LABORATORY OF PARTICLE PHYSICS

The activity of LPP in 2005 was concentrated on the current particle physics experiments and preparation of the new ones, R&D of the particle detectors and different acceleration systems.

ONGOING EXPERIMENTS

The Common Muon and Proton Apparatus for Structure and Spectroscopy, **COMPASS (NA58)**, has been proposed to perform a series of experiments with the high-energy muon and hadron beams at CERN for studying the inclusive and semi-inclusive deep-inelastic scattering of muons on polarized targets, search for effects of the nucleon strange sea polarization in the production of Λ hyperons, and determination of the quark and gluon contribution to the spin of nucleon. In 2005, COMPASS analyzed the data collected in 2002–2004.

The spin-dependent structure function of deuteron was measured proceeding from the data collected in 2002 and 2003 [1] (see Fig. 1) and compared with the data previously obtained in the same region by SMC experiment. An improvement in the accuracy is obvious. The QCD analysis of the above and worldwide data has shown that with new COMPASS data the errors of the value $\Delta\Sigma$ of valence quark contributions to the nucleon spin are reduced by a factor of 2.

The transverse spin asymmetries of the deuteron in semi-inclusive deep-inelastic scattering were measured for the first time [2]. The so-called «Collins and Sivers azimuthal asymmetries» were calculated by COMPASS from the 2002 data (see Fig. 2). All the asymmetries are consistent with zero. The results have been confirmed by recent theoretical estimations and indicate that transverse effects in protons and neutrons compensate each other.

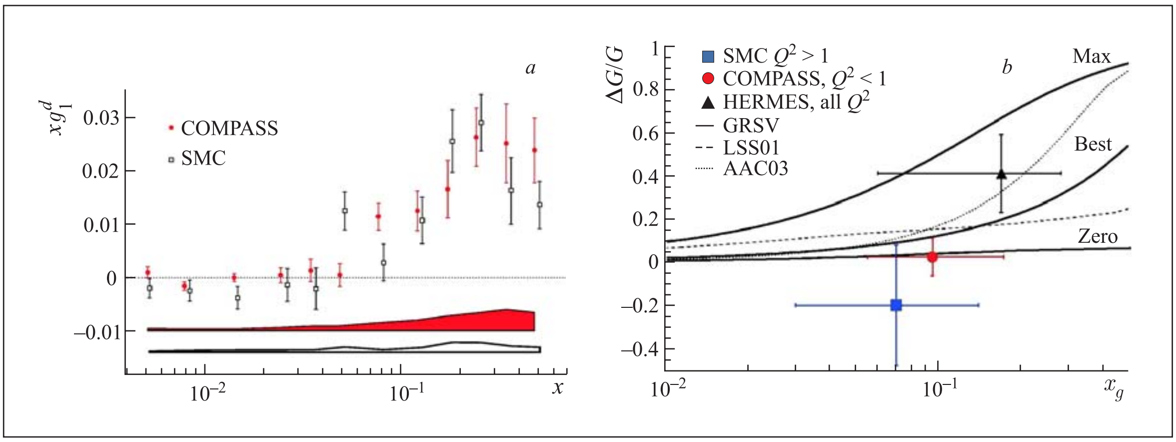

Fig. 1. The spin structure function xg_1 as a function of x (*a*) and the ratio of $\Delta G/G$ as a function of x_g (*b*) measured by COMPASS experiment

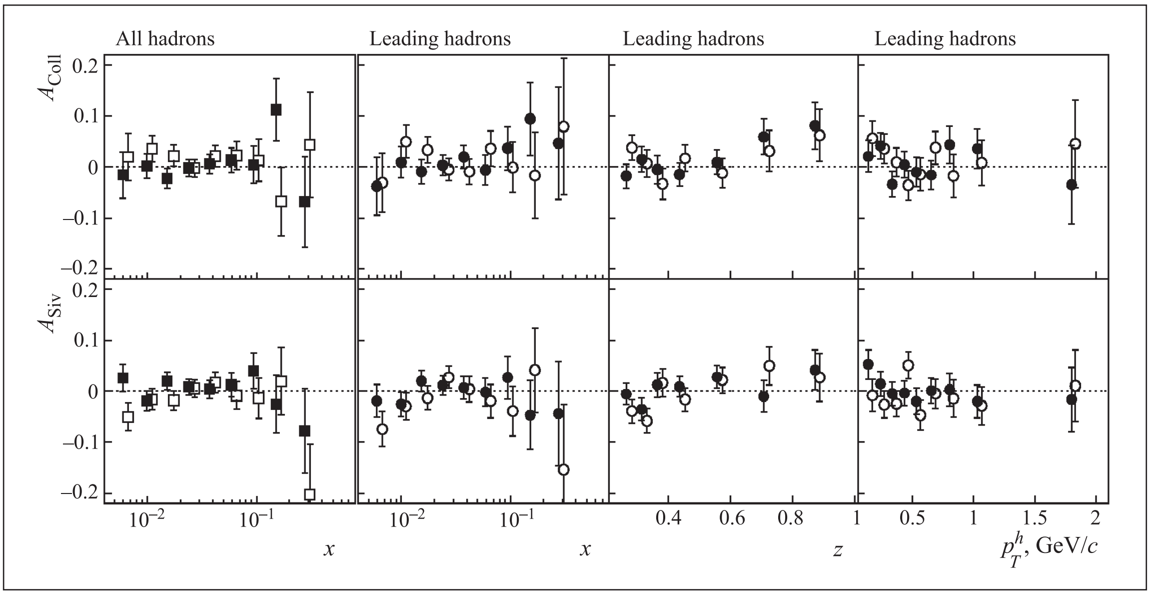

Fig. 2. The transverse spin asymmetries of the deuteron in semi-inclusive DIS as a function of p_T of the detected hadron from recent COMPASS measurement

Search for the $\Theta(1860)$ pentaquark is done at COMPASS [3] (see Fig. 4). No exotic narrow resonances in the systems of $\Xi^-\pi^\pm$ and $\Xi^+\pi^\pm$ are found at COMPASS, while the states $\Xi(1530)^0$ and $\Xi(1530^0)$ are clearly seen. The expected number of events in COMPASS, assuming the same $\Phi(1860)/\Xi(1320)^-$ ratio as in NA49, is almost ten times bigger than the observed upper limit.

The gluon polarization in the nucleon, obtained from quasi-real photoproduction of high-p_T hadron pairs, is also measured [4] (see Fig. 1). The COMPASS data of 2002 and 2003 were analyzed, and $\Delta G/G$ was estimated based on the MC PYTHIA calculations of the fraction of the high-p_T events from the photon–gluon fusion (PGF) process, directly related with $\Delta G/G$, and from other background processes. In COMPASS this fraction makes up $R_{\rm PGF} = 0.313$. So, the results on $\Delta G/G$ are model-dependent:

$$\frac{\Delta G}{G}\,(x_g = 0.095) = \\ = 0.024 \pm 0.089\,(\text{stat.}) \pm 0.057\,(\text{syst.}),$$

where the systematic error also includes theoretical uncertainties.

The COMPASS results indicate that the large value of ΔG, needed to resolve the so-called «spin crisis», is unlikely.

Longitudinal polarization of Λ and $\bar{\Lambda}$ in deep inelastic scattering has been also measured by COMPASS [5] (see Fig. 3). The data of 2003 only are bigger than the world statistics, especially for $\bar{\Lambda}$.

The preliminary data of 2003 have shown that polarization of Λ and $\bar{\Lambda}$ is equal within the errors in spite of different mechanisms of their production.

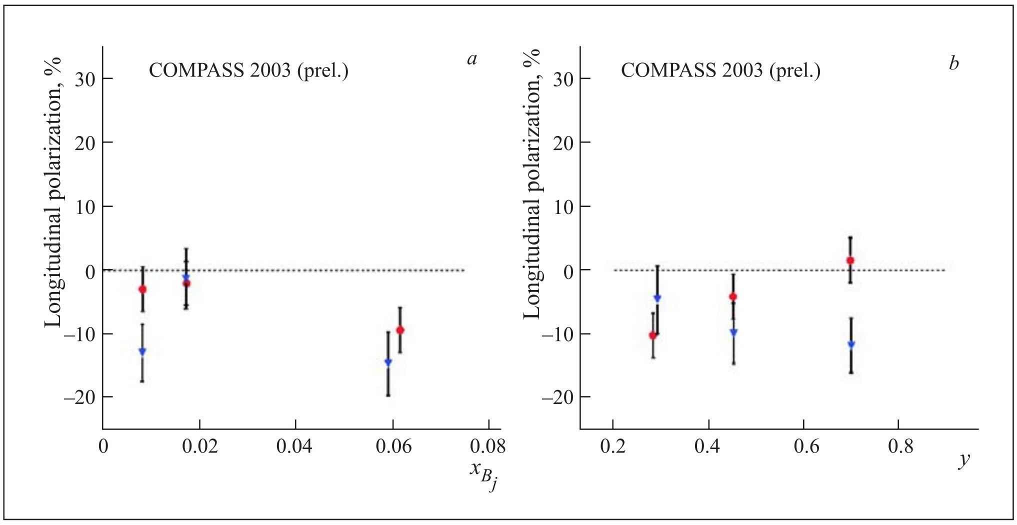

Fig. 3. The Λ (●) and anti-Λ (▼) polarizations as a function of Bjorken variable x_{B_j} (*a*) and y (*b*) measured by COMPASS

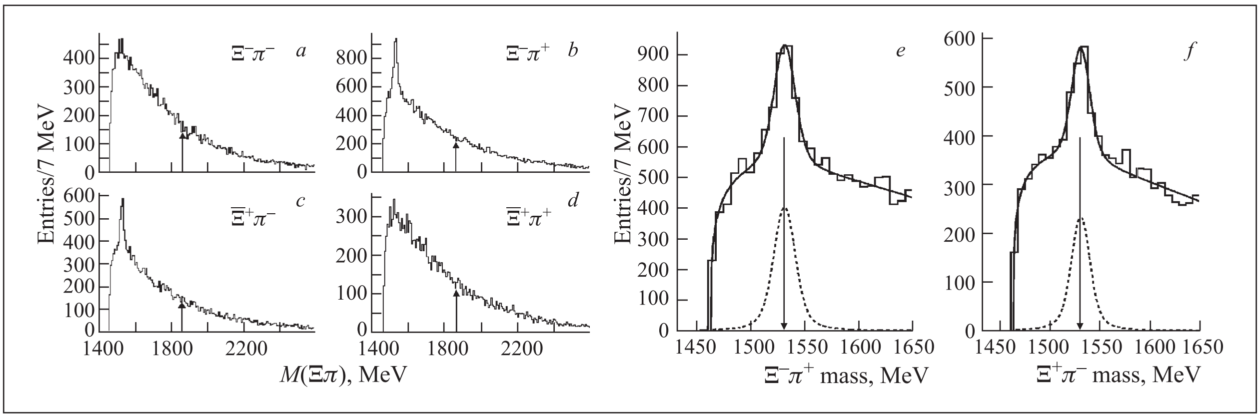

Fig. 4. The invariant mass of the systems of $\Xi\pi^{\pm}$, arrows correspond the 1860 MeV (*a–d*); the invariant mass spectra of $\Xi(1530)^0$ and $\Xi(1530^0)$ are shown at *e, f*

The **NA48** cycle of experiments is devoted to the precise measurement of the ratio ε'/ε in $K \to 2\pi$ decays, to the study of kaon and hyperon rare decays and to the search for C-violating asymmetry in charged kaon decays.

The following kaon and hyperon decays have been studied:

The relative branching ratio of the decay $K_L \to \pi e \nu \gamma$ ($K_{e3}\gamma$) with respect to $K_L \to \pi e \nu$ (γ) (K_{e3} + $K_{e3}\gamma$) decay has been measured [6]. The value of the branching ratio is: $\mathrm{Br}\,(K_{e3}\gamma, E\gamma^* > 30$ MeV, $\theta(e,\gamma)^* > 20°)/\mathrm{Br}\,(K_{e3}) = \left(0.964 \pm 0.008 \begin{matrix}+0.011\\-0.009\end{matrix}\right)$ %. This result agrees with the theoretical predictions but differs from recently published results.

A search for the CP-violating decay $K_S \to 3\pi^0$ has been performed [7]. From a fit to the lifetime distribution of about 4.9 million reconstructed $K^0/\bar{K}^0 \to 3\pi^0$ decays, the CP-violating amplitude $\eta_{000} = A(K_S \to 3\pi^0)/A(K_S \to 3\pi^0)$ has been found to be $\mathrm{Re}\,(\eta_{000}) = -0.002 \pm 0.011 \pm 0.015$ and $\mathrm{Im}\,(\eta_{000}) = -0.003 \pm 0.013 \pm 0.017$. This corresponds to the upper limit of the branching fraction of $\mathrm{Br}\,(K_S \to 3\pi^0) < 7.4 \cdot 10^{-7}$ at the 90 % C.L.

The amplitude of the CP-conserving component of the decay $K_S \to \pi^+\pi^-\pi^0$ relative to $K_L \to \pi^+\pi^-\pi^0$, has been measured [8]. For the characteristic parameter λ, the values $\mathrm{Re}\,(\lambda) = 0.038 \pm 0.010$ and $\mathrm{Im}\,(\lambda) = -0.013 \pm 0.007$ have been extracted. These values agree with earlier measurements and theoretical predictions of the chiral perturbation theory.

Branching ratio of $K_s \to \pi^0 e \nu$ has been measured: $\mathrm{Br}\,(K_s \to \pi^0 e\nu) = (6.8 \pm 0.2(\mathrm{stat.}) \pm 0.2(\mathrm{syst.})) \cdot 10^{-4}$. This value is in agreement with the PDG value and decreases the uncertainty.

Branching ratio $K_s \to \pi^+\pi^-\pi^0$ has been measured: $\mathrm{Br}\,(K_s \to \pi^+\pi^-\pi^0) = \left(4.7^{+2.2}_{-1.7}(\mathrm{stat.})^{+1.7}_{-1.5}(\mathrm{syst.})\right) \times 10^{-7}$. The result agrees with CHIPT and with two other measurements with comparable uncertainties.

A value for the branching ratio of $\Xi^0 \to \Sigma^+ e^- \bar{\nu}_e$ has been extracted: $\mathrm{Br}\,(\Xi^0 \to \Sigma^+ e^- \bar{\nu}_e) = (2.51 \pm 0.03(\mathrm{stat.}) \pm 0.09(\mathrm{syst.})) \cdot 10^{-4}$. Including the dependence of form factors on the momentum transfer and radiative corrections, the following value for V_{us} can be extracted from the branching-ratio measurement: $V_{us} = 0.208 \pm 0.006^{+0.030}_{-0.025}\, g_1/f_1$.

Branching ratio of $\bar{\Xi}^0 \to \bar{\Sigma}^+ e^- \nu_e$ has been extracted: $\mathrm{Br}\,(\bar{\Xi}^0 \to \bar{\Sigma}^+ e^- \nu_e) = \left(2.57 \pm 0.12(\mathrm{stat.})^{+0.10}_{-0.09}(\mathrm{syst.})\right) \cdot 10^{-4}$.

Branching ratio of $\Xi^0 \to \Sigma^+ \mu^- \bar{\nu}_\mu$ has been extracted: $\mathrm{Br}\,(\Xi^0 \to \Sigma^+ \mu^- \bar{\nu}_\mu) = (2.2 \pm 0.3(\mathrm{stat.}) \pm 0.2(\mathrm{syst.})) \cdot 10^{-6}$. This is the largest sample collected so far of muonic decays.

A preliminary result on the asymmetry measurement in $K^\pm \to \pi^+\pi^-\pi^\pm$ decays is: $A_g^c = (0.5 \pm 2.4(\mathrm{stat.}) \pm 2.1(\mathrm{stat.(trig.)}) \pm 2.1(\mathrm{syst.})) \cdot 10^{-4} = (0.5 \pm 3.8) \cdot 10^{-4}$ (Fig. 5). This result is compatible with the SM predictions, and has already an order of magnitude better precision than previous similar measurements.

The preliminary result for asymmetry measurement in the «neutral» mode $K^\pm \to \pi^0\pi^0\pi^\pm$ has been obtained: $A_g^0 = (1.7 \pm 1.7(\mathrm{stat.}) \pm 1.7(\mathrm{syst.}) \pm 0.2(\mathrm{ext.})) \times 10^{-4}$. This result does not indicate an CP violation at the precision level of $3 \cdot 10^{-4}$, which is one order of magnitude better than in other experiments. A more precise result will be obtained using larger statistics accumulated in 2004 (see Fig. 6).

A new structure (a «cusp» effect) has been observed for the first time in the invariant mass spectrum of the $\pi^0\pi^0$ subsystem (M_{00}) in $K^\pm \to \pi^0\pi^0\pi^\pm$ decays (see Fig. 7). The observed effect allowed one to measure the $\pi\pi$ s-wave isoscalar and isotensor scattering lengths a_0 and a_2 with a high precision: $(a_0 - a_2)m_+ = 0.268 \pm 0.010(\mathrm{stat.}) \pm 0.004(\mathrm{syst.})$ and $a_2 m_+ = -0.041 \pm 0.021(\mathrm{stat.}) \pm 0.014(\mathrm{syst.})$. These values are in good agreement with the results obtained in the E865 BNL and DIRAC experiments. The measured difference $(a_0 - a_2)$ is limited by 5% uncertainty of the theoretical model implementation.

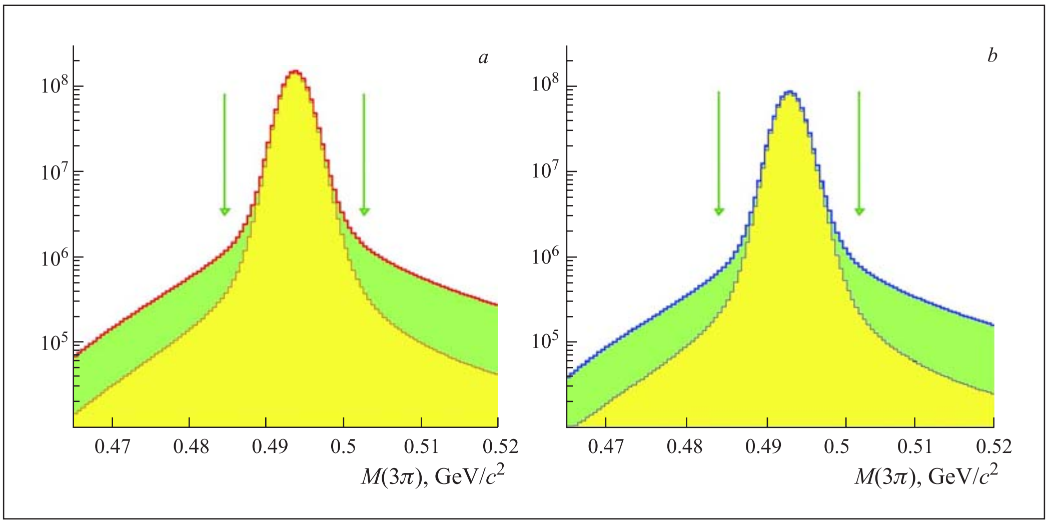

Fig. 5. The mass spectra for charged asymmetry extraction from NA48/2 data

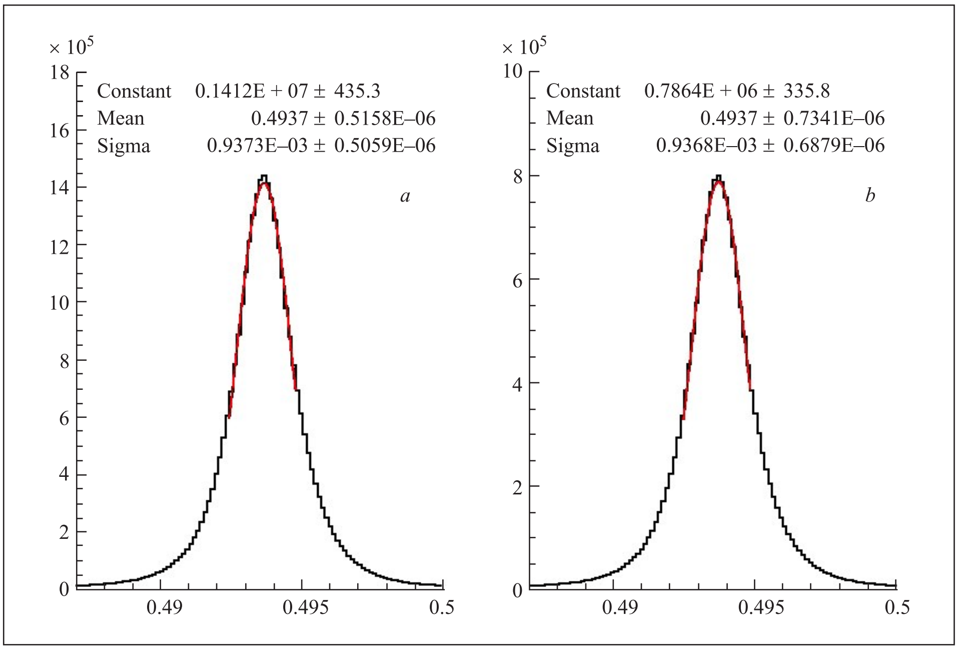

Fig. 6. The fitted mass spectra for charged asymmetry extraction from NA48/2 data

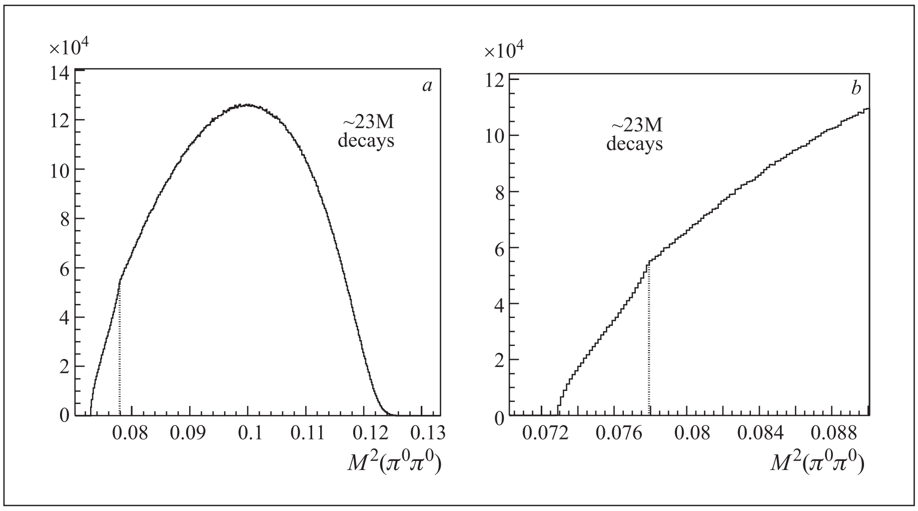

Fig. 7. The squared mass spectra demonstrate the «cusp» effect found by NA4/2 experiment

• The large statistics of charged kaon decays, collected in 2003 and 2004 allows one to study a wide variety of rare kaon decays. In most cases the statistics exceeds those of previous experiments by one or even several orders of magnitude. The K_{e4}-decays analysis has advanced forward, the statistical precision on the determination of $a_0^0 m_+$ is expected to be about ±0.01.

• New measurements of charged kaon semileptonic decays have been done: $K^\pm \to \pi^0\mu^\pm\nu$ $(K_{\mu3})$ and $K^\pm \to \pi^0 e^\pm\nu$ (K_{e3}). The main goals of this study are to extract the individual decay widths because they will allow one to contribute to the measurement of the V_{us} parameter in the Cabibbo–Kobayashi–Maskawa (CKM) quark mixing matrix and to measure the decay width ratio $\Gamma(K_{\mu3})/\Gamma(K_{e3})$ which is a unique function of the slope parameters of the form factors. This ratio provides a consistency check between the measurements made from the form factors and the partial decay widths. The ratios have been measured:

$$R_{K_{e3}/K_{2\pi}} = \Gamma(K^\pm \to \pi^0 e^\pm\nu)/\Gamma(K^\pm \to \pi^0\pi^\pm) = 0.2505 \pm 0.0009(\text{stat.}) \pm 0.0012(\text{syst.}),$$

$$R_{K_{\mu3}/K_{2\pi}} = \Gamma(K^\pm\to\pi^0\mu^\pm\nu)/\Gamma(K^\pm\to\pi^0\pi^\pm) = 0.1646 \pm 0.0006(\text{stat.}) \pm 0.0011(\text{syst.}),$$

and $R_{K_{\mu3}/K_{e3}} = \Gamma(K^\pm\to\pi^0\mu^\pm\nu)/\Gamma(K^\pm\to\pi^0 e^\pm\nu) = 0.657 \pm 0.003(\text{stat.}) \pm 0.003(\text{syst.})$ which is the most precise measurement.

LPP participates in **H1** experiment which investigates DIS processes at the ep collider HERA, DESY. The ep-collision data have been taken with longitudinally polarized lepton beam for the first time in 2005. The high polarization of the lepton beam allows the HERA experiments to further constrain the parton densities of the proton through measurements of the polarization asymmetries and to test the electroweak part of the Standard Model (see Fig. 8).

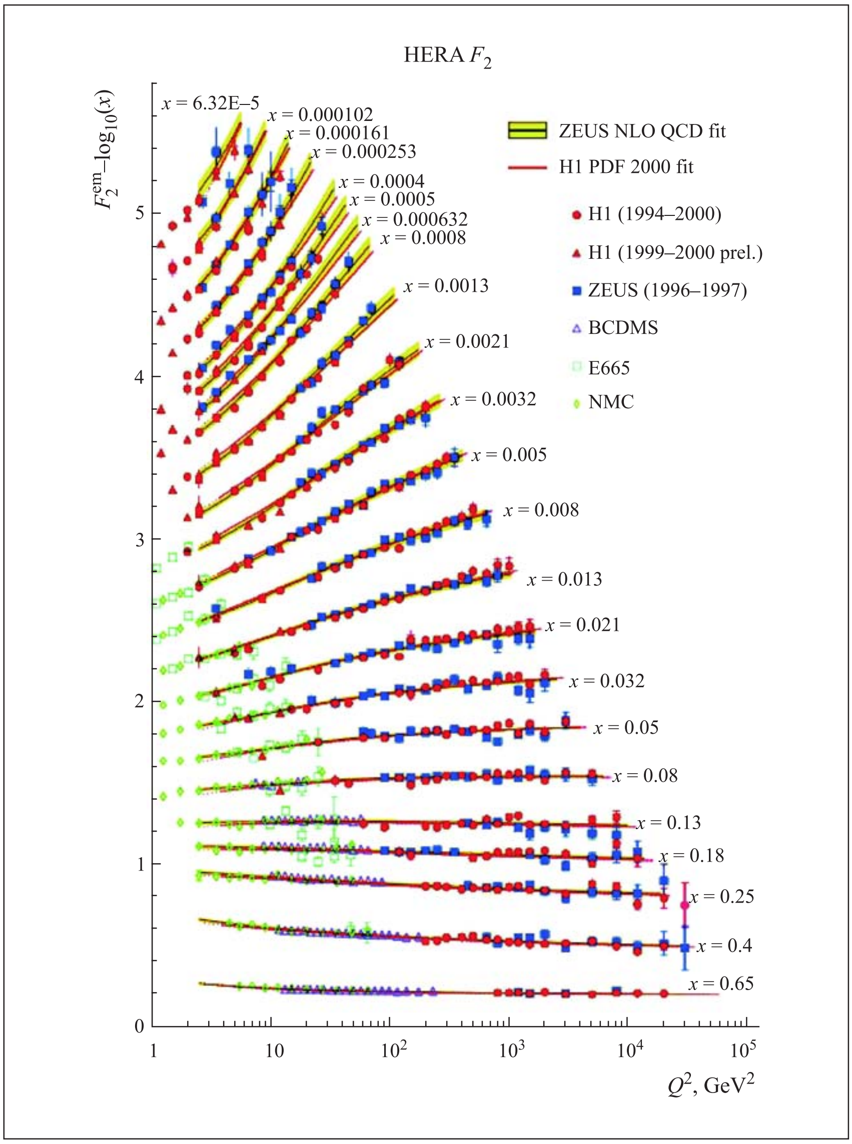

Fig. 8. The world data on structure proton function F_2 versus Q^2 and x with NLO QCD fits by ZEUS and H1 experiments

In 2005, the measurements of the polarization dependence of the total charged current cross section at HERA have been done by H1 collaboration [9, 10] (see Fig. 9). New data taken with the H1 detector, for longitudinally polarized positrons and electrons in the left- and right-handed states in collision with unpolarized protons at HERA, are used to measure the total charged current cross section for $Q^2 > 400$ GeV^2. The polarization dependence of the total charged current cross section is compared with the Standard Model expectations. The Standard Model predicts that the CC cross section should have a linear dependence on polarization, and furthermore, the cross section for fully left-handed positrons should be zero (similarly for fully right-handed electrons). The data of the H1 and ZEUS experiments are used to obtain an extrapolated total charged current cross section for the fully left-handed positron beam: $\sigma = (0.2 \pm 1.8(\text{stat.}) \pm 1.6(\text{syst.}))$ pb. This extrapolation is found to be consistent with the expectations of the Standard Model.

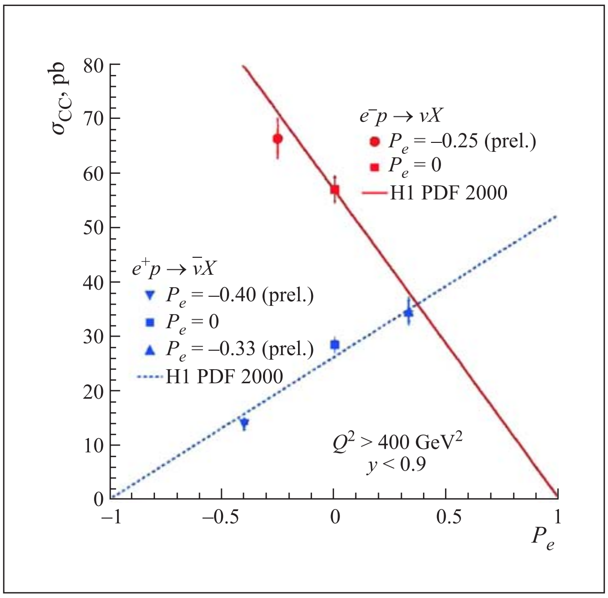

Fig. 9. The polarized *ep* CC cross section versus values of the electron (positron) beam polarization measured by H1 experiment

The LPP group (headed by V. G. Krivokhijin) has taken part in the analysis of the **HERMES** data and performed the technical maintenance of the minidrift vertex chambers (DVC). In 2005, HERMES completed data taking with the polarized targets. During the 2005 data taking period (about 10 months) the DVC operation was very stable. In November 2005, HERA was stopped for a long shutdown. During this shutdown (about 4 months) DVC was removed from the front part of the HERMES spectrometer and after testing and small repair the DVC was installed again. Special survey measurements have been done to define precisely the DVC geometrical position in the front part of the HERMES spectrometer. In 2005, the work was continued to extract the polarized valence distributions and their moments in the next-to-leading order (NLO) of QCD. This analysis was based on the method proposed by O. Yu. Shevchenko, O. N. Ivanov, and A. N. Sissakian [11, 12]. The authors have offered a procedure of direct extraction of the moments of the polarized valence distributions from the semi-inclusive (SIDIS) data as well as of the moment difference of the light sea quark polarized distributions in the next-to-leading QCD order. The validity of the procedure was confirmed by the respective simulations. It was also shown that this procedure could be applied to the HERMES polarized experimental data [13–15]. The preliminary results were obtained and reported at the HERMES Collaboration Meeting in April 2005 [16–17]. The authors of the above method have offered a modification of the Jacobi polynomial expansion method (MJEM) based on the application of the truncated moments instead of the full ones. This allows one to reconstruct the local quark helicity distributions with a high precision even for a narrow measured region of Bjorken x using only four first moments extracted from the data in the NLO of QCD as an input [17]. The analysis of the HERMES experimental data taken in 1995–2000 is in progress to get the data on pion and kaon difference asymmetries and then calculate the polarized valence distributions and their moments in the NLO of QCD. Also the analysis of the HERMES data taken in 2003–2005 with the hydrogen transversely polarized target is in progress to extract the Q^2 dependence of Gerasimov–Drell–Hearn integral.

One of the most interesting new HERMES studies is the measurements of transversity distributions in the nucleon. These studies were finished and published in 2005. Single-spin asymmetries for semi-inclusive electroproduction of charged pions in deep-inelastic scattering of positrons are measured for the first time with transverse target polarization [18] (Fig. 10). The asymmetry depends on the azimuthal angles of both the pion (ϕ) and the target spin axis (ϕ_S) about the virtual photon direction and relative to the lepton scattering plane. The extracted Fourier component $\langle \sin(\phi + \phi_S) \rangle^{\pi}_{UT}$ is a signal of the previously unmeasured quark transversity distribution, in conjunction with the so-called Collins fragmentation function, also unknown. The Fourier component $\langle \sin(\phi - \phi_S) \rangle^{\pi}_{UT}$ of the asymmetry arises from a correlation between the transverse polarization of the target nucleon and the intrinsic transverse momentum of quarks, as represented by the previously unmeasured Sivers distribution function. Evidence for both signals is observed, but the Sivers asymmetry may be affected by exclusive vector meson production.

In 2005, HERMES has finished all studies on the tensor spin structure of the deuteron [19]. The use of a unique tensor polarized deuteron gas target enabled the first measurement of the tensor asymmetry A^d_{zz} and the tensor structure function b^d_1 for average values of the Bjorken variable $0.01 < x < 0.45$ and the values of the

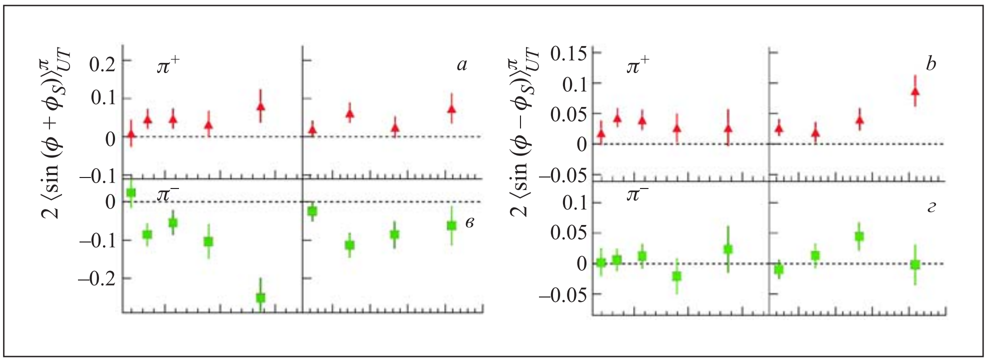

Fig. 10. The asymmetry depends on the azimuthal angles of both the pion weighted with $\langle \sin(\phi + \phi_S) \rangle$ (Collins effect, left panel) and with $\langle \sin(\phi - \phi_S) \rangle$ (Sivers structure function, right panel) measured by the HERMES experiment

squared four-momentum transfer $0.5 < Q^2 < 5$ GeV^2 (Fig. 11). The quantities A^d_{zz} and b^d_1 are found to be nonzero. The rise of b^d_1 for decreasing values of x can be interpreted to originate from the same mechanism that leads to nuclear shadowing in unpolarized deep-inelastic scattering.

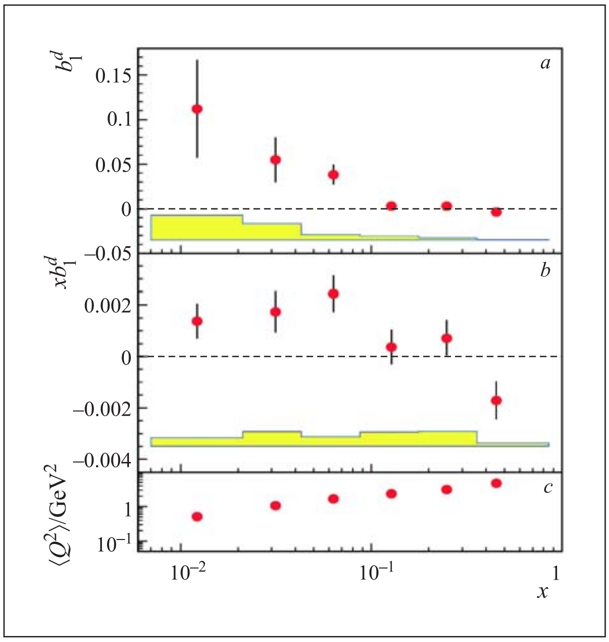

Fig. 11. The tensor structure function b_1 of the deuteron measured by HERMES

According to the JINR commitments, LPP participated in the commissioning of the Outer Tracker (OTR) of the **HERA-B** detector which is a large-aperture spectrometer built to study collisions of 920 GeV protons with the nuclei of target wires positioned in the halo of the HERA proton beam. The OTR is a large system of planar drift chambers with about 113000 read-out channels (world-largest honeycomb-chamber tracker) [20–23]. Its inner part has been designed to be exposed to a particle flux of up to $2 \cdot 10^5$ cm$^{-2} \cdot$ s^{-1} thus coping with conditions similar to those expected in future collider experiments. Thirteen superlayers, each consisting of two individual chambers, have been assembled and installed in the experiment.

The stereolayers inside each chamber were composed of pokalon-C honeycomb drift tube modules with 5 and 10 mm diameter cells. Chamber aging was prevented by coating the cathode foils with thin layers of copper and gold, together with a proper drift gas choice Ar/CF$_4$/CO$_2$. Longitudinal wire segmentation was used to limit the occupancy in the most irradiated detector regions to about 20%. The production of 978 modules was distributed among six different laboratories and took 15 months (LPP, JINR produced about 40% of modules). The successful operation of the OTR showed that a large tracker could be efficiently built and safely operated under a huge radiation load at a hadron collider. The OTR provided efficient reconstruction of charged particle tracks from a distance of 20 cm from the HERA proton beam to the outer acceptance limit of the experiment, as well as fast trigger signals for the first-level trigger in the environment of high track density. The Dubna group also dominated in the preparation and installation of the OTR superlayers, as well as in debugging and monitoring the setup and tuning the electronics thresholds to obtain the optimal performance of tracking and triggering.

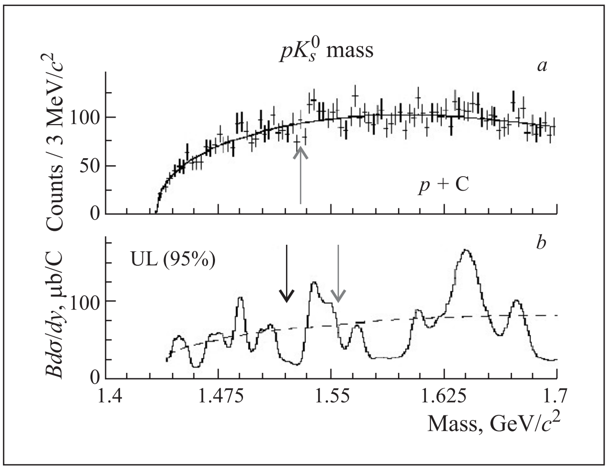

Fig. 12. The invariant mass spectra of pK^0_S which show no indication on pentaquark states from data of HERA-B experiment

The search for $\Theta^+(1540)$ and $\Xi^-(1540)$ pentaquark candidates was carried out in proton-induced reactions on the carbon, titanium, and tungsten targets at midrapidity ($y_{\rm cm} \sim 0$) and $\sqrt{s} = 41.6$ GeV [24] (see Figs. 12, 13). In $2 \cdot 10^8$ inelastic events there was no evidence found for narrow ($\sigma \sim 5$ MeV/c^2) signals in $\Theta^+ \to pK_s \to p\pi^+$ and $\Xi^{--} \to \Xi^-\pi^- \to \Lambda\pi^+\pi^-$ channels. The 95% C.L. upper limits for the inclusive production cross section multiplied by branching fraction $\mathrm{Br}\, d\sigma/dy\,|_{y\approx 0}$, are 3.7 and 2.5 μb/nucleon. The upper limit of the yield ratio of $\Theta^+/\Lambda(1520) < 2.7\%$ is significantly lower than model predictions. The upper limit of $\mathrm{Br}\,\Xi^-/\Xi(1530)^0 < 4\%$ is at variance with the results that have provided the first evidence for the Ξ^{--} signal.

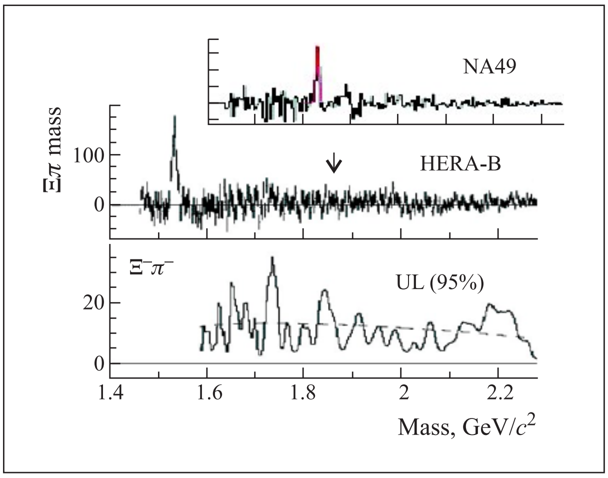

Fig. 13. The invariant mass spectra of $\Xi\pi$ which indicate on pentaquark states at 1520 MeV from data of HERA-B experiment, the data from NA49 are also shown

The **EXCHARM** experiment is devoted to the study of charmed and strange particle-production characteristics and to search for narrow baryonia in neutron–nucleon interactions at the Serpukhov accelerator. In 2005, the studies on searching for pentaquark states were finished and the results were published. Searching for pentaquark states was conducted in the effective mass spectra for the following decays:

$$\Xi(1860)^0 \to \Xi^-\pi^+, \quad \Xi(1860)^{--} \to \Xi^-\pi^-,$$

where Ξ^- was identified by its decay to $\Lambda^0\pi^-$, and Λ^0 — by the decay to $p\pi^-$ [25] (see Figs. 14, 15). The signal from $\Lambda^0 \to p\pi^-$ decay is clearly detected in the $p\pi^-$ effective mass distribution. The background comes from the combinations of charged particles produced in the target ($\approx 53\%$) and in the air ($\approx 43\%$). The background from $K^0_S \to \pi^+\pi^-$ decays, where the positive pion was wrongly identified as a proton, is around 4%. The experiment selected 3 million events with candidates for $\Lambda^0 \to p\pi^-$ decays and around 150 thousand combinations with at least one candidate for Ξ^- decay. For the final analysis, 37 thousand candidates for $\Xi^- \to \Lambda^0\pi^-$ decay were selected. The background in the signal region was around 14.6 thousand combinations. Finally, 17379 candidates for $\Xi(1860)^0$ decay and 7215 candidates for $\Xi(1860)^-$ decay were selected. A clear signal of $\Xi(1530)^0$ was observed in $(\Xi^-\pi^+)$ invariant mass spectrum. The fitted mass $M_0 = (1532.9 \pm 0.4)$ MeV is close to the table value and width $\Gamma = (10.0 \pm 1.7)$ MeV is consistent with the table value. The $M(\Xi^-\pi^+)$ resolution in the region of 1530 MeV/c^2 was determined by Monte Carlo to be 3.7 MeV. The number of decays resulting from the fit is 1492 ± 93. There are no statistically significant signals in the region of large masses or in the region of the desired signal (1862 MeV). There are no signals in $M(\Xi^-\pi^-)$ spectra either. The resolution in $\Xi^-\pi^\pm$ mass in the region of the desired signal, determined by Monte Carlo, is 6.5 MeV.

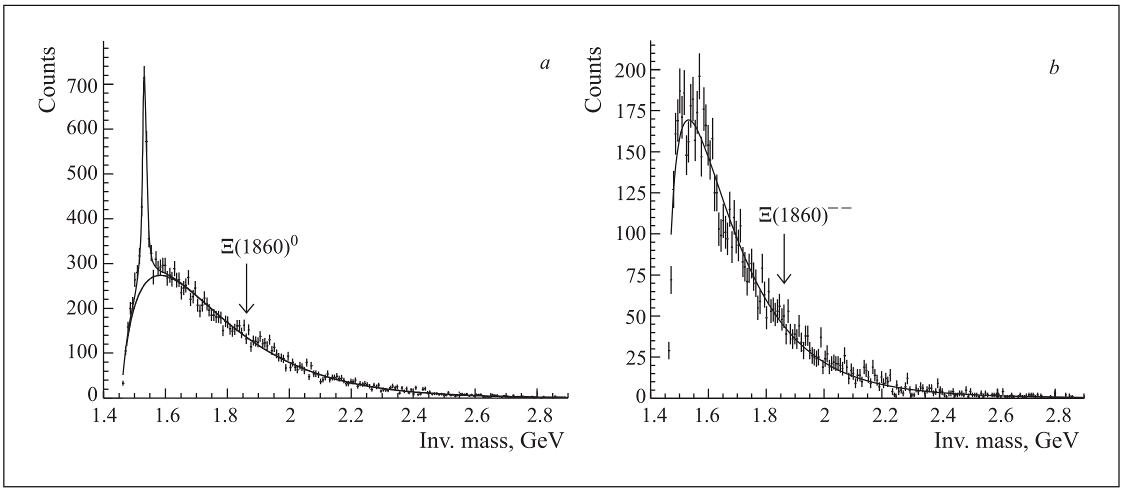

Fig. 14. Effective mass spectrum of the $\Xi^-\pi^+$ system (*a*) and $\Xi^-\pi^-$ system (*b*) from EXCHARM data

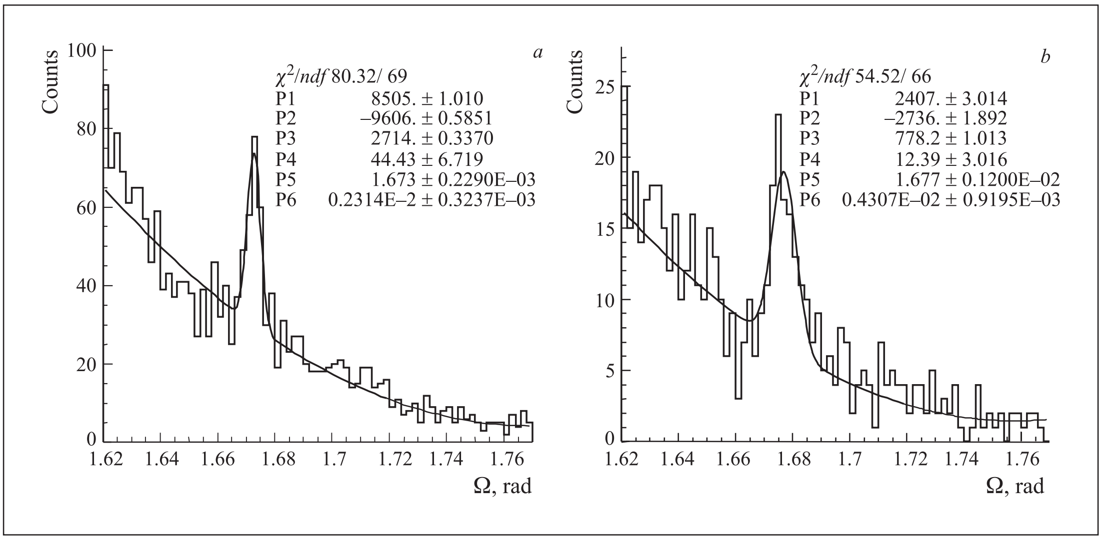

Fig. 15. Effective mass spectrum of the $\Lambda^0\pi^+$ system (*a*) and $K_S^0\ p$ system (*b*) measured by EXCHARM

The **THERMALIZATION** project started in 2003 at the Serpukhov accelerator and it is aimed to study the collective behavior of particles in the process of multiparticle production in pp interaction, $pp \to n_\pi\pi + 2N$ at the beam energy $E_{\rm lab} = 70$ GeV. The domain of high multiplicity $n_\pi = 35{-}40$ will be studied near the threshold of reaction $n_\pi \to n_{\rm lim}$, all particles get small relative momenta. As a consequence of multiboson interference a number of collective effects may show up:

— A drastic increase of partial production cross section $\sigma(n)$ of n particles is expected compared with the commonly accepted extrapolations.

— The formation of jets consisting of identical particles may occur.

— Large fluctuations of charged and neutral components («centauros» or «anticentauros») are anticipated.

— Increase of the rate of the direct photons as a result of the bremsstrahlung in parton cascade and annihilation $\pi^+ + \pi^- \to n\gamma$ in dense and cold pionic gas or condensate, is expected.

— In the domain of high multiplicity, a phase transition to cold QGP may occur, when the major part of the center-of-mass energy is materialized to high density of the hadronic system.

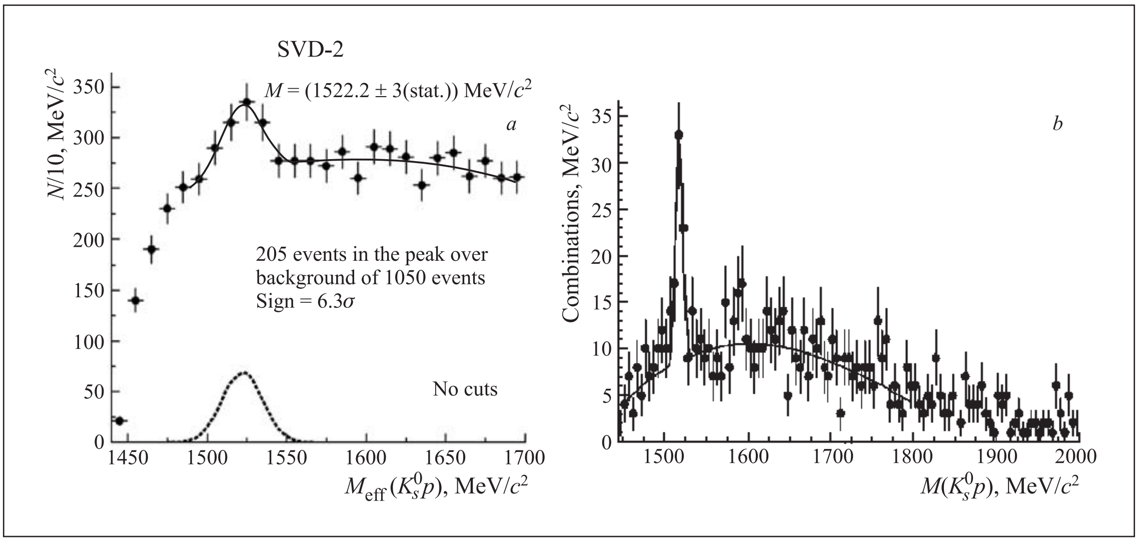

Fig. 16. Observation of resonance in the system K^0p, interpreted as pentaquark Θ^+ measured by «THERMALIZATION» experiment

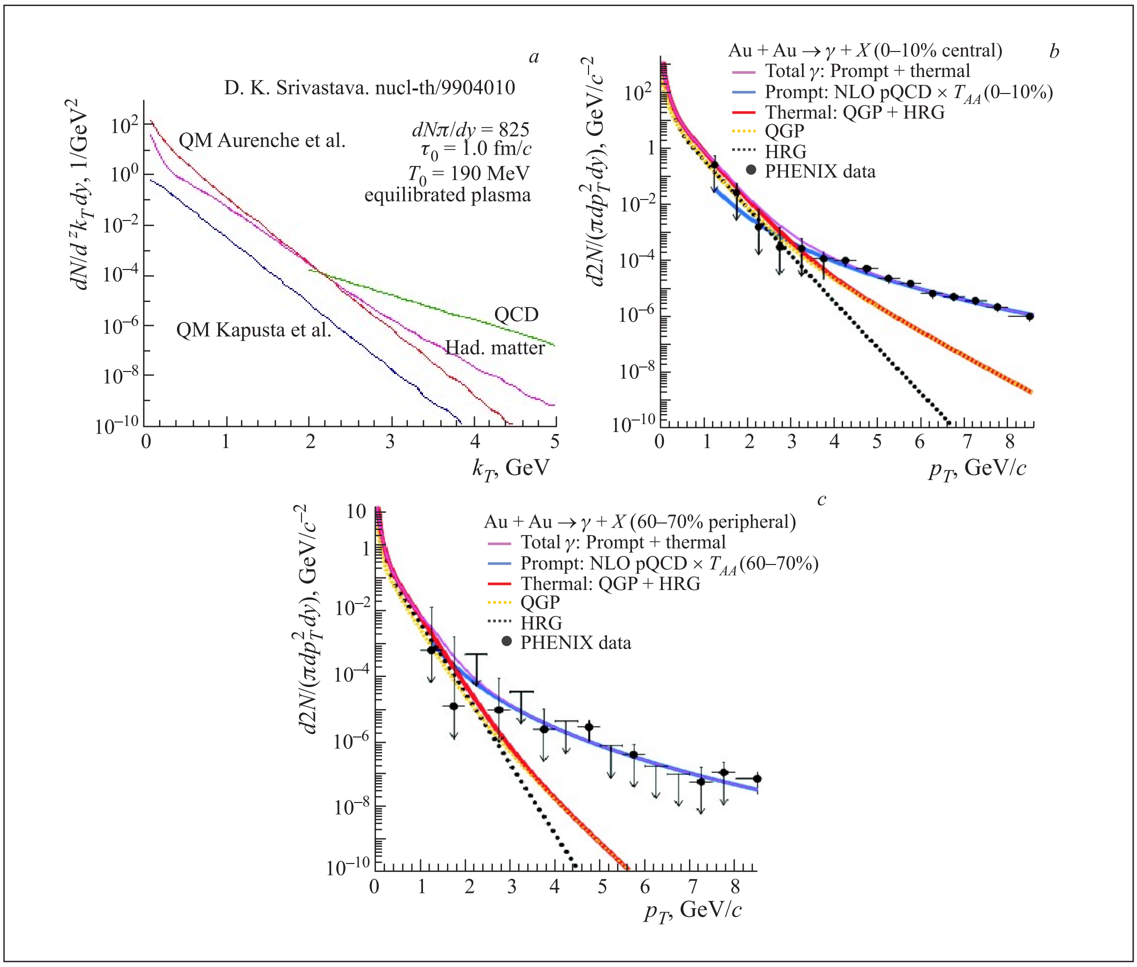

Fig. 17. Direct soft photons spectrum in the pp, $d + $Au, and Au$\,+\,$Au collisions at 200 GeV measured by STAR experiment at RHIC, BNL

The experiment is carried out with the extracted proton beam of IHEP (Protvino) 70 GeV accelerator. The spectrometer with vertex detector (SVD-2) is used. In the last run (November, 2005) the setup included the following basic elements: a scintillation trigger hodoscope, a silicon microstrip vertex detector, a liquid hydrogen target, a drift tube tracker, a magnetic spectrometer with proportional chambers, and a threshold Cherenkov detector. This run has shown that some modification and further improvements of the setup elements are necessary: a system to deliver liquid helium to the hydrogen target must be modified to reduce helium consumption; further test and debugging of the trigger system electronics are necessary; further test and debugging of the drift tube tracker electronics are necessary; the sample of 128-channel circuit VIKING of the silicon vertex detectors has to be upgraded and a significant part of both on-line and off-line software has to be upgraded.

The work performed during 2005 [26–31]: the scintillation trigger hodoscope to register events with high multiplicity, the liquid hydrogen target, the drift tube tracker were manufactured; the experimental data have been analyzed to search for an exotic θ^+-baryon state in the pK^0_s-decay mode in pA collisions. New results were obtained and published (see Fig. 16); the programme package for setup element alignment was implemented. Mathematical simulation and development of the software package for data processing are in progress.

The LPP takes part in the experiments on the 4π-detector **STAR** at the collider RHIC at the Brookhaven National Laboratory (BNL). The LPP physics group and working group of Wayne State University (Detroit, USA) completed construction of the Barrel Electromagnetic Calorimeter (BEMC) of the STAR detector at RHIC, BNL. The last, 120th BEMC module was manufactured and installed on the STAR magnet in January 2005.

Investigation of the nonphotonic high-p_T electron spectra in Au$\,+\,$Au collisions at 200 GeV per NN pair has been continued. A suppression of heavy flavor mesons (mainly D particles) with respect to binary scaling has been observed and an indication of its increase from peripheral to central Au$\,+\,$Au events has been obtained. The first preliminary results on soft thermal photon spectra emitted in $d + $Au and Au$\,+\,$Au collisions at 200 GeV/c per NN pair have been obtained (see Fig. 17). The overall analysis is in progress.

Proton–lambda and neutral kaon correlations in Au + Au collisions at 200 GeV per NN pair have been studied. The measured radii of kaon, proton, and lambda sources agree with the transverse mass scaling thus indicating a universal collective flow. The spin averaged s-wave proton–antilambda scattering length was estimated for the first time [32]. Plenary and invited reports on correlation femtoscopy were respectively given at the XVIII International Conference on Ultra-Relativistic Nucleus–Nucleus Collisions [33] and at the Workshop on Particle Correlations and Femtoscopy [34].

The LPP specialists participate in the international project **BOREXINO** aimed to get a precise and direct determination of the flux of the solar neutrinos produced in the ^{7}Be electron capture process in the Sun and to study the phenomenon of neutrino oscillations. The low-energy solar neutrino spectrum will be measured by using calorimetric, liquid scintillator and low background detector BOREXINO located at the underground laboratory Gran Sasso, Italy (CTF). In 2005, the activity to prepare the detector for data taking was continued [35–41], it is expected that data taking will start in 2006.

PREPARATION OF NEW EXPERIMENTS

The main effort of JINR in the **CMS** Project is concentrated on the design and construction of the endcap detectors, where JINR bears full responsibility in the frame of the RDMS CMS Collaboration: Endcap Hadron Calorimetry (HE) and First Forward Muon Station (ME1/1).

The main JINR obligation on construction of Endcap Hadron Calorimeters has been fulfilled. In cooperation with IHEP (Protvino), NC PHEP (Minsk), HTTC NIKIET (Moscow), MZOR plant (Minsk), ISC and NSC KIPT (Kharkov) both HE endcaps were delivered and assembled at CERN. Industry of Russia and JINR Member States, such as «Krasny Vyborjets» and «Izhorskie Zavody» in St. Petersburg, October Revolution Plant in Minsk, Single Crystal institute in Kharkov, and others were deeply involved in the construction of the endcap hadron calorimeters. In particular, the technology of brass production out of artillery case cartridges for calorimeter absorbers, was developed by NIKIET (Moscow) in cooperation with St. Petersburg plants. Dressing of both the endcap hadron calorimeters at CERN with front-end electronics, phototransducers, laser and radioactive source systems was completed in 2005. Calibration of the calorimeters with the laser and radioactive sources is going on well to be completed before the magnet test. The JINR obligation on proportional chamber construction for ME1/1 muon stations was also fulfilled. All ME1/1 cathode strip chambers including spares were delivered from Dubna to CERN. Installation and tests of the cathode strip chambers were completed in 2005. Mass-production of silicon radiation hard detectors 63×63 mm in cooperation with RIMST (Zelenograd) is going on the schedule. By the end of 2005, 1865 out of 1975 detectors were produced. A part of the produced detectors was tested for radiation hardness at IBR-2 at JINR. The detector database was developed at JINR and installed at CERN to treat the data of the detector measurements. During the year 2005, the intensive work to develop the CMS Physics Programme within a special CPT project (computing, physics, triggering) was continued by the JINR and Member-States physicists. The Dubna group activity covered the file of the analysis group relative to the specific physics studies (Standard Model, SUSY and Beyond the Standard Model, Heavy Ion), and four «detector» groups are focused on methodical work and development of reconstruction and analysis software related to the detector subsystems. The main results of theoretical considerations and full-scale simulation performed by the JINR group were included in the Computing TDR and the Physics TDR V. I of CMS Collaboration. The development of reconstruction software for muon reconstruction is continued. The performance of CMS muon system to detect dimuon pairs in TeV invariant mass region was specified. It was shown that the expected invariant mass resolution for these events was better than 4% for Drell–Yan muon pairs with invariant masses greater than 1 TeV, and the off-line reconstruction efficiency was close to 98%. The optimization of CMS trigger is continued. In particular, it is shown that cuts for calorimeter isolation should be removed from the trigger solution for high-p_T muon triggering. A special study of the CMS trigger system has shown that about 85% of the events have muons in the fiducial volume of muon system $|\eta| \leqslant 2.4$ and that the total trigger efficiency is about 90%. The data processing of the combined EE + HE + ME1/1 beam test was completed. A good agreement between the beam test results and GEANT4 simulation has been demonstrated. The spatial resolution of HE CMS calorimeter has been derived from the beam test data.

It was found out that the Standard Model predictions could be checked by CMS for the Drell–Yan processes up to the invariant mass value of 3 TeV for integrated luminosity of 300 fb^{-1} (three years of LHC operation at high luminosity regime). The total systematic errors in measurable cross sections coming from misalignment, momentum smearing by the detector and software deficiency, etc., were analyzed. Their values are about 5% while systematic uncertainties induced by theoretical ambiguity (PDF, QCD and EW high-order correction) are above 8–9%. The CMS discovery limit to observe new phenomena beyond the Standard Model was derived. The new heavy resonances predicted by scenario with extra dimension at TeV-energy scale and extended gauge models, can be manifested experimentally in dimuon modes up to $1.6-3.5$ TeV in dependence on the model parameters. In the case of nonresonant phenomena, such as indirect estimates of fundamental energy scale of extra dimensions and search for multidimensional gravity in scenario of ADD type, the study of dimuon spectra allows one to reach the value of the effective Planck scale of the order of 7 TeV. To discriminate the models giving the dimuon resonances in the final state, various methods of sophisticated analysis of the spin structure of these events and leptonic forward–backward asymmetry, were applied. The angular distribution of muons in the final state can be used to distinguish the spin-1 and the spin-2 resonance states, at least in the mass region up to 2.3 TeV. Different Z' models can be distinguished (up to the mass value of 2.5 TeV) by using the leptonic forward–backward asymmetry. The jet reconstruction algorithms and calibration techniques implemented in the CMS reconstruction software are studied with high-statistics Monte-Carlo samples of QCD dijet events. The systematic effects of the procedure of jet-energy scale calibration with gamma+jet events, have been studied. The development of the software package for $B_s^0 \to J/\psi(\to \mu^+\mu^-)\varphi(\to K^+K^-)$ event analysis was completed. The results on CMS group activity in 2005 were published in 14 papers [42–54].

According to the JINR obligations in the **ATLAS** experiment, which is under preparation at CERN, the LPP participates in the construction of the Liquid Argon Hadronic Endcap Calorimeter (LArHEC) and Transition Radiation Tracker (TRT).

There were 2 cryostats (cryostat «C» and cryostat «A») in the assembly area of the ATLAS endcap cryostats. Each cryostat is housing a set of 3 calorimeters — electromagnetic, hadronic, and forward. Both cryostats successfully passed tests. The tests showed that relative number of the subsystem's elements, which were not properly functioning, was always less than 1%, and it was a fully acceptable level. In December 2005 the cryostat «C» is planned to be put down to the ATLAS pit, and the 2nd cryostat — to be moved from assembly area to the ATLAS shaft. The work on final assembly of front-end printed boards, which serve to read out signals from the liquid argon hadronic endcap calorimeter, started. In parallel, the general tests of these printed boards are going on. The total number of the printed boards to be passed through the general tests is equal to 1500 pcs. The general purpose ATLAS software, known as «ATHENA», was installed on the PC farms of LPP and LIT. It allows one to work on a wide range of problems starting from analysis of the experimental test beam data, recorded during previous years, up to modeling of different physical final states, which may appear in pp collisions at LHC and can be registered by the ATLAS detector. Using this software, there started the large scale simulation of single particles (pions, electrons, and muons of both signs) passed through ATLAS detector in the energy range from 10 to 1000 GeV and in the polar angle range, which covers boundary area between the calorimeters of the barrel and endcap parts of the detector.

The **NIS** experiment at the JINR Nuclotron is aimed at searching for effects of the hidden polarized strangeness of nucleons. The most striking of these effects is a strong violation of the Okubo–Zweig–Iizuki (OZI) rule. The measurements of the cross sections of the ϕ- and ω-meson production in pp and np scattering: $p + p \to p + p + \phi$, $p + p \to p + p + \omega$, and $d + p \to n + p + \phi + p_s$ at 83, 100, and 120 MeV above their thresholds, are planned at the extracted beam of the JINR Nuclotron. The total beam time for these measurements in 3 energy points is about 100 days. The cross sections of ϕ and ω production were measured [55] in the DISTO experiment at SATURNE-II. Measurements of ϕ production were published by SPES-III [56] and COSY–TOF [57] collaborations. Evidence on OZI-rule violation was observed. It should be emphasized that to find the OZI-rule violation in proton–proton interaction is crucially important for the very notion of the nucleon polarized hidden strangeness. This violation was found in the antiproton–proton interaction and it is important to see whether this effect also exists in the nucleon–nucleon system. The same investigations are in progress at ANKE setup [58, 59].

The search for exotic baryons with positive strangeness in pp scattering and investigation of their properties are also suggested. The proposal is motivated by the very recent claims about a possible discovery of an exotic narrow baryon resonance which cannot be formed by three constituent quarks. It is expected that at the Θ-production cross section of 0.07 μb it will be possible to get not less than 1000 Θ events at the same energy point in 40 days of the «live» beam time. As a by-product of the proposed Θ-baryon search, an additional data point on pp in $pp\phi$ reaction cross section can be measured at the energy excess $\varepsilon \sim 316$ MeV over the ϕ-production threshold. The search for other members of the Θ-baryon family, predicted in theoretical papers triggered by the experiments [60], is possible. Of a particular interest is a search for multiplet members with a multiple electric charge.

The experimental setup at Phase I will include a tracking system based on a large area of MWPCs from EXCHARM and newly produced MDC chambers inside the gap of the analyzing magnet. A particle identification system based on time-of-flight measurements in combination with measured momenta, will be used. At present, the NIS setup is under construction. A part of the main detectors (MWPC, TOF detectors based on RPC) has been mounted. Methodical studies are in progress on the Nuclotron beam and on the test-benches. The liquid hydrogen target is produced. Manufacturing of the first MDC is almost completed; the work on preparation of the start-detector made of scintillation fibres is close to completion. The first beam profile-meter was manufactured, tested and is ready for operation; elements of the other 2 profile-meters are being produced. R&D and tests of multichannel TDC and QDC modules in VME standard have been finished; their mass production has started. R&D on high voltage cells for RPC and MDC has been completed; mass production of the cells and control modules has started. Front-end pre-amplifiers for MDC and SciFi detectors are being prototyped. Modules of trigger logics are in R&D and prototyping stages. Necessary software tools have been developed: software for on-line data taking at test-benches and at the beam; Monte-Carlo tools; tools for the event reconstruction. The main components of the NIS setup were successfully tested at the extracted Nuclotron beam. The future plans are: commission of the setup; calibration measurements at the Nuclotron beam with a subsequent data taking according to the physical programme of the project.

The setup necessary for the NIS project can be also used as itself for a number of other experiments. Some of them, related with strangeness production, have been outlined above. Note, that in most cases these experiments can be done at the polarized proton and deuteron beams from the Nuclotron as well, thus adding to the world data basic unique information on spin-dependent observables in these reactions. The physical programme of the above-mentioned studies is described in [61–64].

ACCELERATION TECHNIQUES

The LPP specialists participate in construction of the **Transverse Damping System at LHC**. The creation of deflectors and powerful broadband amplifiers for the transverse feedback system (TFBS) for the LHC beam was the main direction of the activity in 2005. The main task for that year was a batch production of 20 deflectors and 4 powerful broadband amplifiers. Designing of these devices has been carried out at LPP (JINR). The Ural factories have made 19 (out of 20) vacuum chambers. For maintenance of high vacuum, the unique technology of welding with thickness of a seam not less than 1.5 mm, has been applied. The technology of processing has been developed and successfully used for maintenance of the required accuracy of cylindricity of the internal surface of chambers by cutting with a specially made diamond tool. Accuracy of processing at which the deviation (rejection) of the chamber axis does not surpass ± 0.25 mm at length of 3.2 m (internal diameter of the chamber is 100 mm) has been achieved in correspondence with LHC specifications. The manufactured vacuum chambers have been successfully tested at the vacuum stand of LPP. Vacuum chamber No. 1 is certificated by CERN. Now work on certification of other chambers is in progress. Twenty electrode units for deflectors, system for their assembly and installation in the vacuum chamber deflector, and also 10 supports for deflectors have been made. Preliminary metrological measurements at CERN have shown that the accuracy of manufacturing of these units corresponds to the LHC specifications. No. 1 and No. 2 powerful broadband amplifiers have been made and successfully tested for a full voltage ± 7.5 kV on the specialized stand at LPP (JINR) and at a half of the voltage on a new stand of CERN (employees of LPP (JINR) took part in construction of this stand in 2005). Installation of amplifiers No. 3 and No. 4 is carried out. The 4 manufactured amplifiers are at CERN where their acceptance after necessary testing is carried out, 16 vacuum chambers and 20 electrode units have been transported to CERN. Three vacuum chambers and 10 supports have been prepared for transportation to CERN. Now physicists from LPP (JINR) together with experts of CERN are working to complete vacuum clearing of deflectors at CERN, to perform their final assembly and preparation for installation in LHC tunnel.

The microwave test facility constructed at LPP (JINR) has been designed for experimental definition of lifetime of accelerating structure of an electron–positron collider with respect to pulsed cyclic heating at the frequency of 30 GHz — the operating frequency of the CLIC collider. At high operating frequency of the collider accelerating structure, the induced thermal stresses can exceed the elastic limit of the material and microscopic alterations in its structure can induce damage. This type of the damage known as cyclic fatigue occurs generally on the surface because of irregularity in the crystal lattice. Strains or stresses needed for the occurrence of the damage due to cyclic fatigue are much less than the ones required for the similar damage of the metal undergoing static warping.

The most significant scientific and methodical results obtained during 2005 are [65–69]:

• Elimination of RF breakdown in the test cavity and the output window of the free electron maser (FEM) when reaching the designed parameters, has been elaborated. To eliminate RF breakdown in the test cavity module, a new test cavity has been manufactured at LPP. Its working surfaces were machined with a higher purity degree while several technological imperfections in the previous design were removed. To eliminate the breakdown at the FEM output window, the integrated optimization of the length of the FEM output waveguide and of the position of the FEM vacuum window, has been performed. The optimization included simulation, cold measurements and experiments with the beam.

• After removing the breakdown at the FEM output window, the breakdown of the air channel afterwards the wavebeam extraction from the FEM was detected. Choice of the optimal way to suppress the mentioned breakdown is coordinated now with the IAP RAS collaborators (Nizhny Novgorod, Russia). Overcoming of this breakdown is scheduled between the 2nd and 3rd stages of the Agreement.

• The intense parasitic oscillation of FEM at the frequency of 34.35 GHz, has been eliminated.

• The data acquisition system, collecting microwave radiation parameters in several places of the facility as well as the electron beam parameters in every pulse of the facility operation, has been prepared for operation. The adjustment of the system of the diagnostics and processing of the microwave signals for power, spectrum, etc., has been completed.

• A precise calorimeter has been manufactured and calibrated. It allows one to measure the microwave radiation energy in each pulse at different space points with a high accuracy.

• Systems of stabilization of the high-voltage modules of the linac (electron gun and modulators) have been manufactured. The accuracy of the stabilization is about 0.2%. The adjustment of these modules in the operating regime has been completed.

The following works are scheduled in 2006:

• The facility operation during the run acquiring 10^5 pulses, will be analyzed. Corrections in the test cavity design for the third stage (10^6 pulses), will be made.

• Investigations to reduce the offset of the linac electron beam from the axis, will be carried out.

• The work on introducing the stabilized power supplies of linac magnetic systems, will be continued.

• The system of on-line control of the linac and FEM output parameters, will be put into operation.

After completion of these works, the run acquiring 10^6 pulses is to be started according to the CERN–JINR Agreement No. K723/PS.

In the framework of the innovation activity on **Development of Accelerator for Radiation Technologies** the following works have been done. A series of very simple, compact and cheap accelerators for the radiation technologies based on cold cathodes with threshold emission characteristics, the low-frequency (100 kHz) coaxial resonator and the transistor converter of electrical power from 50 Hz to 100 kHz, has been developed. Experimental investigations of scale models and of the prototype of the accelerator, tentative operation of accelerators in Japan and China have confirmed high efficiency of power transformation of an electric network in the electron beam power.

The basic directions of works in the future are: adaptation of accelerators for concrete technological processes; modernization of accelerator systems to reduce the operation costs and simplify running; increase of the power and energy of electron beams up to 100 kW and 500–700 MeV, respectively.

COMPUTING

The goal of the project is to construct a modern computing infrastructure at LPP (JINR) for ongoing experiments on particle and nuclear physics.

Main results obtained in 2005:

• The power of the LPP–LHE PC-farm has been increased by more than 2 times in comparison with 2004 and by 4 times in comparison with those at the beginning of the project. The total number of CPUs is 66 (34 computers); including CPUs for batch processing — 36 (18 computers).

• A disc space for users has increased by 2.5 times in comparison with 2004 and is 14.3 TB at the moment.

• The ATLAS experiment has started to use actively the LPP–LHE PC-farm.

• A number of new working places, connected in different ways to the local subnets of the Laboratory, has increased

• An area of the confident work of wireless equipment has been extended.

• Work on effective connection of LPP employees to the JINR computer network from home computers, is in progress.

• As a result of the development of the computer infrastructure, LPP became for the first time the largest user of the external network channel at JINR.

• The conference-hall and the videoconference-hall have been fully equipped with the advanced technique.

• Work on centralized IP-telephone usage at LPP has started.

The main results have been published in [68, 69].

Expected results in 2006:

1. The power of LPP–LHE PC-farm will be increased at least by 20% with purchasing and installation of modern computers and communication equipments.

2. A new version of LINUX will be installed in PC-farm computers.

3. Possibilities of wireless usage to connect the LPP local subnets will be enlarged.

4. New GRID technologies for the running experiments in particle physics will be tested.

5. The study of centralized usage of IP-telephony will be continued.

REFERENCES

1. *Ageev E. S. et al. (COMPASS Collab.)* // Phys. Lett. B. 2005. V. 612. P. 154.
2. *Alexakhin V. Yu. et al. (COMPASS Collab.)* // Phys. Rev. Lett. 2005. V. 94. P. 202002.
3. *Ageev E. S. et al. (COMPASS Collab.)* // Eur. Phys. J. C. 2005. V. 41. P. 469.
4. *Ageev E. S. et al. (COMPASS Collab.).* CERN-PH-EP/2005-049; Phys. Lett. B (submitted).
5. *Sapozhnikov M. G. (on behalf of the COMPASS Collab.).* Talk at the SPIN05 Intern. Symp., Dubna, Sept. 2005.
6. *Lai A. et al.* Measurement of the Radiative $K(e3)$ Branching Ratio // Phys. Lett. B. 2005. V. 605. P. 247–255.
7. *Lai A. et al.* Search for CP Violation in $K^0 \to 3\pi^0$ Decays // Phys. Lett. B. 2005. V. 610. P. 165–176.
8. *Batley J. R. et al.* A Measurement of the CP-Conservation Component of the Decay $K_S^0 \to \pi^+\pi^+\pi^0$ // Ibid. V. 630. P. 31–39.
9. *H1 Collab.* Measurement of the Polarization Dependence of the Total $e+p$ Charged Current Cross Section. Paper presented at the Intern. Europhys. Conf. on High-Energy Physics (HEP-2005), Lisbon, Aug. 21–27, 2005.
10. *H1 Collab.* Measurement of the Polarization Dependence of the Total $e-p$ Charged Current Cross Section. Ibid.
11. *Sissakian A. N., Shevchenko O. Yu., Ivanov O. N.* hep-ph/0312084.
12. *Sissakian A. N., Shevchenko O. Yu., Ivanov O. N.* // Phys. Rev. D. 2003. V. 68. P. 031502; hep-ph/0307189.
13. *Shevchenko O. Yu.* NLO QCD Procedure of SIDIS Data Analysis. Talk presented at HERMES Workshop, Dec. 2004.
14. *Ivanov O. N.* Numerical Tests of the Proposed NLO QCD Procedure. Ibid.
15. *Nagaytsev A. P.* Remarks on the NLO QCD Procedure of SIDIS Data Analysis. Ibid.
16. *Shevchenko O. Yu.* Extraction of Helicity Distributions in NLO QCD with Modified Jacobi Polynomial Extention Method. Talk presented at HERMES Collab. Meeting, April 2005.
17. *Nagaytsev A. P.* The First Moments Δu_V and Δd_V from Difference Asymmetries. Ibid.
18. *Sissakian A. N., Shevchenko O. Yu., Ivanov O. N.* // Pis'ma v ZhETF. 2005. V. 82. P. 57;
    Airapetian A. et al. // Phys. Rev. Lett. 2005. V. 94. P. 01200231.
19. *Airapetian A. et al.* // Phys. Rev. Lett. (in press); hep-ex/0506018; DESY-05-077.
20. *Albrecht H. et al.* Aging Studies for the Large Honeycomb Drift Tube System of the Outer Tracker of HERA-B // Nucl. Instr. Meth. A. 2003. V. 515. P. 155–165.
21. *Albrecht H. et al. (HERA-B Outer Tracker Collab.).* The Outer Tracker Detector of the HERA-B Experiment. Part I: Detector. Preprint DESY 05-99. Hamburg, 2005; physics/0507048; Nucl. Instr. Meth. (submitted).
22. *Albrecht H. et al.* The Outer Tracker Detector of the HERA-B Experiment. Part II: Front-End Electronics // Nucl. Instr. Meth. A. 2005. V. 541. P. 610–629.
23. *Abt I. et al.* Limits for the Central Production of Pentaquarks in 920 GeV pA Collisions // Phys. Rev. Lett. 2004. V. 93. P. 212003.
24. *Aleev A. N. et al.* JINR Preprint P1-2005-62. Dubna, 2005; Yad. Fiz. (submitted).
25. *Avdeichikov V. V. et al.* JINR Preprint P1-2004-190. Dubna, 2005.
26. *Ermolov P. F. et al.* Talk given at the 17th Intern. Baldin Seminar on High-Energy Physics Problems: Relativistic Nuclear Physics and Quantum Chromodynamics (ISHEPP 2004), Dubna, Sept. 27 – Oct. 1, 2004.
27. *Kokoulina E. S. et al.* Presented at the 8th Intern. Workshop on Relativistic Nuclear Physics: From Hundreds MeV to TeV, Dubna, May 23–28, 2005.
28. *Kokoulina E. S. et al.* // Proc. of the 35th Intern. Symp. on Multiparticle Dynamics (ISMD 05), Kromeriz, Czech Republic, Aug. 9–15, 2005.
29. *Aleev A. N. et al.* PREPRINT-NPI-MSU-2005-22-788. 2005. 7 p.
30. *Ghetti R. et al.* Light Cluster Production in $E/A = 61$-MeV Ar-36 + Sn-112, Sn-124 Reactions // Phys. Rev. C (submitted); nucl-ex/0507029.
31. *Adams J. et al. (STAR Collab.).* nucl-ex/0511003.
32. *Lednicky R.* Correlation Femtoscopy. nucl-th/0510020; Proc. of the 18th Intern. Conf. on Ultra-Relativistic Nucleus–Nucleus Collisions «Quark Matter 2005», Budapest, Aug. 4–9, 2005 (submitted).
33. *Lednicky R.* Femtoscopy in Heavy Ion Collisions: Theory // Proc. of the Workshop on Particle Correlations and Femtoscopy, Kromeriz, Czech Republic, Aug. 15–17, 2005 (submitted).
34. *Brigatti A. et al.* The Photomultiplier Testing Facility for the Borexino Experiment at Gran Sasso // Nucl. Instr. Meth. A. 2005. V. 537. P. 521–536.
35. *Ianni A. et al.* // Ibid. P. 683–697.
36. *Derbin A. V., Smirnov O. Yu., Zaimidoroga O. A.* // Part. Nucl. 2005. V. 36, No. 3. P. 314–319; Fiz. Elem. Chast. At. Yadra. 2005. V. 36, No. 3. P. 604–649.
37. *Derbin A. V., Ianni A., Smirnov O.* Physics Outside the Standard Model with the Prototype of Borexino Detector // Nucl. Phys. B (Proc. Suppl.). 2005. V. 143. P. 568.
38. *Derbin A. V., Ianni A., Smirnov O.* Ibid. P. 547.
39. *Zaimidoroga O. A.* Detection of Events in Borexino Using Laser Effects // Nucl. Phys. (submitted).

40. *Protsenko I., Uskov A., Zaimidoroga O.* Dipole Nanolaser // Phys. Rev. A. 2005. V. 71. P. 063812.
41. *Golutvin I., Savina M., Shmatov S.* Extra Dimensions and $\mu^+\mu^-$ Production at the LHC // J. Phys. G (submitted).
42. *Golutvin I. et al.* Search for New Neutral Gauge Bosons at LHC. JINR Preprint P2-2005-78. Dubna, 2005; Yad. Fiz. (submitted).
43. *Golutvin I. et al.* LHC ADD Extra Dimensional Gravity and Dimuon Production at LHC // Proc. of the XVIII Intern. Workshop «High Energy Physics and Quantum Field Theory», St. Petersburg, June 17–23, 2004; hep-ph/0502126.
44. *Golutvin I. et al.* Search for New Heavy Resonances at the LHC // Ibid; hep-ph/0502009.
45. *Shulga S.* BTOVVANA: The Package for Analysis of $B^{**}0(S) \to J/\Psi/\Phi$ and $B^{**}0(S) \to J/\Psi K^*$ Decays // Comp. Phys. Commun. (submitted); hep-ph/0501207.
46. CMS Computing TDR. CERN-LHCC-2005-023. 2005.
47. *Golutvin I. et al.* Study of the CSC Anode Self-Trigger Ability with P3 ME1/1 Prototype // EPAN, 2005 (submitted).
48. *Erchov Yu. V. et al.* Cathode Strip Chamber for CMS ME1/1 Endcap Muon Station // Ibid.
49. *Savin I. A., Sissakian A. N., Zaroubin A. V.* Development of Electronic Experimental Methods in Particle Physics. Ibid. P. 55–130.
50. *Zamyatin N. I., Kozlov Yu. F.* Silicon Planar Detectors in Russia. Ibid. P. 141–156.
51. *Shumeyko N. M.* Years of Collaboration and Communication. Ibid. P. 157–174.
52. *Zaroubin A. V.* Collaboration CMS, Russia and JINR Member-States (RDMS). Ibid. P. 217–252.
53. *Savina M. V., Shmatov S. V.* Physics of Additional Measurements at LHC. Ibid. P. 269–314.
54. *Balestra F. et al.* // Phys. Rev. Lett. 1998. V. 81. P. 4572;
Balestra F. et al. // Nucl. Instr. Meth. 1999. V. 426. P. 385.
55. *Hibou F. et al.* // Phys. Rev. Lett. 1999. V. 83. P. 492.
56. *Abd El-Samad S. et al.* // Phys. Lett. B. 2001. V. 522. P. 16;
Boehm A. et al. // Nucl. Instr. Meth. A. 2000. V. 443. P. 238.
57. ANKE COSY proposal No. 104. 2001.
58. *Hartmann M.* // Proc. of «Baryons 2004» Conf., Paleseau, 2004; IKP/COSY Annual report 2004. P. 12.
59. *Barmin V. V. et al. (The DIANA Collab.).* hep-ex/0304040; reported as a talk at the Session of Nucl. Division of the Russian Acad. of Sci., Dec. 3, 2002; Phys. At. Nucl. 2003;
Nakano T. et al. // Phys. Rev. Lett. 2003. V. 91 (in press);
Stepanyan S. et al. (The CLAS Collab.). hep-ex/0307018.
60. *Avramenko S. A. et al.* // Nucl. Phys. A. 1995. V. 585. P. 91c.
61. *Lukstins J.* // Proc. of the 7th Conf. «Mesons and Light Nuclei'98», Prague–Pruhonice, Czech Republic, 1998. Singapore, 1999. P. 198.
62. *Lukstins J.* // Proc. of the III Workshop «Physics and Detectors for DAFNE», Frascati, 1999. Frascati, 1999. P. 719.
63. *Afanasiev S. V. et al.* // JINR Rapid Commun. 1995. No. 1[69]. P. 47.
64. *Elzhov A. V. et al.* Test Facility for Study of Lifetime of Accelerating Structure Imitator for CLIC Collider under Action of Powerful 30 GHz Pulsed Radiation // Part. Nucl., Lett. 2005. V. 2, No. 3. P. 190.
65. *Kaminsky A. K. (on behalf of the JINR–IAP–CLIC Collab.).* Status report of CLIC–JINR–IAP Experiment on Copper Cavity Heating // Proc. of the 6th Intern. Workshop «Strong Microwaves in Plasmas», Nizhny Novgorod, Russia, July 25 – Aug. 1, 2005.
66. *Elzhov A. V. (on behalf of the JINR FEL team).* Status report of CLIC JINR–IAP Experiment on Copper Cavity Heating // Proc. of the XIX Intern. Workshop on Charged Particle Accelerators, Alushta, Ukraine, Sept. 12–17, 2005.
67. *Kaminsky A. K. (on behalf of the JINR–IAP–CLIC Collab.)* // Proc. of the 6th Intern. Seminar on the Problems of Accelerating Techniques Dedicated to the Memory of Prof. V. P. Sarantsev, Dubna, Sept. 30, 2005.
68. *Belosludtsev D. A. et al.* Computing for Ongoing Experiments on High Energy Physics // Part. Nucl., Lett. 2006. V. 3, No. 4(133).
69. *Potrebenikov Yu., Shchinov B.* New Opportunities of the LPP Computer Infrastructure // JINR News. 2005. No. 2. P. 21–24.