I. Preamble

The Chairman of the PAC for Nuclear Physics, M. Lewitowicz, presented an overview of the implementation of the recommendations taken at the previous meeting. Additional information on the recent progress in the construction and commissioning of the Factory of Superheavy Elements (SHE) at FLNR was presented by S. Dmitriev.

JINR Vice-Director M. Itkis informed the PAC about the Resolution of the 125th session of the Scientific Council (February 2019) and the decisions of the Committee of Plenipotentiaries (March 2019).

The PAC is pleased to note that the recommendations of the previous PAC meeting concerning JINR research in the areas of nuclear physics have been accepted by the Scientific Council and the Directorate.

The Scientific Council congratulated the PAC for Particle Physics and the PAC for Nuclear Physics for the careful evaluation, in a joint session of the two PACs on 22 January 2019, of all projects and research themes carried out at JINR in the areas of neutrino physics, astrophysics and dark matter.

II. Information and computing infrastructure of JINR

The PAC heard the report on the theme “Information and Computing Infrastructure of JINR” and the report on the project of the “Multifunctional Information and Computing Complex (MICC)”, included in the theme, with proposals on the extension of this theme and the MICC project, presented by T. Strizh.

The PAC noted the substantial progress in developing the MICC high-performance computing component linked to the commissioning of the Govorun supercomputer as one of the key instruments for the further development of experimental and theoretical physics at JINR and its Member and Associate States.

The PAC appreciates LIT’s efforts to achieve the following objectives: development and upgrade of the JINR telecommunication and network infrastructure; modernization of the MICC engineering infrastructure, increase in performance of computing resources and data storage systems.

The PAC supports the development of the JINR information systems aimed at providing information and software support for the JINR research and management activities within the theme “Information and Computing Infrastructure of JINR”.

The PAC also approves the activities of LIT to develop a system for training and retraining IT-specialists based on the JINR MICC and its educational components, which is

aimed at acquainting young scientists and specialists of JINR and its Member States with state-of-the-art techniques of solving applied problems on novel computing architectures using parallel programming technologies. The PAC notes that the planned studies are well founded and necessary for the implementation of the JINR research programme.

Recommendation. The PAC recommends extension of the theme “Information and Computing Infrastructure of JINR” and the MICC project for the period 2020–2023 with first priority.

III. Investigations of neutron nuclear interactions and properties of the neutron

The PAC heard the report on the theme “Investigations of Neutron Nuclear Interactions and Properties of the Neutron” and proposal on the extension of this theme, presented by E. Lychagin. The PAC is satisfied with the high-quality obtained under the theme. In particular, the PAC notes the extraordinary achievements in the research of fundamental symmetries with polarized neutrons, the wide range of excellent results in the field of applied research within international programmes, and the importance of the work for the development of the accelerator facility carried out at IREN.

The PAC highly appreciates the multilateral cooperation of FLNP with other research centres in Russia and elsewhere.

Recommendation. The PAC recommends extension of the theme “Investigations of Neutron Nuclear Interactions and Properties of the Neutron” for the period 2020–2022 with first priority for further research activities in nuclear physics using FLNP neutron facilities: the highly intense pulsed neutron source IREN, the IBR-2 pulsed reactor and the EG-5 electrostatic generator. In the future the PAC expects more details on the programme of nuclear data measurements, in particular the objectives, the priorities and the complementarity with the worldwide programmes. The FLNP Directorate is advised to focus on the modernization of experimental halls and pavilions with beams of the IREN facility, the construction of a polarized nuclear target for the work with polarized neutrons at IREN, and on the upgrade of the EG-5 electrostatic generator. The PAC recommends that special attention be given to the beam delivery systems to increase neutron fluxes at the experiment places. The PAC expects a detailed report on this topic to be presented at the next meeting.

Project TANGRA

The PAC heard a convincing report on the project “Research and development of the tagged neutron method for identification of the elemental structure of matter and studies of nuclear reactions (TANGRA)” under the theme “Investigations of Neutron Nuclear Interactions and Properties of the Neutron” and a proposal for its extension presented by Yu. Kopatch. The

use of BGO crystals and HP-Ge detectors resulted in significant improvements of γ-ray energy resolution. Applications like searches for diamonds in kimberlite ore are now successfully developed.

Recommendation. The PAC recognizes the importance of the TANGRA project and recommends its extension for the period 2020–2022 with first priority. The international collaboration with the institutes that have expressed their interest should be intensified. The ultimate goal of analysing Martian soil should be vigorously pursued.

Letters of intent to open new projects under the theme "Investigations of Neutron Nuclear Interactions and Properties of the Neutron"

Two letters of intent have been presented. The PAC needs more information about these ambitious programs before giving a recommendation. A detailed plan of the developments addressing technological challenges, the required human resources and the timelines are requested.

The PAC suggests before considering full proposals that the authors:

– prove the stability and the calibration accuracy for single pixel detector for the project "Construction of a prototype of the set-up for measurement of the neutron lifetime using the time-of-flight method";

– propose a realistic design of the cryostat for the project "Construction of a facility for polarization of neutrons and nuclei".

Recommendation. The PAC recommends that the authors develop more detailed work plans by determining the stages, their goals, and the required resources, formalize these activities into new project within the above theme, and submit them to the next PAC meeting.

IV. Development of the new advanced neutron source at JINR

The PAC heard with interest the information about FLNP's proposal for the opening of a new theme "Development of the Conceptual Design of a New Advanced Neutron Source at JINR" presented by V. Shvetsov. The PAC shares the concern of the FLNP Directorate and staff about the situation that may arise after the expiration of the service life of the IBR-2 reactor and supports the need to construct a world-class neutron source at JINR to maintain its leading positions in condensed matter research.

Recommendation. The PAC supports the proposal for the opening of the new theme "Development of the Conceptual Design of a New Advanced Neutron Source at JINR" for the period 2020–2022. The PAC requests the FLNP Directorate and the new theme leaders to keep it regularly informed of the progress of work to develop a new neutron source, taking into account the implementation of the ongoing research programme on nuclear physics.

V. Project GDH&SPASCHARM&NN

The PAC heard a detailed report presented by Yu. Uzikov about GDH&SPASCHARM &NN which consists in fact of three independent experimental activities connected by the study of the nucleon spin structure in strong and electromagnetic interactions, and technically strongly supported by the frozen spin polarized proton and deuteron targets created and maintained by the Dubna group.

The GDH experiment at MAMI-C (Mainz) has produced new results of excellent novelty and quality. It is progressing well with a new polarized target using a horizontal ^{3}He/^{4}He dilution refrigerator to be used with the Crystal Ball and TAPS spectrometer.

The SPASCHARM experiment at IHEP Protvino is well under way using the high energy proton and antiproton beams and will soon produce new significant results in the study of nucleon structure by spin observables. In 2022–23 new polarized beams are in preparation which will significantly enlarge the scope of the experiments.

The NN experiment in Prague is preparing polarized a 14 MeV neutron beam to be directed on a polarized deuterium target to study the 3N forces in strong (nd) interactions.

Recommendation. The PAC acknowledges the important role of the Dubna group in all three experiments and recommends extension of the GDH&SPASCHARM&NN project with first priority for 2020–2022. In order to maintain Dubna's international visibility, the researchers should actively continue to take part in all measurements.

VI. Project E&T&RM

The PAC heard the report on the project "Study of deeply subcritical electronuclear systems and their applications for energy production, SNF (NFW) transmutation and research in the field of radiation materials science" (E&T&RM) presented by A. Baldin. Calculations of radiation fields were carried out when quasi-infinite target was irradiated with a proton beam with energy of E_p = 660 MeV and safe irradiation regimes were chosen. Moreover, experiments with different neutron-forming targets were carried out. These targets were installed in the centre of the blanket of the "Big uranium target". The equipment was prepared to obtain experimental data on the fission numbers of the transmutation and the neutron spectra of the leakage.

The PAC emphasizes the positive aspects of the project, e.g. possibility to study recycling of the spent nuclear fuel, development of new neutron detectors, comparison of Monte Carlo simulations with experimental results, and participation of PhD students.

Recommendation. The PAC notes considerable efforts in the transfer and installation of the "Big uranium target" at the DLNP Phasotron and recommends extension of the E&T&RM project for 2020 with first priority.

VII. Proposal for construction of a prototype of the initial section of a high-current heavy-ion linear accelerator

The PAC heard the report on the opening of a new project “Construction of a prototype of the initial section of a high-current heavy-ion linear accelerator aimed at producing intense radioactive ion beams for basic research”, presented by L. Grigorenko. The PAC notes that a considerable amount of work is aimed at developing and checking various methods of acceleration of high-intensity heavy ion beams with linear accelerators using advanced technological solutions (28 GHz ECR ion source, CW RFQ, CW DTL, CW-SC cavities, solenoids, etc.). The proposed work plan aims to construct a prototype of the initial section of the linear accelerator and a design of LINAC-100. In the future, this high-current accelerator integrated with the downstream equipment for RIB production (fragment separator, ion gas catcher, MR-TOF spectrometer, storage ring system, etc.) will allow unique world-class experiments to be carried out with radioactive beams.

A detailed scientific programme, feasibility studies and a following Conceptual Design Report (CDR) of the future facility are proposed to be accomplished during the initial phase of the project.

Recommendation. The PAC recommends the opening of the project “Construction of a prototype of the initial section of a high-current heavy-ion linear accelerator aimed at producing intense radioactive ion beams for basic research” under the theme “Development of the FLNR Accelerator Complex and Experimental Setups (DRIBS-III)” for the two-year period 2020–2021. The PAC is convinced that the full accomplishment of the project would require its extension beyond this period. This work should be supported both in terms of manpower and financial resources, but so that the just starting programmes on research of SHE at the new SHE Factory are not perturbed. At the same time, the PAC recommends elaborating a more detailed work schedule for the development of the facility by determining the stages, their goals and the required resources. Special attention should be paid to the front-end development of the initial part of the accelerator, to the design of high-power production target and of high-intensity gas cell for radioactive ion beams.

The great interest of a number of Russian and foreign institutes in the technical developments for realization of the presented project is certainly advantageous for a timely completion of the work. This offer should be used to the full extent exploring all possible collaborations with leading international laboratories in which superconducting LINACs are designed and/or operated.

The PAC recommends exploring synergies in the SC LINAC design with the high power LINAC considered in the “Pluton” version of the new JINR neutron facility.

VIII. First results of experiments with the ACCULINNA-2 fragment-separator

The PAC heard with great interest the report on the first results of the experiments performed with the ACCULINNA-2 fragment-separator, presented by A. Fomichev. Highly intense ^{8}He and ^{9}Li radioactive beams obtained by ACCULINNA-2 at the U-400M cyclotron were used to study the production and decay of $^{7}\mathrm{H} \rightarrow \mathrm{t} + 4\mathrm{n}$ and $^{10}\mathrm{Li} \rightarrow \mathrm{n} + {}^{9}\mathrm{Li}$ respectively.

These two flagship experiments were carried out in 2018–2019. The preliminary results of the first experiment, though the statistics may appear relatively low, are being submitted for publication and the data analysis of the second experiment is still in progress.

Recommendation. The PAC congratulates the ACCULLINA-2 group on the successful start with two convincing ^{7}H and ^{10}Li dedicated runs. Since the time schedules and the requested resources remain reasonable, the PAC recommends that the Directorate fully support the ACCULLINA-2 project to continue the scientific programme that appears to be promising. The PAC requests a more detailed presentation on the next experimental investigations (increased efficiency, longer runs, etc.) to be submitted at future meetings.

IX. General recommendation

The PAC in agreement with the JINR Directorate strongly recommends that all proposals for new projects and requests for extension of themes or projects contain full information on required financial and human resources and a SWOT analysis.

X. Scientific report

The PAC heard with great interest the excellent report “Transverse momentum distributions of hadrons in the Tsallis nonextensive statistics” presented by A. Parvan. This investigation is of particular interest for JINR since standard Boltzmann–Gibbs statistics also fails at NICA energies; therefore, the PAC supports its continuation with detailed calculations of Tsallis nonextensive statistics in the NICA energy region.

XI. Poster session

The PAC reviewed 13 poster presentations in the field of nuclear physics research by young scientists from LIT and FLNP. The best posters selected are: “T-odd angular correlations in the emission of prompt gamma rays and neutrons in the fission of uranium by polarized neutrons” presented by D. Berikov, “Measurements of gamma ray yields from (n,xγ) reactions at the TANGRA set-up” presented by N. Fedorov, and “Monte Carlo study of systematic errors in the measurement of the scattering of ^{15}N ions by ^{10,11}B” presented by I. Satyshev.

The PAC recommends the poster “T-odd angular correlations in the emission of prompt gamma rays and neutrons in the fission of uranium by polarized neutrons” to be reported at the session of the Scientific Council in September 2019.

XII. Visit to LIT

The PAC thanks the Directorate of the Laboratory of Information Technologies for the organization of the visit to this Laboratory.

XIII. Next meeting of the PAC

The next meeting of the PAC for Nuclear Physics will be held on 30–31 January 2020.

Its tentative agenda will include:

– reports and recommendations on themes and projects to be completed in 2020;
– status of the SHE Factory and its scientific programme;
– results of the experiments at ACCULINNA-2 (once experiments are accomplished and fully analysed);
– consideration of new projects;
– scientific reports;
– poster presentations of new results and proposals by young scientists in the field of nuclear physics research.

M. Lewitowicz

Chairman of the PAC
for Nuclear Physics

N. Skobelev

Scientific Secretary of the PAC
for Nuclear Physics