

I. Preamble

The Chairman of the PAC for Particle Physics, I. Tserruya, presented an overview of the implementation of the recommendations taken at the previous meeting.

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

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. The Scientific Council endorsed the recommendations of the PACs and considered that the recommendations and the classification would be useful for the DLNP and the JINR Directorates in their efforts towards concentration of resources in selected directions and strengthening the research programme.

The Scientific Council supported the recommendations of the PAC for Particle Physics on the approval of new projects and on the continuation of ongoing projects in particle physics within the suggested time scales, as outlined in the PAC's minutes.

II. Reports on the Nuclotron-NICA project

The PAC heard with interest the report on the progress towards realization of the Nuclotron-NICA project presented by S. Kostromin. The PAC is pleased to support the active work on the mounting of the Booster superconducting magnets inside the Synchrotron yoke and expects the assembly and commissioning with beam to be completed by the end of 2019. The PAC requests to improve the diagnostics of the accelerator complex in order to be able to deliver to the users well identified beams without contaminations.

The PAC heard the report on the infrastructure developments at VBLHEP, including the Nuclotron facility, presented by Yu. Mitrofanova. The Committee acknowledges the progress achieved and welcomes the efforts of the Laboratory to reduce the delay of the construction work schedule for the infrastructure of the collider complex.

The PAC heard the report on the progress towards realization of the NICA/MPD project presented by A. Kisiel. The PAC welcomes the admission of two new institutions to the MPD collaboration — the University of Warsaw and the China Institute of Nuclear

Energy. The Committee is pleased to note the establishment of the Detector Council, Executive Council and Physics Working Groups of this collaboration. The PAC is impressed by the magnitude and quality of the simulations already accomplished and those being performed by the PWG. The PAC welcomes the collaboration efforts to develop the detector elements, as well as its computing and software infrastructure with a view to completing the first stage of the detector by 2021.

The PAC heard the report on the progress towards realization of the BM@N project presented by M. Kapishin. The Committee congratulates the BM@N team for the presentation of first physics results on the production of lambda hyperons and encourages it to shorten the time between data collection and release of preliminary results. The PAC appreciates the ongoing efforts for the preparation of the BM@N set-up for heavy-ion beams in 2021.

III. Reports on projects approved for completion in 2019 and proposed for continuation

General considerations on JINR's participation in the LHC experiments. According to the JINR Topical Plan of Research, each one of the three LHC themes, ALICE, ATLAS and CMS, has two associated projects: one devoted to physics analysis and operations and the other focused on detector upgrade and R&D, with substantial overlap of the JINR personnel involved in the two projects. The PAC considers that the separation into two projects is not justified and recommends that the JINR Directorate consider unifying the two activities into one single project in order to better monitor and regulate the execution of the so far distinct projects.

The PAC found it very convenient and useful to simultaneously review the three LHC projects at the same PAC meeting and thus decided to approve them for the same period of time so as to keep synchronized their future submission and review cycles. In general, the PAC proposes to have a thorough yearly review of each LHC experiment and every 6 months a brief status report just pointing to the progress in the fulfilment of the milestones of relevance for the JINR groups.

The PAC took note of the report on JINR's participation in the CMS experiment at the LHC presented by A. Zarubin. The PAC congratulates the JINR CMS group on the quality of the work carried out in various detector subsystems with major JINR responsibilities, including the forward muon station and the endcap hadronic calorimeter, which contributed to the smooth and stable running of the CMS detector throughout Run2.

The PAC also commends the operation and service work carried out by the group and, in particular, the performance of the Tier1 computer centre.

The Committee notes progress in physics studies with direct participation of JINR members: the study of muon pair production, including Drell–Yan processes, searches for physics Beyond the Standard Model (BSM), measurements of Higgs boson couplings and study of multiple jet production processes.

Recommendation. The PAC encourages the group to better balance the detector maintenance and operation work with the physics studies. In particular, the PAC recommends that the JINR CMS group make larger efforts towards a higher productivity in terms of physics analysis and scientific publications, commensurate with the global contribution of JINR to CMS. Along the same line, the PAC would like to see a physics analysis plan which includes subjects that would allow the group to achieve higher visibility, with identified JINR responsibilities and an increased number of young researchers and students involved. In this regard, the presence of a large number of participants with 0.1 FTE is a matter of concern. The Committee recommends continuation of JINR's participation in the CMS project for the period 2020–2023, with first priority, pending the setting in place of corrective actions to address the above-mentioned concerns, and the presentation at the next PAC meeting of a project-plan/timeline over the next 4 years indicating who is going to work on each subproject together with a series of milestones and deliverables to be used by the PAC to monitor and regulate the execution of the whole project. For that, the PAC requests regular reports at each PAC meeting on the activities and achievements of the group: a short written report at June meetings and a more detailed report with oral presentation at January meetings.

The PAC appreciates the report on the status of the CMS detector upgrade presented by CMS Spokesperson R. Carlin. The Committee is impressed by the scale of the CMS Phase-II upgrade programme and wishes that the Collaboration will succeed in implementing such an ambitious plan together with a visible contribution of the JINR group.

The PAC took note of the report on the physics results obtained by the JINR group in the ATLAS experiment at the LHC presented by E. Khramov. The group fulfilled its obligations for the detector operation and maintenance in terms of shifts. Although only 50% of the experts' operation was covered, the corrective actions have been taken.

The Committee appreciates the progress in the various physics analyses with JINR responsibility, such as those defining the structure of the proton at ultrahigh energies, searching for physics BSM, searching for a valence-like nonperturbative component of heavy quarks in the proton, etc. The JINR group has performed a search for quantum black holes and pentaquarks, precision measurements of the production cross section of $W/Z + b$ -jet and B_c excited states. The group members have also contributed to the observation of associated production of Higgs boson with vector boson and of Higgs boson with $t\bar{t}$ quark pair, and to the search for the tH process.

The PAC notes with pleasure the large number of scientific publications with direct participation of JINR members and the consistency of the research subgroups involving several young researchers.

Recommendation. Although the proposed activities for the next years are relevant and compelling, the PAC recommends that the group concentrate on studies for which it could achieve a leadership role with a visible impact within the ATLAS collaboration, in terms of coordination roles, involvement of new young researchers, and presentations at major conferences. The Committee recommends continuation of JINR's participation in the ATLAS project for the period 2020–2023, with first priority, pending the presentation at the next PAC meeting of a project plan/timeline over the next 4 years indicating who is going to work on each subproject together with a series of milestones and deliverables to be used by the PAC to monitor and regulate the execution of the whole project. For that, the PAC requests regular reports at each PAC meeting on the activities and achievements of the group: a short written report at June meetings and a more detailed report with oral presentation at January meetings.

The PAC took note of the report on the results obtained by the JINR group in the ALICE experiment at the LHC presented by V. Pozdnyakov. The Committee takes note of the involvement of the group in physics analysis that has resulted in several publications. These include a new femtoscopic correlation analysis for pairs of opposite sign kaons produced in Pb-Pb and, for the first time, p-Pb interactions at the energy $\sqrt{s_{NN}}=2.76$ TeV that showed consistency with the predictions of hydrodynamic models. Event generators and software for analysis of heavy quarkonia production, developed with the participation of the JINR group, provided new results for the nuclear modification factors for $Y(1s)$ and $Y(2s)$ in Pb-Pb collisions at 5.02 TeV. The main efforts of the JINR group in the next years will be focused on the study of femtoscopic correlations, the production of light vector mesons in ultraperipheral Pb-Pb collisions and the production

of heavy quarkonia. The group will also contribute to the maintenance and development of the GRID-ALICE analysis at JINR and to the photon spectrometer upgrade.

Recommendation. The PAC is concerned with the relatively low visibility of the JINR team working in ALICE as reflected for example by the lack of talks at the major conferences in the field. The PAC also notes that the group, with several senior scientists, needs rejuvenation. The PAC strongly encourages the group leader to take actions to attract young scientists and students into the project aiming at a strong impact and visibility. The PAC recommends continuation of JINR's participation in the ALICE project for the period 2020–2023 with first priority, pending the setting in place of corrective actions to address the above-mentioned concerns, and the presentation at the next PAC meeting of a project plan/timeline over the next 4 years indicating who is going to work on each sub-project together with a series of milestones and deliverables to be used by the PAC to monitor and regulate the execution of the whole project. For that, the PAC requests regular reports at each PAC meeting on the activities and achievements of the group: a short written report at June meetings and a more detailed report with oral presentation at January meetings.

The PAC took note of the report on the SCAN-3 project presented by S. Afanasiev. The highly excited nuclear matter created in nuclei by a high-energy deuteron beam of the Nuclotron will be studied through observation of its decay products into pairs of particles with opening angle close to 180° . The existing set-up will be upgraded with a new magnetic spectrometer for the detection of charged and neutral particles of the correlated pairs. The measurement of such pairs will enable studies of low-energy η A interactions, search for η -bound states (η -mesic nuclei) and studies of the Δ -isobar produced and stopped inside nuclear matter.

Recommendation. The PAC notes the expertise of the authors in these studies, the large size of the JINR group involved in the project and the very modest requested budget. The PAC recommends continuation of the SCAN-3 project for the period 2020–2022 with first priority, making sure that it does not interfere with NICA operation.

The PAC took note of the report on the NA64 experiment at the SPS CERN, presented by D. Peshekhonov. The PAC notes the relevance of the research programme and its potential in the quest for dark matter. The PAC recognizes the excellent role played by the JINR team in the design, production, test and installation of the straw tube chambers, together with their data acquisition software, online monitoring and visualization,

reconstruction and Monte-Carlo simulation. The PAC also notes that the recommendations made by the PAC for Particle Physics and the PAC for Nuclear Physics at their joint session in January 2019, to improve the ratio of FTE to participants, to attract students and to get involved in data analysis are not properly addressed in the presented material.

Recommendation. The PAC decides to postpone any recommendation on the project till the authors present to the PAC, not later than at the next session in January 2020, a revised proposal including an action plan where the previous recommendations mentioned above are addressed. Till then, if needed, the PAC recommends that the JINR management provide sufficient resources to the group to allow continuation of their work and commitments.

The PAC took note of the report on the development of the JINR Multifunctional Information and Computing Complex (MICC), presented by T. Strizh. The MICC proposal is focused on the major hardware and software components of the computing complex, creation of a state-of-the-art software platform in order to develop methods and algorithms of machine/deep learning (ML/DL) for a wide range of tasks and applications. The ambitious project includes modernization of a high-speed telecommunication, network and engineering infrastructure, development of IT-infrastructure for the NICA project, increase of storage capacity and performance of Tier1 and Tier2/CICC centres, enlargement of the HybriLIT heterogeneous platform with the Govorun supercomputer, extension of the cloud components and other MICC resources in order to satisfy increasing requirements of the JINR large-scale scientific programmes. A unified management system for all MICC components, including big data processing, will be developed.

Recommendation. The PAC recognizes that the implementation of the ambitious research programme of large-scale experiments at JINR basic facilities and worldwide requires continuous and considerable investments in systems providing processing and storage capacity of increasing data volumes. The PAC is pleased to note that LIT has successfully fulfilled the JINR computing needs for all its activities both in-house and outside. The Committee recommends continuation of the MICC project for the period 2020–2023 with first priority.

IV. Proposal of a new project

The PAC took note of the proposal of a new project FASA at the Nuclotron, presented by S. Avdeev. The main goal of the project is the study of space-time characteristics of hot nuclei formed in the collisions of light relativistic ions with heavy targets. The experiment is carried out using relativistic beams from the Nuclotron and the 4π -FASA detector. Its thirty telescopes will allow spectroscopic and correlation measurements in terms of relative angles (from 10° to 180°) or relative velocities of intermediate-mass fragments. Radial flow as a function of the fragment charge, thermalization in the hot spectator of the target, and the time of disintegration will be studied.

Recommendation. The PAC notes that similar work on Multi-Fragmentation of Nuclei was carried out some 40 years ago at Fermilab, at CERN-PS and at Bevatron and Bevalac. The PAC requests the authors to sharpen their scientific case taking into account these earlier data and to present a convincing case on how they can solve the still open question of break-up or thermalization in the multifragmentation of nuclei. The PAC looks forward to receiving an improved proposal with details on the target thickness, the identification power of their telescopes for He and Be isotopes, and a simulation of the performance of the experiment in comparison with theoretical predictions.

V. Development of JINR's strategic long-range plans

The PAC heard with interest the reports concerning the long-range plans of JINR's development in the area of relativistic heavy-ion and spin physics presented by R. Tsenov. The PAC highly appreciates the JINR Directorate's efforts towards establishing priorities and shaping up the strategic plans for the future of JINR. The Committee looks forward to being informed about further developments and proposals to be considered at the next meetings.

VI. Scientific reports

The PAC heard with interest the report "Neutrinoless double-beta decay: theory challenges" presented by F. Šimkovic and "Femto-cyclones and baryon polarization in heavy-ion collisions" presented by O. Teryaev, and thanks the speakers for their presentations.

VII. Young scientists at JINR

The PAC reviewed 17 poster presentations in particle physics by young scientists from DLNP, LIT and VBLHEP. The Committee selected the poster “Neutrino oscillation analysis in the NOvA experiment” presented by L. Kolupaeva to be reported at the session of the Scientific Council in September 2019.

VIII. Next meeting of the PAC

The next meeting of the PAC for Particle Physics will be held on 3–4 February 2020.

The following items are proposed to be included in the agenda of the next meeting:

- follow-up on the to-do-list from this PAC meeting;
- status report on the Nuclotron-NICA project;
- report from the Coordinator of the experimental programme with Nuclotron beams;
- status report on infrastructure issues including Nuclotron;
- status report on the MPD project;
- status report on the BM@N project;
- Conceptual Design Report of the SPD experiment (and formation of the Collaboration);
- progress reports on the JINR participation in the LHC experiments;
- upgrade proposals of the LHC experiments;
- revised proposals of NA64 and FASA;
- consideration of new projects;
- reports and recommendations on the projects to be completed in 2020;
- posters from young scientists.



I. Tserruya

Chairman of the PAC
for Particle Physics



A. Cheplakov

Scientific Secretary of the PAC
for Particle Physics