CHANNELING - 2016

NRNU "MEPhI": from UNIVESITY BASICS to ADVANCED TECHNOLOGIES

NIKOLAY KALASHNIKOV

History

MEPhI was founded during World War II in 23 November,1942 initially as Moscow Mechanical Institute of Ammunition by Stalin's personal order.

The main goal of its foundation was to collect brilliant minds together, train them and urgently start research in creation of nuclear weapon.

Since the end of 50-th the main goal of Moscow Engineering Physics Institute is the peopleware for developing of nuclear industry (research, engineering, technologies)

WHO WAS AT THE ORIGIN

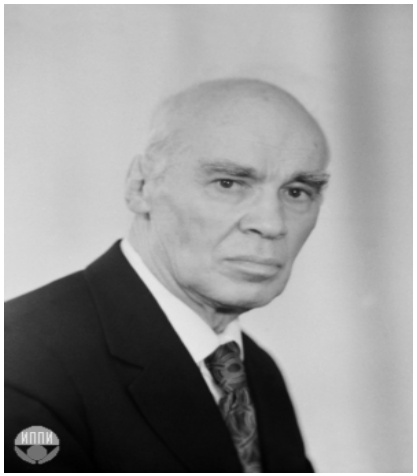
Academicians

I.V. Kurchatov

I.V. Kurchatov was the “father” of the Soviet atomic project.

L.A. Artsimovich

L.A. Artsimovich worked in the field of nuclear fusion and plasma physics. He was known as “the father of the Tokamak”.



I.K. Kikoin

I.K. Kikoin made prominent achievements in research in the field of atomic technologies and solid state physics.

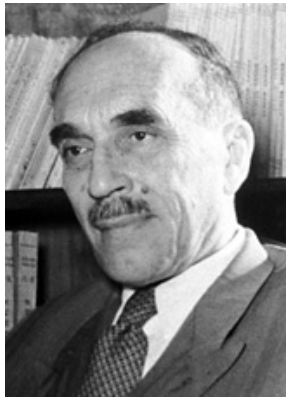
WHO WAS AT THE ORIGIN

The Nobel Prize Winners


P.A. Cherenkov


I.M. Frank


I.E. Tamm


N.N. Semenov


N.G. Basov

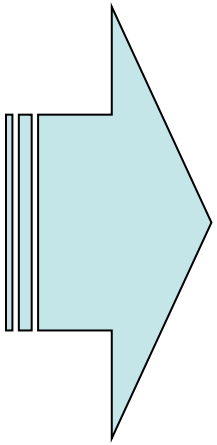

A.D. Saharov

Nuclear Education in Russia

Main challenges:

- human resource development for Russian nuclear renaissance (engineering, technology, research)
- human resource development to support RosAtom international activity
- integration into the world system of nuclear education
- restructuring of higher education system in the Russian Federation: two level study (master and bachelor degrees), new national educational standards for higher education
- negative demographic trends and unpopularity of technical education among young people
- graduates from Moscow Universities stay in Moscow and do not go to regional enterprises

Presidential Decision:



To create **National Research Nuclear University MEPhI** as a **educational** and **research** holding for nuclear industry inside and outside of the Russian Federation

- 2 National Universities – Moscow State University and S-Petersburg State University.
- 29 National Research Universities were organized in 2008-2010.
- 8 Federal Universities were organized in 2006-2010.

MEPhI mission is to provide together with RosAtom the high level human resources for national nuclear industry inside and outside the Russian Federation.

Scientific-educational cluster NRNU MEPhI for training of nuclear technologies

IATE, Obninsk

MEPhI, Moscow

VITI, Volgodonsk

STI, Seversk

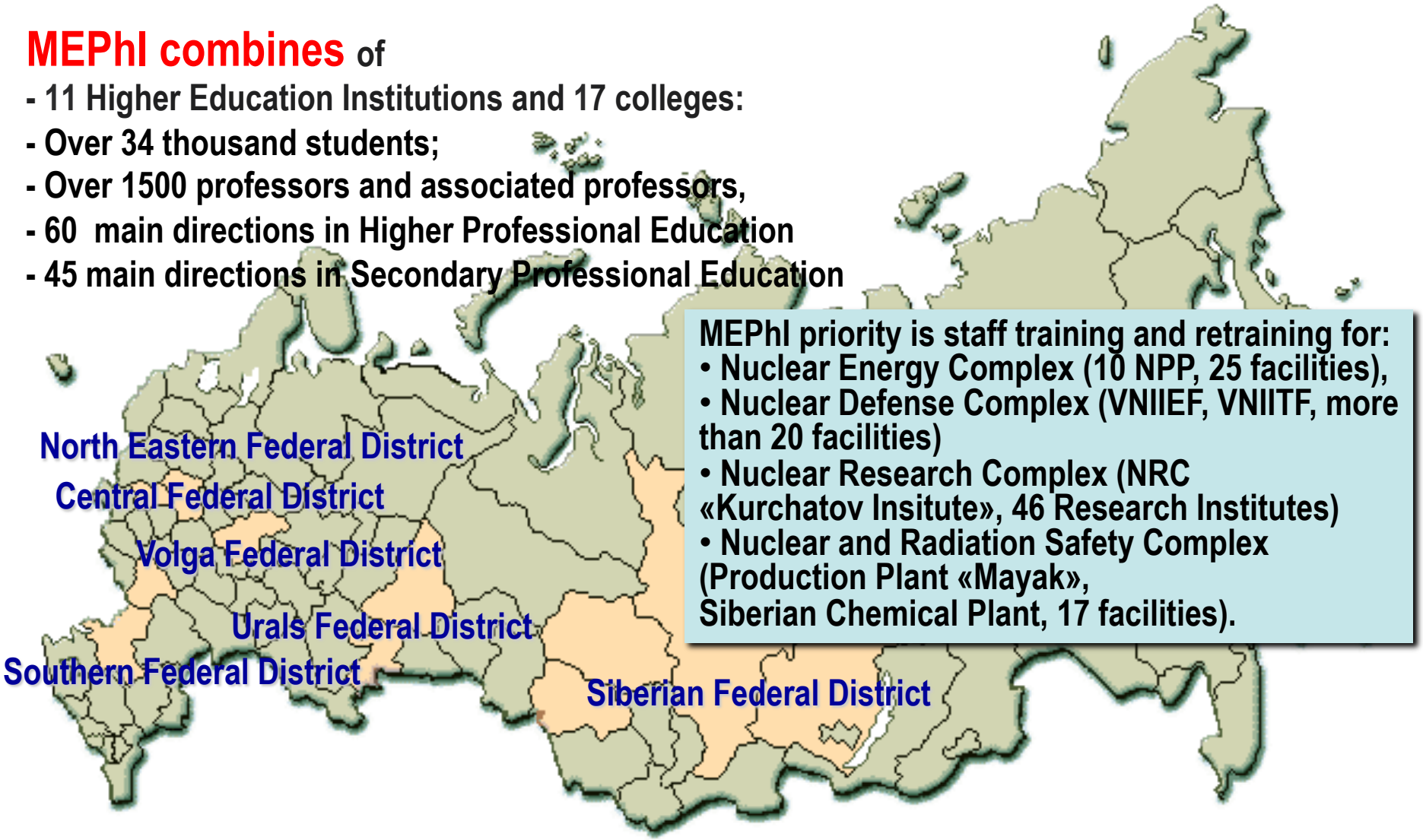
Nuclear Energy Complex (10 NPP, 25 facilities) Nuclear Research Complex (46 Research Institutes) Nuclear and Radiation Safety Complex (Production Plant «Mayak», Siberian Chemical Plant, 17 facilities)

SarFTI, Sarov

National Research Nuclear University «MEPhI» - territorially dispersed educational and research holding for Russian nuclear industry inside and outside the Russian Federation

MEPhI combines of

- 11 Higher Education Institutions and 17 colleges:
- Over 34 thousand students;
- Over 1500 professors and associated professors,
- 60 main directions in Higher Professional Education
- 45 main directions in Secondary Professional Education

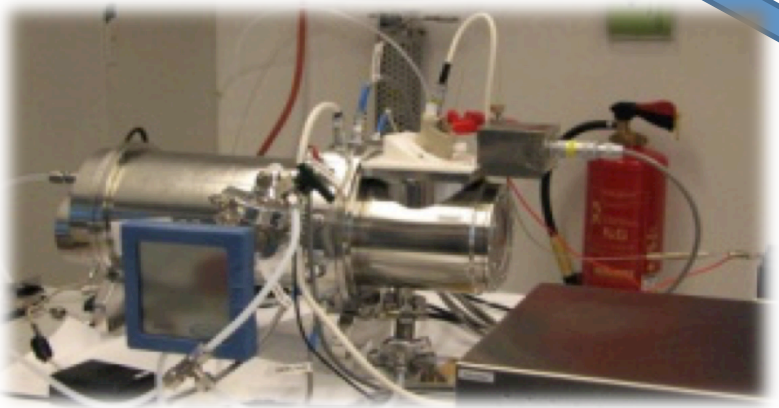


MEPhI priority is staff training and retraining for:
- Nuclear Energy Complex (10 NPP, 25 facilities),
- Nuclear Defense Complex (VNIIEF, VNIITF, more than 20 facilities)
- Nuclear Research Complex (NRC «Kurchatov Insitute», 46 Research Institutes)
- Nuclear and Radiation Safety Complex (Production Plant «Mayak», Siberian Chemical Plant, 17 facilities).

Integration of science and education is a must for HR efficient training and retraining

High quality of education

Integration of **science** **and** **education** in higher professional education



Introduction of developments into production process

MEPhI is Russian Nuclear Education Center
(education, postgraduate education, training & retraining)

Educational Programmes (more than 40)

- Nuclear reactors and power installations
- Nuclear power plants
- Radiation safety of human and the environment
- Security and non-proliferation of nuclear materials
- Physical protection, control and accounting of nuclear materials
- Material science and technology of new materials
- Nuclear and particle physics
- Theoretical physics
- Plasma physics
- Physics of kinetic phenomena
- Applied mathematics
- Medical physics
- Electronics and automation in physical facilities
- Device and methods of for quality control and diagnostics
- Ecology and others

Directions of postgraduate education (more than 30)

- Nuclear power installations (design, exploitation and decommission)
- Radiation safety of human and the environment
- Thermal physics
- High energy physics
- Plasma physics
- Laser physics
- Semiconductor physics
- Nuclear and particle physics
- Solid state electronics
- Micro- and nanoelectronics
- Theoretical physics
- Mathematical physics
- Medical physics
- Ecology etc.

More than training & retraining 200 programs.
Retraining at 25 MEPhI regional branches near enterprises.

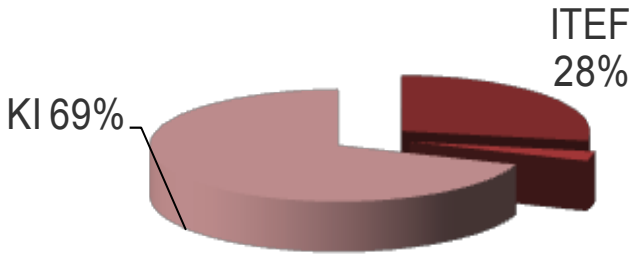
NRNU MEPhI – NRC "Kurchatov institute" educational-scientific cooperation

NRNU MEPhI nuclear, bio- and nanotechnologies institute

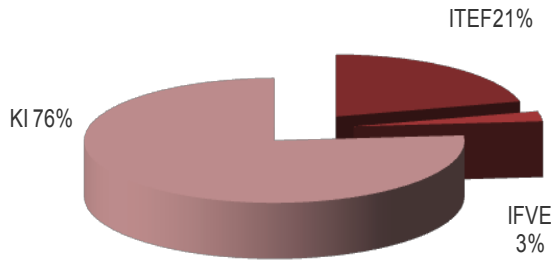
Aim: specialists training for Kurchatov Institute in the fields of

- Fundamental properties of matter
- Plasma Physics
- Reactor materials sciences
- Nuclear medicine
- Superconductivity
- Accelerator physics and technologies
- NBIAK - technologies

2015 г.
37 graduates got job



39 trainees,
graduate students, post-graduates

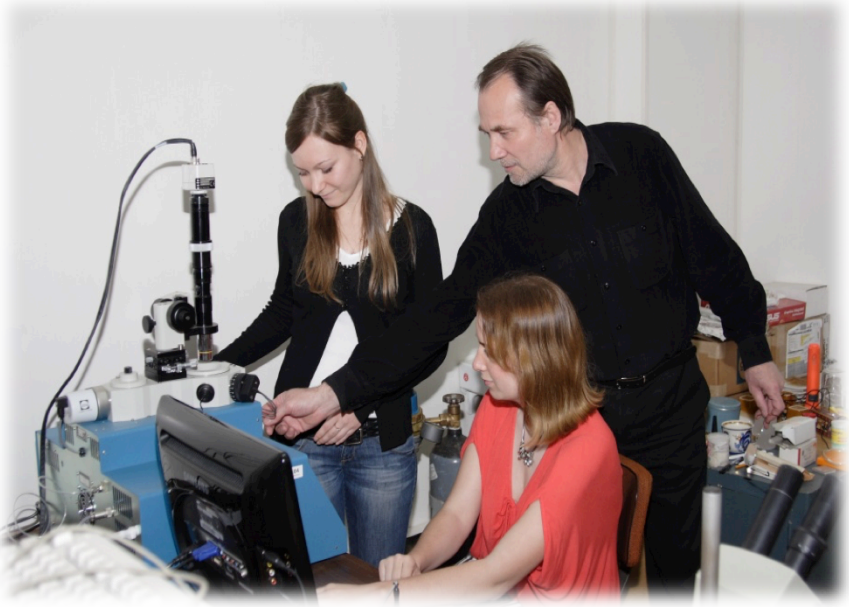


Faculties

- Faculty of experimental and theoretical physics
- Faculty of physics and nuclear power systems
- Faculty of automatics and electronics
- Faculty of cybernetics and information security
- Faculty of management and economics of high technologies

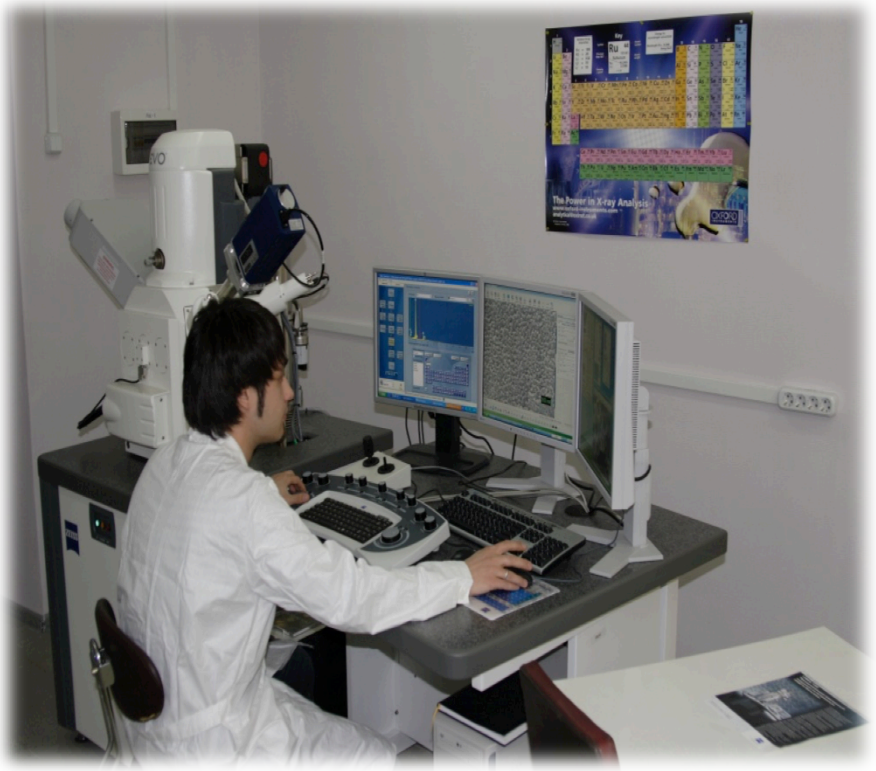
Faculty of experimental and theoretical physics

Condensed matter physics, plasma physics, physics of elementary particles, biophysics, ecology, cosmophysics, nuclear physics, quantum electronics, optical processes and photonics, applied mathematics, high energy physics, theoretical physics, molecular physics, medical physics, superconductivity, physics of nanotechnological processes and nanoelectronics



Faculty of physics and nuclear power systems

Nuclear engineering, nuclear reactor physics, applied nuclear physics, physics of metals, fast process physics, physics of strength, isotopes separation, nuclear material non-proliferation, radiation protection, safety and security of nuclear materials.



Faculty of automatics and electronics

Automatics, electronics, microelectronics, electrophysical installations, electrical engineering and pulse technology, electronic measuring systems.

Faculty of cybernetics and information security

Computer system design and development, data processing systems, monitoring systems for technological processes, automated control systems, software development, complex information protection of automated systems, information security.

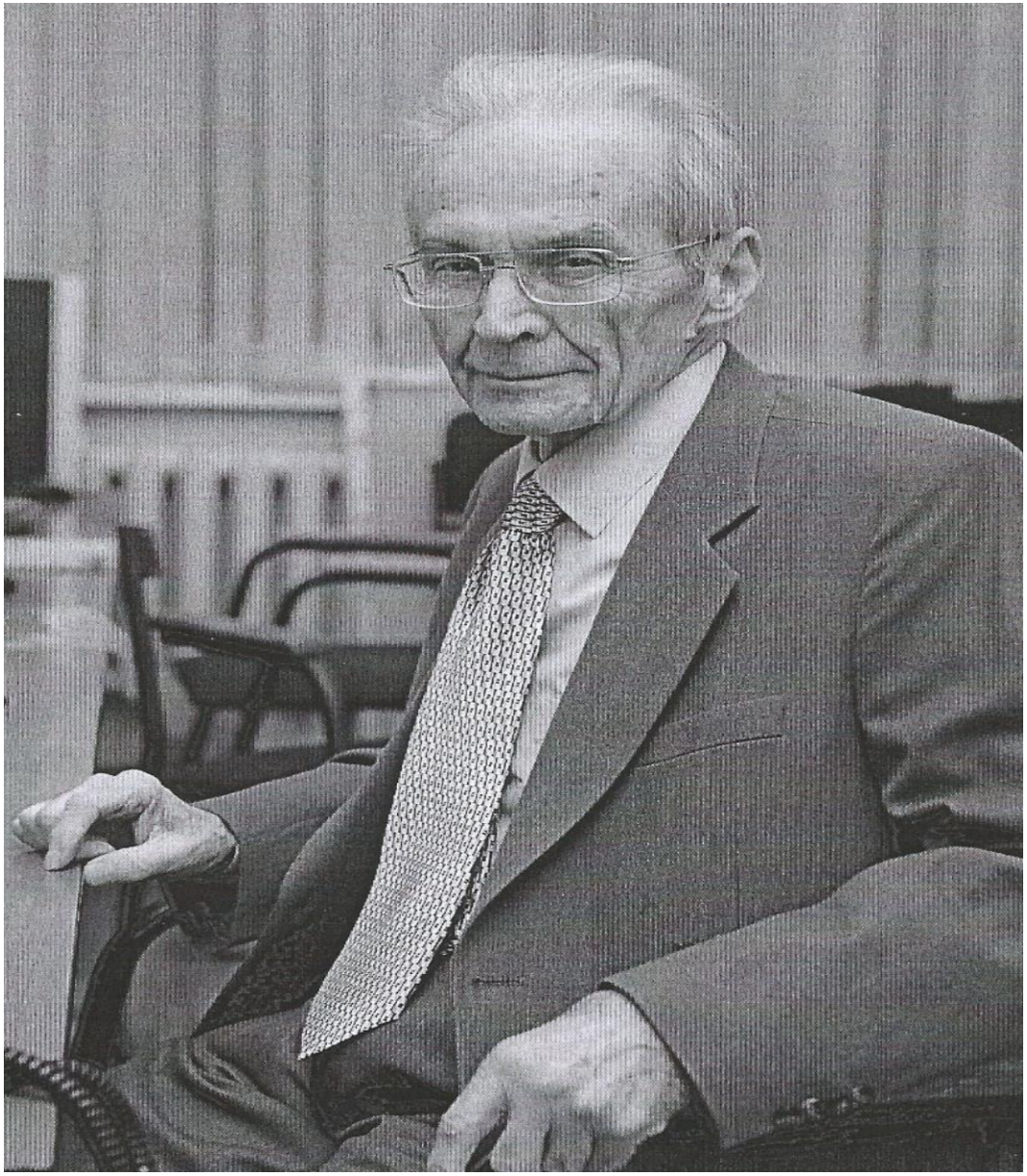
Faculty of management and economics of high technologies

Innovation management, international scientific-technological collaboration, economics and finances, innovative and project management.

Faculty of experimental and theoretical physics
Department of theoretical nuclear physics

- High energy physics, physics of elementary particles;
- Condensed matter physics, solid state physics, superconductivity;
- Plasma physics;
- Nuclear physics;
- Quantum electronics;
- Optical processes and photonics;
- Laser physics;
- Applied mathematics;
- **Channeling and Related Phenomena.**

Channeling and Related Phenomena



Channeling and Related Phenomena

Ryazanov M.I.

Radiation at High-Energy in Condensed Media.

Usp.Fiz. Nauk, v. 114, №3, 1974, p.393-414.

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The Origin 0f the Orientational Maxima in the Bremsstrahlung Spectrum of Nonrelativistic Electrons in a Single Crystal. Fiz. Tverd.Tela, v.14, 1972, p. 1211.

Kalashnikov N.P., Remizovich V.S., Ryazanov M.I.

Collisions of Fast Charged Particles in Solids.

Gordon and Breach Science Publishers. New York, London, Paris, Tokyo. 1985.

Kalashnikov N.P.

Coherent Interactions of Charged Particles in Single Crystals.

Harwood Academic Publishers. London, New York, Paris, Melbourne. 1988.

Channeling and Related Phenomena

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High-energy Electromagnetic Processes in Condensed Media, John Wiley and Sons, Inc. New York, 1972.

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Sulla Bremsstrahlung nei Cristalli. Nuovo Cimento. v. 1, 1950, p.1.

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The Reduction of the Coherence Area of High-energy Electrons in Passage through a Crystal. Nuovo Cimento. v. 9, 1972, p.399; Nuovo Cimento. v. 7B, 1972, p.225.

Channeling and Related Phenomena

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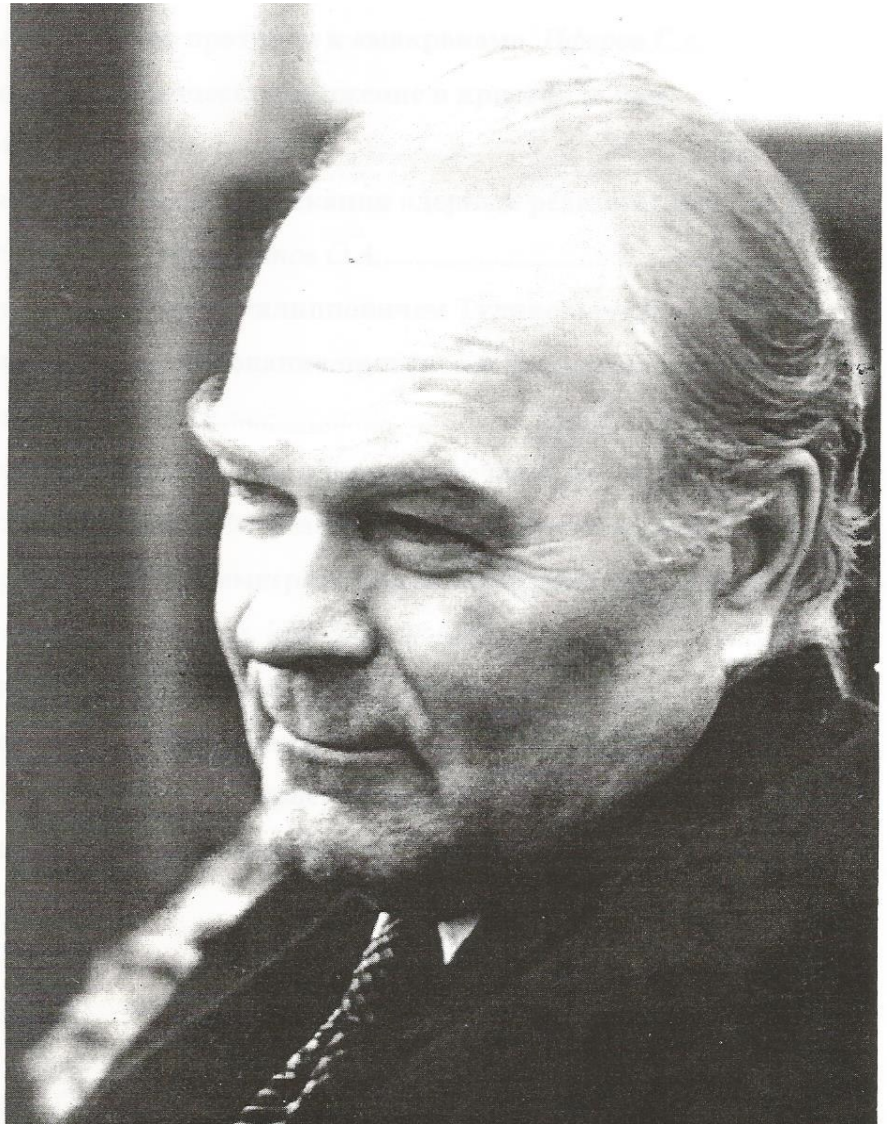

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Effect of the Crystal Lattice on Certain Atomic and Nuclear Processes. Usp.Fiz. Nauk, v. 87, 1965, p. 585.

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A Certain Effect Accompanying the Nuclear Reactions in Single Crystals and the Use of This effect in Physical Reseach, Dokl. Acad. Nauk SSSR v. 162, 1965, p.546.

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Channeling, Radiation and Reactions in Single Crystals at High Energies.

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Quantum Theory of Radiation from Electrons in a Single Crystal. Dokl. Acad. Nauk BSSR, v.18, 1974, p. 499.

Theory of Coherent Processes in a Crystal. Dokl. Acad. Nauk BSSR, v.23, 1979, p. 326.

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Channeling and Related Phenomena

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- **Strikhanov M.N.**

Coherent Electromagnetic Interactions of Fast Charged Particles with Single Crystals.

PhD Thesis, MEPhI, Moscow, 1978.

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Elastic Scattering of Fast Positively Charged Particles by the Atomic Row in a Single Crystal. Nuovo Cimento. v. 29B № 1, 1975, p. 9-17.

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Theory of Diffraction Scattering of Fast, Positively Charged Particles in a Single Crystal. Zh.Eksp.Teor.Fiz. v. 69,1975, p.1253

- Kalashnikov N.P., Strikhanov M.N.

Spontaneous and Induced Gamma-Radiation of Relativistic Charged Channeled Particles. Quantum Electronics v. 8,1981, p. 2293.

Channeling and Related Phenomena

Channeling and Related Phenomena

INSTITUTES
(SAU = Strategic Academic Units)

Modern Transformation of the Structure

(**Transformation Faculty Divisions into Institutes** =

= Optimization of Staff +

+ Introduction of new Qualification Requirements)

- Institute of high energy physics
- Institute of nuclear physics and technologies
- Institute of laser and plasma technologies
- Institute of nanotechnologies in electronics, spintronics and photonics
- Institute of nuclear biomedicine
- Institute of cybernetics and information security
- Institute of management and economics of high technologies
- Institute of fundamental natural sciences

Institute of nanotechnologies in electronics, spintronics and photonics

The order № 207.5 (25.07.2016)

The Laboratory № 418 of Prof. S.B. Dabagov

“The Control for the Beams of the Charged and Neutral Particles”

Institute of nanotechnologies in electronics, spintronics and photonics

The order № 207.9 (25.07.2016)

The Laboratory № 423 of

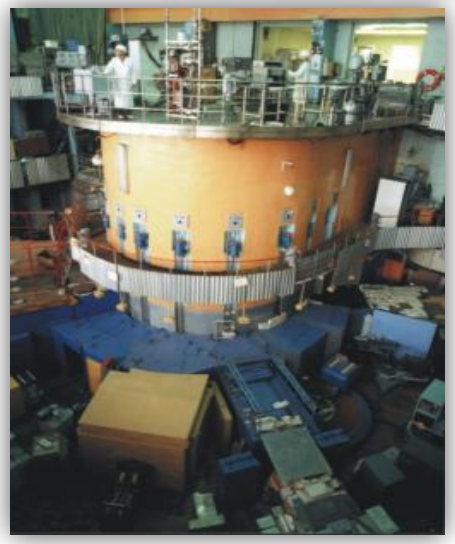
Associate Prof. A. A. Tischenko

"The Radiation of the Charged Particles"

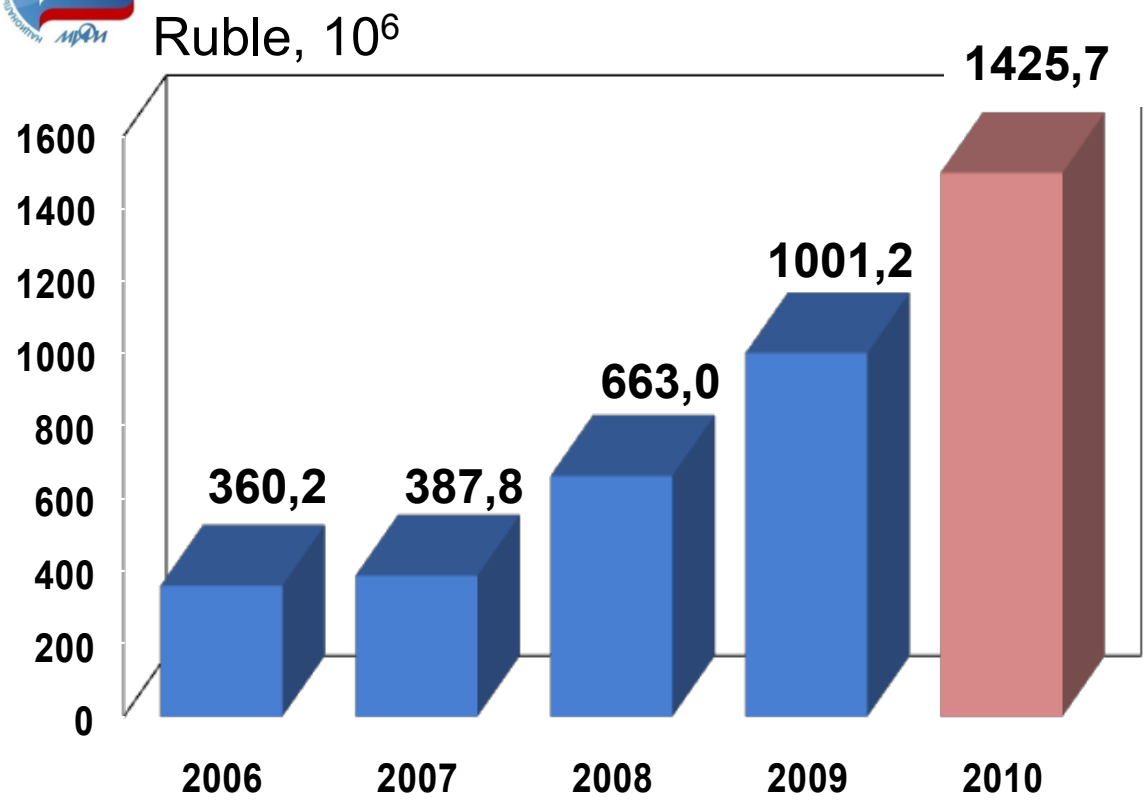
Institute of nanotechnologies
Channeling and Related Phenomena.

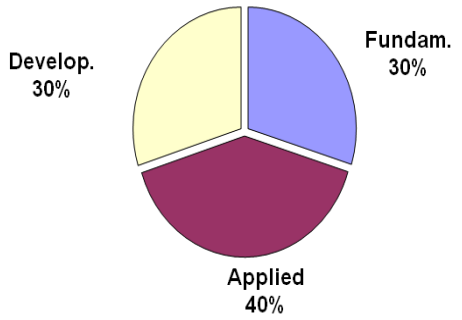
Modern NRNU MEPhI Research & Educational Centers and Laboratories.

- Nuclear reactor center
- Radiation material science and radiation protection center
- Physical protection, control and accounting of nuclear materials center
- Radiation accelerator center
- Neutrino Lab
- Nuclear electronics center
- Carbon fiber and carbon-composite material center
- Superconductivity center
- Nanosystems, nanomaterials and nanotechnologies center
- Laser technological center etc.



Research activity





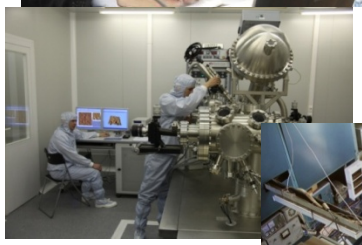
MEPhI Scientific publications among other educational institutions

№	Higher educational institution	Number of publications	Number of citation	Average citation	H -index
1	MSU	9525	19578	2, 06	37
2	SPtSU	9800	40978	4,18	56
3	NRNU MEPhI	5782	34816	6,02	67

“SKOLKOVO”

National Research Nuclear University MEPhI is one of the 14 leading higher educational institutions involved in cooperation with the Foundation “SKOLKOVO”

The expertise of the innovative potential of National Research Nuclear University MEPhI was carried out by the Massachusetts Technological Institute (MIT)



Memorandum of cooperation between the Foundation “SKOLKOVO” (The Centre of development and commercialization of new technologies) and National Research Nuclear University MEPhI

Objectives of join activities:

1.Development of implementation techniques for innovative projects; setting the pool of technological start-ups;

2.Creation of the infrastructure and the bulk of researchers, future residents of “Skolkovo”;

3. Involvement of talented students, post-graduate students and young scientists in innovative environment of “Skolkovo”

Directions of cooperation:

1.Technological development trends analysis;

2. Sharing of scientific and technological knowledge;

3. Involvement of talented youth in research environment;

4. Development of infrastructure; advanced research;

5. Commercialization of the research results.

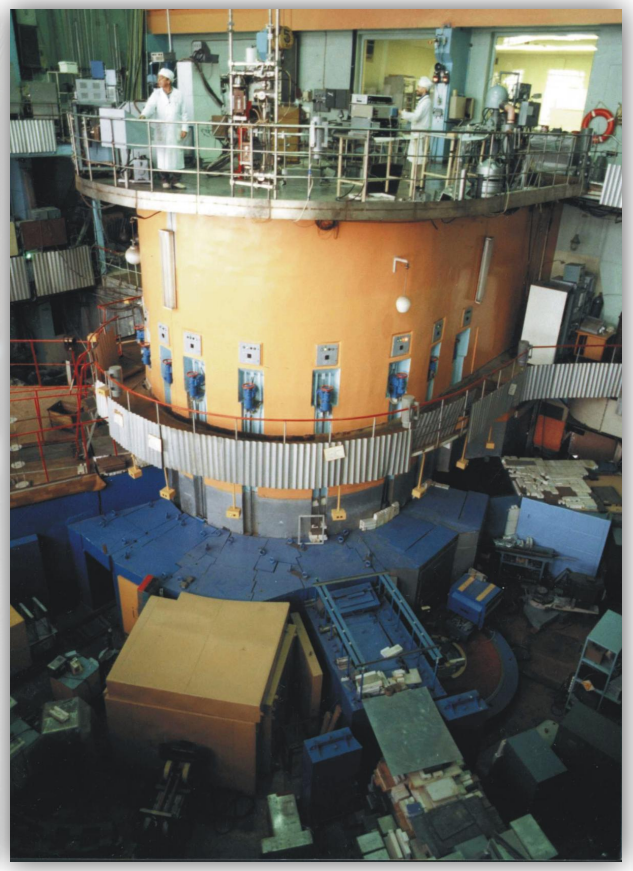
Фонд «Сколково»:

Виктор Вексельберг,
Президент, сопредседатель Совета Фонда

Национальный исследовательский ядерный университет «МИФИ»

Михаил Стриханов, ректор

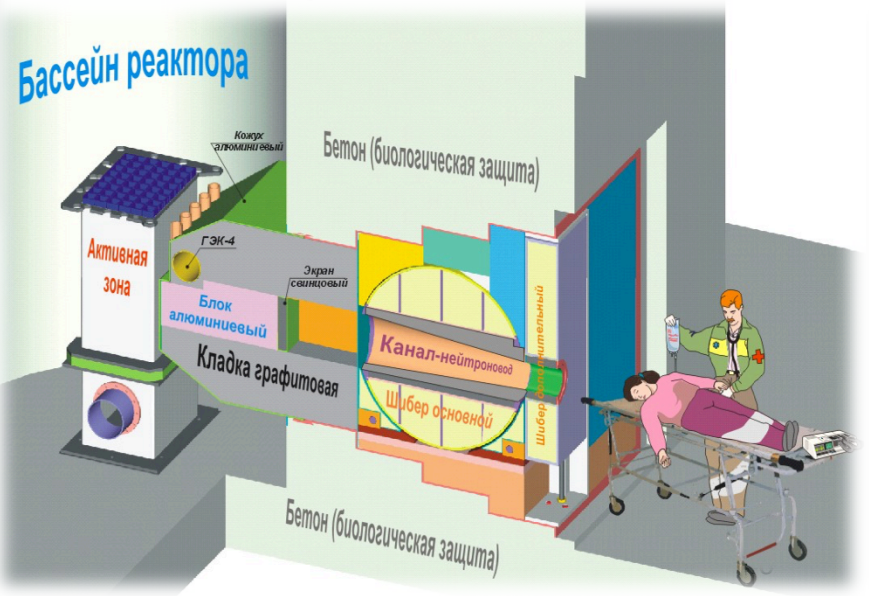
«Nuclear Center» of NRNU MEPhI



Research directions at the IRT MEPhI :

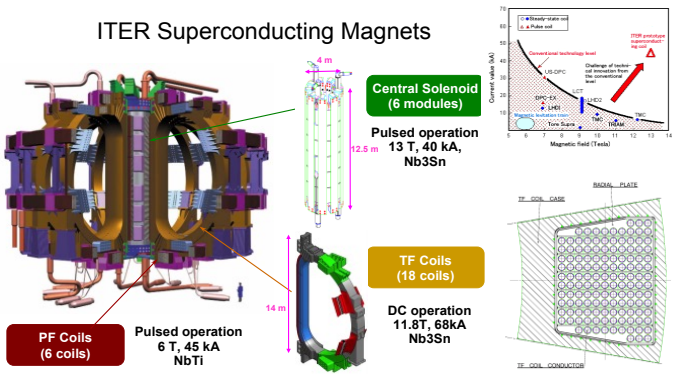
- Neutron studies of matter;
- Nuclear physics;
- Radiation physics;
- Radiation materials science;
- Solid state physics;
- Reactor physics and engineering;
- Applied spectrometry;
- Radiobiology;
- Medical physics

Design of a Clinical Neutron Capture Therapy Channel with Use of Thermal and Epithermal Neutrons

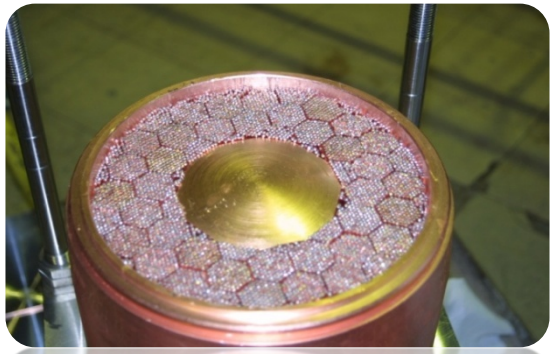


Educational & Research Center «Superconductivity»

Nanostructurised Low temperature superconductors are used in magnetic systems of plasma holding in Tokamak assemblies, acceleration machines, synchrotron radiation sources, magnet systems ITER



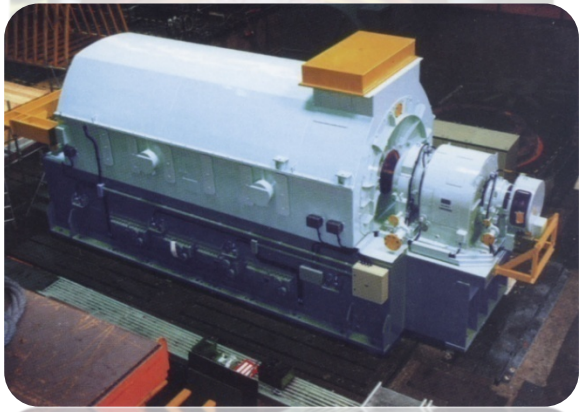
Superconductor for magnet system ITER



Nanstructurised high temperature superconductors of the 1-st generation: used in high temperature superconductor current feedthrough, current regulators,power lines, kinetic energy accumulators

Conventional turbogenerator ►

Superconductive turbogenerator with capacity 20 MB·A ►



Volume 2.5 times less

International laboratory of strong magnetic fields and low temperatures, Wroclaw Poland. ►
Superconductive solenoid 15T

Nanostructurised high temperature superconductors of the 2-nd generation: used in high temperature superconductor current feedthrough, current regulators,power lines, kinetic energy accumulators, vehicles on magnetic cushion (levitation)

Educational & Research Center «Nanocenter»

Basic scientific research, applied research and developments and specialists training in the sphere of heterostructure nanoelectronics, extremal and power electronics, solid-state super- high frequency electronics and optical electronics in the related sciences and science of materials.

Partners from industry:

- **Institute of SHF RAN**
- **PLC «RIT-systems»**
- **3AO «Svetlana»**
- **Federal Government Unitary Research & Development Production Enterprise «Pulsar»**

Embodied technologies:

- **Nanolithograh and electronic microscopy Scanning probe microscopy, nanocharacterization and nanometrology**
- **Contact photolithograph and laser lithograph**
- **metalization**

Electron-beam lithograph Raith 150-Two

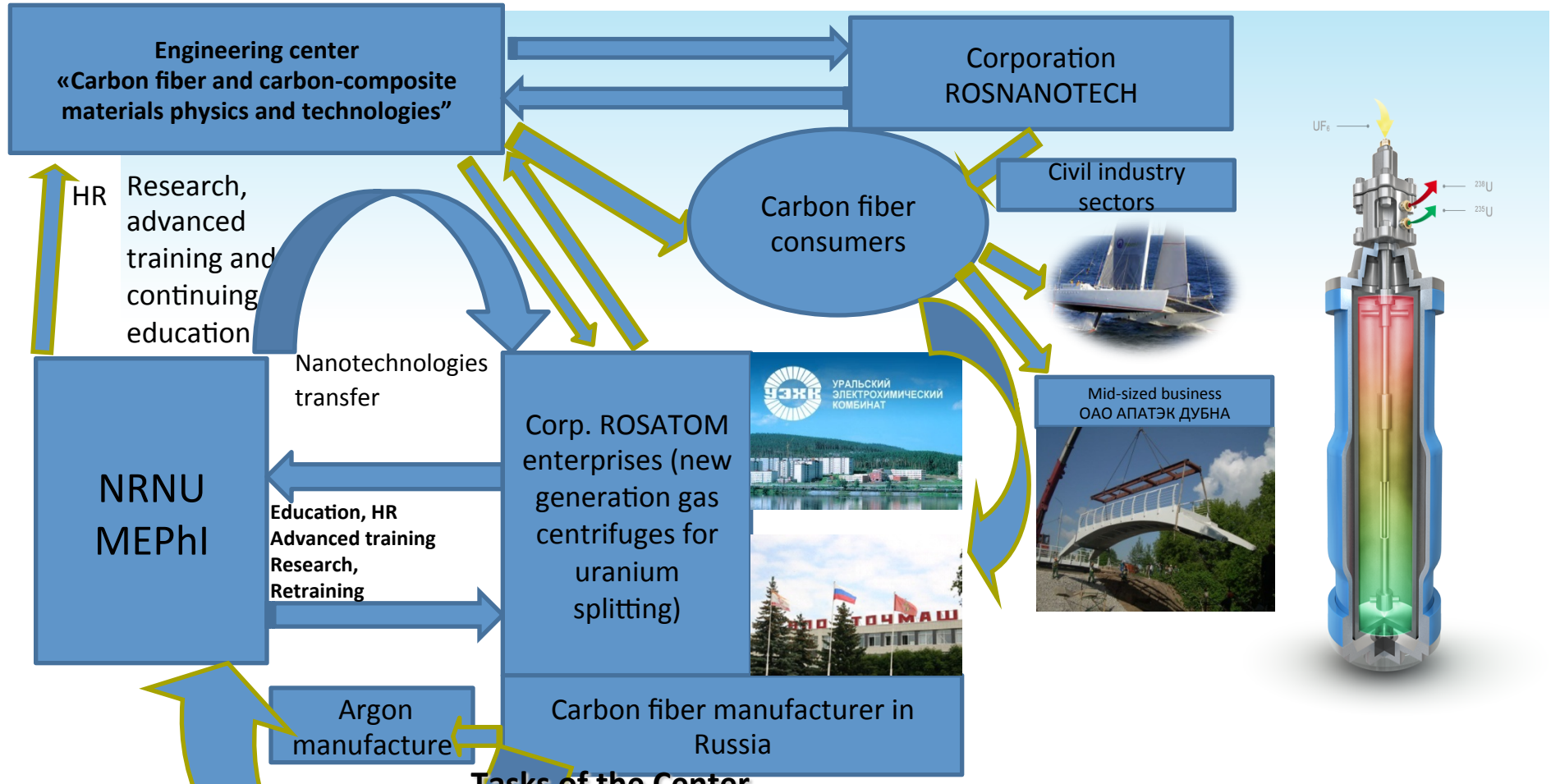
Kurt Lesker PVD 75 and PVD 250 devices

C3M Omicron XMS Complex

Photolithorgaph installation Suss MJB4

Laser imagery gererator Heidelberg DWL66FS

Educational & Research Center «Carbon fiber and carbon-composite materials»



Tasks of the Center

- Development of technological solutions to optimize existing technologies to upgrade Carbon Fiber quality, level of stability of its properties;
- Development of technological solutions to automate technological process of Carbon Fiber manufacturing;
- Development of technological solution and in-process control devises;
- Setting up of a unified scientific-methodological base to maintain metrological back up of the stages of technological process of Carbon Fiber manufacturing and certification;
- To increase Carbon Fiber consumption in the country – supply engineering service to the CF consumers in terms of development of cheap technologies of pooltrusion and vacuum infusion in production of goods from CF for civil sector;
- Specialists training in Carbon Fiber and carbon-composite materials fuiel for RosAtom and military defense sector.

Educational & Research Center «Software development for nuclear power plant's full scale simulator

MEPhI set an ambitious goal to become a global leader in education, science and innovations

The mission of the National Research Nuclear University MEPhI is to generate, disseminate, use and preserve scientific knowledge aiming to address global challenges of the 21st century, as well as to provide innovative transformations in Russia accompanying development of the country competitiveness in the global energy and non-energy high-tech markets

The strategic goal is to become a global leader in education, science and innovation in the field of nuclear, radiation, subnano- and nano-technology and engineering, making a significant contribution to the innovative development and world competitiveness of the State Corporation Rosatom and other leading Russian high-tech companies

Strategic objectives

MEPhI is a strategic "educational" partner for State Corporation Rosatom, providing training, research and innovative support for the nuclear power plants and nuclear technologies

ROSATOM

Beyond the focus on nuclear industry **University aims to actively diversify and expand its positions** in areas such as nuclear medicine, space electronics, optoelectronics, nanodevices and nanomaterials, lasers, cybernetic technologies, technological management

Program Key Indicators

	2013		2020	2012				
	MEPhI			MIT	TAMU	Stanford	TIT	TSINGHUA
Articles per Fac. Memb	1,1		6,0	15,9	6,5	11,8	6,4	4,8
Citation per FM	21		80	117	59	120	63	40
Foreign FM & Researchers (%)	0,1		14	15,7	14,9	15,7	15,3	15,4
The Share of Foreign Students (%)	3,3		21	31,4	10	8,6	16,3	8,6
Share of R&D (%)	43		52	48,6	18	30	30	-
Rank in THE (overall)	226-250	→	121-170	5	159	4	125	50
Rank in THE (subject rank)	74	→	51-100	2	91	5	83	70
Rank in QS	-	→	51-100	1	165	15	65	48

What makes us feel we will do this?

Recent achievements: 40 years experience cooperation with large Centers and Universities

International Labs – MEPhI partners

- CERN
- DESY
- Los Alamos National Laboratory
- Oak Ridge National Laboratory
- Argonne National Laboratory
- Brookhaven National Laboratory
- Sandia National Laboratories
- Idaho National Laboratory
- Princeton Plasma Physics Laboratory
- Lawrence Livermore National Laboratory
- SLAC National Accelerator Laboratory
- Pacific Northwest National Laboratory
- ENFI
- KEK

More then 52% of Russian CERN researchers are MEPhI graduates.

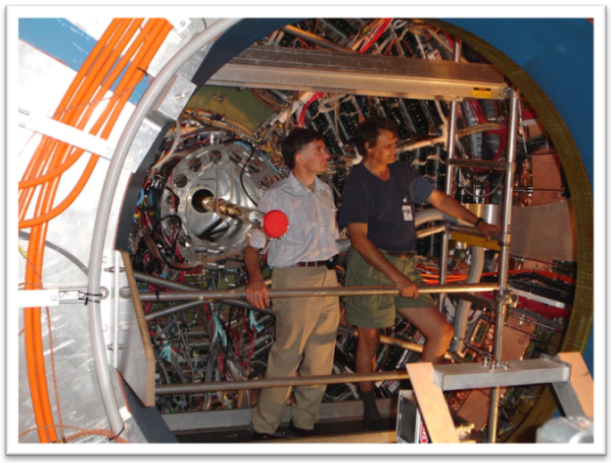
61 support letters from International Labs

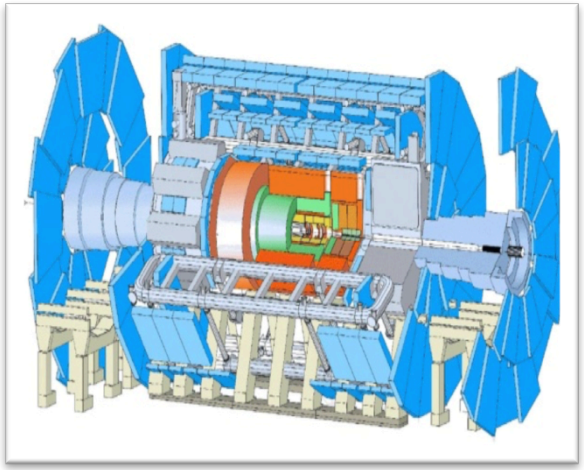
№	Candidate's name	Collaboration Universities / Labs	Curricula
1	Joseph Formaggio	Massachusetts Institute of Technology	Fundamental Symmetries
2	Dan McKinsey	Yale University	Astrophysics
3	Alfred Shukla	Universite de Geneve	Mathematics
4	Zeng Shi	Tsinghua University China	Engineering Physics
5	Blas Cabrera	Stanford University	Astroparticle Physics
6	Adam Bernstein	Livermore National Laboratory	Nuclear Reactor monitoring
7	Beat Ruhstaller	Switzerland/ZHAW	Mathematic modeling
8	Elena Aprile	Columbia University, N.Y.	Astroparticle Physics
9	Michael Maier	Lawrence Berkeley laboratory	Pulsed positron beam
	...		
218	Zurab Berezhiani	University of l'Aquila, Italy	Cosmology
219	Yasuo Ito	The University of Tokyo	Positronium in polymers

International collaboration

- **Major international experiments**

(**STAR, ATLAS, ALICE, PAMELA** etc.)





- **Participation in international programs**

International collaboration

Research:

- Participation at the major international experiments in nuclear physics and high energy physics (STAR, ATLAS, ALICE, PAMELA etc.)
- Participation at the international programs of IAEA, ISTC,CERN, ITER, DESY etc., conferences and workshops
- Hosting of 34 international conferences and workshops (89 foreign delegations from 28 countries visited MEPhI in 2010).
- Face to face research collaboration with the 21 foreign universities and 19 research centers and laboratories.

Nuclear Education and Knowledge Management Activities:

• Participation at the IAEA technical documents development activity ("NKM in research organizations", "NKM in academic organizations", "NKM in national programs", "Methodological background for nuclear nonproliferation and security education", "Reference curricula in nuclear security", "Reference curricula in nuclear engineering" and others)

• Participation at the IAEA activity "Nuclear nonproliferation. Responsible science".

• Participation at IAEA Technical Cooperation Programs of nuclear infrastructure development for Armenia and Belorussia.

• Participation at the IAEA NKM Missions.

• Preparation of the international reference multimedia course "Nuclear Reactor Physics" in Russian language.

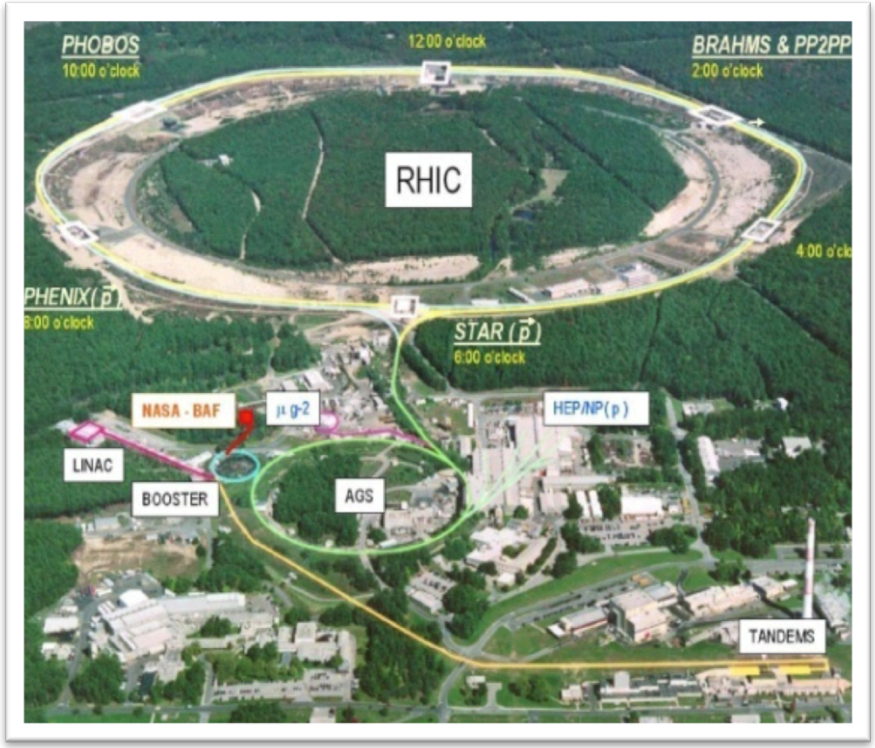
• Participation at the EU-Russian Project «Cooperation in Nuclear Education, Training and Knowledge Management».

• Face to face cooperation with the 37 foreign universities (from the USA and Europe in the field of nuclear education – educational program enhancement, students internship etc.)

The first NKM IAEA Mission at the universities visited MEPhI and gave a very high evaluation NRNU MEPhI as international center of nuclear education (12 experts from 8 countries).

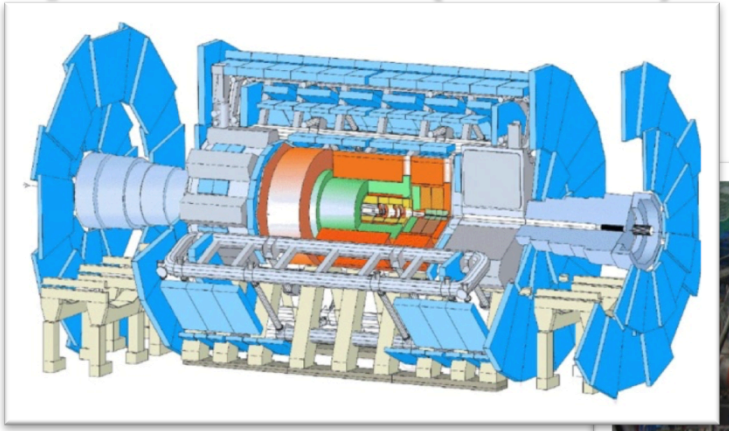
STAR experiment at BNL (USA)

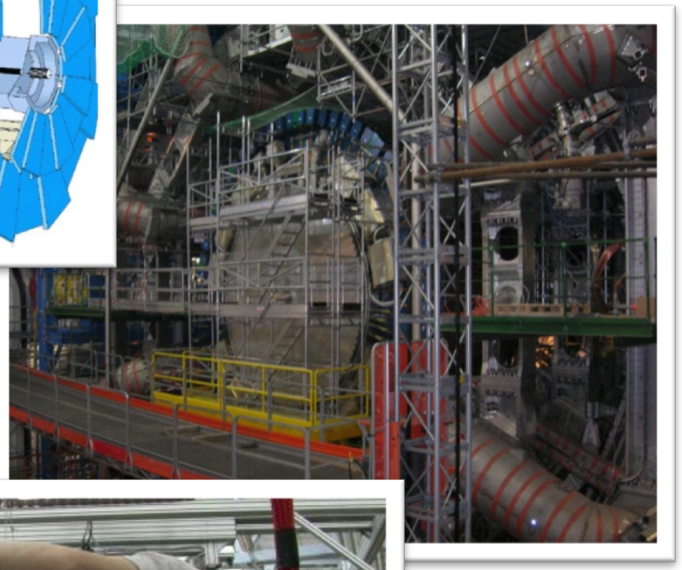
In the STAR experiment on relativistic heavy ion collider (RHIC) at BNL (USA) with the assistance of NRNU MEPhI the strong interacting matter with extremely high density of energy and temperature is studied.



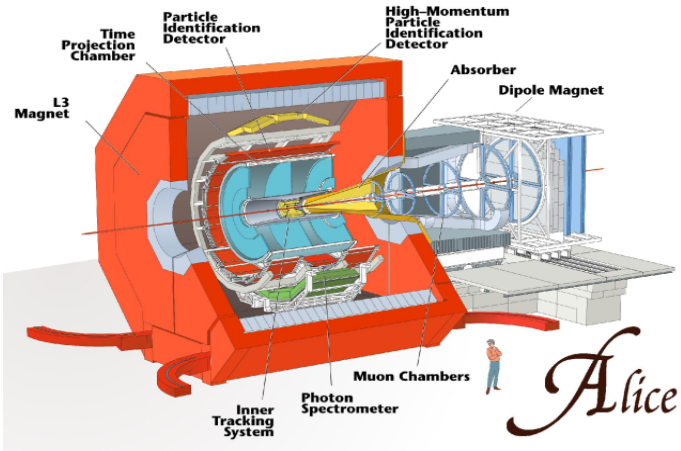
ATLAS and ALICE experiments (CERN) at BHC

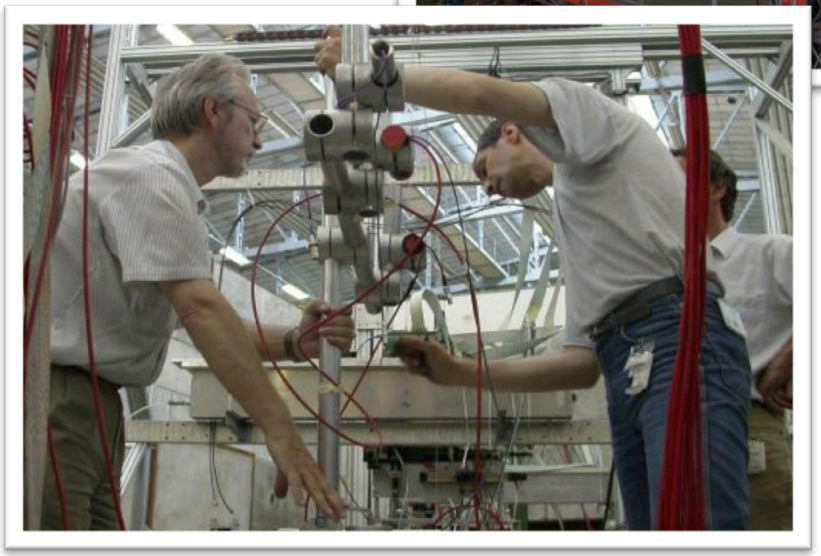
The track detector of the transition radiation for ATLAS experiment is created





The starting detector of ALICE experiment for studying of quark-gluon plasma properties is developed and tested





Segment of global network GRID

The segment of global network GRID possessing a possibility of processing of supermajor data files, arriving from unique large-scale experiments on a high-energy physics on the earth and in space is created and placed in operation. The international network address: **WWW.LXFARM.MEPHI.RU**.

Scheme of the data link of the network

PAMELA and ARINA experiments

15 June 2006 the satellite RESURS DK-1 was launched from Bajkonur with two devices on board: PAMELA, developed for dark matter problem research, and ARINA, for earthquake forecasting

CORONAS-PHOTON experiment

Unique data of hard cosmic rays arising in solar flares, are obtained in Astrophysics Institute of NRNU MEPhI in CORONAS-PHOTON experiment

Thank You for Your Attention!

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CHANNELING 2016

Charged & Neutral Particles Channeling Phenomena

INFN Istituto Nazionale di Fisica Nucleare Laboratori Nazionali di Frascati

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