

**I. General considerations**

The Scientific Council takes note of the comprehensive report by JINR Director V. Matveev, covering the highlights of the year 2019 for JINR, the decisions of the latest session of the JINR Committee of Plenipotentiaries in Hanoi, Vietnam (November 2019), the current state of the JINR priority research programmes, the activities in the area of human resources training and staff qualification raising at JINR as well as recent events in JINR's international cooperation.

The Scientific Council congratulates JINR on its active participation in the key events of the International Year of the Periodic Table of Chemical Elements (IYPT), which ended with the IYPT Closing Ceremony in Tokyo on 5 December 2019. The achievements presented by JINR within the IYPT emphasized the leading role of this Institute in the synthesis and study of properties of new superheavy elements.

The Scientific Council notes with satisfaction the commissioning and the successful technological start-up of the Booster of the NICA complex, which took place on 23 December 2019, and the ongoing work on the installation of the superconducting MPD magnet in the NICA collider hall.

The Scientific Council welcomes the new agreements on joint activities on the NICA project signed with five Polish and five Mexican research centres and universities as well as the updated JINR–GSI Cooperation Agreement on German participation in the NICA project signed by the partners during the Helmholtz Winter Readings in Moscow on 6 February 2020.

The Scientific Council congratulates the leaders of the NICA project, I. Meshkov and V. Kekelidze, on their election as Full Member and Corresponding Member of the Russian Academy of Sciences respectively.

The Scientific Council appreciates the commissioning, in 2019, of five photodetector clusters within the Baikal-GVD project — the largest deep-water neutrino telescope in the Northern Hemisphere with an effective volume of 0.25 km<sup>3</sup>, and notes the plans for installing two additional clusters with 576 optical modules in 2020. The Scientific Council welcomes the coordination by the Russian Ministry of Science and Higher Education of the cooperation within the Baikal-GVD project between JINR and the Institute for Nuclear Research of the Russian Academy of Sciences.

The Scientific Council recognizes the significant progress achieved in developing the concept of a new neutron source at JINR as well as FLNP's activities on continued upgrade and development of the IBR-2 facility, its cryogenic moderators and spectrometers. It also notes the successful implementation of the FLNP User Programme at the IBR-2 spectrometer complex, which provides a wide range of options for research in condensed matter physics and related fields.

The Scientific Council takes note of the agreement signed between JINR and the Rosatom State Atomic Energy Corporation on partnership interactions in some aspects of implementing large projects, including development of the NICA collider complex and of the Factory of superheavy elements, exploitation of the IBR-2 reactor, and development of JINR's new neutron source.

The Scientific Council appreciates the constant attention being paid by the JINR Directorate to human resources training and staff qualification raising. Since the beginning of operation of the new dissertation councils at JINR, on 1 September 2019, on the basis of JINR's right to independently confer academic degrees, three PhD theses have already been defended. The Scientific Council also notes the beginning of operation of the JINR Distinguished Postdoctoral Research Fellowship Programme and one year of operation of the Dubna School of Engineering on the basis of the Cooperation Agreement between JINR, Dubna State University and Bauman Moscow State Technological University with support of the Moscow Region Government.

The Scientific Council welcomes the efforts being undertaken by the JINR Directorate towards ensuring a competitive level of salaries for JINR's qualified scientists, engineers and specialists.

The Scientific Council notes the recent achievements in strengthening JINR's international cooperation. These include the ongoing process of restoration of the full membership of the Republic of Uzbekistan in JINR, the signing of the JINR–Serbia Roadmap for Cooperation, the ongoing implementation of the JINR–BMBF Joint Declaration of Intent, the negotiations held with JINR's participation within two recent meetings of the Group of Senior Officials on Global Research Infrastructures and on BRICS Research Infrastructures.

## **II. Implementation of the Seven-year plan for the development of JINR for 2017–2023 and proposals of updates to the Plan**

The Scientific Council takes note of the reports concerning progress in implementing the Seven-year plan for the development of JINR (2017–2023) in its major

sections, presented by JINR Acting Vice-Director and VBLHEP Director V. Kekelidze (NICA project), by JINR Vice-Director R. Lednický (particle physics), by JINR Vice-Director M. Itkis (nuclear physics), and by JINR Vice-Director B. Sharkov (condensed matter physics, radiation biology).

On the whole, the Scientific Council highly appreciates the ongoing efforts to implement the Seven-year plan. However, it stresses again that JINR needs to consolidate its research programme within the major objectives of this Plan.

The speakers also presented their proposals for updates to the Seven-year plan which concern, in particular:

- the schedules for completion and start of operation of the main elements of the NICA complex;
- the Neutrino programme (challenge of increasing the effective volume of the Baikal-GVD detector to 0.45 km<sup>3</sup>);
- R&D for a new experimental hall (1st class) for chemistry of superheavy elements and a project for a new separator;
- the topic “Neutron scattering and optical research” in the Plan’s Section “Condensed Matter Physics”;
- a new project: “Precision laser metrology for accelerators and detector complexes”;
- further development of the Multifunctional Information and Computing Complex.

The Scientific Council endorses these proposals. At its future sessions, it looks forward to being informed about further progress in implementing the Seven-year plan and its updates.

The Scientific Council would like the format of these presentations to be modified in the future to leave more room for discussion.

### **III. Draft Strategic plan for the long-term development of JINR**

The Scientific Council takes note of the report of the International Working Group on the draft of the Strategic plan for the development of JINR presented by JINR Director V. Matveev and JINR Vice-Director B. Sharkov.

The Scientific Council expresses gratitude to the members of the Working Group for the preparation of a single, integrated document based on the deep analysis of materials presented by the thematic subgroups describing the overall strategy with its flagship projects and partnership priorities. The Scientific Council suggests that the

Working Group should take into account the comments and proposals made during the discussion at this session.

The Scientific Council recommends that the JINR Committee of Plenipotentiaries consider the presented draft as a basis and asks the JINR Directorate to continue work on strategic planning towards developing the Seven-year plan for 2024–2030 taking into account the opinion of the Member States and defining precisely their participation in major research projects and the required human and material resources.

#### **IV. Initiative of IUPAP**

The Scientific Council takes note with interest of the report “International Year of Basic Sciences for Development in 2022: status and prospect” presented by M. Spiro, President of the International Union of Pure and Applied Physics (IUPAP) and member of the JINR Scientific Council.

In November 2019, the UNESCO General Conference adopted a resolution to proclaim 2022 as the International Year of Basic Sciences for Development (IYBSD). The IYBSD would contribute to highlight the crucial role of basic sciences for sustainable development and to emphasize the contributions of basic sciences to the implementation of the 2030 Agenda and achievement of the Sustainable Development Goals.

The proposal for the IYBSD was developed by IUPAP, with the encouragement and support of UNESCO, the International Science Council and its many members and partner institutions including the International Union of Pure and Applied Chemistry (IUPAC).

The Scientific Council recommends that JINR actively support this initiative and hopes that the United Nations General Assembly will take a positive decision.

#### **V. Recommendations in connection with the PACs**

The Scientific Council takes note of the recommendations made by the PACs at their meetings in January-February 2020, as reported at this session by I. Tserruya, Chair of the PAC for Particle Physics, M. Lewitowicz, Chair of the PAC for Nuclear Physics, and D. L. Nagy, Chair of the PAC for Condensed Matter Physics. The Scientific Council requests the JINR Directorate to consider these recommendations while preparing the JINR Topical Plan of Research and International Cooperation for the year 2021.

## Particle physics

The Scientific Council is pleased to note that all the magnets of the Booster synchrotron have been installed in the ring and that commissioning work has started. It supports the active preparatory work for starting the collider assembly: test of the RF1 system and progress in the serial production of the collider magnets. The Scientific Council shares the PAC's appreciation of the openness of the report on the infrastructure developments at VBLHEP pointing out at sources of delay in civil construction and suggesting the need to revise procurement procedures.

The Scientific Council welcomes the efforts of the MPD collaboration to develop the detector elements with a view to completing the first stage of the detector construction and commissioning by 2021. It appreciates the ongoing efforts for the BM@N team toward the completion of the experimental set-up for the heavy-ion run in 2021.

The Scientific Council appreciates the progress made by the JINR group in fulfilling its obligations in the ATLAS upgrade project, in particular the continuation of mass-production of the MicroMegas chambers for the New Small Wheel of the Muon spectrometer. It also notes that results on the search for pentaquark, for  $B_c$  excited states and associated production of the  $t\bar{t}$  quark pair and Higgs boson, were reported at various international conferences. The Scientific Council joins the PAC in reiterating its recommendation to the JINR Directorate to consider unifying the two JINR ATLAS projects, one devoted to physics analysis and operation and the other focused on detector upgrade and R&D, into a single one. The Scientific Council endorses the PAC's recommendation on continuation of the project for the period 2021–2023 with first priority.

The Scientific Council appreciates the effort of the JINR team in the ALICE experiment in physics analysis concerning the photoproduction of light vector mesons in ultraperipheral Pb-Pb collisions and, for the first time, the identical charged kaon femtoscopic correlations in p-Pb collisions at the energy of  $\sqrt{s_{NN}}=5.02$  TeV. It notes the group's contribution to the maintenance and development of the GRID-ALICE analysis at JINR and to the photon spectrometer upgrade, and encourages further increase of these efforts. The Scientific Council supports the PAC's request that the group submit at the next PAC meeting a detailed plan of its future activities with milestones.

The Scientific Council takes note of the contribution of the JINR group in the CMS experiment to the search for extra gauge bosons and extra dimensions in the dimuon channel, the recent results on searches for extra Higgs bosons decaying into pairs of

b-quarks and muons. It also commends the work carried out by the group in the Phase 1 upgrade project, in the operation of the Tier1 and Tier2 computer centres as well as in the CMS Regional Operation Centre.

The Scientific Council notes with pleasure that the action plan previously requested from the participants of the NA64 experiment to improve the ratio of FTE to participants, to attract students and to get involved in data analysis, is satisfactorily addressed in their revised proposal. The Scientific Council endorses the PAC's recommendation to continue the JINR's participation in the NA64 project for the period 2021–2023 with first priority.

The Scientific Council notes that the revised proposal of the FASA experiment at JINR has not answered the criticism raised at the previous PAC meeting. The authors have not convinced the PAC that FASA is a detector capable of resolving the open questions of the multifragmentation process. Data have shown, almost forty years ago, that spectra of these isotopes are very different from each other indicating different times in the reaction mechanism. The FASA detector lacks, in particular, isotope identification of light nuclei like  $^3\text{He}$ - $^4\text{He}$ ,  $^6\text{Li}$ - $^7\text{Li}$ , and  $^7\text{Be}$ - $^9\text{Be}$ . Furthermore, the FASA detector has limited capability in measuring the full event in  $4\pi$  geometry. The Scientific Council seconds the PAC's recommendation to reject the FASA project.

The Scientific Council recognizes the scientific merit of the charged-lepton flavor violation processes as probes for new physics and appreciates the JINR contributions to experiments Mu2e, MEG-II and COMET. The Scientific Council concurs with the PAC that participation in three different experiments with very similar scientific goals and competing with each other is not fully justified. It supports the PAC's proposal to focus effort and resources on one single experiment, thus providing better conditions for the JINR team to achieve stronger impact, visibility and leadership in that experiment. The Scientific Council endorses the PAC's recommendation to approve the project with the three experiments for only one year. This should allow enough time for the proponents, in coordination with the DLNP Director and JINR management, to decide on their long-term involvement in this interesting physics project.

#### Nuclear physics

The Scientific Council notes that the Frank Laboratory of Neutron Physics has good prospects for further development of scientific work in the following areas: research of quantum-mechanic phenomena with ultracold and cold neutrons, study of properties of the neutron, study of nuclear reactions induced by neutrons, and applied research using nuclear physics methods. The scientific programme for the period

2020–2022, reviewed by the PAC for Nuclear Physics, is broad with a large spectrum of activities developing in parallel under the theme “Investigations of Neutron Nuclear Interactions and Properties of the Neutron”.

The Scientific Council recommends that the priorities of this theme be better focused. In particular, special attention should be given to the development of key technologies for the new neutron source. The Scientific Council appreciates the development of activities related to IREN and encourages an active use of the extracted beams both for basic and applied research in order to make more efficient use of the facility's operating time.

The Scientific Council concurs with the PAC that the work on modernization of the EG-5 accelerator at FLNP is important. In preparing a full proposal for this project, expected accelerator specifications should be clearly identified in accordance with the priorities of expanding the research programme. Also, two options should be carefully compared: modernization of the present EG-5 accelerator or purchase of a new accelerator, taking into account the risk associated with the proposed upgrade.

The main goal of the FLNR Factory of superheavy elements in 2019 was to commission the DC-280 cyclotron, including obtaining all necessary permits for work and the production of heavy-ion beams within the design parameters. The operation of the DC-280 cyclotron was officially started on 25 March 2019. To date, beams of  $^{12}\text{C}$ ,  $^{40}\text{Ar}$ ,  $^{48}\text{Ca}$ , and  $^{84}\text{Kr}$  with intensities of a few particle microamperes ( $\mu\text{A}$ ) have been extracted. In particular, the intensity of accelerated  $^{48}\text{Ca}$  ions exceeded 5  $\mu\text{A}$ . The acceleration efficiency was 51%.

The installation and commissioning of the new gas-filled separator (GFS-2) was completed. Furthermore, test experiments were conducted with beams of  $^{40}\text{Ar}$  and  $^{48}\text{Ca}$  which were delivered to GFS-2 situated in the experimental hall. The experiments showed excellent background event suppression in the focal plane of the separator. Experiments with  $^{48}\text{Ca}$  beams and targets of  $^{\text{nat}}\text{Yb}$ ,  $^{174}\text{Yb}$ ,  $^{170}\text{Er}$ , and  $^{206}\text{Pb}$  were carried out. The main goal was to determine the separator's transmission and target stability when irradiated with high-intensity heavy-ion beams. The synthesis of Mc isotopes in the  $^{48}\text{Ca}+^{243}\text{Am}$  reaction will be the first test reaction for the production of superheavy nuclei.

The Scientific Council congratulates the Flerov Laboratory for the excellent work in this highly demanding field of SHE research. The intensities achieved at DC-280 are already among the highest in the world, and the results are extremely encouraging for the continuation of this research programme. The Scientific Council recommends that

FLNR continue the efforts of completing the test experiments and starting the implementation of the experimental programme at the SHE Factory.

The observation of nuclei produced in multinucleon transfer reactions (MNT reactions) with proton numbers up to  $Z = 102$  at the SHIP (GSI) and SHELS (FLNR) separators shows that these reactions can be considered as an alternative pathway to extend the nuclear chart towards the heaviest neutron-rich nuclei. The Scientific Council expects that investigations of MNT reactions will highly benefit from the upgrade of the U-400 cyclotron complex, where it is planned to produce also a uranium beam of sufficient intensity.

#### Condensed matter physics

The Scientific Council is pleased with the progress in developing the concept of the future neutron source for JINR, DNS-IV. Two alternative concepts of DNS-IV were considered in detail by the PAC for Condensed Matter Physics: the pulsed neutron reactor IBR-3 with  $^{237}\text{Np}$  core and the accelerator-driven spallation neutron source with  $\text{PuO}_2$  core providing neutron multiplication factor of about 20-50. Both options have been the subject of a feasibility study at the N. A. Dollezhal Research and Development Institute of Power Engineering (Moscow). The final recommendation made within this study and based on such criteria as achievable neutron characteristics, nuclear safety, engineering complexity, timeline and estimated costs is to choose the option of the pulsed neutron reactor IBR-3 with NpN fuel. This option was selected as the working concept for further development of DNS-IV and a detailed roadmap was developed by FLNP to implement DNS-IV.

At the same time, the Scientific Council shares the PAC's concern about the background levels of the new facility and draws attention to the crucial importance of achieving background values on IBR-3 and its instruments corresponding to the world-best practice.

The Scientific Council also takes note of the beginning of JINR's cooperation with the A. A. Bochvar High-technology Research Institute of Inorganic Materials (Moscow) aimed at developing a roadmap for fabrication of NpN reactor fuel.

The Scientific Council appreciates the wealth of scientific results and new instrumentation developments in the field of condensed matter physics at IBR-2 in 2019. The Scientific Council concurs with the PAC that the activities focused on the upgrade of the IBR-2 instruments are important for providing competitive opportunities for the realization of the FLNP scientific programme to the external users and for expanding the research areas.

The Scientific Council takes note of the statistics of the FLNP User Programme at the IBR-2 spectrometers and supports further development of this Programme, including the neutron activation analysis facility. It also notes the PAC's recommendation on changing the application submitting period for the second round.

The Scientific Council welcomes the regular follow-up by the PAC of the inelastic neutron scattering at IBR-2 and the presentation of analytical reports to the PAC on the current trends in neutron spectroscopy worldwide and on the status of inelastic neutron scattering spectroscopy at FLNP. The Scientific Council takes note of the PAC's conclusion that the two reviewed spectrometers no longer satisfy the requirements of some users. In this regard, the Scientific Council supports the preparatory work towards opening the new project of developing a new inelastic neutron scattering spectrometer and expects that a detailed proposal for this new project will be presented at a future PAC meeting.

The Scientific Council takes note of the development of a neutron radiography and tomography facility at the WWR-K reactor of the Institute of Nuclear Physics in Almaty (Kazakhstan) in collaboration with FLNP. The Scientific Council is pleased with this activity and shares the PAC's recommendation on the beginning of implementation of the proposed research programme.

The Scientific Council notes the successful completion of the project "Development of an open information and educational environment to support research priorities in material science and structure of matter" and supports the PAC's recommendation on opening a new project: "Open information and educational environment for supporting fundamental and applied multidisciplinary research at JINR" for 2021–2023 within the theme "Organization, Support and Development of the JINR Human Resources Programme". The Scientific Council welcomes the results of the completed project which include, in particular, the creation of a system of online courses in the main fields of JINR research and the implementation of the megascience projects. Regarding the new project, the Scientific Council notes its potential to attract a new generation of scientists to the JINR research teams.

#### Common issues

The Scientific Council strongly supports the recommendation of the PAC for Nuclear Physics that all proposals for new projects and requests for extension of themes or projects contain full information on required financial and human resources and a SWOT analysis.

### Reports by young scientists

The Scientific Council followed with interest the reports by young scientists, selected by the PACs for presentation at this session: “Real-time detection of supernova neutrino signal”, “Study of No isotopes with the GABRIELA array”, and “Neutron activation analysis as a tool for tracing the accumulation of silver nanoparticles in tissues of female mice and their offspring”, and thanks the respective speakers: A. Sheshukov (DLNP), A. Kuznetsova (DLNP), and I. Zinicovscaia (FLNP). The Scientific Council welcomes such selected reports in future.

### **VI. Awards and prizes**

The Scientific Council supports the proposal by JINR Director V. Matveev to nominate the team of staff of the Flerov Laboratory of Nuclear Reactions under the leadership of Yu. Oganessian for the Prize of the JINR Committee of Plenipotentiaries for the idea, development and successful realization of the project of the accelerator complex of the Factory of superheavy elements as a major achievement in building JINR’s world-class research infrastructure, which opens unique opportunities for promoting one of the main areas of the JINR research programme — the synthesis and study of properties of new superheavy elements.

The Scientific Council approves the Jury’s recommendations presented by JINR Director V. Matveev on the award of the N. Bogoliubov Prize:

– to D. Kazakov (JINR) for his outstanding contributions to the development of quantum field theory, renormalization theory and renormalization group revealing the renormalization properties of supersymmetric field theories; for his pioneering papers on multiloop calculations in quantum field theory;

– and to Dam Thanh Son (Kadanoff Center for Theoretical Physics, University of Chicago, USA) for his achievements in the fields of quantum chromodynamics, applications of string theory and gauge/gravity duality addressing basic questions in strongly interacting many-body systems; for his pioneering papers on transport coefficients, such as viscosity and conductivity, and on strongly coupled three-dimensional gauge theories.

The Scientific Council approves the recommendations of the Jury presented by its Chair, A. Olshevskiy, on the award of the B. Pontecorvo Prize to F. Gianotti (CERN) for her leading contributions to the experimental studies of fundamental interactions and to the discovery of the Higgs boson.

The Scientific Council approves the Jury's recommendations presented by JINR Vice-Director B. Sharkov on the award of JINR annual prizes for best papers in the fields of scientific research, methodology, research and technology, and applied research (Appendix).

The Scientific Council congratulates Tsolmon Tsogtsaikhan, staff member of FLNP from Mongolia, on the successful defence of his PhD thesis in physics and mathematics at JINR and on the award of the first PhD Diploma issued on the basis of JINR's right to independently confer academic degrees.

### **VII. Election, endorsement, and announcement of vacancies in the directorates of JINR Laboratories**

The Scientific Council elected S. Sidorchuk as Director of the Flerov Laboratory of Nuclear Reactions (FLNR) for a term of five years. The Scientific Council thanks S. Dmitriev for his successful tenure as Director of this Laboratory.

The Scientific Council announces the vacancies of positions of FLNR Deputy Directors. The endorsement of appointments will take place at the next session of the Scientific Council in September 2020.

The Scientific Council endorsed the appointment of A. Boreyko and A. Chizhov as Deputy Directors of the Laboratory of Radiation Biology (LRB), until the completion of the term of office of LRB Director A. Bugay.

The Scientific Council looks forward to more openness, rejuvenation and gender balance in the Directorates of JINR Laboratories.

### **VIII. Rules of Procedure of the Scientific Council**

The Scientific Council discussed the amendments proposed by the Working Group of its members, R. Tsenov, M. Waligorski, and I. Wilhelm, to the Regulations for the Election of Directors and for the Endorsement of Appointment of Deputy Directors of JINR Laboratories, which are part of the Rules of Procedure of the JINR Scientific Council. The Scientific Council decided to continue the consideration of the Draft Regulations together with the JINR Directorate at the next session.

## **IX. Next sessions of the Scientific Council**

The 128th session of the Scientific Council will be held on 17–18 September 2020.

The 129th session of the Scientific Council is planned to be held on 18–19 February 2021.

V. Matveev

Chair of the Scientific Council

C. Borcea

Co-Chair of the Scientific Council

A. Sorin

Secretary of the Scientific Council