INTRODUCTION

The year 2012 was rich in bright achievements in fundamental and applied physics at JINR where scientists obtained a number of world-class results. On the whole, the research outcome of the last year proved once more the achieved balance between scientific research at JINR and its participation in largest international projects, as well as between the contribution to the development of basic experimental facilities and physics data analysis.

The discovery of the new so-called Higgs-like boson in the ATLAS and CMS experiments at the LHC (CERN) was the milestone event of the year. The important contribution of JINR to this achievement was marked by the leaders of CERN and representatives of large international collaborations.

A group of physicists from JINR contributed significantly to the research programme of neutrino oscillations at the experimental complex in Daya Bay in China and to the most important result obtained in the measurement of the neutrino mixing angle θ_{13}.

JINR theorists showed in the framework of the Constrained Minimal Supersymmetric SM (CMSSM) that direct search for dark matter is a supplementary one to the direct search for supersymmetry and Higgs particles. In this approach, the combined data of the LHC, WMAP and XENON100 indicate that in the CMSSM the gluino of mass less than 1 TeV and lightest supersymmetric paricles of mass less than 160 GeV are excluded, irrespective of the squarks' mass.

Considerable progress was achieved in the preparation activities to construct the NICA accelerator complex. The complex designing work was completed and the project underwent an international scientific-technical expert evaluation; an international tender was announced to select a general contractor organization to construct the NICA accelerator complex.

In preparation for the first phase of the programme on heavy ion physics, a regular run at the Nuclotron for the first time brought in deuteron beam extraction with an energy of 4.5 GeV/nucleon.

In 2012, the discovery of the superheavy element of the Mendeleev periodic system with atomic number 117 made by Dubna scientists was officially confirmed. The data obtained in a new cycle of experiments on the study of radioactive properties of element 117 isotopes and their α-decay products in the complete fusion reaction $^{249}\mathrm{Bk} + {}^{48}\mathrm{Ca}$ fully confirmed the results of the pioneer research in the synthesis of element 117.

Among the bright achievements is the insertion of two new superheavy elements, 114 and 116, into the Mendeleev table. They were discovered at JINR in collaboration with American colleagues from the Lawrence Livermore National Laboratory (USA). In October 2012, an international colloquium on giving the new elements the names «flerovium» and «livermorium» and on the official acknowledgement of the Dubna and Livermore scientists' authorship in this outstanding discovery was held in Moscow at the RAS Central House of Scientists.

Along with successful development of the scientific programme of the Flerov Laboratory of Nuclear Reactions, active work was performed on the construction of a new experimental hall in the framework of the DRIBs complex for heavy ions.

The upgrading of the IBR-2 reactor was successfully completed; the world's first granulated cold neutron moderator of the reactor was launched; regular operation of the reactor started for scientific experiments. For the first time in the world, a tablet cryogenic moderator was used in the reactor operation, which considerably increases the capacity and efficiency of the facility. Active work was conducted throughout the year to upgrade the IBR-2 spectrometers. An international programme for users of the spectrometer complex at the reactor was started. It took into account the applications from institutions of the world for studies at extracted neutron beams.

Considerable progress was made in the development of the JINR grid infrastructure, in particular, in the establishment of the Russian Tier-1 centre to maintain the experimental programme for the LHC. The work is carried out in accordance with an Agreement signed by the Russian Government with the CERN Directorate. On the basis of the Agreement, a complex of this level is under construction in collaboration with the NRC «Kurchatov Institute».

Over 6.5 million tasks on LHC data acquisition and processing were solved at JINR in 2012. The Institute possesses 46% of the full computing time spent in RDIG (Russian Data Intensive Grid) for LHC tasks.

Applied research was marked by important results. In collaboration with the Federal Space Agency ROSKOSMOS, scientists from Dubna developed the CTN detector — a detector of themal neutrons for the «Curios-

ity Rover» space apparatus, intended for research of dynamical reflection and neutron moderation on the surface of Mars.

Experiments were held to work out and optimize track membranes of advanced capacity with an additional selection of pores. As a result, a patent was obtained for a new type of track membranes. Systematic studies of diode-like properties of asymmetric nanopores filled with the electrolyte solution resulted in observation of conditions under which the ion current recovery coefficient becomes maximal.

An analysis of the boron content in phosphate-based samples was performed by the neutron spectroscopy methods at the pulsed source of resonance neutrons IREN. It was shown that the new multipurpose materials combine properties of an efficient neutron protector with high thermoresistance and mechanical firmness.

In radiation biology, research of radiation effects and simulation of the action of heavy charged particles of space origin on biological objects were performed. For example, the first phase of research to measure the neuromediator level in different parts of the brain under radiation effect was carried out at accelerated ion beams from the Nuclotron-M in collaboration with specialists from the Institute of Medical-Biological Problems of RAS and the Institute of Higher Nervous Activity of RAS.

In collaboration with the RF Federal Medical-Biological Agency and other medical institutions, the proton therapy method is successfully developed and applied in medical practice at the Medical-Technical Complex of JINR.

Much progress was achieved in close cooperation between JINR and GSI/FAIR (Germany), as well as in integration of JINR into the European scientific research infrastructure: negotiations were successfully held with the European Commission and leaders of ESFRI (the European Strategic Forum on Research Infrastructures) — the organization that coordinates the construction and operation of major basic installations of fundamental science.

Every year the educational component of JINR activities obtains more and more advantages. In 2012, about 440 students of basic chairs of MSU, MPTI, MIREA, «Dubna» University, and universities of the Member States studied at JINR. About 80 students from Armenia, Belarus, Germany, Moldova, RF, Turkey, and Ukraine studied at the JINR postgraduate courses. About 120 persons took part in the annual student practice. A regular JINR–CERN school was held in Dubna for teachers of physics from JINR Member States, and CERN hosted a scientific school for Russian teachers. On the initiative of JINR, an educational centre named after Academician A. Sissakian was organized on the basis of the «Dubna» University to train senior school students — future university students, and school teachers of physics.

Dubna hosted a visiting session of the RAS Department of Physiology of Fundamental Medicine. Contacts of this type among physicists and medical scientists are of great importance for working out the right strategy for radiobiological research at JINR.

One of the major events of the year was the signing of an Agreement between JINR and BMBF (Germany) on the development of international cooperation in the fundamental physics of heavy ions, which makes provision for opportunities to join efforts in implementation of the NICA project in Dubna and FAIR in Darmstadt, and in training of young specialists.

In 2012, Dubna was invited to take part in the open symposium on elaboration of the European strategy in elementary particle physics, which was held in Cracow. The participants (about 500 scientists) discussed long-term plans of development of this field of physics. Apart from the studies at the LHC, they discussed other issues of research, such as latest important achievements in neutrino physics.

JINR representatives took part in the meetings on the occasion of the 10th anniversary of ESFRI in Brussels. In 2006, ESFRI issued its first road map on the development of scientific infrastructure in Europe. Now this programme includes 48 projects. The forum participants listened with interest to the presentation made by JINR scientists on the scientific programme of the IBR-2 reactor upgrading, the NICA and DRIBs projects.

Noteworthy also is the ASPERA international meeting devoted to the issues of astrophysics, neutrino physics, and related fields. A project of the next generation, ApPEC, was established on the basis of ASPERA and ASPERA2, which were completed in 2012. JINR and Russian state organizations that finance research in astrophysics and particle physics — the RF Ministry of Education and Science, RFBR, and MSU — are invited to take part in the new project.

In August 2012, Chairman of the State Duma of the Federal Assembly of RF S. Naryshkin visited Dubna. He was closely acquainted with scientific achievements of JINR and the status of the NICA project.

Throughout the year, much work was in progress to increase the efficiency of the management system of JINR on the basis of the analysis of the seven-year plan implementation. Saving of financial and material resources and their concentration in the main directions of the strategic plan of JINR development was promoted.

The bright results obtained by the community of the Institute in 2012 have illustrated the readiness of Dubna scientists to be at the forefront of scientific research, and for this the following prerequisites are necessary: the development of international cooperation of JINR with leading European and world centres, upgrading of the home unique scientific infrastructure, intensifying of the educational programme, and growth of the innovation component in the activities of the Institute.

V. Matveev
Director
Joint Institute for Nuclear Research