National Research Nuclear University "MEPhI"

"Modernization of Russian Nuclear Education System for Nuclear Power Programmes Human Resource Development".

Kryuchkov E.F. ,Murogov V.M.,Strikhanov M.N.

International Conference on Human Resource Development for Introducing and Expanding Nuclear Power Programmes, Abu Dhabi of the UAE.
14-18 March 2010.

History

MEPhI was founded during World War II in 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

He was the “father” of the Soviet atomic project.

L.A. Artsimovich

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

I.K. Kikoin

He made prominent achievements in research in the field of atomic technologies and solid state physics.

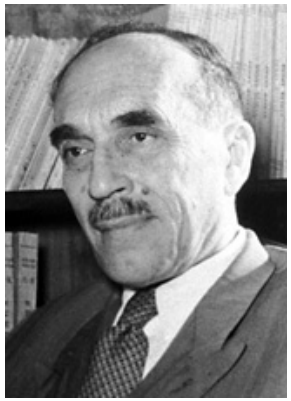
WHO WAS AT THE ORIGIN

The Nobel Prize Winners


P.A. Cherenkov


I.M. Frank


I.E. Tamm


N.N. Semenov

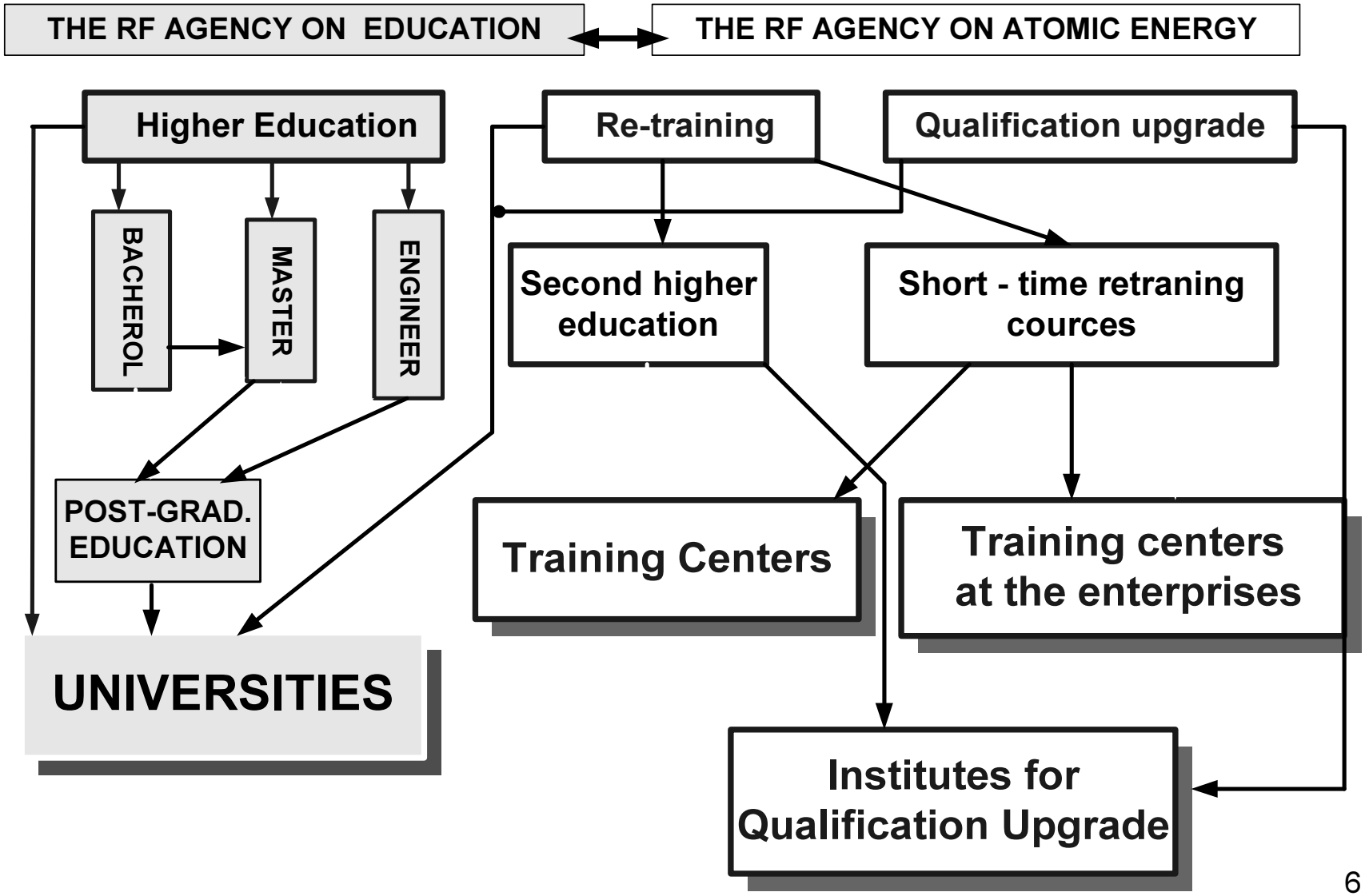

N.G. Basov


A.D. Saharov

General layout of the higher school system in Russia is presented in Fig. 1. It should be noted that Russian traditional form of education is a continuous higher education during 5-6 years. After successful defense of the diploma project, the graduates are awarded a qualification of engineer-physicist, engineer-designer, engineer-mathematician, etc. (for technical specialties).

Russian system of the higher education is much wider than the higher school because the former also includes the specialists re-training system and the specialists qualification upgrading system.

FIG. 1. ***Structure of the nuclear engineering educational system in Russia.***



Modernization of the Russian educational system

♦Siberian Federal University (Krasnoyarsk) and Southern Federal University (Rostov-on-Don) were organized in 2006.

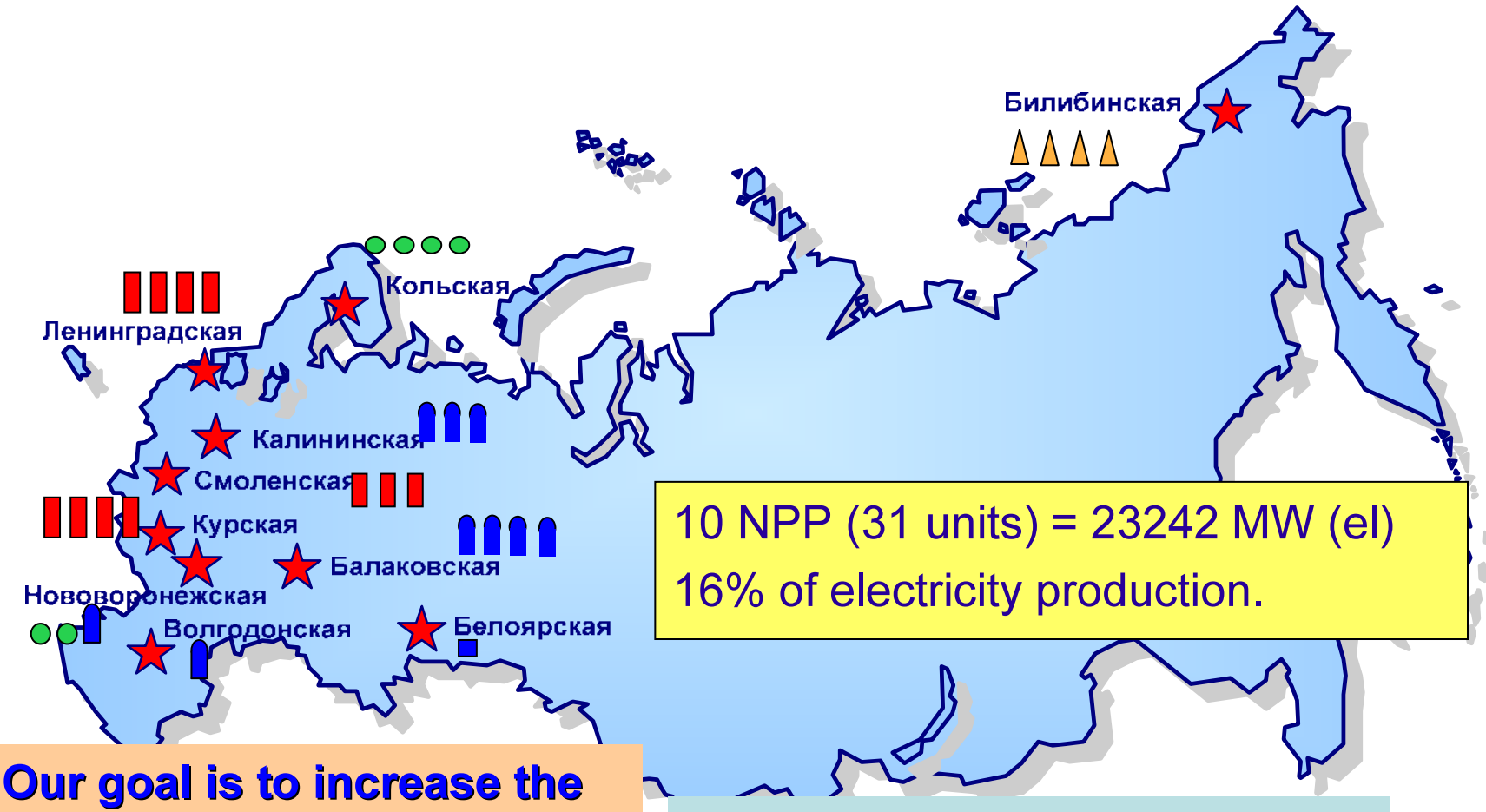
♦ National Research Nuclear University based on the Moscow Engineering Physics Institute (State University) and National Research Technological University based on Moscow Institute of Steel and Alloys were organized in 2009 (the President of the Russian Federation signed the Degree on October 7, 2008 and Russian Government Degree on April 8, 2009).

♦ 12 National Research Universities were organized in 2009.

♦ 5 Federal Universities were organized in 2009.

♦ From 2011 education in Russia will be based on Bologna Process.

Nuclear Power in Russia



10 NPP (31 units) = 23242 MW (el)
16% of electricity production.

Our goal is to increase the fraction of nuclear power generation to 25% to 2020.

V. Putin

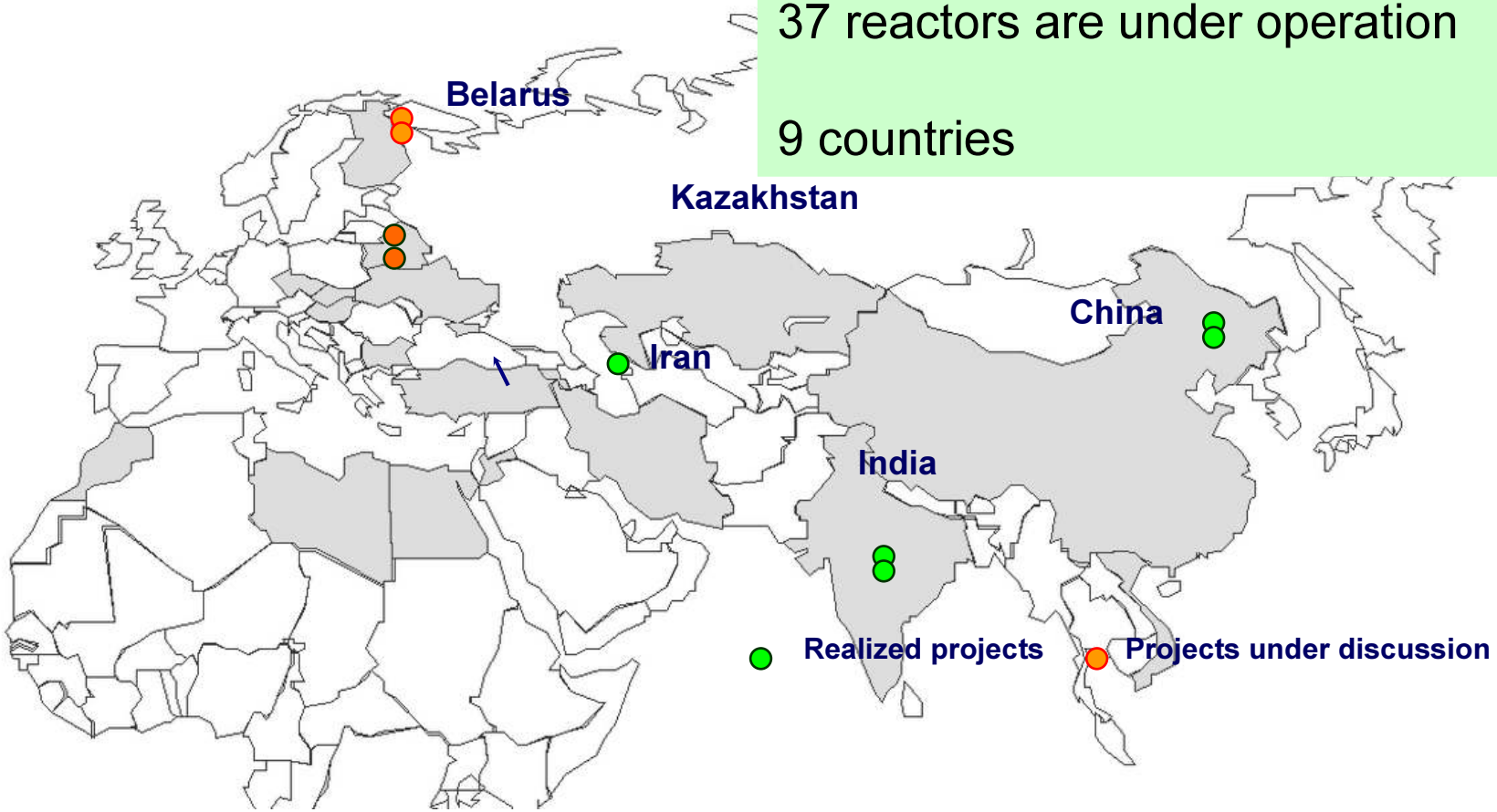
Russia has to increase the power of nuclear power plans from 23.5 GW in 2006 to 53.2 GW in 2020.

Nuclear Power in Russia (experience of export)

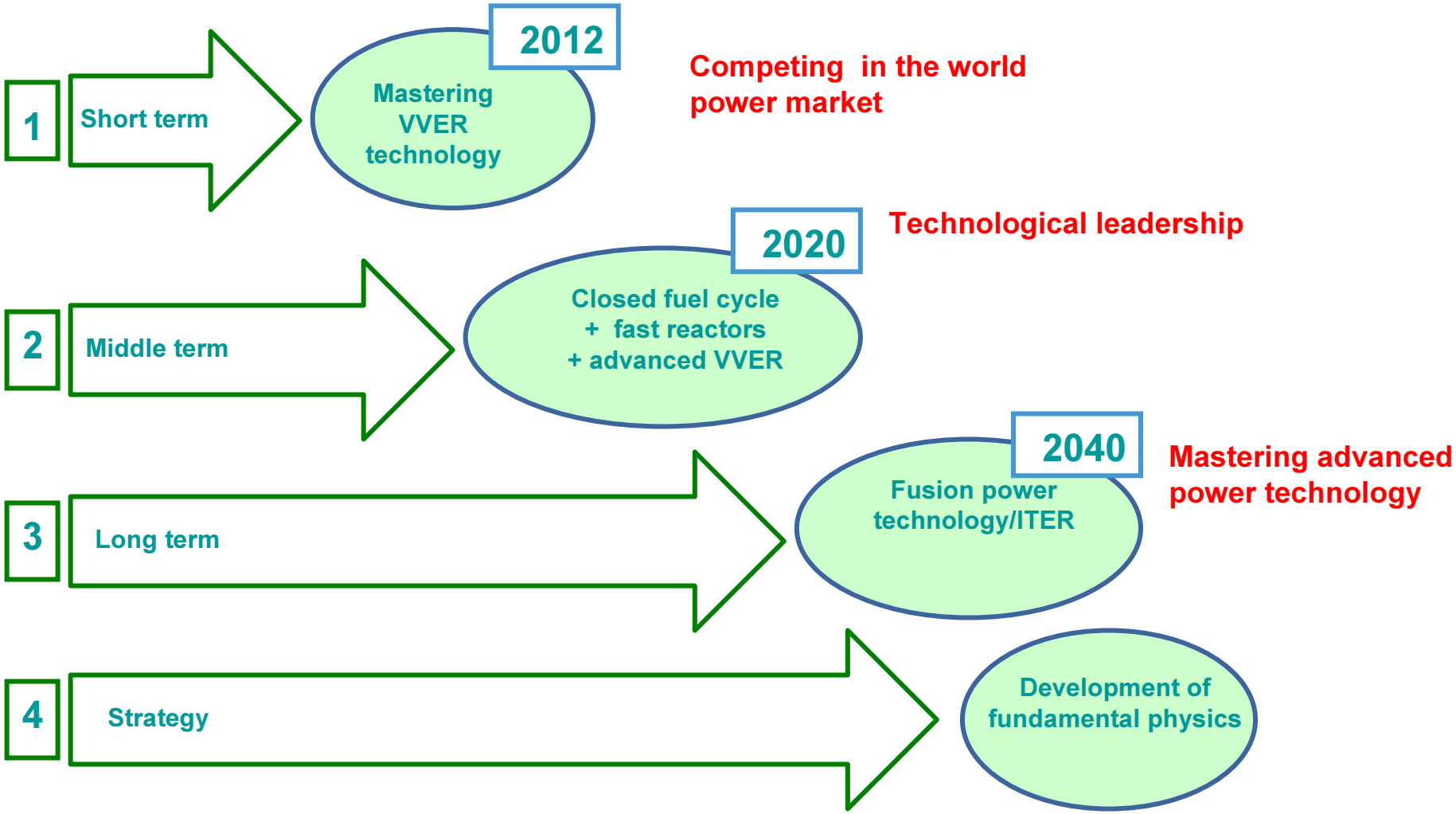
52 reactor units were constructed outside Russia by Russian design

37 reactors are under operation

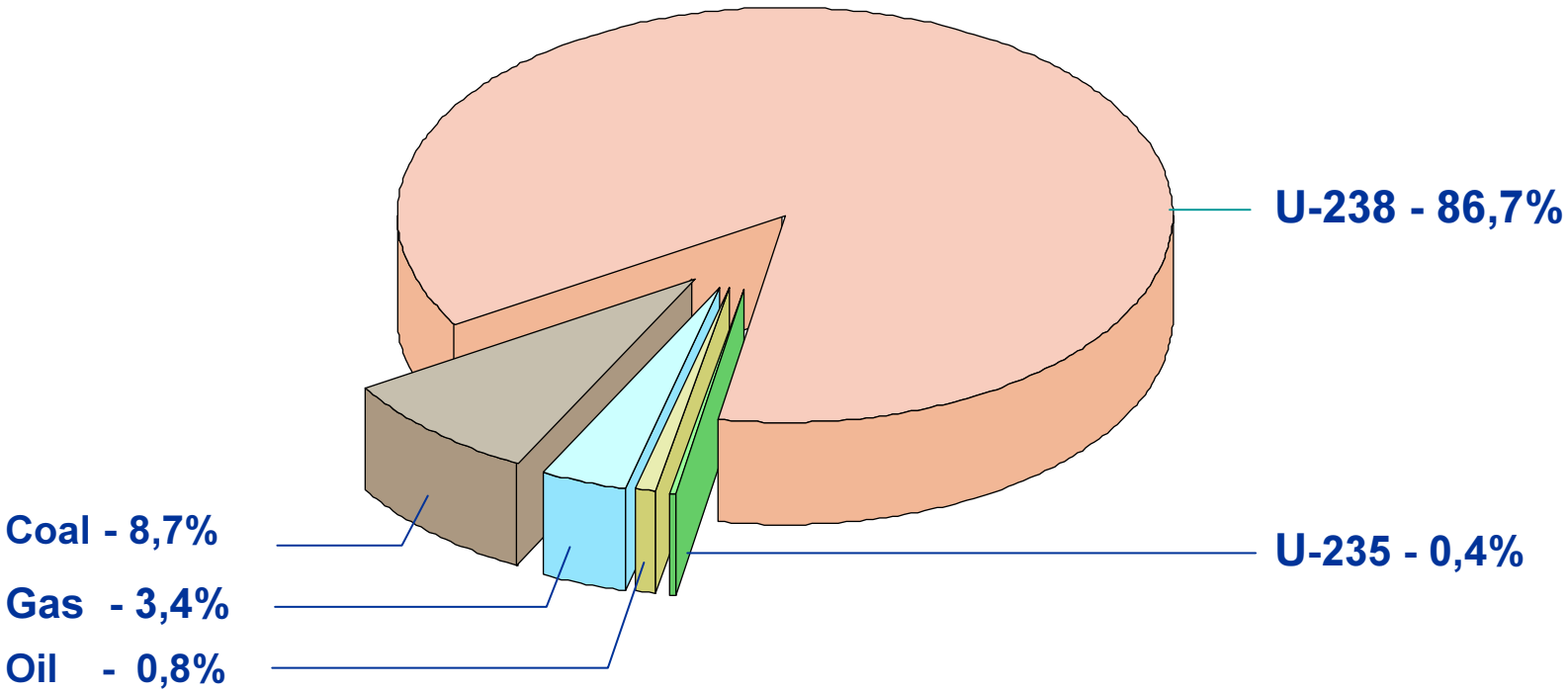
9 countries



Nuclear Power in Russia (R&D horizons)



Relative energy content of natural fuel resources



The demand of R&D Institutes for nuclear engineers increased for the past five years. Now we have more requests from R&D Institutes and NPP than we can satisfy annually. It can be explained by the reasons related with the difficulties encountered by nuclear R&D Institutes. These difficulties became particularly sharp for the last time when inflow of young specialists into nuclear area drastically decreased. The main problem of nuclear R&D Institutes is an ageing of the personnel. During the last 15 years the number of people with the age between 25 and 30 decreased more than twice. At the same period the number of people with the age more than 60 increased more than twice. The average age of Doctor of Science is 64, Philosophy Doctors is 56.

This is a real scientific-technical disaster associated with the loss of the scientific school:

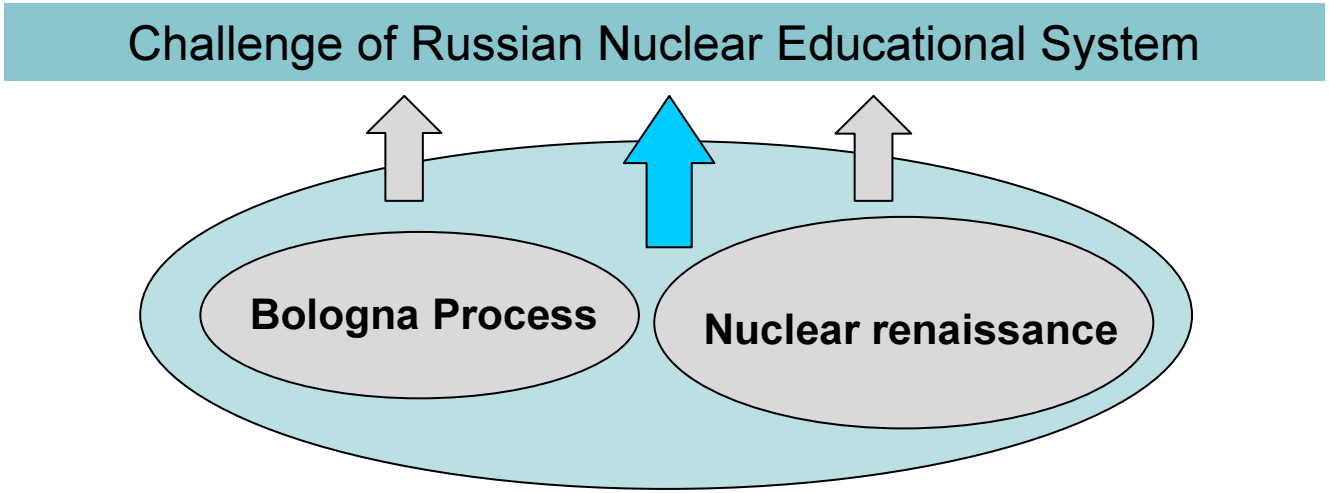
- qualified skilled personnel;
- loss of the educational system in this field (primarily, teaching staff and researchers);
- loss of experimental base;
- loss of contacts and new generations of young scientists.

But this is not internal Russian problem; **this is a common problem for all developed and leading nuclear countries.**

RUSSIA HAS TO MODIFY OF NUCLEAR EDUCATION SYSTEM

- From educational institutes to powerful modern research universities.
- New approaches to nuclear education.

  National Research Nuclear University is the Russian center for nuclear knowledge preservation and expansion.



Conditions under which the problems of nuclear educations are solved:

- Wide reformation and consolidation of the nuclear industry.
- Reformation of the education system in Russia including the transition to the two-level system, the introduction of new education standards, and the classification of universities.

Problems:

- Downward demographic trend.
- Aging personnel.
- Global competition on the world labor market and education market.
- Absence of an efficient quality control system at universities.

National Research Nuclear University “MEPhI”: preservation and concentration of the nuclear knowledge

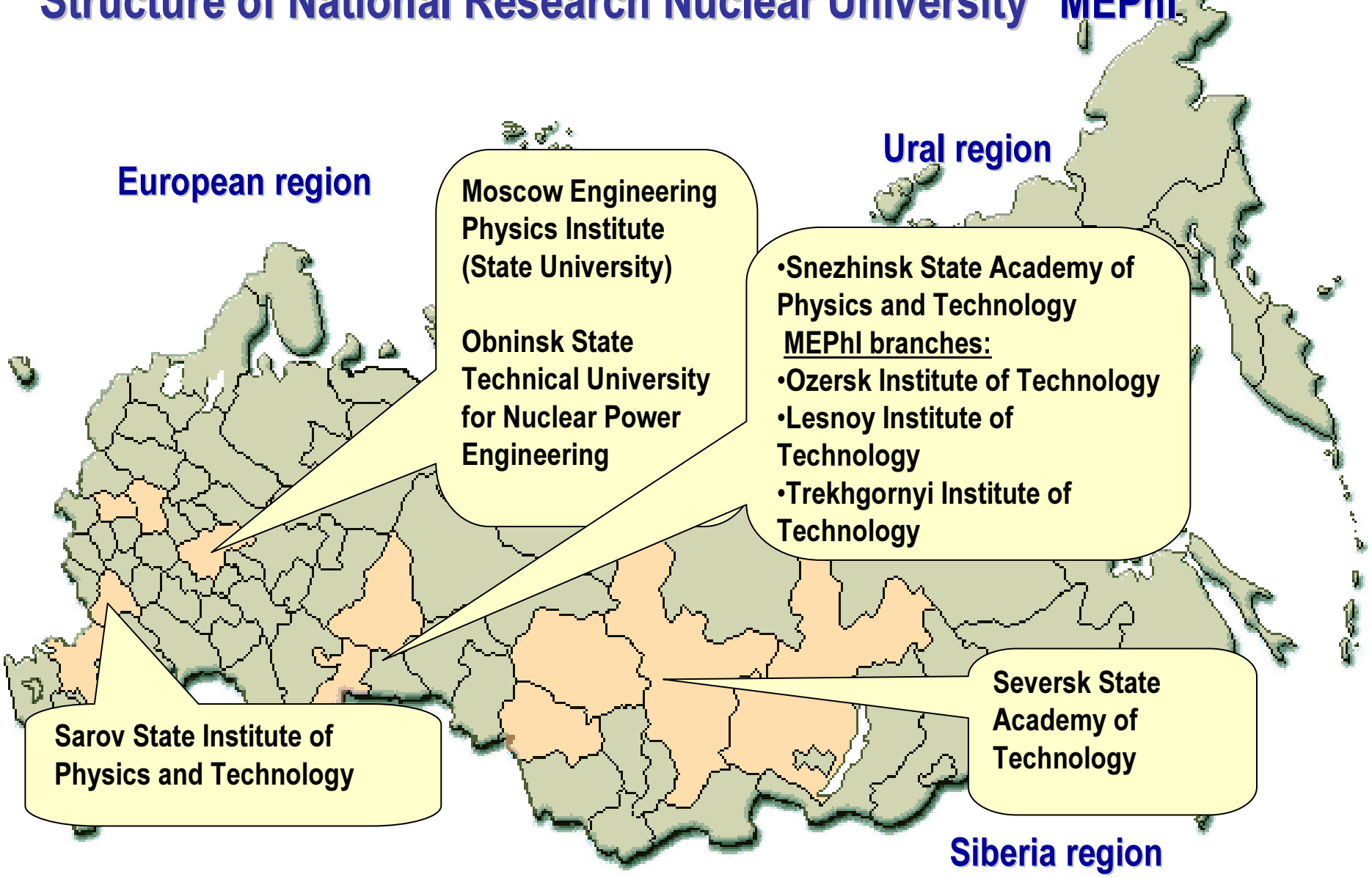
NRNU

is unite 5 specialized universities, 3 MEPhI branches and 13 secondary professional schools on the basis of MEPhI

The regional-industrial principle is realized for the formation of the NRNU

The Program of creation and development of NRNU MEPhI was approved by Russian Government Degree on July 13, 2009 with financial support (400 bln. rub. per year in 2009-2013). The State Corporation for Atomic Energy agreed to support the Program as well (400 bln. rub. per year in 2009-2017). The main focus of support is infrastructure and educational program development.

Structure of National Research Nuclear University "MEPhI"



Mission of the NRNU MEPhI:

provide human resources and scientific innovations for the nuclear industry and other high-technology branches of the Russian economy on the basic of the system modernization of multilevel education and integration of science, education and industry.

Total staff:

- Personnel ~ 8700
  Teaching staff: 2380
  - professors – 485
  - associate professors – 1135
- Students:
  - Higher education ~ 22 000
  - Specialized secondary education ~ 14 000
  - Postgraduate ~ 1000

Goals of the National Research Nuclear University "MEPhI"

- Training and retraining of human resources in modern science-intensive technologies.
- Providing human resources for Russian nuclear power and defense industries, radiation safety complex and scientific technological complex.
- Training of high-skilled human resources (graduate, postgraduate and doctoral education) in science-intensive specialties.
- Training of managers and analytical experts for science-intensive branches of the Russian economy and specialists for the development of cooperation in science and technologies in the international competitive market.

Whole educational cycle

- School training
- Secondary special education
- Higher professional education
  - Bachelor
  - Specialist
  - Master
- Post graduate course
- Advanced training and retraining

Priority directions of training and research(1)

- **Nuclear-physics and nano-physics**: physics of atomic nucleus, elementary particle physics, plasma physics, interaction of radiation with matter and physics of high density of energy, quantum physics of condensed matter, physics of nano- technological processes and laser physics etc;

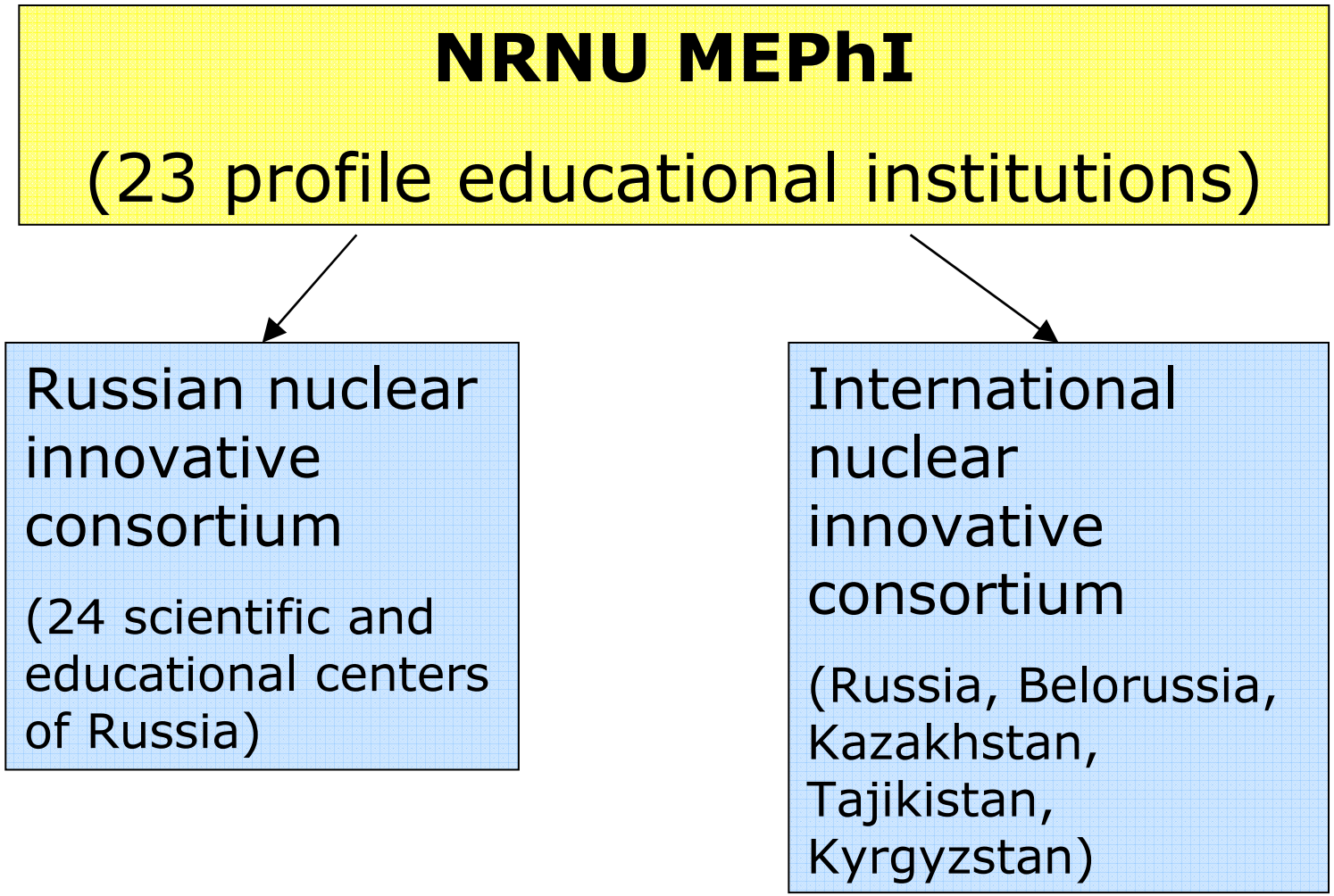
- **Nuclear-engineering** : nuclear technology and power engineering, radiation protection, nuclear engineering, nano-technologies and nano- materials, laser, plasma, and beam technologies, isotope separation, nuclear materials, radiation material science, micro- and nano - electronics, physical-chemical technologies, nuclear medicine, biotechnologies etc.;

Priority directions of training and research(2)

- **Modern information technologies:** information technologies in fundamental and applied research, modeling of technological and physical processes, simulators, network engineering, information and technological protection etc.;

- **Economics and management** in the field of high technologies, first of all of nuclear- and nanotechnologies: management, international scientific-technological collaboration etc.

NRNU is basic educational institution of Russian nuclear industry



NRNU – the Russian center for international cooperation in nuclear education

- Education of the foreign student.
- Cooperation with nuclear educational networks (MEPhI has agreement with ENEN and ANENT).
- Cooperation with the foreign nuclear universities (development common master of science programs, postgraduate training, curricula analysis and enhanced).
- Participation at the IAEA activity and representation of the Russian Federation at the World Nuclear University.
- Cooperation with the nuclear centers all over the world.

The International Center for Nuclear Education was created at MEPhI for organization and coordination of international training activities in the area of peaceful use of atomic energy.

Purpose of the Centre

- **Purpose of center creation is determined by the necessity to solve the tasks in the field of international activity of NRNU:**
  - **Creation of system of continuous personnel training for EurAsEC states in the field of nuclear power applications based on the international standards;**
  - **Development of educational service export as the leaders in the world educational market;**
  - **Development of educational and scientific contacts to IAEA, WNU, ENEN, ANENT, biggest scientific centers and universities of USA, EU and Asia.**

- Participation in international researches to preserve and create nuclear knowledge;
- Preparation and retraining of experts for international projects and international organizations;
- Informational and analytic studies for global market analysis;
- Monitoring on international laws in the nuclear fields.

ICNE main field of activities

- **Education. Transfer of knowledge to new generation, to new developing countries and cooperation on nuclear education with leading countries;**
- **Scientific enlightening activity – students, specialists, decision makers;**
- **Informational and analytical work.**

- **«Inventory» of scientific school – professors, leading experts, specialists;**
- **«Inventory» of technological and experimental facilities suitable for training activities – students in nuclear engineering areas;**
- **«Inventory» of training materials (books, manuals, CBT courses, references book, video, etc.);**
- **Establishment of the internet-based library network connected to the IAEA library network;**
- **Establishment of common information workspace and participation in international research and educational projects (IAEA, WNU, ENEN, ANENT, EC, etc.).**

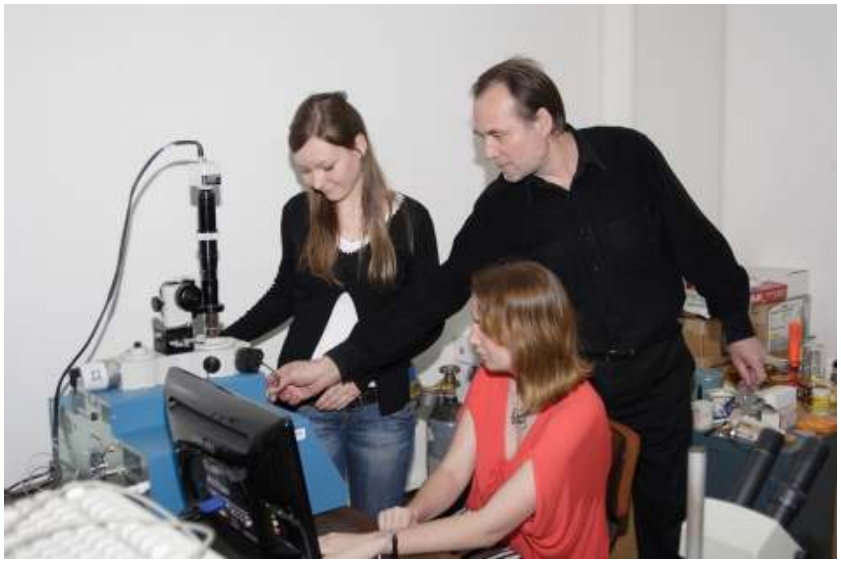
Moscow Engineering Physics Institute

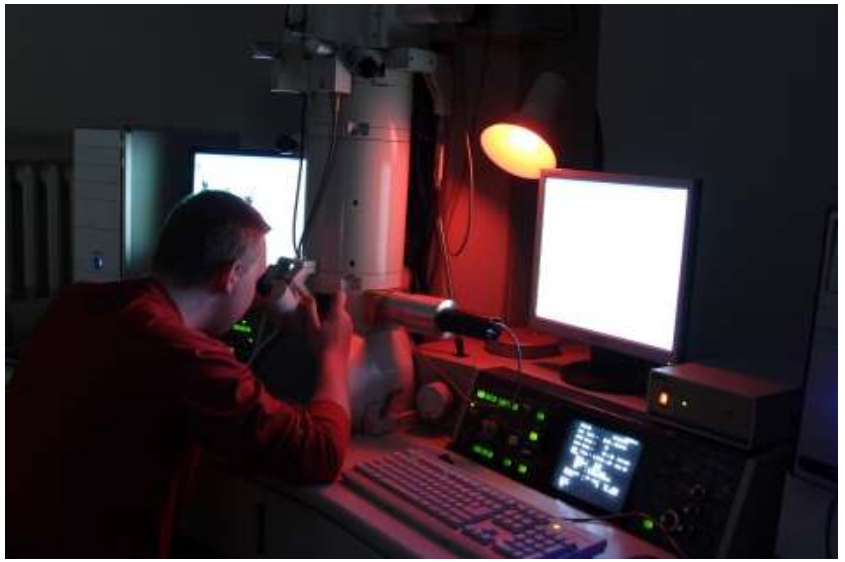
Departments

- Department of experimental and theoretical physics
- Department of physics and technics
- Department of automatics and electronics
- Department of cybernetics
- Department of information security
- Department of management and economics of high technologies

Department 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, medical physics,superconductivity, physics of nanotechnological processes and nanoelectronics





Department of physics and technics

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

Department of automatics and electronics

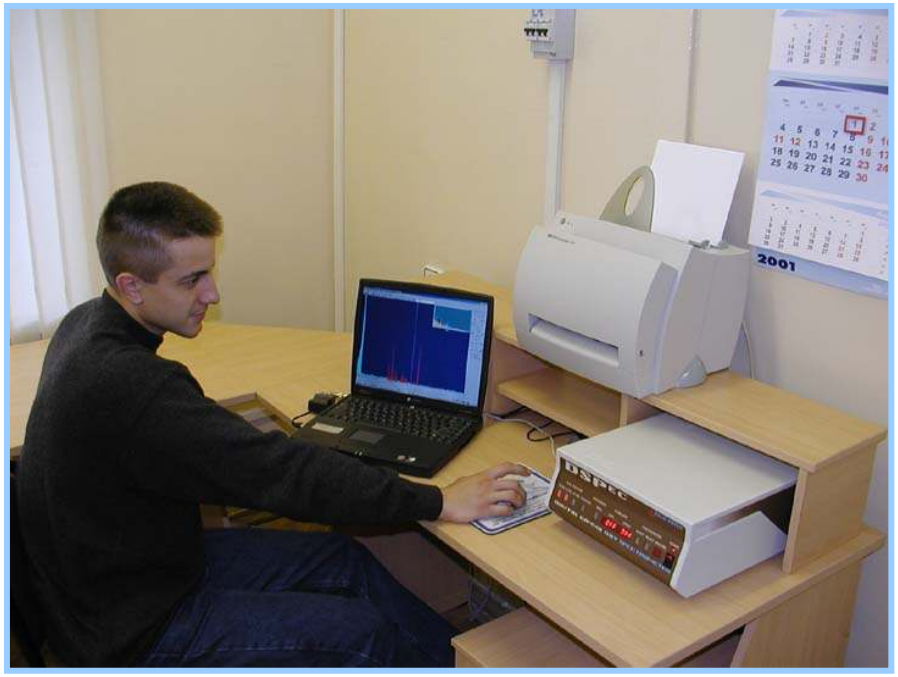
Automatics, electronics, microelectronics, electrophysical installations, electrical engineering and pulse technology, electronic measuring systems.

Department of cybernetics

Computer system design and development, data processing systems, monitoring systems for technological processes, automated control systems, software development

Department of information security

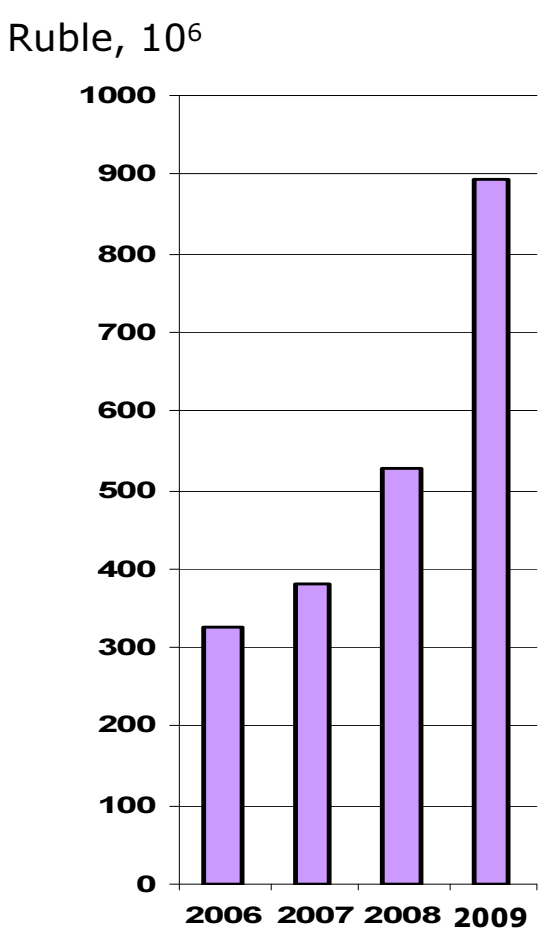
Complex information protection of automated systems, information security, safety and security of nuclear facilities.

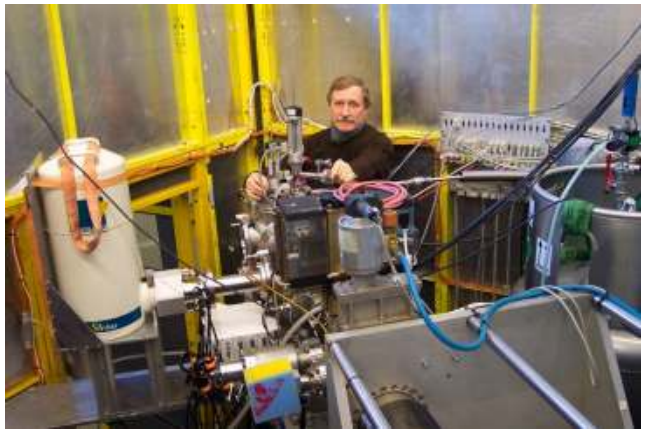


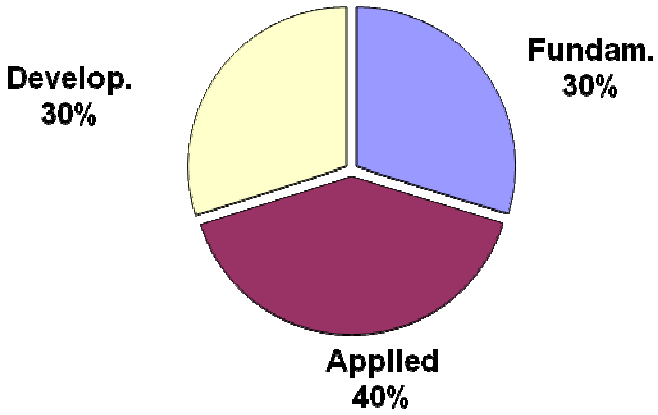
Department of management and economics of high technologies

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

Scientific activity







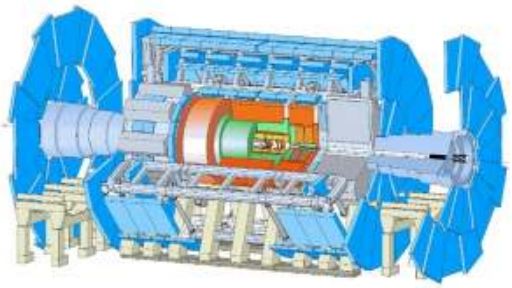
Educational-research centers

- Nuclear center
- Radiation accelerate center
- Radiation material science and radiation protection
- Physical protection, control and accounting of nuclear materials
- Nanosystems, nanomaterials and nanotechnologies
- Laser technological center
- Neutrino laboratory

and others

International collaboration

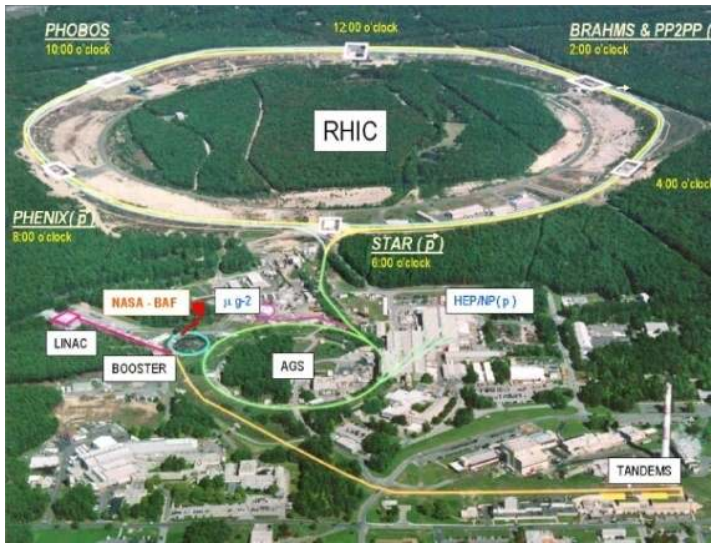
- Major international experiments (STAR, ATLAS, ALICE, PAMELA …)


- Participation in international programs

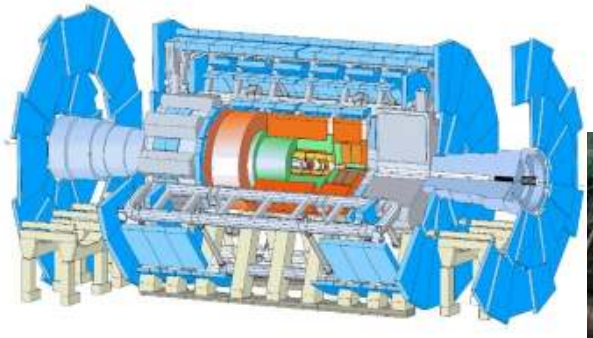

STAR experiment at BNL (USA)

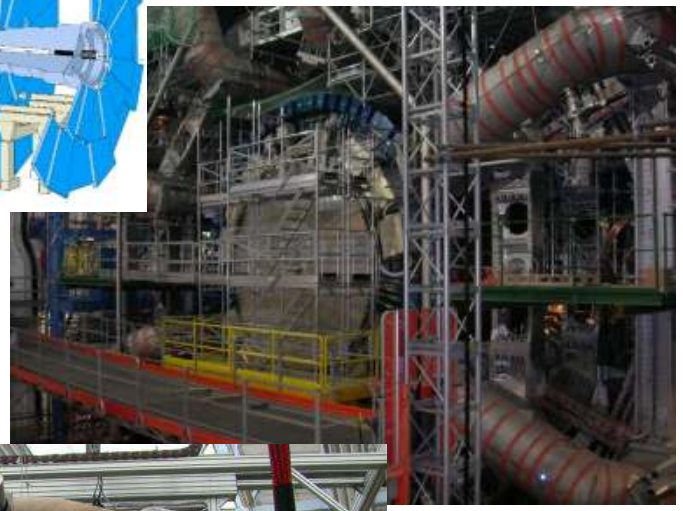
In the STAR experiment on relativistic heavy ion collider (RHIC) at BNL (USA) with the assistance of MEPhI the strong interacting matter with extremely high density of energy and temperature is studied.



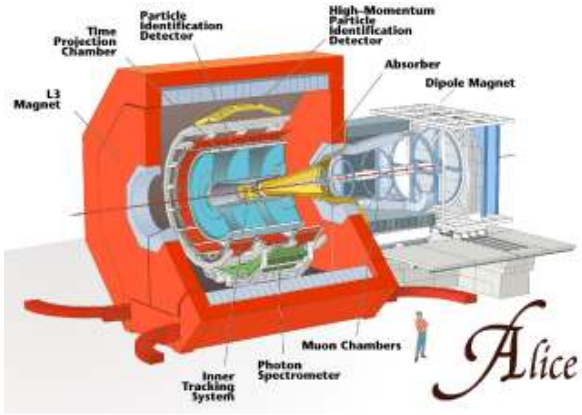
ATLAS and ALICE experiments (CERN) at BHC

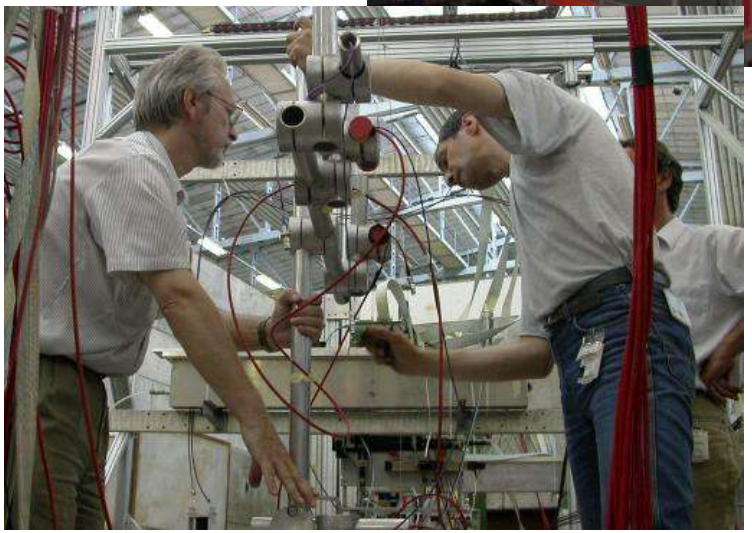
The track detector of the transitive radiation for ATLAS experiment is created





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





Segment of global network GRID

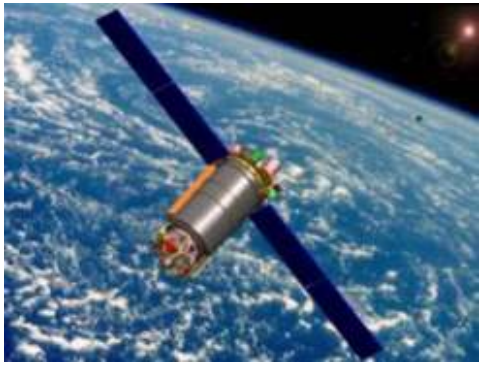
The segment of global network GRID possessing a possibility of processing of supermajor data files, arriving from unique large-scale experiments on a high-energy physics on the earth and in space is created and placed in operation. The international network address: WWW.LXFARM.MEPHI.RU.

Scheme of the data link of the network

PAMELA and ARINA experiments

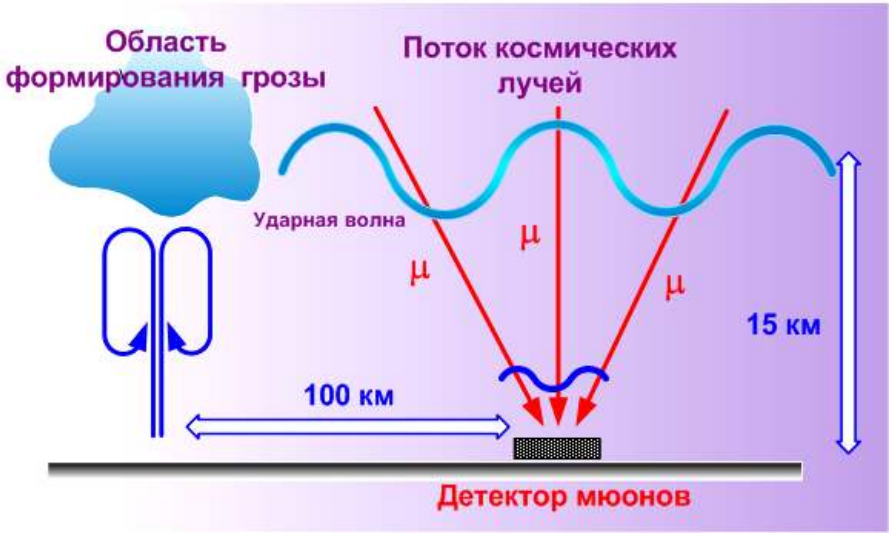
15 June 2006 the satellite RESURS DK-1 was launched from Bajkonur with two devices on board: PAMELA, developed for dark matter problem research, and ARINA, for earthquake forecasting

CORONAS-PHOTON experiment



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

Muon diagnostics

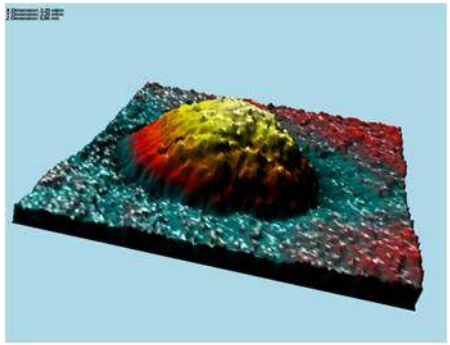


New direction of distance monitoring of the Earth atmosphere and near-Earth space, the muon diagnostics, is developed at experimental complex NEVOD

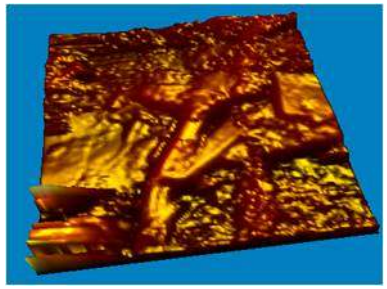
Upper detector

Side detectors

Nanoenergetics



Carbon nanotubes



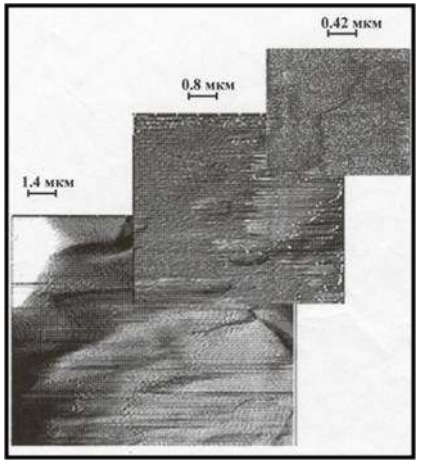
Graphite paper with Y-nanotube

Developing and research of new nanomatter on the base of metastable clusters able to store and emit an amount of energy which is significantly much compared with known chemical energy resources

Laser evaporation of thin nanostructured HTSC films for superconducting energy stores

Mechanical energy accumulator developing and devices of new generation on the base of nanosystems “non-moisturing liquid – nanoporous matter”

Nanopowder of uranium dioxide for improvement of fuel tablets properties for using at nuclear power plants



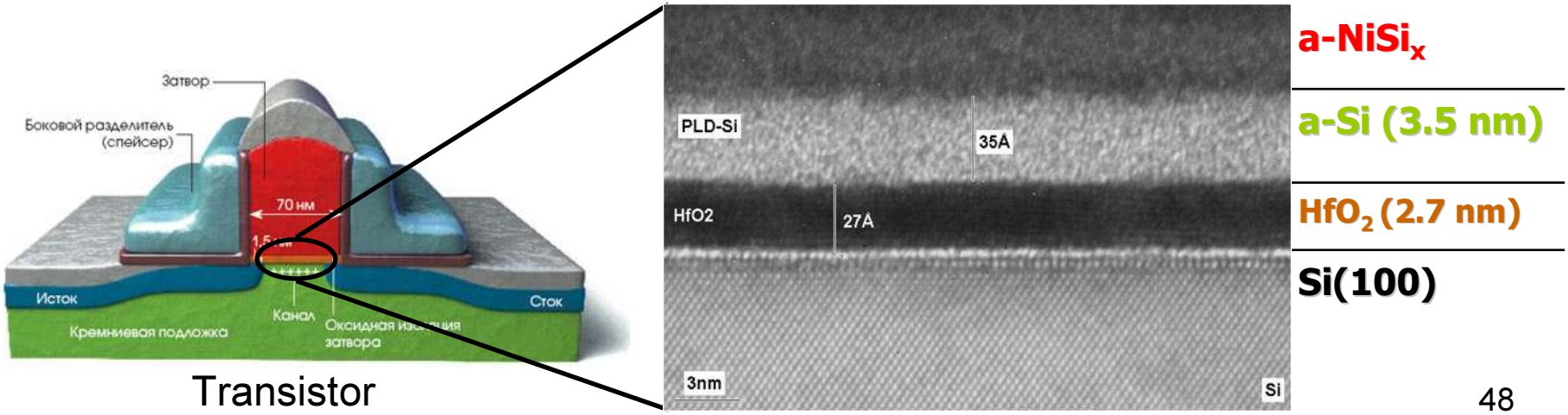
Surface of nanostructures fuel tablet

Nanoelectronics

Synthesis and research of new materials on the base of ultrathin layers of rare-earth oxides for transistors of new generation

Synthesis and research of conducting materials for devices of new generation

Physical base of memory element manufacturing on the base of magnetic tunneling (spintronics)

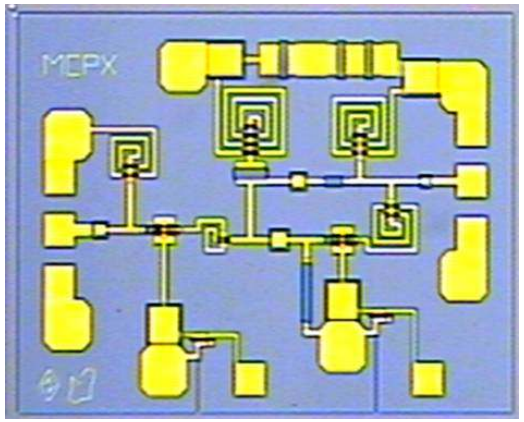


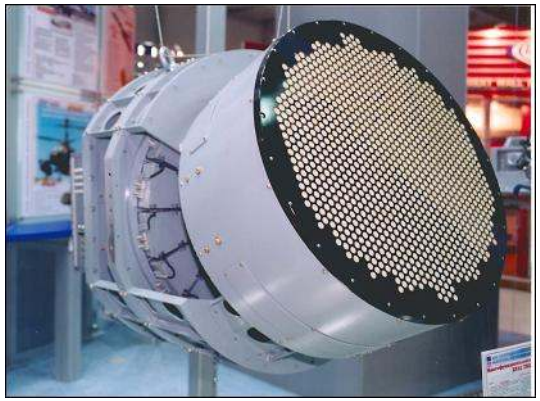
Transistor

Superhigh frequency solid state nanoelectronics

In collaboration with Institute of Superhigh frequency semiconductor electronics of RAS

First Russian small-scale integration circuit based on nanogeterostructures developed in collaboration with Tomsk group





AFAR

Full scale simulator of the third block of Kalininskaya nuclear power plant

Amorphous alloy-solder technologies

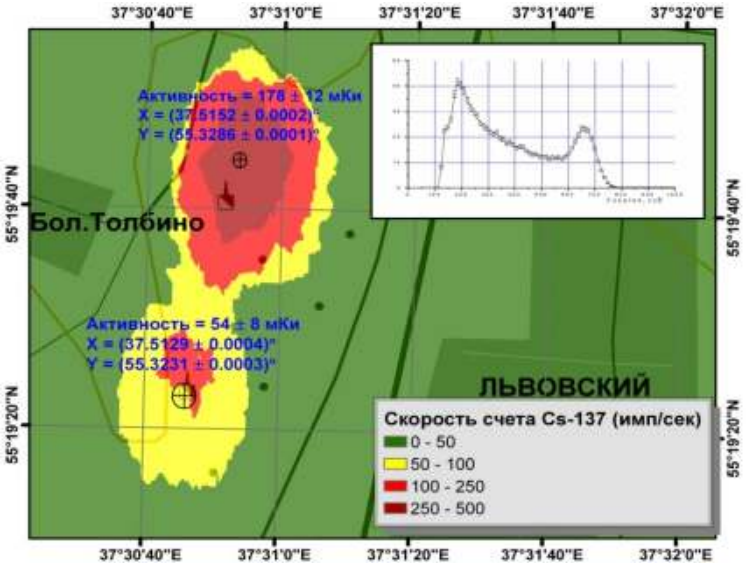
Technology and manufacturing of fast tempered amorphous alloy-solders for high temperature soldering of different materials for nuclear and space equipment are developed

Installation for fast tempering of melts

Fast tempered solders

On-board hardware-software complex for gamma spectrometry

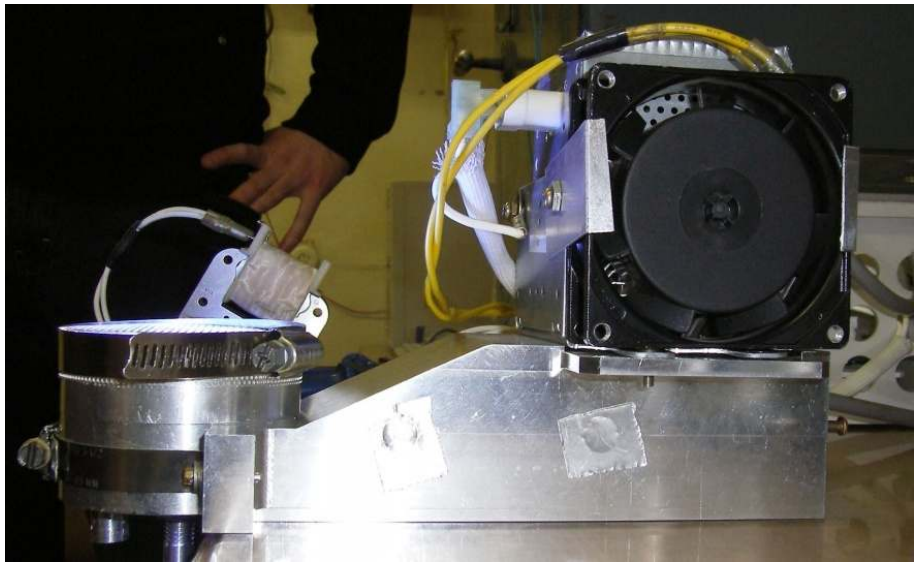
High resolution radiation reconnaissance (10 m^2)



Identification and localization of discovered anthropogenic source according to the results of spectrometric research

Superhigh frequency sources of natural light

High efficiency SHF source of natural light with low capacity (370 watt) on the base of Ar-S plasma glow in the resonator; the luminosity is 5 times much compared with existing light sources



Ion mobility spectrometer for registration of very-small concentrations

Identification of very-small concentrations of explosive and narcotic matter in air

The IAEA SSAC course

In 2004, 2006 and 2008 the IAEA SSAC course was successfully realized for 32 countries on the base of nuclear educational-research complex of MEPhI by international team of lecturers from Russia, France and USA

Thank you!