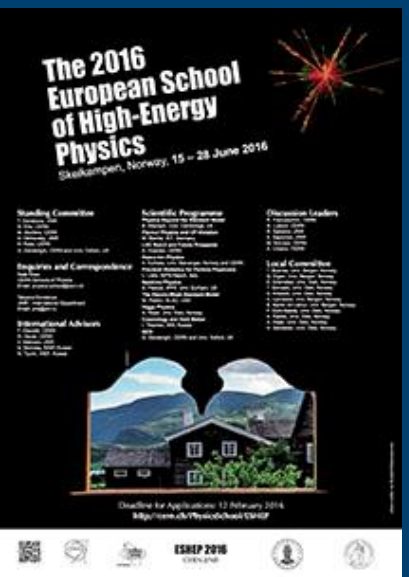
JINR (Dubna)
1956 - 2016

"The JINR: Present Status and Perspectives"

(to the 60 years jubilee of the Joint Institute for Nuclear Research)

Victor A.Matveev



The 2016 European School of High-Energy Physics
Skeikampen, Norway
15 - 28 June 2016

The 2016 European School of High-Energy Physics

Skeikampen, Norway 15 – 28 June 2016

-- JINR history

-- Science priorities

-- Topmost results

-- Perspectives

-- Conclusion

V. Matveev Skeikampen June 24, 2016

JOINT INSTITUTE for NUCLEAR RESEARCH

International Intergovernmental Organization

The Agreement on the establishing JINR was signed by 11 member states on 26 March 1956 in Moscow

to unite scientific and material potential of its member states in order to study fundamental properties of matter

‘‘ ATOM for PEACE ’’

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

JINR : Back to the Beginning

High-level visits to JINR.

JINR, Dubna, 1958:
P. Dirac with JINR theorists
D. Blokhintsev, N. Bogolyubov,
Ya. Smorodinsky

JINR, Dubna, 1961:
N. Bohr with
D. Blokhintsev, V. Djelepov

JINR – CERN partnership: 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

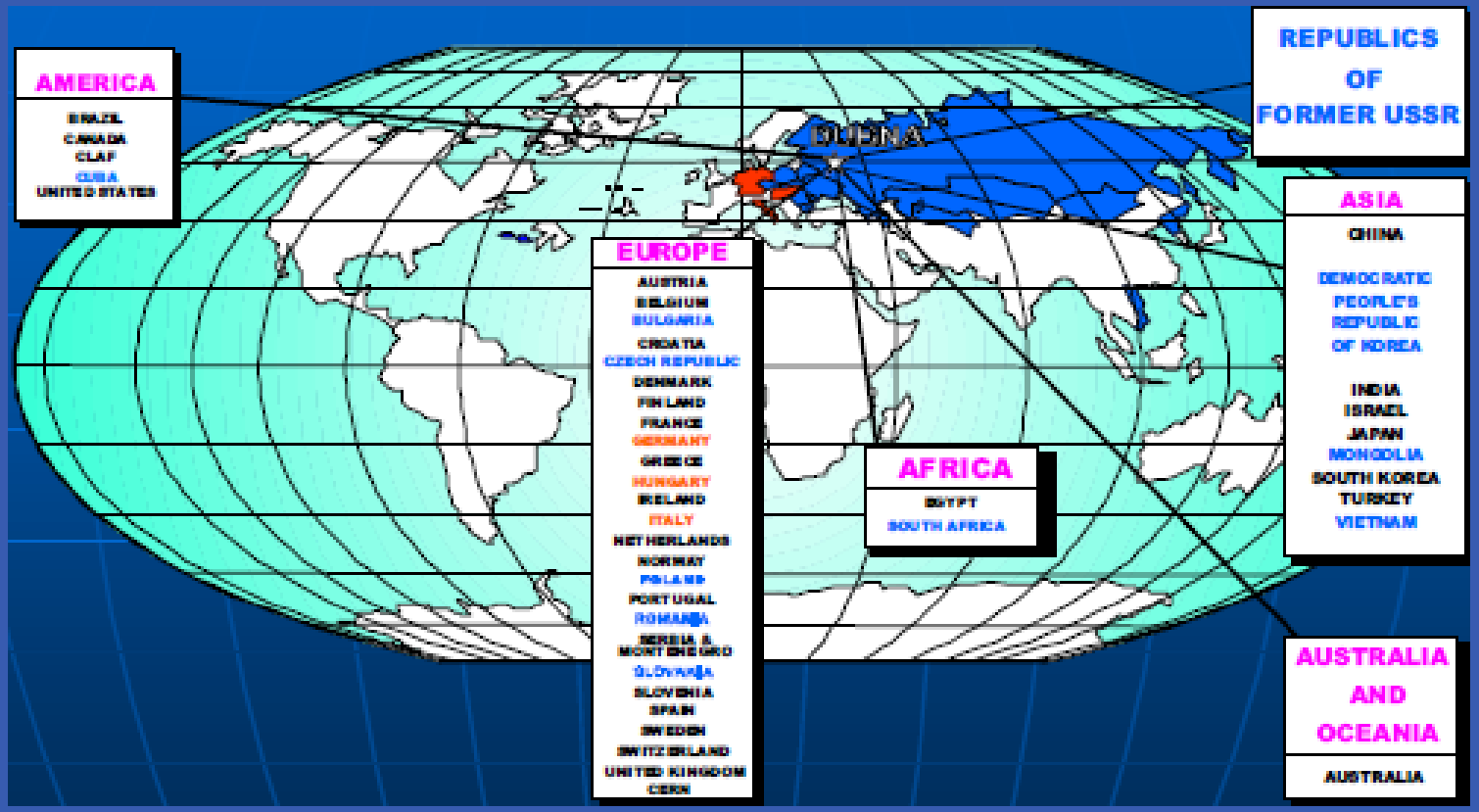
JINR has at present 18 Member States:

Armenia
Azerbaijan
Belarus
Bulgaria
Cuba
Czech Republic
Georgia
Kazakhstan
DRP 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 collabiraton

JINR collaborates with more than 700 scientific centres and universities in 64 countries over the world.



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

Frank Laboratory of Neutron Physics

Laboratory of
Information Technologies

Flerov
Laboratory of Nuclear Reactions

Laboratory of Radiation Biology

JINR University Centre

JINR Research Experimental Facilities

- **Heavy Ion Superconducting Complex Nuclotron-NICA**
  - Physics of dense and hot baryon matter
  - Spin structure and dynamics of nuclear matter
- **Intensive pulsed neutron breader reactor IBR-2 :**
  - Condensed matter & Nuclear physics IRENA
- **High Power Cyclotron Complex and SHE Factory**
  - Superheavy elements and Exotic nuclei
  - Dubna Radioactive Ions Beam studies DRIBs
- **Complex of computing & information technologies**
  - Tier-1 complex for LHC and NICA
- **Neutrino Gigaton Volume Detector GVD at Baikal lake**
  - Neutrino Physics and Astrophysics
- **Accelerator facility for radiobiology and medical studies**
  - Hadron therapy, astrobiology, cosmic medicine

JINR in some figures

JINR`s staff members ~ 4500 :

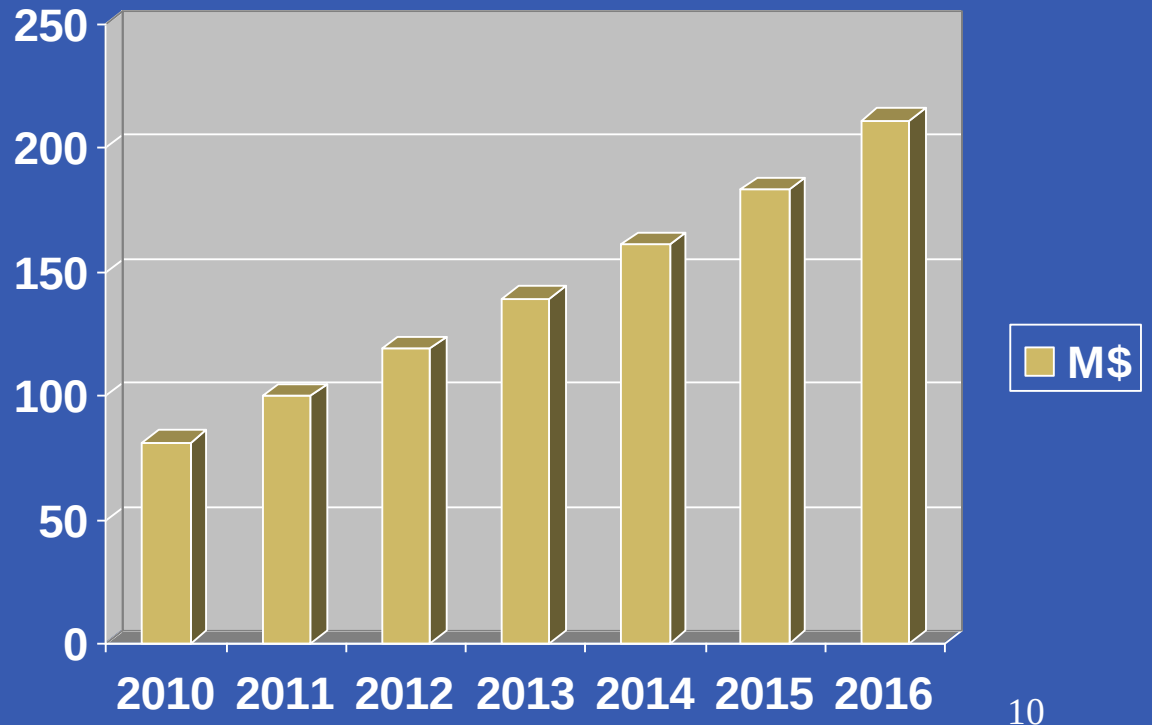
- **Researchers ~ 1300**

  including from the Member States (but Russia) ~ 450

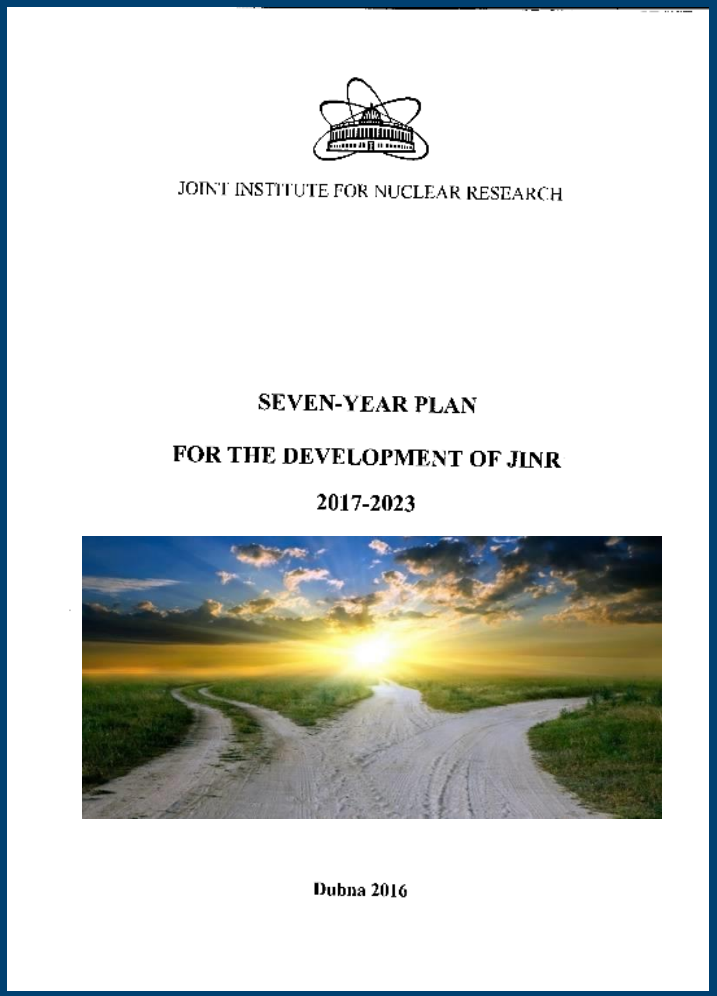
  PhD and Full Doctors of Science ~ 1100

- **Engineers and specialists ~2100**
- **Services ~ 1100**

JINR Budget: actual and foreseen in the current 7-year Plan for 2010-2016



Introduction into the 7-year JINR plan for 2017 - 2023



JINR is unique for its time-tested trinity of basic research, wide international cooperation, educational and multi-disciplinary approach. Research area of JINR includes particle physics, relativistic heavy ion physics, advanced physics of super heavy elements and exotic nuclei, precision nuclear spectroscopy, neutrino physics and astrophysics, IT and computing, fundamental neutron studies, theoretical and mathematical physics, condensed matter physics, biophysics and radio-biology, modern equipment and experimental technique and innovations.

Working Group on The JINR LONG RANGE STRATEGY up to 2030

CUMULATIVE

BARYON DENSITY

FRONTIER

NICA (Nuclotron based Ion Colider fAcility)

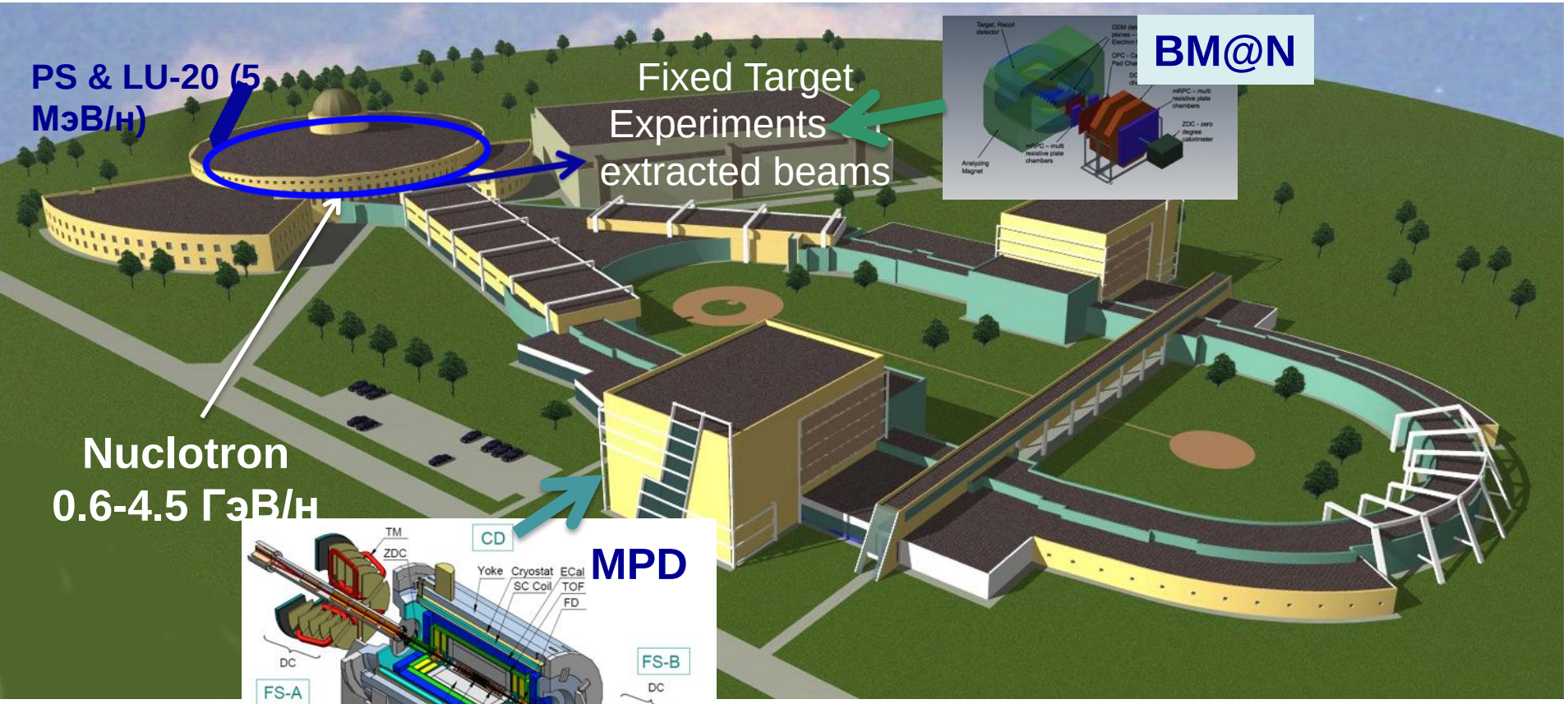
the flagship project in HEP of Joint Institute for Nuclear Research (JINR)

Main targets of the NICA project:

- ***study the hot and dense baryonic matter , search for the critical phenomena in heavy ions collisions***
- ***investigation of nucleon and light nuclei spin structure, study the polarization phenomena in hadron collisions***
- ***development of accelerator facility for HEP providing intensive beams of relativistic ions from p to Au and polarized protons and deuterons with max energy up to $\sqrt{S_{NN}}$= 11 GeV (Au^{79+}) and =27 GeV (p)***

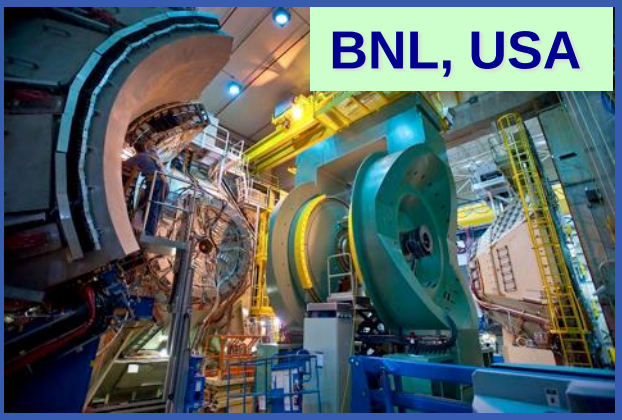
Мега-проект «Комплекс NICA»

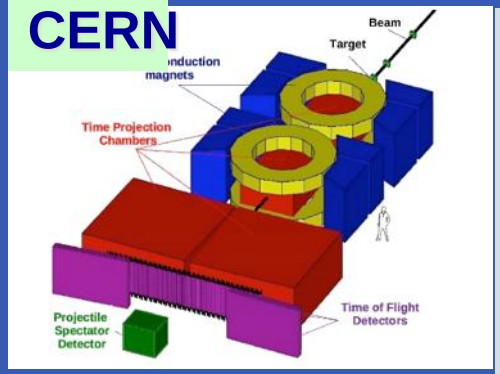
Existing elements

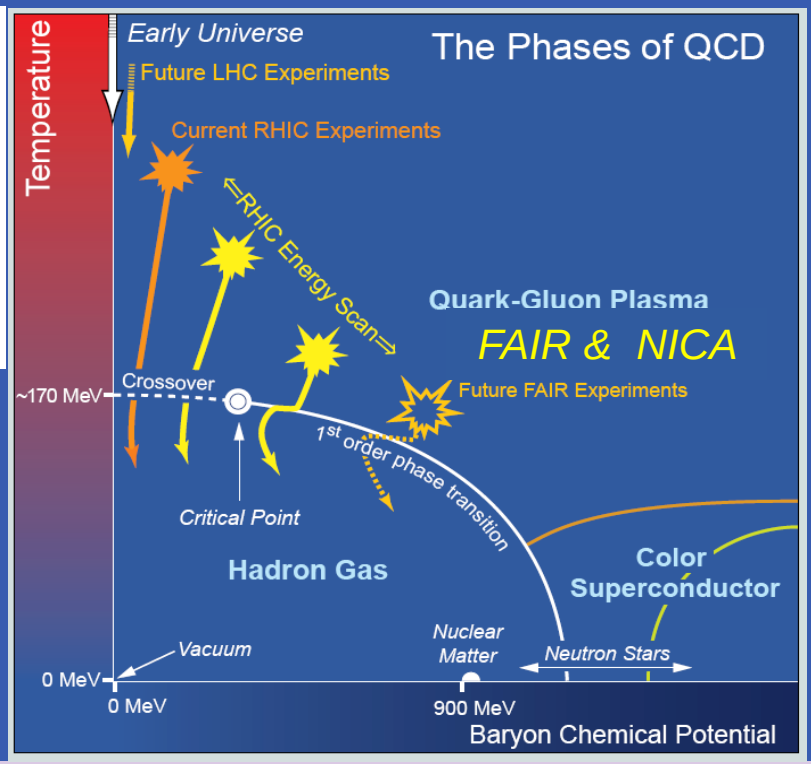


Study of the principally new phase state of the nuclear matter – super dense and hot baryonic matter – the Quark-Gluon Plasma produced initially at the birth of our Universe by the Big Bang.

JINR NICA-
in the list of international Mega-Science Projects on the RF territory







NICA has the most interesting energy diapason ($\sqrt{s_{NN}}$ ~ 10 GeV) corresponding to the region of the maximal density of baryonic or nuclear matter which nobody has had yet achieved in the laboratories. Main Goal - studying the critical phenomena and phase transitions happened to appear in the Early Universe and presumably existing in the Neutron Stars.

- ✓ **FAIR *(Darmstadt) – Fixed target experiments***
- ✓ **NICA *(ОИЯИ, Dubna)* – Collider experiments**

NICA International collaboration

Belarus
NC PHEP BSU (Minsk)
GSU (Gomel)
…
…

Germany
GSI (Darmstadt)
JLU (Giessen)
UR (Regensburk)
Frankfurt/Main Univ.
FIAS
FZJ (Julich)
FAU(Erlangen)

Bulgaria
INRNE BAS (Sofia)
TU-Sofia
SU
ISSP BAS
LTD BAS
SWU
PU (Plovdiv)
TUL (Blagoevgrad)

Poland
Tech.University (Warsaw)
Warsaw University
Fracoterm (Krakow)
Wroclaw University
INP (Krakow)

Ukraine
BITP NASU, KSU (Kiev)
KhNU, KFTI NASU (Kharkiv)

Russia
INR RAS (Moscow)
NRC KI (Moscow)
BINP RAS (Novosibirsk)
MSU (Mscow)
LPI RAS (Moscow)
St.Pet. Univ ersity
RI (St.Petersburg)
…
…

Australia
Azerbaijan
CERN
China
France
Georgia
Greece
India

Czech Republic
TUL (Liberec)
CU (Prague)
Rzezh, …

RSA
UCT (Cape Town)
UJ (Johannesburg)
iThemba Labs

Italy
Japan
Moldova
Mongolia
Romania
Serbia
Slovakia
USA

JINR-France (IN2P3) MoU

Megaprojects: Workshop in Dubna (Italy, Germany, France, China, Egypt, SAR, RF)

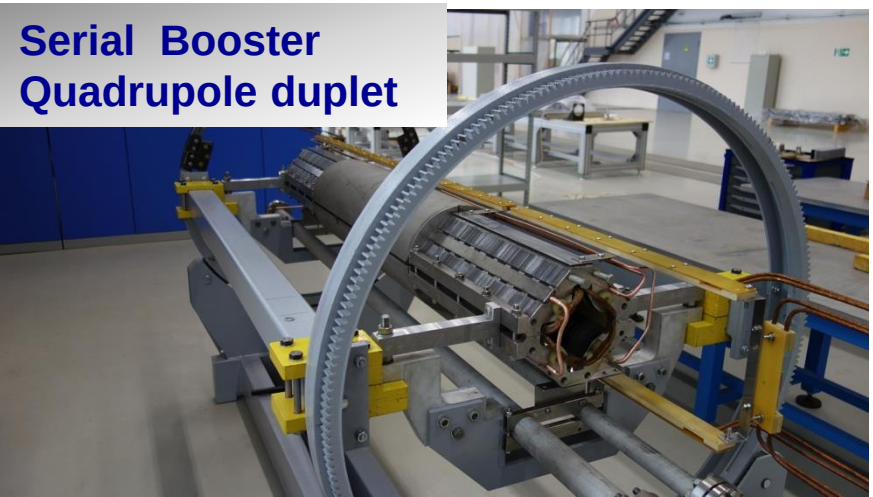
February 2015
Cooperation Agreement FAIR (Darmstadt) – JINR

Test Facility for SC magnets of NICA and FAIR: excellent collaboration of JINR and Germany (BMBF). Start of operation – December'14. Serial assembly and cold tests (6 arms) – December 2015

1st cold test of Booster dipole with magnetic measurements made in December'14
Cold test of serial quadrupole duplet – Feb-March 2015

Serial production of Booster dipoles and quadrupoles started in Oct 2014

Serial Booster Quadrupole duplet



		2015				2016				2017				2018				
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I
Booster																		
dipoles	40+3	■	■	■	■	■	■	■										
quadrupoles	48+6	■	■	■	■	■	■	■	■									
multipole correctors	40+4					■	■	■	■									
Collider																		
dipoles	80+5					■	■	■	■	■	■	■	■	■	■	■	■	
quadrupoles	86+5					■	■	■	■	■	■	■	■	■	■	■	■	
multipole correctors																		
nonstructurals																		

Magnet production plan

Khodzhibagiyan, S. Kostromin

Status on 04.04.2016			
	total	schedule	delivered yokes
dipoles	**40**	**20**	**5**
quadrupol	**48**	**36**	**26**

2020 | II | III | IV

Booster

dipoles

quadrupoles

multipole correctors

Collider

dipoles

quadrupoles

multipole correctors

nonstructurals

SIS-100

pre-series quadrupole

pre-series sextupole c

pre-series dipole corre

pre-series multipole c

quadrupole

sextupole correctors

dipole correctors

multipole correctors **12**

NICA Mega-Science Project
International Consortium

6 countries

Protocol signed by:

Belarus, *Bulgaria,*
Germany, Kazakhstan,
Russia, Ukraine

(Dubna, August 08, 2013.)

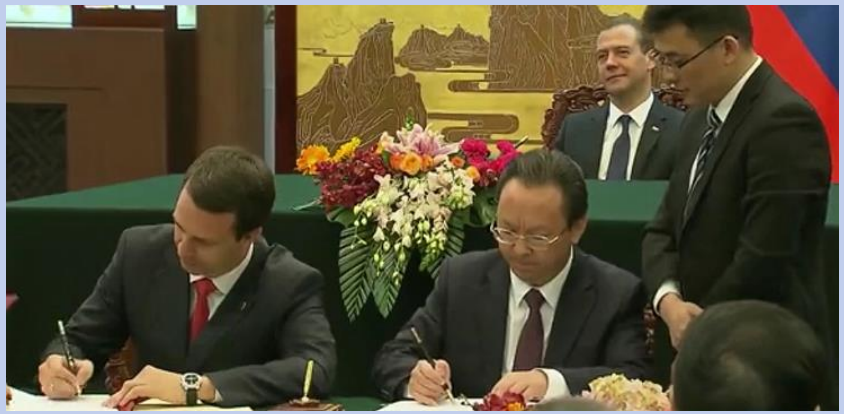
V.V.Putin visited JINR in 05 July 2011

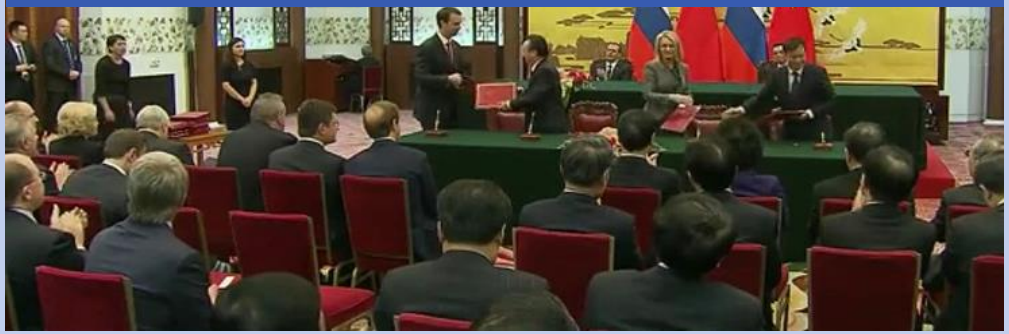
A Quadripartite Protocol signed in China

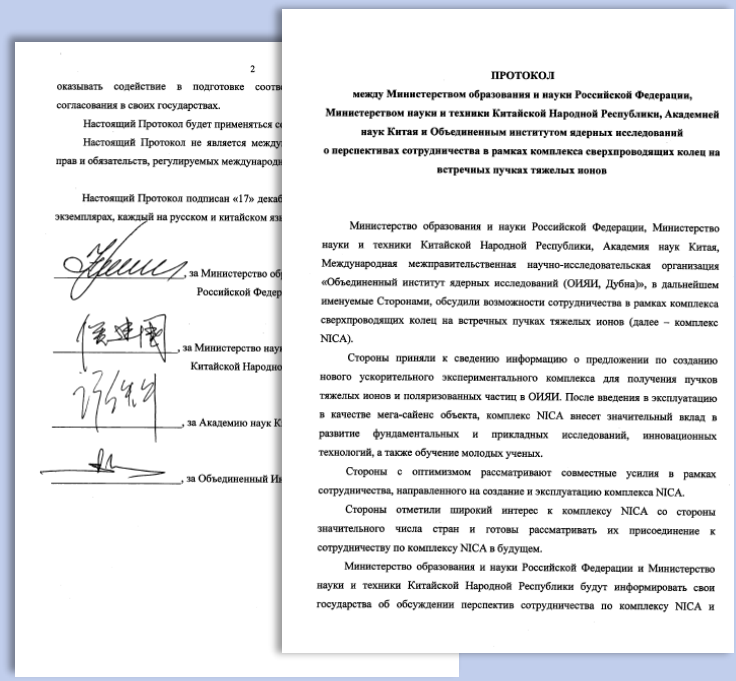
At the 20th Regular Meeting of Prime Ministers of Russia and China

December 17, 2015, Beijing

On behalf of JINR **Grigory TRUBNIKOV** (JINR vice-director), signed a Quadripartite Protocol between the Ministry of Education and Science of Russia (Deputy minister **Natalya TRETYAK**), the Ministry of Science and Technology of China (vice-minister **YIN Hejun**), the Chinese Academy of Sciences (vice-president **HOU Jianguo**) and JINR on the prospects of cooperation in the frames of the complex of superconducting rings with colliding beams of heavy ions NICA.







ПРОТОКОЛ

между Министерством образования и науки Российской Федерации, Министерством науки и техники Китайской Народной Республики, Академией наук Китая и Объединенным институтом ядерных исследований о перспективах сотрудничества в рамках комплекса сверхпроводящих колец на встречных пучках тяжелых ионов

Министерство образования и науки Российской Федерации, Министерство науки и техники Китайской Народной Республики, Академия наук Китая, Международная межправительственная научно-исследовательская организация «Объединенный институт ядерных исследований (ОИЯИ, Дубна)», в дальнейшем именуемые Сторонами, обсудили возможности сотрудничества в рамках комплекса сверхпроводящих колец на встречных пучках тяжелых ионов (далее – комплекс NICA).

Стороны приняли к сведению информацию о предложении по созданию нового ускорительного экспериментального комплекса для получения пучков тяжелых ионов и поляризованных частиц в ОИЯИ. После введения в эксплуатацию в качестве мега-сайенс объекта, комплекс NICA внесет значительный вклад в развитие фундаментальных и прикладных исследований, инновационных технологий, а также обучение молодых ученых.

Стороны с оптимизмом рассматривают совместные усилия в рамках сотрудничества, направленного на создание и эксплуатацию комплекса NICA.

Стороны отметили широкий интерес к комплексу NICA со стороны значительного числа стран и готовы рассматривать их присоединение к сотрудничеству по комплексу NICA в будущем.

Министерство образования и науки Российской Федерации и Министерство науки и техники Китайской Народной Республики будут информировать свои государства об обсуждении перспектив сотрудничества по комплексу NICA и

The protocol was signed with the aim of uniting the efforts of the parties in the frames of cooperation for establishment and use of the NICA complex.
China considers joining the project and notes a wide interest of Chinese research organizations to participate in the project.

Towards ESFRI Roadmap

As a result of the initiative expressed in the letter of March 2013 signed by Plenipotentiaries of 5 JINR&EU member states, JINR has been invited through the Chair of European Strategy Forum on Research Infrastructures (ESFRI) to become an observer in the ESFRI Physical Science and Engineering Strategic Working Group (PSE-SWG).

At the beginning of 2015, the proposal for including NICA to the updated ESFRI Roadmap has been submitted by Bulgaria and supported by Czech Republic, Slovakia and Romania.

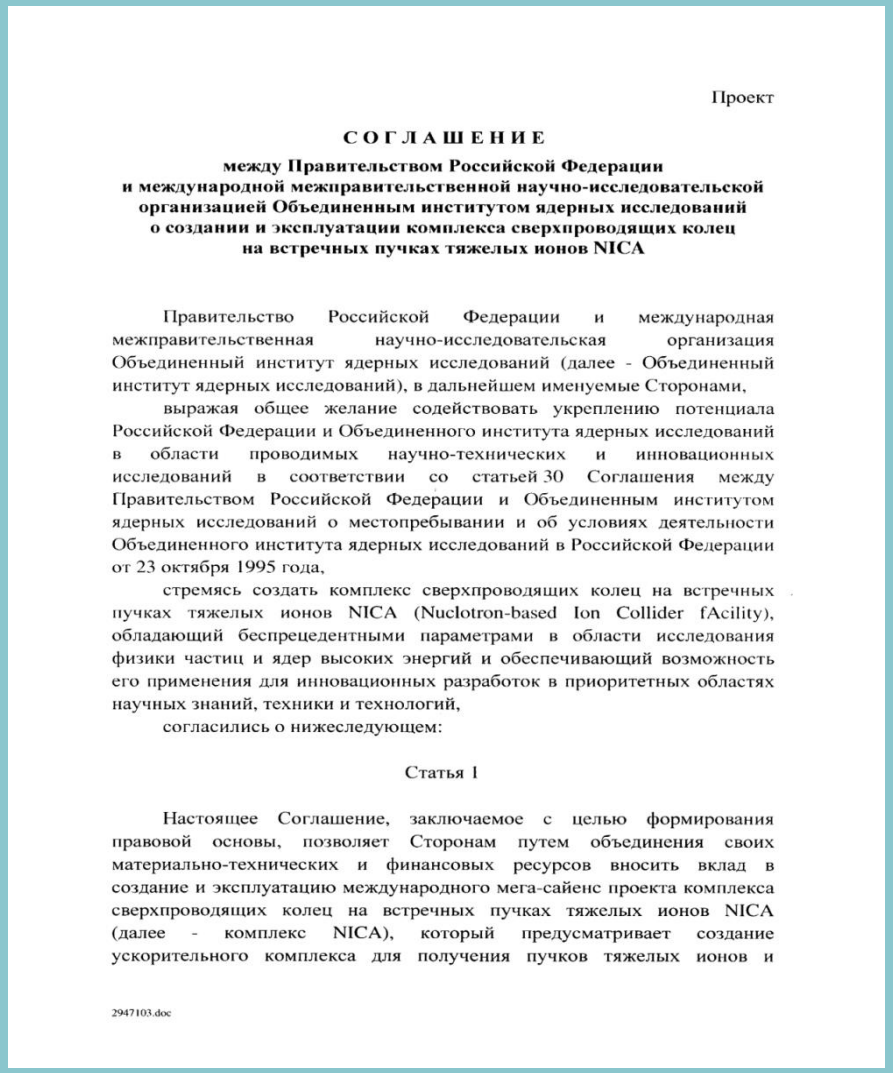
Citation from the ESFRI Updated Roadmap (2016):

"JINR has made important efforts to reach beyond its traditional community. The construction of NICA and the FAIR/ GSI accelerators is in fact tightly linked via a strong collaboration between GSI and JINR on the FAIR project and there is potential for a similar close detector collaboration (MPD/SPD/BM@NICA). The synergy and complementarity of the NICA and of the ESFRI Landmark FAIR and to some extent of the ESFRI Landmark SPIRAL2 make it very desirable to develop a joint coordinated effort for identifying a strong programme and for offering the best opportunities to international nuclear experimental physics. To this end ESFRI encourages these Ris both to work closely together and to pay special attention to developing NICA as a Global Research Infrastructure concept."

Agreement between Government of Russian Federation and JINR on realization of the international mega-sciences project of the superconducting heavy ion collider NICA

03 June 2016

It is signed!



Проект

СОГЛАШЕНИЕ

между Правительством Российской Федерации и международной межправительственной научно-исследовательской организацией Объединенным институтом ядерных исследований о создании и эксплуатации комплекса сверхпроводящих колец на встречных пучках тяжелых ионов NICA

Правительство Российской Федерации и международная межправительственная научно-исследовательская организация Объединенный институт ядерных исследований (далее - Объединенный институт ядерных исследований), в дальнейшем именуемые Сторонами,

выражая общее желание содействовать укреплению потенциала Российской Федерации и Объединенного института ядерных исследований в области проводимых научно-технических и инновационных исследований в соответствии со статьей 30 Соглашения между Правительством Российской Федерации и Объединенным институтом ядерных исследований о местопребывании и об условиях деятельности Объединенного института ядерных исследований в Российской Федерации от 23 октября 1995 года,

стремясь создать комплекс сверхпроводящих колец на встречных пучках тяжелых ионов NICA (Nuclotron-based Ion Collider fAcility), обладающий беспрецедентными параметрами в области исследования физики частиц и ядер высоких энергий и обеспечивающий возможность его применения для инновационных разработок в приоритетных областях научных знаний, техники и технологий,

согласились о нижеследующем:

Статья 1

Настоящее Соглашение, заключаемое с целью формирования правовой основы, позволяет Сторонам путем объединения своих материально-технических и финансовых ресурсов вносить вклад в создание и эксплуатацию международного мега-сайенс проекта комплекса сверхпроводящих колец на встречных пучках тяжелых ионов NICA (далее - комплекс NICA), который предусматривает создание ускорительного комплекса для получения пучков тяжелых ионов и

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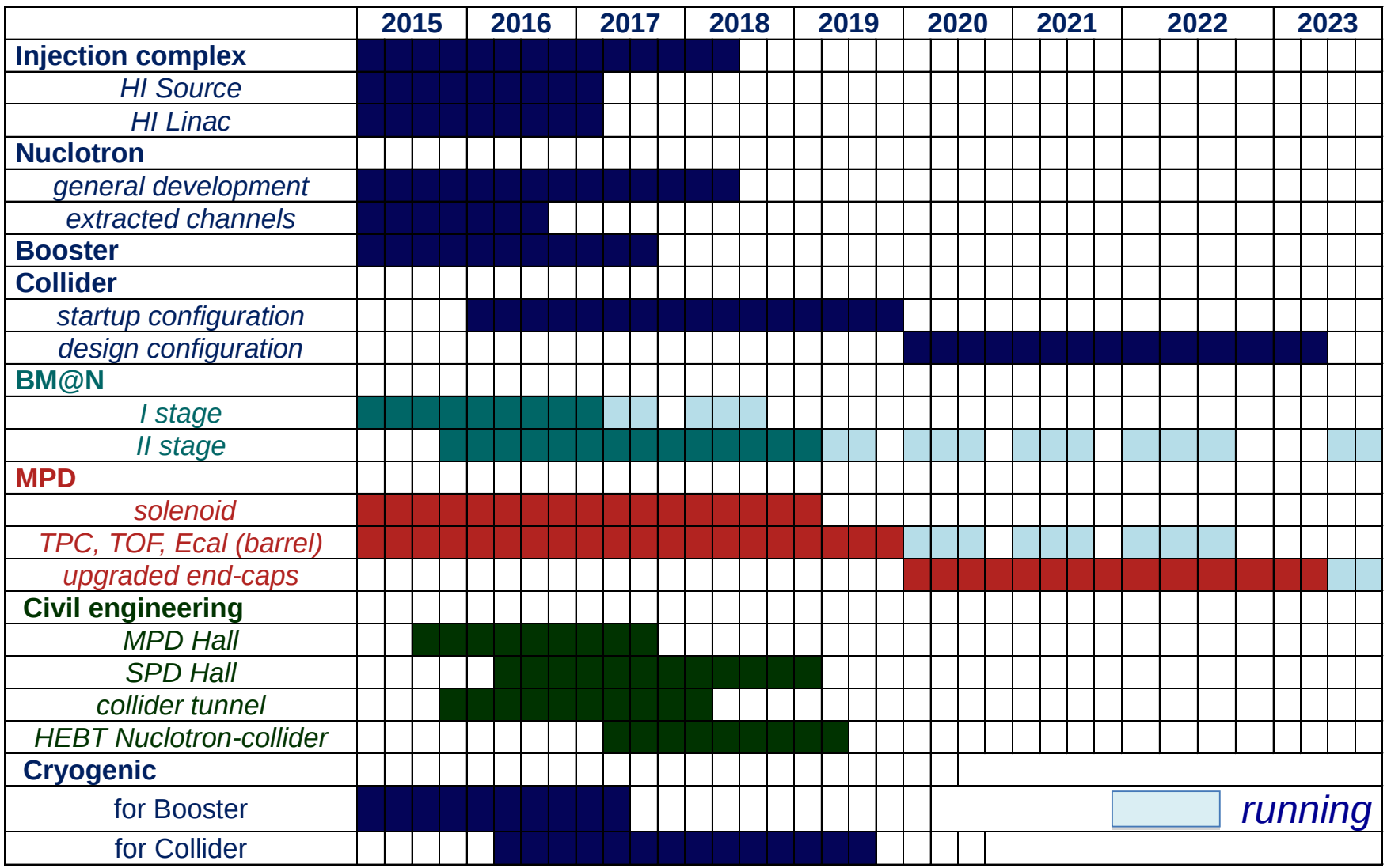
NICA schedule

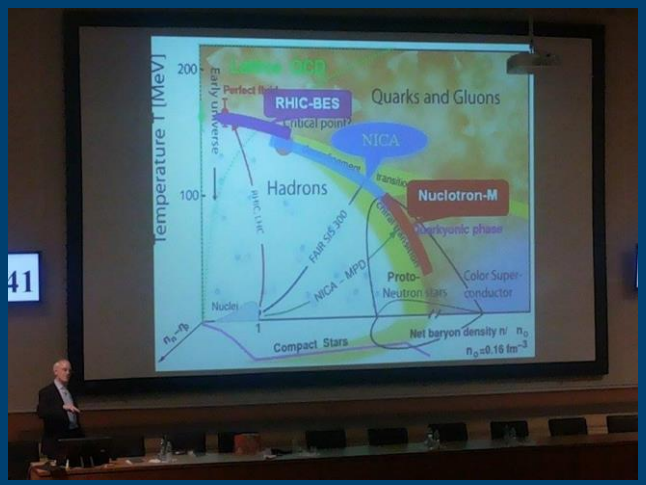


The decommissioning is foreseen after 2040

Signing the Contract on the production of the MPD Magnet with the ASG (Italy)
16 February 2016, Dubna

NICA Civil Construction
Contract signed in Sept'15.
Duration: 43 months

25 March 2016. NICA “corner stone” ceremony at LHEP JINR



D.GROSS: «QCD — first example of the consistent theory without limits of credibility.Complicated part of theory: what will happen if to squeeze or to heat strongly particles, say nucleons? If to heat nucleons up to very high temperatures, the quarks inside them will become free. And matter must pass into other state? The same must be at squeeze at the collision.

Such experiments were done and they confirmed up to some extent that nucleons get melted and there appear phase transition into the state of Quark-Gluon Plazma.

NICA will study what will happened at the ultra high baryon density at not too high temperatures. Similar conditions are assumed to be inside the Neutron Stars.

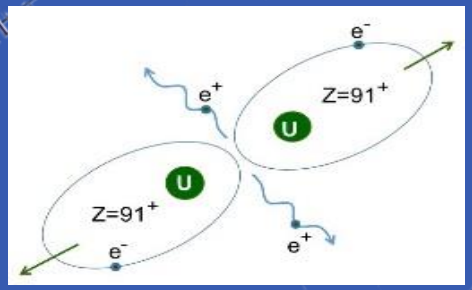
QCD has strong connections with the String theory. String theory has been invented to understand the strong interaction. QCD explain not only properties of quarks and gluons but also of the open and closed strings, what can lead to the understanding of what is the gravitation.

When you study the properties of the phase transitions at the heavy ion collisions the results could be used as well for investigation of the black holes. NICA can investigate a new region at the graphic of the phase transitions.

Many new and interesting are waiting us!

…What NEXT ?…

Creation of supercritical Coulomb fields with merging bare Uranium beams)



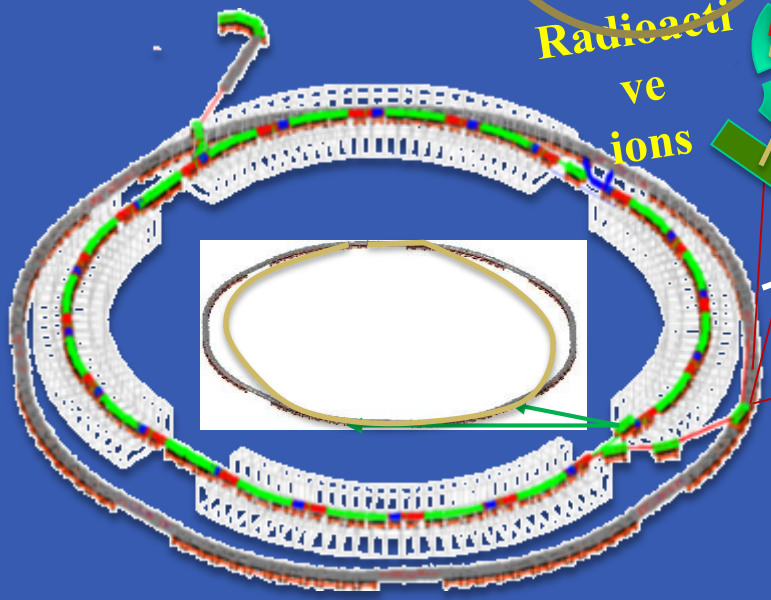
"Collector ring", C~150-200m

Radioactive ions

Fragment-Separator (~30m)

e- beam SC linac, 1 GeV, ~ 30m

Target



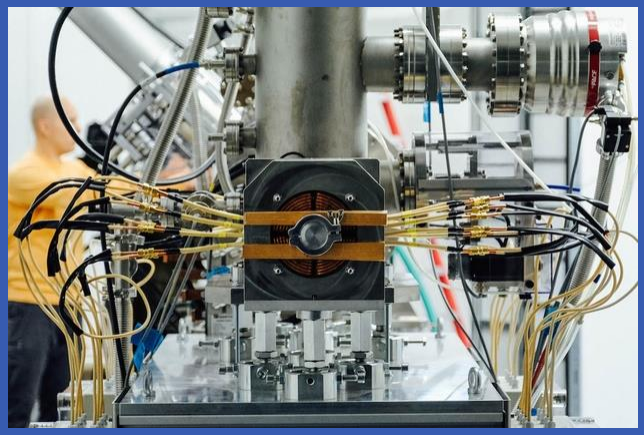
Merging $^{92+}U^{235}$ beams
E~ 0,6 GeV/u
~ 11 Tm ring

1. Mass-spectroscopy of radioactive heavy ion beams in isochronous mode (using collider ring);
2. Merging of RI fragments in the collider ring
3. Scanning of massive nuclei PDF with colliding electron beam (up to ~ 1 GeV);

INNOVATIONS @ NICA

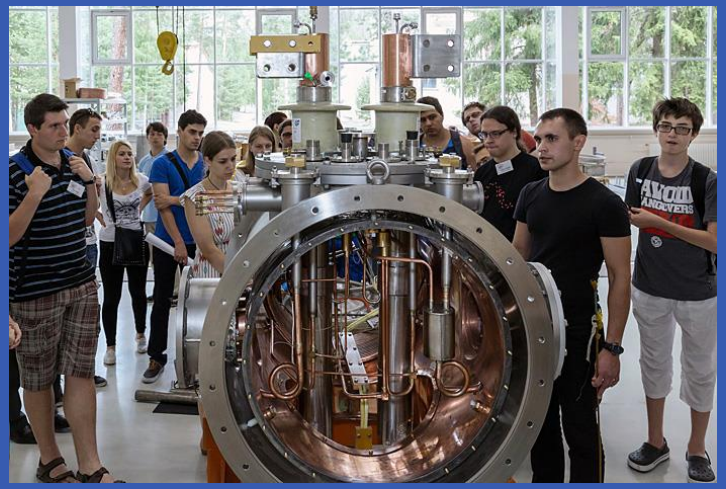
Innovative cluster:

- Areas for an innovative and applied researches with use of linear accelerators and Nuclotron extracted beams;
- Areas for an innovative and applied researches on the booster and Nuclotron beams;



Infrastructure cluster:

- NICA user's canter;
- IT complex for experimental data storage and analysis;



Education field:

- Areas equipped with use of modern ttechnologies for school, university and special education (i.e. engineering, etc);

Flerov Laboratory of Nuclear Reactions

Quest for the Island of Stability of the Super Heavy Elements

Frontier

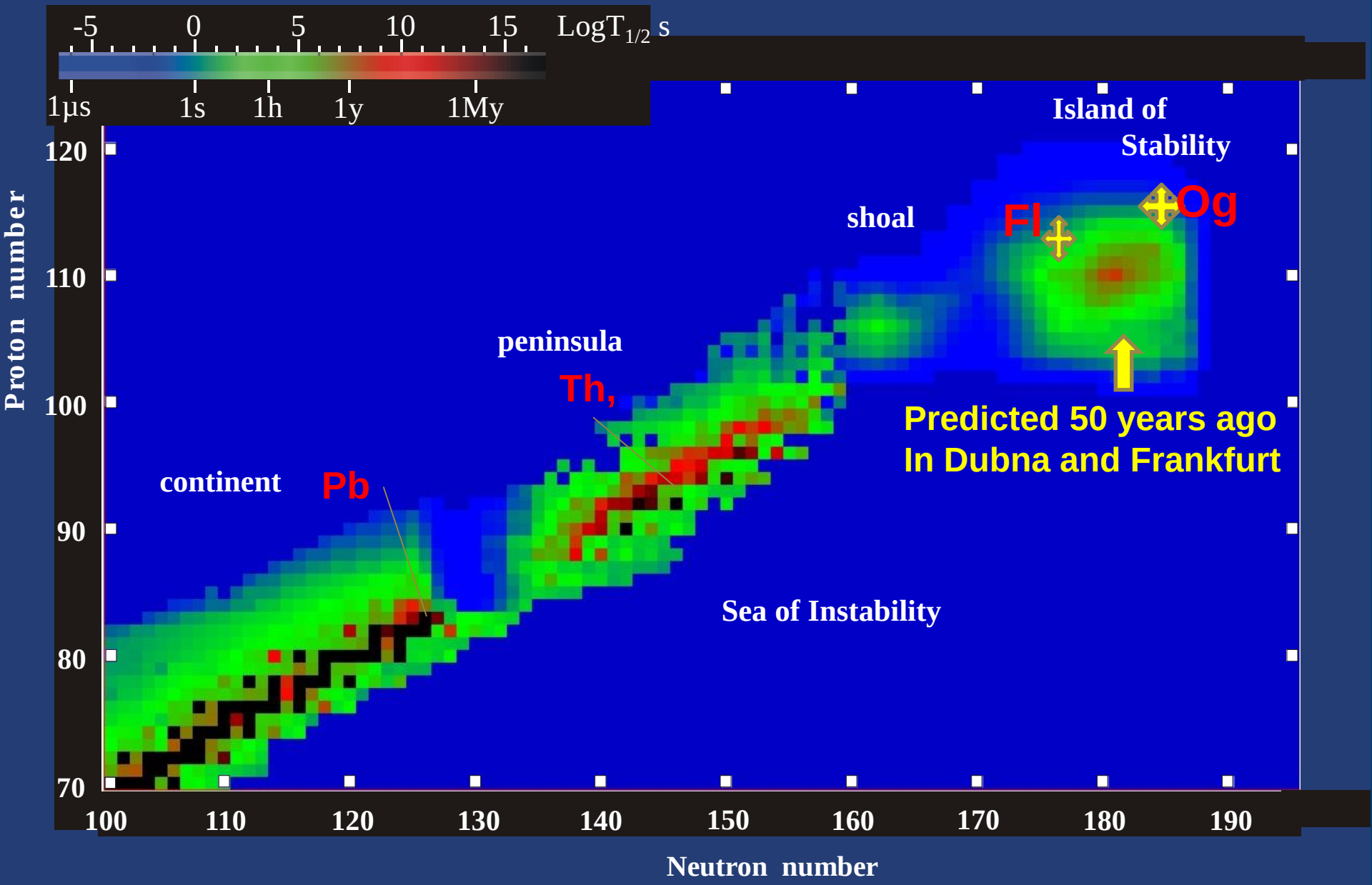
LABORATORY FOUNDER

Georgiy Nikolaevich FLEROV

1913 – 1990

1940	Discovery of spontaneous fission of uranium
1942-1950	**Participation in Russian atomic project**
1955	**First beams of accelerated heavy ions**
1957	**Foundation of Laboratory of Nuclear Reactions (Dubna)**
1962-1975	**Synthesis of new elements: 102, 103, 104, 105 (Dubnium), 106, 107**
2012	**Element 114 named Flerovium**

New lands Search for new Island of Stability



International Union of Pure and Applied Chemistry

May 2011:

Approval of the discovery of new elements *114* and *116*

May 2012:

Official approval of the name *Flerovium* for element *114*
and the name *Livermorium* for element *116*

30th December 2015:

Approval of the discovery of new elements *113, 115, 117, and 118*

Priority for elements *115* and *117* is assigned to:
JINR (Dubna) - LLNL (USA) – ORNL (USA) collaboration
Priority for element *118* is assigned to JINR (Dubna) – LLNL collaboration.

8th June 2016:

Provisional recommendations for naming elements *113, 115, 117, 118*

(Нихоний) 113	Флеровий 114	(Московий) 115	Ливерморий 116	(Теннессин) 117	(Оганесон) 118
(Nh)	Fl	(Mc)	Lv	(Ts)	(Og)
(Nihonium)	Flerovium	(Moscovium)	Livermorium	(Tennessine)	(Oganesson)

The 7th period of the periodic table of elements is now complete

All these elements were synthesized for the first time at the U400 accelerator complex of the Flerov Laboratory of Nuclear Reactions of JINR.

Периодическая таблица элементов Д.И. Менделеева (2016 год)

Бор 5	Углерод 6	Азот 7	Кислород 8	Фтор 9	Неон 10
B	**C**	**N**	**O**	**F**	**Ne**
10,811	12,011	14,0067	15,9994	18,9984	20,1797
Boron	Carbon	Nitrogen	Oxygen	Fluorine	Neon

Алюминий 13	Кремний 14	Фосфор 15	Сера 16	Хлор 17	Аргон 18
Al	**Si**	**P**	**S**	**Cl**	**Ar**
26,981539	28,0855	30,97376	32,066	35,4527	39,948
Aluminum	Silicon	Phosphorus	Sulfur	Chlorine	Argon

Никель 28	Медь 29	Цинк 30	Галлий 31	Германий 32	Мышьяк 33	Селен 34	Бром 35	Криптон 36
Ni	**Cu**	**Zn**	**Ga**	**Ge**	**As**	**Se**	**Br**	**Kr**
58,6934	63,546	65,39	69,723	72,61	74,92159	78,96	79,904	83,80
Nickel	Copper	Zinc	Gallium	Germanium	Arsenic	Selenium	Bromine	Krypton

Палладий 46	Серебро 47	Кадмий 48	Индий 49	Олово 50	Сурьма 51	Теллур 52	Иод 53	Ксенон 54
Pd	**Ag**	**Cd**	**In**	**Sn**	**Sb**	**Te**	**I**	**Xe**
106,42	107,8682	112,411	114,818	118,710	121,757	127,60	126,90447	131,29
Palladium	Silver	Cadmium	Indium	Tin	Antimony	Tellurium	Iodine	Xenon

Платина 78	Золото 79	Ртуть 80	Таллий 81	Свинец 82	Висмут 83	Полоний 84	Астат 85	Радон 8
Pt	**Au**	**Hg**	**Tl**	**Pb**	**Bi**	**Po**	**At**	**Rn**
195,08	196,96654	200,59	204,3833	207,2	208,98037	[209]	[210]	[222]
Platinum	Gold	Mercury	Thallium	Lead				

Дармштадтий 110	Рентгений 111	Коперниций 112	(Нихоний) 113
Ds	**Rg**	**Cn**	**(Nh)**
[269]	[272]	[277]	[286]
Darmstadtium	Roentgenium	Copernicium	(Nihonium)

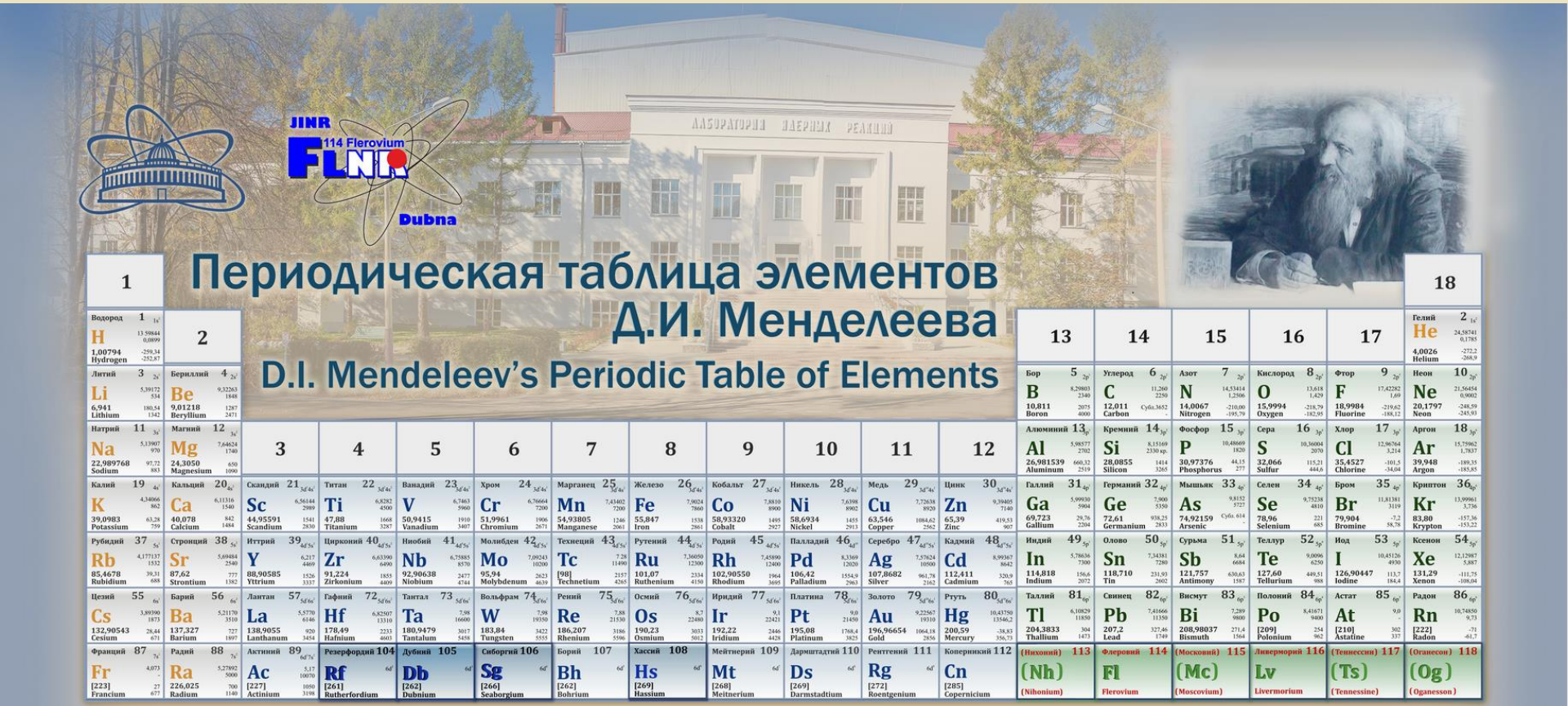
Flerovium 114	(Moscovium) 115	Livermorium 116	(Tennessine) 117	(Oganesson) 118
Fl	**(Mc)**	**Lv**	**(Ts)**	**(Og)**
Флеровий	(Московий)	Ливерморий	(Теннессин)	(Оганесон)

105

Db

Dubnium

Mendeleev's Table Today



Периодическая таблица элементов Д.И. Менделеева

D.I. Mendeleev's Periodic Table of Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Водород 1 $1s^1$ **H** 1,00794 Hydrogen												Бор 5 $2p^1$ **B** 10,811 Boron	Углерод 6 $2p^2$ **C** 12,011 Carbon	Азот 7 $2p^3$ **N** 14,0067 Nitrogen	Кислород 8 $2p^4$ **O** 15,9994 Oxygen	Фтор 9 $2p^5$ **F** 18,9984 Fluorine	Гелий 2 $1s^2$ **He** 4,0026 Helium
Литий 3 $2s^1$ **Li** 6,941 Lithium	Бериллий 4 $2s^2$ **Be** 9,01218 Beryllium											Алюминий 13 $3p^1$ **Al** 26,981539 Aluminium	Кремний 14 $3p^2$ **Si** 28,0855 Silicon	Фосфор 15 $3p^3$ **P** 30,97376 Phosphorus	Сера 16 $3p^4$ **S** 32,066 Sulfur	Хлор 17 $3p^5$ **Cl** 35,4527 Chlorine	Аргон 18 $3p^6$ **Ar** 39,948 Argon
Натрий 11 $3s^1$ **Na** 22,989768 Sodium	Магний 12 $3s^2$ **Mg** 24,3050 Magnesium																
Калий 19 $4s^1$ **K** 39,0983 Potassium	Кальций 20 $4s^2$ **Ca** 40,078 Calcium	Скандий 21 $3d^1 4s^2$ **Sc** 44,95591 Scandium	Титан 22 $3d^2 4s^2$ **Ti** 47,88 Titanium	Ванадий 23 $3d^3 4s^2$ **V** 50,9415 Vanadium	Хром 24 $3d^5 4s^1$ **Cr** 51,9961 Chromium	Марганец 25 $3d^5 4s^2$ **Mn** 54,93805 Manganese	Железо 26 $3d^6 4s^2$ **Fe** 55,847 Iron	Кобальт 27 $3d^7 4s^2$ **Co** 58,93320 Cobalt	Никель 28 $3d^8 4s^2$ **Ni** 58,6934 Nickel	Медь 29 $3d^{10} 4s^1$ **Cu** 63,546 Copper	Цинк 30 $3d^{10} 4s^2$ **Zn** 65,39 Zinc	Галлий 31 $4p^1$ **Ga** 69,723 Gallium	Германий 32 $4p^2$ **Ge** 72,61 Germanium	Мышьяк 33 $4p^3$ **As** 74,92159 Arsenic	Селен 34 $4p^4$ **Se** 78,96 Selenium	Бром 35 $4p^5$ **Br** 79,904 Bromine	Криптон 36 $4p^6$ **Kr** 83,80 Krypton
Рубидий 37 $5s^1$ **Rb** 85,4678 Rubidium	Стронций 38 $5s^2$ **Sr** 87,62 Strontium	Иттрий 39 $4d^1 5s^2$ **Y** 88,90585 Yttrium	Цирконий 40 $4d^2 5s^2$ **Zr** 91,224 Zirkonium	Ниобий 41 $4d^4 5s^1$ **Nb** 92,90638 Niobium	Молибден 42 $4d^5 5s^1$ **Mo** 95,94 Molybdenum	Технеций 43 $4d^5 5s^2$ **Tc** [98] Technetium	Рутений 44 $4d^7 5s^1$ **Ru** 101,07 Ruthenium	Родий 45 $4d^8 5s^1$ **Rh** 102,90550 Rhodium	Палладий 46 $4d^{10}$ **Pd** 106,42 Palladium	Серебро 47 $4d^{10} 5s^1$ **Ag** 107,8682 Silver	Олово 50 $5p^2$ **Sn** 118,710 Tin	Индий 49 $5p^1$ **In** 114,818 Indium	Олово 50 $5p^2$ **Sn** 118,710 Tin	Сурьма 51 $5p^3$ **Sb** 121,757 Antimony	Теллур 52 $5p^4$ **Te** 127,60 Tellurium	Иод 53 $5p^5$ **I** 126,90447 Iodine	Ксенон 54 $5p^6$ **Xe** 131,29 Xenon
Цезий 55 $6s^1$ **Cs** 132,90543 Cesium	Барий 56 $6s^2$ **Ba** 137,327 Barium	Лантан 57 $5d^1 6s^2$ **La** 138,9055 Lanthanum	Гафний 72 $5d^2 6s^2$ **Hf** 178,49 Hafnium	Тантал 73 $5d^3 6s^2$ **Ta** 180,9479 Tantalum	Вольфрам 74 $5d^4 6s^2$ **W** 183,84 Tungsten	Рений 75 $5d^5 6s^2$ **Re** 186,207 Rhenium	Осмий 76 $5d^6 6s^2$ **Os** 190,23 Osmium	Иридий 77 $5d^7 6s^2$ **Ir** 192,22 Iridium	Платина 78 $5d^9 6s^1$ **Pt** 195,08 Platinum	Золото 79 $5d^{10} 6s^1$ **Au** 196,96654 Gold	Ртуть 80 $5d^{10} 6s^2$ **Hg** 200,59 Mercury	Таллий 81 $6p^1$ **Tl** 204,3833 Thallium	Свинец 82 $6p^2$ **Pb** 207,2 Lead	Висмут 83 $6p^3$ **Bi** 208,98037 Bismuth	Полоний 84 $6p^4$ **Po** [209] Polonium	Астат 85 $6p^5$ **At** [210] Astatine	Радон 86 $6p^6$ **Rn** [222] Radon
Франций 87 $7s^1$ **Fr** [223] Francium	Радий 88 $7s^2$ **Ra** 226,025 Radium	Актиний 89 $6d^1 7s^2$ **Ac** [227] Actinium	Резерфордий 104 **Rf** [261] Rutherfordium	Дубний 105 **Db** [262] Dubnium	Сиборгий 106 **Sg** [266] Seaborgium	Борий 107 **Bh** [262] Bohrium	Хассий 108 **Hs** [269] Hassium	Мейтнерий 109 **Mt** [268] Meitnerium	Дармштадтий 110 **Ds** [269] Darmstadtium	Рентгений 111 **Rg** [272] Roentgenium	Коперникий 112 **Cn** [285] Copernicium	(Нихоний) 113 **(Nh)** (Nihonium)	Флеровий 114 **Fl** Flerovium	(Московий) 115 **(Mc)** (Moscovium)	Ливерморий 116 **Lv** Livermorium	(Теннессин) 117 **(Ts)** (Tennessine)	(Оганесон) 118 **(Og)** (Oganesson)

Лантаноиды Lanthanides

Церий 58 $4f^1 5d^1 6s^2$ **Ce** 140,115 Cerium	Празеодим 59 $4f^3 6s^2$ **Pr** 140,90765 Praseodymium	Неодим 60 $4f^4$ **Nd** 144,24 Neodymium	Прометий 61 $4f^5$ **Pm** [145] Promethium	Самарий 62 $4f^6$ **Sm** 150,36 Samarium	Европий 63 $4f^7$ **Eu** 151,965 Europium	Гадолиний 64 $4f^7 5d^1$ **Gd** 157,25 Gadolinium	Тербий 65 $4f^9$ **Tb** 158,92534 Terbium	Диспрозий 66 $4f^{10}$ **Dy** 162,50 Dysprosium	Гольмий 67 $4f^{11}$ **Ho** 164,93032 Holmium	Эрбий 68 $4f^{12}$ **Er** 167,26 Erbium	Тулий 69 $4f^{13}$ **Tm** 168,93421 Thulium	Иттербий 70 $4f^{14}$ **Yb** 173,04 Ytterbium	Лютеций 71 $4f^{14} 5d^1$ **Lu** 174,967 Lutetium

Актиноиды Actinides

Торий 90 $6d^2 7s^2$ **Th** 232,0381 Thorium	Протактиний 91 $5f^2 6d^1 7s^2$ **Pa** 231,03588 Protactinium	Уран 92 $5f^3 6d^1 7s^2$ **U** 238,0289 Uranium	Нептуний 93 $5f^4 6d^1 7s^2$ **Np** [237] Neptunium	Плутоний 94 $5f^6$ **Pu** [244] Plutonium	Америций 95 $5f^7$ **Am** [243] Americium	Кюрий 96 $5f^7 6d^1$ **Cm** [247] Curium	Берклий 97 $5f^9$ **Bk** [247] Berkelium	Калифорний 98 $5f^{10}$ **Cf** [251] Californium	Эйнштейний 99 $5f^{11}$ **Es** [252] Einsteinium	Фермий 100 **Fm** [257] Fermium	Менделевий 101 $5f^{13}$ **Md** [258] Mendelevium	Нобелий 102 $5f^{14}$ **No** [259] Nobelium	Лоуренсий 103 $5f^{14} 6d^1$ **Lr** [262] Lawrencium

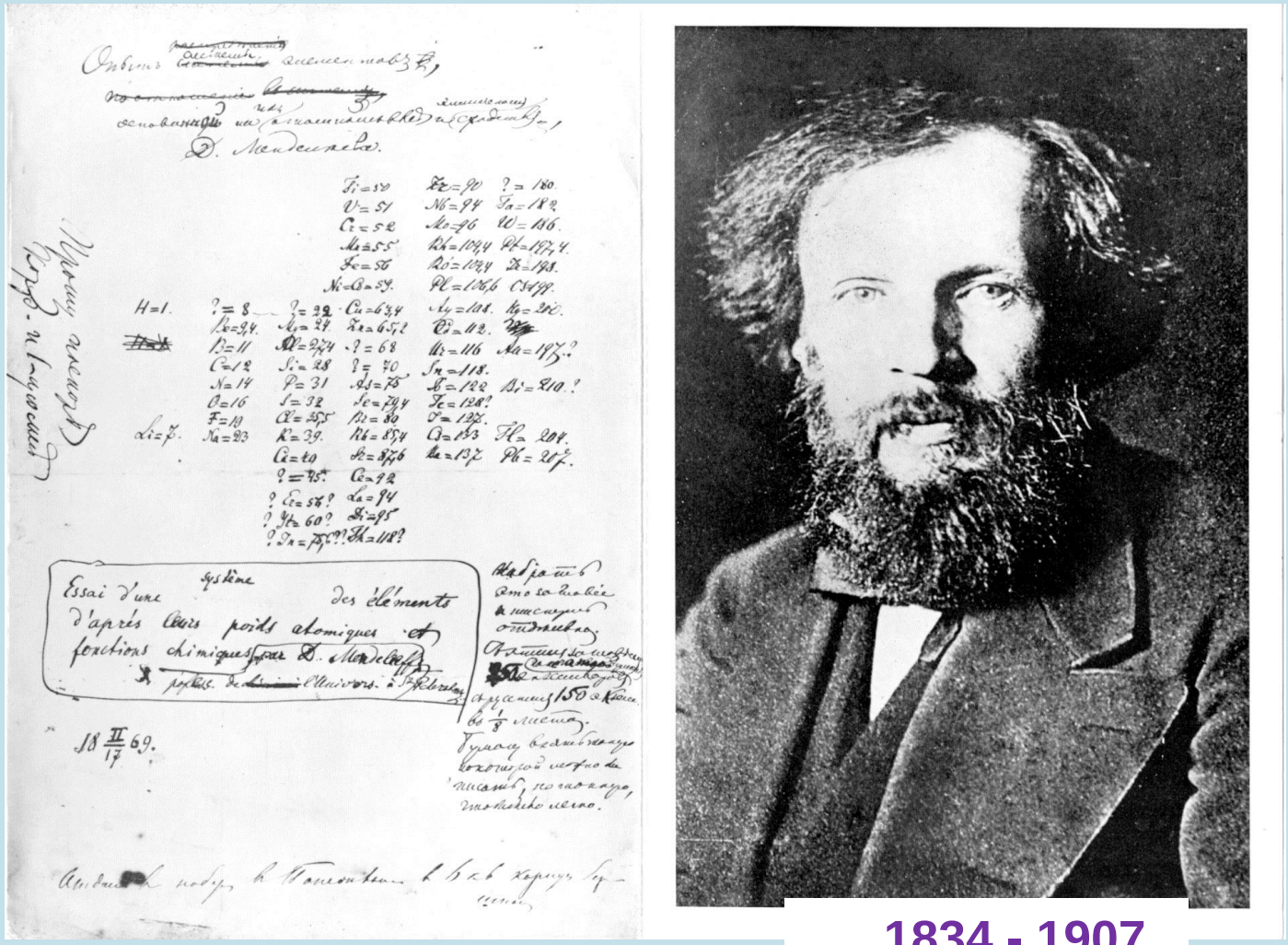
Водород 1 $1s^1$ **H** 1,00794 Hydrogen	13,59844 0,0899 -259,34 -252,87

H - символ/symbol
1,00794 - атомная масса/atomic mass
1s1 - электронная конфигурация/Electron configuration
13,59844 -1-й потенциал ионизации, эВ/1st ionization potential, eV
0,0899 - плотность, кг/м3/density, kg/m3
-259,34 - температура плавления,oC/melting temperature, oC
-252,87 - температура кипения,oC/boiling temperature, oC

S - ЭЛЕМЕНТЫ/ELEMENTS
p - ЭЛЕМЕНТЫ/ELEMENTS
d - ЭЛЕМЕНТЫ/ELEMENTS
f - ЭЛЕМЕНТЫ/ELEMENTS

11 of 18 elements discovered during last 60 years were first synthesized in Dubna

Physics of SHE – is the triumph of Mendeleev Periodic Law connecting the chemical properties of elements with their atomic numbers

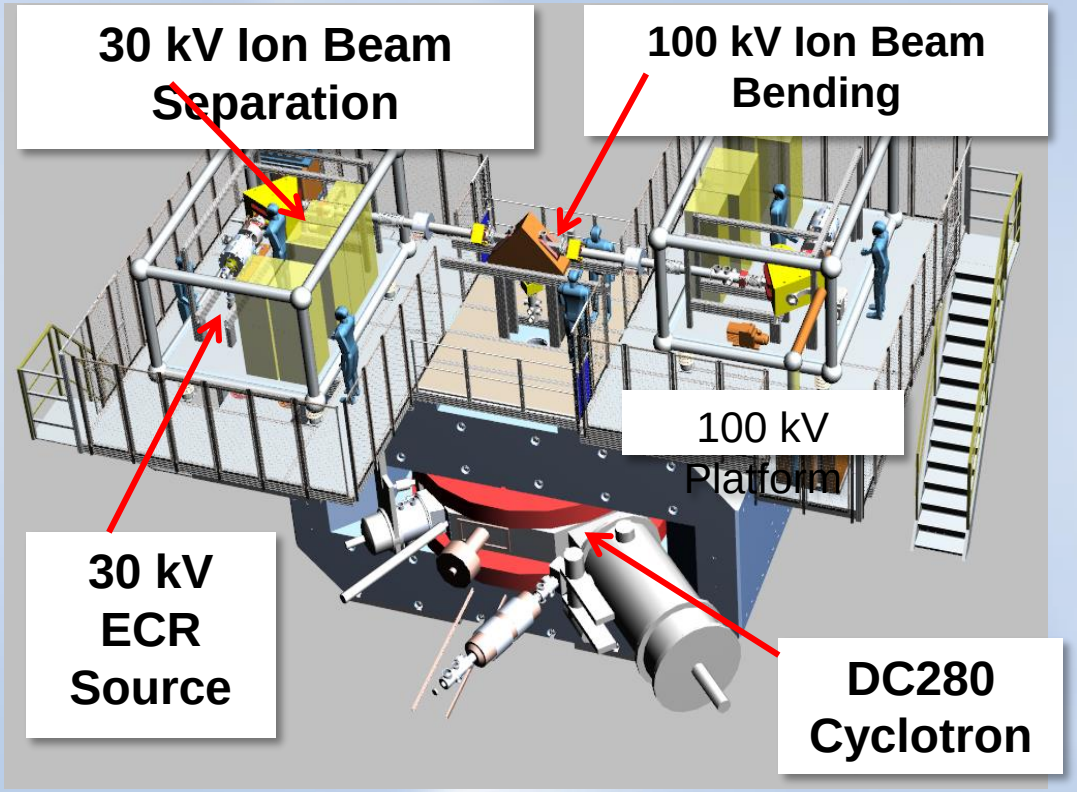


Essai d'une système des éléments d'après leurs poids atomiques et fonctions chimiques par D. Mendeleeff

18 II/17 69.

1834 - 1907

DC280-cyclotron – SHE-factory



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

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

DC-280 Cyclotron – Production Status

Main magnet

Vacuum chamber

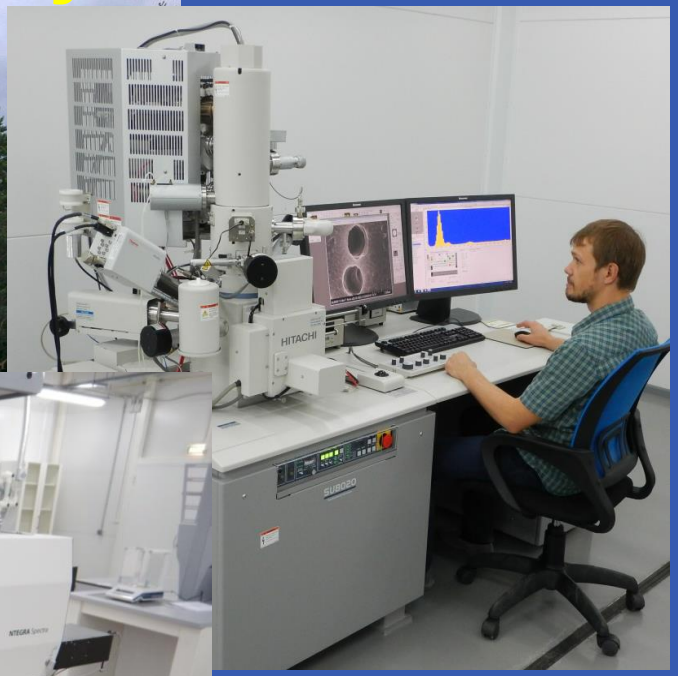
Bending magnet

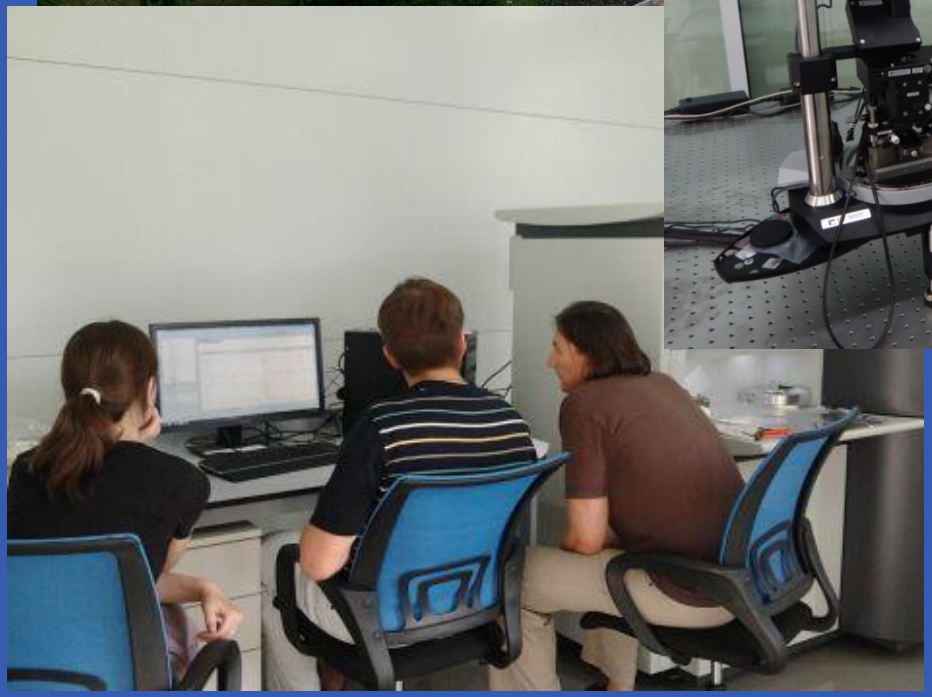
Produced by Novokramatorsky factory in Ukraine and delivered to Dubna

Resonators

Water cooling system

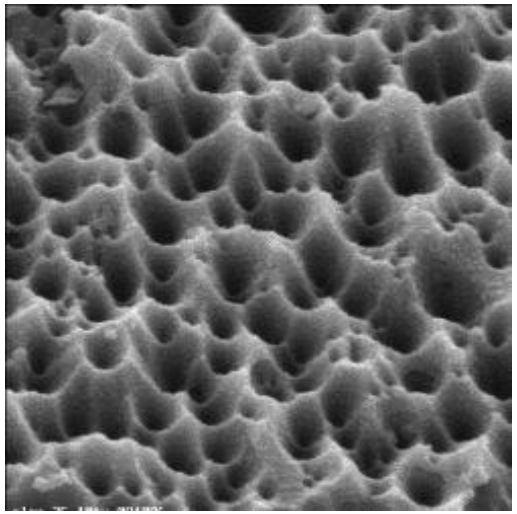
Nano Laboratory

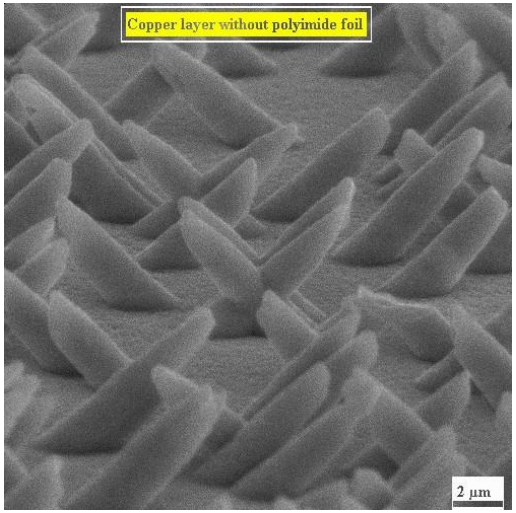




- Scanning electron microscopes
- Atomic force microscopy
- X-Ray photoelectron spectroscopy
- Equipment for sample preparation
-

Heavy-Ion-born nanostructures



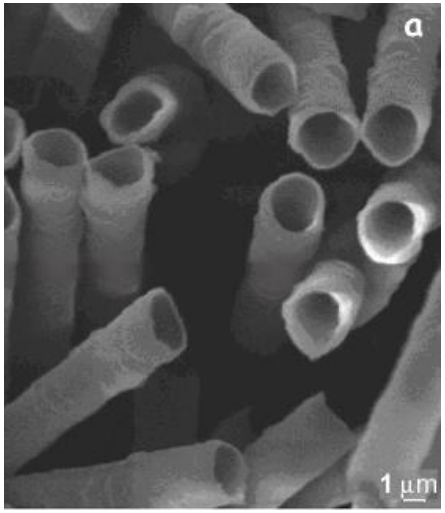


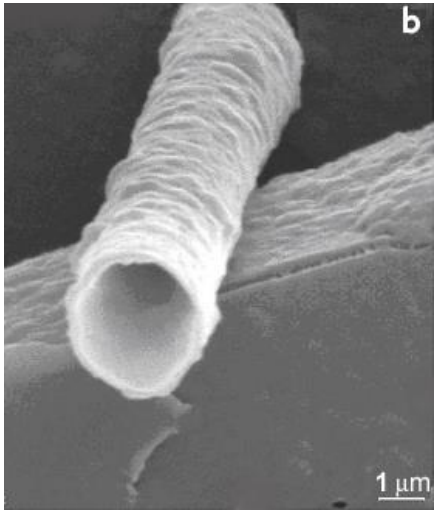
new composite materials:

- extended layers adhesion strength
- increased thermal resistance
- flexible printed circuit boards

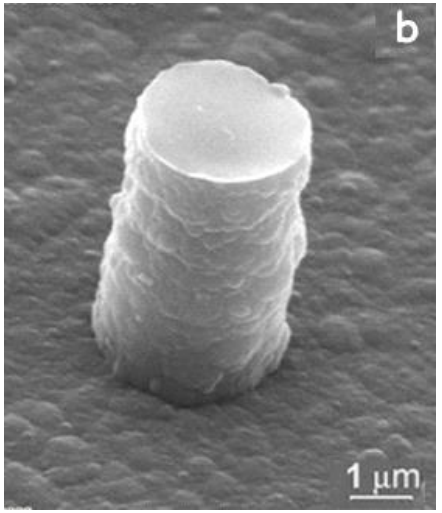
Polymer composites produced with the use of track membranes

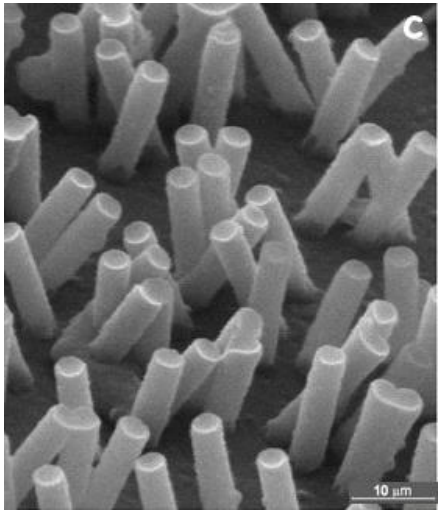
nanotubes





nanowires

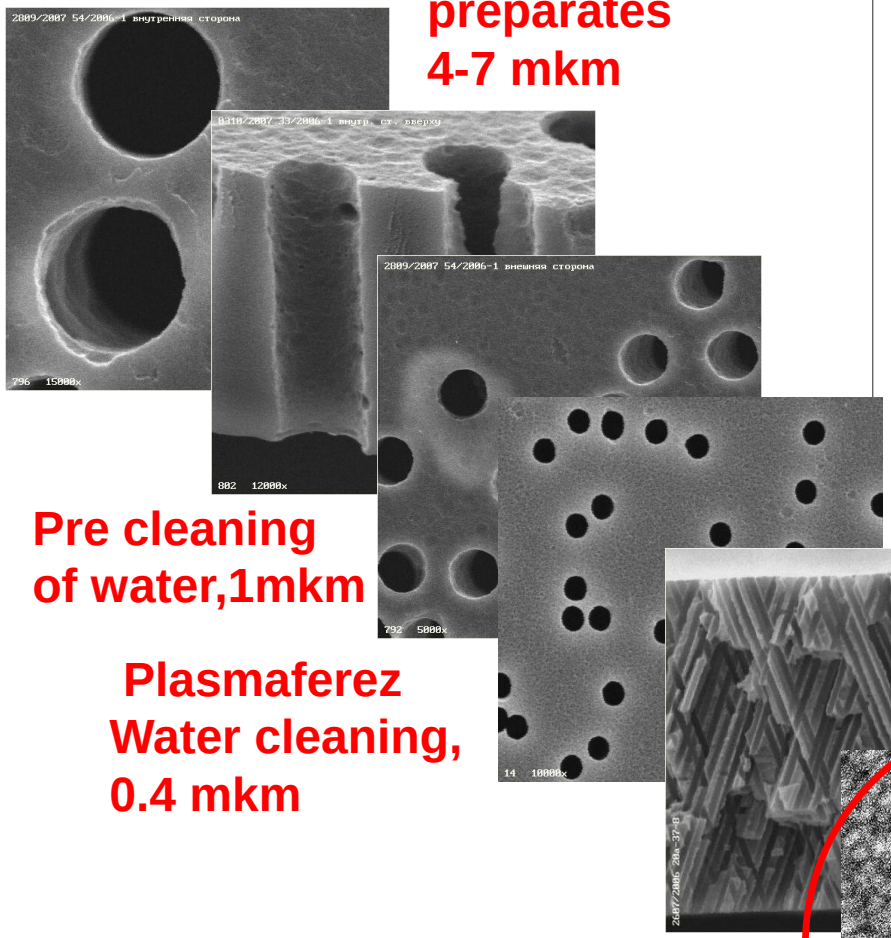




Production of track membranes (IC-100)

Micrometers

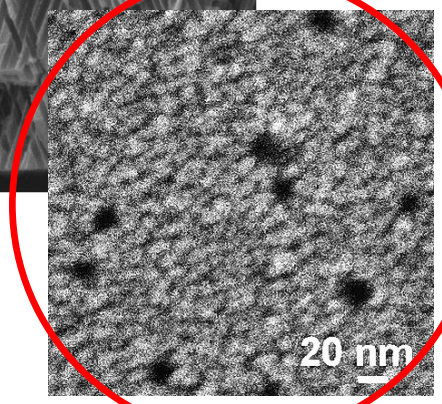
Cleaning pharm preparates 4-7 mkm



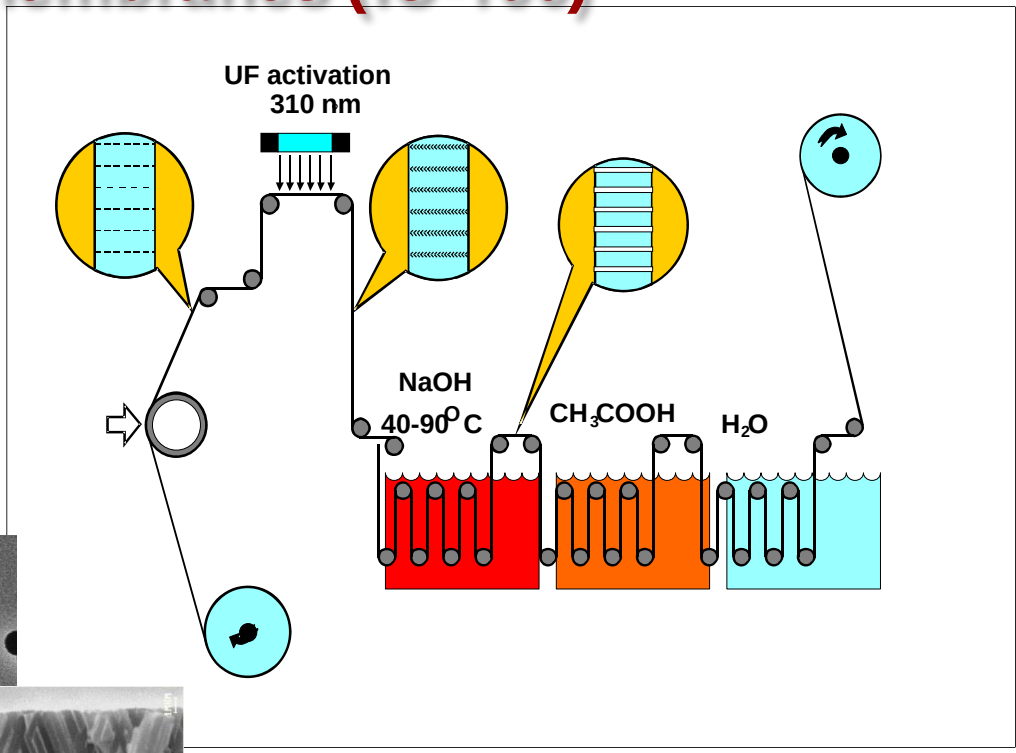
Pre cleaning of water,1mkm

Plasmaferez Water cleaning, 0.4 mkm

Molecular sensors < 20 nm

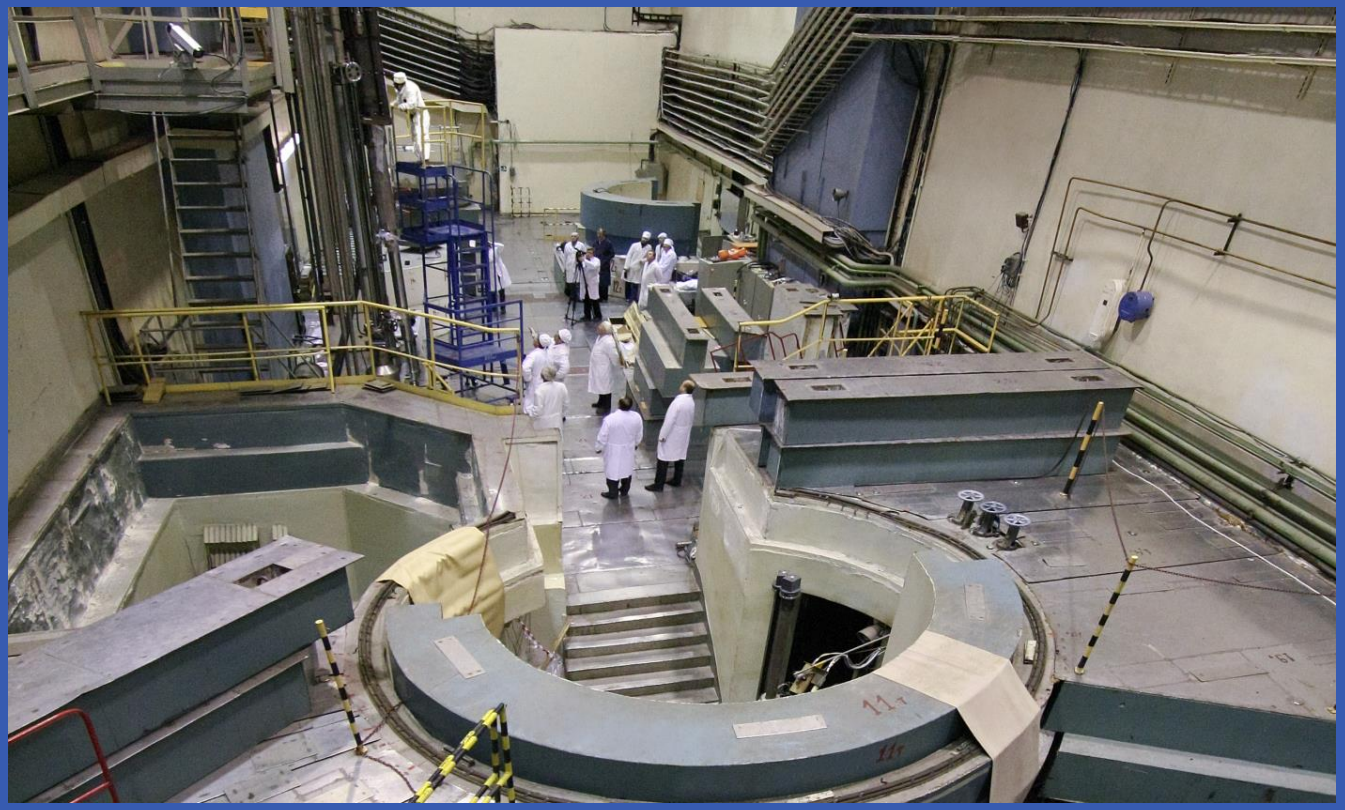


Nanometers



IBR-2: Pulsed reactor with fast neutrons

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} n/cm^2 /s
maximum in pulse: 10^{16} n/cm^2 /s

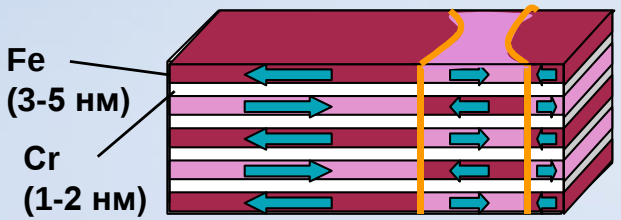


Frank LNP Large-Scale Basic Facilities

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

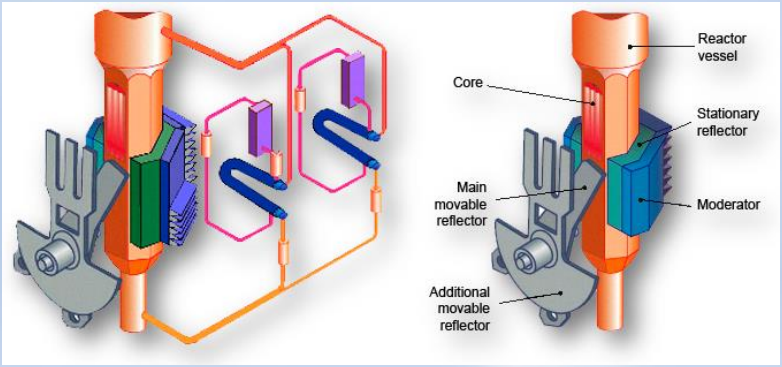
Nanosystems and Nanotechnologies

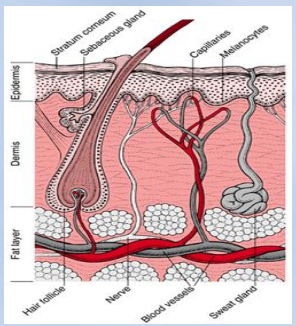
Novel Materials

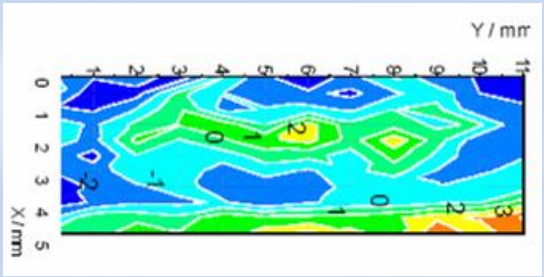


Biomedical Research

Engineering diagnostics.
Earth Sciences
Ecology testing

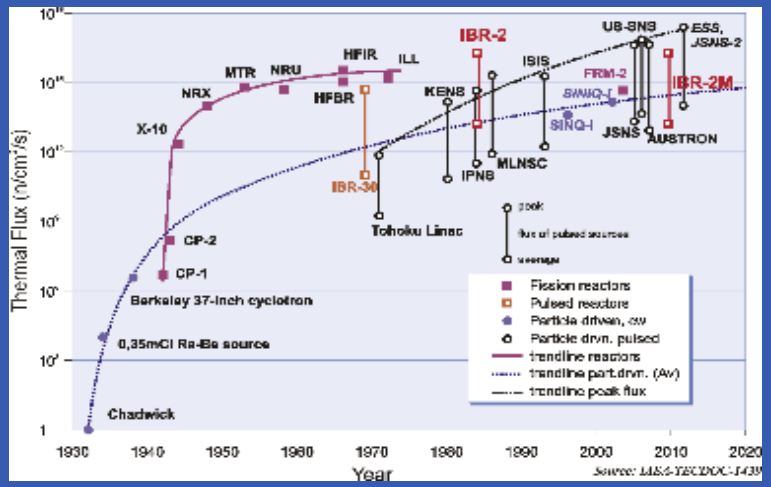






Main directions: Fundamental and applied research in condensed matter physics and related fields: biology, medicine, material sciences, geophysics, ecology studies, engineer diagnostics - aimed at probing the structure and properties of nanosystems, new materials and biological objects, and at developing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

Modernization of the reactor has been performed as scheduled. The extensive program of experiments on the reactor (more than 150 per year, with large geographical coverage of users) is ongoing.



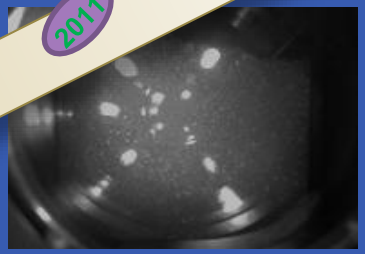
Creation and testing of the stand for the 2nd cold moderator

Development of three new spectrometers NRT, FSS and RTD

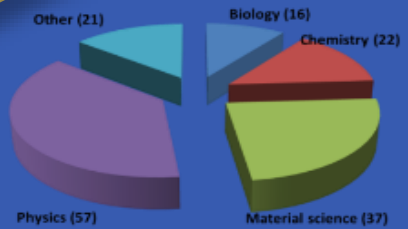
Technical design and manufacturing of the 2nd cold moderator

The modernized IBR-2 reactor physical start up was commenced according to the plan

- **The user program restarts**
- **Physical start up of the 1st cold moderator: first cold neutrons for users!**



Commissioning of two new spectrometers: DN-6 and GRAINS



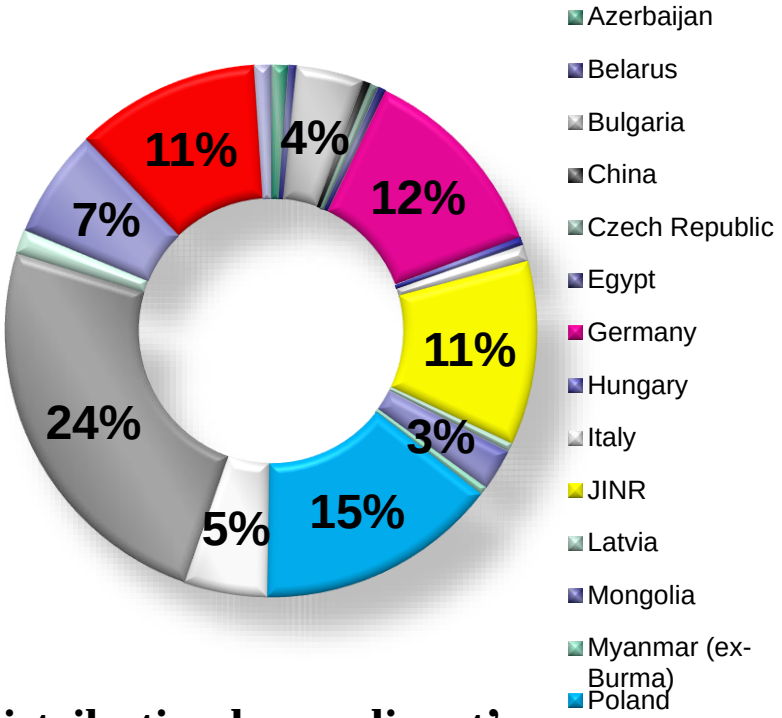
2010 2011 2012 2013 2014 2015 2016

Starting of the work for physical experiments

- **Testing of the stand for the 1st cold moderator**

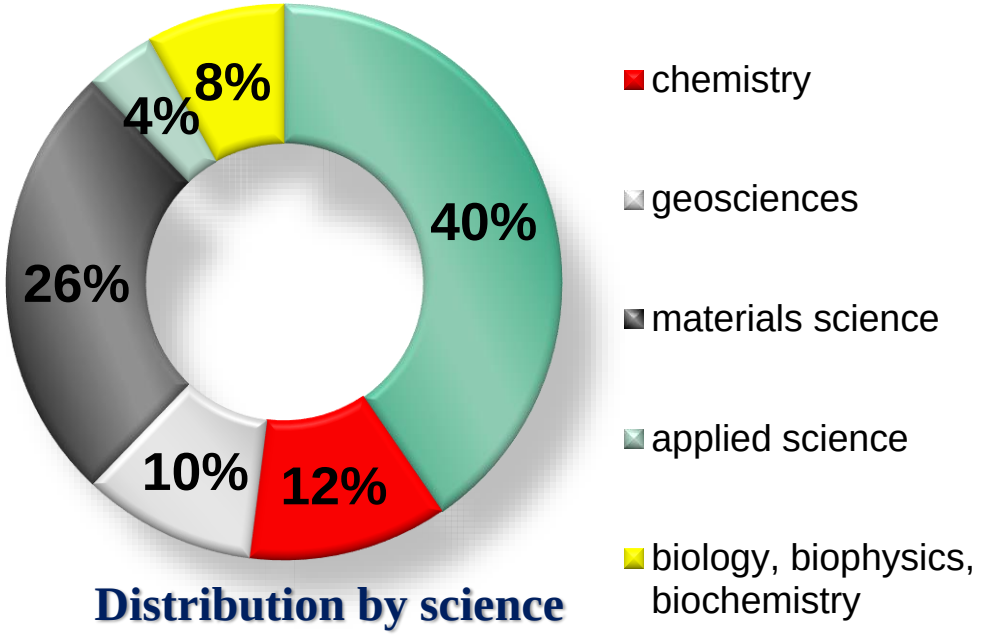
FLNP USER PROGRAME (2015)

197 proposals
19 countries

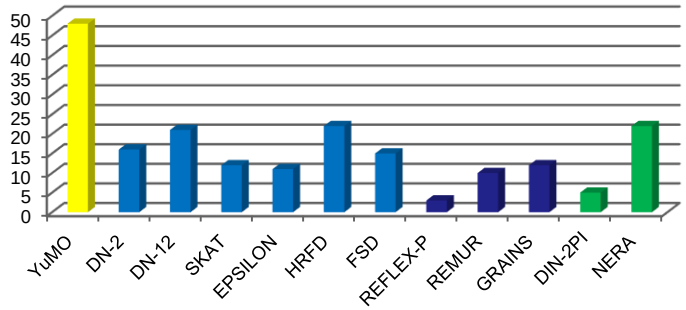


Distribution by applicant's affiliation

About 60 visiting users from more then 10 countries



Distribution by science



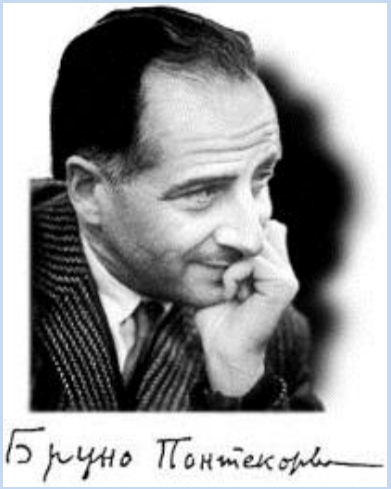
Distribution by experimental facilities

Nobel Prize Award in Physics

6 October 2015

Big Day for DUBNA !

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Physics for 2015 to



Takaaki Kajita
Super-Kamiokande Collaboration
University of Tokyo, Kashiwa, Japan

Arthur B. McDonald
Sudbury Neutrino Observatory Collaboration
Queen's University, Kingston, Canada
"for the discovery of neutrino oscillations, which shows that neutrinos have mass"

Гипотеза существования осцилляций нейтрино высказана в Дубне в !957 году академиком Бруно Понтекорво

JINR Neutrino Program

Astrophysical neutrino sources (BAIKAL GVD)
Sterile neutrino searches (DANSS/KNPP)

Coherent neutrino-nucleus scattering (vGEN)
Precise measurements of neutrino oscillations (Daya Bay, BOREXINO, OPERA)
Neutrino mass hierarchy (JUNO, NOvA)
Neutrinoless 2β –Decay search: (SuperNEMO, GERDA, Majorana)

Kalinin NPP (DANSS)

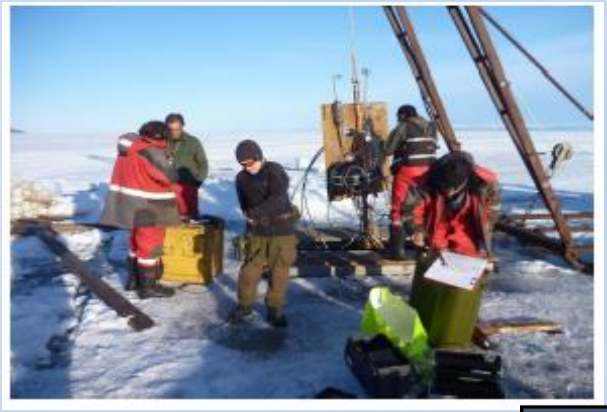
Nu- sources:
Solar
Reactor
Accelerator
Astrophysical
Atmospheric
Geophysical

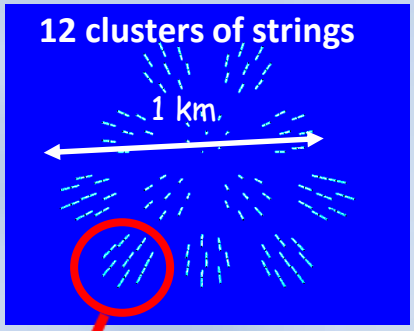
Central Physics Goals:

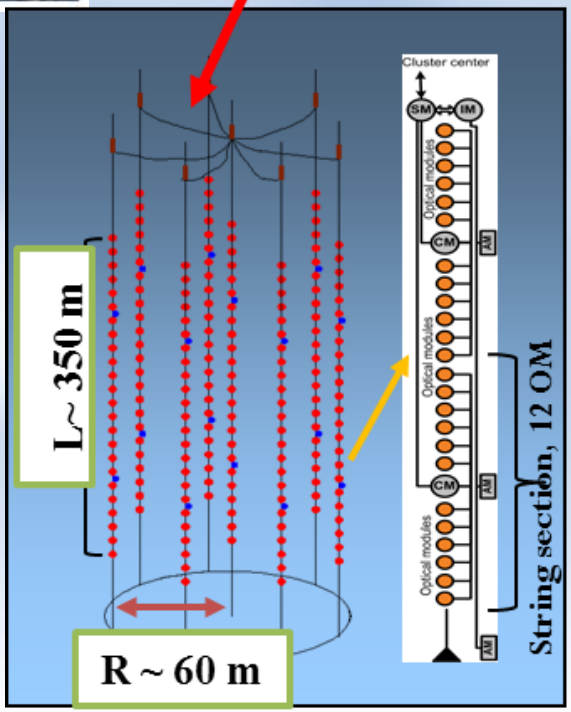
- **The Galactic and Extragalactic neutrino "point sources" in energy range > 3 TeV**
- **Diffuse neutrino flux energy spectrum, local and global anisotropy, flavor content**
- **Transient sources (GRB, …)**
- **Dark matter – indirect search**

Baikal project: Gigaton Volume Detector (GVD)

General Requirements for the Setup: 1) km^3-scale 3D-array of photo sensors, 2) flexible structure allowing an upgrade and/or a rearrangement of the main building blocks (clusters), 3) high sensitivity and resolution of neutrino energy, direction and neutrino flavor content.

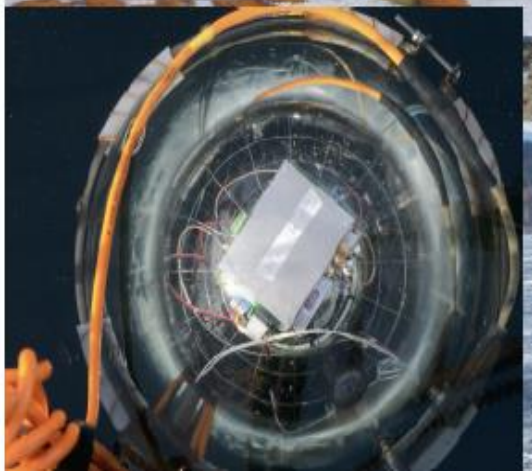






Neutrino Physics and Astrophysics

Assembling of the First Cluster of the GVD at the Baikal lake, Start at March 2015



JINR

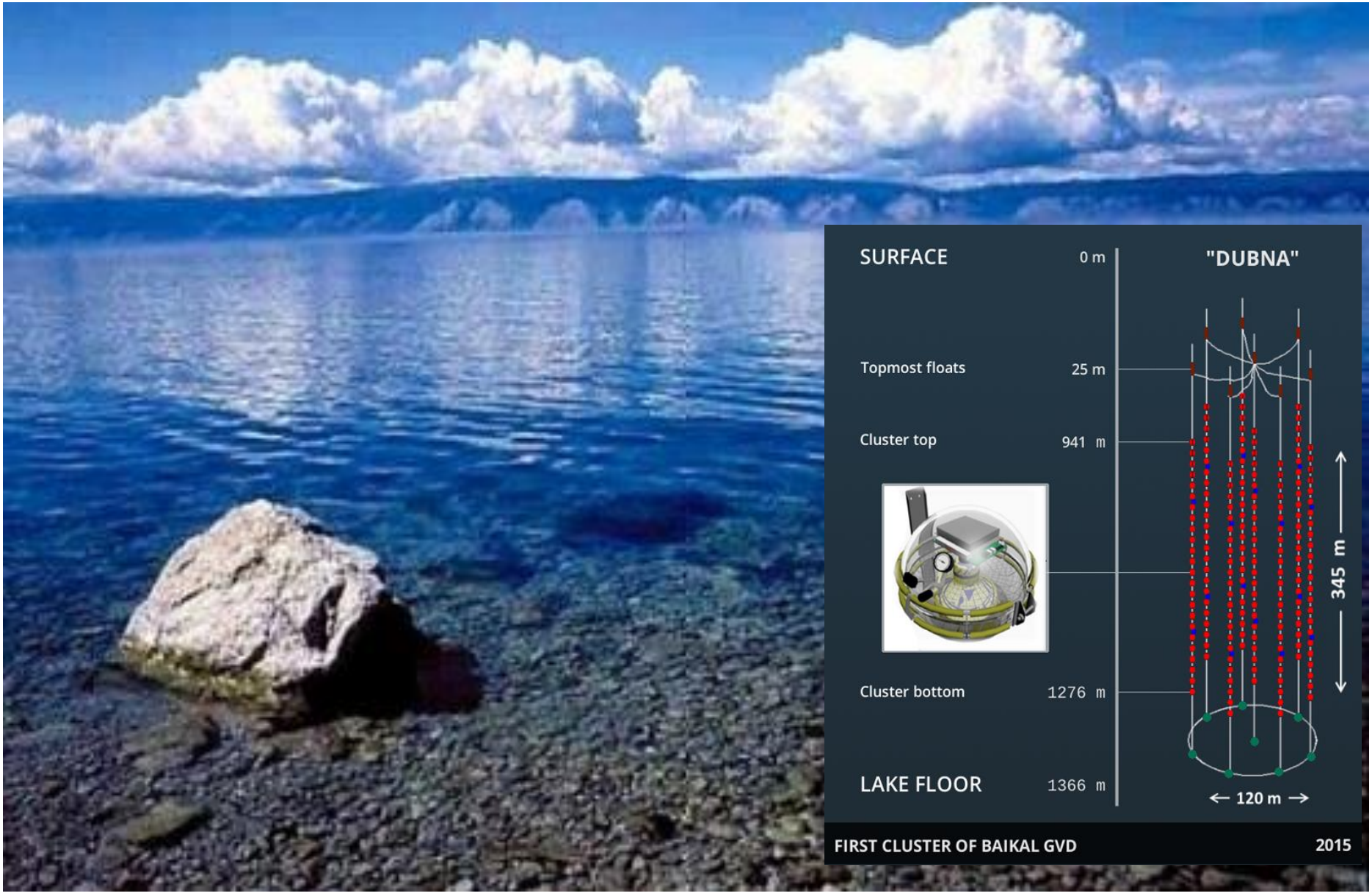
Dzhelepov Laboratory for Nuclear Problems

INR of RAS

Institute for Nuclear Research of the Russian Academy of Sciences

M.A.Markov

First GVD cluster “DUBNA” at Baikal lake already in operation in 2015 !



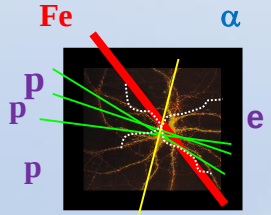
Radiation Biology at JINR

Based on experiments at JINR's accelerators, the LRB resolved one of the central issues of radiobiology: the problem of the genetic effectiveness of ionizing radiations.

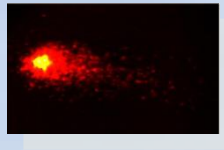
Outlook for research

- **study of the regularities and mechanisms of the effect of heavy charged particles on *eye structures*: the lens and retina;**

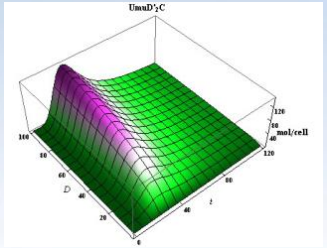
- **evaluation of the risk of the damaging effect of ionizing radiations with different physical characteristics on *the nervous system and higher nervous activity* (regularities of nervous cell death; impairments of the intercellular signal transmission; and disorders in mental functions: learning, memory, behavior, and consciousness);**



- **research on the mechanisms of the *genetic effect* of radiations with different physical characteristics (formation and repair of different DNA lesions; programmed cell death mechanisms; and genetic instability);**

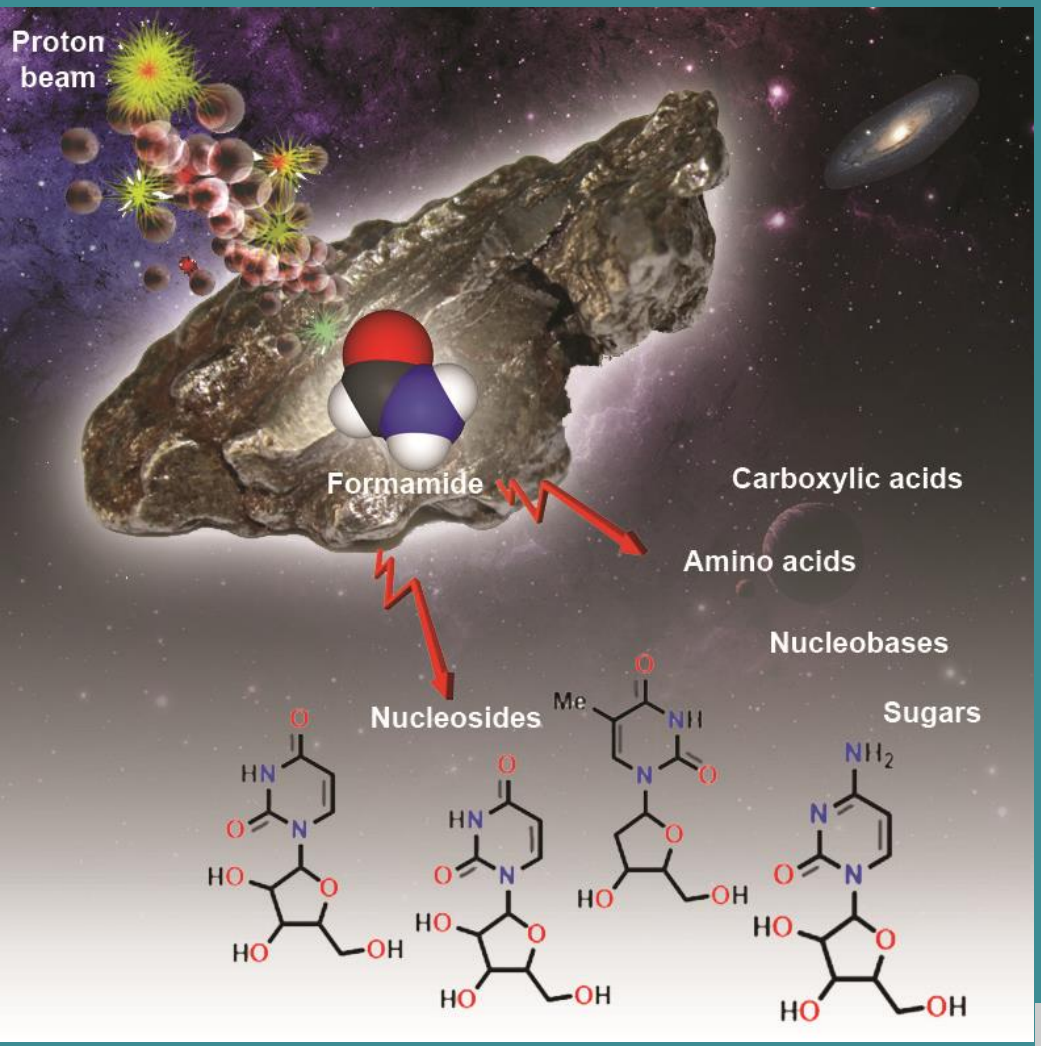


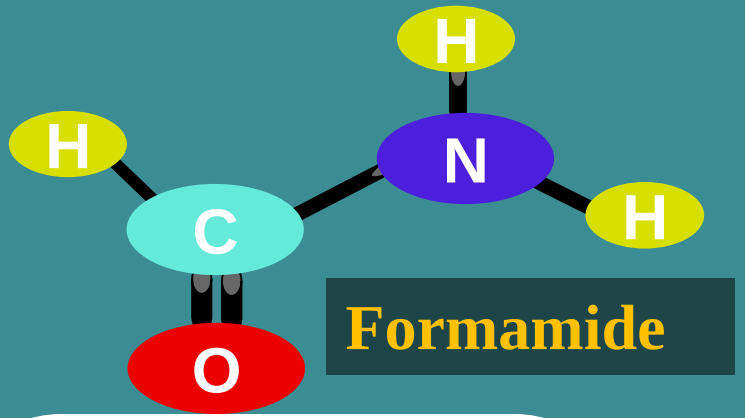
- ***mathematical modeling* of biophysical systems.**

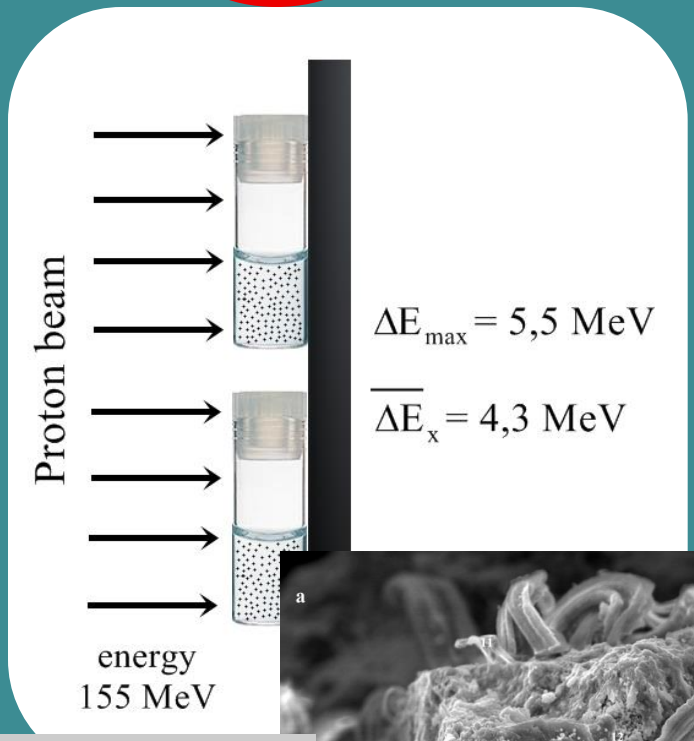


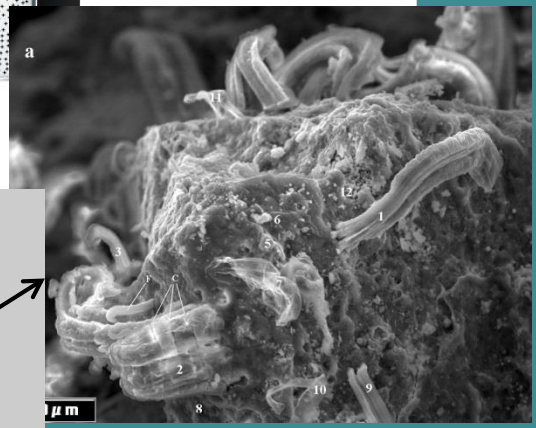
Cosmic medicine and the Project "Man Fly to Mars"

JINR LRB: Astrobiology







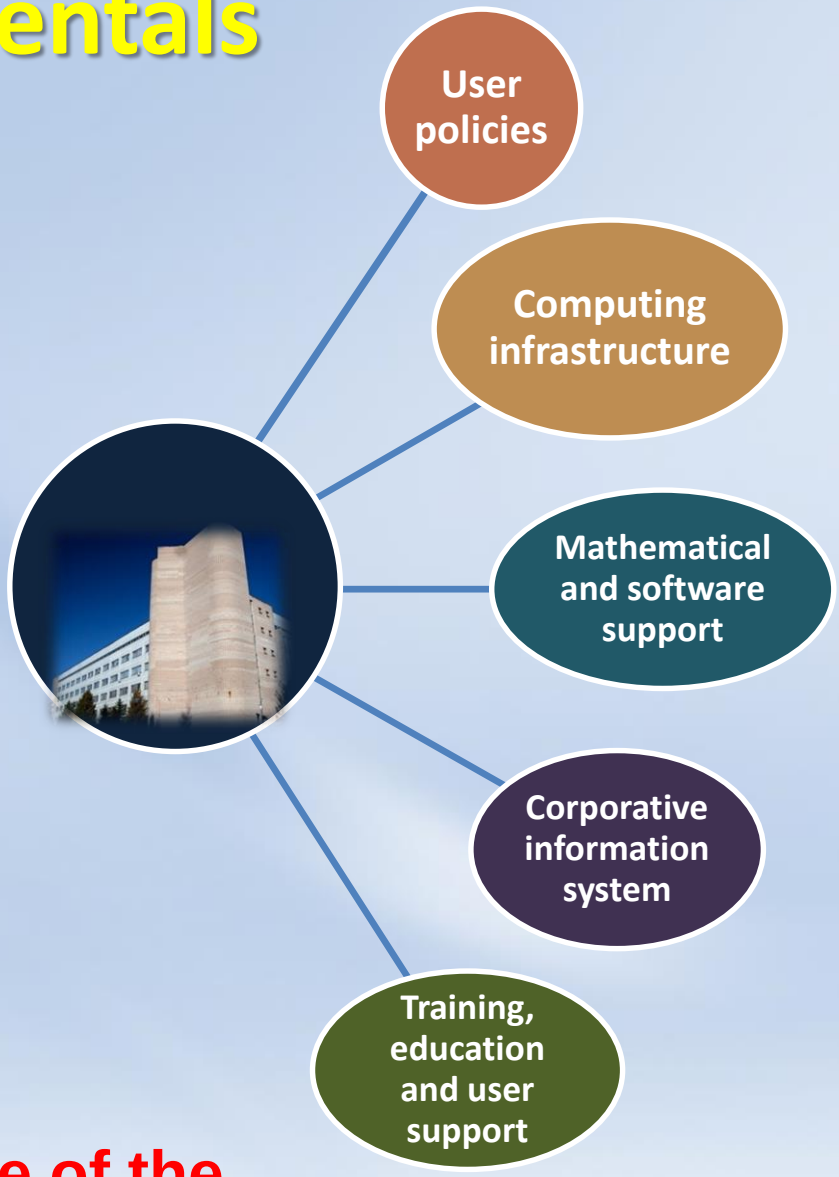


Orgueil CI1 Meteorite, biofossils

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

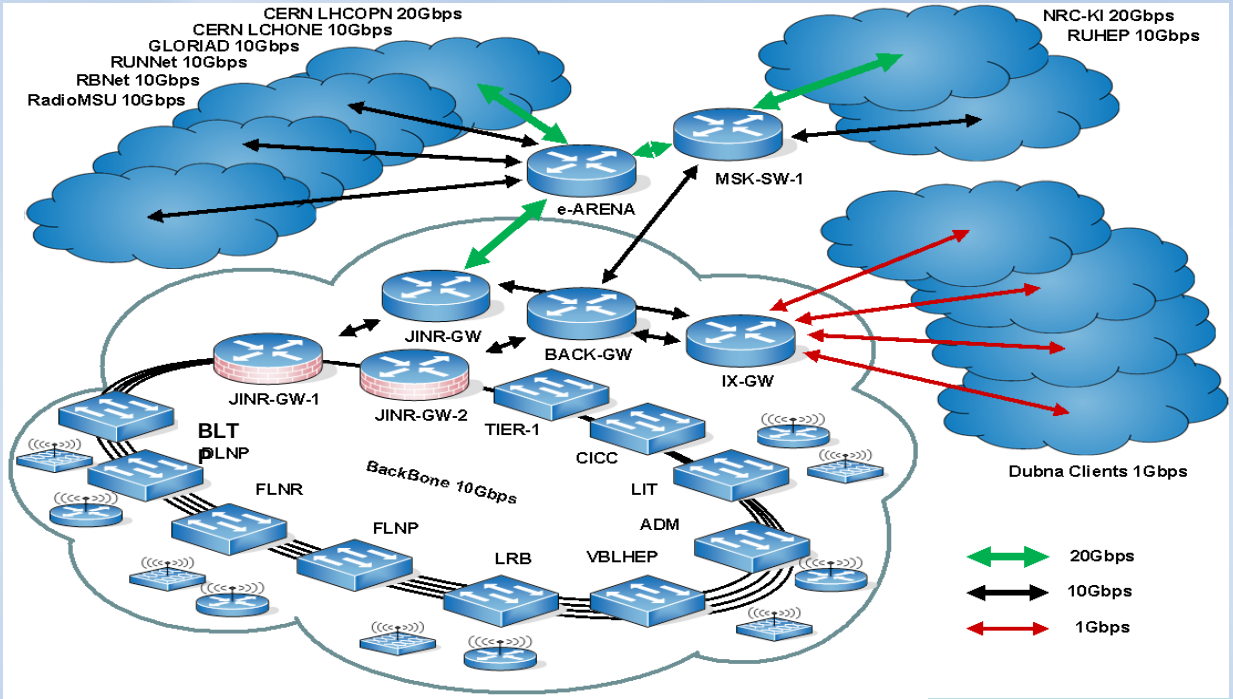
LIT Fundamentals

- Provide IT services necessary for the fulfillment of the JINR Topical Plan on Research and International Cooperation in an efficient and effective manner
- Building world-class competence in IT and computational physics
- 24/7 support of computing infrastructure and services such availability is called non stop service



IT-infrastructure is one of the major JINR basic facilities

Network and Telecommunication at JINR



Controlled-access at network entrance. General network authorization system involves basic services (Kerberos,AFS, batch systems, JINR LAN remote access, etc.) IPDB database - registration and the authorization of the network elements and users, visualization of statistics of the network traffic flow, etc.

JINR Local Area Network

Comprises 8146 computers & node

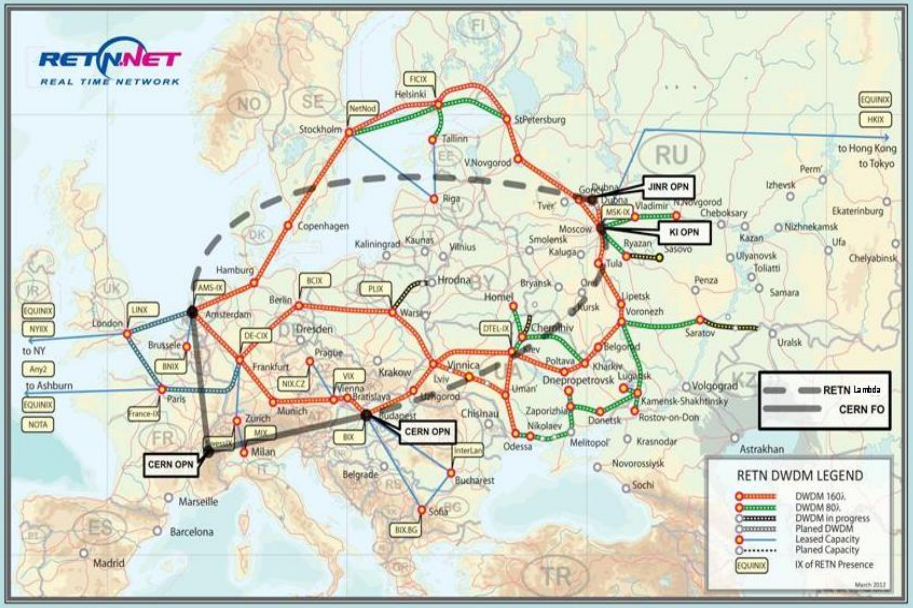
Users – 4379, IP – 13436

Remote VPN users – 780

E-library- 1475, mail.jinr.ru-2400

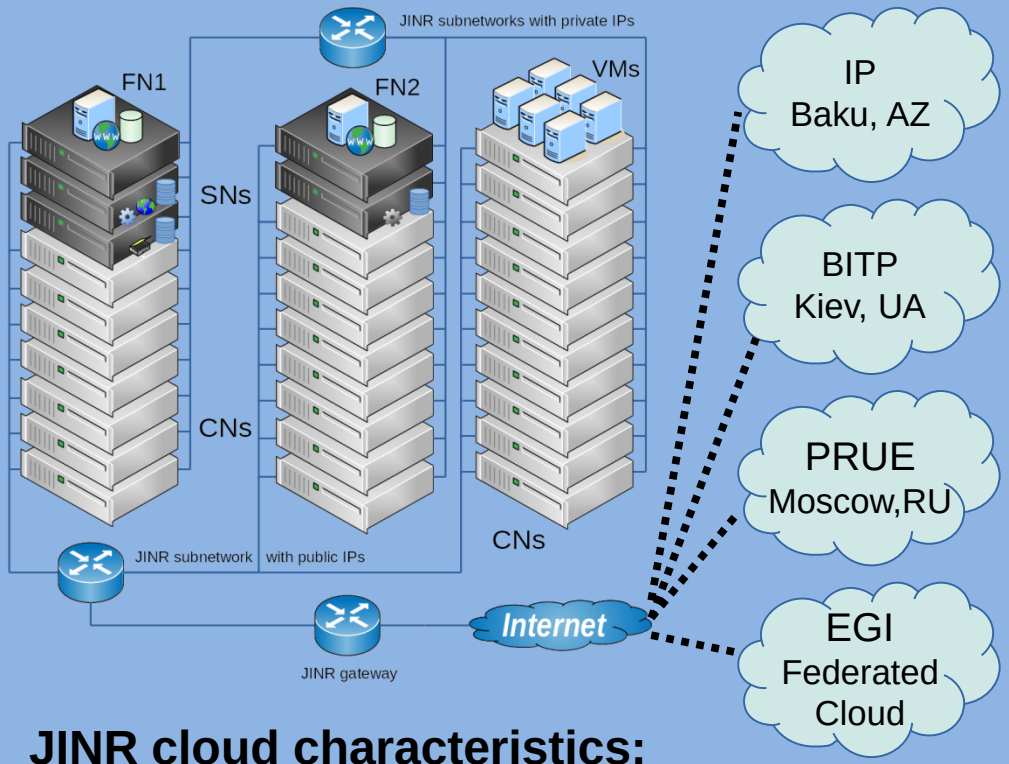
High-speed transport (10 Gb/s)

The upgrade of the JINR-Moscow telecommunication channel for data transfer up to 100 Gb/s speed has been approved

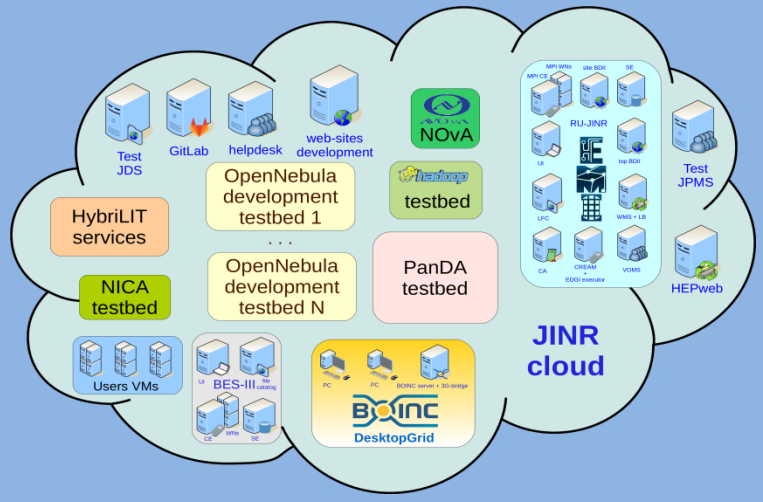


JINR cloud infrastructure

JINR Cloud architecture



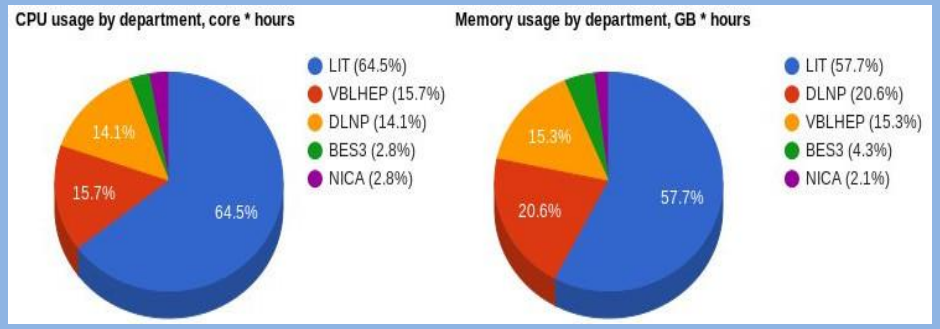
JINR Cloud utilization



JINR cloud characteristics:

Based on OpenNebula
CPU cores: 400
Total RAM: 800
Total disk capacity: 26 TB
Registered users: 100
# of running VMs: 120

JINR Cloud usage statistics



Worldwide LHC Computing Grid Project (WLCG)

The primary goal of the WLCG project is to create a global infrastructure of regional centers for processing, storage and analysis of data of the LHC physical experiments.
The grid-technologies are a basis for constructing this infrastructure.

A protocol between CERN, Russia and JINR on participation in the LCG project was signed in 2003. MoU about participation in the WLCG project was signed in 2007.

Tasks of the Russian centers and JINR within WLCG :

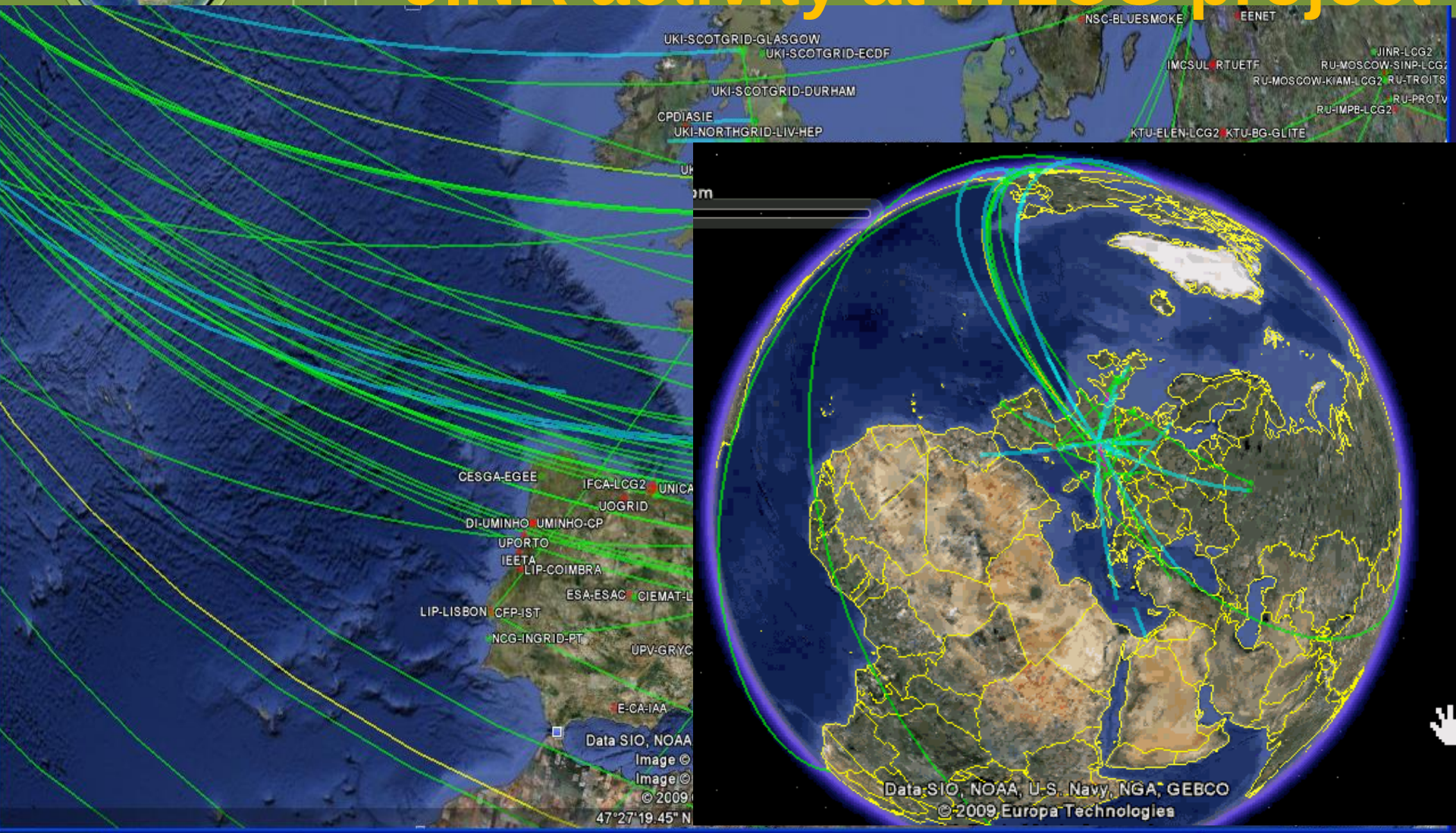
- **Creation of a complex of tests for WLCG software**
- **Introduction of WLCG services for experiments**
- **Development of WLCG monitoring systems**
- **Development of simulation packages for experiments**
- **Creation of a Tier1 center in Russia**

JINR activity at WLCG project

- Participation in development of software for ATLAS, ALICE, CMS
- Development WLCG Dashboard
- Global data transfer monitoring system for WLCG infrastructure NOSQL storage
- Integration GRID, Cloud, HPC
- Local and global Monitoring of Tier2/3 centers
- Development of DDM, AGIS for ATLAS , GENSER & MCDB, Tier1 center for CMS

WLCG Google Earth Dashboard

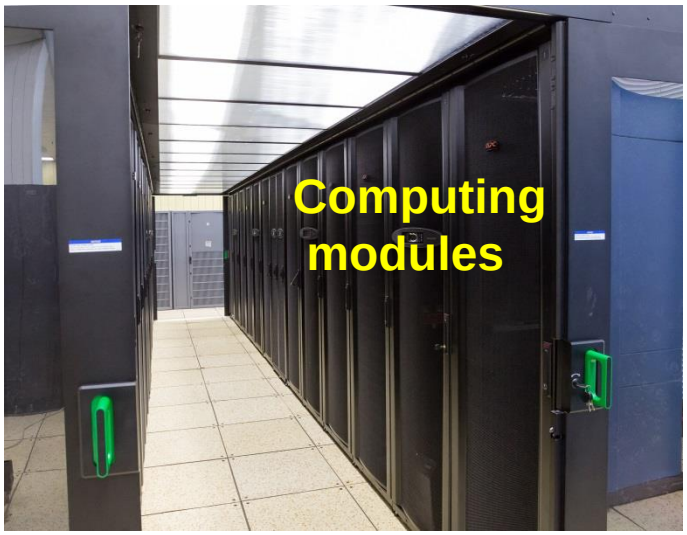
JINR activity at WLCG project



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



Grid technologies - a way to success

On a festivity dedicated to receiving the Nobel Prize for discovery of the **Higgs boson**, CERN Director professor Rolf Dieter Heuer directly called the grid-technologies one of three pillars of success (alongside with the LHC accelerator and physical installations).

Without implementation of the grid-infrastructure on LHC it would be impossible to process and store enormous data coming from the collider and therefore to make discoveries.

Nowadays, every large-scale project will fail without using a distributed infrastructure for data processing.

Training courses on HybriLIT

Tutorials on the basis of *HybriLIT*:

- **Regular tutorials on parallel programming technologies both for the institute staff and for students and young scientists from JINR member-states organized by the UC;**
- **Specialized courses from the leading software developers.**

Specialized courses and seminars within conferences and schools organized by JINR. In particular within GRID'2014, International youth conference *MPAMCS'2014*, The Helmholtz International Summer School "Lattice QCD, Hadron Structure and Hadronic Matter" 2014; *MMCP'2015*, *NEC'2015, AIS-GRID'2015*.

GRID 2016

July 4 - 9 2016

7th International Conference "Distributed Computing and Grid-technologies in Science and Education" will be held at the Laboratory of Information Technologies (LIT) of the Joint Institute for Nuclear Research (JINR) on 4 - 9 July 2016 in Dubna (**grid2016.jinr.ru)**

This year Conference is dedicated to the 60'th anniversary of JINR and 50’th anniversary of LCTA/LIT.

BLTP Bogoliubov Laboratory of Theoretical Physics

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.

Publications, 2015
Journals & Conf. Proc ~ **490**

JINR University Centre
Attracting youth to science

JINR
UNIVERSITY CENTRE
EDUCATING FUTURE SCIENTISTS
25 YEARS

Students
& graduates

International student practice
www.uc.jinr.ru (events)

Summer student programe
students.jinr.ru

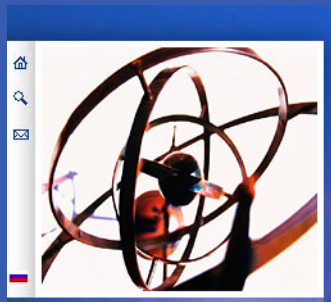
Preparation of the student Magistre diploma and PhD and Candidate of Science works

OUTREACH

International Schools for school teachers of physics in JINR and CERN
teachers.jinr.ru

For school boys and girls
Excursions
Videoconferences
Days of knowledge
Interschool curses in physics and mathematics

Research-educational projects



University Centre

- General information
- News
- International cooperation
- JINR UC study projects and laboratories
- The JINR Postgraduate Studies
- Opportunities for students
- For secondary school pupils and teachers
- Events

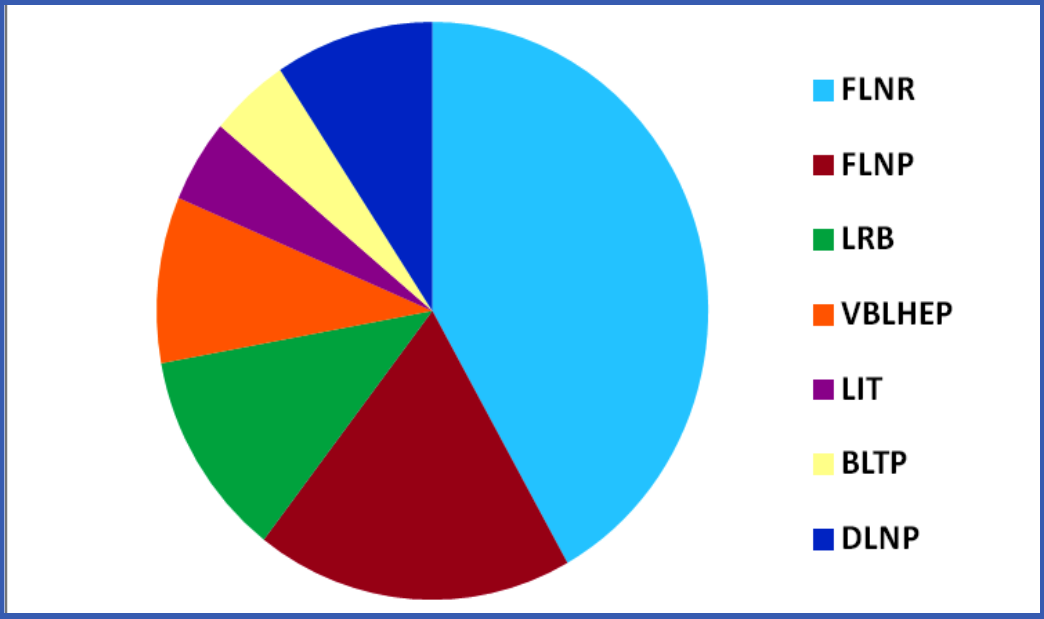
General information

- Regulations of the JINR University Center
- UC staff
- FAQ
- Courses offered in the academic

Projects and their description

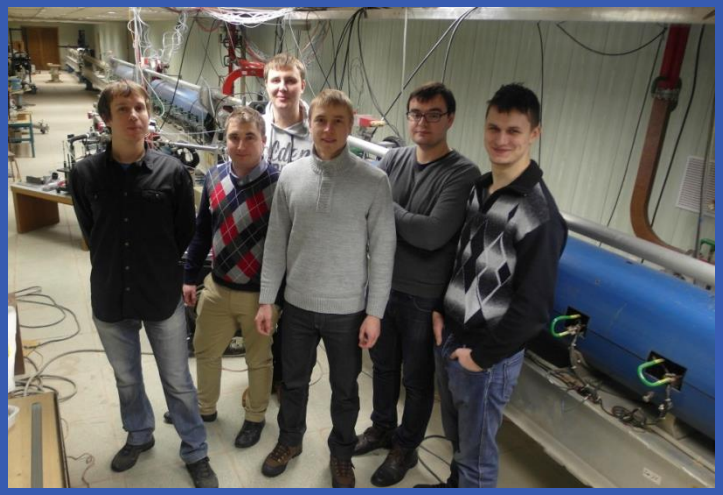
Flerov Laboratory of Nuclear Reactions (FLNR)

A. Artyukh	**Study of the transfer and fragmentation reactions near Fermi energy. Production of exotic nuclei beams**
O. Orelovitch	**Scanning electron microscopy methods in study of micro objects**
V.A. Skuratov	**The irradiation testing of nuclear ceramics and oxides with heavy ions of fission fragment energy**



JINR Infrastructure to train engineer-physicists

- Scientific-engineering department at UC was created
- This department has to develop regular training programs on real "training" facilities
- These programs can be offered to the Member States and can be used in organizing International Student Practices and the Summer Student Program



Teacher Programs (CERN & JINR)

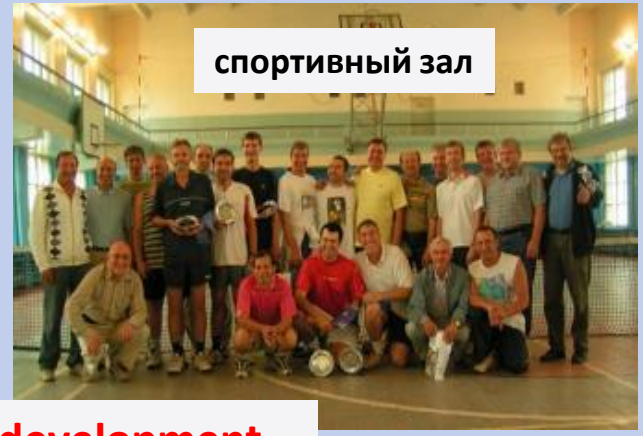
http://teachers.jinr.ru/

First School held in 2009

Seven Schools at CERN (260 part.)

Five Schools at JINR (210 part.)

Бассейн на 50 m



спортивный зал

JINR Social Infrastructure and its development

Летние школы для школьников и студентов

Футбольные, хоккейные и теннисные поля

В.А. Матвеев_Астана_15.06.16

Events dedicated to 60th anniversary of JINR: *Conferences*

29 June- 3 July 2015 - St.Petersburg, Russia
65th International Conference on Nuclear Physics

13 – 17 July 2015 Tatry, Slovakia
International Conference «Mathematical Modeling and Computational Physics»

27 July – 2 August 2015 - Prague, Czech Republic
International conference «Symmetries and Spin»

27 July – 7 August 2015 - Gomel, Belarus
International School Conference «Actual Problems of Micro world Physics»

20 – 26 August 2015 - Moscow, Russia
17th Lomonosov Conference on Elementary Particle Physics

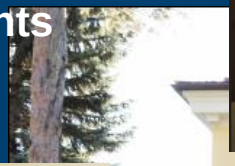
27 August – 4 September 2015
Verkhny Smokovets, Bulgaria
6th International Pontecorvo Neutrino Physics School

28 September - 3 October 2015
Montenegro Budva
25th International Symposium on Nucle
Electronics & Computing (NEC-2015)

Most recent event dedicated to 60th anniversary of JINR

Week of South Africa in JINR
21-25 September, 2015 Dubna

* 10 years of signing the MoU between the government of South Africa and the JINR
* 4th Symposium ”Few- to May- Body Systems and Methods and Applications”
* 15th session of the JCC
* Closing the Practice for SA students
* Presentation of the South-African mega-science project SKA



Forthcoming days of JINR dedicated to 60th anniversary of JINR in the Member States

3-6 November 2015, Bucharest
JINR Days in Romania

17-21 November 2015, Minsk
Meeting of FC and
Session of CP

3-7 November 2015, Warsaw
NICA Days in Warsaw

1-5 February 2016, Habana
JINR days in Latin America
40 years of Cuba in JINR

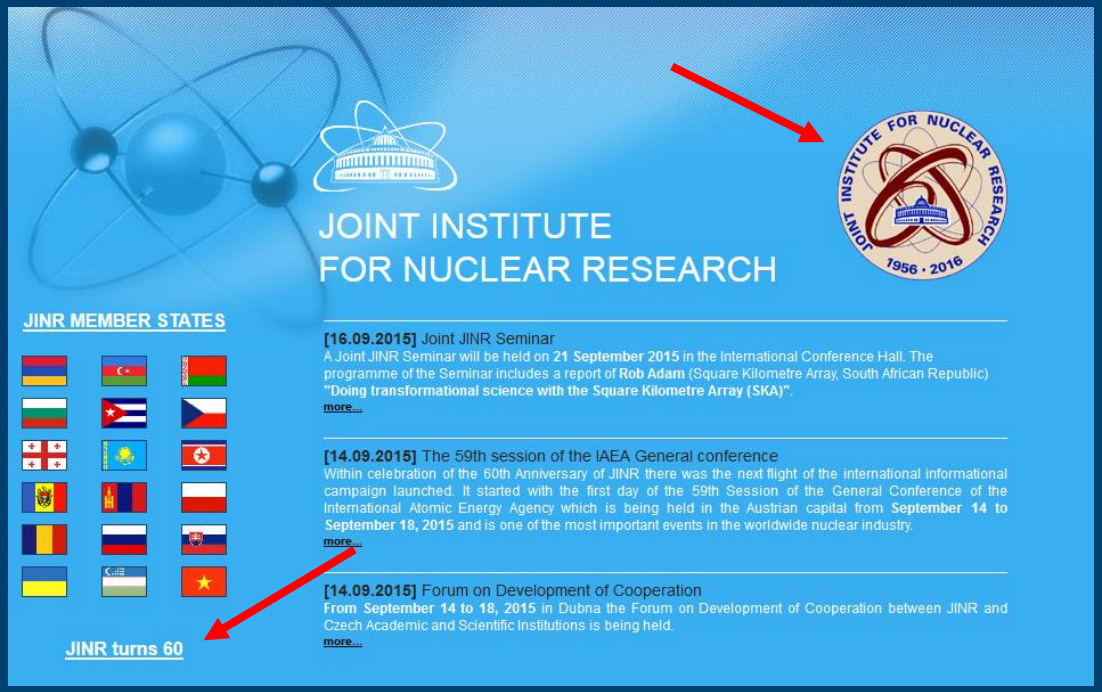
4-5 April 2016, Sofia
Opening the JINR exhibition

15-17 June 2016, Astana
Days of JINR in Kazakhstan
10 years DC-60

28 Nov.-02 Dec. 2016, Pretoria
Forum "10 Years Together"

…..

Full list of the scheduled events at the JINR web-page



Also in 2016:
JINR days in CERN
JINR days in UNESCO

Recent development of the JINR international cooperation

Involving the new countries into the JINR

Brazil and India
New contacts gained recently in various topics
at the Forums on developing the cooperation with JINR.
Negotiations with the national agencies on atomic energy
are in progress.

China
Strong interest to NICA and very active position of
Chinese senior officials. Next high level event in JINR: 26/10/16
Multidisciplinary Forum China-JINR: June 2016

Turkey
Remarkable interest of a number of Turkish institutions to access
the research facilities of JINR for scientific research and educatio

Clusters of the countries in the world regions facilitated by Cuba, Egypt, South Africa, Vietnam
New contacts are already gained with the research organizations
and universities of Guatemala, Tunis, Botswana, Thailand
(to be continued)

Montenegro
Negotiations are going with the Ministry of Education and
Sciences on the signing an Agreement with JINR


4 March 2014. Ambassadors of 11
Latin American countries visited JINR

Visibility of JINR in Europe and in the World
and involvement of young researchers are among
the main JINR priorities

JINR Teams Participation in the international and World Global projects

I. CERN (LHC): LHC development – consolidation of SC magnets;
CMS, ALICE and ATLAS – data taking & analysis & *upgrade*;

II. CERN (SPS):
COMPASS – finished 1st phase. Detector modification to measure GPD (DVCS) and polarized/unpolarized D-Y;
NA61 – neutrino and heavy-ion programs;
NA62 – measurement of extremely rare decays ($K^+ \to \pi^+ \nu\nu$) ;
DIRAC – lifetime measurement of $\pi\pi$ and πK atoms completed at PS; collaboration formed to continue at SPS (20-40 gain in stat.)

III. BNL (RHIC):
STAR - energy scan HI program and physics with polarized beams (important experience for future research at NICA)

IV. Fermilab:
CDF, D0 – data analysis: the most precise masses of W and t-quark
Mu2e ($\mu \to e$), muon g-2.

V. GSI, FAIR (SIS-18/100/300):
HADES – data analysis, CBM, PANDA – in preparation

VI. J-PARC & KEK: COMET ($\mu \to e$)

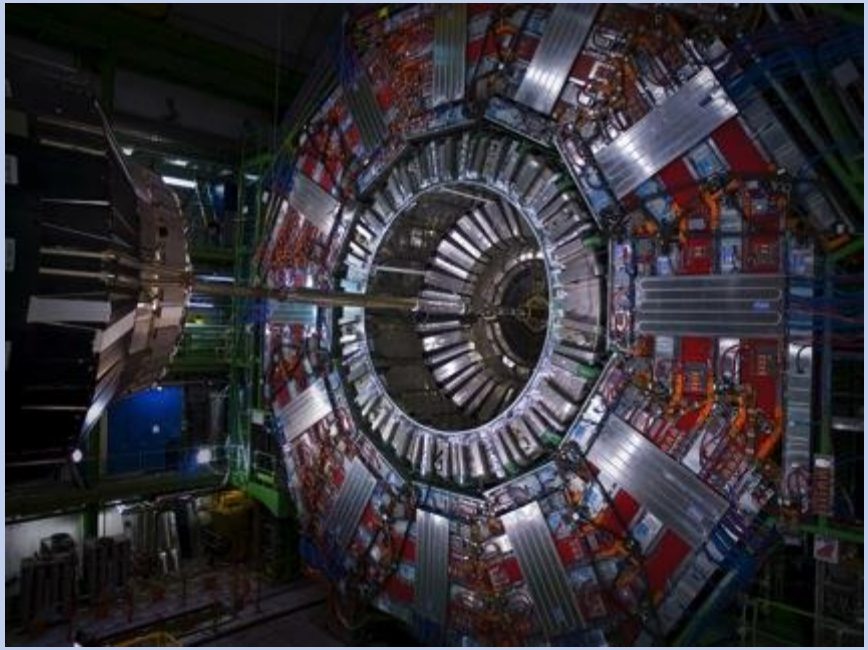
VII. BEPCII: BESIII – new narrow mesons around 4 GeV with hidden charm

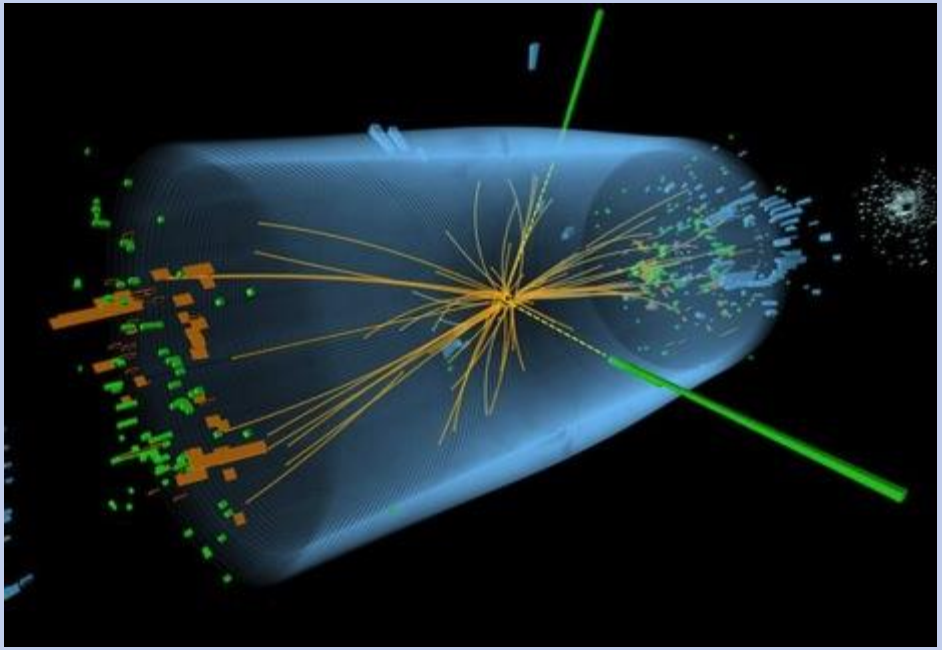
VIII. ν-oscillations: OPERA (**direct** $\nu_\mu \to \nu_\tau$) - data analysis
BOREXINO (**Solar** ν) – confirmed MSW theory of oscill. in matter
Daya Bay (**Reactor** ν) – measured nonzero $\theta_{13} \Rightarrow$ open a way to solve ν mass hierarchy in long base projects Daya Bay II (JUNO), NOvA …

JINR continues energy frontier research at the LHC with ALICE, ATLAS & CMS

Breakthrough in Experiments @ LHC:

The most important event in Particle Physics in XXI century
is the discovery of the **Higgs Boson** at CMS and ATLAS at LHC





JINR will continue to be one of the main contributors to the ATLAS & CMS experiments on the Large Hadron Collider, two of the experiments that discovered the Higgs boson in 2012. In 2015, the LHC started its second run, at the highest energies ever harnessed for a scientific experiment.

19 June 2015 CERN

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Two protocols on the General cooperation agreement between CERN and JINR were signed the same day: on PARTICIPATION BY JINR IN THE LARGE HADRON COLLIDER PROJECT (LHC) and on COLLABORATION AND COMMON DEVELPOMENTS IN THE AREA OF NEUTRINO PHYSICS AND TECHNOLOGY, AS WELL AS IN RELATED FIELDS.

CERN – JINR Partnership

- "… 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

JINR is an Observer to CERN Council

CERN Council September 2014

CERN is an Observer to JINR CP

JINR CP November 2014

Thank you for your attention!

Welcome to Dubna!

Our colleagues in member–states are saying:
“JINR in Dubna – it is our common house on the bank of the great Russian river Volga”

CERN COUNCIL DECISION
JUNE 2016

“Another important topic this week was the formal approval of the High Luminosity LHC project, HL-LHC.

This comes as extremely good news not only for CERN, but also for particle physics globally.

HL-LHC is the top priority of the European Strategy for Particle Physics in its 2013 update, and is part of the 2016 roadmap of the European Strategy Forum on Research Infrastructures, ESFRI. It was also identified as a priority in the US P5 strategy process, and in Japan’s strategic vision for the field. It secures CERN’s future until 2035, and ensures that we will achieve the maximum scientific return on the investment in the LHC. “

SOME OF THE MAJOR RESULTS OF JINR

-Accelerators – Phase Stability Principle (Veksler);

-Synthesis of the new super-heavy elements “105”, “113-118” and indications on the existence of the Stability Island (Flerov, Oganesian);

-Phenomenon of the Neutrino Oscillation (Pontecorvo);

-Construction of the Pulsed Breader Reactors IBR and 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)

In Pursuit of New Elements

USA, California, Berkeley:

1958 – 102(No), 1961 – 103(Lr), …

Glenn Seaborg, Albert Ghiorso

USSR, Dubna: 1964-1975 – 102,103,104,105 (Db), 106,107,108

JINR: 2000 – 114, 2002 – 116, 2003 – 113, 115, 118, 2009 – 117

G.N. Flerov, Yu.Ts. Oganessian

Germany, Darmstadt, GSI:

1989 - 2000 – 108, 109, 110, 111, 112

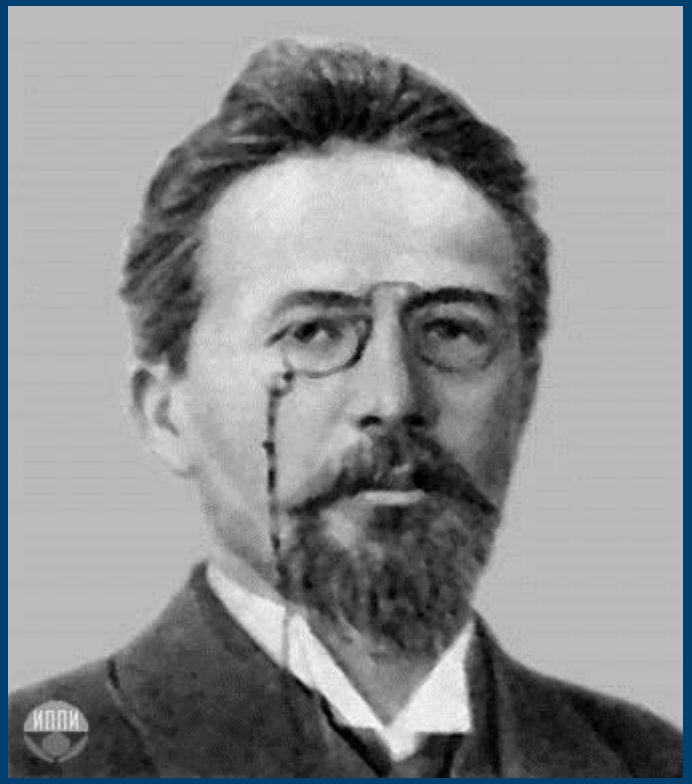
P. Armbruster, G. Münzenberg , S. Hofmann

Japan, Tokyo, RIKEN:

2002 – 110, 111, 112, 2004 – 113

K. Morita

Science Bringing Nations Together



"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".

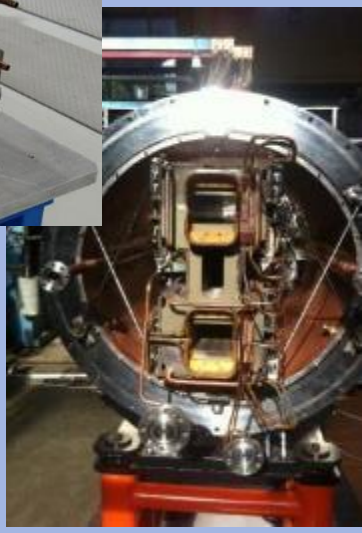
Anton Chekhov

(1860 – 1904)

Ultra-high vacuum

High-temp Superconductivity

Collider pre-serial dipoles



Collider quadrupole

Ultra-modern technologies

Curved UHV chambers

Magnetic measurements

Multipole SC magnets

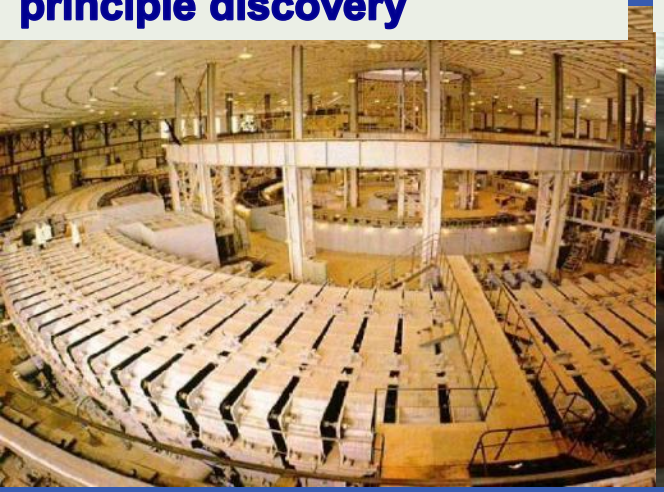
Synchrophasotron – Nuclotron – NICA

1957 – 2002 Synchrophasotron

10 GeV proton accelerator – world leader in energy.

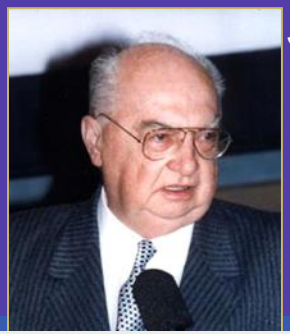
Beginning of era of high-energy physics

V.Veksler – phase stability principle discovery



1993 – Nuclotron

First in the world Superconducting Synchrotron of heavy ions



A.Baldin –start of relativistic nuclear physics era

2019 – NICA

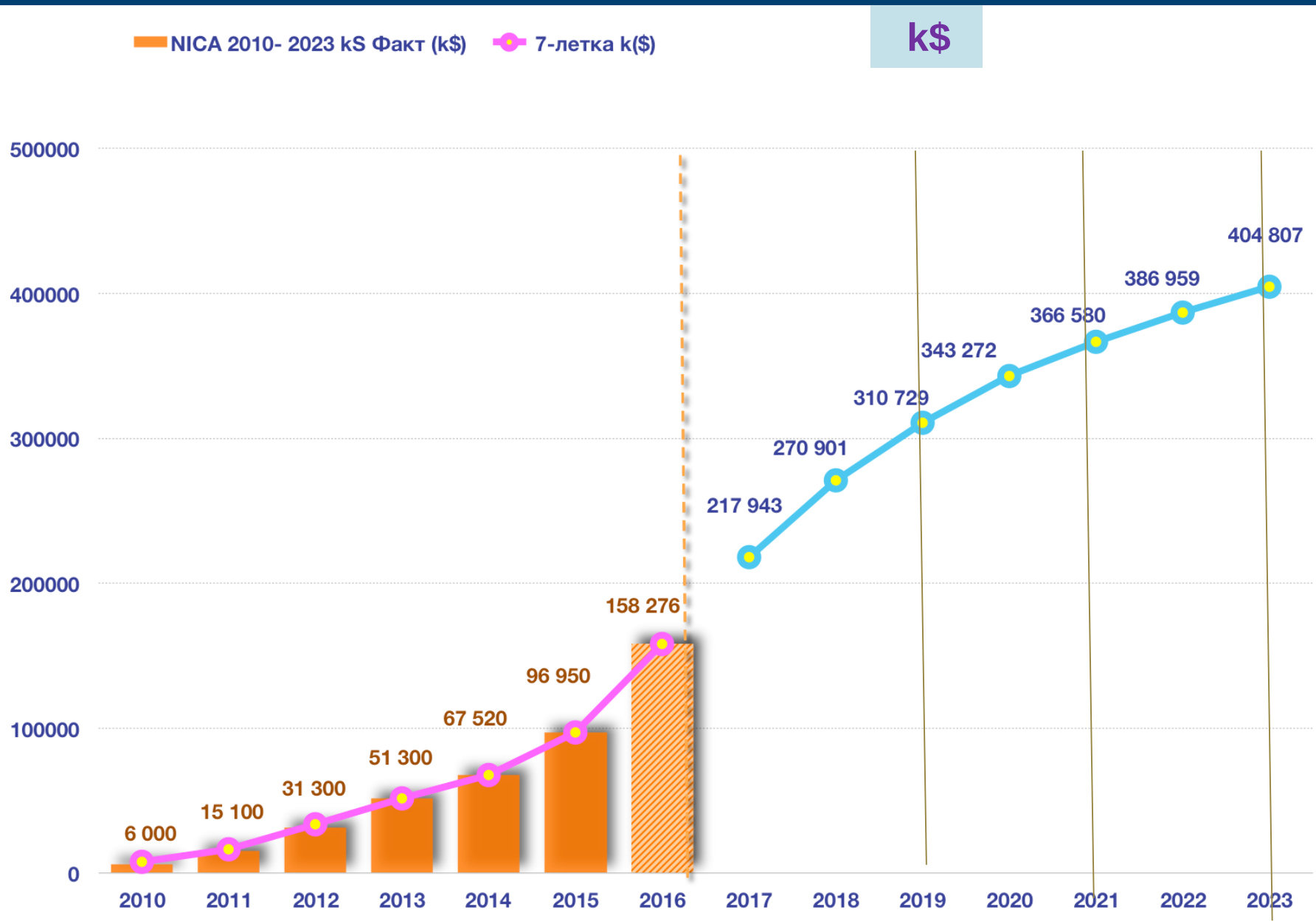
Superconducting collider of heavy ions

Study of baryonic matter at extreme conditions (max net baryon density)

NICA – the JINR flagship project in HEP - the highest priority of the Long Range Plan of the JINR strategy

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

NICA FUNDING PROFILE FOR THE PERIOD 2010 – 2023



FLNR's Basic Directions of Research

1. Heavy and superheavy nuclei:

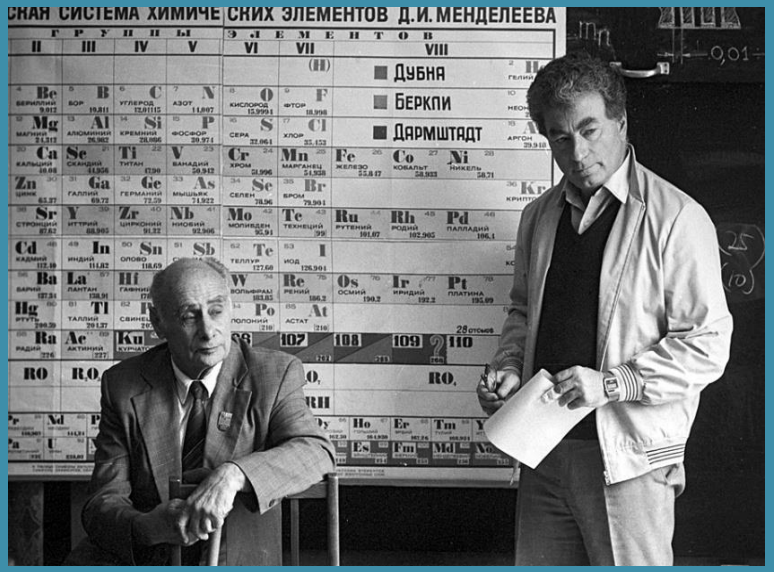
- synthesis and study of properties of superheavy elements;
- chemistry of new elements;
- fusion-fission and multi-nucleon transfer reactions;
- nuclear- , mass-, & laser-spectrometry of SH nuclei.

2. Light exotic nuclei:

- properties and structure of light exotic nuclei;
- reactions with exotic nuclei.

3. Radiation effects and physical groundwork of nanotechnology.

Modernization of the complex of the isohrone cyclotrones and developing the new Complex of the Dubna Radioactive Ion Beams DRIBs on the basis of the Cyclotrone DC-280

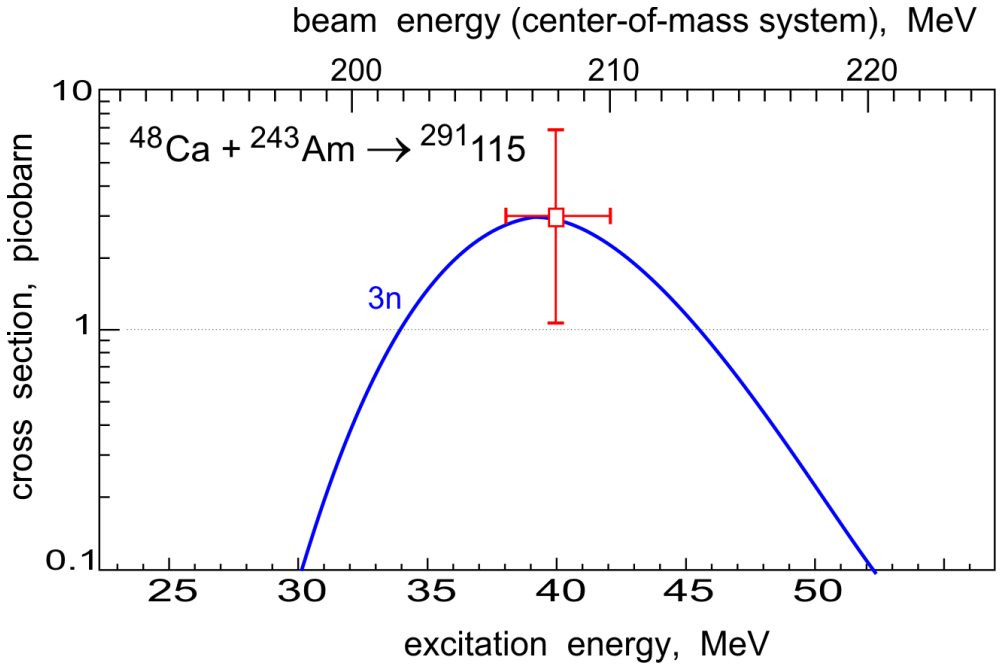


Physics Problems

Which nuclei are to be fused ?

- **«cold» synthesis:** $^{208}Pb + {}^{64}Ni, {}^{70}Zn, \ldots \rightarrow {}^{272}110, {}^{278}112, \ldots$ **(GSI, Germany)**
- **«hot» synthesis:** $^{238}U, {}^{244}Pu, {}^{248}Cm, {}^{249}Cf + {}^{48}Ca \rightarrow {}^{286}112, {}^{292}114, {}^{296}116, {}^{297}118$ **(Dubna)**
- **Symmetric combinations:** $^{148}Nd + {}^{154}Sm \rightarrow {}^{302}122$ **?**
- **Radioactive ion beams?**

How to choose colliding energy ?



JINR became the member of APPEC and NuPECC

NuPECC

Prof. Victor Matveev
Joint Institute for Nuclear Research
Dubna Moscow Region
Russia 141980

October 21, 2014

Dear Prof. Matveev,

In the last NuPECC meeting we discussed your request of having one representative of JINR as a member of NuPECC.
As a first important comment let me convey to you that the board was very happy to have received attention by such a prestigious institution operating in the field of nuclear science with many top line activities.
As you mentioned in your letter, we are well aware of the many productive collaborations that JINR has with many colleagues in several countries that are members of NuPECC. To have JINR in NuPECC will surely strengthen further our collaborations.
The board has thus decided to have one colleague from JINR as a NuPECC member. The next meeting will be in Athens on March 13 and 14, 2015 (see also http://www.nupecc.org/index.php?display=misc/meetings)
Concerning the membership please also contact Jean-Claude Worms at ESF under jcworms@esf.org.
Looking forward to receiving from you the name of the expert in nuclear physics who will join us in our NuPECC meetings and activities.

Yours sincerely,

Prof. Angela Bracco
University of Milano and INFN
NuPECC Chair

PS: You will receive an invoice for the membership fee (5628.80 €) from ESF.

NuPECC is an Expert Committee of the European Science Foundation
Scientific Secretariat: Dr. Gabriele-Elisabeth Körner
c/o Physikdepartment E12 der Technischen Universität München, D-85748 Garching
Tel.: +49 89 289 12280; +49 17289 15013, Fax: +49 89 289 12298, e-mail: gisa.koerner@ph.tum.de

EUROPEAN SCIENCE FOUNDATION

From Protokol of the NuPECC meetings:

…"To have JINR in NuPECC will surely strengthen further our collaborations."

…"The board has thus decided to have one colleague from JINR as a NuPECC member. The next meeting will be in Athens on March 13 and 14, 2015."

…"Looking forward to receiving from you the name of the expert in nuclear physics who will join us in our NuPECC meetings and activities."