Joint Institute for Nuclear Research

International Intergovernmental Organization

Status and Development of Basic Facilities and New Accelerator Projects at JINR

Grigori SHIRKOV

IAEA, 4-8 May 2009, Vienna, Austria

IAEA.org International Atomic Energy Agency

International Topical Meeting on Nuclear Research Applications and Utilization of Accelerators

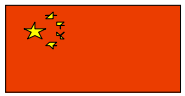
JINR – the Bridge between West and East

JOINT INSTITUTE for NUCLEAR RESEARCH

1956


Albania


Bulgaria


China


Czechoslovakia


GDR


Hungary


D.P.R.Korea


Mongolia


Poland


Romania


USSR


Vietnam

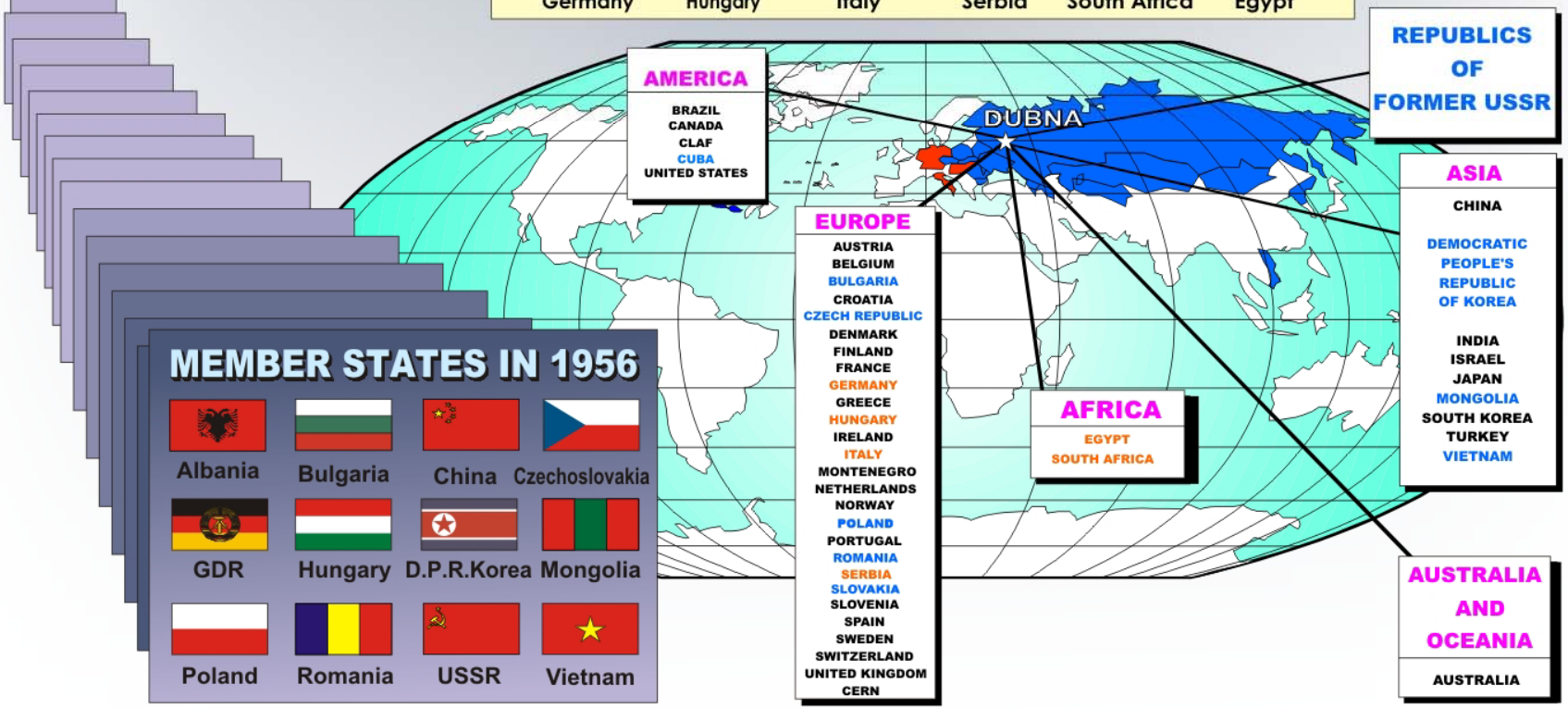
The agreement on the establishment of JINR was signed on 26 March 1956 in Moscow

JINR MEMBER STATES

Armenia, Azerbaijan, Belarus, Bulgaria, Cuba, Czech Rep., Georgia, Kazakhstan, D.P.R. Korea
Moldova, Mongolia, Poland, Romania, Russia, Slovakia, Ukraine, Uzbekistan, Vietnam

AGREEMENTS at GOVERNMENTAL LEVEL

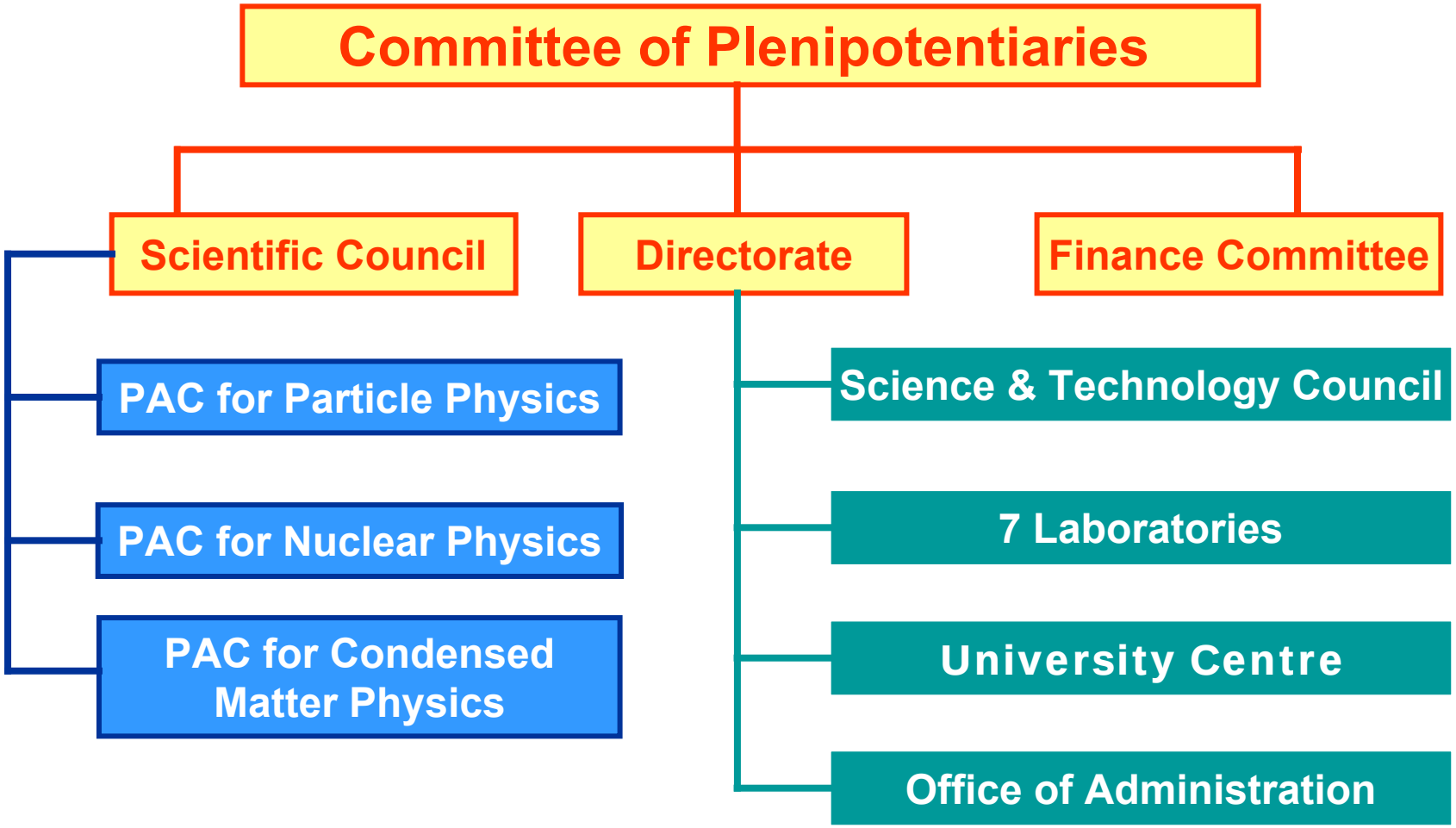
Germany, Hungary, Italy, Serbia, South Africa, Egypt



MEMBER STATES IN 1956

Albania, Bulgaria, China, Czechoslovakia
GDR, Hungary, D.P.R.Korea, Mongolia
Poland, Romania, USSR, Vietnam

Governing Bodies & Structure

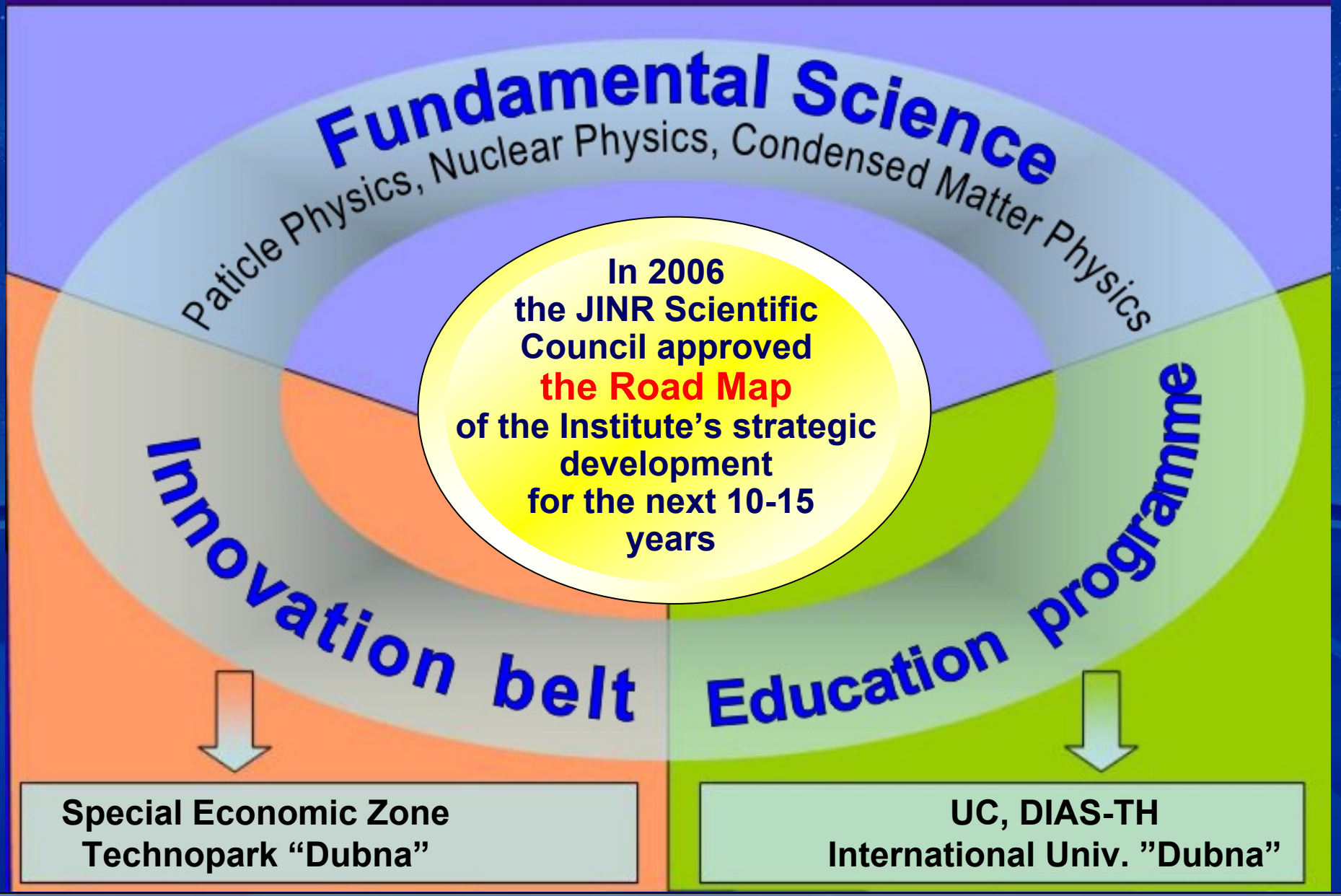


JINR in figures

JINR's staff members	~ 5500
researchers	~ 1300
including from the Member States (but Russia)	~ 500
Doctors and PhD	~ 1000
Total operation of basic facilities	~ 15000 hours/year
JINR budget in 2007 -	45 M$
in 2008 -	55 M$
in 2009 -	70 M$
in 2015 (plan) -	about 200 M$

JINR Dubna

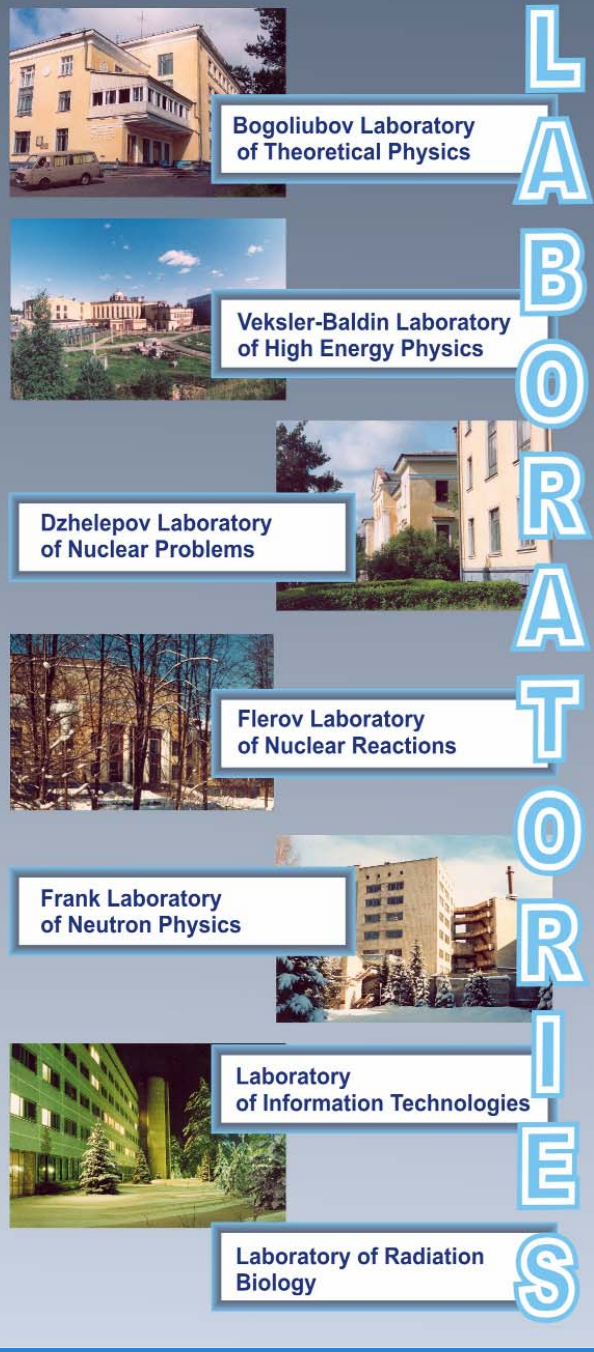
JINR's Science Policy Today and Tomorrow



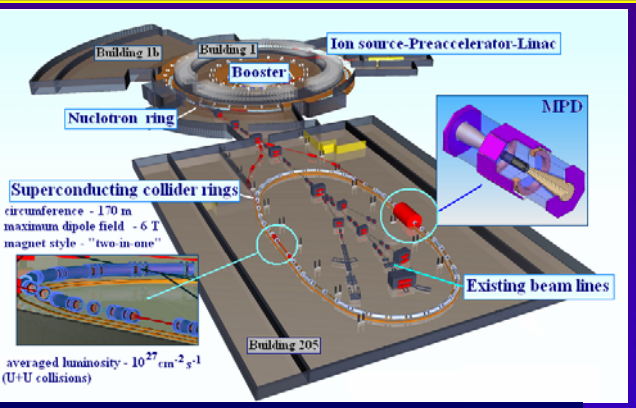
JINR Dubna

JINR's research niche offered by home facilities

- **Heavy-Ion Physics:**
  - at high energies (up to 5 GeV/n) (in future $\sqrt{s_{NN}}$ = 9 GeV, NICA facility)
  - at low and intermediate energies (5 – 100 MeV/n)
- **Condensed Matter Physics** using nuclear physics methods

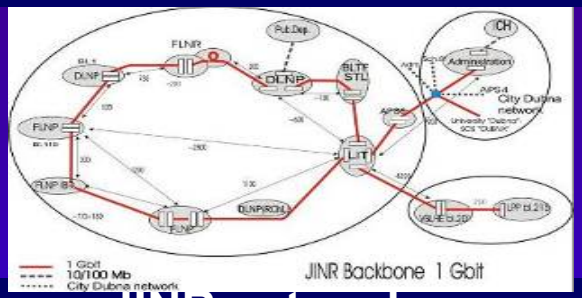


Upgrade and Development of JINR Basic Facilities

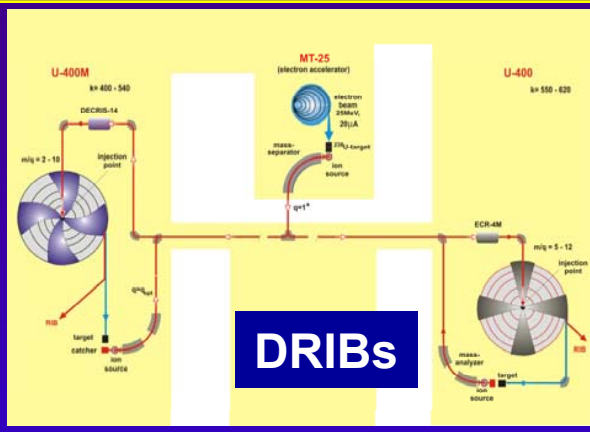


Upgraded Nuclotron-M (2009) + NICA (2013-2014)

Telecommunication channels:
77 Gbps – November 2008,

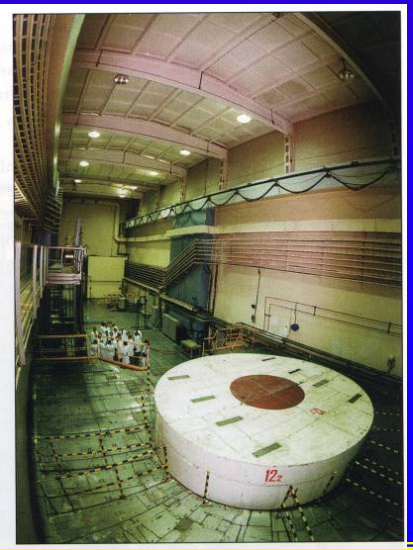


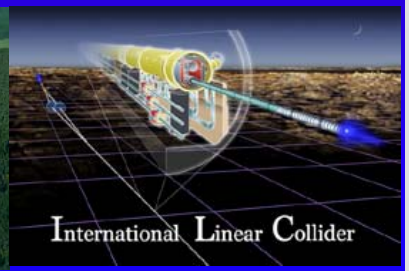
JINR networks, including GRID technology



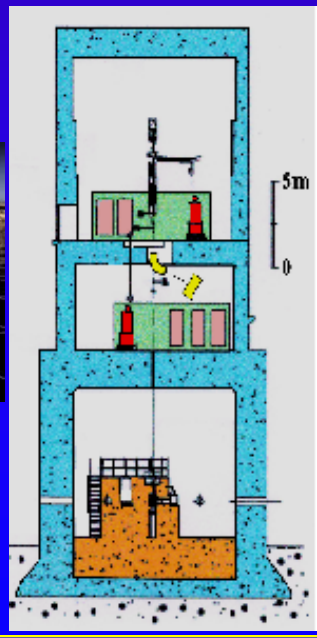
second phase 2009

Participating in LHC, RHIC, TEVATRON…
In future: FAIR, ILC …





New reactor IBR-2M 2010



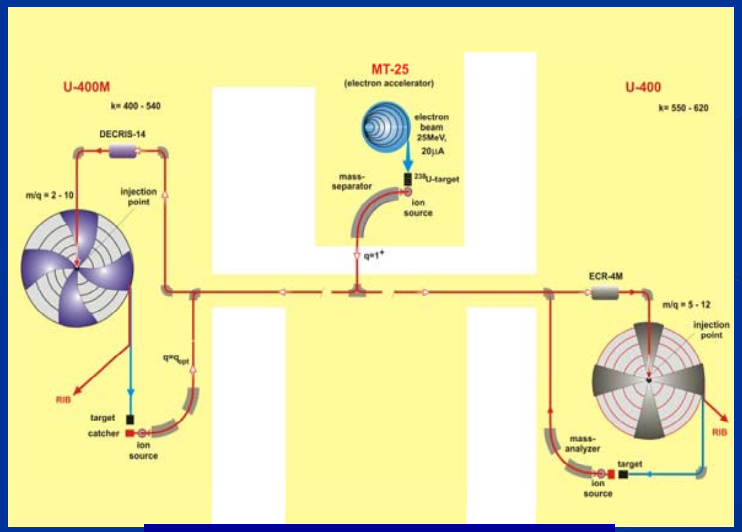
IREN-I 2008

Low Energy Heavy Ion Physics

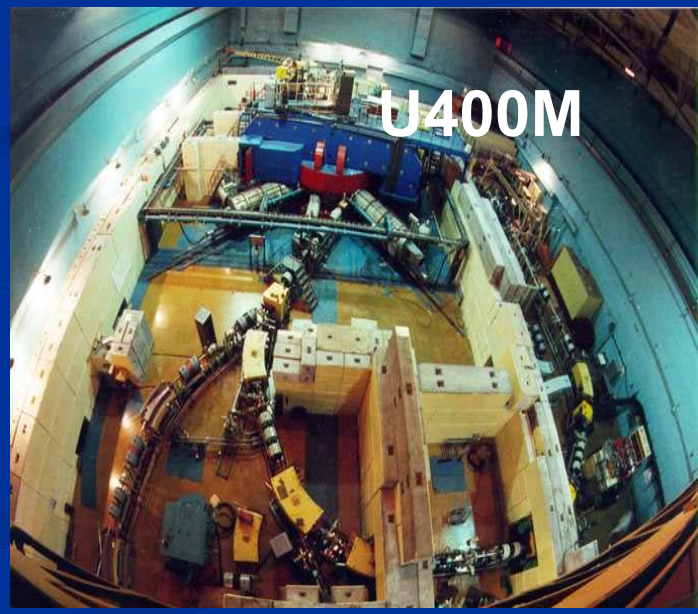
The main home facilities (today):
Cyclotrons U400 and U400MR,
accelerator complex DRIBs-I

Future plans:
- U400R, accelerator complex DRIBs-II

(in operation since 1979)



DRIBs –
Dubna Radioactive
Ion Beams

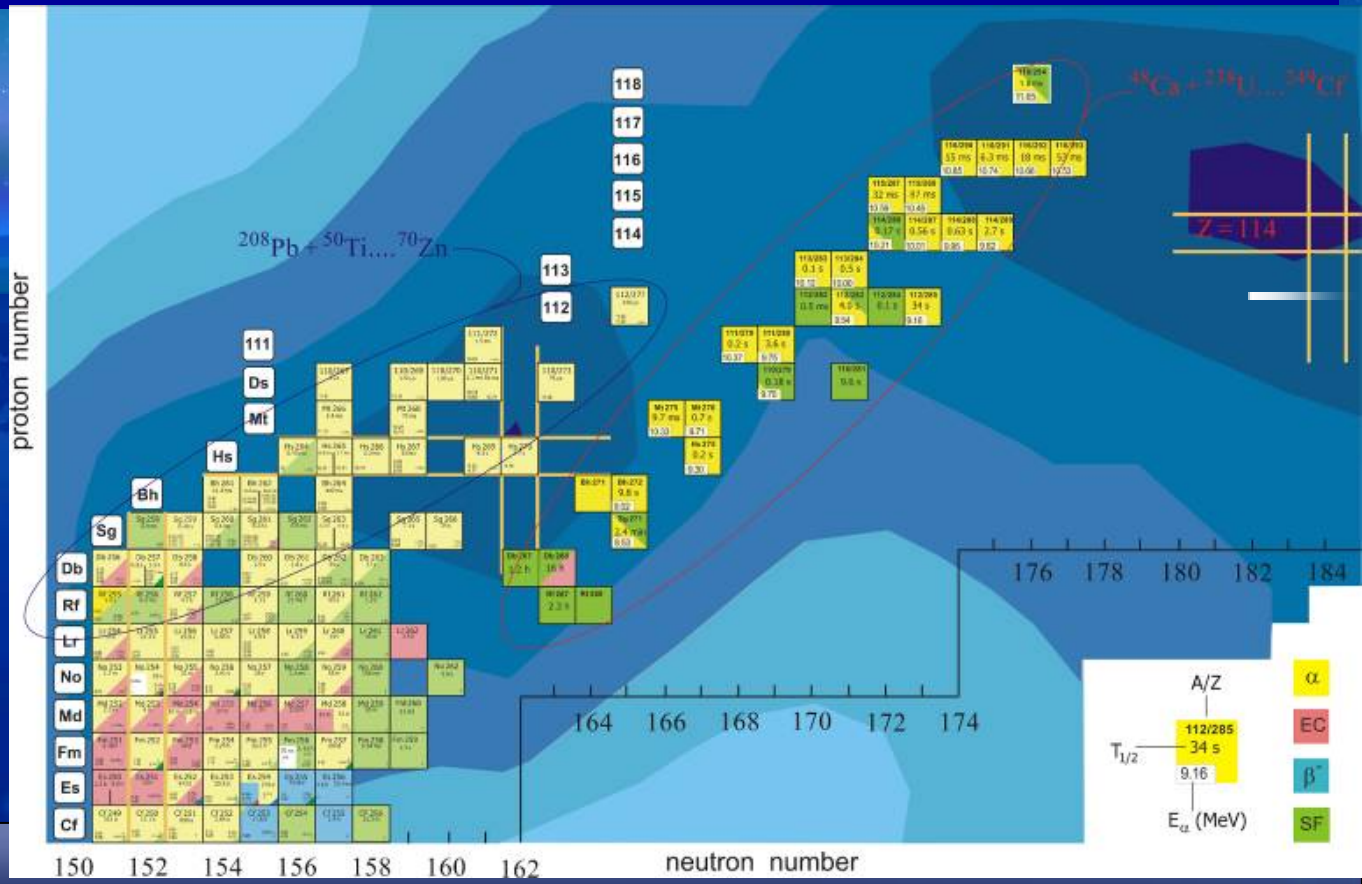


(in operation since 1993)

Priorities in Heavy Ion Physics

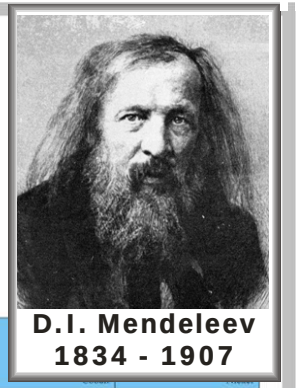
- Physics and chemistry of the superheavy nuclei with Z ≥ 112; structure and properties of the neutron-reach light exotic nuclei
- Accelerator technology
- Heavy ion interaction with matter; applied researches

To accomplish these tasks, the FLNR Cyclotron Complex will be upgraded for producing intense beams of stable (^{48}Ca, ^{58}Fe, ^{64}Ni, ^{86}Kr) and radioactive (^{6}He, ^{8}He) isotopes.



Georgiy N. Flerov

Yuri Oganessian



D.I. Mendeleev
1834 - 1907

период	ряд	группы элементов																			
		а I б		а II б		а III б		а IV б		а V б		а VI б		а VII б		а VIII б					
1	I	Водород **H** 1 $1s^1$ 1,00794 Hydrogen														Гелий **He** 2 $1s^2$ 4,0026 Helium					
2	II	Литий **Li** 3 $2s^1$ 6,941 Lithium		Бериллий **Be** 4 $2s^2$ 9,012182 Beryllium		Бор **B** 5 $2p^1$ 10,811 Boron		Углерод **C** 6 $2p^2$ 12,011 Carbon		Азот **N** 7 $2p^3$ 14,00674 Nitrogen		Кислород **O** 8 $2p^4$ 15,9994 Oxygen		Фтор **F** 9 $2p^5$ 18,9984032 Fluorine		Неон **Ne** 10 $2p^6$ 20,1797 Neon					
3	III	Натрий **Na** 11 $3s^1$ 22,989768 Sodium		Магний **Mg** 12 $3s^2$ 24,3050 Magnesium		Алюминий **Al** 13 $3p^1$ 26,981539 Aluminum		Кремний **Si** 14 $3p^2$ 28,0855 Silicon		Фосфор **P** 15 $3p^3$ 30,973762 Phosphorus		Сера **S** 16 $3p^4$ 32,066 Sulfur		Хлор **Cl** 17 $3p^5$ 35,4527 Chlorine		Аргон **Ar** 18 $3p^6$ 39,948 Argon					
4	IV	Калий **K** 19 $4s^1$ 39,0983 Potassium		Кальций **Ca** 20 $4s^2$ 40,078 Calcium		Скандий **Sc** 21 $3d^1 4s^2$ 44,955910 Scandium		Титан **Ti** 22 $3d^2 4s^2$ 47,88 Titanium		Ванадий **V** 23 $3d^3 4s^2$ 50,9415 Vanadium		Хром **Cr** 24 $3d^5 4s^1$ 51,9961 Chromium		Марганец **Mn** 25 $3d^5 4s^2$ 54,93805 Manganese		Железо **Fe** 26 $3d^6 4s^2$ 55,847 Iron					
	V	Медь **Cu** 29 $3d^{10} 4s^1$ 63,546 Copper		Цинк **Zn** 30 $3d^{10} 4s^2$ 65,39 Zinc		Галлий **Ga** 31 $4p^1$ 69,723 Gallium		Германий **Ge** 32 $4p^2$ 72,61 Germanium		Мышьяк **As** 33 $4p^3$ 74,92159 Arsenic		Селен **Se** 34 $4p^4$ 78,96 Selenium	9,75238	Бром **Br** 35 $4p^5$ 79,904 Bromine		Криптон **Kr** 36 $4p^6$ 83,80 Krypton					
5	VI	Рубидий **Rb** 37 $5s^1$ 85,4678 Rubidium		Стронций **Sr** 38 $5s^2$ 87,62 Strontium		Иттрий **Y** 39 $4d^1 5s^2$ 88,90585 Yttrium		Цирконий **Zr** 40 $4d^2 5s^2$ 91,224 Zirconium		Ниобий **Nb** 41 $4d^4 5s^1$ 92,90638 Niobium		Молибден **Mo** 42 $4d^5 5s^1$ 95,94 Molybdenum		Технеций **Tc** 43 $4d^5 5s^2$ [98] Technetium		Рутений **Ru** 44 $4d^7 5s^1$ 101,07 Ruthenium		Родий **Rh** 45 $4d^8 5s^1$ 102,90550 Rhodium		Палладий **Pd** 46 $4d^{10}$ 106,42 Palladium	
	VII	Серебро **Ag** 47 $4d^{10} 5s^1$ 107,8682 Silver		Кадмий **Cd** 48 $4d^{10} 5s^2$ 112,411 Cadmium		Индий **In** 49 $5p^1$ 114,818 Indium		Олово **Sn** 50 $5p^2$ 118,710 Tin		Сурьма **Sb** 51 $5p^3$ 121,757 Antimony		Теллур **Te** 52 $5p^4$ 127,60 Tellurium		Иод **I** 53 $5p^5$ 126,90447 Iodine		Ксенон **Xe** 54 $5p^6$ 131,29 Xenon					
6	VIII	Цезий **Cs** 55 $6s^1$ 132,90543 Cesium		Барий **Ba** 56 $6s^2$ 137,327 Barium		Лантан **La** 57 $5d^1 6s^2$ 138,9055 Lanthanum		Гафний **Hf** 72 $5d^2 6s^2$ 178,49 Hafnium		Тантал **Ta** 73 $5d^3 6s^2$ 180,9479 Tantalum		Вольфрам **W** 74 $5d^4 6s^2$ 183,84 Tungsten		Рений **Re** 75 $5d^5 6s^2$ 186,207 Rhenium		Осмий **Os** 76 $5d^6 6s^2$ 190,23 Osmium		Иридий **Ir** 77 $5d^7 6s^2$ 192,22 Iridium		Платина **Pt** 78 $5d^9 6s^1$ 195,08 Platinum	
	IX	Золото **Au** 79 $5d^{10} 6s^1$ 196,96654 Gold		Ртуть **Hg** 80 $5d^{10} 6s^2$ 200,59 Mercury		Таллий **Tl** 81 $6p^1$ 204,3833 Thallium		Свинец **Pb** 82 $6p^2$ 207,2 Lead		Висмут **Bi** 83 $6p^3$ 208,98037 Bismuth		Полоний **Po** 84 $6p^4$ [209] Polonium		Астат **At** 85 $6p^5$ [210] Astatine		Радон **Rn** 86 $6p^6$ [222] Radon					
7	X	Франций **Fr** 87 $7s^1$ 4,073 [223] Francium		Радий **Ra** 88 $7s^2$ 226,025 Radium		Актиний **Ac** 89 $6d^1 7s^2$ [227] Actinium		Резерфордий **Rf** 104 [261] Rutherfordium		Дубний **Db** 105 [262] Dubnium		Сиборгий **Sg** 106 [266] Seaborgium		Борий **Bh** 107 [267] Bohrium		Хассий **Hs** 108 [269] Hassium		Мейтнерий **Mt** 109 [268] Meitnerium		Дармштадтий **Ds** 110 [269] Darmstadtium	
	XI	111		112		113		114		115		116		117		118					

s-элементы
p-элементы
d-элементы
f-элементы

Лантаноиды Lanthanides

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

Актиноиды Actinides

Торий **Th** $7s^2 6d^2$ 232,0381 Thorium	Протактиний **Pa** $5f^2 6d^1$ 231,03588 Protactinium	Уран **U** $5f^3 6d^1$ 238,0289 Uranium	Нептуний **Np** $5f^4 6d^1$ [237] Neptunium	Плутоний **Pu** $5f^6$ [244] Plutonium	Америций **Am** $5f^7$ [243] Americium	Кюрий **Cm** $5f^7 6d^1$ [247] Curium	Берклий **Bk** $5f^9$ [247] Berkelium	Калифорний **Cf** $5f^{10}$ [251] Californium	Эйнштейний **Es** $5f^{11}$ [252] Einsteinium	Фермий **Fm** $5f^{12}$ [257] Fermium	Менделевий **Md** $5f^{13}$ [258] Mendelevium	Нобелий **No** $5f^{14}$ [259] Nobelium	Лоуренсий **Lr** $5f^{14} 6d^1$ [262] Lawrencium

112
Chemical identification in 2006

113
Discovered at JINR in 2003

114
Discovered at JINR in 1999

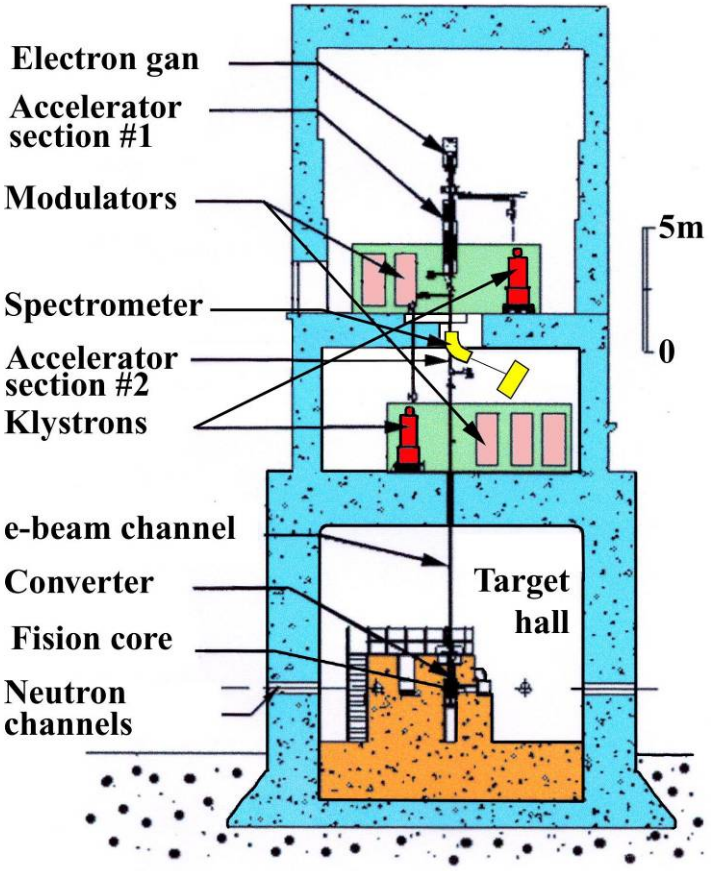
115
Discovered at JINR in 2003

116
Discovered at JINR in 2000

118
Discovered at JINR in 2001

Intense Resonance Neutron Sourse (IREN)

IREN



IREN 1-st stage
parameters with TH2129 klystron

Max. electron energy – 75 MeV

Av. electron energy – 50 MeV

Peak electron current – 2.8 A

Pulse duration – 200 ns

Repetition rate – 50 Hz

Beam power – 1.4 kW

Neutron flux ~ $3 \cdot 10^{12}$ n/s

First e-beam November 2008
Start of experimental program:
May 2009

High Energy Physics

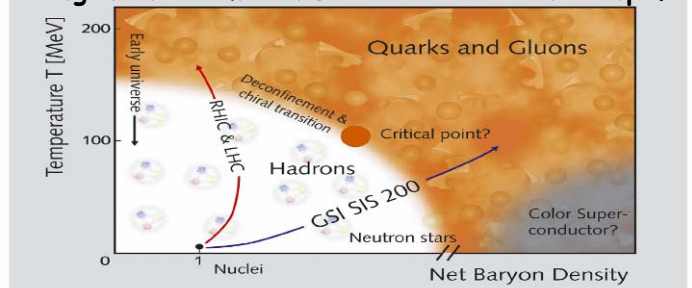
Nuclotron is superconducting synchrotron for heavy ions

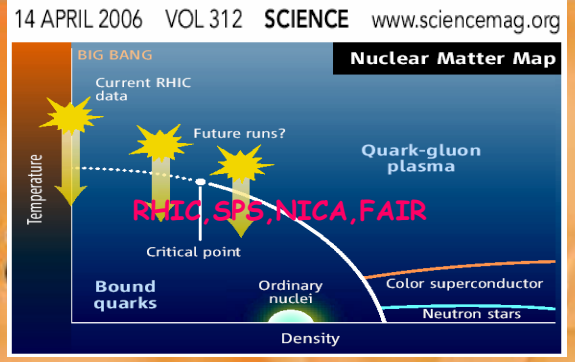
(has been operating since 1993).

The main home facility (today): Nuclotron complex of VBLHEP (upgrade till 2009).

Future plan: creation of NICA/MPD – Nuclotron-Based Ion Collider Facility and Multipurpose Detector (2014).

www.gsi.de/documents/DOC-2004-Mar-196-2.pdf





T

Early universe

Quarks and Gluons

Critical point?

Deconfinement and chiral transition

Mixed phase

Hadrons

RHIC, LHC

FAIR SIS 300

NICA

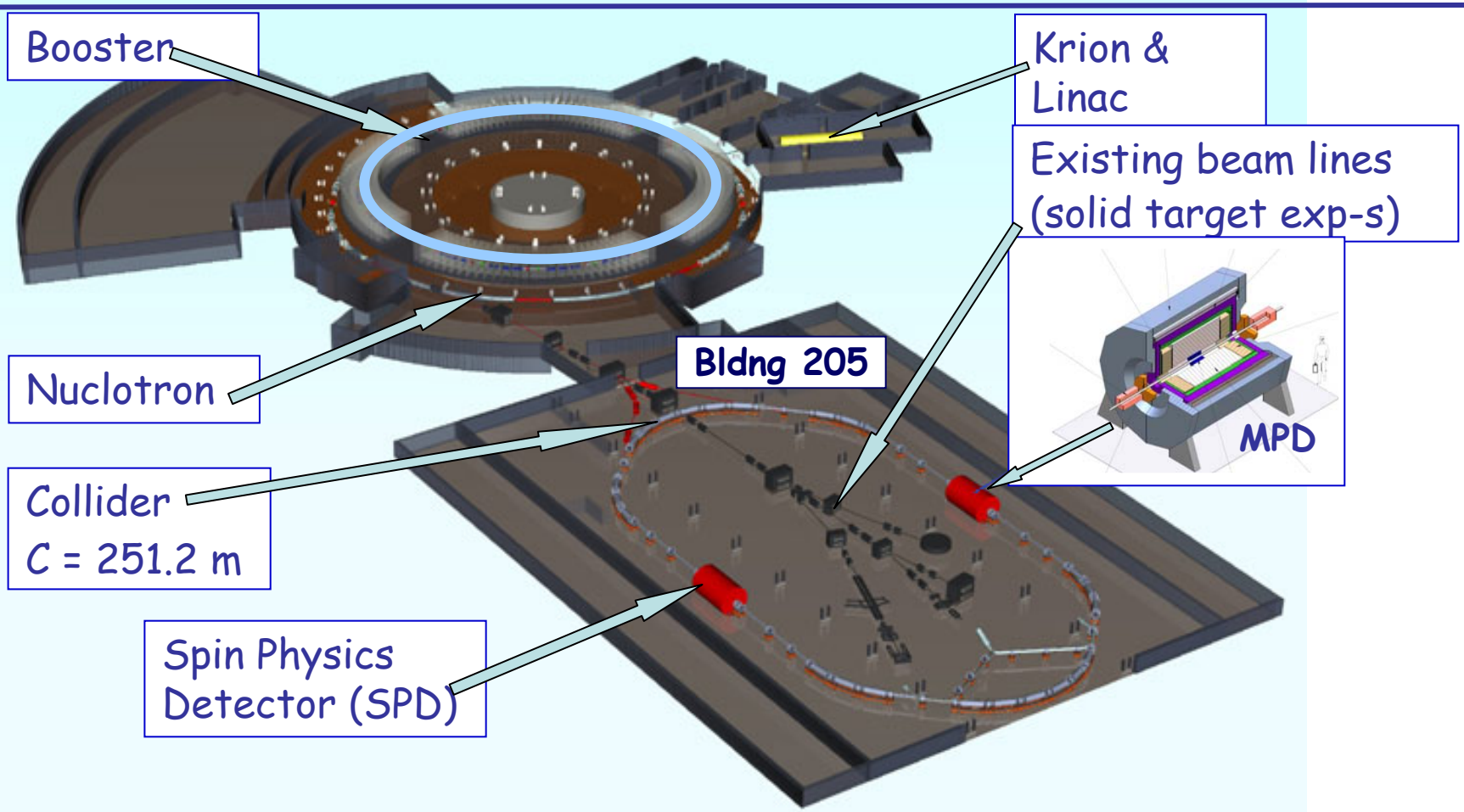
Neutron stars

Color Super-conductor?

N_B

A.N.Sissakian
A.S.Sorin
M.K.Suleymanov
V.D.Toneev
G.M.Zinovjev

NICA Scheme and Operation Scenario



NICA Scheme and Operation Scenario

Injector: 2×10^9 ions/pulse of $^{238}U^{32+}$ at energy 6 MeV/u

Booster (30 Tm)
2(3?) single-turn injections, storage of 3.2×10^9, acceleration up to 50 MeV/u, electron cooling, acceleration up to 400 MeV/u

Collider (45 Tm)
Storage of 15 bunches × $1\cdot10^9$ ions per ring at 1÷4.5 GeV/u, electron and/or stochastic cooling

Stripping (40%) $^{238}U^{32+} \Rightarrow {}^{238}U^{92+}$

Nuclotron (45 Tm)
injection of one bunch of 1.1×10^9 ions, acceleration up to 1÷4.5 GeV/u max.

IP-1

Two superconducting collider rings

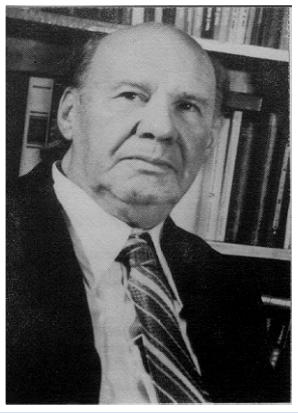
IP-2

2x15 injection cycles

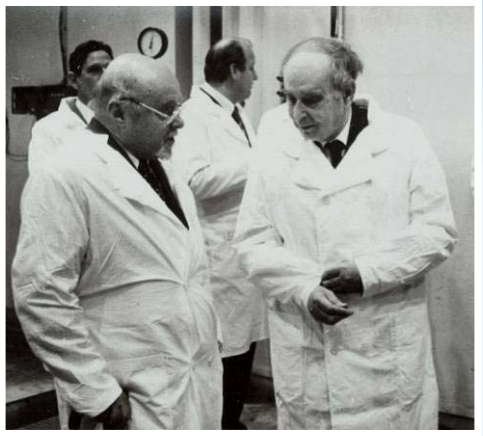
Bunch compression ("overturn" in phase space)

Neutron Reactor IBR-2

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



D. Blokhintsev



N. Dollezhal and I. Frank

operating since 1984

Parameters of Source

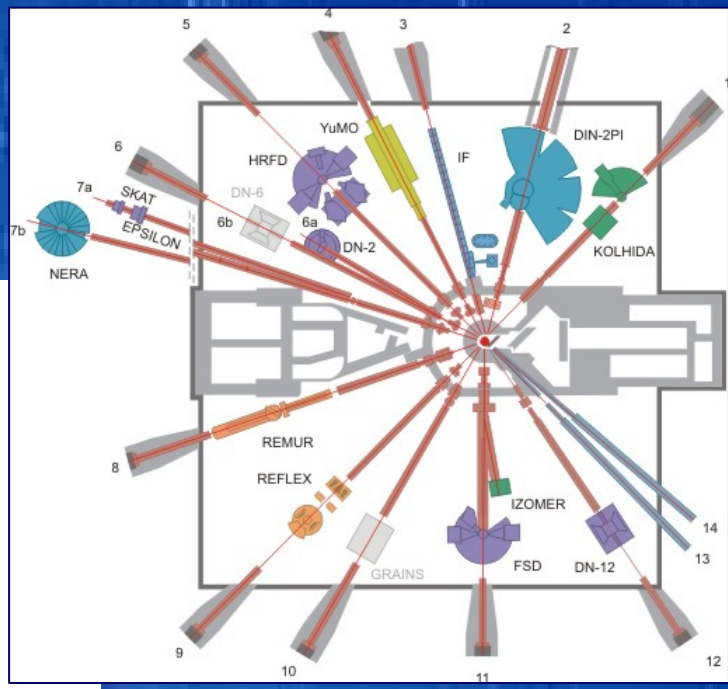
Power: mean 2 MW,
in pulse 1500 MW

Pulse freqency: 5 Hz.

Neutron flux in pulse 5 x 10^{15}

Neutron pulse width: 320 μs

“Road Map” – in the field of Condensed Matter Physics



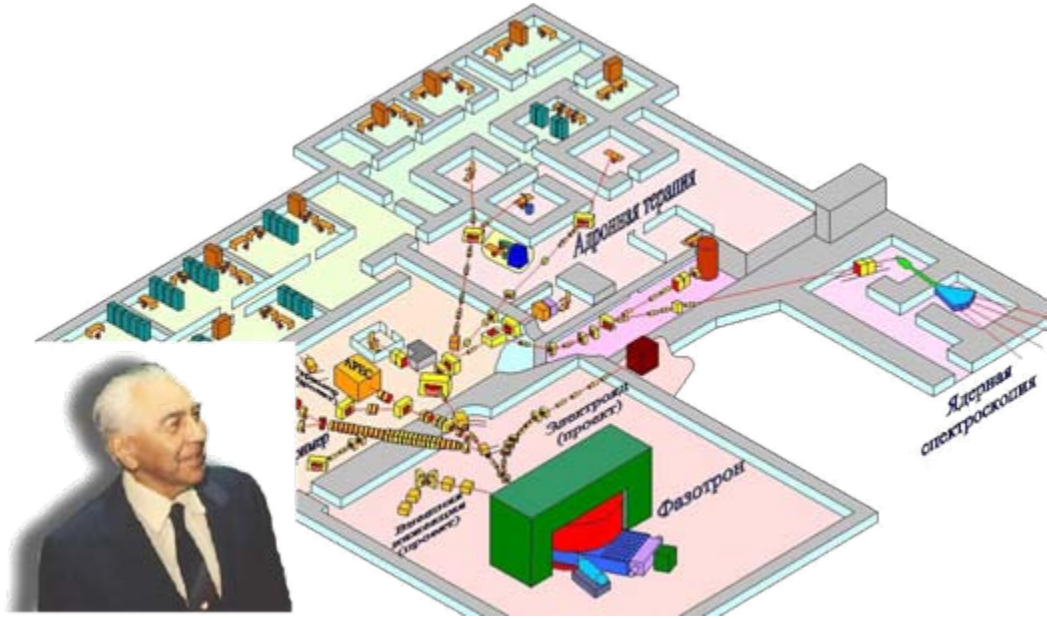
The main home facility:
reactor IBR-2
(now under reconstruction)

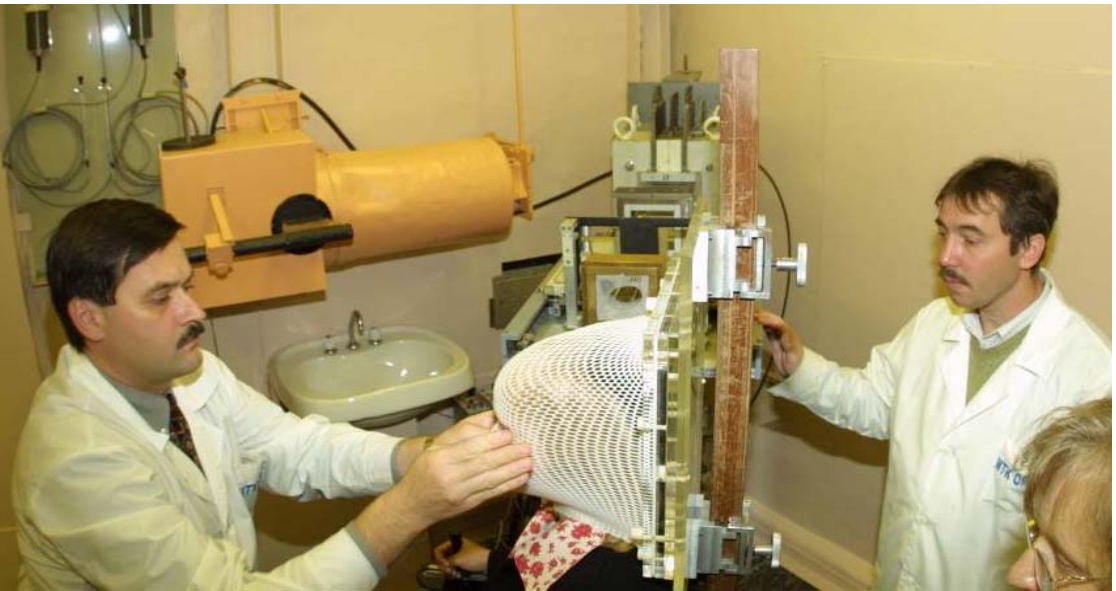
Plans:

- **upgraded reactor IBR-2M (2010)**
- **creation of a complex of modern neutron spectrometers around modernized reactor (2011-2015)**

JINR Medical-Technical Complex on proton beams of synchrocyclotron

1967 – First investigations at cancer treatment;
1999, – Creation of radiological department in Dubna hospital;
2000 – 2008, – 456 patients were radiated by proton beam.



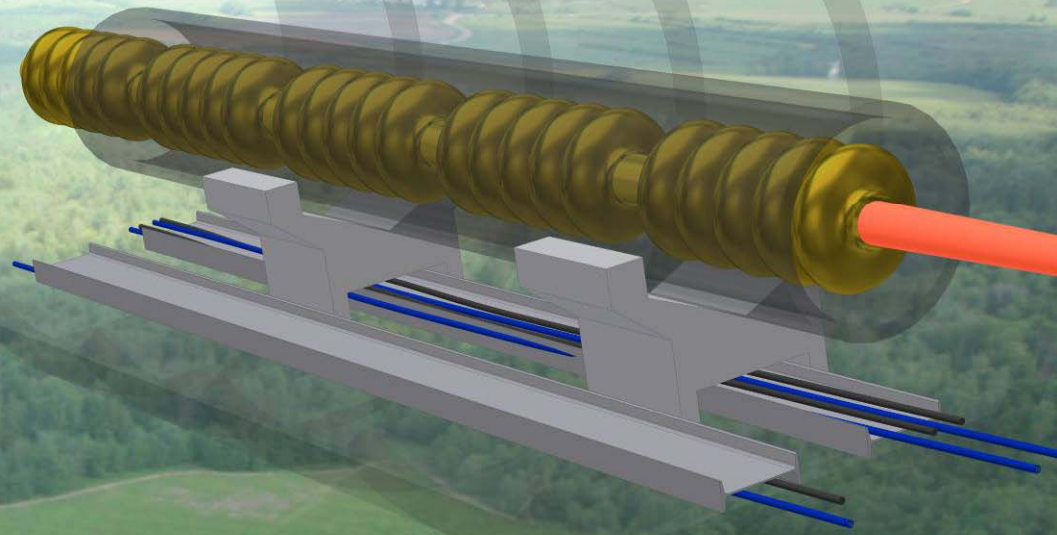


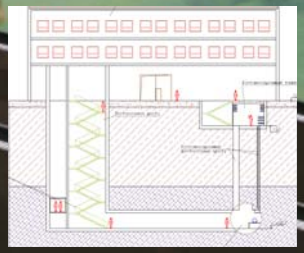
During last years around 100 patients per year were radiated by proton beam in JINR

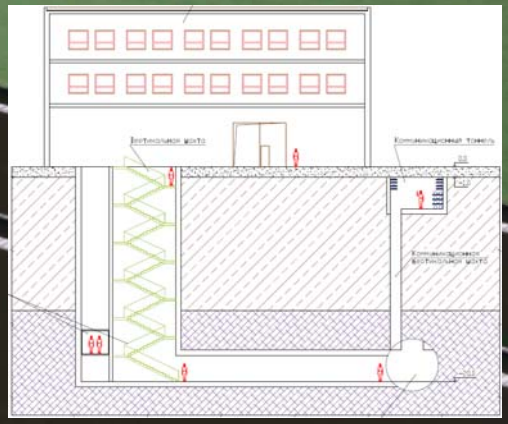
New facility for proton therapy at JINR: cyclotron IBA C235

The prototype of C235 will be assembled, tested and put in operation at JINR in cooperation with IBA (Belgium)

DUBNA SITING and ILC ACTIVITY in JINR

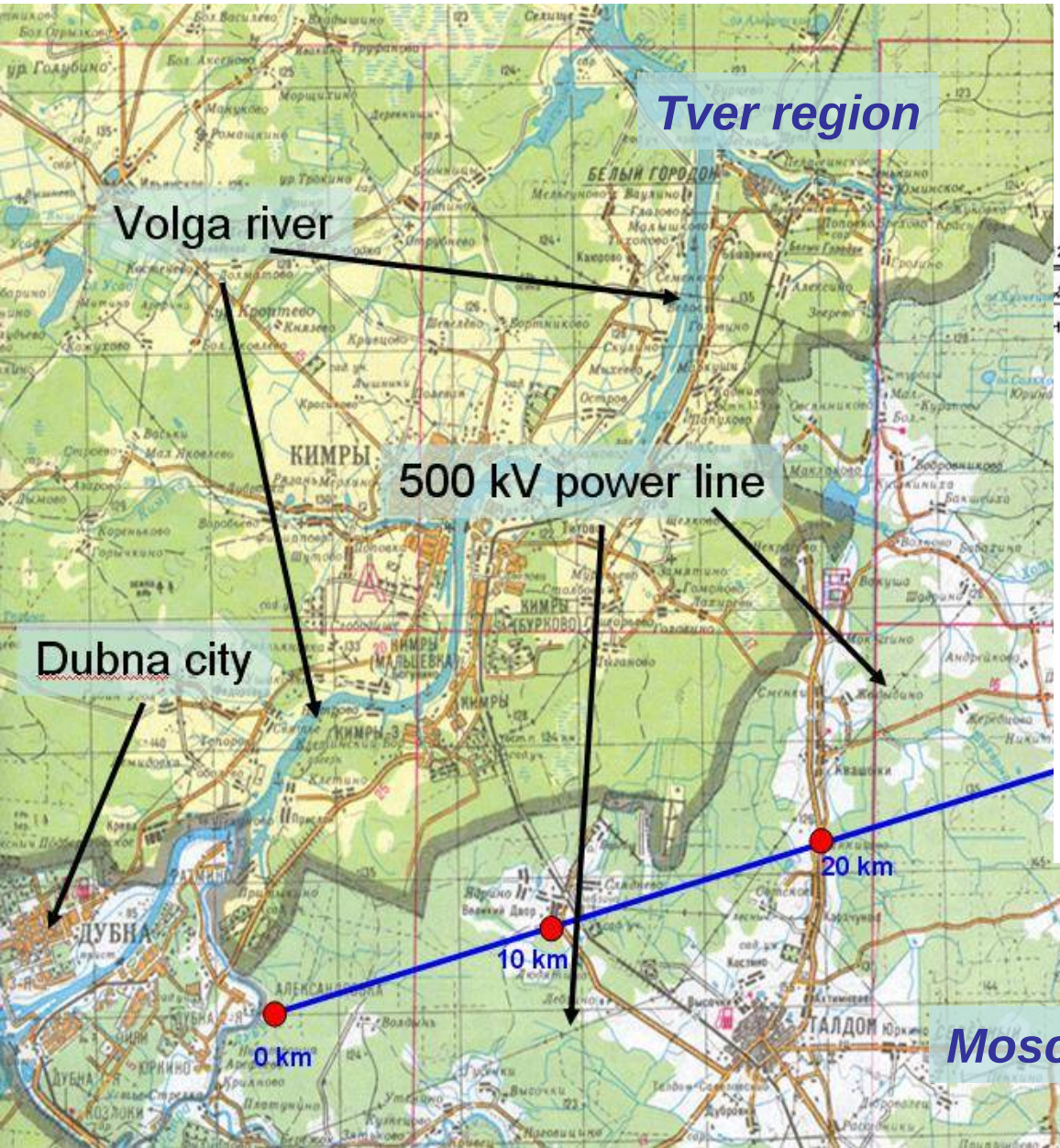






Shallow site layout with one tunnel in the Dubna region

Layout of ILC in the Moscow Region



МИНИСТЕРСТВО
ПРОМЫШЛЕННОСТИ И НАУКИ
МОСКОВСКОЙ ОБЛАСТИ

25009, Москва, ул. Тверская, 12, стр. 2 тел.: 629-61-62, факс: 629-02-52

29.03.2007 № 15.3-589/1

На № _____ от _____

Директору Объединенного
института ядерных исследований

А.Н. Сисакяну

Уважаемый Алексей Норайрович!

Министерству промышленности и науки Московской области поручено проинформировать Вас, что Губернатор Московской области Б.В. Громов поддерживает инициативу ОИЯИ по размещению Международного Линейного Коллайдера на территории Московской области и готов на соответствующем этапе оказать содействие в пределах полномочий Московской области как субъекта Российской Федерации (обращение от 16.02.2007 № 010-28/186).

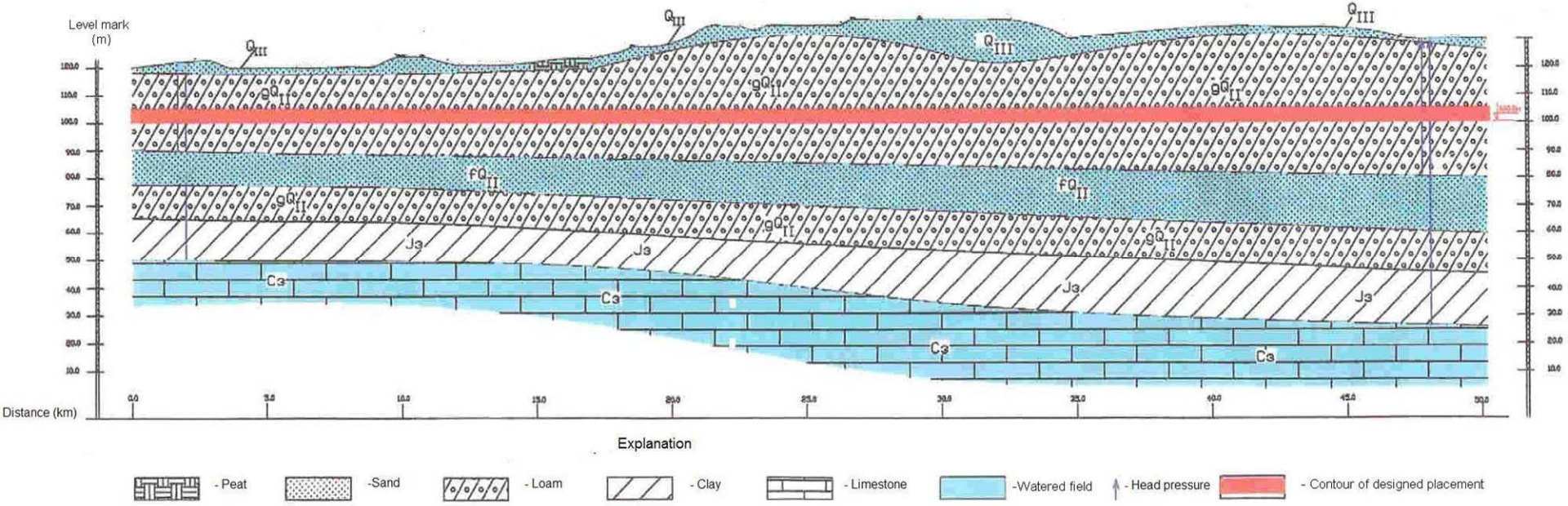
С уважением,

Министр В.И. Козырев

Unique Proposal of Shallow Tunnel Solution in Dubna Region

The ILC is proposed to be placed in the drift clay at the depth of 20 m (at the mark of 100.00 m) with the idea that below the tunnel there should be impermeable soil preventing from the underlying groundwater inrush. It is possible to construct tunnels of the accelerating complex using tunnel shields with a simultaneous wall timbering by tubing or falsework concreting.

Standard tunnel shields in the drift clay provide for daily speed of the drilling progress specified by the Project of the accelerator (it is needed approximately 2.5 years for the 50 km tunnel).



GDE Meeting at JINR: Dubna Site Discussion

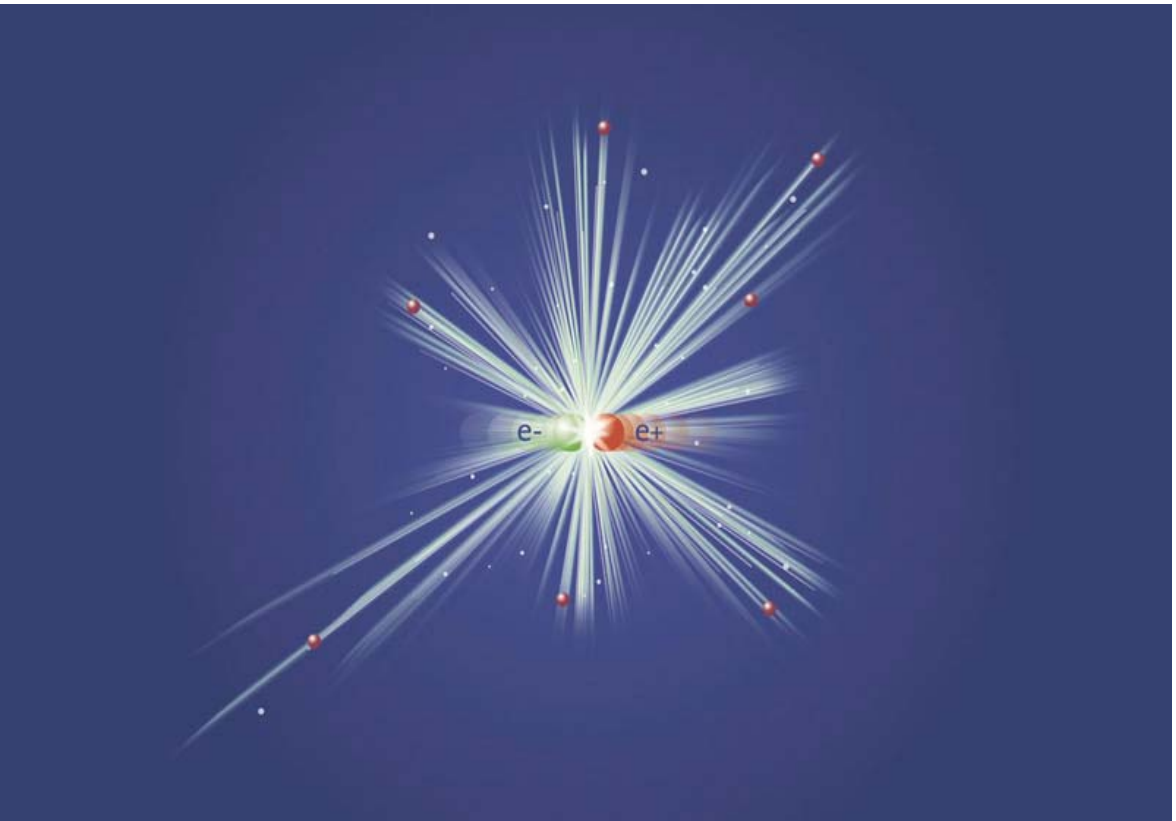
Members of GDE and ILCSC
Dubna, June 7, 2008

Participation of JINR in the ILC International Technical Activity

International Linear Collider: accelerator physics and engineering

Theme leaders:

A.N. Sissakian
G.D. Shirkov



Period: 2007- 2009

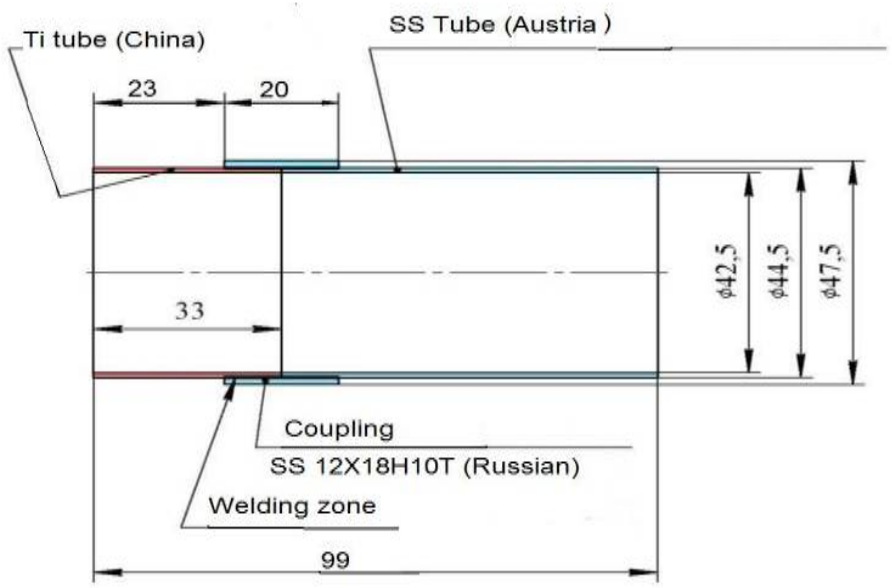
-Preparation of works of JINR;

-Participation in estimations and design of ILC elements

JINR Participation in the ILC Cryomodule design.

This international effort includes contributions from many institutions, including JINR together with FSUE “RFNC-VNIIEF” (Sarov, Russia). The key participants at the JINR are J.Budagov, B.Sabirov and A.Sukhanova.

In the recent months JINR and Sarov have started a collaboration with INFN-Pisa on a bi-metallic Ti-SS transition tube to connect the Titanium helium vessel with a 76-mm diameter two-phase helium line in an ILC cryomodule (CM). Such a transition would allow for a very substantial cost savings in the ILC cryomodule production. Successful preliminary tests with prototype transition tubes of a smaller diameter, supplied by JINR and Sarov, were conducted by JINR in collaboration with INFN-Pisa.



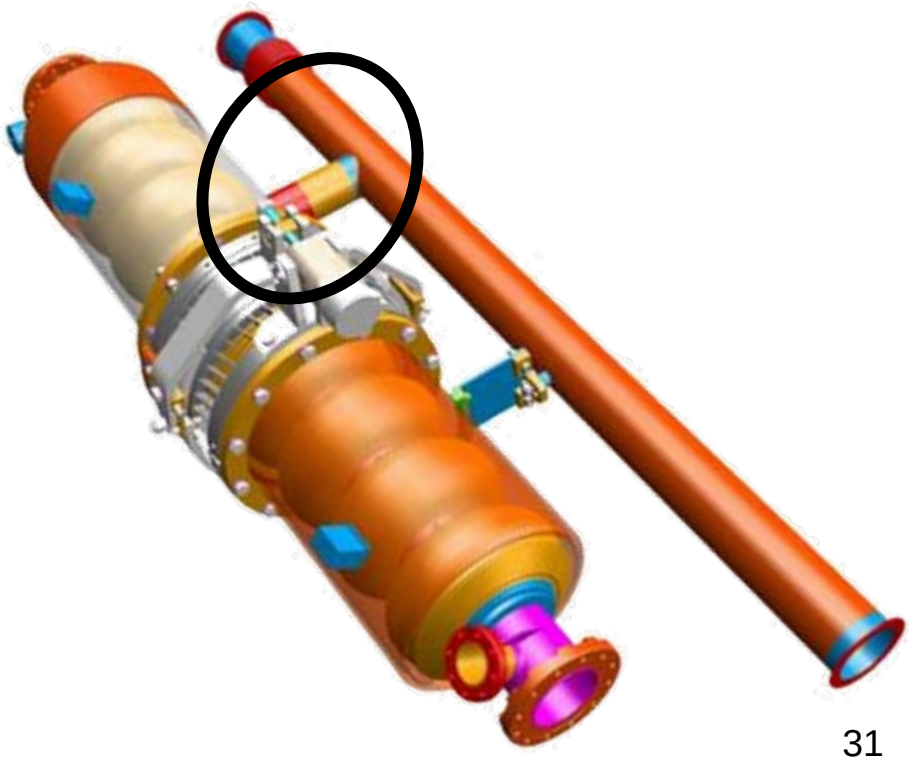
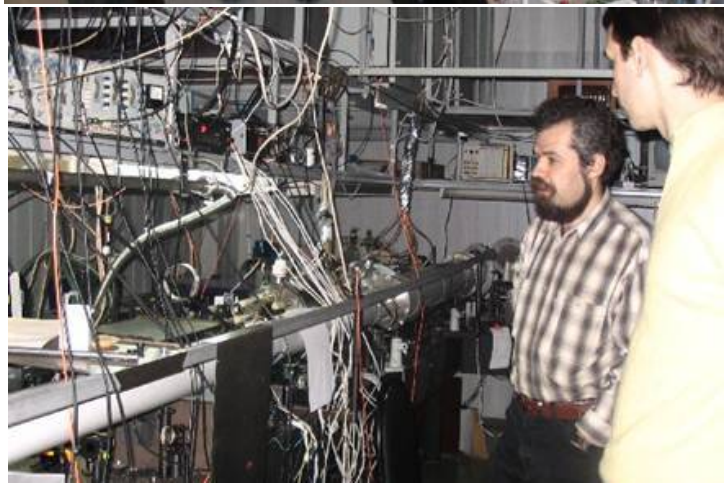
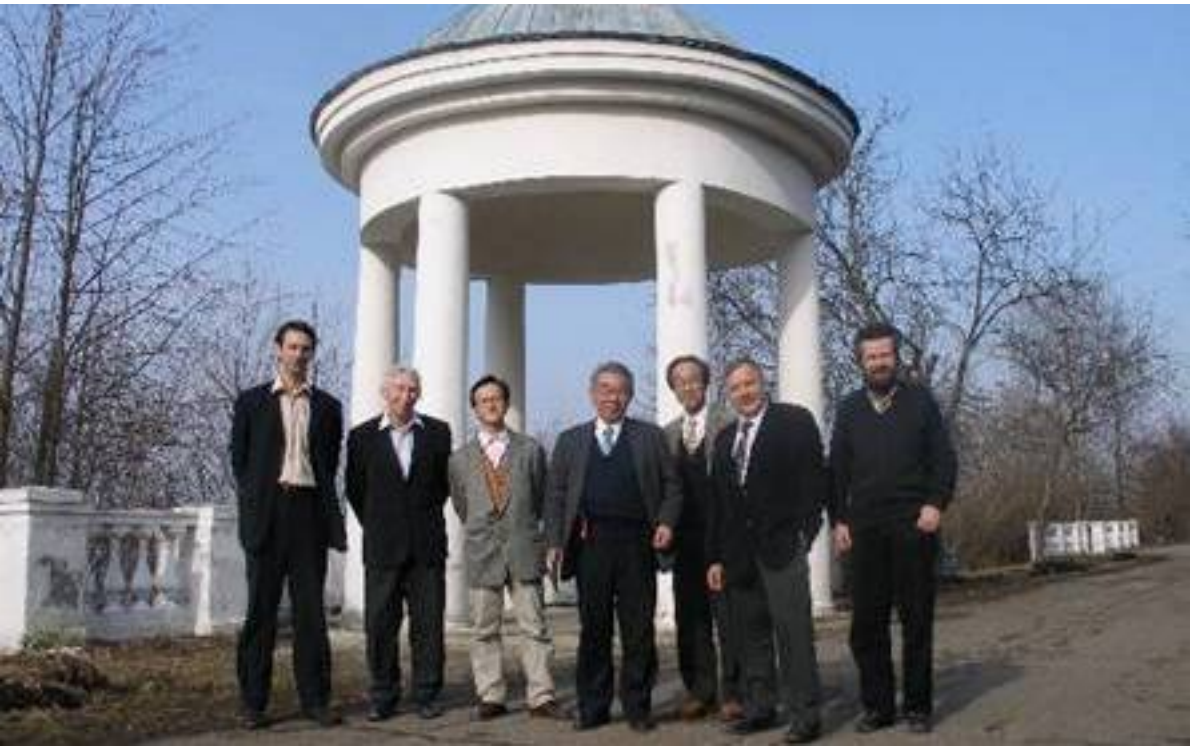


Photo injector prototype activity

Main results:

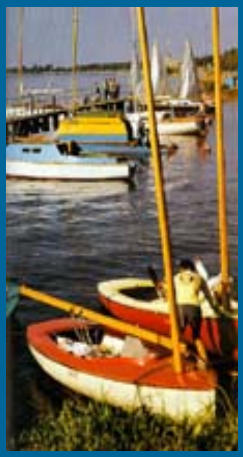
- JINR scientists worked in operation runs at PITZ and FLASH. Several scientific missions of JINR staff to DESY Hamburg and Zoethen were done.
- *JINR performed design and started construction* of the test bench for CsTe photocathode preparation. This test bench is planed to be used for preparation of GaAs photocathode in future.





Welcome to JINR (Dubna)




JINR Dubna