

# Programme Advisory Committee for Condensed Matter Physics

59th meeting, 24–25 June 2024

## Recommendations

### **I. Preamble**

The Chair of the PAC for Condensed Matter Physics D. L. Nagy, welcomed the PAC members, the ex officio members from JINR and 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 135th session of the JINR Scientific Council held in February 2024 and the decisions of the Committee of Plenipotentiaries of the Governments of the JINR Member States in March 2024.

### **II. Current status of work on the new neutron source**

The PAC took note of the information on the efforts of the FLNP team working on the development of the new neutron source, presented by E. Lychagin. The PAC endorses the main directions of activities, including work to outline the suite of necessary instruments of the facility, develop models of reactor dynamics, and study the heating of the modulator elements and the reactor vessel. In further work on the project of the new reactor facility, the most pressing tasks for the near future are research into the mechanisms of power feedback formation and the development of mathematical models describing the processes leading to fluctuations in pulse energy on the basis of the IBR-2 operation experience.

Recommendation. The PAC recommends continuing work on the project to develop the new neutron source. The PAC agrees with the proposal of the FLNP Directorate that at this stage of work, activities should be focused on the following issues: (1) development of the concept of the new source; (2) development of mathematical models describing processes leading to fluctuations in pulse energy on the basis of the IBR-2 operation experience; (3) continuation of work on developing a scientific program for the new reactor with a concept of the instrument base; (4) continuation of work on developing the concept of a system for fast changing the working material in the chamber of the cryogenic moderator of the reactor, and extending activities on determining the optimal configuration of the cryogenic moderator chamber of the new neutron source with a working substance based on hydrogen-containing materials.

### **III. Current plans to resume operation of the IBR-2 reactor and preparations for the restart of the FLNP User Programme**

The PAC took note of the information on the progress of obtaining a license to operate the IBR-2 nuclear research facility and on the preparatory work to replace the air heat exchangers of the reactor's secondary cooling circuit, presented by B. Mukhametuly. At the moment, the FLNP Directorate plans to resume the operation of the reactor in the fall of this year.

Recommendation. The PAC highly appreciates and supports FLNP's plans and efforts to restart the operation of the IBR-2 nuclear research facility in 2024–2025 and resume the FLNP User Programme in 2025. The PAC notes the need to attract a sufficient number of experts to review projects.

### **IV. Status reports on the upgrade of FLNP instruments**

The PAC was informed about the status and progress of instrument modernization at the IBR-2 reactor, presented by V. Bodnarchuk. The PAC notes that active preparations are underway at the IBR-2 spectrometers for the reactor start-up at the end of 2024. All important elements of the spectrometers are being tested and adjusted for correct operation. The detector systems of the spectrometers are undergoing routine testing to ensure their readiness for the reactor start-up. Two new scintillation detectors (ASTRA-M, BSD) have been installed on the IBR-2 beamlines and are ready for test measurements after the IBR-2 reactor starts its operation. Most of the choppers with their control electronics have already been tested and are ready for operation. At present, implementation of the BJN project and activity on the SANSARA instrument are in progress.

Recommendation. The PAC supports overall progress in preparing spectrometers and equipment for the reactor start-up. In particular, the PAC supports activities on the development of the new BJN spectrometer. The PAC heard a report on the status of the SANSARA instrument and notes the progress in its creation within the instrument development programme of the project "Investigations of functional materials and nanosystems using neutron scattering". The PAC appreciates the progress in implementing the BJN project and recommends continuing its implementation.

The PAC heard the report on the current state of the DN-6 diffractometer for the study of materials at ultrahigh pressures, presented by E. Lukin. The PAC notes a significant modernization of the instrument, which makes it possible to increase the incident neutron flux density onto the sample and improve the quality of experimental data.

Recommendation. Considering that the DN-6 diffractometer is one of the most advanced facilities in the world for neutron scattering studies of materials under extreme conditions, the PAC supports the further development of this diffractometer.

## **V. Reports on projects**

The PAC took note of the proposal to open a new project, “High-sensitivity sensors based on molecular recognition for virus detection”, presented by A. Nechaev. The PAC concurs with the authors of the proposal that there is rapidly increasing interest in the development of detection test systems based on surface-enhanced Raman spectroscopy (SERS). An urgent task is to study and optimize the structures of optical aptasensors operating on the SERS effect for highly specific detection of biological agents, with the aim of developing a test system that, in a few minutes, allows the identification of biological agents, such as viruses, bacteria, toxins and low molecular weight products of cell activity, in complex biological fluids. The PAC particularly notes the presence of highly qualified scientists in the international project team.

Recommendation. The PAC recommends opening the new project “High-sensitivity sensors based on molecular recognition for virus detection” for its implementation in 2025–2029 within the theme “Radiation Materials Science, Nanotechnological and Biomedical Investigations with Heavy-Ion Beams”.

The PAC took note of the progress report on the project “Protection against physical and chemical stresses with tardigrade proteins (TARDISS)”, presented by M. Zarubin. The PAC welcomes the study of the molecular mechanisms of multiple-stress resistance in extremophiles, which is becoming possible due to the emergence of omics technologies. In the Sector of Molecular Cell Genetics of DLNP, the properties, molecular structure and perspective practical applications of the radioprotective tardigrade Dsup protein (Damage suppressor) are being studied. During collaborative experiments with FLNP on determining the structure and properties of the protein, the authors of the project showed that Dsup is an intrinsically disordered protein that forms a highly dynamic complex with DNA and is itself resistant to radiation degradation. Based on new data, in collaboration with the FLNR Centre of Applied Physics, the composite biomaterial was created, which is a track membrane functionalized with the Dsup protein for selective cell-free isolation of DNA from solutions.

Recommendation. The PAC welcomes the ongoing activities within the project TARDISS and recommends further continuation of the project within the theme “Study of Molecular Genetic Mechanisms of Adaptations of Extremophilic Organisms”.

## **VI. Scientific reports**

The PAC heard with interest the scientific reports “Functional renormalization group approach to some problems of condensed matter physics” and “Study of phase transitions in cathode materials for sodium-ion batteries”, presented by G. Kalagov and N. Samoylova, respectively. The PAC thanks the speakers for the excellent reports.

## **VII. Virtual presentations by young scientists**

The PAC reviewed 19 virtual presentations made by young scientists in the field of condensed matter physics and related fields. The virtual poster presentation “Pressure effect on crystal, magnetic structure and vibrational properties of van der Waals materials” made by O. Lis was selected as the best presentation of the session. The PAC also noted two more virtual poster presentations of a high level: “Convolutional neural networks for reconstruction of three-dimensional neutron tomography models from incomplete data” by B. Bakirov and “The effect of calcium ions on the structure and morphology of lipid membranes in the presence of amyloid-beta peptide” by S. Kurakin. All three authors will be awarded diplomas of the PAC.

Recommendation. The PAC recommends the poster “Pressure effect on crystal, magnetic structure and vibrational properties of van der Waals materials” to be presented at the session of the JINR Scientific Council in September 2024.

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

The next meeting of the PAC for Condensed Matter Physics is scheduled for 27–28 January 2025.

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 September 2024 and of the Committee of Plenipotentiaries in November 2024;
- progress in the development of the concept for a new neutron source of JINR;
- information about resuming the IBR-2 operation and plans for the IBR-2 User Programme;
- 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