The 2017 European School of High-Energy Physics

Evora, Portugal, 6 – 19 September 2017

Scientific program of the Joint Institute for Nuclear Research:

Victor A. Matveev

16 September 2017
Evora, Portugal

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

-- JINR: what and where

-- 7-Year Plan of JINR development for 2017-2023

its science priorities

-- Topmost results

-- Perspectives

-- Conclusion

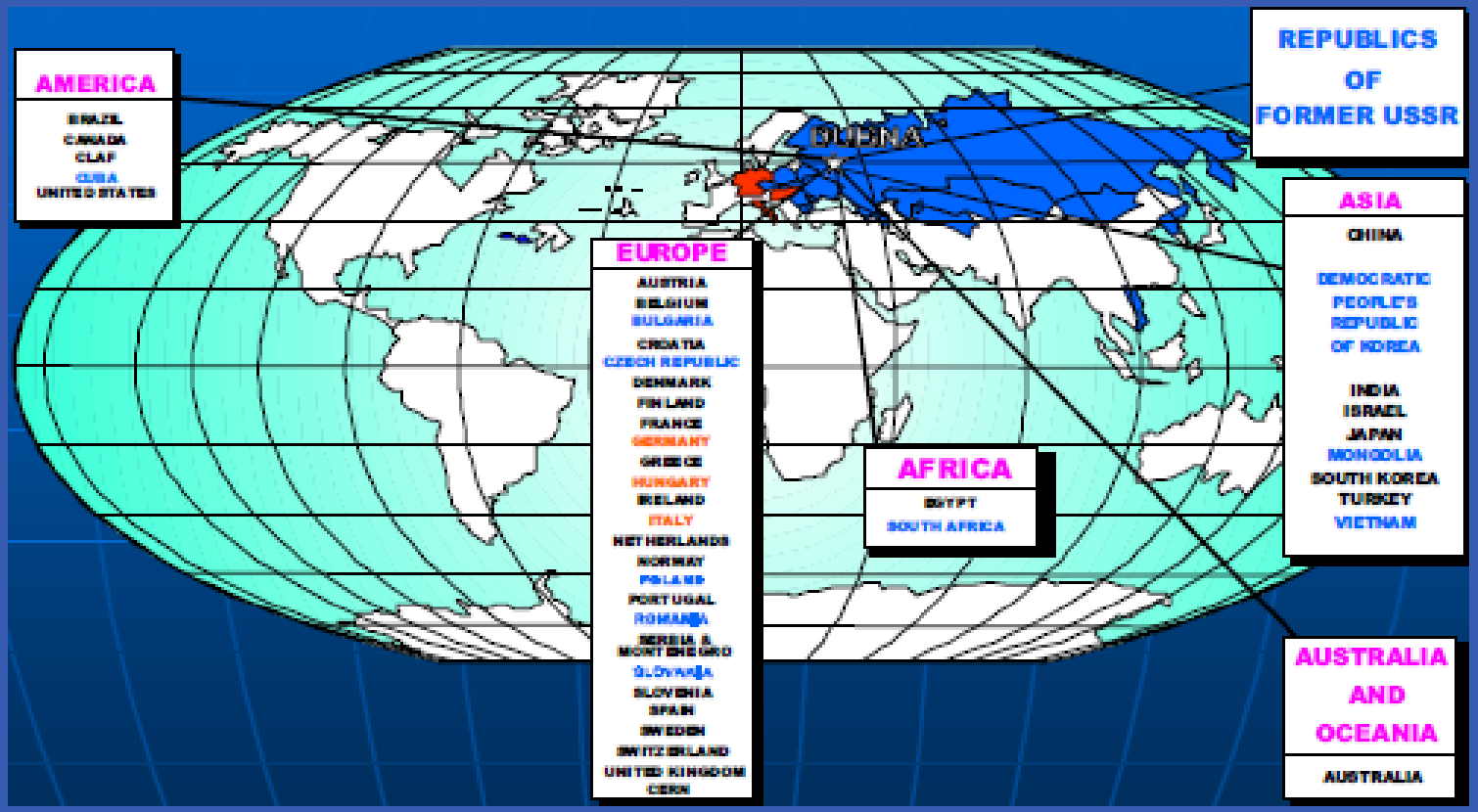
V. Matveev , Evora, Portugal, September 16, 2017


Russia
Moscow Region
Moscow
Dubna
JINR
r.Volga
Dubna
r.Sestra
r.Dubna
Dmitrov
Sheremetyevo
Airport
Moscow

JINR – International Intergovernmental Organization joining 18 member states and 6 associated states. It is located in the city of Dubna in 120 km to the north from Moscow

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

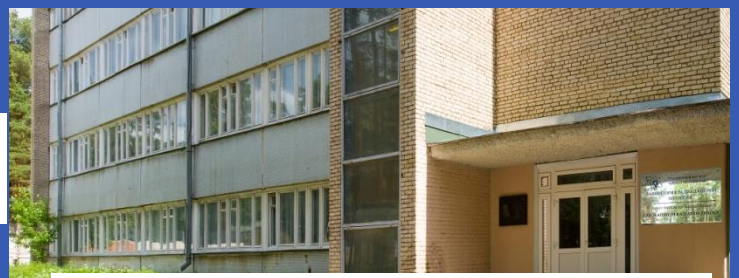
Veksler and Baldin
Laboratory of High Energy Physics

Bogoliubov Laboratory
of Theoretical Physics

Flerov
Laboratory of Nuclear Reactions

Frank Laboratory of Neutron Physics

Laboratory of
Information Technologies



Laboratory of Radiation Biology

JINR University Centre

JINR in some figures

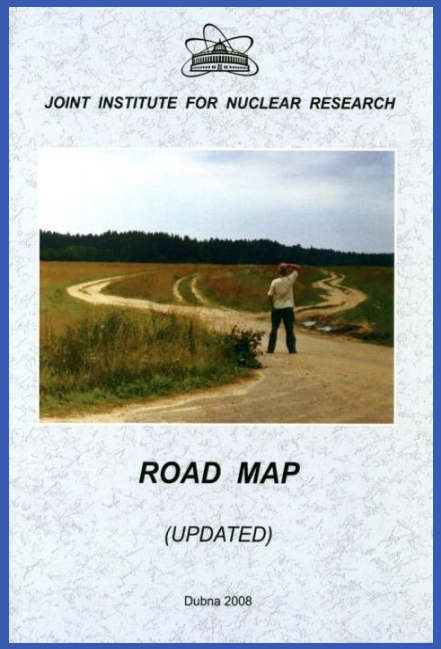
JINR`s staff members ~ 4750 :

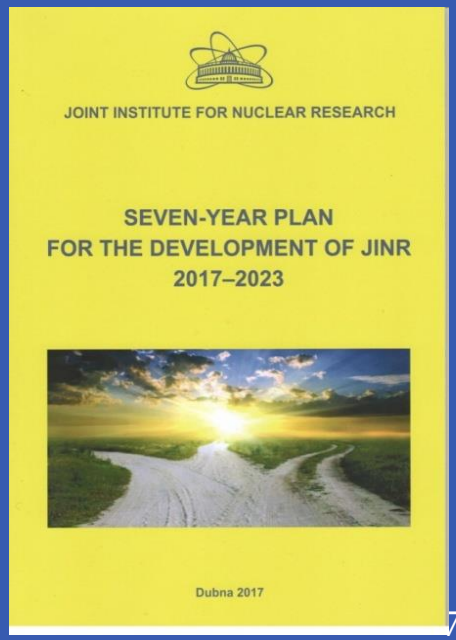
- **Researchers ~ 1350**

  including from the Member States (but Russia) ~ 450

  PhD and Full Doctors of Science ~ 1200
- **Engineers and specialists ~2100**
- **Services ~ 1300**

New 7-year Plan for JINR development for 2017 - 2023 has been approved in November 2016 by the JINR CP`s in Krakow, Poland.





JINR Research Experimental Facilities

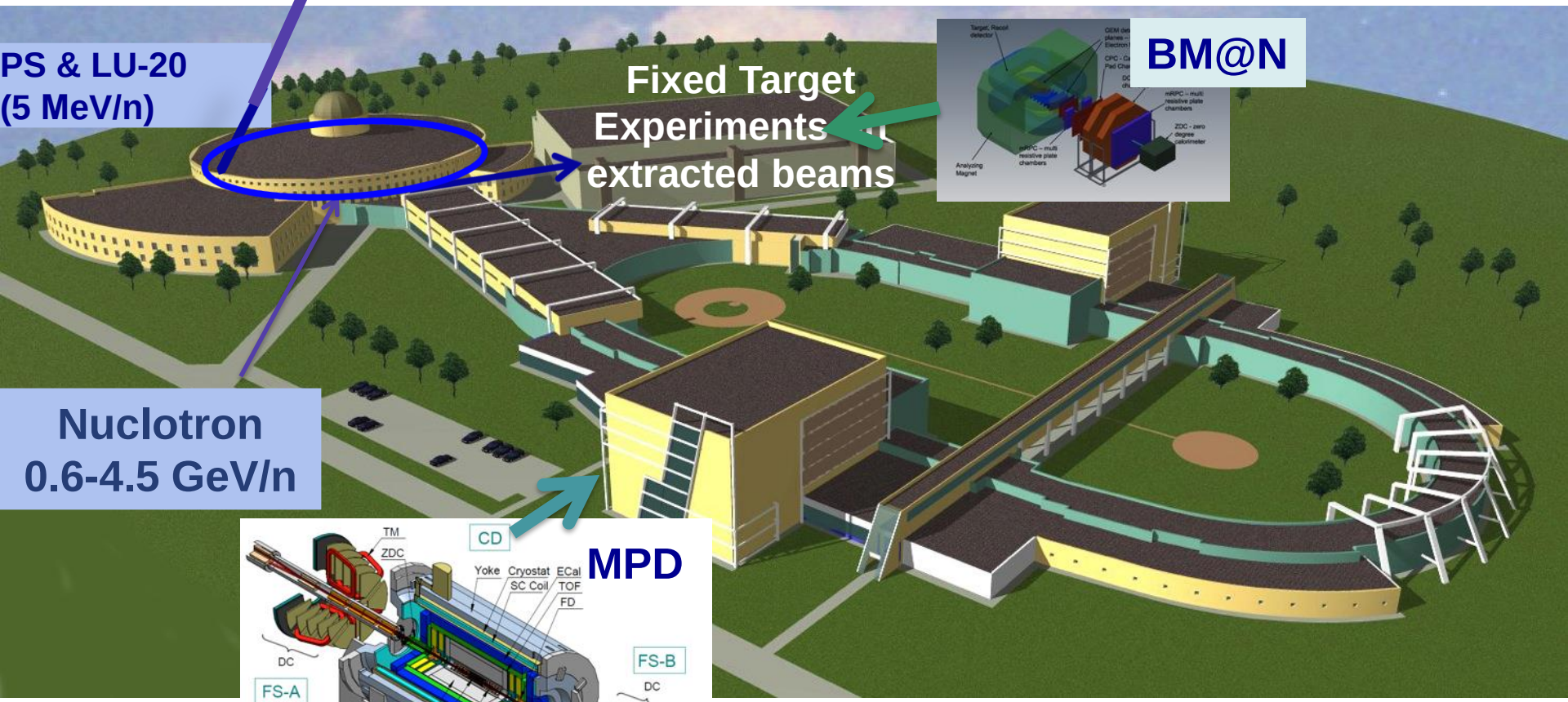
- Heavy Ion Superconducting Complex Nuclotron-NICA
  Physics of dense and hot baryon matter
  Spin structure and dynamics of nuclear matter
- Intensive pulsed neutron breader reactor IBR-2M :
  Condensed matter & Nuclear physics IRENA
- High Power Cyclotron Complex and SHE Factory
  Superheavy elements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

NICA (Nuclotron based Ion Colider fAcility) - the flagship project in HEP of the Joint Institute for Nuclear Research (JINR)

High Baryon Density Frontier

Мега-проект «Комплекс NICA»

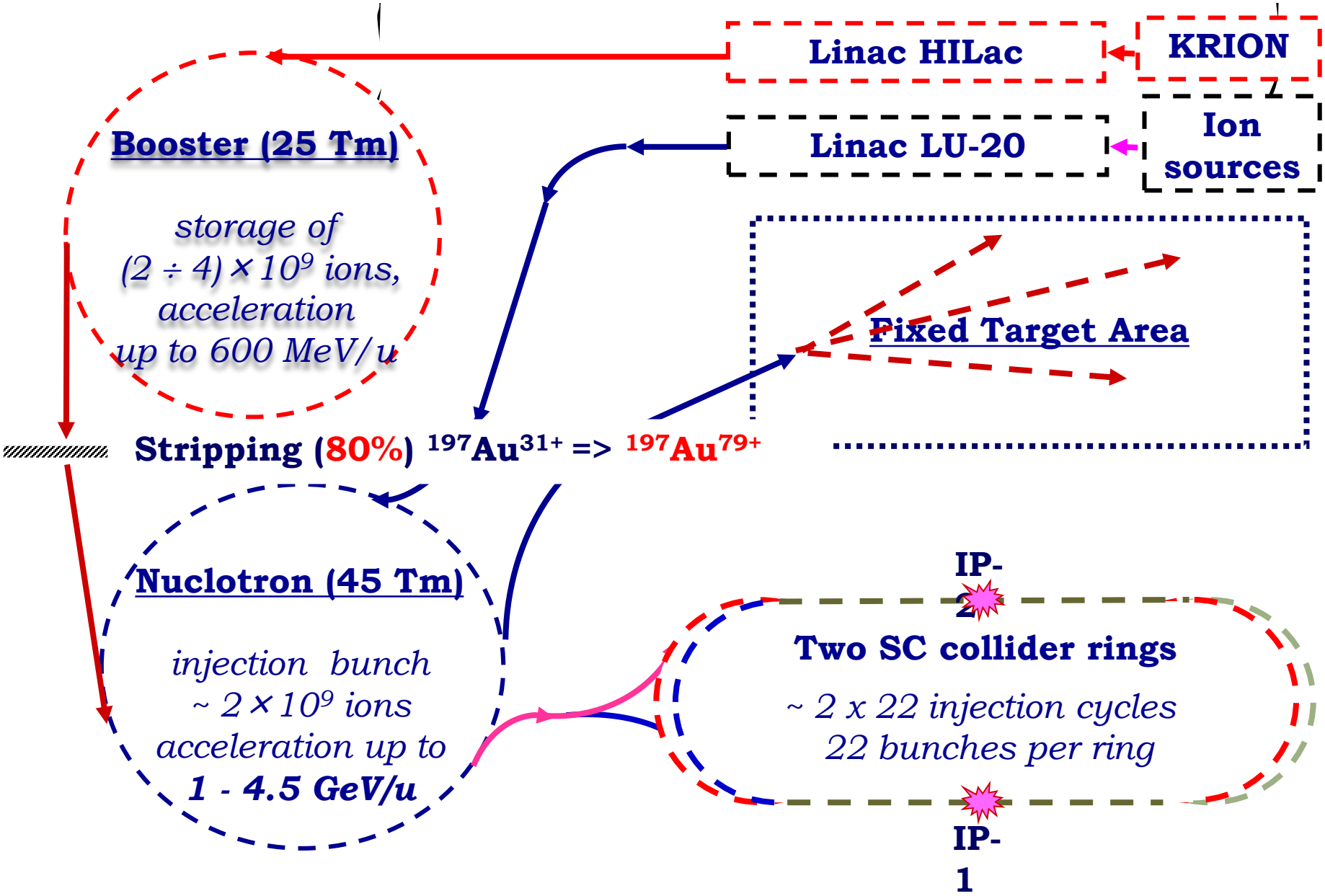
Existing elements

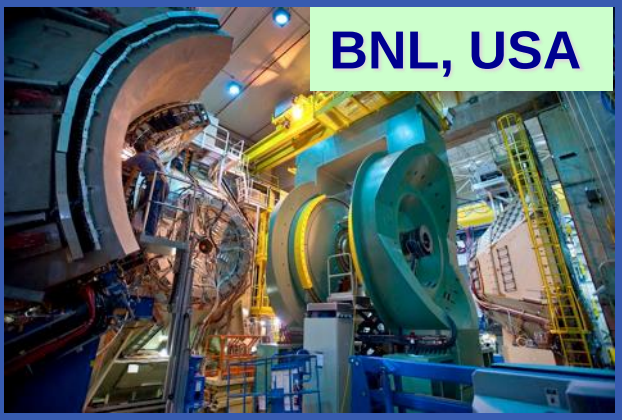


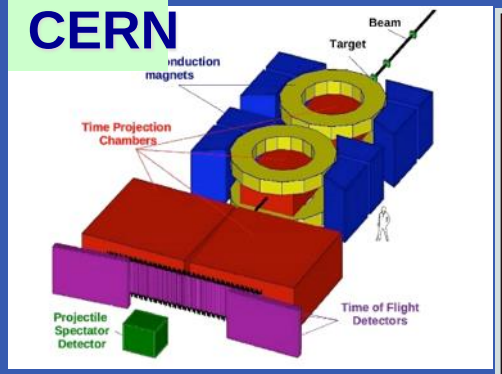
Study of the principally new phase state of the nuclear matter – super dense and hot baryonic matter – the Quark-Gluon Plasma produced initially at the birth of our Universe by the Big Bang.

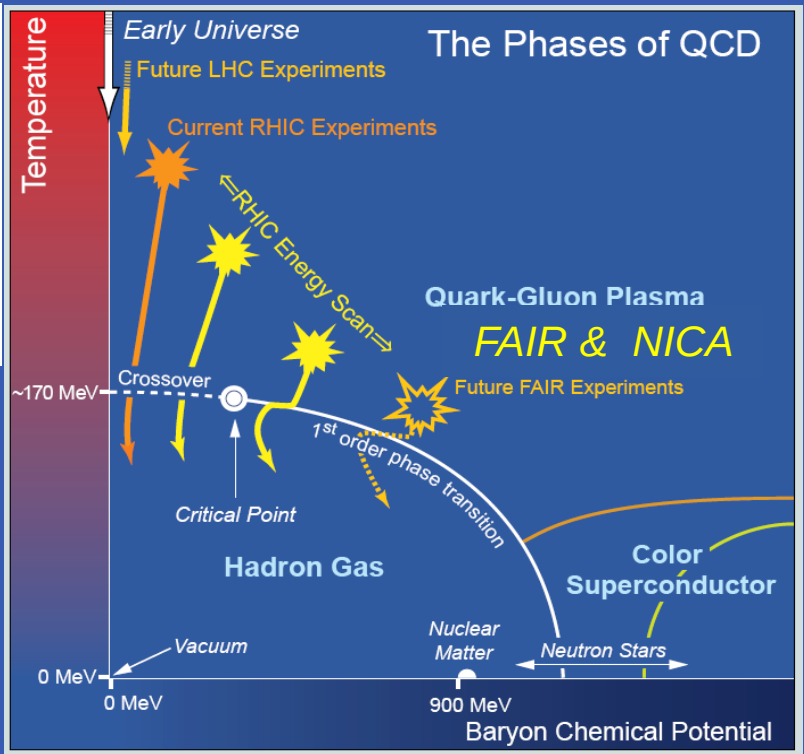
JINR NICA-
in the list of international Mega-Science Projects on the RF territory

Structure and Operation Regimes







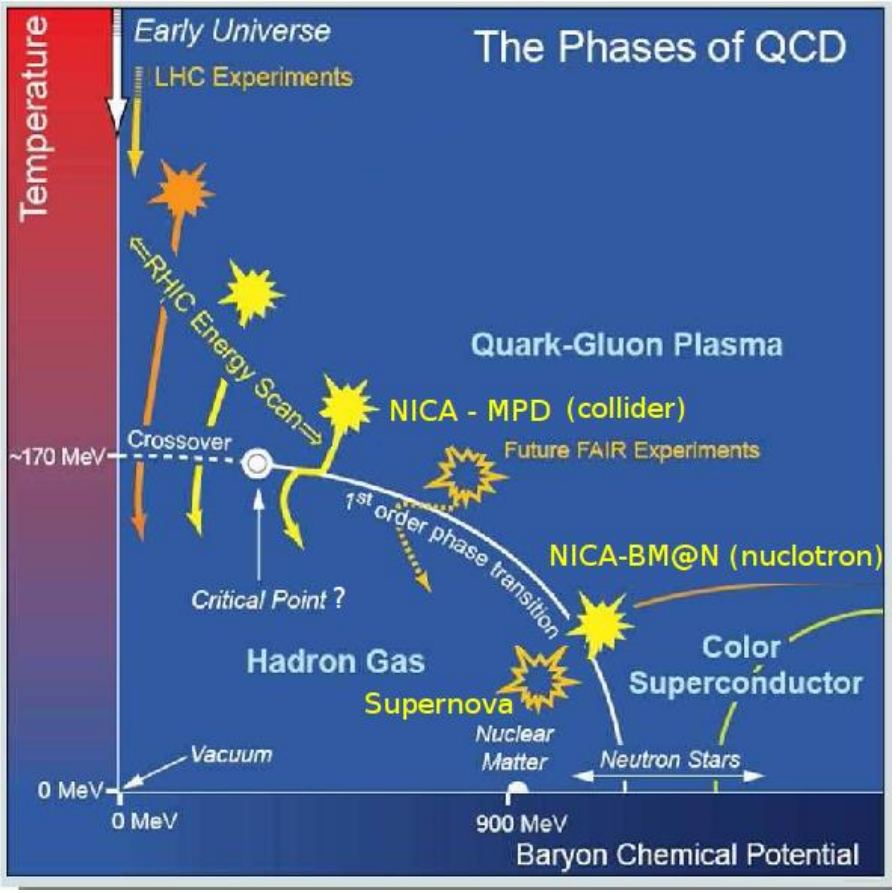


NICA has the most interesting energy diapason ($\sqrt{s_{NN}}$ ~ 10 GeV) corresponding to the region of the maximal density of baryonic or nuclear matter which nobody has had yet achieved in the laboratories. Main Goal - studying the critical phenomena and phase transitions happened to appear in the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

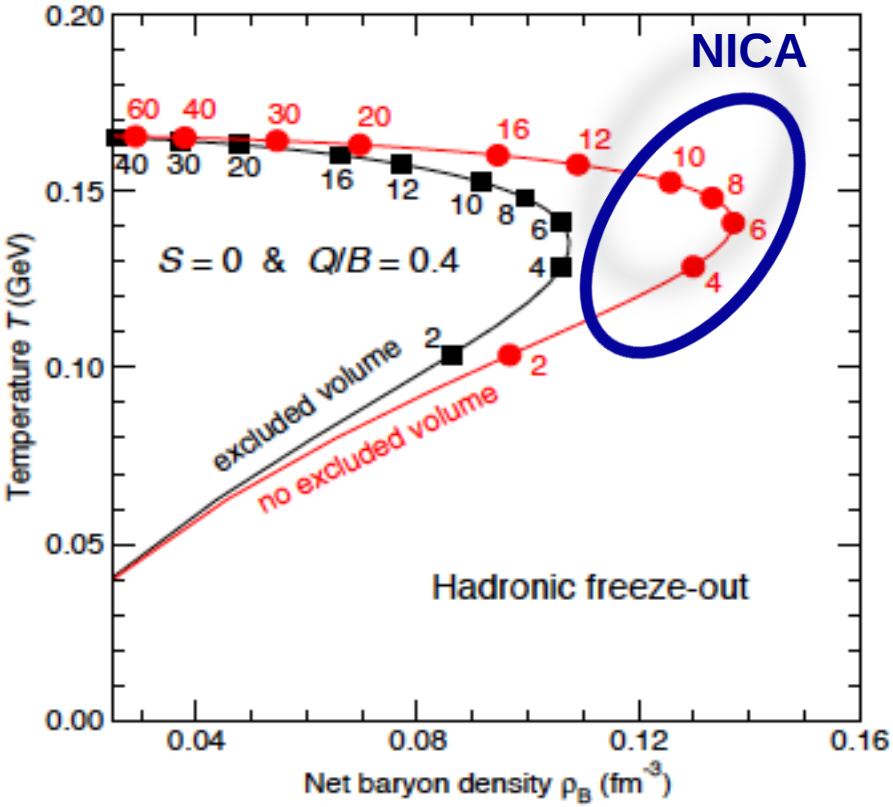
- ✓ **FAIR *(Darmstadt) – Fixed target experiments***
- ✓ **NICA *(ОИЯИ, Dubna)* – Collider experiments**

Exploration of the QCD PD – Density Frontier

Exploring high-density baryonic matter: maximum freeze-out density



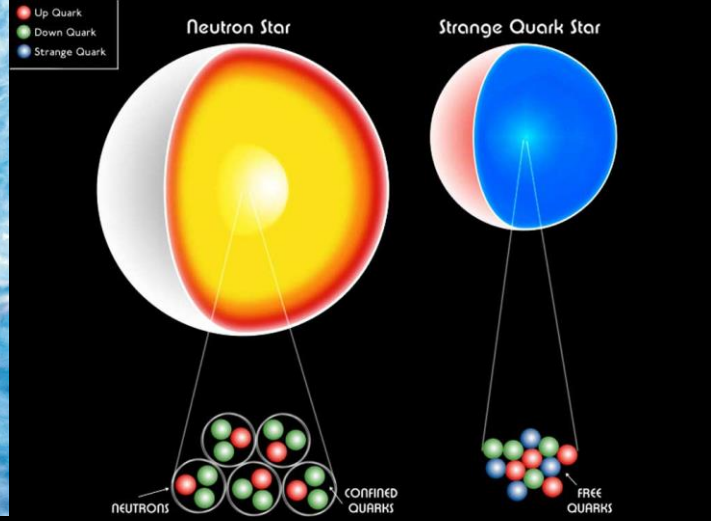
J. Randrup, J. Cleymans; White Paper



NICA is well suited for exploring the transition between the hadronic and q-g phases at the high net baryon density.

<u>This is the top priority of the NICA program</u>.

The Neutron Star



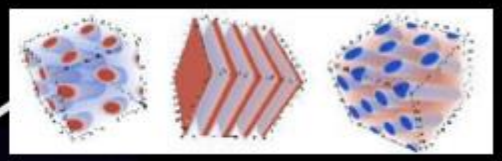
- **Highest density matter in the universe**

  $M = 1\sim2\ M_{\odot}$, $R \sim 10\sim20$ km

  ⇒ Density of the core = $3\sim10\rho_0$ (1～3 Btons/cm³)

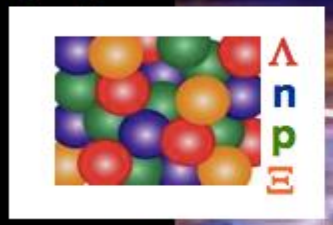
  ρ_0: nuclear density

- **Various forms of matter made of almost only quarks**



Nuclear "Pasta"

Nuclear + Neutron Matter



Neutron Matter

Superfluid

Strange Hadronic Matter ?

High density nuclear matter with hyperons (strange quarks)

Quark Matter ??

Deconfined quarks
Color superconductivity

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)

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)
…
…

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

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

CERN-JINR cooperation Agreement

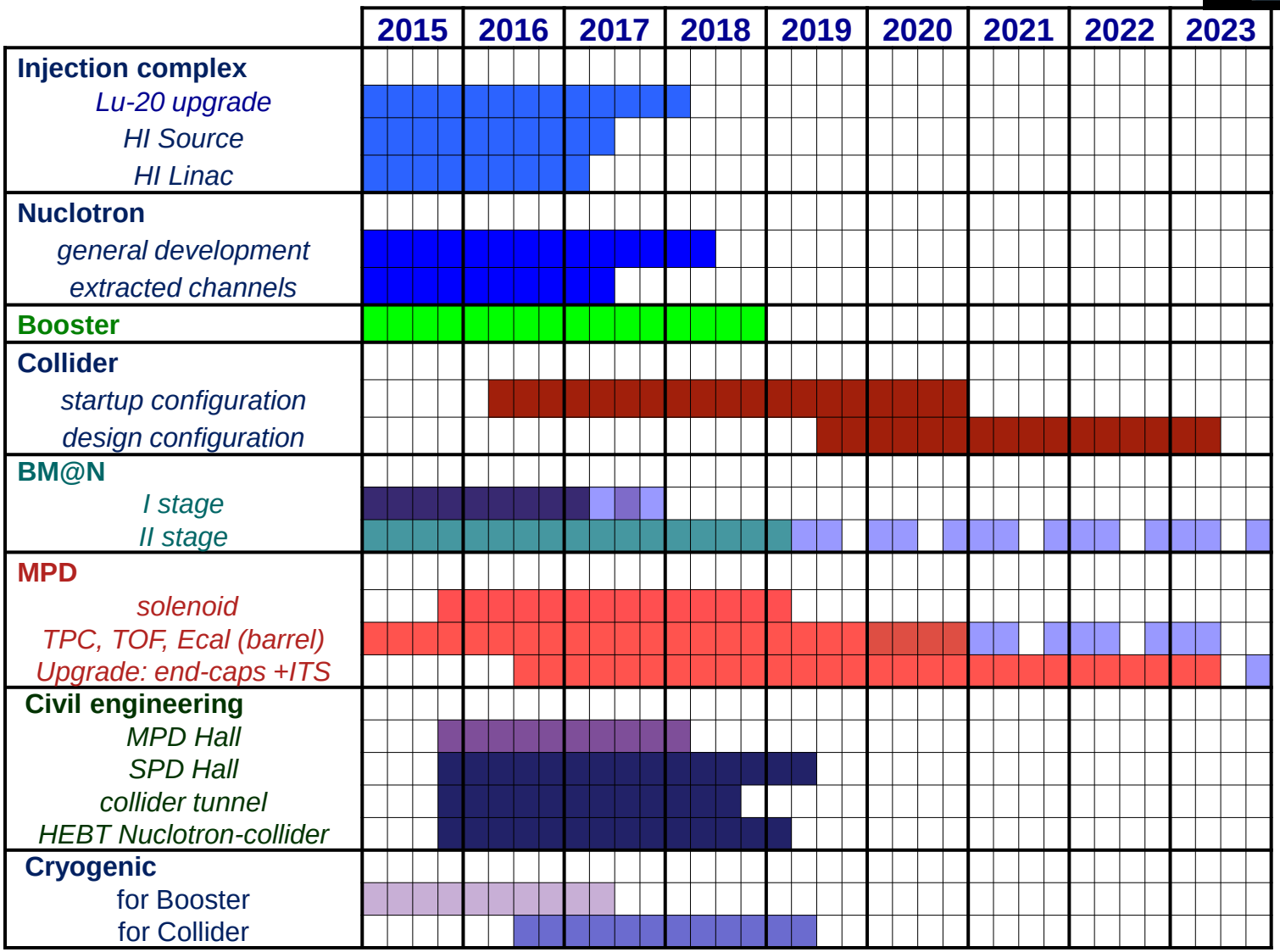
JINR–BMBF Agreement

JINR – INFN Agreement

Workshop in Dubna on Megaprojects - Russia, Italy, Germany, France, China, Egypt, South Africa Republic, others.

NICA – FAIR Agreement

NICA schedule



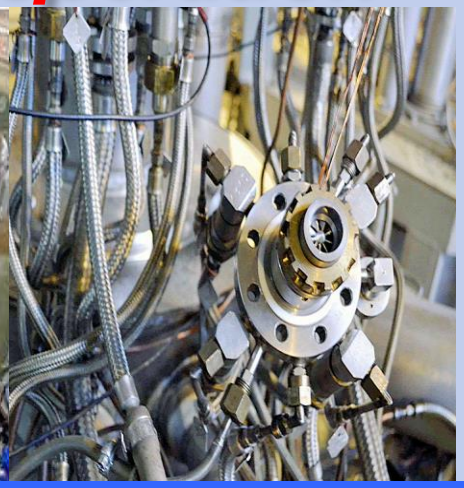
running time

SP magnets for NICA & FAIR

Serial fabrication of Booster magnets is going on

Procurement of magnet systems for NICA and FAIR is in progress

Cryogenic complex:
new He liquefier put in operation



Most powerful in Russia

MPD status

The MPD superconducting magnet progress in 2017

- SC cable – ordered, manufacturing is in progress
- Copper conductor for the trim coils – delivered to the supplier's site
- Aluminium support cylinder for SC coil – ready
- Winding machines for SC solenoid and trim coils – in operation
- Cryogenic He refrigerator – designed and ordered
- Magnet yoke – 80% ready

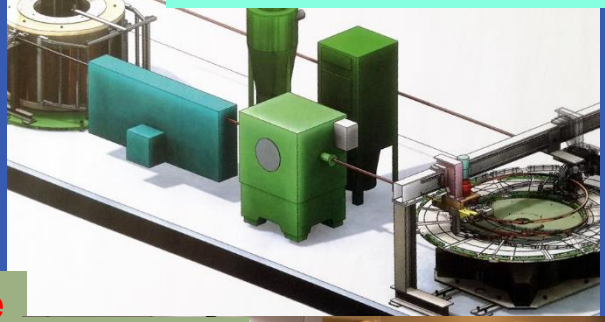
Transportation of aluminum support cylinder blanks for SC coil

Progress with subsystems

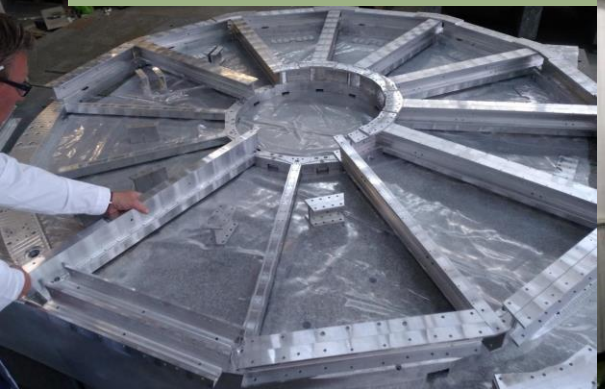
TPC Clean room (S=84 m^2 ISO-6)

A TOF module

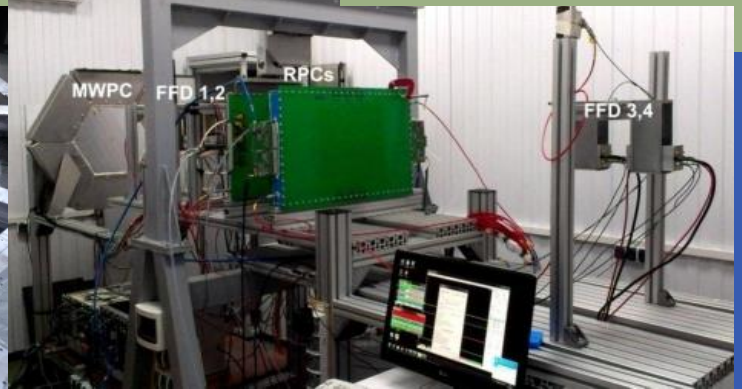
Winding machine for SC solenoid



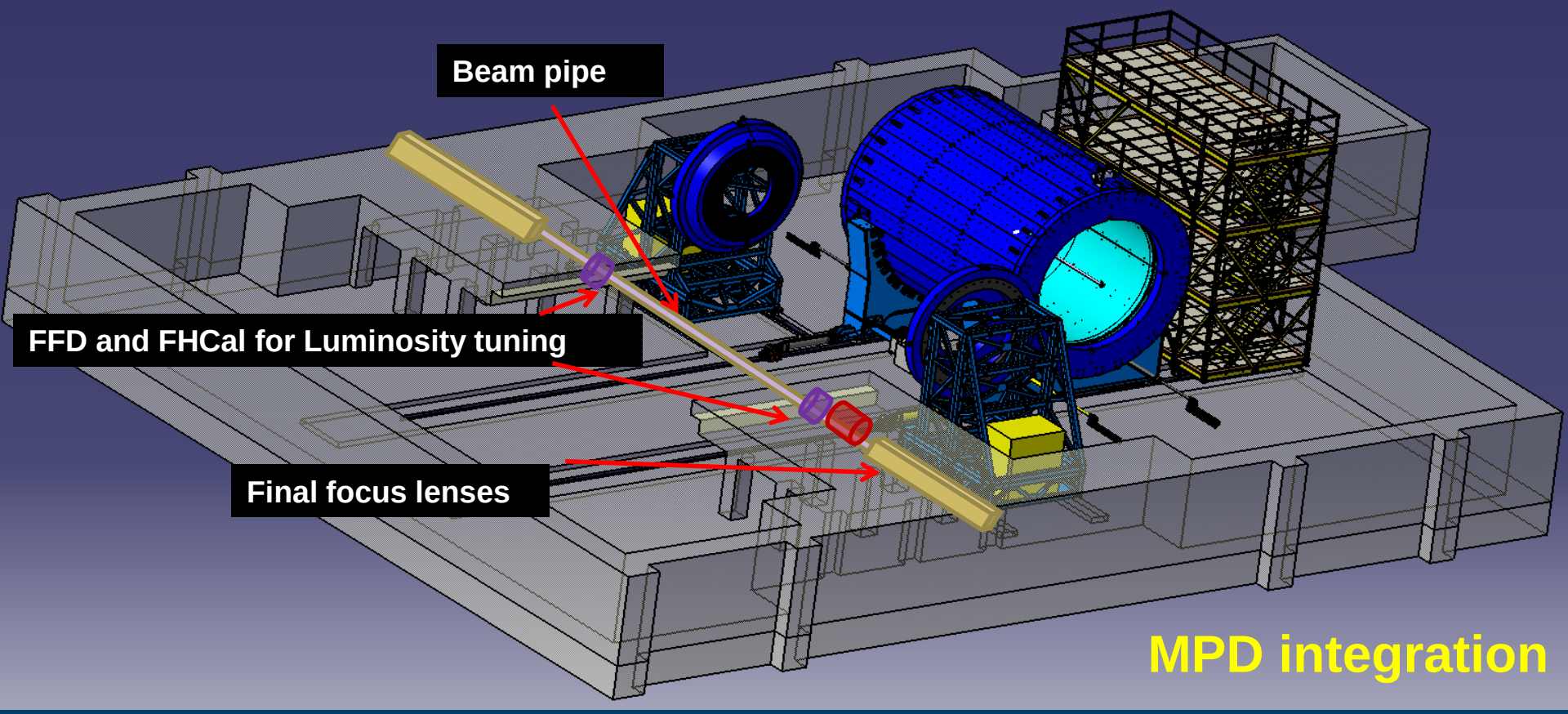
Service wheel of the TPC flange



Beam test of FFD module



IT clean room



MPD integration

Progress in 2017

- Mass-production of MPD elements is getting closer (TPC, TOF, FFD, FHCAL)
- TDR is ready for Stage'1 MPD elements, the evaluation by DAC is ongoing
- Magnet fabrication is progressing well, the yoke is ready for 80%,

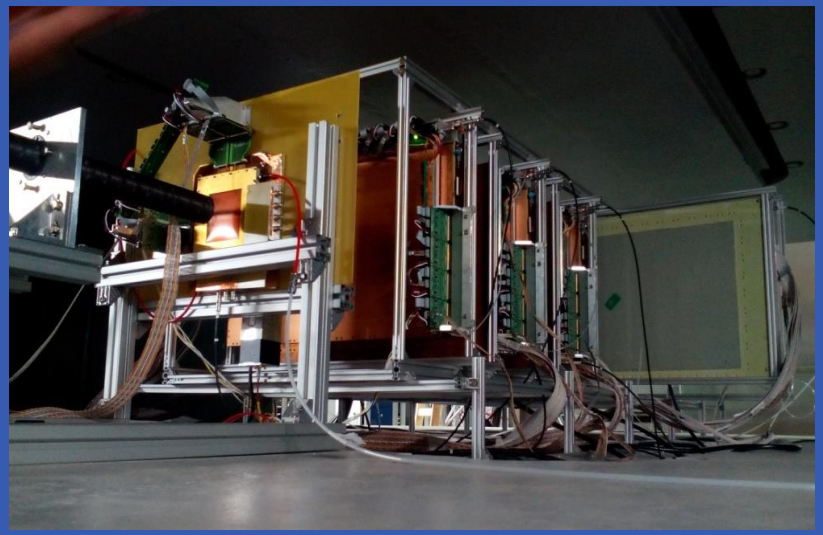
control assembling is planned for Oct. 2017.

- The MPD-NICA interface simulation has started
- The MPD Collaboration is growing: new groups from Mexico and Poland have joined it

BM@N - many new detector subsystems installed

D beam 2.94, 4.0, 4.6 GeV/n (52-53 runs)

5 GEM detectors 66 x 41cm^2 + 1 detector 163 x 45 cm^2

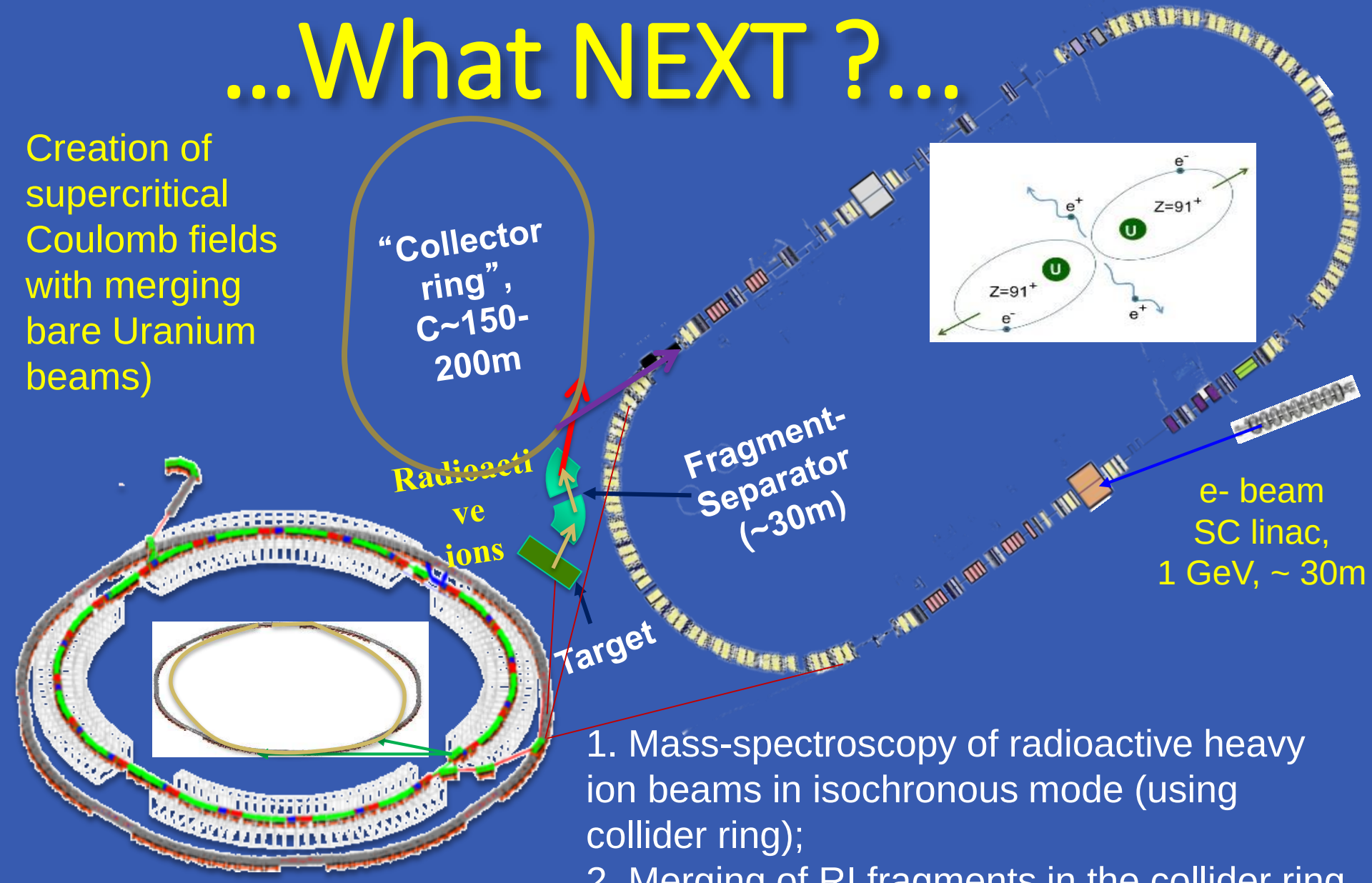


NICA Civil Construction

- September 2017
- > 4200 piles are already pressed in
- concrete works are in progress

…What NEXT ?…

Creation of supercritical Coulomb fields with merging bare Uranium beams)



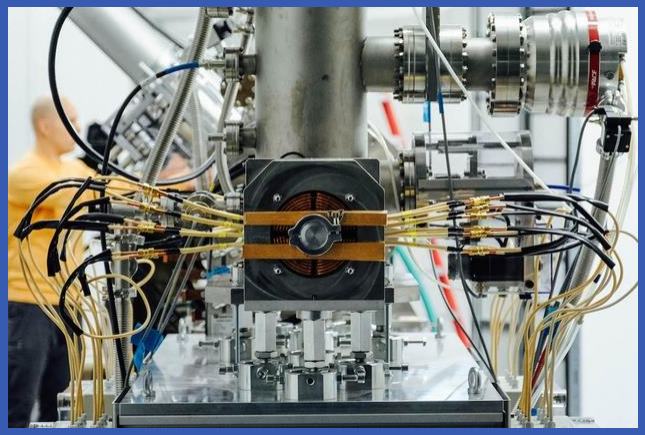
Merging $^{92+}U^{235}$ beams
E~ 0,6 GeV/u
~ 11 Tm ring

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

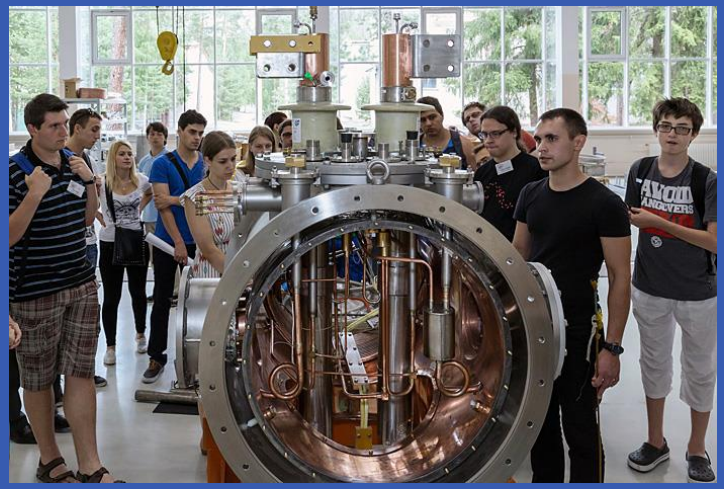
Innovative cluster:

- 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;



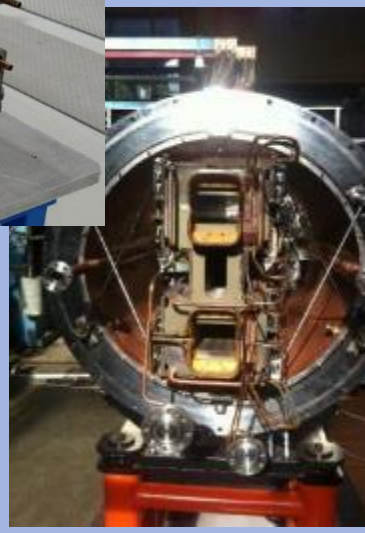
Education field:

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

High-temp Superconductivity

Ultra-high vacuum

Collider pre-serial dipoles



Collider quadrupole

Ultra-modern technologies

Magnetic measurements

Curved UHV chambers

Multipole SC magnets

JINR and
Low Energy Heavy Ion Physics :

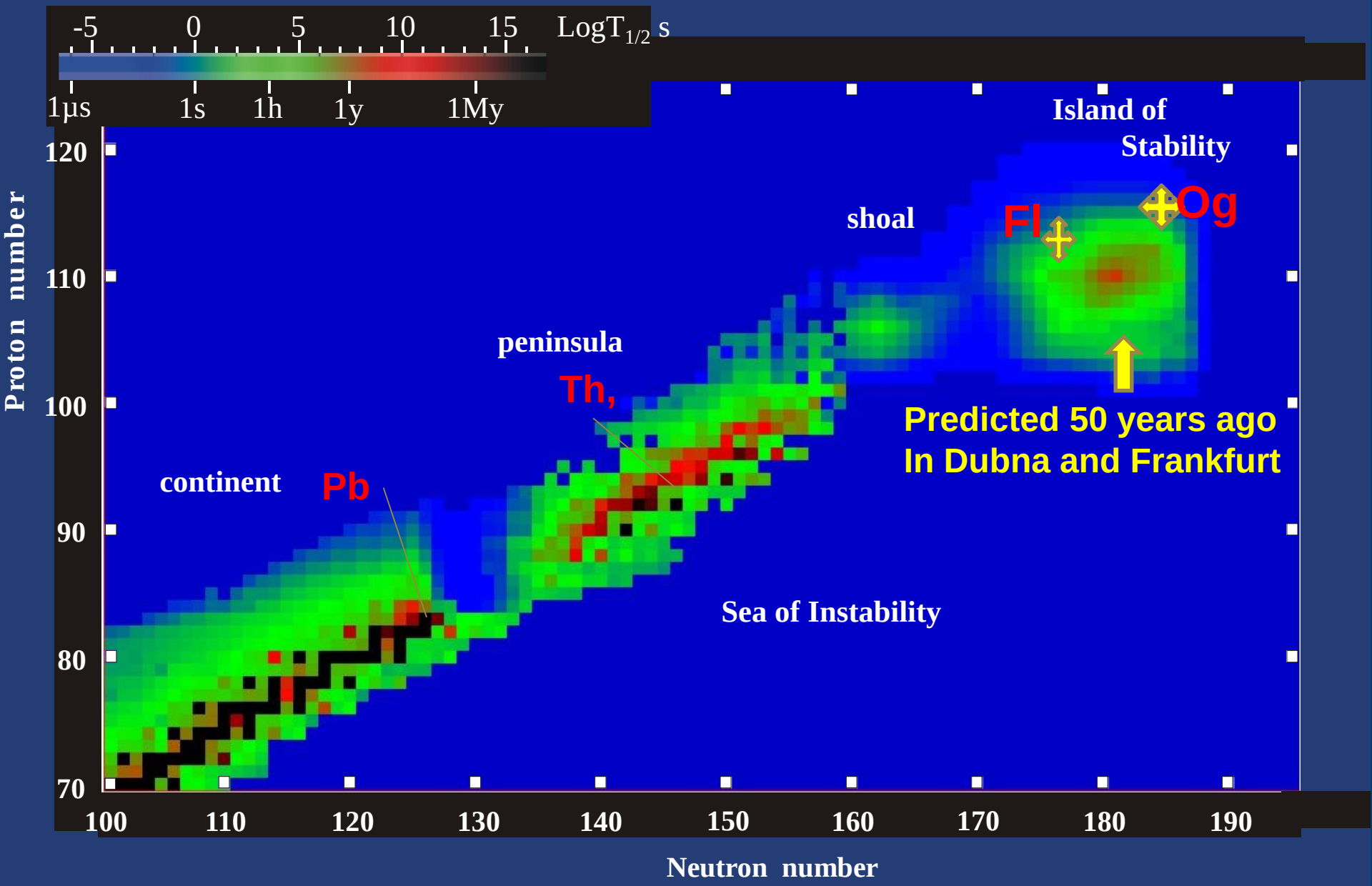
Physics of exotic nuclei
Super heavy nuclei
Critical Coulomb fields

$Z\alpha \sim 1$

Flerov Laboratory of Nuclear Reactions

Quest for the Island of Stability of the Super Heavy Elements Frontier

New lands Search for new Island of Stability



International Union of Pure and Applied Chemistry

May 2012:

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

30th December 2015:

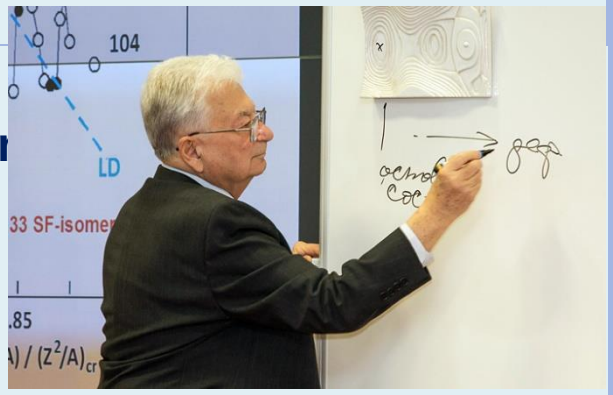
Approval of the discovery of new elements: *113,115,117,and 118*

- **element 113: RIKEN (Japan)**
- **elements *115* and *117*: JINR (Dubna) - LLNL (USA) – ORNL (USA) collaboration**
- **element *118:* JINR (Dubna) – LLNL collaboration.**

28th November 2016:

IUPAC approved names and symbols of new elemen

Nihonium (Nh) for element 113,
Moscovium (Mc) for element 115,
Tennessine (Ts) for element 117,
Oganesson (Og) for element 118.



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

All these elements were synthesized for the first time at the U-400 accelerator complex of the Flerov Laboratory of Nuclear Reactions of JINR.

Inauguration of elements 115 (Moscovium), 117 (Tennessine), 118 (Oganesson)

Prof. N. Tarasova
IUPAC

Dr. K. Reed
IUPAP

Prof. O. Vasilieva
Minister of S&E, Russia

Prof. L. Kostov
CPP of JINR Member States

Moscow
Central House of Scientists
of RAS
March 2, 2017

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

105
Db
Dubnium

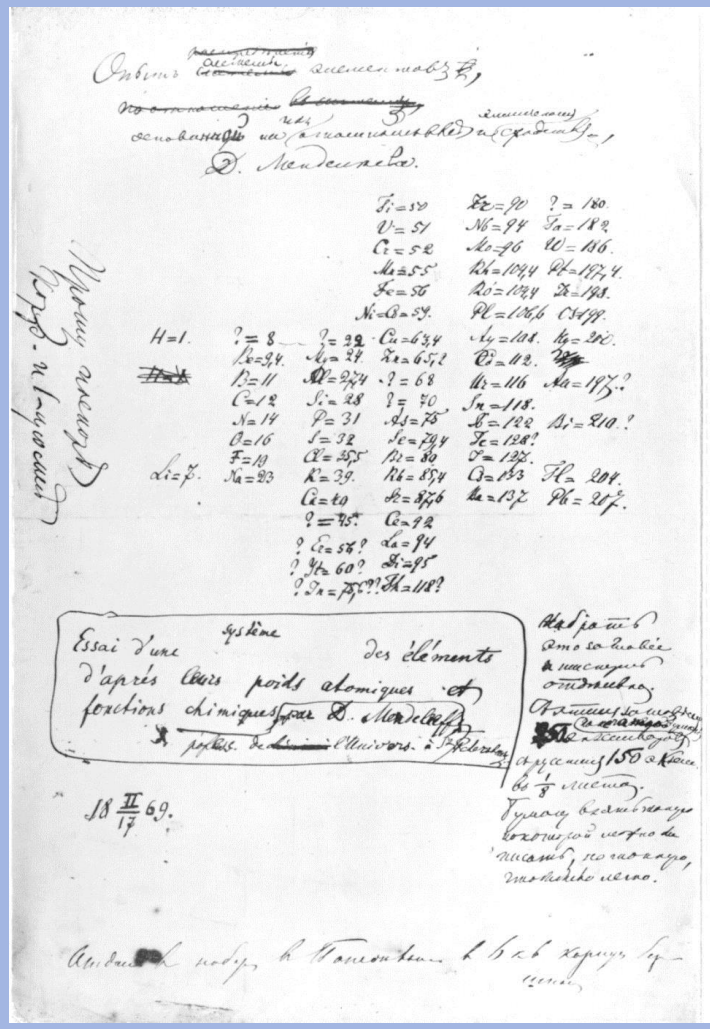
Бор 5 **B** 10,811 Boron	Углерод 6 **C** 12,011 Carbon	Азот 7 **N** 14,0067 Nitrogen	Кислород 8 **O** 15,9994 Oxygen	Фтор 9 **F** 18,9984 Fluorine	Неон 10 **Ne** 20,1797 Neon	
Алюминий 13 **Al** 26,981539 Aluminum	Кремний 14 **Si** 28,0855 Silicon	Фосфор 15 **P** 30,97376 Phosphorus	Сера 16 **S** 32,066 Sulfur	Хлор 17 **Cl** 35,4527 Chlorine	Аргон 18 **Ar** 39,948 Argon	
Никель 28 **Ni** 58,6934 Nickel	Медь 29 **Cu** 63,546 Copper	Цинк 30 **Zn** 65,39 Zinc	Галлий 31 **Ga** 69,723 Gallium	Германий 32 **Ge** 72,61 Germanium	Мышьяк 33 **As** 74,92159 Arsenic	Селен 34 **Se** 78,96 Selenium	Бром 35 **Br** 79,904 Bromine	Криптон 36 **Kr** 83,80 Krypton
Палладий 46 **Pd** 106,42 Palladium	Серебро 47 **Ag** 107,8682 Silver	Кадмий 48 **Cd** 112,411 Cadmium	Индий 49 **In** 114,818 Indium	Олово 50 **Sn** 118,710 Tin	Сурьма 51 **Sb** 121,757 Antimony	Теллур 52 **Te** 127,60 Tellurium	Иод 53 **I** 126,90447 Iodine	Ксенон 54 **Xe** 131,29 Xenon
Платина 78 **Pt** 195,08 Platinum	Золото 79 **Au** 196,96654 Gold	Ртуть 80 **Hg** 200,59 Mercury	Таллий 81 **Tl** 204,3833 Thallium	Свинец 82 **Pb** 207,2 Lead	Висмут 83 **Bi** 208,98037	Полоний 84 **Po** [209]	Астат 85 **At** [210]	Радон 8 **Rn** [222]
Дармштадтий 110 **Ds** [269] Darmstadtium	Рентгений 111 **Rg** [272] Roentgenium	Коперниций 112 **Cn** [277] Copernicium	(Нихоний) 113 **(Nh)** [286] (Nihonium)					

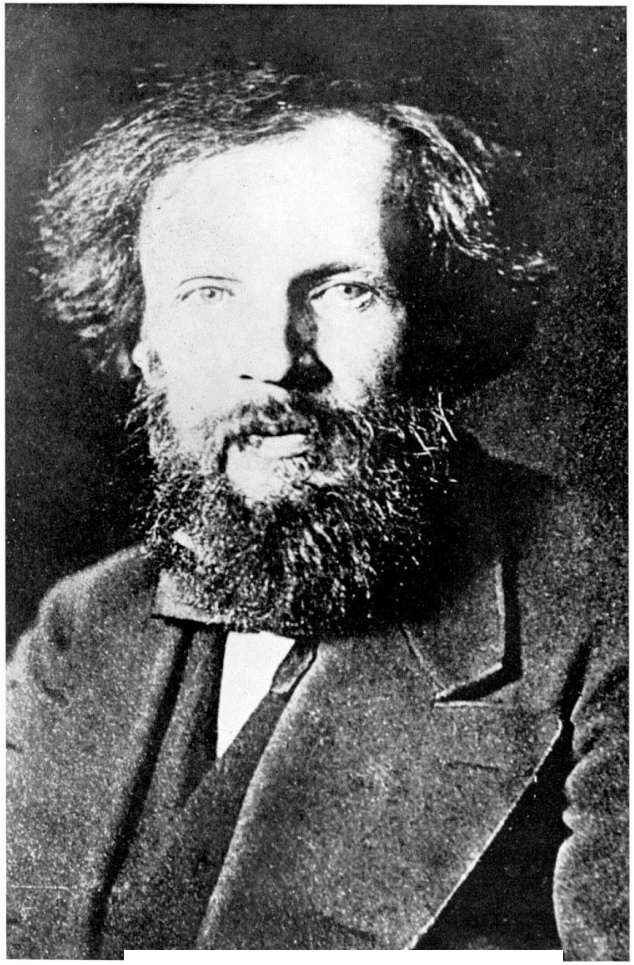
Flerovium 114 **Fl** Флеровий	(Moscovium) 115 **(Mc)** (Московий)	Livermorium 116 **Lv** Ливерморий	(Tennessine) 117 **(Ts)** (Теннессин)	(Oganesson) 118 **(Og)** (Оганесон)

Mendeleev’s Table Today

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

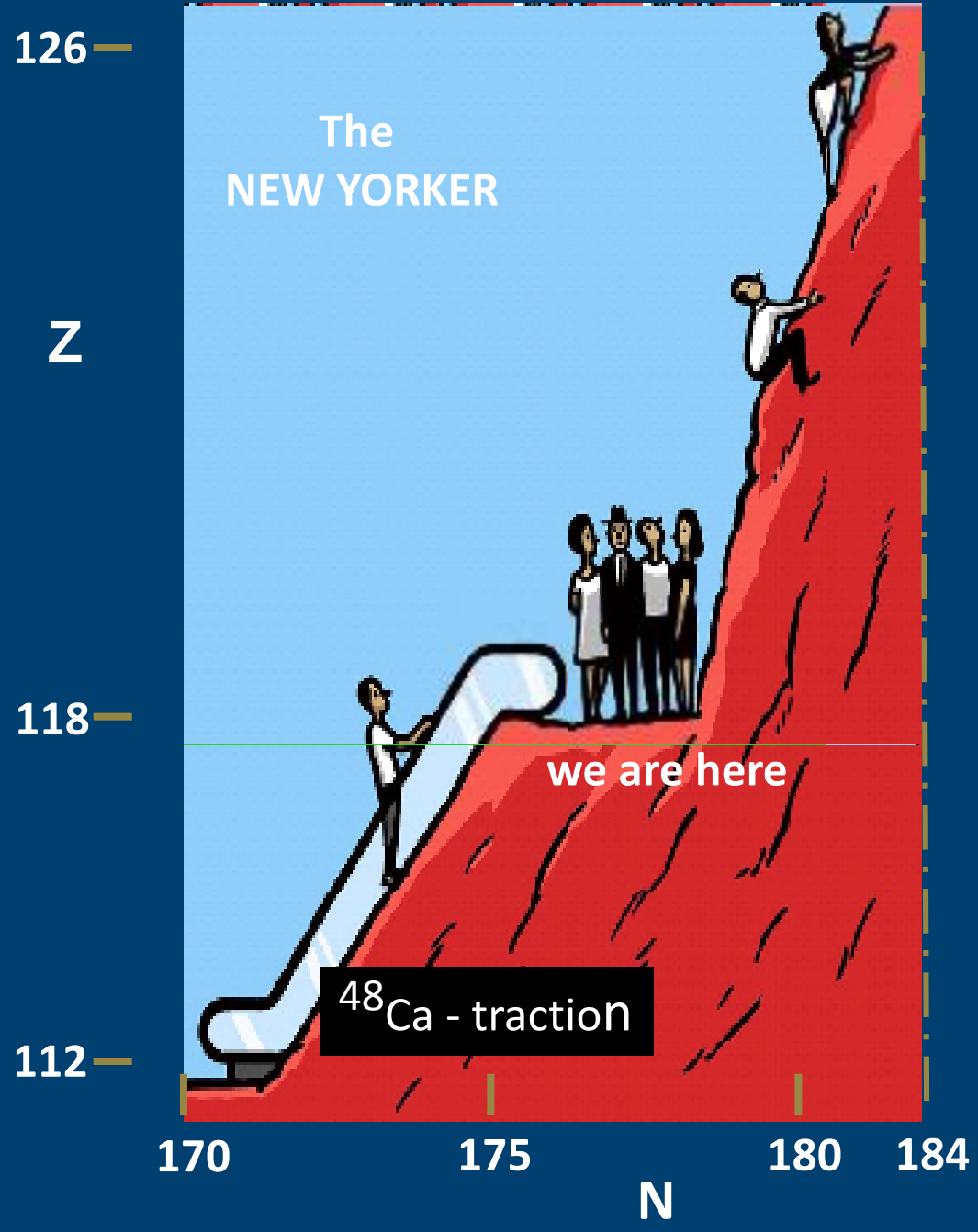
Physics of SHE – is the triumph of Mendeleev Periodic Law connecting the chemical properties of elements with their atomic numbers



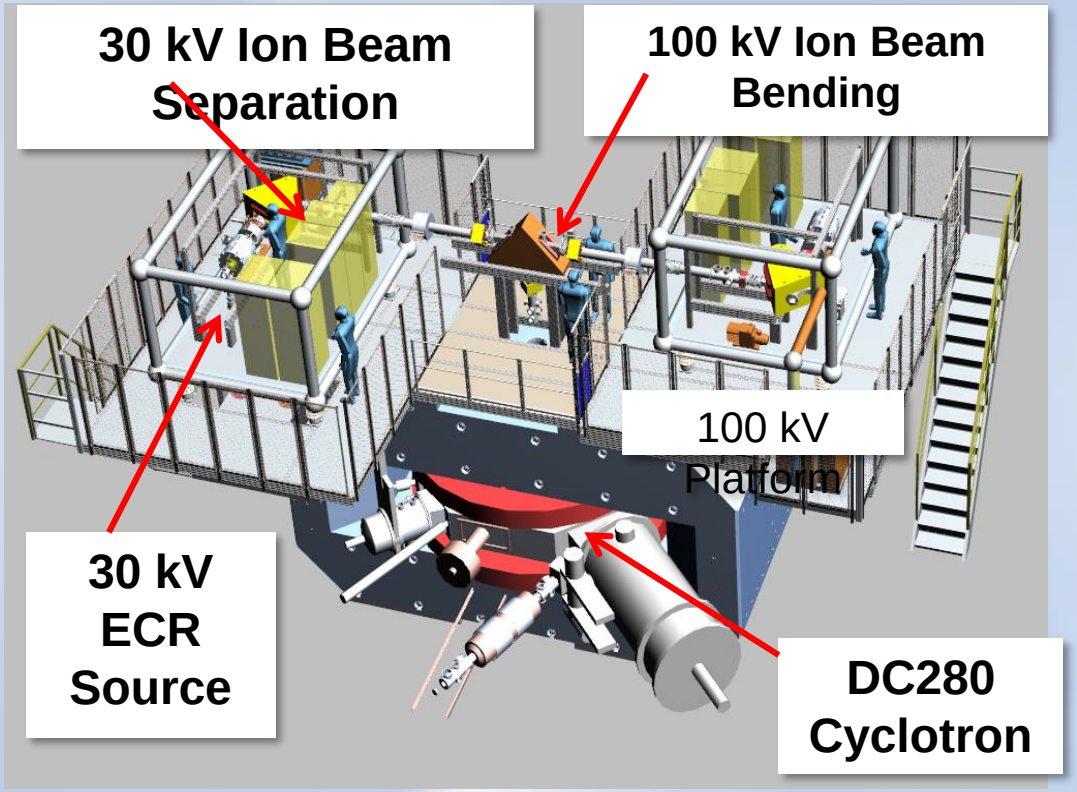


1834 - 1907

Yu. Oganessian. "Nuclear at the Mass Limit, Discovery of SHN " Seminar on NP of INPh April 4, 2017, MSU, Moscow



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.

SuperHeavy Elements Factory (SHEF)

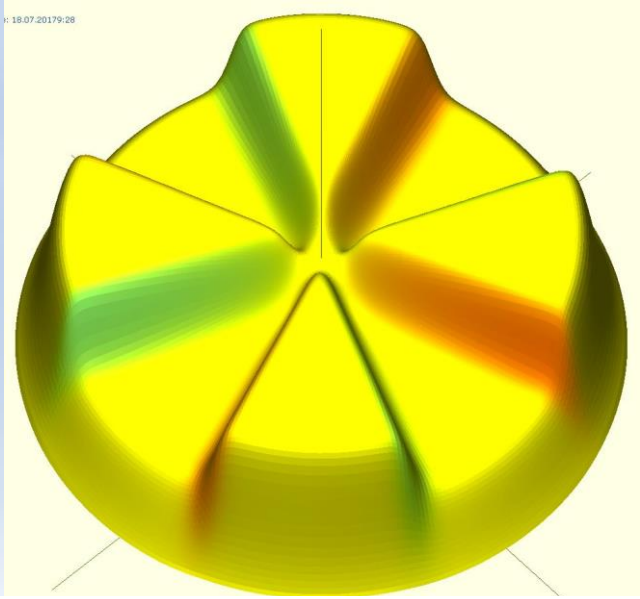
included into the NuPECC Long-Range Plan

Magnetic field measurements

Purpose:
Mapping of the magnetic field distribution at different regimes

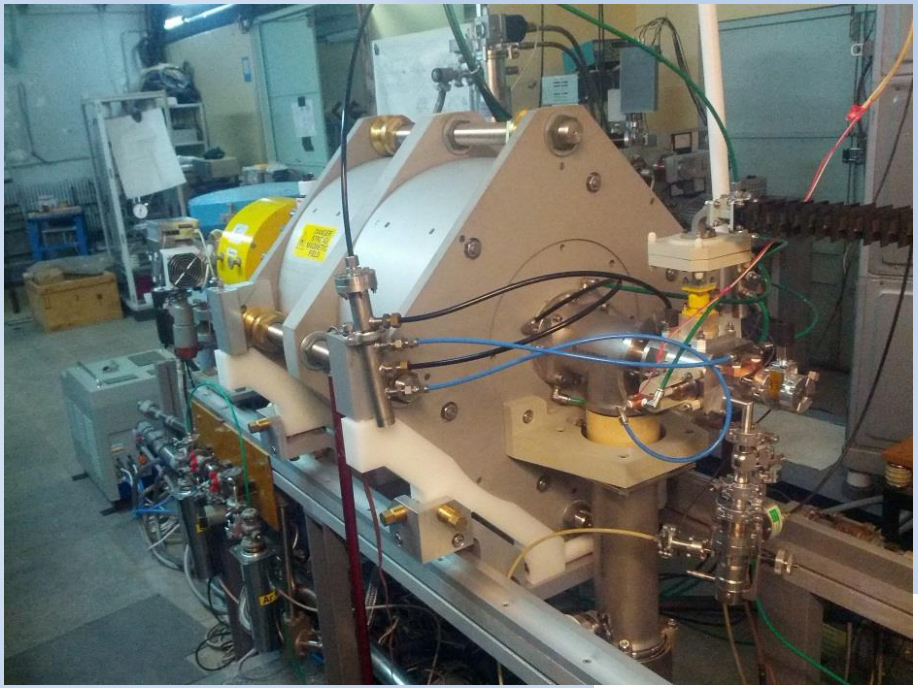
Started: end of June 2017

Duration: 2-3 months

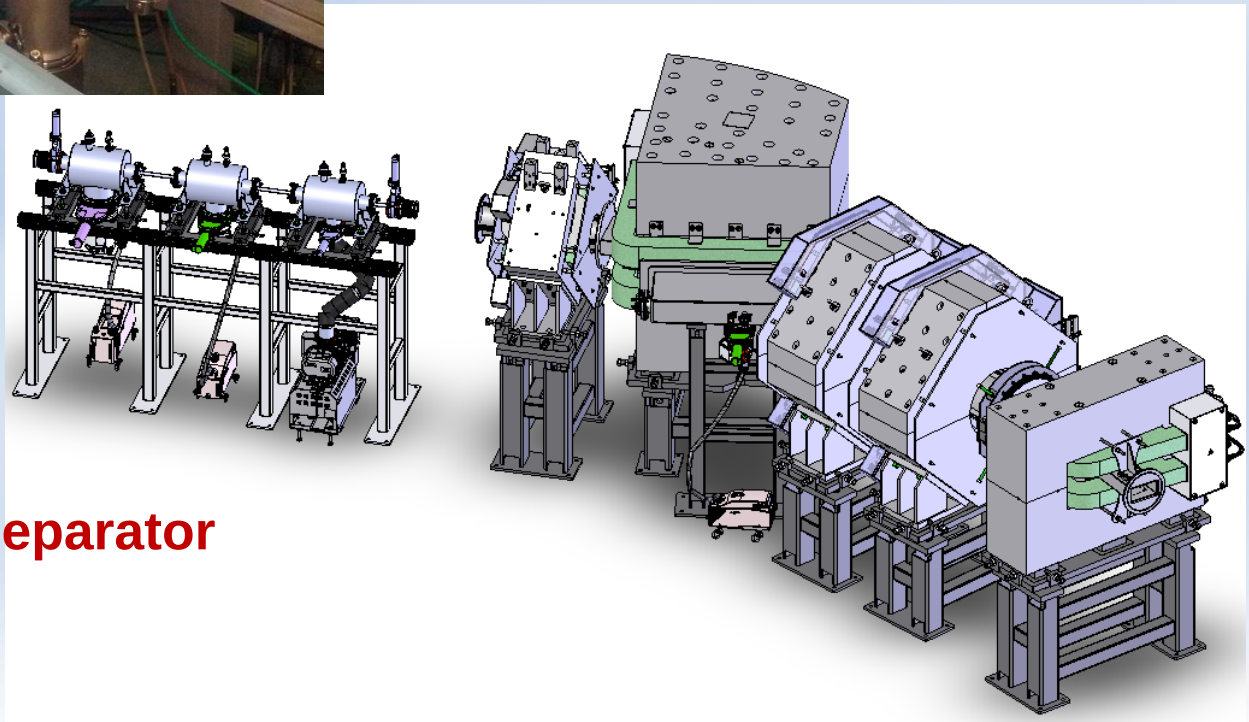


Example of the measured magnetic field

SuperHeavy Elements Factory (SHEF)

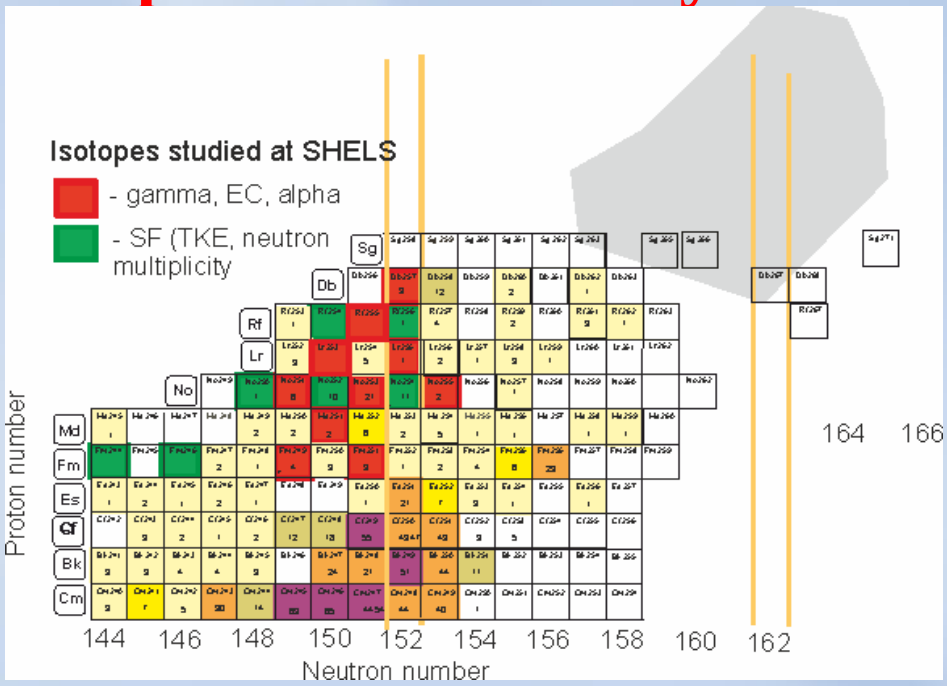


ECR ion-source of the SHE Factory



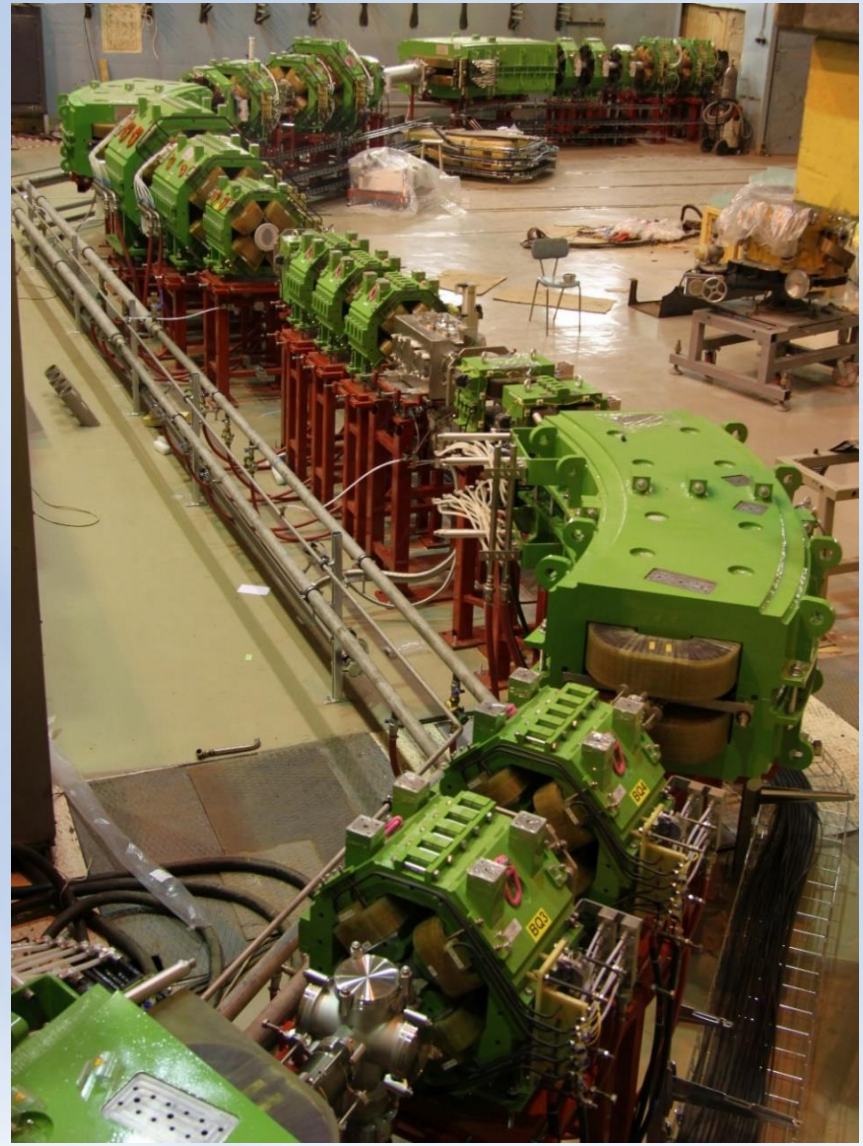
New gas-filled separator

Separator for Heavy ELement Spectroscopy (SHELS)



Fragment separator ACCULINNA-2: future basic facility for light radioactive nuclei research

- **First RIBs are obtained at ACCULINNA-2 in March 2017.**
- **Designed parameters (counting rate, purity, beam sport geometry) are confirmed.**
- **RI Beam intensities are on average 20 times larger than on existing ACCULINNA-1 setup and comparable with beams provided by leading centers.**
- **Setup is ready for the 1st experiment (planned for November 2017).**



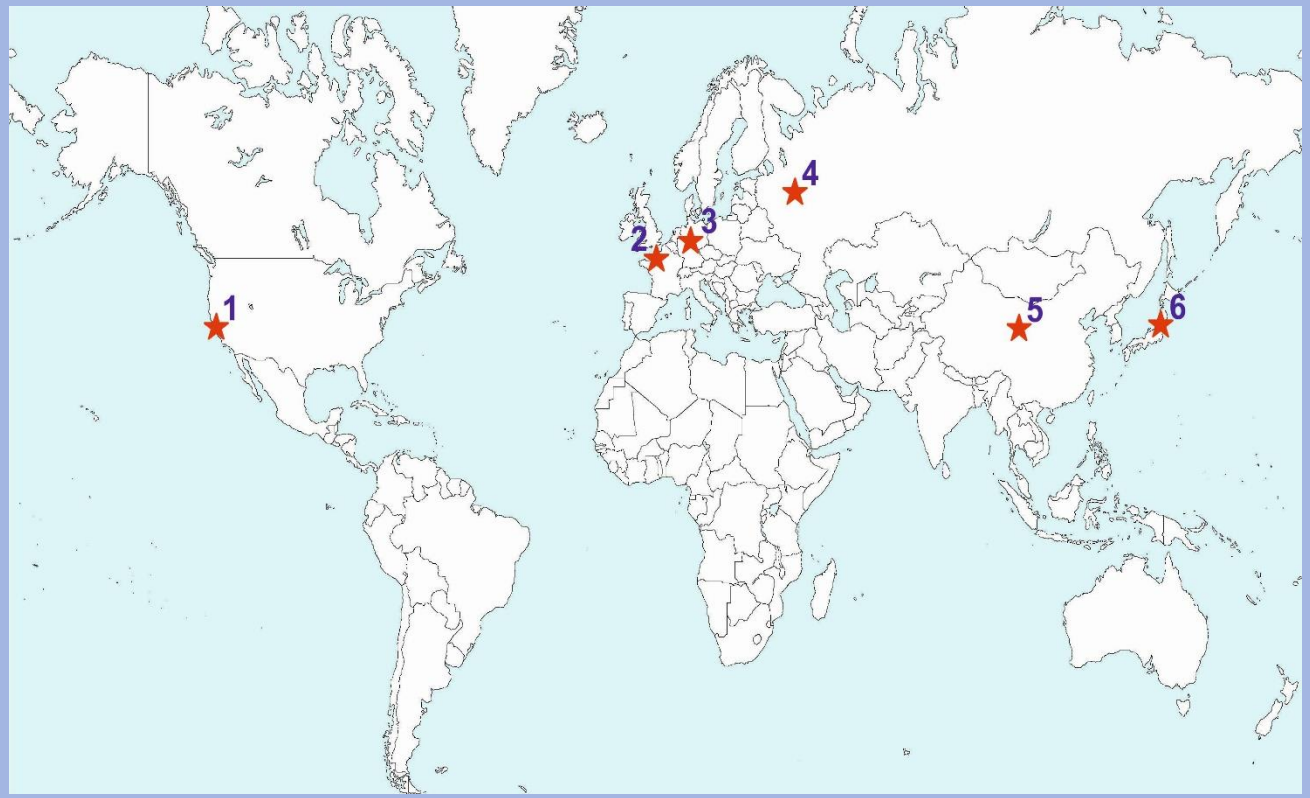
included into the NuPECC Long-Range Plan

DRIBS-III ACCELERATOR COMPLEX

Flerov Laboratory of Nuclear Reactions basic directions of research:

- Heavy and superheavy nuclei
- Light exotic nuclei
- Radiation effects and physical groundwork of nanotechnology
- Accelerator technologies

Study of heavy and superheavy elements in the world



1 Berkeley National Laboratory, USA

2 GANIL, Caen, France

3 Helmholtz Centre GSI, Darmstadt, Germany

4 JINR, Dubna, Russia

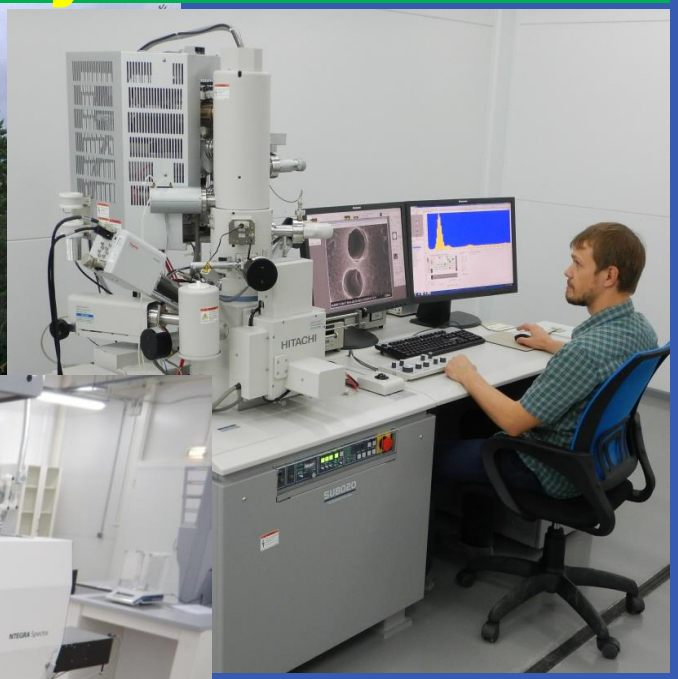
5 IMP, Lanzhou, China

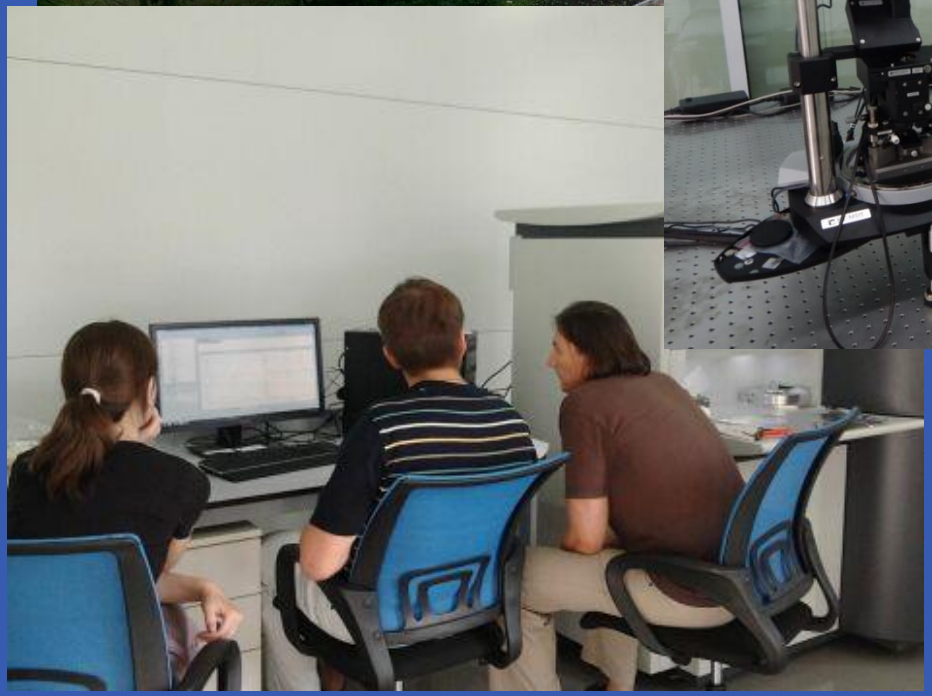
6 RIKEN, Wako, Japan

Advantages of JINR:

- wide range of accelerated ions;
- availability of actinide isotopes for targets;
- broad international cooperation (JINR member states; Livermore & Oak Ridge National Laboratories, Vanderbilt University, University of Tennessee, USA; Paul Scherer Institute, Switzerland, Universite Louis Pasteur, Universite Paris Sud, GANIL, France*)*;
- longstanding traditions and a scientific school;
- full-time availability of an accelerator complex – SHE-Factory.

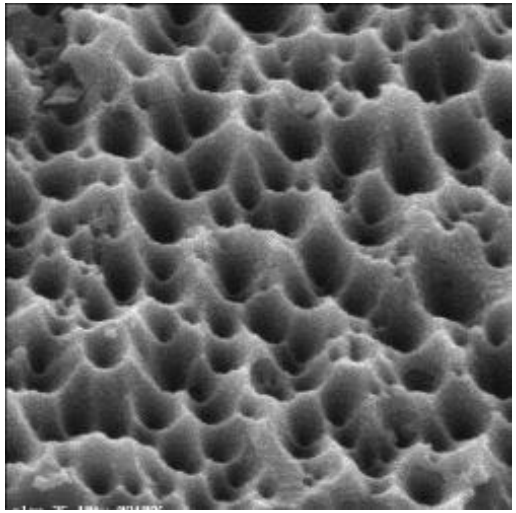
Nano Laboratory

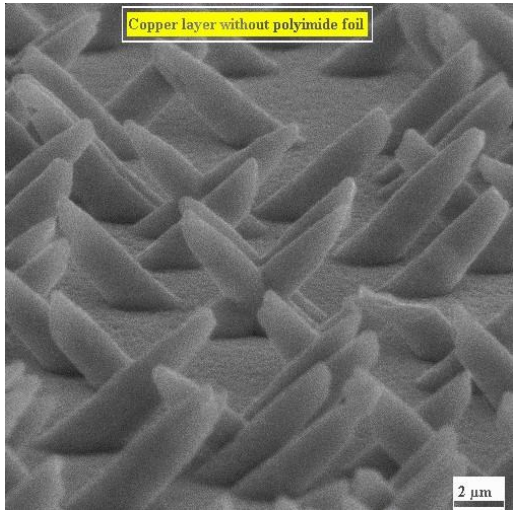




- Scanning electron microscopes
- Atomic force microscopy
- X-Ray photoelectron spectroscopy
- Equipment for sample preparation
-

Heavy-Ion-born nanostructures



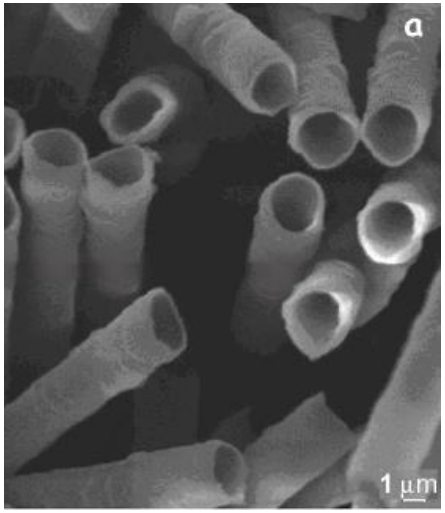


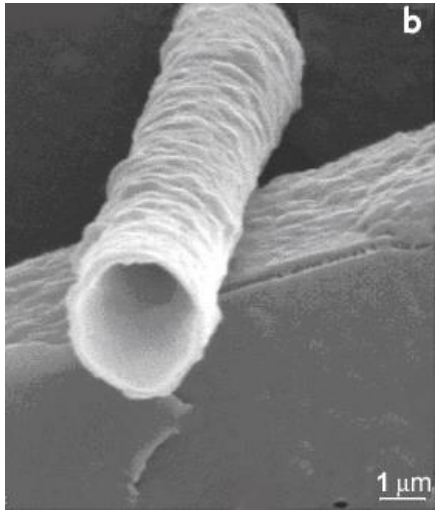
new composite materials:

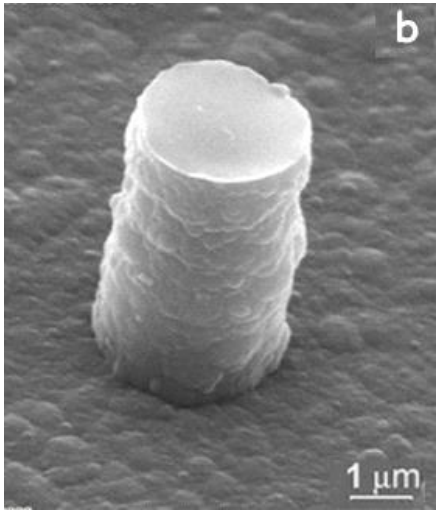
- **extended layers adhesion strength**
- **increased thermal resistance**
- **flexible printed circuit boards**

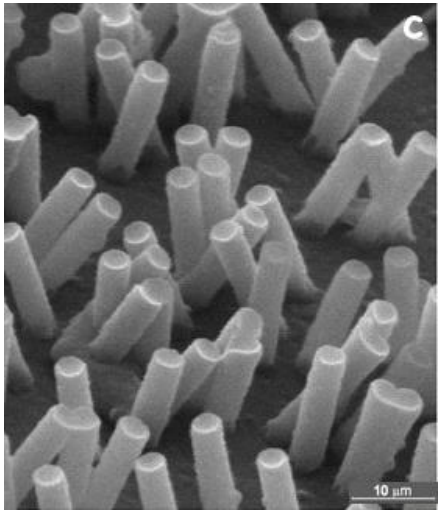
Polymer composites produced with the use of track membranes

nanotubes **nanowires**





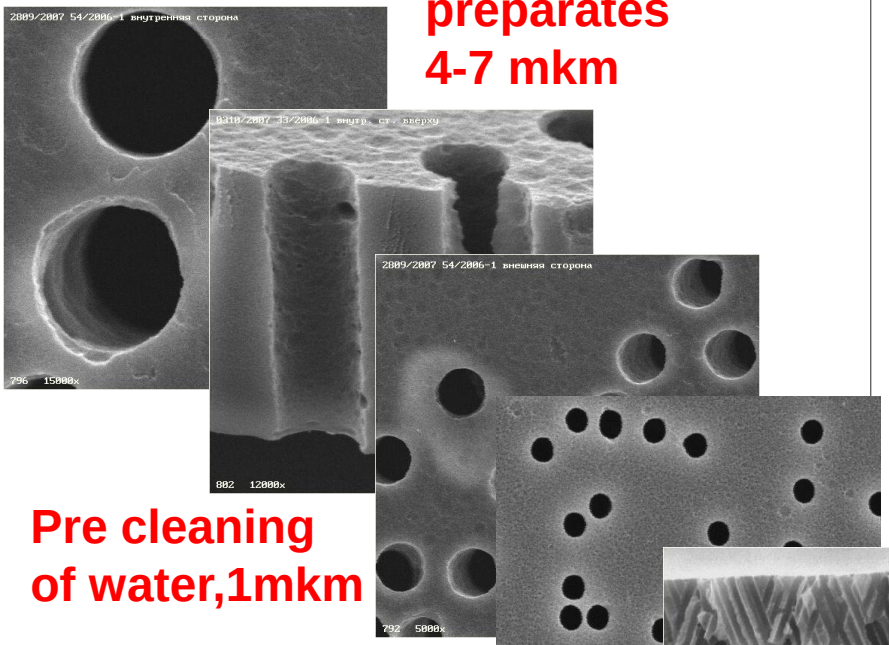




Production of track membranes (IC-100)

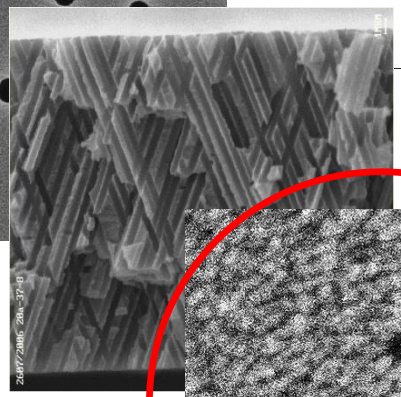
Micrometers

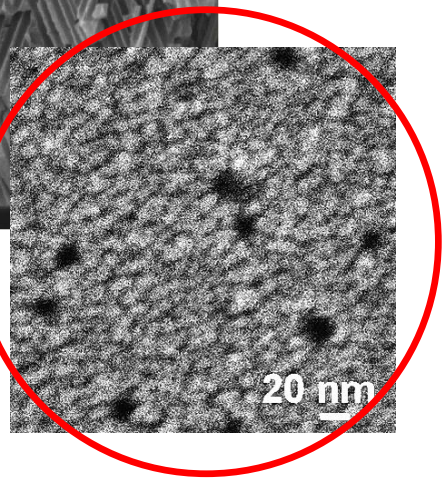
Cleaning pharm preparates 4-7 mkm



Pre cleaning of water,1mkm

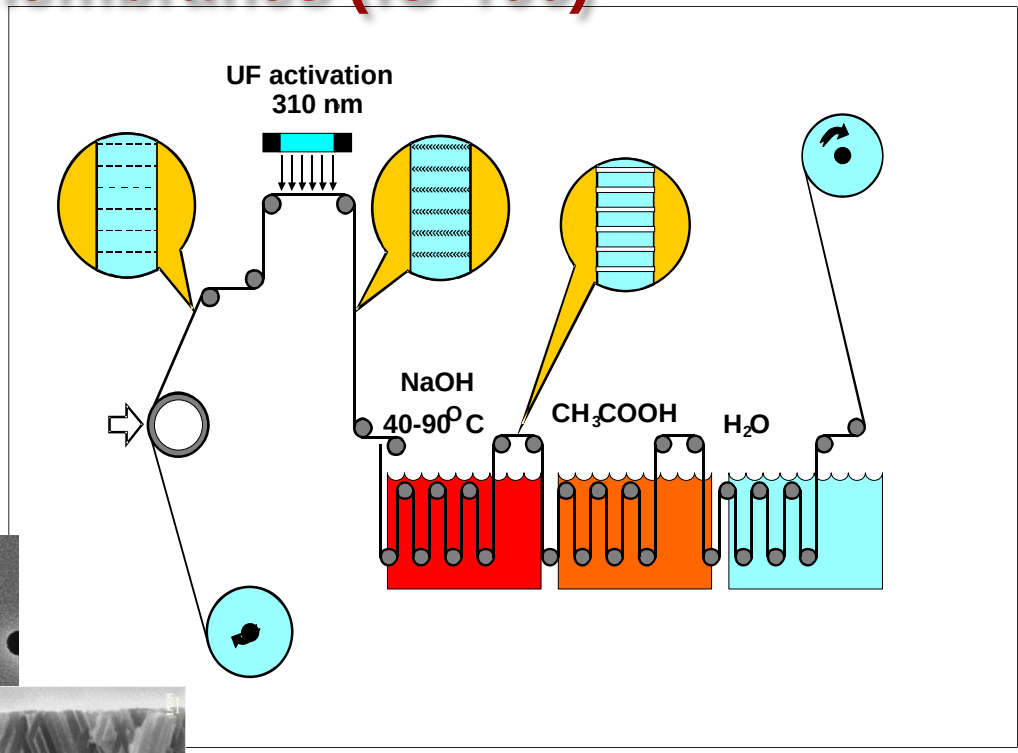
Plasmaferez Water cleaning, 0.4 mkm





Molecular sensors < 20 nm

Nanometers



JINR Neutrino Program

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

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

NuLab @ Kalinin APS

Nu- sources:
Solar
Reactor
Accelerator
Astrophysical
Atmospheric
Geophysical

GVD at Baikal : 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

Neutrino experiments at Kalinin APS

(Tveri region, 285 km from Dubna)

Pressurised water reactor;
Termal power 3 100 MW;
Neutrino flux ~ 6 10^{20} ν_e

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

JINR

Dzhelepov Laboratory for Nuclear Problems

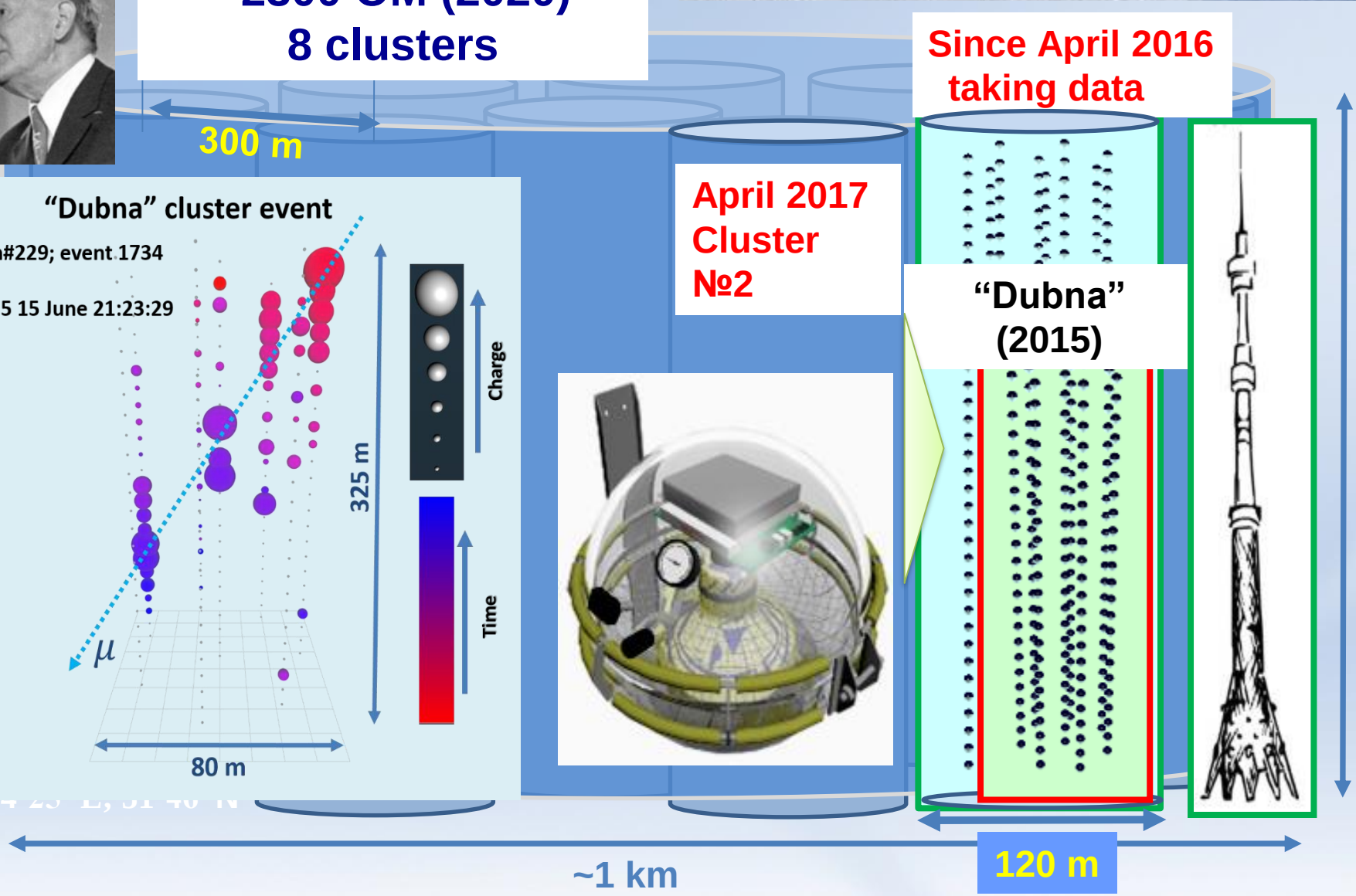
INR of RAS

Institute for Nuclear Research of the Russian Academy of Sciences

M.A.Markov

BAIKAL - GVD project

~2300 OM (2020)
8 clusters



GVD-1 Project time line

2009-2010: R&D with single prototype strings

2011-2014: R&D with prototype cluster of 3 to 5 strings

2015: *„DUBNA“* Demonstration cluster *started to work*

BAIKAL-GVD-1

2304 light sensors combined in 8 clusters of vertical strings at 750 – 1300 m depths.

Detection volume 0.4km^3

Objectives:

- Neutrino astrophysics above few TeV
- Dark matter – indirect search
- Exotic particles – monopoles, Q-balls, nuclearites, …

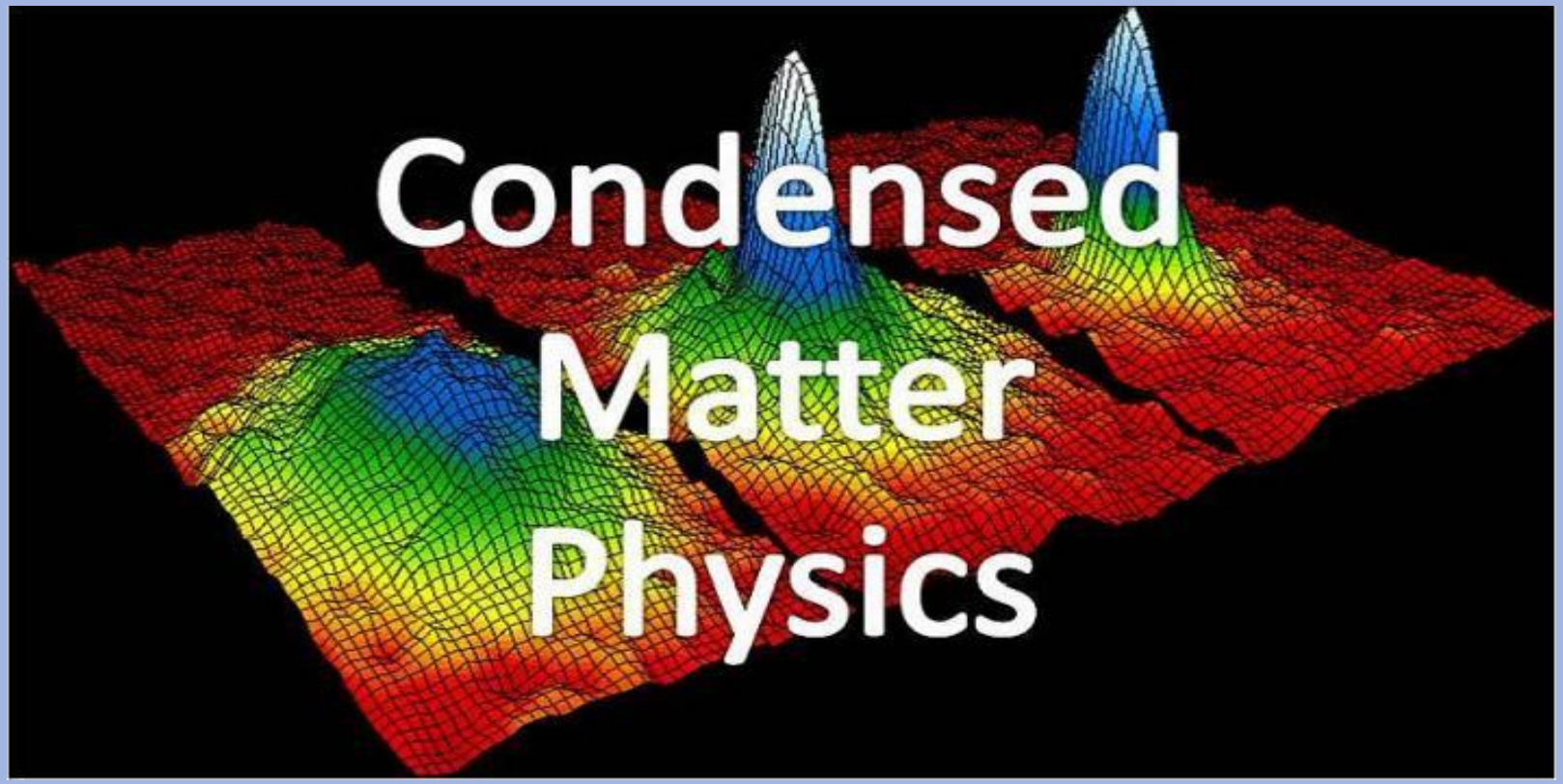
Cumulative number of full clusters and OMs

Year	2016	2017	2018	2019	2020
Cluster-288 OM	*1* *288*	*2* *576*	*4* *1152*	*6* *1728*	*8* *2304*

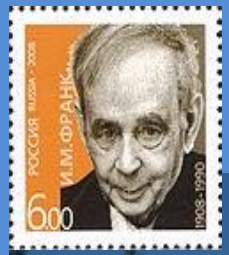
Permanent data taking

Effective volume GVD-1 (cascades) ~ 0.4 km^3

1957 – for the first time the hypothesis of neutrino oscillations has been issued at JINR in Dubna by the prominent physicist Bruno Pontecorvo



Neutron scattering & Nuclear Structure
Life Science Problems
Radiobiology & Astrobiology
Nuclear Ecology & Cosmic Medicine



Neutron Physics at JINR

One of the best sources in the world for thermal neutrons !

IBR-2 is included in the 20-year European strategic research program in the field of neutron scattering

mean power ***2 MW***

pulse frequency ***5 Hz***

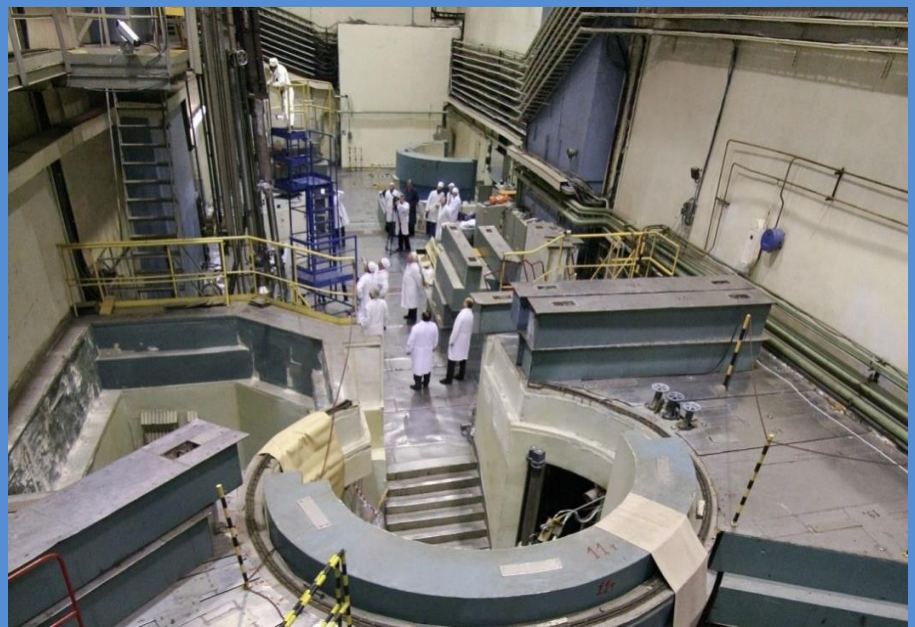
pulse width for fast neutrons

200 μs

thermal neutrons flux density on the moderator surface:

10^{13} n/cm^2 /s

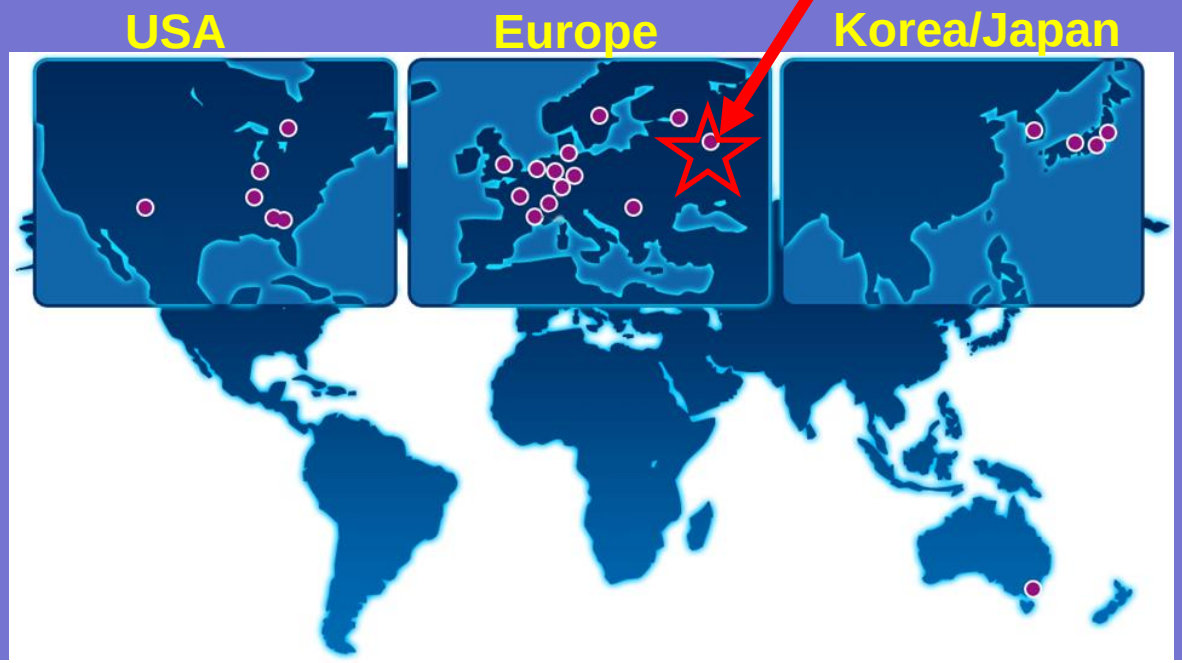
maximum in pulse: ***10^{16} n/cm^2 /s***



World trends in neutron scattering

- Studies of real time processes in condensed matter;
- Studies of condensed matter under extreme conditions (ultrahigh pressures);
- Magnetic excitations in strongly correlated electronic systems;
- Neutron imaging of cultural heritage objects.

23 world neutron research centres

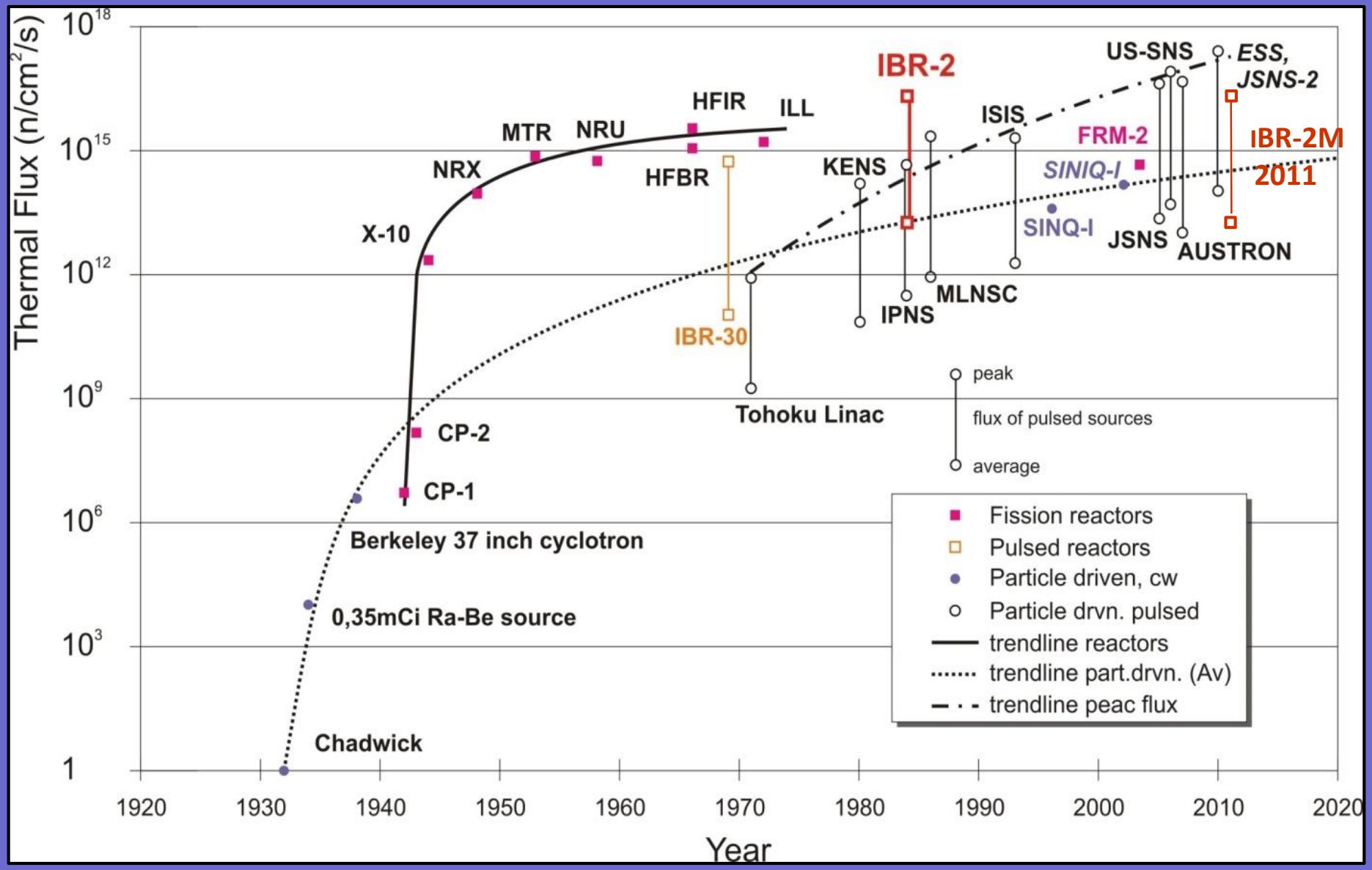


JINR

IBR-2 is included in the 20-year European strategic research program in the field of neutron scattering

Scientific research at the spectrometers of the JINR's IBR-2 reactor follows most of the modern trends and keeps up with the world competition

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

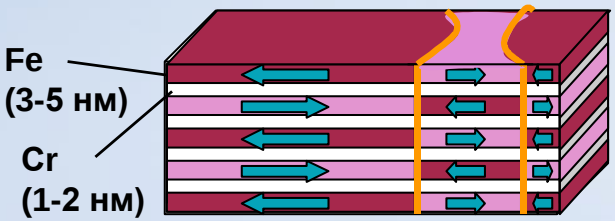


Frank LNP Large-Scale Basic Facilities

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

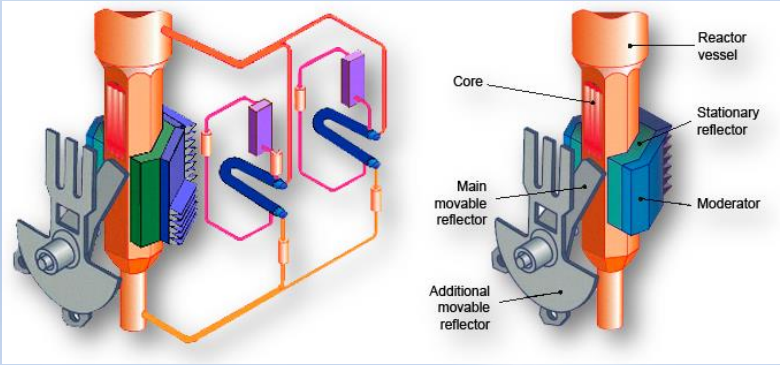
Nanosystems and Nanotechnologies

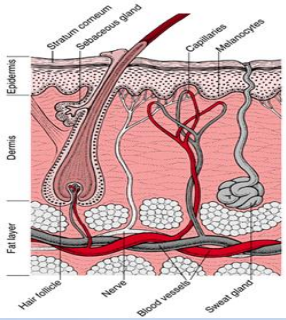
Novel Materials

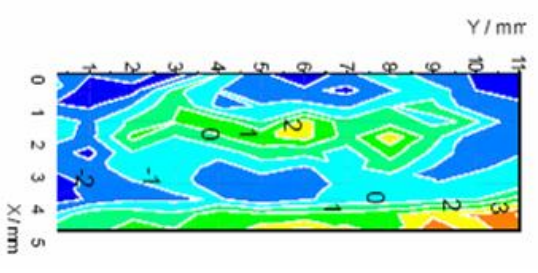


Biomedical Research

Engineering diagnostics.
Earth Sciences
Ecology testing



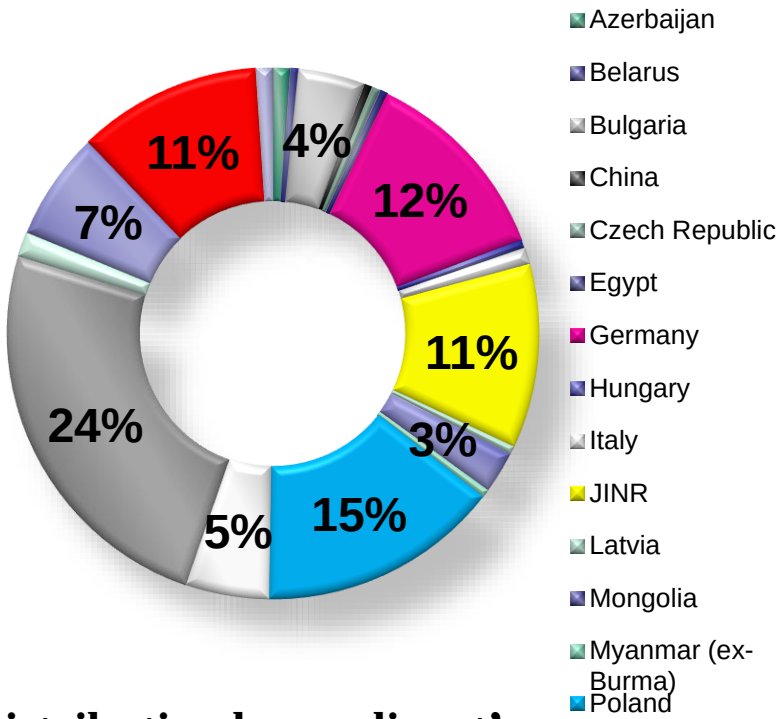




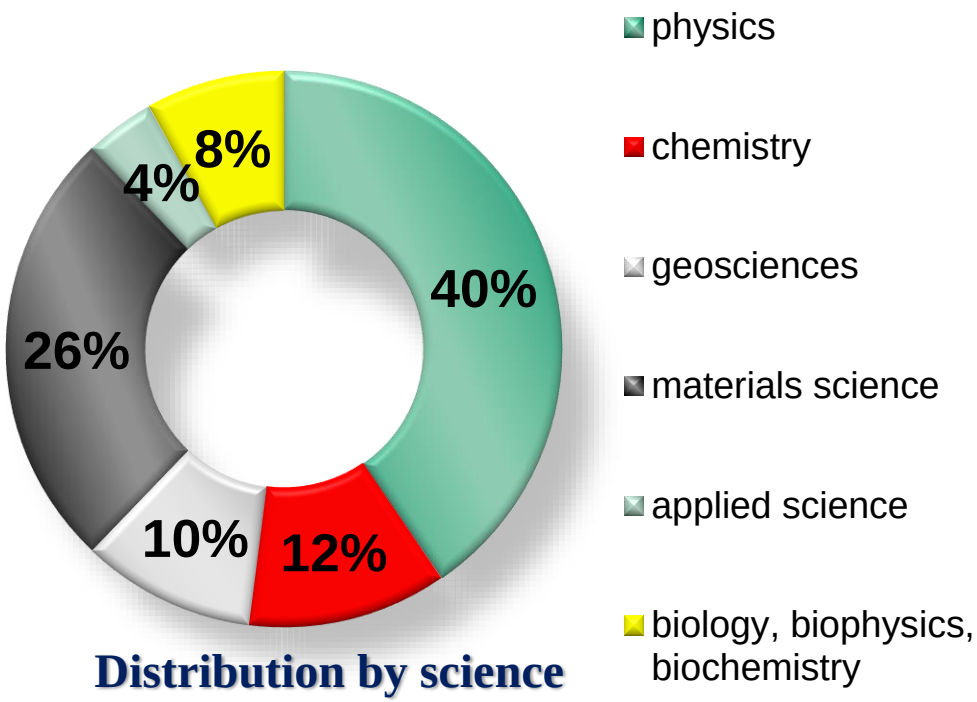
Main directions: Fundamental and applied research in condensed matter physics and related fields: biology, medicine, material sciences, geophysics, ecology studies, engineer diagnostics - aimed at probing the structure and properties of nanosystems, new materials and biological objects, and at developing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

FLNP USER PROGRAME (2016)

197 proposals
19 countries

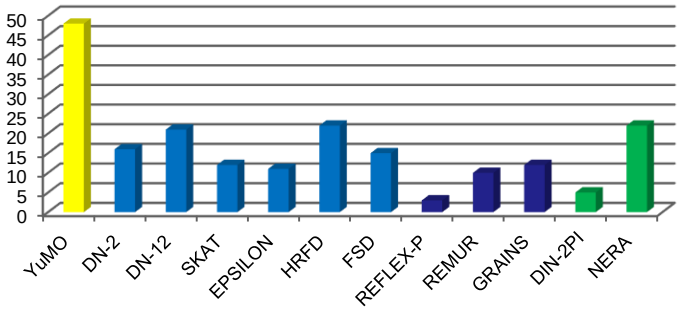


Distribution by applicant's affiliation



Distribution by science

About 60 visiting users from more then 10 countries



Distribution by experimental facilities

Upgrading the spectrometers complex and serving the user community

New

DN-6
diffractometer

microsamples under extreme conditions (P ≤ 0.5 Mbar)

New

NRT
spectrometer

radiography
tomography

New

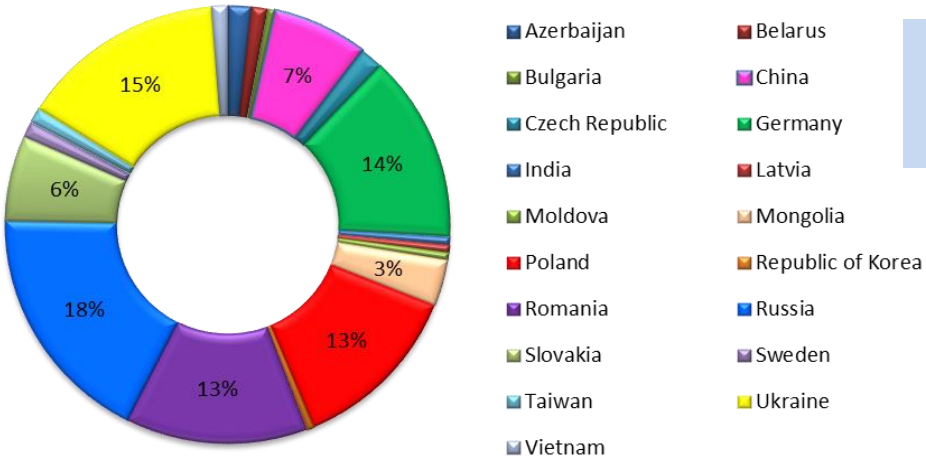
GRAINS
reflectometer

soft and liquid interfaces

New

FSS
spectrometer

bulk industrial components
new advanced materials



User distribution by countries

2017 → 15 new instruments

2016

+ 2 new instruments for users

+ 64% more applications for experiments

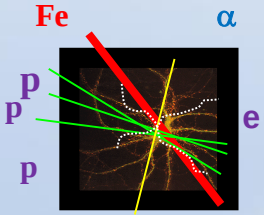
2011

Radiation Biology at JINR

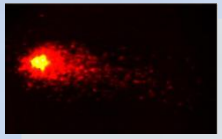
Based on experiments at JINR's accelerators, the LRB resolved one of the central issues of radiobiology: the problem of the genetic effectiveness of ionizing radiations.

Outlook for research

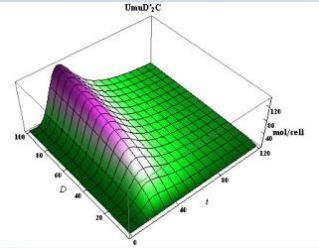
- study of the regularities and mechanisms of the effect of heavy charged particles on ***eye structures***: the lens and retina;



- 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.

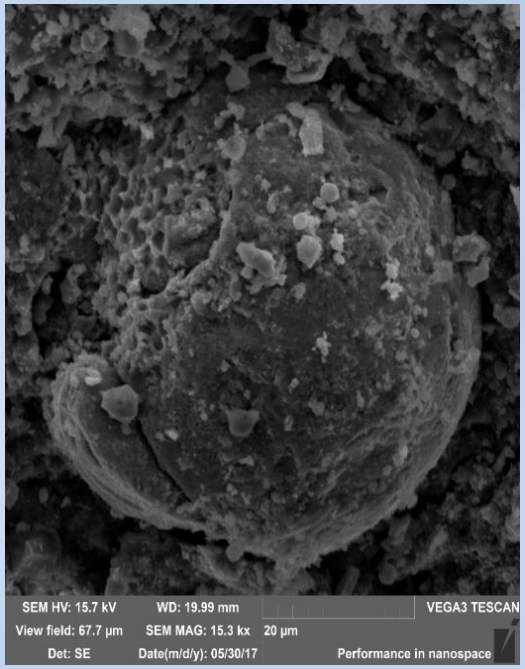
Cosmic medicine and the Project "Man Fly to Mars"

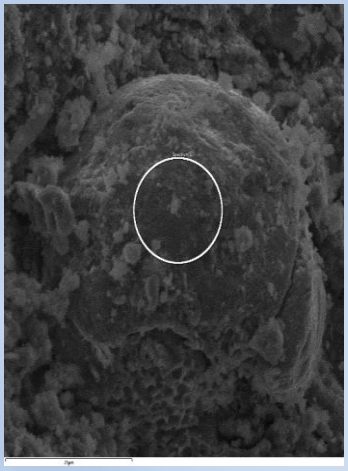
LRB's main fields of research in 2017—2023

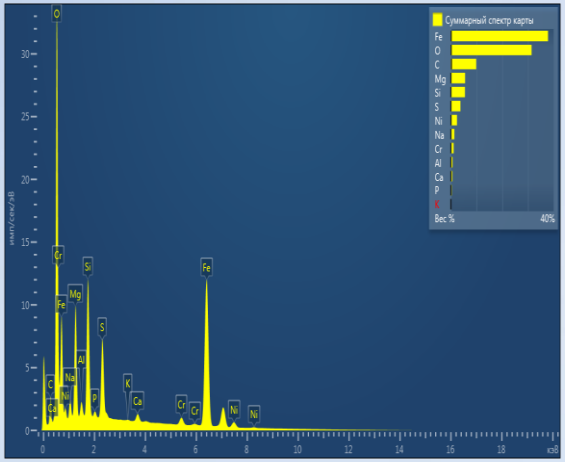
- ***Research on the regularities and mechanisms of molecular damage induction and repair in the DNA structure in mammalian and human cells for radiations with different linear energy transfer (LET) in vivo and in vitro.***
- ***Obtaining comparative data on the regularities in the induction of gene and structural mutations in mammalian and lower eukaryotic cells under exposure to sparsely and densely ionizing radiations with different LET.***
- ***Research on the mechanisms of the heavy ion-induced damage to the eye retina and its repair.***
- ***Identification of the heavy ion-induced functional and morphological disorders in the central nervous system.***
- ***Mathematical modeling of the effects of ionizing radiations with different LET at the molecular and cellular levels. Development and analysis of mathematical models of the molecular mechanisms of ionizing radiation-induced disorders in the CNS structure and functions.***
- ***Astrobiological research will be focused on the problem that is central for understanding the production of the prebiotic compounds underlying the formation of the living systems: what is primary for the origin of life, genetics or metabolism?***

Origin of Life

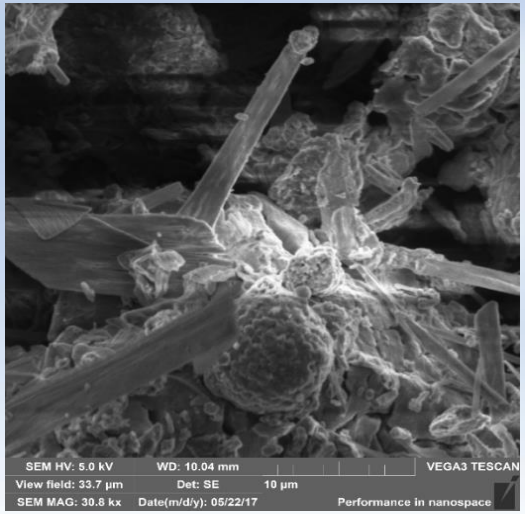
Studying microfossils in meteorites





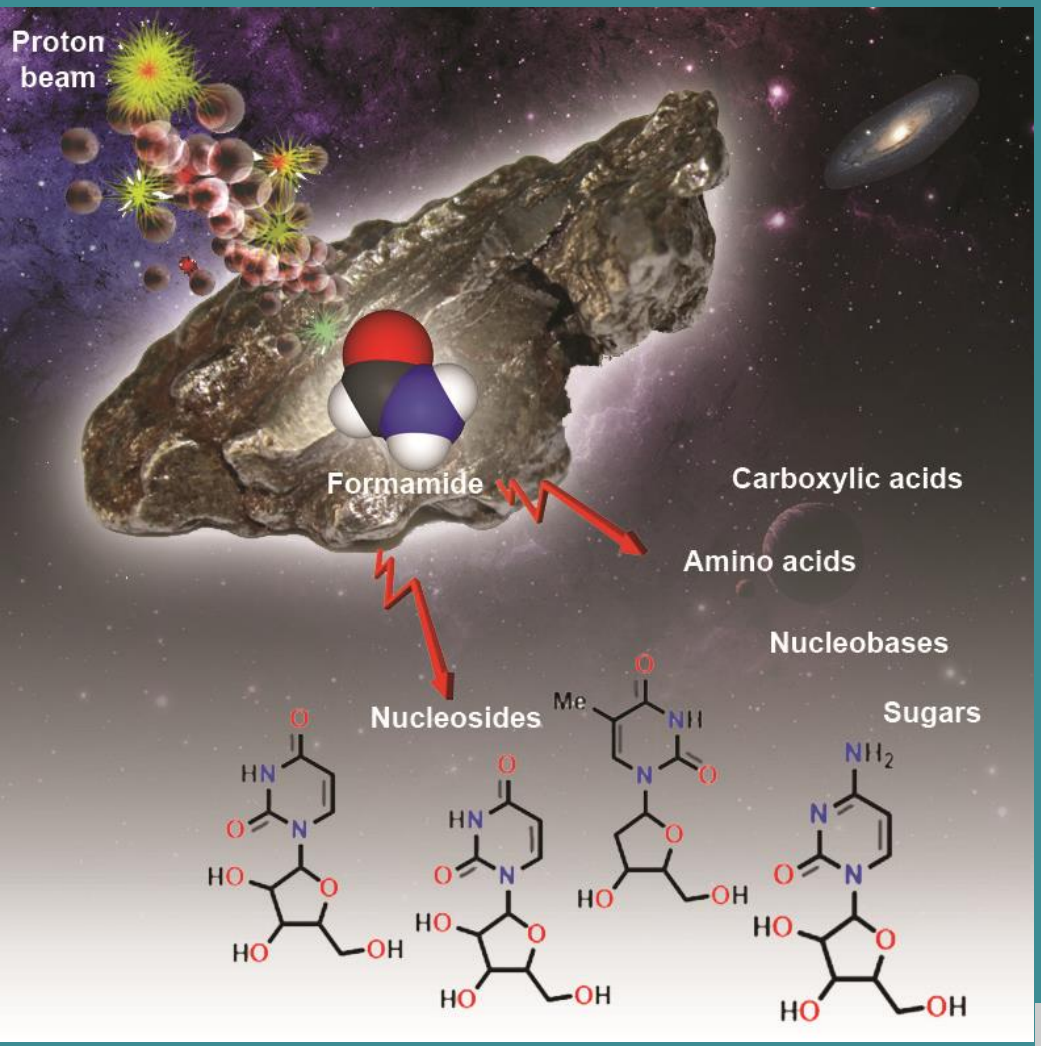


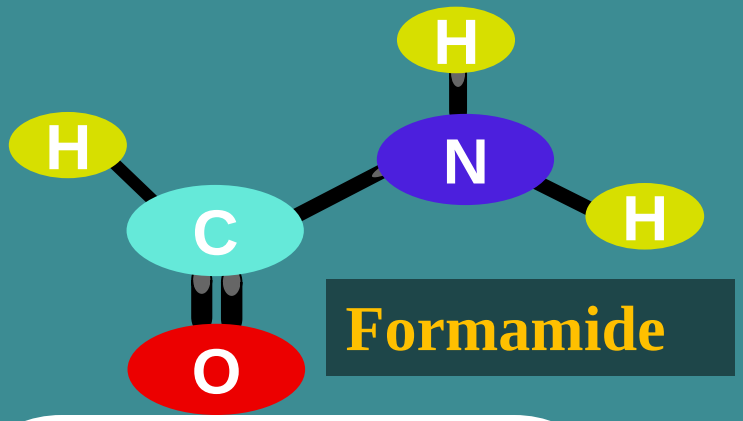
A prasinophyte alga in the Murchison meteorite. The absence of nitrogen in the spectrum indicates that this object is not a modern biocontamination.

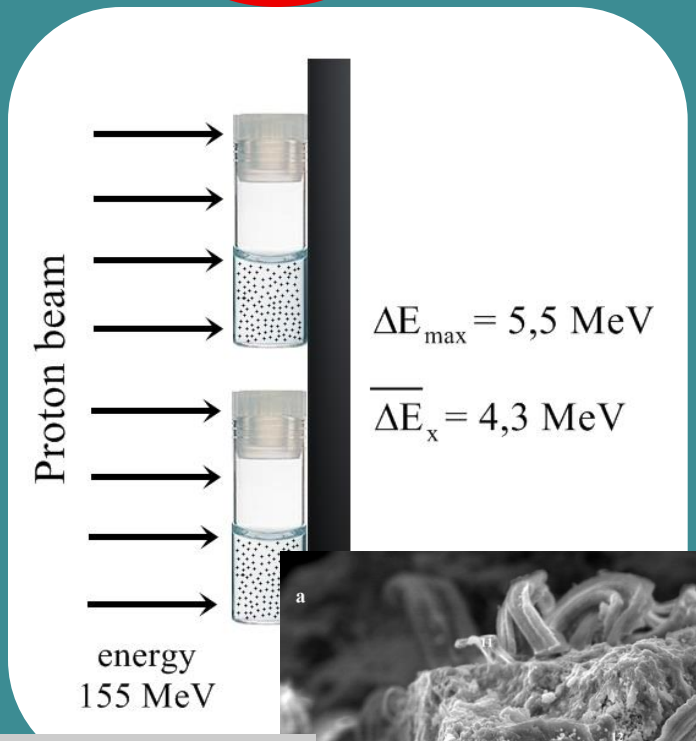


A cyanobacterial thread with an apical heterocyst; bacterial sheaths and a framboid (the Orgueil meteorite)

JINR LRB: Astrobiology





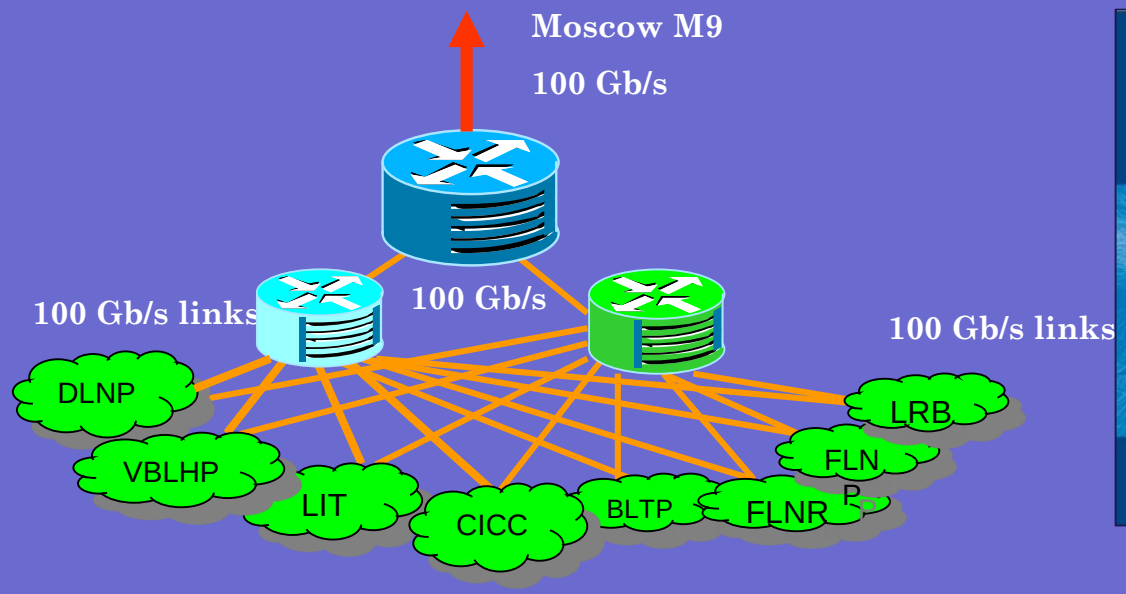


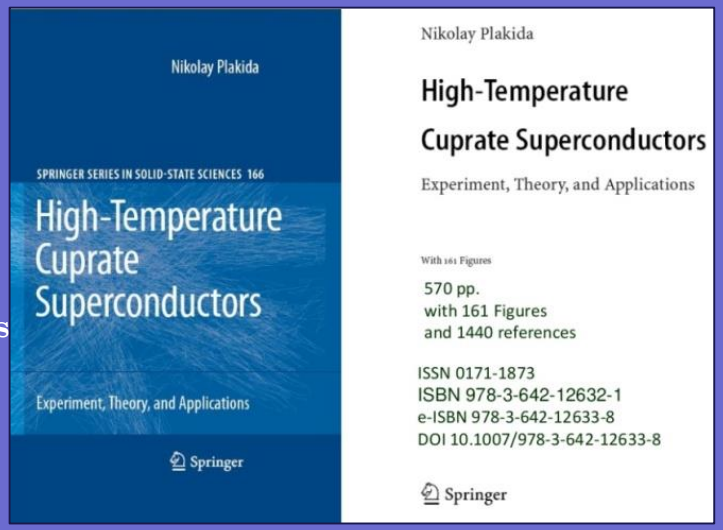
Orgueil CI1 Meteorite, biofossils

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

THEORETICAL STUDIES
and
INFORMATION TECHNOLOGIES (including GRID)

are of utmost importance for the successful activities of the Joint Institute and research centres of the Member States

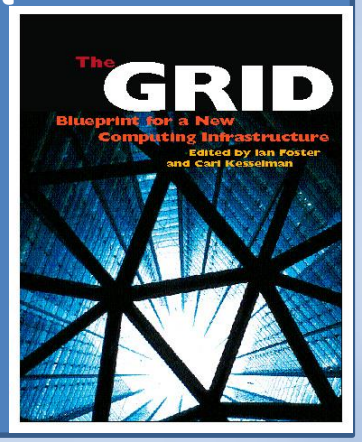




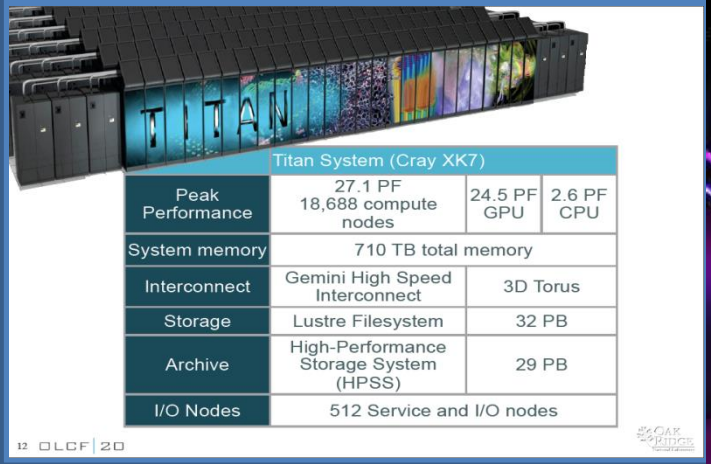
Computing in High Energy Physics and Nuclear Physics

Grids

- Collaborative environment
- Distributed resources

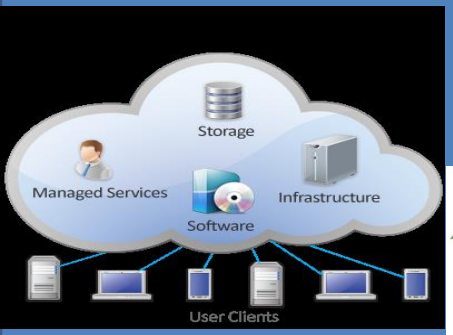


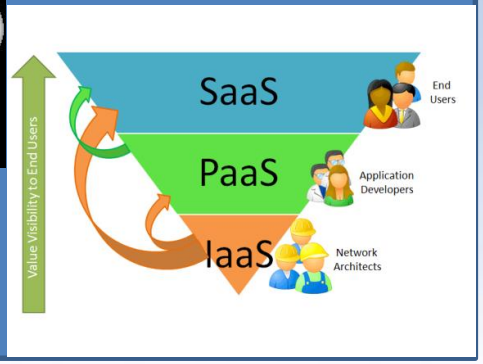
Supercomputers



	Titan System (Cray XK7)		
Peak Performance	27.1 PF 18,688 compute nodes	24.5 PF GPU	2.6 PF CPU
System memory	710 TB total memory		
Interconnect	Gemini High Speed Interconnect	3D Torus	
Storage	Lustre Filesystem	32 PB	
Archive	High-Performance Storage System (HPSS)	29 PB	
I/O Nodes	512 Service and I/O nodes		

Clouds





Big Data

- *Volume*
- *Velocity*
- *Variety*

One of the main task of LIT in the next 7 years is to develop the Multifunctional Information and Computing Complex

LIT IT-infrastructure is the one of JINR basic facilities

- LAN: 10 Gbps
- WAN: 100 Gbps + 2x10 Gbps
- Tier-1: 4160 core, 5,4 PB disk, 8 PB tape
- CICC/Tier-2: 3500 core, 2PB disk
- HybriLIT: 252 CPU, 77184 GPU cores, 182 PHI-cores, 2.4 TB RAM, 57.6 TB HDD, 142 Tflops
- Cloud: 700 CPU, 1 TB RAM

MICC: main components

JINR grid sites of WLCG/EGI: Tier-1 for CMS
Tier-2 for ALICE, ATLAS, CMS, STAR, LHCb, BES, biomed, fermilab

Cloud infrastructure

Heterogeneous(CPU + GPU) computing cluster HybriLIT

Off-line cluster and storage system for BM@N, MPD, SPD Storage and computing facilities for local users

Network infrastructure

Engineering infrastructure

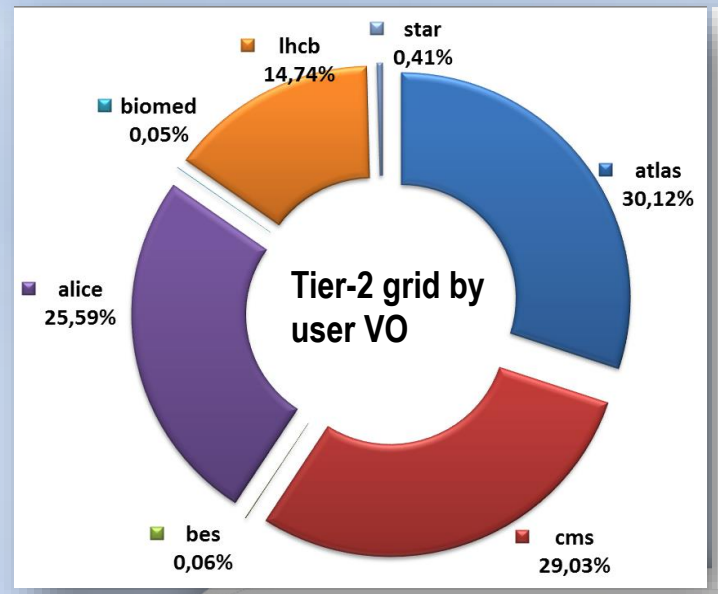
Tier-1: JINR participation in the Worldwide LHC Computing Grid (WLCG)

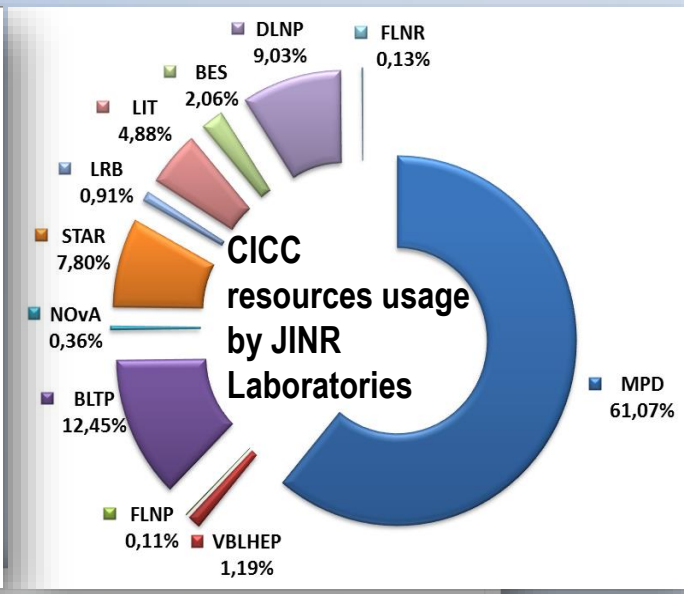
Grid Tier-1 is one of the 7 centres in the world intended for large-scale processing of experimental and event-modeling data coming from the centres of Tier-0 (CERN), as well as Tier-1 and Tier-2 of the Worldwide Computing Grid WLCG for the CMS experiment. This component is considered as a prototype of the system of processing and storage of the experimental data from the mega-project NICA as a centre of Tier-0 and Tier-1.

Tier 2 & CICC

Experiments

BM@N,
MPD,
CMS,
ATLAS,
ALICE,
LHCb,
COMPASS,
PANDA,
CBM,
STAR,
NOvA,
BESIII,
DIRAC,
OPERA
NEMO
Mu2e,
NUCLON,
HONE,
FUSION
BIOMED

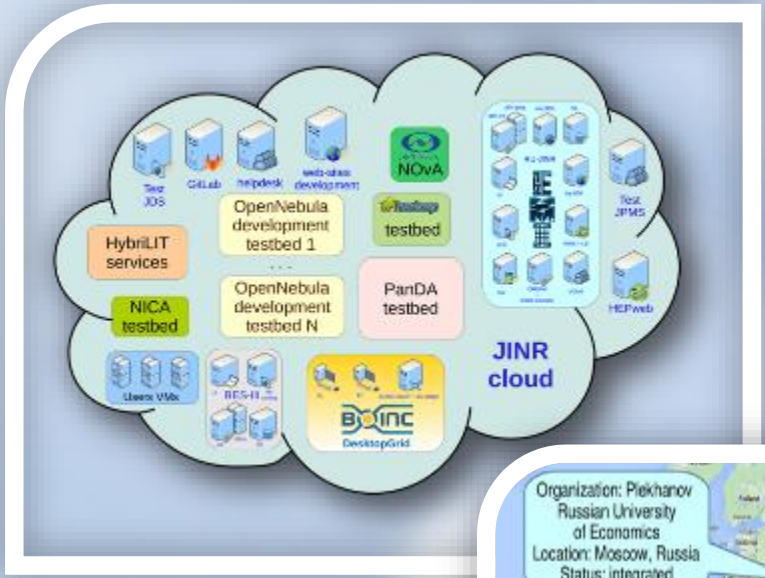




Tier-1 and Tier-2:
JINR in Worldwide LHC Computing Grid

JINR Cloud

One of the most important trends in the cloud technologies is the development of method of integrating various cloud infrastructures.
In order to join the cloud resources of partner organizations from JINR Member State for solving common tasks as well as to distribute a peak load across them, a cloud bursting driver has been designed by the JINR cloud team. It allows one to integrate the JINR cloud with the partner clouds either OpenNebula-based one or any other cloud platform which supports Open Cloud Computing Interface (OCCI).

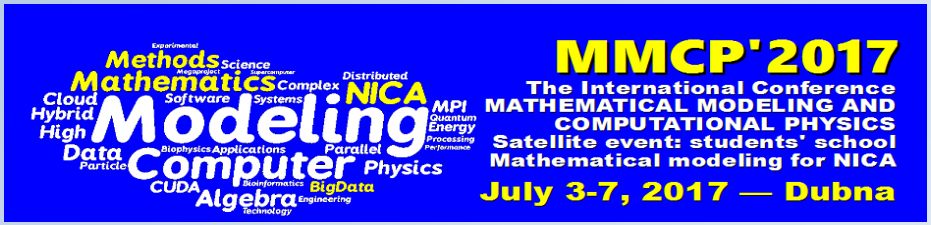


The geographical location of the partner's organizations from JINR Member States whose cloud resources are integrated into the JINR cloud following the so-called “cloud bursting” model.

Besides, the JINR cloud is integrated into EGI Federated cloud thus enabling a possibility to use part of the JINR computing resources by EGI FedCloud Virtual Organizations.

LIT traditional conferences and schools in 2017

International Conference “Mathematical Modeling and Computational Physics”



Total number of participants was 300 scientists from various Institutes and Universities of Armenia, Bulgaria, Russia, and others. During the conference, there was over 250 reports on a wide spectrum of problems in the field on mathematical modeling.
Youth conference-school on mathematical modeling for NICA was held in the framework of the Conference.

26th Symposium on Nuclear Electronics and Computing

The 26th symposium on nuclear electronics and computing will be held in Budva in the 25-29 September 2017, Montenegro, Budva, Becici.
Organizers of the event are JINR and CERN.

The 2nd International School on heterogeneous computing infrastructure, programming, Big Data analytics, scientific visualization, supercomputing will be held in the framework of the Conference.

BLTP Bogoliubov Laboratory of Theoretical Physics

Multidisciplinary research:

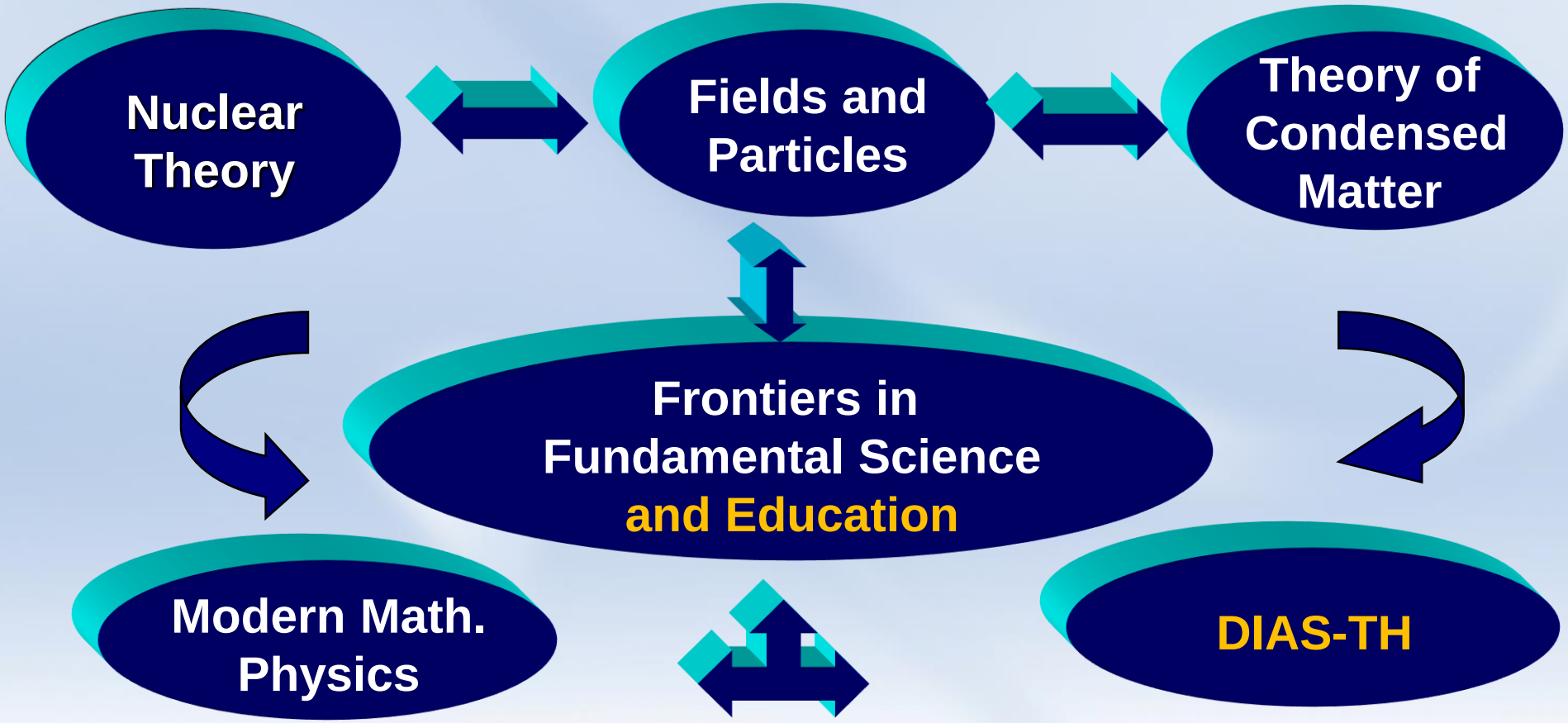
- Theory of Fundamental Interactions
- Theory of Nuclear Structure and Nuclear Reactions
- Theory of Condensed Matter
- Modern Mathematical Physics: Strings and Gravity, Supersymmetry, Integrability

Research and Education Project DIAS-TH :
"Dubna International Advanced School of Theoretical Physics"

Helmholtz International Summer Schools (HISS) Dubna

Theory: Science Policy

- Support of the JINR Experimental Programme;
- Development of research in Theoretical Physics on the basis of Advanced Mathematics;
- Strengthening of the efficiency of scientific staff through the interplay of research and education.



JINR University Centre
Attracting youth to science

JINR UC Educational Programmes

and 7-years Plan for the Development of JINR for the years 2017 - 2023

Educational Programmes: ranging from school students and teachers to the bachelor, master and PhD students realizing the principle "Attracting Youth to Science"

- Among JINR educational activities there are the outreach programmes, preparation of qualification works at either bachelor, master or PhD levels, International student practice at JINR, Summer student programs, training programmes for engineers etc.
- In 2017 JINR has applied to the Russian Government to enter the system giving the right of issue its own diploma of assigning the JINR PhD degree. And has got this right !
- JINR is going to create a special fond to support JINR postdoc positions at the major projects of the JINR basic facilities like NICA, SHE, GVD at Baikal lake etc.

Attracting youth to science

JINR is a school of excellence for the Member States!

JINR UC offers graduate programmes in the fields of:

- Elementary Particle Physics
- Nuclear Physics
- Theoretical Physics
- Condensed Matter Physics
- Technical Physics
- Radiobiology

Bachelor's, Master's & PhD theses at JINR

JINR has departments (Chairs) of the major universities

MSU

МФТИ

Казанский федеральный УНИВЕРСИТЕТ

SAINT PETERSBURG STATE UNIVERSITY

We enable students and postgraduates from the Member States Universities to prepare their qualifying theses at JINR

Schools at JINR

http://teachers.jinr.ru/

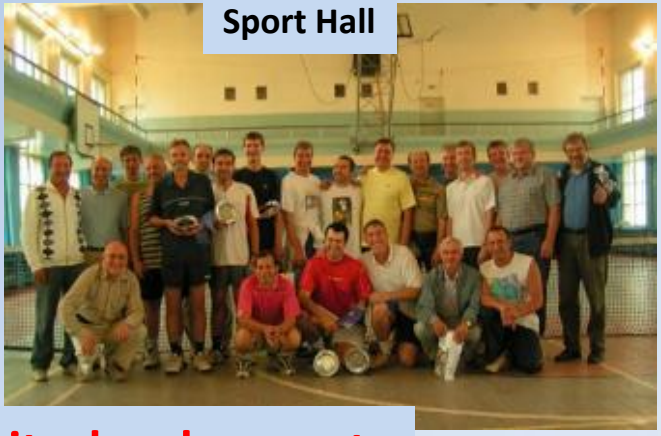
Bringing Science closer to School

Schools at CERN

JINR Social Infrastructure and its development

Swimming Pool 50 m

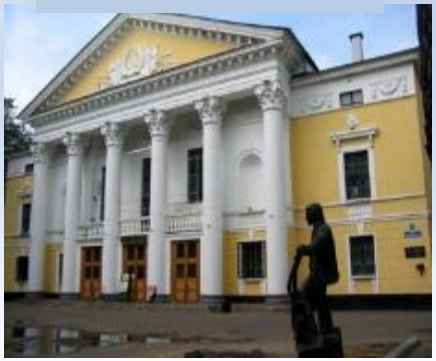
Concert Hall



Sport Hall

Summer schools for children

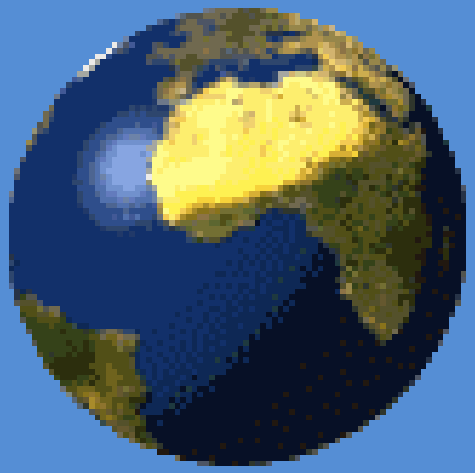
Football, Tennis, Hockey fields



Culture House

JINR and

INTERNATIONAL COOPERATION



Large scale physics

JINR participation in the world wide international collaborations:

CERN, FAIR, DESY, FNAL, BNL,

CNRS, LNGS at Gran Sasso, KEK,

T2K, Daya Bay and others …

some examples →

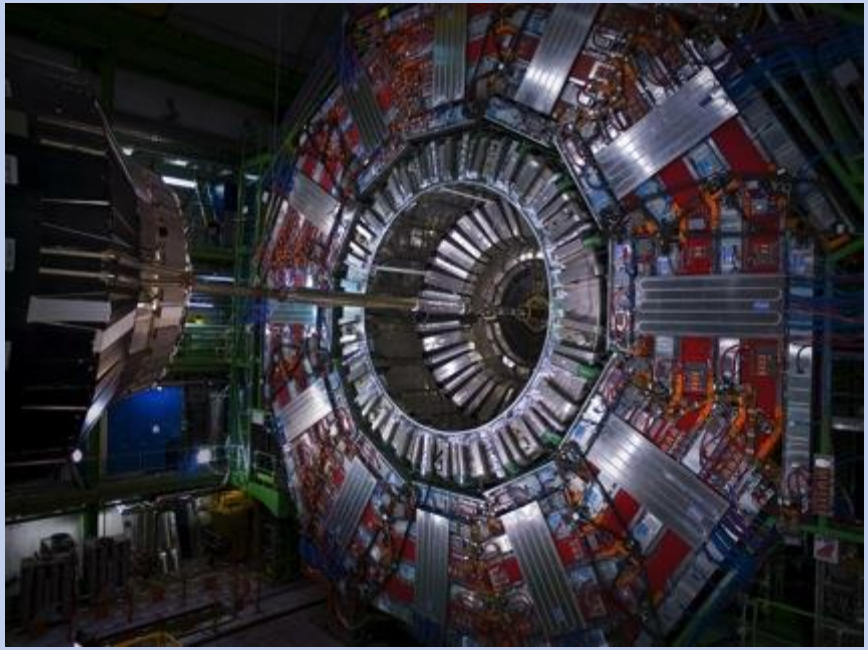
JINR – CERN strategic partnerships

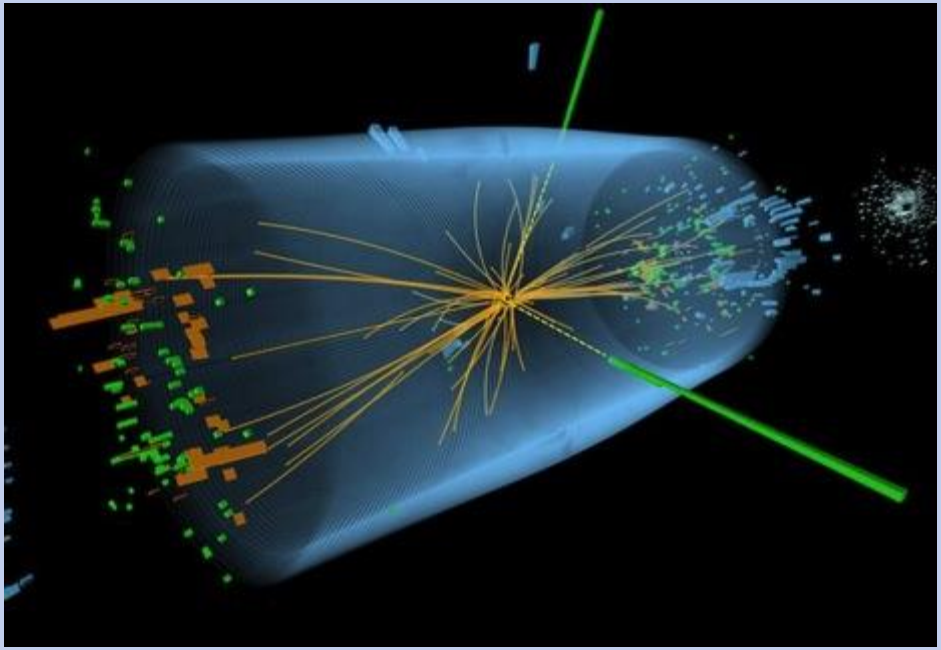
- JINR actively participates in the LHC programmes including the ATLAS, CMS , ALICE and the Collider itself and planning to contribute to the LHC detectors upgrade.
- Besides, JINR participate in the four SPS projects:
- Compass-II (NA58) – nucleon spin structure, hadron spectroscopy (with interests to future SPD at NICA);
- NA61 – (intersects with BM@Nuclotrone and MPD);
- NA62 – CP-violation and rare decays;
- NA64 – search for the dark photon;
- Accelerator development: **CLIC**, **ILC**, **FCC**, precise laser metrology,
- Computing and Information Technologies, **WLCG, Tier-1**
- Neutrino platform, nTOF, DIRAC, Educ.Teachers programs etc

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



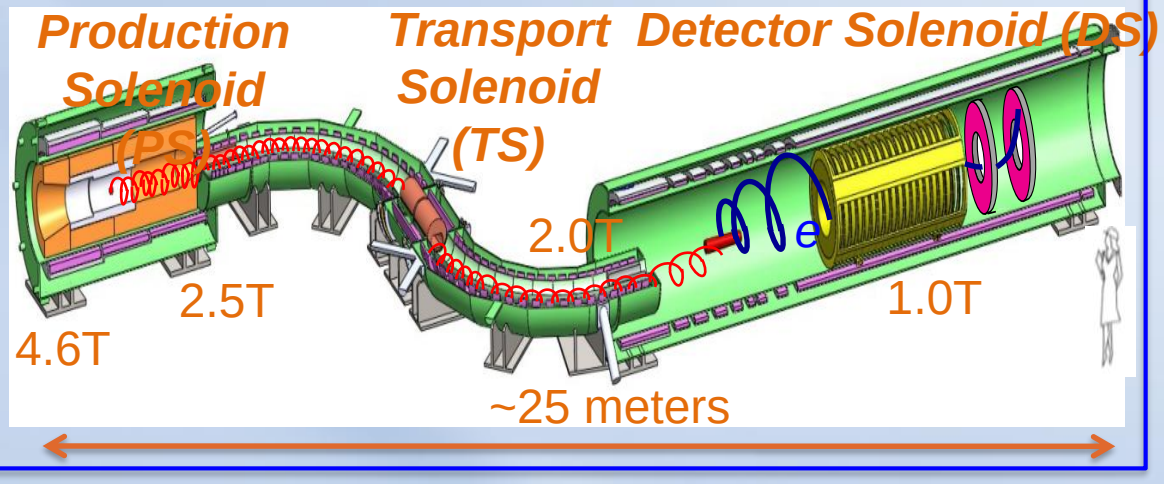


JINR will continue to be one of the main contributors to the ATLAS & CMS experiments on the Large Hadron Collider, two of the experiments that discovered the Higgs boson in 2012. In 2015, the LHC started its second run, at the highest energies ever harnessed for a scientific experiment.

JINR – INR RAS
in Fermilab

Mu-to-e conversion: (the idea of V. Lobashov)

A System of superconducting solenoids and an intense muon beam

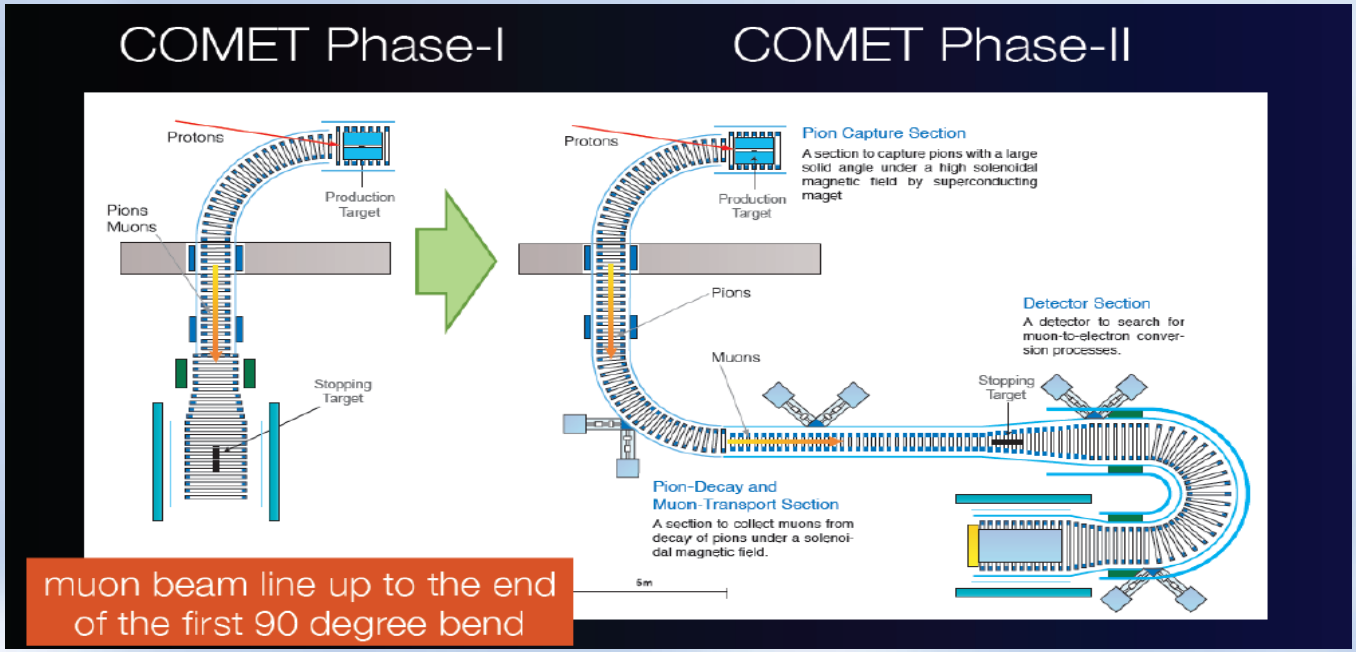


Academician Vladimir Lobashov was pioneer of studies of P and CP-invariance as well as neutron and neutrino physics. His studies set the most stringent limits on neutron dipole moment and on neutrino mass in beta decay. He proposed new method for lepton flavor violation search in muon to electron conversion using pulsed proton beam which Fermilab is now using im mu2e experiment.

R. Djilkibaev and V. M. Lobashov, Sov. J. Nucl. Phys. 49(2), 384 (1989)

JINR in COMET (J-PARC, Japan)

Search for neutrino-less conversion of a muon to an electron, $\mu + N(A,Z) \rightarrow e + N(A,Z)$ at J-PARC with unprecedented sensitivity of ~10^{-15} (at Phase-1) and ~10^{-17} (at Phase-2).



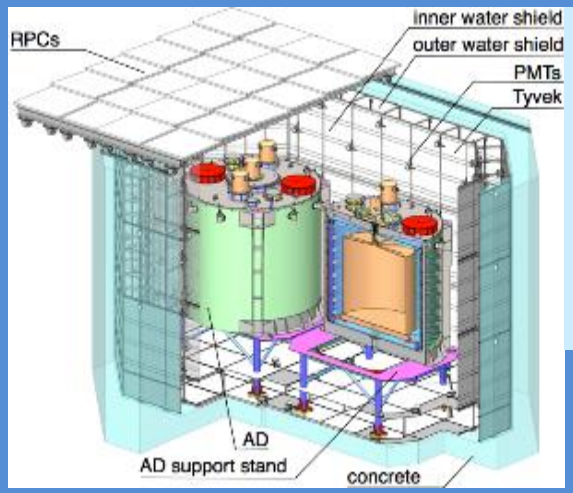
The main task of the JINR physicists at the current stage: participation in creation of the experimental setup.

Two areas of the JINR full responsibility:
1) production of the straw tubes for the tracker;
2) test of crystals for the electromagnetic calorimeter

JINR in Daya BayII (JUNO)

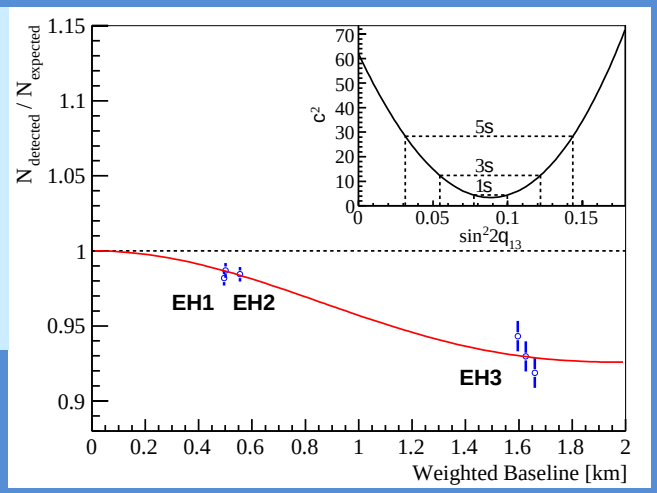
6 Antineutrino Detectors (ADs) give 120 tons total target mass.

6 commercial reactor cores with 17.4 GW total power.



Data taking

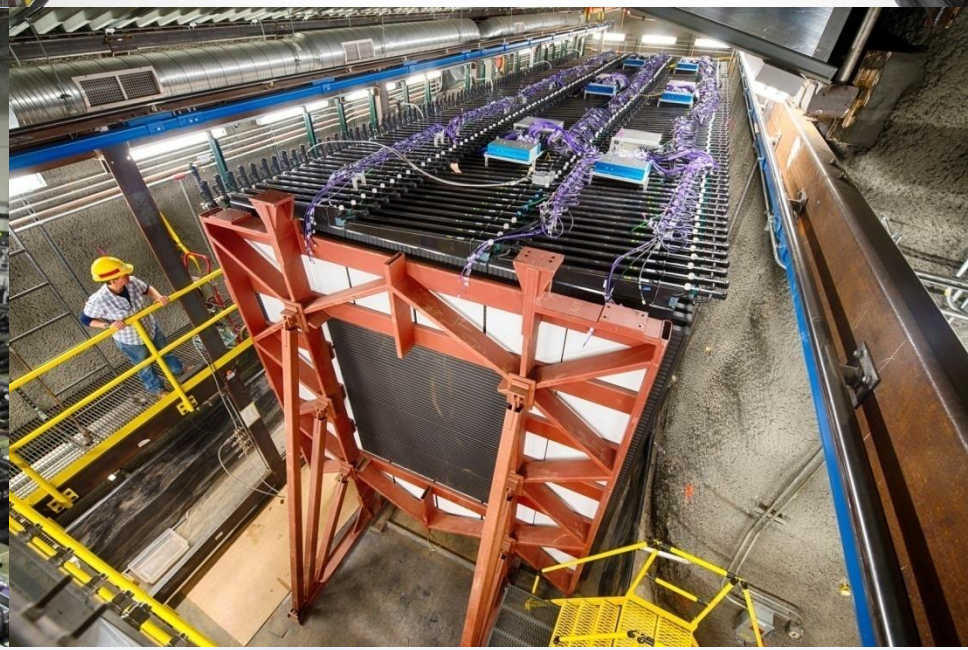
~200K events in close detectors
~30K in far detectors



Update precise measurement

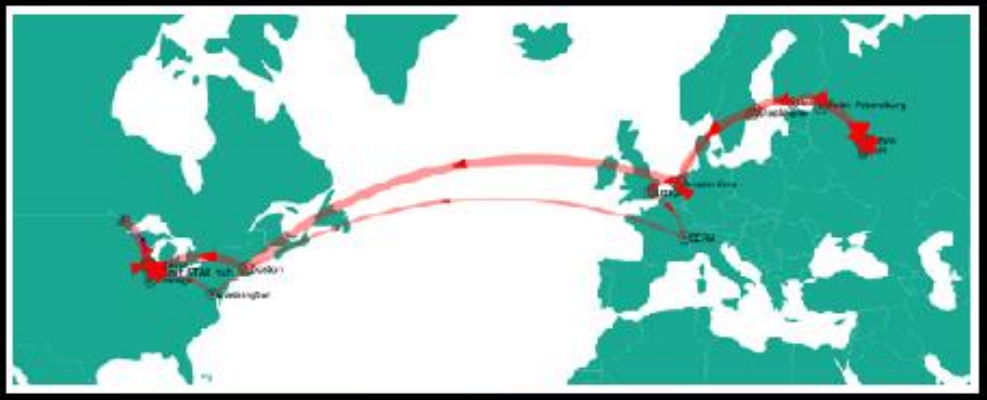
$$\sin^2 2\theta_{13} = 0.089 \pm 0.010\ (\text{stat}) \pm 0.005\ (\text{syst})$$

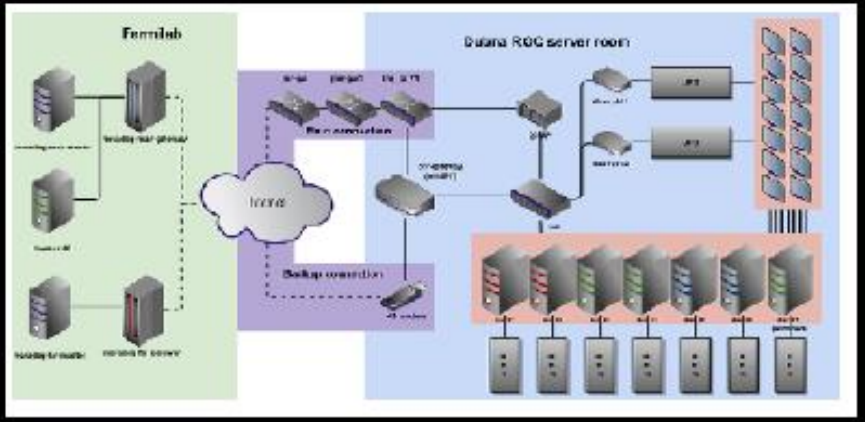
JINR @ NOvA neutrino experiment (FNAL)



JINR at NOvA – remote operation center in Dubna

- Developed infrastructure of the ROC–Dubna allows for non–interruptible continuous work
- Includes: stable and backed up internet connection, communication tools including international land–line, kitchen, etc.
- A computing monitoring system, based on Nagios, controls ROC–Dubna equipment and notifies JINR experts in case of trouble.



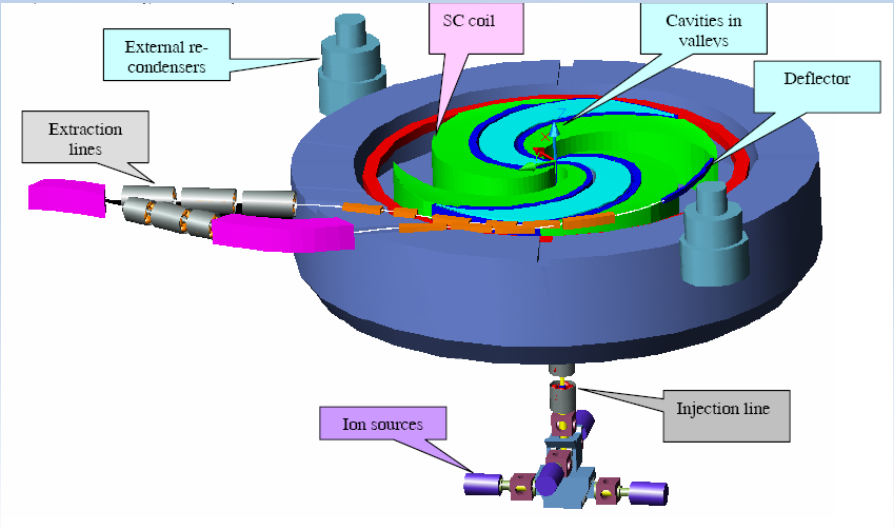


Applied Research: proton therapy and medical accelerators development

Proton Therapy at DLNP 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 company & ASIPP (Hefei, China)



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)

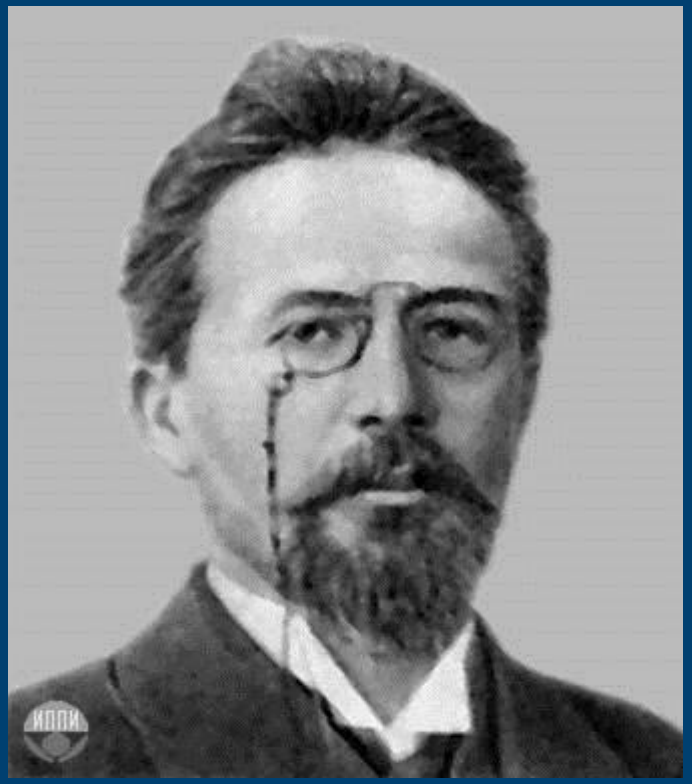
Montenegro

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

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

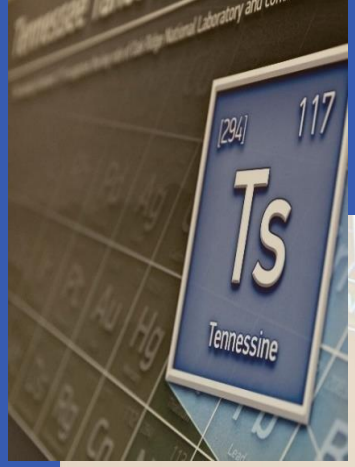
(1860 – 1904)

Welcome to Dubna!

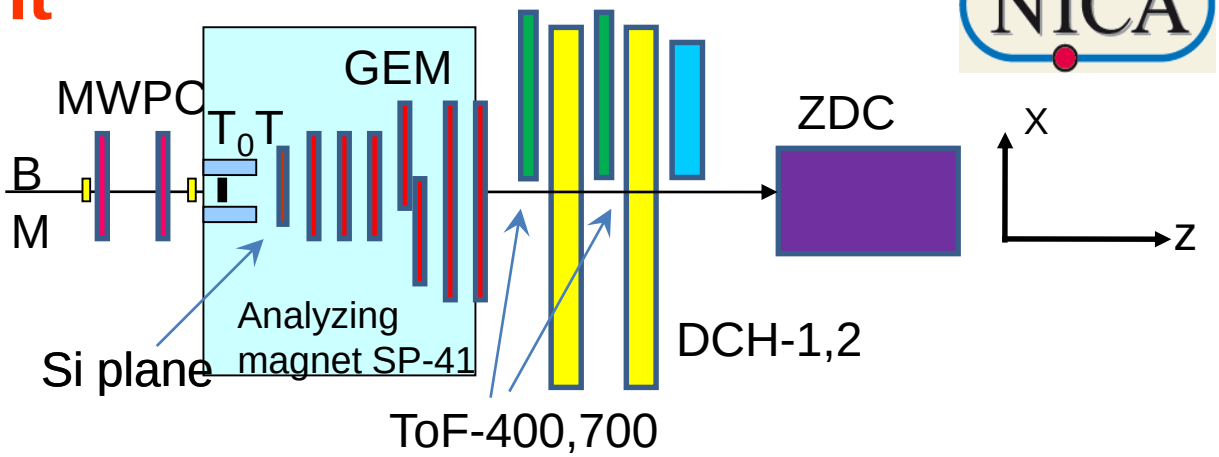
Thank you !

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

Inauguration of element 117, Tennessine TN, USA



BM@N experiment
at the NICA Fixed Target Area



Deuteron beam,
T_0= 4.0, 4.6 GeV/n

Carbon beam,
T_0= 3.5, 4.0, 4.5, 5,16 GeV/n

Focus on testing and commissioning of the central tracker inside the analyzing magnet → 5 GEM detectors 66 x 41cm^2 + 2 GEM detectors 163 x 45 cm^2 and a plane of the Si detector for tracking Test / calibrate ToF, T0+Trigger barrel detector, full ZDC, part of ECAL Near-term plan: heavy ions (Ar, Kr); GEM tracker (+ 4 detectors), Silicon detector (+ 2 planes)

JINR University Centre
Attracting youth to science

JINR UC Educational Programmes

- International Scientific Schools for physics teachers and school students at JINR and CERN (647 participants from 8 countries since 2009, 52 in 2017)
- Qualification thesis (955 students and PhDs since 2013, 237 in 2017)
- International Student Practice (1294 parts since 2004, 140 in 2017)
- Summer Student Programme (128 parts since 2014, 49 in 2017)
- Engineering and Physics Training (since 2014)