

VEKSLER AND BALDIN LABORATORY OF HIGH ENERGY PHYSICS

The V.I. Veksler and A.M. Baldin Laboratory of High Energy Physics was founded on the 4th of May 2008 by the JINR Order No. 112 of the 19th of February 2008 according to the Resolution of the Committee of Plenipotentiaries of JINR to perform high priority research in high-energy heavy-ion and particle physics.

The main task of LHEP is to create an adequate accelerating, experimental and research basis which enables JINR to occupy a leading position among the world scientific centres in the above directions and strengthen the attractiveness of the Institute for the JINR Member-States.

DEVELOPMENT OF THE ACCELERATING COMPLEX

The Nuclotron-M

In 2008, the work to refurbish the accelerating complex of the Laboratory was carried out according to the schedule of the project Nuclotron-M. The leadership of the Laboratory made up a decision to perform runs only at rather good guarantees for the accelerator stable operation. The priorities for the runs were determined on the basis of the following urgent tasks:

- the total revision of the main accelerator systems to meet the requirements of the project;
- repair, improvement, substitution of the knots having expired their resources, for the more advanced ones to provide the required quality of the beams, long-lasting, reliable and stable operation of the accelerator.

Main results concerning the subsystems of the accelerating complex:

1. Modernization of the Nuclotron Vacuum System

The average vacuum value in the ring before modernization was $\sim 5 \cdot 10^{-7}$ Torr (nitrogen equivalent at the room temperature). As a result of the complex of the performed work the average vacuum value measured in the 38th run (June 2008) was $\sim 5 \cdot 10^{-9}$ Torr. Thus, the 1st stage of the Nuclotron vacuum system modernization was completed and the work of the 2nd stage began: further improvement of the vacuum and construction of the automatic vacuum control system for the Nuclotron ring.

2. Modernization of the RF System

In 2008, the following new apparatus was manufactured and installed for testing:

- For adiabatic capture over all the RF-amplitude range;
- Noise screens at the RF-stations;
- For the beam injection to the descending and rising magnetic field;
- For diagnostics of the accelerating voltage;
- System «orbit»;
- Advanced electronics of the new generation.

3. Slow Beam Extraction System. Control Systems

The supply system EC of the septum was modernized to increase the operating voltage from 110–120 till 160–180 kV, that, in its turn, will provide carrying out extraction of the ion beam with the energy close to the design (4 GeV/n), now it is 2.3 GeV/n.

— In collaboration with specialists from Slovakia a new subsystem with the magnetic field cycle control has started testing to be commissioned;

— Commissioning of the new diagnostic apparatus is in progress;

— Full modernization of the system of «setting the beam onto the orbit» has been performed, a reserve variant has been done for operating without emergency;

— The apparatus to control IP orbit correctors has been commissioned;

— The total full-scale upgrading of the main server knot has been carried out;

— Development, designing and manufacturing of the elliptical pick-up stations are in progress.

4. Modernization of the Supply Systems for the Acceleration Complex

— A principally important stage of work was completed to increase the fields in magnets and lenses from 0.9 till 1.4–1.5 T during the 39th run by using a specially developed and installed prototype SEE. The next step — to increase the magnetic field till the designed value — 1.8–1.9 T, is supposed to be performed at the end of 2009 (by using the operating variant of SEE).

— A prototype of the additional current source for lens F has been manufactured and tested;

— A new cycle-programming apparatus has been switched on;

— Electro-technical protection of the compressor cascade has been made.

5. Modernization of the Cryogenic Supply System

The apparatus of the cryogenic complex used at the Nuclotron had fully expired its resources and required total modernization and repair. Performance of runs under these conditions did not guarantee the fulfilment of the given tasks and could result in loosing the expensive devices. In June 2008, when the 38th run was over, the total modernization of the Nuclotron cryogenic complex was begun.

— Jointly with KRIOGENMASH the repair of the oil-cleaning block MO-800 was carried out. At the moment the work on its installation, mounting, testing and commissioning is close to be completed. The expenditures for this work are 110 k\$;

— At the beginning of 2009 the work to refurbish the systems of helium liquidizer KGY-1600 will be completed (6 pairs of oil-separators and adsorbers, purification and de-oiling of the low-temperature blocks, substitution of the adsorbents, cleaning and blowing-through, block-pressing, substitution of the CASCADE compressor filtering elements), repair of turbo-detenders is performed by HELIUMASH. This work is planned to be completed by the 1st of February 2009. The cost of the contract is 400 k\$.

6. Linear Pre-accelerator Linac

In Protvino a Technical Design Report was prepared for a new heavy-ion linear accelerator. The paper work has been started.

7. Heavy-Ion Source KRION

In 2008, the electron-jet ionizer Krion-2 with a solenoid magnetic field of 3 T had 4 runs, 1 month long each on the average. As a result, the following systems and devices have been developed, manufactured and tested:

- A new electron gun with a cathode diameter increased till 1.2 mm;

- An automatic system regulating the cathode emission current during the electron pulse;

- A diagnostic system of forming «the electron string» and holding the ions;

- The second construction of the input pulse cell into «the electron string» of ions of gases CH₄, N₂, O₂ and Ar, purposed for the development of the ion–ion cooling technology;

- The external modulator of the electron beam for 8 kV (to obtain Xe⁴⁴⁺ ions, it is necessary to have the energy of electrons which are injected via impulse to «the string», to be not less than 7 keV).

A series of experiments has been performed to obtain high-voltage ions of Xe at its permanent input to «the electron string». Ions of Xe³⁶⁺ have been obtained at the energy of injected electrons equal to 3.7 keV. It has been shown that this method of input leads to «poisoning» of the electron gun cathode of the ionizer. The pulsed input is required and the above-mentioned cell is planned to be used for this.

The programme of developing a new ion source Krion-6Tc was fulfilled according to the schedule.

NICA

In January 2008, the «Conceptual Design Report» of the accelerating complex NICA was prepared. The following concept of the collider was considered as the basic one:

- 17 bunches with the intensity of 10⁹ ions of ¹⁹⁷Au⁷⁹⁺ are circulating in 2 rings;

- Electron cooling is used to suppress IBS;

- $\beta = 0.5$ m; $L = 1 \cdot 10^{27}$ cm⁻² · s⁻¹;

- The colliding angle of the beams is 0 mrad.

At present the following variant has been preferred in the result of studies and calculations carried out during the year:

- 25 bunches, each — 10⁹ ions of ¹⁹⁷Au⁷⁹⁺ are circulating in 2 rings;

- Stochastic cooling is used to suppress IBS;

- $\beta < 0.5$ m; $L = 2 \cdot 10^{27}$ cm⁻² · s⁻¹;

- The colliding angle of the beams = 10 mrad.

The preparation of the «Technical Design Report» is close to be completed.

The preparation of the first concept of the polarized proton and deuteron beams has begun.

IREN, LUE-200

The employees of the LHEP acceleration division actively take part in project IREN, their obligation is the key element — Linear Accelerator of Electrons LUE-200. In December 2008, the technical start of IREN was fulfilled, electrons were accelerated and first neutrons were registered (Fig. 1).

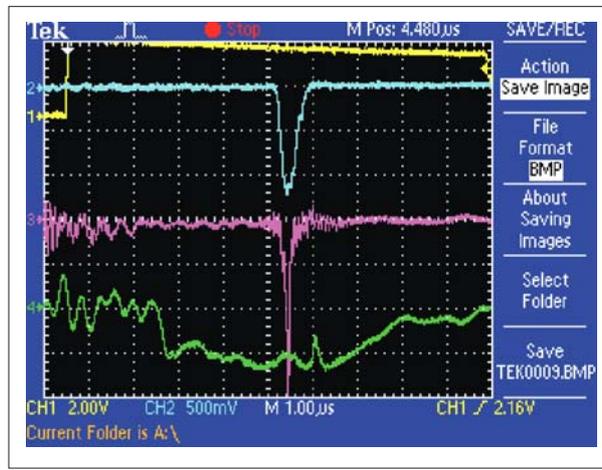


Fig. 1. The dependence of beam shifting (LUE-200, IREN) on the corrector field corresponds to the energy of electrons of 20 MeV. The current on the exit of the accelerator is 1.2 A (the upper curve). The signal of «Rogovsky belt» at the entrance to the target hall is 0.4 A (the middle curve). The amplitude line of RF field — the bottom curve

THE MOST IMPORTANT RESULTS IN PHYSICS

NA48/NA62

In the frame of experiment NA48 (CERN, SPS), the following main results were obtained in 2008 by significant contribution of the JINR employees on the basis of the data taken in 2003–2004:

- Analysis of $\sim 6 \cdot 10^7$ decays of $K_{3\pi}$ ($K^\pm \rightarrow \pi^0\pi^0\pi^\pm$) and $\sim 10^6$ decays of K_{e4} ($K^\pm \rightarrow \pi^+e^-e^-\gamma$) was performed [1]. Values a_0 and a_2 were extracted for the length of S -wave of $\pi\pi$ scattering with isotopic spin of 0 and 2 within the experimental error of several per cent that exceeds by 3 times the results of the previous measurements and gives an opportunity to carry out a precision checking of the chiral perturbative theory predictions. This result is considered at CERN as one of the most significant in 2008.

- A new measurement of the properties of decay $K^\pm \rightarrow \pi^+\pi^-e^\pm\nu$ was fulfilled, which was based on the part of the existing statistics including more than 67 thousand of decays for both kaon charges registered in the run of 2003 [2]. In ten intervals independent of $\pi\pi$ masses the hadron current formfactors were measured (F , G , H) as well as the phase difference of $\pi\pi$ scattering ($\delta = \delta_s - \delta_p$) to study their variations. Significant acceptance for big masses of pair $\pi\pi$, low background level and a very good resolution affected the improvement of the experimental precision of measuring the scattering length of pions a_0^0 and a_0^2 that was improved by twice in comparison with the previous experiment. Supposing the isospin symmetry and using a numerical solution of the Roy equation, the following values in the plane (a_0^0 , a_0^2) were obtained: $a_0^0 = 0.233 \pm 0.016_{\text{stat}} \pm 0.007_{\text{syst}}$, $a_0^2 = -0.0471 \pm 0.011_{\text{stat}} \pm 0.004_{\text{syst}}$.

- The «cusp» effect analysis was completed in Dalitz distribution of $K^\pm \rightarrow \pi^0\pi^0\pi^\pm$, the concluding paper is in progress.

The obtained results were presented at many international workshops including 8 reports made by the JINR representatives of the collaboration. A doctor's dissertation «Study of CP -Violation in Decays of Neutral Kaons into 2 Pions in NA48 Experiment» has been submitted for defense.

The collaboration has started the preparation of experiment NA62 on the beam CERN SPS dedicated to the study of extremely rare decays of charged kaons into a charged pion and two neutrinos. A methodical run on the beam at CERN tested different read-out electronics and carried out optimization of the gas mixture for the straw detector developed and constructed at JINR.

COMPASS

In 2008, Collaboration COMPASS (CERN, SPS) was taking data on the hadron beam. The programme included the search for glueballs in the region of masses more than 2 GeV/c in the inclusive diffraction pp scattering, the study of lepton and semilepton decays of charmed hadrons, the diffraction and Primakov scattering.

The data analysis was completed on measurements of Collins and Sivers asymmetries for identified hadrons produced in deep-inelastic scattering of μ^+ at the energy of 160 GeV on the transversely polarized ${}^6\text{LiD}$ target [3]. Both asymmetries turned out to be comparable with zero in the limits of statistical errors that is in agreement with the expected compensation between u - and d -quarks.

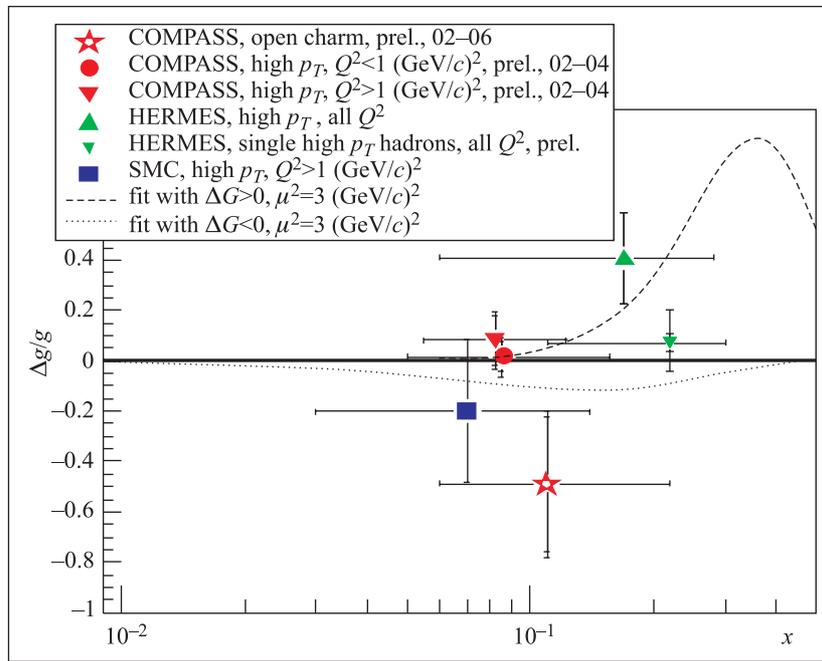


Fig. 2. Results of the $\langle \Delta g/g \rangle_x$ measurements from the open charm and high p_T hadron pair production by COMPASS, SMC and HERMES as a function of Bjorken x . The curves display parameterizations from the NLO QCD analysis in the $\overline{\text{MS}}$ scheme at $Q^2 = 3$ (GeV/c)²: fits with $\Delta G > 0$ (the broken line) and with $\Delta G < 0$ (the dotted line)

The gluon polarization was defined in the nucleon in D^0 meson decays [4]. In the leading order (LO) the QCD mean value of gluon polarization was $\langle \Delta g/g \rangle_x = -0.49 \pm 0.27$ (stat.) ± 0.11 (syst.) for $\langle x_g \rangle \approx 0.11$ (Fig. 2).

Preliminary data were obtained on polarized parton distributions in LO QCD from the data obtained in 2002–2006 [5]. It was found that the value $(\Delta u_v + \Delta d_v)$ is positive and weakly sensitive to the type of the fragmentation function used in the analysis; $(\Delta \bar{u}_v + \Delta \bar{d}_v)$ and $x\Delta s$ are comparable with zero.

In October–November of 2008, during the methodical run the Dubna group carried out testing of the module prototypes for the electromagnetic calorimeter ECAL0 with new avalanche multipixel photo-diodes produced at JINR. The ECAL0 construction is planned to measure the generalized parton distributions in the future physical programme of COMPASS.

The JINR representatives of the Collaboration presented 14 talks at international conferences and symposia.

STAR

In 2008, the LHEP employees taking part in experiments on the setup STAR (BNL, RHIC) published 11 papers on the nuclear and spin effects in $p + p$, $d + \text{Au}$, $\text{Au} + \text{Au}$ collisions at RHIC. Besides participation in shifts (3 weeks) of the RHIC run in 2008, the JINR physicists gave 21 talks at seminars, conferences, workshops, and fulfilled the following work.

A model of heavy-ion collisions has been developed — Heavy-Ion Event Generator HYDJET++ (hydrodynamics + jets) [6]. The soft part of HYDJET++ includes longitudinal, radial and elliptical flows and decays of hadronic resonances [7].

A cycle of femtospectroscopical correlation studies was performed (including correlations of nonidentical particles as π , Ξ) and consequences following from them which influence the particle production dynamics [6–9].

In the frame of z -scaling theory the data analysis was carried out on the transverse hadron spectra obtained at the setup STAR in comparison with the data reached by other collaborations. New properties of z -image were defined for proton–(anti-)proton interactions — flavor independence and saturation of the scaling function in the region of small z .

Comparison of predictions was performed on asymptotic behavior of the scaling function in the frame of QCD and z -scaling theory.

Algorithms and new methods were developed for:

- Soft photons reconstruction by using the prototype of Crystal Detector (UCLA, Dubna), the main sources of the background were analyzed and work at the detector geometry was completed;

- Determination of the reaction plane based on preserving the directions of the angle momenta in the initial and final states of the collision process;

- Analysis of the data of the $d + \text{Au}$ interactions at 200 GeV. Preliminary data were obtained on spectra K_S^0 , Λ and anti- Λ up to $p_t = 9$ GeV/c.

During 2008 two technological schemes were scrutinized for the improved variant of BBC (Beam Beam Counter) for STAR and MPD (NICA). The main parameters which influence the efficiency of the trigger operation of the zero level, were estimated at the collision energy $\sqrt{S_{NN}} = 9$ GeV and reliability of the reaction plane reconstruction.

Method of random matrices was applied to analyze the data from the setup STAR and generalized for the intermediate energy region. The results which have been obtained on the analysis of the particle production spectra in CC interactions at the energy of 4.2 GeV, enable one to conclude that the choice of kinematical variables (energy and momentum) in the initial spectrum of particles does not influence the distribution function behavior $p(s)$.

The study of the global structure of the pC , dC , αC , CC interactions was performed by using the method based on the consideration of distributions on the maximum of the transverse momentum of particles in the event.

TPD

The 38th Nuclotron run continued measurements of tensor polarizability of deuterons while unpolarized deuteron beam was going through the unpolarized target to confirm the results of 2007 [10] at the increased statistics.

The results are given in Fig.3 in comparison with the previous data and theoretical predictions.

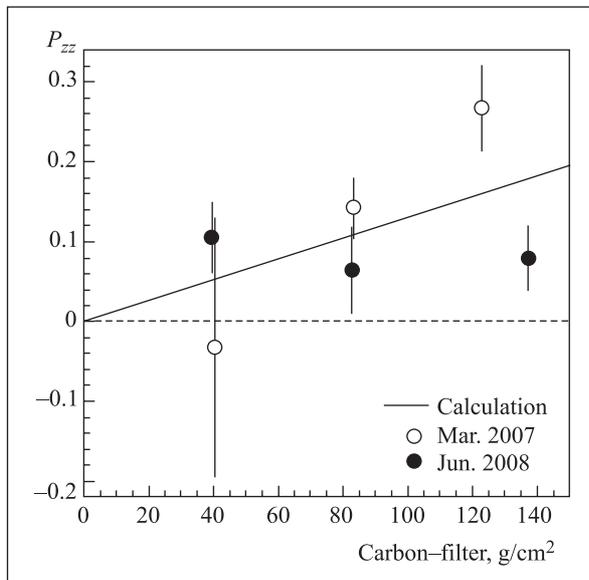


Fig. 3. Tensor polarization of deuterons vs thickness of the target. The dashed region shows the error values, the solid line is the theoretical prediction

THERMALIZATION

In 2008, the JINR employees occupied in the project «Thermalization» participated in the complex

of works to upgrade and prepare the apparatus of the setup and perform 2 physical runs (March and November) when more than 5 million events were registered with the trigger level on multiplicity not lower than 8.

Jointly with employees of BITP (Kiev, Ukraine) the collaboration continues to study opportunities of finding Bose–Einstein condensation in pp collisions with high multiplicity at the energy of the projectile proton of 59 GeV.

In the frame of the extended statistical model the region of the soft and hard processes was combined. It is shown that in a more relativistic model there are nontrivial correlations between the number of charged and neutral particles; the dependence of the impulse spectrum on the number of charged particles has been also obtained.

Searching for ring events in pp and pA interactions with high multiplicity is continued.

CMS

In 2008, the JINR employees fulfilled commissioning of the end-cap hadron calorimeter (HE), performed its calibration as well as of the forward muon stations (ME1/1).

They carried out the analysis of the experimental data of the combined test on the SPS beams of the CMS calorimetrical system. The resolution of the isolated HE calorimeter was $114\%/\sqrt{E} + 2.7\%$ ($5 \leq E \leq 300$ GeV) (Fig. 4, a), a good signal linearity was demonstrated (Fig. 4, b).

The cosmic data at the magnetic field of 3.8 T were used to obtain a special resolution of the chambers ME1/1b. It was as follows: 92.5 mcm — for a single plane, and for the whole chamber — 46 mcm.

The main efforts of the JINR physicists in CMS are concentrated to prepare the first run of data taking and develop the CMS physics programme.

The JINR group is focused on the programme of studying the production processes of the muon pair with a big invariant mass in the final state. The CMS potential of registering muon pairs in Drell–Yan process was estimated as well as observation of signals of new physics beyond the Standard Model for the integral luminosity of 100 pb^{-1} . It is shown that CMS is able to observe graviton of model RS1 with a mass up to 1.5 TeV, if the model constant c is equal to 0.1. For $c = 0.05, 0.02, 0.01$ the reachable mass limit is 1200, 780 and 500 GeV, correspondingly.

For the case of small luminosity ($L = 2 \times 10^{33} \text{ cm}^{-2} \cdot \text{s}^{-1}$) a procedure of establishing the jet energy scale was studied in detail in the events with direct photon production and associated jets. It is shown that the acceptable calibration precision is provided at the photon energy of $E_T^\gamma = 20$ GeV.

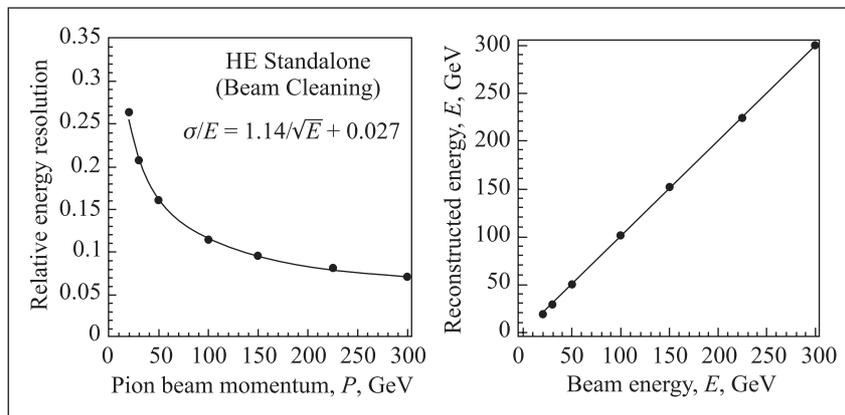


Fig. 4. The energy resolution (left) and ratio between the reconstructed and beam energy (right) for the combined end-cap calorimetry

The results were presented at the CMS workshops, published in 12 internal CMS notes and referenced journals.

Development of computing infrastructure based on the GRID-technologies was going on.

ALICE

In 2008 the JINR group in ALICE Collaboration fulfilled the following work:

- In the frame of programme AliRoot, a package to storage information on the events in the format of the ROOT Tree;

- Modeling and studies of decays of ρ , ω , ϕ , J/ψ into e^+e^- pair in collisions of Pb–Pb at the energy of 5.5 TeV/n were completed;

- Integration of the package Universal HydroKinetic Model (UHKM) in AliRoot was completed. Modeling and analysis of HBT correlations began;

- Studies to estimate opportunities of the ALICE setup were performed to investigate charmonium and bottomonium in decays into two muons while Pb–Pb collisions at the energy of 5.5 TeV/n;

- An opportunity was studied to extract parton distributions of the nucleon in the region of Bjorken variable $x \sim 10^{-5} \div 10^{-6}$ from the ALICE data as well as the structure function of the gluon from the data of J/ψ production in pp interactions at $\sqrt{S} = 14$ TeV;

- The JINR employees participated in the development and upgrading of the mathematical software for calorimeter PHOS, as well as in maintenance and upgrading of the ALICE Data Challenges in Russia;

- The JINR group of the ALICE Collaboration took part in the test start-up of the machine at LHC;

21 chambers of TRD were manufactured, tested and transported to Germany for the ALICE machine. 12 more chambers are in the process of manufacturing and studying their parameters.

NA49

In the frame of experiment NA49 (CERN, SPS) processing of the earlier taken data in the beams of lead nuclei and of lighter secondary nuclei in the energy range from 20 up to 158 A·GeV, was going on. Data on nuclei interactions at high energy have been obtained. The data analysis was fulfilled to receive new information on production of pions, kaons, hadron spectra with large transverse momenta, Bose–Einstein correlations of the pion pairs, elliptical flows and fluctuations of secondaries in Pb + Pb collisions [11–16].

The JINR group of the Collaboration took part in preparation of the setup (TOF detector is the JINR obligation) for the run and during the run which was successfully performed in autumn 2008 at the accelerator SPS in CERN.

HADES

Activities on the HADES setup (GSI, SIS-18) included the following:

- Data processing, development of the new trigger and participation in the experimental run when about 4 billion events were taken in $p + \text{Nb}$ interactions at 3.5 GeV;

- The MDC trigger electronics for 6 chambers was manufactured, tested and transferred to GSI;

- The JINR group of the Collaboration performs data processing on elastic dp scattering at 1.25 GeV to study short-lasting nucleon–nucleon correlations in deuteron;

- Data processing is continued on the pion pairs production in the data on pp interactions at 2 GeV.

MPD

In 2008, the activities to develop a concept and R&D of basic elements of the MPD setup were carried out. They included the following:

TPC. The main parameters of TPC were determined for detector MPD (MPD LOI).

Modeling of the main working characteristics of the read-out chamber ROC was made (loading, drift time, signals from pads, etc.).

Drafts were prepared and the design documentation for prototype No. 1 of ROC is under development. The AI-body and several other main knots of ROC were manufactured. The study of the programme package is going on for mechanical design «Solid Edge». The pad plane structure was defined; the order for its manufacturing is under preparation.

The study of the proposal to use electronics TPC/ALICE is about to be completed.

Time-of-Flight Detector TOF. Activities were carried out to prepare elements and finalize the procedure of assembling the prototype of a multigap plane-parallel chamber (mRPC) for the time-of-flight system of MPD NICA.

A prototype of a multigap plane-parallel resistive chamber was assembled that will be the main element of the time-of-flight system of MPD NICA.

A gaseous system was assembled and calibrated to provide the prototype mRPC with the working mixture.

Modeling of the particle identification system on the time-of-flight in the region of pseudo-rapidities more than 1.5 was carried out including the information from the combined system TPC, straw tubes and TOF (mRPC).

The database on the time-of-flight system of MPD including a procedure of calculating the hits on the read-out electrodes of the time-of-flight system of the detector and defining the particle coordinate while operating of several neighboring read-out electrodes, was created.

End-Cap Tracker of the Setup. Geometry of different variants of the End-Cap trackers was described in the format FairRoot. The energy losses by light charged hadrons (p , K , π) were calculated while their passing through the substance of the End-Cap tracker.

A scheme improving the operation of the End-Cap tracker was offered which was based on using a time-projection chamber with a radial drift.

Calorimetry. The method of reading-out the information was improved and preparatory work with a calorimeter of the «shashlyk» type was carried out. The calorimeter module with the sizes 12×12 cm, length — $20X_0$ of KOPIO type, was prepared for the run. The new 16th block of fast digitizing ADC16 was made as read-out electronics.

A data taking run was successfully performed on the accelerator in Hamburg. The processing of the obtained data will allow one to make a conclusion on the opportunities of using the calorimeter of the given construction for MPD and develop a technical task for manufacturing of the calorimeter module adapted to the requirements of MPD.

During the 38th Nuclotron run on the beam of ${}^6\text{Li}$ nuclei with the energy of 2.2 GeV/n, the assembly was tested: 9 modules 15×15 cm with the structure of 40· (2 cm iron + 0.5 cm scintillator). The work was car-

ried out in a close co-operation with the group headed by A. B. Kurepin (INR RAS).

Development of Mathematical Software. During 2008, the framework FairRoot was adapted to the computer farm and system platforms used at LHEP. Upgrading of the external libraries (ROOT, GEANT, CLHEP and others) used in the framework was also carried out. Description of the main track detectors of the setup MPD (TPC and TOF) was implemented into the framework MPDRoot as well as of the detectors ZDC, StrawECT tracker and electromagnetic calorimeter. The current state of the detector implemented into the framework is shown in Fig. 5. The storage base was made for all framework programs and software products being developed.

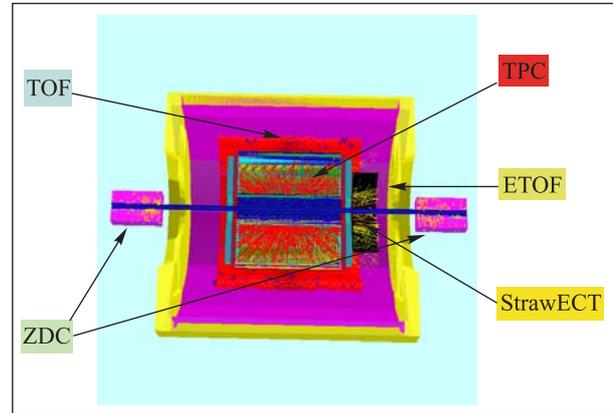


Fig. 5. MPD detector

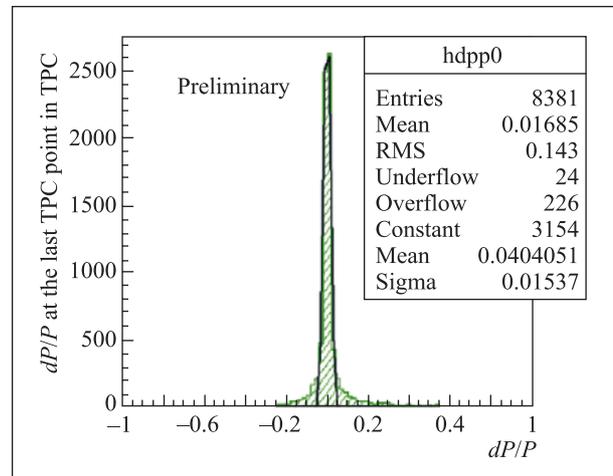


Fig. 6. The relative momentum resolution for charged particles

Methods of track reconstruction in TPC and End-Cap MPD were developed on the basis of Kalman filter. The obtained resolution on the charged particle moment is given in Fig. 6.

The JINR group performed the work to develop a Dubna Cascade Code based on the Cascade model and adaptable with ROOT, as well as to create a generator of events which allows one to include phase transitions.

PHASA-2

In 2008, Collaboration PHASA published the data for the critical temperature value T_c for the nuclear phase transition of liquid-gas [17], Fig. 7: value $T_c = (17 \pm 2)$ MeV from the data analysis by PHASA on multifragmentation and $T_c = (16.5 \pm 2)$ MeV — from the analysis of reliable measurements of the excited nuclei deletion.

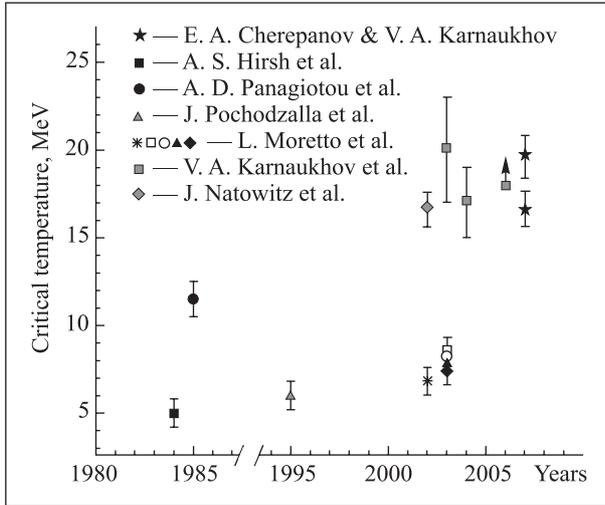


Fig. 7. The experimental values of the critical temperature measured in 1984–2008

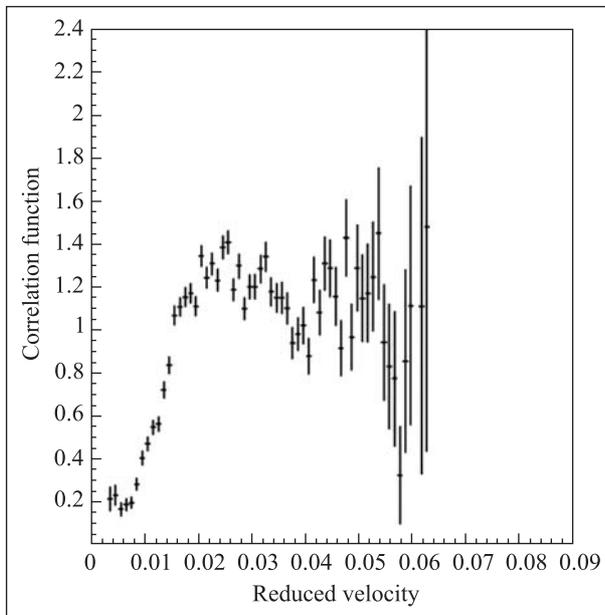


Fig. 8. The correlation function of fragments depending on the relative velocity. Its value is proportional to the probability of the fragment pair production with the given relative velocity

The data taking was continued on the setup PHASA. After upgrading it includes 30 telescopes-spectrometers located at the relative angles from 10 to 180°. Each

telescope consists of a cylindrical ionizing chamber (ΔE -signal) and a silicon detector (E -signal). It allows one to obtain high geometrical efficiency and spectra of kinetic energy for the fragments of the intermediate mass (FIM) from Li to Ar in this angle range.

In the 2008 run a thin target made of gold (1 mg/cm²) was radiated by the extracted beam of deuterons with the energy of 5 GeV and intensity of $\sim 10^8$ per second. Figure 8 shows the correlation function for FIM in dependence on the relative velocity of fragments produced in one event. The value of the correlation function is proportional to the probability of the fragment pair production with the given relative velocity. If the fragments evaporate independently of each other, one may expect isotropy for their distribution on the relative angle. If they fly out from the hot nucleus practically simultaneously, the small relative angles will be suppressed due to the Coulomb repulsion of the fragments from each other. The picture shows the suppression of the yield of fragments with small relative velocities.

At present the analysis of the obtained correlation functions is in progress to extract the information on the time scale of the process. Obtaining of qualitatively new results is expected.

LHC Damper

Commissioning of the transverse oscillation damping system for LHC was successfully performed. The design parameters were received and the equipment of the powerful part SP was successfully used in September 2008 for the bunch transverse oscillations excitation while measuring the betatron frequencies (Figs. 9, 10).

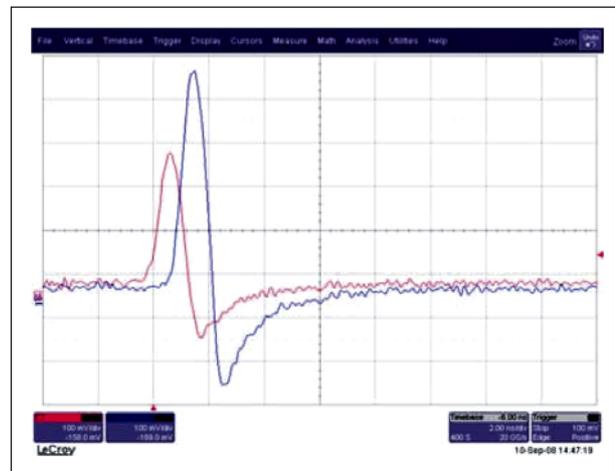


Fig. 9. Signals from the LHC Damper pick-up for the first shot of beam 2. The 10th of September 2008

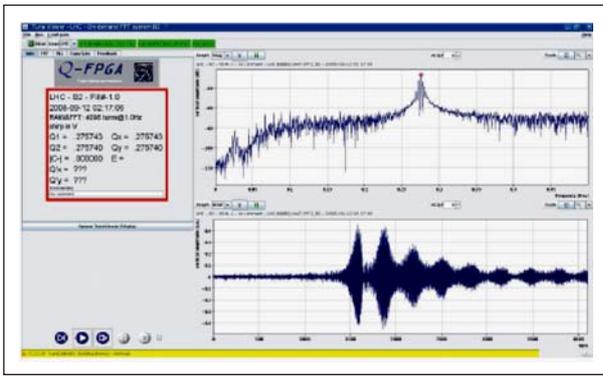


Fig. 10. A tune measurement using «Chirp» excitation (courtesy of the CERN AB/BI Group). The bottom trace shows the vertical beam response and the top trace is the spectrum of the signal with the vertical tune peak

The final reports were presented in June at the 11th European Conference on charged particle accelerators EPAC'08 [18] and in October at the XXI Russian Conference on the charged particle accelerators RuPAC-2008 [19].

ILC

In June 2008, the Global Design Effort meeting of the ILC project leaders was held which was followed by the session of the JINR Scientific Council where Dubna was pronounced as one of the main candidates to host the International Linear Collider. At present in the frame of the ILC project the geological work has been started along the probable tunnel of the future collider (the report will be submitted in March 2009 in Japan).

The following activities are carried out on the accelerator directions:

- Studies on the test bench with the electron beam based on Linac-800;
- Cryogenic diagnostics studies;
- Work on the storage ring of low-energy positrons. Project LEPTA;
- Studies of the damaged wall of the accelerating structure caused by pulsed cyclic RF heating (project CLIC);
- Studies on solid body physics and biophysics by using electron beams and RF radiation;
- Theoretical and experimental development of a powerful pulsed source of sublimated irradiation;
- Upgrading of accelerator LIU-3000.

REFERENCES

1. *Batley J.R. et al.* First Observation and Measurement of the Decay $K^+ \rightarrow \pi^+ e^+ e^- \gamma$ // *Phys. Lett. B.* 2008. V. 659. P. 493–499; hep-ex/0711.4313.

2. *Batley J.R. et al.* New High Statistics Measurement of K_{e4} Decay Form Factors and $\pi\pi$ Scattering Phase Shifts // *Eur. Phys. J. C.* 2008. V. 54. P. 411–423.
3. *Alexeev M. et al.* Collins and Sivers Transverse Spin Asymmetries for Pions and Kaons on Deuterons. CERN-PH-EP/2008-002; hep-ex/0802.2160; *Phys. Lett. B.* (submitted).
4. *Alexeev M. et al.* Direct Measurement of the Gluon Polarization in the Nucleon via Charm Meson Production. CERN-PH-EP/2008-003; hep-ex/0802.3023.
5. *Santos H. on behalf of COMPASS.* New COMPASS Results on SIDIS. Talk given in Intern. Conf. on Particles and Nuclei (PANIC 2008), Eilat, Israel, Nov. 9–14, 2008.
6. *Lokhtin I.P. et al.* Heavy Ion Event Generator HYD-JET++ (HYDroynamics Plus JETs) // *Comp. Phys. Commun.* (submitted); hep-ph/0809.2708.
7. *Amelin N.S. et al.* Fast Hadron Freeze-out Generator. Part II. Noncentral Collisions // *Phys. Rev. C.* 2008. V. 77. P. 014903.
8. *Lednický R.* Notes on Correlation Femtoscopy // *Phys. At. Nucl.* 2008. V. 71. P. 1572–1578.
9. *Lednický R.* Finite-Size Effect on Two-Particle Production // *J. Phys. G: Nucl. Part. Phys.* 2008. V. 35. P. 125109.
10. *Azhgirei L.S. et al.* Observation of Tensor Polarization of Deuteron Beam Traveling through Matter // *Part. Nucl. Lett.* 2008. V. 5, No. 5(147).
11. *Alt C. et al.* Pion and Kaon Production in Central Pb + Pb Collisions at 20A and 30A GeV: Evidence for the Onset of Deconfinement // *Phys. Rev. C.* 2008. V. 77. P. 024903-1–10.
12. *Alt C. et al.* Energy Dependence of Multiplicity Fluctuations in Heavy Ion Collisions at 20 to 158A GeV // *Phys. Rev. C.* 2008. V. 78. P. 034914.
13. *Alt C. et al.* Energy Dependence of Phi Meson Production in Central Pb + Pb Collisions at $\sqrt{s_{NN}} = 6$ to 17 GeV // *Ibid.* P. 044907.
14. *Alt C. et al.* Energy Dependence of Lambda and Xi Production in Central Pb + Pb Collisions at 20, 30, 40, 80, and 158A GeV Measured at the CERN Super Proton Synchrotron // *Ibid.* P. 034918.
15. *Alt C. et al.* High Transverse Momentum Hadron Spectra at $\sqrt{s_{NN}} = 17.3$ GeV in Pb + Pb and $p + p$ Collisions Measured by CERN-NA49 // *Ibid.* V. 77. P. 034906-1–11.
16. *Rybczynski M. et al.* Energy Dependence of Fluctuations in Central Pb + Pb Collisions from NA49 at the CERN SPS // *J. Phys. G.* 2008. V. 35. P. 104091.
17. *Avdeev S.P. et al.* Critical Temperature for Liquid–Gas Phase Transition (from Multifragmentation and Fission) // *Yad. Fiz.* 2008. V. 71, No. 12. P. 2101.
18. *Baudrenghien P. et al.* LHC Transverse Feedback System and Its Hardware Commissioning // *Proc. of the 11th Eur. Particle Accelerator Conf., Genoa, Italy, June 23–27, 2008.* P. 3266–3268.
19. *Gorbachev E.V. et al.* LHC Transverse Feedback System: First Results of Commissioning // *Proc. of the XXI Russian Particle Accelerator Conf., Zvenigorod, Russia, Sept. 28–Oct. 3, 2008.* P. 97–100.