JOINT INSTITUTE FOR NUCLEAR RESEARCH

2005-201

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THE RESULTS OF 2005 AND THE RESEARCH PROGRAMME OF THE VEKSLER AND BALDIN LABORATORY OF HIGH ENERGIES FOR 2006–2008

Report to the 99th Session
of the JINR Scientific Council
January 19–20, 2006

Dubna 2005

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I. Introduction

In 2005 the scientific programme of the Veksler and Baldin Laboratory of High Energies (VBLHE) of the Joint Institute for Nuclear Research (JINR), as in the previous years, was concentrated on Relativistic Nuclear Physics [1-4].

This report presents some new results obtained at VBLHE in 2005 and the research programme for the next three years.

The major part of the research at the VBLHE is carried out at the Laboratory accelerator complex on the basis of the superconducting accelerator Nuclotron.

The VBLHE co-operates with CERN, many physics center in Russia, JINR member states, physics centers in the US, Germany, France, Japan, and other countries.

II. Some new physics results obtained at the VBLHE accelerator complex in 2005.

Delta-Sigma Collaboration.

Energy dependence of the ratio $R_{dp} = d\sigma/d\Omega(nd)/d\sigma/d\Omega(np)$ has been measured at 0 degrees in the laboratory frame. The experimental observable R_{dp} is the ratio of the quasi-elastic *nd* and free *np* elastic scattering differential cross sections.

For the case of registration under an angle of 0° in the laboratory frame the following equation

$$R_{dp} = \tfrac{2}{3} \cdot d\sigma/d\Omega_{SD}(np) / d\sigma/d\Omega(np),$$

where $d\sigma/d\Omega_{SD}(np)$, is the "spin-dependent" part of the $np \rightarrow pn$ differential cross section.

The neutron beam incident on the hydrogen target was used. The experimental results are shown in Fig.1. They were reported at an International Workshop [5].

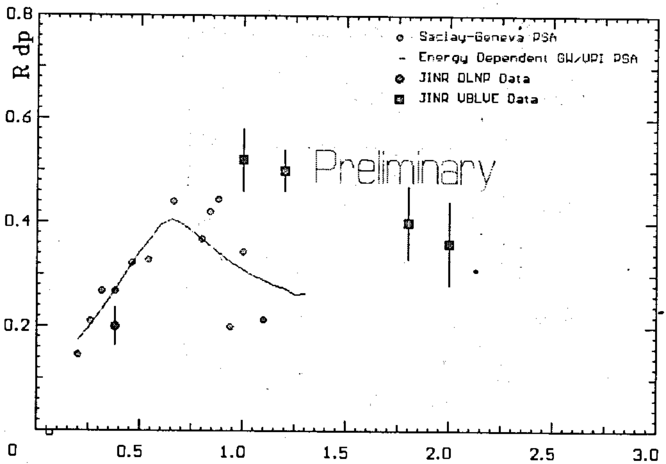


Fig. 1. Energy dependence of the R_{dp} ratio for elastic charge exchange process $np \rightarrow pn$ at 0° in the lab. frame.

It is a very important result. These measurements have shown that no asymptotic behavior is observed at least up to 2 GeV, and the momentum approximation is not valid.

LNS – pHe3 Collaboration.

This Collaboration includes the following participating organizations:

- Joint Institute for Nuclear Research (LHE & LNP & LNR)
- Center for Nuclear Study of the University of Tokyo, Tokyo, Japan
- RIKEN, Wako-shi, Japan
- Institute for Nuclear Research, RAS, Troitsk, Russia.
- University of Chemical Technology and Metallurgy, Sofia, Bulgaria
- Institute of Physics, Slovac Academy of Sciences, Bratislava, Slovakia
- P.J.Safarik University, Kosice, Slovakia
- Advanced Research Institute for Electrical Engineering, Bucharest, Romania
- Institute of Physics and Technology, Ulaanbaatar, Mongolia

The LNS-pHe3 Collaboration includes young scientists. The average age of young employees is 28 years. Dr. V. P.Ladygin (leader of Collaboration) is 39.

The first phase of the experiment for an energy up to 270 MeV was carried out in Japan at RIKEN under the leadership of Dr. V. P. Ladygin. The results of this experiment on polarization characteristics of the $d + d \rightarrow {}^3He + n$ reaction were published in 2005 [6, 7].

These measurements were carried out with high accuracy and are very important for construction of the theory of three nucleon forces (Fig.2).

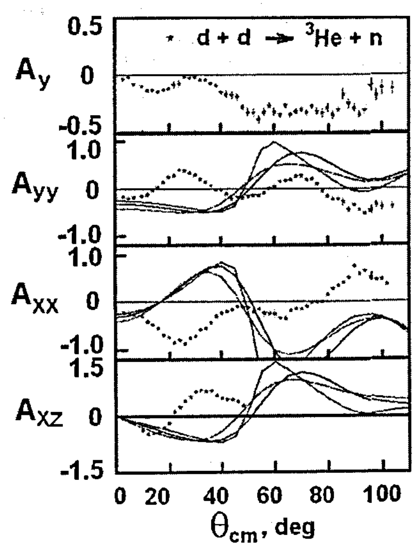


Fig. 2. Angular dependences of the analyzing powers of the deuteron beam in the $d(d,{}^3He)n$ reaction at 270 MeV.

The run with polarized deuterons took place at the Nuclotron this summer. During this run the upgraded LNS set-up operated at the internal beam (Fig.3).

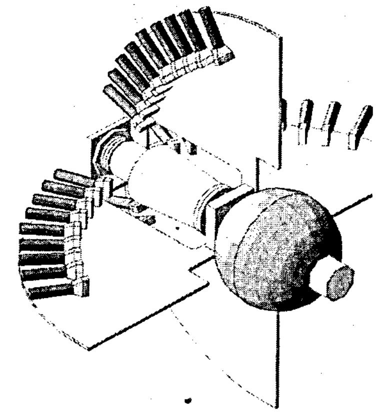


Fig. 3. The upgraded LNS set-up at the internal beam of the Nuclotron. 36 scintillator detectors mounted in four planes are directed towards the internal target area (spherical area).

The experimental data on the angular dependence of *dp* elastic scattering were obtained for deuteron energies of 270, 880 and 2000 MeV. The data at 270 MeV were collected for comparison with the data obtained in RIKEN at the same energy. This comparison is shown in Fig.4. A good agreement is seen of the results obtained at RIKEN and JINR.

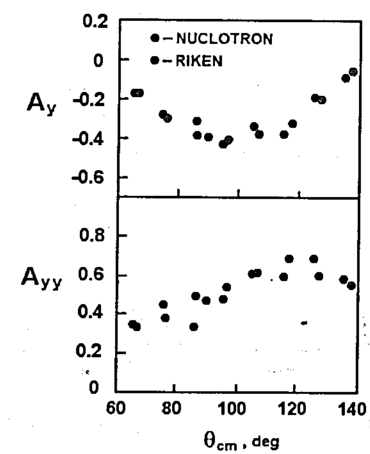


Fig. 4. *dp* elastic scattering in the region of the Sagara discrepancy effect at a deuteron energy of 270 MeV (preliminary).

The preliminary results of data processing were obtained for 880 MeV and those for 2 GeV are being processed. The results for 880 MeV are shown in Fig.5.

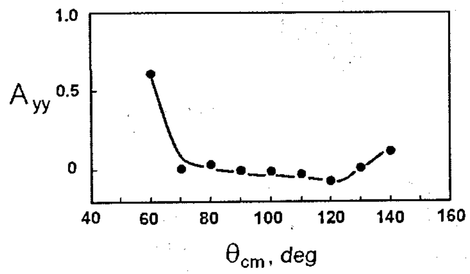


Fig. 5. *dp* elastic scattering in the region of the Sagara discrepancy effect at a deuteron energy of 880 MeV (preliminary).

The polarization of the internal and extracted beams was measured (Fig.6). A good agreement of the results from both measurements is observed.

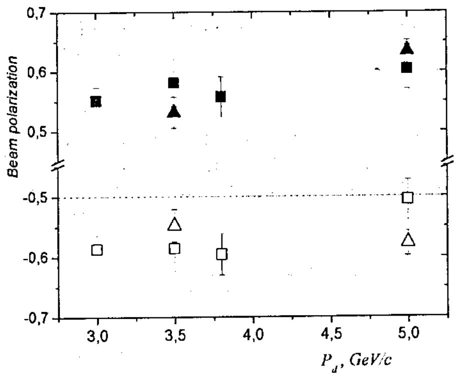


Fig. 6. Deuteron beam polarization measured with the internal (■) and external (ALPOM) (▲) polarimeters.

Some other results on polarization experiments are given in [8-12].

BECQUEREL Collaboration.
The study of alpha-clustering of nuclei continued [13]. The new data for ^{14}N and ^{9}Be were obtained. It was shown that at an energy of the nitrogen nucleus of 2 GeV in 33 % of cases the nucleus decays emitting three alpha particles and in 31 % of cases decays emitting a carbon nucleus.

For various decay channels with emission of alpha particles the following ratios were obtained:

^{6}Li	(He + p)/(He + d) ≈ 1
^{10}B	(2*He + p)/(2*He + d) ≈ 1
^{14}N	(3*He + p)/(3*He + d) ≈ 2:1

The Becquerel Collaboration Meeting dedicated to the 90th Anniversary of Prof. K.D. Tolstov who was the founder of the emulsion group at the Laboratory took place in Dubna

on October 4-5, 2005. At this meeting an extensive programme of Collaboration research was presented.

First Observation of the Parametric X-Ray Radiation from Moderately Relativistic Nuclei in Crystals.
The following organizations participated in this research:

- Joint Institute for Nuclear Research
- Nuclear Physics Institute at TPU, Tomsk
- Institute in Physical-Technical Problems, Moscow
- Moscow State Institute of Electronic Technology, Zelenograd

The experiment was carried out at the Laboratory of High Energies at the Nuclotron with 5 GeV protons and 2.2 A·GeV carbon nuclei [15]. The layout of the experiment on Parametric X-Ray Radiation is shown in Fig.7; the results are shown in Fig.8.

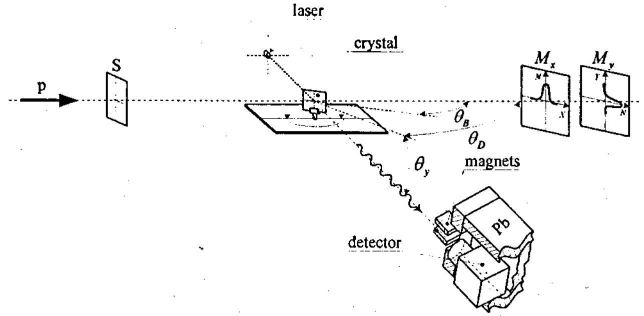


Fig. 7. Layout of experiment on Parametric X-Ray Radiation from nuclei at the Nuclotron.

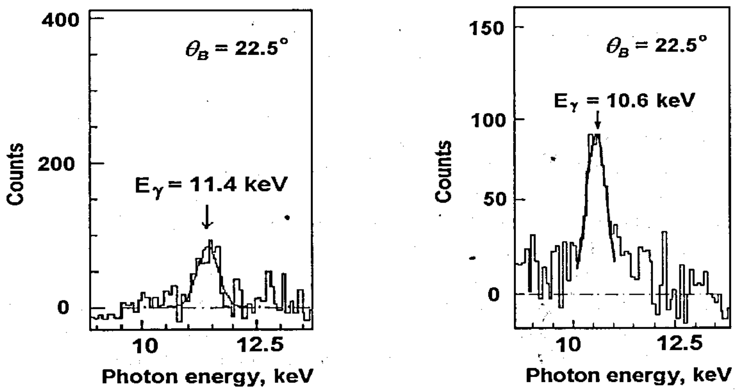


Fig. 8. Experimental X-Ray spectra registered for 5-GeV protons (left) and 2.2 A·GeV ^{12}C nuclei (right).

The Parametric X-Ray Radiation yield observed from carbon nuclei is tens times higher than that from protons. Observation of the Parametric X-Ray Radiation from nuclei opens possibilities for Parametric X-Ray Radiation applications in nuclear beam diagnostic.

DELTA-2 collaboration.

In 2005 a series of measurements at the internal target were carried out at the DELTA-2 setup.

The purpose of measurements was to check the results obtained in 2004 on resonant structure in the reaction of π meson production at beam energies between 340 and 350 MeV/nucleon. In March, 2005 the π meson production in interaction of the internal deuteron beam with the silver target was measured at 73 degrees. The preliminary data of these measurements confirm the results obtained in 2004. These results testify the existence of a resonant structure of the reaction excitation function (Fig.9).

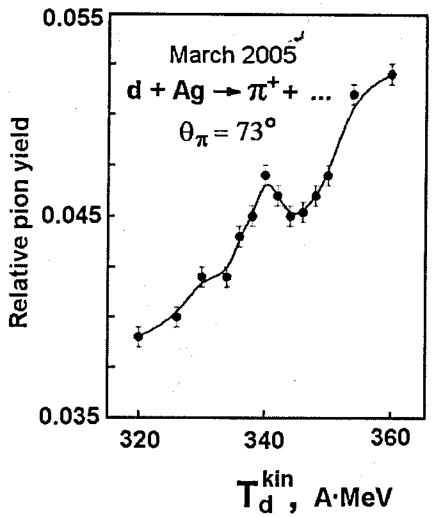


Fig. 9. Relative pion production in $d + Ag$ reaction as a function of the beam kinetic energy.

Brightness Award.

This year the prestigious international premium "Brightness Award" has been awarded to the group under the leadership of Prof. E. D. Donets (LHE) for a series of works "The Source of Highly Charged Ions on the basis of the Electron String". This award was founded by the international community of researchers engaged in physics and technology of ions and ion sources and is awarded once in two years.

The achievements of the group under the leadership of Prof. E. D. Donets were characterized as a breach in physics of ions; and it was emphasized that the authors had not only discovered the phenomenon of electron strings, but had also developed theory in agreement with experiment and implemented it into practice at the Nuclotron.

Mixed Phase.

The Round table discussion on the search for the mixed phase of strongly interacting matter at the Nuclotron was held on July 7-9, 2005.

The idea of the search for the mixed phase of nuclear matter at the Nuclotron was put forward by Prof. A. N. Sissakian. Figure 10 shows the title of the report made by Prof. A. N. Sissakian and Prof. A. S. Sorin.

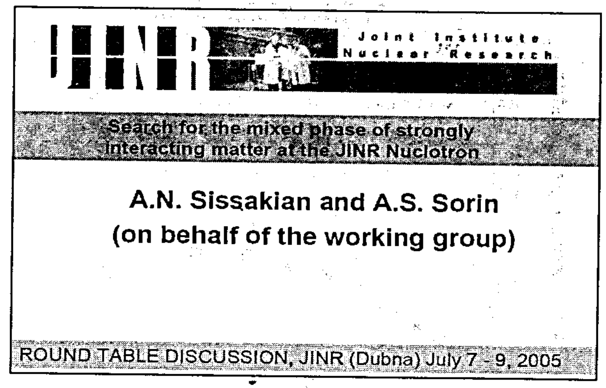


Fig. 10. Title slide of the talk delivered by Prof. Sissakian and Prof. A.S.Sorin at the Round Table Meeting on observation of the Mixed Phase at the Nuclotron.

Calculations at energy of 5 A·GeV carried out by Prof. V. D. Toneev et al. showed a feasibility of observation of the mixed phase at the Nuclotron (Fig.11).

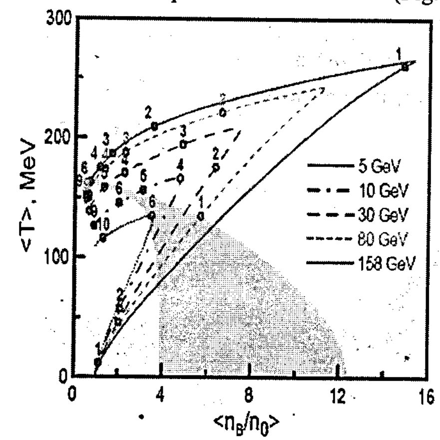


Fig. 11. Numerical results (Prof.Toneev V.D. et al.).

Now in Bogoliubov Laboratory of Theoretical Physics and Veksler and Baldin Laboratory of High Energies is in processes of preparation new project for observation of the mixed phase at the Nuclotron.

PHENIX Collaboration.

The group of Dr. A. G. Litvinenko actively participated in the physical runs at RHIC at the PHENIX installation. The system of aerogel Cherenkov counters produced together with the colleagues from Japan was used to obtain experimental data. Very interesting data on the anisotropy parameter v_2 (Fig.12), Jet Quenching (Fig.13), J/Ψ suppression (Fig.14) and direct photons (Fig.15) were obtained [16-25].

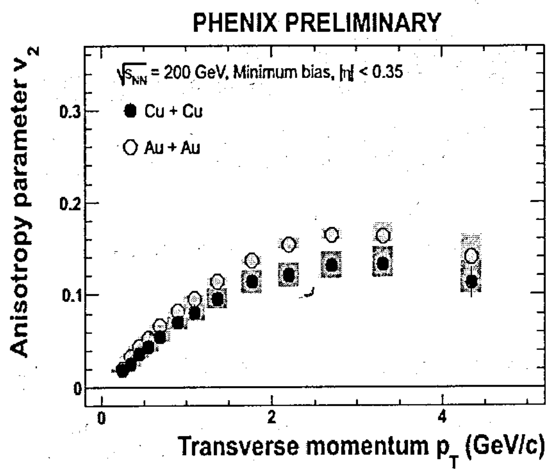


Fig. 12. Elliptic flow v_2 as a function of transverse momentum p_T. The termalization parameter $\tau_{therm} \sim 0.6$ -1.0 fm at the density $\varepsilon \sim 15\text{-}25$ GeV/fm^3 ($\varepsilon_{norm} \sim 0.16$ GeV/fm^3) was evaluated using the above data.

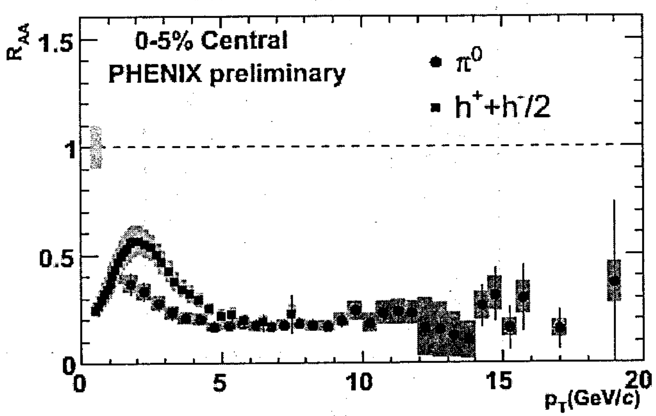


Fig. 13. Jet Quenching. Suppression of high p_T neutral pions' and charged hadrons' yield in central Au+Au collisions persists all the way till 20 GeV/c. R_{AA} – nuclear modification factor (the ratio of the measured AA invariant yields to the NN collision invariant yields).

Figure13 implies the following:

- The suppression is strong (R_{AA} =0.2!) and flat up to 20 GeV/c
- The matter is extremely opaque
- The data should provide a *lower bound* on the initial gluon density.

J/Ψ suppression in collisions of various nuclei at 62 and 200A·GeV in central nucleus-nucleus collisions was observed (Fig.14). For these collisions the suppression factor is about 3.

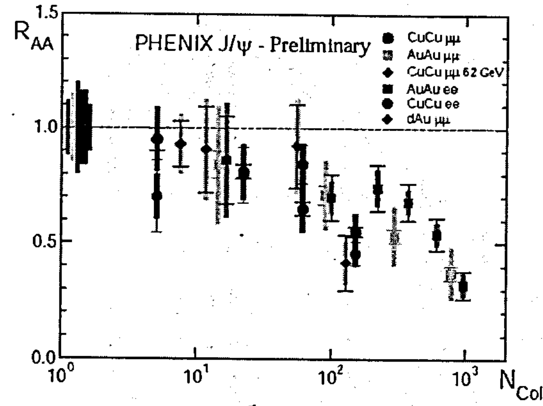


Fig. 14. J/Ψ suppression in collisions of various nuclei. The suppression factor is about 3 in the central region.

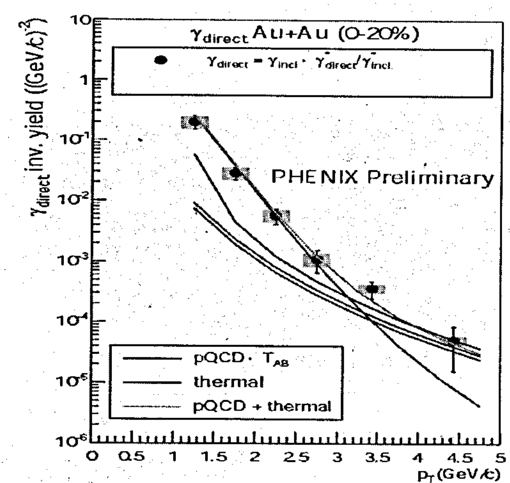


Fig. 15. P_T dependence of direct photon invariant-yield. The best fit is given by the perturbative QCD taking thermalization into account.

The next step of the VBLHE participation in PHENIX is related to the construction of the Nose Cone Calorimeter (NCC) (Fig.16). This calorimeter is necessary to study the proton spin structure and the Color Glass Condensate.

The prototype of NCC is ready for test runs with the beam. This prototype was produced by the group of the Moscow State University and the PHENIX group at Dubna (Fig.17).

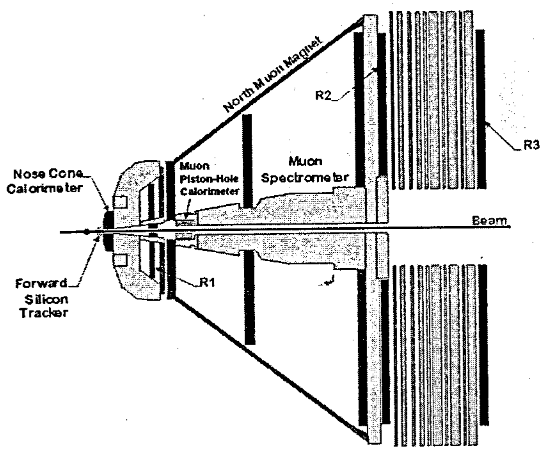


Fig. 16. Layout of the Nose Cone Calorimeter (NCC) for PHENIX. The calorimeter will consist of tungsten plates and semiconductor detectors.

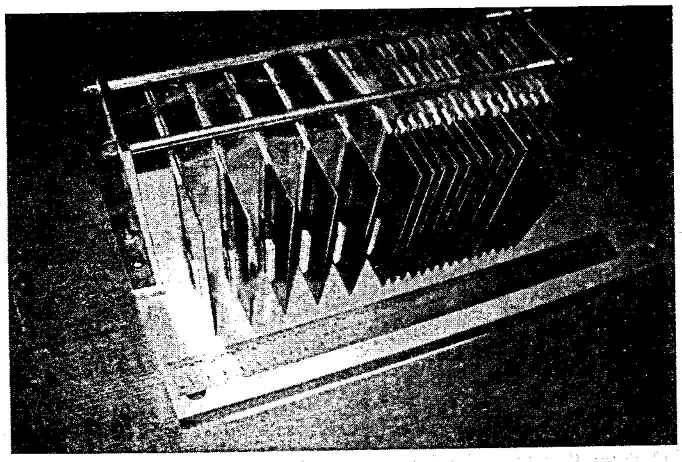


Fig. 17. Prototype the Nose Cone Calorimeter (NCC) for PHENIX. The calorimeter consists of tungsten plates and semiconductor detectors.

STAR Collaboration.

The group of Prof. Yu. A. Panebratsev actively participate in the STAR collaboration.

The following results of the STAR Collaboration are of the greatest interest: the evidence for early thermalization, th ethermodynamic and chemical equilibration, the parton energy loss, the evidence of degrees of freedom relevant to hadronization, the saturation at high gluon density [26-29].

ALICE Collaboration.

The Dipole Magnet was disassembled and then successfully assembled in the operational position (Fig.18). It was tested and mapped at full current [30, 31].

- About 700 crystals for the Photon Spectrometer out of 1000 will be available by the end of 2005
- The spectrophotometer to test the crystals was delivered to JINR
- 60 drift chambers will be constructed by the end of 2005
- Extensive physics simulations were performed for the Physics Performance Report
- GRID computing for the Russia-ALICE team was developed.

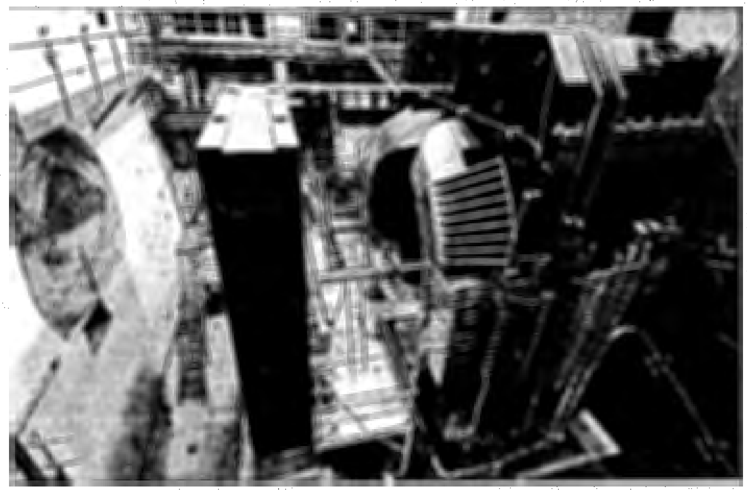


Fig. 18. View of the ALICE Dipole Magnet.

CMS Collaboration.

The group of Prof. V. A. Smirnov carried out a large series of studies:

1. Test of the readout system before the detector installation.

During 2005, each of the 36 readout boxes underwent several tests: a set of quality control tests, a set of burn-in tests, a set of tests before and after the modification of each readout module connected to some changing of Z-plate inside readout module for proper nitrogen purification.

2. Installation of the readout systems in the detector.

36 readout boxes were installed on both absorbers. All power suppliers and cables were assembled and labeled. All readout boxes were connected to the water-cooling system. Two laser distribution boxes were tested and installed on both absorbers. After completion of installation of the cables on both detectors, the modules were mounted inside the readout boxes and all connections between them were made (Fig.19).

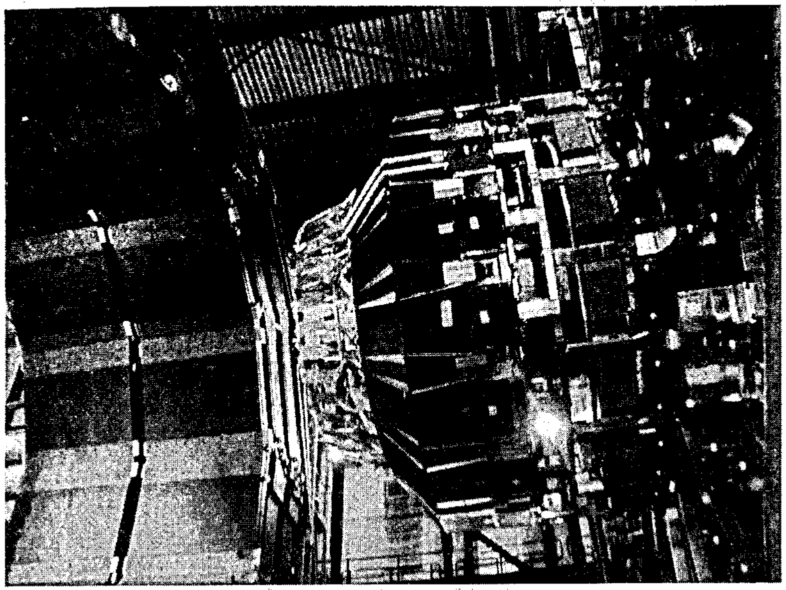


Fig. 19. View of the hadron endcup calorimeter with the installed readout system for CMS.

3. Test of installed read-out system.

A set of tests after installation of the readout boxes were performed. For these tests the power suppliers, optical signals, calibration cables between the optical patch panel and the place where the DAQ computer is located were installed. The laser set-up and the interface box were also made.

The read-out module pedestals, light diode signals for all readout boxes of the hadron endcup calorimeter were measured during testing.

4. Radioactive source calibration.

Radioactive source calibration of the hadron endcup calorimeter should be performed during the rest of this year. At present the source calibration of the hadron endcup calorimeter is in progress. A special device (radioactive source mover) moves the source (Co60, ~5 mCu) to each scintillator of the hadron endcup calorimeter. The source moves across a scintillator tray at 10 cm/s. As the source traverses a scintillator, there is a slight broadening and upward shift of the pedestal distribution. The calibration is insensitive to possible shifts in the pedestal over timescales which are larger than the ms data collection time. With the front-end electronics clocked at the LHC machine frequency of 40 MHz, 800k events can be collected every 2-mm. This is a sufficient number of events to meet the goal of a 2% measurement of the source response in the absence of systematic errors.

The source calibration provides two goals: obtaining the calibration constants for each tower or subtower and obtaining the evidence of connection of the megatile cables.

III. Development of the Nuclotron Accelerator Complex.

1. The first priority task each year is the Nuclotron operation. For 2005 this task was formulated in the Topical plan as follows:

"The Nuclotron annual running time of 2500 hours. Providing the works on the accelerator development program and physics experiments using internal targets and extracted beams. Improvement of the extracted beam parameters from the Nuclotron ring to hall No 205."

The scheduled running time for 2005 was 2500 hours divided into 4 runs. Two runs were performed by now: RUN 31 (17.02 – 18.03) and RUN 32 (06.06 – 02.07). The last one was interrupted on 26.06 due to the main Dubna electric power supply line damage by the storm. Thus the Nuclotron running time during the nine months was about 1144 hours. Protons, deuterons and carbon nuclei were accelerated in Run 31. Run 32 was devoted mainly to the experiments with polarized deuterons at internal target in accordance with the request of the LNS-PHe3 – collaboration. The third run is planned in the end of the year. Thus, the Nuclotron annual running time in 2005 of about 2300 hours is expected. Physics experiments use about 80% of the total beam time. The parameters of extracted beams were improved. In particular, intensities of the deuteron and carbon beams were increased up to $5 \cdot 10^{10}$ and $2 \cdot 10^{9}$ particle per cycle, respectively. The other activities aimed at further improvement of the Nuclotron operation efficiency were:

- the system for remote control of the beam slow extraction parameters from the main control room was designed, manufactured and put into operation
- in accordance with the user's requests, information about the current Nuclotron operating parameters and status of the main systems is available via the web
- the test fragment of the system for remote control of the magnetic elements of the beam extraction line between the Nuclotron output window and point F3 of the experimental area was designed, manufactured and put into operation
- additional beam position monitor was designed, fabricated and installed at a warm straight section of the Nuclotron ring. The new diagnostic device makes it possible to obtain turn-to-turn information about the number of particles, radial position and betatron frequency.

2. The special programme for reaching the peak beam energy at the Nuclotron was approved by the JINR director in 2004. The program was supported by the JINR directorate grant. The main goal is acceleration of the deuteron beam up to maximum energy of 6 A·GeV in the accelerator ring. The result obtained by now is illustrated in Fig.20. The deuteron beam accelerated to 4.32 A·GeV was obtained in accordance with a generated dipole field of 1.57 T during the Nuclotron run in December, 2004. The work is continued and the next test is expected in December, 2005.

This year the Nuclotron has passed a serious test for durability. During the summer run Dubna experienced a strong hurricane. For a long time electricity was switched off. All the systems of the Nuclotron ring worked correctly and the superconducting magnets were not damaged.

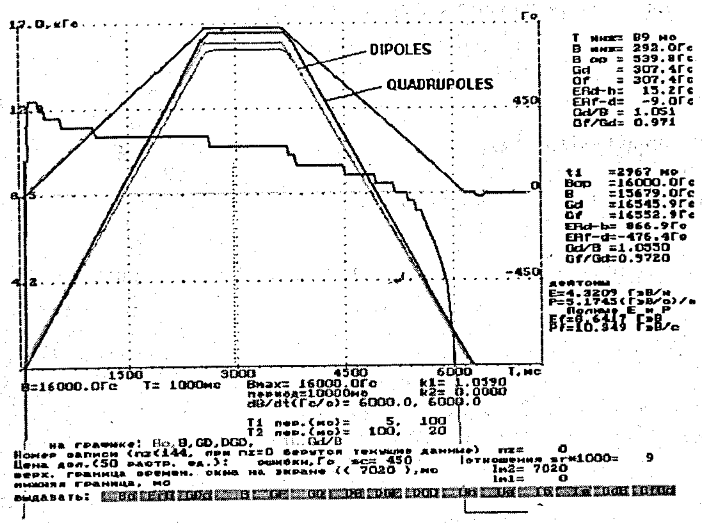


Fig. 20. The Nuclotron magnet cycle controls monitor data from the run in December 2004. The deuteron beam energy is 4.32 GeV/u.

3. *Providing the polarized deuteron beams with the intensities up to 10^9 pps.*

The main strategic line is oriented at the use of the CIPIOS polarized proton and deuteron ion source at the Nuclotron. Such decision, taken two year ago by the JINR directorate and supported by the agreements with INR (Troitsk) and IUCF (Indiana University, Bloomington), can provide the desired result at a lower price. The ion source equipment was disassembled and prepared for transportation from Bloomington to Dubna by October 2004. At present the preparation work for the future equipment assembling and tests at the LHE is carried out. A special test bench is under design. A part of equipment for the new polarized deuteron source was transported from DAPHNIA (Saclay) to Dubna.

4. *Extension of the heavy ion beams available for physics experiments up to Xe.*

The trend to heavier ion beams at the Nuclotron is related first of all with adequate development of the KRION ion source. The source was improved (electron string mode) and used at the Nuclotron for acceleration of N^{6+}, N^{7+}, Ar^{16+} and Fe^{24+} ions. The R&D on the KRION upgrade, scheduled for 2004-2005, was connected with investigation of the new possibility: the source with reflecting tubular electron beam. The main research goal is the increase in the ion intensity by an order of magnitude due to storing a much larger number of electrons in the source. The necessary design modification of the source was performed and the set of test runs was carried out at the test facility. At present the ion source is being rearranged back again to the electron string mode. The modification of the source systems aimed at producing Au^{52+} ions is in progress. The next application of the KRION at the Nuclotron is planned for February-March 2006. The ions of Xe^{44+} will be obtained as well.

5. *Increasing the efficiency and operating reliability of the Nuclotron cryogenic supply system.*

The liquid nitrogen cooling system is the most important part of the Nuclotron cryogenic system whose upgrade and partial modification are necessary. The new large liquid nitrogen storage vessel was bought, installed and put into operation. (Fig. 21).

Fig. 21. The new liquid nitrogen storage vessel integrated into the Nuclotron cryogenic system.

A substantial increase in the storage capacity made it possible to reduce technological breaks during the Nuclotron runs and added about 50 hours of beam time to the total running time. The other research goal is minimization of liquid nitrogen consumption. This problem can be solved with design and realization of the closed liquid nitrogen cooling circuit for the Nuclotron cryo-magnetic system. The conceptual design of the system was performed. The design of the technical project is planned for the next year.

6. *Development of the new superconducting magnets for rapid cycling heavy-ion synchrotrons and beam transport channels. Construction of the prototype magnets for the booster ring.*

New results were obtained in design an tests of the superconducting fast-cycling and fast ramped magnets and cables aimed for both SIS100 at GSI (this part is supported by the GSI funds) and Nuclotron booster. The obtained data can also be useful for the future LHC booster upgrade.

6.1 New results of the investigation of the 2T superferric model dipoles operating at 4 T/s, 1 Hz. The study was performed within the R&D program on the design the SIS100 synchrotron at GSI in Darmstadt. One of the main research goals is minimization of the overall AC power losses in the magnet at a 4 K level. Different modifications of the dipole were proposed and tested. At present the losses are reduced to about 17 W/m of the magnet length, while the reference Nuclotron dipole loses about 38 W/m in the same operating mode. (Fig. 22)

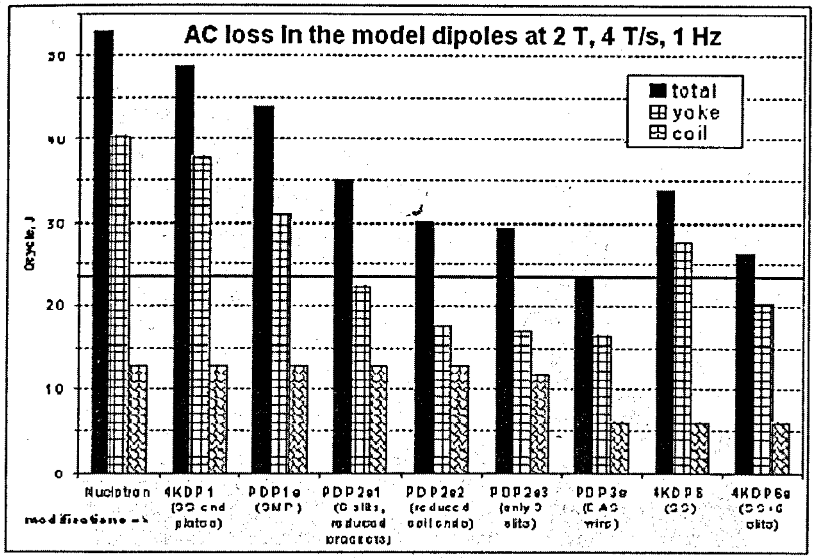


Fig. 22. Summary table of the model dipoles design and tests at the VBLHE JINR. (the last six tests were prepared and performed in 2004/05).

6.2. The new design of a fast-ramped fast-cycling 4 T superconducting *Cosθ* – type dipole based on a single-layer coil made from hollow NbTi cable was made. The main advantages of the new concept are much higher cooling efficiency of the superconductor and much smaller inductance of the magnet winding in comparison with the traditional dipole based on the classical Rutherford cable. One of the key issues is the design and fabrication of a superconducting cable operating at 30 kA, 30 kA/s and a gap magnetic field of 4 T and higher. We continue to explore the concept of NbTi multi wire hollow cable cooled with two-phase helium flow similar to the one proposed and used for the Nuclotron 2 T, 4 T/s superferric magnets.

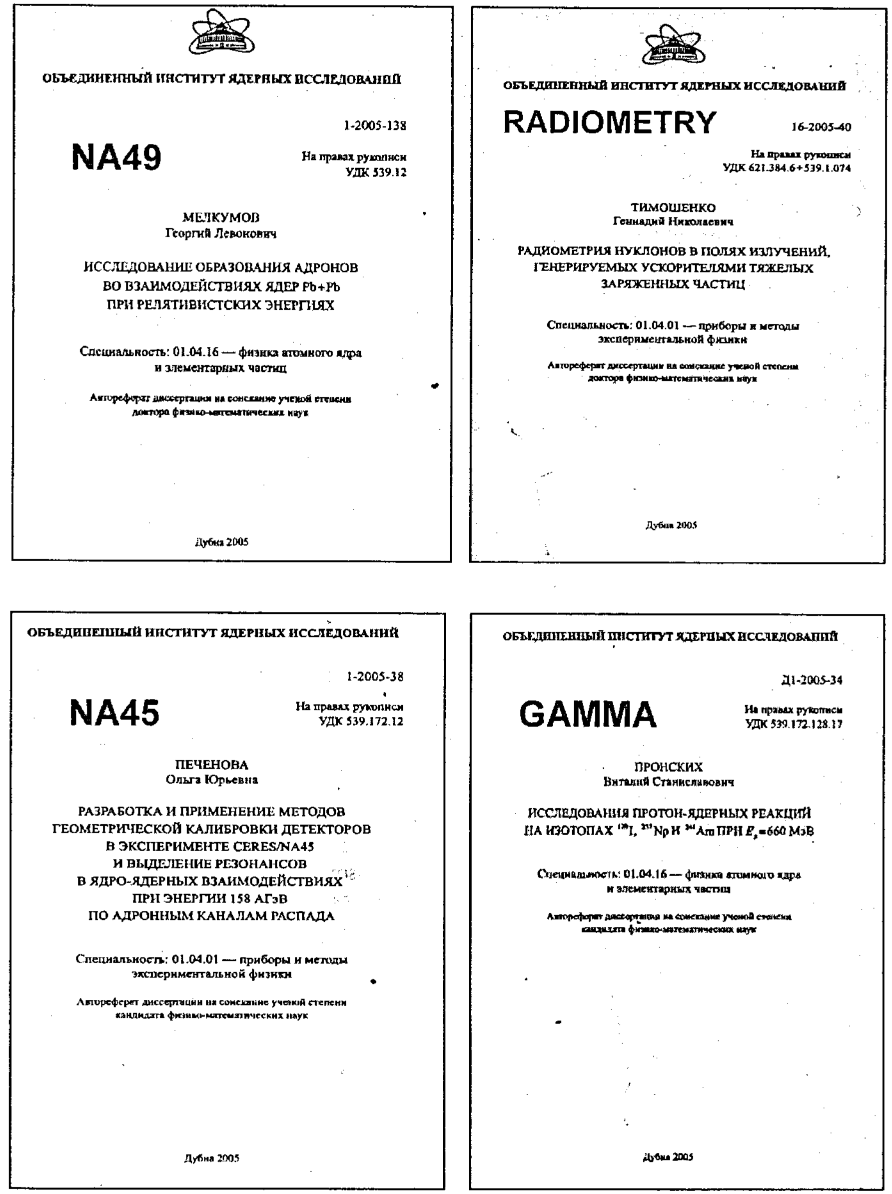
6.3. Tests of the new model magnet with a single-layer coil made of the new NbTi superconducting wire were performed. The pulse repetition rate up to about 6 Hz was reached.

Miscellaneous

The other results obtained at VBLHE in 2005 are published in [32-79].

Within 2005, two Doctoral theses (G.L.Melkumov and G.N.Timoshenko) and two PhD theses (O.Yu.Pechenova and V.S.Pronskih) were defended on the basis of results obtained at VBLHE [77-79].

The title pages of these theses are shown in Fig.23.



ОБЪЕДИНЕННЫЙ ИНСТИТУТ ЯДЕРНЫХ ИССЛЕДОВАНИЙ

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МЕЛКУМОВ
Георгий Левонович

ИССЛЕДОВАНИЕ ОБРАЗОВАНИЯ АДРОНОВ
ВО ВЗАИМОДЕЙСТВИЯХ ЯДЕР Pb+Pb
ПРИ РЕЛЯТИВИСТСКИХ ЭНЕРГИЯХ

Специальность: 01.04.16 — физика атомного ядра и элементарных частиц

Автореферат диссертации на соискание ученой степени доктора физико-математических наук

Дубна 2005

ОБЪЕДИНЕННЫЙ ИНСТИТУТ ЯДЕРНЫХ ИССЛЕДОВАНИЙ

RADIOMETRY

16-2005-40

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УДК 621.384.6+539.1.074

ТИМОШЕНКО
Геннадий Николаевич

РАДИОМЕТРИЯ НУКЛОНОВ В ПОЛЯХ ИЗЛУЧЕНИЙ,
ГЕНЕРИРУЕМЫХ УСКОРИТЕЛЯМИ ТЯЖЕЛЫХ
ЗАРЯЖЕННЫХ ЧАСТИЦ

Специальность: 01.04.01 — приборы и методы экспериментальной физики

Автореферат диссертации на соискание ученой степени доктора физико-математических наук

Дубна 2005

ОБЪЕДИНЕННЫЙ ИНСТИТУТ ЯДЕРНЫХ ИССЛЕДОВАНИЙ

1-2005-38

NA45

На правах рукописи
УДК 539.172.12

ПЕЧЕНОВА
Ольга Юрьевна

РАЗРАБОТКА И ПРИМЕНЕНИЕ МЕТОДОВ
ГЕОМЕТРИЧЕСКОЙ КАЛИБРОВКИ ДЕТЕКТОРОВ
В ЭКСПЕРИМЕНТЕ CERES/NA45
И ВЫДЕЛЕНИЕ РЕЗОНАНСОВ
В ЯДРО-ЯДЕРНЫХ ВЗАИМОДЕЙСТВИЯХ
ПРИ ЭНЕРГИИ 158 АГэВ
ПО АДРОННЫМ КАНАЛАМ РАСПАДА

Специальность: 01.04.01 — приборы и методы экспериментальной физики

Автореферат диссертации на соискание ученой степени кандидата физико-математических наук

Дубна 2005

ОБЪЕДИНЕННЫЙ ИНСТИТУТ ЯДЕРНЫХ ИССЛЕДОВАНИЙ

Д1-2005-34

GAMMA

На правах рукописи
УДК 539.172.128.17

ПРОНСКИХ
Виталий Станиславович

ИССЛЕДОВАНИЯ ПРОТОН-ЯДЕРНЫХ РЕАКЦИЙ
НА ИЗОТОПАХ ^{129}I, ^{237}Np И ^{241}Am ПРИ E_p=660 МэВ

Специальность: 01.04.16 — физика атомного ядра и элементарных частиц

Автореферат диссертации на соискание ученой степени кандидата физико-математических наук

Дубна 2005

Fig.23. Title pages of the two Doctoral theses (G.L. Melkumov and G.N. Timoshenko) and two PhD theses (O.Yu. Pechenova and V.S. Pronskih) defended at VBLHE in 2005.

3. VBLHE plans for 2006-2008.

The program of the VBLHE in 2006-2008 is based on the perspective program of research at the laboratory for 2006-2015 (Road Map). The draft program is presented in Fig.26.

It contains the following basic directions:

- Basic research
- Applied research
- Development of the Nuclotron Accelerator Complex
- Educational program

Basic research includes investigations of heavy ion interactions, polarization phenomena at the Nuclotron and investigations in relativistic nuclear physics at other scientific centers.

Applied research is related to life sciences and energy problems.

It is planned to develop the accelerator complex in order to produce higher quality particle and nuclear beams.

Main Directions	Tasks		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Basic Research	Heavy Ions		MIXED PHASE of Nuclear Metter									
			Nonperturbative QCD, Cumulative Processes									
	Polarization		Deuteron Spin Structure									
				Fundamental Role of Three Nucleon Forces								
				Nature of Nucleon Spin								
	Light Nuclei		Phase Transitions in Nuclear Matter									
			Clustering in Stable and Radioactive Nuclei									
	Research in other Centers	BNL	RHIC (STAR, PHENIX) PHENIX- large P_t, STAR – polarization									
		CERN	SPS (NA49) anti-p, d									
			LHC(CMS, ALICE) CMS – Heavy Ions, ALICE – Heavy Ions at Ultrarelativistic Energy									
		GSI	SIS (HADES) – Resonances in Dense Medium									
			FAIR (CBM, PANDA) CBM – E/M processes & polarization, PANDA – anti-p									
Applied Research	Life Sciences		Med-Nuclotron				Clinical Center					
				Medical Accelerator								
			Radiobiological Investigations, Space Medicine									
	Energy problems		Transmutation, Accelerator-Driven System									
				Heavy Ion Driver for Thermonuclear Fusion								
Development of the Nuclotron Accelerator Complex	Heavy Ions A=200			Development of KRION								
	d↑, ^{3}He↑, I > 10^{10} p/cycle		New polarized source									
	$I_{p,d}$ > 10^{13} p/cycle					BOOSTER						
	Secondary beams		Beam Lines									
	Control & Diagnostics		Diagnostic, Control Systems & etc.									
Educational Prog.	Yang physicist training			NPEEC - Nuclotron Physical Experimental Educational Center								

Fig.24. Draft perspective programme of the Veksler and Baldin Laboratory of High Energies.

The following topics are planned for 2006-2008 at the Veksler and Baldin Laboratory of High Energies:

Topics Related to Development of Large Installations and Carrying out Large-Scale Research

- 0983 – «Study of Multiple Production in 4π-geometry. Experiments at the Nuclotron» – First priority.
- 0941 – «Search for Non-Nucleon Degrees of Freedom and Spin Effects in Few-Nucleon System» – All-institute topic – First priority.
- 0979 – «Development of Nuclotron Accelerator Complex» – First priority. Basic facility.

Topics: R&D, Data taking and Data analysis

- 1011 – «Investigation of the Properties of Nuclear Matter in Experiments with Nuclei and Polarized Particles (STAR)» - First priority.
- 1020 – «High-Acceptance Toroidal Spectrometer HADES. R&D of New Particle Detectors» - First priority.
- 0001 – «ALICE: A Large Ion Collider Experiment at CERN's LHC (Project ALICE)» - First priority.
- 1010 – «Investigation of Relativistic Multiparticle Interactions (Project MARUSYA)» - First priority.
- 1033 – «Leading Particle» (Scintillation Magnetic Spectrometer MSU) and «SPIN» - Second priority.

- New topic – «Use of Nuclotron Beams for Applied Research»
- New topic – «Med-Nuclotron» - First priority.
  All-institute topic (VBLHE, DLNP, LRR)

The financing necessary for realization of the VBLHE program in 2006-2008 is summarized in Table 1.

Table 1.

Relativistic Nuclear Physics
2006 - 2008

Topic & Future Plan		Priority	Plan 2006	Plan 2007	Plan 2008
Development of the Nuclotron Accelerator Complex (R&D)	*0979*	1	150	150	150
Search for Non-Nucleon Degrees	*0941*	1	90	93	93
4π- geometry	*0983*	1	250	250	270
Investigation at the GSI Accelerator Complex	*1059*	1	40	40	40
NIS (LPP)	*1044*	1	20	20	20
ALICE	*0001*	1	80	100	100
MARUSYA	*1010*	1	80	80	80
STAR	*1011*	1	80	100	100
HADES	*1020*	1	50	100	100
Med-Nuclotron	*new*	1	20	20	20
Development & Future Plans	*Dev.*	1	55	115	115
Experiments Leading Particles & SPIN	*1033*	2	1	1	1
Applied Research	*new*	2	5	5	5
TOTAL (k$):			921	1074	1094

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