

Scientific Research Programme at JJNR

DUBNA

**“ JINR:
Past, Present and Future“**



V. Matveev (Director JJNR)



***CERN Council, 176th Session,
June 19th 2015***

**JINR is located in the city of Dubna in 120 km
to the north from Moscow**



JOINT INSTITUTE for NUCLEAR RESEARCH

International Intergovernmental Organization



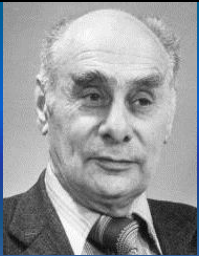
The Agreement on the establishment
of JINR
was signed on 26 March 1956 in Moscow



“ATOM for PEACE”

The results of the researches carried out
at the Institute can be used solely for
peaceful purposes for the benefit of
mankind

Founders of JINR



G.Flerov



V.Veksler



I.Frank



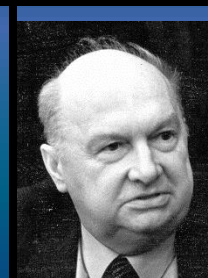
M.Meshcheryakov



V.Dzhelepov



N.Bogoliubov,
D.Blokhintsev



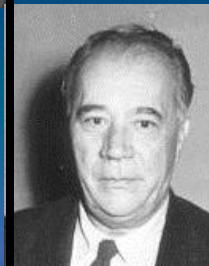
A.Baldin



L.Infeld



B.Pontecorvo



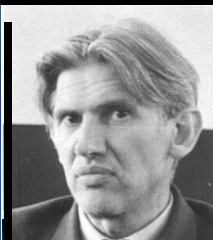
H.Hulubei



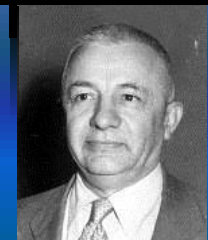
Wang Ganchang



H.Niewodniczanski



L.Janossy



G.Najakov

JINR has at present 18 Member States:

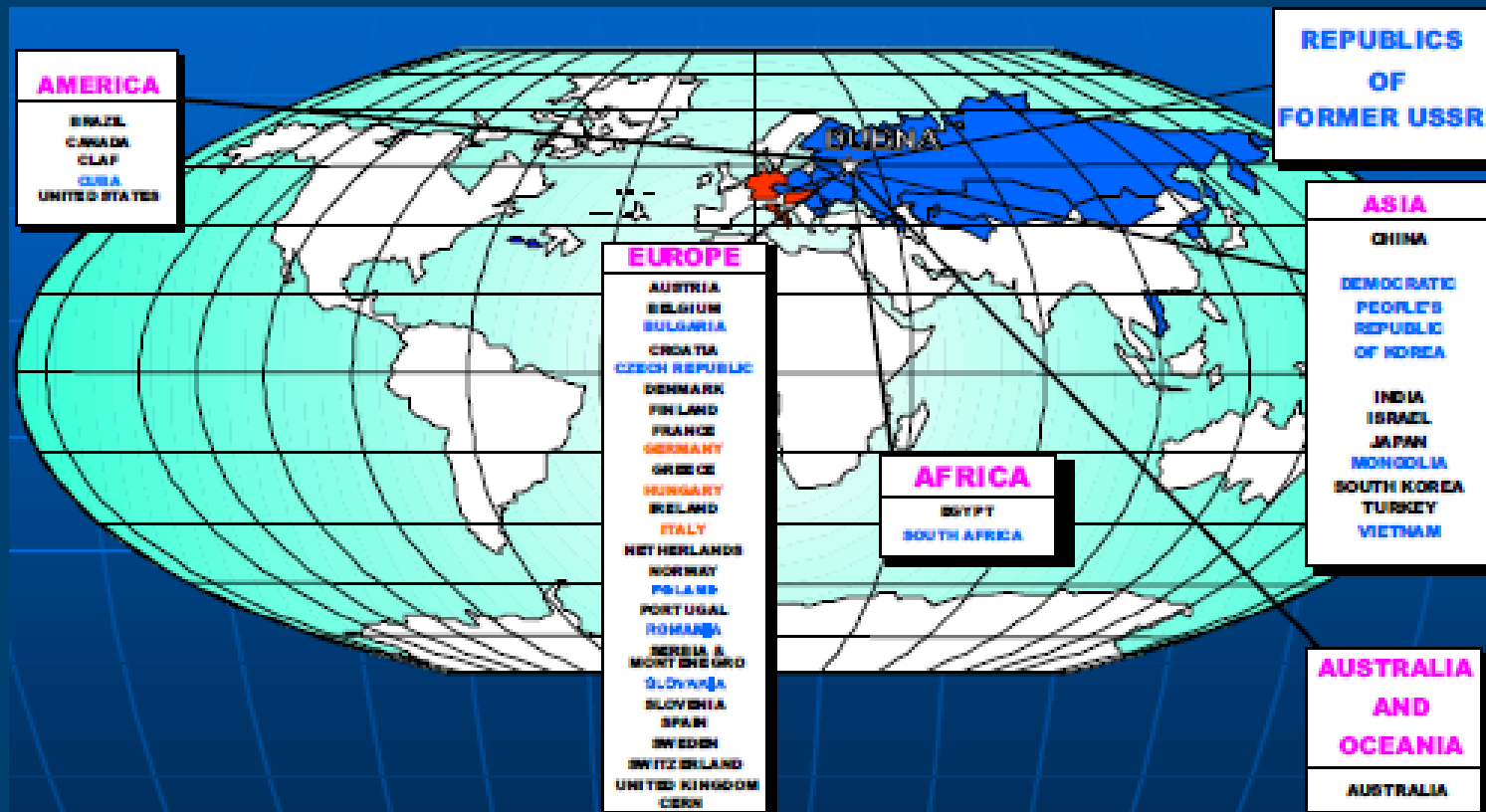


Armenia
Azerbaijan
Belarus
Bulgaria
Cuba
Czech Republic
Georgia
Kazakhstan
D. P. Republic of Korea
Moldova
Mongolia
Poland
Romania
Russian Federation
Slovakia
Ukraine
Uzbekistan
Vietnam

Participation of **Egypt, Germany, Hungary, Italy, the Republic of South Africa and Serbia** in JINR activities is based on bilateral agreements signed on the governmental level.

International collaboration

JINR collaborates with more than 700 scientific centres and universities in 63 countries of the world.



The Supreme governing body of JINR is the Committee of Plenipotentiaries of the governments of JINR Member States



In November 2014, the Committee of Plenipotentiaries decided to grant the European Organization for Nuclear Research the status of Observer at JINR, following a similar decision on the status of Observer of JINR at CERN taken earlier by the CERN Council.

The research policy of JINR is determined by the Scientific Council, which consists of eminent scientists from the Member States, as well as outstanding researchers from China, France, Germany, Greece, Hungary, India, Italy, and CERN



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



Dzhelepov
Laboratory of Nuclear Problems



Veksler and Baldin
Laboratory of High Energy Physics



Bogoliubov
Laboratory of Theoretical Physics



Flerov
Laboratory of Nuclear Reactions



Frank Laboratory of Neutron Physics



Laboratory of Radiation Biology



Laboratory of
Information Technologies

SOME OF THE MAJOR RESULTS OF JINR

Accelerators – Phase Stability Principle (Veksler);

Synthesis of the new superheavy elements

“105”, “112-116”, “118”

and indications on the existence of the Stability Island

(Flerov, Oganessian);

Phenomenon of the Neutrino Oscillation (Pontecorvo);

Construction of the Impulse Breeder Reactor IBR-2

(Blokhintsev, Frank, Shapiro);

First superconducting heavy ion accelerator (Baldin);

Development of the Basic Principles of the Local Quantum

Field Theory (Bogoliubov, Shirkov);

Hypothesis of the new quantum number of quarks (BST)

MAJOR DIRECTIONS OF JINR RESEARCH ACTIVITIES:

- ❑ BASIC PHYSICS RESEARCH
- ❑ EDUCATIONAL PROGRAMMES
- ❑ INNOVATION DEVELOPMENTS

Multidisciplinary researches:

Medicine physics, hadron therapy treatments

Nanotechnologies, track membrane productions

Radiobiology, cosmic medicine, ecology

Astrobiology,

Information technologies

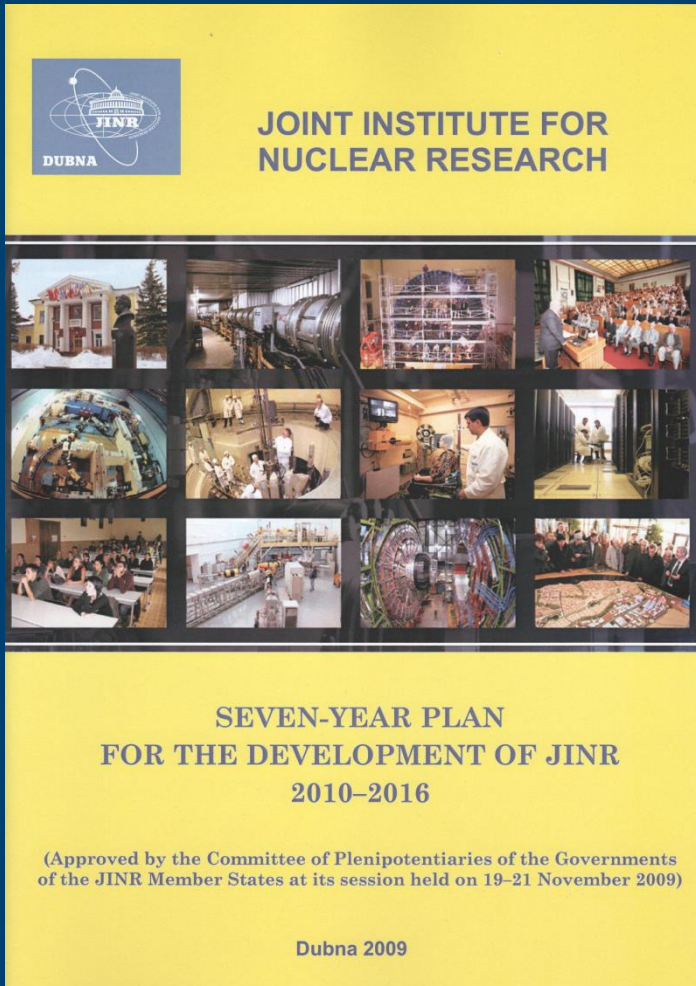
7-Year Plan (2010 – 2016)

The concept of the Seven-Year Plan is based on the concentration of resources to update the accelerator and reactor base of the Institute. The key elements of the qualitative improvement of the research infrastructure are the following basic facilities:

– the ion collider NICA (Nuclotron-based Ion Collider fAcility) for research in the field of high-energy heavy-ion physics ;

– the cyclotron complex DRIBs-III (Dubna Radioactive Ion Beams) for the search for new superheavy elements of Mendeleev's Periodic Table and for studies of the properties of radioactive and exotic neutron-rich nuclei;

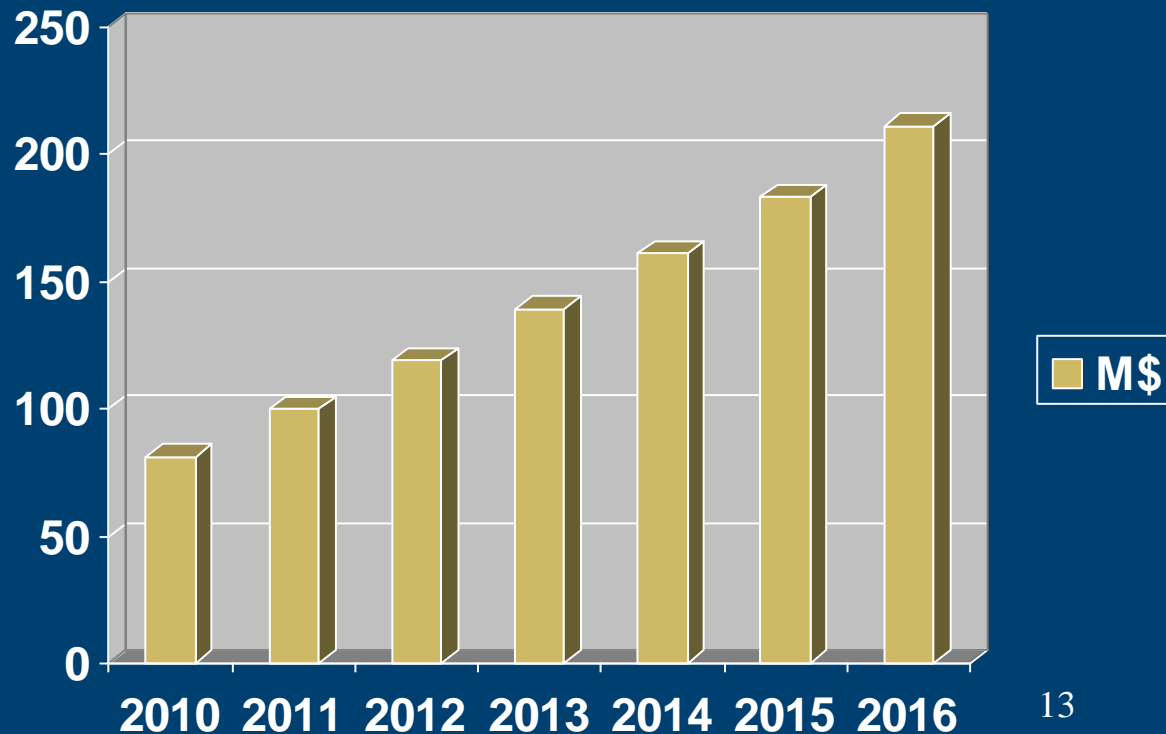
– the modernized reactor IBR-2M for research in condensed matter physics and particularly in the fields of nanoscience and nanotechnology.



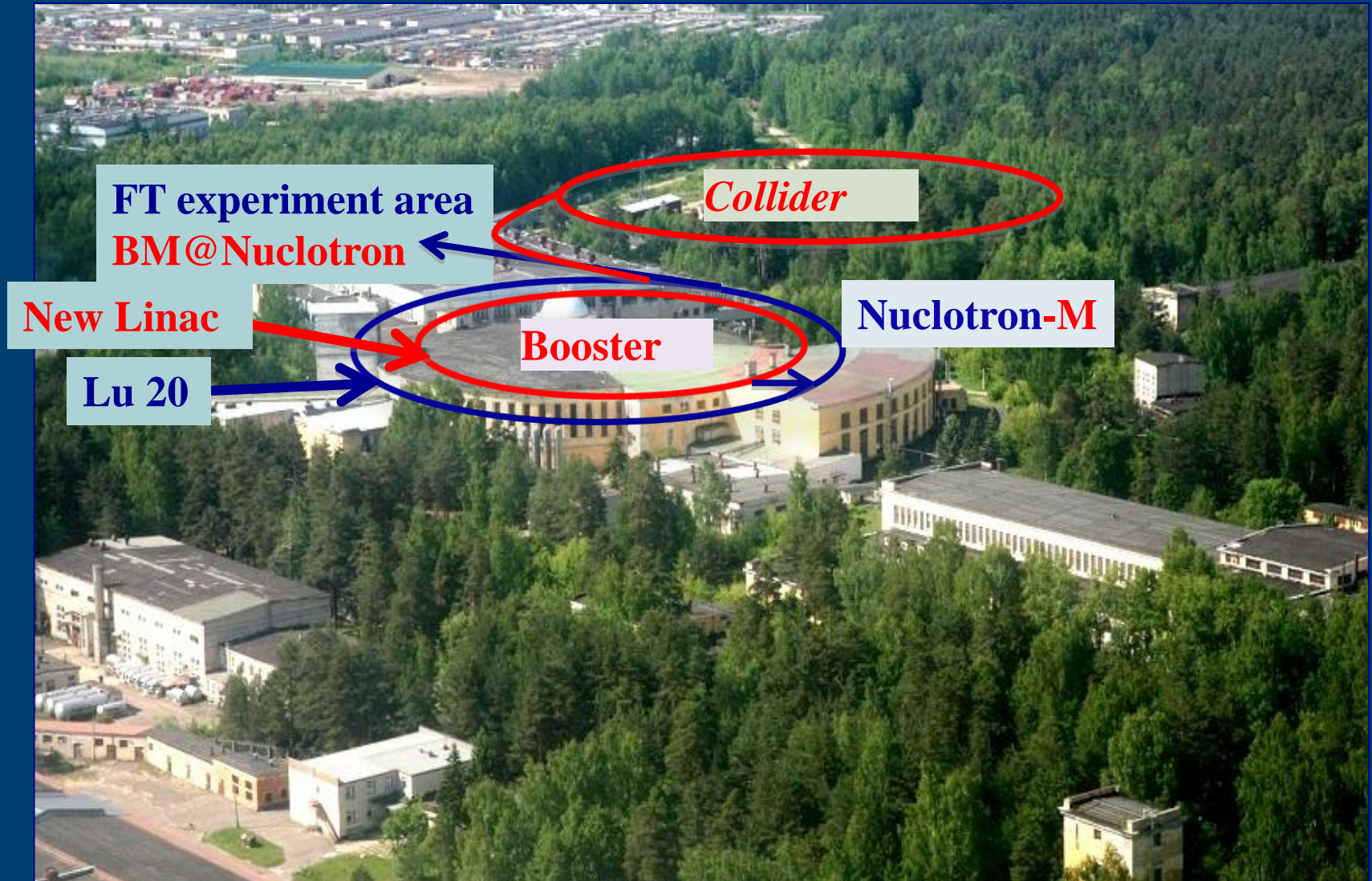
JINR in some figures

- ▣ JINR's staff members ~ 4500
- ▣ **Researchers ~ 1200**
including from the Member States (but Russia) ~ 400
- ▣ Full Doctors and PhD ~ 1000

**JINR Budget
(actual and foreseen
in the 7-year Plan)**

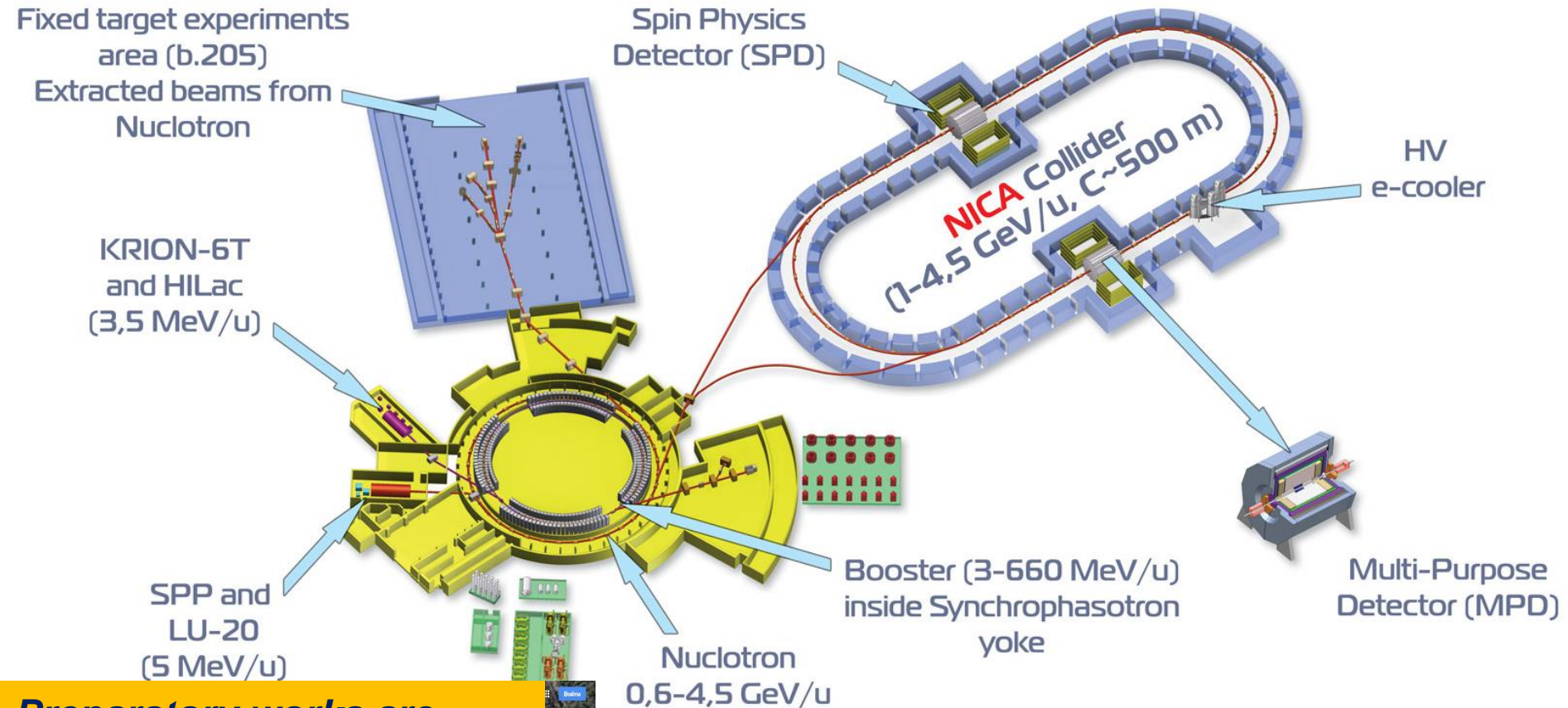


Area of Nuclotron-NICA Facility



Superconducting accelerator complex **NICA**

(**N**uclotron based **I**on **C**ollider **f**Acility)



Preparatory works are completed ~60 000 m²!

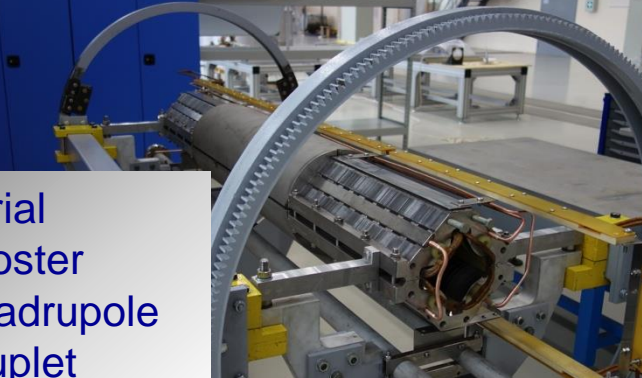


NICA parameters:

- Energy range: $\sqrt{s_{NN}} = 4-11 \text{ GeV}$
- Beams: from p to Au
- Luminosity: $L \sim 10^{27} \text{ (Au)}, 10^{32} \text{ (p)}$
- Detectors: MPD (ions), SPD (spin physics)



Pre-serial collider dipole

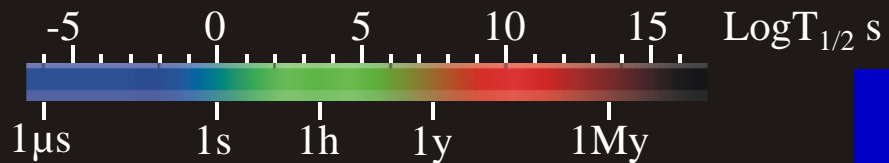


Serial
Booster
Quadrupole
doublet

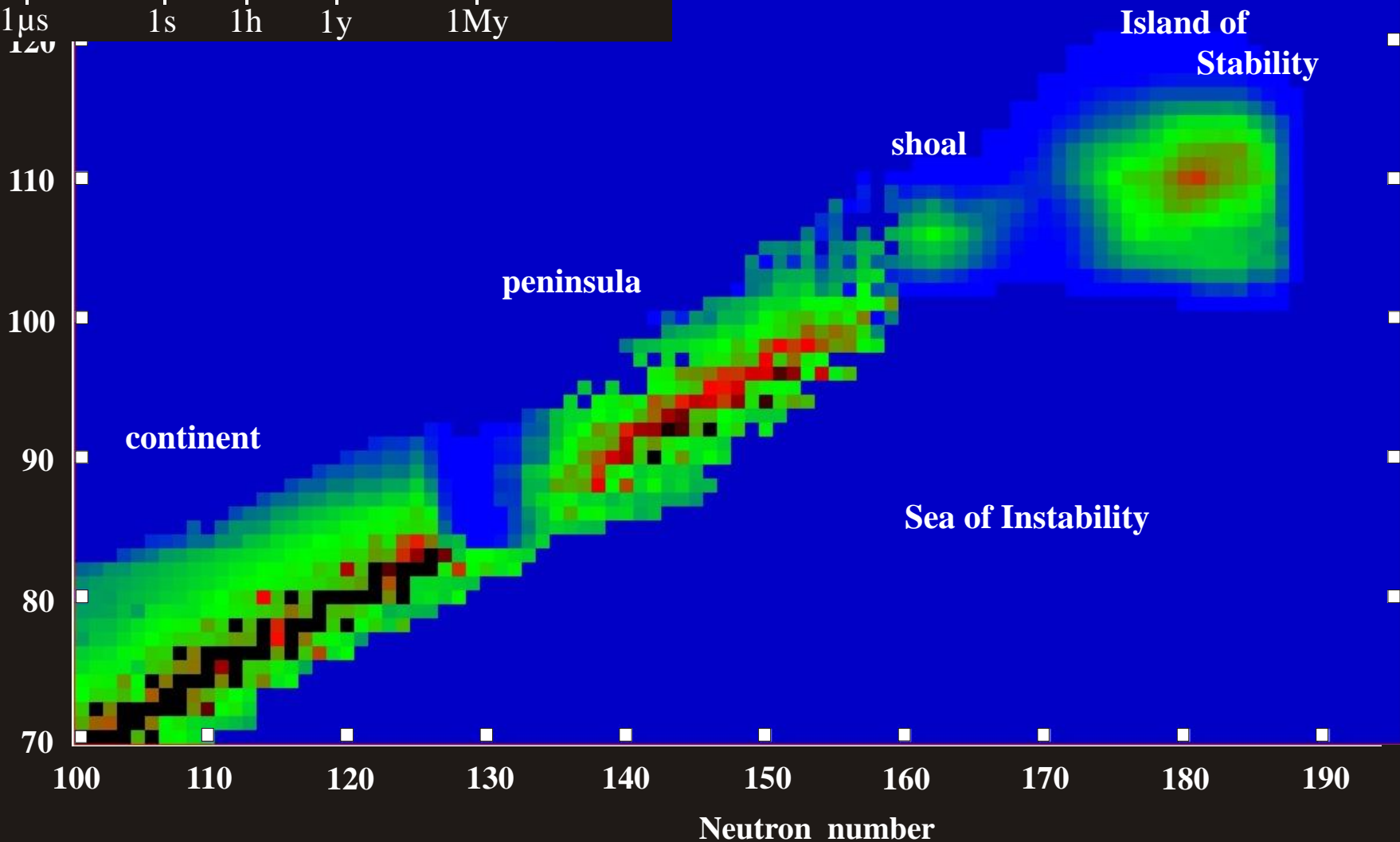
Serial
Booster
Quadrupole
douplet

[illegible]

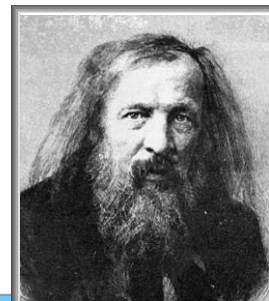
New lands



Proton number



период	ряд	группы элементов																															
		а	I	б	а	II	б	а	III	б	а	IV	б	а	V	б	а	VI	б	а	VII	б	а	VIII	б								
1	I	Водород H 1 1s ¹ 1,00794 Hydrogen																				Гелий He 2 1s ² 4,0026 Helium											
2	II	Литий Li 3 2s ¹ 6,941 Lithium				Бериллий Be 4 2s ² 9,012182 Beryllium				Бор B 5 2p ¹ 10,811 Boron				Углерод C 6 2p ² 12,011 Carbon				Азот N 7 2p ³ 14,00674 Nitrogen				Кислород O 8 2p ⁴ 15,9994 Oxygen				Фтор F 9 2p ⁵ 18,9984032 Fluorine				Неон Ne 10 2p ⁶ 20,1797 Neon			
3	III	Натрий Na 11 3s ¹ 22,989768 Sodium				Магний Mg 12 3s ² 24,3050 Magnesium				Алюминий Al 13 3p ¹ 26,981539 Aluminum				Кремний Si 14 3p ² 28,0855 Silicon				Фосфор P 15 3p ³ 30,973762 Phosphorus				Сера S 16 3p ⁴ 32,066 Sulfur				Хлор Cl 17 3p ⁵ 35,4527 Chlorine				Аргон Ar 18 3p ⁶ 39,948 Argon			
4	IV	Калий K 19 4s ¹ 39,0983 Potassium				Кальций Ca 20 4s ² 40,078 Calcium				21 3d ⁴ 4s ² Scandium 44,955910 Scandium				22 3d ⁴ 4s ² Титан Ti 47,88 Titanium				23 3d ⁴ 4s ² Ванадий V 50,9415 Vanadium				24 3d ⁴ 4s ² Хром Cr 51,9961 Chromium				25 3d ⁴ 4s ² Марганец Mn 54,93805 Manganese				26 3d ⁴ 4s ² Железо Fe 55,847 Iron			
	V	29 3d ¹⁰ 4s ¹ Медь Cu 63,546 Copper				30 3d ¹⁰ 4s ² Цинк Zn 65,39 Zinc				Галлий Ga 69,723 Gallium				31 4p ¹ Германий Ge 72,61 Germanium				33 4p ³ Мышьяк As 74,92159 Arsenic				34 4p ⁴ Селен Se 78,96 Selenium				35 4p ⁵ Бром Br 79,904 Bromine				36 4p ⁶ Криптон Kr 83,80 Krypton			
5	VI	Рубидий Rb 37 5s ¹ 85,4678 Rubidium				Стронций Sr 38 5s ² 87,62 Strontium				39 4d ⁵ 5s ² Иттрий Y 88,90585 Yttrium				40 4d ⁵ 5s ² Цирконий Zr 91,224 Zirconium				41 4d ⁵ 5s ² Нибой Nb 92,90638 Niobium				42 4d ⁵ 5s ² Молибден Mo 95,94 Molybdenum				43 4d ⁵ 5s ² Технеций Tc [98] Technetium				44 4d ⁵ 5s ¹ Рутений Ru 101,07 Ruthenium			
	VII	47 4d ¹⁰ 5s ¹ Серебро Ag 107,8682 Silver				48 4d ¹⁰ 5s ² Кадмий Cd 112,411 Cadmium				49 5p ¹ Индий In 114,818 Indium				50 5p ² Олово Sn 118,710 Tin				51 5p ³ Сурьма Sb 121,757 Antimony				52 5p ⁴ Телур Te 127,60 Tellurium				53 5p ⁵ Йод I 126,90447 Iodine				54 5p ⁶ Ксенон Xe 131,29 Xenon			
6	VIII	55 6s ¹ Цезий Cs 132,90543 Cesium				56 6s ² Барий Ba 137,327 Barium				57 5d ¹ 6s ² Лантан La 138,9055 Lanthanum				72 5d ⁴ 6s ² Гафний Hf 178,49 Hafnium				73 5d ⁴ 6s ² Тантал Ta 180,9479 Tantalum				74 5d ⁴ 6s ² Вольфрам W 183,84 Tungsten				75 5d ⁵ 6s ² Рений Re 186,207 Rhenium				76 5d ⁶ 6s ² Осний Os 190,23 Osmium			
	IX	79 5d ¹⁰ 6s ¹ Золото Au 196,96654 Gold				80 5d ¹⁰ 6s ² Ртуть Hg 200,59 Mercury				81 6p ¹ Таллий Tl 204,3833 Thallium				82 6p ² Свинец Pb 207,2 Lead				83 6p ³ Висмут Bi 208,98037 Bismuth				84 6p ⁴ Полоний Po [209] Polonium				85 6p ⁵ Астат At [210] Astatine				86 6p ⁶ Радон Rn [222] Radon			
7	X	87 7s ¹ Франций Fr [223] Francium				88 7s ² Радий Ra 226,025 Radium				89 6d ¹ 7s ² Актиний Ac [227] Actinium				104 Резерфордий Rf [261] Rutherfordium				105 Дубний Db [262] Dubnium				106 Сиборгий Sg [266] Seaborgium				107 Борий Bh [267] Bohrium				108 Хассий Hs [269] Hassium			
	XI	111				112				113				114				115				116				117				118			



D.I. Mendeleev
1834 - 1907

■ s-элементы

■ p-элементы

■ d-элементы

■ f-элементы

Лантаноиды Lanthanides

Церий Ce 4f ¹ 5d ¹ 140,115 Cerium	Прометий Pr 4f ³ 140,90765 Promethium	Неодим Nd 4f ⁴ 144,24 Neodymium	Прометий Pm [145] Promethium	Самарий Sm 4f ⁵ 150,36 Samarium	Европий Eu 4f ⁶ 151,965 Europium	Гадолиний Gd 4f ⁷ 5d ¹ 157,25 Gadolinium	Тербий Tb 4f ⁹ 158,925 Terbium	Диспрозий Dy 4f ¹⁰ 162,50 Dysprosium	Гольмий Ho 4f ¹¹ 164,93032 Holmium	Эрбий Er 4f ¹² 167,26 Erbium	Тулий Tm 4f ¹³ 168,93421 Thulium	Иттербий Yb 4f ¹⁴ 173,04 Ytterbium	Лютеций Lu 4f ¹⁴ 5d ¹ 174,967 Lutetium
--	---	---	--	---	--	---	--	--	--	--	--	--	---

Актиниды Actinides

Торий Th 5f ² 6d ² 232,0375 Thorium	Протактиний Pa 5f ² 6d ¹ 231,03688 Protactinium	Уран U 5f ³ 6d ¹ 238,02891 Uranium	Нептуний Np 5f ⁴ 6d ¹ [237] Neptunium	Плутоний Pu 5f ⁶ [244] Plutonium	Америций Am 5f ⁷ [243] Americium	Кюрий Cm 5f ⁷ 6d ¹ [247] Curium	Беркелий Bk 5f ⁹ [247] Berkelium	Калифорний Cf 5f ¹⁰ [251] Californium	Эйнштейний Es 5f ¹¹ [252] Einsteinium	Фермий Fm 5f ¹² [257] Fermium	Менделевий Md 5f ¹³ [258] Mendelevium	Нобелий No 5f ¹⁴ [259] Nobelium	Лоуренсий Lr 5f ¹⁴ 6d ¹ [262] Lawrencium
--	--	---	--	--	--	--	--	---	---	---	---	---	---

112
Chemical
identification
in 2006

113
Discovered
at JINR in
2003

114
Discovered
at JINR in
1999

115
Discovered
at JINR in
2003

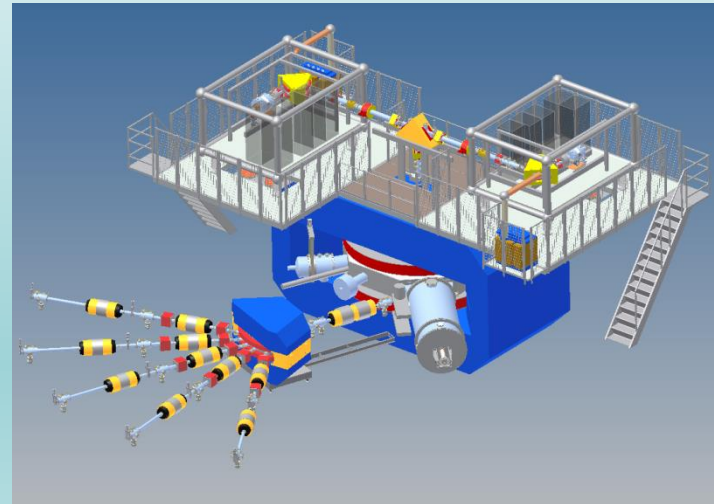
116
Discovered
at JINR in
2000

118
Discovered
at JINR in
2001

Super Heavy Elements (SHE) Factory

High-current cyclotron
DC-280

New facilities



New experimental
hall



DC280-cyclotron – SHE-factory



- Synthesis and study of properties of superheavy elements.
- Search for new reactions for SHE-synthesis.
- Chemistry of new elements.

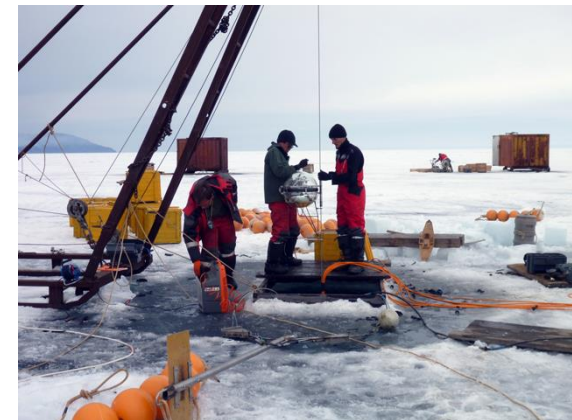
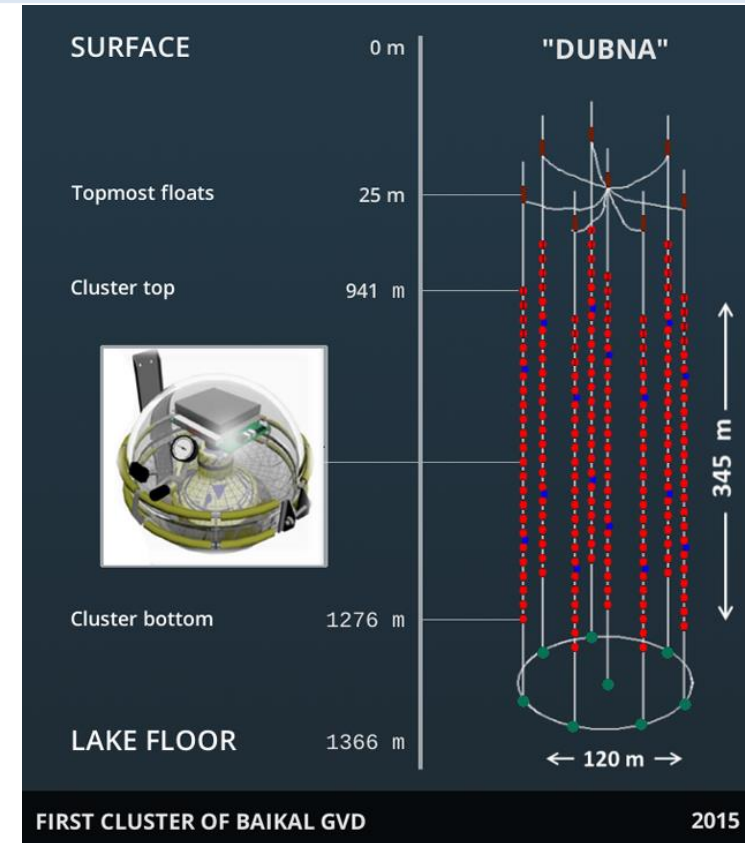
DC280 (project) E=4÷8 MeV/A		
Ion	Ion energy [MeV/A]	Output intensity
${}^7\text{Li}$	4	1×10^{14}
${}^{18}\text{O}$	8	1×10^{14}
${}^{40}\text{Ar}$	5	6×10^{13}
${}^{48}\text{Ca}$	5	$0,6-1,2 \times 10^{14}$
${}^{54}\text{Cr}$	5	2×10^{13}
${}^{58}\text{Fe}$	5	1×10^{13}
${}^{124}\text{Sn}$	5	2×10^{12}
${}^{136}\text{Xe}$	5	1×10^{14}
${}^{238}\text{U}$	7	5×10^{10}

Baikal project: Gigaton Volume Detector (GVD)

First "DUBNA" cluster of GVD in operation!

Central Physics Goals:

- Investigate Galactic and extragalactic neutrino "point sources" in energy range > 3 TeV
- Diffuse neutrino flux – energy spectrum, local and global anisotropy, flavor content
- Transient sources (GRB, ...)
- Dark matter – indirect search
- Exotic particles – monopoles, Q-balls, nuclearites, ...

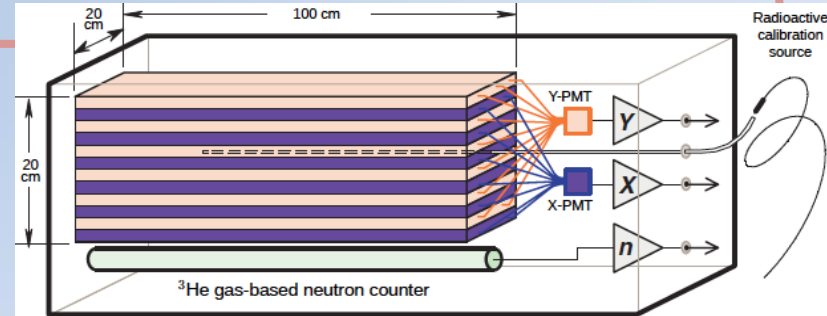


Neutrino physics

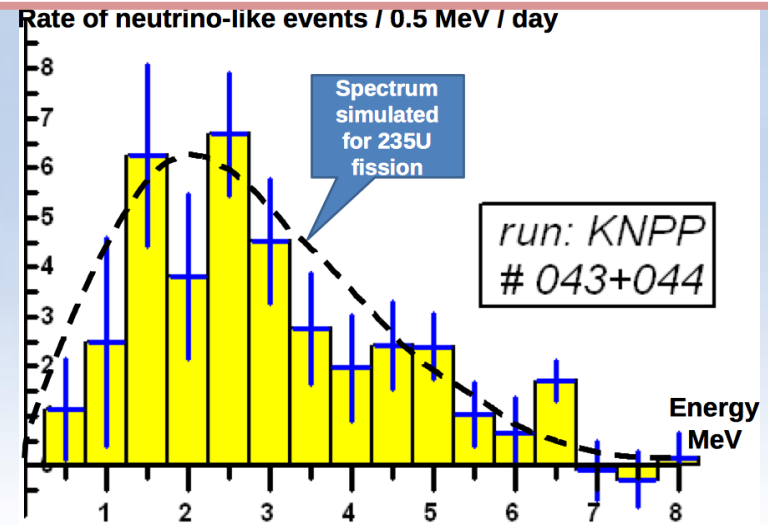
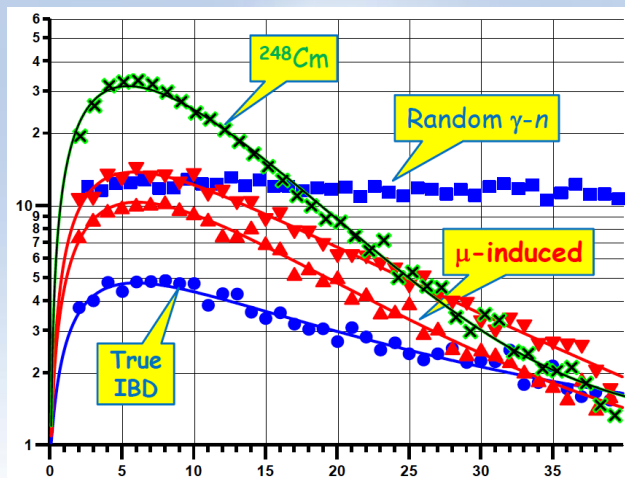
DANSS experiment at the Kalinin APS

To check the DANSS design, a pilot version

DANSSino (DANSS/25) was created !



Measured reactor $\bar{\nu}$ -spectrum!



IBR-2: Pulsed reactor with fast neutrons

mean power **2 MW**

pulse frequency **5 Hz**

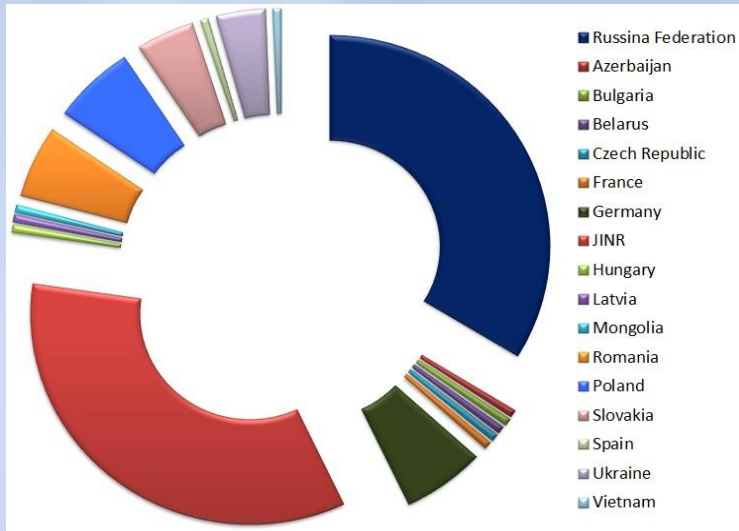
pulse width for fast neutrons **200 μ s**

thermal neutrons flux density on the moderator surface: **10^{13} n/cm² /s**

maximum in pulse: **10^{16} n/cm² /s**

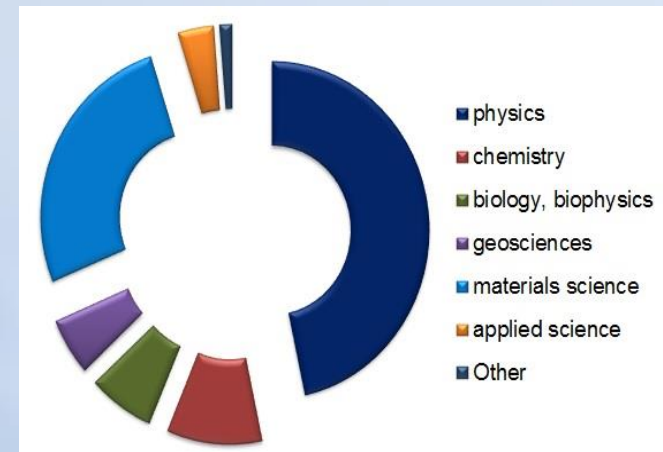


User policy at the IBR-2 (2014)

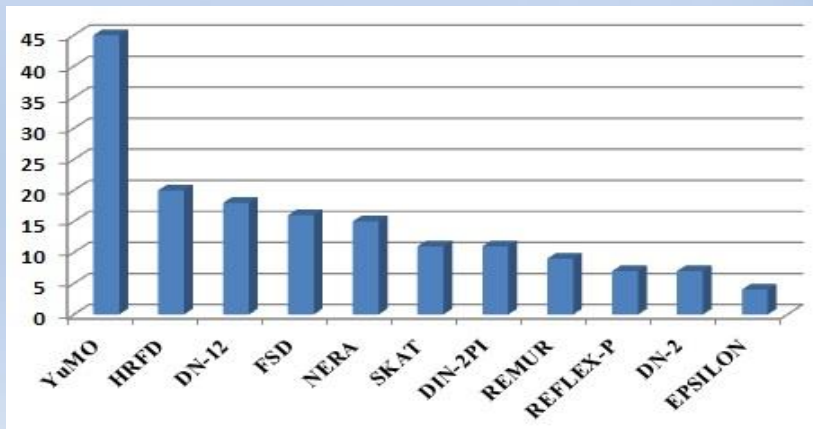


Proposal distribution by applicant's affiliation

**163 proposals were received in total
150 proposals accepted for realization**



Proposal distribution by science



Proposal distribution by facilities

In 2014 the IBR-2 reactor operated for 2,492 hours for experiments.

JINR Multifunctional Centre for Data Storage, Processing and Analysis

Start Tier-1 at 26 March 2015

Grid-Infrastructure at Tier1 and Tier2 Levels

General Purpose Computing Cluster

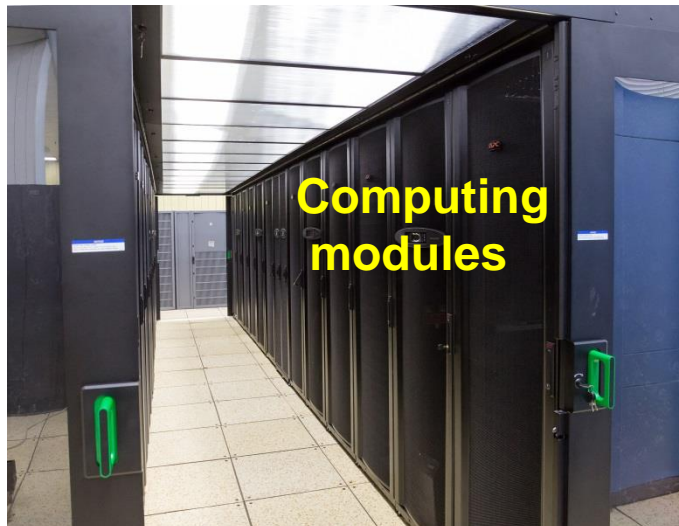
Cloud Computing Infrastructure

**Heterogeneous Computing Cluster
HybriLIT**

**Education and Research Infrastructure
for Distributed and Parallel Computing**



Cooling system



Computing modules



Tape robot



Uninterrupted power supply



Bogoliubov Laboratory of Theoretical Physics

Publications, 2014
Journals & Conf. Proc
~ 490

**Conferences and
Schools**
Total - 16 (~ 1000
participants)
DIAS-TH and Helmholtz
Schools - 4
> 20 countries were
represented

Educational Activity
More than 40 lecture
courses at JINR UC,
DIAS-TH, Moscow U.,
Dubna U., MPTI, etc

JINR Educational Programs

At present **340** graduate students are taking part in various JINR educational programs. According to the law “On Education in RF” a new JINR **PhD program** has been started in 2015.

International Student Practice (ISP) and JINR Summer Student Program (SSP) in 2015



University Center is ready to run ISP in 2015 in three stages. Participation of students from 9 JINR MS is expected. The call for applications for SSP-2015 was launched on January 15.

JINR Outreach Activity in 2014-2015

Outreach programs for teachers and school students from JINR Member States at CERN and JINR have been continued in cooperation with the Centre of National Intellectual Reserve of Moscow State University.



Teacher Programs (CERN & JINR)

<http://teachers.jinr.ru/>

First School held in 2009

Seven Schools at CERN (260 part.)

Five Schools at JINR (210 part.)

Five S

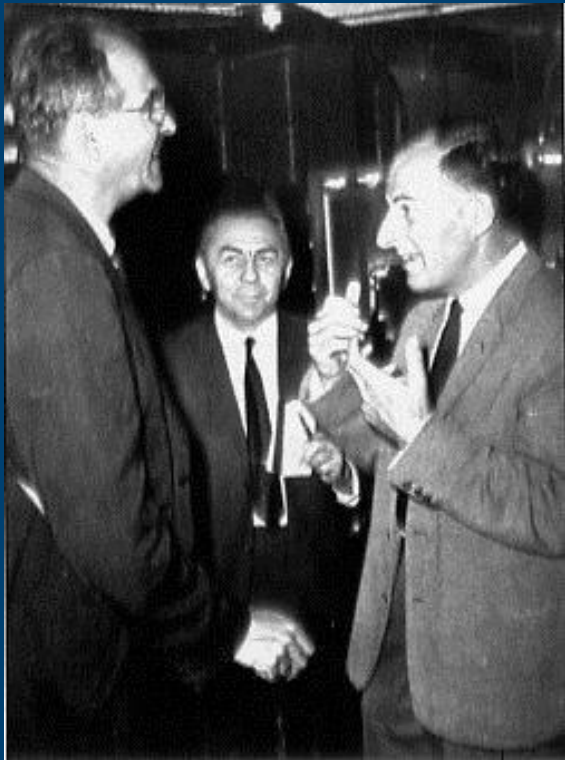


Back to the beginning...

1957 – first contacts between CERN/JINR scientists

1962 – up to now: CERN-JINR Schools series on High-Energy Physics

1963 – first formalized agreement between JINR and CERN



1963:

V. Weisskopf

V. Dzhelepov

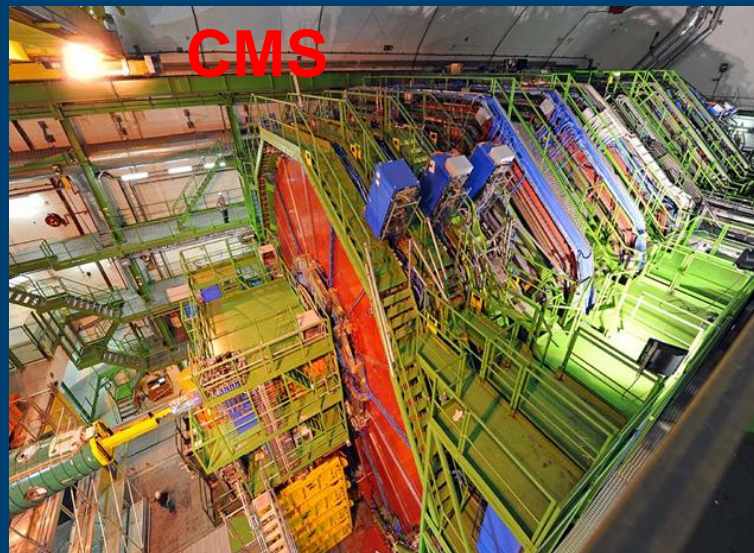
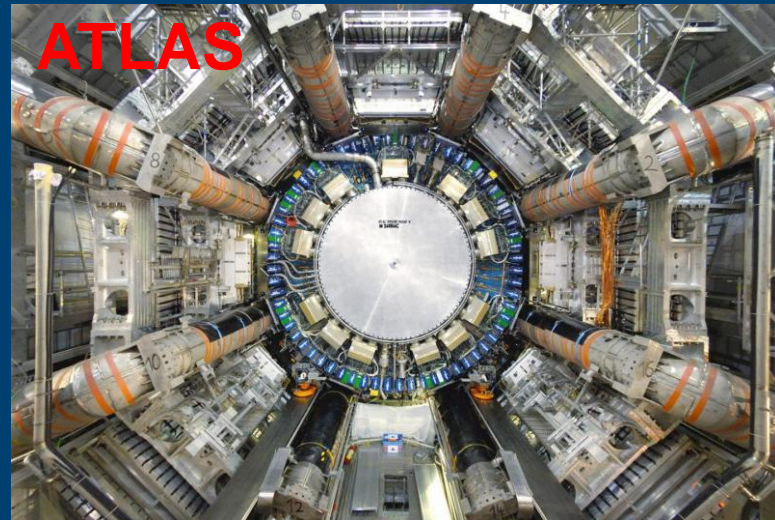
B. Pontecorvo



1971:

W. Jentschke, N. Bogoliubov

1992 - CERN-JINR co-operation agreement on JINR's participation in the construction of the LHC and the ALICE, ATLAS and CMS detectors and in other experiments at CERN SPS and PS, as well as in information technologies



The last co-operation agreement between the JINR and CERN was signed in January 2010. This agreement foresees both, the continuation of JINR contribution to the CERN research program, and the help of CERN to the NICA complex construction.





2014: CERN–JINR reciprocal Observer status

“... the reciprocal granting of Observer status by CERN and JINR, as proposed by JINR, would further strengthen the close ties between the two organisations. The improved exchange of information and mutual consultation on programmes and strategies would create new synergies and provide a basis for even more intense and successful co-operation in the future ...”

CERN Council September 2014

CERN – JINR Long Year Partnership

Committee of the Plenipotentiaries of the governments
of the JINR Member States 25-26 March 2015 :

We were happy to welcome in Dubna
the President of Council of CERN

Prof. Agnieszka Zalewska

and the Head of the International Department of CERN,

Dr. Ruediger Voss

as the high representatives of the European Organization
for Nuclear Research (CERN) at the JINR

For many years from the very beginning of JINR
organization we have enjoyed close partnership relations
between CERN and JINR.



Today, two new Protocols to the 2010 Cooperation agreement will be signed, concerning

**PARTICIPATION BY JINR IN THE LARGE HADRON COLLIDER PROJECT
(LHC)**

and

**COLLABORATION AND COMMON DEVELOPMENTS IN THE AREA OF
NUETRINO PHYSICS AND TECHNOLOGY,
AS WELL AS IN RELATED FIELDS**

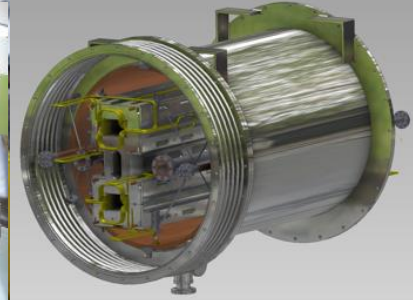
All these creates very efficient basis for the continues fruitful cooperation beneficial for the both sides and contributes to the scientific progress.

In 2016 JINR will celebrate its 60th anniversary. You all are welcome to take part in this remarkable event !



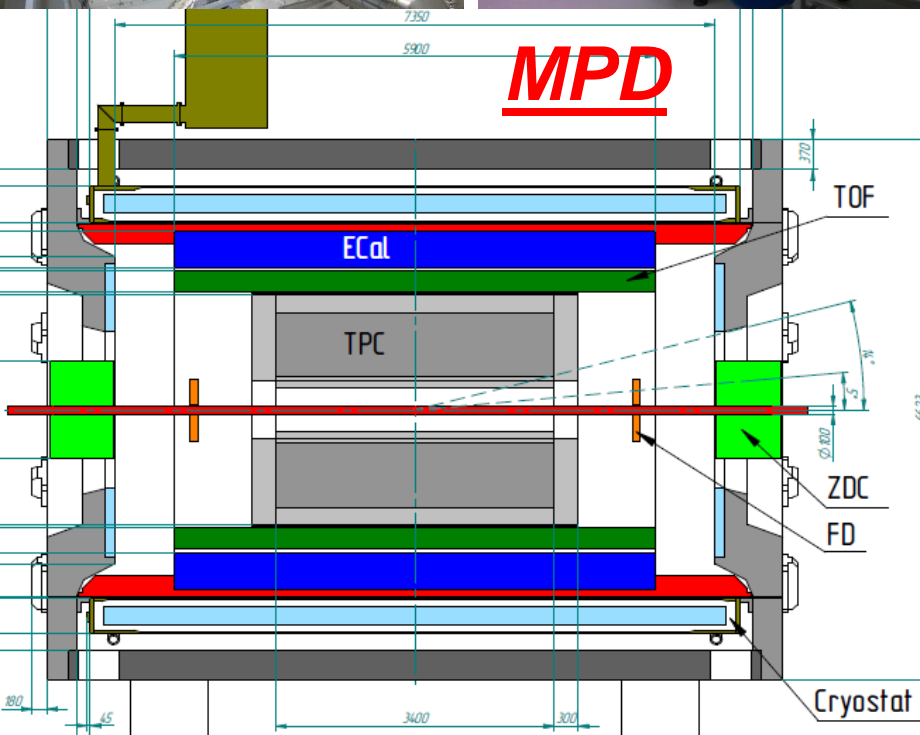
Thank you and welcome to Dubna!





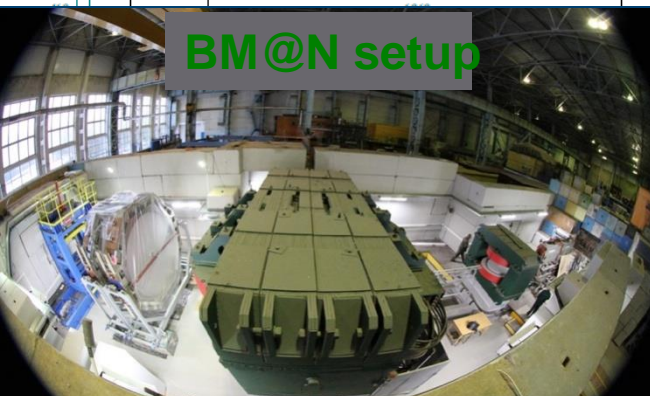
	2014				2015				2016				2017				2018				2019			
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Injection complex																								
Nuclotron upgrade stage II																								
Booster																								
Collider																								
BM@N / stage																								
MPD																								
<i>solenoid</i>																								
<i>TPC, TOF, Ecal (barrel)</i>																								
Collider civil engineering																								
<i>MPD Hall</i>																								
<i>SPD Hall</i>																								
<i>Collider tunnel</i>																								
<i>HEBT Nuclotron-collider</i>																								
Cryogenic full scale (collider & MPD)																								





Detailed energy & system size scan with a step $\sim 10 \text{ MeV/u}$ in selected regions with a high L aimed in a search for anomalies:

- in particle production in the vicinity of the critical point,
- signatures of in-medium modification of the vector-spectral functions,
- study of the properties of the mixed phase of strongly interacting matter



BM@N setup

CERN: drift chambers, SC solenoid

INR RAS: ZD, RP calorimeters

GSI: silicon tracker

Ukraine: EM calorimeters

RNL:



BM@N setup

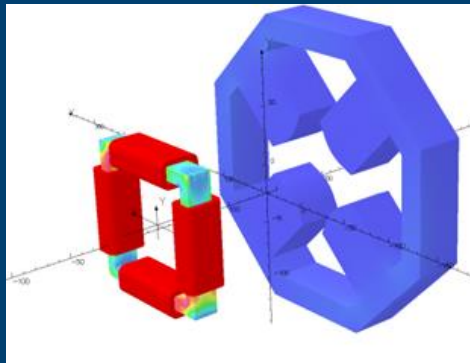
- Key accelerator and detector technologies in NICA/NA61/CBM/BES at the frontier level are driven by challenging requirements of experiments and could be obtained fast only with our common efforts: intellectual exchange and sharing of resources
- Long successful experience of CERN-JINR collaboration in large projects and international scientific expertise allows to our member-countries support new mega-experiments.
- NICA project has tough schedule but it is realistic if supported by international scientific community, high-level expertise and actively working collaborations. Promised State support very important and needs constant assurance from international community.
- International common efforts and complementarity of our experiments give us a strong argument in building European (global) distributed scientific infrastructure for heavy ion physics

MAGNETS

Contributions on magnetic design

- Electromagnetic design and analysis of complete magnets. Ex: the magnet for the AWAKE electron line.
- Advanced optimization of field quality in 3D. Ex: the magnets for the Hie-Isolde project.
- Contributions on the development of novel concepts of permanent and of hybrid magnets. Ex the hybrid magnets for CLIC and ILC (in particular the hybrid permanent magnets concept).

AWAKE: coupling of magnetic field between corrector and quadrupole



Hybrid final focusing permanent magnet quadrupole for linear colliders



Contributions on constructional design

- Design of advanced manufacturing tooling. Ex: the stack assembly of the sextupole magnets for Sesame.
- Design of different types of magnets for accelerators and experiments. For example the large permanent magnet spectrometer for n-TOF.

Advanced tooling for precision stacking of the laminations for the Sesame sextupole magnets



large permanent magnet spectrometer for n-TOF



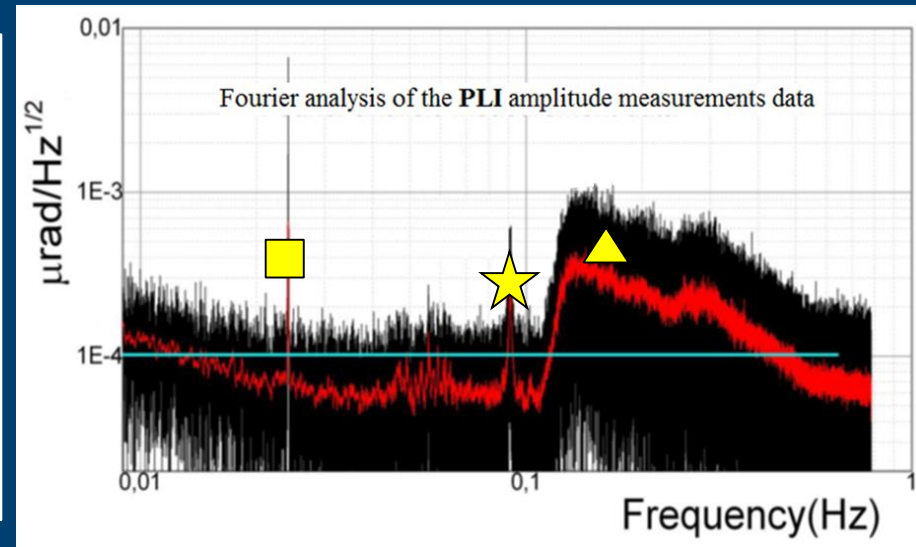
THE PRECISION LASER INCLINOMETER (PLI)

*Reported on the CLIC Workshop 2015, January 26-30, CERN by **N.AZARYAN**, **V.BATUSOV**, **J.BUDAGOV**, **V.GLAGOLEV**, **M.LYABLIN**, **G.TRUBNIKOV**, **G.SHIRKOV** (JINR) and **B. DI GIROLAMO**, **J.-C.GAYDE**, **D.MERGELKUHL**, **M. NESSI** (CERN)*

The **PLI** uses the GRAVITY vector as a stable reference line with angular variation $<10^{-10}$ Rad. The resolution of **PLI** is $\sim 10^{-10}$ Rad enables it to discover and detect the SUPERWEAK GROUND ANGULAR MOTION.

On the PICTURE – the **PLI** frequency spectrum with signals:

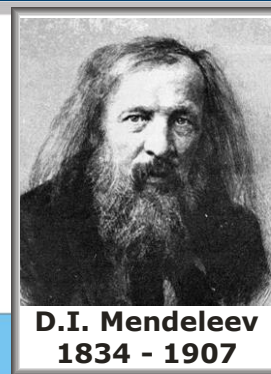
- for instrumental calibration frequency;
- ★ for the tunnel-boring machine in Alpes;
- ▲ for the experimental observation of **Microseismic Peak** detected as ground ANGULAR motion caused by ocean water oscillations.



The **PLI** data can be used for stabilization of the space location of the Long Laser Fiducial Line for Multy-TeV Accelerators & Detectors

Currently in the CERN Transport Tunnel #1 the long-term tests of the two-coordinates **PLI** are in progress. The **PLI** signals are being online registered in the Laboratory of Nuclear Problems, JINR.

период	ряд	группы элементов																										
		a	I	б	a	II	б	a	III	б	a	IV	б	a	V	б	a	VI	б	a	VII	б	a	VIII	б			
1	I	Водород 1 H 1,00794 Hydrogen																					Гелий 2 He 4,0026 Helium					
2	II	Литий 3 Li 6,941 Lithium			Бериллий 4 Be 9,012182 Beryllium			Бор 5 B 10,811 Boron			Углерод 6 C 12,011 Carbon			Азот 7 N 14,00674 Nitrogen			Кислород 8 O 15,9994 Oxygen			Фтор 9 F 18,9984032 Fluorine			Неон 10 Ne 20,1797 Neon					
3	III	Натрий 11 Na 22,989768 Sodium			Магний 12 Mg 24,3050 Magnesium			Алюминий 13 Al 26,981539 Aluminum			Кремний 14 Si 28,0855 Silicon			Фосфор 15 P 30,973762 Phosphorus			Сера 16 S 32,066 Sulfur			Хлор 17 Cl 35,4527 Chlorine			Аргон 18 Ar 39,948 Argon					
4	IV	Калий 19 K 39,0983 Potassium			Кальций 20 Ca 40,078 Calcium			21 3d ⁴ 4s ² Scandium Sc 44,955910			22 3d ⁴ 4s ² Titanium Ti 47,88			23 3d ⁴ 4s ² Vanadium V 50,9415			24 3d ⁴ 4s ² Chromium Cr 51,9961			25 3d ⁴ 4s ² Manganese Mn 54,93805			26 3d ⁴ 4s ² Iron Fe 55,847					
	V	29 3d ¹⁰ 4s ¹ Copper Cu 63,546			Медь 30 3d ¹⁰ 4s ² Zinc Zn 65,39			Цинк 31 4p ¹ Gallium Ga 69,723			Германий 32 4p ² Germanium Ge 72,61			Мышьяк 33 4p ³ Arsenic As 74,92159			Селен 34 4p ⁴ Selenium Se 78,96			Бром 35 4p ⁵ Bromine Br 79,904			Криптон 36 4p ⁶ Krypton Kr 83,80					
5	VI	Рубидий 37 5s ¹ Rubidium Rb 85,4678			Стронций 38 5s ² Strontium Sr 87,62			39 4d ⁵ 5s ² Yttrium Y 88,90585			40 4d ⁵ 5s ² Zirconium Zr 91,224			41 4d ⁵ 5s ¹ Niobium Nb 92,90638			42 4d ⁵ 5s ¹ Molybdenum Mo 95,94			43 4d ⁵ 5s ² Technetium Tc [98]			44 4d ⁵ 5s ¹ Ruthenium Ru 101,07					
	VII	47 4d ¹⁰ 5s ¹ Silver Ag 107,8682			Кадмий 48 4d ¹⁰ 5s ² Cadmium Cd 112,411			Индий 49 5p ¹ Indium In 114,818			Олово 50 5p ² Tin Sn 118,710			Сурьма 51 5p ³ Antimony Sb 121,757			Теллур 52 5p ⁴ Tellurium Te 127,60			Йод 53 5p ⁵ Iodine I 126,90447			Ксенон 54 5p ⁶ Xenon Xe 131,29					
6	VIII	Цезий 55 6s ¹ Cesium Cs 132,90543			Барий 56 6s ² Barium Ba 137,327			57 5d ⁶ 6s ² Lanthanum La 138,9055			72 5d ⁶ 6s ² Hafnium Hf 178,49			73 5d ⁶ 6s ² Tantalum Ta 180,9479			74 5d ⁶ 6s ² Tungsten W 183,84			75 5d ⁶ 6s ² Rhenium Re 186,207			76 5d ⁶ 6s ² Osmium Os 190,23					
	IX	79 5d ¹⁰ 6s ¹ Gold Au 196,96654			Ртуть 80 5d ¹⁰ 6s ² Mercury Hg 200,59			Таллий 81 6p ¹ Thallium Tl 204,3833			Свинец 82 6p ² Lead Pb 207,2			Висмут 83 6p ³ Bismuth Bi 208,98037			Полоний 84 6p ⁴ Polonium Po [209]			Астат 85 6p ⁵ Astatine At [210]			Радон 86 6p ⁶ Radon Rn [222]					
7	X	Франций 87 7s ¹ Francium Fr [223]			Радий 88 7s ² Radium Ra 226,025			89 6d ⁷ 7s ² Actinium Ac [227]			104 Rutherfordium Rf [261]			105 Dubnium Db [262]			106 Seaborgium Sg [266]			107 Bohrium Bh [267]			108 Hassium Hs [269]					
	XI	111			112			113			114			115			116			117			118					



■ s-элементы

■ p-элементы

■ d-элементы

■ f-элементы

Лантаноиды Lanthanides

Церий Ce 4f ¹ 5d ¹ 140,115 Cerium	Прозеродим Pr 4f ³ 140,90765 Praseodymium	Неодим Nd 4f ⁴ 144,24 Neodymium	Pm 4f ⁵ [145]	Самарий Sm 4f ⁶ 150,36 Samarium	Европий Eu 4f ⁷ 151,965 Europium	Гадолиний Gd 4f ⁷ 5d ¹ 157,25 Gadolinium	Тербий Tb 4f ⁹ 158,92534 Terbium	Диспрозий Dy 4f ¹⁰ 162,50 Dysprosium	Гольмий Ho 4f ¹¹ 164,93032 Holmium	Эрбий Er 4f ¹² 167,26 Erbium	Тулий Tm 4f ¹³ 168,93421 Thulium	Йттербий Yb 4f ¹⁴ 173,054 Ytterbium	Лютеций Lu 4f ¹⁴ 5d ¹ 174,967 Lutetium
--	---	---	-----------------------------	---	--	---	--	--	--	--	--	---	---

Актиноиды Actinides

Торий Th 7s ² 6d ² 232,0381 Thorium	Протактиний Pa 7s ² 5f ² [231] Protactinium	Уран U 5f ³ 6d ¹ 238,0289 Uranium	Нептуний Np 5f ⁴ [237] Neptunium	Плутоний Pu 5f ⁶ [244] Plutonium	Америций Am 5f ⁷ [243] Americium	Кюрий Cm 5f ⁸ [247] Curium	Берклий Bk 5f ⁹ [247] Berkelium	Калифорний Cf 5f ¹⁰ [251] Californium	Эйнштейний Es 5f ¹¹ [252] Einsteinium	Фермий Fm 5f ¹² [257] Fermium	Менделевий Md 5f ¹³ [257] Mendelevium	Нобелий No 5f ¹⁴ [259] Nobelium	Лавендий Lw 5f ¹⁴ 6d ¹ [260] Lawrencium
--	--	--	--	--	--	--	---	---	---	---	---	---	--

113

Discovered
at JINR in 2003

114

Discovered
at JINR in 1999

115

Discovered
at JINR in 2003

116

Discovered
at JINR in 2000

117

Discovered
at JINR in 2009

118

Discovered
at JINR in 2001

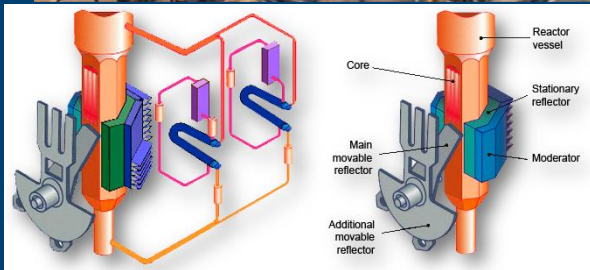
JINR's Large-Scale Basic Facilities

The IBR-2M pulsed reactor of periodic action is included in the 20-year European strategic programme of neutron scattering research.



Parameters

Fuel	PuO_2
Active core volume	22 dm ³
Cooling	liquid Na
Average power	2 MW
Pulsed power	1500 MW
Repetition rate	5 s ⁻¹
Average flux	$8 \cdot 10^{12}$ n/cm ² /s
Pulsed flux	$5 \cdot 10^{15}$ n/cm ² /s
Pulse width (fast / therm.)	215 / 320 μ s
Number of channels	14



Fundamental and applied research in condensed matter physics and related fields — biology, medicine, material sciences, geophysics, engineer diagnostics — aimed at probing the structure and properties of nanosystems, new materials, and biological objects, and at developing new electronic, bio- and information nanotechnologies.

Web of Science®

JINR

CERN

2011-2013

Total number of publications: **2897**
Total number of citations: **34079**
Average citations per article: **11.76**
h-index: **52**
budget (2013): \approx **143.2** million **USD**

Total number of publications: **3561**
Total number of citations: **48012**
Average citations per article: **13.48**
h-index: **79**
budget (2013): \approx **1 264** million **USD**

2014

Total number of publications: **897**
Total number of citations: **1149**
budget (2014): \approx **158.7** million **USD**

Total number of publications: **1240**
Total number of citations: **3216**
budget (2014): \approx **1 125** million **USD**

Due to collaboration between CERN and JINR at LHC and other facilities a considerable part of publications in experimental elementary particle physics is joint. However above statistics (total number of publications and citations as well as h-index) of JINR includes also serious contribution related to nuclear and neutrino physics, condensed matter physics and biophysics, theoretical physics.

Both organizations look comparably efficient in terms of bibliometry. In terms of human and finance resources (JINR has 2 times less number of scientists and 7 times smaller budget) the publication activity of JINR is quite impressive.

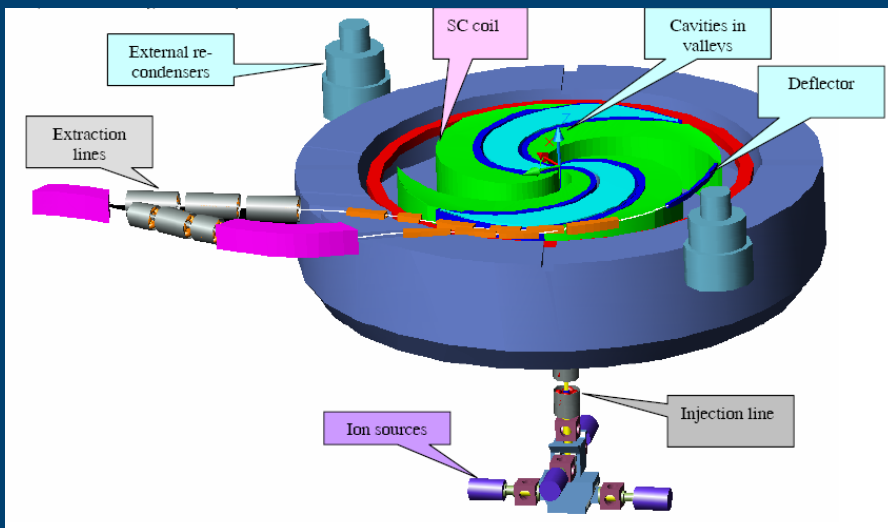
Proton therapy and medical accelerators

Proton Therapy at JINR's Phasotron

- Unique in Russia experience of application of **conformal 3D therapy method**
- About **100 patients per year since 2000**
- Development of the project of PT Center



C400 SC Cyclotron Project for p & C Therapy (together with IBA, AFK "Sistema", ...)



The analysis of medicinal plants using neutron activation analysis at the IBR-2 reactor



Sanguisorba officinalis

International Journal of Medicinal Plants. Photon 106 (2014) 481-492

<https://sites.google.com/site/photonfoundationorganization/home/international-journal-of-medicinal-plants>

Original Research Article. ISJN: 6672-4384; Impact Index: 3.12

International Journal of Medicinal Plants

Photon

Investigation of Elemental Content of Some Medicinal Plants from Mongolia

Nyamsuren Baliinnyam^{a*}, Nanzad Tsevegsuren^b, Baasanjav Jugder^c, Marina Vladimirovna Frontasyeva^a, Sergey Sergeevich Pavlov^a

The authors receive Thomas Edison Award-2014 in the domain of Medicinal Plants for Inspiration and Knowledge Distribution among young research scholars.

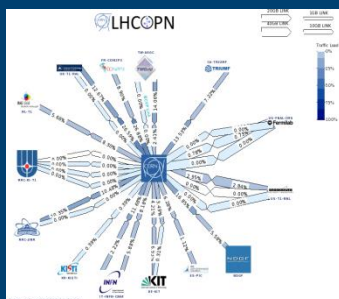
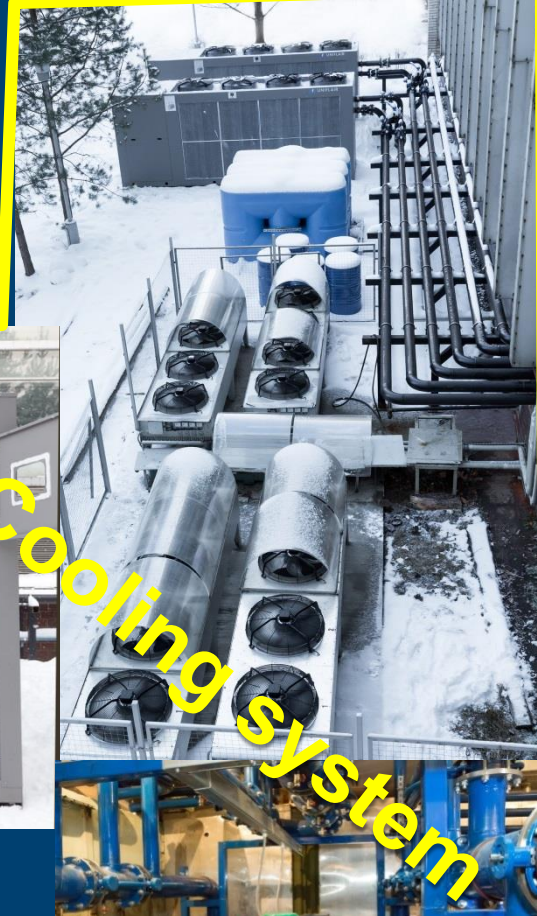


Carduus crispus

Tier-1 (CMS)

Start - March 2015

- LHCOPN
- 2400 cores (~ 30 kHS06)
- 5 PB tapes (IBM TS3500)
- 2,4 PB disk
- Close-coupled, chilled water cooling InRow
- Hot and cold air containment system
- MGE Galaxy 7000 – 2x300 kW energy efficient solutions 3Ph power protection with high adaptability



42nd Meeting of the PAC for Nuclear Physics, June 4, 2015

CERN – JINR Partnership

**Committee of the Plenipotentiaries of the governments
of the JINR Member States 25-26 March 2015 :**

**We were happy to welcome in Dubna
the President of Council of CERN**

Prof. Agnieszka Zalewska

and the Head of the International Department of CERN,

Dr. Ruediger Voss

**as the high representatives of the European
Organization for Nuclear Research (CERN) at the JINR**

**For many years from the very beginning of JINR
organization we have enjoyed close partnership
relations between CERN and JINR.**

Astrobiology



Collaboration: University of Viterbo, Sapienza Università of Rome (Italy) and LRB (JINR)

Meteorite-catalyzed syntheses of nucleosides and of other prebiotic compounds from formamide under proton irradiation

