

**I. Preamble**

The Chairperson of the PAC, W. Greiner, welcomed the PAC members and the *ex-officio* members from JINR, and presented the implementation of the recommendations taken at the previous meeting.

JINR Vice-Director M. Itkis informed the PAC about the Resolution of the 105th session of the Scientific Council (February 2009), the decisions of the Committee of Plenipotentiaries (March 2009), and about the preparation of the Seven-Year Plan for the Development of JINR for 2010–2016.

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.

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.

**II. Recommendations 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 nuclear physics research presented by JINR Vice-Director M. Itkis.

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 meeting for preparing the final version of the seven-year plan to be presented at the next session of the Scientific Council.

### **III. Recommendations on the themes and projects to be completed in 2009 and proposals of new themes**

#### ***“Synthesis of New Nuclei and Study of Nuclear Properties and Heavy-Ion Reaction Mechanisms”***

The PAC discussed in detail the report on the closing theme “Synthesis of New Nuclei and Study of Nuclear Properties and Heavy-Ion Reaction Mechanisms” (03-5-1004-94/2009) and the scientific programme of the Flerov Laboratory of Nuclear Reactions proposed for the next five years.

The PAC notes the significance and high efficiency of the studies of nuclei far from the stability line, which have been performed in the Flerov Laboratory. A number of experiments carried out with the use of actinide targets and of beams of  $^{48}\text{Ca}$  ions have resulted in the synthesis and/or discovery of 6 new elements ( $Z=112, 113, 114, 115, 116,$  and  $118$ ) and of 34 new heavy nuclides. The data obtained are a direct proof of the existence of the region of increased stability expected in the vicinity of the magic numbers  $Z=114$  and  $N=184$ . The experiments have explored the area of stability and confirmed several decay chains by a large extent using cross bombardment. This constitutes a strong argument in favour of the consistency and reliability of the bulk of the decay chains observed.

The PAC also regards as remarkable the work done on the studies of fusion-fission and quasifission aimed at determining the entrance channel properties better suited for the synthesis of superheavy elements. The attempts to identify observables useful to distinguish between quasifission and fusion-fission are very promising and should be continued with high priority.

The PAC also highly appreciates the pioneering experimental results on the study of the chemical properties of superheavy elements 112 and 114 obtained in the Laboratory within the framework of the concluding theme.

The PAC notes the impressive results obtained in the study of the structure of light neutron-rich nuclei near and beyond the drip line.

Recommendation 1. The theme “Synthesis of New Nuclei and Study of Nuclear Properties and Heavy-Ion Reaction Mechanisms” should be completed by the end of 2009.

Recommendation 2. The PAC recommends continuation of the studies within the new theme “Synthesis and Properties of Nuclei at the Stability Limits” for the period 2010–2014 with first priority.

***“Development of the FLNR Cyclotron Complex for Producing Intense Beams of Accelerated Ions of Stable and Radioactive Isotopes” and “Development and Construction of the Accelerator Complex for Producing Radioactive Ion Beams (Project DRIBs)”***

The PAC took note of the report on the closing themes “Development of the FLNR Cyclotron Complex for Producing Intense Beams of Accelerated Ions of Stable and Radioactive Isotopes” (03-5-1014-96/2009) and “Development and Construction of the Accelerator Complex for Producing Radioactive Ion Beams (Project DRIBs)” (03-0-0002-2000/2009).

The PAC highly appreciates the results of the activity of the Flerov Laboratory within the closing accelerator topics dedicated to the development of the FLNR cyclotron complex. In particular, the PAC notes that the project DRIBs-I was successfully commissioned and put into operation. Intense secondary beams of  $^{6,8}\text{He}$  produced at the U400M cyclotron and accelerated at the U400 cyclotron were used in a number of outstanding experiments. The cyclotron U400M was substantially modernized and is able now to accelerate low-energy beams needed for physical and chemical studies of superheavy elements. The PAC notes the success in developing superconducting electron cyclotron resonance ion sources in the Laboratory. The optimization of the accelerator systems resulted in a noticeable increase of the stability and effectiveness of the operation of the cyclotrons. The PAC notes that since 1997 the total operation time of the cyclotron complex for experiments amounts to approximately 100 000 hours.

Recommendation 1. The PAC recommends completion of the themes “Development of the FLNR Cyclotron Complex for Producing Intense Beams of Accelerated Ions of Stable and Radioactive Isotopes” and “Development and Construction of the Accelerator Complex for Producing Radioactive Ion Beams (Project DRIBs)” by the end of 2009.

Recommendation 2. The PAC recommends approval of the new theme “Accelerator Complex of Ion Beams of Stable and Radioactive Nuclides (DRIBs-III)” for the period 2010–2014 with first priority.

Recommendation 3. The PAC is in full agreement with the seven-year plan stating the need for construction of a high-intensity accelerator of heavy ions. In particular, it is of great interest to provide acceleration of ions from carbon to uranium up to the energy range 5–10 MeV/n with stepwise and smooth variation.

### ***“Improvement and Development of the JINR Phasotron for Fundamental and Applied Research”***

The PAC heard with interest the report on the results of numerous activities within the closing theme “Improvement and Development of the JINR Phasotron for Fundamental and Applied Research” (03-2-1038-2001/2009).

In 2005–2006, repair and renewal operations were carried out at the Phasotron and radiation therapy beam channel, after the fire accident on 9 April 2005. Repair and renewal work on the muon and pion channels was performed during 2008–2009.

Medical or biological and clinical research for cancer treatment with proton beams at the JINR Phasotron is very important. Accelerators dedicated to these activities are also desirable. Therefore, the effort of DLNP accelerator physicists is particularly focused on the design and improvement of cyclotrons for hadron therapy applications.

Recommendation 1. The PAC recommends completion of the theme “Improvement and Development of the JINR Phasotron for Fundamental and Applied Research” by the end of 2009.

Recommendation 2. The PAC recommends continuation of this programme within the new theme “Improvement of the JINR Phasotron and Development of Cyclotrons for Fundamental and Applied Research” in 2010–2012 with first priority.

## **IV. Recommendations for new projects**

### **Projects under the new theme “Non-Accelerator Neutrino Physics and Astrophysics”**

The PAC heard with great attention the set of projects of DLNP proposed for the seven-year plan for 2010–2016 aimed at the study of neutrino physics and dark matter (double-beta decay and neutrino magnetic moment: projects NEMO-3, GERDA&MAJORANA, GEMMA-II) and astrophysics (projects LESI, EDELWEISS-II). In recent years, all these projects have made great progress in investigation of neutrino

masses, especially in double-beta searches of elements  $^{76}\text{Ge}$ ,  $^{100}\text{Mo}$ , and  $^{82}\text{Se}$ ; in search for a neutrino magnetic moment and for dark matter signals, as well as the measurement of basic cross sections for  $pd$  and  $dd$  reactions at the lowest energies, important for understanding the burning of the Sun and the stars. With the proposed improvements of the new stages, there lies in the future a great discovery potential.

Recommendation. The PAC recommends supporting the projects NEMO-3 (SUPERNEMO), EDELWEISS-II, GERDA&MAJORANA, GEMMA-II, and LESI for 2010–2012 with first priority.

### **Projects under the new theme “Physics of Light Mesons”**

#### ***SPRING (Spin Physics at hadron storage RINGs)***

The PAC recognizes the fundamental importance of polarization studies proposed in the project. The SPRING project combines investigations of short-range NN properties using the ANKE facility at COSY and preparatory work for the future PAX experiment at GSI/FAIR. The latter opens a completely new field of research using an intense polarized antiproton beam and by measuring transversity, the last missing piece in QCD description of the nucleon structure. The expertise of the DLNP group in the field of the project is recognized.

Recommendation. The PAC recommends approval of the SPRING project for 2010–2012 with first priority.

#### ***PEN-MEG (Precise investigation of rare pion decays and search for forbidden muon decays)***

The PAC heard with interest the information on DLNP’s participation in two ambitious experiments at PSI on the decays  $\pi^+ \rightarrow e^+\nu$  and  $\mu^+ \rightarrow e^+\gamma$  which will provide a precision test of  $\mu-e$  universality and a search for new physics beyond the Standard Model. Both experiments received significant experimental support from DLNP scientists. At present, both of these experiments are in the stage of data taking.

Recommendation. The PAC considers the PEN-MEG project to be very important for DLNP and recommends its approval for 2010–2012 with first priority.

#### ***PAINUC (A study of pion interactions with helium nuclei at intermediate energies)***

The PAC heard with interest the information on the programme of studies of pion interactions with helium nuclei at intermediate pion energies (below the  $\Delta$ -resonance). The

project will reveal whether the production of single  $\gamma$ s (akin to prompt photons) in  $\pi^\pm$ <sup>4</sup>He interactions depends on the incident pion energy and whether there is influence of the nuclear matter density on the  $\Delta$ -resonance excitation. The programme also includes studies of three-prong reaction channels, in particular pion absorption, involving low-energy strongly ionizing secondaries. The collaboration also intends to study the possibility of improving the direct measurement of the  $\nu_\mu$  mass, given the small number of such direct measurements. The proposed method is unique and very promising if good energy resolution of the emerging muon can be demonstrated.

Recommendation. The PAC considers the PAINUC project to be very important for DLNP and recommends its approval for 2010–2012 with first priority.

### **Project under the theme “Research on Relativistic Heavy and Light Ion Physics. Experiments at the Nuclotron”**

#### **FASA-3**

The PAC heard with interest a report on the experimental study of the dynamics of thermal nuclear multifragmentation performed with the modified  $4\pi$  set-up FASA-3 on the Nuclotron beam. The new data on the relative velocity correlations of intermediate mass fragments in collisions of 5 GeV deuterons with the gold target give the fragment emission time less than 50 fm/c (or  $1.5 \cdot 10^{-22}$ s). These experiments are considered to be part of the programme of first measurements of the time scale of the expansion process of hot nuclei and could contribute to understanding the nuclear phase transitions of the liquid-fog and liquid-gas types.

Recommendation. The PAC appreciates the results obtained in the FASA-3 project and recommends continuation of this programme in 2010–2011.

### **V. Poster session**

The PAC was particularly pleased with the presentations of new results and proposals by young scientists in the field of nuclear and particle physics research. This type of presentations should be continued in future. The PAC appreciates the fact that direct responsibilities for set-ups and data analysis have been given to young scientists. This is an important move to increase their confidence and to guarantee their strong future involvement in research.

## VI. Next meeting of the PAC

The next meeting of the PAC for Nuclear Physics will be held on 25–26 January 2010.

Its tentative agenda will include:

- Reports and recommendations on themes and projects to be completed in 2010
- Consideration of new projects
- Results of the implementation of the concluding “Programme of the Scientific Research and Development of JINR (2003–2009)” and the JINR Programme of Nuclear Physics Research proposed for 2010–2012
- Status report on the MASHA and GABRIELA set-ups
- Special report on new detecting set-ups and time scales
- Poster presentations of new results and proposals by young scientists in the field of nuclear physics research
- Scientific reports.



Walter Greiner

Chairperson of the PAC