},3\text{-}4\text{n})^{295,296}120 \]
\[ ^{251}\text{Cf}(^{50}\text{Ti},3\text{-}4\text{n})^{297,298}120 \]
\[ ^{248}\text{Cm}(^{54}\text{Cr},3\text{-}4\text{n})^{298,299}120 \]

\[ \sigma=50 \text{ fb}, \ h_t=0.3 \text{ mg/cm}^2, \ \varepsilon_{\text{coll}}=0.6, \ i_{\text{beam}}=3 \text{ p\mu A} \rightarrow \approx 1 \text{ event per month} \]

Synthesis of new element 119

\[ ^{249}\text{Bk}(^{50}\text{Ti},3\text{-}4\text{n})^{295,296}119 \]

25 March 2019

Yu. Oganessian

JINR, Dubna
Isotope production in the reactors for the targets

HFIR, ORNL, Oak Ridge, USA, 85 MW
CM-3, IAR, Dimitrovgrad, RF, 100 MW
DRIBs – Dubna Radioactive Ion Beams complex

JINR

DC-280
SHE factory

U-400
Heavy and superheavy nuclei

U-400M
Light exotic nuclei

IC-100
Applied research

NanoLab

Flerov Laboratory of Nuclear Reactions
Empty “thematic niche” in the RIB research infrastructure

Storage ring physics with RIBs

Studies of RIBs in electron-RIB collider

RIB storage ring

Isochronous mass spectrometry

Precision reaction studies on internal gas jet target

Atomic physics studies with striped ions

Radioactivity studies with striped ions

Studies of electromagnetic form factors of exotic nuclei in e-RIB collider

New applications
Concept of DERICA (Dubna Electron – Radioactive Ion Collider fAcility project)

**Long-term research program of RIB at JINR**

- **Stage 0:** Lol, CDR, R&D etc. (2018-2019)
- **Stage 1:** Buildings, LINAC–100, DFS, EH-1,2 (2020-2024)
- **Stage 2:** Gas cell etc., LINAC–30, FRR, EH-3 (2022-2027)
- **Stage 3:** CR, e-RIB collider, ring experiments (2025-2030)
Neutron scattering & Nuclear Structure
Life Science Problems
Radiobiology & Astrobiology
Nuclear Ecology & Cosmic Medicine
mean power: 2 MW
pulse frequency: 5 Hz
pulse width for fast neutrons: 200 μs
thermal neutrons flux density on the moderator surface: $10^{13} \text{n/cm}^2/\text{s}$
maximum in pulse: $10^{16} \text{n/cm}^2/\text{s}$

IBR-2M is one of the best sources of the thermal neutrons and its program is a part of the European strategic research program in the field of neutron scattering.
The User Programme at the spectrometer complex of the upgraded IBR-2 reactor is implemented successfully. At the reactor, specialists from many countries conduct experiments in physics, material science, biology, geology, etc.

In 2018: 203 proposals for experiments came from 17 countries.
Neutron source channels at IBR-2M
Condensed matter physics at JINR

- Physics and Chemistry of Novel Functional Materials;
- Physics of Nanosystems and Nanoscale Phenomena;
- Physics and Chemistry of Complex Liquids and Polymers;
- Molecular Biology and Pharmacology;
- Materials and Engineering Sciences;
- Neutron Radiography and Tomography;
- Neutron Ecological studies;
- Neutron beams as the method for solving problems of Life Science.
Development of neutron imaging techniques at IBR-2 and applications to natural heritage objects

- 3D reconstruction of Fe-Ni alloy distribution in Seimchan meteorite from neutron tomography data
- 3D reconstruction of internal structure of Protosequoia cone (cretaceous period) from Paleontological Institute RAS using neutron tomography data
- 3D reconstruction of internal structure of the biotite gneiss sample from Kola Superdeep Borehole, depth 8802 m and its surface analogue using neutron tomography data
Neutron radiography and tomography at the Beam #14 are used to study archeological objects, especially metallic artifacts.
Neutron radiography and tomography used to study archeological objects, especially metallic artifacts.

- Site of dispersed joint
- Areas with other composition of gold
- Traces of concealment of a joint
- Site of dispersed joint
IBR-2 Future

**Short term perspectives:**
- Development and upgrade of the IBR-2 instruments. Already now there are examples at JINR of more than 10-fold increase in efficiency.
- Startup of the IREN source at designed parameters.

**Long term perspectives** – new accelerator based neutron source in order to replace IBR-2 after the end of its lifetime > **Superbooster** NEPTUN

The Long Range Strategy for JINR up to 2030
Why a superbooster

What to choose?!

I prefer this way

Super booster!
Fourth generation Dubna Pulsed Neutron Source

IBR, IBR-30
1960-2001

Power = 1-20 kW

U-235

Pu-239

Np-237

Void!

Power = 10÷15 MW

NEPTUN
> 2037

Evolution & Continuity

TiH₂
Progress outline:

1. **A superbooster** (multiplying target of proton linear accelerator with periodic reactivity modulation) is being considered for the new neutron source.

2. **Feasibility study** of 2 concepts (*neptunium* and *plutonium* based) has been started.

3. **Time schedule road map** has been developed that establishes 6 major stages and proposes the finalization in **2035** – replacing the present source IBR-2M smoothly.

---

N. Kučerka & E.V. Lychagin: Development of the scientific case for a new source of neutrons at JINR
E. Shabalin & Yu.N. Pepelyshev: Concepts of JINR’s high-flux pulsed neutron source
V.N. Shvetsov & V.L. Aksenov: Milestones and time schedule proposal to the strategy plan of JINR
Comparison of NEPTUN with other sources (basic data from the ESS report).

![Diagram showing brightness and flux density comparisons between different sources, including NEPTUN, IBR-2, ESS, PIK, and IBR-IV.]
Fundamental problems of Particle and Nuclear Physics
Neutrino Physics and Astrophysics
Neutrino Astronomy
Charged particles propagating in cosmic space lose their initial direction and energy. Photons are getting absorbed.

Neutrino astronomy is possible because of weak interaction neutrino with cosmic matter and magnetic fields in space.
M.A. Markov:
«We propose to install detectors deep in a lake or in the sea and determine the direction of charged particles with the help of Cherenkov radiation».

Dubna, 1960
The pace of development of the DUMAND Program

1960 - M. Markov - main idea.
1976 - Discussions of DUMAND project
1980 - Start of works on construction BAIKAL Detector lead by G. Domogatsky (INR of RAS)
1993 - NT-36 (36 OM) @ BAIKAL
1996 - NT-96 (96 OM)
1997 - AMANDA B10 (302 OM) @ South Pole
1998 - NT-200 (192 OM)
2000 - AMANDA II (677 OM)
2005 - NT-200+ (228 OM)
2005 – Ice Cube (first string)
2010 – Ice Cube (last string)
2016 - BAIKAL GVD («Dubna» cluster)
2017 and 2018 – BAIKAL GVD (two more clusters)
2019 – BAIKAL GVD (added two more new clusters)
Now Baikal GVD have in total 5 clusters of 0,25 km³ !)
Why Baikal is interesting?
First of all, Baikal detector looks almost in opposite sky zenith sphere in comparison with the Ice Cube detector. And water in Baikal is more transparent than in Antarctic ice, what allows more accurate determination of the coming neutrino direction. Also light re-scattering in ice is larger than in Baikal.
Neutrino programme: Baikal-GVD

Project NT-1000 International Collaboration BAIKAL GVD

- Search for the extragalactic neutrino “point sources” in energy range > 3 TeV
- Study local diffuse neutrino flux – energy spectrum

BAIKAL-GVD-1
2304 light sensors combined in 8 clusters of vertical strings at 750 – 1300 m depths. Detection volume 0.4 km$^3$

- Installed 2016, 2017, 2018 Taking data
- “Dubna” Demonstration Cluster (2015)

<table>
<thead>
<tr>
<th></th>
<th>GVD-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>OMs</td>
<td>2304</td>
</tr>
<tr>
<td>Clusters (8 Strings)</td>
<td>8</td>
</tr>
<tr>
<td>Depths, m</td>
<td>750 – 1275</td>
</tr>
<tr>
<td>Eff. Volume ($E_{sh} &gt; 100$ TeV)</td>
<td>0.4 km$^3$</td>
</tr>
</tbody>
</table>

Directional resolution
Cascades: ~3°
Muons: 0.25° - 0.5°
Expedition 2019 has achieved its goal: two more clusters were installed.
### Baikal GVD deployment status

<table>
<thead>
<tr>
<th>Number of clusters</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤1</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

| Number of OM       | 192  | 288  | 576  | 864  | 1440 |

March 2019: Baikal GVD - the largest Neutrino Telescope in Northern hemisphere
The neutrino telescope world map 2018

**ANTARES**
- Deep water
- 0.01 km³
- 2008 – 2019

**KM3NeT**
- Deep water
- 1 + 0.006 km³
- Construction

**Baikal/GVD**
- Deep water
- ~1 km³
- Construction

**IceCube**
- Deep ice
- 1 km³
- 2011 –

**IceCube-Gen2**
- Deep ice
- ~10 km³
- Projected, 1st phase imminent
Neutrino programme: DANSS

Detector of AntiNeutrino based on Solid state Scintillator:
*Reactor monitoring and search for short-range neutrino oscillations — JINST 11 (2016) no.11, P11011; arXiv:1606.02896*

- Segmented XY plastic scintillator (1.1 t) close to the core of the KNPP reactor 4
- Overburden 50 m w.e. (reactor cauldron, cooling pond, concrete)
- 3D-information about each event
- Lifting platform, distance is varied on-line (from 10.7 to 12.7 m) within 5 min each 2-3 days
- Evolution of the flux and spectrum with distance, model-independent analysis

Kalinin Nuclear Rower Station
Reactor # 4
The νGeN Experiment at the Kalinin Nuclear Power Plant

Experiment for Detection Coherent $\nu - \text{Ge Nucleus Elastic Scattering}$

Detectors with low energy threshold

Point contact HPGe detectors produced by Dubna in cooperation with BSI (Riga) (4x400 g).

The energy thresholds from 300-350 eV

Low background cryostat (material selection: Dubna, production: BSI), and low noise electronics

For correct interpretation of results many methodical studies (energy calibration for $E \sim 1$ keV, fiducial volume, own background). We use one of the best low background infrastructure available - EDELWEISS-I shield in the LSM underground laboratory.

Measurements with highest available neutrino flux

Kalinin Nuclear Power Plant at 10 m from the reactor core the flux is $5.4 \times 10^{13}$ cm$^2$ per sec.

Improved low background shield of GEMMA experiment (world leader of neutrino magnetic moment measurements). The available place for measurements is just under the reactor, which provides about 70 m.w.e. shielding from cosmic rays.
Achieved a precision of $2.4 \times 10^{-11}$ rad/Hz$^{1/2}$ in the frequency range $[10^{-3}, 12.4]$ Hz

High precision monitoring of even tiny Earthquake effects on LHC collisions (Magnitude 3 in the picture)

The PLI is more sensitive than classic seismometers – Magnitude 2.3 to 2.6 Earthquakes in France in October 2018

Professional PLI is commissioned at CERN in TT1 tunnel since Sept. 2017.

It detects any type of Earth movement due to seismic events and cultural noise in a wide frequency range. Wide applications and expressed interest: from multi-TeV colliders (HL-LHC, FCC, CLIC, ILC) to dark matter search and gravitational wave experiments, to societal applications for Earthquakes warning.
Precision Laser Inclinometer (PLI)

The device confidently registers the angular slopes of the Earth's surface caused by the Moon, the Sun, remote (more than $10^4$ km) earthquakes, micro seismic peaks and sources of industrial origin, the Unique detector of angular oscillations the earth's surface in two orthogonal directions:

- frequency range $10^{-6} - 4$ Hz
- sensitivity $2.4 \cdot 10^{-11}$ rad/Hz$^{1/2}$

CERN and JINR discuss the use of PLI to stabilize the spatial position of beams in the priority CERN program for increasing the luminosity of the Large Hadron Collider.

2019: JINR/CERN/ INFN has agreed to use PLI in LIGO/Virgo experiment for detecting GW.
Strategy of Information Technologies and Scientific Computing in JINR
Annual data production follows to exponential the law.

In 2020 > 40 ZB data will be created.

CERN Large Hadron Collider > 20 Pb/Year, > 200 Pb stored

Large Synoptic Survey Telescope (LSST) > 10 Pb/Year (estimation)

Square Kilometre Array radio telescope (SKA) > 20 Pb/Day (estimation)

An International radiotelescope for the 21st century

High Energy Physics

Baisic

Science

Nanotechnology

Climate

Life sciences and innovations

Astrophysics

...et cetera
The aims:

- Increase of computational power for massive parallel computations required for acceleration of the complex theoretical investigations held at LTP in collaboration with BLTP and VB LPHE in frames of “Hadronic matter under extreme conditions”, theme 01-3-1113, “Theory of fundamental interactions”

- Development of a test bed for study a feasibility of use of the newest computation platforms for computing on NICA project

Total performance: 5 Pflops (x10)

Putting into operation: March 27, 2018
NICA computing challenge

Super-Computer "GOVORUN"

QCD phase diagram

Events reconstruction

Big Data + HPC

Simulations

Physics analysis

MPD experiment
Machine learning algorithms bring a lot of potential to the tracks reconstruction problem due to their capability to learn effective representations of high-dimensional data through training, and to parallelize on HPC architectures.

Input data for the first step algorithm were simulated by GEANT in MPDRoot framework for the real detector BM@N configuration.

Real track
True found track
Ghost track
White dots are both hits and fakes

Efficiency 97.5%
Hot theoretical physics topics for HPC

THEORY OF HADRONIC MATTER UNDER EXTREME CONDITIONS

Wide international cooperation in parallel and single-core computing at LIT for HMEC-TH

IMP CAS (Lanzhou, China),
Helsinki Univ. (Helsinki, Finland),
ITP Uni. Graz (Graz, Austria),
ITP Heidelberg Uni. (Germany), Jena Uni. (Jena, Germany),
ITP Giessen Uni. (Giessen, Germany), Technische Uni. Dresden (Dresden, Germany),
ITP Goethe-Uni. (Frankfurt, Germany), GSI (Darmstadt, Germany),
ITP Leipzig Uni. (Leipzig, Germany), ZOQ Hamburg Uni. (Hamburg, Germany),
Tokyo Institute of Technology (Tokyo, Japan), RCNP Osaka Uni. (Osaka, Japan),
RIKEN (Wako, Japan),
IOP Bhubaneswar (Bhubaneswar, India),
INFN Frascati (Rome, Italy), INFN (Pisa, Italy),
Uni. of Wroclaw (Wroclaw, Poland),
FEFU (Vladivostok, Russia),
NRC Kurchatov Institute (Moscow, Russia), ITEP NRC KI (Moscow, Russia),
IHEP NRC KI (Protvino, Russia), MEPHI (Moscow, Russia),
IDSTU SB RAS (Irkutsk, Russia), Saratov Uni. (Saratov, Russia),
SINP MSU (Moscow, Russia), St. Petersburg Uni. (St. Petersburg, Russia),
P.J. Safarik University (Kosice, Slovakia), Matej Bel Uni. (Banska Bystrica, Slovakia),
Valencia Uni. IFIC (Valencia, Spain),
BITP (Kiev, Ukraine)
Multidisciplinary research:

- Theory of Fundamental Interactions
- Particle Physics and Cosmology
- Theory of Nuclear Structure and Nuclear Reactions
- Theory of Condensed Matter

- Mathematical Physics: Strings and Gravity, Supersymmetry, Integrability
- Quantum Statistics
- Research and Educational Project “Dubna International Advanced School of Theoretical Physics (DIAS-TH)
Modern trends in radiobiology

Fundamental radiobiological research: studying mechanisms of radiation action at the molecular, cellular, tissue, and organismal levels of biological organization.

Radiation and nuclear medicine: refinement of tumor radiation therapy techniques (proton and carbon therapy); designing new radio sensitizers and radio protectors; extension of the list of the radionuclide pharmaceuticals for diagnostics and treatment.

Radiation safety of deep space flights: refinement of the approaches to human protection from heavy charged particles.

Origin of Life on the Earth, Astrobiology.

Fundamental aspects of radioecology: research at the level of ecosystems and populations, participation in EU programs.

Applied radiation technologies: development of methods of raising crop capacity and improvement of agricultural product quality; elimination of pathogenic micro- and macroflora; disinfection of agricultural waste, etc.
New method of enhancing the biological effectiveness of ionizing radiation

New Results!

**Protons 0.6 Gy**
Bragg peak

**With Ara C**

**11B ions 1Gy**
8 MeV/u

**Without Ara C**

<table>
<thead>
<tr>
<th>Time, h</th>
<th>Number of γH2AX/53BP1 foci/cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 min</td>
<td></td>
</tr>
<tr>
<td>1 h</td>
<td></td>
</tr>
<tr>
<td>4 h</td>
<td></td>
</tr>
<tr>
<td>24 h</td>
<td></td>
</tr>
</tbody>
</table>

Human cells

- Protons 1.25 Gy with Ara C
- Protons 1.25 Gy without Ara C
- $^{11}$B 1 Gy without Ara C

Ara C
JINR UC Educational Programmes
and 7-year Plan for the Development of JINR

Implementing the goal “Attracting Youth to Science”

Major JINR UC educational activities:
• Outreach programmes for school students and teachers;
• Preparation of qualification works at Bachelor, Master, or PhD level;
• International Student Practices at JINR;
• Summer Student Programme;
• Training programmes for engineers, etc.

➢ In 2019 JINR has received from Russian Government the right to have the JINR own system of defending theses at JINR and assigning the JINR PhD degree.
➢ JINR has established a special fund to support JINR postdoc positions.

V. Matveev
• Scientific Schools for physics teachers at CERN and JINR (started in 2009) [http://teachers.jinr.ru/](http://teachers.jinr.ru/)

• Visits to the JINR laboratories for school and university students;

• Festivals of sciences, etc.
Outreach (popularisation of science achievements) Open education at JINR edu.jinr.ru

We started to do video lectures with our colleagues:
- Experimental high energy physics
- Detectors in the nuclear and high energy physics
- Heavy ions and the synthesis of heavy elements
- Mega-science project NICA
- Quantum Computation and Quantum Information

http://edu.jinr.ru/courses
JINR Distinguished Postdoctoral Research Fellowship Programme

The programme for the selection of young researchers within a specialized international competition for nominal positions, bearing the names of distinguished JINR scientists (Distinguished Postdoctoral Research Fellowship), is aimed at staffing of main research directions and flagship projects of JINR.

The programme provides young talented scientists an opportunity to actively participate in JINR’s scientific research being conducted at the world-level.

The JINR Director Order has been signed which established the Special International Coordination Committee with the task to workout together with the laboratories the list of the topics and scientific themes and announce a call for the candidates using a number of scientific magazines, the internet sites and mass media.
The Long Range Strategy for JINR development

From the Seven Year Plan for JINR development for the period 2017 – 2023

2030
JINR’s Long Range Strategy plan for up to 2030

- NICA – II (SpinPD, MPD-Upgr., NICA-HL, Innov.Centre)
- DRIBS-III (Dubna Radioactive Beam Complex for Super-Heavy Elements and Exotic Nuclei studies)
- SC HI LINAC-100 and DERICA Project (Dubna Electron Radioactive Ion Collider fAcility)
- Physics with the ultra cold neutrons at IBR-2M
- Dubna PNS-IV: Super booster “NEPTUN” (Proton beam initiated Pulsed Np-237 Neutron Reactor)
- Baikal–GVD Neutrino Telescope Upgrade above 1 km³
- BIG DATA and DATA LAKES IT Technologies Center, Supercomputer “Govorun” Upgrade
- Hadron Therapy research complex, Radiobiology Center
- Participation in the World Global Projects (ILC, Fcc, etc)
Realization of all the priority projects of the JINR 7-year program is going successfully according the plans.

Construction of NICA complex is going close to the schedule with a small delay.

Construction of the SHE complex is finished and the First Day program of experiments on synthesis of the new 119 and 120 elements will start this year.

Both projects got recognition as part of European research infrastructure and both are open for new participants and users.

Deep underwater neutrino telescope Baikal GVD achieved ¼ of km3 volume.

Other major IR projects – Pulsed neutron reactor IBR-2, Multifunctional Computer Center with Supercomputer “Govorun” are successfully developing.

Long Range Strategy of JINR development up to 2030 under consideration which requires development of new accelerator technologies (SC HI cavities, RIB physics with storage rings, e-RIB collider rings or the DERICA - ISOL technology, crystalline beams in CR, etc.) and of the new Pulsed Neutron Reactor projects like super booster “NEPTUNE” or the Hadron Therapy research complex.

Cooperation with world physics research and accelerator community is very much appreciated as well as expanding the scientific ties with countries not presently having the full or associated membership in JINR.
JINR – CERN strategic partnerships

- JINR actively participates in the LHC programmes including the ATLAS, CMS, ALICE and the Collider itself and planning to contribute to the LHC detectors upgrade.
- Besides, JINR participate in the four SPS projects:
  - Compass-II (NA58) – nucleon spin structure, hadron spectroscopy (with interests to future SPD at NICA);
  - NA61 – (intersects with BM@Nuclotron and MPD);
  - NA62 – CP-violation and rare decays;
  - NA64 – search for the dark sector;
- Accelerator development: HL-LHC CLIC, ILC LHeC, FCC, Precise laser metrology (super sensitive inclinometr),
- Computing and Information Technologies, WLCG, Tier-1,2
- Neutrino platform, DUNE; other - nTOF, DIRAC,
- Education and Teachers programs etc.
Observer Status allows non-member states to attend Council meetings and to receive Council documents without taking part in the decision-making procedures of the organization.

For today, Observer states and organizations at CERN are: the European Commission, India, Japan, Russian Federation, Turkey, UNESCO and the USA. And now the new one – the JINR.

Approval of mutual observerships of JINR at CERN and of CERN at JINR

Session of the Committee of Plenipotentiaries of the Governments of the Member States of JINR, November 2014.

Strategic step towards intensifying the mutually beneficial partnership between two international organizations which have a long story of cooperation.
Acknowledgements
to organizers of the EU-HEP (CERN-JINR) School in Saint-Petersburg, March, 2019

Thank you!

Welcome to JINR!
“Science cannot be national, in the same way that a multiplication table cannot be national. If a science becomes national it ceases to be a science”.

Anton Chekhov

(1860 – 1904)
News from our colleagues from China

Prof. Gao Jie: “I have attended the CPCC Conference which is like SENATE meeting in your country. I have made proposal to President Xi in a face to face meeting on suggestions including China should apply to Dubna associate membership. My written proposal has been deposited to MOST. We think it is good for China and Dubna”.
OM assembling hall @DLNP JINR

12 OM/day
JINR Research Programme

The Seven Year Plan for 2017-2023

The Long Range Strategy of JINR development up to 2030