Ministry of education and science of the Russian Federation

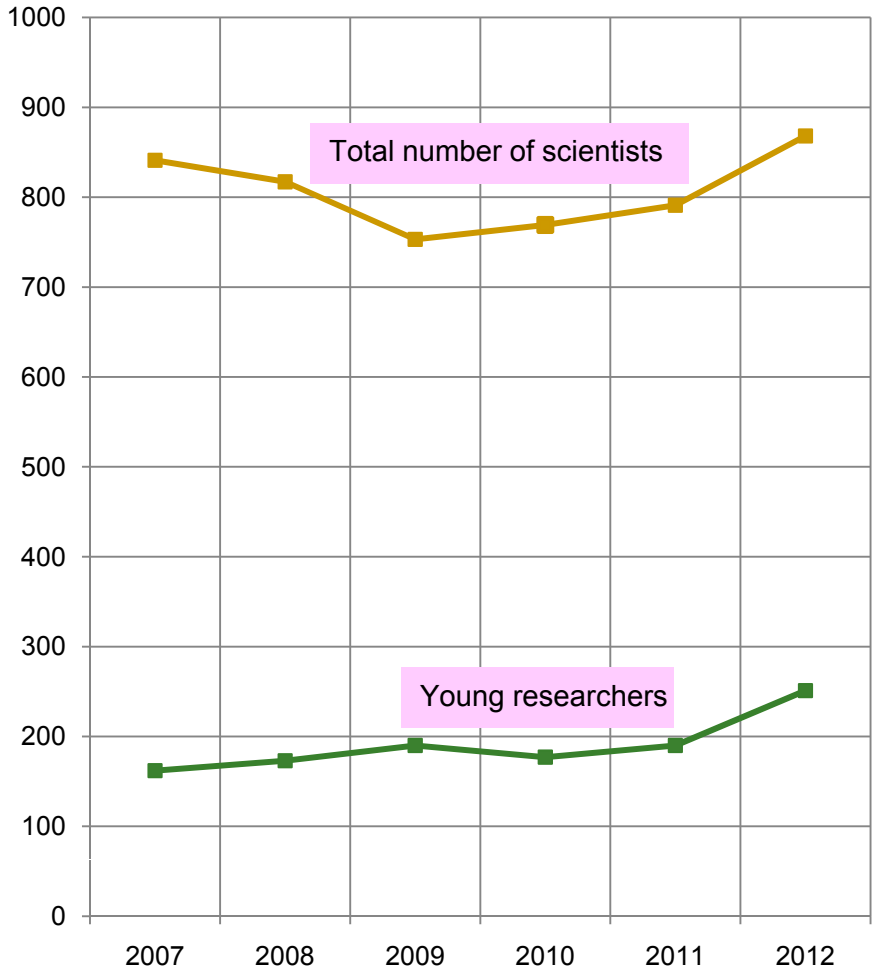
International cooperation with World research centers to study fundamental properties of matter

Sergey Salikhov
Director of the Department

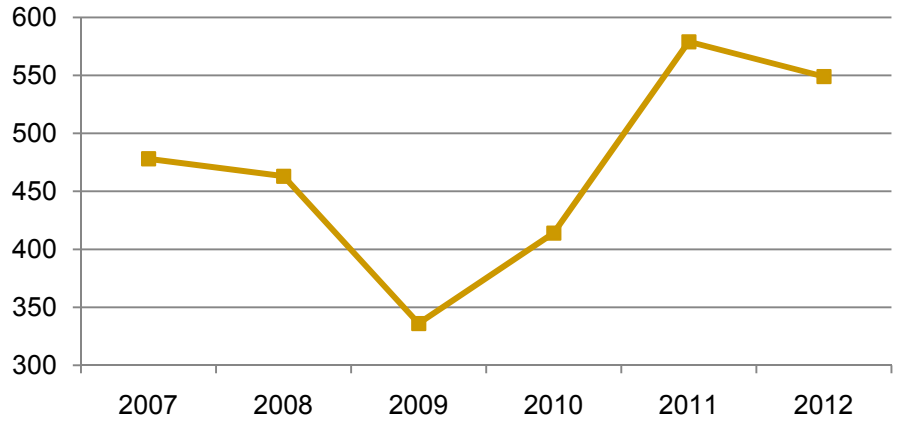
Department of science and technology

Participation of Russian scientists in study of fundamental properties of matter in World research centers

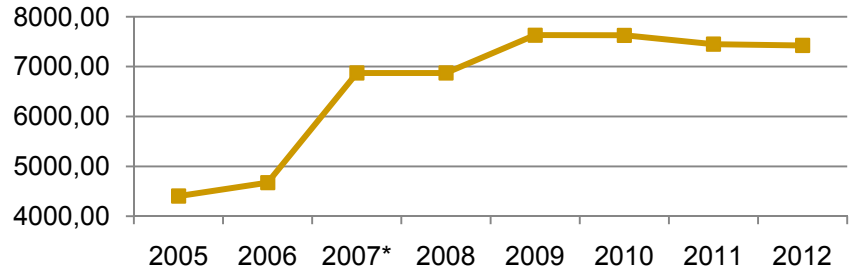
The number of Russian scientists working in World research centers



The number of publications by Russian scientists



Funding of Russian scientists working in World research centers (USD)



Participation of Russian Research Centres in the CERN experiments

Since 1999 Russia has the status Observer at CERN. In December 2012 on behalf of the Government the application was conveyed to the CERN Council about the intention of the Russian Federation to enter CERN as an associate member.

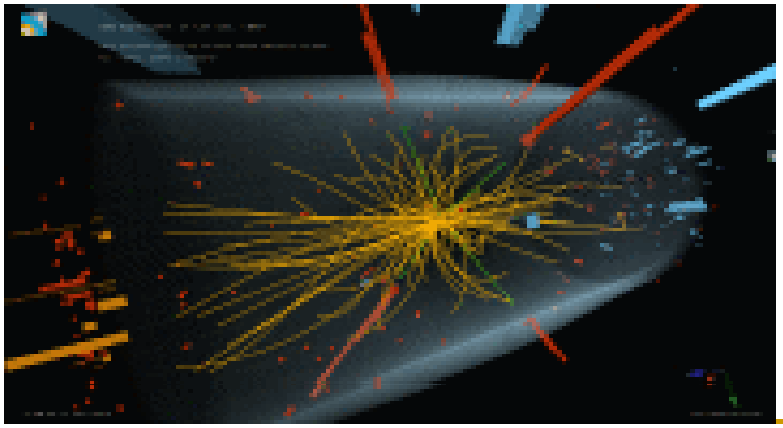
About 700 Russian specialists are involved in CERN projects, and more than 350 of them are included in the author lists of publications on results of studies carried out in the CERN experiments.

Major efforts of the Russian research institutions are connected with participation in the Large Hadron Collider experiments: ATLAS, CMS, ALICE LHCb.

Main goals of these studies are the Standard Model check, search for the Higgs boson, search for manifestation of new physics – supersymmetry, extra dimensions, dark matter, as well as studies of the extreme matter states for understanding the appearance and Evolution of the Universe, study of B meson decays for explanation of the baryon asymmetry in the Universe et cet.

Russian organizations participating in 18 CERN projects

National Research Center “Kurchatov Institute”
Russian Academy of Science
Russian Universities
Russian State Corporation of Atomic Energy
Joint Institute of Nuclear Research in Dubna



During the period of more than three years of the LHC continuous operation a plenty of important physical results has been achieved with participation of Russian scientists. The most outstanding one was the discovery of a Higgs-like particle.

As a result of experimental data analysis by the ATLAS and CMS Collaborations the existing of a new particle with the mass of 125 GeV and the Higgs-like characteristics was revealed. It was shown a good compatibility of the observed data to the Standard Model predictions, and its main quantum numbers were defined on a high confidential level.

Deutsches Elektronen-Synchroton (DESY, Hamburg)

Main goals:

Participation in the European X-ray Free-Electron Laser Project (*XFEL)*
Photon science Experiments on DESY-PETRA III facility
Study of the deep-inelastic scattering on the electron-proton collider HERA

12-m section of the main helium pipeline for the XFEL (IHEP)

98 specialists participate in these collaborations
from 12 scientific centers of Russia:
Kurchatov
Institute, ITEP, IHEP, PNPI, SINP MSU,
INR RAS, BINP SB RAS *et al.*

In year 2012 69 papers have been published and
67 reports have been presented on the International Conferences

Main results: Measurements of Charm Production Cross Section in Deep-Inelastic ep Scattering at HERA (Experiments H1 and ZEUS)
Photon physics: Study of the defect structure in colloidal crystals.
Development of the cooling system of detector for the fast X-ray tomography

The European X-ray Free-Electron Laser

Financial participation (2005 Euro)


663 M€*


306 M€*


36 M€


33 M€


25 M€*


17.5 M€*


17 M€*


12.7 M€*


11 M€ each


4 M€

* Increased contribution decided in 2012

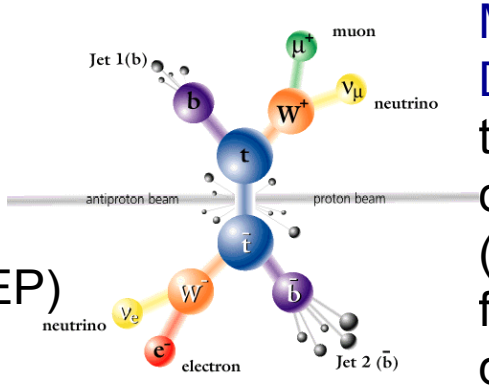
Fermi National Accelerator laboratory (USA)

68 Institutes and Laboratories from 19 countries are participating in D0 experimental program. Russian Federation: IHEP, PNPI and ITEP (NRC "Kurchatov Institute"), SINP (MSU) and JINR – 55 physicists in total. Russian contribution – detectors, working out of scientific program, data taking and analysis, publications. In total: 435 papers in leading scientific journals, more than 200 reports at the conferences.

Muon counters plane (6 in total) of D0 experiment (IHEP)

Research on proton-antiproton collider (Tevatron) with the use of D0 and CDF detectors . Ultimate goals: verification of the Standard Model and beyond (search for new particles and phenomena).

Main achievement: discovery of t-quark and detail study of its characteristics



Mass – 173.18±0.94 Gev/c^2. Decay time – $3 \cdot 10^{-25}$s. This means that top-quark appearance and its decay happens inside proton (antiproton) without any chance to form bound state with the other quarks.

Brookhaven National Laboratory (USA)

Research program is conducted by 75 Institutes and Universities from 15 countries - PHENIX. Russian Federation: 33 physicists and engineers from IHEP, PNPI, RSC KI (NRC «Kurchatov Institute») and JINR. STAR Facility: 59 physics groups from 12 countries; Russia – 17 physicists from IHEP, ITEP and MEPhI. Russian contribution: R&D, delivery and maintenance of the detectors, data taking, data analysis, preparation of the publications. In total: 320 papers in scientific magazins, tens of talks presented at the physics conferences.

Research on Relativistic Heavy Ions Collider (RHIC) with the use of PHENIX and STAR detectors. Goals:
-Search and study of quark-gluon plasma (QGP) in heavy ion collisions
-Study of the proton spin structure in proton-proton and proton-nuclear collisions

STAR

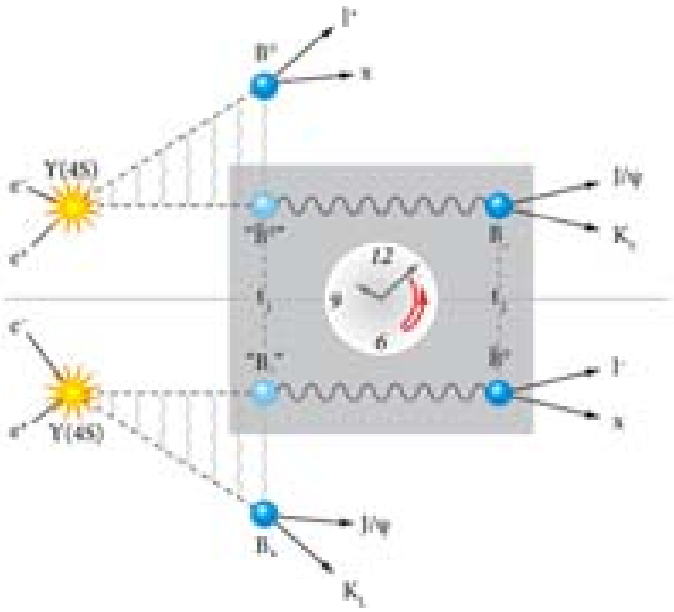
Main result: discovery of the new deconfined phase of strongly interacting QGP with the properties of ideal liquid under collisions of heavy ions
Firs observation of antihelium-4 nuclei in AuAu collisions

PHENIX

Stanford Linear Accelerator Center (USA)

Participants of the program: 73 Institutes and Laboratories from 13 countries;
Russian Federation: BINP RAS, Novosibirsk 13 physicists.

Research at The electron-positron collider PEP-II with the use of BaBar Detector
Goals of the experiments: study of CP-invariance violation in B-mesons decays, precise measurements of the CKM – matrix parameters
Main result: discovery of direct violation of CP- invariance and T- invariance in decays of B-mesons (2012)



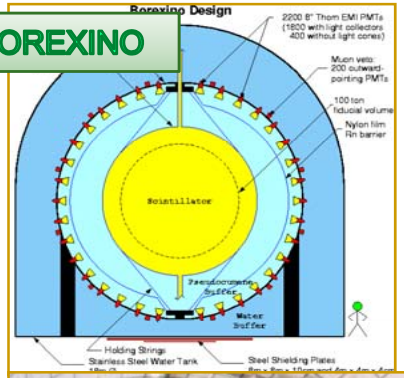
Experiment has started in 1994. Since that time – 1200 scientific publications

Diagrams of B0 → B_ and B_→ B0 transitions

Gran Sasso National Laboratory

Foreign scientists: 343 from 22 countries / Italian: 298 / Russian: 44

BOREXINO



- ✓*Flux of the pep*-neutrino from the Sun.
- ✓Neutrino velocity limit is
- ✓(v − c)/c < 2,1 × 10 −6
- ✓ Search for axions in the reaction *p*(*d*,3He)*A* in the Sun
- ✓Seasonal modulation of the cosmic ray muon flux

LVD

- ✓Supernova collapse limit is 1/8.69 year -1 (90% C.L.)
- ✓Neutrino velocity limit is -3.3·10-6 < (vv-c)/c < 3.5·10-6
- ✓ δtLVD-OPERA show OPERA timeshift δt = (73 ± 9) ns in the 2008-2011 yy.

GERDA

- ✓Search for neutrinoless double beta decay

- ✓Two events of the tau-neutrinos.
- ✓Get limits on the Δm23=2.45E-3, Sin2θ23=0.51.
- ✓Neutrino velocity limit is (vv-c)/c= (2.7 ± 3.1 (stat) (+3.4 -3.3) (sys)) ×10-6

OPERA

High Energy Accelerator Research Organization (KEK)/ Japan Proton Accelerator Research Complex (J-PARC), Japan

KEK: BELLE

J-PARC: T2K

Belle: 470 members from 70 centers
35 from Russia (BiNP, ITEP, IHEP)
Belle II (2016-): 518 members from 95 institutions from 22 countries
36 from Russia (BINP, ITEP, IHEP, MEPhI)

Main result - First observation of CP violation in B-decays

T2K — KEK, J-PARC, Super-Kamiokande: 500 members from 59 institutions of 11countries
16 members from Russia (INR)

Main result: Discovery of $\nu_\mu \rightarrow \nu_e$ *appearance at 7.5* σ *significance*

Efficiency of international cooperation

International cooperation provides good opportunities for:

- **broad participation of Russian scientists in large projects;**
- **development of modern technology in Russia;**
- **improvement of professional level of Russian scientists;**
- **active involvement of students in scientific research;**
- **creation of new jobs**

Thank you
for your attention!