I. Preamble

1. The Programme Advisory Committee for Particle Physics takes note of the information presented by JINR Vice-Director R. Lednický on the Resolution of the 102nd session of the JINR Scientific Council (September, 2007), on the decisions of the JINR Committee of Plenipotentiaries (November 2007), and on the preparation of the JINR Programme of Particle Physics Research for the years 2008–2010 in accordance with the main provisions of the updated JINR road map.

The PAC is pleased to learn about the decision of the Committee of Plenipotentiaries to increase the JINR budget by 24% in 2008.

The PAC emphasizes, as part of the effort to optimize the staffing of JINR, the JINR Directorate should take deliberate actions to attract and retain the best young scientists from the Member States of the Institute. This is essential to secure the future of JINR.

The PAC notes with interest the decision of the Committee of Plenipotentiaries to approve the proposal of the Institute Directorate to make changes to the structure of JINR in view of the plans for the upgrade of the Nuclotron accelerator complex and for the realization of the NICA project. In order to concentrate the human and financial resources on the implementation of this priority programme of JINR, it is envisaged to establish the Veksler and Baldin Laboratory of High Energy Physics, excluding from the Institute structure the Veksler and Baldin Laboratory of High Energies and the Laboratory of Particle Physics. The PAC stresses the need to accomplish this merger in a way which maintains the high motivation of the talented scientists and technical staff of both laboratories.

The PAC is pleased to learn about the renewal, after a long period of time, of the participation of the Republic of Cuba in the activities of JINR as well as about the new initiatives of the Directorate towards the restoration of the membership of the People's Republic of China in JINR.

The PAC notes with interest the plan being considered by the Institute Directorate together with the Russian Research Centre "Kurchatov Institute" concerning the establishment, with JINR's key participation, in Dubna, of a JINR-based International Nanotechnology Centre of the Member States.

2. The PAC notes the importance of the agreement signed by 11 participating countries (including Russia and other Member States of JINR) about the start-up of the joint realization of the FAIR project in Darmstadt.

II. General recommendation on the Programme of Particle Physics Research for 2008–2010

The PAC takes note of the reports presented by V. Kekelidze, Director of the Veksler-Baldin Laboratory of High Energies, A. Sorin, Deputy Director of the Bogoliubov Laboratory of Theoretical Physics, Yu. Potrebenikov, Acting Deputy Director of the Laboratory of Particle Physics, A. Olchevski, Director of the Dzhelepov Laboratory of Nuclear Problems, and by V. Ivanov, Director of the Laboratory of Information Technologies, and the main lines of the JINR Programme of Particle and Relativistic Nuclear Physics Research proposed by them in accordance with the main provisions of the updated road map for the period 2008–2010.

The PAC notes that this programme will be adjusted after the unification of the Veksler-Baldin Laboratory of High Energies and the Laboratory of Particle Physics.

III. Recommendation for activities at JINR related to the ILC

The PAC takes note of the information presented by JINR Chief Engineer G. Shirkov on the progress for ongoing developments at JINR related to the ILC.

The PAC would like to be informed regularly about the progress of these activities.

IV. Recommendation on the participation of BLTP in the preparation of physics programmes for the ALICE, ATLAS, CMS, and NICA/MPD experiments

The PAC takes note of the report, presented by A. Sorin, on the participation of BLTP in the preparation of the physics programmes for the ALICE, ATLAS, and CMS experiments and for the NICA/MPD project.

The PAC highly appreciates the proposals made by BLTP for the programme targeting new physics searches in experiments at the LHC. The PAC recommends that BLTP's proposals for the physics programmes of LHC experiments be supported and BLTP's participation in modeling and interpretation of LHC experimental data be enhanced in future.

The PAC notes the important role of BLTP in the preparation of the scientific part of the NICA/MPD project and recommends that this activity be continued.

V. Recommendation for a new project

The PAC takes note of the written review (Appendix 1) presented by the Chairman of the Independent Expert Panel for the Nuclotron-M project, B. Sharkov (ITEP, Moscow), and highly appreciates the work done by this Panel.

The PAC has considered the proposal for realization of the NICA project and its first stage — “Nuclotron-M”. The PAC recommends approval of the project Nuclotron-M for execution until the end of 2010.

The PAC supports the proposed strategy of the step-by-step realization of the NICA project. To realize this goal, it is essential that the financing schedule, endorsed by the Directorate, be fulfilled.

The PAC stresses that timely progress towards achieving the milestone of the Nuclotron-M upgrade is crucial to the future of the high-energy programme at JINR. To help track this progress, the PAC strongly encourages that the Directorate appoint a standing Machine Advisory Committee comprised of independent experts. This committee should meet two times per year to review progress towards achieving the milestones of the Nuclotron-M upgrade. The chairman of this advisory committee should make regular reports to the Directorate and the PAC.

The PAC looks forward to further elaboration of the compelling spin and heavy-ion physics programmes that will be accomplished at NICA. This should be documented in a white paper suitable for international review.

VI. Recommendations on activities previously approved for completion in 2007 and proposed for continuation

1. The PAC takes note of the report on the theme “Information, computer and network support of JINR’s activity". The PAC recognizes the progress of the work towards a substantial increase in the performance of the JINR Central Information and Computing Complex (CICC) in 2007. The PAC appreciates the significant amount of work already accomplished by LIT on the preparation of software within the WLCG (Worldwide LHC Computing Grid) project. The PAC welcomes the activity carried out by LIT on the construction of the 10 Gbps JINR-Moscow data link and notes the importance of this work for maintaining the physics programme of LHC experiments. The PAC endorses the plans for an essential increase both in the performance of the JINR CICC and in the mass data storage capability in accordance with the requirements of experiments. The PAC notes the particular importance of the work performed under this theme for the provision of scientific work at JINR on the LHC experiments.

The PAC looks forward to a report by the JINR CICC user community concerning the experience with using the JINR computing infrastructure.

The PAC recommends continuation of this theme in 2008–2010.

2. The PAC takes note of the report on the NIS project and recommends its continuation until the end of 2008. The PAC notes the active work on the preparation for data taking and looks forward to first results of the experiment.

3. The PAC takes note of the written report on the theme “Investigations at the GSI accelerator complex” which focuses on the design of the future FAIR facility and recommends continuation of this activity until the end of 2010.

4. The PAC takes note of the written report on the theme “Development of particle detection methods based on thin-wall drift tubes for precision coordinate measurements at high luminosity” and recommends continuation of this activity until the end of 2008.

5. The PAC takes note of the written report on the OKA project and, in view of JINR’s modest participation in this project, recommends its continuation under the DLNP laboratory theme.

6. The PAC takes note of the written report on the project “Movable polarized target” and recommends its continuation until the end of 2008.

7. The PAC takes note of the written report on the Med-Nuclotron project and recommends its continuation until the end of 2008. The PAC looks forward to a report in the future concerning the position of this facility in comparison with state-of-the-art radiotherapy facilities world-wide.

VII. Recommendations on the projects previously approved for completion in 2007

1. The PAC takes note of the written report on the GIBS project and recommends that the JINR Directorate close this project. This scientific topic will be continued in the context of the NIS project.

2. The PAC takes note of the written report on the project “η nuclei” and recommends that JINR Directorate close this project and continue the corresponding activity within the framework of the theme “Study of multiple production in 4π-geometry. Experiments at the Nuclotron”.

3. The PAC takes note of the project “Leading particles” and recommends that the JINR Directorate close this project.

VIII. Miscellaneous

The PAC for Particle Physics recalls that at its 18th session (11–12 November 2002) it recommended that the procedure of treatment of the requests for extensions of ongoing experiments be included in the “JINR Rules of Proposal Preparation”, noting that these requests should be treated in much the same manner as new proposals. Unfortunately, this

recommendation so far has not been implemented and this procedure has not been defined in the existing rules. The PAC strongly recommends that this suggestion be realized.

IX. Recommendations on first-priority activities

The list of the themes and projects having first priority is presented in Appendix 2.

The PAC notes that as part of the ongoing effort to streamline the JINR particle physics programme, the priority and funding of all projects, including those with first priority, may be reviewed as appropriate, even if they have been previously approved for a three-year period.

XI. Next meeting of the PAC

The next meeting of the PAC for Particle Physics will be held on 10–11 June 2008.

The following items are proposed to be included in the agenda:

- Consideration of new projects and themes
- Reports and recommendations on the projects to be completed in 2008
- Information about the structure of the JINR new laboratory, VBLHEP, and its near-term scientific programme
- Report on progress for ongoing developments at JINR related to the ILC
- Report on progress towards realization of the Nuclotron-M/NICA projects
- Report from the Nuclotron-M Machine Advisory Committee
- Report on further elaboration of the scientific programme of NICA
- Report on readiness of the JINR teams working on the LHC experiments to produce first scientific results
- Report from the JINR CICC user community concerning its experience with using the JINR computing infrastructure.

J. Nassalski
Chairperson of the PAC

Appendix 1

Review by the Independent Expert Panel for the Nuclotron-M project "Development of the Nuclotron accelerator complex aimed at producing beams of heavy nuclei with energies up to 5 GeV/nucleon"

(B. Sharkov (ITEP, Moscow) — Chairman)

As explained previously, the Nuclotron-M project is the initial stage of a general project aimed at developing the JINR experimental base for production of intense beams of heavy ions and polarized nuclei with the purpose of studying the problem of phase transitions in strongly interacting nuclear matter. The NICA project envisages that a luminosity of the order of 10^{27} $cm^{-2}s^{-1}$ will be achieved at collisions of Au or U nuclei and that the Nuclotron will accelerate no less than $2.5x10^{9}$ corresponding particles (with account of their subsequent accumulation in the collider) in order to achieve this luminosity. The maximum kinetic energy of ions injected into the NICA collider is limited by the value 3.5 GeV/n.

According to the information provided in the project, the Nuclotron-M project is the first stage of realizing the NICA facility and parameters required for NICA will be reached only upon implementation of individual projects, particularly, realizing a new linear accelerator and booster synchrotron.

The Nuclotron-M project targets acceleration of gold ions up to an energy of 3.5 GeV/n with an intensity not less than 10^{7} particles per acceleration cycle by the year 2009, which is a fairly serious (and unfortunately by far not the last) milestone on the hard road towards execution of the NICA project. Secondary goals of the Nuclotron-M project are to improve the accelerator's operating parameters, which have their own significance, without regard to the NICA project, for extending the experimental possibilities of the complex, thus being necessary but not solely sufficient.

The programme of the Nuclotron upgrade includes the following subprojects:

SP1.1	Development and creation of a heavy-ion source based on the KRION technology
SP1.2	Improvement of the power supplies, shielding and energy dump system of the lattice magnets and lenses
SP1.3	Upgrade of the vacuum system of the Nuclotron ring
SP1.4	Development of the RF system, driving electronics and beam capture system
SP1.5	Extraction of accelerated heavy ions at the maximum energy
SP1.6	Modernization of the automation system for control, beam diagnostics and monitoring of parameters of the accelerator complex

SP1.7	Extracted beam transport channels and their radiation shielding
SP1.8	Improvement of the cryogenic supply system
SP1.9	Creation of a new preaccelerator with injection and extraction channels
SP1.10	Development and creation of a high-intensity polarized deuteron source

and is intended to principally improve the technical level and therefore the quality of the accelerator's basic operating systems.

Among the drawbacks of the programme is that it lacks a separate section devoted to experimental studies and analysis of the beam dynamics in the accelerator that provide a basis for upgrade activities currently being conducted and planned. The project is actually lacking in data on the experimental study of the Nuclotron beam dynamics such as the operating point, resonance widths, orbit distortion, measured chromaticity coefficients, etc. Fragmentary data on the nature of particle losses in the Nuclotron that the project provides do not allow one to make a reliable judgement on the causes of these losses.

Development and creation of a heavy-ion source based on the KRION technology (subproject SP1.1)

This subproject appears to be one of the most advanced and sufficiently substantiated. The results obtained from the "KRION-2" source, which made it possible to accelerate Ar^{16+} ions in the Nuclotron in 2002 and Fe^{24+} ions in 2003 as well as to produce Au^{51+} ions in 2007, look impressive and promising as a basis for further development of ion-source technologies such as EBIS wherein VBLHE is a worldwide leader. The minimal experience in operating the "KRION-2" source at the Nuclotron with the obtained highly charged ions can be regarded as a shortcoming of the performed work because it has been practically limited only to the physical start-up, which, as a rule, does not allow forming a judgement on the long-term reliability and stability of the source beam parameters under conditions of continuous operation.

The entire programme envisaged for the development of the KRION technology is well substantiated and of interest not only for individual projects but for the whole accelerator science. The only thing that can be suggested is to reduce the duration of this subproject on the ground that this direction is critical for the whole project.

Improvement of the power supplies, shielding and energy dump systems of the lattice magnets and lenses (subproject SP1.2)

Upgrading of the power supply system of the Nuclotron ring magnet is planned to be performed in two main directions: 1) modernization of the data system and replacement of the key elements of the shielding and energy dump systems protecting the magnetic

elements in emergency situations and 2) changing of the power-supply circuits of the magnetic elements to enhance accuracy and stability of current regulation in the circuits of the magnets and quadrupole lenses.

The necessity for planned activities in the first direction is forced and does not raise any doubt.

The proposed new scheme for the power supply of the magnetic elements allows one to reduce ripples in the circuit of the quadrupole lenses but does not ensure the needed field rise rates and therefore requires further improvement. Apart from that, the new scheme provides narrowing of the regulation range for the current in the quadrupole lenses compared to the current in the magnet circuits, which can make setting of the beam acceleration mode more difficult at large fields in the magnets when their saturation begins to appear.

Upgrade of the vacuum system of the Nuclotron ring (subproject SP1.3)

The programme of upgrading the vacuum system is lacking in sufficient information concerning its current status and computational reasoning for the proposed circuit solutions to vacuum problems.

It is common knowledge that with cryogenic pumping, which prevails at the Nuclotron, average vacuum will be defined by the cleanness of the wall surfaces and external leakage that is always present. If both have a small effect, vacuum goes to 10th degree. In case the inner surfaces of the vacuum chamber are not sufficiently outgased, average vacuum drops to a level of 10^{-6} mbar and will be defined by the hydrogen molecules poorly adhering to the walls. The status of the vacuum chamber conditions is usually tested by the leakage in a “warm” state with the pumping equipment switched off.

The proposed programme envisages improvement of the average vacuum in the accelerator ring chamber by two orders of magnitude as a result of upgrading the vacuum system. The first stage of upgrade activities will provide a vacuum improvement by an order of magnitude due to installation of turbomolecular pumps at three “problem” sites and employment of additional pumping for the “cryostat insulating vacuum space” near the slow extraction system elements. At the second stage of upgrading, “a tandem of two turbomolecular pumps is planned to be installed at each of the 22 available pumping outlets of the chamber”.

The need to conduct the first stage of upgrading activities raises no doubt. The results of this stage will be most probably considerably more modest compared to what has been planned because the average vacuum will be defined by the condition of the whole chamber, which does not receive sufficient outgassing before cooling.

The scheme of the second stage is correct on the whole and targets creation of a powerful external system for ultrahigh-vacuum pumping distributed around the periphery of

the accelerator. This approach will certainly lead to success even with an imperfect condition of the vacuum chamber. In this case one may discuss whether the same problem can be solved by making better preparations for the chamber, reducing the number of vacuum pipes and involving cheaper ion or getter pumps.

The list of equipment for purchase is lacking a mass spectrometer, which is required for the residual gas analysis.

Development of the RF system, driving electronics and beam capture system (subproject SP1.4)

The programme of modernizing the Nuclotron accelerating (RF) system focuses on bringing the system into the normal, from a contemporary viewpoint, operating condition. Improvement of the power supply of the RF system and replacement of the scheme used for the resonator phase tuning with one that allows programmable phase tuning and includes, in addition, a “self-adapting” control function will make it possible to bring the Nuclotron accelerating system to a brand new level and probably solve a number of problems related to beam losses during acceleration.

The proposed system providing accelerating voltage control during beam acceleration allows one to obtain “comprehensive information”, which is not actually required in conditions of real operation and can prove to be harmful, if not useful.

Too much attention in the programme is devoted to the problem of adiabatic capture, which, in my opinion, is exceedingly overcomplicated. Simulation shows that requirements to the speed of changing important parameters during adiabatic capture and beam acceleration are fairly soft and do not pose a problem. It is known from experience that capturing a large longitudinal phase space of the beam is a far easier task compared to dragging it throughout the acceleration cycle up to the final energy without any particle losses; especially it concerns heavy ions with a slowly changing relativistic factor.

Extraction of accelerated heavy ions at the maximum energy (subproject SP1.5)

The proposed methods of slow beam extraction from the Nuclotron at the maximum energy are based on using a crystal deflector to provide initial deflection of particle trajectories with large amplitudes of betatron oscillations through an angle of 3 mrad so that the extraction septum magnet can enter the magnetic gap. This extraction scheme can function with unclear (most likely low at the energies considered here) efficiency under the condition of a fairly large dynamic aperture of the ring because at large fields Nuclotron magnets become saturated, the dynamic aperture can turn out to be small and so the scheme will not work.

Modernization of the automation system for control, beam diagnostics and monitoring of parameters of the accelerator complex (subproject SP1.6)

Improvement of the computerized control and parameter monitoring system of the accelerator ensures its operation at a modern technological level. Within the existing control system of the Nuclotron a fairly powerful information network structure has been built, and a number of important technological problems have been solved at a modern level.

The programme presented here contains detailed information on the current status of the system and planned modernizations that have tendencies toward increasing processed data volumes, improving efficiency and performance of the existing systems based on the latest advances in electronic technologies. Considerably less attention is altogether paid to enhancement of the control system functionality aimed at improving the Nuclotron operating parameters (first and foremost, intensity) on the basis of a detailed analysis of the beam dynamics and machine condition on the whole. Naturally, building a global system for measuring the orbit of each bunch at each turn throughout the acceleration cycle is a very fine thing but it is also expensive and will not solve all the problems. Of greater importance would be building a few simpler and cheaper systems that would allow one to obtain more quickly data on the orbit at several points of the magnetic cycle, real chromaticity of the ring, matching parameters of the injected beam, and dynamic aperture of the ring.

Extracted beam transport channels and their radiation shielding (subproject SP1.7)

This subproject covers three basic problems (renovation of the transport channels to ensure operation with the maximum energy of accelerated beams, minimizing the amount of substance in the extraction channel, creation of an automated control subsystem for the magnetic optical elements) which are absolutely important and ought to be solved. Programme details for this subproject are lacking.

Improvement of the cryogenic supply system (subproject SP1.8)

The cryogenic system serves as a base for the superconducting complex and during its intensive operation periods must be maintained at a high operating level. The programme aimed at improving the existing cryogenic system that has been ensuring the Nuclotron operation over many years is fairly efficient and targets maintaining long-term operation of the equipment, further enhancement of reliability and energy efficiency as well as reduction of the operation costs.

Creation of a new preaccelerator with injection and extraction channels (subproject SP1.9)

This subproject deals with the intention to create a new injection complex for the Nuclotron that will allow one to dramatically increase the intensity of the accelerated beam. The new injection complex will be fully independent of the existing one and will include a Krion ion source (6 T), U linac (30+, 5-6 MeV/n) and booster synchrotron. The programme for this project covers design and preparatory work and will be further singled out into an independent NICA subproject.

Development and creation of a high-intensity polarized deuteron source (subproject SP1.10)

VBLHE is acknowledged as one of the leaders both in Russia and throughout the world in creating and using polarized deuteron sources at synchrotrons that continues to successfully develop this direction. The programme for this subproject envisages working out a few modifications of high-current sources of polarized deuterons and other particles, as well as renovating the premises and high-voltage platform of the LU-20 injector to meet the new technological conditions. This work will be carried out at the frontier of state-of-the-art technologies and will allow bringing acceleration of polarized particles in the Nuclotron to a brand new level by the year 2010.

Conclusion

1. The project Nuclotron-M is on the whole aimed at solving the key technological problems that restrict the operating parameters of the Nuclotron accelerator essential both for the NICA project and for the efficiency of the physics experiments currently being conducted and planned at the accelerator.

2. The project implementation plan envisages ten lines of work, offering a wide range of activities in upgrading the equipment and bringing the Nuclotron accelerator to a brand new technological level.

Appendix 2

List of First–Priority Activities

The following activities are noted to have first priority in the JINR Programme of Particle Physics and Relativistic Nuclear Physics for the year 2008:

- Fields and particles
- Modern mathematical physics
- Dubna International Advanced School of Theoretical Physics
- International Linear Collider: accelerator physics and engineering
- Development of the JINR basic facility for generation of intense heavy ion and polarized nuclear beams aimed at searching for the mixed phase of nuclear matter and investigation of polarization phenomena at the collision energies up to $\sqrt{S_{NN}}$ = 9 GeV
- Study of multiple production in 4π-geometry. Experiments at the Nuclotron. Projects HADES (JINR's participation), NA49 (JINR's participation), PHENIX (JINR's participation), BECQUEREL, MARUSYA
- Search for non-nucleon degrees of freedom and spin effects in few-nucleon systems (projects STRELA, DELTA-SIGMA, LNS, pHe3, DELTA-2, MPT)
- Study of the hadron structure in the experiments with the COMPASS (NA58, CERN), HERMES and H1 (DESY) spectrometers (JINR's participation)
- JINR's participation in the physics research programme at the upgraded Fermilab Tevatron (projects CDF, D0)
- Charmed and strange quarks in hadronic reactions (projects NA48–CERN and OKAPI–CERN (JINR's participation))
- Study of neutrino oscillations and determination of oscillation parameters (project OPERA (JINR's participation))
- Search for effects of nucleon polarized hidden strangeness (project NIS)
- DIRAC (JINR's participation)
- ATLAS (JINR's participation)
- CMS (JINR's participation)
- ALICE (JINR's participation)
- Study of rare processes (projects E391 (JINR's participation), KLOD, NN&GDH)
- STAR (JINR's participation)
- Investigations at the GSI accelerator complex (JINR's participation)

- Study of e^+e^- interactions, linear collider physics and detector (projects SANC, BES-III (JINR's participation))
- Med–Nuclotron
- Astrophysical studies in space experiments (projects TUS and NUCLEON (JINR's participation))
- Physics and engineering of feedback systems in synchrotrons
- Mathematical support of experimental and theoretical studies conducted by JINR
- Information, computer and network support of JINR's activity
- Organization, maintenance, and development of the university-type educational process at JINR.