Due to significant air travel difficulties for PAC members, the 59th meeting of the Programme Advisory Committee for Particle Physics was held in a hybrid format via videoconference.

I. Preamble

The Chair of the PAC for Particle Physics, I. Tserruya, presented an overview of the implementation of the recommendations adopted at the previous meeting. JINR Vice-Director V. Kekelidze highlighted the resolution of the 134th session of the JINR Scientific Council (held in September 2023) relevant to particle physics and the decisions of the JINR Committee of Plenipotentiaries (held in November 2023). The Scientific Council supported all recommendations of the PAC on the evaluation of new projects and the extension of ongoing projects in particle physics within the suggested timescale and ranking, as outlined in the PAC's recommendations.

The PAC welcomes the adoption of the new Seven-year plan for the development of JINR and the plans of the Institute's Directorate to concentrate efforts on the priority implementation of major projects, including the flagship mega-science project NICA.

II. Reports on the Nuclotron-NICA projects

The PAC heard the progress report on implementing the Nuclotron-NICA project presented by A. Sidorin. The Committee appreciates the successful completion of the assembly of the ISCRA and SIMBO stations for applied research. The installation of the NICA collider magnets continues in the tunnel, as the building's engineering infrastructure located in key areas is commissioned. In particular, the elements of the RF1 and RF2 systems were installed, vacuum annealing and vacuum tests were carried out. The power supply system for structural elements of the collider is ready for commissioning. The PAC is pleased to note the start of a personnel training programme in preparation for the collider's commissioning in 2025.

The PAC takes note of the progress report on the development of the VBLHEP infrastructure, including the Nuclotron facility, presented by N. Agapov. General construction work is being completed in the new buildings of the NICA complex – the collider building and the new compressor station. The staff is carrying out installation and adjustment of

equipment. Full completion of this work is expected during 2024. The main part of the helium cryogenic equipment has been put into operation; full completion of the commissioning of the NICA cryogenic complex is planned for August 2024. The PAC notes that attention is paid to work on automation of processes of the engineering systems in connection with preparing for operation of the NICA complex in long-term sessions.

The PAC takes note of the report on implementing the MPD project presented by V. Riabov. The production of all components of the MPD first-stage detector is progressing with minimal delays. The time-projection chamber, the time-of-flight system and 40 out of 50 half-sectors of the electromagnetic calorimeter remain on track to be installed in 2024. The most critical task is still cooling and current supply of the large superconducting solenoid. The temporary cryogenic system for the solenoid cooling was assembled, vacuumized and operated in test mode at -50 °C at the end of 2023. Cooling to liquid nitrogen and liquid helium temperatures starts in January. Further progress will strongly rely on the readiness of engineering systems in the MPD building, including stable electricity and water-cooling systems, which are required to be fully operational by May 2024. Magnetic field measurements will start in June 2024 and take three months for different field configurations using the mapper produced by Novosibirsk INP. Installation of the carbon fiber support frame and detector subsystems will follow starting from September. The PAC congratulates the team on finding viable solutions for the critical issues arising for many aspects of the detector construction, assembling and commissioning.

The PAC appreciates the progress in implementing the BM@N project presented by M. Kapishin. The BM@N team efforts were concentrated on aligning the detectors, improving the tracking algorithm, calibrating the time-of-flight system, and correcting the pile-up in the forward detectors for centrality determination. The first processing of the reconstructed data recorded in 3.8 A GeV Xe-CsI collisions was performed using the DIRAC system at the MLIT Tier-1/Tier-2 computers. Statistically significant signals of Λ-hyperon and K^0_S-meson were reconstructed for further physics analysis. The BM@N team also presented results on the production of protons, deuterons and tritons in argon-nucleus interactions at 3.2 A GeV. The next physics run of the BM@N experiment is planned with a Xe beam at a reduced energy of 2–3 A GeV. The PAC emphasizes the lack of manpower for the ongoing analysis of recorded data.

The PAC takes note of the report on the updated version of the SPD Technical Design Report presented by A. Guskov. Compared to the previous version, the detector size has

been increased according to the revised allowed load on the floor of the experimental hall. The design has been modified for the aerogel detector, micromegas-based central tracker, and beam-beam counter. Alternatives for the front-end electronics of the first-stage detectors have also been considered, the DAQ and computing systems are adapted accordingly. The cost estimate has been updated taking into consideration current prices and availability of materials and equipment. The Committee appreciates the appointment of the international SPD Detector Advisory Committee and the progress in forming the SPD collaboration. The PAC recommends that the new DAC conduct a thorough review of the updated TDR and present a report at the next PAC session.

III. Reports on the ongoing projects

The PAC heard the report on implementing the SCAN-3 project presented by S. Afanasiev. The decision to extend the project was postponed at the last PAC session with the request to the JINR team "to make a clear presentation outlining the original goals of the project in 2019, the achievements over the past four years, and its plans for the requested extension period". The project aims at the study of η-nuclei. During 2020–2023, a TOF system was developed based on a SiPM matrix and a fast plastic scintillator, two neutron counters were assembled, the magnet spectrometer received from the Lebedev Physical Institute was modified and equipped with proper electronics, two straw drift chambers complemented the two-coordinate proportional chamber and microstrip silicon vertex detector for the tracking system. For technical reasons, the beam time initially approved for the experiment was not provided. In 2024, the team plans to perform testing and tuning the magnetic spectrometer and to demonstrate an energy resolution of up to 4–5 MeV for measuring correlated πN-pairs.

Recommendation. The PAC supports the team's plans to study η- and Δ–nuclei formation. The PAC recommends extending the SCAN-3 project for 3 years until the end of 2027 with ranking A.

The PAC heard the progress report on the implementation of the in-house ALPOM-2 project presented by N. Piskunov. The main goal of the project is to measure the analyzing power of scattering reactions of polarized nucleons on various targets at the highest momenta available at the Nuclotron – 7.5 GeV/c for protons and 6.0 GeV/c for neutrons. These measurements are also of particular importance to the JLab experiments. Over the past years, the authors have replaced the hadronic calorimeter, increasing its acceptance,

manufactured new drift chambers, improving the reconstruction of tracks at small angles, equipped the facility with a new data acquisition system, and developed new software for experimental data analysis. The PAC notes that beam time for measurements has not yet been allocated.

Recommendation. The PAC supports the team's plan to perform this experiment, as it will ensure JINR's leadership in the field of polarimetric equipment and research. The PAC recommends extending the ALPOM-2 project until the end of 2027 with ranking A.

The PAC takes note of the report on the implementation of the DSS experiment on the internal target of the Nuclotron presented by V. Ladygin. The PAC recognizes significant progress in obtaining experimental data on power analysis in deuteron-proton elastic and proton-proton quasi-elastic scattering, in the development of deuteron and proton beam polarimetry for NICA, and in detector upgrade to continue the spin programme at the Nuclotron.

Recommendation. The PAC recommends extending the DSS project until the end of 2027 with ranking A.

The commissioning of the NICA facility in the next years, including the accelerator complex and the experiments, together with the high priority given to the NICA flagship experiments – BM@N, MPD, and SPD, makes it questionable whether or not beam time will be available for other experiments. This may affect the timely realization of the SCAN-3, ALPOM-2, and DSS projects. In view of that, the PAC recommends that the VBLHEP and NICA managements define an overall strategy for the availability of beam time for users for the next 2–3 years. Once this strategy is defined, the PAC will be ready to prioritize and quantify the beam time to be allocated to these experiments.

IV. Proposal of new projects

The PAC heard the proposal to open a new project "Fundamental and applied physics using beams of relativistic accelerated electrons (FLAP)" presented by A. Baldin. The FLAP collaboration is planning to carry out its research at the linear electron accelerator LINAC-200. The project is related to the fundamentals of electromagnetic interactions as well as new applications. The task list includes the study of controllable generation of electromagnetic radiation by relativistic electrons using functional materials, the investigation of the characteristics and controllable generation of Cherenkov, synchrotron, and transition radiation with a frequency of up to the GHz scale, the interaction of beams of relativistic

electrons with surface and corrugated structures, the creation of secondary neutron beams for neutron radiography, and testing new detectors for non-destructive beam diagnostics with high spatial and time resolution.

Recommendation. The PAC supports the proposal to develop these interlaboratory activities at JINR and recommends opening the new project FLAP for the period of 2025–2029 with ranking A.

The PAC heard with interest the proposal to open a new project entitled "HyperNIS+SRC: HyperNuclear Intrinsic Strangeness and Short-Range Correlations" presented by A. Averyanov. The initial stage of the experimental programme aims at studying the lightest neutron-rich hypernuclei, like $^{6}_{\Lambda}$H, $^{4}_{\Lambda}$H, $^{3}_{\Lambda}$H. The search for such hypernuclei can be performed with a special setup, such as HyperNIS. At present, it includes beam monitor counters, a system of trigger counters, 55 cm long vacuum decay vessel, 4 groups of proportional chambers, and two analyzing magnets with a magnetic field of 0.6 T. Adding the SRC apparatus dedicated to the study of short-range correlations will considerably expand the physics programme. The study of the possibility to locate the SRC experiment at the HyperNIS setup area is ongoing.

Recommendation. The PAC supports the proposed experiment with hypernuclei at the Nuclotron, the plans to expand the setup for the SRC study, and recommends approval of this project until the end of 2029 with ranking A.

V. Reports on research results obtained by JINR groups in the LHC experiments

The PAC takes note of the report presented by E. Rogochaya on the new results obtained by the JINR team in the ALICE experiment on femtoscopic correlations of non-identical charged kaons in p-Pb interactions at 5.02 TeV, in ultra-peripheral p-Pb collisions (UPC) at 8.16 TeV, and on the development of a thermal model of particle generation in pp and A-A interactions. When analysing femtoscopic kaon correlations in p-Pb collisions, it was shown that the contribution from the ϕ meson and Coulomb interaction in the final state is more noticeable compared to Pb-Pb collisions at 2.76 TeV. In the UPC analysis, it was shown that the cross section of the exclusive J/ψ meson photoproduction is well described by a power-law function depending on the energy of the photon-proton systems, similarly to the results of other experiments. The updated version of the Thermal Model is being prepared for publication. The group continues its participation in the maintenance of the GRID-ALICE system at JINR. Progress has been made in the development of new electronics for the

PHOS spectrometer, which provides good energy resolution (~2%) and makes it possible to improve the time resolution to 100 ps.

The PAC takes note of the new results and current activities in the ATLAS experiment presented by E. Khramov. Topics under study at JINR include the applicability of the Standard Model (SM) and verification of its predictions, the search for additional exotic bosons in two-jet processes, and the search for supersymmetric long-lived particles and supersymmetric charged Higgs bosons. With significant participation of the JINR group, new results have been obtained in the study of SM processes and the Higgs boson. The limits of physics beyond the Standard Model have also been updated. The group made significant contributions, within the ATLAS upgrade programme, to the production and assembly of all 32 micromegas quadruplets for the New Small Wheel, which are partially included in the trigger system. During the first half of 2023, the JINR group significantly contributed to ten ATLAS journal publications and presented its results at two international conferences.

The PAC takes note of the report presented by V. Karjavin on the new results obtained by the JINR team in the CMS experiment. JINR physicists contributed to the study of processes with leptons in the TeV energy range using the Run2 and Run3 data. The main topics of analysis were the search for candidates for non-baryonic dark matter, processes with violation of the lepton number, and models with extended Higgs sector. Other studies have provided a new method for measuring the fractions of quark and gluon jets. The JINR group is actively involved in the HL-LHC detector upgrade, participating in the construction of the high-granularity calorimeter HGCal and modernization of the forward muon station ME1/1. The JINR group made a leading contribution to the distributed CMS data processing and effective data operations within the Tier-1 and Tier-2 grid sites of JINR. Young scientists from Dubna contributed directly to a large number of scientific publications in 2023.

VI. Scientific reports

The PAC takes note of the reports “Status of the COMET experiment” presented by D. Chokheli and “Preparation of the SRC experiment” presented by M. Patsyuk, and thanks the speakers for their interesting presentations.

VII. Presentations by young scientists

The PAC reviewed 25 reports presented by young scientists from BLTP, DLNP, MLIT, and VBLHEP at the poster session. The Committee selected the report “Development of

technology for the production of double-sided silicon microstrip modules for upgrading the NICA BM@N Silicon Tracking System" made by A. Sheremetiev to be presented at the next session of the Scientific Council in February 2024.

VIII. Next meeting of the PAC

The next meeting of the PAC for Particle Physics is scheduled for 17–18 June 2024.

The preliminary agenda for the next meeting includes:

- status report on the Nuclotron-NICA project,
- status report on the infrastructure issues including the Nuclotron,
- report from the coordinator of the experimental programme with the Nuclotron beams,
- status report on the MPD project including simulation results,
- report on the BM@N project including physics results for the Xe run,
- report from the SPD DAC on the TDR,
- progress reports on JINR's participation in the LHC experiments,
- consideration of new projects,
- final reports and recommendations for the projects to be completed in 2024,
- posters from young physicists.

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Chair of the PAC
for Particle Physics

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