INTRODUCTION

The Joint Institute for Nuclear Research started the year 2010 with a new seven-year plan of development. Its concept, based on the triad principles: science – education – innovation, made primary provisions for the concentration of staff and financial resources for upgrading the research grounds of the Institute.

Unanimous enthusiastic disposition at the beginning of the year was suddenly extinguished by the unexpected death of JINR Director Academician Alexei Norairovich Sissakian, member of the Presidium of the Russian Academy of Sciences, a famous theoretical physicist, science and international scientific cooperation organizer.

Today we can firmly say that, despite the severe loss for JINR and all scientific community, the main goal of the Institute scientific policy was successfully advocated as further development of JINR was tightly connected with the implementation of advanced ambitious projects initiated by Academician A. Sissakian.

Latest important achievements of the JINR community prove the chosen route. The success attained in the synthesis and chemistry of superheavy elements is very impressive: element 117 of the periodic table was synthesized. The cycle of experiments on the synthesis of the new element was accomplished in collaboration with laboratories in Oak Ridge and Livermore, Vanderbuilt University (USA), and the Institute of Atomic Reactors in Dimitrovgrad (Russia).

Radioactive properties of 11 new nuclides were studied. They demonstrate a significant growth of nuclei stability as the number of neutrons increases and they reach the region of spherical shells $Z = 114$–126 and $N = 184$. New nuclei and those synthesized before make a conformal picture of nuclei properties in the region of heaviest nuclides; they demonstrate the determinant role of nuclear shells and prove experimentally the existence of the predicted region of superheavy elements.

During the year 2010, new facilities within the DRIBs-III programme were actively developed: an ACCULINNA fragment-separator and a multipurpose gas-filled separator of heavy nuclei. The new facilities meet modern requirements for experimental research.

The schedule of the Nuclotron-M and NICA projects was strictly fulfilled: the autumn run at the Nuclotron showed stable operation of the new system of power and protection of structure magnets and lenses, as well as the magnetic system at a maximal field value of 2 T. A new rotary compressor CASCADE-2 with a capacity of 6000 m^3/h, an air-pump compressor that had been fully upgraded, and new elements of the accelerator diagnostics system (the orbit correction system and the digital orbit correction system) were put into operation. Therefore, the upgrade of the Nuclotron was completed.

In late 2010, the upgrade of the IBR-2 reactor, a high-intensity neutron source of the world class, was accomplished and the physical start-up of the facility was made. A huge amount of work in the development and design was done. New important systems and elements of the reactor complex were assembled and adjusted. The IREN-1 facility continued to be developed to reach higher intensity of the neutron source.

Among significant results of the year are the experimental data obtained by JINR physicists involved in the experiments ALICE, ATLAS, and CMS at the LHC. First collisions of Pb nuclei were registered there in November. In 2010, within the joint CERN–JINR project, the work to start up the damping system was accomplished for the beam transverse coherent oscillations in the LHC. This system successfully operated at an energy of 3.5 TeV.

The JINR–INFN–FNAL group refined the method to measure the top-quark mass starting from the CDF data in the channel of «two-lepton» decay. The results of the GDF and D0 experiments, obtained independently, considerably increase the precision of individual limits and provide new data for the region of feasible Higgs boson masses within the Standard Model.

The JINR group obtained a new result in the D0 experiment in the measurement of the two-parton processes contribution to proton–antiproton collisions at the Tevatron. According to the data, it is neces-

sary to take into account two-parton processes in the research beyond the Standard Model.

A high level of theoretical studies should be marked. Theoretical research dwelt with the main trends of the JINR scientific programme. A field-theoretic approach was constructed to describe Dirac fermions on the elastic membrane with disclination beyond the limit of absolute rigidity. This approach was used to study the modification of the Landau levels and density of electron states in the graphene membrane.

A new method was suggested to calculate the rates of nuclear processes related to weak interactions in hot stellar matter. The temperature dependence of force distributions of the Gamow–Teller transitions, as well as the charge-exchange transitions, was calculated for several iron and germanium isotopes.

Dubna physicists contributed greatly to new achievements in neutrino physics and astrophysics. For example, the OPERA experiment registered the first candidate for a $\nu\tau$ event (the confidence level 2.36σ). It is an important advance to the long expected direct experimental proof of the ability of muon neutrinos to transform into tau neutrinos. The result obtained in 2010 with active involvement of a JINR group in the EDELWEISS-II experiment for the cross section of the spin-independent WIMP–nucleon interaction, which amounted to $5.0 \cdot 10^{-44}$ cm^2, is one of the three best results in the world.

The studies in condensed matter physics and radiobiology conducted by JINR scientists can also be regarded as very fruitful. The phenomenon of the neutron wave splitting in the processes of reflection and deflection of neutrons from a nanolayer placed in a static magnetic field and an oscillating magnetic field perpendicular to it was predicted. The obtained results point to possibility and necessity to develop a new method of investigating the dynamic characteristics of laminated nanostructures, which is based on the phenomenon of the neutron magnetic resonance.

The structure of biocompatible ferroliquids was determined with small-angle neutron scattering for the therapy of cancerous tumours of human brain. Besides, the degree of penetration of magnetic nanoparticles of the studied ferroliquids into the cancerous cells of glioblastoma was defined. It was shown that nanoparticles have comparatively low toxicity in relation to brain cells.

In the field of nanobiotechnology, postradiation cell death was studied due to the application of the unique laser probing CARS microscope. The research was conducted with various microbiological and molecular methods that allow identification of the cell structure elements and their damage under radiation effects.

As part of the joint studies of JINR and the Institute of Space Research of RAS, work was continued to prepare neutron detectors and gamma spectrometers for investigation of planets with nuclear physics methods.

In 2010, the increased capacity of the information and computing infrastructure of JINR and grid services promoted the intensification of information and network support of scientific activities at JINR, as well as the development of JINR integrated network and the unified grid environment. These efforts were undertaken in cooperation with scientific organizations of the JINR Member States and other countries. Due to its efficient operation, the JINR grid site ranks among the first dozen of grid sites incorporated in the global grid infrastructure of the LHC project. The contribution of JINR to the solution of tasks in the framework of the Russian grid for active operation with data amounted to 40% in 2010, as the Russian grid overlaps the grid segments of JINR and 16 resource centres in institutes of Russia and Member States.

Special attention was focused on the development and enhancement of the JINR educational programme, in particular, on the organization of conditions for efficient training and fast involvement of young scientists in research programmes of the Institute and on closer contacts with school teachers. In 2010, JINR and CERN organized two scientific schools for teachers of physics from general education institutions in the JINR Member States. One was held in summer in Dubna, the other in autumn in Geneva. The participants were quite impressed by the events — it was an obvious success that demonstrated the usefulness of such schools. They evidently help teachers to stimulate school students' interest in modern physics.

Traditional annual international student practice courses in JINR fields of research were attended by students from Egypt, Belarus, Bulgaria, Poland, Romania, Serbia, Slovakia, Czechia, and the Republic of South Africa.

The international cooperation was enforced with active development of partnership programmes with the Member States and other countries, international and national scientific organizations. The signing of bilateral agreements of JINR with CERN, the Budker Institute of Nuclear Physics, the Brookhaven National Laboratory (BNL, USA), the Fermi National Accelerator Laboratory (FNAL, USA), and the Moscow Engineering Physics Institute (National Nuclear Research University) is a notable result of these activities.

Most important innovation projects are implemented in Dubna — with the major JINR participation and under the support of the ROSNANO state corporation. One of them is the project of the establishment of an infrastructure nanotechnological centre. In 2010, corresponding investment agreements were concluded and modern equipment for the future centre started to be purchased. Another project was under implementation. It concerned extending the production of multipurpose detectors for identification of a wide range of substances on the basis of the tagged neutron technique.

In 2010, JINR and the Foundation «Skolkovo» signed a Memorandum on cooperation. It presupposes

joint activities in implementation of innovation projects, construction of innovation infrastructure, involvement of students, postgraduates and young scientists in innovation studies to attract additional resources for the development of the experimental base of the Institute.

The year of 2010 at JINR marked the centenary of the Corresponding Member of the USSR Academy of Sciences M. Meshcheryakov (1910–1994), one of the city founders, head of the development work of the Dubna first accelerator — the synchrocyclotron. A monument was erected on the Volga embankment in memory of the scientist.

Jubilee dates of the journals «Physics of Elementary Particles and Atomic Nuclei» and «Physics of Elementary Particles and Atomic Nuclei, Letters» were also celebrated in 2010. These famous JINR editions started publishing scientific papers 40 and 25 years ago, respectively. As before, the journals are distinguished by a high level of papers, a splendid selection of authors from the Institute Member States, and a high citation index.

The Introduction, which traditionally opens a detailed report on the work and major achievements of the Institute community during the year, very briefly describes the most significant events in the Institute life. But even this list, being far from a detailed one, demonstrates in general the strict and successful accomplishments of JINR responsibilities according to the new seven-year plan. Undoubtedly, it encourages us to continue sustainable development of our international scientific centre in future.

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