# 57th Meeting of the Programme Advisory Committee for Nuclear Physics

29-30 June 2023

*Valery Nesvizhevsky*

# Programme Advisory Committee for Nuclear Physics, 57th. meeting, 29-30 June 2023

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| 1. Opening of the meeting | *V. Nesvizhevsky* |
| 2. Implementation of the recommendations of the 56th PAC meeting | *V. Nesvizhevsky* |
| 3. Information on the Resolution of the 133rd session of the JINR Scientific Council (February 2023) and on the decisions of the JINR Committee of Plenipotentiaries (March 2023) | *S. Dmitriev* |
| **4. Proposals for opening new projects within the theme "Theory of Nuclear Systems":** | |
| **4.1 Project "Low-energy nuclear dynamics and properties of nuclear systems"** | **N. Antonenko** |
| **4.2 Project "Microscopic models for exotic nuclei and nuclear astrophysics"** | **A. Dzhioev** |
| **4.3 Project "Quantum few-body systems"** | **A. Motovilov** |
| **4.4 Project "Relativistic nuclear dynamics and nonlinear quantum processes“** | **S. Bondarenko** |
| **5. Proposal for extending the theme "Synthesis and Properties of Superheavy Elements, the Structure of Nuclei at the Limits of Nucleon Stability":** | **S. Sidorchuk** |
| **5.1 Proposals for opening new projects within the theme "Synthesis and Properties of Superheavy Elements, the Structure of Nuclei at the Limits of Nucleon Stability“** | |
| **5.1.1. Project "Investigation of heavy and superheavy elements“** | **A. Karpov** |
| **5.1.2. Project "Light exotic nuclei at the borders of nuclear stability“** | **G. Kaminski** |
| **6. Report on the theme "Development of the FLNR Accelerator Complex and Experimental Setups (DRIBs-III)". Proposals for its reformation into a large research infrastructure project (LRIP)** | **I. Kalagin** |
| **6.1. Proposals for opening new projects within the LRIP "Development of the FLNR accelerator complex and experimental setups (DRIBs-III)“** | |
| **6.1.1. Project "The U-400R accelerator complex“** | |
| **6.1.2. Project "Development of experimental setups to study the chemical and physical properties of superheavy elements"** | **A. Eremin** |

# Programme Advisory Committee for Nuclear Physics, 57th. meeting, 29-30 June 2023

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| **7. Report on the theme "Investigations of Neutron Nuclear Interactions and Properties of the Neutron“ and on the projects "TANGRA", "ENGRIN" and "Modernization of EG-5". Proposals for extending the projects "TANGRA" and "Modernization of EG-5"** | **Yu. Kopatch** |
| **8. Proposals for opening a new theme "Nuclear Physics with Neutrons" and a new project "Investigations of neutron nuclear interactions and properties of the neutron“** | **V. Shvetsov** |
| **9. Proposal for extending the project "BECQUEREL 2023“** | **P. Zarubin** |
| **10. Proposal for extending the project "E&T&RM" with the new title "ADSR“** | **M. Paraipan** |
| **11. Proposal for extending the project "Study of the nucleon spin structure in strong and electromagnetic interactions (GDH&SPASCHARM&NN)"** | **Yu. Plis** |
| **12. Proposal for opening a new project "Radiochemistry and spectroscopy for astrophysics and nuclear medicine“** | **A. Baimukhanova** |
| **13. Proposal for opening a new project "Short baseline reactor neutrino studies"** | **I. Zhitnikov** |
| **14. Proposal for opening a new project "Nuclear spectrometry for the search and investigation of rare phenomena“** | **E. Yakushev** |
| **15. Report on the project "BAIKAL-GVD" and proposal for its extension** | **I. Belolaptikov** |

**Closed session:**

16. Meeting of the PAC members with the JINR Directorate
17. Drafting the PAC recommendation
18. Proposals for the agenda of the next PAC meeting
19. Presentation of the PAC recommendations to the directorates of JINR and the laboratories
20. Closing of the meeting

# BLTP: Proposals for opening new projects within the theme "Theory of Nuclear Systems"


## "Low-energy nuclear dynamics and properties of nuclear systems"

To study in detail the effects of environment on the rate of astrophysical reactions. Thus, further development of the theory of open quantum systems. Thus, considering the low-energy dipole excitations that play presumably a noticeable role in the stellar nucleosynthesis.


## "Microscopic models for exotic nuclei and nuclear astrophysics"

The project plays an important role in the development of theoretical methods for the self-consistent description of nuclear structure and its application to the study of exotic and superheavy nuclei, predicting their decay properties for the experiments planning and the astrophysical applications.


## "Quantum few-body systems"

The project plays an important role in the development of methods and approaches of the theory of few-body systems. One of the interesting directions of research is the study of universal features in the behavior of few-body systems at ultra-low energies.


## "Relativistic nuclear dynamics and nonlinear quantum processes"

The goal of the project is to study the properties of heated and compressed nuclear matter in the collision of heavy ions. Of particular interest is the study of possible phase transitions that occur during the cooling of the system, as well as the problem of CP invariance violation in strong interaction.

# The Concept of the Theme «Theory of Nuclear Systems»

Development of theoretical ⟺ Applications for experimental methods

*Multidisciplinar nature*

## Attraction of young researchers to nuclear theory

The future theoretical studies will be closely associated with the programs of operating and commissioning the facilities at JINR (SHE-factory, ACCULINA-2) and over the world (FAIR, ISOL, HIE-ISOLDE, SPES, SPIRAL2, FRIB, RAON, HIAF). The studies of heavy-ion collisions at high energies will be associated with the NICA project at JINR.

## Recommendation:

**The PAC recommends opening four new projects: “Low-energy nuclear dynamics and properties of nuclear systems”, “Microscopic models for exotic nuclei and nuclear astrophysics”, “Quantum few-body systems”, and “Relativistic nuclear dynamics and nonlinear quantum processes” until the end of 2028.**

**The PAC supports the proposed structure of the extended theme “Theory of Nuclear Systems”.**

# Proposal for extending the theme "Synthesis and Properties of Superheavy Elements, the Structure of Nuclei at the Limits of Nucleon Stability"


## Flerov Laboratory: Scientific Themes for 2024 - 2030

2024

2028

2030

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**Synthesis and Properties of SHE, Structure of Nuclei at the Limits of Nucleon Stability**

Scientific leader: Yu.Ts. Oganessian
Leader: S.I. Sidorchuk

Investigation of H&SH nuclei

**2024 - 2028**

**Leaders:**
M.G. Itkis,
A.V. Karpov

Structure of the lightest nuclei at the borders of nucleon stability

**2024 - 2028**

**Leaders:**
G. Kaminski,
S.I. Sidorchuk

**Development of the FLNR Accelerator Complex and Experimental Setups (DRIBS-III)**

Scientific leader: Yu.Ts. Oganessian
Leaders: I.V. Kalagin, S.I. Sidorchuk

U400R accelerator complex

**2024 - 2028**

**Leaders:**
I.V. Kalagin,
A.G. Popeko

Development of the setups for the study of properties of superheavy nuclei

**2024 – 2028**

**Leader:**
A.V. Yeremin,

New projects:

- Mass measurements of SH nuclei;
- Chemistry of short-lived SHE;
- Mechanisms of MNT reactions;
- Reaction mechanisms competing with fusion;
- Production of new neutron-rich isotopes in MNT reactions and study of their properties;
- …

# Project “Investigation of heavy and superheavy elements”




## Main directions of research:

### Synthesis of new elements

*SHE Factory – DGFRS II*

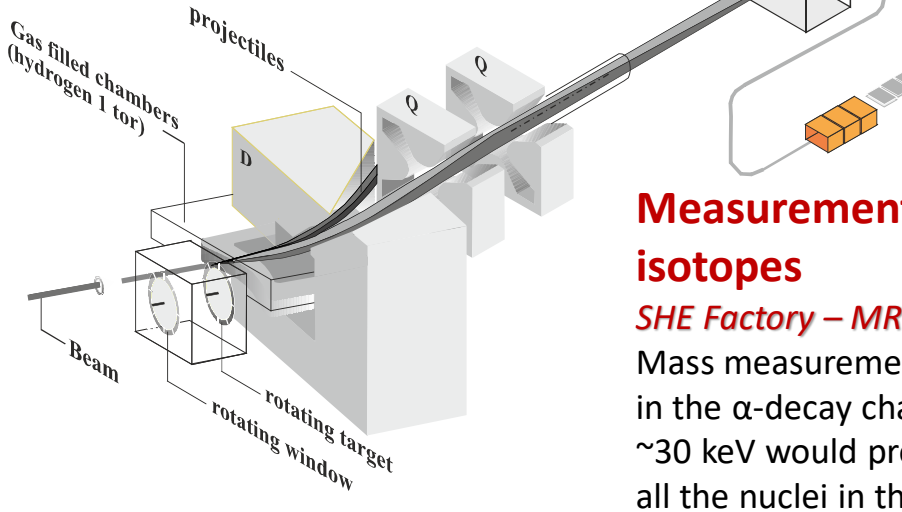
119 and 120 is a task of the highest importance. $^{249}Bk+^{50}Ti\rightarrow^{299}119^*$, $^{249\text{-}251}Cf+^{50}Ti\rightarrow^{299\text{-}301}120^*$ $^{248}Cm+^{54}Cr\rightarrow^{302}120^*$

### Nuclear SHE spectroscopy

*SHE Factory – GRAND*

*U400R – SHELS*

Radioactive decay and the structure of isotopes of heavy and superheavy elements. The first experiments on the study of Fl and Mc isotopes in the $^{48}Ca+^{242}Pu,^{243}Am$ reactions.




### Synthesis of new SHE isotopes

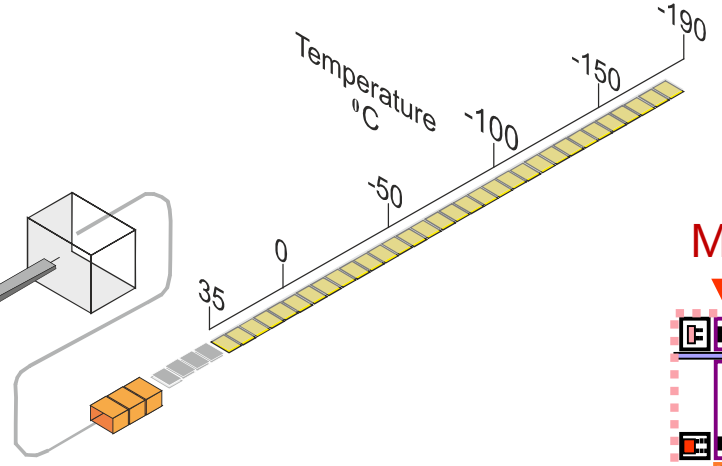
*SHE Factory – DGFRS II*

- 2n channels of fusion reactions;
- p1n- p3n channels, EC;
- MNT reactions U+U, U+Cm;
- More neutron-rich targets.

### Chemistry of SHE

*SHE Factory – GRAND, GASSOL*

Chemical properties of SHE with Z = 112 – 114 ($T_{1/2}$>0.5 sec) at the GRAND separator. New experimental setups for the study of heavier elements

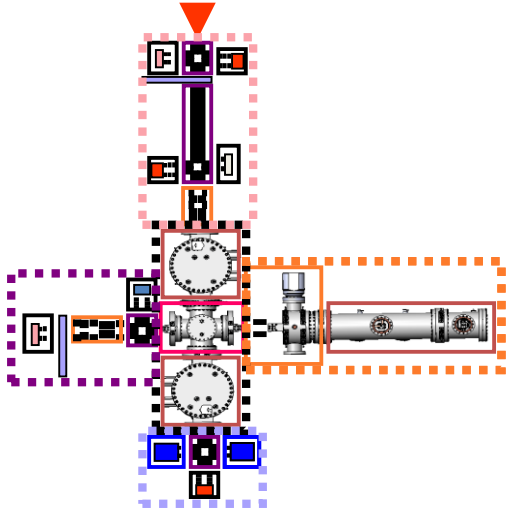



### Measurement of masses of SH isotopes

*SHE Factory – MR TOF*

Mass measurement of any of the nuclei in the α-decay chain with a precision of ~30 keV would provide the masses of all the nuclei in the chain

MR-TOF
Mass-Analyzer



# Project “Light exotic nuclei at the borders of nuclear stability”


## Planned research areas: 2024 - 2028

- Structure of neutron-rich isotopes in **(d,p), (d,t), (d,$^{3}$He)** reactions
- Impact of the reaction mechanism on the population of low energy spectra of exotic nuclear systems
- Exotic radioactivity - formation of **2*p*** radioactive nuclei in the **($^{3}$He,n)** and **(p,d)** reactions
- Study of production cross sections of exotic nuclei
- Beyond the nucleon stability line with **2n**-transfer **$^{10}$He,$^{13}$Li,$^{16}$Be** using tritium-target. Lighter neutron-rich isotopes like **$^{6,8}$He, $^{11}$Li, $^{11-14}$Be** are also in the zone of interest
- Study the energy dependence of total reaction cross section in the reactions **$^{10-14}$Be+$^{28}$Si, $^{12-15}$B+$^{28}$Si, etc.**

Transfer reactions via $^{2}$H target

- $^{6}$He(d,$^{3}$He)$^{5}$H
- $^{6}$He(d,t)$^{5}$He
- $^{6}$He(d,p)$^{7}$He

Transfer reactions on H target

- $^{7}$Be(p,d)$^{6}$Be
- $^{8}$B(p,d)$^{7}$B
- $^{9}$C(p,d)$^{8}$C

$\sigma_R(E)$ and $\sigma_\Sigma(E)$

- $^{10-14}$Be+$^{28}$Si
- $^{12-15}$B+$^{28}$Si

Transfer reactions on $^{3}$He target

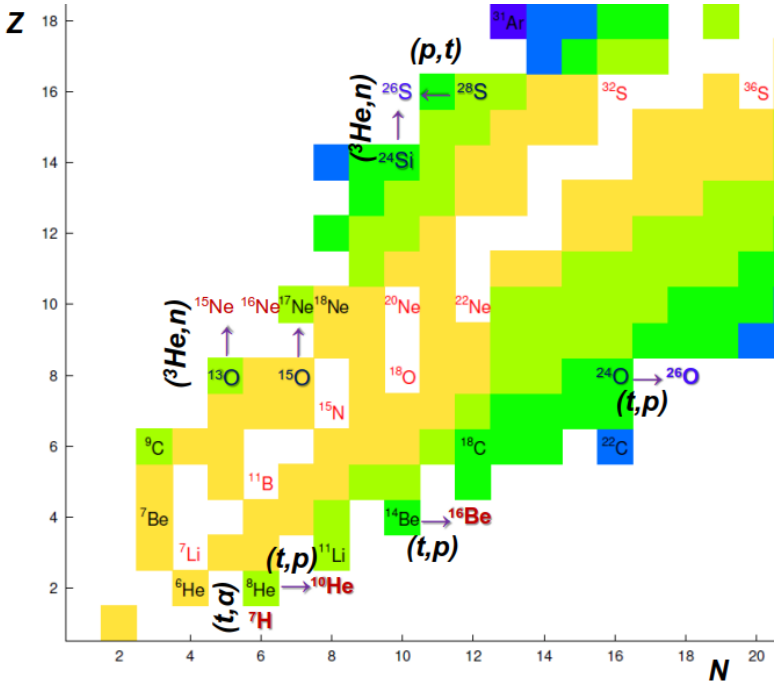
- $^{13}$O($^{3}$He,n)$^{15}$Ne
- $^{24}$Si($^{3}$He,n)$^{26}$S

Transfer reactions on $^{3}$H target

- $^{8}$He(t,p)$^{10}$He
- $^{14}$Be(t,p)$^{16}$Be
- $^{8}$He(t,$\alpha$)$^{7}$H

Charge-exchange reactions

- (p,n),($^{3}$He, $^{3}$H),($^{3}$He, $^{3}$H)



## Recommendation:

**The PAC highly appreciates the proposals of FLNR for the development of research in the field of heavy-ion physics and recommends opening two new projects "Investigation of heavy and superheavy elements" and "Light exotic nuclei at the borders of nuclear stability" until the end of 2028.**

**In order to be able to open and implement two new projects, as well as to conduct other experiments in the field of heavy-ion physics, the PAC recommends extending the theme "Synthesis and Properties of Superheavy Elements, the Structure of Nuclei at the Limits of Nucleon Stability" for a period of 7 years until the end of 2030.**

**The target preparation and the recycling of the target material are urgent issues.**

# Large research infrastructure project “Development of the FLNR Accelerator Complex and Experimental Setups (DRIBs-III)” and proposals for opening new projects in this LRIP


Within the framework of this **LRIP**, it is planned to open **two projects**:

- “Construction of the U-400R accelerator complex”;
- “Development of the experimental setups to study the chemical and physical properties of superheavy elements”.

In addition, within this project, it is planned:

- To complete the construction, to commission and develop the DC-140 accelerator complex for applied research.
- The project also includes support for experiments performed at the FLNR accelerator complex, in particular ensuring the required operating parameters for existing accelerators, improving the reliability of accelerators, and developing experimental facilities.

# New projects: “Construction of the U-400R accelerator complex” and “Development of the experimental setups to study the chemical and physical properties of superheavy elements”


## Project “Construction of the U-400R accelerator complex”

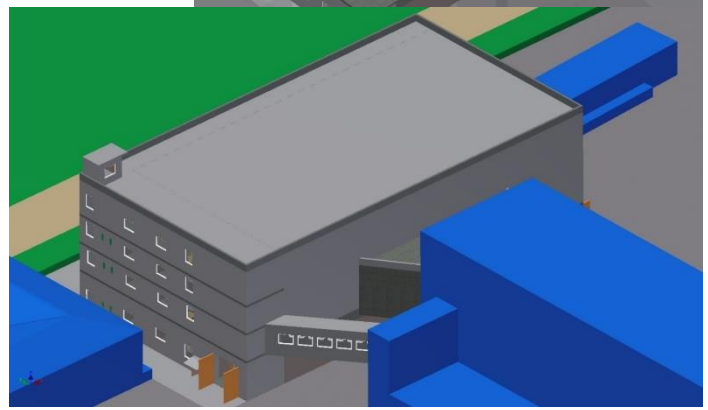
### Upgrade of the U400 cyclotron: main purposes of upgrade

- Improvement of the quality and intensity of stable and radioactive beams (48Ca – 2÷2.5 pμA );
- Upgrade of the beam extraction system (electrostatic deflector in addition to the recharging foils )
- Providing a smooth variation of the ion energy in the range of 0.8 – 27 MeV/A;
- Decreasing the total cyclotron power consumption from 1 to 0.4 MW.

Upgrade: 2024 – 2026

### Extension of the experimental areas through the construction of a new building

Currently the total experimental area of the U400 cyclotron is about **200 m²** (building 131). The physical facilities located on two levels of the building occupy almost the entire available area. New facilities of the U400R complex require additional space.



### Main purposes:

**Extension of the experimental areas by constructing an experimental building with a total area of about 1200 m² for placing new experimental facilities there**

# New projects: “Construction of the U-400R accelerator complex”
# “Development of the experimental setups to study the chemical and physical properties of superheavy elements”

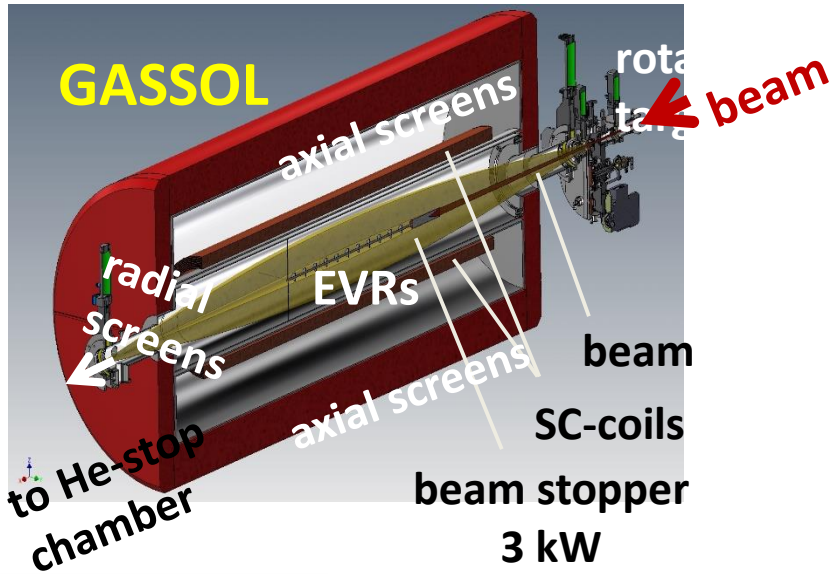
**Project “Development of the experimental setups to study the chemical and physical properties of superheavy elements”**

## New experimental setups at the operating DC280 cyclotron (SHE factory: DGFRS2 and GRAND

**Pre-Separator for studies of the chemical properties of short-lived SH nuclides based on a superconducting solenoid (GASSOL)**

**The task is:**

- To provide the delivery of synthesized SH isotopes within a time comparable with their lifetimes;
- To provide a high level of separation.

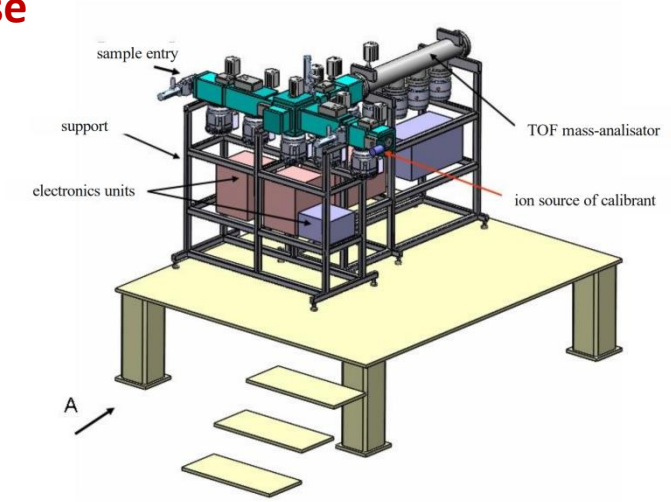



**Multi-Reflection Time-Of-Flight (MR-TOF) spectrometer for the precise measurements of masses of heavy and superheavy nuclides**

- Measuring masses of SH isotopes with an accuracy of $10^{-7}$ (30 кeV)
- Theory predictions ~ 300 keV

**Requirements for a facility:**

- High rate of analysis;
- Low losses;
- High degree of purification;
- Accuracy of $10^{-7}$ (30 кeV);
- Mass range 266 – 300.



**Recommendation:**

**The PAC recommends that the theme "Development of the FLNR Accelerator Complex and Experimental Facility (DRIBs-III)" be reformed into a large research infrastructure project with the same title for the period 2024–2030.**

**The PAC recommends opening two new projects "Construction of the U-400R accelerator complex" and "Development of the experimental setups to study the chemical and physical properties of superheavy elements" until the end of 2028.**

# Theme “Investigations of Neutron Nuclear Interactions and Properties of the Neutron” Proposals for extending the projects “TANGRA” and “Modernization of EG-5”

**Projects in 2023:**

1. **TANGRA. Leader Kopatch Y.N. (2014-2023)**
2. **ENGRIN. Leader Zeinalov Sh. S. (2022-2023)**
3. **Modernization of EG-5. Leader Doroshkevich A.S. (2022-2023)**


The theme “Investigations of Neutron Nuclear Interactions and Properties of the Neutron” was started in 2017 and was extended in 2022 for one year.

The project “TANGRA” was started in 2014 and was extended in 2022 for one year.

The projects “ENGRIN” and “Modernization of EG-5” were started in 2022, also for one year.

**Scientific research was focused in three areas:**

- the study of violations of fundamental symmetries in the interactions of neutrons with nuclei and collection of nuclear data;
- the study of the fundamental properties of the neutron, physics of ultracold and very cold neutrons;
- applied and methodological research.

| Recommendation: |
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| The PAC notes the high quality of the results obtained and the prospects of the proposed scientific programme and takes note of the report on the completion of work under the ENGRIN project and the theme “Investigations of Neutron Nuclear Interactions and Properties of the Neutron”. Recommendation. |
| The PAC recommends the completion of the project “ENGRIN” and closing the theme “Investigations of Neutron Nuclear Interactions and Properties of the Neutron”. |
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# Proposals for opening a new project “Investigations of neutron nuclear interactions and properties of the neutron” and a new theme “Nuclear Physics with Neutrons”


**Directions in research and activities:**

**Investigations of neutron nuclear interactions and properties of the neutron.**

- P, T – parity conservation in nuclear reactions
- Fission physics (ROT & TRI effects, rare modes)
- Nuclear reactions for nuclear data & nuclear theory
- Cold, very cold & ultracold neutrons, neutron optics
- Applied research (NAA, PGNAA, RBS, neutron mutagenesis, etc.)

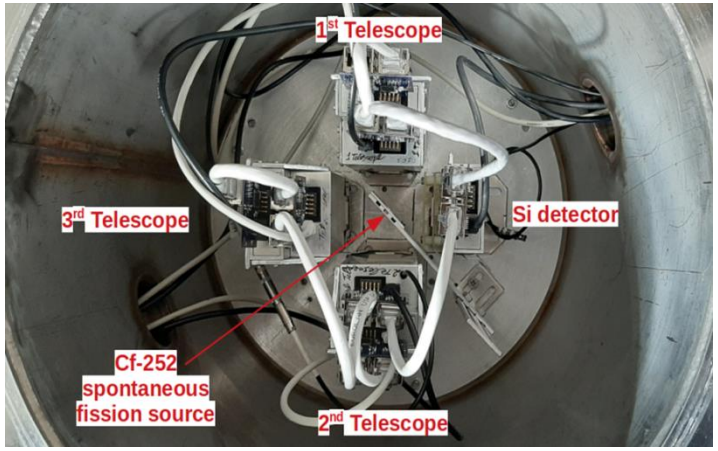
**Development of the tagged neutron method (TNM) for determining the elemental structure of matter and studying nuclear reactions (TANGRA project).**

- TNM for nuclear reaction research & nuclear data
- Fast elemental analysis (method & compact facilities)

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

- To realize nuclear reactions research program
- For applied research.

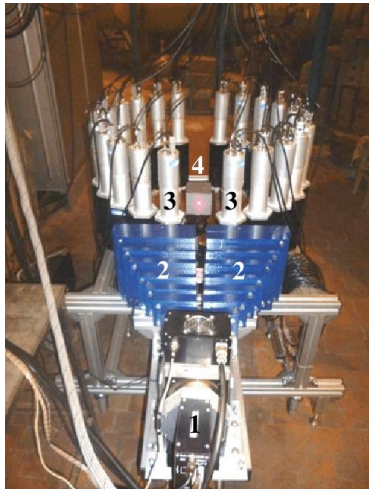
# NEUTRON NUCLEAR PHYSICS AT NEUTRON GENERATOR, IBR-2 AND OTHER NEUTRON SOURSES




**Nuclear fission process:**

- measurement of mass-energy and angular distributions of fragments;
- prompt and delayed neutrons and γ-quanta;
- search for rare and exotic fission modes – quaternary and quinary fission, etc;
- measurements of T-odd effects in fission.

## TANGRA Project




**Application of the tagged neutron method for measurements of angular and energy distributions of emitted γ-rays and neutrons in the (n,n') reactions with neutrons at the energy of 14 MeV.**

**Tasks for the next 7 years:**

- Development of an original method for measuring the neutron lifetime in a beam of a pulsed neutron source.
- Development and application of neutron and nuclear methods: instrumental activation analysis; prompt-γ neutron activation; elemental analysis of surface layers of solids.
- Development of experimental infrastructure (design of neutron polarizers, new detector systems etc)
- Nuclear data

## RESEARCH WITH ULTRACOLD NEUTRONS

**Scientific program for UCN source in Dubna:**

- **Plan for the next seven years** is to build a prototype UCN source at IBR-2 reactor with world-class parameters based on the time-focusing principle;
- Measurement of the neutron lifetime (better than 1 sec).
- Investigation of anomalous UCN losses
- Non-stationary quantum effects and neutron optics

# Plans for 2024-2030

**IREN neutron source. It allows realizing a research program on fundamental nuclear physics with neutrons and nuclear data measurements analogous to the programs at other neutron sources like GELINA (IRMM, Geel).**

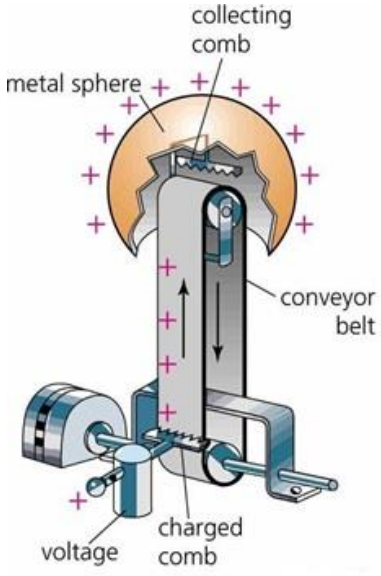
**Scientific program for IREN**

- Nuclear fission in resonances.
- Search and study of P- and T- violating effects.
- Nuclear data for nuclear engineering and astrophysics.
- Neutron activation analysis and prompt-γ analysis.
- Experimental study of the isotopes production in photonuclear reactions

**Tasks:**

- Increase neutron yield up to $3 \cdot 10^{12}$ n/sec
  - ✓ Electron energy up to 150 MeV;
  - ✓ Peak current 2.5 A;
  - ✓ Pulse length 150-200 ns
- modernization of the experimental halls
- Increase the operation time up to 3000 hours/year

## EG-5 electrostatic generator as neutron source and source for ion beam analysis




**Scientific program for the EG-5 in nuclear physics**

Collecting data for nuclear engineering and astrophysics: integral and differential neutron cross sections, angular correlations in the relevant energy range.

**Tasks:**

- increase current up to 50 $\mu$A;
- increase energy up to 4.1 MeV;
- modernization of the experimental infrastructure;
- design of ion microbeams.

## Recommendation:

**The PAC recommends opening the new project "Investigations of neutron nuclear interactions and properties of the neutron" for a period of 5 years until the end of 2028.**

**The PAC also recommends extending the project "TANGRA" for a period of 5 years until the end of 2028 and the project "Modernization of the accelerator EG-5 and its experimental infrastructure" for a period of 3 years until the end of 2026.**

**In relation to the proposals to open the new project, extend two other projects, as well as to open the new activity, the PAC recommends opening the new theme "Nuclear Physics with Neutrons" for a period of 7 years until the end of 2030.**

# Large research infrastructure project “BAIKAL-GVD”


The Baikal-GVD project is one of the leading projects at JINR and the largest detector of astrophysical high energy neutrino in the North hemisphere. The project is highlighted as a Large Infrastructure Project since 2024. Currently the activity is related to the theme 03-2-1100-2010/2024 (Non-accelerated neutrino physics and astrophysics).

**Baikal Collaboration:**

1. Joint Institute for Nuclear Research (Dubna, Russia)
2. Institute for Nuclear Research, Russian Academy of Sciences (Moscow, Russia)
3. Irkutsk State University (Irkutsk, Russia)
4. Skobeltsyn Institute of Nuclear Physics, MSU (Moscow, Russia)
5. Comenius University (Bratislava, Slovakia)
6. Czech Technical University in Prague (Prague, Czech Republic)
7. Institute of Nuclear Physics ME RK (Almaty, Kazakhstan)
8. Nizhni Novgorod State Technical University (Nizhni Novgorod, Russia)
9. St. Petersburg State Marine Technical University (St. Petersburg, Russia)

**Objectives:**

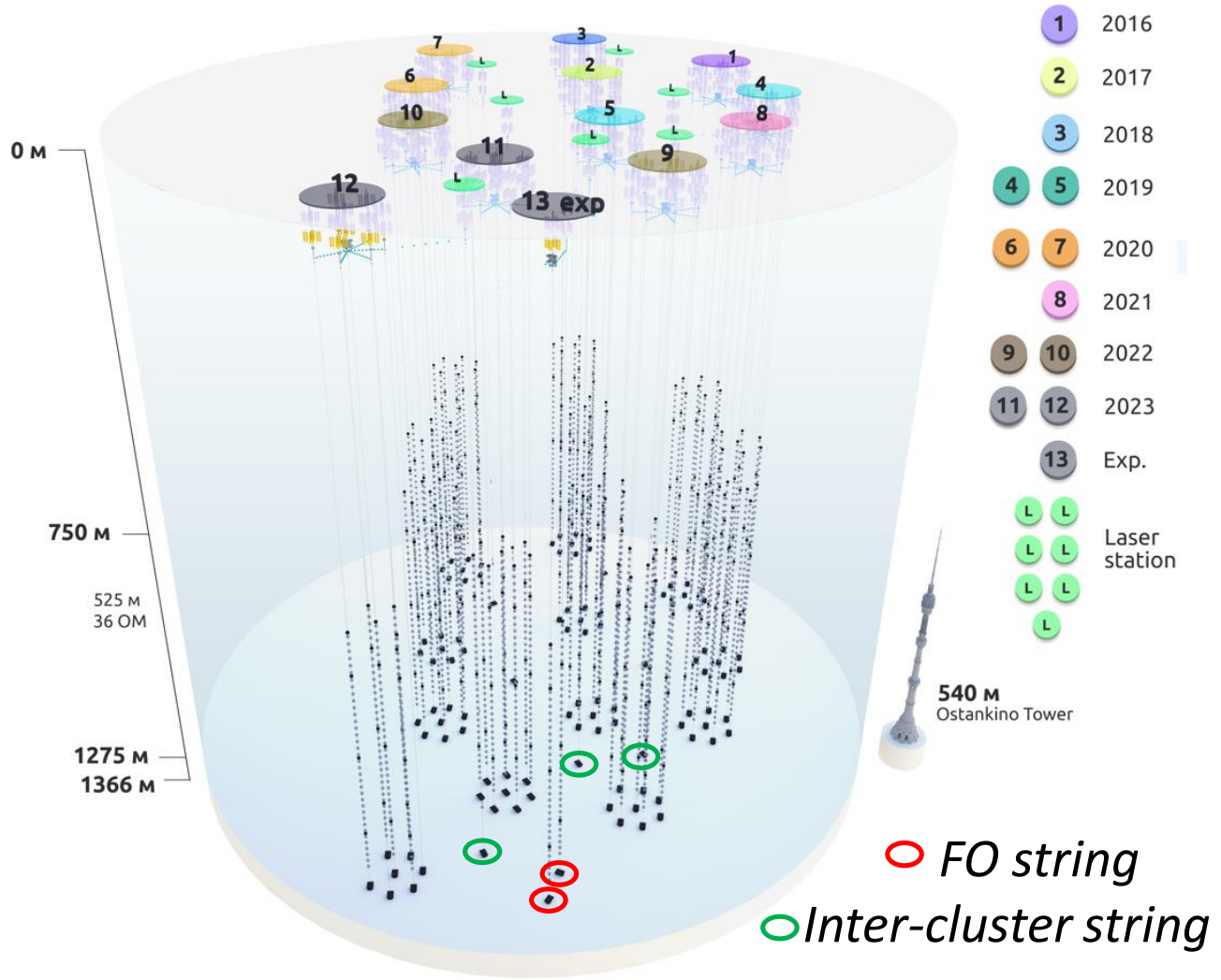
- flexible structure allowing an upgrade and/or a rearrangement of the main building blocks (clusters)
- $km^3$-scale 3D-array of photo sensors
- high sensitivity and resolution of neutrino energy, direction and flavor content

**Main Physics Goals:**

- Diffuse neutrino flux – energy spectrum, local and global anisotropy, flavor content
- Investigate Galactic and extragalactic neutrino “point sources” in energy range > TeV
- Transient sources (GRB, …)
- Dark matter – indirect search
- Exotic particles – monopoles, Q-balls, nuclearites, …

# Current status of Baikal-GVD

- Currently, the deployment of the Baikal-GVD neutrino telescope is successfully underway.
  - 12 clusters with 3456 OMs.
  - About **10 astrophysical neutrinos per year**.
- The production and technical base of the Baikal project provides the deployment of **two clusters annually**.
- GVD has **developed shore infrastructure**: control center, laboratories, workshops, deployment tools, living quarters.
- GVD is **testing ground** for the development the systems for next-generation telescope:
  - 2 strings with fiber-optic DAQ;
  - 3 inter-cluster strings.



| Recommendation: |
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| **The PAC appreciates the high scientific importance of the project “BAIKAL-GVD” and JINR’s leading role in its implementation.** |
| **The PAC strongly recommends extending the project “BAIKAL-GVD” as a large research infrastructure project until the end of 2028.** |
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# Project “Nuclear spectrometry for the search and investigation of rare phenomena”


**The project combines research on the fundamental properties of neutrinos and the search for dark matter particles in the experiments with JINR’s participation:**

- LEGEND (Large Enriched Germanium Experiment for Neutrinoless double β-Decay);
- TGV (Telescope Germanium Vertical);
- SuperNEMO (Neutrino Ettore Majorana Observatory);
- MONUMENT (Muon Ordinary capture for the NUclear Matrix elemENTs);
- EDELWEISS (Expérience pour DétEcter Les WIMP En Site Souterrain).

**The above experiments are aimed at solving the following main scientific problems:**

- the search and study of neutrinoless double β-decay using detectors enriched with $^{76}$Ge (LEGEND), low-background germanium detectors (TGV spectrometer) as well as the application of a unique potentially zero-background tracking-calorimetric technique (SuperNEMO);
- measurements of muon capture on several daughter nuclei, candidates for 0ν2β-decay (MONUMENT);
- the direct search for dark matter using the array of single-crystal germanium bolometers (EDELWEISS).

**Recommendation:**

**The PAC notes the significant contribution of JINR scientific groups to the above experiments and recommends opening the new project "Nuclear spectrometry for the search and investigation of rare phenomena" until the end of 2028.**

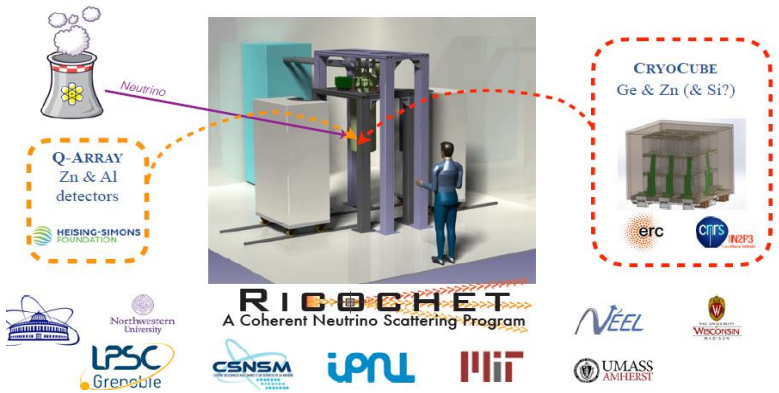
# Project “Investigations of reactor neutrinos on a short baseline”

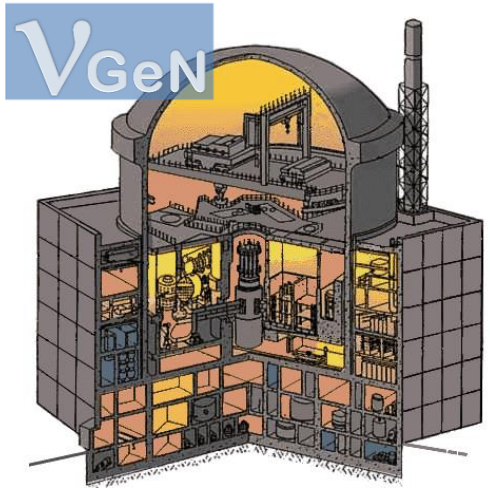
The PAC heard a proposal to open a new project “Investigations of reactor neutrinos on a short baseline” presented by Igor Zhitnikov.

The project combines research on the fundamental properties of neutrinos in the DANSS, vGeN, and Ricochet experiments with JINR’s participation.

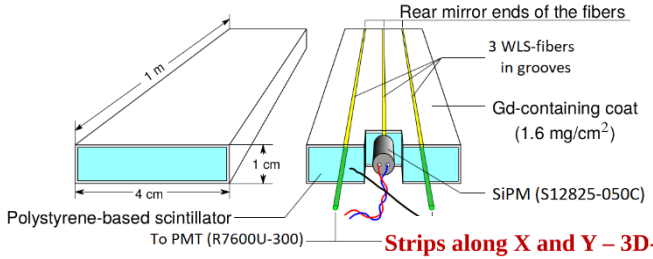
**Scientific program:**

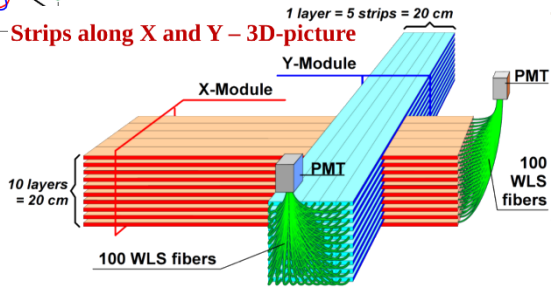
- the search for and investigations of Coherent Elastic neutrino Nuclear Scattering (CEvNS) with low-threshold germanium detectors (vGeN) and low-threshold cryogenic detectors (Ricochet)
- the search for the neutrino magnetic moment (vGeN and Ricochet)
- the search for short-baseline reactor antineutrino active-sterile oscillations with a highly-segmented plastic scintillator detector (DANSS, DANSS-2)
- remote monitoring of nuclear reactor core operation measuring the antineutrino flux (DANSS, DANSS-2)




**DANSS Detector design**



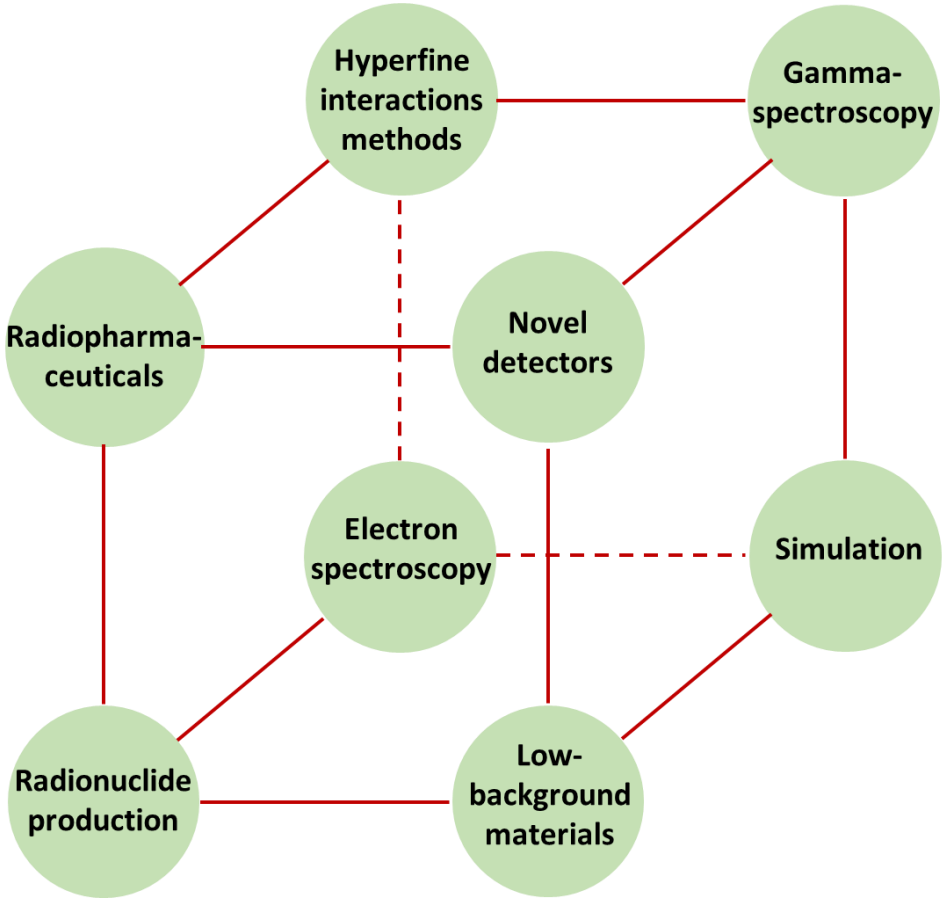



## Recommendation:

**The PAC recommends opening the new project “Investigations of reactor neutrinos on a short baseline” until the end of 2028.**

# Project “Radiochemistry and spectroscopy for astrophysics and nuclear medicine”

The PAC heard a proposal to open a new project “Radiochemistry and spectroscopy for astrophysics and nuclear medicine” presented by Ayagoz Baimukhanova.




**Scientific research** in the project is devoted to the development of nuclear spectroscopy and radiochemistry methods to study rare phenomena associated with the weak interaction and a number of problems in astrophysics, as well as the development of radiopharmaceuticals and their application in nuclear medicine.

**The project focuses on the following areas of work:**

- designing novel detectors;
- high-resolution “post-decay” spectroscopy of electrons and other emissions with an emphasis on extremely low energies;
- γ-spectroscopy based on semiconductor detectors;
- development of methods for the production and purification of radionuclide preparations for the synthesis of radiopharmaceuticals;
- development and application of methods and techniques for the production and analysis of low-background materials with a uniquely low content of radioactive impurities.

## Recommendation:

**The PAC recommends opening the new project "Radiochemistry and spectroscopy for astrophysics and nuclear medicine" until the end of 2028.**

# Project “Study of the nucleon spin structure in strong and electromagnetic interactions (GDH&SPASCHARM&NN)”

The PAC heard a detailed report on the project “Study of the nucleon spin structure in strong and electromagnetic interactions (GDH&SPASCHARM&NN)” and a proposal for its extension presented by Yuri Plis.

This project includes three independent experiments related to the study of the spin structure of the nucleon in strong and electromagnetic interactions:

1. **GDH**
   - **A2 Collaboration at MAMI, Mainz** (Participation from 2008. 21 papers have been published. A lot of talks at different International Conferences and A2 Collaboration Meetings were presented).
   - **CBELSA/TAPS Collaboration, Bonn** (Participation from 2018. Preliminary results have been presented).
   - **P2 Collaboration at MESA, Mainz** (Participation from 2019. Research and development stage).
2. **SPASCHARM** (Participation from 1978).
3. **NN** (Participation from 1984).

## Recommendation:

**The PAC recommends extending the project "Study of the nucleon spin structure in strong and electromagnetic interactions (GDH&SPASCHARM&NN)" until the end of 2028.**

# Proposal for extending the project “E&T&RM” with the new title “ADSR” (Accelerator Driven Subcritical Reactor)


## Main objectives of the project

- Experimental study on the effect of the material used for the converter by measuring the neutron yield for various beam-converter combinations.
- Design of an extended graphite target for the experimental verification of the efficiency of proton and ion beams with different converters.

## Factors which affect the efficiency of ADSR

Systematic study of the conditions which maximize the energy gain, provide high fuel burnup and long period between refueling:

- factors related to the core structure and composition
- particle beam and energy
- accelerator type

The PAC notes that, in spite of the almost general opinion that the optimal beam for ADS is a proton beam with an energy of about 1–1.5 GeV, it was shown that **heavier ion beams** have a superior energy efficiency than protons. Research within the framework of the project will be aimed at studying the conditions, which maximize the energy efficiency of ADS systems and ensure a high burnup.

## Recommendation:

**The PAC appreciates the work done during the previous period of the project implementation and supports its extension for the period 2024–2027 with updated content and the title “Accelerator driven subcritical reactor (ADSR)”.**

# Project “BECQUEREL2023”


The PAC heard a report on extending the project “BECQUEREL2023” at the Nuclotron-NICA accelerator complex to study peripheral interactions of relativistic nuclei presented by P. Zarubin.

The project is focused on the search for α-particle Bose-Einstein condensate (αBEC). Identification of decays $^{8}Be \rightarrow 2\alpha$, $^{9}Be \rightarrow 2\alpha$, and $^{12}C(0^{+}_{2}) \rightarrow {}^{8}Be\alpha$ (the Hoyle state) by the invariant mass was tested for light nuclei, including radioactive ones.

**Recommendation:**

**The PAC recommends extending work on the project “BECQUEREL2023” in the status of activity.**

The next meeting of the PAC for Nuclear Physics is going to be held on **29–30 January 2024.**

# THANK YOU FOR YOUR ATTENTION!