VEKSLER AND BALDIN LABORATORY OF HIGH ENERGIES

The activity of LHE in 2007 was concentrated on the realization of the first stage of the NICA/MPD project (Nuclotron-M subproject) as well as on the fulfillment of the existing obligations on IREN, ILC, in particle physics experiments and R&D of particle detectors and acceleration systems.

NICA/MPD

The new flagship project of the Joint Institute for Nuclear Research is the NICA/MPD project. The main goal of this project is an experimental study of hot and dense strongly interacting QCD matter at the new JINR facility. This goal is proposed to be reached by:

1) development of the existing accelerator facility (the 1st stage of the NICA/MPD accelerator programme: Nuclotron-M subproject) as a basis for generation of intense beams over atomic mass range from protons to uranium and light polarized ions;

2) design and construction of heavy ion collider with maximum collision energy of $\sqrt{s_{NN}} = 9$ GeV and averaged luminosity 10^{27} cm^{-2}·s^{-1} (for U^{92+});

3) design and construction of the Multipurpose Detector (MPD).

NICA/MPD Goals and Physics Problems

New JINR facility will make it possible to study in-medium properties of hadrons and nuclear matter equation of state, including a search for possible signatures of deconfinement and/or chiral symmetry restoration phase transitions mixed phase and QCD critical endpoint in the region of the collider energy $\sqrt{s_{NN}} = 3{-}9$ GeV [1].

The following processes will be studied at the first stage of experiment:

• multiplicity and spectral characteristics of the identified hadrons including strange particles, multi-strange baryons, and antibaryons characterizing entropy production and system temperature at a final interaction stage;

• event-by-event fluctuations in multiplicity, charges, transverse momenta and K/π ratios as a generic property of critical phenomena;

• collective flows (directed, elliptic, and higher ones) for observed hadrons including strange particles driven by the pressure in the system;

• HBT interferometry of identified particles and particle correlations (femtoscopy).

At the second stage of the experiment the electromagnetic probes (photons and dileptons) will be used to study heavy-ion interactions.

The beam energy of the NICA is much lower than the energy of the RHIC and the LHC, but it is located right on the top of the region where the baryon density at the freeze-out is expected to be the highest. In this energy range the system occupies a maximal space-time volume in the mixed quark–hadron phase (the phase of coexistence of hadron and quark–gluon matter similar to the water–vapor coexistence phase). The energy region of NICA will allow analyzing the highest baryonic density under laboratory conditions. By the end of 2007, the first draft of the Letter of Intent for the MultiPurpose Detector (MPD) to study heavy-ion collisions has been prepared [2].

NICA General Layout

Construction of the new facility is based on the existing buildings and infrastructure of the Synchrophasotron/Nuclotron of the Veksler–Baldin Laboratory of High Energies. The accelerator chain includes: heavy ion source — RFQ injector — linac — booster ring — Nuclotron — superconducting collider rings. The designed kinetic energy of U^{92+} ions in the collider is 3.5 A GeV. Beam cooling and bunching systems are foreseen. The collider system is fitted to the existing building 205.

Several schemes of the NICA accelerator complex have been considered. The specified average luminosity of 10^{27} cm$^{-2}\cdot$s^{-1} can be reached at the parameters of the collider presented in the Table. The project design presumes the use of some fixed target experiments. Polarized deuteron and proton beams will be available also.

The expected parameters of the collider

Ring circumference, m	224
Ion kinetic energy, GeV/n, min/max	1/3.5
Particle number per bunch, $N_{\rm ion/bunch}$	$1.0 \cdot 10^9$
Bunch number, $n_{\rm bunch}$	$10 \div 20$
Horizontal emittance, ε, π mm mrad	0.7
Momentum spread, $\Delta p/p$	0.001
IBS lifetime, s	$\geqslant 100$
β function at interaction points, β*, m	0.5
RF voltage, $U_{\rm RF}$, kV	100
Laslett tune shift, ΔQ	0.0044
Beam–beam parameter	0.009
Luminosity, L, cm$^{-2}\cdot$s^{-1}, peak/average	$2/(1{-}1.5) \cdot 10^{27}$

Subproject Nuclotron-M

In 2007, the Conceptual Design Report (CDR) of the NICA facility [3] has been prepared and the realization of the 1st stage (Nuclotron-M subproject) was started. During the 37th acceleration session, the LHE accelerator division carried out a set of experiments and tests directed on the investigation of current Nuclotron conditions and started its modernization. In particular:

• $^6Li^{3+}$ ions have been accelerated (beam with intensity of 10^9 particles and 5 MeV was accelerated up to 25 MeV);

• Estimation of beam lifetime using comparison of deuterons and H_2^+ circulation time was done. Measured value $\tau > 3$ ms corresponds to $1{-}3\cdot 10^{-8}$ Torr (for N_2 equivalent) that is one order of magnitude better than it was expected ($\leqslant 10^{-7}$);

• The 1st experiment on pseudo-adiabatic bunching at constant magnetic field was started and successfully performed. It was shown that the beam intensity can be increased by a factor of 2;

• Methodical shifts aimed at investigation of particle losses on the first turns were done.

Other technical experiments and methodical studies were done, and some new diagnostic equipment was installed and successfully tested.

NICA/MPD scientific and accelerator programmes have been broadly represented in 2007 at different workshops and conferences. Mention the presentation at the XXIII International Symposium on Lepton and Photon Interactions at High Energy [4] by Prof. A. Sissakian and the International seminar dedicated to the 100th anniversary of V. I. Veksler and 50 years since the Synchrophasotron starts-up, where the hole day (October 11) has been completely dedicated to reports and discussions on different topics of the NICA/MPD science and accelerator programmes. The strategy of the NICA/MPD project has been reported at the 27th and 28th sessions of the Particle Physics PAC and at the JINR Scientific Council session where it was completely approved and supported.

ONGOING EXPERIMENTS AT THE NUCLOTRON

The 36th accelerator run of the Nuclotron has been carried out from February 26 till March 21. 362 hours ($>$ 60% of the total run duration) has been used by physicists, 124 hours took cooling, the rest has been taken by accelerator division staff for the tests and tuning of the accelerator systems. Six physical groups participated in the run (TPD, NIS/GIBS, STRELA, FAZA, Delta-Sigma, and «Energy and Transmutation»); they used a deuteron beam with intensity up to 10^{10} particles/cycle and the maximal kinetic energy up to 2.2 GeV.

TPD Experiment

A high-intensity extracted deuteron beam of the Nuclotron allows one to carry out a number of experiments with unpolarized deuterons to study spin effects appearing when they are passing through the unpolarized targets. In particular, the appearance of the tensor polarization of deuterons when they are crossing the lengthy target can be studied. It is also possible to perform the quantitative check of two different mechanisms which can be responsible for the polarization appearance, namely:

• phenomena of spin rotation and spin dichroism for particles with spin $S \geqslant 1$ in the unpolarized medium;

• effect correlated with the presence of large tensor effects in the inclusive inelastic reaction $A + d \to d' + X$ in the region of 4-momentum transfer near $|t| = 0.3$ (GeV/c)^2.

Measurements of deuteron tensor polarization at different target densities will help distinguishing between these two effects.

In March 2007, during the set of experiments carried out at the Nuclotron, it has been discovered that:

• Initially unpolarized deuteron beam passing through the carbon target has to be polarized. The value of polarization increases with the target thikness;

• The phenomenon of spin dichroism (defined as a production of spin polarization in the unpolarized beam) predicted by V. Baryshevsky was observed with unpolarized deuteron beam of 5.5 GeV/c (Fig. 1);

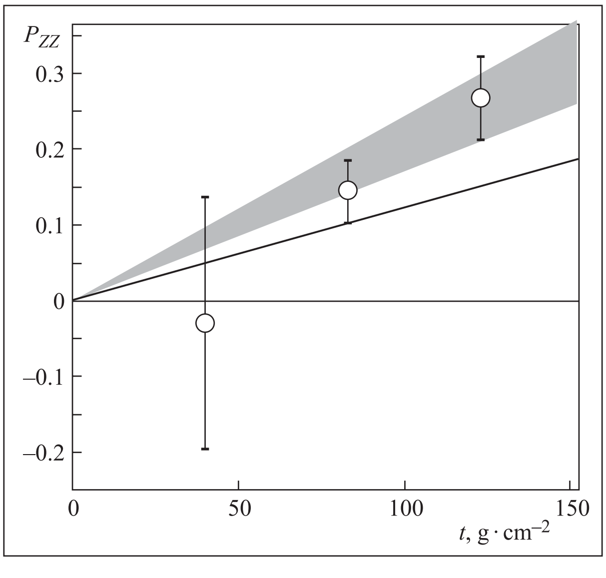

Fig. 1. The value of the tensor polarization as a function of carbon target thikness. Curve corresponds to calculations performed in the framework of the Glauber multiple scattering theory. Shadow region shows experimental uncertainty

• To describe the observed effect, the formalism developed in the framework of the Glauber multiple scattering theory was elaborated. Results of calculations are in qualitative agreement with the experimental data;

• The observed effect can be used to produce tensor polarized deuteron beam of small intensity at high energy.

Obtained results have been reported at the Conference DSPIN-2007 (3–7 September, JINR, Dubna).

LNS–PHe$_3$ Projects

LNS and PHe$_3$ projects are aimed at the study of spin effects in few-nucleon systems in polarized nuclei interactions at RARF (RIKEN, Japan) and at the Nuclotron. In 2007, work in the collaboration was concentrated on the analysis of the experimental data on the analyzing power in $dd \to ^3\text{He}n(^3\text{H}p)$ reactions and dp elastic scattering obtained at RARF and at the Nuclotron, respectively.

The aim of the experiment at RARF is the measuring of the vector, A_y, and tensor, A_{yy}, A_{xx}, and A_{xz}, analyzing powers in the $dd \to ^3\text{He}n(^3\text{H}p)$ reaction at moderate energies in order to study the short-range spin structure of ^{3}He(^{3}H) and to search for the charge symmetry breaking (CSB) in polarization observables for two mirror channels: $^3\text{He}-n$ and $^3\text{H}-p$.

The final results on the angular dependences of the analyzing powers A_y, A_{yy}, A_{xx}, and A_{xz} in the $dd \to ^3\text{He}n(^3\text{H}p)$ reactions at 270 MeV at the forward angles are presented in [5–7]. The difference between $^3\text{H}-p$ and $^3\text{He}-n$ channels is small and within the achieved experimental accuracy for all analyzing powers. Therefore, no evidence of CSB is observed. The evaluation of the systematic errors for the analyzing power diferences is in progress.

In 2007, preliminary results on the A_y, A_{yy}, A_{xx}, and A_{xz} analyzing powers in the $dd \to ^3\text{H}p$ reaction at 200 MeV have been obtained [8, 9]. The peculiarities of data for $^3\text{H}-p$ channel at 200 MeV are the same as those obtained at 270 MeV: small value of the vector analyzing power A_y; reasonable agreement of the tensor analyzing powers with the nonrelativistic calculations at small angles and strong deviation at large angles in c. m. s.

The aim of the experiment at the Nuclotron is the investigation of the energy dependence of the analyzing powers in dp elastic scattering in the region of large scattering angles where the spin structure of three-nucleon forces is relevant. In 2007, the collaboration concentrated on the analysis of the A_y, A_{yy}, and A_{xx} measured in dp elastic scattering at 880 MeV.

Preliminary results were compared with different theoretical predictions; good agreement with the calculations [10] has been observed. The analysis and calculations are in progress.

DELTA-SIGMA

The aim of the project is to extend investigations of properties of nucleon–nucleon (NN) interaction over 1.2–3.7 GeV energy region with polarized neutron beam. The main task of the study is the determination of the imaginary and real parts of all spin-dependent forward scattering NN amplitudes over the specified energy region.

During the 36th accelerator run:

• methodical studies and calibrations of different subsystems were done with low intencity deuteron beam ($(1-2)\cdot 10^5$ with energy 1.1 GeV) in 1B channel;

• set-up was tested with secondary neutrons generated in 1B channel by the deuteron beam with intensity of $5\cdot 10^9$ d/cycle and energy 1.1 GeV;

• ~ 50 k triggers have been stored with the neutron beam $E = 0.55$ GeV scattered on the solid CH_2, CD_2 and C targets to study $np \to pn$ and $nd \to pnn$ processes of elastic charge-exchange under 0^0;

Results were presented at the Conference SPIN-2007.

BECQUEREL

The technique of nuclear track emulsions is used to explore the fragmentation of light relativistic nuclei down to the most peripheral interactions — nuclear «white» stars.

In the emulsion exposed to relativistic ^{9}Be nuclei, 371 events of fragmentation to a narrow pair of relativistic He nuclei were analyzed under the assumption of their correspondence to 2α particles [11, 12]. The clear appearance of two peaks in the distribution over the invariant mass above the α-particle pair mass threshold $Q_{2\alpha}$ was observed (Fig. 2). It was concluded that the 0^+ and 2^+ states of ^{8}Be are revealed in the spectra over $Q_{2\alpha}$.

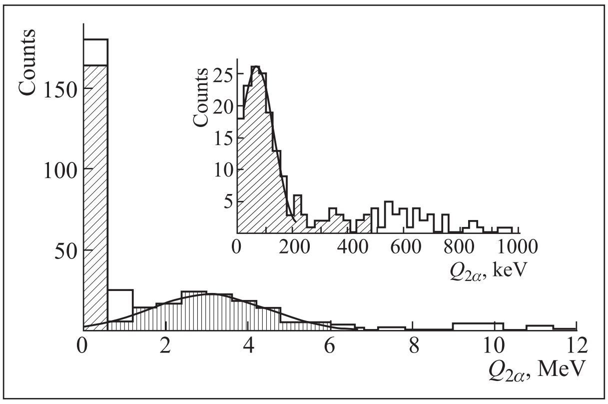

Fig. 2. The invariant energy $Q_{2\alpha}$ distribution of α-particle pairs in the $^9\mathrm{Be} \to 2\alpha$ fragmentation reaction at $1.2\,A$ GeV. In the inset: the $Q_{2\alpha}$ range from 0 to 1 MeV

ONGOING EXPERIMENTS AT CERN, GSI AND BNL

ALICE

Scientific programme of the ALICE experiment is aimed at the study of quark–gluon plasma and phase transition in the relativistic heavy-ion experiment at the LHC.

Main results obtained with JINR group participation in 2007:

1. Electromagnetic calorimeter PHOS:

• Lead tungsten crystals were tested at the JINR set-up and certified (optical properties) to use;

• One fully assembled module of PHOS has been tested with cosmic muons at CERN.

2. Transition radiation detector TRD:

• New detector laboratory with climate facility and clean rooms (~ 120 m^2) was built up;

• Drift chambers were constructed and tested at LHE;

• The TRD module has been tested at CERN.

3. Physics simulation:

• Investigation of vector-meson production in $p+p$ at 14 TeV and in Pb + Pb at $5.5\,A$ TeV:

— Simulation study of $\phi \to K^+K^-$ decays using $p+p$ ALICE–GRID production data of 2006. Study of particle identification possibility for K^+/K^- using ITS, TPC, and TOF detectors. Study of the signal-background ratio. The results were reported at two ALICE Meetings at CERN.

— Simulation of $\phi \to K^+K^-$, $\phi \to e^+e^-$, $\omega \to e^+e^-$, $J/\psi \to e^+e^-$ decays in Pb+Pb collisions at $5.5\,A$ TeV. The first step of resonance peak analysis was finished using TPC and TRD detectors for e^+e^- identification and taking into account e^+e^- background from gamma conversions. The final results were reported at ALICE Meeting. The publication is under preparation.

• Investigation of particle momentum correlation (femtoscopy physics);

• Integration of Universal-Hydro-Kinetic-Model (UHKM) code created in Dubna to the ALICE simulation package (AliRoot). Installation of new official version of AliRoot with special package for the femtoscopy physics. Integration of the UHKM code to the new femtoscopy package. Tuning the UHKM model parameter for Pb–Pb collisions at the LHC energy and carring out an analysis of $\pi\pi$-pairs correlation. Carrying out of 3D analysis to study correlation radii dependence from transverse momentum. Comparison with the RHIC results.

NA49/NA61 Experiments

NA49 and NA61 experiments at CERN study hadron production in hadron and nucleus induced reactions at CERN SPS for relativistic heavy ion, neutrino, and cosmic ray physics.

In 2007:

• CERN SPSC approved the continuation of analysis programme and the request of support from CERN for NA49 experiment;

• NA61 experiment has been approved by the Research Board as the new experiment at SPS;

• JINR group prepared 1800 channels of TOF for data taking. During the accelerator session the reaction $p+^{12}$C at 31 GeV/c with different target thicknesses was studied.

JINR group are involved in the analysis devoted to (anti)nucleus and (anti)hyperon production in nucleus–nucleus collisions. Results obtained in 2007 have been presented by the members of JINR group at the International Conferences HEP-2007 (Manchester, UK) and CPOD2007 (Darmstadt, GSI, Germany).

Investigations with Crystals (Theme 1065)

Data taking with crystals has been fulfilled in 2007 at the proton beam of the CERN SPS according to the programme of the H8RD22 experiment. The goal of the experiment is to study the possibility of using bent crystals at the LHC and other accelerators in the experiments on the diffractive physics; for the beam extraction and for the halo collimation systems [13, 14].

The experiment performed with 400 GeV proton beam proved the possibility of creating a sequence of short bent crystals, working in the regime of volume reflection. The efficiency of the beam deflection for the sequence of five silicon crystal reflectors exceeded 90%.

It was found that the dynamical keeping of particles near the bent atomic string direction of the crystal occurs due to the uniform distribution of particle transverse momenta established in multiple scattering of particles with the atomic strings.

HADES

The HADES project aims the systematic investigation on the accelerator facility SIS, GSI (Darmstadt) of the properties and behaviour of hadrons in the nuclear medium by studying collisions ranging from pions and protons as projectiles to heavy nuclei. Observables include masses, decay widths, and special functions of vector mesons, such as ρ and ω mesons.

Previous experimental study conducted by the DLS Collaboration at Berkeley (Ca + Ca, at 1 A GeV) has shown an overproduction of e^+e^- pairs in the low pair mass region ($M < 0.6$ GeV/c^2) compared to theoretical calculations based on the known sources of dielectrons. The in-medium modification of hadrons is thought to be a signature of the partial restoration of chiral symmetry, predicted by QCD. However, the DLS data suffered from the detector's poor pair mass resolution (10%) and very limited acceptance.

The physics results obtained by HADES in C + C collisions (Fig. 3) [15–17] agree with DLS results. There was shown by theorists that this effect can be explained by bremsstrahlung as the dominant contribution for $0.15 < M < 0.55$ GeV at 1 A GeV.

Presently HADES has collected $\sim 7 \cdot 10^9$ events. Analysis of the recent (2007) experiments with proton and deuteron beams is expected to provide better understanding of elementary processes and to shed more light on the anomalous pair yield.

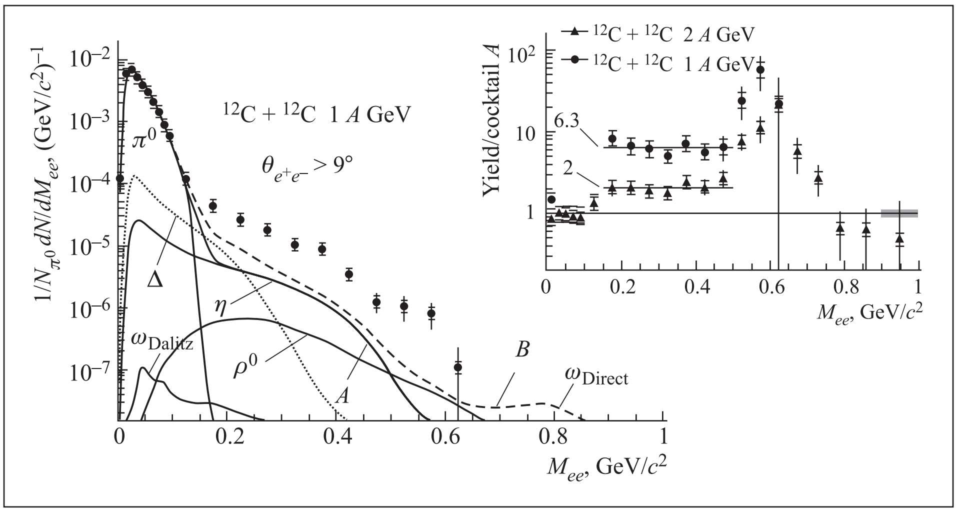

Fig. 3. HADES confirmed the DLS puzzle in C + C (1 A GeV) experiments. There was shown ~ 6 times excess overproduction of dielectron pairs in the mass region $0.15 < M < 0.55$ GeV. It also has been shown that for C + C (2 A GeV) this excess value is three times less

PHENIX

In 2007, activity of the LHE group in the PHENIX experiment was devoted to:

• Participation in data taking as shifters and experts responsible for the Aerogel Cherenkov Counters (ACC). During this period the highest luminosity has been achieved what allowed one to obtain information on the dependence of the cross section for J/Ψ production on the collision centrality;

• Taking part in the:

1) development and preparation of the Technical Design Report of the forward calorimeter (NCC),

2) designing and manufacturing samples of stripiksel detectors (with the BNL staff),

3) front-end electronics manufacturing.

• Participation in the test run aimed to study samples of stripiksel detectors and electronics. Data obtained during this run are being analyzed now.

• Taking part in the simulation and preparation of the algorithm for neutral pions and jet reconstruction in NCC detector.

STAR

The first discovery phase at RHIC has yielded unambiguous scientific evidence for the creation of a new state of matter — the strongly interacting quark–gluon plasma (sQGP) in central collisions of $^{197}\mathrm{Au} + {}^{197}\mathrm{Au}$. Above $\sim$ 6 GeV/c in transverse momentum, particles containing light quarks are suppressed by a factor of five compared to $p + p$ collisions, when scaled by the number of binary scatterings in the Au nucleus; that is a clear evidence of the quenching of jets in the dense matter. Particles containing up, down, and strange quarks exhibit strong elliptic flow resulting from the pressure gradient in the asymmetrically shaped strongly interacting matter mutually initially swept out by the two gold nuclei when they collide. Such measurements provide indisputable proof that what has been discovered at RHIC is the hottest, densest matter ever studied at the laboratory, which flows as a nearly perfect liquid, with systematic patterns suggesting quark degrees of freedom and a viscosity-to-entropy density ratio lower than in any known fluid.

The next step in RHIC's exploration of this new frontier is to characterize the properties of the sQGP to determine its critical parameters such as its shear viscosity, speed of sound, transport coefficients, and ultimately equation of state. This will require the development of new approaches to the analysis of RHIC heavy ion data, and upgrades of the detector capability and machine luminosity.

The Laboratory of High Energy is actively participating in pioneering the next phase of RHIC exploration. Specifically, it is developing new techniques for precise detection of short-lived hadrons, improving the signal to noise dramatically through constrained fitting techniques. This work is essential for detection of strange and multistrange hadrons, and charm hadrons in the future, heavy flavor being a sensitive probe of the early conditions and possible thermalization at the partonic stage in the sQGP. A study is made of the scaling behavior of high-p_T particle production over a wide range of beam systems and energies to develop tools to detect novel behavior indicating new physics at RHIC. Similarly, are studied the correlations and fluctuations (the K3 correlator in particular) to see if different populations of RHIC events can be isolated based on the observed correlations. The study of back-to-back charm correlations and tagging of the quark parent of leading particles in jets will provide a unique window on the production processes which form heavy quarks and the conditions in the earliest moments of the collision. The techniques being developed by LHE will be essential to tease out the necessary information from such observables in this exceptionally complex final state. Finally, the JINR group is exploring the possibility of a technical contribution to the STAR Heavy Flavor Tracker (HFT).

Presently, transverse stochastic cooling of heavy-ion beams appears to be a promising approach to reduce interbunch and intrabunch beam scattering to achieve the necessary luminosity for the exploration of heavy flavor and rare probes in the next phase of RHIC discoveries. The STAR detector is upgrading its data acquisition system to handle higher luminosity with (almost) zero dead time. Additionally, under construction is a TOF barrel to provide additional particle identification capability, and a new «charm class» microvertex detector called the Heavy Flavor Tracker. A Forward Meson Spectrometer, constructed of lead glass cells, will allow one the study of the parton distribution in the initial state Au nucleus to document the initial conditions which lead to such dramatic final state effects.

The scientific priority for the STAR LHE group was to obtain a deeper understanding of the spin structure and dynamics of the proton by studying how the intrinsic spin of the proton is distributed among its underlying constituents (quark, antiquarks, and gluons). The obtained data on single and double spin asymmetries of hadron and jet production allows us to determine the spin-dependent gluon distribution.

INNOVATION ACTIVITY

Med-Nuclotron Project

In the time period 2005–2006, there were three experiments performed with profilometer, parallel plate ionization chambers, and diamond dosimeter. The first try of carbon beam visualization when it stops in the plastic was performed. In year 2007, we have worked with data analysis and simulation of the Bragg peak.

The Main Results:

1. These experiments gave the first experience for construction of medico-technical ion beam line with the monitoring system. This experience will be used on the stage of construction of specialized medical accelerator of protons and ions.

2. The results of the first experiment with the carbon beam of the energy of 500 MeV/n have demonstrated the possibility to carry out irradiation of deeply located (up to 35 cm in the tissue) targets. But 500 MeV/n is the too high energy for patient treatment, the optimal energy is 350–400 MeV/n.

3. The intensity of the carbon beam — 10^9 per spill — is already enough to provide medico-biological research for the cancer hadron therapy. The Bragg curve was measured with ionization chambers and diamond detector.

4. The controlled dose field with high linear energy transfer (LIT) was formed. The first biological samples of living cells and small animals were irradiated in the absolute dose field.

Energy and Transmutation

In the frame of this activity the Nuclotron proton and deuteron beams are used to study the neutron generation and multiplication in heavy targets (Pb, W, etc.), exploration of cross sections of transmutation of radioactive wastes, irradiation of heavy element samples by direct photon and deuteron beams, and determination of cross sections of transmutation of long-lived radioactive wastes of nuclear power reactors.

ANNIVERSARY

On March 4, 2007 the centurial jubilee of Academician Vladimir Josephovich Veksler was celebrated. He was an outstanding scientist in the field of accelerator physics and the phase stability principle discovered by him. It is used in all modern cyclic accelerators of charged particles and nuclei. The first European electron synchrotron was made at the Physics Institute of the Academy of Sciences under the leadership of V. Veksler in 1947, as well as the proton accelerator — Synchrophasotron, the biggest machine of this type in the world, commissioned in Dubna 50 years ago in April 1957.

V. Veksler was the founder of the Laboratory of High Energies at the Joint Institute for Nuclear Research named after him together with Academician A. M. Baldin.

REFERENCES

1. *Stachel J.* // Intern. J. Mod. Phys. A. 2006. V. 21. P. 1750–1763;
   Andronic A., Braun-Munzinger P., Stachel J. // Nucl. Phys. A. 2006. V. 772. P. 167.
2. *Sissakian A. et al.* The Multipurpose Detector — MPD to Study Heavy-Ion Collisions at NICA. Letter of Intent. JINR. Not published.
3. *Sissakian A. et al.* Design and Construction of Nuclotron-Based Ion Collider Facility (NICA). Conceptual Design Report. Dubna: JINR, 2007.
4. *Sissakian A.* The Project NICA/MPD at JINR: Search for the Mixed Phase of Strongly Interacting Matter at Nuclotron-Based Ion Collider Facility // XXIII Intern. Symp. on Lepton and Photon Interactions at High Energy, Daegu, Korea, Aug. 13–18, 2007.
5. *Janek M. et al.* // Eur. Phys. J. A. 2007. V. 33. P. 39.
6. *Ladygin V. P. et al.* // Czech. J. Phys. 2006. V. 56. P. F135.
7. *Ladygin V. P. et al.* Talk at the Intern. Symp. on New Facet of Three Nucleon Force — 50 Years of Fujita–Miyazawa Three Nucleon Force (FM50), Tokyo, Oct. 29–31, 2007.
8. *Kurilkin A. K. et al.* // Proc. of the Advanced Studies Institute on Symmetries and Spin, Prague, July 8–14, 2007; EPJ ST (submitted).
9. *Kurilkin A. K. et al.* // Proc. of the XII Workshop on High Energy Spin Physics (DSPIN2007), Dubna, Sept. 3–7, 2007 (in press).
10. *Ladygina N. B.* nucl-th/0705.3149; Yad. Fiz. (submitted).
11. *Artemenkov D. A. et al.* // AIP Conf. Proc. 2007. V. 912. P. 78; nucl-th/0704.0384.
12. *Artemenkov D. A. et al.* // Phys. At. Nucl. 2007. V. 70. P. 1226; nucl-ex/0605018v1.
13. *Scandale W. et al.* // Phys. Rev. Lett. 2007. V. 98. P. 154801.
14. *Taratin A. M., Scandale W.* // Nucl. Instr. Meth. B. 2007. V. 262. P. 340.
15. *Agakichiev G. et al.* Dielectron Production in $^{12}C + ^{12}C$ Collisions at 2*A* GeV with the HADES Spectrometer // Phys. Rev. Lett. 2007. V. 98. P. 052302.
16. *Przygoda W. (HADES Collab.)* Dielectron Production in C + C Collisions at 2*A* GeV with HADES // Nucl. Phys. A. 2007. V. 783. P. 583c.
17. *Spataro S. et al.* Eta-Meson Reconstruction in *pp* Reactions at 2.2 GeV with HADES // Intern. J. Mod. Phys. A. 2007. V. 22. P. 533.