Mega Projects of National Research Centre “Kurchatov Institute”

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Scientific and Technological Breakthroughs in XX century

**MEGASCIENCE**

Accelerators

- Synchrotron radiation facilities
- X-Ray Free Electron Laser

Neutron sources

**Fundamental research**

**NUCLEAR PROJECT**

main goal – atomic weapon

- Nuclear power generation
  - Thermo-nuclear power generation
  - Nuclear-hydrogen power generation
- Superconductivity
- Electricity

- Nuclear energy in space

- Computing and modeling

- Material Science

- Nuclear fleet
  - Submarines
  - Icebreakers
  - Sea based petroleum platforms
  - Development of Arctic regions

Nuclear medicine

Isotopes
## Scientific Coordination of International Megascience Projects by NRC “Kurchatov Institute”

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International Centre for Neutron Research (ICNR) on the basis of the reactor PIK

Creating the ICNR PIK will provide the Russian Federation and International Community with methods using neutron radiation for fundamental and applied research in priority areas of science and include such critical technologies as industry of nanosystems and materials, cellular biotechnology, hydroenergetics and many others.

To develop ICNR Scientific Program in the field of the neutron research and a common Concept of the experimental ICNR PIK stations 11 Working Groups including more than 50 scientists from PNPI NRC “Kurchatov Institute”, JINR, HFZ (Germany), ILL (France), ESS (Sweden) and BNC (Hungary) were created.

Common Concept includes 32 experimental stations and respective research programs:

1. **Experimental stations for physics of condensed matter and molecular biology (22):**
   - Diffractometers (7),
   - Spectrometers for inelastic scattering (5),
   - Stations for small angle scattering (6),
   - Reflectometers (4).

2. **Experimental stations for particle physics and fundamental interactions (10):**
   - Stations for research with ultra cold neutrons and for neutron physics (4),
   - Beam channels and stations for research with ultra cold neutrons (3),
   - Stations for nuclear spectroscopy (3).
Specialized Synchrotron Radiation Source of the 4th generation SSRS-4

The project aims to create a fundamentally new specialized X-ray source - a specialized synchrotron radiation source of the 4th generation (SSRS-4) with extremely high spatial coherence corresponding to that of laser radiation, a record high brightness and temporal structure.

The current status of the SSRS-4 project is the preparation of the technical proposal with preliminary design.

The crucial point nowadays is formation of the Russian Scientific Community in the field of research using synchrotron radiation in order to provide photon science national expertise and elaborate Scientific Program.

It is planed to establish the International Scientific Advisory Committee for the SSRS-4 project.

The representatives of NRC “Kurchatov Institute”, ANL, DESY, ESRF, SLAC and SPRING-8 recognize the importance of X-ray science for the future development of International Society beyond 2020 and signed Agreement on International Design Effort for the Future Light Source (Moscow Communiqué).

International cooperation in the SSRS-4 project realization is provided in the framework of joint Russian-German Ioffe-Roentgen Institute (coordinated by NRC “Kurchatov Institute” and DESY).
The purpose of the Russian-Italian Ignitor project is the creation of the first world-wide tokamak with a stationary very strong magnetic field in which very strong current will heat up dense deuterium-tritium plasma to the temperature necessary for excitation of thermonuclear fusion reactions without powerful additional heating systems.

The Memorandum of Understanding between the Russian and Italian Ministries of Education and Science for the development of the Tokamak Ignitor has been signed. The Russian organizations responsible for the project implementation are NRC “Kurchatov Institute” (scientific coordinator) and SC Rosatom (infrastructure), the responsible Italian organization is Istituto Nazionale di Fisica Nucleare (INFN).

The status of the project: development of the Conceptual Design Report (CDR) by the especially appointed by the Russian and Italian Ministries of Education and Science joint Russian-Italian Working Group.

The CDR will include Scientific Program, research infrastructure and joint operation, risk analysis and finances. The CDR will be the basis for the Intergovernmental Russian-Italian Agreement on the Ignitor project realization including development of the Technical Design Report (TDR).

It is planned to complete the CDR in April, 2015.
The main goal of participation of Russian organizations in the XFEL project is development of the facility to generate ultrashort X-ray flashes in order to access new research areas. The representatives of the NRC “Kurchatov Institute” are members of the XFEL Management Boards (XFEL Council, In-kind Review Board, AFC, SAC, MAC).

NRC “Kurchatov Institute” formed the Working Group including representatives of the leading Russian Research Institutes with a mission to develop national Scientific Program for the XFEL project.

Main directions of the National Scientific Program include:

- Structure of single Particles and Biomolecules;
- Materials Imaging and Dynamics;
- Femtosecond Diffraction experiment;
- High Energy Density matter;
- Small Quantum Systems / Soft X-ray;
- Soft X-ray Coherent Scattering.

One of the main directions of the National Scientific Program is preparation for the conceptual design of the Specialized Synchrotron Radiation Source of the 4th generation SSRS-4.
The main goal of participation of Russian organizations in the ESRF is to conduct fundamental and applied research using the most powerful in Europe Synchrotron Radiation Source of the 3rd generation.

By Russian Federation Government Decree the NRC “Kurchatov Institute” represents the Russian Federation, realizes the scientific coordination and forms Scientific Program of the Russian participation in the ESRF project.

In accordance with Protocol of Russian Federation Accession to the ESRF Convention the Russian Federation became the Member of ESRF in 2014.

The representatives of the NRC “Kurchatov Institute” entered ESRF Management Boards (ESRF Council, AFC, SAC, MAC).

It is planned for the representatives of the Russian Institutes and Universities to enter to all Scientific Research Expert Groups of ESRF for the scientific coordination of the Russian organizations participation in ESRF Scientific Programs.
The main goal of participation of Russian organizations in the CERN is to conduct research in nuclear and high energy physics using the unique experimental accelerator base of CERN.

By Russian Federation Government Decree the NRC “Kurchatov Institute” represents the Russian Federation and realizes the scientific coordination of the Russian participation in CERN.

In 2014 under the guidance of the NRC “Kurchatov Institute” the Scientific Coordination Committee was formed in order to coordinate participation of Russian Institutes and Universities in CERN programs. Scientific Coordination Committee formed Program of participation of Russian organizations in CERN for the period 2014-2020.
The main goal of participation of Russian organizations in FAIR is to conduct fundamental and applied (material science and biology) research using unique international accelerator facility for the experiments with heavy ions and antiprotons.

By Russian Federation Government Decree the NRC “Kurchatov Institute” realizes the scientific coordination of the Russian participation in the FAIR project.

NRC “Kurchatov Institute” developed National Scientific Program for the FAIR project. The Scientific Program includes 5 main directions:

- **Nuclear Structure, Astrophysics and Reactions (NuSTAR)**
- **Compressed Baryonic Matter experiment (CBM)**
- **Antiproton Annihilation at Darmstadt (PANDA)**
- **Atomic, Plasma Physics and Applications (APPA Physics)**
- **Computing (using NRC KI computer center at full capacity, it is planned to use Tier-I)**

In the framework of FAIR-Russia activity NRC KI in cooperation with Helmholtz Association will provide financial support for young scientists, scientific conferences, workshops, seminars, Summer Schools, scientific exchange programs for students, graduate students, post-docs and young scientists from 2015.
International Thermonuclear Experimental Reactor ITER

The main goal of participation of Russian organizations in the ITER project is to demonstrate scientific and technological feasibility of use of thermonuclear energy in industrial volumes. By Russian Federation Government Decree the NRC “Kurchatov Institute” realizes the scientific coordination and coordinates engineering experimental design work of Russian organizations in the ITER project.

Russia produces 19 unique types of this installation; over 30 leading scientific and technological institutions, enterprises and complexes are involved.

The representatives of the NRC “Kurchatov Institute” are members of the ITER Management Boards (ITER Council, STAC, MAC).

Besides scientific coordination NRC “Kurchatov Institute” has its own engineering experimental base for the development of the particular systems, modules and prototypes for ITER.
Scientific Programs of the NRC “Kurchatov Institute”

I. Interdisciplinary research in nano-, bio-, info-, cognitive, socio-humanistic sciences (NBICS-technologies), on the base of x-ray, synchrotron and neutron radiation (NBICS)

II. Fundamental and applied research, using unique properties of synchrotron radiation source (PHOTON)

III. Fundamental and applied research in plasma physics and tokamaks (THERMONUCLEAR)

IV. Nuclear technology developments for next generation of nuclear power facilities (AE)

V. Fundamental and applied research using neutrons (NEUTRON)

VI. Fundamental and applied research using protons (PROTON)

VII. Fundamental and applied research using heavy ions and nuclear medicine (ION and NM)

VIII. Development of information and communication technologies and systems (ICT)

IX. Interdisciplinary educational activity (STAFF)
Thank you for your attention!