Programme Advisory Committee for Particle Physics

57th meeting, 23 January 2023

Recommendations

Due to the significant air travel difficulties for PAC members, the 57th meeting of the Programme Advisory Committee for Particle Physics was held via videoconference with a reduced agenda.

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 132nd session of the JINR Scientific Council (held on September 2022) relevant to the PAC for Particle Physics and the decisions of the JINR Committee of Plenipotentiaries meeting that took place in 2022.

The PAC notes the importance of the Statement by the JINR Committee of Plenipotentiaries (CP) on preserving the unity of the Institute, its scientific mission, and international partnerships within a peaceful environment, adopted at the extraordinary session of the CP on 21 March 2022. The PAC fully supports the steps taken by the JINR Directorate to emphasize the international status of the Institute and overcome the difficulties of this challenging time.

II. Recommendations for the Seven-Year Plan for the Development of JINR for 2024–2030 in the field of the particle physics research

The PAC was very pleased by the detailed presentation of the draft of the new Seven-Year Plan for the Development of JINR for 2024–2030 made by V. Kekelidze. The Committee strongly supports the established priorities in the area of particle physics and relativistic heavy-ion physics:

- implementation of a physics programme to study hot and dense baryonic matter and phase transitions at the BM@N and MPD experimental facilities after the commissioning of the basic configuration of the NICA acceleration complex;
- creation of the first stage of the SPD experimental setup for research in the field of spin physics;
- launch and support of an international user programme for interdisciplinary applied research at the NICA facilty, creation of a user infrastructure around the ARIADNA channels and irradiators;

— promotion of international cooperation around JINR's major projects, at NICA BM@N, MPD, and SPD experiments, and at the Baikal-GVD neutrino project.

The PAC reiterates its recommendation on the allocation of manpower within VBLHEP to ensure timely completion of the NICA complex, including experimental facilities, and realization of their ambitious physics programme. Every effort should be made to attract outside collaborators as well as to strengthen interlaboratory cooperation at the NICA complex and in-house experiments.

III. Reports on the Nuclotron-NICA projects

The PAC heard the progress report on the realization of the Nuclotron-NICA project presented by A. Sidorin. The Committee appreciates the intensive work of the VBLHEP accelerator complex for the experimental programme at the SRC and BM@N facilities. The PAC congratulates the NICA team for the successful completion and joint operation of several elements of the NICA complex — the ion source, the heavy-ion linear accelerator, the Booster, the Nuclotron, and the modernized 136-meter beam transport line, and for the installation of all dipole superconducting magnets in the arcs of the collider tunnel. This is a very significant achievement in the collider assembly and preparation for machine commissioning.

The PAC takes note of the progress report on the development of the VBLHEP infrastructure, including the Nuclotron facility, presented by N. Agapov. At the main transformer substation "Dubna" 110/6 kV, the transformers were replaced, making it possible to increase the supplied power to 40.8 MW. This fully meets the needs of the NICA megaproject. The complete commissioning of the substation has been prepared and is planned after the end of the current run of the accelerator complex. The largest helium liquefier in Russia with a capacity of 1000 liters per hour and a 2000 W refrigerator for the Booster were put into operation at the cryogenic complex. All other components of the complex have been installed; the commissioning is underway. The construction of the collider building is at the final stage, which will allow installation of equipment of the collider, the MPD detector and the electron cooling system.

The PAC takes note of the report on the realization of the MPD project presented by V. Ryabov. The production of all components of the MPD first-stage detector configuration is progressing well. All activities continue despite the recent changes in the geopolitical and economic situation. The commissioning of the time-projection chamber and the time-of-flight subsystems with their readout electronics remains on track to be completed for the detector assembly in 2023. The production of 1600 modules of the electromagnetic

calorimeter has been completed in Russia and China in equal shares. Test assembly of the first half-sectors using carbon fiber baskets has begun. Sixteen ECAL sectors out of a total of twenty-five are expected to be ready by November 2023. There are attempts to produce 400 additional modules in Russia for their installation in the detector prior to the start of its operation. The timely delivery of the wavelength shifters will be a decisive factor. The most critical tasks for the first part of 2023 will be cooling, current supply and tests of the MPD large superconducting solenoid followed by magnetic field measurements. The PAC congratulates the MPD team on finding viable solutions for the critical issues arising for many aspects of the detector construction, assembly and commissioning.

The PAC appreciates the progress in the realization of the BM@N project presented by M. Kapishin. An important milestone of the project is the physics run with a 3.6 A GeV xenon beam interacting with a CsI target which started in November and continues to the end of January . The data acquisition system has already recorded over 300 million Xe+CsI interactions. The experiment is running with a full set of detectors, which include beam trackers, a central tracking system consisting of silicon and GEM detectors, outer tracker consisting of a cathode strip and drift chambers, time-of-flight system, trigger detectors, as well as a hadron calorimeter and hodoscopes for the event centrality determination. The PAC notes the successful operation of the vacuum beam line and beam profile meters between the Nuclotron and the BM@N as well as inside the BM@N setup. The installation of the vacuum beam line has significantly reduced the beam background in the BM@N detectors.

The PAC takes note of the report on the preparation of the Technical Design Report of the SPD experiment presented by A. Guskov. The Committee acknowledges the progress made by the SPD collaboration in preparing the TDR based on the results obtained during the development and testing of the prototypes of the SPD subsystems. A classical magnetic system with a solenoid magnet was chosen. The SPD project is expected to be implemented in two phases. The basic configuration will be used for measurements with polarized proton and deuteron beams at low collision energies and below nominal luminosity (10^{32} cm^{-2} s^{-1}). It will include a muon system, a straw tracker, a central detector based on Micromegas, zero angle calorimeters and beam collision detectors (BCD). At the second stage, a complete configuration with a silicon vertex detector, a time-of-flight system, an electromagnetic calorimeter, and an aerogel detector will be built, which is necessary for the implementation of the main task of the SPD — the study of the polarized gluon structure of nucleons.

Recommendation. The PAC encourages the team to update the project, taking into account the current availability of materials and equipment, as well as their cost. The Committee recommends JINR management to appoint a Detector Advisory Committee for a thorough review of the SPD TDR.

IV. Reports on the ongoing projects

Following the request made at the 55th session, the PAC heard progress reports from the two JINR groups participating in the T2K-II and COMET projects.

The progress report on the JINR participation in the T2K-II project was presented by Yu. Davydov. Over the past 1.5 years, the JINR group has contributed to the upgrade of the near detector ND280 of the T2K experiment: a platform and a top access system for the SFGD target assembly were developed, manufactured, and sent to Japan. Members of the JINR team are involved in assembling the detector at J-PARC and in the development of the SFGD calibration system.

Recommendation. The PAC appreciates the participation of the JINR group in the T2K-II experiment. The PAC reiterates its concern, expressed in the recommendations of the 55th PAC for Particle Physics, on the role, strategy and scientific visibility of the JINR group within the T2K-II project. The PAC recommends continuation of the JINR's participation in the second phase of the T2K experiment until the end of 2024 with ranking B.

The progress report on JINR's participation in the COMET project at J-PARC was presented by Z. Tsamalaidze. In 2022, JINR physicists made a significant contribution to the development and production of several subdetectors for the initial phase of the COMET experiment. A technique has been developed for the production of straw tubes with parameters superior to those available so far. The JINR team took part in the assembly and testing of the first station of the straw tracker at J-PARC and continued to work on modeling and optimizing the calorimeter. The R&D on the Cosmic Rays Veto Counter was completed, the proposed design of the detector was adopted, and the first module was manufactured.

Recommendation. The PAC acknowledges the leading role the JINR group is playing in the development and construction of the main subsystems of the COMET detector. The PAC also notes with satisfaction the participation of members of the JINR group in the management structures of the COMET collaboration. The PAC recommends continuation of the project until the end of 2024 with ranking A.

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

The PAC takes note of the report presented by B. Batyunya on the new results obtained by the JINR group in the ALICE experiment on femtoscopic di-kaon correlations in peripheral and central PbPb and pPb interactions at an energy of 5.02 TeV and on the development of the Thermal model for the production of particles in pp and AA interactions. In the new 3D analysis of femtoscopic correlations in pPb collisions, the source size of kaon emission was studied, and it was shown that the kaon emission time is three times smaller than in PbPb collisions. All these results were presented at the December meeting of the ALICE collaboration, and approved for publication. Good agreement of the predicted elliptic flow parameter in the new version of the Thermal model with the ALICE experimental data for PbPb interactions has been obtained. This version is now being prepared for publication. In addition, the team continued to participate in the maintenance of the GRID-ALICE analysis at JINR. The PAC appreciates the progress on the PHOS spectrometer upgrade with a new readout scheme, improved energy characteristics and good time resolution of 140 ps.

The PAC takes note of the new results and current activities of the JINR group in the ATLAS experiment presented by I. Yeletskikh. JINR physicists participated in the development of new analysis methods, new measurements of Standard Model processes, and contributed to the search for new physics beyond the SM. The discovery of narrow signals in J/Ψ-J/Ψ and J/Ψ-Ψ' spectra near the threshold made it possible to suggest new mechanisms in charmonium interactions — the possible existence of exotic tetraquark states with masses of 6.6, 6.9, and 7.3 GeV. Further clues will be found by careful study of their production and decay kinematics. A sophisticated analysis was performed for the production of the Higgs boson in association with single/pair top-quarks. The JINR group participated in the selection of data and the development of machine learning methods for separating signals and background. The PAC acknowledges the significant contribution of the group to the upgrade of the ATLAS detector. All commitments of the JINR group in the Phase-1 were successfully met, including the commissioning of the NSW detector with all thirty-two large Micromegas quadruplets produced in Dubna.

The PAC takes note of the new results and current activities of the JINR group in the CMS experiment presented by V. Karjavin. The Committee notes the participation of the JINR group in the development of physics analyses based on the data collected during the LHC operation in Run2 and Run3, which started in the middle of 2022. With a significant contribution of JINR physicists, for the combined production of di-jets and di-leptons, the

most stringent lower mass limits to date have been established for dark matter particles and spin-1 mediators with a dark sector. The JINR group was actively involved in the commissioning and start of operation of the detector; it participated in the data collection during Run3 and data processing at the Tier-1 center of the JINR MICC. The PAC notes the important role of the JINR group in the construction of a high-granularity calorimeter (HGCal) and the modernization of the Forward Muon Station (ME1/1) as part of JINR's responsibility in the CMS Phase-2 upgrade for the operation in high luminosity conditions at the HL-LHC.

The PAC notes with satisfaction the growing visibility and increased involvement in physics analyses of the three JINR teams participating in experiments at the LHC.

VI. Presentations by young scientists

The PAC reviewed 18 posters presented in the Zoom breakout room mode by young scientists from VBLHEP, MLIT, and DLNP. The PAC was very pleased with the overall good quality of the reports. The Committee selected the report "A study of the correlation between the kinetic energy of a track and its energy response in the ZDC for run7 of the BM@N experiment" made by K. Alishina to be presented at the next session of the Scientific Council in February 2023.

VII. Next meeting of the PAC

The next meeting of the PAC for Particle Physics is scheduled for 21–22 June 2023.

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, in particular from the Xe run;
- report on the preparation of the TDR for the SPD detector;
- 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 2023.
- posters from young physicists.

I. Tserruya

Chairman of the PAC
for Particle Physics

A. Cheplakov

Scientific Secretary of the PAC
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