

**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 105th session of JINR Scientific Council (February 2009), on the decisions of the JINR Committee of Plenipotentiaries (CP) (March 2009), and on the preparation of the Seven-Year Plan for the Development of JINR for 2010–2016.

The PAC shares the high appreciation by the Committee of Plenipotentiaries of the work of JINR teams in the external experiments, in particular on neutrino physics (NEMO-3), on charged kaon decays (NA48/2, CERN), and on the detection of a new particle — the  $\Omega_b$  baryon (D0, FNAL).

The PAC highly appreciates the active work of the JINR Directorate to involve new partner countries in the activities of JINR. It notes with satisfaction the recent conclusion of the government-level agreement with the Arab Republic of Egypt and the signature of the Letter of Intent with the Hungarian Republic concerning intensification of joint basic and applied research at JINR as well as the intention of the Hungarian Republic to consider the possibility of restoration of its full membership at JINR.

The PAC notes the importance of the general agreement, signed in February 2009, between JINR and the Russian Research Centre “Kurchatov Institute” on further development of cooperation in the areas of basic and applied research, education, and innovations, and of the trilateral agreement between JINR, the Kurchatov Institute, and the International Association of Academies of Sciences concerning their participation in the establishment of an International Innovation Centre for Nanotechnology.

The PAC appreciates the extension of the Agreement between JINR and the Federal Ministry of Education and Research (BMBF) of Germany until the end of 2011 and welcomes the decision of the German side about the increase of the annual contribution of Germany to the JINR budget.

**II. Recommendation on the scientific programme for the next seven-year period**

The PAC takes note of the draft Seven-Year Plan for the development of JINR for 2010–2016 in the field of particle physics research presented by JINR Vice-Director R. Lednický.

The PAC appreciates the large amount of work accomplished by the JINR Directorate to elaborate a competitive long-term programme of the Institute, and looks

forward at its future meetings to regular progress reports concerning implementation of the seven-year plan.

The PAC recommends that the JINR Directorate take into account the remarks and suggestions made at this session for preparing the final version of the seven-year plan to be presented at the next session of the Scientific Council.

### **III. Recommendations on progress towards realization of the Nuclotron-M/NICA projects**

The PAC takes note of the report on the progress towards realization of the Nuclotron-M/NICA projects presented by JINR Deputy Chief Engineer G. Trubnikov. The PAC appreciates the significant advances that have been made in upgrading the VBLHEP accelerator complex and in the preparation of the NICA project. The PAC notes that several new external laboratories are prepared to sign the MoU concerning the realization of the project.

The PAC recommends that the JINR Directorate provide the required funding for the Nuclotron-M project stages (especially, modernization of the experimental test benches and engineering infrastructure) in accordance with the programme and time schedule for the successful completion of this project.

### **IV. Recommendations concerning the report from the Chairman of the Nuclotron-M/NICA MAC**

The PAC takes note of the report from the Chairman of the Machine Advisory Committee for the Nuclotron-M/NICA accelerator complex, Professor B. Sharkov (ITEP, Moscow), presented on his behalf by JINR Deputy Chief Engineer G. Trubnikov (Appendix 1).

The PAC appreciates the progress achieved in the realization of this project and supports the efforts of VBLHEP and of the whole Institute aimed at the creation of the Nuclotron-M/NICA accelerating complex.

The PAC recommends that the JINR Directorate consolidate the manpower and financial resources on the NICA realization steps in order to keep the project schedule and support the R&D work related to the design and construction of the future complex elements. The PAC emphasizes the importance of an in-person meeting of the Machine Advisory Committee (MAC) at JINR within the next six months so that in addition to in-depth discussion, the members of the MAC can visit the Nuclotron as well as other important engineering sites relevant to the Nuclotron-M and NICA/MPD projects.

## **V. Recommendations on progress towards a white paper for the NICA/MPD programme**

The PAC takes note of the report by BLTP Deputy Director A. Sorin on the ongoing preparation of a white paper for the NICA/MPD programme on the mixed phase and spin physics. The PAC notes the progress achieved in this direction, the noticeable effort to internationalize this activity, and recommends continuation of the work to elaborate a competitive research programme in view of its complementarity with studies planned at CERN, RHIC, and FAIR.

The PAC emphasizes the near-term priority of introducing a chapter in the MPD Conceptual Design Report or the forthcoming NICA physics white paper which shows, based on first order calculations, the feasibility, taking into account essential characteristics such as the expected luminosity and the detector acceptance, of measuring key observables related to the main physics themes of the project. These calculations should be followed up with detailed modeling of the detector capability.

The PAC takes note that the white paper is proposed to be a growing collection of various ideas on important physics subjects to be investigated at NICA and that the detailed simulations of relevant observables will be made in the MPD TDR. The PAC takes note of the broad range of present contributions and suggests that the future working groups organized during round-table meetings make their assessment taking into account the NICA energy and luminosity.

## **VI. Recommendations on the first draft of the MPD Conceptual Design Report**

The PAC appreciates the first draft of the Conceptual Design Report for the MPD detector presented by VBLHEP Acting Director V. Kekelidze. The PAC congratulates the MPD development team on producing a professional, well organized document, and encourages the team to continue this activity to completion prior to the next meeting of the Scientific Council. The PAC endorses the proposed concept and supports the strategy of stage-by-stage construction of this detector. The PAC notes the necessity of a critical assessment of the physics ideas presented in the white paper for simulations of the relevant physics channels. The PAC recommends that the JINR Directorate support the activity for MPD construction and for preparation of a compelling research programme for this experiment. The PAC notes that new institutions have joined the collaboration and stresses that a well documented MPD CDR will be important to attract broader international interest.

The PAC emphasizes the importance of close collaboration between the MPD and NICA development teams to insure the needs of the detector are incorporated into the design of the NICA complex and the physics capabilities of MPD are not compromised. The PAC looks forward to an integrated plan for the location of the MPD detector by the end of 2009.

## **VII. Recommendations on the proposal to begin consolidation of the VBLHEP physics programme**

The PAC is pleased to note the report on the proposal to begin consolidation of the VBLHEP physics programme presented by VBLHEP Acting Director V. Kekelidze. The PAC notes the large amount of work done on the preparation of the scientific research programmes at the JINR basic facilities and at the world's largest accelerator centres. It endorses the proposal of the Laboratory to consolidate its physics programme, and recommends that the JINR Directorate support the implementation of this programme. In particular, the PAC notes the incentives in progress directed to attract physicists to the NICA/MPD project.

## **VIII. Recommendations for activities at JINR related to the ILC**

The PAC notes with interest the report presented by JINR Chief Engineer G. Shirkov on the progress for ongoing developments at JINR related to the ILC which were centered on the geological investigation of the ILC possibly being sited in the Moscow Region.

The PAC emphasizes strongly that to maximize the possibility of the ILC being sited in the Moscow Region, a continuous vigorous effort by the JINR Directorate is necessary to establish the ILC as a Russian national priority through dialogue with the Russian national authority.

The PAC recommends that the important work being carried out at JINR be highly visible to the ILC GDE.

## **IX. Recommendations for new projects**

The PAC has considered the proposals of new projects presented at the session, and has the following recommendations.

1. The PAC recommends approval of JINR's participation in the NA62 project until the end of 2012. The PAC notes the high scientific importance and uniqueness of the proposed research, as well as the significant intellectual and methodological contributions by JINR scientists to realization of this project.

2. The PAC recommends approval of the project “Strangeness in nucleons and nuclei” (HyperNIS project) for execution until the end of 2012. The PAC notes with satisfaction that this project is part of the ongoing formulation of a competitive research programme at the Nuclotron-M.

3. The PAC recommends approval of the project “Deuteron spin structure” (DSS project) for execution until the end of 2012. The PAC notes the importance of the proposed research to study polarization and spin effects at the Nuclotron-M.

4. The PAC recommends approval of the ALPOM-2 project for execution until the end of 2012. The PAC notes the importance of the proposed research to study the analyzing power of polarimeters at the Nuclotron-M in view of future proton form factor measurements at JLAB.

5. The PAC recommends approval of the project “Development of prototype units for a Complex of Carbon Radiotherapy” for execution until the end of 2012. The PAC notes the high practical importance of this activity.

#### **X. Recommendation on the preparation of the JINR groups for data taking and analysis in LHC experiments**

The PAC takes note of the information about readiness of the JINR groups participating in the ALICE, ATLAS, and CMS experiments for data taking and analysis. The PAC notes the presence of PhD and diploma students and encourages the groups to attract further students. The PAC looks forward at the next meeting to receiving documented projects for JINR’s further participation in the ALICE, ATLAS, and CMS experiments that should be prepared according to the JINR standard procedure.

#### **XI. Recommendations concerning availability of the JINR networking, computing and information infrastructure for real data taking and data processing in the LHC experiments**

The PAC highly appreciates the LIT activity on the commissioning of the high-speed 20 Gbps telecommunication channel JINR–Moscow and notes the availability of the implemented technological solutions for the further extension of the channel bandwidth.

The PAC welcomes the realization by LIT of the plans to increase the performance of the JINR Central Information and Computing Complex (CICC) up to 2200 KSI2K and the data storage capacity up to 400 TB. It also appreciates the large amount of work accomplished to optimize the CICC network infrastructure and notes the results obtained in

testing this infrastructure within the preparation for real data processing in the LHC experiments.

## **XII. Recommendations on the activities previously approved for completion in 2009 and proposed for continuation**

1. The PAC takes note of the report on JINR's participation in the OPERA project and highly appreciates the results obtained in this experiment with important contributions by JINR physicists. The PAC recommends continuation of this activity until the end of 2012.

2. The PAC takes note of the written report on the project "Preparation of proposals for JINR's participation in the design, manufacturing and testing of the prototypes of linear collider elements", and notes the high quality of the accomplished work. The PAC recommends continuation of this activity until the end of 2012.

3. The PAC takes note of the written report on JINR's participation in the BOREXINO project and highly appreciates the important first results obtained in this experiment. The PAC recommends continuation of this activity until the end of 2012.

4. The PAC takes note of the written report on the SANC project. It notes the leading role of JINR physicists in this project, the high quality of the work under way, and its special importance prior to LHC start-up and the design of the ILC. The PAC recommends continuation of this activity until the end of 2012.

## **XIII. Recommendations on the projects previously approved for completion in 2009**

1. The PAC takes note of the written report on JINR's participation in the HERMES experiment and highly appreciates the obtained results. The PAC recommends closing this project and supports the VBLHEP proposal to complete the HERMES data analysis under the theme "Study of the nucleon and baryon structure at CERN (COMPASS) and DESY (HERMES, H1)".

2. The PAC takes note of the written report on JINR's participation in the H1 experiment and highly appreciates the obtained results. The PAC recommends closing this project and supports the VBLHEP proposal to complete the H1 data analysis under the theme "Study of the nucleon and baryon structure at CERN (COMPASS) and DESY (HERMES, H1)".

3. The PAC takes note of the written report on the KLOD project and notes the high quality of the work accomplished at JINR. The PAC recommends closing the KLOD project for the sole reason that concrete financing and a schedule for implementing this project

cannot be defined now due to the absence of the necessary quality of kaon beams at the U-70 accelerator (Protvino).

#### **XIV. Recommendations on first-priority activities**

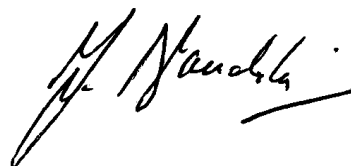
The list of the themes and projects in the JINR programme on particle physics and relativistic nuclear physics having first priority in 2010 is presented in Appendix 2.

#### **XV. Next meeting of the PAC**

The next meeting of the PAC for Particle Physics will be held on 14–15 January 2010.

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 2009
- Results of the implementation of the concluding “Programme of the Scientific Research and Development of JINR (2003–2009)” and the JINR Programme of Particle Physics Research proposed for 2010–2012
- Report on progress for ongoing developments at JINR related to the ILC
- Status report on the Nuclotron-M project
- Report from the Nuclotron-M/NICA Machine Advisory Committee.
- Report on progress towards the NICA Technical Design Report
- Report on progress towards the MPD Conceptual Design Report
- Report on progress towards the NICA White Paper
- Report on the first experience in LHC data taking.



J. Nassalski  
Chairperson of the PAC

### **Review on the Progress in the Realization of the Nuclotron-M Project**

The Nuclotron-M project is considered to be the initial phase of the NICA/MPD project aimed at developing the JINR experimental base for production of intense beams of heavy ions and polarized nuclei with the ultimate goal of studying the problem of phase transitions in strongly interacting nuclear matter. Very active work was continued during the first half of 2009, and essential results were obtained in the realization of several dedicated subprojects.

The full-scale upgrade of the VBLHEP cryogenic complex, started in August 2008, has been completed. Total modernization of the oil-cleaner units for liquid helium at the KGU-1600/4.5 plant was realized. The main part of the KGU-1600/4.5 equipment was renovated. Such reconstruction procedures of KGU-1600/4.5 will allow the accelerator complex of VBLHEP to be safely and stably operational for extended runs and will decrease liquid helium and liquid nitrogen consumption substantially in the next few decades. All the equipment was transferred to Moscow plants, then delivered back and installed at the cryogenic complex; commissioning started in March and then was successfully completed in May 2009.

Substantial progress has been achieved in the Nuclotron vacuum system upgrade. The first stage of the programme was successfully fulfilled in 2008. The vacuum conditions in the Nuclotron beam pipe are estimated to be improved by about two orders of magnitude. The realization of the second stage started in October 2008 with emphasis on the development of the automatic control system for the Nuclotron vacuum equipment and on further installation of new vacuum equipment. This work is performed in close collaboration with Czech companies (Vacuum Praha, FOTON) using modern electronic components. The work started from the design stage and was completed in April 2009 by commissioning the system. Incorporation of the vacuum control system into the Nuclotron one is in progress.

The development of the high-intensity, high-charge state "Electron String Ion Source" (ESIS) is well advanced. Four runs (one month long each) with the existing ion source KRION-2 (solenoid field 3T) were performed with  $\text{Xe}^{36+}$  ions in 2008. Two runs of the four scheduled for 2009 were performed during spring; the third run is starting now. The goal of the experiments is to prepare the source for operation in the Nuclotron run (autumn of 2009) with  $\text{Xe}^{44+}$  ions ( $A=129$ ,  $Z/A=0.341$ ).

The upgrade of the automation and diagnostic systems, RF system and extraction of the accelerated beam are in a very active phase. The RF system is prepared for realization



of beam adiabatic capture in the acceleration that will be tested during the nearest Nuclotron run. A prototype of the new high voltage power supply for the electrostatic septum was constructed and tested at the voltage up to 190 kV. Work on the creation of a new control system of RF and B (magnetic field) synchronization with a new digital synthesizer are in the final stage and its prototype will be tested in the upcoming run. Three of the existing 20 pick-up stations (#2, 11 and 16) were totally reconstructed and experimentally tested at room and helium temperatures and now are ready for the run at the machine. The R&D work on design, construction, and installation of new elliptical pick-ups are in good progress (stage of prototype manufacture).

More attention was devoted to the work related to the upgrade of the existing linac LU-20, which is planned to be used in the proton and light polarized ion injection chain. New power supplies for correctors were installed and commissioned; operational version of the new synchronization system for all linac control channels was commissioned. A dedicated run with beam at LU-20 was performed during preparation for the spring Nuclotron run. The programme of the LU-20 acceleration and RF system upgrade is under preparation now.

### **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. To the moment, essential results have been obtained in the realization of the main part of the project stages.

3. The final conclusion about successive modernization can be made after the commissioning of all the renewed systems with a circulating ion beam in the nearest run.

4. The nearest milestone of the Nuclotron-M project summarizing subproject results has to be passed in the autumn of 2009 during the Nuclotron run with  $\text{Xe}^{44+}$  ions ( $A=129$ ,  $Z/A=0.341$ ).

The MAC recommends that the JINR Directorate provide, with more attention, the required funding for all the project stages (especially, modernization of the required experimental test benches and engineering infrastructure) in accordance with the programme and time schedule for the successful completion of the Nuclotron-M project.



Chairman of the Nuclotron-M/NICA Machine Advisory Committee

Professor B. Sharkov

6 June 2009

## **Review on the Progress in the Development of the NICA/MPD Project**

The design stage of the NICA project is well in progress.

The concept of the NICA injection chain was sufficiently developed; technical solutions for the main part of the equipment are based on well-established technologies. The technical design of the new injector linac and booster is in the final stage.

The linac is based on a structure with focusing by the accelerating field (RFQ and RFQ DTL) which is an adequate solution for a low-energy beam. The right direction of the development is that linac design is performed in cooperation with IHEP (Protvino) team having long experience in design and construction of such type of accelerators.

The booster is based on the Nuclotron type magnets; therefore a long related R&D stage is not necessary, which is obviously an advantage. Thus, serious attention should be paid to modernization and development of the existing VBLHEP experimental test bench for cryomagnetic tests. It is important both for the booster magnet commissioning and for R&D of the collider magnets.

The Nuclotron upgrade programme is realized in accordance with the NICA requirements, and an essential part of the accelerator systems was renewed. Ability of the Nuclotron operation as part of the NICA injection chain should be demonstrated in the Nuclotron run with  $\text{Xe}^{44+}$  ions ( $A=129$ ,  $Z/A=0,341$ ) at the magnetic field value  $\sim 1.9$  T.

Accelerator studies and simulations should be completed soon for the collider rings in order to optimize the ring lattice structure. It is very important to put more flexibility into optics, which is required for the variation of the working point, beta function values at interaction point and optimization of the frequency-momentum slipping factor for effective stochastic cooling.

The beam cooling in the collider is an essential part of the project. It is a challenging task requiring R&D studies, but it would provide a long luminosity life time and improve the collider duty factor. It is desirable to construct the stochastic cooling system prototype for experimental test and study. It should be an important stage of the system development. Closer collaboration with BNL will be very fruitful for the design of the electron cooling system because BNL develops a similar system for luminosity increase at low-energy RHIC operation. Electron cooling can lead to formation of long tails in the ion distribution function, thus the beam halo influence on the detector should be carefully assessed.

More serious attention should be devoted to simulation of space charge effects and coherent instabilities in the intensive heavy-ion beam. It is necessary to include conventional feedback systems into the collider design in order to suppress coherent instabilities of the intensive bunches.

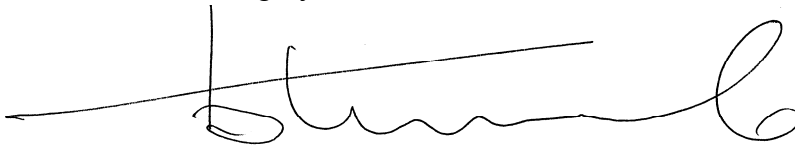
## Conclusion

1. The NICA/MPD project is an important step for further development of JINR as a major centre of high-energy accelerator physics. Design of the accelerator complex is well in progress.

2. To the moment, adequate technical solutions have been developed for the main elements of the collider injection chain.

3. Optimization of the collider lattice structure has to be prolonged in order to have more flexibility of the optics and provide stability of the intensive bunches.

The MAC recommends that the JINR Directorate consolidate the manpower and financial resources on the NICA development in order to keep the project schedule and to support the R&D work related first of all to the design of the future collider dipole magnets and beam cooling systems.

A handwritten signature in black ink, appearing to read 'B. Sharkov', with a long horizontal stroke extending to the left.

Professor B. Sharkov

Chairman of the Nuclotron-M/NICA Machine Advisory Committee

6 June 2009

### **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 2010:

- Theory of elementary particles
- Modern mathematical physics: gravitation, supersymmetry, integrability
- Research and education project “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  $\sqrt{s_{NN}} = 11$  GeV
- Projects HADES (JINR’s participation), NA49/61 (JINR’s participation), BECQUEREL
- Search for non-nucleon degrees of freedom and spin effects in few-nucleon systems. Projects DSS, ALPOM-2
- Study of the nucleon and baryon structure at CERN (COMPASS) and DESY (HERMES, H1) (JINR’s participation)
- Projects CDF, D0 (JINR’s participation)
- Charmed and strange quarks in hadronic reactions (project NA62, CERN) (JINR’s participation)
- Study of neutrino oscillations and determination of oscillation parameters (projects OPERA, Daya Bay, BOREXINO) (JINR’s participation)
- Project HyperNIS
- DIRAC (JINR’s participation)
- ATLAS (JINR’s participation)
- CMS (JINR’s participation)
- ALICE (JINR’s participation)
- NN&GDH
- STAR (JINR’s participation)
- Investigation at the GSI accelerating complex (JINR’s participation)
- Study of  $e^+e^-$  interactions, physics and detectors (projects SANC, BES-III (JINR’s participation))

- Development of prototype units for a Complex of Carbon Radiotherapy
- Project TUS (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, support and development of the education process at JINR.