

I. Preamble

The Chair of the PAC for Nuclear Physics, M. Lewitowicz, presented an overview of the implementation of the recommendations taken at the previous meeting.

JINR Vice-Director M. Itkis informed the PAC about the Resolution of the 126th session of the Scientific Council (September 2019) and the decisions of the Committee of Plenipotentiaries (November 2019).

The PAC is pleased to note that the recommendations of the previous PAC meeting concerning JINR research in the areas of nuclear physics have been accepted by the Scientific Council and the Directorate.

II. Status and prospects of investigations of neutron nuclear interactions and properties of the neutron

The PAC heard the report on the status of the investigations carried out under the theme “Investigations of Neutron Nuclear Interactions and Properties of the Neutron” and plans for the near future, presented by E. Lychagin. This report covers the results obtained in recent months and the prospects for the further development of scientific work in the various areas: research of quantum-mechanical 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 PAC notes that the research areas within the framework of this theme are developing successfully, and the scientific programme for the period 2020–2022 is broad and relevant.

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

III. Modernization of the EG-5 accelerator and development of its experimental infrastructure

The PAC heard the report on the plans for the modernization of the EG-5 accelerator, presented by A. Doroshkevich. The PAC considers the work on the modernization of the accelerator very important for maintaining and developing the

scientific potential of the Frank Laboratory of Neutron Physics, as well as for expanding the field of scientific investigations. Its successful realization will make it possible to restore the possibility of studying reactions with fast quasimonoenergetic neutrons at JINR and in the future to implement a microbeam project.

Recommendation. The PAC supports the presentation of a full proposal within the theme “Investigations of Neutron Nuclear Interactions and Properties of the Neutron”. The project should define expected accelerator specifications in accordance with the priorities of the scientific programme. The PAC recommends comparing carefully the two options: modernization of the present EG-5 accelerator or purchase of a new accelerator taking into account the risk associated with the proposed upgrade. The full project should include detailed information about the schedule, human and financial resources as well as a risk analysis.

IV. New project BECQUEREL

The PAC heard the proposal for opening a new project: “Experiment BECQUEREL at the NICA accelerator complex (new project BECQUEREL)” presented by P. Zarubin.

Studies of nuclear fragmentation using nuclear emulsions have a very long history. Nevertheless, this method still keeps promising opportunities, in particular due to the high resolution in determination of emission angles of relativistic fragments. The project is devoted to experiments with various accelerators; apart from studies of multifragmentation processes, the authors plan to search for unstable states in nuclei.

Recommendation. The PAC recommends that the VBLHEP Directorate provide financial support for renovation of the equipment used in the BECQUEREL experiment in 2021. The proposal should be presented at the PAC meeting in January 2021.

V. Status of the SHE Factory

The PAC heard with great interest the reports on the status and plans for the Factory of superheavy elements (SHE Factory) presented by V. Semin (DC-280 cyclotron) and V. Utyonkov (GFS-2 separator).

DC-280 cyclotron

The main goal in 2019 was to commission the DC-280 cyclotron, including the approval of 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}C , ^{40}Ar , ^{48}Ca and ^{84}Kr with intensities of a few particle microamperes (μA) have been extracted. In particular, the intensity of

accelerated ^{48}Ca ions exceeded 5 μA . The acceleration efficiency was 51%. Furthermore, test experiments were conducted with beams of ^{40}Ar and ^{48}Ca which were delivered to the gas-filled separator GFS-2 situated in the experimental hall.

GFS-2 separator

The installation and commissioning of the new gas-filled separator (GFS-2) was completed. A series of test experiments for the optimization of the parameters of the separator was conducted with alpha-particles and the $^{\text{nat}}\text{Yb}(^{40}\text{Ar},x\eta)^{207-212}\text{Ra}$ reaction products. The experiments showed excellent background event suppression. The measured spatial dispersion in the focal plane of the separator demands for a larger area detector system. Experiments with ^{48}Ca beams and targets of $^{\text{nat}}\text{Yb}$, ^{174}Yb , ^{170}Er , and ^{206}Pb were carried out. The main goals were to determine the separator's transmission and target stability when irradiated with high-intensity heavy-ion beams.

The implementation of the experimental programme at the SHE Factory will begin when the GFS-2 testing programme is completed. 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.

Recommendation. The PAC congratulates the Flerov Laboratory of Nuclear Reactions 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 PAC recommends that FLNR continue the efforts of completing the test experiments and starting the implementation of the experimental programme at the SHE Factory.

VI. Prospects of investigation of multinucleon transfer reactions

The PAC heard the report "Prospects of investigation of multinucleon transfer reactions" presented by A. Yeremin, concerning the current status and prospects of studying the structure of heavy nuclei produced in multinucleon transfer reactions (MNT-reactions). The observation of isotopes with proton numbers up to $Z = 102$ at the SHIP (GSI) and SHELS (FLNR) separators shows that MNT-reactions can be considered as an alternative pathway to extend the nuclear chart towards the heaviest neutron-rich nuclei. The PAC remarks that, along with the study of new isotopes, the exploration of MNT-reaction mechanism is of great importance, and strongly supports the development of a specialized set-up dedicated to a comprehensive study of such mechanism. 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.

Recommendation. The PAC recommends presenting as soon as possible a detailed project of a new dedicated set-up aimed at measuring features of the MNT reactions and their products (for instance, mass, energy, angular distributions, and possibly charge). The PAC also recommends substantiating this project with an in-depth theoretical study aimed at clarifying the correlation of the entrance channel of the reaction with the above-mentioned features of the MNT reactions and products.

VII. Scientific report

The PAC heard the report “Fusion reactions in nuclear astrophysics” presented by V. Sargsyan. Using quantum diffusion approach, the S-factors for fusion reactions like $^{12}\text{C}+^{12}\text{C}$ — important for stellar evolution — are calculated, extrapolated to low energy and compared with experimental data.

The PAC heard with interest the report “Investigation of prompt neutrons from fission induced by resonance neutrons” presented by Sh. Zeynalov. The PAC highly appreciated the investigations conducted to study the process of nuclear fission after passing through the saddle point. A very interesting development of these studies has become the approach developed to study resonance-neutron-induced fission and thermal-neutron-induced subbarrier fission. The PAC supports the programme of near-future investigations with beams of the IREN facility and looks forward to hearing a report soon on new scientific results.

VIII. Poster session

The PAC reviewed 13 poster presentations in the field of nuclear physics research by young scientists from FLNR. The best posters selected are: “Study of No isotopes with the GABRIELA array” presented by A. Kuznetsova, “Effective method of excitation function measurement for (α, n) reactions at low energies” presented by E. Gazeeva, and “Data acquisition and control systems developed for the synthesis of superheavy elements at the experiment DGFRS-II FLNR JINR” presented by L. Schlattauer.

The PAC recommends that the poster “Study of No isotopes with the GABRIELA array” be reported at the session of the Scientific Council in February 2020.

IX. General recommendations

The PAC reiterates its strong recommendation 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.

For the subsequent meetings the PAC requests that all presentations of projects and themes be available on Indico at least one week prior to the PAC meeting.

X. Next meeting of the PAC

The next meeting of the PAC for Nuclear Physics will be held on 25–26 June 2020.

Its tentative agenda will include:

- reports and recommendations on themes and projects to be completed in 2020;
- first experiments at the SHE Factory and further scientific programme;
- results of the experiments at ACCULINNA-2;
- consideration of new projects;
- scientific reports;
- poster presentations of new results and proposals by young scientists in the field of nuclear physics research.



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