I. Preamble

The Chair of the PAC for Condensed Matter Physics, D. L. Nagy, welcomed the PAC members, including the new members M. Tashmetov, D. Tayurskii, I. Ushakov, and N. Verga, the ex officio members from JINR, as well as the members of the JINR Directorate. The Chair presented an overview of the implementation of the recommendations made at the previous PAC meeting concerning the JINR research in the area of condensed matter physics.

JINR Vice-Director L. Kostov informed the PAC about the resolution of the 132nd session of the JINR Scientific Council in September 2022 and the decisions of the Committee of Plenipotentiaries of the Governments of the JINR Member States in November 2022.

II. Status of the IBR-2 reactor

The PAC took note of the report on the status of the IBR-2 reactor in the framework of the new Seven-Year Plan for the Development of JINR presented by V. Shvetsov. The PAC was satisfied with the progress in replacing the air heat exchangers of the secondary cooling circuit of the IBR-2 reactor and obtaining an operating license for this facility. The PAC endorsed the FLNP plans for the next seven years, which include the manufacturing of a new fuel load for IBR-2 in order to provide the necessary conditions for extending the reactor's service life for the period after 2032. The PAC notes that a confirmation of the technical feasibility of its production and an estimate of the cost of the work have been obtained.

The PAC also appreciates the continuation of activity towards studying the mechanism of the occurrence of fluctuations in the power pulses of the IBR-2 reactor in cooperation with NIKIET and other organizations of Rosatom State Corporation.

Recommendation. The PAC supports the efforts on replacing the air heat exchangers of the secondary reactor cooling circuit and recommends that FLNP decide on the choice of the manufacturer of components for a new fuel load for IBR-2.

The PAC took note of the report on the problems and prospects for IBR-2 operation presented by A. Dolgikh. The PAC underlines the importance of obtaining a new license as soon as possible, which will give an opportunity to resume the operation of the IBR-2 facility for physics experiments, to carry out the planned upgrade of safety-related

equipment and systems, including the further development of the suite of cryogenic moderators.

Recommendation. The PAC considers it a major task to resume regular operation of the IBR-2 facility for physics experiments in 2023.

III. Reports on the themes to be included in the Topical Plan for JINR Research and International Cooperation for 2024

The PAC took note of the report presented by D. Kozlenko on the FLNP theme "Investigations of Functional Materials and Nanosystems Using Neutron Scattering", which discussed main activities and projects in the framework of the Seven-Year Plan for the Development of JINR for 2024–2030. The PAC appreciates timeliness and multidisciplinary character of the research activities planned within the theme. Further development of the IBR-2 instrumentation and realization of the project "Development of an inelastic neutron scattering spectrometer in inverse geometry at the IBR-2 reactor" will make it possible to maintain the research quality at the competitive level in comparison with the world-leading neutron scattering centres and provide a basis for further extension of research activities. The PAC also notes that the implementation of the User Programme remains a very important activity in the framework of the theme.

Recommendation. The PAC supports main directions suggested for implementation within the theme and recommends that the authors present a detailed structure and content of the projects constituting the theme.

The PAC took note of the report presented by V. Bodnarchuk on projects and activities in the framework of the FLNP theme "Scientific and Methodological Research and Developments for Condensed Matter Investigations with IBR-2 Neutron Beams" for the next seven-year period. The PAC endorses plans for the development of new technologies in the field of neutron detection for their application in the instruments of IBR-2 and the development of the corresponding infrastructure.

Recommendation. The PAC recommends the support of the projects and activities aimed at developing the experimental infrastructure of the IBR-2 reactor.

The PAC took note of the report on the new FLNP theme "Optical Methods in Condensed Matter Studies" presented by G. Arzumanyan. The PAC considered, in particular, the current activities within the ongoing theme "Modern Trends and Developments in Raman Microspectroscopy and Photoluminescence for Condensed Matter Studies", which will be completed in 2023. Based on the results presented in the report, the PAC notes significant progress in the implementation of activities on this theme

and especially the advances in life sciences. The PAC considers them as an appropriate basis for the further development of optical methods for condensed matter research.

The PAC notes that since the beginning of the new Seven-Year Plan for the Development of JINR for 2024–2030, it is proposed to open–the new theme “Optical Methods in Condensed Matter Studies” and the project “Nanobiophotonics”.

Recommendation. The PAC appreciates the progress made in experiments using optical methods and recommends closer collaboration on these topics with other laboratories of JINR, including in particular LRB and MLIT.

The PAC took note of the report presented by M. Bulavin on the FLNP theme “Development of the Conceptual Design of a New Advanced Neutron Source – Fast Pulse NEPTUNE Reactor at JINR” in terms of the current status and plans for 2024–2030. The PAC recognizes the importance of the R&D programme for the development of the new NEPTUNE reactor and the elaboration of the concept of complementary instruments for condensed matter physics, nuclear physics, and applied research, including the prototyping of individual components at IBR-2. The PAC also supports activities towards solving the formal issues related to the development of the new reactor, including the preparation of formal documents for government agencies, the submission of an application for the inclusion of a new facility in the federal target programme, and obtaining a license for the placement and construction of the reactor.

Recommendation. The PAC appreciates the scope of presented activities and recommends continuing the implementation of the project, as it was detailed in the report.

The PAC took note of the report on the status and prospects for the development of the scientific programme of MLIT presented by O. Derenovskaya. The PAC supports the efforts aimed at providing the research underway at JINR with state-of-the-art computing facilities based on the Multifunctional Information and Computing Complex, including the “Govorun” supercomputer, as well as advanced studies in the field of numerical modelling of complex physical systems, experimental data processing and analysis, machine and deep learning, artificial intelligence and robotics, the development of methods of computer algebra, quantum information and computing, big data analytics. The PAC notes the research on the development of an information system as a set of IT solutions providing the storage, analysis and visualization of data from radiobiological experiments (together with LRB), as well as studies carried out in collaboration with FLNP within the UNECE International Cooperative Programme on Vegetation (ICP Vegetation) for monitoring and predicting air pollution processes in Europe and Asia using a combination of satellite data, biomonitoring measurements, and different machine and deep learning technologies.

Recommendation. The PAC notes that a distinctive feature of research areas related to information technology is the close cooperation with all the JINR laboratories, organizations of the JINR Member States and other countries, and recommends that research in this direction be continued.

The PAC took note of the report on the plans for the development of the BLTP theme “Theory of Complex Systems and Advanced Materials” presented by E. Anitas. The PAC is pleased with the overview of the current state of research within the theme and the composition of the following four projects proposed for implementation in 2024–2030: complex materials, mathematical models of statistical physics of complex systems, nanostructures and nanomaterials, and methods of quantum field theory in complex systems. The PAC welcomes the basic scientometric information on the theme as well as the composition of the personnel and the proposed types of collaboration.

Recommendation. The PAC supports the general composition of the theme “Theory of Complex Systems and Advanced Materials”, including four projects within it.

The PAC took note of the report on the DLNP themes “Development of Scientific DLNP Infrastructure for Research Using Semiconductor Detectors, Laser Metrology, Electrons, Positrons and Cryogenic Technology” and “Biomedical and Radiation-Genetic Studies Using Different Types of Ionizing Radiation” presented by V. Glagolev. The PAC notes the progress in the development of the LINAC200 facility and the demand for its electron beams by various research organizations. The PAC is pleased to learn about the project on laser metrology focused on the development and installation of high-precision instruments at the NICA facility and in the laboratories of JINR Member States. The PAC notes the interest of the research community in the positron spectroscopy facility for testing samples of metals, compounds, nanocomposites, diamonds, and many others.

Recommendation. The PAC appreciates the wide range of R&D studies carried out and the high quality of the results obtained and supports further continuing these activities.

The PAC took note of the report on the LRB themes “Research on the Biological Effects of Heavy Charged Particles of Different Energies” and “Research on Cosmic Matter on Earth and in Nearby Space; Research on the Biological and Geochemical Specifics of the Early Earth” presented by A. Bugay. The PAC notes the intention to close these themes after their completion and to open a new consolidated theme “Research on the Biological Effects of Ionizing Radiation with Different Physical Characteristics” for the next seven years. Research on the presented theme will be aimed at studying the mechanisms of action of ionizing radiation with different physical characteristics at the molecular, cellular, tissue and organismal levels of biological organization. The planned research in

astrobiology is aimed at solving the problem of the origin and persistence of life in the Universe using nuclear physics methods.

Recommendation. The PAC supports implementation of the research on biological effects of ionizing radiation with different physical characteristics within the next seven years and considers these topics important for general radiotherapy.

The PAC took note of the report on the new FLNR theme “Radiation Materials Science, Nanotechnological and Biomedical Investigations with Accelerated Heavy Ion Beams” presented by P. Apel. The PAC notes the results obtained in the framework of the ongoing theme, which show the relevance and demand of fundamental and applied research based on the use of accelerated heavy ion beams for the studies of material properties and materials modification. Due to the increasing role of nanotechnology and life sciences, further applied research using heavy ion beams will include R&D works on nanocomposite and functional track-etched membranes, biomedical applications of track-etched membranes and isotopes for nuclear medicine and technology. The PAC is pleased that two new projects are proposed in the framework of this theme: “Radiation tolerance of materials to the impact of high-intensity heavy ion beams” and “Nanocomposite and functional track-etched membranes”. The PAC especially notes that the implementation of the theme will largely be based on the new DC-140 cyclotron being developed at FLNR.

Recommendation. The PAC appreciates the structure of the presented theme and supports the development of biomedical applications of track-etched membranes as well as research work on nuclear isotopes and ecological investigations, which will have the status of activities at the first stage of the theme.

IV. General recommendations

The PAC wishes to hear full-length proposals for the projects constituting the considered themes at its next meeting.

The PAC welcomes the intention of the JINR Directorate to update the approach to the formation of the Topical Plan for JINR Research and International Cooperation by setting the duration of themes equal to seven years. The PAC also supports the introduction of a new mandatory condition for a theme to be active, which is an obligatory presence of at least one ongoing project within such theme.

V. Scientific report

The PAC heard with interest the scientific report “Diagnostics of socially significant diseases using affine track membranes modified with DNA aptamers” presented by

E. Zavyalova. The PAC thanks the speaker for the excellent report and notes the prospects for close cooperation with FLNR team, which intends to develop this direction of research over the next seven-year period.

VI. Virtual presentations by young scientists

The PAC reviewed 10 virtual presentations made by young scientists in the field of condensed matter physics and related fields of information technology. The virtual poster presentation “Development of lithium-ion batteries with increased specific energy and power” made by M. Yerdauletov was selected as the best presentation of the session. The PAC also noted two more virtual poster presentations of a high level: “BIOHLIT — information system for radiobiological research” by I. Kolesnikova and “Pressure-induced phase transition in a nanostructured zinc ferrite” by N. Belozerova. All three authors will be awarded diplomas of the PAC.

Recommendation. The PAC recommends the poster “Development of lithium-ion batteries with increased specific energy and power” for presentation at the session of the JINR Scientific Council in February 2023.

VII. Next meeting of the PAC

The next meeting of the PAC for Condensed Matter Physics is scheduled for 15–16 June 2023.

The preliminary agenda for the next meeting of the PAC includes:

– report by the PAC Chair on the implementation of the recommendations above;
– report by the JINR Directorate on the sessions of the Scientific Council in February 2023 and of the Committee of Plenipotentiaries in March 2023;
– discussion of the next Seven-Year Plan for the Development of JINR for 2024–2030 regarding condensed matter physics;
– reports and recommendations on the projects to be included in new themes within the next Seven-Year Plan for the Development of JINR;
– progress in the development of the concept for a new neutron source of JINR;
– status reports on the upgrade of FLNP instruments;
– information about scientific meetings;
– scientific reports (not more than three);
– poster (or virtual presentation) session.

D. L. Nagy
Chair of the PAC
for Condensed Matter Physics

O. Belov
Scientific Secretary of the PAC
for Condensed Matter Physics