Annex 3.

Form of opening for Project

APPROVED

JINR DIRECTOR

____________/__________________

"_____"_____ ___ _________ 202_ г.

SCIENTIFIC AND TECHNICAL REASONING FOR THE OPENING OF PROJECT IN RESEARCH AREA WITHIN THE TOPICAL PLAN FOR JINR RESEARCH

1. General information on the project

1.1 Theme code

03-2-1100-2010

1.2 Project/sub-project of a MIP code (for renewed themes)

1.3 Laboratory

Dzelepov Laboratory of Nuclear Problems

1.4 Scientific field

IV Nuclear physics

1.5 The name of the Project

Radiochemistry and spectroscopy for astrophysics and nuclear medicine

1.6 Project Leader

D. V. Filosofov

1.7 Project Deputy Leaders (scientific supervisor of the project)

A. Baimukhanova, A. I. Velichkov, Yu. B. Gurov, A. Kh. Inoyatov, D. V. Karaivanov, J.H. Khushvaktov

2 Scientific rationale and organisational structure

2.1 Annotation

The aim of the project is the development of the methods of nuclear spectroscopy and radiochemistry, which in addition to their tasks, cover several scientific, material and technical basis for the design and improvement of the relevant experiments in the fields of astrophysics and neutrino physics (particle detection techniques, calibration, background description, uniquely pure materials, etc.), as well as nuclear medicine (production and purification of radioisotopes, radiopharmaceuticals design and synthesis, the study of the influence mechanisms on substances at radionuclides decay locations, etc.). A necessary condition for goal achievement in the declared areas very often is the utilization of some modern registration method, a uniquely pure material, preparation of a specific radionuclide, etc. The project is aimed at the development and implementation of the methods for the current laboratory (institute) projects, as well as for expanding their horizon. Specific areas are:

a) novel detectors (semiconductor detectors, liquid and plastic organic scintillators, composite scintillation detection systems, neutron and radon detectors, etc.);

b) "post-decay" spectroscopy of electrons and other emissions with an emphasis on extremely low energies;

c) traditional gamma-spectroscopy based on semiconductor detectors (SPD) with an emphasis on the determination precision of the emission energy and activity of the sources (pointlike and volumetric) to study decay modes and determine the cross sections of nuclear reactions;

d) application of hyperfine interactions (HFI) methods using radioactive tracers, namely the method of perturbed angular correlation (PAC) and the emission mode of Mössbauer spectroscopy for the study of radiopharmaceuticals and their precursors in water-containing systems and other matrices;

e) development of production and purification methods of radionuclide preparations for the radiopharmaceuticals synthesis, including the development of generator routes for their production, physicochemical methods for properties evaluation of radionuclides and radiopharmaceuticals (their precursors) in homogeneous and heterogeneous systems;

f) development and application of methods and techniques for the production and analysis of low-background materials with a uniquely low content of radioactive impurities, in particular using inductively coupled plasma mass spectrometry (ICP-MS), as well as other analytical and nuclear spectroscopic methods.

2.2 Scientific justification (purpose, relevance and scientific novelty, methods and approaches, methodologies, expected results, risks)

The project aims to develop and implement the methods and techniques of radiochemistry and spectrometry, which are applied in astrophysics, neutrino physics and nuclear medicine.

Utilization of nuclear spectroscopy and radiochemistry methods in studying of neutrino properties, searching for dark matter particles, and researching rare and other physical processes are firmly and deservedly recommended in numerous experiments, conducted on these topics of fundamental physics. Almost the same can be said about their role in nuclear medicine. Thus, the relevance of this topic is undeniable. A key to the scientific novelty of the project is a focus on the techniques and methods of development that allow expanding the horizon of the declared target experiments. For these purposes, in many cases it is necessary to improve the energy (or/and time) resolution of the detectors, taking into account the optimization of their size and "emitting" samples, as well as other properties. At the same time, all kinds of material purities are required. The last point almost always requires a uniquely low level of impurities, which will undoubtedly transform the resulting preparative and analytical tasks from technical to advanced science. The same can be said about any important spectrometric characteristic of facilities. It is also very important to emphasize that the requirements of astrophysical, neutrino and nuclear medical research are often parallel or opposite. For example, the purification of low-background material from radioactive impurities and the separation of radionuclides from irradiated targets are formally opposite problems, but in practice they both refer to a single task of separating a micro-amount from a macro-amount of a substance. The next fact is that the most important general, but not yet fully resolved the scientific problem in nuclear medicine (radiobiology) and modern spectrometry is the energy redistribution in the range of less than 500 eV between carriers (electrons, ions, excited defect particles, photons, phonons) in a condensed matter both during radioactive decay and ionization by external radiation. Similar examples could be continued.

Project parts subsections:

a) new detectors - development and application of detectors based on silicon carbide (SiC) for nuclear radiation registration. SiC detectors that have high radiation resistance (10 times higher than silicon) and operability at high temperatures > 400°C are planned to be used to monitor the operation of high-current accelerators and nuclear reactors, as well as hot plasma diagnostics;

- development and research of liquid tellurium-containing scintillators for the search for double neutrinoless β-decay (it is possible to use it in the JUNO large-scale detector), as well as other types of liquid and plastic scintillators;

- development of composite scintillation registration systems for neutrino experiments;

- development and application of ^{3}He counters for detecting low neutron fluxes (less than 10^{-6} n×cm^{-2}×s), development of a compact sensitive radon detector, technology development for production of low-radioactive parts using 3D printing;

b) experimental study of the low-energy electrons spectra (0 -50 keV) on the ESA-50 spectrometer and the gamma and X-ray radiation spectra on the SCD during radioactive decay to obtain new data on low-excited states of nuclei and post-decay relaxation of atomic systems, search for spectrometry ways of post-decay photons (from the edge of infrared radiation to soft X-ray) in the energy range 1-200 eV;

c) technique development for modeling codes application (Geant4, MCNP and FLUKA) of the HPGe spectrometer characteristics at the LINAC-200 electron accelerator to determine the yields of photonuclear reactions and at other JINR basic facilities. Decay modes study of a wide range of radionuclides, and their content in samples (^{96}Zr, ^{40}K, ^{138}La, etc.) to study rare processes;

d) improvement of the methods of perturbed angular correlations (PAC) and Mössbauer spectroscopy (emission mode) using radioactive tracers ^{111}In, ^{152}Eu, ^{154}Eu, ^{119}Sb, ^{119m}Sn, ^{57}Co, ^{161}Tb, etc., to study of radiopharmaceuticals and their precursors (components) in aqueous systems and other matrices, the development of physicochemical methods for evaluation of the properties of radionuclides and radiopharmaceuticals in homogeneous and heterogeneous systems;

e) radiochemistry and nuclear medicine - the study of sorption processes for various solution-sorbent systems as the chemical basis for the purification methods (low-background materials as well) and the radionuclide generators design for the production of the radiopharmaceuticals;

- development of the production and isolation methods (including mass separation) of radionuclides from targets irradiated with protons, neutrons and gamma quanta for the production of radiopharmaceuticals (^{103}Pd, ^{119}Sb, ^{161}Tb, several alpha emitters, etc.);

- development of a large range of radionuclide generators ($^{44}Ti \rightarrow {}^{44}Sc$, $^{68}Ge \rightarrow {}^{68}Ga$, $^{90}Sr \rightarrow {}^{90}Y$, $^{238}U \rightarrow {}^{234}Th$, $^{237}Np \rightarrow {}^{233}Pa$, $^{229}Th \rightarrow {}^{225}Ac$, $^{227}Ac \rightarrow {}^{227}Th \rightarrow {}^{223}Ra$, $^{202}Pb \rightarrow {}^{202}Tl$, $^{194}Hg \rightarrow {}^{194}Au$, $^{32}Si \rightarrow {}^{32}P$, etc.) will be continued based on reverse-tandem methods to expand the possibilities of medical radionuclides production. The possibility of 1-2 generators of significant activity for external users will be considered;

- methods development for radiolabeling for radiopharmaceuticals synthesis based on chelators with "slow" kinetics, the study of the radium chelation;

f) methods development and implementation of samples production (^{82}Se, ^{96}Zr, shielding materials, solder, etc.) for astrophysical and neutrino problems at a new ultra-low level of impurity content (from mBq/kg to μBq/kg of Th and U). The main approaches to solving the identified problems are: the use of reverse chromatography, low-boiling and other prepared or selected reagents, the use of selected and prepared reactor materials;

- methods development and implementation for samples analysis at an ultra-low sensitivity level (from mBq/kg to μBq/kg of Th and U) using ICP-MS, neutron activation analysis (NAA) and other methods, development of methods for the precise determination of the chemical and isotopic composition of substances - materials used in astrophysical and neutrino experiments.

2.3 Estimated completion date

Until 2028. The project will be prolonged further depending on the obtained results.

2.4 Participating JINR laboratories

2.4.1 MICC resource requirements

Computing resources	Distribution by year				
	1st year	2nd year	3rd year	4th year	5th year
Data storage (TB) - EOS - Ribbons					
Tier 1 (core-hour)					
Tier 2 (core-hour)					
SC Talker (core-hour) - CPU - GPU					
Clouds (CPU cores)					

2.5. Participating countries, scientific and educational organisations

Organisation	Country	City	Participants	Type of agreement

2.6. Co-executing organisations *(those collaborating organisations/partners without whose financial, and infrastructural participation the implementation of the research program is impossible. An example is JINR's participation in the LHC experiments at CERN).*

3. Staffing

3.1. Staffing needs in the first year of implementation

№№ n/a	Category employee	Core staff, Amount of FTE	Associated Personnel Amount of FTE
1.	scientific staff	16.35	
2.	engineers	11.05	
3.	professionals	1	
4.	employees	-	
5.	workers	1.1	
	Total:	**29.5**	

3.2. Human resources available

3.2.1. JINR core staff

№№ п/а	Category of employees	NAME	Division	Position	Amount of FTE
1.	scientific staff	Baimukhanova A.	DLNP	research scientist	1
		Vaganov Yu.	DLNP	research scientist	0.7
		Velichkov A.	DLNP	senior scientist	1
		Vorobyeva M.	DLNP	research scientist	0.8
		Gurov Yu.	DLNP	head of the sector	0.2
		Dadakhanov J.	DLNP	junior scientist	1
		Inoyatov A.	DLNP	head of the sector	0.3
		Karaivanov D.	DLNP	senior scientist	0.7
		Kartvtsev O.	DLNP	senior scientist	0.5
		Mirzaev N.	DLNP	junior scientist	0.7
		Morozov V.	DLNP	chief scientist	0.6
		Ponomarev D.	DLNP	junior scientist	0.1
		Rasulova F	DLNP	junior scientist	1
		Rakhimov A.	DLNP	research scientist	0.8
		Rozov S.	DLNP	deputy head of department	0.2

		Salamatin A.	DLNP	senior scientist	0.4
		Salamatin D.	DLNP	junior scientist	0.3
		Sandukovskiy V.	DLNP	consultant at the directorate of the DLNP	0.25
		Solnyshkin A.	DLNP	senior scientist	1
		Stegailov V.	DLNP	research scientist	1
		Suslov I.	DLNP	junior scientist	0.5
		Temerbulatova N.	DLNP	junior scientist	0.8
		Timkin V.	DLNP	research scientist	0.1
		Trofimov V.	DLNP	research scientist	0.6
		Filosofov D.	DLNP	head of the sector	0.8
		Khushvaktov Ju.	DLNP	senior scientist	0.5
		Yakushev E.	DLNP	head of department	0.2
		Nemchenok I.	DLNP	head of the group	0.3
2.	engineers	Abd Alngar M.	DLNP	engineer	0.8
		Alekseesv I.	DLNP	senior engineer	0.4
		Vagina O.	DLNP	engineer	0.5
		Vinokurov N.	DLNP	senior engineer	0.5
		Volnykh V.	DLNP	lead engineer	0.25

		Dadakhanova Kh.	DLNP	engineer	1
		Denisova E.	DLNP	engineer	0.5
		Evseev S.	DLNP	engineer	0.8
		Kalinova B.	DLNP	engineer	0.3
		Kamnev I.	DLNP	engineer	0.4
		Katulin S.	DLNP	senior engineer	0.1
		Katulina S.	DLNP	senior engineer	0.3
		Kurakina E.	DLNP	engineer	0.5
		Morozova N.	DLNP	engineer	1
		Mukhina M.	DLNP	senior engineer	1
		Rozova I.	DLNP	engineer	0.2
		Samatov J.	DLNP	engineer	1
		Fateev S.	DLNP	engineer	0.8
		Shakhov K.	DLNP	engineer	0.1
		Shevchenko M.	DLNP	engineer	0.3
		Sherbakova I.	DLNP	engineer	0.3
3.	professionals	Kulkova E.	DLNP	document management specialist	0.1
		Lednicka T.	DLNP	laboratory assistant	0.2
		Morozova T.	DLNP	senior inspector	0.2
		Khusenova Yu.	DLNP	laboratory assistant	0.5
4.	workers	Emeliyanov A.	DLNP	mechanic-repairman	0.5
		Zaikin A	DLNP	mechanic of experimental stands and setups	0.1

		Fariseeva V	DLNP	senior technician	0.5
	Total:	**57**			**29.5**

3.2.2. JINR associated personnel

№№ п/а	**Category of employees**	**Partner organisation**	**Amount of FTE**
1.	Scientific employees		
2.	engineers		
3.	professionals		
4.	workers		
	Total:		

4. Financial support

4.1 Total estimated cost of the project

Forecast of the total estimated cost (specify cumulatively for the whole period, excluding FPC).

3000 thousand of dollars

The details are given in a separate form.

4.2 Extrabudgetary funding sources

Estimated funding from co-executors/customers - total.

Project Leader __________/___________/

Date of submission of the project to DSOA: _________

Date of decision of the laboratory's STC: _________ document number: _________

Year of the project opening: ________________

(for renewable projects) -- Project start year: _______

Schedule proposal and resources required for the implementation of the Project

Names of costs, resources, sources of funding			**Cost (thousands of dollars) resource requirements**	**Cost, distribution by year**				
				1st year	2nd year	3rd year	4th year	5th year
		International cooperation (IC)	550	110	110	110	110	110
		Materials	550	110	110	110	110	110
		Equipment and third-party services (commissioning)	1500	300	300	300	300	300
		Commissioning work	100	20	20	20	20	20
		Services of research organisations	50	10	10	10	10	10
		Acquisition of software	100	20	20	20	20	20
		Design/construction	50	10	10	10	10	10
		Service costs (*planned in case of direct project affiliation)*	100	20	20	20	20	20
Resources required	**Normo-hours**	Resources						
		– the amount of FTE,	29.5	29.5	29.5	29.5	29.5	29.5
		– accelerator/installation,						
		– reactor,….						
Sources of funding	**Budgetary resources**	JINR budget *(budget items)*	3000	600	600	600	600	600
	Extrabudgetary (supplementary estimates)	Contributions by co-contractors Funds under contracts with customers Other sources of funding						

Project Leader __________/_________________/

Laboratory Economist __________/_________________/

APPROVAL SHEET FOR PROJECT

NAME OF THE PROJECT

Radiochemistry and spectroscopy for astrophysics and nuclear medicine

DESIGNATION OF THE PROJECT

THEME CODE

03-2-1100-2010

NAME OF THE PROJECT LEADER

D. V. Filosofov

AGREED			
JINR VICE-DIRECTOR	______________ SIGNATURE	____________ NAME	____________ DATE
CHIEF SCIENTIFIC SECRETARY	______________ SIGNATURE	____________ NAME	____________ DATE
CHIEF ENGINEER	______________ SIGNATURE	____________ NAME	____________ DATE
LABORATORY DIRECTOR	______________ SIGNATURE	____________ NAME	____________ DATE
CHIEF LABORATORY ENGINEER	______________ SIGNATURE	____________ NAME	____________ DATE
LABORATORY SCIENTIFIC SECRETARY	____________ SIGNATURE	____________ NAME	____________ DATE
THEME LEADER	____________ SIGNATURE	____________ NAME	____________ DATE
PROJECT LEADER	_____________ SIGNATURE	____________ NAME	____________ DATE
APPROVED BY THE PAC	______________ SIGNATURE	____________ NAME	____________ DATE

Annex 4

Project report form

1. General information on the project

1.1. Scientific field

IV Nuclear physics

1.2. Name of the project

Radiochemistry and spectroscopy for astrophysics and nuclear medicine

1.3. Project code

1.4. Theme code

03-2-1100-2010

1.5. Actual duration of the project

1.6. Project Leader

D. V. Filosofov

2. Scientific report

2.1. Annotation

This project is being opened for the first time. However, it should be noted that the project range of challenges and studies are traditional for the team, which were carried out within the framework of the projects of the topic 03-2-1100-2010 or within the activities of this topic. A very large amount of work has been carried out on the relevant topics in past years and quite recently, and significant scientific results have been obtained. The new results are listed below:

- a production technique of SiC detectors based on Schottky diodes has been developed;

- a series of new tellurium-containing scintillators have been developed;

- spectra of low-energy electrons for determination of the decay modes have been obtained;

- the cross sections of photonuclear reactions on holmium (Ho) have been determined;

- the characteristics of the dynamic process of formation and stability of radiopharmaceuticals precursors using the PAC method have been determined;

- the parameters of sorption processes for various solution-sorbent systems using methods of radioactive tracers and ICP-MS have been determined;

- techniques for purification and analysis of low-background materials have been developed;

- isolation methods of the radionuclides for radiopharmaceuticals design have been developed (via accelerator experiments, and generator pairs), and review articles on this subject have been published.

2.2. A detailed scientific report

2.2.1. Description of the mode of operation and functioning of the main systems and equipment

(for the LRIP subproject).

2.2.2. A description of the experiments carried out (for pilot projects).

- preparation and irradiation of the developed SiC detectors with Xe ions with an energy of 165 MeV;

- optimization of the chemical process (selection of reagents, equipment, synthesis conditions, etc.) for the production of liquid and plastic tellurium-containing scintillators;

- sources production and measurements of the electron spectra from the radionuclides decay using the ESA 50 with a resolution of ~ 4 eV in the energy range of 0 - 40 keV;

- preparation and carrying out the experiments for determination of the photonuclear reaction cross sections by the irradiation at the LINAC-200 electron accelerator;

- sources production of medical isotopes and their analogs (^{111}In, ^{152}Eu, ^{154}Eu, etc.), measurements of the dynamic process of precursors formation and stability (complexes with DTPA in solutions) using the PAC method, as well as the measurement of hyperfine interaction in solid samples;

- radioactive tracer production and determination of the sorption processes characteristics for various solution-sorbent systems using radionuclide techniques and the ICP-MS method;

- selection and preparation of separation and conditioning systems for low-background materials purification, implementation of these methods and analysis of the obtained samples;

- selection of a nuclear reaction and/or a generator pair for the radionuclides production, selection of target irradiation parameters and/or physicochemical scheme of the generator, isolation of radiopreparation, selection of a conditioning method for radiopharmaceuticals synthesis, in some cases selection of a synthesis method of radiopharmaceuticals, implementation and optimization of these processes.

2.2.3. A description of the scientific work undertaken and the results obtained.

- production method of SiC detectors based on Schottky diodes has been developed; for the first time it was shown that during the SiC detectors irradiation with Xe ions (E = 165 MeV), their radiation resistance is much higher than silicon detectors;

- liquid scintillators stable in time with a record concentration of tellurium suitable for utilization of the large-scale detectors (JUNO) have been developed; for the first time, plastic tellurium-containing scintillators were produced;

- the structure of low-energy transitions of ^{227}Th, populated from β-decay of ^{227}Ac were defined; it was shown that the 9.2 keV transition in ^{227}Th has a mixed type of multipolarity M1+E2;

- cross sections of photonuclear reactions (γ,n), (γ,3n), (γ,4n), (γ,5n) и (γ,6n) for ^{165}Ho in the energy range of 50 - 110 MeV were experimentally defined for the first time;

- using the PAC method, it is shown that during the electron capture process in the aqueous solution of DTPA for lanthanides almost all daughter nuclei leave the vicinity of the parent nuclei (^{152}Eu(EC)^{152}Sm). In the case of β^--decay, daughter nuclei do not leave the complex (^{154}Eu(β^-)^{154}Gd), and in the case of $^{111}In(EC)^{111}Cd$ half of the daughter nuclei remain in the complex. This made it possible to determine the thermodynamic and kinetic characteristics of the radiopharmaceutical precursors of medical radionuclides and their analogs using ^{154}Eu and ^{111}In. Moreover, this opens new opportunities for carrying out radiopharmaceutical research *in vitro* and even *in vivo*. Hyperfine interactions of several solid-state samples have also been investigated;

-the distribution coefficients of elements in various solution-sorbent systems using radionuclide tracers and the ICP-MS method have been determined;

- purification and conditioning method of ^{82}Se (2 kg) with a uniquely low content of radioactive impurities (tens or hundreds of μBq/kg of Th and U) has been developed, this isotope will be used for searching for a neutrinoless mode of the double beta decay in the NEMO -Demonstrator experiment;

- production methods of low background solder and fluxes have been developed, obtained materials analysis using ICP-MS and NAA have showed the impurities content of μBq/kg and below for Th and U;

- production methods of radiopreparation for nuclear medicine have been developed: radionuclides production for positron emission tomography (PET) using radionuclide generators $^{68}Ge \rightarrow ^{68}Ga$, $^{86}Zr \rightarrow ^{86}Y$; the reverse-tandem scheme of the generator $^{44}Ti \rightarrow ^{44}Sc$; production of ^{44}Sc using an accelerator; production of therapeutic isotopes ^{119}Sb and ^{225}Ac; for several produced radionuclides, the methods of radiopharmaceutical synthesis based on them were evaluated; review articles on the role of radionuclide sources for the radiopharmaceutical synthesis were published.

2.2.4. A list of the main publications of JINR authors, including associated personnel on the results of the project work (list of bibliographical references).

1. Filosofov D. V., Baimukhanova A. E., Kurakina E. S., Karaivanov D. V., Velichkov A. I., Radchenko V. I., Yakushev Y. A. "Radiochemical Investigations for Radiopharmaceutical Nuclear Medicine at JINR Laboratory of Nuclear Problems." Physics of Particles and Nuclei 2, 2023. Accepted. IF 0.786
2. I. Alekseev, K. Balej, V. Belov, S. Evseev, D. Filosofov, M. Fomina, Z. Hons, D. Karaivanov, S. Kazartsev, J. Khushvaktov, A. Kuznetsov, A. Lubashevskiy, D. Medvedev, D. Ponomarev, A. Rakhimov, K. Shakhov, E. Shevchik, M. Shirchenko, K. Smolek, S. Rozov, I. Rozova, S. Vasilyev, E. Yakushev, I. Zhitnikov. "First results of the νgeN experiment on coherent elastic neutrino-nucleus scattering." *Physical Review D* 106, 5, 2022, ISSN 2470-0010, https://doi.org/10.1103/PhysRevD.106.L051101. IF 5.296
3. E. Armengaud and EDELWEISS collaboration. "Search for sub-GeV dark matter via the Migdal effect with an EDELWEISS germanium detector with NbSi transition-edge sensors." *Physical Review D* 106, 6, 2022, ISSN 2470-0010, https://doi.org/10.1103/PhysRevD.106.062004. IF 5.296
4. E.S. Kurakina, L. Wharton, C. Hoehr, C. Orvig, E.P. Magomedbekov, D. Filosofov, V. Radchenko. "Improved separation scheme for ^{44}Sc produced by irradiation of ^{nat}Ca targets with 12.8 MeV protons." *Nuclear Medicine and Biology* 104, 2022, pp. 22-27, ISSN 0969-8051, https://doi.org/10.1016/j.nucmedbio.2021.11.002. IF 2.947
5. Yu. B. Gurov, S. A. Evseev, N. I. Zamyatin, Yu. A. Kopylov, S. V. Rozov, V. G. Sandukovsky, E. A. Streletskaia, L. Hrubcin, B. Zat’ko, P. Boháček. "Radiation Resistance of SiC Detectors after Neutron Irradiation", Physics of Particles and Nuclei Letters, 19, 6, 740, 2022, ISSN 1547-4771, https://doi.org/10.1134/S1547477122060115 IF 0.57

6. B. Zaťko, L. Hrubčín, A. Šagátová, J. Osvald, P. Boháček, E. Kováčová, Y. Halahovets, S. V. Rozov, V.G. Sandukovskij. "Study of Schottky barrier detectors based on a high quality 4H-SiC epitaxial layer with different thickness", Applied Surface Science, 536, 1-3,14780, 2021, ISSN:0169-4332, https://doi.org/10.1016/j.apsusc.2020.147801 IF 1.147

7. M. Agostini and GERDA collaboration. "Search for exotic physics in double-β decays with GERDA Phase II." *Journal of Cosmology and Astroparticle Physics* 2022, 12, 2022, ISSN 1475-7516, https://doi.org/10.1088/1475-7516/2022/12/012. IF 7.28

8. N. A. Mirzayev, Kh. F. Mammadov, Zh. P. Burmii, D. V. Karaivanov, E. S. Kurakina, N. T. Temerbulatova, A. Baimukhanova, A. V. Rakhimov, S. V. Rozov, G. K. Salimova, A. A. Mirsagatova, I. I. Sadikov, D. V. Filosofov, E. A. Yakushev. "High-purity ammonium acetate solution for low-background electronics." *Journal of Radioanalytical and Nuclear Chemistry* 331, 12, 2022, pp. 5539-5545, ISSN 0236-5731, https://doi.org/10.1007/s10967-022-08608-3. IF 1.754

9. J. H. Khushvaktov, V. I. Stegailov, J. Adam, V. V. Kobets, A. A. Solnyshkin, J. Svoboda, Yu. G. Teterev, P. Tichy, S. I. Tyutyunnikov, J. Vrzalova, B. S. Yuldashev, M. Zeman. "Study of Photonuclear Reactions in ^{165}Ho Nucleus at the LINAC-200 Accelerator." *Physics of Particles and Nuclei Letters* 19, 4, 2022, pp. 347-352, ISSN 1547-4771, https://doi.org/10.1134/S1547477122040161. IF n/a

10. A. Baimukhanova, G. Engudar, G. Marinov, E. Kurakina, J. Dadakhanov, D. Karaivanov, H. Yang, C. F. Ramogida, P. Schaffer, E.P. Magomedbekov, D. Filosofov, V. Radchenko. "An alternative radiochemical separation strategy for isolation of Ac and Ra isotopes from high energy proton irradiated thorium targets for further application in Targeted Alpha Therapy (TAT)." *Nuclear Medicine and Biology* 112, 2022, pp. 35-43, ISSN 0969-8051, https://doi.org/10.1016/j.nucmedbio.2022.06.003. IF 2.947

11. D. Filosofov, E. Kurakina, V. Radchenko. "Potent candidates for Targeted Auger Therapy: Production and radiochemical considerations." *Nuclear Medicine and Biology* 94, 2021, pp. 1-19, ISSN 0969-8051, https://doi.org/10.1016/j.nucmedbio.2020.12.001. IF 2.947

12. Abusleme, A…., I. Nemchenok and JUNO collaboration. "Optimization of the JUNO liquid scintillator composition using a Daya Bay antineutrino detector." *Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* 988, 2021, ISSN 0168-9002, https://doi.org/10.1016/j.nima.2020.164823. IF 1.445

13. Abusleme, A…., I. Nemchenok and JUNO collaboration. "The design and sensitivity of JUNO’s scintillator radiopurity pre-detector OSIRIS." *European Physical Journal C* 81, 11, 2021, ISSN 1434-6044, https://doi.org/10.1140/epjc/s10052-021-09544-4. IF 4.994

14. J. Dadakhanov, A. Marinova, A. Baimukhanova, D. Karaivanov, N. Temerbulatova, J. Kozempel, F. Roesch, D. Filosofov. "Sorption of various elements on ion-exchange resins in acetic media." *Journal of Radioanalytical and Nuclear Chemistry* 327, 3, 2021, pp. 1191-1199, ISSN 0236-5731, https://doi.org/10.1007/s10967-021-07600-7. IF 1.754

15. A. Kovalík, A.Kh. Inoyatov, L.L. Perevoshchikov, M. Ryšavý, D.V. Filosofov, P. Alexa, J. Kvasil. "The first experimental evidence for the (M1 + E2) mixed character of the 9.2 keV transition in ^{227}Th." *Physics Letters, Section B: Nuclear, Elementary Particle and High-Energy Physics* 820, 2021, ISSN 0370-2693, https://doi.org/10.1016/j.physletb.2021.136593. IF 4.95

16. V. Radchenko, A. Baimukhanova, D. Filosofov. "Radiochemical aspects in modern radiopharmaceutical trends: a practical guide." *Solvent Extraction and Ion Exchange* 39, 7, 2021, pp. 714-744, ISSN 0736-6299, https://doi.org/10.1080/07366299.2021.1874099. IF 2.513

17. D. Ponomarev, D. Filosofov, J. Khushvaktov, A. Lubashevskiy, I. Rozova, S. Rozov, K. Shakhov, Yu. Shitov, V. Timkin, E. Yakushev, I. Zhitnikov. "NaI(Tl+Li) scintillator as multirange en-

ergies neutron detector." *Journal of Instrumentation* 16, 12, 2021, ISSN 1748-0221, https://doi.org/10.1088/1748-0221/16/12/P12011. IP 1.121

18. A. Kovalík, A. Kh. Inoyatov, L. L. Perevoshchikov, M. Ryšavý, D. V. Filosofov, J. A. Dadakhanov. "Experimental investigation of the 9.2 and 24.3 keV nuclear transitions in ^{227}Th." *European Physical Journal A* 57, 10, 2021, ISSN 1434-6001, https://doi.org/10.1140/epja/s10050-021-00577-7. IF 3.131

19. Rakhimov, A.V and SuperNemo collaboration. "Development of methods for the preparation of radiopure ^{82}Se sources for the SuperNEMO neutrinoless double-beta decay experiment." *Radiochimica Acta* 108, 2, 2020, pp. 87-97, ISSN 0033-8230, https://doi.org/10.1515/ract-2019-3129. IF 2.083

20. E. S. Kurakina, V. Radchenko, A. N. Belozub, G. Bonchev, G. A. Bozhikov, A. I. Velichkov, M. Stachura, D. V. Karaivanov, E. P. Magomedbekov, D. V. Filosofov. "Perturbed Angular Correlation as a Tool to Study Precursors for Radiopharmaceuticals." *Inorganic Chemistry* 59, 17, 2020, pp. 12209-12217, ISSN 0020-1669, https://doi.org/10.1021/acs.inorgchem.0c01208. IF 5.436

21. N.A. Mirzayev, D. Filosofov, Kh. Mammadov, M. De Jésus, D.V. Karaivanov, D. Ponomarev, A. Rakhimov, I. Rozova, S. Rozov, N. Temerbulatova. "Low radioactive NH_4Cl flux." *Journal of Instrumentation* 155, 2020, ISSN 1748-0221, https://doi.org/10.1088/1748-0221/15/05/T05004. IP 1.121

22. J.H. Khushvaktov, P. Tichý, J. Adam, A.A. Baldin, M. Baznat, M. Brunčiaková, W.I. Furman, S.A. Gustov, D. Král, A.A. Solnyshkin, V.I. Stegailov, J. Svoboda, V.M. Tsoupko-Sitnikov, S.I. Tyutyunnikov, R. Vespalec, J. Vrzalová, V. Wagner, I.P. Yudin, B.S. Yuldashev, L. Závorka, M. Zeman. "Study of the residual nuclei generation in a massive lead target irradiated with 660 MeV protons." *Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* 959, 2020, ISSN 0168-9002, https://doi.org/10.1016/j.nima.2020.163542. IF 1.445

2.2.5. A complete list of publications (electronic annex, for journal publications with journal impact factor).

1. Filosofov, D. et al. "Radiochemical Investigations for Radiopharmaceutical Nuclear Medicine at JINR Laboratory of Nuclear Problems." Physics of Particles and Nuclei 2, 2023. Accepted. IF 0.786

2. Chen, S. et al. "Determination of distribution coefficients of mercury and gold on selected extraction chromatographic resins - towards an improved separation method of mercury-197 from proton-irradiated gold targets." *Journal of Chromatography A* 1688, 2023, 463717, https://doi.org/10.1016/j.chroma.2022.463717. IF 4.759

3. Wang, J. et al. "Damping signatures at JUNO, a medium-baseline reactor neutrino oscillation experiment." *Journal of High Energy Physics* 6, 2022, ISSN 1029-8479, https://doi.org/10.1007/JHEP06(2022)062. IF 6.376

4. Abusleme, A. et al. "Sub-percent precision measurement of neutrino oscillation parameters with JUNO." *Chinese Physics C* 46, 12, 2022, ISSN 1674-1137, https://doi.org/10.1088/1674-1137/ac8bc9. IF 2.944

5. Alekseev, I. et al. "First results of the νgeN experiment on coherent elastic neutrino-nucleus scattering." *Physical Review D* 106, 5, 2022, ISSN 2470-0010, https://doi.org/10.1103/PhysRevD.106.L051101. IF 5.296

6. Agostini, M et al. "Pulse shape analysis in Gerda Phase II." *European Physical Journal C* 82, 4, 2022, ISSN 1434-6044, https://doi.org/10.1140/epjc/s10052-022-10163-w. IF 4.994

7. Armengaud, E. et al. "Search for sub-GeV dark matter via the Migdal effect with an EDEL-

WEISS germanium detector with NbSi transition-edge sensors." *Physical Review D* 106.6, 2022, ISSN 2470-0010, https://doi.org/10.1103/PhysRevD.106.062004. IF 5.296

8. Abusleme, A. et al. "Mass testing and characterization of 20-inch PMTs for JUNO." *European Physical Journal C* 82, 12, 2022, ISSN 1434-6044, https://doi.org/10.1140/epjc/s10052-022-11002-8. IF 4.994

9. Kurakina, E.S. et al. "Improved separation scheme for ^{44}Sc produced by irradiation of ^{nat}Ca targets with 12.8 MeV protons." *Nuclear Medicine and Biology* 104, 2022, pp. 22-27., ISSN 0969-8051, https://doi.org/10.1016/j.nucmedbio.2021.11.002. IF 2.947

10. Y.B. Gurov et al. "Radiation Resistance of SiC Detectors after Neutron Irradiation", Physics of Particles and Nuclei Letters, 19, 6, 740, 2022, ISSN 1547-4771, https://doi.org/10.1134/S1547477122060115 IF 0.57

11. B. Zat'ko et al. "Study of Schottky barrier detectors based on a high quality 4H-SiC epitaxial layer with different thickness", Applied Surface Science, 536, 1-3, 14780, 2021, ISSN:0169-4332, https://doi.org/10.1016/j.apsusc.2020.147801 IF 1.147

12. Kurakina, E.S. et al. "An improved separation scheme for ^{44}Sc purification from proton irradiated calcium." *Nuclear Medicine and Biology*, 96-97-S1, 2021. https://doi.org/10.1016/s0969-8051(21)00417-0. IF 2.947

13. Radchenko, V. et al. "Production of emerging theranostic radionuclides at TRIUMF." *Nuclear Medicine and Biology*, 108-109-S172, 2021. https://doi.org/10.1016/s0969-8051(21)00417-0. IF 2.947

14. Huang, X et al. "Potential of core-collapse supernova neutrino detection at JUNO." *Proceedings of Science* 395, 2022, ISSN 1824-8039. IF n/a

15. Zhao, J. et al. "Feasibility and physics potential of detecting ^{8}B solar neutrinos at JUNO." *Proceedings of Science* 395, 2022, ISSN 1824-8039. IF n/a

16. Andre, J.P. et al. "JUNO Physics Prospects." *Proceedings of Science* 395, 2022, ISSN 1824-8039. IF n/a

17. Cheng, J. et al. "Detection of the diffuse supernova neutrino background with JUNO." *Proceedings of Science* 395, 2022, ISSN 1824-8039. IF n/a

18. Agostini, M. et al. "Search for exotic physics in double-β decays with GERDA Phase II." *Journal of Cosmology and Astroparticle Physics* 2022, 12, 2022, ISSN 1475-7516, https://doi.org/10.1088/1475-7516/2022/12/012. IF 7.28

19. Marnieros, S et al. "High Impedance TES Bolometers for EDELWEISS." *Journal of Low Temperature Physics*, 2022, ISSN 0022-2291, https://doi.org/10.1007/s10909-022-02899-2. IF 1.618

20. Mirzayev, N.A. et al. "High-purity ammonium acetate solution for low-background electronics." *Journal of Radioanalytical and Nuclear Chemistry* 331, 12, 2022, pp. 5539-5545., ISSN 0236-5731, https://doi.org/10.1007/s10967-022-08608-3. IF 1.754

21. Agostini, M. et al. "Erratum: First Search for Bosonic Superweakly Interacting Massive Particles with Masses up to 1 MeV / c2 with GERDA." *Physical Review Letters*, 2020, 125 (011801), https://doi.org/10.1103/PhysRevLett.125.011801. IF 9.161

22. Khushvaktov, J.H. et al. "Study of Photonuclear Reactions in ^{165}Ho Nucleus at the LINAC-200 Accelerator." *Physics of Particles and Nuclei Letters* 19, 4, 2022, pp. 347-352, ISSN 1547-4771, https://doi.org/10.1134/S1547477122040161. IF n/a

23. Baimukhanova, A. et al. "An alternative radiochemical separation strategy for isolation of Ac and Ra isotopes from high energy proton irradiated thorium targets for further application in Targeted Alpha Therapy (TAT)." *Nuclear Medicine and Biology* 112, 2022, pp. 35-43., ISSN 0969-8051, https://doi.org/10.1016/j.nucmedbio.2022.06.003. IF 2.947

24. Alekseev, I. et al. "Observation of the temperature and barometric effects on the cosmic muon

flux by the DANSS detector." *European Physical Journal C* 82, 6, 2022, ISSN 1434-6044, https://doi.org/10.1140/epjc/s10052-022-10471-1. IF 4.994
25. Alekseev, I. et al. "Optimized scintillation strip design for the DANSS upgrade." *Journal of Instrumentation* 17, 4, 2022, ISSN 1748-0221, https://doi.org/10.1088/1748-0221/17/04/P04009. IP 1.121
26. Abusleme, A. et al. "Calibration strategy of the JUNO experiment." *Journal of High Energy Physics* 2021, 3, 2021, ISSN 1029-8479, https://doi.org/10.1007/JHEP03(2021)004. IF 6.376
27. Filosofov, D et al. "Potent candidates for Targeted Auger Therapy: Production and radiochemical considerations." *Nuclear Medicine and Biology* 94, 2021, pp. 1-19, ISSN 0969-8051, https://doi.org/10.1016/j.nucmedbio.2020.12.001. IF 2.947
28. Abusleme, A. et al. "Optimization of the JUNO liquid scintillator composition using a Daya Bay antineutrino detector." *Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* 988, 2021, ISSN 0168-9002, https://doi.org/10.1016/j.nima.2020.164823. IF 1.445
29. Abusleme, A. et al. "Feasibility and physics potential of detecting ^{8}B solar neutrinos at JUNO." *Chinese Physics C* 45, 2, 2021, ISSN 1674-1137, https://doi.org/10.1088/1674-1137/abd92a. IF 2.944
30. Abusleme, A. et al. "JUNO sensitivity to low energy atmospheric neutrino spectra." *European Physical Journal C* 81, 10, 2021, ISSN 1434-6044, https://doi.org/10.1140/epjc/s10052-021-09565-z. IF 4.994
31. Abusleme, A. et al. "Radioactivity control strategy for the JUNO detector." *Journal of High Energy Physics* 2021, 11, 2021, ISSN 1029-8479, https://doi.org/10.1007/JHEP11(2021)102. IF 6.376
32. Agostini, M. et al. "Characterization of inverted coaxial ^{76}Ge detectors in GERDA for future double- β decay experiments." *European Physical Journal C* 81, 6, 2021, ISSN 1434-6044, https://doi.org/10.1140/epjc/s10052-021-09184-8. IF 4.994
33. Abusleme, A. et al. "The design and sensitivity of JUNO's scintillator radiopurity pre-detector OSIRIS." *European Physical Journal C* 81, 11, 2021, ISSN 1434-6044, https://doi.org/10.1140/epjc/s10052-021-09544-4. IF 4.994
34. Agostini, M. et al. "Calibration of the Gerda experiment." *European Physical Journal C* 81, 8, 2021, ISSN 1434-6044, https://doi.org/10.1140/epjc/s10052-021-09403-2. IF 4.994
35. Dadakhanov, J. et al. "Sorption of various elements on ion-exchange resins in acetic media." *Journal of Radioanalytical and Nuclear Chemistry* 327.3, 2021, pp. 1191-1199., ISSN 0236-5731, https://doi.org/10.1007/s10967-021-07600-7. IF 1.754
36. Kovalik, A. et al. "The first experimental evidence for the (M1 + E2) mixed character of the 9.2 keV transition in ^{227}Th." *Physics Letters, Section B: Nuclear, Elementary Particle and High-Energy Physics* 820, 2021, ISSN 0370-2693, https://doi.org/10.1016/j.physletb.2021.136593. IF 4.95
37. S. R. Palvanov et al. "Excitation of Isomeric states in the reactions (γ,n) and (n,2n) on the ^{81}Br nucleus." *Physics of Particles and Nuclei Letters* 18, 2021, 672-675. IF n/a
38. Radchenko, V. et al. "Radiochemical aspects in modern radiopharmaceutical trends: a practical guide." *Solvent Extraction and Ion Exchange* 39, 7, 2021, pp. 714-744., ISSN 0736-6299, https://doi.org/10.1080/07366299.2021.1874099. IF 2.513
39. Ponomarev, D. et al. "NaI(Tl+Li) scintillator as multirange energies neutron detector." *Journal of Instrumentation* 16, 12, 2021, ISSN 1748-0221, https://doi.org/10.1088/1748-0221/16/12/P12011. IP 1.121
40. Kovalik, A. et al. "Experimental investigation of the 9.2 and 24.3 keV nuclear transitions in ^{227}Th." *European Physical Journal A* 57.10, 2021, ISSN 1434-6001, https://doi.org/10.1140/epja/s10050-021-00577-7. IF 3.131

41. Zavorka, L et al. "Transmutation efficiency of the spallation neutron target measured with the actinide sandwiches." *Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* 988, 2021, ISSN 0168-9002, https://doi.org/10.1016/j.nima.2020.164934. IF 1.445

42. Agostini, M. et al. "Final Results of GERDA on the Search for Neutrinoless Double- β Decay." *Physical Review Letters* 125, 25, 2020, ISSN 0031-9007, https://doi.org/10.1103/PhysRevLett.125.252502. IF 9.161

43. Arnaud, Q. et al. "First Germanium-Based Constraints on Sub-MeV Dark Matter with the EDELWEISS Experiment." *Physical Review Letters* 125, 14, 2020, ISSN 0031-9007, https://doi.org/10.1103/PhysRevLett.125.141301. IF 9.161

44. Agostini, M. et al. "First Search for Bosonic Superweakly Interacting Massive Particles with Masses up to 1 MeV/c2 with GERDA." *Physical Review Letters* 125, 1, 2020, ISSN 0031-9007, https://doi.org/10.1103/PhysRevLett.125.011801. IF 9.161

45. Agostini, M. et al. "Modeling of GERDA Phase II data." *Journal of High Energy Physics* 2020.3, 2020, ISSN 1126-6708, https://doi.org/10.1007/JHEP03(2020)139. IF 6.376

46. Rakhimov, A.V. et al. "Development of methods for the preparation of radiopure ^{82}Se sources for the SuperNEMO neutrinoless double-beta decay experiment." *Radiochimica Acta* 108, 2, 2020, pp. 87-97., ISSN 0033-8230, https://doi.org/10.1515/ract-2019-3129. IF 2.083

47. Kurakina, E.S. et al. "Perturbed Angular Correlation as a Tool to Study Precursors for Radio-pharmaceuticals." *Inorganic Chemistry* 59, 17, 2020, pp. 12209-12217., ISSN 0020-1669, https://doi.org/10.1021/acs.inorgchem.0c01208. IF 5.436

48. Kurakina, E.S. et al. "Production of ^{111}In and Radioisotopes of Te and Sn from an Antimony Target Irradiated with High-Energy Protons." *Radiochemistry* 62, 3, 2020, pp. 393-399., ISSN 1066-3622, https://doi.org/10.1134/S1066362220030121. IF 0.9

49. Khushvaktov, J.H. et al. "Study of the Rate of Photonuclear Reactions in ^{165}Ho Nucleus." *Physics of Particles and Nuclei Letters* 17, 6, 2020, pp. 821-825., ISSN 1547-4771, https://doi.org/10.1134/S1547477120060060. IF n/a

50. Mirzayev, N.A. et al. "Low radioactive NH_4Cl flux." *Journal of Instrumentation* 15.5, 2020, ISSN 1748-0221, https://doi.org/10.1088/1748-0221/15/05/T05004. IP 1.121

51. Agostini, M. et al. "Searching for neutrinoless double beta decay with GERDA." *Journal of Physics: Conference Series* 1342, 1, 2020, ISSN 1742-6588, https://doi.org/10.1088/1742-6596/1342/1/012005. IF 0.547

52. Holomb, R.R. et al. "Experimental and simulated data at fragment productions in 100 MeV proton-induced reaction on ^{232}Th." *Proceedings - 2020 21st International Scientific Conference on Electric Power Engineering, EPE 2020*, 2020, https://doi.org/10.1109/EPE51172.2020.9269277. IF n/a

53. Haysak, I.I. et al. "Monte carlo simulation of bremsstrahlung spectra for low energy electron accelerators." *Proceedings - 2020 21st International Scientific Conference on Electric Power Engineering, EPE 2020*, 2020, https://doi.org/10.1109/EPE51172.2020.9269252. IF n/a

54. Kral, D. et al. "Measurement of activation products in chloride salts irradiated by spallation neutrons." *Proceedings - 2020 21st International Scientific Conference on Electric Power Engineering, EPE 2020*, 2020, https://doi.org/10.1109/EPE51172.2020.9269174. IF n/a

55. Khushvaktov, J.H. et al. "Study of the residual nuclei generation in a massive lead target irradiated with 660 MeV protons." *Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* 959, 2020, ISSN 0168-9002, https://doi.org/10.1016/j.nima.2020.163542. IF 1.445

2.2.6 List of papers presented at international conferences and meetings (electronic annex).

1. Kurakina E.S. et al. An improved separation scheme for ^{44}Sc purification from proton irradiated calcium, Virtual meeting Society of Radiopharmaceutical Sciences, 17-19 May, USA.
2. Chen S. Towards an improved methodology for separating mercury-197 from proton-irradiated gold targets – a study of mercury adsorption behaviour on different extraction resins in hydrochloric acid, Virtual meeting Society of Radiopharmaceutical Sciences, 17-19 May, USA.
3. Kurakina E.S. et al. ^{44m}Sc/^{44g}Sc generator based on the after-effects of radioactive decay, The XXV International Scientific Conference of Young Scientists and Specialists, 11-15 October, 2021, Almaty, Kazakhstan.
4. Khushvaktov J.H. et al. Study of photonuclear reactions in ^{165}Ho nucleus at the LINAC-200 accelerator, The International conference “Modern Problems of nuclear energetics and nuclear technologies”, 23-25 November, 2021, Ulugbek, Tashkent, Uzbekistan.
5. Tyutyunnikov S.I. et al. Results of the investigation into nucleus isomers far from the target nuclei of ^{209}Bi, ^{165}Ho, ^{238}U on the beams of accelerators at JINR, The International conference “Modern Problems of nuclear energetics and nuclear technologies”, 23-25 November, 2021, Ulugbek, Tashkent, Uzbekistan.
6. Tyutyunnikov S.I. et al. An investigation of products of (n,f), (n,γ) and (γ, f), (γ,xn,p) reactions on samples of uranium and bismuth using the phasotron and LINAC-200 accelerators at JINR: experiments and calculations, The International conference “Modern Problems of nuclear energetics and nuclear technologies”, 23-25 November, 2021, Ulugbek, Tashkent, Uzbekistan.
7. Tyutyunnikov S.I., et al. On the relevance of using large-volume HPGe detectors in spectrometric studies of reaction products on proton and electron beams of JINR accelerators, The International conference “Modern Problems of nuclear energetics and nuclear technologies”, 23-25 November, 2021, Ulugbek, Tashkent, Uzbekistan.
8. Salamatin D. The pals study of B20 monosilicides, International conference HYPERFINE interactions and their applications, 5-10 September, 2021, Brasov, Romania.
9. Zaťko B. Study of the pulse height defect of ^{4}H-SiC Schottky barrier detectors in heavy ion detection, 23-25 June, 2021, Strbske pleso, Slovakia.
10. Kovalík A. et al. Natural widths of atomic levels in thorium determined by the ices method, LXXII International conference "Nucleus-2022: Fundamental problems and applications", July 11-16, 2022, Moscow, Russia.
11. Inoyatov A. Kh. et al. Experimental investigations of the 9.2, 15.1, and 24.3 keV nuclear transitions in ^{227}Th and consequences of their results for spin-parity assignment to low-lying states of ^{227}Th, LXXII International conference "Nucleus-2022: Fundamental problems and applications", July 11-16, 2022, Moscow, Russia.
12. Palvanov S. R. et al. Study excitation of isomeric states in (γ,n), (n,2n) and (n, γ) reactions on ^{108,110}Pd, LXXII International conference "Nucleus-2022: Fundamental problems and applications", July 11-16, 2022, Moscow, Russia.
13. Inoyanov A. Current fundamental and applied problems of low-energy nuclear electron spectroscopy, II International Forum "Physics-2022", 4-5 October, 2022, Namangan, Uzbekistan.
14. Rakhimov A. V. et al. Purification and analysis of macro quantities of selenium-82 for low-background studies, All-Russian Symposium "Separation and Concentration in Analytical Chemistry and Radiochemistry" with international participation, 26.09.2021-02.10.2021, Krasnodar, Russia.

15. Tretyak V. Investigation of double beta decay of ^{150}Nd to excited states of ^{150}Sm in NEMO-3, LXXI International conference “Nucleus-2021”, 20-25 September, 2021, Saint Petersburg, Russia.
16. Salamatin D.A. Pressure influence on the valence and magnetic state of Yb in noncentrosymmetric heavy-fermion $YbNiC_2$, VI International Workshop Dzyaloshinskii-Moriya Interaction and Exotic Spin Structures, September 6-10, 2021, Vyborg, Russia.
17. I. A. Suslov et al. Telluric liquid scintillator based on linear alkylbenzene, All-Russian conference with international participation "Physical and analytical chemistry of natural and technogenic systems", 14-15 April, 2021, Dubna, Russia.
18. I. A. Suslov et al. New plastic scintillator for neutron detection, All-Russian conference with international participation "Physical and analytical chemistry of natural and technogenic systems", 2-3.12.2021, Dubna, Russia.
19. Kazartsev S. V. et al. Investigation of muon capture in various nuclei. Technical aspects, Youth Conference on Theoretical and Experimental Physics, 15-18 november, 2021, Moscow, Russia.
20. Chernyshev B. A. et al. Spectroscopy of heavy helium isotope ^{9}He in reactions of stopped pion absorption, LXXI International conference “Nucleus-2021”, 20-25 September, 2021, Saint Petersburg, Russia.
21. Gurov Yu. B. et al. Method for reconstruction the spectra of short-range charged particles in stopped π^+-meson absorption by nuclei, LXXI International conference “Nucleus-2021”, 20-25 September, 2021, Saint Petersburg, Russia.
22. Hrubčín L. et al. SiC nuclear radiation detectors for detection of heavy ions, LXXI International conference “Nucleus-2021”, 20-25 September, 2021, Saint Petersburg, Russia.
23. Tyutyunnikov S.I. et al. Studies of isomeric states of nuclei on the proton beam of the phasotron and electron beam of the LINAC-200 accelerators at JINR using the ^{209}Bi, ^{238}U, ^{165}Ho targets, LXXI International conference “Nucleus-2021”, 20-25 September, 2021, Saint Petersburg, Russia.
24. Tyutyunnikov S.I. et al. The first experiments at E=180 MeV on the electron beam of the LINAC-200 accelerators to determine isomers of bismuth and lead, LXXI International conference “Nucleus-2021”, 20-25 September, 2021, Saint Petersburg, Russia.
25. Tyutyunnikov S.I. et al. ^{238}U in the neutron field and the bremsstrahlung radiation field on the beams of protons and electrons of the accelerators at JINR: Calculations and experiments, LXXI International conference “Nucleus-2021”, 20-25 September, 2021, Saint Petersburg, Russia.
26. Tyutyunnikov S.I. et al. ^{237}Np, ^{239}Pu actinides in the neutron field of the “Quinta” uranium target, LXXI International conference “Nucleus-2021”, 20-25 September, 2021, Saint Petersburg, Russia.
27. Evseev S. et al. Characteristics of SiC detectors after neutron irradiation, LXXI International conference “Nucleus-2021”, 20-25 September, 2021, Saint Petersburg, Russia.
28. Rakhimov A. et al. Distribution coefficients of elements in the system of cation exchanges resin – selenous acid, LXXI International conference “Nucleus-2021”, 20-25 September, 2021, Saint Petersburg, Russia.
29. Morozov V. A., Delayed emission of electrons in a photomultiplier, LXXI International conference “Nucleus-2021”, 20-25 September, 2021, Saint Petersburg, Russia.
30. Bohacek P. et al. SiC nuclear radiation detectors, X Interinstitutional Youth Conference "Elementary Particle Physics and Cosmology 2021", 19-20 April, 2021, Moscow, Russia.
31. Hrubčín L. et al. SiC nuclear radiation detectors based on ^{4}H-SiC epitaxial layer, LXX International conference "NUCLEUS – 2020", 12-17 October, 2020, Saint Petersburg, Russia.
32. Chernyshev B.A. et al. Monitor system for stopped pion selection, LXX International conference "NUCLEUS – 2020", 12-17 October, 2020, Saint Petersburg, Russia.

33. Egorov N.Y. et al. In situ gamma spectroscopy determination of radioactive concentration in soils, LXX International conference "NUCLEUS – 2020", 12-17 October, 2020, Saint Petersburg, Russia.

34. Gurov Yu. B. et al. Method for reconstruction the spectra of short-range charged particles in stopped (ϖ) – meson sbsorption by nuclei, LXXI International conference "NUCLEUS-2021”, 20-25 September, 2021, Saint Petersburg, Russia.

35. Hrubčín L. et al. SIC nuclear radiation detectors for detection of heavy ions, LXXI International conference "NUCLEUS-2021”, 20-25 September, 2021, Saint Petersburg, Russia.

36. Chernyshev B. A. et al. Hydrogen isotopes production under π^- - meson absorptionin silicon “live” target, LXXII International conference "Nucleus-2022: Fundamental problems and applications", July 11-16, 2022, Moscow, Russia.

37. Chernyshev B. A. et al. ^{8}He spectroscopy in stopped pion absorption reaction, LXXII International conference "Nucleus-2022: Fundamental problems and applications", July 11-16, 2022, Moscow, Russia.

38. Evseev S. et al. Radiation resistance of sic detectors under neutron irradiation, LXXII International conference "Nucleus-2022: Fundamental problems and applications", July 11-16, 2022, Moscow, Russia.

39. Hrubčín L. et al. SiC nuclear radiation detectors after irradiation by heavy ions and neutrons, LXXII International conference "Nucleus-2022: Fundamental problems and applications", July 11-16, 2022, Moscow, Russia.

40. Evseev S et al. Radiation damage of SiC detectors irradiated with Xe ions and neutrons, 6th International Conference on Particle Physics and Astrophysics, 29.11-02.12.2022, Moscow, Russia.

41. Gurov Yu. B. et al. Level structure of unbound heavy helium isotopes ^{7,9}He, 6th International Conference on Particle Physics and Astrophysics, 29.11-02.12.2022, Moscow, Russia.

2.2.7. Patent activity (if any)

2.3. Status and stage (TDR, CDR, ongoing project) of the project (subproject) (including percentage of implementation of the declared milestones of the project (subproject of the LRIP) *(if applicable)*

2.4. Results of related activities

2.4.1. Research and education activities. List of defended dissertations.

A. V. Rakhimov , degree of chemical sciences candidate on the topic "Radiochemical aspects of high dispersed selenium-82 production with a low content of radioactive impurities and analysis of materials for low-background studies"

2.4.2. JINR grants (scholarships) received.

Competition for JINR Young Scientists and Specialists

2023:

A. Baimukhanova

S. A. Evseev

2022:

N. Mirzayev
S. A. Evseev

2021:
K. V. Shakhov

2.4.3. Awards and prizes.
2.4.4. Other results (expert, scientific-organisational, scientific-propaganda activities).

3. International scientific and technical cooperation.

Actually participating countries, institutions and organisations

Organisation	**Country**	**City**	**Participants**	**Type of agreement**

4. Plan/actual analysis of resources used: human (including associated personnel), financial, IT, infrastructure

The project will be opened for the first time, all works described above was carried out in the framework of the topic 03-2-1100-2010 and activities

Theme Leader

_____________/______________/
"_____"__________________ 202_г.

Project leader (project code)

_____________/____/
"_____"____________ 202_г.