

# Budker Institute of Nuclear Physics

Siberian Branch of Russian Academy of Science

---



# Contents

---

- ☐ General information
- ☐ Basic research
- ☐ Applied research
- ☐ Production capability
- ☐ Collaboration
- ☐ Our guests

---

# General information

BINP winter view





# History

---

- ❑ Institute of Nuclear Physics was founded in 1958 as a lab in Moscow Institute of Atomic Energy (Kurchatov Institute)
- ❑ The founder of INP was the prominent Soviet physicist Andrey M. Budker (1918-1977)
- ❑ In 1960 the Institute moved from Moscow to Novosibirsk
- ❑ Academician Aleksander N. Skrinsky – INP director from 1977 till 2015.
- ❑ Corresponding member of RAS Pavel V. Logatchev – INP director from June 1, 2015.
- ❑ Today BINP is the largest institute in the Russian Academy of Sciences



Academician A.M. Budker –  
INP founder and first Director  
(1958-1977)

# Location



# Staff

---

Total staff of BINP is ~2700; among them

- ❑ Scientists ~ 420
- ❑ Engineers ~ 400
- ❑ Laboratory technicians ~ 400
- ❑ Workshop personnel ~ 1000
- ❑ Administration ~ 200
- ❑ Support personnel ~ 200



# Directorate (Sci. & Tech.)

**Director  
Academician  
of RAS  
P.Logatchev**



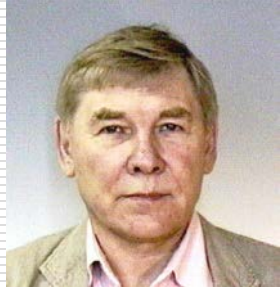
**BINP Scientific leader  
Acad. A.Skrinsky**



**RAS adviser  
Acad. G.Kulipanov**



## Vice Directors:



**N. Mezentsev  
SR and FELs**



**A.Ivanov  
plasma  
research**



**Yu.Tikhonov  
HEP,  
detectors**



**E.Levichev  
colliders,  
accelerators**



**A.Bondar  
HEP,  
detectors**



**A.Burdakov  
plasma  
research**



**A.Vasil'ev**



**Sci. Secretary Ya.Rakshun**



**Chief Engineer I.Churkin**



**Workshop Chief A.Steshov**

# Scientific council

---

Scientific Council consists of prominent investigators and research program leaders and directs the BINP scientific strategy





---

BINP fall view

Basic research

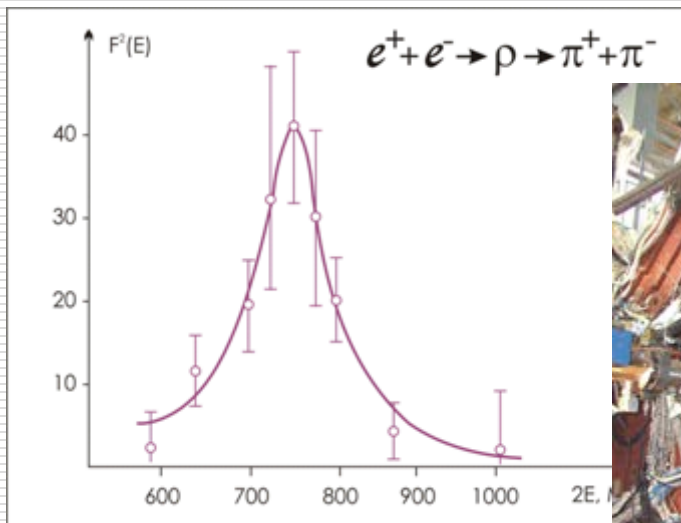
# Basic research activity

---

- ☐ High energy physics and  $e^+e^-$  colliders
- ☐ Accelerator physics and technology
- ☐ Thermonuclear research
- ☐ Theoretical physics

# HEP and colliders

- ❑ The first collider was demonstrated at BINP, Frascati LNF and SLAC
- ❑ Electron-positron colliders VEP-1, VEPP-2, VEPP-2M, VEPP-4 operated at BINP in the past
- ❑ VEPP-4M (5 GeV) and VEPP-2000 (1 GeV, round beams) are currently in operation



The world's first experiment at  $e^+e^-$  colliders



Detector KEDR at VEPP-4M



VEPP-2000 - the first collider with round beam option

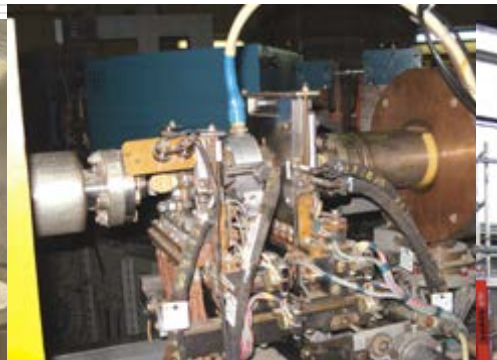


# Accelerator technology

- ❑ Colliding beam method realization
- ❑ Electron cooling invention and realization
- ❑ Charge exchange injection development
- ❑ Proposing and development of the optical klystron – the FEL modification with the highest radiation power
- ❑ High field Li-lens has been proposed



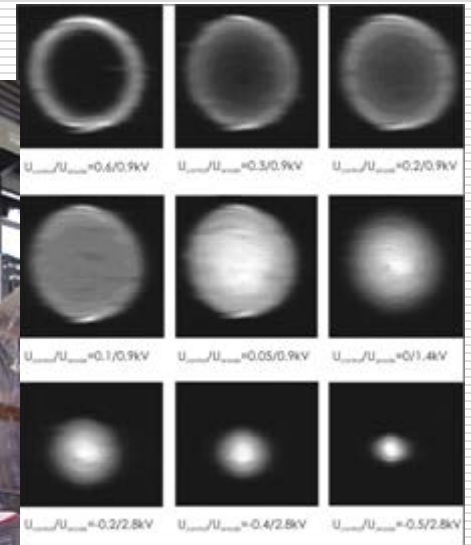
High voltage accelerating columns



Li lens for positrons collection



9 T superconducting magnet

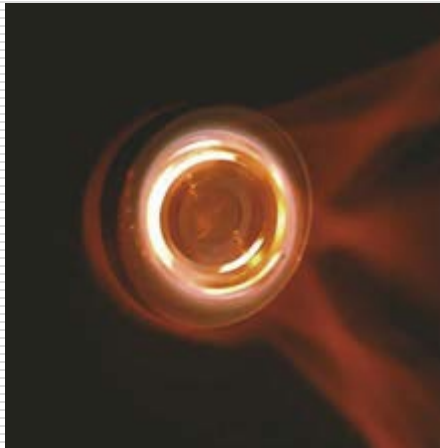


Electron cooling of a proton beam

# Thermonuclear research

---

- ❑ Mirror and multi-mirror traps for plasma have been proposed at BINP
- ❑ Ambipolar trap for plasma has been invented
- ❑ Gas-dynamic trap has been suggested and implemented
- ❑ Ion injectors with record-breaking parameters (beam power  $\sim 1\text{MW}$ ) for the plasma heating have been developed



The light from  
hot plasma



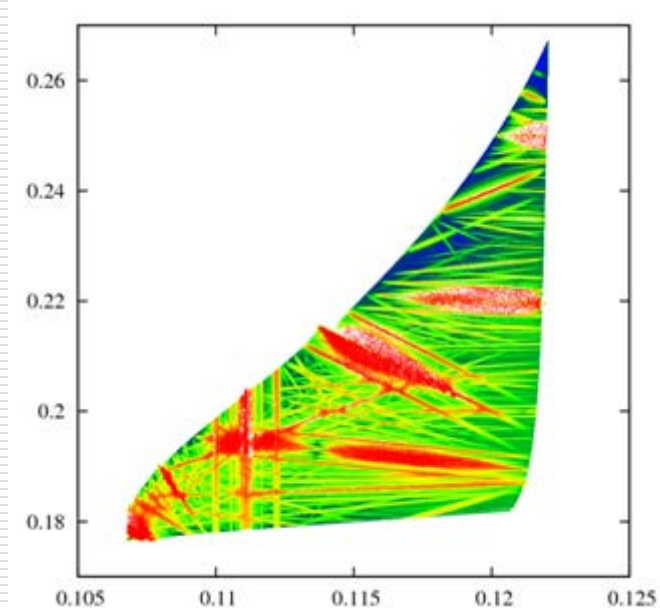
Gas-dynamic plasma trap



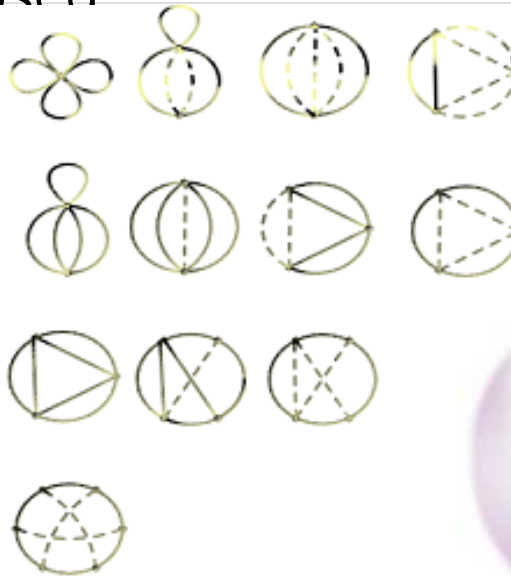
Multi-mirror plasma trap

# Theoretical physics

- ❑ Discovery of the coherence effect at gluons radiation in chromo dynamics
- ❑ The well known BFKL equation for energy dependence of QCD half-rigid process amplitudes has been derived
- ❑ Outstanding contribution into the investigation of standard model properties
- ❑ Stochasticity resonance overlapping criterion (Chirikov criterion) has been proposed

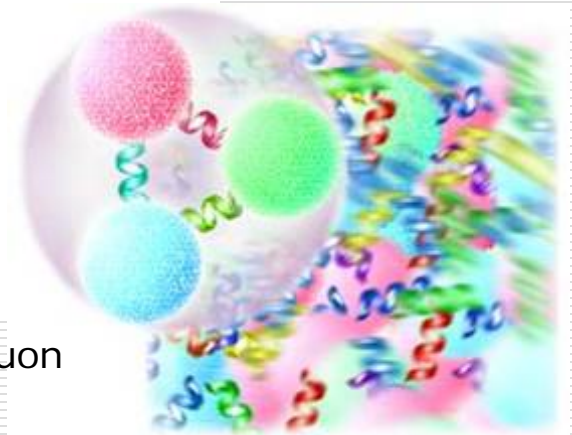


Stochastic areas in the BB footprint



Four-loop integrals developed at BINP for description of QGP

Quark-gluon plasma





---

Liquid Kr storage



Applied research

# Applied research activity

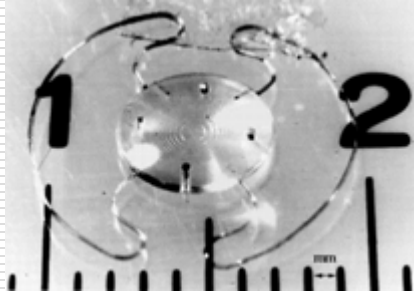
---

- ☐ Synchrotron radiation and FEL
- ☐ Industrial accelerators
- ☐ Physics for medical application
- ☐ Accelerator mass spectrometer

# Synchrotron radiation and FEL

---

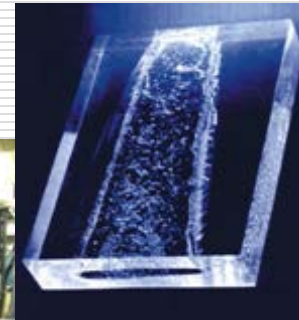
- ❑ Siberian Synchrotron Radiation Center is based at BINP
- ❑ SR researches at the storage rings VEPP-3 (2 GeV) and VEPP-4 (1 - 5 GeV)
- ❑ FEL with the record-high radiation power (500 W average) in the terahertz region



Artificial crystalline lens produced by the SR LIGA technology



SR research hall at VEPP-3



Hole melted in Plexiglas by powerful radiation



Terahertz light from FEL at the sample



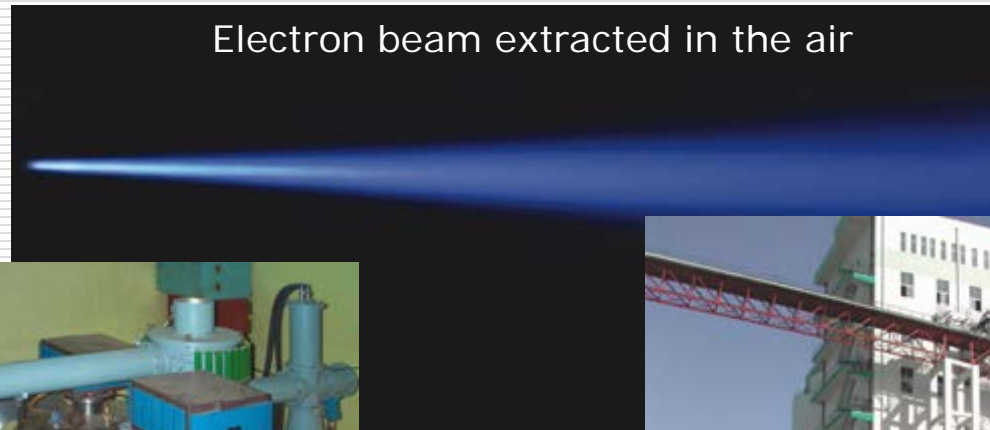
# Industrial accelerators

Two types of small electron accelerators for industrial applications (radio-chemistry, food, drug, medical equipment sterilization, water and flue-gas treatment, etc.). More than 100 devices were supplied to China, Korea, Japan, USA, et.

- ❑ ILU-type RF accelerators (electron energy up to 5 MeV)
- ❑ ELV-type rectifier type accelerators (energy 0.4-1 MeV, beam power up to 400 kW)



400 kW ELV  
accelerator



Electron beam extracted in the air



Compact ILU accelerator



Grain storage in China  
equipped with the ELV  
accelerator for insect  
sterilization

# Medical and safety application

- ❑ Cancer therapy synchrotron project based on the electron cooling
- ❑ Extremely low dose X-ray imaging systems
- ❑ Medical stuff and equipment sterilization by powerful electron beam
- ❑ New drugs production with electron beam
- ❑ X-ray anti-terror system



Cancer therapy synchrotron project

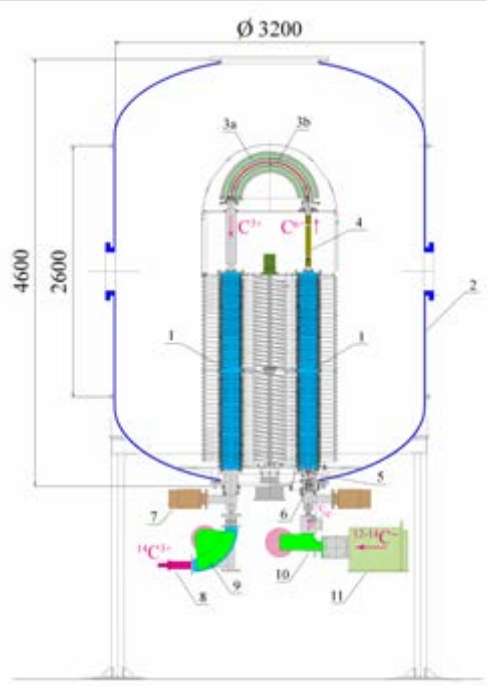
"Terrorist" with clearly seen plastic knife, gun and explosive

Anti-terror X-ray system in Moscow airport



# Accelerator mass spectrometer

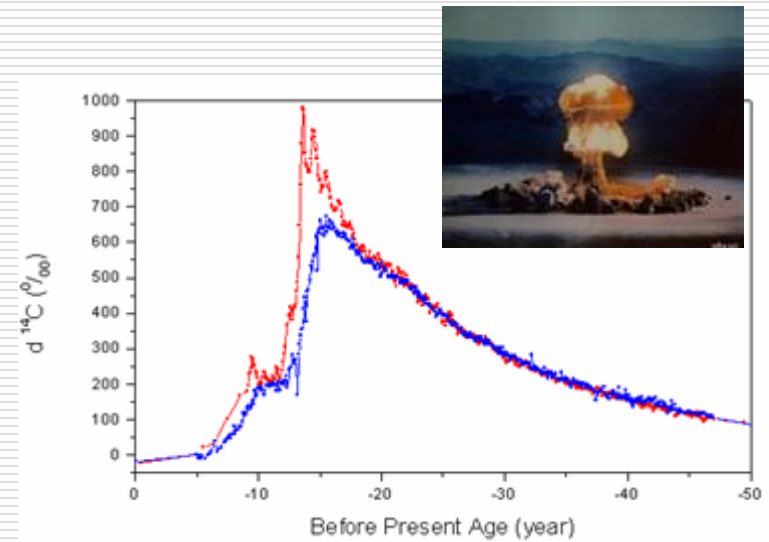
- ❑ The first AMS in Russia has been developed by BINP for Siberian Branch of Russian Academy of Sciences
- ❑ The AMS is based on the 2 MV electrostatic tandem accelerator. A 180-deg bend at the head of accelerator provides effective filtering of many ion species and isobars
- ❑ Applications: archeology dating, medical, biology and pharmaceuticals tests, etc.



BINP AMS schematic view



AMS tandem accelerator



Nuclear test peak of C14 measured in Novosibirsk



---

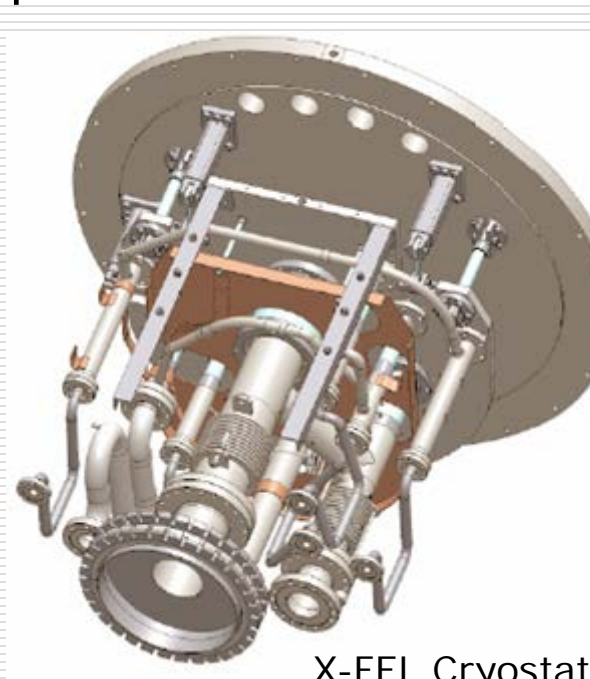
# Production capability



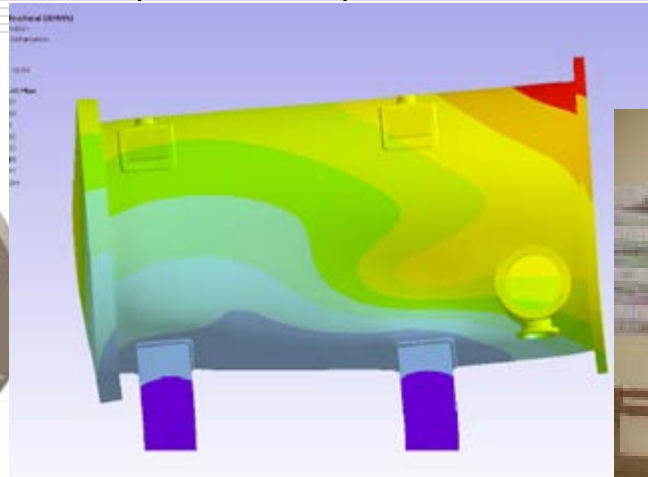
# Development and design

---

- ❑ Experienced scientists can develop any (new) product required by customer from scratch
- ❑ A Design Department (70 designers) is equipped with the modern CAD software
- ❑ BINP designers are familiar with design standards, tools, procedures of CERN, DESY, BESSY, etc.



X-FEL Cryostat  
end cup



ANSYS simulation of the vacuum  
tank deformation due to the  
vacuum failure



Design approving  
procedure

# Manufacture

---

The Workshop comprises 150 technological divisions, sectors and specialized shops with the total area of 60000 m<sup>2</sup>, about 1000 of workers, technologists and engineers



Main workshop Google view



Workshop departments view





# Test facilities

---

We have many precise stands for mechanical, magnetic, electrical, vacuum, cryogenic, water, etc. tests of manufactured equipment



3D coordinate measurement machine



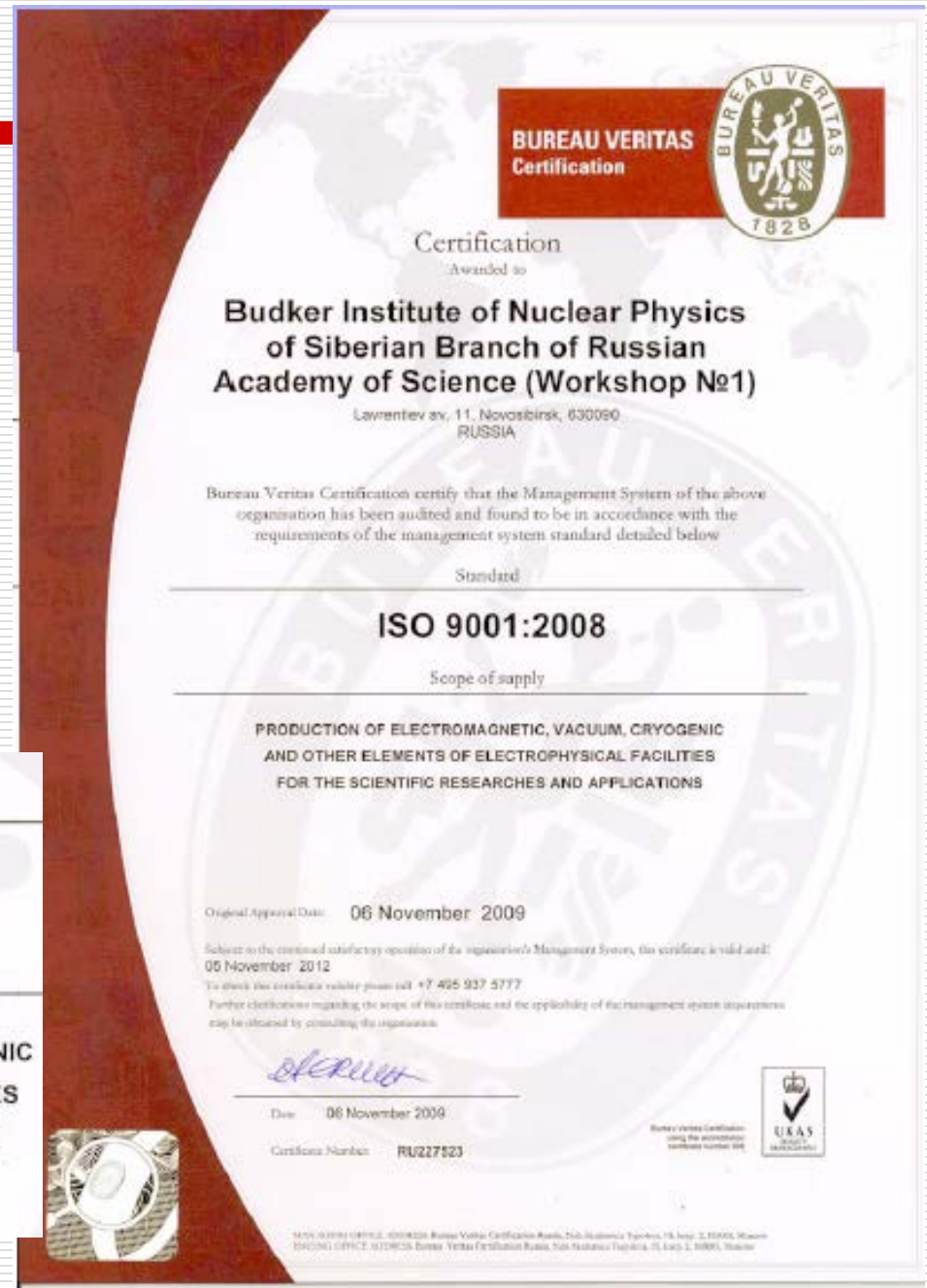
CERN magnets at the magnetic measurement bench



Vacuum welding test equipment



- ❑ ISO 9001 certificate
- ❑ Certificates for welding, pressure vessels production, inspection tests, technologists, etc.





# International collaboration





# International collaboration

---

- ❑ BINP has experience of more than a 40-year collaboration with tens of institutes and laboratories all over the world
- ❑ BINP participated and is participating in all major accelerator, HEP, SR, plasma projects (LHC, PETRA III, X-FEL, FAIR, Belle, BaBar, etc.)
- ❑ BINP has an experience in supplying equipment abroad including commercial negotiations, transportation, customs clearance, international insurance, etc.



Truck with LHC magnets is headed from BINP for Geneva



BINP custom logistic terminal

# Collaboration map

Distribution of the equipment produced by BINP in the world and in Europe





# Product groups (incomplete...)



Magnets



PS and electronics



Compact neutron source



Industrial  
e- accelerators



SC wigglers



Undulators



MW ion source



High vacuum systems



BNCT



e- cooler



RF systems

AMS



X-ray scanners



Turn-key facilities



# CERN Golden Hadron

---



Golden Hadron Prize awarded to BINP by European Organization for Nuclear Research (CERN) for the production and delivery of equipment for the Large Hadron Collider (LHC).

# Our guests (incomplete...)



Charles de Gaulle (1966)



Jiang Zemin (1998)



Boris Eltsin (1991)



Dmitry Medvedev (2006)



Rajiv Gandhi (1983)



Piotr Kapitsa (1961)



Vladimir Putin (2000)



Josip Broz Tito (1968)



Zhores Alferov (2005)



Georges Pompidou (1970)



R. Moessbauer (1986)



G. Sharpak (1988)

# Conclusion

---

- ❑ BINP is the one of the world's leading scientific centers in the field of HEP,  $e^+e^-$  colliders, SR and plasma research, etc.
- ❑ BINP is a well known engineering company for production of accelerator components, equipment and turn-key systems
- ❑ BINP has experience of the long-term successful collaboration and contractual activity with many laboratories all over the world
- ❑ BINP has expertise in the legal, customs, transport, warrant and all other necessary maintenance of producing goods and services



# Welcome to BINP! Welcome to Siberia!

---



Mushrooms collected at the BINP recreation camp located at the Ob' Lake shore