Due to the worldwide pandemic, the 55th meeting of the Programme Advisory Committee for Particle Physics was held via videoconference.

I. Preamble

At the opening of the meeting, the JINR Director, G. Trubnikov, and the Chair of the PAC for Particle Physics, I. Tserruya, payed tribute to the memory of Prof. Jean Cleymans, member of the PAC since 2010, who passed away in a tragic accident on February 22, 2021. A minute of silence was observed by all meeting participants.

I. Tserruya presented an overview of the recommendations taken at the previous meeting and highlighted the Resolution of the 129th session of the JINR Scientific Council of February 2021 relevant to the PAC for Particle Physics. The Scientific Council supported all the recommendations of the PAC on the evaluation of new projects and on the continuation of ongoing projects in particle physics within the suggested period as outlined in the PAC's recommendations.

The evaluation of new projects, as well as those seeking continuation, was conducted following the guidelines proposed by the JINR Director, G. Trubnikov, aiming at classifying the projects into three categories (A, B and C), using the scheme adopted at the previous joint sessions with the PAC for Nuclear Physics in 2019 and 2021. The ranking is primarily based on the scientific merit of the project, and the performance, impact and visibility of the JINR group. For this purpose, the project leaders were requested to answer a short questionnaire prepared by the PAC. The questionnaire itself, the answers to the questionnaire and the referee reports have been uploaded to the Indico webpage of the session. The final evaluation of each project was made taking into account the opinion of its referees and the subsequent discussion of the project at the PAC session.

Following the directives of the JINR Directorate, the projects were approved till the end of the current Seven-Year Plan, i.e. till the end of 2023, with the understanding that for those projects that will be included in the next Seven-Year Plan, the approval will automatically be extended till the end of the requested period.

II. JINR news

The PAC PP heard with interest the report presented by the JINR Vice-director, V. Kekelidze, on the ongoing activities in the Institute, the Resolution of the Scientific Council taken at the 129th session of February 2021, the decisions of the Committee of Plenipotentiaries taken at the meeting of March 2021, and the development of new managerial structures aimed at the consolidation of intellectual, material and human resources in accordance with the priorities of the Seven-Year Plan.

III. Reports on the ongoing projects with regard for the pandemic situation

The PAC heard the progress report on the realization of the Nuclotron-NICA project presented by A. Sidorin. The PAC noted with satisfaction the confirmation of the completion of the installation of the beam transport channel from the Booster to the Nuclotron and the plans for the second Booster run in 2021. The PAC is pleased to note that, in spite of the delay in completing the civil work in the collider building 17, the target time for launching the NICA collider is unaffected.

The PAC takes note of the progress report on the infrastructure developments at VBLHEP, including the Nuclotron facility, presented by N. Agapov. The PAC acknowledges with satisfaction that, despite problems caused by the pandemic, significant progress was achieved, in particular, in commissioning of power substations, preparations of the central cryogenic plant, installation of equipment in the new compressor building, and commissioning of the main new buildings.

The PAC appreciates the report on the realization of the MPD project presented by A. Kisiel. The PAC takes note of the schedule for the magnet assembly and for the installation and commissioning of the main subsystems of Stage-I: the Time Projection Chamber, the Time-of-Flight, the Fast Forward Detector, the Hadronic Calorimeter and 14 sectors of the Electromagnetic Calorimeter. The PAC notes with satisfaction the growth of the MPD collaboration with the recent affiliation of 3 new institutions. The PAC underlines the importance of further simulation work aimed at optimization of the detector performance, the analysis methodology and the readiness for the first physics measurements at the start of NICA operations.

IV. Proposal of new projects

The PAC takes note of the report on JINR's participation in the T2K-II and Hyper-Kamiokande experiments presented by V. Glagolev. T2K is a first-class leading experiment in the field of neutrino physics. The group has experience in the development of detectors, electronics, data processing and engineering design. The group is involved in the design of the platform for the new superFGD for the near detector and the development of an LED calibration system for the superFGD in view of running T2K phase-II in collaboration with the preexisting INR group.

Recommendation. The PAC recognizes the team's plan to potentially contribute to the upgrade of the T2K-II near detector. However, the role, the strategy and the perspectives of the group present elements of qualitative and quantitative concern. Therefore, the PAC recommends JINR's participation in T2K phase-II till the end of 2023 with ranking B and requests a progress report in one year. The possible participation in the future large-scale Hyper-Kamiokande experiment should be decoupled from the one in T2K-II due to the much higher level of commitment and support that are needed and should be considered by the JINR management when defining the next JINR Seven-Year Plan.

The PAC takes note of the report on the new project "Upgrade of the CMS Detector" presented by V. Karjavine. The goal of the project is to prepare the CMS detector for effective operation at the HL-LHC conditions with proton-proton collisions at 14 TeV center-of-mass energy and with instantaneous luminosity higher than $5 \cdot 10^{34}\,\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$. According to the Memorandum of Understanding (MoU) for the CMS detector construction between CERN and JINR, the JINR team shall participate in the design and construction of the high granularity calorimeter HGCal and the upgrade of the forward muon station ME1/1.

Recommendation. The PAC recognizes the importance of JINR's obligations and recommends approval of the JINR's participation in the second phase of the CMS detector upgrade till the end of 2023 (the requested period is till 2026) with ranking A.

V. Scientific report

The PAC heard the scientific report "Current and future neutrino experiments at accelerators" presented by Yu. Kudenko. The PAC thanks the speaker for his very interesting presentation.

VI. Reports on the projects approved for completion in 2021 and proposals for their continuation

The PAC appreciates the progress towards realization of the BM@N project presented by M. Kapishin. The team is focused on the preparation of detectors, further development of the data analysis methods and simulation for the forthcoming runs of the BM@N detector with ion beams starting in 2022. The analysis of the data collected with carbon and argon beams on fixed targets continues.

Recommendation. The PAC reiterates its concern about the lack of sufficient manpower (mainly students and post-docs) for the data analysis and simulations. The PAC acknowledges the high importance of the BM@N detector successful operation in the first run of the accelerator complex including the Booster and recommends continuation of the BM@N project till the end of 2023 (the requested period is till 2026) with ranking A.

The PAC takes note of the report on JINR's participation in the COMET project at J-PARC presented by Z. Tsamalaidze. The experiment aims at searching for a possible charged-lepton flavour violation (CLFV) through the neutrinoless process of muon-to-electron transition, as a probe into/of physics beyond the Standard Model. The PAC notes with satisfaction that JINR followed the PAC's recommendation and converged into one major experiment in the field with strengthened participation and that the JINR group is playing an important role in the development and construction of the main subdetector systems of the COMET set-up. This is backed up by a visible participation of JINR in the research coordination and management of the international collaboration.

Recommendation. The PAC appreciates the work carried out by the JINR group in the COMET experiment and the future plans. The PAC recommends continuation of the project until the end of 2023 (the requested period is till 2024) with ranking A and requests a progress report in one year.

The PAC takes note of the report on JINR's participation in the NA62 experiment at the SPS presented by D. Madigozhin. The experiment aims at measuring the very rare kaon decay $K^+ \to \pi^+ \nu\nu$. NA62 is planning a test of the Standard Model (SM) by means of a 10%-precision measurement of the Cabibbo–Kobayashi–Maskawa (CKM) matrix element V_{td}. JINR made a significant contribution to the design, construction, operation and maintenance of the spectrometer, to software development, data collection and analysis, and to the expansion of the NA62 scientific programme. The PAC appreciates the results

of the 2016–2018 datasets analysis that led to the observation of 20 candidate events of the rare decay and the publication of first results.

Recommendation. The PAC notes that the data taking of the NA62 experiment is expected to be completed within a couple of years and recommends continuation of JINR's participation in the NA62 experiment till the end of 2023 (the requested period is till 2024) with ranking B.

The PAC heard the progress report on the realization of the in-house ALPOM-2 project presented by N. Piskunov. The main goal of the project is to extend the measurements of analyzing power for the reactions of polarized nucleon scattering on different targets at the highest momenta available at the Nuclotron, 7.5 GeV/c for protons, and 6.0 GeV/c for neutrons. The PAC notes the particular relevance of these measurements to the JLab experiments. The authors plan to upgrade the detector increasing its acceptance and improving the track reconstruction at small angles. The PAC congratulates the ALPOM-2 team for having successfully finalized the data analysis and for publishing the results obtained at lower momenta.

Recommendation. The PAC supports the group's plan to pursue this experiment and recognizes that it will secure JINR's leadership in polarimetry equipment and study. The PAC notes the possible difficulties in allocating the requested 336h of polarized deuteron beam in 2022–2023, due to the strong competition for, and the limited availability of, beam time in this period. The PAC recommends continuation of the ALPOM-2 experiment till the end of 2023 with ranking A.

The PAC takes note of the report on JINR's participation in the STAR experiment at RHIC presented by Yu. Panebrattsev. JINR has been participating in the STAR experiment since its inception and has contributed to the construction and maintenance of the endcap and barrel EM calorimeters, to the preparation of the new reaction plane detector (EPD), to the software development and data analysis. The JINR group has contributed to several physics analyses including the energy dependence of the global polarization for hyperons and antihyperons, measurements of the longitudinal spin asymmetries for W boson production and the longitudinal spin asymmetry for jet production in pp collisions. The PAC notes that, over the past 3 years, the impact and visibility of the JINR team in terms of leadership positions within the collaboration, papers published with major JINR contribution and talks at conferences, are not commensurate with the very large size of the group of 33 members (21 FTE).

Recommendation. Noting that the experience gained by the team is relevant to the NICA project and that the STAR experiment is expected to complete its data taking phase within several years, the PAC encourages the team to gradually shift its focus to the NICA experiment. The PAC recommends continuation of JINR's participation in the STAR experiment till the end of 2023 (the requested period is till 2024) with ranking B.

The PAC heard the progress report on the realization of the DSS project presented by M. Janek. The experiment is focused on the study of the spin structure of 2N and 3N short-range correlations via measurements of polarization observables in deuteron induced reactions at intermediate and high energies at the Nuclotron. The PAC recognizes the significant contributions of the JINR team to hardware, software development and data analysis that resulted in several publications with major JINR involvement. The JINR team is planning an upgrade of the DSS set-up, mainly the development of a proton polarimeter for measurements with polarized deuterons and protons.

Recommendation. The PAC supports the plans of the JINR team. The PAC notes possible difficulties in allocating the requested 700 h of polarized deuteron and proton beams in 2022–2024 due to the strong competition for, and the limited availability of, beam time in this period. The PAC recommends continuation of the DSS experiment till the end of 2023 (the requested period is till 2024) with ranking B.

The PAC takes note of the report on JINR's participation in the HADES experiment at GSI presented by V. Ladygin. The HADES spectrometer is devoted to the study of low-mass dilepton production and in-medium modification of light vector mesons in the warm and dense matter created in heavy-ion collisions at the SIS-18 accelerator at GSI. The PAC recognizes the JINR contributions to hardware (the second plane of the MWPCs and its associated front-end electronics), software development and data analysis focused on the study of elementary reactions. The JINR group plans to participate in the HADES upgrade programme and in the physics analysis of p+p data.

Recommendation. The PAC notes the relatively small size of the JINR team, the relevance of HADES and CBM to the MPD and BM@N physics programme and the possible synergy between these experiments. The PAC supports the plans to merge the JINR groups participating in HADES and CBM into one group focusing on the research programme of the CBM experiment. The PAC recommends continuation of JINR's participation in the HADES experiment till the end of 2023 (the requested period is till 2026) with ranking B.

The PAC takes note of the report on JINR's participation in the NA61 experiment at the SPS presented by A. Dmitriev. The PAC notes the new results obtained from the energy scan programme of the NA61 experiment and the involvement of the JINR group in the upgrade of the NA61 apparatus (ToF detector based on Multigap Resistive Plate Chambers in cooperation with the MPD team). The PAC notes the research interests of the group including studies of light nuclei, hyperon, hyper-nuclei and anti-matter production in heavy-ion collisions. The PAC urges the group to complete these studies and publish the results. The PAC notes the low ratio of FTE to members (5.6/15). The PAC recognizes the relevance of NA61 to the NICA project and the possible benefit of training young researchers in the framework of the NA61 experiment for the NICA project.

Recommendation. The PAC recommends continuation of JINR's participation in the NA61 experiment till the end of 2023 (the requested period is till 2024) with ranking B.

The PAC heard the progress report on the "Precision laser metrology for accelerators and detector complexes" project presented by M. Lyablin. The project aims at developing precision instruments for registration of microseismic phenomena. The group contributed to the design and manufacture of mechanical elements of PLI (Precision Laser Inclinometer), developed PLI associated software and participates in the assembly, installation and maintenance of the PLIs. The use of this instrumentation is growing. In particular, four PLIs are installed in the LHC tunnel and two more PLIs are used for the VIRGO detector.

Recommendation. The PAC notes that work is underway with the goal of using PLIs for possible earthquake predictions. The PAC supports the group involvement in the registration of the angular microseismic tilts of the earth's surface for the NICA, LHC and FCC colliders, as well as the use of compact PLIs for the "Einstein Telescope" project. The PAC recommends continuation of the project till the end of 2023 with ranking A.

VII. Written reports on the projects approved for completion in 2021

The PAC takes note of the written reports on the ARIEL and HyperNIS projects for the period of 2019–2021, presented by L. Kalinovskaya and D. Krivenkov, respectively.

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

The PAC takes note of the report on JINR's participation in the ALICE experiment presented by B. Batyunya. The femtoscopy studies performed by the group comprise non-identical and identical kaon pair production in PbPb-collisions and identical kaon pair production in pp-collisions. A paper-draft has been prepared and approved by the Collaboration for publication in Physical Review C. The JINR group is carrying out an analysis of ρ(1450) and ψ(2S) photoproduction in ultra-peripheral collisions with subsequent decays into four pions and J/ψ + two pions, respectively. The results were reported at international conferences and ALICE meetings.

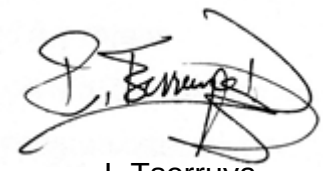
The PAC takes note of the report on JINR's participation in the ATLAS experiment presented by V. Lyubushkin. The PAC notes the progress in various physics analyses, such as: defining the structure of the proton at ultra-high energies, searching for manifestations of physics beyond the Standard Model and observation of the production of a Higgs boson in association with a W or Z boson. There are also achievements in the search for pentaquark, search for B_c excited states and associated production of a $t\bar{t}$ quark pair and a Higgs boson. Good results were also obtained by the group participating in the module production for the muon spectrometer. The PAC is pleased to note that the Micromegas problems have been solved and the first Small Wheel is being commissioned for Run3.

The PAC takes note of the report presented by M. Savina on the results obtained by the JINR group in the CMS experiment. The main research activities are search for candidates for non-baryonic dark matter, signals of low-energy gravity, processes with violation of lepton number and extended Higgs models. The PAC acknowledges the significant contribution made by JINR physicists to the results of the CMS Collaboration obtained with the full statistics of the LHC Run2 with very high energy leptons. Other studies provide precision tests and measurements of fundamental Standard Model parameters. The PAC commends the significant contribution of JINR to the development of CMS data processing and operations within the Tier-1 and Tier-2 GRID sites of the JINR MICC (Multifunctional Information and Computing Complex).

IX. Next meeting of the PAC

The next meeting of the PAC for Particle Physics is scheduled for 24–25 January 2022. The preliminary agenda for the next meeting includes:

- follow-up to the to-do list from this PAC meeting;
- status report on the Nuclotron-NICA project;
- status report on infrastructure issues including Nuclotron;
- report from the Coordinator of the experimental programme with Nuclotron beams;
- status report on the MPD project including simulation results;
- report on the BM@N project including simulation and physics results;
- report on the SPD CDR by the SPD DAC;
- progress reports on JINR's participation in the LHC experiments;
- consideration of new projects;
- reports and recommendations on the projects to be completed in 2022;
- poster presentations by young physicists.



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