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TOPICAL PLAN
FOR JINR RESEARCH
AND INTERNATIONAL COOPERATION
2023

Contens

All the themes in the Plan are listed by fields of research. Each theme is coded according to the JINR system of classification and contains the following information:

the first number*	-	the field of research;
the second number **	-	the conventional number of Laboratory or other Division of JINR;
the third number	-	the theme's ordinal number;
the fourth and the fifth numbers	-	the years of the activity's beginning and completion.

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* 01 – Theoretical Physics
02 – Elementary Particle Physics and Relativistic Nuclear Physics
03 – Nuclear Physics
04 – Condensed Matter Physics and Radiobiological Research
05 – Networking, Computing, Computational Physics
06 – Educational Programme

** 0 – All-Institute topics
1 – Veksler and Baldin Laboratory of High Energy Physics (VBLHEP)
2 – Dzhelepov Laboratory of Nuclear Problems (DLNP)
3 – Bogoliubov Laboratory of Theoretical Physics (BLTP)
4 – Frank Laboratory of Neutron Physics (FLNP)
5 – Flerov Laboratory of Nuclear Reactions (FLNR)
6 – Meshcheryakov Laboratory of Information Technologies (MLIT)
8 – Scientific Organizing Department (SOD)
9 – Laboratory of Radiation Biology (LRB)

Prepared by
N.A. Boklagova
D.S. Korobov

Dubna 2022

Theoretical Physics (01)

01-3-1135-2019/2023	Priority:	1

Status: Being concluded

Fundamental Interactions of Fields and Particles

Leaders: D.I. Kazakov
O.V. Teryaev

Participating Countries and International organizations:

Argentina, Armenia, Azerbaijan, Belarus, Bulgaria, Canada, CERN, Chile, China, Croatia, Czech Republic, Finland, France, Georgia, Germany, Greece, Hungary, ICTP, India, Italy, Japan, Kazakhstan, Mexico, Mongolia, New Zealand, Norway, Portugal, Poland, Republic of Korea, Russia, Serbia, Slovakia, Spain, Sweden, Switzerland, Ukraine, United Kingdom, USA, Uzbekistan, Vietnam.

Issues addressed and main goals of research:

The main aim of the research within the theme is the construction of theoretical models and their application to the description of properties of elementary particles and their interactions. This research includes the following directions of activity. The development of quantum field theory formalism in gauge and supersymmetric theories. Construction and investigation of the models of particle physics beyond the Standard Model.
Theoretical support of experiments at the Large Hadron Collider on the search of new physics and the study of the properties of the Higgs boson.
Calculation of radiative corrections to the processes of particle creation within the Standard Model and its extensions. Investigation of neutrino properties and neutrino oscillations. Investigation of the hadron properties within quantum chromodynamics and phenomenological quark models. Study of the hadron spin structure with the help of generalized and transverse momentum dependent parton distributions and theoretical support of NICA/SPD program.
Study of heavy quark properties and exotic hadrons. Lattice simulations for obtaining nonperturbative results in gauge theories. Investigation of dense hadronic matter and theoretical support of the MPD/NICA program.
Theoretical support of a wide range of current and future experiments at JINR, IHEP, CERN, GSI, JLab and other physics centers.

Expected main results in the current year:

1. Verification of the completeness of basis functions for elliptic polylogarithms by explicit calculations of the two-loop Feynman diagrams in the nonrelativistic QCD.

   Development of algorithm for the epsilon expansion of generalized hypergeometric functions at integer and half-integer index values via reduction of the corresponding differential system to the epsilon form.

   Derivation of systematic solution of quantum spectral curve equations for the case of maximally supersymmetric Yang-Mills theory in 4 dimensions by expansion in the double limit of weak coupling and large spins of sl(2) operators.

   Perturbative calculation of anomalous dimensions of large-charge operators in different QFT models and comparison of results with predictions obtained via semi-classical methods.

   Comprehensive analysis of the prospects for experimental discovery of different signatures in a number of Standard Model extensions with additional abelian gauge symmetries. Investigation of the possibility of resonant leptogenesis in the so-called superweak extensions of the SM.

   Calculation of effective potentials in modified gravity models taking into account quantum effects. Determination of the range of parameters of these models allowing realistic solutions for the inflationary epoch of the early universe.

   Detailed cosmological and astrophysical analysis of the properties of Primordial Black Holes as candidates for Dark Matter and connections with the current Supermassive Black Holes.

   Analytical evaluation of 2-loop radiative corrections to the parapositronium lifetime.

   Investigations of the multiplicities of quark and gluon jets with the account of resummation of large logarithms arising in the high-energy limit.

   Derivation of convenient parameterization for the transverse-momentum-dependent parton densities in nucleons and nuclei in the first two orders of perturbation theory.

Fit of the strong coupling constant from the deep inelastic scattering data in the first four orders of perturbation theory taking into account the resummation of large threshold logarithms

Study of the relations for the spacelike and timelike kernel functions for the hadronic contribution to the muon anomalous magnetic moment.

2. Analytic evaluation of 3-loop 2-point Feynman master-integrals with composite external vertices for arbitrary indices of propagators as a hypergeometric series.

   Derivation and analysis of a full differential equation system for Feynman integral with maximal powers of masses and momenta using the Mellin-Barnes integral representation.

   Calculation of the $a_s^2(a_s\beta_0)^{n-1}$ and $a_s^3\beta_1(a_s\beta_0)^{n-2}$ contributions to the nonsinglet Efremov-Radyushkin-Brodsky-Lepage evolution kernel and the correlator of two vector composite quark currents in QCD that will allow to clarify numeric hierarchy among different parts of the beta-expansion for the correlator and kernel in the orders a_s^2 and a_s^3 (a_s and β_n are the strong coupling and (n+1)-loop coefficient of the beta-function expansion in QCD, respectively).

   Calculation of pion electromagnetic form factors in framework of the light-cone sum rules in the low and (or) moderate energy regime. The domain of the framework applicability will be expanded by using analytic perturbation theory in order $O(\alpha_s)$ and compared with high precision Jlab experimental data.

   Revision of the distribution amplitudes (leading twist) of (pseudo)scalar and (longitudinal and transverse) vector mesons within the QCD SRs taking into account new QCD corrections $O(\alpha_s^2)$ obtained for all of their components.

   Analytical and numerical optimization of perturbation series for observables using beta-expansion and renormalization group in QCD for improvement of estimates of: $R[e^-e^+\rightarrow\text{hadrons}]$, width of tau-decay, Bjorken polarized SR that are known in multiloop calculation and comparison of our results with experimental data.

   Evaluation of the QCD analytic coupling constant in high orders of perturbation theory and its use for studying processes at small values of the square of the momentum transfer.

   Study of the sum rules for hadron fragmentation functions in QCD making use of the generalized truncated Mellin moments approach.

   Study of the new-found types of transverse momentum dependent parton distributions within the original framework. The new approach involves the new-found additional contribution in the inverse Radon transforms.

   Extraction of transverse generalized parton distributions from pseudoscalar meson leptoproduction at electron-ion colliders.

   Study of the hadronic structure function of the Drell-Yan processes in the framework of perturbative QCD in α_s^2 order in the coupling constant. Check of the Lam-Tung relation in α_s^2 order in the strong coupling constant.

   Establishing of a computational framework to analyze CMS Open Data.

   Examination of the methods of extraction of the total cross sections to understand a tension between the data obtained by different collaborations based on the analysis of experimental data on the elastic differential cross sections in the energy range 7-13 TeV. Determination of the structure of the elastic scattering amplitude in the framework of the High Energy Genarelized Structure model taking into account the hadron structure at NICA energies.

   Study of the dark axion portal and implementation to fixed target experiments to obtain bounds for a model. Bounds are needed for analysis of New physics and NA64 experiment, in particular. The visible mode of the axion and dark photon will be studied.

   Study the phase diagram of SU(2)-Higgs electroweak theory. Study of Z(N) symmetry and thermodynamic properties of meta-stable states at very high temperature in the context of QCD and electroweak theory.

3. Calculation of the branchings of both leading electromagnetic decays and suppressed weak nonleptonic two-particle decays of vector B-mesons.

   Search for possible theoretical explanation of the observed anomalies in B-physics.

Contribution to the research program for future electron-positron colliders. High-precision theoretical predictions for the processes of particle interaction at these colliders and the effects associated with the polarization of the initial beams and produced tau leptons.

Investigation of the spectral structure of the pionic/kaonic helium using the NRQED formalism with account of $m\alpha^6$ and partially $m\alpha^7$ order corrections. Calculation of the dependence of the spectral lines on the masses of pions (kaons).

Derivation and calculation of the relativistic and radiative corrections for the forbidden dipole (E1) transitions in the H_2^+ hydrogen molecular ion. It is expected that precision spectroscopy of H_2^+ ions will provide the most accurate data for the proton-to-electron mass ratio with the relative precision better than 10^{-12}.

4. Study of propagation of nonlinear waves inside the nonextensive quark-gluon plasma medium under the influence of a magnetic field.

Study of the thermodynamics of the quark-gluon and the hadronic medium using anisotropic quasi-power-law distributions.

Study of the violations of the Okubo-Zweig-Iizuka rule in the lattice gauge theory for the scalar, pseudoscalar, vector, and axial vector channels and estimation of the effects of monopoles, instantons, and strong magnetic fields.

Analysis and interpretation of the data from the Large Hadron Collider on the charge balance function from Pb+Pb collisions at the center-of-mass energy 2.76 TeV per nucleon pair in the framework of the HYDJET++ model.

Analysis of velocity, vorticity, and helicity and estimation of global polarization of hyperons in heavy-ion collisions at NICA energies using the Parton-Hadron-String Dynamics model.

Study of recently predicted thermal-shear and spin-Hall contributions to the particle polarization in heavy-ion collisions and their impact on the Λ polarization in the NICA-FAIR-HADES energy range.

Study of a collective flow of light nuclei produced in heavy-ion collisions in the SPS-RHIC energy range within the thermodynamic approach based on the three-fluid dynamics.

Description of the Delta resonance–nucleon system at finite temperature and a small baryon chemical potential.

Description of the formation of the quasi-periodic and periodic structures at phase transitions in nuclear matter.

Investigation of the properties of phase transitions and anisotropy of interquark interaction in a fast rotating (quark-)gluon plasma in lattice QCD. Study of the possibility for the existence of inhomogeneous phases in rotating QCD.

Calculation of nonlocal observables for a strongly coupled plasma within the holographic approach. Phase transition analysis and investigation of rotation effects.

Study of the Equation of State of QCD at nonzero baryon density in the external magnetic field using lattice simulation with physical quark masses.

Calculation of the thermodynamic potential in the 3-flavour chiral quark models with the inclusion of the full momentum dependence of the in-medium meson polarization loops and the corresponding meson Landau damping in the quark medium for the zero and finite baryon chemical potential.

Study of the equation of state of the cold quark matter using a new chiral density functional including diquark degrees of freedom and its effect on the neutron star structure.

Investigation of an algorithm for solving the Israel-Stewart hydrodynamic equations using an implicit method for numerical solving the relaxation equations.

Investigation of hadronic vacuum polarization contributions to the anomalous magnetic moment of muon in the framework of the Domain Model of QCD vacuum taking into account radially excited mesons.

Study of critical phenomena in hadronic matter due to the condensation of gluon tachyonic modes in chromomagnetic fields in the deconfined phase.

Study of the photon production in heavy ion collisions via the conversion of gluons to photon in the presence of the background gauge fields taking into account the contribution of all Landau levels in the quark propagator, including the contribution of quarks with mass squared of the order of the strength of the background field.

Study of anomalous transport phenomena in a relativistic quantum medium related to its stability with respect to the space-time curvature effects related to the fundamental question of the relationship between gravity, quantum physics and thermodynamics.

5. Investigation of tau lepton decays and processes of electron-positron annihilation into mesons including processes with three pseudoscalar mesons in the final state.

   Calculation of the contributions of the leading and following the leading logarithmic corrections to the processes of electron-positron annihilation, Bhabha scattering and muon-electron scattering studied in experiments at modern and future colliders, including the Super Charm-Tau Factory, FCC-ee, CEPC, etc.

   Obtaining an effective action of QCD at low energies, the constants of which are expressed in terms of parameters characterizing the explicit and spontaneous breaking of chiral symmetry.

   Calculation of masses, electromagnetic form factors, decay widths and other experimentally observed characteristics of mesons based on the new effective action of QCD at low energies. Finding the contributions describing the effects of a clear violation of aromatic symmetry which are not taken into account by the standard Nambu-Jona-Lasinio model.

   Calculation of the cross sections for the electron-positron annihilation into a proton-antiproton pair for a number of charmoniums (J/Ψ, $\Psi(2S)$, χc (3556)) in the intermediate state for the conditions of the BES-III and PANDA experiments. Determination of the relative phases between the individual contributions of intermediate vector mesons and the electrodynamic channel.

   Determination of the contributions of the channels with charmoniums in the intermediate state to Drell-Yan-like processes with protons and nuclei in the initial state in the context of their study at the NICA collider.

   Study of neutrino-nucleus interactions within the models with running axial nucleon mass, superscaling and light meson production; application of the results to event simulation in the current neutrino experiments (NOvA, DUNE, and others).

   Global statistical analysis of electron scattering data on hydrogen and deuterium in order to refine the parameterizations of the electromagnetic form factors of the nucleon. Application of the results to neutrino oscillation experiments.

   Development of a model that implements the idea of loop generation of the hierarchical fermion spectrum of the Standard Model based on the corresponding flavor symmetry.

   Study of the behavior of the dressed neutrino propagator at short macroscopic baselines within the covariant quantum-field formalism with wave packets.

   Investigations of gravitational lensing and shadow formation for the Ruffini–Arguelles–Rueda model of dark matter.

   Finding constraints on the models of the Galactic Center and the center of the galaxy M87 from observations of their shadows and trajectories of bright stars.

   Development of a software package for selecting data from the TAIGA experiment to search for events co-located with ultra-high energy neutrinos registered by the IceCube and Baikal-GVD facilities and with gravitational-wave events registered by the LIGO and Virgo detectors.

List of Activities

	Activity or experiment Laboratory or other Division of JINR	**Leaders** Main researchers
1.	**Quantum field theory and physics beyond the Standard Model** BLTP	**D.I. Kazakov** **A.V. Bednyakov** A.B. Arbuzov, A.N. Baushev, M.A.Bezuglov, A.T. Borlakov, Ch.R. Das, R.M.Iakhibbaev, M.A.Ivanov, A.V. Kotikov, G.A. Kozlov, Mukhaeva A.I., A.V. Nesterenko, A.I. Onishenko, A.F. Pikelner, O.P.Solovtsova, D.M. Tolkachev, A.A. Vladimirov, 3 students

MLIT	O.V. Tarasov
DLNP	V.A. Bednyakov, D.V. Naumov, L.V. Kalinovskaya
VBLHEP	V.G. Krivokhizhin, B.G. Shaikhatdenov
2. QCD parton distributions for modern and future colliders	**I.V. Anikin** **O.V. Teryaev**
BLTP	V.V. Byt'yev, M. Deka, S.V. Goloskokov, D.B. Kotlorz, S.V. Mikhailov, A.G. Oganesyan, A.A. Pivovarov, G.Yu. Prokhorov, O.V. Selyugin, A.J. Silenko, N.I. Volchanskiy, 6 students
VBLHEP	Yu.I. Ivanshin, A.P. Nagaitsev, I.A. Savin, R. Tsenov
DLNP	A.V. Guskov
3. Strong interactions phenomenology and precision physics	**M.A. Ivanov** **V.I. Korobov**
BLTP	A.B. Arbuzov, A.K. Bekbaev, Yu.M. Bystritsky, S.M. Eliseev, C. Ganbold, S.B. Gerasimov, A.N. Isadykov, L. Martynovich, K. Nurlan, A.A. Osipov, A.V. Sidorov, Yu.S. Surovtsev, Zh. Tyulemisov, M.K. Volkov, 5 students
4. Theory of Hadronic Matter under extreme conditions	**V.V. Braguta** **E.E. Kolomeitsev** **S.N. Nedelko**
BLTP	T. Bhattacharyya, M. Deka, S. Dorkin, A.V. Friesen, A.A. Golubtsova, E.-O. Hanu, M. Hasegawa, M. Hnatic, Y.Heo, Yu.B. Ivanov, L. Kaptari, A.S. Khvorostukhin, S.Libing, K. Maslov, V.S. Melezhik, K.D.Montenegro, E.E.Kolomeutsev, N. Kolomoets, A.V. Nikolsky, A. Parvan, A.A.Roenko, A.M. Snigirev, V.D. Tainov, O.V. Teryaev, V.D. Toneev, N.S.Tsegelnik, V.E. Voronin, D. Voskresensky, Zakharov V.I., 4 students
MLIT	A.S. Ayriyan, H. Grigorian, Yu.L. Kalinovsky, E.G. Nikonov
VBLHEP	O.V. Rogachevsky, V. Voronyuk
5. Theory of electroweak interactions and neutrino physics	**A.B. Arbuzov** **V.A. Naumov** **F. Simkovic**
BLTP	A.V. Bednyakov, Yu.M. Bystritskiy, V.V. Byt'yev, I.D. Kakorin, M.I. Krivoruchenko, K.S. Kuzmin, A.F. Pikel'ner, G. Seylkhanova, I.A. Sokal'skiy, 1 student
VBLHEP	V.A. Zykunov
DLNP	Ye.V. Dydyshko, L.V. Kalinovskaya, D.V. Naumov, O.N. Petrova, R.R. Sadykov, A.A. Sapronov, D.S. Shkirmanov, O.Yu. Smirnov, V.I. Tretyak, 2 students

Collaboration

Country or International Organization	City	Institute or Laboratory
Argentina	Buenos Aires	CNEA
Armenia	Yerevan	Foundation ANSL
		RAU
Azerbaijan	Baku	BSU
		IP ANAS
Belarus	Gomel	GSTU
		GSU
	Minsk	BSU
		INP BSU
		IP NASB
		JIPNR-Sosny NASB
Bulgaria	Sofia	INRNE BAS
		SU
Canada	Corner Brook	MUN
	Montreal	UdeM
CERN	Geneva	CERN
Chile	Arica	UTA
	La Serena	ULS
	Valparaiso	UTFSM
		UV
China	Beijing	PKU
	Lanzhou	IMP CAS
	Wuhan	WIPM CAS
Croatia	Zagreb	RBI
Czech Republic	Prague	CTU
		CU
		IP CAS
	Rez	NPI CAS
Finland	Helsinki	UH
France	Lyon	UCBL
	Metz	UPV-M
	Montpellier	UM2
	Paris	LPTHE
		UPMC
	Saclay	IRFU
		SPhN CEA DAPNIA
Georgia	Tbilisi	RMI TSU
		TSU
Germany	Aachen	RWTH
	Berlin	FU Berlin
		HU Berlin
	Bielefeld	Univ.
	Bochum	RUB

	Bonn	UniBonn
	Darmstadt	GSI
		TU Darmstadt
	Dortmund	TU Dortmund
	Erlangen	FAU
	Frankfurt/Main	FIAS
	Hamburg	DESY
		Univ.
	Heidelberg	Univ.
	Jena	Univ.
	Julich	FZJ
	Kaiserslautern	TUK
	Karlsruhe	KIT
	Mainz	HIM
		JGU
	Munich	LMU
	Regensburg	UR
	Rostock	Univ.
	Tubingen	Univ.
	Wuppertal	UW
	Zeuthen	DESY
Greece	Rethymno	UoC
Hungary	Budapest	ELTE
		Wigner RCP
ICTP	Trieste	ICTP
India	Bhubaneswar	IOP
	Chennai	IMSc
	Kolkata	VECC
Italy	Naples	INFN
	Padua	UniPd
	Pavia	INFN
	Pisa	INFN
	Trieste	SISSA/ISAS
	Turin	UniTo
Japan	Chiba	Chiba U
	Kyoto	Kyoto Univ.
	Nagoya	Nagoya Univ.
	Osaka	Osaka Univ.
	Tokyo	Meiji Univ.
		Tokyo Tech
		UT
	Tsukuba	KEK
Kazakhstan	Almaty	FAPHI
		INP
	Astana	BA INP
Mexico	Cuernavaca	UNAM
Mongolia	Ulaanbaatar	IPT MAS
New Zealand	Hamilton	Univ.

Norway	Trondheim	NTNU
Poland	Kielce	JKU
	Krakow	INP PAS
	Lodz	UL
	Otwock (Swierk)	NCBJ
	Wroclaw	ITP UW
Portugal	Coimbra	UC
Republic of Korea	Cheongju	CBNU
	Daegu	KNU
	Seoul	SNU
Russia	Belgorod	BelSU
	Chernogolovka	LITP RAS
	Gatchina	NRC KI PNPI
	Irkutsk	ISDCT SB RAS
		ISU
	Ivanovo	ICS RAS
		ISU
	Kazan	KFU
	Moscow	IBRAE
		IMM RAS
		ITEP
		LPI RAS
		MI RAS
		MISiS
		MSU
		PFUR
		SCC RAS
		SINP MSU
	Moscow, Troitsk	INR RAS
	Novosibirsk	BINP SB RAS
		IM SB RAS
		NSU
	Omsk	OmSU
	Perm	PSNRU
	Protvino	IHEP
	Rostov-on-Don	SFedU
	Samara	SSU
		SU
	Saratov	SSU
	Sarov	VNIIEF
	St. Petersburg	SPbSPU
		SPbSU
	Tomsk	IHCE SB RAS
		TSU
	Tver	TvSU
	Yoshkar-Ola	VSUT
Serbia	Belgrade	Univ.
Slovakia	Bratislava	CU

		IP SAS
	Kosice	IEP SAS
Spain	Granada	UGR
	Santiago de Compostela	USC
	Valencia	UV
Sweden	Lund	LU
Switzerland	Bern	Uni Bern
Ukraine	Dnipro	DNU
	Kharkov	NSC KIPT
	Kiev	BITP NASU
	Lutsk	EENU
	Lviv	IAPMM NASU
		IFNU
	Sumy	SumSU
United Kingdom	Canterbury	Univ.
	London	Imperial College
		QMUL
USA	College Park, MD	UMD
	East Lansing, MI	MSU
	Lemont, IL	ANL
	Long Beach, CA	CSULB
	Minneapolis, MN	U of M
	New York, NY	CUNY
		RU
	Newport News, VA	JLab
	Norman, OK	OU
	Philadelphia, PA	Penn
	San Diego, CA	SDSU
	University Park, PA	Penn State
Uzbekistan	Tashkent	IAP NUU
		NUU
Vietnam	Hanoi	IOP VAST

01-3-1136-2019/2023		Priority:	1
		Status:	Being concluded

Theory of Nuclear Systems

Leaders: N.V. Antonenko
S.N. Ershov
A.A. Dzhioev

Participating Countries and International organizations:

Armenia, Belarus, Belgium, Brazil, Bulgaria, China, Czech Republic, Egypt, France, Germany, Greece, Hungary, India, Iran, Italy, Japan, Kazakhstan, Lithuania, Moldova, Norway, Poland, Republic of Korea, Romania, Russia, Serbia, Slovakia, South Africa, Spain, Sweden, Ukraine, United Kingdom, USA, Uzbekistan.

Issues addressed and main goals of research:

Suggestion of new theoretical approaches for description and prediction of properties of superheavy, unstable nuclei and exotic nuclear systems, calculation of their characteristics; improvement of models for explanation of mechanisms of reactions of nuclei with particles and nuclei at low and intermediate energies; establishment of universal laws in low-dimensional small-particle systems and small-particle systems at ultra-low energies; development of the two-stage hybrid model of nuclear collisions at relativistic energies; study of nonlinear quantum processes in the interaction of photons with ultrashort high-frequency laser pulses.

Expected main results in the current year:

1. Microscopic calculations of EC/β^+-decay half-lives for nuclei along the α-decay chain of ^{288}Mc.

   Investigation of the anomalous behavior of the moment of inertia in well deformed light nuclei.

   Calculation and analysis of the double-gamma decay widths of quadrupole states of medium-heavy and heavy nuclei.

   Study of relativistic corrections to the symmetric nuclear matter and pure neutron matter equations of state based on the modified Fayans functional.

   Study of the nature of low-lying 2^+, 1^+ and 0^+ states in axially symmetric nuclei by the Wigner function moments method. Calculation of energies, excitation probabilities and the corresponding currents.

   Analysis of the contribution of 3 particle - 3 hole configurations in the formation of isoscalar giant monopole resonance of ^{48}Ca.

   Study of the collective dynamics in nuclei from different mass regions within the framework of the proton-neutron symplectic model.

   Study of non-adiabatic effects in the properties of the negative parity bands of the ^{238}U nucleus.

   Study of the possibility of constructing an energy density functional that allows describing the nucleus-nucleus potential.

2. Prediction of the energies of 2^+_1 states in superheavy nuclei.

   Study of the structure of low-lying states and electromagnetic transitions in odd-proton nuclei in alpha-decay chains of superheavy nuclei.

   Formulation of the collective model with pairing and alpha-particle type correlations. Description of the lowest states of transient nuclei.

   Suggestion of the method for calculating the pre-equilibrium emission of clusters in the collision of heavy ions to analyze the mechanism of incomplete fusion of nuclei. Calculation of the angular and energy distributions of these clusters.

   Investigation of reactions for obtaining superheavy elements 119 and 120. Study of the isotopic dependence of the complete fusion cross section.

   Prediction of the fission properties of superheavy nuclei. Consideration of fission from isomeric states. Study of the influence of the shape of the scission configuration of a fissioning nucleus on the dynamics of fragments.

Investigation of the possibility of obtaining exotic nuclei in cluster transfer reactions.

Application of the quantum-diffusion approach to the description of astrophysical fusion reactions.

Description of one-nucleon transfer reactions in ^{9}Be + ^{3}He collisions.

Description of the ^{8}He structure within the five-body approach.

Study of the effects of spin-orbit interaction on the transport properties of nanosystems (graphene, quantum dots, wires). Features of the qubit embedded in the thermostat.

3. Investigation of the structural features of light weakly bound nuclei. Time-dependent numerical analysis of breakup reaction of halo nuclei within the quantum-quasiclassical approach.

   Effect of the supernova explosion mechanism in neutrino spectra and prospects for observations by large-volume telescopes.

   Regularization of the three-body problem with contact and singular interactions at the triple collision point.

   Investigation of diatomic molecule alignment in two-color laser fields.

   Determination of the limit of probabilities of ionization and excitation of atoms by the laser field at a carrier frequency tending to zero.

   Establishment of quantum speed limits for the subspace evolution governed by time-dependent Hamiltonians.

   Investigation of low-energy electron-neutron scattering.

   Development of a method for locating extremely narrow resonances and calculating their parameters.

   Analysis of strong-field atomic dynamics within quantum quasi-classical approach including the center of mass motion.

   Study of the problem of “tunneling time” in laser ionization of atoms by the method of Bohmian (quantum) trajectories.

   Development of a method for calculating the parameters of the generalized optical potential model via a scattering matrix of the incoming wave boundary condition model for sub-barrier fusion heavy ion reactions.

4. Analysis of the pi-mesons, proton- and nucleus-nucleus scattering cross-sections in the region of collision energies from 30 MeV to 1 GeV based on the development of appropriate models of microscopic optical potential.

   Analytical calculations of the lepton g-2 anomaly.

   Investigation of the finite-temperature behavior of ghost and gluon propagators within an approach based on the rainbow truncated Dyson-Schwinger equations in the Landau gauge.

   Study of essentially multi-photon quantum processes in interaction of ultra-relativistic electrons with polarized intense laser pulses. Finding of observables that are sensitive to the dynamics of multi-photon processes, for example, differential distributions of Compton photons and electron-positron pairs formed in electron-laser interaction.

   Development of methods of nonextensive statistical mechanics applied to describe the particle production and transverse momentum distributions of hadrons in heavy-ion and proton-proton collisions.

   Construction of a model for describing short-range quasideuteron correlations in nuclei and its application for describing of proton-nucleus reactions at relativistic energies, including knockout of the correlated pn-pair and cumulative production.

   Development of relativistic methods to study the polarized elastic proton-deuteron scattering at high energies.

   Investigation of the cross sections of Y absorption and Y production in BB-collisions in the framework of the covariant quark model with SU(5) Lagrangian including anomalous interactions. Investigation of two-photon decays and Dalitz-decays of light mesons in the framework of the NJL model at finite temperature and baryon density.

   Analysis of the Bethe-Salpeter solutions in coordinate space, establishing some patterns and investigation of abnormal solutions.

List of Activities

Activity or experiment Laboratory or other Division of JINR	Leaders Main researchers
1. Microscopic models for exotic nuclei and nuclear astrophysics	**V.V. Voronov** **A.A. Dzhioev** **J. Kvasil**
BLTP	N.N. Arsenyev, E.B. Balbutsev, I.N. Borzov, H. Ganev, V.A. Kuz'min, L.A. Malov, E.V. Mardyban, I.V. Molodtsova, V.O. Nesterenko, A.P. Severyukhin, G. Stratan, A.V. Sushkov, A.I. Vdovin, P. Vishnevskiy, 2 students
MLIT	N.Yu. Shirikova
FLNP	A.M. Sukhovoi
2. Low-energy nuclear dynamics and properties of nuclear systems	**S.N. Ershov** **N.V. Antonenko** **R.V. Jolos**
BLTP	G.G. Adamian, A.V. Andreev, A.N. Bezbakh, Sh. Kalandarov, V.G. Kartavenko, R.G. Nazmitdinov, A.K. Nasirov, A. Rahmatinedzhad, I.S. Rogov, V.V. Sargsyan, T.M. Shneidman, N.B. Shulgina, B. Urazbekov, 2 students
FLNR	L.V. Grigorenko, S.M. Lukyanov, Yu.E. Penionzhkevich, A.I. Svirikhin
DLNP	A.S. Zhemchugov
3. Quantum few-body systems	**A.K. Motovilov** **A.S. Melezhik**
BLTP	I. Ishmukhamedov, D. Janseitov, E.A. Kolganova, V.N. Kondratyev, E.A. Koval, A.V. Malykh, E.V. Mardyban, Yu.V. Popov, V.V. Pupishev, S.A. Rakityanskiy, S.A. Shadmehri, E.A. Solov'ev, D. Valiolda, S.I. Vinitsky, 3 students
DLNP	O.I. Kartavtsev
MLIT	O. Chulunbaatar, A.A. Gusev
4. Relativistic nuclear dynamics and nonlinear quantum processes	**M. Gaidarov** **S.G.Bondarenko**
BLTP	M.Baznat, S.M.Dorkin, A.V. Frisen, L.P. Kaptari, A.B. Larionov, V.K. Lukyanov, A.S. Parvan, A.I. Titov, V.D. Toneev, S.A. Yur'ev, 1 student
MLIT	Yu.L. Kalinovskiy, K.V. Lukyanov, E.V. Zemlyanaya
VBLHEP	V.P. Ladygin, N.B. Ladygina, A.I. Malakhov, N.M. Piskunov, Yu.A. Panebratsev, E.P. Rogochaya
DLNP	Yu.N. Uzikov

Collaboration

Country or International Organization	City	Institute or Laboratory
Armenia	Yerevan	RAU
		YSU
Belarus	Gomel	GSU
	Minsk	IP NASB
Belgium	Brussels	ULB
	Louvain-la-Neuve	UCL
Brazil	Florianopolis, SC	UFSC
	Niteroi, RJ	UFF
	Sao Jose dos Campos, SP	ITA
	Sao Paulo, SP	UEP
Bulgaria	Sofia	INRNE BAS
		NBU
China	Beijing	CIAE
		ITP CAS
		PKU
	Lanzhou	IMP CAS
Czech Republic	Prague	CU
Egypt	Giza	CU
France	Caen	GANIL
	Orsay	IJCLab
Germany	Berlin	HZB
	Bielefeld	Univ.
	Bonn	UniBonn
	Cologne	Univ.
	Darmstadt	GSI
		TU Darmstadt
	Dresden	HZDR
		TU Dresden
	Erlangen	FAU
	Frankfurt/Main	Univ.
	Giessen	JLU
	Hamburg	Univ.
	Leipzig	UoC
	Mainz	JGU
	Rostock	Univ.
	Siegen	Univ.
Greece	Athens	INP NCSR "Demokritos"
Hungary	Budapest	Wigner RCP
	Debrecen	Atomki
India	Chandigarh	PU
	Kasaragod	CUK
	New Delhi	IUAC
Iran	Zanjan	IASBS

Italy	Catania	INFN LNS
	Messina	UniMe
	Naples	INFN
	Turin	UniTo
Japan	Kobe	Kobe Univ.
	Morioka	Iwate Univ.
	Osaka	Osaka Univ.
		RCNP
Kazakhstan	Almaty	INP
		KazNU
Lithuania	Kaunas	VMU
Mexico	Mexico City	UNAM
Moldova	Chisinau	IAP
Norway	Bergen	UiB
	Oslo	UiO
Poland	Krakow	INP PAS
	Lublin	UMCS
	Otwock (Swierk)	NCBJ
	Warsaw	UW
Republic of Korea	Daegu	KNU
	Daejeon	IBS
	Jeonju	JBNU
	Seoul	SNU
Romania	Bucharest	IFIN-HH
		UB
	Cluj-Napoca	UBB
Russia	Dolgoprudny	MIPT
	Gatchina	NRC KI PNPI
	Khabarovsk	PNU
	Moscow	MSU
		NNRU "MEPhI"
		NRC KI
		PFUR
		SINP MSU
	Moscow, Troitsk	INR RAS
	Omsk	OmSU
	Saratov	SSU
	St. Petersburg	SPbSU
	Tomsk	TPU
	Vladivostok	FEFU
Serbia	Belgrade	IPB
Slovakia	Bratislava	CU
		IP SAS
South Africa	Johannesburg	WITS
	Pretoria	UP
	Somerset West	iThemba LABS
	Stellenbosch	SU
Spain	Palma	UiB

Sweden	Goteborg	Chalmers
	Lund	LU
Ukraine	Kiev	KINR NASU
		NUK
United Kingdom	Guildford	Univ.
USA	Notre Dame, IN	ND
	University Park, PA	Penn State
Uzbekistan	Namangan	NamMTI
	Tashkent	Assoc. P.-S. PTI
		IAP NUU
		INP AS RUz

01-3-1137-2019/2023		Priority:	1

Status: Being concluded

Theory of Complex Systems and Advanced Materials

Leaders: V.A. Osipov
A.M. Povolotskii

Participating Countries and International organizations:

Armenia, Australia, Austria, Belarus, Belgium, Brazil, Bulgaria, Canada, Czech Republic, Denmark, Ecuador, Egypt, Finland, France, Germany, Hungary, India, Iran, Italy, Japan, Mongolia, New Zealand, Poland, Republic of Korea, Romania, Russia, Serbia, Slovakia, Slovenia, South Africa, Spain, Switzerland, Taiwan, Ukraine, United Kingdom, USA, Uzbekistan, Vietnam.

Issues addressed and main goals of research:

Development of analytical and numerical methods for studying complex many-body systems that are of current interest in modern condensed matter physics, the development of mathematical models of these systems and the identification of universal laws on the example of studied models. Analysis of both lattice and field-theory models of equilibrium and non-equilibrium statistical systems and modeling of a wide class of new materials, including nanostructured materials, which are of great practical importance. The concepts of scaling and universality allow one to go beyond the model approach and to apply the results obtained to broad classes of phenomena studied in the physics of condensed matter. Study of a wide range of universal phenomena in complex systems - phase transitions in condensed media and high-energy physics, scaling in (magneto)hydrodynamic turbulence, chemical reactions, percolation, etc. by the methods of quantum field theory including the functional renormalization group. The results obtained will be used in carrying out experimental studies of condensed matter at JINR. It is important to note the markedly growing interdisciplinary nature of research, where condensed matter physics and statistical physics closely intersect with atomic and nuclear physics, particle physics, mathematical physics, astrophysics, and biology.

Expected main results in the current year:

1. Theoretical and experimental investigations of 3D dense random packing with a power-law size distribution at nano and micro scales.

   Simulation of contrast-variation small-angle neutron scattering experiments from biological macromolecules.

   Numerical investigation of irradiation resistance of Si-, B- carbides, as well as of $HfC_{(x)}N_{(1-x)}$ nonstehiometric compound.

   Ab initio estimation of the exchange parameters of Kitaev materials based on transition and rare-earth metals and calculation of their spin-wave spectrum.

   Exploration of Kitaev candidate material $RuCl_3$ and its minimal model.

   Calculation of the magnetic phase diagram in strongly-correlated electronic systems within the t-J model for electron doping. Comparison of the obtained results with experiments in the electron-doped cuprates.

   Development of a theory of stability for mixtures of quantum fluids.

   Elaboration of a model of solids with superfluid dislocations.

   Preparation of a review on the models of mixed matter.

   Application and development of quantum algorithms for computational problems in condensed matter physics and quantum chemistry.

2. Study of physical phenomena in Josephson nanostructures with ferromagnetic layers.

   Development of a model of the Josephson junction coupled to a closed chain of nanomagnets. Study of the possibility of using this junction for determining the state of a chain of nanomagnets.

   Investigation of the temperature dependence of the characteristics of various nanostructures such as the band gap, conductivity, and mobility. Application of the frozen phonon method to various modified carbon nanotubes and graphene for determining ways of improvement of their transport characteristics.

   Study of the transport properties of quasi-two dimensional polycrystalline Molybdenum disulfide. Investigation of the behavior of electrical resistivity as a function of the transport gap and grain boundary size for different carrier densities.

Study of the topological Hall effect induced by the classical spin background and topological superconductors on the skyrmion lattice using gauge theory.

Investigation of the backscattering of chiral fermions in topological insulators due to rough edges.

3. Description of the characteristics of the dimer models on finite-dimensional lattices with different geometries under different boundary conditions. Detailed investigation of the "entangled states" of a complex quantum system with single-ion anisotropy.

   Application of the rotor-router model, known as the Eulerian walk, to studying of the dynamics of double-strand breaks of DNA.

   Detailed investigation of multidimensional complex hypergeometric integrals in the Mellin-Barnes representation.

   Construction of new exactly computable integrals and symmetry transformations for integrals of higher order that are derived by reduction of known relations for elliptic hypergeometric integrals describing superconformal indices in four-dimensional field theories.

   Proof of the Derkachov-Manashov hypotheses for the complex Gustafson integrals in the theory of non-compact spin chains.

   Construction of a parafermionic generalization of hypergeometric functions and a detailed investigation of the supersymmetric case related to 6j-symbols for supergroups in the Ramond sector as well as in the Neveu-Schwartz sector. Proof of characteristic identities (i.e., of quantum versions of the Cayley-Hamilton theorem) for a family of orthogonal Quantum Matrix algebras.

   Investigation of the quasi-oscillator presentation for the linear quantum groups Uq(gln): construction of finite-dimensional representations and realization of the Hopf structures in terms of the quasi-oscillators.

   Construction of nonlocal correlation functions in the branching polymer model near the boundary in the presence of anisotropy.

   Classification of Markov dualities in one dimensional integrable stochastic models and two-dimensional lattice models constructed with the use of representations of Hecke algebras of infinite order and their application to solutions of these models.

   Evaluation of densities of loops in the O(1) dense loop models and of percolation clusters in critical percolation on the cylindrical lattice of rotated orientation and with an odd circumference.

4. Investigation of BEC-BCS crossover in multi-component ultra-cold fermions within the functional renormalization group approach: elucidation of possible phase diagrams and calculation of the respective transition temperatures. Elaboration of an appropriate computational machinery in view of non-perturbative renormalization group flows.

   Development of computational methods for calculating the contributions of multi-loop diagrams to the renormalization group functions of dynamic models. Investigation of the dynamics of the superconducting phase transition in low-temperature superconductors.
   Investigation of the effects associated with the violation of mirror symmetry in magneto-hydrodynamic developed turbulence. Calculation of two-loop Feynman diagrams generated by the Lorentz force and two-loop diagrams of the response function, leading to an exponential growth of magnetic field fluctuations in the region of large scales. Study of turbulent dynamo.

   Construction of field theory models with some effective actions for investigation of chemical reactions of different kinds of particles occurring in random environments. Study of the infrared scaling behavior of statistical correlations of particle densities by renormalization group methods.

   Study of isotropic and directed bond percolation. Calculations of three-loop Feynman diagrams generating ultraviolet divergences. Calculation of fixed points of the renormalization group equation and calculation of critical exponents for physically significant and experimentally observable quantities - response functions, density of active nodes (agents), effective radius and mass of active zones.

Study of the effects of isotropic motion of a medium with various statistical characteristics on the possibility of the Hua-Kardara self-organized criticality model to exhibit anisotropic scaling behavior.

Investigation by means of the functional renormalization group method of possible asymptotic regimes corresponding to non-universal scaling behavior of a surface growing in a random media and described by a model including an infinite number of types of interactions.

List of Activities

Activity or experiment	Leaders
Laboratory or other Division of JINR	Main researchers
1. Complex materials	**E.M. Anitas** **N.M. Plakida**
BLTP	A.Yu. Cherny, A.A. Donkov, A.L. Kuzemsky, P.A. Maksimov, Tung Nguen Dan, A.A. Vladimirov, V.I. Yukalov, V.Yu. Yushankhai
FLNP	V.L. Aksenov, A.M. Balagurov, A.S. Doroshkevich, A. Islamov, D.P. Kozlenko, A.I. Kuklin, E.P.Popov
MLIT	L.A. Syurakshina, E.P. Yukalova
FLNR	M. Mirzaev
2. Nanostructures and nanomaterials	**V.A. Osipov** **E.A. Kochetov**
BLTP	D. Anghel, T. Belgibaev, V.L. Katkov, K.K. Keshrpu, D.V. Kolesnikov, S.E. Krasavin, K.V. Kulikov, A. Mazanik, I.R. Rachmonov, O.G. Sadykova, Yu.M. Shukrinov
MLIT	E.B. Zemlianaya
LRB	A.N. Bugay
FLNR	A. Olejniczak
3. Mathematical models of statistical physics of complex systems	**A.M. Povolotsky**
BLTP	V.I. Inozemtsev, V. Papoyan, P.N. Pyatov, V.P. Spiridonov, P.E. Zhidkov
4. Methods of quantum field theory in complex systems	**M. Hnatic**
BLTP	L.Ts. Adzhemyan, N.V. Antonov, G. Kalagov, M.V. Kompaniets, N. Lebedev, L. Mizisin, Yu.G. Molotkov, M.Yu. Nalimov, L.A. Sevastyanov
MLIT	J. Busa

Collaboration

Country or International Organization	City	Institute or Laboratory
Armenia	Yerevan	Foundation ANSL
		YSU
Australia	Sydney, NSW	Univ.
Austria	Linz	JKU
Belarus	Minsk	BSTU
		IP NASB
		SPMRC NASB

Brazil	Brasilia, DF	UnB
	Natal, RN	IIP UFRN
	Sao Paulo, SP	USP
Bulgaria	Plovdiv	PU
	Sofia	IMech BAS
		INRNE BAS
		ISSP BAS
		SU
Canada	Kingston, ON	Queen's
	London, ON	Western
	Montreal	Concordia
	Quebec	UL
Czech Republic	Olomouc	UP
	Rez	NPI CAS
Denmark	Lyngby	DTU
Ecuador	Quito	USFQ
Egypt	Giza	CU
Finland	Helsinki	UH
France	Marseille	CPT
		UPC
	Nice	UN
	Paris	UPMC
	Valenciennes	UVHC
Germany	Braunschweig	TU
	Bremen	Univ.
	Darmstadt	GSI
		TU Darmstadt
	Dortmund	TU Dortmund
	Dresden	IFW
		MPI PkS
	Jena	Univ.
	Leipzig	UoC
	Magdeburg	OVGU
	Rostock	Univ.
	Wuppertal	UW
Hungary	Budapest	Wigner RCP
India	Kolkata	IACS
Iran	Zanjan	IASBS
Italy	Catania	UniCT
	Fisciano	UNISA
Japan	Utsunomiya	UU
Mongolia	Ulaanbaatar	IPT MAS
		NUM
New Zealand	Auckland	Univ.
Poland	Katowice	US
	Krakow	JU
	Poznan	AMU
		IMP PAS

	Warsaw	IPC PAS
	Wroclaw	WUT
Republic of Korea	Daejeon	CTPCS IBS
	Incheon	Inha
Romania	Timisoara	UVT
Russia	Belgorod	BelSU
	Gatchina	NRC KI PNPI
	Kazan	KFU
	Moscow	ITEP
		LPI RAS
		MI RAS
		MIREA
		NNRU "MEPhI"
		NRC KI
		NRU HSE
		PFUR
		SINP MSU
	Moscow, Troitsk	HPPI RAS
	Novosibirsk	ISP SB RAS
		NIIC SB RAS
	Perm	PSNRU
	Protvino	IHEP
	Samara	SU
	Saratov	SSU
	St. Petersburg	ETU
		Ioffe Institute
		ITMO Univ.
		PDMI RAS
		SPbSPU
		SPbSU
	Voronezh	VSU
	Yekaterinburg	IMP UB RAS
Serbia	Belgrade	INS "VINCA"
Slovakia	Bratislava	CU
	Kosice	IEP SAS
		UPJS
Slovenia	Ljubljana	UL
South Africa	Pretoria	UNISA
Spain	Madrid	ICMM-CSIC
Switzerland	Villigen	PSI
	Zurich	ETH
Taiwan	Taipei	IP AS
Ukraine	Kiev	NUK
	Lviv	ICMP NASU
United Kingdom	Coventry	Warwick
USA	Irvine, CA	UCI
	Louisville, KY	U of L
	New York, NY	CUNY

	Pasadena, CA	Caltech
	Rochester, NY	UR
	Tallahassee, FL	FSU
Uzbekistan	Tashkent	Assoc. P.-S. PTI
Vietnam	Hanoi	IMS VAST

01-3-1138-2019/2023		Priority:	1

Status: Being concluded

Modern Mathematical Physics: Gravity, Supersymmetry and Strings

Leaders: A.P. Isaev
S.O. Krivonos
A.S. Sorin

Participating Countries and International organizations:

Armenia, Australia, Brazil, Bulgaria, Canada, CERN, Czech Republic, Estonia, France, Germany, Greece, ICTP, India, Israel, Iran, Ireland, Italy, Japan, Lithuania, Luxembourg, Norway, Poland, Portugal, Republic of Korea, Russia, Spain, Taiwan, Ukraine, United Kingdom, USA.

Issues addressed and main goals of research:

The main purpose of research in modern mathematical physics is the development of mathematical methods for solving the most important problems of modern theoretical physics: clarifying the nature of fundamental interactions and their symmetries, construction and study of effective field models arising in the theory of strings and other extended objects, uncovering of the geometric description of quantum symmetries and their spontaneous breaking in the framework of search for a unified theory of all fundamental interactions, including quantum gravity. Mathematical physics in recent years has been characterized by increasing interest in identifying and effective use of integrability in various areas, and in applying powerful mathematical methods of quantum groups, supersymmetry and non-commutative geometry to quantum theories of fundamental interactions as well as to classical models.

The main goals and tasks of the research within the theme include: development of new mathematical methods for investigation and description of a variety of classical and quantum integrable models and their exact solutions; analysis of a wide range of problems in supersymmetric theories including models of superstrings and superbranes, study of non-perturbative regimes in supersymmetric gauge theories; development of cosmological models of the early Universe, primordial gravitational waves and black holes. The decisive factor in solving the above problems will be the crucial use of the mathematical methods of the theory of integrable systems, quantum groups and noncommutative geometry as well as superspace techniques.

Expected main results in the current year:

1. Investigation of holographic renormalization group flows in 3d supergravity at zero and finite temperatures using the theory of dynamical systems. Construction of asymptotic gravity solutions corresponding to holographic RG flows in 3d supergravity. Investigation of fixed-point deformation using the trace of the energy-momentum tensor (TTbar-deformation) in the framework of the holographic approach.

   Study of the interior of a black hole using random matrix ensembles holographically dual to dilaton gravity. Calculation of spectral correlators for 2d dilaton gravity and analysis using random matrix ensembles.

   In the context of holographic correspondence, integrable structures on Sasaki-Einstein-type manifolds $Y^{p,q}$ and $L^{p,q,r}$ following the chain Fuchsian equations, Heun equations and Painleve-type equations will be studied. Test of the holographic duality hypothesis using string dynamics on these manifolds. The focus will be on $Y^{p,q}$ spaces which can be used as internal manifolds for supersymmetric AdS5 or Schrodinger invariant IIB supergravity solutions.

   Construction of analogs of super-Schwarzians and Schwarzian mechanincs associated with d=1 superconformal algebras with extended supersymmetry, in particular, osp(N|2), su(1,1|N), osp(4*|4), F(4). Study of what properties of super-Schwarzians can be extended to the case of N>4 supersymmetries.

   Construction of a twistor description of massless fields with continuous spin in four-dimensional Minkowski space. Investigation of the transition from massless fields with continuous spin to massless fields with helicities in this description. Study of the dynamics of massless fields with continuous spin.

   Derivation of universal formulas for the projectors onto invariant subspaces and the corresponding eigenvalues of the split Casimir operator in the tensor product of four adjoint representations of simple Lie algebras and Lie superalgebras. Construction of a matrix model that defines the interpretation of the diagrams corresponding to the split Casimir operator in the defining and adjoint representations as Feynman diagrams. Derivation of group factors of the diagrams of this model.

New methods in Geometric Quantization of synthetic type, unified vector and lagrangian approaches, based on the programme of Special Bohr-Sommerfeld geometry.

Inversion of operators related to generalizations of V.P. Maslov's quasiclassical approximations and topological properties of Liouville vector fields on open symplectic manifolds.

2. Construction and investigation of new types of static Q-cloudy black holes in the Einstein-Maxwell-Fridberg-Lee-Sirlin model.
Construction of N=4,8 supersymmetric extensions of systems with generic Kähler phase space.

   Exploration of the integrability issues in the supersymmetric Euler-Calogero-Moser model and construction of the relevant set of integrals of motion.

   Development of the BRST formalism for describing massless infinite spin fields and superfields in 6D space.

   Working out the manifestly N=(4,4) supersymmetric harmonic superfield approach to T-duality in the hyper-Kähler and quaterrnion-Kähler 2D sigma models.

   Construction of the harmonic superspace formulation of N=2 superconformal higher spins and its reduction to AdS background.
Construction and investigation of new multi-soliton solution of the Skyrme-Maxwell theory.

   Study of N=4, d=1 non-linear mirror multiplets of supersymmetric quantum mechanics and construction for them of Wess-Zumino-type Lagrangians and couplings to other N=4, d=1 mirror multiplets.

   Construction of generalized lens elliptic gamma functions and proof that they describe the superconformal index of 4D N=1 supersymmetric theories on a product of a circle and a generalized squashed lens space.

3. Analysis of inflationary scenarios in scalar-tensor models of gravity, calculation of observable parameters such the slope of the primordial perturbation spectrum and the tensor-to-scalar ratio.

   Investigation of photon orbits in the regime of a strong gravitational field in modified gravity theories and setting limits on the parameters of modified theories based on current observational data.

   Study of quantum effects in scalar-tensor models of gravity and opportunities for their empirical verification.

   Development of the FeynGrav package and its application to the computation of one-loop amplitudes in scalar-tensor gravity models. Investigation of the structure of divergencies in these models and the possibility of their ultraviolet extension.

   Study of phenomenological theories of gravity containing higher derivatives of the Ricci scalar and the trace of the energy-stress tensor. Analysis of instabilities in this kind of theories and possibility to construct ghost-free and phantom-free subclasses. Investigation of possible cosmological consequences of these theories.

   Investigation of gravitational bursts generated by null strings and setting limits on the parameters of such strings based on current observational data.

   Analysis of the influence of the gravitational-wave background on physical processes available for observation.

   Study of diffraction and interference of electromagnetic and gravitational waves aginst the background of null cosmic strings. Application of the Picard-Lefschetz theory for estimating the diffraction integrals arising from these problems. Investigation of the caustics of world surfaces of null cosmic strings by methods of the Arnold's theory of singularities of differentiable mappings.
Investigation of quantum fluctuations of an electromagnetic field against the background of anisotropic integrable optical profiles generalizing the classical "Maxwell's fisheye".

   Development of a quantum field theory approach to the description of topological insulators.

List of Activities

	Activity or experiment Laboratory or other Division of JINR	Leaders Main researchers
1.	**Quantum groups and integrable systems**	**A.P. Isaev** **S.O. Krivonos** **N.A. Tyurin**
	BLTP	Ch. Burdik, H. Dimov, P. Fiziev, A.A. Golubtsova, N.Yu. Kozyrev, M. Podoinitsyn, G.S. Pogosyan, A.A. Provorov, A.V. Silantyev
	UC	S.Z. Pakuliak
2.	**Supersymmetry**	**E.A. Ivanov**
	BLTP	S.A. Fedoruk, A. Nersessian, G. Sarkissyan, S.S. Sidorov, Ya.M. Shnir, A.O. Sutulin, N.M. Zaigraev
3.	**Quantum gravity, cosmology and strings**	**I.G. Pirozhenko** **V.V. Nesterenko**
	BLTP	I. Bormotova, E.A. Davydov, D.V. Fursaev, B. Latosh, A.B. Pestov, A.A. Provorov, E.A. Tagirov, P.V. Tretyakov, A.S. Sorin, E. Radionova
	MLIT	A.M. Chervyakov
	VBLHEP	E.E. Donets

Collaboration

Country or International Organization	City	Institute or Laboratory
Armenia	Yerevan	Foundation ANSL
		YSU
Australia	Perth, WA	UWA
	Sydney, NSW	Univ.
Brazil	Juiz de Fora, MG	UFJF
	Sao Paulo, SP	USP
	Vitoria, ES	UFES
Bulgaria	Sofia	INRNE BAS
		SU
Canada	Edmonton	U of A
	Montreal	Concordia
CERN	Geneva	CERN
Czech Republic	Opava	SlU
	Prague	CTU
	Rez	NPI CAS
Estonia	Tartu	UT
France	Annecy-le-Vieux	LAPP
	Lyon	ENS Lyon
	Marseille	CPT
	Nantes	SUBATECH
	Paris	ENS
		LUTH
	Tours	Univ.

Germany	Bonn	UniBonn
	Hannover	LUH
	Leipzig	UoC
	Oldenburg	IPO
	Potsdam	AEI
Greece	Athens	UoA
	Thessaloniki	AUTH
ICTP	Trieste	ICTP
India	Chennai	IMSc
	Kolkata	BNC
		IACS
Iran	Tehran	IPM
Ireland	Dublin	DIAS
Israel	Tel Aviv	TAU
Italy	Frascati	INFN LNF
	Padua	UniPd
	Pisa	INFN
	Trieste	SISSA/ISAS
	Turin	UniTo
Japan	Tokyo	Keio Univ.
		UT
Lithuania	Vilnius	VU
Luxembourg	Luxembourg	Univ.
Norway	Trondheim	NTNU
Poland	Bialystok	UwB
	Lodz	UL
	Wroclaw	UW
Portugal	Aveiro	UA
Republic of Korea	Seoul	SKKU
Russia	Chernogolovka	LITP RAS
	Kazan	KFU
	Moscow	ITEP
		LPI RAS
		MI RAS
		MSU
		SAI MSU
	Moscow, Troitsk	INR RAS
	Novosibirsk	NSU
	Protvino	IHEP
	St. Petersburg	PDMI RAS
	Tomsk	TPU
		TSPU
Spain	Barcelona	IEEC-CSIC
	Bilbao	UPV/EHU
	Santiago de Compostela	USC
	Valencia	IFIC
	Valladolid	UVa
Taiwan	Taoyuan City	NCU

Ukraine	Kharkov	KhNU
		NSC KIPT
	Kiev	BITP NASU
United Kingdom	Cambridge	Univ.
	Canterbury	Univ.
	Durham	Univ.
	Glasgow	U of G
	Leeds	UL
	London	Imperial College
	Nottingham	Univ.
USA	Amherst, MA	UMass
	College Park, MD	UMD
	Coral Gables, FL	UM
	New York, NY	CUNY
		SUNY
	Norman, OK	OU
	Piscataway, NJ	Rutgers
	Rochester, NY	UR
	Tempe, AZ	ASU

01-3-1117-2014/2023	Priority:	1

Status: Being concluded

Dubna International Advanced School of Theoretical Physics (DIAS-TH)

Leader: I.G. Pirozhenko

Rector of DIAS-TH: D.I. Kazakov

Participating Countries and International organizations:

Armenia, Austria, Belarus, Brazil, Bulgaria, Canada, China, CERN, Czech Republic, France, Germany, Greece, Hungary, India, Israel, Italy, Japan, Norway, Poland, Romania, Russia, Serbia, Slovakia, South Africa, Spain, Turkey, Ukraine, United Kingdom, USA, Vietnam.

The Bogoliubov Laboratory of Theoretical Physics (BLTP) has a good record of organizing international workshops and schools in Dubna. DIAS-TH organizes and supervises all educational programs for students, postgraduates, and young scientists at BLTP. It should function continuously and the standard short schools (about 3-4 a year) should be organized coherently. Other educational programs in Dubna such as the JINR University Center may also correlate with DIAS-TH (common programs on modern theoretical physics, workshops for students and young scientists, etc.).

The main goals of DIAS:

1. Training courses for students, graduates, and young scientists in the JINR Member States and other countries (according to special agreements and grants).
2. Looking for and supporting gifted young theorists in the JINR Member States; creating databases of students and young researchers.
3. Organization of schools of different levels in Dubna and coordination with similar schools in Russia, Germany, and other European countries.
4. Support of the JINR experimental programs by organizing lecture courses and review lectures on new trends in modern physics.
5. Cooperation with the JINR University Center in training students and postgraduates as well as in organizing schools for students.
6. Coordination of the research - training programs with workshops and conferences at JINR.
7. Coordination with the schools and workshops supported by the European
8. Participation in nets of workshops and schools in Europe.
9. Publication of lectures and discussions in different forms, in particular, with the use of modern electronic equipment, etc.
10. Supporting the WEB page of DIAS-TH which should become the organizing center of the programs related to DIAS-TH.

The main topics of the DIAS activity should be centered around the most important directions of research at BLTP: Theory of Fundamental Interactions; Nuclear Theory; Theory of Condensed Matter; Modern Mathematical Physics.

Expected main results in the current year:

1. Organization at BLTP of three schools on theoretical physics for students, post-graduates and young scientists.
2. Organization of one-day lectures/discussions and regular seminars for students and post-graduates.
3. Computer processing of video records of lectures, support of digital archive of video records.
4. Support of Web-site of DIAS-TH.

List of Activities

Activity or experiment	Leaders
Laboratory or other Division of JINR	Main researchers
1. DIAS-TH	**D.I.Kazakov** **V.V Voronov**
BLTP	E.A. Davydov, A.V. Frizen, D.V. Fursaev, A.P. Isaev, M.A. Ivanov, R.V. Jolos, E.A. Kolganova, V.A. Osipov, I.G. Pirozhenko, A.S. Sorin, V.P. Spiridonov, A.A. Starobinsky, O.V. Teryaev, P.V. Tretyakov, V.I. Zhuravlev, 4 students
MLIT	Yu.L. Kalinovsky, V.V. Korenkov
UC	S.Z. Pakuliak
FLNP	V.L. Aksenov
VBLHEP	V.D. Kekelidze, M.V. Savina, S.V. Shmatov
DLNP	V.A. Bednyakov, D.V. Naumov
FLNR	A.S. Denikin, V. Khudoba, Yu.Ts. Oganessian

Collaboration

Country or International Organization	City	Institute or Laboratory
Armenia	Yerevan	YSU
Austria	Vienna	ITP TU Wien
Belarus	Gomel	GSTU
Brazil	Santo Andre, SP	UFABC
	Sao Paulo, SP	USP
Bulgaria	Sofia	INRNE BAS
		SU
Canada	Edmonton	U of A
	Montreal	UdeM
CERN	Geneva	CERN
China	Wuhan	WHU
Czech Republic	Prague	CTU
	Rez	NPI CAS
France	Annecy-le-Vieux	LAPP
	Dijon	UB
	Lyon	ENS Lyon
	Marseille	CPT
	Nantes	SUBATECH
	Paris	ENS
		LPTHE
	Valenciennes	UVHC
Germany	Bonn	UniBonn
	Hamburg	DESY
	Hannover	LUH
	Jena	Univ.
	Leipzig	UoC
	Munich	MPI-P
	Potsdam	AEI

	Rostock	Univ.
	Zeuthen	DESY
Greece	Athens	UoA
Hungary	Budapest	Wigner RCP
India	Kolkata	BNC
Israel	Rehovot	WIS
Italy	Fisciano	UNISA
	Frascati	INFN LNF
	Padua	UniPd
	Pavia	INFN
	Pisa	INFN
	Trieste	SISSA/ISAS
	Turin	UniTo
Japan	Chiba	CIT
	Kyoto	KSU
		RIMS
	Tsukuba	KEK
Norway	Oslo	UiO
Poland	Warsaw	UW
	Wroclaw	UW
Romania	Bucharest	IFIN-HH
Russia	Chernogolovka	LITP RAS
	Dolgoprudny	MIPT
	Moscow	ITEP
		LPI RAS
		MI RAS
		MSU
		NRU HSE
		SAI MSU
		SCC RAS
		SINP MSU
		VNIIMS
	Moscow, Troitsk	INR RAS
	Novosibirsk	BINP SB RAS
	Protvino	IHEP
	Saratov	SSU
	Tomsk	TPU
Serbia	Belgrade	IPB
		Univ.
Slovakia	Banska Bistrica	UMB
South Africa	Cape Town	UCT
Spain	Madrid	UAM
Turkey	Istanbul	BU
Ukraine	Kiev	BITP NASU
United Kingdom	Cambridge	Univ.
	Durham	Univ.
	London	Imperial College
	Southampton	Univ.

	York	Univ.
USA	Cincinnati, OH	UC
	College Park, MD	UMD
	Coral Gables, FL	UM
	Minneapolis, MN	U of M
	New York, NY	CUNY
	Newport News, VA	JLab
	Philadelphia, PA	Penn
	Piscataway, NJ	Rutgers
	Rochester, NY	UR
	Salt Lake City, UT	U of U
Vietnam	Hanoi	IOP VAST

Elementary Particle Physics and Relativistic Nuclear Physics (02)

02-2-1123-2015/2023	Priority:	1

Status: Being concluded

Study of Fundamental Interactions in e^+e^- and Hadronic Collisions

Leader: A.S. Zhemchugov
Deputy: A.V. Guskov

Participating countries and international organizations:

Belarus, CERN, China, Germany, Italy, Poland, Russia, Sweden.

Issues addressed and main goals of research:

The Standard Model (SM) provides the most accurate and universal description of physics phenomena on a microscale nowadays. However, it is not free from a number of shortcomings. Some predictions of the Standard Model still have not been observed experimentally. In many cases the accuracy of predictions is limited by experimental knowledge of the key free parameters of the theory. At the same time, the search for New Physics beyond the Standard Model may show the way to further develop the theory and to get rid of its shortcomings. The main tool for these studies is collider experiments using both proton-proton (LHC) and electron-positron collisions. The latter are most suitable for precision studies of elementary particles with obvious advantages from well-defined kinematics of the initial state and the absence of the large QCD background typical of hadronic colliders. The precision test of SM predictions and search for new phenomena beyond the SM in charmonium and tau lepton decays are fulfilled in the scope of this theme using the world best facility in this energy domain - the unique electron-positron collider BEPC-II and the BES-III detector. At the same time, preparation for experiments at future electron-positron colliders (ILC, CLIC, CEPC, FCC-ee) is underway.

An important complement to the studies of e^+e^- collisions are the planned measurements at the AMBER experiment to address fundamental issues of quantum chromodynamics which are expected to lead to significant improvements in understanding of QCD as the present theory of strong interactions. AMBER (Apparatus for Meson and Baryon Experimental Research) is a new fixed-target experimental facility at the M2 beam line of the CERN SPS. The proposed measurements cover the range from lowest-Q2 physics as the determination of the proton radius by elastic muon-proton scattering over average-Q2 reactions to study hadron spectroscopy to high-Q2 hadron-structure investigations using the Drell-Yan, charmonia, and prompt-photon production hard processes.

Expected results in the current year:

1. BES-III data analysis.
2. Development of offline software and analysis tools.
3. Development of a multipurpose MC event generator to describe the main processes of e^+e^- annihilation including radiative corrections at a level of more than one loop. The generator will take into account the particle polarization for both the initial and final states.
4. Development of standard program codes to calculate radiation corrections at a level of 2 (for EW interactions) and 3 (for strong interactions) loops.
5. Study of the research potential of the experiments at the CLIC, FCC, CEPC colliders in the domain of precision measurements and search for new physics on the basis of full detector simulation.
6. Development of proposals for the physics research program of the Super c-t Factory.
7. Test run to determine the proton radius by elastic muon-proton scattering.
8. R&D to develop a prototype of the Micromegas chamber of 50 cm x 50 cm followed by the test-beam studies.

List of projects

	Project	Leader	Priority (period of realisation)
1.	BES-III	I.I. Denisenko	1 (2007-2023)

List of Activities

Activity or Experiment Laboratory or other Division of JINR Responsible person	Leaders Main researchers	Status
1. BES-III Project	**I.I. Denisenko**	Realization
DLNP	O.V. Bakina, I.R. Boyko, D.V. Dedovich, P.A. Egorov, A.V. Guskov, Yu.A. Nefedov, S.N. Pogodin, G.A. Shelkov, A.S. Zhemchugov	
MLIT	V.V. Korenkov, G.A. Ososkov, I.S. Pelevanyuk	
2. Theoretical support of collider experiments	**L.V. Kalinovskaya**	Realization
DLNP	I.R. Boyko, E.V. Dydyshko, Yu.A. Nefedov, N.E. Pukhaeva, L.A. Rumyantsev, A.A. Sapronov, R.R. Sadykov, A.S. Zhemchugov, V. Yermolchyk, Yu. Yermolchyk	
BLTP	A.B. Arbuzov, S.G. Bondarenko, V.V. Bytev	
MLIT	I.S. Pelevanyuk	

Collaboration

Country or International Organization	City	Institute or Laboratory
Belarus	Minsk	INP BSU
CERN	Geneva	CERN
China	Beijing	IHEP CAS
Germany	Hamburg	DESY
	Hannover	LUH
Italy	Turin	UniTo
Poland	Katowice	US
	Krakow	INP PAS
Russia	Gatchina	NRC KI PNPI
	Novosibirsk	BINP SB RAS
Sweden	Lund	LU

02-0-1081-2009/2024		Priority:	1

Status: In-progress

ATLAS.
Upgrade of the ATLAS Detector and Physics Research at the LHC

Leader: V.A. Bednyakov

Deputies: E.V. Khramov
A.P. Cheplakov

Participating countries and international organizations:

Armenia, Azerbaijan, Belarus, Bulgaria, Canada, CERN, Czech Republic, France, Georgia, Germany, Israel, Italy, Netherlands, Russia, Slovakia, Spain, USA, Uzbekistan.

Issues addressed and main goals of research:

Absolutely new and unique data will be obtained in multifaceted and comprehensive research of proton-proton scattering processes. The analysis of these data will allow solving several fundamental physical problems. JINR scientists will participate in this analysis within this project.

It is expected to obtain new results and make publications on all above-mentioned tasks where JINR scientists have responsibilities. The most important tasks are the studies of the proton structure and hadron state spectrum, probing of the Standard Model at the LHC energies, search for and investigation of supersymmetry, search for the evidence of existence of new particles and new interactions. In addition, JINR intends to obtain new results that will help specify properties of already known elementary particles such as *W*- and *Z*-bosons, top quarks, heavy baryons, etc.

The implementation of this Project aimed at solving highly significant scientific problems will also bring unique applied results which may significantly change the quality of life. Among these results the experience in operation of remote monitoring systems for technically complicated devices, big data processing, development and practical use of distributed comtputing systems (GRID), and database monitoring applications in long-term large-scale experiments can be noted.

Expected results in the current year:

1. Investigation of applicability of the Standard Model and verification of SM predictions (including interactions of heavy ions), determination of the structure of the proton at ultra-high energies (PDFs), tuning and improvement of relevant computer codes and event generators, etc.
2. Search for the chiral Z^*/W^* bosons in two-jet decays and in a process with more complex topology of their associative production including heavy *b* and *t* quarks.
3. Search for (supersymmetric) charged Higgs bosons via their specific decay modes (3-lepton, etc.).
4. Analyses of associated productions of the SM Higgs with the top-antitop pair and search for production with a single top.
5. Search for a valence-like nonperturbative component of heavy quarks in the proton (intrinsic heavy quarks) via specific final state topology in the pp interactions.
6. Search for new hadrons and baryons containing heavy c and b quarks and study of their properties.
7. Measurement of the Drell-Yan triple-differential cross section and effective leptonic weak mixing angle in the Z-boson decay.
8. New comprehensive study of the gluon structure of the proton, etc.
9. Search for quantum black holes in the lepton+jet channel at 13 TeV.
10. Participation in development of event trigger indexing infrastructure.
11. Development and maintenance of the TDAQ system.
12. Development of database monitoring applications.

List of projects

	Project	Leader	Priority (period of realisation)
1.	ATLAS. Physical researches at the LHC	V.A. Bednyakov Deputies: E.V. Khramov A.P. Cheplakov	1 (2010-2023)
2.	Upgrade of the ATLAS Detector	A.P. Cheplakov	1 (2013-2023)

List of Activities

Activity or Experiment Laboratory or another Division of JINR Responsible person	Leaders Main researchers	Status
1. The ATLAS experiment	**V.A. Bednyakov** **E.V. Khramov** **A.P. Cheplakov**	Technical Proposal
DLNP V.A. Bednyakov N.A. Russakovich G.P. Chelkov	A.M. Artikov, N.V. Atanov, V.Yu. Baranov, V.Yu. Batusov, I.R. Boyko, Z.A. Budtueva, E.A. Cherepanova, M.V. Chizhov, Z. Chubinidze, Yu.I. Davydov, D.V. Dedovich, M.A. Demichev, A.R. Didenko, A.V. Ershova, A.B. Gazzaev, L.R. Gladilin, V.V. Glagolev, A. Gongadze, I. Gongadze, L. Gongadze, M.I. Gostkin, R.Z. Gurtsiev, A.V. Guskov, N. Huseinov, Yu.P. Ivanov, L.V. Kalinovskaja, S.N. Karpov, Z.M. Karpova, N.N. Kaurtsev, N.V. Kirichkov, D.V. Kharchenko, I.A. Kochergin, D.A. Kokaev, O.A. Koval, N.A. Kovyazina, D.A. Kozhevnikov, V.G. Kruchonok, Yu.A. Kultchitsky, M.V. Lyablin, F.V. Lapkin, G.I. Lykasov, I. Lyashko, V.V. Lyubushkin, T.V. Lyubushkina, S.N. Malyukov, M. Manashova, I. Minashvili, I. Minashvili I., Yu.A. Nefedov, A.A. Nozdrin, E.M. Plontikova, S.Yu. Porokhovoy, I.N. Potrap, F.V. Prokoshin, T.O. Rudenko, R.R. Sadykov, A.A. Sapronov, A.V. Shaikovskii, A.V. Simonenko, P.I. Smolyanskiy, R.V. Sotenskii, M.M. Shiyakova, A.N. Shalyugin, V.V. Tereschenko, I.N. Troeglazov, P.V. Tereshko, S.M. Turchikhin, Yu.A. Usov, Z. Usubov, V.A. Vasiliev, A.O. Vasyukov, I.V. Yeletskikh, A.S. Zhemchugov	
VBLHEP A.P. Cheplakov	F.N. Ahmadov, Yu.A. Fillipov, A.V. Ivanov, V.V. Kukhtin, E.A. Ladygin, S.N. Nagorny, A.A. Soloshenko, N.I. Zimin, B.G. Shaykhatdenov, T. Turtuvshin	
MLIT V.V. Korenkov, P.V. Zrelov	E.I. Alexandrov, I.N. Aleksandrov, N.I. Gromova, A.V. Iakovlev, A.I. Kazymov, M.A. Mineev, V.N. Shigaev	
BLTP D.I. Kazakov	A.B. Arbuzov, A.V Bednyakov, S.G. Bondarenko, N.I. Kochelev, A.F. Pikelner, O.V. Teryaev	
FLNP M.V. Bulavin		

Collaboration

Country or International Organization	City	Institute or Laboratory
Armenia	Yerevan	Foundation ANSL
Azerbaijan	Baku	IP ANAS

Belarus	Gomel	GSTU
		GSU
	Minsk	IAP NASB
		INP BSU
		IP NASB
		JIPNR-Sosny NASB
Bulgaria	Sofia	SU
Canada	Montreal	UdeM
	Vancouver	TRIUMF
CERN	Geneva	CERN
Czech Republic	Prague	CU
France	Clermont-Ferrand	LPC
	Orsay	LAL
Georgia	Tbilisi	HEPI-TSU
Germany	Munich	MPI-P
	Zeuthen	DESY
Israel	Rehovot	WIS
Italy	Pisa	INFN
Netherlands	Amsterdam	NIKHEF
Russia	Moscow	ITEP
		LPI RAS
		MSU
	Protvino	IHEP
	Vladikavkaz	NOSU
Slovakia	Bratislava	CU
		IP SAS
Spain	Barcelona	IFAE
USA	Lemont, IL	ANL
Uzbekistan	Samarkand	SSU

02-2-1144-2021/2023			
		Priority:	1
		Status:	Being concluded

Search for New Physics in the Lepton Sector

Leaders: V.V. Glagolev
Z. Tsamalaidze

Participating countries and international organizations:

Belarus, Bulgaria, Czech Republic, France, Georgia, Germany, Italy, Japan, Kazakhstan, Russia, Slovakia, Switzerland, Ukraine, United Kingdom, USA.

Issues addressed and main goals of research:

The COMET experiment at J-PARC, the Mu2e experiment at Fermilab and the MEG II experiment at PSI are a dedicated search for the CLFV processes $\mu^- N \rightarrow e^- N$, $\mu^+ \rightarrow e^+ \gamma$. Once neutrino masses are included, the process is allowed but still unobservable since the rate is proportional to $(\Delta m^2_{ij}/M^2_W)^2$, where Δm^2_{ij} is the mass difference squared between ith and jth neutrino mass eigenstates, and M_W is the mass of the W boson. The predicted rates for the $\mu^- N \rightarrow e^- N$ and $\mu^+ \rightarrow e^+ g$ CLFV processes are less than 10^{-50} each. This makes this process a very theoretically clean place to search for NP effects. In many NP models that include a description of neutrino mass, the rates for these processes are enormously enhanced so that they occur at a level to which the COMET and Mu2e experiment will have sensitivity. The conversion measurement at the level of 10^{-17}, which is COMETs goal, will be 10000 times better than the current experimental limit $B(\mu^- + Au \rightarrow \mu e^- + Au) < 7 \cdot 10^{-13}$ from SINDRUM-II at PSI.

The T2K experiment is the first to study the mechanism of CP-symmetry breaking in the lepton sector, which is experimentally manifested in the difference between oscillation probabilities of neutrinos and antineutrinos. The observation of CP-symmetry breaking in neutrino oscillations together with nonconservation of the lepton number can serve as an argument in favor of explaining the baryon asymmetry of the Universe through the mechanism of leptogenesis (leptogenesis is a process of the appearance of lepton-antilepton asymmetry (nonzero lepton number) in the early stages of the formation of the Universe). On the basis of data of the T2K experiment, the observation of CP violation with a significance of 3σ or higher is expected in the case of large CP violation, as well as the measurement of neutrino mixing parameters, θ_{23} and Δm^2_{32}, with an accuracy of 1.7° or better and 1%, respectively.

Expected results in the current year:

1. Participation in preparation, engineering, and physics run, data acquisition and analysis of Phase-a.
2. Finalization of assembling, testing, calibration, installation, cosmic test and maintenance of the straw detector for Phase-I.
3. R&D program for production of straw tubes with a 12-mm wall thickness and 5 mm in diameter. Creating a straw prototype (64 channels) with new tubes (12 mm, 5 mm) and measurements with the beam.
4. Test (certification) of LYSO crystals to be used in the calorimeter. Development and optimization of the crystal calibration method for the COMET calorimeter. Participation in calorimeter designing, assembling, installation, cosmic test, and maintenance.
5. Participation in assembly and maintenance of the CRV for Phase-I.
6. Participation in assembling, testing, installation, and maintenance of the whole detector system for Phase-I.
7. Complex detector system (tracker, calorimeter etc.) simulation.
8. Participation in engineering and physics run, data acquisition and analysis.
9. Tests of *CsI* and BaF_2 electromagnetic calorimeter elements with gamma sources and the electron beam.
10. Manufacture and installation of electronics of the Super FGD photodetector calibration system.
11. Assembly of the SuperFGD as part of the Near Detector of the T2K experiment using a unique box support and top access systems.
12. Preparation of the launch of the Near Detector of the T2K experiment, participation in engineering and operation runs, taking of new data and analysis.
13. Investigation of systematic uncertainties for measuring δ_{CP}.

14. Search for manifestations of new physics in the T2K data including the search for light dark matter.
15. Filling the batch of Mu2e scintillation counters with CKTN and testing them for leakage.
16. Maintenance of the visualization and control software.
17. Development and tests of Mu2e electromagnetic calorimeter preamplifiers at JINR.
18. Participation in radiation hardness tests of detector elements.
19. Participation in development of a positron tracker for the MEG-II experiment, DAQ, data analysis.
20. Participation in data taking and analysis of experimental data obtained with CERN hadron beams.

List of projects

	Project	Leader	Priority (period of realisation)
1.	COMET	Z. Tsamalaidze	1 (2021-2023)
1.	T2K-II	V.V. Glagolev Yu.I. Davydov	1 (2022-2023)

List of Activities

Activity or Experiment Laboratory or another Division of JINR Responsible person	Leaders Main researchers	Status
1. COMET Project	**Z.Tsamalaidze**	R&D Realization
DLNP	G. Adamov, A.M. Artikov, A.V. Boikov, D.Sh. Chokheli, V.N. Duginov, P.G. Evtukhovich, I.L. Evtukhovich, V.A. Kalinnikov, Kh. Khubashvili, E.S. Kaneva, A.V. Pavlov, B.M. Sabirov, A.G. Samartsev, A.V. Simonenko, V.V. Tereschenko, S.V. Tereschenko, N. Tsverava, I.I. Vasilyev, E.P. Velicheva, A.D. Volkov, I.Yu. Zimin	
BLTP	D.Aznabaev, A. Issadykov, G.A. Kozlov	
MLIT	D. Goderidze, A. Khvedelidze	
VBLHEP	D. Baigarashev, T.L. Enik	
2. T2K-II Project	**V.V. Glagolev** **Yu.I. Davydov**	R&D Realization
DLNP	A.M. Artikov, V.Yu. Baranov, A.V. Boikov, A.O. Brazhnikov, D.L. Demin, N.V. Khomutov, N.V. Kirichkov, V.I. Kiseeva, A.O. Kolesnikov, A.V. Krasnoperov, V.L. Malyshev, B.A. Popov, A.V. Shaikovskiy, I.A. Suslov, V.V. Tereschenko, S.V. Tereschenko, I.I. Vasilyev	
BLTP	G.A. Kozlov, V.A. Matveev	
3. Mu2e Experiment	**V.V. Glagolev**	R&D Realization
DLNP	A.M. Artikov, N.V. Atanov, O.S. Atanova, V.Yu. Baranov, Yu.I. Davydov, D.L. Demin, S.M. Kolomoets, A.V. Sazonova, A.N. Shalyugin, I.A. Suslov, V.V. Tereschenko, S.V. Tereschenko	
BLTP	D.I. Kazakov, G.A. Kozlov	
MLIT	V.V. Korenkov, O.V. Tarasov, V.V. Uzhinsky	

VBLHEP	A.S. Galoyan	
4. MEG Experiment	**N.V. Khomutov**	Realization Data taking Data processing
DLNP	V.A. Baranov, V.V. Glagolev, Yu.I. Davydov, N.A. Kuchinsky, N.P. Kravchuk, V.L. Malyshev, A.M. Rozhdestvensky, A.O. Kolesnikov, V.A. Krylov	
5. CERN Neutrino platform	**B.A. Popov**	Data taking Data processing
DLNP	N.V. Atanov, A.O. Kolesnikov, A. V. Krasnoperov, V.V. Lyubushkin, V.L. Malyshev, S.V. Tereschenko, V.V. Tereschenko	

Collaboration

Country or International Organization	City	Institute or Laboratory
Belarus	Minsk	BSU
		INP BSU
		IP NASB
Bulgaria	Sofia	SU
Czech Republic	Prague	CTU
		CU
France	Paris	IN2P3
Georgia	Tbilisi	GTU
		HEPI-TSU
		UG
Italy	Frascati	INFN LNF
	Pisa	UniPi
Japan	Fukuoka	Kyushu Univ.
	Osaka	Osaka Univ.
	Tsukuba	KEK
Kazakhstan	Almaty	INP
Romania	Bucharest	IFIN-HH
Russia	Gatchina	NRC KI PNPI
	Irkutsk	ISU
	Moscow	ITEP
		NNRU "MEPhI"
	Moscow, Troitsk	INR RAS
	Novosibirsk	BINP SB RAS
		NSU
Slovakia	Bratislava	CU
		IP SAS
Switzerland	Villigen	PSI
Ukraine	Kharkov	ISMA NASU
United Kingdom	Didcot	RAL
	London	Imperial College
USA	Batavia, IL	Fermilab
	Charlottesville, VA	UVa
	Lexington, KY	UK

02-2-1099-2010/2023		Priority:	1

Status: Being concluded

Study of Neutrino Oscillations

Leaders: D.V. Naumov
A.G. Olshevskiy

Participating countries and international organizations:

China, Czech Republic, France, Germany, Japan, Italy, Romania, Russia, Slovakia, Switzerland, Turkey, USA.

Issues addressed and main goals of research:

1. Measurement of the neutrino mixing angle θ_{13} and the squared mass difference Δm^2_{ee} in the Daya Bay experiment.
2. Neutrino mass hierarchy determination and measurement of the CP violation phase of the neutrino mixing matrix in the JUNO and NOvA experiments.
3. Measurement of solar neutrino fluxes, search for the sterile neutrino state and new particles.
4. Study of tau neutrino production in proton-nuclear interactions at the CERN SPS.
5. Development of detector systems of the DUNE ND.

Expected results in the current year:

1. Physics analysis of the Daya Bay experiment data on determination of θ_{13} and other oscillation parameters.
2. Estimation of the mass hierarchy measurement precision in the JUNO experiment with the TAO Near Detector.
3. Tests of detection elements and electronics of JUNO/TAO.
4. Installation and commissioning of the JUNO detector (PMT, HV, TT-veto).
5. Using of the NOva Remote Operation Centre at JINR for shift working, mass testing of JUNO PMTs with scanning stations.
6. Data analysis in the NOvA experiment, new results considering the hierarchy and CP monitoring of the JUNO veto system planes with cosmic muons.
7. Preparation of prototype tests of DUNE ND detector systems.
8. Development of the GNA project: GPU support and automatic differentiation.
9. Preparation of the full physics run and data analysis of the pilot run data, development of algorithms of charm particles decay search in high track density conditions.
10. Analysis of solar neutrino parameters and search for rare processes in the Borexino detector, the DS-50 data analysis.

List of projects

	Project	Leader	Priority (period of realisation)
1.	JUNO	D.V. Naumov	1 (2009-2023)
2.	NOvA/DUNE	A.G. Olshevskiy	1 (2015-2023)

List of Activities

	Activity or Experiment Laboratory or another Division of JINR Responsible person	Leaders Main researchers	Status
1.	**JUNO Project**	**D.V. Naumov** **M.O. Gonchar**	Construction Data taking
	DLNP	N.V. Anfimov, T.A. Antoshkina, S.V. Biktemerova, A.E. Bolshakova, A.V. Chetverikov, A.V. Chukanov, S.G. Dmitrievsky, D.A. Dolzhikov, D.V. Fedoseev, Yu.A. Gornushkin, V.O. Gromov, M.V. Gromov, A.V. Krasnoperov, K. Kuznetsova, Yu. Malyshkin, E.A. Naumova, I.B. Nemchenok, A.G. Olshevskiy, A.V. Rybnikov, A.B. Sadovsky, A.S. Selunin, V.I. Sharov, A.V. Shaydurova, V.B. Shutov, O.Yu. Smirnov, S.A. Sokolov, A.P. Sotnikov, V.D.Tchalyshev, K.A. Treskov, V. Zavadskiy	
	MLIT	N.A. Balashov, N.A. Kutovskiy	
2.	**NOvA/DUNE Project**	**A.G. Olshevskiy** **N.A. Anfimov** **O.B. Samoylov**	Data taking
	DLNP	A.I. Antoshkin, A.V. Chetverikov, D.V. Fedoseev, V.O. Gromov, A.I. Kalitkina, O.A. Klimov, Ch. Kullenberg, L.D. Kolupaeva, D.V. Korablev, K.I. Kuznetsova, A.D. Morozova, O.N Petrova, A.Yu. Rybnikov, V.I. Sharov, A.S. Selyunin, A.S. Sheshukov, S.A. Sokolov, A.P. Sotnikov, V.V. Tchalyshev, S.G. Vasina	
	BLTP	I.D. Kakorin, K.S. Kuzmin, V.A. Matveev, V.A. Naumov	
	MLIT	N.A. Balashov, A.V. Baranov, A.G. Dolbilov, E.A. Kuznetsov, N.A. Kutovskiy	
3.	**Experiment Ds Tau**	**Yu.A. Gornushkin**	Data analysis
	DLNP	A.V. Chukanov, S.G. Dmitrievsky, A.B. Sadovsky, A.P. Sotnikov, S.G. Vasina	
4.	**Experiment Borexino/DarkSide**	**O.Yu. Smirnov**	Data analysis
	DLNP	M.V. Gromov, D.V. Korablev, O.B. Samoylov, A.P. Sotnikov, A.S. Sheshukov, A.V. Vishneva, T.Enik	
5.	**R&D on SAND/STT**	**T.Enik** **S.Movchan**	R&D
	LHEP	D. Baygarashev, V. Bautin, Y. Kambar, G. Kekelidze, V. Kramarenko, V. Lysan, K. Salamatin, N. Azorskiy, E. Vasilieva, I. Zhukov, A. Kolesnikov, V. Pavlov, S. Parzhickiy	

Collaboration

Country or International	City	Institute or Laboratory
China	Beijing	IHEP CAS
Czech Republic	Prague	CU
France	Strasbourg	CRN
Germany	Aachen	RWTH
	Hamburg	Univ.
Italy	Milan	UNIMI
	Salerno	INFN

Japan	Fukuoka	Kyushu Univ.
	Nagoya	Nagoya Univ.
	Tokyo	Toho Univ.
Romania	Magurele	ISS
Russia	Irkutsk	ISU
	Moscow	SINP MSU
Slovakia	Bratislava	CU
Switzerland	Bern	Uni Bern
Turkey	Ankara	METU
USA	Batavia, IL	Fermilab
	Cambridge, MA	Harvard Univ.
	Columbia, SC	UofSC
	Indianapolis, IN	IUPUI

02-0-1108-2011/2023	Priority:	1

Status: Being concluded

PANDA Experiment at the FAIR Accelerator Complex

Leader: G.D. Alexeev
Deputies: A.N. Skachkova
A.S. Vodopyanov

Participating countries and international organizations:

Belarus, CERN, Germany, Italy, Russia.

Issues addressed and main goals of research:

The study of exotic nuclear-matter states and the nucleon structure in the PANDA experiment at FAIR. Start of construction of the PANDA muon detector.

Expected results in the current year:

1. Signing of the FAIR-JINR contract on the muon system construction.
2. Preparation of a mass production workshop for MDT detectors.
3. Finalizing of electronics design.
4. Calibration of prototypes at CERN and JINR for all types of particles in the energy range of 0.5-10 GeV.
5. Development of particle identification algorithms (PID) tuned on the basis of beam test results.

List of projects

	Project	Leader	Priority (period of realisation)
1.	Experiment PANDA at FAIR	G.D. Alexeev	1 (2022-2023)

List of Activities

	Activity or Experiment Laboratory or another Division of JINR Responsible person	Leaders Main researchers	Status
1.	**Experiment PANDA**	**G.D. Alexeev**	Technical Proposal
	DLNP A.N. Skachkova	V.M. Abazov, G.A. Golovanov, S.A. Kutuzov, A.A. Piskun, I.K. Prokhorov, A.M. Rozhdestvensky, A.G. Samartsev, N.B. Skachkov, V.V. Tokmenin, L.S. Vertogradov, Yu.L. Vertogradova, V.P. Volnykh, A.Yu. Verkheev, N.I. Zhuravlev	
	VBLHEP A.S. Vodopyanov	V.I. Astakhov, M.Yu. Barabanov, B.V. Batyunya, V.A. Budilov, A.S. Galoyan, V.K. Dodokhov, A.A. Efremov, A.A. Feshchenko, E.K. Koshurnikov, V.I. Lobanov, Yu.Yu. Lobanov, P.V. Nomokonov, I.A. Oleks, E.A. Strokovsky, S.S. Shimansky, A.O. Sidorin	
	MLIT	V.V. Uzhinsky, T.I. Mikhaylova	
	BLTP	A.S. Sorin, O.V. Teryaev	

Collaboration

Country or International Organization	City	Institute or Laboratory
Belarus	Minsk	IP NASB
CERN	Geneva	CERN
Germany	Darmstadt	GSI
	Frankfurt/Main	Univ.
	Munich	TUM
Italy	Genoa	INFN
		UniGe
	Trento	ECT*
Russia	Novosibirsk	BINP SB RAS
	Omsk	OB IM SB RAS
	Protvino	IHEP

02-2-1125-2015/2023		Priority:	1
		Status:	Being concluded

Astrophysical Researches with the TAIGA Experiment

Leader: A.N. Borodin
Deputy: L.G. Tkachev

Participating countries and international organizations:

Italy, Japan, Mexico, Republic of Korea, Romania, Russia.

Issues addressed and main goals of research:

1. Search for local galactic sources of gamma rays with energies above 20-30 TeV.
2. Study of gamma rays fluxes from known sources in the same energy region.
3. Search for diffuse gamma rays from the galactic disk.
4. Study of the energy spectrum and the mass composition of cosmic rays in the energy range of 10^{15} to 10^{17} eV in order to detect spots of Lorentz invariance violation.
5. Search for galactic PeVatrons.
6. The TAIGA observatory also plans to introduce a "hybrid method" of observation - the combined use of IACT and HiScore wide angle Cherenkov detectors. This method will not only significantly improve the quality of high-energy gamma-rays emission signal selection from background hadron events, but will also help to match currently available parts of the cosmic ray spectrum obtained by ground-based and orbital detectors.
7. In the NUCLEON space experiment, the spectra and elemental composition of cosmic rays were measured in the energy range of 10^{11}-10^{15} eV. Further progress in applying this technique is the planned OLVE-HERO experiment. The unique parameters of the detector within 5 years of direct extra-atmospheric measurements will provide data, large statistics which allow identifying changes to the cosmic ray composition at an energy up to 10^{16} eV and measuring angular anisotropy of cosmic rays.

Expected results in the current year:

1. Design, manufacturing, and testing IACT telescopes for the TAIGA experiment.
2. Development of event simulation programs in the TAIGA experiment. Upgrade of software for collectioning and processing data for the IACT telescopes, as well as for their hybrid mode of operation in conjunction with HiScore detectors.
3. MC simulation of the joint operation of IACT telescopes and the TAIGA observatory's wide-angle Cherenkov detectors and optimization of selection of gamma rays events from the background.
4. Monitoring of the brightest gamma-ray sources in a hybrid mode at the TAIGA observatory. Upgrade of software for the IACT data analysis.
5. Completion of the data analisys of the TUS space experiments.
6. Design and beam tests of OLVE-HERO prototypes.
7. Study of the Crab Nebula gamma radiation in the energy range of 2-10 TeV. Observation of the brightest extragalactic sources of gamma radiation Mrk-421, Mrk-501.

List of projects

	Project	Leader	Priority (period of realisation)
1.	TAIGA	A.N. Borodin	1 (2015-2023)

List of Activities

	Activity or Experiment / Laboratory or another Division of JINR / Responsible person	Leaders / Main researchers	Status
1.	**Experiment TAIGA**	**A.N. Borodin**	Implementation
	DLNP	A.V. Blinov, V.M. Grebenyuk, F.F. Grinyuk, M.V. Lavrova, A. Pan, S.Yu. Porokhovoy, L.G. Tkachev Shaikovskiy A.V.	
	VBLHEP	N.V. Gorbunov, A.V. Skrypnik	
	MLIT	I. Satyshev	
2.	**Experiment TUS**	**L.G. Tkachev**	Completion
	DLNP	A.V. Blinov, V.M. Grebenyuk, F.F. Grinyuk, M.V. Lavrova, A.V. Tkachenko	
3.	**Experiment OLVE-HERO**	**L.G. Tkachev**	Preparation
	DLNP	A.V. Blinov, V.M. Grebenyuk, N.I. Lavrova, A. Pan, S.Yu. Porokhovoy, A.B. Sadovsky, A.V. Tkachenko	
	VBLHEP	N.V. Gorbunov	
	MLIT	I. Satyshev	
	FLNP	A.D. Rogov	

Collaboration

Country or International Organization	City	Institute or Laboratory
Italy	Turin	UniTo
Japan	Wako	RIKEN
Mexico	Puebla	BUAP
Republic of Korea	Seoul	EWU
Romania	Magurele	ISS
Russia	Irkutsk	RIAP ISU
	Moscow	NNRU "MEPhI"
		SINP MSU
	Moscow, Troitsk	INR RAS

02-1-1106-2011/2023	Priority:	1

Status: Being Concluded

Investigations of Compressed Baryonic Matter at the GSI Accelerator Complex

Leaders: V.P. Ladygin
V.V. Ivanov

Deputy: O.Yu. Derenovskaya

Participating countries and international organizations:

Czech Republic, France, Germany, Poland, Romania, Russia.

Issues addressed and main goals of research:

Development and testing of detector prototypes based on the drift tubes and scintillation counters with SiPM readout for experiments at NICA with possible use in the CBM experiment at the FAIR/GSI accelerator complex. Preparation of publications on magnetic and force calculations for a superconducting dipole magnet. Study of the dynamics of multiple particle production in heavy ion collisions in the collider mode. Adaptation of advanced algorithms and software for triggering, modeling and data analysis for projects at NICA.

Expected results in the current year:

1. Development and testing of prototype detectors based on drift tubes and scintillation detectors for SPD.
2. Publication of results for magnetic and force calculations for the superconducting dipole magnet of the CBM experiment.
3. Adaptation of advanced algorithms and software for triggering and data analysis for SPD.
4. Simulation of the multiparticle dynamics in heavy ion collisions.
5. Application of advanced mathematical methods and fast computational algorithms for data analysis and selection of signal events for projects at NICA.
6. Adaptation of tracking and data analysis algorithms at HADES to fast online selection at SPD.
7. Theoretical support for NICA initial phase experiments.

List of projects

	Project	Leader	Priority (period of realisation)
1.	CBM	V.P. Ladygin V.V. Ivanov	1 (2011-2023)
2.	HADES	V.P. Ladygin O.V. Fateev	1 (2010-2023)

List of Activities

	Activity or Experiment Laboratory or other Division of JINR Responsible person	Leaders Main researchers	Status
1.	**CBM Project** **Development and production of detector prototypes based on drift tubes and scintillation detectors for NICA experiments. Application of the developed algorithms and software for trigger, simulation and analysis of data, prototypes high-speed coordinate detectors.**	**V.P. Ladygin** **V.V. Ivanov**	Realization

Publication of results on magnetic calculations of a superconducting dipole magnet and silicon detectors		
	VBLHEP	S.P. Avdeev, I.V. Boguslavsky, A.V. Bychkov, D.V. Dementiev, V.V. Elsha, O.V. Fateev, Yu.V. Gusakov, A.P. Ierusalimov, G.D. Kekelidze, N.B. Ladygina, V.M. Lysan, A.I. Malakhov, Yu.A. Murin, A.D. Sheremetiev, A.L. Voronin, A.I. Zinchenko, D.A.Zinchenko, N.I. Zamyatin
	MLIT	P.G. Akishin, E.P. Akishina, E.I. Alexandrov, I.N. Alexandrov, D.V. Belyakov, O.Yu. Derenovskaya, I.A. Filozova, V.V. Ivanov, A.V. Kryanev, A.M. Raportirenko, T.P. Sapozhnikova, P.V. Zrelov
	BLTP	S.G. Bondarenko
2.	**Experiment HADES**	**V.P. Ladygin** **O.V. Fateev**
	VBLHEP	A.V. Belyaev, A.P. Ierusalimov, S.G. Reznikov, A.Yu. Troyan, A.I. Zinchenko
	DLNP	G.I. Lykasov

Realization

Collaboration

Country or International Organization	**City**	**Institute or Laboratory**
Czech Republic	Rez	NPI CAS
France	Orsay	IPN Orsay
Germany	Darmstadt	FAIR
		GSI
		TU Darmstadt
	Dresden	HZDR
	Frankfurt/Main	Univ.
	Giessen	JLU
	Heidelberg	Univ.
	Munich	TUM
Poland	Krakow	SIP
Romania	Bucharest	IFIN-HH
Russia	Moscow	ITEP
		NNRU "MEPhI"
		SINP MSU
	Moscow, Troitsk	INR RAS

02-1-1096-2010/2023		Priority:	1

Status: Being concluded

Study of Rare Charged Kaon Decays and Search for Dark Sector in Experiments at the CERN SPS

Leaders: V.D. Kekelidze

Deputies: D.V. Peshekhonov
D.T. Madigozhin

Participating countries and international organizations:

Belarus, Belgium, Bulgaria, Canada, CERN, Chile, Czech Republic, Germany, Italy, Mexico, Romania, Russia, Slovakia, Switzerland, United Kingdom, USA.

Issues addressed and main goals of research:

Realization of the NA62 Project allows to clarify the CP-violation problem, to measure precisely very rare charged kaon decay to charged pions and two neutrinos, to carry out a search for supersymmetric particles and their partners to observe physics beyond the Standard Model. In addition, the characteristics of rare kaon and hyperon decays will be improved. Straw-detectors of the NA62 high resolution magnetic spectrometer working in vacuum will be supported during experimental runs. Development of a new detector prototype based on straws with a smaller diameter will be started to use it at higher intensity of the beams. Software for simulation, data analysis and processing will be developed.

The main objective of the NA64 experiment is to search for new physics beyond the SM, namely the search for the dark photon (A'), hypotetical boson with 16.7 MeV mass and other manifestations of the dark sector in the experiments on the CERN SPS electron and muon secondary beams. Tracking detectores based on the straw tube technology support. Software for data MC simulation and analysis will be developed. Data analysis will be provided.

Expected results in the current year:

In frame of NA62:

1. NA62 and NA48/2 data analysis will be carried out.
2. Software for the simulation of the magnetic spectrometer and full set-up will be developed; system for detector calibration and event reconstruction will be upgraded; general software of the experiment will be developed.
3. Calibration and testing of the NA62 straw detectors will be carried out.
4. Participation in the NA62 experimental run at the CERN SPS.

In frame of NA64:

1. NA64, analysis of the experimental data.
2. Development and putting into operation of new track stations based on 6~mm straw tubes. Operation and support of the detectors.
3. Participation in NA64 experimental runs in the new experimental zone on the H4 and muon SPS channels, CERN.
4. On-line and off-line software development, for the straw chambers analysis and for the DAQ experiment in particular.
5. Participation in the data taking at the CERN SPS.

List of projects

	Project	Leader	Priority (period of realisation)
1	NA62	V.D. Kekelidze Deputy: D.T. Madigozhin	1 (2010-2023)
2.	NA64	V.A. Matveev D.V. Peshekhonov	1 (2017-2023)

List of Activities

	Activity or Experiment Laboratory or other Division of JINR Responsible person	Leaders Main researchers	Status
1.	**Experiment NA62**	**V.D. Kekelidze**	Data taking Data analysis
	VBLHEP	A.Z. Baeva, A.A. Belkova, D. Baygarashev, V.P. Falaleev, T.L. Enik, D.D. Emelyanov, S.R. Gevorgyan, L.N. Glonti, V.N. Gorbunova, E.A. Gudzovsky, D. Kereibay, A.M. Korotkova, D.T. Madigozhin, N.A. Molokanova, S.A. Movchan, I.A. Polenkevich, S.N. Shkarovsky	
2.	**Experiment NA64**	**V.A. Matveev** **D.V. Peshekhonov**	Preparation Data taking Data analysis
	VBLHE	V.E. Burtsev, T.L. Enik, A.A. Festchenko, G.D. Kekelidze, E.A. Kasianova, V.A. Kramarenko, V.M. Lysan, S.S. Parzhitsky, V.V. Pavlov, L.N. Tarasova, E.V. Vasilieva, P.V. Volkov, I.A. Zhukov, A.V. Zinin	
	DLNP	V.N. Frolov	

Collaboration

Country or International Organization	City	Institute or Laboratory
Belarus	Minsk	INP BSU
Belgium	Louvain-la-Neuve	UCL
Bulgaria	Blagoevgrad	SWU
	Plovdiv	PU
	Sofia	SU
Canada	Vancouver	TRIUMF
		UBC
CERN	Geneva	CERN
Chile	Valparaiso	UTFSM
Czech Republic	Prague	CU
Germany	Bonn	UniBonn
	Mainz	JGU
Italy	Ferrara	INFN
	Florence	INFN
	Frascati	INFN LNF
	Naples	INFN
	Perugia	INFN
	Pisa	INFN
	Rome	INFN
		Univ. "Tor Vergata"
	Turin	INFN
Mexico	San Luis Potosi	UASLP
Romania	Bucharest	IFIN-HH

Russia	Moscow	LPI RAS
	Moscow, Troitsk	HPPI RAS
		INR RAS
	Protvino	IHEP
	Tomsk	TPU
Slovakia	Bratislava	CU
Switzerland	Zurich	ETH
United Kingdom	Birmingham	Univ.
	Bristol	Univ.
	Glasgow	U of G
	Lancaster	LU
USA	Boston, MA	BU
	Fairfax, VA	GMU
	Menlo Park, CA	SLAC
	Merced, CA	UCMerced
	Upton, NY	BNL

02-0-1083-2009/2023	Priority:	1

Status: Being concluded

CMS.
Compact Muon Solenoid at the LHC

Leader: V.Yu. Karjavin

Scientific leader: I.A. Golutvin

Participating countries and international organizations:

Armenia, Austria, Belarus, Belgium, Brazil, Bulgaria, CERN, China, Croatia, Cyprus, Czech Republic, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, India, Iran, Ireland, Italy, Lithuania, Mexico, Montenegro, Netherlands, New Zealand, Pakistan, Poland, Republic of Korea, Russia, Serbia, Spain, Switzerland, Taiwan, Turkey, United Kingdom, USA, Uzbekistan.

Issues addressed and main goals of research:

The CMS Collaboration has constructed a general-purpose detector to be operational at the start-up of the Large Hadron Collider (LHC/CERN) to exploit its full discovery potential. Study of fundamental properties of the matter in Super High Energy proton-proton and nucleus-nucleaus interactions.
The major activities of JINR are focused on the following directions:
– hadron calorimetry, including endcap hadron;
– forward muon stations with cathode strip chambers;
– development and realization of Physics program to test SM and BSM.

Expected results in the current year:

1. Processing and analysis of experimental data, development and improvement of muon and jet reconstruction algorithms.
2. Upgrade and technical support of the CMS detectors.
3. CMS shifts, data taking, and data quality monitoring.
4. Development of software for GRID-based distributed system for data processing and analysis. Data transmission between CMS Tier-1/Tier-2 and JINR.

List of projects

	Project	Leader	Priority (period of realisation)
1.	CMS	V.Yu. Karjavin I.A. Golutvin	1 (2010-2023)
2.	Upgrade of the CMS Detector	V.Yu. Karjavin I.A. Golutvin	1 (2022-2023)

List of Activities

Activity or Experiment Laboratory or other Division of JINR Responsible person	Leaders Main researchers	Status
1. Research physics programme with the CMS detector	**S.V. Shmatov**	Realization
VBLHEP	V.Yu. Alexakhin, S.V. Afanasiev, P.D. Budkovsky, I.I. Belotelov, M.G. Gavrilenko, I.N. Gorbunov, A.Yu. Kamenev, V.Yu. Korsakov, A.V. Lanev, A.I. Malakhov, M.V. Savina, V.V. Shalaev, S.G. Shulga, K.V. Slizhevsky, I.A. Zhizhin, V.A. Zykunov, A.V. Zarubin	

BLTP	M. Deka, G.A. Kozlov, O.V. Teryaev	
MLIT	V.V. Korenkov, G.A. Ososkov, V.V. Palchik, N.N. Voytishin	
GA&C	B.S. Yuldashev	
2. Hadron calorimetry	**A.V. Zarubin**	Maintenance Data taking
VBLHEP	P.D. Bunin, N.S. Golova, Yu.V. Ershov, Kobylets, A.M. Kurenkov	
3. Forward muon station ME1/1	**Yu. Karjavin**	Upgrade Maintenance Data taking
VBLHEP	A.O. Golunov, N.V. Gorbunov, Yu.V. Ershov, A.Yu. Kamenev, A.M. Kurenkov, A.M. Makan'kin, V.V. Perelygin, A.V. Zarubin	
MLIT	V.V. Palchik, N.N. Voytishin	
4. Construction of the high granularity calorimeter	**S.V. Afanasyev**	Realization
4.1 Experemental facility for complex tests of HGCal Cassettes	**S.V. Afanasyev** **A.I. Malakhov**	
4.2 Cooling plates and sensors for the High Granularity Calorimeter	**A.V. Zarubin**	
VBLHE	V.Yu. Alexakhin, P.D. Bunin, Yu.V. Ershov, A.O. Golunov, N.V. Gorbunov, S.V. Kilchakovskaya, A.M. Kurenkov, V.A. Smirnov, E.V. Sukhov, T.V. Trofimov, V.V. Ustinov, N.I. Zamyatin, A.V. Zarubin	
MLIT	A. Khvedelidze, V.V. Korenkov, V.V. Palchik, N.N. Voytishin	
GA&C	B.S. Yuldashev	
5. Development of software for distributed computation, data processing and analysis based on GRID-technology	**V.V. Korenkov**	Realization
MLIT	A.G. Dolbilov, A.O. Golunov, V.V. Korenkov, I.S. Kadochnikov, I.A. Kashunin, V.V. Mitsyn, D.A. Oleynik, G.A. Ososkov, V.V. Palichik, A.Sh. Petrosyan, R.N. Semenov, I. Satyshev, T.A. Strizh, V.V. Trofimov, I.A. Filozova, N.N. Voytishin,	
VBLHEP	I.I. Belotelov, I.N. Gorbunov, N.V. Gorbunov, A.O. Golunov, S.V. Shmatov	

Collaboration

Country or International Organization	City	Institute or Laboratory
Armenia	Yerevan	Foundation ANSL
Austria	Vienna	HEPHY
Belarus	Gomel	GSU
	Minsk	INP BSU
Belgium	Antwerp	UAntwerp
	Brussels	ULB
		VUB
	Ghent	Ugent
	Leuven	KU Leuven
	Louvain-la-Neuve	UCL
	Mons	UMONS
Brazil	Rio de Janeiro, RJ	CBPF
		UERJ
	Sao Paulo, SP	Unesp
Bulgaria	Sofia	INRNE BAS
		SU
CERN	Geneva	CERN
China	Beijing	"Tsinghua"
		IHEP CAS
		PKU
	Hangzhou	ZJU
Croatia	Split	Univ.
	Zagreb	RBI
Cyprus	Nicosia	UCY
Czech Republic	Prague	CU
Estonia	Tallinn	NICPB
Finland	Helsinki	HIP
		UH
	Lappeenranta	LUT
France	Lyon	UL
	Paris	IN2P3
	Saclay	IRFU
	Strasbourg	IPHC
Georgia	Tbilisi	GTU
		HEPI-TSU
Germany	Aachen	RWTH
	Hamburg	DESY
		Univ.
	Karlsruhe	KIT
Greece	Athens	INP NCSR "Demokritos"
		NTU
		UoA
	Ioannina	UI
Hungary	Budapest	Wigner RCP
	Debrecen	Atomki

		UD
India	Chandigarh	PU
	Jatani	NISER
	Kolkata	SINP
	Mumbai	BARC
		TIFR
Iran	Tehran	IPM
Ireland	Dublin	UCD
Italy	Bari	INFN
	Bologna	INFN
	Catania	INFN LNS
	Florence	INFN
	Frascati	INFN LNF
	Genoa	INFN
	Milan	INFN
	Naples	INFN
	Padua	INFN
	Pavia	INFN
	Perugia	INFN
	Pisa	INFN
	Rome	INFN
	Trieste	INFN
	Turin	INFN
Lithuania	Vilnius	VU
Mexico	Mexico City	Cinvestav
	Puebla	BUAP
Montenegro	Podgorica	Univ.
Netherlands	Eindhoven	TU/e
New Zealand	Auckland	Univ.
	Christchurch	UC
Pakistan	Islamabad	QAU
Poland	Krakow	AGH
		AGH-UST
	Otwock (Swierk)	NCBJ
	Warsaw	UW
Republic of Korea	Daejeon	KIST
	Gwangju	CNU
	Seoul	KU
		SJU
		SKKU
		SNU
		Yonsei Univ.
Russia	Dolgoprudny	MIPT
	Gatchina	NRC KI PNPI
	Moscow	ITEP
		LPI RAS
		NIKIET
		NNRU "MEPhI"

		SINP MSU
	Moscow, Troitsk	INR RAS
	Novosibirsk	NSU
	Protvino	IHEP
	Snezhinsk	VNIITF
	St. Petersburg	Electron
	Tomsk	TPU
		TSU
	Zhukovsky	MDB
Serbia	Belgrade	INS "VINCA"
Spain	Madrid	CIEMAT
		UAM
	Oviedo	UO
	Santander	IFCA
Switzerland	Villigen	PSI
	Zurich	ETH
		UZH
Taiwan	Taipei	NTU
	Taoyuan City	NCU
Turkey	Adana	CU
	Ankara	METU
	Istanbul	BU
		YTU
United Kingdom	Bristol	Univ.
	Didcot	RAL
	London	Imperial College
USA	Baltimore, MD	JHU
	Batavia, IL	Fermilab
	Boston, MA	BU
		NU
	Boulder, CO	CU
	Buffalo, NY	UB
	Cambridge, MA	MIT
	Charlottesville, VA	UVa
	Chicago, IL	UIC
	College Park, MD	UMD
	Columbus, OH	OSU
	Davis, CA	UCDavis
	Detroit, MI	WSU
	Evanston, IL	NU
	Gainesville, FL	UF
	Houston, TX	Rice Univ.
	Iowa City, IA	UIowa
	Ithaca, NY	Cornell Univ.
	Knoxville, TN	UTK
	Lawrence, KS	KU
	Lincoln, NE	UNL
	Livermore, CA	LLNL

	Los Angeles, CA	UCLA
	Lubbock, TX	TTU
	Madison, WI	UW-Madison
	Manhattan, KS	KSU
	Minneapolis, MN	U of M
	Nashville, TN	VU
	New Brunswick, NJ	RU NB
	New York, NY	RU
	Notre Dame, IN	ND
	Oxford, MS	UM
	Pasadena, CA	Caltech
	Pittsburgh, PA	CMU
	Princeton, NJ	PU
	Providence, RI	Brown
	Riverside, CA	UCR
	Rochester, NY	UR
	San Diego, CA	SDSU
	Santa Barbara, CA	UCSB
	Tallahassee, FL	FSU
	Tuscaloosa, AL	UA
	Wako, TX	BU
	West Lafayette, IN	Purdue Univ.
Uzbekistan	Tashkent	INP AS RUz

02-0-1085-2009/2023		Priority:	1

Status: Being concluded

Studies of the Nucleon and Hadron Structure at CERN

Leaders: A.V. Guskov
A.P. Nagaytsev

Participating countries and international organizations:

CERN, Czech Republic, France, Germany, India, Israel, Italy, Japan, Poland, Portugal, Russia, Taiwan, USA.

Issues addressed and main goals of research:

Studies of the generalized parton distributions in various exclusive processes. Study of the mechanisms of exclusive production of photons, pions and vector mesons in the processes of deep inelastic scattering of muons on nuclei (DIS) and in processes of deep inelastic virtual Compton scattering (DVCS). Measurements of the polarizability of a pion. Study of the structure of nucleons in Drell-Yan processes. Study of inclusive and semi-inclusive processes in DIS reactions of muons and hadrons on polarized targets.

1. Measurements of the structure functions of a nucleon, polarized parton distributions of nucleons.
2. Measurements of the structure of nucleons in vuon pair production (Drell-Yan, J/Psi).
3. Spin effects in hadron interactions at 0.3-3.0~GeV.
4. Study of the mechanisms of exclusive production of photons, pions and ρρ-mesons in DIS and DVCS processes.
5. Measurement of the Primakoff reactions cross sections.
6. Creation and development of a set of programs for modeling and data processing. System support for CERN software.
7. Preparation of detectors for the COMPASS-II spectrometer.

Expected results in the current year:

1. Measurement of π^0 production in the processes of exclusive deep inelastic scattering of muons on a hydrogen target.
2. Measurements of Collins and Sivers asymmetry on hydrogen and deuterium targets.
3. Measurement of semi-inclusive scattering on hydrogen and deuterium targets with 2 gadrons production.
4. Measurement of transverse spin asymmetries in semi-exclusive scattering processes.
5. Software development and modeling of vaious reactions studied on the COMPASS-II spectrometer. Analysis of data in JINR and preparation of publications.
6. Theoretical studies on the program COMPASS-I and COMPASS-II.
7. Extraction of spin asymmetries from the 2022 run data of Semi-Inclusive Deep-Inelastic Scattering (SIDIS) of muons off transversely polarised ^{6}LiD target.

List of projects

	Project	Leader	Priority (period of realisation)
1.	COMPASS-II	A.P. Nagajtsev	1 (2011-2023)

List of Activities

	Activity or Experiment Laboratory or other Division of JINR Responsible person	Leaders Main researchers	Status
I.	**Experiment COMPASS-II**	**A.P. Nagaytsev**	Data taking Data analysis
1.	**Hadron calorimeter**	**O.P. Gavrishchuk**	Maintenance
	VBLHEP	V.A. Anosov	
	DLNP	A.S. Selyunin, A.V. Rybnikov	
2.	**Electromagnetic calorimeter**	**A.P. Nagaytsev** **N.V. Anfimov**	Maintenance
	VBLHEP	V.A. Anosov, O.P. Gavrishchuk	
	DLNP	A.I. Antoshkin, A.V.Guskov, V.M. Kudryavtsev, A.G. Olshevskiy, A.V. Rybnikov, A.S. Selyunin, I.E. Tchirikov-Zorin, V.N.Frolov	
3.	**Muon system**	**G.D. Alekseev**	Maintenance
	DLNP	V.M. Abazov, G.A. Golovanov, A.A. Piskun, A.G. Samartsev, V.V. Tokmenin, L.S. Vertogradov, N.I. Zhuravlev	
4.	**System of the data taking**	**V.N. Frolov**	Maintenance
5.	**Software devlopment. Data analysis**	**E.V. Zemlyanichkina** **A.V. Guskov**	Realization
	VBLHEP	R.R. Akhunzyanov, R. Gushcherski, A.V. Ivanov, Yu.I. Ivanshin, O.M. Kuznetsov, A.P. Nagaytsev, N.S. Rogacheva, D.V. Peshekhonov, I.A. Savin, E.A. Salmina	
	DLNP	N.V. Anfimov, A.I. Antoshkin, A.O. Gridin, I.I. Denisenko, A. Maltsev, A.G. Olshevskiy, A.V. Rybnikov, A.S. Selyunin	
	MLIT	P.V. Zrelov, A.Sh. Petrosyan	
6.	**Measurements of generalized parton distributions**	**A.P. Nagaytsev** **A.V. Guskov** **I.A. Savin**	Realization
	VBLHEP	R.R. Akhunzyanov, R. Guscherski, G.V, O.M. Kuznetsov, N.S. Rogacheva, V.D. Peshekhonov, E.A. Salmina, O.V. Teryaev, E.V. Zemlyanichkina	
	DLNP	I.I. Denisenko, A. Maltsev, A.G. Olshevskiy	
	BLTP	O.V. Teryaev	
7.	**Studies of Drell-Yan processes**	**A.V. Guskov**	Realization
	DLNP	I.I. Denisenko, A.O. Gridin, A. Maltsev	
8.	**Spin effects in hadron interactions at 0.3-3.0 GeV**	**A.V. Kulikov** **D.A Tsirkov**	Data processing
	DLNP	T.I. Azaryan, S.N. Dymov, V.I. Komarov, V.S. Kurbatov, Zh. Kurmanaliev, A. Kunsafina, V.V. Shmakov, Yu.N. Uzikov, B.Zh. Zalikhanov	

9. Studies of semi-inclusive reactions	**I.A. Savin** **E.V. Zemlyanichkina**	Realization
VBLHE	A.V. Ivanov, Yu.I. Ivanshin, S.R. Gevorgyan, N.S. Rogacheva, E.A. Salmina	
II. Theoretical studies	**O.V. Teryaev**	Realization
BLTP	S.B. Gerasimov, A.V. Kotikov, A.M. Sidorov	
III. Exploring fundamental properties of hadrons at AMBER experiment	**A.V. Guskov**	Realization
DLNP	G.D. Alexeev, I.I. Denisenko, V.N. Frolov, A. Gongadze, M.I. Gostkin, A.O. Gridin, N.A. Kovyazina, V.G. Kruchonok, A. Maltsev	
VBLHEP	V.A. Anosov, O.P. Gavrishchuk, R.I. Gushterski, A.Yu. Korzenev, O.M. Kouznetsov, I.A. Savin, E.V. Zemlyanichkina	

Collaboration

Country or International Organization	**City**	**Institute or Laboratory**
CERN	Geneva	CERN
Czech Republic	Brno	BUT
	Liberec	TUL
	Prague	CU
France	Saclay	SPhN CEA DAPNIA
Germany	Bochum	RUB
	Bonn	UniBonn
	Freiberg	TUBAF
	Mainz	JGU
	Munich	TUM
India	Kolkata	MIERE
Israel	Tel Aviv	TAU
Italy	Trieste	INFN
	Turin	INFN
Japan	Yamagata	Yamagata Univ.
Poland	Otwock (Swierk)	NCBJ
	Warsaw	WUT
Portugal	Aveiro	UA
	Lisbon	LIP
Russia	Moscow	LPI RAS
	Protvino	IHEP
	Tomsk	TPU
Taiwan	Taipei	AS
USA	Urbana, IL	I

02-1-1086-2009/2023		Priority:	1
		Status:	Being concluded

Strangeness in Hadronic Matter and Study of Inelastic Reactions Near Kinematical Borders

Leaders: E.A. Strokovsky
E.S. Kokoulina
D.O. Krivenkov

Participating countries and international organizations:

Belarus, Czech Republic, Japan, Russia, Slovakia, Ukraine.

Issues addressed and main goals of research:

Strangeness in hadronic matter and study of boundary effects:

– study of stabilizing effects of strangeness in nuclear matter and properties of the lightest hypernuclei;

– study of multi-particle dynamics in the inelastic proton-proton and proton-nucleus interactions with extremally high multiplicity;

– study of spectra and yields of soft photons in the deuteron-nucleus and nucleus-nucleus interactions.

Expected results:

1. Experimental conclusion about the existence of the hypernucleus $^{6}_{\Lambda}$H.
2. New experimental data on the properties of the lightest hypernuclei and experimental verification of corresponding theoretical models for these hypernuclei.
3. New experimental data on the drip-line location for loosely bound light hypernuclei with high neutron excess, necessary for the development of the theory of neutron-rich hypernuclei and models of their production in non-central nucleus-nucleus interactions.
4. New experimental data on the production of strangeness and vector mesons (including those, containing strange quarks) by polarized photons (close to the relevant thresholds).
5. Measurement of the measured energy spectra of gamma-quanta (in the energy range up to several MeV), produced in the interactions of different nuclear beams (from deuterium to heavy nuclei) of Nuclotron with various nuclear targets, with theoretical predictions depending on the multiplicity of charged and neutral particles, as well as on the photon emission angle; verification of various physical hypotheses about the mechanisms of production of "direct" photons in the nuclear interactions.
6. Production of an electromagnetic calorimeter prototype for detecting soft photons and testing it on the “Alpom” facility and the “MiniSPD” test bench.

Expected results in the current year:

1. Data taking for $^{6}_{\Lambda}$H search using beam of ^{7}Li nuclei. Analysis of the first experimental data for the $^{6}_{\Lambda}$H search and for the measurements of hyperhydrogen isotopes $^{6}_{\Lambda}$H and $^{4}_{\Lambda}$H lifetimes.
2. Upgrade of the HyperNIS magnetic spectrometer (tracking system) by adding the planes of GEM detectors. These detectors, which have already been (partially) purchased and are being tested at the HyperNIS setup by staff, will be integrated into this setup to improve accuracy of the hypernucleus decay vertex determination. Preparation of a project for joint experiments with SRC, integration of detectors, development of a technical design for a spectrometer with two magnets (installations of a second magnet, supply of communications, supports for detectors), common data acquisition systems (design and tests), MC for the optimal geometry of joint detectors.
3. Within the collaboration with Japan: data taking at LEPS/LEPS2 setups on the production of strangeness and vector mesons (including those, containing strange quarks) by polarized photons (close to the relevant thresholds); analysis of data on such reactions, taken before.

4. Development of silicon photomultipliers (SiPM) for a compact soft photon spectrometer based on the Gadolinium Gallium Garnet (GaGG:Ce). Investigation of the percentage ratio of the Cu-W components of the composite material as radiators of the soft photon calorimeter. Manufacture of silicon photomultipliers (SiPM) at "Integral" holding (Minsk). Development and manufacture of a calibration device based on a picosecond solid-state laser in cooperation with the PFP Research Institute (Minsk).
5. Participation in the simulation of the calorimeter use in the SPD setup for the task of direct photon registration, within the development of the SPD physical program with polarized beams of light nuclei and protons. Participation in works on simulation of the polarimeters (to be created) for experiments with polarized beams at the VBLHEP accelerator complex.
6. Preparing a new project to replace the one being completed.
7. Comparison of the average of the transverse and longitudinal momentum components of charged particles as a function of multiplicity. Determination of the critical multiplicity at which the components become indistinguishable and establishing its connection with the pion condensate region.

List of Activities

	Activity or Experiment Laboratory or other Division of JINR Responsible person	**Leaders** Main researchers	**Status**
1.	**Experiment NIS-GIBS**	**E.A. Strokovsky** **J. Lukstins** **D.O. Krivenkov**	Realization Data taking
	VBLHE	V.D. Aksinenko, M.H. Anikina, T. Atovullaev, A.V. Averyanov, A.N. Bayeva, S.N. Bazylev, A.E. Baskakov, D.V. Dementiev, A.A. Feschenko, A.A. Fedyunin, A.I. Filippov, S.V. Gertsenberger, A.M. Korotkova, Yu.A. Murin, S. Nepochatykh, O.V. Okhrimenko, S.N. Plyashkevich, N.G. Parfenova, M. Patsyuk, P.A. Rukoyatkin, A.V. Shipunov, M.O. Shitenkov, A.D. Sheremetiev, I.V. Slepnev, V.M. Slepnev, N.A. Tarasov, A.V. Terleskiy, A.L. Voronin	
	DLNP	B.A. Popov, V.V. Tereschenko, S.V. Tereschenko	
	OCE	A.N. Parfenov	
2.	**Experiment NEMAN**	**E.S. Kokoulina** **V.A. Nikitin**	Project preparation Data taking
	VBLHEP	V.P. Balandin, N. Barlykov, Yu.T. Borzunov, V.B. Dunin, V. Dudin, O.P. Gavrischuk, V.Yu. Ivanenko, A.V. Konstantinov, D.A. Kirillov, R.I. Kukushkina, Yu.P. Petukhov, V.V. Popov, I.A. Rufanov, M.V. Tokarev, S.Yu. Sinelcshikova, V.A. Zykunov	
	BLTP	Yu.A. Bystritsky	

Collaboration

Country or International Organization	**City**	**Institute or Laboratory**
Belarus	Gomel	GSTU
		GSU
	Minsk	"INTEGRAL"
		"Radateh"
		BSUIR
		IAP NASB
		INP BSU
		IP NASB

Czech Republic	Prague	CTU
		CU
Japan	Osaka	RCNP
Russia	Chernogolovka	ISSP RAS
	Moscow	"Azimuth-Photonics"
		"FOMOS-MATERIALS"
		NNRU "MEPhI"
		SINP MSU
	Moscow, Zelenograd	RIMST
	Protvino	IHEP
	St. Petersburg	SPbSPU
	Syktyvkar	DM Komi SC UrB RAS
Slovakia	Banska Bistrica	UMB
Ukraine	Kiev	BITP NASU

02-0-1065-2007/2023		Priority:	1
		Status:	Being concluded

NICA Complex: Design and Construction of the Complex of Accelerators, Collider and Physics Experimental Facilities at Extracted and Colliding Ion Beams Aimed at Studying Dense Baryonic Matter and the Spin Structure of Nucleons and Light Ions, and at Carrying out Applied and Innovation Projects

Leaders: V.D. Kekelidze
A.S. Sorin
G.V. Trubnikov

Deputies: A.V. Butenko
V.M. Golovatyuk
M.N. Kapishin

Participating countries and international organizations:

Armenia, Australia, Azerbaijan, Belarus, Bulgaria, CERN, Chile, China, Cuba, Czech Republic, Egypt, France, Georgia, Germany, Israel, Italy, Japan, Mexico, Moldova, Mongolia, Poland, Romania, Russia, Serbia, Slovakia, South Africa, Sweden, Ukraine, USA.

Issues addressed and main goals of research:

Search and investigation of phase transitions in strongly interacting nuclear matter at extremely high baryon densities, study of the nucleon spin structure, of light nuclei and polarization phenomena in few nucleon systems. Development of theoretical models of the studied processes and theoretical support of the experiments. Development of the Nuclotron accelerator complex as a basic facility for studying relativistic nuclear collisions in the range of atomic masses A = 1÷197. Investigation of reaction dynamics and studing modifications of hadron properties in nuclear matter, near-threshold strange hyperons production and search for hyper nuclei in interactions of the Nuclotron extracted ion beams with fixed targets at the BM@N detector. Investigation of the nuclear structure at short internucleon distances at the BM@N detector. Development and stage-by-stage creation of the NICA heavy ion collider accelerator complex, the multi-purpose detector (MPD/NICA) and spin physics detector (SPD/NICA) for experiments with colliding heavy ions beams. Modernization of extraction beam lines. Carrying out of experiments with ion beams and polarized proton and deuteron beams at the Nuclotron. Development of the infrastructure for applied research at NICA heavy ion beams.

Expected results in the current year:

1. Development and expansion of the physical programme presented in the "White Paper" of the NICA project. Obtaining new theoretical results for processes of strong interactions in the non-perturbative QCD region, development and tests of models for nuclear matter properties descriptions at extremely high temperatures and densities, investigation of possible nuclear matter states and nuclear collision dynamics at extreme baryonic densities as well as observation of these phenomena in P-odd effects and spin asymmetries.
2. Completion of the planned tasks within the Nuclotron-NICA project: assembly and testing of the main subsystems. Development of beam diagnostics systems. Increasing the intensity of the beam from the SPI polarized particle source. Preparation of the Nuclotron for solving first-priority tasks of the NICA program within available running time. Technical design on the SC resonator prototype for the proton linacs. Design of new proton and light ion linear accelerator LILAC.

3. Commissioning of the HILAC linear accelerator ($z/A \geq 0.14$), achieving its design parameters. Development and upgrade of the engineering infrastructure. The Booster tests and physics beam runs.
4. Tests of the elements of the beam extraction and transportation system from the Booster to Nuclotron. Manufacturing the elements of beam transfer system from Nuclotron to Collider.
5. Completion of the tunnel building works for installation the NICA collider elements and systems.
6. Preparing the BM@N set-up for the physics run with a heavy ion beam extracted from the Nuclotron. New data collection with a heavy ion beam at BM@N. Analysis of new experimantal data collected at BM@N.
7. Construction and tests of the MPD setup systems in accordance with the work schedule. Serial production of the start option detectors.
8. Preparation of the technical project of the SPD experiment. Development of the physics motivation, modeling, optimization of the set-up configuration, including continuation of theoretical studies of charmonia production processes in polarized proton and deuteron collisions.
9. Increase in computing power of the NICA computing cluster and upgrade of its infrastructure.
10. Completion of manufacturing and tests the NICA lattice collider magnetic system elements.
11. Put the new cryogenic-compressor station and cryogenic facilities in building 1b.
12. Reconstruction of the Measuring hall for the applied channels system.
13. Completion of equipment installation at applied research channels, at the station for irradiation of electronic components and biological objects with long-range ions and at the station for irradiation of electronic components with low-energy ions.
14. Expert assessment of the technology solutions used during development of the beamlines for applied research, of stations for irradiating electronic components and biological objects with long-range ions and of stations for irradiating electronic components with low-energy ions. Formulation of proposals for the development of beamlines and irradiation stations for applied research.
15. Preparation of the program of the first experiments on beamlines for irradiation of electronic components and biological objects.

List of projects

	Project	Leader	Priority (period of realisation)
1.	Nuclotron-NICA	A.V. Butenko G.G. Khodzhibagiyan Scientific leader: I.N. Meshkov	1 (2011-2023)
2.	BM@N	M.N. Kapishin	1 (2012-2026)
3.	MPD	V.M. Golovatyuk V.D. Kekelidze	1 (2011-2025)
4.	SPD	A.V. Guskov Deputy: V.P. Ladygin	1 (2020-2023)

List of Activities

	Activity or Experiment	Leaders	Status
	Laboratory or other Division of JINR Responsible person	Main researchers	
1.1.	**NICA injection complex: technical design preparation and construction of the NICA injection complex:(sources of heavy ions and polarized light nuclei, HILAC linear accelerators of heavy ions and light nuclei of beam transporting to the Nuclotron)**	**A.V. Butenko** **V.A. Monchinsky** **E.M. Syresin** **A.V. Tuzikov**	Realization
1.1.a.	**Commissioning of the heavy ion source (KRION)**	**E.E. Donets**	Realization
1.1.b.	**Upgrade the polarized proton and deuteron source (SPI)**	**V.V. Fimushkin** **R.A. Kuzyakin**	Realization
1.1.c.	**Development and construction of the beam injection systems and beam transportation channels. Development of the beam control and diagnostics systems**	**D.E. Donets** **E.V. Gorbachev** **A.V. Tuzikov** **V.I. Volkov**	Realization
1.1.d.	**Design and start of construction the new proton and light ion injector LILAC**	**A.V. Butenko** **K.A. Levterov** **B.V. Golovensky** **E.M. Syresin**	Realization
	VBLHEP	M.Yu. Averyanov, V.S. Alexandrov, A.V. Alfeev, V.P. Akimov, V.A. Andreev, A.M. Bazanov, A.Yu. Boytsov, E.A. Butenko, A.A. Fateev, A.R.Galimov, N.I. Garanzha, A.G. Kobets, V.V. Kobets, V.N. Karpinsky, O.S. Kozlov, S.Yu. Kolesnikov, A.E. Kirichenko, M.V.Kulikov, L.V. Kutuzov, R.A.Kuzyakin, D.A. Lyuosev, A.A. Martynov, S.V. Mikhaylov, V.V. Myalkovsky, A.V. Nesterov, K.G.Osipov, R.V. Pivin, D.O. Ponkin, Yu.V. Prokof'ichev, A.Yu. Ramzdorf, D.N. Rassadov, S.V. Romanov, G.S. Sedykh, V.V. Seleznev, A.O. Sidorin, I.V. Shirikov, V.B. Shutov, V.V. Tarasov, A.V. Tuzikov, A.A. Voronin, A.V. Zakharov	
	GA&C	G.V. Trubnikov	
1.2.	**Assembling and start-up of the NICA Booster and its technological systems**	**A.V. Butenko** **G.G. Khodzhibagiyan** **I.N. Meshkov** **E.M. Syresin** **A.O. Sidorin**	Realization
1.2.a.	**Magnet cryostat system, vacuum system, system of electron cooling**	**A.R. Galimov** **A.O. Sidorin**	Realization
1.2.b.	**Power supply and energy evacuation system**	**E.V. Ivanov** **V.N. Karpinsky**	Projecting Realization

1.2.c. RF accelerating system of the Booster	**O.I. Brovko**	Realization
1.2.d. Diagnostics, injection, correction of optics, beam extraction and transport systems	**A.V. Tuzikov** **V.I. Volkov**	Projecting Realization
VBLHEP	N.N. Agapov, A.S. Averichev, M.Yu. Averiyanov, V.A. Andreev, R.V. Andryukhin, A.V. Alfeev, A.M. Bazanov, A.A. Baldin, V.I. Batin, A.N. Beloborodov, D.N. Bogoslovsky, V.P. Chernyaev, D.E. Donets, V.M. Drobin, V.N. Emelianenko, G.E. Ivanov, A.A. Fateev, S.A. Goncharov, E.V. Gorbachev, A.Yu. Grebentsov, I.L. Guryleva, A.A.Fateev, A.V.Filippov, O. Kazinova, P.R.Kharyuzov, A.E. Kirichenko, H.G. Khodzhibagiyan, S.A. Korovkin, O.S. Kozlov, S.Yu. Kolesnikov, A.V. Konstantinov, S.A. Kostromin, M.A. Korobitsyna, A.I.Korobkov, V.V. Kosachev, E.V. Kostyukhov, A.V. Kudashkin, G.L. Kuznetsov, E.A. Kulikov, O.A. Kunchenko, N.I. Lebedev, A.V. Lushin, S.V. Mikhaylov, V.A. Mikhaylov, V.V. Myalkovsky, A.V. Nesterov, D. N.Nikiforov, A.L. Osipenkov, K.G.Osipov, A.V. Peltikhin, M.V. Petrov, G.A. Petrovsky, R.V. Pivin, N.V. Pilyar, O.V. Prozorov, S.V. Romanov, P.A. Rukoyatkin, T.V. Rukoyatkina, A.B. Safronov, N.V. Semin, G.S. Sedykh, V.V. Seleznev, A.S. Sergeev, A.V. Shabunov, M.M. Shandov, V.S.Shvetsov, A.A. Shurygin, A.I. Sidorov, Z.I. Smirnova, A.N. Svidetelev, V.V. Tarasov, A.M. Tikhomirov, N.D. Topilin, Yu.A. Tumanova, V.I. Tyulkin, B.V. Vasilishin, A.I. Zagrai, A.Yu. Zakharov	
DLNP	E.V. Akhmanova, V.I. Hilinov, O.S. Orlov, A.Yu. Rudakov, N.A. Rybakov, L.V. Soboleva, A.A. Sidorin, S.L. Yakovenko	
GA&C	G.V. Trubnikov	
1.3. Development of the Nuclotron	**A.V. Butenko** **A.O. Sidorin** **E.M. Syresin**	Projecting Realization
1.3.a. Magnet cryostat system, vacuum system	**A.R.Galimov**	Projecting Realization
1.3.b. Power supply and energy evacuation system	**E.V. Ivanov** **V.N. Karpinsky**	Projecting Realization
1.3.c. RF accelerating system of the Nuclotron	**O.I. Brovko**	Projecting Realization
1.3.d. Diagnostics, injection, correction of optics, beam extraction and transportation systems	**E.V. Gorbachev** **P.A. Rukoyatkin** **V.I. Volkov**	Projecting Realization
VBLHEP	S.Yu. Anisimov, A.S. Averichev, M.Yu. Averiyanov, V.A. Andreev, R.V. Andryukhin, A.V. Alfeev, A.M. Bazanov, V.V. Batin, V.V. Borisov, V.P. Chernyaev, D.E. Donets, A.A.Fateev, A.V.Filippov, A.Yu. Grebentsov, S.A. Goncharov, I.V. Gorelyshev, S. Gusev, G.E. Ivanov, A.E. Kirichenko, G.G. Khodzhibagiyan, A.I. Korobkov, O.S. Kozlov, S.Yu. Kolesnikov, N.G. Kondratiev, A.V. Konstantinov, A.V. Kopchenov, V.V. Kosachev, S.A. Kostromin, A.V. Kudashkin, G.L. Kuznetsov, O.A. Kunchenko, N.I. Lebedev, S.V. Mikhaylov, V.A. Mikhaylov, A.V. Merkuriev, D.V. Monakhov, V.V. Myalkovsky, A.V. Nesterov, A.L. Osipenkov, K.G. Osipov, G.A. Petrovsky, R.V. Pivin, O.V. Prozorov, S.V. Romanov, N.V. Semin, G.S. Sedykh, V.V. Seleznev, A.S. Sergeev, V.S. Shvetsov, A.I. Sidorov, A.A. Shurygin, V.V. Tarasov, A.V. Tuzikov, V.B Vasilishin, A.Yu. Zakharov	

1.4.	**Technical design, R&D of technological systems and construction of the NICA heavy ion collider with an energy of E_{CM}= 4-11 GeV and an average luminosity of $1 \cdot 10^{27}$ см $^{-2}$с $^{-1}$ and light polarised nuclei with a luminosity of $1 \cdot 10^{32}$ см $^{-2}$с $^{-1}$ (by protons, at E_{CM}=27 GeV)**	**S.A. Kostromin** **V.A. Lebedev** **I.N. Meshkov** **A.O. Sidorin** **E.M. Syresin**	Projecting Realization
1.4.a.	**Magnet cryostat and vacuum systems**	**A.R. Galimov** **G.G. Khodzhibagiyan**	Realization
1.4.b.	**Power supply and energy evacuation system**	**E.V. Ivanov** **V.N. Karpinsky**	Realization
1.4.c.	**RF system of the Collider**	**O.I. Brovko** **A.Yu. Grebentsov**	Projecting Realization
1.4.d.	**Beam diagnostics, injection and transportation systems**	**A.V. Tuzikov** **V.I. Volkov**	Projecting Realization
1.4.e.	**Beam cooling systems**	**A.O. Sidorin**	Projecting Realization
1.4.f.	**Systems of proton and deuteron polarization monitoring and control**	**S.A. Kostromin**	Projecting Realization
	VBLHEP	S.A. Arefiev, N.N. Agapov, V.S. Alexandrov, A.V. Alfeev, V.A. Andreev, R.V. Andryukhin, A.S. Averichev, A.M. Bazanov, V.I. Batin, N.A. Blinov, O.I. Brovko, V.V. Borisov, S.A. Dolgy, A.M. Donyagin, V.M. Drobin, A.V. Eliseev, A.A. Fateev, A.V. Filippov, M.N. Filippov, N.A. Filippov, V.V. Fimushkin, O.M. Golubitsky, S.A. Goncharov, E.V. Gorbachev, I.V. Gorelyshev, Yu.V. Gusakov, G.E. Ivanov, I.E. Karpunina, M.A. Kashunin, H.G. Khodzhibagiyan, A.E. Kirichenko, S.V.Kirov, O.S. Kozlov, N.G. Kondratiev, A.V. Konstantinov, A.V. Kopchenov, A.I. Korobkov, S.A. Korovkin, V.V. Kosachev, A.V. Kudashkin, P.I. Kudryashov, E.A. Kulikov, M.V. Kulikov, O.A. Kunchenko, L.V. Kutuzov, G.L. Kuznetsov, R.A. Kuzyakin, N.I. Lebedev, A.A. Makarov, D.V. Monakhov, D.N. Nikiforov, A.M. Nikitin, E.A. Negey, A.V. Nesterov, A.L. Osipenkov, K.G. Osipov, M.V. Petrov, G.A. Petrovsky, R.V. Pivin, O.V. Prozorov, S.V. Romanov, P.A. Rukoyatkin, T.V. Rukoyatkina, N.V. Semin, M.M. Shandov, A.V. Shemchuk, E.V. Shevtchenko, V.M. Shumkov, A.A. Shurygin, A.O. Sidorin, A.I. Sidorov, S.A. Smirnov, Z.I. Smirnova, E.M. Syresin, A.N. Scherbakov, A.L. Svetov, V.S. Shvetsov, V.V. Tarasov, A.M. Tikhomirov, N.D. Topilin, G.V. Trubnikov, Yu.A. Tsvetkova, Yu.A. Tumanova, B.V. Vasilishin, A.I. Zagray, A.Yu. Zakharov, V.M. Zhabitsky, A.G. Zorin	
	DLNP	E.V. Akhmanova, V.I. Khilinov, O.S. Orlov, A.Yu. Rydakov, N.A. Rybakov, L.V. Soboleva, T.A. Stepanova, A.A. Sidorin, S.L. Yakovenko	
	LRB	G.N. Timoshenko	
	DRB	V.N. Buchnev, V.Yu. Schegolev	

1.5.	**R&D, construction and development of cryogenic systems**	**N.N. Agapov** **G.G. Khodzhibagiyan**	Projecting Realization
	VBLHEP	A.B. Arefiev, V.I. Batin, N.A. Baldin, M.A. Basheva, D.M. Belov, Yu.T. Borzunov, V.M. Drobin, N.L. Egorova, N.E. Emelyanov, E.Yu. Filippova, I.N. Goncharov, S.P. Gorelikov, E.V. Gromova, S.V. Gudkov, E.Yu. Ivanenko, E.V. Ivanov, M.V. Kondratiev, K.K. Kozlovski, A.V. Konstantinov, V.A. Kosinov, E.A. Kulikov, D.V. Lobanov, Yu.A. Mitrofanova, V.V. Orlov, I.M. Petrov, R.V. Peshkov, S.A. Sidorov, S.A. Smirnov, E.I. Vorobiev, O.B. Yarovikova	
2.	**BM@N project**	**M.N. Kapishin**	Realization
2.1.	**Development of the operational area of the setup: increasing the radiation protection, improving detector subsystems and engineering infrastructure**	**S.Yu. Anisimov** **M.N. Kapishin** **S.M. Piyadin**	Realization
2.2.	**Construction of the basic detector complex of the BM@N setup**	**M.N. Kapishin** **A.I. Maksymchuk**	Realization
2.3.	**Development of the technological and engineering systems, control systems and test areas of the setup**	**S.Yu. Anisimov** **S.M. Piyadin** **N.D. Topilin**	Realization
	VBLHEP	Kh.U. Abraamyan, G.N. Agakishiev, S.V. Afanasiev, K.A. Alishina, T.A. Atovullaev, V.A. Babkin, D.A.Baranov, P.N. Batyuk, S.N. Bazylev, D.N. Bogoslovsky, M.G. Buryakov, S.G. Buzin, A.I. Chebotov, B. Dabrovska, D.V. Dementiev, A.V. Dmitriev, P.O. Dulov, D.K. Dryablov, D.S. Egorov, V.V. Elsha, A.A. Fedyunin, I.A. Filippov, I.R. Gabdrakhmanov, A.V. Galavanov, O.P. Gavrischuk, K.V. Gertsenberger, V.M. Golovatyuk, M.N. Kapishin, V.Yu. Karzhavin, R.R. Kattabekov, V.D. Kekelidze, Yu.T. Kiryushin, S.V. Khabarov, Yu.S. Kovalev, V.I. Kolesnikov, A.A.Kolozhvari, Yu.A. Kopylov, L.D. Kovachev, A.S. Kuznetsov, S.N. Kuklin, E.M. Kulish, E.A. Ladygin, N.A. Lashmanov, V.V. Lenivenko, A.M. Makan'kin, A.I. Maksimchuk, A.I. Malakhov, S.P. Merts, A.N. Morozov, Yu.A. Murin, R.V. Nagdasev, D.N. Nikitin, S.V. Novozhilov, M.A. Patsyuk, Yu.P. Petukhov, S.M. Piyadin, V.A.Plotnikov, V.Yu. Rogov, P.A. Rukoyatkin, M.M. Rumyantsev, I.A. Rufanov, D.G. Sakulin, S.A.Sedykh, S.V. Sergeev, A.D. Sheremetiev, A.I. Sheremetieva, M.O. Shitenkov, A.S. Sorin, V.N. Spaskov, Yu.Yu. Stepanenko, E.A. Streletskaya, D.A. Suvarieva, I.V. Slepnev, V.M. Slepnev, I.P. Slepov, B.V. Sukhov, M.O. Shitenkov, A.V. Shutov, V.B. Shutov, A.V. Schipunov, N.D. Topilin, B.L. Topko, Yu.A. Topko, N.A. Tarasov, O.G. Tarasov, A.V. Terletsky, V.V. Teryaev, V.V. Tikhomirov, A.A. Timoshenko, N.D. Topilin, I.A. Tyapkin, V.A. Vasendina, A.V. Vishnevsky, A.A.Voronin, V.I. Yurevich, N.I. Zamyatin, V.N. Zhezher, A.I. Zinchenko, E.V. Zubarev	
	MLIT	E.I. Alexandrov, I.N. Alexandrov, N.A. Balashov, I.A. Filozova, Zh.Zh. Musulmanbekov, V.V. Palichik, I.S. Pelevaniuk, D.V. Podgainy, O.I. Streltsova, N.N. Voytishin, M.I. Zuev	
	FLNP	E.I. Litvinenko	
	BLTP	M. Baznat, A.S. Khvorostukhin	
2.4.	**Analysis of BM@N experimantal data and feasibility studies for BM@N program in heavy ion beams**	**M.N. Kapishin** **A.I. Zinchenko**	Realization
3.	**MPD project**	**V.M. Golovatyuk** **V.D. Kekelidze** **V.G. Ryabov**	Realization

	VBLHEP	S.V. Afanasev, G.N. Agakishiev, N.V. Anfimov, A.A. Aparin, V.I. Astakhov, S.V. Andreeva, T.V. Andreeva, G.S. Averichev, A.V. Averiyanov, V.A. Babkin, I.A. Balashov, M.Yu. Barabanov, D.A. Baranov, A.E. Baskakov, P.N. Batyuk, A.G. Bazhazhin, S.N. Bazylev, A.V. Belyaev, E.V. Belyaev, S.E. Beleaev, V. Benda, D.N. Bogoslovsky, I.V. Boguslavsky, M.G. Buryakov, A.V. Butorin, A.V. Bychkov, S.G. Buzin, V.V. Chalyshev, V.A. Cheplakova, V.V. Chepurnov, V.F. Chepurnov, G.A. Cheremukhina, P.V. Chumakov, B. Dabrovska, D. Dabrovsky, D.V. Dementiev, A.V. Dmitriev, V.Kh. Dodokhov, E.V. Dolbilina, A.G. Dolbilov, D.E. Donets, A.Yu. Dubrovin, P.O. Dulov, N.V. Dunin, V.B. Dunin, V. Dyatlov, A.A. Efremov, D.S. Egorov, V.V. Elsha, A.E. Emelianov, N.E. Emelianov, O.V. Fateev, Yu.I. Fedotov, A.A. Fedyunin, I.A. Filippov, M.A.Gaganova, T.T.Gandzhelashvili, I.V. Gapienko, O.P. Gavrischuk, K.V. Gertsenberger, N.V.Gorbunov, A.V. Ivanov, A.Yu. Isupov, S.I. Kakurin, M.N. Kapishin, L.A. Kartashova, G.D. Kekelidze, A.O. Kechechan, V.A. Kireev, Yu.T. Kiryushin, I.S. Kiryutin, H.G. Khodzhibagiyan, V.I. Kolesnikov, A. Kolozhvari, V.G. Komarov, E.V. Kozhin, V.A. Kramarenko, L.M. Krasnova, Yu.F. Krechetov, I.V. Kruglova, A.V.Krylov, S.I. Kukarnikov, S.N. Kuklin, E.A. Kulikov, N.A. Kozlenko, V.S. Kuz'min, N.A. Lashmanov, R. Lednicky, A.G. Litvinenko, G.N. Litvinova, A.N. Livanov, V.I. Lobanov, Yu.Yu. Lobanov, S.N. Lobastov, Yu. Lukstin'sh, D.T. Madigozhin, V.I. Maksimenkova, A.I. Malakhov, I.V. Malikov, L.V. Malinina, D.G. Melnikov, S.P. Merts, I.N. Meshkov, I.I. Migulina, Yu.I. Minaev, S.A. Movchan, N.A. Molokanova, A.E. Moskovsky, A.A. Moshkin, I.V. Moshkovsky, A.A. Mudrokh, Yu.A. Murin, K.A. Mukhin, D. Myktybekov, E.N. Nazarova, A.V. Nechaevsky, V.A. Nikitin, I.A. Oleks, O.E. Orlov, S.S.Parzhitsky, V.A. Pavlyukevich, V.A. Penkin, V.A. Petrov, D.V. Peshekhonov, N.V. Pilyar, S.M. Piyadin, A.E. Potanina, S.V. Razin, N.O. Ridinger, O.V. Rogachevsky, V.Yu. Rogov, K. Roslon, M.M. Rumyantsev, I.A. Rufanov A.A. Rybakov, A.A. Rymshina, Z.Ya-O. Sadygov, V.M. Samsonov, A.A. Savenkov, S, Sebalos Sanches, S.A.Sedykh, T.V. Semchukova, A.Yu. Semenov, I.A. Semenova, S.V. Sergeev, N.A. Sergeeva, E.V. Serochkin, A.O. Sidorin, I.P. Slepov, V.M. Slepnev, I.V. Slepnev, Yu.A. Solnyshkin, A.S. Sorin, E.A. Streletskaya, N.V. Sukhov, S.I. Sukhovarov, N.N. Surkov, V.L. Svalov, A.V. Shabunov, A.D. Sheremetiev, A.I. Sheremeteva, R.A. Shindin, M.O. Shitenkov, K. Shtejer Dias, A.A.Shunko, A.B. Shutov, V.B. Shutov, A.N.Scherbakov, B.G. Schinov, A.V. Schipunov, N.A. Tarasov, A.V. Terletsky, O.V. Teryaev, A.A. Timoshenko, V.V. Tikhomirov, G.P. Tkachev, N.D. Topilin, A.V. Trubnikov, I.A. Tyapkin, S.Yu. Udovenko, V.A. Vasendina, I.N. Vasilev, S.V. Vereschagin, N.V. Vlasov, A.S. Vodopiyanov, O.A. Volodina, A.A. Voronin, G.A. Yarygin, M.V. Zaitseva, N.I. Zamyatin, S.A. Zaporozhets, A.I. Zinchenko, D.A. Zinchenko, V.N. Zryuev
	DLNP	A.V. Guskov, A.G. Olshevsky
	MLIT	V.V. Ivanov, Zh.Zh. Musulmanbekov, T.A. Strizh
	FLNP	E.I. Litvinenko
3.1.	**Design and construction of the superconducting solenoid and magnet yoke**	**K.A. Mukhin** **N.D. Topilin**
	VBLHEP	R.V. Baratov, I.A. Smelyansky, A.E. Emelyanov, D.A. Tereshin, G.P. Tkachev, S.E. Gerasimov, V.A. Novoselov, T. Smolyanin, Yu.Yu. Lobanov, A.A. Efremov, S.E. Belyaev, E.V. Belyaeva, R. Shindin
3.2.	**Construction of the detector complex of the start configuration of the MPD setup**	**V.M. Golovatyuk** **V.D. Kekelidze**
	VBLHEP	V.A. Babkin, C.N. Bazylev, A. Ivashkin, S.A. Movchan, Yu.A. Myrin, I.A. Tyapkin, N.D. Topilin, V.I. Yurevich

Realization

Realization

3.3.	**Design and creation of the data acquisition and control systems**	**S.N. Bazylev** **I.V. Slepnev**	Realization
	VBLHEP	A.E. Baskakov, A.A. Fedyunin, I.A. Filippov, S.N. Kuklin, V.M. Slepnev, N.A. Tarasov, A.V. Terletsky, A.B. Shutov, A.V. Schipunov	
3.4	**Development of MPD physical program**	**V.G. Ryabov** **V.I. Kolesnikov** **A.I. Zinchenko**	Realization
4.	**Theoretical investigations, calculations and development of models describing nuclear matter properties at high temperatures and compressions, dynamics of high energy nuclear interactions at extremely high baryonic densities, spin and P-odd effects**	**D. Blaschke** **A.S. Sorin** **O.V. Teryaev**	Realization
	BLTP	V.V. Braguta, A. Frizen, Yu.B. Ivanov, A.S. Khvoroctukhin, Ya.N. Klopot, A.G. Oganesyan, A. Parvan, A.A. Roenko	
	MLIT	Yu.L. Kalinovsky, Zh.Zh. Musulmanbekov, E.G. Nikonov	
	DLNP	G.I. Lykasov	
	VBLHEP	Kh.U. Abraamyan, D.A. Artemenkov, P.N. Batyuk, D.K. Dryablov, V.D. Kekelidze, M.A. Kozhin, R. Lednicky, A.G. Litvinenko, A.I. Malakhov, S.G. Reznikov, O.V. Rogachevsky, V. Voronyuk, V.N. Zhezher	
5.	**Computer infrastructure: online and offline clusters of the distributed computer complex, system of simulation, data transfer and analysis, information and technological computer systems**	**A.G. Dolbilov** **O.V. Rogachevsky**	Realization
	VBLHEP	V.F. Dydyshko, O.S. Fedoseev, D.G. Mel'nikov, Yu.I.Minaev, S.A. Mityukhin, D.V. Peshekhonov, I.P. Slepov, B.G. Schinov, I.V. Slepnev, S.N. Shkarovsky, V.L. Svalov	
	MLIT	I.A. Kashunin, D.V. Kekelidze, V.V. Korenkov, V.V. Mitsyn, D.A. Oleynik, I.S. Pelevanyuk, A.Sh. Petrosayn, M.S. Plyashkevich, D.V. Podgainy, V.V. Trofimov, T.A. Strizh, P.V. Zrelov	
6.	**SPD project: conceptual and technical design of the Spin Physics Detector (SPD) at the NICA collider**	**A.V. Gus'kov** **V.P. Ladygin**	Project preparation

VBLHEP	R.R. Akhunzyanov, V.A. Anosov, N.I. Azorsky, A.A. Baldin, E.G. Baldina, M.Yu. Barabanov, A.N. Beloborodov, A.V. Belyaev, V.V. Bleko, D.N. Bogoslovsky, I.V. Boguslavsky, V.B. Chmil, V.B. Dunin, A.A. Feshchenko, Yu.N. Filatov, T.L. Enik, O.P. Gavrischuk, A.S. Galoyan, L. Glonti, S.M. Golubykh, N.O. Grafov, A.S. Gribovsky, V.A. Gromov, S.A. Gromov Yu.V. Gurchin, Yu.V. Gusakov, N.Ya. Ivanov, A.Yu. Isupov, E.A. Kas'yanova, G.D. Kekelidze, M.A. Kozhin, E.S. Kokoulina, E.V. Kostyukhov, Yu.A. Kopylov, P.S. Korovkin, A.Yu. Korzenev. V.A. Kramarenko, V.N. Kruglov, S.V. Khabarov, P.R. Kharyuzov, A.N. Khrenov, V.M. Lysan, R. Lednicky, A.M. Martovitsky, O. Minko, I.V. Moshkovsky, D.N. Nikiforov, S.N. Nagorny, V.A. Nikitin, V.V. Pavlov, S.S. Parzhitsky, E.E. Perepelkin, D.V. Peshekhonov, V.V. Popov, S.G. Reznikov, N.S. Rogacheva, A.B.Safonov, K.M. Salamatin, I.A. Savin, A.A. Savenkov, S.Yu. Starikova, Ya.T. Skhomenko, E.A. Streletskaya, O.G. Tarasov, A.A.Terekhin, O.V. Teryaev, A.V. Tishevsky, N.D. Topilin, B.L. Topko, Yu. A. Topko, Yu.A. Troyan, E.A. Usenko, A.I. Sheremetieva, S.S. Shimansky, E.V. Vasilieva, I.S.Volkov, P.V. Volkov, I.P. Yudin, N.I. Zamyatin, I.A. Zhukov, A.V. Zinin, E.V. Zubarev
DLNP	V.M. Abazov, G.D. Alexeev, L.G. Afanasiev, A.P. Belova, A.V. Bobkov, T.V. Boltushkin, E.V. Brazhnikov, I.I. Denisenko, G.A. Golovanov, A.O. Gridin, K.I. Gritsay, A.V. Guskov, A.N. Fedorov, M. Finger, M. Finger(Jr.), V.N. Frolov, A.V.Karpishkov, N.V. Kirichkov, V.I. Komarov, A.V. Kulikov, V.S. Kurbatov, Zh. Kurmanaliev, S.A. Kutuzov, A. Maltsev, E.O. Mitrofanov, A.A. Pavlova, B. Parsamyan, A.A. Piskun, I.K. Prokhorov, E.P. Rezvaya, V.M. Romanov, A.I. Rudenko, A. Rymbekova, M.A. Rumyantsev, N.A. Rybakov, A.G. Samartsev, A.V. Semenov, A.A. Sinitsa, V.N. Shaikovsky, A.V.Shipilova, K. Shtejer, A.N. Skachkova, M. Slunecka, V. Sluneckova, V.V. Tereschenko, V.V. Tokmenin, N.O. Trunov, Yu.N. Uzikov, L.S. Vertogradov, Yu.L.Vertogradova, A.Yu. Verkheev, V.A.Vesenkov, N.I. Zhuravlev
MLIT	P.V. Goncharov, D.A. Oleynik, G.A. Ososkov, A.Sh. Petrosyan, D.V. Podgainy, I.S. Pelevanyuk, V.V. Trofimov, V.V. Uzhinsky, M.I. Zuev
BLTP	I.V. Anikin, S.V. Goloskokov, Yu. Klopot, D. Strizhik, N.I. Volchansky

7.	**Construction and development of the test zone for detector R&D at the linear electron accelerator at DLNP**	**A.S. Zhemchugov**	Projecting Realization
VBLHEP	A.A. Baldin, T. L. Enik, O. Gavrishchuk, V.V. Kobets, Yu.A. Murin, V.G. Shabratov		
DLNP	A.E. Brukva, M.I. Gostkin, D.L. Demin, V.G. Kruchonok, S.Yu. Porokhovoy, Ya.A. Samofalova, A.N. Trifonov, K.E. Yunenko		
8.	**Construction and development of infrastructure for applied and innovation research at the NICA complex**	**A.V. Butenko** **A.S. Sorin**	Projecting Realization

8.1	**Construction of beamlines for applied research, of stations for irradiation of electronic components and biological objects with long-range ions and stations for irradiation of electronic components with low-energy ions**	**A.V. Butenko** **E.M. Syresin**	Realization
8.2	**R&D for the development and exploitation of irradiation stations for applied research at the NICA complex; organization of international collaboration**	**O.V. Belov** **S.I. Tyutyunnikov**	Projecting Realization
	VBLHEP	A.A. Baldin, E.A. Levterova, A.V. Rogachev, V.N. Shalyapin, 3 pers.	
	DLNP	K.V. Belokopytova	
	FLNP	M.V. Bulavin	
9.	**Construction of the complex of buildings with engineering infrastructure for object placement, engineering systems and carrying out R&D for the NICA complex**	**N.N. Agapov** **V.D. Kekelidze** **N.D. Topilin**	Projecting Realization
9.1.	**Technical designing, coordination of the construction of the building complex and engineering infrastructure development**	**A.V. Dudarev** **I.N. Meshkov**	Projecting Realization
9.2.	**R&D, production of prototypes and full-scale superconducting magnets for the NICA booster and collider**	**G.G. Khodzhibagiyan**	Projecting Realization
	VBLHEP	N.N. Agapov, V.V. Agapova, A.S. Averichev, A.M. Bazanov, N.P. Bazylev, V.I. Batin, N.A. Blinov, Yu.T. Borzunov, V.V. Borisov, A.A. Bortsova, A.V. Butenko, A.V. Bychkov, S.A. Dolgy, A.M. Donyagin, V.M. Drobin, N.A. Filippov, E.Yu. Filippova, E. Fischer, A.R. Galimov, O.M. Golubitsky, Yu.V. Gusakov, E.Yu. Ivanenko, V.N. Karpinsky, R.A. Karpunin, I.E. Karpunina, H.G. Khodzhibagiyan, S.Yu. Kolesnikov, A.V. Konstantinov, V.S. Korolev, S.A. Kostromin, A.V. Kudashkin, G.L. Kuznetsov, E.A. Kulikov, O.A. Kunchenko, V.I. Lipchenko, D.V. Lobanov, A.A. Makarov, Yu.A. Mitrofanova, A.Yu. Merkur'ev, A.V. Nesterov, D.N.Nikiforov, M.S.Novikov, A.L. Osipenkov, R.V. Pivin, D.O. Ponkin, T.F. Prakhova, A.S. Sergeev, S.A. Smirnov, A.V. Shabunov, M.M.Shandov, A.V.Shemchuk, E.V. Shevtchenko, N.D.Topilin, Yu.A. Tumanova, A.S. Vinogradov, N.A. Zhil'tsova	
	MLIT	P.G. Akishin	
9.3.	**Upgrade and development of electric power and technological nets aimed at the increasing of economics and technical efficiency**	**N.N. Agapov** **N.V. Semin**	Projecting Realization
	VBLHEP	A.V. Alfeev, E. Fischer, A.M. Karetnik, H.G. Khodzhibagiyan, A.A. Makarov, M.I. Migulin, Novikov M.S., E.V. Serochkin, V.M. Stepanov, A.N. Sotnikov, A.V. Shabunov, V.Yu. Shilov, O.M. Timoshenko, N.D. Topilin, V.P. Tchernyaev	

AS&CC Office	Yu.N. Balandin, I.S. Frolov, L.I. Tikhomirov
OCE	V.N. Buchnev, 2 pers.
LRB	G.N. Timoshenko, 3 pers.

Collaboration

Country or International Organization	City	Institute or Laboratory
Armenia	Yerevan	Foundation ANSL
		YSU
Australia	Sydney, NSW	Univ.
Azerbaijan	Baku	NNRC
Belarus	Minsk	BSUIR
		INP BSU
		IP NASB
		JIPNR-Sosny NASB
		PTI NASB
		SPMRC NASB
Bulgaria	Blagoevgrad	SWU
	Plovdiv	PU
	Sofia	INRNE BAS
		ISSP BAS
		LTD BAS
		SU
		TU-Sofia
CERN	Geneva	CERN
Chile	Valparaiso	UTFSM
China	Beijing	"Tsinghua"
		CIAE
		IHEP CAS
	Hefei	IPP CAS
		USTC
	Hengyang	USC
	Huzhou	HU
	Jinan	SDU
	Lanzhou	IMP CAS
	Shanghai	Fudan
		SINAP CAS
	Wuhan	CCNU
	Yichang	CTGU
Cuba	Havana	InSTEC
Czech Republic	Liberec	TUL
	Olomouc	UP
	Prague	CTU
		CU
		VP
	Rez	NPI CAS
	Vitkovice	VHM
Egypt	Cairo	ECTP

	Giza	CU
France	Nantes	SUBATECH
	Saclay	CEA
Georgia	Tbilisi	AIP TSU
		GTU
Germany	Darmstadt	GSI
		TU Darmstadt
	Dresden	ILK
	Erlangen	FAU
	Frankfurt/Main	FIAS
		Univ.
	Giessen	JLU
	Julich	FZJ
	Mainz	JGU
	Regensburg	UR
	Tubingen	Univ.
Israel	Jerusalem	HUJI
	Tel Aviv	TAU
Italy	Brescia	Forgiatura Morandini
	Genoa	ASG
	Turin	INFN
Japan	Nagoya	Nagoya Univ.
	Tokyo	Nihon Univ.
Mexico	Mexico City	UNAM
	Puebla	BUAP
Moldova	Chisinau	IAP
		MSU
Mongolia	Ulaanbaatar	IPT MAS
Poland	Chorzow	Frako-Term
	Otwock (Swierk)	NCBJ
	Warsaw	WUT
	Wroclaw	ILT&SR PAS
		UW
Romania	Bucharest	IFIN-HH
		INCDIE ICPE-CA
	Magurele	INOE2000
Russia	Belgorod	BelSU
	Chernogolovka	LITP RAS
	Dolgoprudny	MIPT
	Dubna	PELCOM
	Fryazino	ISTOK
	Gatchina	NRC KI PNPI
	Kazan	Compressormash
		Spetshmash

	Moscow	Cryogenmash
		Geliymash
		IBMP RAS
		ITEP
		LPI RAS
		MIREA
		MSU
		NNRU "MEPhI"
		NRC KI
		SINP MSU
		VEI
	Moscow, Troitsk	INR RAS
	Novocherkassk	SRSPU NPI
	Novosibirsk	BINP SB RAS
		STL "Zaryad"
	Protvino	IHEP
	Samara	SU
	St. Petersburg	KRI
		Neva-Magnet
		SPbSPU
		SPbSU
	Syktyvkar	DM Komi SC UrB RAS
	Tomsk	NPI TPU
		TSU
	Vladikavkaz	NOSU
	Vladivostok	FEFU
	Zhukovsky	TECHNOLOGY
Serbia	Belgrade	Univ.
Slovakia	Bratislava	IMS SAS
	Kosice	UPJS
	Zilina	UZ
South Africa	Johannesburg	UJ
		WITS
	Somerset West	iThemba LABS
	Stellenbosch	SU
Sweden	Stockholm	SU
Ukraine	Kharkov	ISMA NASU
		KhNU
		LTU
		NSC KIPT
	Kiev	BITP NASU
USA	Batavia, IL	Fermilab
	Cambridge, MA	MIT
	Stony Brook, NY	SUNY
	Upton, NY	BNL

02-0-1127-2016/2023	Priority:	1
	Status:	Being concluded

Advanced Studies of Systems of New-Generation Accelerators and Colliders for Fundamental and Applied Research

Leader: G.D. Shirkov

Participating countries and international organizations:

Belarus, CERN, Georgia, Germany, Italy, Russia, Slovakia.

Issues addressed and main goals of research:

Investigation of various carbon-based transmission photocathodes, installation of the second beamline with a 213-nm laser at the photogun bench, development of the photoinjector bench: 150-KeV electron energy achievement, development of radiation safety, interlock and control systems. Development, determination of design parameters and commissioning of the LINAC-200 linear electron accelerator with the aim of its experimental and educational applications. Optimization of accelerator parameters for users. Maintenance of the FLASH infrared undulator and participation in its experimental program, as well as in the new undulator development; development of photon diagnostics for FLASH, FLASH2 and XFEL and experiment participation. Experimental investigations of 3D ellipsoidal shape electron bunches with small emittances at PITZ with the new laser system. Preparation of proposals and start of JINR participation in international collaborations on future high-energy colliders.

Expected results in the current year:

1. Fabrication of the nanostructured carbon photocathodes and investigation of their electrophysical properties (λ = 213 / 266 nm). Assembling of the pepper-pot emittance measurement system main components for the photoinjector bench. Vacuum system assembling and pumping. Design, fabrication and assembling of a cryopump for the bench vacuum system. Assembling, tuning and calibration of the nanosecond range high-sensitivity electron bunch charge sensor prototype. Bench startup with the energy of 120 keV.
2. Optimization of the LINAC-200 beam parameters at 200 MeV. Extraction of the beam with wide-range parameters from single electrons to 30 mA with the repetition rate up to 25 Hz into the atmosphere, optimization of beam parameters for users. Manufacturing of the beam parallel transfer system (DLNP program) after the 2nd and 3rd accelerating stations. Modernization of the cooling, control and interlock systems.
3. Investigation of the electron beam and FEL physics: generation of infrared radiation from the JINR undulator at FLASH and measurements of a longitudinal bunch profile on the basis of this radiation; diagnostics of electron bunches at FLASH2 by using microchannel plate detectors; test experiments with XFEL microchannel plate detectors on the PETRA III synchrotron sources, experimental investigations of the 3D ellipsoidal shape electron bunches at PITZ with the new laser system.
4. Preparation of proposals for JINR participation in international collaborations on future high-energy colliders. Analysis of 6-T high-efficient dipole magnets aimed at the FCC "low energy" pp-collider option at CERN.

List of Activities

	Activity or Experiment Laboratory or another Division of JINR Responsible person	**Leaders** Main researchers	**Status**
1.	**R&D of Photoinjecting systems**	**N.I. Balalykin** **M.A. Nozdrin**	Technical Proposal Realization
	VBLHEP	V.G. Shabratov, A.V. Shevelkin	

2.	**LINAC-200 electron accelerator**	**G.D. Shirkov** **V.V. Kobets**	Technical Proposal Realization
	VBLHEP	N.I. Garanzha, M.A. Nozdrin, A.V. Skrypnik, A.G. Sorokin, V.G. Shabratov, A.S. Slepne	
	DLNP	E.M. Acosta, A.E. Brukva, D.S. Shokin, A.S. Zhemchugov	
	UC	D.S. Belozerov, K.B. Gikal, S.Z. Pakulyak, K.A. Verlamov, D.A. Zlydenny	
3.	**R&D of free electron lasers**	**E.M. Syresin** **O.I. Brovko** **M.V. Yurkov**	Technical Proposal
	UC	A.F. Chesnov, N.A. Morozov, D.C. Petrov	
4.	**Preparation of proposals and start of JINR participation in international collaborations on future high-energy colliders**	**G.D. Shirkov**	Preparation

Colaboration

Country or International Organization	**City**	**Institute or Laboratory**
Belarus	Minsk	INP BSU
CERN	Geneva	CERN
Georgia	Tbilisi	HEPI-TSU
Germany	Hamburg	DESY
Italy	Pisa	INFN
Russia	Nizhny Novgorod	IAP RAS
	Petropavlovsk-Kamchatsky	FRC GC RAS
		KSU
Slovakia	Bratislava	IEE SAS

02-1-1097-2010/2023		Priority:	1
		Status:	Being concluded

Study of Polarization Phenomena and Spin Effects at the JINR Nuclotron-M Facility

Leader: E.A. Strokovsky

Deputies: N.M. Piskunov
V.P. Ladygin
R.A. Shindin

Participating countries and international organizations:

Bulgaria, Czech Republic, France, Germany, Japan, Poland, Romania, Russia, Slovakia, Sweden, United Kingdom, USA, Uzbekistan.

Issues addressed and main goals of research:

Polarization studies are undoubtedly relevant now. They combine the efforts of the JINR Laboratories and many foreign laboratories, both participating and non-participating countries, in the design and conduct of experiments using unique beams of polarized deuterons with energies ranging from 5 MeV per nucleon to 5.6 GeV/n, secondary beams of polarized protons and neutrons, as well as beams of polarized protons directly accelerated in the Nuclotron. The possibility of obtaining beams of accelerated polarized protons in the Nuclotron without significant investment, demonstrated in 2017, became the basis for intensifying work on the spin program of the NICA project and, in particular, for the development of polarimetry techniques, the creation of new methods for precise control of the direction of the spin of protons, deuterons and other particles. This part of the work on the topic is directly related to the creation of the NICA complex and the testing of a new approach to controlling the polarization in the spin transparency mode. Of undoubted interest is also the study of the possibility of setting up experiments at the collider to measure EDM and parity violation. The most important scientific and methodological direction of work within the framework of the topic is the development of infrastructure for conducting research with polarized beams, namely: the creation and development of systems for polarimetry and spin direction control. At the forthcoming stage of work, due to the concentration of efforts on the implementation of the NICA project, this component also has the first priority. Within the framework of the theme, two projects are being carried out: ALPOM-2 and DSS. Preparation of the project on spin effects measurements in nucleon-nuclear scattering with using Movable Polarized Target Saclay-ANL-JINR (MPT) and Delta-Sigma and Delta-2 spectrometers. Extension proposals for these projects for 2019-2023. were reported at the STC VBLHEP in April 2021 and approved with a recommendation to assign the first priority to these works. Taking into account the presence of polarized beams, new experimental data will be obtained on the study of charge-exchange processes, on the study of the structure of 2- and 3-nucleon correlations in the reactions of deuteron-proton elastic scattering and deuteron breakup (experiments on the internal target of the Nuclotron), by measuring tensor analyzing power and spin correlation in the dp scattering reaction in the deuteron core region, as well as other processes that are important for the development of theoretical models describing the interactions of the simplest nuclear systems with allowance for relativism and the contribution of the meson and quark-gluon components of the internal motion of constituents in nucleons.

Expected results in the current year:

1. Works:
   a) testing a low-energy polarimeter for protons and deuterons on the injection channel into the Nuclotron;

   b) designing a polarizing helium-3 target.

   c) modernization of the polarimeter at focus f3.

2. Carrying out work on approved projects and agreements, taking into account their resource availability, including ALPOM-2 and DSS projects. Completion of the data analysis on the analyzing powers A_y, A_{yy} and A_{xx} in deuteron-proton elastic scattering at the energies 400-1300 MeV. Publication and reports of the results.

3. Creation of a project for the placement of polarimetry elements for beam diagnostics and polarization control at the SPD section of the NICA collider ring.

4. Modernization of the MPT. Preparation of the Delta-Sigma and Delta-2 spectrometers. Carrying out calculation and design work on detector around target (DTS).

5. Continuation of the development of new calculation methods of the amplitudes and polarization characteristics of deuteron fragmentation and deuteron elastic scattering on protons and nuclei taking into account FSI and relativistic effects.

6. Analysis of the possibility of staging new experiments with polarized beams of protons and deuterons at the NICA complex, in particular, on the search for EDM.

List of projects

	Project	Leader	Priority (period of realisation)
1.	ALPOM-2	N.M. Piskunov	1 (2010-2023)
2.	DSS	V.P. Ladygin M. Janek K. Sekiguchi	1 (2010-2023)

List of Activities

	Activity or Experiment Laboratory or other Division of JINR Responsible person	Leaders Main researchers	Status
1.	**Development of spin physics research infrastructure at the Nuclotron and other facilities. Design, construction and development of spin control and polarimetry systems. The EDM searching analysis at NICA**	**A.V. Butenko**	Realization
	VBLHEP	A.V. Averyanov, Yu.N. Filatov, V.V. Fimushkin, D.O. Krivenkov, R.A. Kuzyakin, M.V. Kulikov, V.P. Ladygin, K.S. Legostaeva, A.N. Livanov, N.M. Piskunov, S.G. Reznikov, R.A. Shindin, E.A. Strokovsky, A.M. Taratin	
	DLNP	M. Finger, M. Finger (Jr.), Yu.N. Uzikov	
2.	**ALPOM-2 Project**	**N.M. Piskunov** **E. Tomasi-Gustafsson** **C.F. Perdrisat** **V. Punjabi**	Preparation Data taking
	VBLHEP	S.N. Bazylev, O.P. Gavrishchuk, V.V. Glagolev, A.A. Druzhinin, A.N. Livanov, D.A. Kirillov, P.A. Rukoyatkin, R.A. Shindin, I.M. Sitnik	
3.	**DSS Project**	**V.P. Ladygin** **M. Janek** **K. Sekiguchi**	Preparation Data taking
	VBLHEP	E.V. Chernykh, Yu.V. Gurchin, A.Yu. Isupov, A.N. Khrenov, N.B. Ladygina, A.N. Livanov, S.G. Reznikov, A.A. Terekhin, A.V. Tishevsky, I.S. Volkov	
	DLNP	G.I. Lykasov	
4.	**Delta-Sigma setup. Tests and inspections of the basic MPT systems, carrying out design and design work on new cryostat for MPT with the possibility to have the polarizing and holding magnetic fields**	**R.A. Shindin** **Yu. A. Usov (DNLP)** **M. Finger (Jr.) (DNLP)**	Data analysis Proposal preparation
	VBLHEP	C.P. Avdeev, A.A. Druzhinin, O.P. Gavrishchuk, N.O. Grafov, D.A. Kirillov, A.N. Livanov, A.P. Nagaytsev	

	DLNP	N.S. Borisov, N.A. Bazhanov, M. Finger	
	FLNP	A.N. Chernikov	
5.	**Experiments on the program STRELA at polarized beam**	**N.M. Piskunov**	Data taking
	VBLHEP	S.N. Bazylev, V.V. Glagolev, A.A. Druzhinin, D.A. Kirillov, A.A. Povtoreyko, R.A. Shindin, I.M. Sitnik	
6.	**Theoretical calculations of polarized processes**	**V.K. Lukyanov (BLTP)**	Data analysis
	BLTP		
	VBLHEP	N.B. Ladygina, A.P. Ierusalimov	

Collaboration

Country or International Organization	City	Institute or Laboratory
Bulgaria	Sofia	UCTM
Czech Republic	Brno	ISI CAS
	Prague	CTU
		CU
	Rez	UJV
France	Orsay	IPN Orsay
	Saclay	IRFU
Germany	Bochum	RUB
	Dresden	TU Dresden
	Freiburg	FMF
	Julich	FZJ
	Tubingen	Univ.
Japan	Hiroshima	Hiroshima Univ.
	Wako	RIKEN
Poland	Otwock (Swierk)	NCBJ
Romania	Bucharest	INCDIE ICPE-CA
Russia	Belgorod	BelSU
	Moscow	LPI RAS
		NRC KI
	Moscow, Troitsk	INR RAS
		LPP LPI RAS
Slovakia	Bratislava	IP SAS
	Kosice	IEP SAS
		UPJS
	Zilina	UZ
Sweden	Uppsala	TSL
United Kingdom	Glasgow	U of G
USA	Newport News, VA	JLab
	Norfolk, VA	NSU
	Upton, NY	BNL
	Williamsburg, VA	W&M
Uzbekistan	Tashkent	Assoc. P.-S. PTI
		INP AS RUz

02-1-1087-2009/2023		
	Priority:	1
	Status:	Being concluded

Research on Relativistic Heavy and Light Ion Physics. Experiments at the Accelerator Complex Nuclotron/NICA at JINR and CERN SPS

Leader: A.I. Malakhov
Deputy: S.V. Afanasiev

Participating countries and international organizations:

Armenia, Bulgaria, CERN, China, Czech Republic, Germany, Japan, India, Mongolia, Poland, Romania, Russia, Slovakia, Switzerland, USA, Uzbekistan.

Issues addressed and main goals of research:

Study of new phenomena in multiple particle productions associated with the manifestation of the quark and gluon degrees of freedom in the interaction of relativistic nuclei. Study of nucleon and nuclear interactions at the VBLHEP accelerator complex, CERN SPS. Energy scan of interactions of nuclei at 20-158 GeV/nucleon energies and the study of their dependence on the atomic number of nuclei. To search for the critical point on the phase diagram of nuclear matter at the NA61/SHINE (SPS, CERN). Study of hadron production in hadron-nucleus interactions. Use of the obtained data for the precision calculations of neutrino spectra and fluxes in the accelerator experiments to study the neutrino oscillations. Investigation of nucleon clustering and the contribution of unstable nuclear-molecular States to the dissociation of light stable and radioactive isotopes, as well as the properties of rarefied baryonic matter in the dissociation of heavy nuclei. Experimental and theoretical study of deep subthreshold, cumulative processes, the formation of hadrons and antimatter in the transition energy region. Investigation of processes in the region of large P_T ($P_T \geq$ 1 GeV/c) in non-cumulative and cumulative kinematic regions at SPIN and FODS setups. Study of the behavior of elementary particles, nucleon resonances and nucleon fluctuations in nuclear matter on the SCAN spectrometer. Preparation of proposals of the experiments at the VBLHEP accelerator complex on the Nuclotron extracted beams and NICA Collider. Study of the short-range nucleon-nucleon correlations and the cluster structure of the nuclei using the beams of ions, polarized protons and deuterons at the internal target of the Nuclotron in the framework of the SCAN-3 project.

Expected major results in the current year:

1. Investigation of new phenomena in multiple particle productions associated with the manifestation of the quark and gluon degrees of freedom.
2. Preparation and performance of the experiments on the internal and extracted Nuclotron beams.
3. NA61/SHINE data analysis (SPS, CERN). Study of hadron production in hadron-nucleus interactions. Use of the obtained data for the precision calculation of neutrino spectra and fluxes in the accelerator experiments to study the neutrino oscillations. Modernization of the TOF system. Configuration and testing of the three-arms SCAN magnetic spectrometer. Modernization of electronics for data taken. Analysis of experimental data.
4. Analysis of the experimental data on the processes of the multiple emission of intermediate mass fragments on the beams of relativistic light ions using a 4-π PHASE-3 setup for the registration of nuclear fragments. Performing data analysis to determine the mechanism of multifragmentation and to obtain new information about the nuclear phase transitions "liquid-fog" and "liquid-gas". Investigation of properties of hot nuclei formed in the collisions of light relativistic ions with heavy targets. Production of the detector system for the registration of the decay of hypernuclei.
5. Verification of the consequences of the principles of self-similarity and weakening of correlations in the formation of multiple particles.
6. Upgrade of the SCAN setup. Analysis of the experimental data on the behavior of nucleon resonances and nucleon fluctuations in nuclei, on the search and study of properties of the bound state-meson in nuclear matter, study of np and pp correlations. Modernization of the Internal target station of the Nuclotron.
7. Search and study of the Hoyle state and more complex nuclear-molecular States in the dissociation of light nuclei. Analysis of the isotopic composition of the fragmentation of heavy nuclei. Use of automated microscopes, as well as improvement of the NE technology.

8. Updating the Marusya installation for conducting the experimental studies with the extracted Nuclotron beams. Investigation of A-dependences of rare subthreshold and cumulative processes of the formation of pions, kaons and antiprotons depending on the type and energy of the incoming nuclei, the momentum and angle of the detected particles. Carrying out correlation experiments with registration of groups of particles in the final state, one of which is cumulative.
9. Collection, processing and digitization of the film information obtained using bubble chambers and in electronic experiments with fixed targets under the conditions of registration of multiple birth of particles in the energy range of 1-300 GeV.
10. Use of heavy and light ions for applied research.
11. Analysis of the experimental data obtained in the PHENIX experiment.
12. Processing of the experimental data from 5-9 Runs at the PHENIX setup. Participation in the formation of the program for e-RHIC.
13. Preparation of a project to study spin asymmetries at the LHEP accelerator complex.
14. Collection of new experimental data in pA-and AA-interactions in the region of large p_T ($p_T \geq 1$ GeV/c) at SPIN and FODS facilities, data processing and publication of results.
15. Refinement of the results obtained on a propane two-meter chamber, and analysis of data on the results of the NA61/SHINE experiment.

List of projects

	Project	Leader	Priority (period of realisation)
1.	NA61/SHINE	A.I. Malakhov	1 (2021 - 2023)
2	SCAN-3	S.V. Afanasiev	1 (2017 - 2023)
3.	BECQUEREL2022	P.I. Zarubin	2 (2022 - 2023)

List of Activities

	Activity or Experiment Laboratory or other Division of JINR Responsible person	Leaders Main researchers	Status
1.	**Experiment NA61/SHINE**	**A.I. Malakhov** **G.L. Melkumov**	Upgrade Preparation Data analysis
	VBLHEP	V.A. Babkin, M.G.Buryakov, V.M. Golovatyuk, A.V. Dmitriev, V.I. Kolesnikov, R.Yu.Kolesnikov, V.A. Kireev, V.A. Lenivenko, V.A. Matveev, M.M. Rumyantsev, A.A. Zajtsev	
	DLNP	V.V. Lyubushkin, G.I. Lykasov, B.A. Popov, V.V. Tereschenko	
2.	**Experiment BECQUEREL2022**	**P.I. Zarubin**	Data taking Data analysis
	VBLHEP	D.A. Artemenkov, V. Bradnova, N.K. Kornegrutsa, V.V. Rusakova, P.A. Rukoyatkin, A.A. Zaytsev	
3.	**Experiment FASA-3 for registration of nuclear fragments**	**S.P. Avdeev**	Upgrade Preparation Data analysis
	DLNP	V.I. Stegaylov	

	FLNR	V.V. Kirakosyan, E.M.Kozulin, G.V. Mushinsky, O.V. Strekalovsky	
	VBLHE	H.U. Abraamian, Z.A. Igamkulov, V. Karach, L.V. Kornyushina, A.G. Litvinenko, P.A. Rukoyatkin, Z.A. Sadygov	
4.	**Project SCAN-3**	**S.V. Afanasiev** **A.I. L'vov**	Preparation Data analysis Upgrade
	VBLHEP	Yu.S. Anisimov, A.A. Baldin, V. Bekirov, D.K. Dryablov, B.V. Dubinchik, S.V. Kilchakovskaia, Yu.F. Krechetov, A.S. Kuznetsov, M. Paraypan, D.G. Sakulin, V.A. Smirnov, E.V. Sukhov, V.V Ustinov, P.R. Kharyuzov, V. Vartik	
5.	**Search and investigation of new phenomena using information obtained with bubble chambers and their theoretical interpretation. Creation of data base of experimental data and educational programs in the field of relativistic nuclear physics**	**A.A. Baldin** **V.V. Glagolev**	Data analysis
	VBLHEP	S.G. Arakelyan, E.G. Baldina, A.V. Belyaev, A.V.Beloborodov, Ver.V.Bleko, Vit. V. Bleko, D.N.Bogoslovsky, A.P. Ierusalimov, V.V. Ilyushchenko, P.R. Kharyuzov, D.S.Korovkin, N.E. Pukhaeva, O.V. Rogachevsky, A.B. Safonov, A.Yu. Troyan, Yu.A. Troyan	
6.	**Investigation of deep subthreshold processes, applied and educdtional programs at MARUSYA set up**	**A.A. Baldin**	Preparation Data taking
	VBLHEP	V.A. Arefiev, S.V. Afanasiev, E.G. Baldina, A.V. Belyaev, S.N. Bazylev, A.I. Berlev, A.V.Beloborodov, Ver.V.Bleko, Vit. V. Bleko, D.N.Bogoslavsky, D.K. Dryablov, E.A. Efimova, P.R. Kharyuzov, D.S.Korovkin, S.Yu. Starikova, I.V. Slepnev, S.S. Shimansky, A.B.Safonov, A.Yu. Troyan,Yu.A. Troyan	
	BLTP	S.G. Bondarenko	
	DLNP	A.N. Fedorov	
7.	**Investigation with light and heavy ions for applied research**	**A.I. Malakhov**	Realization Preparation Data taking
	VBLHEP	N.N. Agapov, Yu.S. Anisimov, A.A. Baldin, E.G. Baldina, D.K. Dryablov, M. Paraypan	
8.	**Upgrade of equipment the station of internal target of the Nuclotron**	**S.V. Afanasiev** **R.Yu.Kolesnikov**	Upgrade Data taking
	VBLHEP	Yu.S. Anisimov, V.N. Bekirov, D.K. Dryablov, B.V. Dubinchik, S.V. Kilchakovskaia, A.S.Kuznetsov, S.N. Kuznetsov, D.G. Sakulin, T.V. Trofimov	
9.	**Test of the detectors for measurements and control the luminosity at the collider NICA**	**A.G. Litvinenko**	R&D Technical Proposal
	VBLHEP	R.A. Akbarov, K.U. Abraamyan, T.Y. Bokova, Z.A. Igamkulov, L.V. Kornyushina, I.I. Migulina, A.Z. Sadygov, Z.Y. Sadygov, V.I. Shokin, G.D. Milnov	
	FLNP	E.I. Litvinenko	

10. Study of the short range nucleon-nucleon correlations at modernized internal target station at Nuclotron — **V.P. Ladygin** — Preparation, Data taking

VBLHEP — Yu.V. Gurchin, A.Yu. Isupov, A.N. Khrenov, N.B. Ladygina, A.I. Malakhov, S.G. Reznikov, A.A. Terekhin, A.V. Tishevsky

11. The data processing of the Phoenix experiment. Preparing a program for measurements on the RHIC — **A.G. Litvinenko** — R&D, Technical Proposal

VBLHEP — S.V. Afanasiev, A.I. Malakhov, P.A. Rukoyatkin, S.P. Avdeev, K.U. Abraamyan

12. Search and investigation of a new charged particle in the 2-120 MeV mass range — **V.A. Nikitin** — Data analysis

VBLHEP — M.Kh. Anikina, A.V. Beloborodov, V.S. Rikhvitsky, A.Yu. Troyan, A.A. Zaicev

Collaboration

Country or International Organization	City	Institute or Laboratory
Armenia	Yerevan	Foundation ANSL
		YSU
Bulgaria	Blagoevgrad	AUBG
	Sofia	INRNE BAS
		Inst. Microbiology BAS
		SU
CERN	Geneva	CERN
China	Beijing	CIAE
		IHEP CAS
	Wuhan	CCNU
Czech Republic	Prague	CTU
		CU
		IMC CAS
	Rez	NPI CAS
Germany	Darmstadt	TU Darmstadt
	Frankfurt/Main	FIAS
		Univ.
India	Jaipur	Univ.
	Mumbai	BARC
Japan	Tsukuba	Univ.
Mongolia	Ulaanbaatar	IPT MAS
Poland	Krakow	INP PAS
	Lodz	UL
	Otwock (Swierk)	NCBJ
	Warsaw	UW
Romania	Bucharest	IFIN-HH
		INCDIE ICPE-CA
		UB
	Constanta	UOC
	Magurele	ISS

Russia	Belgorod	BelSU
	Chernogolovka	ISMAN RAS
	Moscow	ITEP
		LPI RAS
		MSU
		SINP MSU
	Moscow, Troitsk	INR RAS
	Protvino	IHEP
	Sarov	VNIIEF
	Smolensk	SSU
	St. Petersburg	FIP
	Tomsk	TPU
	Vladikavkaz	NOSU
		VTC "Baspik"
Slovakia	Bratislava	IP SAS
	Kosice	UPJS
Switzerland	Geneva	UniGe
USA	Berkeley, CA	Berkeley Lab
	Iowa City, IA	UIowa
	Upton, NY	BNL
Uzbekistan	Jizzakh	JSPI
	Samarkand	SSU
	Tashkent	Assoc. P.-S. PTI

02-0-1066-2007/2023		
	Priority:	1
	Status:	Being concluded

Investigation of the Properties of Nuclear Matter and Particle Structure at the Collider of Relativistic Nuclei and Polarized Protons

Leaders: R. Lednicky
Yu.A. Panebratsev

Participating countries and international organizations:

Azerbaijan, Bulgaria, Czech Republic, France, Germany, Poland, Russia, Slovakia, USA.

Issues addressed and main goals of research:

Investigation of the properties of nuclear matter with extremely high density and temperature, search for the signatures of the quark deconfinement and possible phase transitions at the collisions of heavy nuclei at the energies of the Relativistic Heavy Ion Collider (RHIC). Measurement of spin dependent structure functions of nucleons and nuclei using polarized proton beams at RHIC.

Expected results in the current year:

1. Beam Energy Scan-II data analysis for collider mode and fixed target measurements.
2. Study of spin effects in collisions of transversely polarized protons at 510 GeV and forward rapidities.
3. Study of event structure, collective variables, correlation characteristics, femtosopic correlation functions and high-p_T processes.
4. Study of future possibility of investigation of the nuclear structure and the proton spin in *e*-*p* and *e*-A collisions at colliders.
5. Participation in joint educational programs in relativistic nuclear physics with BNL and universities of the JINR Member States. Development of JINR educational portal.

List of projects

	Project	Leader	Priority (period of realisation)
1.	STAR	Yu.A. Panebratsev R. Lednicky	1 (2010-2023)

List of Activities

	Activity or Experiment Laboratory or other Division of JINR Responsible person	Leaders Main researchers	Status
1.	**Beam Energy Scan-II data analysis for collider mode and fixed target measurements** VBLHEP	**Yu.A. Panebratsev** A. Aitbayev, A.A. Aparin, G.S. Averichev, T.G. Dedovich, V.B. Dunin, A.O. Kechechyan, O. Kenzhegulov, A.A. Korobitsyn, S.S. Panyushkina, V.V. Tikhomirov, M.V. Tokarev, G.A. Yarygin	Data taking Data analysis
2.	**Study of spin effects in collisions of trunsversely polarized protons at 510 GeV at forward rapidities** VBLHEP	**M.V. Tokarev** A.A. Aparin, T.G. Dedovich, V.V. Lyuboshits, O.V. Teryaev, E.I. Schakhaliev	Realization

	MLIT	Zh.Zh. Musulmanbekov	
	BLTP	S.V. Goloskokov	
3.	**The study of event structure, collective effects, femtoscopic correlations and high-p_T processes**	**R. Lednicky** **Yu.A. Panebratsev**	Realization
	VBLHEP	G.N. Agakishiev, A.A. Aparin, T.G. Dedovich, A.O. Kechechyan, A.A. Korobitsyn, S.S. Panyushkina, E.A. Pervyshina, S.I. Snigirev, M.V. Tokarev, A. Tutebayeva, E.I. Schakhaliev	
	MLIT	G.A. Ososkov	
4.	**Participation in the heavy ion program Hot QCD in the STAR experiment at forward rapidities**	**Yu.A. Panebratsev**	Data taking Data processing Data analysis
	VBLHEP	A.A. Aitbaev, G.N. Agakishiev, A.A. Aparin, G.S. Averichev, T.G. Dedovich, A. Kenzhegulov, E.V. Potrebenikova, M.V. Tokarev, A. Tutebaeva	
	MLIT	V.V. Korenkov, V.V. Mitsyn, G.A. Ososkov	
5.	**Development of the software and formation of the infrastructure for the STAR data processing at JINR**	**Yu.A. Panebratsev** **V.V. Korenkov**	Realization
	VBLHEP	A.A. Aparin, G.N. Agakishiev, A.A. Korobitsyn, P.D. Semchukiv	
	MLIT	N. Balashov, V.V. Mitsyn, G.A. Ososkov, T.A. Strizh	
6.	**Participation in joint educational programs in relativistic nuclear physics with BNL and universities of the JINR Member States. Development of JINR educational portal**	**N.E. Sidorov** **E.V. Potrebenikova**	Realization
	VBLHEP	E.I. Golubeva, K.V. Klygina, P.D. Semchukov, N.I. Vorontsova, M.P. Osmachko	
	UC	S.N. Balalykin, A.O. Komarova, L.V. Platonova, O.A. Smirnov, T.G. Stroganova	
7.	**Elaboration of proposals for the development of detectors for the study of polarization phenomena at colliders**	**V.B. Dunin**	Project development
	VBLHEP	V.V. Fimushkin	
8.	**Study of future possibility of investigation of the nuclear structure and the proton spin in *e-p* and *e*-A collisions at colliders**	**A.A. Aparin**	Project development
	VBLHEP	V.B. Dunin, A.A. Korobitsyn, N.A. Lashmanov, S.I. Manukhov, S.S. Panyushkina, V.Yu. Rogov	
	JINR	A.S. Zhemchugov	

Collaboration

Country or International Organization	City	Institute or Laboratory
Azerbaijan	Baku	IRP ANAS
Bulgaria	Sofia	INRNE BAS
		SU
Czech Republic	Prague	CU
		IP CAS
	Rez	NPI CAS
France	Nantes	SUBATECH
Germany	Heidelberg	Univ.
Poland	Warsaw	WUT
Russia	Moscow	ITEP
		NNRU "MEPhI"
	Protvino	IHEP
	St. Petersburg	SPbSU
Slovakia	Kosice	UPJS
USA	Berkeley, CA	Berkeley Lab
	Bloomington, IN	IU
	Chicago, IL	UIC
	Lemont, IL	ANL
	New Haven, CT	Yale Univ.
	Stony Brook, NY	SUNY
	University Park, PA	Penn State
	Upton, NY	BNL

02-1-1088-2009/2023		Priority:	1

Status: Being concluded

ALICE.
Study of Interactions of Heavy Ion and Proton Beams at the LHC

Leader: A.S. Vodopyanov

Participating countries and international organizations:

Armenia, Austria, Azerbaijan, Bangladesh, Brazil, Bulgaria, CERN, China, Croatia, Cuba, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, India, Indonesia, Italy, Japan, Malta, Mexico, Netherlands, Norway, Pakistan, Peru, Poland, Republic of Korea, Romania, Russia, Slovakia, South Africa, Sri Lanka, Sweden, Thailand, Turkey, Ukraine, United Kingdom, USA.

Issues addressed and main goals of research:

1. Participation in the preparation of ALICE upgrade (Photon spectrometer PHOS, assembly of the setup).
2. Participation in the upgrade of ALICE Inner Tracking System (ITS).
3. Realization of experiments at the LHC, data analysis, preparation of publications.
4. Physics research program at the ALICE detector.
5. Development and upgrade of data analysis computing GRID-ALICE in Russia.
6. Participation in the maintenance and operation tasks on the ALICE detector.

Expected results in the current year:

1. Participation in the construction of the full-scale prototype of the signal registration system and in the preparation of the proposal for the upgrade of photon spectrometer PHOS.
2. Participation in the development of the ALICE ITS data control system.
3. Participation in the physics project preparation.
4. Physics simulation of heavy ions and protons interactions at LHC energies.
5. Data analysis. Preparation of publications.
6. Upgrade, testing and supporting of GRID.
7. Participation in the maintenance and operation tasks on the ALICE detector.

List of projects

	Project	Leader	Priority (period of realisation)
1.	ALICE	A.S. Vodopyanov	1 (2010-2023)

List of Activities

Activity or Experiment Laboratory or other Division of JINR Responsible person	Leaders Main researchers	Status
1. Particle detectors VBLHEP	**A.S. Vodopyanov** V.I. Astakhov, V.A. Arefiev, V.H. Dodokhov, E.M. Klass, V.I. Lobanov, P.V. Nomokonov, I.A. Rufanov	Realization

2.	**Physical process simulation and data analysis**	**B.V. Batyunya**	Realization
	VBLHEP	M.Yu. Barabanov, S.S. Grigoryan, A.V. Kuznetsov, L.V. Malinina, K.P. Mikhaylov, V.N. Pozdnyakov, E.P. Rogochaya, G.E. Romanenko, Yu.L. Vertogradova	
	DLNP	G.I. Lykasov	
	BLTP	D. Blaschke, A.V. Sidorov	
3.	**ALICE. Computing in the distributed environment-GRID**	**A.S. Vodopyanov**	Realization
	VBLHEP	B.V. Batyunya, G.G. Stiforov	
	MLIT	A.O. Kondratiev, V.V. Mitsyn	
4.	**Photon Spectrometer PHOS**	**A.S. Vodopyanov** **P.V. Nomokonov**	Realization
	VBLHE	N.V. Gorbunov, A.V. Kuznetsov, Yu.P. Petukhov, S.A. Rufanov, M. Buryakov, A. Burdyko, S. Buzin	
5.	**Inner Tracking System ITS**	**A.S. Vodopyanov**	Realization
	VBLHEP	N.A. Baldin, R.A. Diaz, V.Kh. Dodokhov, S.C. Ceballos, G.G. Stiforov	

Collaboration

Country or International Organization	**City**	**Institute or Laboratory**
Armenia	Yerevan	Foundation ANSL
Austria	Vienna	SMI
Azerbaijan	Baku	NNRC
Bangladesh	Dhaka	DU
Brazil	Campinas, SP	UNICAMP
	Porto Alegre, RS	UFRGS
	Santo Andre, SP	UFABC
	Sao Paulo, SP	USP
Bulgaria	Sofia	IAPS
		SU
CERN	Geneva	CERN
China	Beijing	CIAE
	Hefei	USTC
	Shanghai	SINAP CAS
	Wuhan	CCNU
		HBUT
Croatia	Split	Univ.
	Zagreb	RBI
		UZ
Cuba	Havana	CEADEN
Czech Republic	Prague	CTU
		IP CAS
	Rez	UJV
Denmark	Copenhagen	NBI
Finland	Helsinki	HIP

	Jyvaskyla	UJ
France	Clermont-Ferrand	LPC
	Grenoble	LPSC
	Lyon	UL
	Nantes	SUBATECH
	Orsay	IJCLab
	Saclay	IRFU
	Strasbourg	IPHC
	Villeurbanne	CC IN2P3
Germany	Bonn	UniBonn
	Darmstadt	GSI
		TU Darmstadt
	Frankfurt/Main	FIAS
		Univ.
	Heidelberg	Univ.
	Munich	TUM
	Munster	WWU
	Tubingen	Univ.
	Worms	ZTT
Greece	Athens	UoA
Hungary	Budapest	Wigner RCP
India	Aligarh	AMU
	Bhubaneswar	IOP
	Chandigarh	PU
	Guwahati	GU
	Indore	IIT Indore
	Jaipur	Univ.
	Jammu	Univ.
	Jatani	NISER
	Kolkata	BNC
		SINP
		UC
		VECC
	Mumbai	BARC
		IIT Bombay
Indonesia	Jakarta	LIPI
Italy	Alessandria	DiSIT UPO
	Bari	DIF
		INFN
		Poliba
	Bologna	INFN
		UniBo
	Brescia	UNIBS
	Cagliari	INFN
		UniCa
	Catania	INFN
		UniCT
	Erice	EMFCSC

	Foggia	Unifg
	Frascati	INFN LNF
	Legnaro	INFN LNL
	Messina	UniMe
	Padua	INFN
		UniPd
	Pavia	UniPv
	Rome	CREF
		INFN
		Univ. "La Sapienza"
	Salerno	INFN
	Trieste	INFN
		UNITR
	Turin	INFN
		Polito
		UniTo
	Vercelli	UPO
Japan	Hiroshima	Hiroshima Univ.
	Nagasaki	NiAS
	Nara	NWU
	Osaka	RCNP
	Saga	Saga Univ.
	Tokai	JAEA
	Tokyo	UT
	Tsukuba	Univ.
	Wako	RIKEN
Malta	Msida	UM
Mexico	Culiacan	UAS
	Mexico City	Cinvestav
		UNAM
	Puebla	BUAP
Netherlands	Amsterdam	AUAS
		NIKHEF
	Utrecht	UU
Norway	Bergen	HVL
		UiB
	Oslo	UiO
	Tonsberg	USN
Pakistan	Islamabad	COMSATS
		PINSTECH
Peru	Lima	PUCP
Poland	Krakow	AGH
		INP PAS
	Otwock (Swierk)	NCBJ
	Warsaw	WUT
Republic of Korea	Cheongju	CBNU
	Daejeon	KIST
	Gangneung	GWNU

	Incheon	Inha
	Jeonju	JBNU
	Pusan	PNU
	Seoul	Konkuk Univ.
		SJU
		Yonsei Univ.
Romania	Bucharest	IFIN-HH
		UPB
	Magurele	ISS
Russia	Gatchina	NRC KI PNPI
	Moscow	ITEP
		NNRU "MEPhI"
		NRC KI
		SINP MSU
	Moscow, Troitsk	INR RAS
	Novosibirsk	BINP SB RAS
	Protvino	IHEP
	Sarov	VNIIEF
	St. Petersburg	FIP
Slovakia	Bratislava	CU
	Kosice	IEP SAS
		TUKE
		UPJS
South Africa	Cape Town	UCT
	Johannesburg	WITS
	Somerset West	iThemba LABS
Sri Lanka	Moratuwa	Univ.
Sweden	Lund	LU
Thailand	Bangkok	KMUTT
	Chachoengsao	TMEC
	Nakhon Ratchasima	SLRI
		SUT
Turkey	Istanbul	Univ.
		YTU
	Konya	Karatay Univ.
Ukraine	Kharkov	NSC KIPT
	Kiev	BITP NASU
United Kingdom	Birmingham	Univ.
	Daresbury	DL
	Derby	Univ.
	Liverpool	Univ.
USA	Austin, TX	UT
	Berkeley, CA	Berkeley Lab
		UC
	Chicago, IL	CSU
	Columbus, OH	OSU
	Detroit, MI	WSU
	Houston, TX	UH

Knoxville, TN	UTK
Los Alamos, NM	LANL
New Haven, CT	Yale Univ.
Oak Ridge, TN	ORNL
Omaha, NE	Creighton Univ.
San Luis Obispo, CA	Cal Poly
West Lafayette, IN	Purdue Univ.

02-1-1107-2011/2023

Priority:	1

Status: Being concluded

Development and Construction of the Prototype of a Complex for Radiotherapy and Applied Research with Heavy-Ion Beams at the NICA

Leader: S.I. Tyutyunnikov

Deputy leader: A.A. Baldin

Participating countries and international organizations:

Armenia, Belarus, Moldova, Mongolia, Russia, Uzbekistan.

Issues addressed and main goals of research:

Investigation of various subcritical setups and using them for energy prodution and radioactive waste transmutation, research of radiation hardness of materials. The quasi-infinite target (Project E&T&RM).

Participation in the design of the applied research area at the NICA complex.

Study of radiation effects in HTSC tapes to optimise their characteristics.

Expected main results:

Receiving data about the multiplicities and special istribution of energy-time neutron spectra. Research on massive targets of natural (depleted) uranium and thorium energy production capabilities and processing of radioactive waste, the study of radiation hardness of superconductors by the beams of neutrons and protons.

Expected results in the current year:

1. Installation of a big uranium target at the Phazotron in DLNP, beam adjustment on the target.
2. Investigation of neutron leakage from the surface of the massive uranium target by activation method.
3. Thermocouple device installation and callibration at the massive uranium target "BURAN".
4. Investigation of impact of high-power laser radiation on the radioactive decay of minor actinides.
5. Investigation of radiation defects in high-temperature superconductors under the irradiation with protons with energy E = 660 MeV.

List of projects

	Project	Leader	Priority (period of realisation)
1.	E&T&RM	S.I. Tyutyunnikov	1 (2018-2023)

List of Activities

	Activity or Experiment Laboratory or other Division of JINR Responsible person	Leaders Main researchers	Status
1.	**Development of the technical specifications for the detector system of setup "big uranium target" on the basis of the temperature sensor and silicon photomultipliers** VBLHEP	**S.I. Tyutyunnikov** **A.A. Solnyshkin** **A.A. Baldin** **Z. Y. Sadygov** **R.A. Akbarov** A.I. Berlev, I.P. Yudin	Realization

2.	**Design, manufacture of detectors for the measurement of ion energy in the range of Ee=0.1 Gev/nucleon on the Nuclotron-M beams**	**N.I. Zamyatin** **Y.S. Kopylov**	Realization
	VBLHEP	S.V. Khabarov, Yu.S. Kovalev, O.G. Tarasov	
3.	**Upgrade of spectrum-analitical complex for activation measurements**	**V.N. Shalyapin** **V.I.Stegaylov**	Realization
	VBLHEP	I.A. Kryachko, M. Paraipan, E.V. Strekalovskaya, Toan Tran Ngor	
	DLNP	V.I. Stegaylov	
4.	**Production of the monitoring elements for the superconducting systems**	**Yu.P. Filippov**	R&D
5.	**Development of HTS magnetic and cryogenic systems for experimental facilities (MPT). Carrying out construction works for the development of transverse polarization coils based on systems with HTSC**	**S.I. Tyutyunnikov**	R&D
	VBLHEP	M.S. Novikov	
	FLNP	A.N. Chernikov	

Collaboration

Country or International Organization	**City**	**Institute or Laboratory**
Armenia	Yerevan	YSU
Belarus	Minsk	INP BSU
		ISEI BSU
		JIPNR-Sosny NASB
		RI PCP BSU
Russia	Dubna	BSINP MSU
		IAS "Omega"
	St. Petersburg	KRI
	Tomsk	TPU
Uzbekistan	Tashkent	INP AS RUz

Nuclear Physics (03)

03-0-1129-2017/2023		Priority:	1
		Status:	Being concluded

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

Leaders: I.V. Kalagin
S.N. Dmitriev
S.I. Sidorchuk

Scientific leader: Yu.Ts. Oganessian

Participating countries and international organizations:

Belgium, Bulgaria, Canada, CERN, China, Czech Republic, Egypt, France, Germany, Italy, Kazakhstan, Mongolia, Poland, Republic of Korea, Romania, Russia, Serbia, Slovakia, South Africa, USA.

Issues addressed and main goals of research:

The implementation of the DRIBs-III project that includes the upgrade and development of the FLNR cyclotron complex, expansion of the experimental infrastructure of the Laboratory (construction of new physics set-ups), and the development of accelerator systems. The project aims at improving the operation stability of accelerators, increasing the intensity and improving the quality of ion beams of stable and radioactive nuclides in the energy range from 5 to 100 MeV/nucleon, while at the same time reducing power consumption. The project objective is to significantly improve the efficiency of experiments on the synthesis of superheavy elements and light nuclei at nucleon drip lines and study of their properties. Moreover, the programme of experiments with beams of radioactive nuclides is anticipated to be expanded.

Expected results in the current year:

1. Support for experiments on the synthesis of superheavy elements and study of their properties at the Superheavy Element Factory.
2. Development of a pre-separator for radiochemical studies at of SHE (GASSOL).
3. Development of a separator for multinucleon transfer reaction products (STAR).
4. Completion of the upgrade and the commissioning of the U-400M cyclotron.
5. Development of the infrastructure of the ACCULINNA-2 fragment separator (RF kicker, tritium system).
6. Implementation of the programme of physics experiments at the U-400 cyclotron.
7. Construction of the U-400R cyclotron experimental hall.
8. Preparation for the reconstruction of the U-400 cyclotron (U-400R).
9. Development of the detector system in the focal plane of the MAVR analyzer and the MULTI spectrometer comprising a 4π-neutron detector and a gamma-detector.
10. Development of methods for the diagnostics of beams of stable and radioactive nuclides.
11. Further work on constructing the GALS separation set-up based on selective laser ionization of nuclear reaction products stopped in gas.
12. Completion of assembling the cryogenic gas ion catcher and the start of adjusting the vacuum and cryogenic systems.
13. Construction of the DC-140 cyclotron.
14. Elaboration of data for designing a radiochemical laboratory of class 1.

List of Activities

Activity or Experiment Laboratory or other Division of JINR Responsible person	Leaders Main researchers	Status
1. Development of the Superheavy Element Factory	**I.V. Kalagin**	Preparation
FLNR	G. Bondarenko, S.L. Bogomolov, O.A.Chernyshev, K.B. Gikal, G.G. Gulbekian, M.V. Habarov, G.N. Ivanov, I.A. Ivanenko, N.Yu. Kazarinov, V.A. Kostyrev, N.F. Osipov, S.V. Pashchenko, N.N. Pchelkin, A.V. Reshetov, V.A. Semin, V.A. Veryovochkin	
VBLHEP	A.A. Fateev, 2 pers.	
2. Development of the U-400M and U-400R complexes	**I.V. Kalagin**	Preparation Data taking
FLNR	S.L. Bogomolov, P.G. Bondarenko, O.A. Chernyshev, G.N. Ivanov, I.A. Ivanenko, N.Yu. Kazarinov, N.F. Osipov, S.V. Pashchenko, N.N.Pchelkin, A.V. Reshetov, V.A. Semin, V.A. Sokolov, R.E. Vaganov	
MLIT	P.G. Akishin, E.A. Airian, A.M. Chervyakov, V.V. Korenkov	
DLNP	G.A. Karamysheva, E.V. Samsonov, S.B. Vorozhtsov	
3. Construction of the DC-140 cyclotron complex	**I.V. Kalagin**	Preparation
FLNR	S.L. Bogomolov, O.A. Chernyshev, G.G. Gulbekian, M.V. Habarov, G.N. Ivanov, I.A. Ivanenko, N.Yu. Kazarinov, V.A. Kostyrev, S.V. Mitrofanov, N.F. Osipov, S.V. Pashchenko, N.N. Pchelkin, V.A. Semin, V.A. Veryovochkin	
DLNP	G.A. Karamysheva, 5 pers.	
VBLHEP	A.A. Fateev, 2 pers.	
4. Development of the ECR ion sources	**S.L. Bogomolov**	Preparation
FLNR	V.V. Behterev, A.E. Bondarchenko, A.A. Efremov, G.N. Ivanov, K. I. Kuzmenkov, A.N. Lebedev, V.N. Loginov, V.E. Mironov, D.K. Pugachev, N.Yu. Yazvitskiy	
VBLHEP	E.D. Donets, V.M. Drobin, E.E. Donets, S.A. Kostomin	
5. Development of the MT-25 microtron	**S.V. Mitrofanov**	Preparation Data taking
FLNR	N.V. Aksenov, S. I. Alekseev, O.A. Chenyshov, N.F. Osipov, S.V. Pashchenko, V.A. Semin, Yu.G. Teterev	
6. Development of the fragment separator ACCULINNA-2	**A.S. Fomichev**	Preparation Data taking
FLNR	E. Almanbetova, C.G. Belogurov, A.A. Bezbakh, V. Chudoba, E. M. Gazeeva, A.V. Gorshkov, V.A. Gorshkov, M.S. Golovkov, G. Kaminsky, A.N. Karpinsky , A.G. Knyazev, S.A. Krupko, K. A. May, B. Mauey, I.A. Muzalevsky, E.Yu. Nikolskii, P.G. Sharov, R.S. Slepnev, S.V. Stepantsov, G.M. Ter-Akopian, B.R. Khamidullin, M.S. Hirk, R. Wolski	
MLIT	E.V. Ovcharenko, V.N. Schetinin	

7. Development of a GASSOL pre-separator for radiochemical studies of SHE	**A.V. Eremin, G.G. Gulbekian**	Preparation
FLNR	K.B. Gikal, N.Yu. Kazarinov, A.M. Lomovtsev, V.I. Lisov, N.F. Osipov, K.V. Papenkov, D.I. Solovev, A.I. Svirikhin	
8. Development of a separator for the products of multinucleon transfer reactions	**A.G. Popeko** **A.V. Eremin**	Preparation
FLNR	V.I. Chepigin, M.L. Chelnokov, A.V. Isaev, I.N. Izosimov, S.A. Kalinin, D.E. Katrasev, O.N. Malyshev, , R.S. Mukhin, Yu.A. Popov, A.I. Svirikhin, E.A. Sokol, B. Saylaubekov	
9. Construction of the gas catcher and design of the MR-TOF spectrometerr	**A.M. Rodin, A.V. Karpov**	Preparation
FLNR	E.V. Chernysheva, A.V. Guljaev, A.V. Guljaeva, P. Kohout, A. Kohoutova, A.B. Komarov, L. Krupa, A.S. Novoselov, A.Opihal, A.V. Podshibyakin, V.S. Salamatin, V.Yu. Vedeneev, S.A. Yukhimchuk	
10. Development of a separator based on resonance laser ionization	**S.G. Zemlyanoy**	Preparation
FLNR	K.A. Avvakumov, E.M. Kozulin, G.V. Myshinskiy, T. Tserensambuu, V.I. Zhemenik, B. Zuzaan	
11. Project preparation for the construction of a radiochemical laboratory of class 1	**N.V. Aksenov**	Preparation
FLNR	A.Yu. Bodrov, A. Sh. Madumarov, S.V. Mitrofanov, A.V. Sabelnikov	

Collaboration

Country or International Organization	City	Institute or Laboratory
Belgium	Leuven	KU Leuven
Bulgaria	Sofia	INRNE BAS
Canada	Vancouver	TRIUMF
CERN	Geneva	CERN
China	Beijing	PKU
	Lanzhou	IMP CAS
Czech Republic	Brno	FEEC BUT
	Prague	FME CTU
		FNSPE CTU
		VP
	Rez	NPI CAS
Egypt	Giza	CU
	Shibin El Kom	MU
France	Caen	GANIL
	Orsay	IJCLab
		IPN Orsay
	Strasbourg	IPHC
	Vannes	SigmaPhi
Germany	Darmstadt	GSI
	Heidelberg	MPIK
Italy	Padua	INFN

Kazakhstan	Almaty	INP
	Astana	BA INP
		ENU
Mongolia	Ulaanbaatar	NRC NUM
Poland	Krakow	INP PAS
	Warsaw	HIL UW
		IEP WU
Republic of Korea	Daejeon	IBS
Russia	Moscow	HTDC
		ITEP
		ITT-Group
		MSU
		NNRU "MEPhI"
		NRC KI
	Moscow, Troitsk	INR RAS
	Nizhny Novgorod	IAP RAS
	Novosibirsk	BINP SB RAS
	Sarov	VNIIEF
	Snezhinsk	VNIITF
	St. Petersburg	IAI RAS
		NIIEFA
	Tomsk	TPU
Serbia	Belgrade	INS "VINCA"
	Novi Sad	UNS
Slovakia	Bratislava	CU
		IP SAS
	Nova Dubnica	EVPU
South Africa	Somerset West	iThemba LABS
	Stellenbosch	SU
USA	East Lansing, MI	MSU
	Nashville, TN	VU
	Oak Ridge, TN	ORNL
		MI RAS
		MSU
		NRU HSE
		SAI MSU
		SCC RAS
		SINP MSU
		VNIIMS
	Moscow, Troitsk	INR RAS
	Novosibirsk	BINP SB RAS
	Protvino	IHEP
	Saratov	SSU
	Tomsk	TPU
Serbia	Belgrade	IPB
		Univ.
Slovakia	Banska Bistrica	UMB
South Africa	Cape Town	UCT
Spain	Madrid	UAM
Turkey	Istanbul	BU
Ukraine	Kiev	BITP NASU
United Kingdom	Cambridge	Univ.

	Durham	Univ.
	London	Imperial College
	Southampton	Univ.
	York	Univ.
USA	Cincinnati, OH	UC
	College Park, MD	UMD
	Coral Gables, FL	UM
	Minneapolis, MN	U of M
	New York, NY	CUNY
	Newport News, VA	JLab
	Philadelphia, PA	Penn
	Piscataway, NJ	Rutgers
	Rochester, NY	UR
	Salt Lake City, UT	U of U
Vietnam	Hanoi	IOP VAST

03-5-1130-2017/2023		Priority:	1
		Status:	Being concluded

Synthesis and Properties of Superheavy Elements, the Structure of Nuclei at the Limits of Nucleon Stability

Leaders: M.G. Itkis
S.I. Sidorchuk

Scientific leader: Yu.Ts. Oganessian

Participating countries and international organizations:

Belgium, Bulgaria, CERN, China, Czech Republic, Egypt, Finland, France, Germany, India, Italy, Japan, Kazakhstan, Mongolia, Poland, Republic of Korea, Romania, Russia, Slovakia, South Africa, Spain, Sweden, Switzerland, Ukraine, United Kingdom, USA, Vietnam.

Issues addressed and main goals of research:

Synthesis of nuclei at stability limits and the investigation of their properties. Investigation of the mechanisms of heavy-ion-induced reactions. Study of the physical and chemical properties of heavy and superheavy elements.

Expected results in the current year:

1. Experiments at the Dubna gas-filled recoil separator GFS-2 of the SHE Factory aimed at studying the production cross sections of nuclei in reactions with the ^{48}Ca, ^{50}Ti, and ^{54}Cr ions and the decay properties of synthesized nuclei.
2. Preparation for experiments on the synthesis of elements 119 and 120.
3. Experiments on the study of the radioactive decay (α-, β-decay, spontaneous fission) properties of short-lived isotopes with Z>100 (No, Rf, Sg) produced in reactions with Ne, Ca, Ti, and Cr ions at the SHELS and GRAND (GFS-3) separators using the GABRIELA and SFiNX detector systems.
4. Experiments for studying the chemical properties of Cn and Fl at the Superheavy Element Factory.
5. Development of technologies for manufacturing accelerator targetsfrom stable and radioactive isotopes, which are stable under long irradiation with high-intensity heavy-ion beams.
6. Investigation of mass-energy and angular distributions of fragments produced in multi-nucleon transfer reactions. Study of the multi-body decay of low-excited heavy and superheavy nuclei. Development of physics set-ups.
7. Study of nuclei near the boundaries of nucleon stability. Preparation for and the conduct of experiments at the ACCULINNA-2 fragment separator using radioactive beams and the cryogenic targets H_2, D_2, T_2, ^{3}He, and ^{4}He.
8. Experiments at the MAVR set-up aimed at studying reactions with the emission of fast charged particles near the kinematic limit in coincidence with fission fragments. Experiments for studying the structure of neutron-rich nuclei in transfer reactions. Measurements of individual channel cross sections and total cross sections for the reactions with weakly bound nuclei.
9. Theoretical studies of the mechanisms of heavy-ion-induced reactions.
10. Maintenance and update of the web knowledge base on nuclear physics.

List of Activities

Activity or Experiment Laboratory or other Division of JINR Responsible person	Leaders Main researchers	Status
1. Synthesis of new isotopes of superheavy elements at SHE Factory FLNR	**V.K. Utyonkov** F.Sh. Abdullin, D. A. Ibadullayev, N.D. Kovrijnykh, D.A. Kuznetsov, A.N. Polyakov, O.V. Petrushkin, R.N. Sagaidak, V.D. Shubin, V.G. Subbotin, M.V. Shumeiko, D.I. Solov'ev, Yu.S. Tsyganov, A.A. Voinov, A.M. Zubareva	Data taking
2. α-, β- and γ-spectroscopy of heavy nuclei at the SHELS separator FLNR	**A.V. Yeremin** V.I. Chepigin, M.L. Chelnokov, A.V. Isaev, I.N. Izosimov, S.A. Kalinin, D.E. Katrasev, A.A. Kuznetsova, O.N. Malyshev, R.S. Mukhin, Yu.A. Popov, V.M. Popov, A.G. Popeko, E.A. Sokol, A.I. Svirikhin, V.A. Sbitnev, M.S. Tezekbaeva, B. Saylaubekov	Data taking
3. Chemical properties of superheavy elements FLNR	**S.N. Dmitriev** N.V. Aksenov, D. Abdusamadzoda, Yu.V. Albin, A.A. Astakhov, A.Yu. Bodrov, G.A. Bozhikov, I. Chuprakov, N.S. Gustova, A.I. Holtzman, K.V. Lebedev, A.Sh. Madumarov, I.V. Murav′yev, E. V. Pishchalnikova, L.S. Porobanyuk, A.V. Sabelnikov, G.Ya. Starodub, M.G. Voronyuk	Data taking
4. Experiments at the magnetic analyzer of superheavy atoms MASHA FLNR	**A.M. Rodin** E.V. Chernysheva, A.V. Guljaev, A.V. Guljaeva, A. Kohoutova, P. Kohout, A.B. Komarov, L. Krupa, A.S. Novoselov, A.Opihal, A.V. Podshibyakin, V.S. Salamatin, V.Yu. Vedeneev, S.A. Yukhimchuk	Data analysis
5. Study of the processes of fusion-fission, quasi-fission and multi-nucleon transfer reactions. CORSET-DEMON, CORSAR and MiniFOBOS set-ups FLNR MLIT	**M.G. Itkis** **E.M. Kozulin** I.N. Dyatlov, O.V. Falomkina, Z.I. Gorya'nova, Yu.M. Itkis, D.V. Kamanin, V.V. Kirokasian, N.I. Kozulina, G.N. Knyazheva, K.A. Kulkov, E.A. Kuznetsova, C.H. Meghashree, E. Mukhamedzhanov, E.I. Nikolenko, K.V. Novikov, A.A. Ostroukhov, I.V. Pchelintsev, Yu.V. Pyatkov, E.O. Savelieva, Yu.B. Semenov, A.N. Solodov, A.O. Strekalovsky, O.V. Strekalovskiy, R. S. Tikhomirov, I.V. Vorob'ev, A.O. Zhukova, V.E. Zhuchko P.V. Goncharov, G.A. Ososkov, A.V. Uzhinsky, V.B. Zlokazov	Data taking Data analysis Preparation
6. Study of the structure of exotic nuclei near and beyond the drip-lines at the ACCULINNA-2 and COMBAS fragment separators FLNR	**A.S. Fomichev** E. Almanbetova, E. Batchuluun, S.G. Belogurov, A.A. Bezbakh, V. Chudoba, M.S. Golovkov, L.V. Grigorenko, A.V. Gorshkov, V. A. Gorshkov, E.M. Gazeeva, A. Ismailova, G. Kaminski, A. N. Karpinsky, A. G. Knyazev, S.A. Krupko, S.A. Klygin, G.A. Kononenko, K.A. May, B. Mauyey, I.A. Muzalevskiy,	Data analysis

		E.Yu. Nikolskii, Yu.L. Parfenova, S.A. Rimzhanova, Yu.M. Sereda, S.I. Sidorchuk, R.S. Slepnev, P.G. Sharov, S.V. Stepantsov, G.M. Ter-Akopian, R. Wolski, A.N. Vorontsov, B.R. Khamidullin, M.S. Hirk	
	BLTP	S.N. Ershov, N.B. Shulgina	
	LIT	V.N. Shchetinin	
7.	**Investigation of reactions induced by stable and radioactive ion beams leading to the formation of exotic nuclei. Development of MAVR and MULTI set-ups**	**Yu.E. Penionzhkevich**	Data taking Preparation
	FLNR	D.T. Aznabaev, A. Azhibekov, A. Ch. Amer, I. V. Butusov, T. Isataev, S.M. Lukyanov, V.A. Maslov, K.O. Mendibaev, A. V. Shakhov, N.K. Skobelev, Yu.G. Sobolev, V.I. Smirnov, S.S. Stukalov, D.A. Testov, J. Zeynulla	
8.	**Theoretical studies of nuclear reaction mechanisms**	**A.V. Karpov**	Data taking Data analysis
	FLNR	E.A. Cherepanov, A.S. Denikin, I. A. Egorova, M.A. Naumenko, V.A. Rachkov, V.V. Samarin, V.V. Saiko	
9.	**Development and update of the network knowledge base on nuclear physics**	**A.V. Karpov** **A.S. Denikin**	Data taking
	FLNR	M.A. Naumenko, V.A. Rachkov, V.V. Samarin, V.V. Saiko	
10.	**Laser spectroscopy of isotopes**	**S.G. Zemlyanoy**	Data taking
	FLNR	K.A. Avvakumov, G.N. Myshinskiy, T. Tserensambuu, V.I. Zhemenik, B. Zuzaan	

Collaboration

Country or International Organization	City	Institute or Laboratory
Belgium	Leuven	KU Leuven
Bulgaria	Sofia	INRNE BAS
CERN	Geneva	CERN
China	Beijing	CIAE
		PKU
	Lanzhou	IMP CAS
Czech Republic	Olomouc	UP
	Prague	CTU
		VP
	Rez	NPI CAS
Egypt	Shibin El Kom	MU
	Tanta	Univ.
Finland	Jyvaskyla	UJ
France	Caen	GANIL
	Orsay	CSNSM
		IPN Orsay
	Saclay	SPhN CEA DAPNIA
	Strasbourg	CRN
		IPHC
Germany	Darmstadt	GSI
	Heidelberg	MPIK
	Mainz	JGU
	Tubingen	Univ.

India	Kolkata	VECC
	Roorkee	IIT Roorkee
	Rupnagar	IIT Ropar
Italy	Legnaro	INFN LNL
	Naples	Unina
Japan	Tokai	JAEA
	Wako	RIKEN
Kazakhstan	Almaty	IETP KazNU
		INP
	Astana	BA INP
		ENU
		NU
Poland	Krakow	INP PAS
	Poznan	AMU
	Warsaw	HIL UW
		UW
Republic of Korea	Daejeon	IBS
Romania	Bucharest	IFIN-HH
Russia	Dimitrovgrad	SSC RIAR
	Dubna	IPTP
	Gatchina	NRC KI PNPI
	Moscow	INEOS RAS
		MSU
		NNRU "MEPhI"
		NRC KI
		SINP MSU
	Neutrino	BNO INR RAS
	Sarov	VNIIEF
	St. Petersburg	IAI RAS
		Ioffe Institute
		KRI
		NIIEFA
		SPbSU
	Voronezh	VSU
Slovakia	Bratislava	CU
		IP SAS
South Africa	Somerset West	iThemba LABS
	Stellenbosch	SU
Spain	Huelva	UHU
Sweden	Goteborg	Chalmers
	Lund	LU
Switzerland	Villigen	PSI
Ukraine	Kiev	KINR NASU
United Kingdom	Manchester	UoM
USA	East Lansing, MI	MSU
	Nashville, TN	VU
	Oak Ridge, TN	ORNL
Vietnam	Hanoi	IOP VAST

03-2-1100-2010/2024	Priority:	1
	Status:	In-progress

Non-Accelerator Neutrino Physics and Astrophysics

Leaders: E.A. Yakushev
A. Kovalik

Participating countries and international organizations:

Azerbaijan, Bulgaria, Czech Republic, Finland, France, Germany, Italy, Kazakhstan, Mongolia, Poland, Russia, Slovakia, Switzerland, United Kingdom, USA, Uzbekistan.

Issues addressed and main goals of research:

Search for the neutrinoless mode and investigation of the double-neutrino mode of the double beta decay, clarification of the neutrino nature, Majorana or Dirac, and the absolute neutrino mass scale and hierarchies. Search for the neutrino magnetic moment, coherent elastic neutrino-nucleus scattering and dark matter. Investigation of galactic and extragalactic neutrino sources, the diffusive neutrino cosmic background, and search for exotic particles (monopoles). Use of the neutrino detector for a distant investigation of processes inside of the reactor core of the Kalinin Nuclear Power Plant (KNPP). Search for sterile neutrinos. Spectroscopy of nuclei far from stability. Development of new methods for charged and neutral particle detection.

Expected results in the current year:

1. Data taking in the *2b0n* decay measurements of ^{82}Se with the SuperNEMO spectrometer. Processing of the data collected in the GERDA experiment, set $T_{1/2}$ limits for different 2b-decay modes.
2. Processing of experimental data and determination of $T_{1/2}$(2b2n) for ^{48}Ca, ^{96}Zr, ^{130}Te, ^{116}Cd, ^{82}Se. Set a refined value of $T_{1/2}(2\beta2\nu)$ for ^{76}Ge based on the GERDA Phase II data.
3. Data taking with the HPGe-based low-background νGeN spectrometer at the Kalinin Nuclear Power Plant. Search for a signal of coherent neutrino scattering on germanium nuclei. Data taking start searching for the neutrino magnetic moment at the sensitivity level of ~ $(5\text{-}9)\cdot 10^{-12}$ μ_B after several years of data taking.
4. Continuation of data taking in the EDELWEISS experiment with new detectors operating with an energy threshold of 0.1 keV suitable for the extra-low mass WIMP region. Analysis of previously accumulated data, determination of parameters for light dark matter for the mass region below 1 GeV/c ^{2}. Start of the Ricochet phase of the experiment for precision CEnNS studuing at ILL with the detectors developed by EDELWEISS.
5. Start of data taking in the tone-scale LEGEND experiment searching for the 2b2n decay of ^{76}Ge. Assessment of the background level with the first batch of enriched detectors (~60 kg). Adding all available detectors and launching a full-scale experiment.
6. Data taking with ten clusters of the BAIKAL-GVD neutrino telescope. Search for and study of high-energy neutrinos of astrophysical nature. Construct on and commissioning of new detector clusters. Development and testing of new data acquisition and data transmission systems aiming at a lower energy threshold (Baikal project).
7. Continuation of the study of low-energy electrons from radioactive decay. Measurement of Auger spectra for ^{103}Pd and ^{125}I and low-energy conversion electrons from the decay of ^{227}Ac. Commissioning of the new vacuum evaporation setup in a radiochemical laboratory. ^{57}Co calibration measurements of the ESA-50 spectrometer. Processing of measurement results for 2022 and 2023.
8. Development and testing of new low-threshold (~ 200 eV) HPGe detectors for searching for the coherent neutrino scattering, as well as of plastic scintillator detectors for their active shielding.
9. Results of search for sterile neutrinos on the 2016-2021 data accumulated by the DANSS spectrometer. Precision estimates of the gamma and neutron background at the location of the DANSS spectrometer (room A336 under the reactor of the 4th power unit of the KNPP). R&D results of the spectrometr modernization.

10. The radiochemical laboratory of the 2nd class will be commissioned at DLNP; equipment for manufacture of radioactive sources for brachytherapy of cancer diseases will be installed; obtained sanitary and epidemiological certificates for the radiochemical laboratory will be concluded.

11. Continuation of the MONUMENT project. Analysis of data from 2021 and 2022 the experimental campaigns, namely for the measured ^{136}Ba, ^{76}Se, ^{100}Mo enriched isotopes. Preparation for measurements in 2023 (purchase of isotopically enriched elements, modernization of the muon trigger system). Data taking and analysis of accumulated data.

List of projects

	Project	**Leader**	**Priority (period of realisation)**
1.	SuperNEMO	O.I. Kochetov	1 (2013-2023)
2.	*v*GEN (GEMMA)	A.V. Lubashevskiy E.A.Yakushev	1 (2010-2023)
3.	EDELWEISS/RICOCHET	E.A. Yakushev	1 (2010-2023)
4.	GERDA (LEGEND)	K.N. Gusev	1 (2010-2023)
5.	DANSS	M.V. Shirchenko	1 (2011-2023)
6.	BAIKAL	I.A. Belolaptikov	1 (2009-2023)
7.	MONUMENT	D.R. Zinatulina	1 (2021-2023)

List of Activities

Activity or Experiment Laboratory or another Division of JINR Responsible person	**Leaders** Main researchers	**Status**
1. SuperNEMO Project	**O.I. Kochetov**	R&D Data taking
DLNP	D.V. Filosofov, I.I. Kamnev, D.V. Karaivanov, F.F. Klimenko, M.A. Mirzaev, I.B. Nemchenok, A.V. Rahimov, A.V. Salamatin, A.A. Smolnikov, Yu.A. Shitov V.V. Timkin, V.I. Tretyak, O.V. Vagina	
2. Investigation of *2K2n* and *2K0n* decays of ^{106}Cd with the TGV spectrometer	**N.I. Rukhadze** **I. Shtekl**	Data taking
DLNP	K.N. Gusev, S.L. Katulina, A.A. Klimenko, S.V. Rozov, A.V. Salamatin, V.G. Sandukovskiy, V.V. Timkin, V.P. Volnikh, E.A. Yakushev	
3. GERDA (LEGEND) Project	**K.N. Gusev**	Preparation Data taking
DLNP	Yu.V. Gurov, S.A. Evseev, D.I. Filosofov, M.V. Fomina, A.A. Klimenko, O.I. Kochetov, A.V. Lubashevsky, I.I. Kamenev, Z.Kh. Khushvaktov, F. Mamedov, I.B. Nemchenok, A.V.Rakhimov, S.V. Rozov, N.S. Rumyantseva, V.G. Sandukovsky, K.V. Shaktov, Yu.A. Shitov, E.A. Shevchik, M.V. Shirchenko, A.A. Smolnikov, S.I. Vasilev, V.P. Volnikh, I.V. Zhitnikov, D.R. Zinatulina, E.A. Yakushev	

4. vGEN (GEMMA) Project

A.V. Lubashevskiy
E.A. Yakushev

Modernization
Data taking

DLNP

V.V. Belov, S.A.Evseev, D.V. Filosofov, M.V. Fomina, L.Grubchin, U.B. Gurov, A.Kh. Inoyatov, S.L. Katulina, S.V. Kazartsev, S.P. Kiyanov, A.S. Kuznetsov, D.V. Medvedev, D.V. Ponomarev, D.S. Pushkov, A.V. Salamatin, V.G. Sandukovsky, K.V. Shakhov, T.A. Shevchik, M.V. Shirchenko, Z.Kh. Khukhvatov, S.V. Rozov, I.E. Rozova, V.P. Volnykh, I.V. Zhitnikov

5. EDELWEISS/RICOCHET Project

E.A. Yakushev
S.V. Rozov

Modernization
Data taking

DLNP

V. Belov, Yu. Gurov, A. Inoyatov, D. Karaivanov, S. Kazartsev, J. Khushvaktov, S. Evseev, A.V. Lubashevskiy, D.Filosofov, N.A. Mirzaev, D.V. Ponomarev, F.V. Rakhimov, I.E. Rozova, A.Salamatin, K.V. Shakhov, N.Temerbulatov, V. Trofimov, Yu. Vaganov

6. BAIKAL Project

I.A. Belolaptikov

Preparation
Data taking

DLNP

V.F. Allakhverdyan, P.I. Antonov, I.V. Borodina, V. Dik, I.S. Dotsenko, M.S. Dovbnenko, R. Dvornicky, A.A. Doroshenko, T.V. Elzhov, A.N. Emelianov, S.A. Evseev, K.V. Golubkov, N.A. Gorshkov, M.S. Katulin, S.A. Katulin, S.L. Katyulina, M.M. Kolbin, K.V. Konishev, A.V. Korobchenko, M.V. Kruglov, Y.M. Malyshkin, M.B. Milenin, M.L. Minaev, V. Nazari, D.V. Naumov, D.A. Orlov, D.P. Petukhov, E.N. Pliskovski, I.E. Rozova, V.D. Rushay, A.V. Salamatin, G.B. Safronov, S.I. Sinegovsky, A.E. Sirenko, M.N. Sorokovikov, N.I. Sosunov, I.A. Stepkin, A.P. Stromakov, E.V. Khramov, B.A. Shaybonov, K.I. Shevchenko, Yu.V. Yablokova, D.V. Zvezdov, D. Seitova, A.G. Solovjev

7. Experimental strudy of low-energy electron spectra arising in radioactive decay with the aim to obtain new data on low-excited states of nuclei and radiation-free relaxation of atomic systems

A.Kh. Inoyatov
A. Kovalik

Data taking

DLNP

M.A. Abd Al'ngar, M.S. Dovbnenko, S.V. Fateev, N.V. Morozova, V.A. Morozov, A.E. Sirenko, V.I. Stegailov, A.A. Solnyshkin, D.V. Filosofov, Yu.V. Yablokova

FLNR

I.N. Izosimov

8. Radiochemical support of irradiation of targets, separation of radionuclides from them by radiochemistry and mass separation methods, preparation of ionizing radiation sources for physical research at DLNP; chemical, radiochemical and mass separator support of low-background measurements for neutrino physics

D.V. Filosofov
A.Kh. Inoyatov

Preparation

DLNP

Yu.A. Vaganov, A.I. Velichkov, D.V. Karaivanov, N.V. Morozova, J.K. Samatov, A.A. Solnyshkin, J.A. Dadakhanov, E.S. Kurakina, A.E. Baimukhanova, A.V. Rakhimov, N.A. Mirzayev, M.Y. Vorobyeva, E.A. Denisova

FLNR

G.A. Bozhikov

9.	**Development of methods for the separation of elements (radiochemistry and mass separation); development of methods for obtaining radioisotopes for nuclear medicine and the synthesis of radiopharmaceuticals based on them; development and manufacture of micro sources for cancer brachytherapy; study of the physicochemical properties of condensed matter using the method of perturbed angular correlations of nuclear radiation**	**D.V. Filosofov**	Preparation
	DLNP	A. Baymukhanova, Yu.A. Vaganov, A.I. Velichkov, D.V. Karaivanov, A.A. Solnyshkin, A.V. Salamatin, D.A. Salamatin, N.T. Temerbulatova, E.S. Kurakina	
	FLNR	G.A. Bozhikov	
10.	**Development and production of low-energy-threshold HPGe detectors. Development and production of special types of Si and Ge detectors for low background measurements. Development and production of plastic scintillators for low-background spectrometers, neutron detectors, and cosmic muon detection. Development and production of a muon detection network for continuous atmosphere control in the Moscow region**	**E.A. Yakushev**	Preparation
	DLNP	Yu.B. Gurov, L. Grubchin, K.N. Gusev, S.L. Katulina, I.B. Nemchenok, D.V. Ponomarev, S.V. Rozov, V.G. Sandukovskiy	
	FLNR	A.M. Rodin	
	VBLHEP	N.I. Zamyatin	
11.	**DANSS Project**	**M.V. Shirchenko**	Data taking Modernization
	DLNP	V.V. Belov, M.V. Fomina, S.V.Kazartsev, S.P. Kiyanov, A.S. Kuznetsov, F. Mamedov, D.V. Medvedev, D.S. Pushkov, I.E. Rozova, A.V. Salamatin, D.V. Filosofov, E.A. Shevchik, I.V. Zhitnikov, V.P. Volnykh	
12.	**MONUMENT Project**	**D.R. Zinatulina** **M.V. Shirchenko**	Data taking Modernization
	DLNP	V.V. Belov, M.V. Fomina, K.N. Gusev, S.V. Kazartsev, N.S. Rumyantseva, E.A. Shevchik, E. Sushenok, I.V.Zhitnikov	

Collaboration

Country or International Organization	City	Institute or Laboratory
Azerbaijan	Baku	IRP ANAS
Bulgaria	Plovdiv	PU
	Sofia	INRNE BAS
Czech Republic	Prague	CTU
	Rez	NPI CAS
Finland	Jyvaskyla	UJ
France	Grenoble	UGA
	Lyon	IPNL
	Modane	LSM
	Orsay	CSNSM
	Saclay	CEA
Germany	Heidelberg	MPIK
	Karlsruhe	KIT
	Mainz	JGU
	Munich	TUM
	Tubingen	Univ.
Italy	Assergi	INFN LNGS
Kazakhstan	Almaty	INP
Malaysia	Johor Bahru	UTM
Mongolia	Ulaanbaatar	IPT MAS
Poland	Krakow	INP PAS
Russia	Dubna	Dubna State Univ.
	Gatchina	NRC KI PNPI
	Moscow	ITEP
		NNRU "MEPhI"
		SC "VNIINM"
		SINP MSU
	Moscow, Troitsk	HPPI RAS
		INR RAS
	Neutrino	BNO INR RAS
	St. Petersburg	FIP
		KRI
	Tomsk	NPI TPU
	Voronezh	VSU
Slovakia	Bratislava	CU
		IEE SAS
Switzerland	Villigen	PSI
	Zurich	UZH
United Kingdom	London	UCL
	Manchester	UoM
USA	Chapel Hill, NC	UNC
	Tuscaloosa, AL	UA
Uzbekistan	Tashkent	INP AS RUz
		NUU

03-4-1128-2017/2023			
		Priority:	1
		Status:	Being concluded

Investigations of Neutron Nuclear Interactions and Properties of the Neutron

Leader: E.V. Lychagin

Deputies: Yu.N. Kopatch
P.V. Sedyshev

Participating countries and international organizations:

Albania, Armenia, Australia, Austria, Azerbaijan, Belarus, Botswana, Bulgaria, CERN, China, Croatia, Czech Republic, Egypt, Finland, France, Georgia, Germany, Hungary, IAEA, India, Italy, Japan, Kazakhstan, Moldova, Mongolia, North Macedonia, Norway, Poland, Republic of Korea, Romania, Russia, Serbia, Slovakia, Slovenia, South Africa, Switzerland, Thailand, Turkey, Ukraine, USA, Uzbekistan, Vietnam.

Issues addressed and main goals of research:

Experimental and theoretical investigations of symmetry breaking effects in reactions with neutrons and fundamental properties of the neutron to test the parameters of the Standard Model and search for "new physics". Investigation of the properties of excited nuclei, reactions with emission of charged particles, fission physics. Obtaining of relevant data for astrophysics, nuclear power engineering and nuclear waste transmutation problem using neutron- and gamma-induced reactions. Application of neutron physics methods in other fields of science and technology. Development and construction of detectors of neutrons and other ionizing radiation, as well as applied methods in nuclear physics with neutrons. Development of the Intense REsonance Neutron Source (IREN) and the experimental base at the IREN and IBR-2 facilities.

Expected results in the current year:

Investigations of violations of fundamental symmetries in neutron-nucleus interactions and related data

1. Measurement of energy spectra and forward-backward emission asymmetry of gamma-rays in resonances.
2. Measurement of yields of rare fission modes of ^{252}Cf .
3. Measurement of gamma-ray yields in reactions with 14 MeV neutrons.
4. Measurements of prompt fission neutrons (PFN) for ^{235}U in the resonance region.
5. Measurement of the cross section for ^{171}Yb(n,α)^{168}Er and (n,α) reaction cross sections on gas samples (N, O, F, Ne, Ar) at E_n 3-5 MeV.
6. Measurement of the forward-backward asymmetry of the ^{14}N(n,p)^{14}C reaction at E_n=100-700 keV on EG-5 and of the ^{35}Cl(n,p)^{35}S reaction at En=0.1-1.0 keV on IREN.

Investigation of fundamental properties of the neutron, UCN physics:

1. Study of the possibility of creating a radiation-resistant UCN neutron guide for IBR-2 with losses and a fraction of nonspecular reflections ~10^{-3} per collision.
2. Simulation of the propagation of very cold neutrons (VCN) in various diamond nanopowders to optimize their parameters and increase the efficiency of VCN extraction from the source.
3. Investigation of the effect of the density of diamond nanopowders on the properties of slow neutron reflectors developed on their basis.
4. Design of an experimental setup to demonstrate the time focusing of UCN at a pulsed reactor.
5. Investigation of the possibility of increasing the intensity of a UCN source, based on the idea of time focusing using strong magnetic fields and neutron resonance spin-flippers.
6. Theoretical study of nonstationary phenomena in the reflection of UCN from an oscillating resonance potential.

Applied and methodological research

1. Creation of an experimental setup for measuring the R-effect in fission by polarized neutrons at the IBR-2 reactor.
2. Development of a method for determining the carbon concentration in soil using the tagged neutron method.
3. Investigation of optical and electronic properties of semiconductor materials using X-rays at the EG-5 accelerator.
4. Modernization of the EG-5 accelerator and its infrastructure.
5. Analysis of archaeological, biological and ecological samples by nuclear-physics methods at the IREN, REGATA2 facilities and using the laboratory equipment.
6. Completion of the modernization of the REGATA facility and its pneumatic conveying system at the IBR-2 reactor.
7. Creation of a charged particle spectrometer on the 1st channel of IREN.

Development of the IREN facility

1. Providing the neutron beam time from IREN for physics experiments.

List of projects

Project	Leader	Priority (period of realisation)
1. TANGRA	Yu.N. Kopatch	1 (2014-2023)
2. Modernization of the EG-5 accelerator	A.S. Doroshkevich	1 (2022-2023)
3. ENGRIN	Sh.S. Zeynalov Deputy: L.V. Mitsyna	1 (2022-2023)

List of Activities

Activity or Experiment	Leaders	Status
Laboratory or other Division of JINR Responsible person	Main researchers	
1. Investigations of violations of fundamental symmetries in neutron-nucleus interactions and related data	**Yu.N. Kopatch**	Upgrade Data taking Data analysis
FLNP	G.S. Ahmedov, D. Berikov, S.B. Borzakov, G.V. Danilyan, Yu.M. Gledenov, D.N. Grozdanov, N.A. Gundorin, Sh.S. Zeinalov, V.L. Kuznetsov, Zh.V. Mezentseva, I.A. Oprea, K.D. Oprea, Yu.N. Pokotilovski, A.B. Popov, P.V. Sedyshev, M.V. Sedysheva, O.V. Sidorova, N.V. Simbirtseva, V.R. Skoj, A.M. Sukhovoj, S.A. Telezhnikov, T.Yu. Tretyakova, Fan Lyong Tuan, I. Chuprakov, S. Enkhbold, 12 engineers, 8 workers	
2. Investigation of fundamental properties of the neutron, UCN physics	**E.V. Lychagin**	Upgrade Data taking Data analysis
FLNP	S.V. Goryunov, T.L. Enik, M.A. Zakharov, V.L. Kuznetsov, G.V. Kulin, L.V. Mitsyna, S.N. Mironov, A.Yu. Muzychka, A.Yu. Nezvanov, Yu.N. Pokotilovski, A.B. Popov, N.V. Rebrova , V.A. Strelkov, A.I. Frank, W.I. Furman, E.I. Sharapov, 4 engineers	

3. Applied research	**P.V. Sedyshev**	Upgrade Data taking Data analysis
FLNP	Yu.V. Aleksiayenak, G.S. Ahmedov, D. Berikov, S. B. Borzakov, O.E. Chepurchenko, O. Chaligava, I. Chuprakov, A.S. Doroshkevich, A.Yu. Dmitriev, T.L. Enik, A. Ergashov, Fan Lyong Tuan, N.A. Fedorov, O.C. Filippova, A.I. Frank, M.V. Frontasyeva, W.I. Furman, V.M.B. Ged, Yu.M. Gledenov, D.S. Grozdov, D.N. Grozdanov, N.A. Gundorin, C. Hramco, G.Ya. Hristozova, Yu.N. Kopatch, V.L. Kuznetsov, G.V. Kulin, E.V. Lychagin, A.I. Madadzada, A.G.Malinin, S. Mazhen, Zh.V. Mezentseva, L.V. Mitsyna, A.Yu. Muzychka, T.B. Nguen, A.Yu.Nezvanov, B. Niedobova, P.S. Nekhoroshkov, I.A. Oprea, K.D. Oprea, I. Pavlikova, Yu.N. Pokotilovski, A.B. Popov, N.V. Rebrova, A. Svozilikova Krakovska, E.I. Sharapov, M. Sedysheva, O.V. Sidorova, N.V. Simbirtseva, V.R. Skoy, V.A. Strelkov, V.N. Shvetsov, M.C. Shvetsova, A.M. Sukhovoj, S.A. Telezhnikov, K.N. Vergel, S. Zeinalov, I.I. Zinicovscaia, K.N. Zhernenkov, 35 engineers, 20 workers.	
4. Development of the IREN facility	**V.N. Shvetsov**	Upgrade
FLNP	E.A. Golubkov, V.G. Pjataev, 17 engineers, 1 worker	
VBLHEP	A.P. Sumbaev, 3 engineers	
5. Development of experimental infrastructure of the IREN facility	**E.V. Lychagin**	Upgrade
FLNP	A.A. Beliakov, E.V. Lychagin, V.G. Pyataev, P.V. Sedyshev, V.A. Trepalin, 15 engineers.	
6. Modernization of EG-5 accelerator	**A.S. Doroshkevich**	Upgrade
FLNP	I.A. Chepurchenko, R.Sh. Issaev, Yu.N. Kopach, A.N. Likhachev, V.N. Semenov, K.E. Studnev, S.N. Tkachenko, K.N. Udovichenko, I.A. Zaitsev, A.S. Zakharova, T.Yu. Zeleniak	
7. Project ENGRIN	**Sh.S. Zeynalov**	Data taking Data analysis
FLNP	A.M. Lebedev, L.V. Mitsyna, O.V. Sidorova, A.M. Sukhovoy	
8. Project TANGRA	**Yu.N. Kopatch**	Upgrade Data taking Data analysis
FLNP	V.R. Skoy, N.A. Gundorin, V.N. Shvetsov, T.Yu. Tretiakova, F. Aliev, D. Grozdanov, N.A. Fedorov, C. Hramco	
VBLHEP	V.Yu. Aleksakhin, N.I. Zamiatin, E.V. Zubarev, M.G. Sapozhnikov, Yu.N. Rogov, V.M. Slepnev, S.V. Khabarov	
DLNP	A.V. Krasnoperov, A.B. Sadovskii, A.V. Salamatin	
LRB	G.N. Timoshenko	

Collaboration

Country or International Organization	City	Institute or Laboratory
Albania	Tirana	UT
Armenia	Yerevan	SRCHCH
Australia	Melbourne, VIC	Univ.
Austria	Innsbruck	Univ.
Azerbaijan	Baku	BSU
		IGG ANAS
		IRP ANAS
Belarus	Minsk	BSU
		INP BSU
		SPMRC NASB
Botswana	Palapye	BIUST
Bulgaria	Plovdiv	PU
		UFT
	Sofia	IE BAS
		INRNE BAS
CERN	Geneva	CERN
China	Beijing	IHEP CAS
	Xi'an	NINT
Croatia	Zagreb	Oikon IAE
		RBI
Czech Republic	Ostrava	VSB-TUO
	Prague	CEI
		CTU
	Rez	CVR
Egypt	Alexandria	Univ.
	Cairo	NRC
	Giza	CU
	Mansoura	MU
	Shibin El Kom	MU
Finland	Jyvaskyla	UJ
	Oulu	UO
France	Cadarache	CC CEA
	Grenoble	ILL
		LPSC
	Saclay	LLB
	Strasbourg	IPHC
Georgia	Tbilisi	AIP TSU
		TSU
Germany	Darmstadt	GSI
	Dresden	HZDR
	Kleve	HSRW
	Mainz	JGU
	Munich	TUM
	Tubingen	Univ.
Hungary	Budapest	RKK OU
IAEA	Vienna	IAEA
India	Varanasi	BHU
Italy	Rome	ENEA
Japan	Kyoto	KSU

	Tsukuba	KEK
Kazakhstan	Almaty	INP
	Astana	ENU
	Kyzylorda	KazSRIRG
Moldova	Chisinau	IChem
		IMB ASM
Mongolia	Ulaanbaatar	CGL
		NRC NUM
North Macedonia	Skopje	UKiM
Poland	Gdansk	GUT
	Krakow	INP PAS
	Lodz	UL
	Lublin	UMCS
	Opole	UO
	Otwock (Swierk)	NCBJ
	Poznan	AMU
	Wroclaw	UW
Republic of Korea	Daejeon	KAERI
	Pohang	PAL
	Seoul	Dawonsys
Romania	Baia Mare	TUCN-NUCBM
	Bucharest	IFIN-HH
		IGR
		INCDIE ICPE-CA
		UB
		UPB
	Cluj-Napoca	INCDTIM
	Constanta	UOC
	Galati	UG
	Iasi	NIRDTP
		UAIC
	Magurele	ISS
		NIMP
	Oradea	UO
	Pitesti	ICN
	Ramnicu Valcea	I.C.S.I.
	Sibiu	ULBS
	Targoviste	UVT
	Timisoara	UVT
Russia	Arkhangelsk	NArFU
	Borok	IBIW RAS
	Dolgoprudny	MIPT
	Dubna	Diamant
		Dubna State Univ.
	Gatchina	NRC KI PNPI
	Grozny	CSPU
	Irkutsk	LI SB RAS
	Ivanovo	ISUCT
	Izhevsk	UdSU
	Moscow	GIN RAS
		GPI RAS
		IA RAS

		IKI RAS
		IPCE RAS
		ITEP
		MSU
		NRC KI
		SC "IASRWA"
		Sechenov Univ.
		SIAS
		SINP MSU
		VNIIA
	Moscow, Troitsk	INR RAS
	Nizhny Novgorod	IPM RAS
	Obninsk	IPPE
	Perm	PSNRU
	Sevastopol	IBSS
	St. Petersburg	Botanic garden BIN RAS
		FIP
		Ioffe Institute
		KRI
		SPMU
		SPSFTU
	Tula	TSU
	Vladikavkaz	NOSU
	Voronezh	VSU
	Yekaterinburg	UrFU
Serbia	Belgrade	IPB
		Univ.
	Novi Sad	UNS
Slovakia	Bratislava	CU
		IEE SAS
		IP SAS
Slovenia	Ljubljana	GeoSS
South Africa	Bellville	UWC
	Pretoria	UNISA
	Stellenbosch	SU
Switzerland	Villigen	PSI
Thailand	Hat Yai	PSU
Turkey	Canakkale	COMU
Ukraine	Berdyansk	BSPU
	Donetsk	DonIPE
	Kharkov	ISMA NASU
		NSC KIPT
	Kiev	KINR NASU
		NUK
	Uzhhorod	IEP NASU
USA	Durham, NC	Duke
	Los Alamos, NM	LANL
	Oak Ridge, TN	ORNL
Uzbekistan	Tashkent	INP AS RUz
Vietnam	Hanoi	IOP VAST
		VNU

Condensed Matter Physics, Radiation and Radiobiological Research (04)

04-4-1142-2021/2025			
		Priority:	1
		Status:	In-progress

Investigations of Functional Materials and Nanosystems Using Neutron Scattering

Leaders: D.P. Kozlenko
V.L. Aksenov
A.M. Balagurov

Participating countries and international organizations:

Armenia, Azerbaijan, Belarus, Bulgaria, China, Cuba, Czech Republic, Egypt, France, Germany, Hungary, India, Italy, Japan, Kazakhstan, Latvia, Mongolia, Poland, Romania, Russia, Serbia, Slovakia, South Africa, Spain, Switzerland, Tajikistan, Ukraine, United Kingdom, USA, Uzbekistan, Vietnam.

Issues addressed and main goals of research:

Investigations of structural features and dynamics of novel functional materials and nanosystems focused on determination of microscopic mechanisms of the formation of physical properties and phenomena that are important for the development of modern concepts in the areas of condensed matter physics, materials science, chemistry, geophysics, engineering sciences, biology, pharmacology, and for the development of modern technologies.

Expected results in the current year:

Realization of scientific program

1. Analysis of the structural phase transformations features in magnetostrictive alloys at variation of thermodynamic conditions, synthesis conditions, thermomechanical processing.
2. Determination of parameters of the atomic and magnetic structure of Heusler alloys $MnNi_{1-x}M_xSb$ (M – transition metal) in a wide range of thermodynamic conditions.
3. Determination of parameters of crystal, magnetic and electronic subsystems of multifunctional oxides based on cobalt, manganese, iron in the region of spin transition and antiferromagnetic-ferromagnetic-paramagnetic and metal-insulator phase transitions in a wide range of temperatures and pressures.
4. Analysis of high-pressure effects on crystal and magnetic structure of layered low-dimensional magnetic materials.
5. Study of the effect of microstructure of electrodes with varying composition on charge-discharge processes in compact electric power sources. Clarification of structural mechanisms responsible for the capacity and lifetime of batteries. Selection of optimal discharge/charge modes during cycling.
6. Analysis of processes of deposition and intercalation of electrically active ions and their derivatives from liquid and solid electrolytes at electrochemical interfaces in compact electric power sources. A comparative study of characteristics of adsorption layers (density, thickness, homogeneity) at electrochemical interfaces for electrolytes and electrodes.
7. Study of phenomena and effects induced by the interaction of ferromagnetic and superconducting order parameters in complex heterostructures with ferromagnetic and helicoidal magnetic ordering.
8. Investigation of structural stability of colloidal systems, including biomedical solutions, in bulk and at interfaces under various conditions. Determination of characteristics of adsorption layers at interfaces in case of loss of stability as a result of external influence of gradient electric and magnetic fields, as well as temperature effects. Study of the effect of aggregate formation in bulk on adsorption.
9. Investigation of the structure of a number of advanced nanosystems based on composite carbon- and silicon-containing materials, including those based on fullerenes, nanodiamonds and their bioactive derivatives. Study of complex multicomponent systems. Determination of conditions for synthesis of homogeneous systems. Investigation of effects of phase separation in advanced practical systems.
10. Determination of structural characteristics of magnetic elastomers, holding promise for technological applications.

11. Study of structure and vibrational spectra of molecular complexes: ionic-molecular inclusive materials and complexes with electric charge transfer, structural and dynamic parameters of hydrogen bonds in bioactive materials.
12. Investigation of molecular mechanisms of protein interaction, dimerization and functional characteristics of supramolecular structures and molecular complexes. Study of regularities and relationships between structural characteristics and functions of proteins, protein complexes and membrane-protein aggregates. Analysis of the effect of composition and external parameters on the phase state of membranes.
13. Determination of structural characteristics and diffusion properties of lipid nanosystems for transport of drugs and nano-drugs.
14. Analysis of geophysical processes in the lithosphere using data on textures of deep-seated and near-surface rocks. Investigation of relationships between seismic anisotropy of lithosphere rocks and textures of minerals, preferentially-oriented cracks and pores.
15. Investigation of crystallographic texture and phase composition of biological objects (mollusk shells, corals, animal bones, teeth, biomineralized structures).
16. Nondestructive testing of residual internal stresses and microstrains in real industrial products and advanced structural materials induced by various technological processes (metal and heat treatment, welding, rolling, stamping, 3D printing, etc.).
17. Investigation of relationships between microstructure and thermomechanical properties of advanced functional and structural materials (high-strength steels, aluminum and magnesium alloys, composites, cermets, etc.), analysis of mechanical behavior of structural materials under external stimuli (load, temperature).
18. Analysis of internal structure and construction of 3D models of objects of cultural and natural heritage, industrial materials and products using neutron tomography and radiography data.
19. Clarification of mechanisms of radiation damage to solids, obtaining long-life operating data on radiation damage resistance of materials.

Realization of instrument development program for the IBR-2 spectrometers

1. Development and construction of the main units for a new inverse geometry inelastic scattering spectrometer at the beamline 2.
2. Development and construction of elements of basic configuration of a small-angle scattering and imaging spectrometer at beamline 10.
3. Development of neutron guide and detector system for the new DN-6 diffractometer for studies of microsamples, aimed at improving its technical parameters and expanding the available range of high pressures.
4. Improvement of technical parameters and expansion of experimental capabilities of the GRAINS multifunctional reflectometer (startup of a new neutron beam chopper, development of electrochemical and liquid cells for conducting experiments).
5. Modernization of the available IBR-2 spectrometers (HRFD, RTD, DN-12, YuMO, FSD, REFLEX, REMUR, SKAT, EPSILON) aimed at improving their technical characteristics (enhancement of luminosity, suppression of neutron background, improvement of data acquisition systems and expansion of experimental capabilities).
6. Development and construction of a prototype of a small-angle spin-echo scattering spectrometer at beamline 9.
7. Improvement of technical characteristics of the radiography and tomography spectrometer at beamline 14 (spatial resolution, radiation resistance of the detector system).
8. Upgrade of the FSS correlation spectrometer at beamline 13 and improvement of its technical parameters. Further development of the RTOF correlation method.
9. Development of neutron methods for condensed matter research, including spin-echo, neutron standing waves, neutron wave splitting, neutron magnetic resonance, radiography, tomography, and other techniques.
10. Development of neutron scattering methods for in-operando monitoring and study of electrochemical materials and interfaces. Creation of a laboratory site for the study of chemical current sources at the INP, Almaty, development of specialized electrochemical cells for neutron reflectometry.

List of projects

	Project	Leader	Priority (period of realisation)
1.	DINSS	D.M. Chudoba	1 (2021-2023)

List of Activities

	Activity or Experiment Laboratory or other Division of JINR	Leaders Main researchers	Status
1.	**Study of structure and properties of new inorganic and organic functional materials**	**A.M. Balagurov** **D.P. Kozlenko** **S.I. Tiutiunnikov** (VBLHEP)	Data taking
	FLNP	E.B. Askerov, A.I. Beskrovnyi, R.N. Golosova, S.E. Kichanov, M.L. Kraus, E.V. Lukin, G.M. Mironova, D.S. Neov, A. Pawlukojc, B.N. Savenko, N.Yu. Samoilova, V.V. Sikolenko, S.V. Sumnikov, V.A. Turchenko, Vasin, N.O., T.N. Vershinina	
	MLIT	V.B. Zlokazov	
	VBLHEP	V.A. Artyukh, V.V. Efimov, Yu.S. Kovalev, I.A. Kryachko, A.V. Rogachev, V.N. Shalyapin, N.I. Zamyatin	
2.	**Investigation of structural and magnetic properties of materials under extreme conditions**	**D.P. Kozlenko**	Data taking
	FLNP	A. Asadov, N.M. Belozerova, N.O. Golosova, S.E. Kichanov, E.V. Lukin, A.V. Rutkauskas, B.N. Savenko	
3.	**Real-time investigations of physical and chemical processes in functional materials**	**N.Yu. Samoilova**	Data taking
	FLNP	A.I. Beskrovnyi, S.V. Sumnikov, O.Yu. Ivanshina, V.G. Simkin, G.M. Mironova, T.N. Vershinina, I.A.Bobrikov	
4.	**Computer simulation of structure and properties of new functional materials and nanosystems**	**A. Pawlukojc**	Data taking
	FLNP	Kh.T. Kholmurodov	
5.	**Investigation of structural and magnetic properties of layered nanostructures**	**Yu.V. Nikitenko**	Data taking
	FLNP	S.V. Kozhevnikov, A.V. Petrenko, V.D. Zhaketov, Ye.D. Kolupaev	
6.	**Investigation of structure of carbon-and silicon-containing nanomaterials**	**V.L. Aksenov**	Data taking
	FLNP	D.M. Chudoba, M. Jazdzewska, K.B. Ludzik-Dychto, A.Zh. Nazarova, T.V. Tropin	
7.	**Investigation of molecular dynamics of functional materials**	**D.M. Chudoba**	Data taking
	FLNP	P. Bilski, E.A. Goremychkin, M. Jazdzewska, K.B. Ludzik-Dychto, Z. Surowiec, J. Waliszewski, I. Zuba	

8. Investigation of dispersed systems and complex fluids in bulk and at interfaces	**M.V. Avdeev**	Data taking
FLNP	M.Yerdauletov, Kh. Kholmurodov, T.V. Tropin	
9. Investigation of structural organization of biogenic and non-biogenic nanoparticles, composites based on magnetic fluids, polymers and other nanomaterials	**M. Balasoiu**	Data taking
FLNP	O.I. Ivankov, A.Kh. Islamov, A.I. Kuklin, A. Nabiev, A.V. Rogachev, V.A. Turchenko	
FLNR	N.E. Lizunov, O.L. Orelovich	
MLIT	A.G. Soloviev, T.M. Solovieva	
10. Investigation of supramolecular structure and functional characteristics of biological nanosystems	**A.I. Kuklin**	Data taking
FLNP	O.I. Ivankov, A.Kh. Islamov, Yu.S. Kovalev, T.N. Murugova, A.V. Rogachev, V.V. Skoy, A.V. Vlasov, Yu.L. Rijikov, A.A. Nabiev, M.I. Rulev, D.V.Solovyev	
MLIT	A.G. Soloviev, T.M. Solovieva	
11. Investigations of structure and properties of lipid membranes and complexes	**M.A. Kiselev**	Data taking
FLNP	O.I. Ivankov, V.A. Maslova	
MLIT	E.V. Zemlyanaya	
12. Investigations of structure and properties of biohybrid complexes	**Yu.E. Gorshkova**	Data taking
FLNP	O.Yu. Ivanshina, T.V. Tropin	
13. Investigation of internal stresses and microstrains in structural materials and industrial products	**G.D. Bokuchava**	Data taking
FLNP	A.A. Kruglov, B. Mukhametuly, I.V. Papushkin, A.V. Tamonov, Yu.V. Taran	
14. Investigation of features of internal structure of cultural and natural heritage objects, structural materials and industrial products	**D.P. Kozlenko**	Data taking
FLNP	S.E. Kichanov, E.V. Lukin, K.M. Nazarov, A.V. Rutkauskas, B.N. Savenko, V.S. Smirnova, A. Zhomartova, I.Yu. Zel	
15. Investigation of texture and properties of rocks and minerals, structural materials, biological objects	**D.I. Nikolaev**	Data taking

FLNP	B. Altangerel, T.I. Ivankina, T.A. Lychagina, V.V. Sikolenko, R.N. Vasin	
16. Study of radiation damage effects in solid-state materials	**S.I. Tiutiunnikov** (VBLHEP)	Data taking
VBLHEP	V.A. Artyukh, V.V. Efimov, Yu.S. Kovalev, I.A. Kryachko, A.V. Rogachev, V.N. Shalyapin, N.I. Zamyatin	
17. Development of IBR-2 spectrometers	**M.V. Avdeev** **D.P. Kozlenko** **D.M. Chudoba**	Realization
FLNP	A.I. Beskrovnyi, V.I. Bodnarchuk, G.D. Bokuchava, E.A. Goremychkin, S.V. Kichanov, A.I. Kuklin, A.I. Ivankov, E.V. Lukin, Yu.V. Nikitenko, Yu.V. Petrenko, B.N. Savenko, V.G. Simkin, V.I. Sukhanov, S.V. Sumnikov, V.A. Turchenko	
18. Development of neutron methods to study functional materials and nanosystems	**G.D. Bokuchava** **D.P. Kozlenko** **M.V. Avdeev**	Data taking
FLNP	S.E. Kichanov, S.V. Kozhevnikov, E.V. Lukin, Yu.V. Nikitenko, A.V. Rutkauskas, V.D. Zhaketov	

Collaboration

Country or International Organization	City	Institute or Laboratory
Armenia	Yerevan	Foundation ANSL
		SRCHCH
Azerbaijan	Baku	AzTU
		IP ANAS
Belarus	Minsk	BSTU
		IAP NASB
		INP BSU
		RI PCP BSU
		SPMRC NASB
Bulgaria	Sofia	ASCI Ltd
		IE BAS
		IEES BAS
		INRNE BAS
		ISSP BAS
		UCTM
China	Harbin	HEU
Cuba	Havana	InSTEC
Czech Republic	Prague	BC CAS
		CTU
		CU
		IG CAS
		IP CAS
	Rez	NPI CAS
Egypt	Cairo	ASU
		EAEA
	Giza	CU
France	Grenoble	IBS
		ILL

	Saclay	LLB
Germany	Bochum	RUB
	Bonn	UniBonn
	Darmstadt	TU Darmstadt
	Freiberg	TUBAF
	Geesthacht	Hereon
	Halle	MLU
	Karlsruhe	KIT
	Kiel	IFM-GEOMAR
	Rostock	Univ.
	Stuttgart	MPI-FKF
Hungary	Budapest	Wigner RCP
India	Patna	NIT Patna
Italy	Messina	UniMe
Japan	Minato	Keio Univ.
	Tokyo	Waseda Univ.
Kazakhstan	Almaty	INP
Latvia	Riga	ISSP UL
Mongolia	Ulaanbaatar	IPT MAS
Poland	Bialystok	BUT
		UwB
	Krakow	AGH-UST
		INP PAS
		JU
	Lublin	UMCS
	Poznan	AMU
	Szczecin	WPUT
	Warsaw	INCT
	Wroclaw	UW
Romania	Baia Mare	TUCN-NUCBM
	Bucharest	INCDIE ICPE-CA
		UB
	Cluj-Napoca	INCDTIM
		RA BC-N
		UBB
	Constanta	MINAC
	Craiova	UC
	Iasi	NIRDTP
		TUIASI
		UAI
		UAIC
		USAMV
	Magurele	NIMP
	Pitesti	UPIT
	Targoviste	UVT
	Timisoara	ICT
		ISIM
		UVT
	Tulcea	DDNI
Russia	Chelyabinsk	SUSU
	Chernogolovka	ISSP RAS
	Dolgoprudny	MIPT

	Dubna	Dubna State Univ.
	Gatchina	NRC KI PNPI
	Kaliningrad	IKBFU
	Kazan	KFU
		KNRTU
	Krasnoyarsk	FRC KSC SB RAS
		KIP SB RAS
		SibFU
	Moscow	IA RAS
		IC RAS
		ICP RAS
		IEPT RAS
		IGEM RAS
		IGIC RAS
		IMET RAS
		INMI RAS
		Inst. Immunology
		IPE RAS
		MIET
		MISiS
		MSU
		NNRU "MEPhI"
		NRC KI
		PIN RAS
		SINP MSU
	Moscow, Troitsk	HPPI RAS
		INR RAS
	Nizhny Novgorod	IPM RAS
		UNN
	Perm	ICMM UrB RAS
		ITCh UrB RAS
	Rostov-on-Don	RIP SFU
	St. Petersburg	CRISM "Prometey"
		IMC RAS
		Ioffe Institute
		SPbSU
	Sterlitamak	SB BSU
	Tula	TSU
	Tyumen	UTMN
	Yekaterinburg	IMP UB RAS
		UrFU
Serbia	Belgrade	INS "VINCA"
Slovakia	Bratislava	CU
	Kosice	IEP SAS
South Africa	Pretoria	Necsa
		UP
Spain	Barcelona	ICMAB-CSIC
	Leioa	BCMaterials
	Madrid	CENIM-CSIC
Switzerland	Villigen	PSI
Tajikistan	Dushanbe	NAST
		PHTI NAST

		TTU
Ukraine	Donetsk	DonIPE
		DonNU
	Kiev	DonIPE NASU
United Kingdom	Didcot	RAL
USA	Berkeley, CA	UC
Uzbekistan	Tashkent	INP AS RUz
Vietnam	Da Nang	DTU
	Hanoi	IOP VAST

04-4-1105-2011/2023		Priority:	1

Status: Being concluded

Development of the IBR-2 Facility with a Complex of Cryogenic Neutron Moderators

Leaders: A.V. Vinogradov
A.V. Dolgikh

Participating countries and international organizations:

Azerbaijan, Belarus, Mongolia, Poland, Romania, Russia, Spain.

Issues addressed and main goals of research:

The main task of the theme is to increase the efficiency of the use of the IBR-2 facility for realization of the program of experimental studies, maintenance of operational reliability and safety of the reactor, development and construction of the complex of cryogenic neutron moderators.

Expected results in the current year:

1. Obtaining Rostekhnadzor license for the operation of the IBR-2 nuclear research facility.
2. Maintenance of the IBR-2 reactor operation for physics investigations.
3. Check assembling, adjustment and testing of the backup movable reflector MR-3R at the FLNP test bench. Experimental investigations on determination of dynamic characteristics and parameters of vibrations of the units and structure modules at the stage of assembly and bench testing of MR-3R. Preparation of MR-3R for regular operation.
4. Commissioning of the Linde AG cryogenic refrigerator with a cooling power of 1800 W at 10 K (KGU 1800/10) to ensure the most efficient use of the suite of IBR-2 instruments in cold neutron experiments. Optimization of the operation of the cryogenic complex.
5. Trial operation of cryogenic moderators CM-201 and CM-202.
6. Phased replacement and upgrade of the basic technological and electrical safety-related equipment of the IBR-2 nuclear research facility.
7. Development of the hardware and software structure of the information-measuring system for research and diagnostics of the IBR-2 reactor state, as well as further work on the computational and experimental substantiation of the safe and reliable operation of IBR-2 under conditions of long-term operation and intensification of degradation processes in the core.
8. Exploring the possibility of manufacturing and supplying an additional batch of fresh fuel for the IBR-2 core (in cooperation with the Mayak Production Association) to extend the service life of the reactor for physics experiments until 2040-2042.

List of projects

	Project	Leader	Priority (period of realization)
1.	Construction of the complex of cryogenic moderators at the IBR-2 facility	A.A. Belyakov M.V. Bulavin	1 (2014-2023)

List of Activities

	Activity or Experiment Laboratory or other Division of JINR	Leaders Main researchers	Status
1.	**Operation of the IBR-2 facility in regular mode** FLNP	**A.V. Dolgikh** **A.V. Vinogradov** M.V. Andrianov, A.A. Belyakov, Yu.N. Pepelyshev, S.V. Rudenko, S.A. Tsarenkov, V.A. Krivov, D.Yu. Denisenko, 30 engineers, 50 workers	Realization
2.	**Provision of physics research program** FLNP	**A.V. Vinogradov** **A.V. Dolgikh** A.A. Belyakov, Yu.N. Pepelyshev, S.V. Rudenko, V.A. Krivov, D.Yu. Denisenko, 57 engineers, 68 workers	Realization
3.	**Test operation of CM-201 and CM-202 cryogenic moderators. Operation of cryogenic moderators using new cryogenic refrigerator by Linde in the regular place** FLNP	**A.A. Belyakov** **M.V. Bulavin** V.A. Skuratov, A.V. Galushko, 15 engineers, 15 workers	Realization
4.	**Assembling of backup movable reflector MR-3R. Preparation for regular operation** FLNP	**A.V. Vinogradov** **A.V. Dolgikh** Yu.M. Slotvitsky, 9 engineers, 6 workers	Realization
5.	**Phased replacement and upgrade of basic technological and electrical equipment** FLNP	**A.V. Vinogradov** **A.V. Dolgikh** A.A. Belyakov, D.Yu. Denisenko, 30 engineers, 50 workers	Realization

Collaboration

Country or International Organization	City	Institute or Laboratory
Azerbaijan	Baku	IRP ANAS
		NNRC
Belarus	Minsk	JIPNR-Sosny NASB
Mongolia	Ulaanbaatar	IPT MAS
Poland	Krakow	AGH-UST
Romania	Bucharest	IFIN-HH
Russia	Moscow	INEUM
		OKSAT NIKIET
		SSDI
		SYSTEMATOM
Spain	Valencia	UPV

04-4-1143-2021/2025		Priority:	1
		Status:	In-progress

Scientific and Methodological Research and Developments for Condensed Matter Investigations with IBR-2 Neutron Beams

Leaders: V.I. Bodnarchuk
V.I. Prikhodko

Participating countries and international organizations:

Argentine, Armenia, Belarus, Czech Republic, Germany, Hungary, Republic of Korea, Romania, Russia, Sweden, Switzerland, Ukraine, United Kingdom, Uzbekistan.

Issues addressed and main goals of research:

Regular operation, modernization and development of control systems for CM-201 and CM-202 cryogenic moderators. Development and equipping of new spectrometers, as well as modernization and reconstruction of equipment for the existing IBR-2 spectrometers in order to improve their parameters, expand experimental capabilities and ensure their faultless operation. Scientific and technical support for the development of beam-forming systems, neutron detectors, sample environment systems, cryostats and cryomagnetic systems, as well as electronics and software of data acquisition systems. Development of FLNP information and computing infrastructure.

Expected results in the current year:

1. Maintenance of regular operation of the complex of CM-201 and CM-202 cryogenic pelletized moderators for physics experiments. Automation of the vacuum system and the system for supplying helium to the pneumatic transport pipeline of the CM-202 cryogenic moderator; upgrade and development of software for control systems of the CM-202 moderator. Manufacturing of a prototype dropper for the formation of methane pellets for a complex of cryogenic moderators and carrying out of pre-commissioning works.
2. Investigation of radiation resistance of materials using the radiation research facility. Neutron activation analysis of irradiated samples using a high-purity germanium spectrometer.
3. Development of a new system for data acquisition from PSD-based multi-detector systems for the DN-12 diffractometer.
4. Introduction of new MPD32-USB 3 electronic modules into data acquisition systems at IBR-2 spectrometers.
5. Introduction of industrial digitizers in PSD-based measuring systems. Optimization of digitizer parameters to obtain the best counting and coordinate characteristics of PSD. Application of a new 32-channel digitizer for data acquisition from a prototype of the scintillation PSD developed and manufactured at the CM Department.
6. Installation and adjustment of the Astra-M scintillation detector for the FSD diffractometer.
7. Manufacturing and assembly of sectors of the BSD detector, assembly and adjustment of eight MPD32-USB 3 modules for data acquisition on the HRFD diffractometer in accordance with the project schedule.
8. Completion of the second stage of assembling the detector system for the REMUR spectrometer.
9. Manufacturing, installation and commissioning of a beam monitor on the YuMO spectrometer.
10. Development of technology for creating thermal neutron detectors based on the B_4C converter, manufacturing and testing of detector prototypes.
11. Commissioning of a horizontal-vertical cryostat with a superconducting magnet on the DN-12 diffractometer in cooperation with the specialists from the NICM Department.
12. Research and development of devices based on closed-cycle cryocoolers for obtaining temperatures in the range of 4.2-0.5 K by liquefying ^{3}He and pumping out its saturated vapor.

13. Application of VITESS, McStas and other software packages for simulating neutron scattering in samples and in individual components of spectrometers. Complex calculations and optimization of spectrometers.
14. Development of a system to control the frequency and rotation phase of mechanical neutron beam choppers based on programmable logic controllers (PLC). Modernization of PLC devices at the request of users, development of technical specifications for the application of PLC for automation of spectrometer components (positioning devices, control systems of special sample environment equipment, etc.).
15. Development and manufacturing of units for neutron beam choppers with two drums for REMUR and GRAINS reflectometers.
16. Development of a mechanical neutron beam filter with time focusing.
17. Development of specialized sample cells for the GRAINS reflectometer (cell with humidity control, liquid-solid flow cell).
18. Maintenance and development of the Sonix+ software package at the request of users, as well as on the basis of the latest versions of the software packages and systems used. Upgrade of Sonix+ on the DN-6, DN-12, RTD spectrometers. Development of modules (within the framework of Sonix+) for controlling MPD32 controllers and CAEN N673 digitizer, as well as software for new detectors on HRFD and FSD diffractometers.
19. Software support for further automation of control systems for the complex of cryogenic pelletized moderators CM-201 and CM-202.
20. Modernization of the FLNP central data repository for experimental data. Development of Wi-Fi network in buildings 42 (first and second floors), 42a and 44.

List of projects

	Project	Leader	Priority (period of realisation)
1.	Construction of a wide-aperture backscattering detector (BSD) for the HRFD diffractometer	V.M. Milkov	(2021-2023)

List of Activities

	Activity or Experiment	Leaders	Status
	Laboratory or other Division of JINR	Main researchers	
1.	**Maintenance of regular operation and development of the complex of CM-201 and CM-202 cryogenic pelletized moderators. Further automation of moderators' control systems**	**M.V. Bulavin**	Realization
2.	**Investigation of radiation resistance of materials, electronics and detectors for large-scale physics facilities: ATLAS, CMS, NICA, ITER, ESS, etc.; applied research**	**M.V. Bulavin**	Realization
	FLNP	A.V. Altynov, M.O. Belova, A.V. Galushko, A.S. Kirilov, K.A. Mukhin, T.B. Petukhova, 10 engineers	

3.	**Development of VITESS software package and simulation of individual components of spectrometers. Investigation of neutron background conditions at IBR-2 spectrometers, development of recommendations to reduce the background level**	**V.I. Bodnarchuk**	Realization
	FLNP	R. Erhan, V.V. Sadilov	
4.	**Development of the horizontal/vertical cryostat with a superconducting magnet. Development and modernization of cryostats at IBR-2 spectrometers. Modernization of the cryogenic test bench for working with liquid helium**	**A.N. Chernikov** **S.E. Kichanov**	Realization
	FLNP	A.P. Buzdavin, 1 engineer, 1 laboratory assistant	
5.	**Completion of development and construction of the BSD detector. Putting the detector into operation at the HRFD diffractometer. Commissioning of the upgraded ASTRA-M detector at FSD**	**V.M. Milkov** **A.A. Bogdzel** **A.S. Kirilov**	Realization
	FLNP	G.D. Bokuchava, V.A. Drozdov, V.V. Shvetsov, V.G. Simkin, 3 engineers, 4 laboratory assistants	
6.	**Development and investigation of prototypes of PSD systems based on counters with a resistive anode wire up to 1 m long and large-area (~1 m^2) scintillation position-sensitive detectors. Development of a 2D PSD with a central opening for a direct beam for the REMUR spectrometer. Investigation of boron-based neutron converters. Development and equipping of IBR-2 spectrometers with beam monitors**	**A.V. Churakov** **V.M. Milkov** **A.A. Bogdzel**	Realization
	FLNP	V.A. Drozdov, A.K. Kurilkin, V.M. Milkov, S.M Murashkevich, V.V. Zhuravlev, 3 engineers	
7.	**Modernization of detector and data acquisition electronics for IBR-2 spectrometers**	**A.A. Bogdzel** **A.S. Kirilov**	Realization
	FLNP	V.A. Drozdov, E.I. Litvinenko, V.M Milkov, S.M. Murashkevich, V.M. Shvetsov, V.V. Zhuravlev, 2 engineers	
8.	**Introduction of programmable logic controllers in control systems for actuators, sample environment equipment and spectrometers' choppers. Installation of additional equipment at IBR-2 spectrometers at the request of instrument responsibles**	**V.I. Bodnarchuk** **I.V. Gapon**	Realization
	FLNP	A.V. Altynov, A.S. Kirilov, T.B. Petukhova, N.D. Zernin, V.V. Zhuravlev, 2 engineers	
9.	**Maintenance and development of the Sonix+ software package and installation of its new versions at IBR-2 spectrometers. Development of FLNP central servers and network infrastructure in accordance with the development strategy of the JINR computer network. Modernization of Laboratory's mail system and Wi-Fi network**	**A.S. Kirilov** **V.I. Prikhodko**	Realization

FLNP	A.S. Kirilov, G.A. Sukhomlinov, 4 engineers
MLIT	A.G. Dolbilov, 1 engineer

Collaboration

Country or International Organization	City	Institute or Laboratory
Argentina	Bariloche	CAB CNEA
Armenia	Yerevan	Foundation ANSL
Belarus	Minsk	BSTU
		INP BSU
Czech Republic	Rez	NPI CAS
Germany	Berlin	HZB
	Darmstadt	GSI
	Julich	FZJ
Hungary	Budapest	Wigner RCP
Republic of Korea	Daejeon	KFE
Romania	Bucharest	INCDIE ICPE-CA
	Cluj-Napoca	INCDTIM
	Iasi	UAIC
	Targoviste	UVT
Russia	Dubna	Dubna State Univ.
	Gatchina	NRC KI PNPI
	Moscow	NRC KI
		PC ITER RF
	Moscow, Troitsk	INR RAS
	Yekaterinburg	IMP UB RAS
Sweden	Lund	ESS ERIC
Switzerland	Villigen	PSI
Ukraine	Lviv	LPNU
United Kingdom	Didcot	RAL
Uzbekistan	Tashkent	INP AS RUz

04-4-1133-2018/2023		Priority:	1

Status: Being concluded

Modern Trends and Developments in Raman Microspectroscopy and Photoluminescence for Condensed Matter Studies

Leaders: G.M. Arzumanyan
N. Kučerka

Participating countries and international organizations:

Armenia, Belarus, India, Kazakhstan, Poland, Romania, Russia, Serbia, Slovakia, Uzbekistan.

Issues addressed and main goals of research:

Fundamental and applied research in the field of spontaneous and nonlinear Raman microspectroscopy aimed at highly sensitive biosensing. Study of mechanisms and nature of surface-enhanced Raman scattering (SERS) taking into account the anomalous ratio of line intensities in the anti-Stokes and Stokes spectral regions. Applied research is aimed at using Raman spectroscopy and fluorescence microscopy in biomedical research, in particular, in the search for spectral markers of NETosis, as well as some features of lipid-protein interactions.

Expected results in the current year:

1. Investigation of a possible anomaly in the ratio of aSt/St peaks in SERS spectra depending on the pump power.
2. Elucidation of conformational changes in the Raman spectrum of proteins in the presence of membrane mimetics.
3. Light-induced NETosis upon excitation of neutrophil cells by radiation in the visible region of the spectrum: identification of mechanisms and signaling pathways.
4. Application of fluorescence microscopy to identify programmed death of neutrophil cells under the influence of various activators, including UV- and visible radiation.

List of projects

	Project	Leaders	Priority (period of realisation)
1.	BIOPHOTONICS	G.M. Arzumanyan N. Kučerka Deputy: K.Z. Mamatkulov	1 (2021-2023)

List of Activities

	Activity or Experiment	Leaders	Status
	Laboratory or other Division of JINR	Main researchers	
1.	**Study of the features of Stokes and anti-Stokes components of SERS spectra from analyte molecules in order to understand the processes of enhancement in SERS spectroscopy**	**G.M. Arzumanyan**	Data taking Realization
	FLNP	K.Z. Mamatkulov, Ye. Arynbek, I.A. Morkovnikov, 2 engineers	
2.	**Determination of the range of pump intensities for recording reproducible aSt/St spectra**	**G.M. Arzumanyan** **K.Z. Mamatkulov**	Data taking Realiazation
	FLNP	Ye. Arynbek, A.A. Shutikov, 1 engineer	
3.	**Stabilization of membrane proteins and studies of their structure using liposomes/**	**G.M. Arzumanyan** **N. Kučerka**	Realization

	lipodiscs by Raman spectroscopy, electron microscopy and SANS		
	FLNP	K.Z. Mamatkulov, A. Damir, A.A. Shutikov, D.S. Zakritnaya	
4.	**Testing the technique for obtaining Raman spectra of liposomes / lipodiscs with membrane proteins and "empty" liposomes / lipodiscs**	**K.Z. Mamatkulov** **N. Kučerka**	Realization
	FLNP	Ye. Arynbek, A. Damir, A.A. Shutikov, D.S. Zakrinaya, 1 engineer	
5.	**Study of the influence of lipid environment on the structure of membrane protein**	**G.M. Arzumanyan** **N. Kučerka**	Data taking Realization
	FLNP	K.Z. Mamatkulov, Ye. Arynbek, 1 engineer, 2 laboratory assistants	
6.	**Search for spectral / Raman markers of NETosis**	**G.M. Arzumanyan** **K.Z. Mamatkulov**	Data taking Realization
	FLNP	Ye Arynbek, E.M. Demina, I.M. Pugachevskaya, A.A. Shutikov, D.S. Zakritnaya, 1 engineer	
7.	**Study of mechanisms of sterile activation of NETosis under UV- and visible radiation**	**G.M. Arzumanyan** **K.Z. Mamatkulov**	Data taking Realization
	FLNP	Ye. Arynbek, E.M. Demina, D.S. Kravtsunova, A.A. Shtikov, D.S. Zakritnaya	
8.	**Mastering the technique of ultra-low frequency Raman spectroscopy ~ 10 cm^{-1}**	**G.M. Arzumanyan** **K.Z. Mamatkulov**	Realization
	FLNP	Ye. Arynbek, A.A. Shutikov, 2 engineers	

Collaboration

Country or International Organization	**City**	**Institute or Laboratory**
Armenia	Yerevan	Foundation ANSL
Belarus	Minsk	BSUIR
		SOL instruments
India	Aizawl	MZU
Kazakhstan	Almaty	INP
Poland	Krakow	JU
Romania	Cluj-Napoca	UBB
	Magurele	NIMP
Russia	Moscow	GPI RAS
		MSU
Serbia	Belgrade	Univ.
Slovakia	Kosice	UPJS
Uzbekistan	Jizzakh	JSPI

04-4-1140-2020/2023		Priority:	1
		Status:	Being concluded

Development of the Conceptual Design of a New Advanced Neutron Source at JINR

Leaders: V.N. Shvetsov
M.V. Bulavin

Participating Countries and International organizations:

Argentina, Belarus, Czech Republic, France, Germany, Hungary, Romania, Russia, South Africa, Sweden, Uzbekistan.

Issues addressed and main goals of research:

Development of the conceptual design of a new advanced neutron source at JINR.

Expected main results in the current year:

1. Selection of a concept for the new source. Technical specification for the design of the new source with a suite of instruments for neutron beam-based research.
2. Publication of a "White book". CDR of the new neutron source project.
3. Simulation of the first three instruments for the new source.
4. Start of R&D on fuel for the new source.

List of Activities

	Activity or experiment Laboratory or other Division of JINR	**Leaders** Main researchers
1.	**Scientific rationale for the creation of the new source, "White book"**	**V.N. Shvetsov** **M.V. Bulavin**
	FLNP	
2.	**Development and justification of the choice of a conceptual design of a high-flux pulsed neutron source of periodic operation**	**V.N. Shvetsov** **M.V. Bulavin**
	FLNP	
	OKSAT NIKIET	I.T. Tretiakov
3.	**Preparatory work on the manufacturing of fuel loading/target for the new source**	**V.N. Shvetsov** **M.V. Bulavin**
	FLNP	A.V. Vinogradov, A.V. Dolgikh
	SC "VNIINM"	Yu.A. Ivanov

4. Development of the concept of layout of neutron moderators, neutron beamlines and instruments	**V.N. Shvetsov** **M.V. Bulavin**
FLNP	
5. Development of technical specifications for the design of the new source with a suite of research instruments at beamlines	**V.N. Shvetsov** **M.V. Bulavin**
FLNP	A.V. Vinogradov

Collaboration

Country or International Organization	City	Institute or Laboratory
Argentina	Bariloche	CAB CNEA
Belarus	Minsk	BSTU
Czech Republic	Rez	NPI CAS
France	Grenoble	ILL
Germany	Berlin	HZB
	Julich	FZJ
Hungary	Budapest	Wigner RCP
Romania	Bucharest	INCDIE ICPE-CA
Russia	Gatchina	NRC KI PNPI
	Moscow	NRC KI
		OKSAT NIKIET
		SC "VNIINM"
	Moscow, Troitsk	INR RAS
South Africa	Pretoria	UP
Sweden	Lund	ESS ERIC
Uzbekistan	Tashkent	INP AS RUz

04-4-1141-2020/2023		Priority:	1
		Status:	Being concluded

Development of the SOLCRYS Structural Research Laboratory at the SOLARIS National Synchrotron Radiation Centre

Leader: N. Kučerka

Participating Countries and International organizations:

Belarus, Poland, Russia, Slovakia, Ukraine.

Issues addressed and main goals of research:

The development of a new laboratory for structural research of new materials (catalysts, polymers, etc.), nanomaterials (nanoparticles, nanocomposites, etc.), materials under extreme conditions (superconductors, perovskites, etc.) and biomaterials (proteins, DNA, etc.) utilizing synchrotron X-rays.

Expected main results in the current year:

1. The finalization of construction works on the extension of current experimental hall for placing there the end stations of experimental beamlines, as well as the sample preparation laboratory.
2. The design of experimental beamlines, purchase and installation of the research infrastructure.
3. The development of user program for engaging potential users during the infrastructure design and their full access to the SOLCRYS laboratory.

List of Activities

	Activity or experiment Laboratory or other Division of JINR	**Leaders** Main researchers
1.	**Elaboration and development of technical infrastructure within a scope necessary to install and properly operate the research equipment of the SOLCRYS laboratory**	**N. Kučerka**
2.	**Design, purchase and installation of a superconducting wiggler as a radiation source in the X-ray range with an upper photon energy at least 20 keV**	**N. Kučerka**
3.	**Design, purchase and installation of research lines of synchrotron radiation**	**A.I. Kuklin** **E.V. Lukin**
4.	**Design, purchase and installation of measuring stations for diffraction studies and studies of scattering at small angles**	**A.I. Kuklin** **E.V. Lukin**
5.	**Design and assembly of control systems as well as of data acquisition and storage systems**	**N. Kučerka** **A.I. Kuklin** **E.V. Lukin**

Collaboration

Country or International Organization	City	Institute or Laboratory
Belarus	Minsk	BSU
Poland	Krakow	SOLARIS
	Poznan	AMU
Russia	Novosibirsk	BINP SB RAS
Slovakia	Bratislava	CU
Ukraine	Kiev	NUK

04-5-1131-2017/2023			
		Priority:	1
		Status:	Being concluded

Radiation Physics, Radiochemistry, and Nanotechnology Investigations Using Beams of Accelerated Heavy Ions

Leaders: S.N. Dmitriev
P.Yu. Apel

Participating countries and international organizations:

Armenia, Belarus, Bulgaria, China, Czech Republic, Vietman, Germany, Hungary, Kazakhstan, Moldova, Mongolia, Poland, Romania, Russia, Serbia, Slovak Republic, South Africa, USA.

Issues addressed and main goals of research:

Transition to a new level of research and development in the fields of radiation solid-state physics, applied radiochemistry, and materials science, with possible nanotechnology applications. The main emphasis will be on the modification of materials at the nanometer scale and on the study of the effects produced by heavy ions in matter with the aim of revealing the fundamental mechanisms and developing nanotechnology applications of ion beams. Upgrade of the FLNR facilities for the production of medical isotopes and the development of materials modification methods.

Expected results in the current year:

1. Determination of the radiation resistance of MgAl2O4 to swift heavy-ion irradiation using optical spectroscopy.
2. Modelling of swift heavy-ion tracks in subsurface layers and interfaces of nanostructured dielectric and composite materials.
3. Production of self-organized silver and gold nanostructures on the surface of polyester and polyimide track membranes as platforms for analytical devices.
4. Development of track membranes functionalized by silver nanoparticles and aptamers for concentrating and detecting viruses in the environment. Construction of sensors based on track membranes using a Raman-active label for detecting viral contamination.
5. Development of track membranes based on immobilized proteins suppressing the damage of nucleic acid for the study of free DNA in the environment and for the use in non-destructive methods of material analysis.
6. Development and study of track membranes coated with amphipathic fusion inhibitors and other virucidal compounds against RNA containing enveloped viruses.
7. Analysis of the effect of the chemical composition and the architecture of the track membrane porous structure on cell growth. Development of bioreactors using track membranes for cell growth with a view to fabricating personalized tissue prostheses.
8. Production of hybrid nanomaterials using ion track etching technologies, vacuum deposition, electrospinning of polymer nanofibers, and directed chemical modification for novel separation processes and energy conservation.
9. Optimization of the parameters for the formation of nanoscale coatings based on polyolefins, fluoropolymers, and organosilicon compounds formed on the surfaces of polyethylene terephthalate track membranes from an active gas phase.
10. Assessment of the distribution of trace elements and radionuclides in the ecosystems of the Gobi region of Mongolia.
11. Acquisition of nuclear data required for producing nuclear medicine radioisotopes using MT-25 microtron.

List of Activities

Activity or Experiment Laboratory or other Division of JINR	Leaders Main researchers	Status
1. Investigations of radiation damages in solids and formation of nanostructures	**V.A. Skuratov** **P.Yu. Apel**	Data taking
FLNR	V.A. Altynov, I.V. Blonskaja, O.M. Ivanov, N.S.Kirilkin, E.A. Korneeva L.I. Kravets, O.V. Kristavchuk, N.E. Lizunov, A.N. Nechaev, O.L. Orelovich, A. Roussow, R.A.Rymzhanov, V.K. Semina, H.V.Serpionov, V.V. Shirkova, A.S. Sohatsky, D.V. Shchegolev, I.I.Vinogradov, Yu.Yamauchi	
MLIT	V.V. Trofimov	
FLNP	M.V. Frontasyeva, Yu.E. Gorshkova, O.Yu. Ivanshina, A.I. Kuklin, T.N. Vershinina, I. Zenkovskaya	
LRB	I.V. Koshlan	
LNP	E.V. Kravchenko	
2. Production of ultra-pure isotopes	**N.V. Aksenov**	Preparation
FLNR	A.Yu. Bodrov, G.A. Bozhikov, M.V. Gustova, A.Sh. Madumarov, S.V. Mitrofanov, A.V. Sabelnikov, I. Chuprakov	
3. Radioanalytical studies	**M.V. Gustova**	Data taking
FLNR	D. Abdusamadzoda, N.S. Gustova, S.P. Kaplina, T.N. Sabelnikova, M.G. Voronyuk	
4. Project of specialized beam lines at DC-140	**S.V. Mitrofanov**	Preparation
FLNR	S.L. Bogomolov, O.A. Chernyshev, B.N. Gikal, G.N. Ivanov, I.A. Ivanenko, I.V. Kalagin, N.Yu. Kazarinov, V.A. Kostyrev, N.F. Osipov, S.V. Pashchenko, N.N. Pchelkin, V.A. Semin, V.A. Veryovochkin	
VBLHEP	A.A. Fateev, 2 pers.	

Collaboration

Country or International Organization	City	Institute or Laboratory
Armenia	Yerevan	ICP NAS RA
		IMB NAS RA
Belarus	Gomel	GSU
	Minsk	BSU
Bulgaria	Sofia	TU-Sofia
China	Beijing	PKU
Czech Republic	Brno	BUT
	Olomouc	UP
	Prague	CU
Germany	Darmstadt	GSI
Hungary	Budapest	GetGiro Kft
Kazakhstan	Almaty	PhysTI
	Astana	BA INP

		ENU
		NU
Moldova	Chisinau	MSU
Mongolia	Ulaanbaatar	CGL
		NRC NUM
Poland	Lublin	UMCS
	Torun	UMK
	Warsaw	INCT
Romania	Baia Mare	TUCN-NUCBM
	Bucharest	CSSNT-UPB
		IFIN-HH
		UB
		UPB
	Iasi	UAI
		UAIC
	Magurele	INFLPR
	Timisoara	UVT
Russia	Chernogolovka	BInEPCP RAS
		ISSP RAS
	Dubna	BMC
		Dubna-Biopharm
		Trackpore Technology
	Kaliningrad	IKBFU
	Krasnodar	KSU
	Moscow	GPI RAS
		IC RAS
		IGIC RAS
		IMET RAS
		ISPM RAS
		LPI RAS
		MAI
		MIEM
		MSU
		NMRC RB
		NRC KI
		Sechenov Univ.
	Novosibirsk	ISP SB RAS
	Obninsk	REATRACK-Filter
	Saratov	SSMU
	St. Petersburg	Ioffe Institute
		MMA
		SPbSPU
	Vladimir	Vladisart
Serbia	Belgrade	INS "VINCA"
Slovakia	Bratislava	PF SK
South Africa	Bellville	UWC
	Port Elizabeth	NMU
	Pretoria	UP
	Stellenbosch	SU
USA	Knoxville, TN	UTK
	Stanford, CA	SU
Vietnam	Hanoi	IOP VAST

04-9-1077-2009/2023		Priority:	1

Status: Being concluded

Research on the Biological Effects of Heavy Charged Particles of Different Energies

Leaders: E.A. Krasavin
A.N. Bugay

Participating countries and international organizations:

Armenia, Belarus, Bulgaria, Czech Republic, Cuba, Germany, Italy, Mongolia, Poland, Romania, Russia, Serbia, Slovakia, Uzbekistan, Vietnam.

Issues addressed and main goals of research:

Theoretical and experimental research on the biological effects of heavy charged particles of different energies at JINR's basic facilities.

Research and development will include:

1. Research on the mechanisms of the development of DNA molecular damage and its repair in cultures of human and mammalian normal and tumor cells and in histological sections of normal and tumor tissues of animals exposed to radiations of different LET.
2. Research on the induction and molecular nature of gene and structural mutations and genetic stability mechanisms in higher and lower eukaryote cells after exposure to ionizing radiations of different quality.
3. Research on the formation of complex chromosomal aberrations in human and mammalian normal and tumor cells after exposure to radiations of different LET.
4. Research on behavioral reaction disorders and pathomorphological changes in central nervous system (CNS) structures of irradiated laboratory animals.
5. Research on neurodegenerative changes in different CNS structures after exposure to ionizing radiations of different quality.
6. Research on the molecular and cellular mechanisms of the action of cytosine arabinoside (Ara-C) in normal and tumor cells in combination with different modifiers of reparative DNA synthesis after proton beam and photon exposure.
7. Mathematical modeling of acute and long-term biological effects at different levels of biological organization (from the molecular to tissue one) after exposure to radiations of different quality.
8. Improvement of methods of physical and dosimetric monitoring of charged particle beams of different energies for radiobiological experiments. Calculation of shieldings for new nuclear physics facilities. Participation in designing and testing nuclear planetary science instruments.

Expected results in the current year:

1. To continue the analysis of clustered DNA double-strand break (DSB) formation and repair in human skin fibroblast nuclei and radioresistant U87 glioblastoma tumor cells after accelerated heavy charged particle exposure.
2. To continue the analysis of the formation and structure of complex clustered DNA damage by immunocytochemical staining of the repair proteins γH2AX, 53BP1, OGG1, and XRCC1 in human fibroblast nuclei after accelerated heavy ion exposure.
3. To continue comparative analysis of the proportion of different DNA DSB repair pathways in human fibroblasts by immunocytochemical staining of the repair proteins RAD51 (HR) and DNA PKcs (NHEJ) after exposure to radiations of different quality.
4. To continue experiments to study the expression of the genes encoding the repair proteins (RAD51, DNAPKcs, NBS1, MRE11, etc.) in human skin fibroblasts after accelerated heavy charged particle exposure.

5. To continue studying apoptosis induction in human skin fibroblasts and mammalian CNS neurons after accelerated heavy charged particle exposure.
6. To continue studying clustered DNA DSB formation and repair in mammalian CNS cells after photon and accelerated heavy ion exposure.
7. To continue research on the induction of structural rearrangements in yeast cells by radiations of different LET.
8. To continue research on the influence of mitochondrial DNA damage on yeast cell radiosensitivity and mutagenesis.
9. To continue the analysis of chromosomal damage in radiation-induced mutants at different times after irradiation of a mammalian cell culture.
10. To perform metaphase and mFISH analysis of chromosomal aberrations in peripheral blood lymphocytes of *Macaca mulatta* monkeys induced by ionizing radiations with different physical characteristics.
11. To continue mFISH analysis of complex aberrations in human normal and tumor cells induced by ionizing radiations with different physical characteristics.
12. To study the radiation-induced secretion of the inflammatory cytokines TNF alpha, IL-1, IL-6, and MCP-1 in mouse brain homogenates in the long term after mouse head irradiation with accelerated protons.
13. To evaluate the level of the myelin basic protein (MBP) in mouse brain homogenates in the long term after mouse head irradiation with accelerated protons.
14. To continue studying the formation and elimination of γH2AX/53BP1 foci in cultures of U87 glioblastoma and B16 melanoma cells after exposure to Bragg peak protons and photons in the presence of Ara-C in combination with different modifiers of reparative DNA synthesis.
15. To continue studying DNA DSB formation in different parts of rodent CNS after in vivo irradiation with protons and photons in the presence of Ara-C in combination with different modifiers of reparative DNA synthesis.
16. To analyze and evaluate morphological changes and apoptosis (by TUNEL staining) in the liver, brain, and kidneys of mature rats after the combined use of AraC and proton radiation.
17. To analyze the neuroprotective effect of Cerebrolysin after proton irradiation of small laboratory animals.
18. To continue the study of behavioral, morphological, and functional disorders in rodents at different times after exposure to photon and proton beams.
19. To apply computer vision algorithms to biological data processing, in histology, and in behavioral experiments.
20. To continue mathematical modeling of DNA damage formation and repair kinetics after irradiation of normal and tumor cells with heavy charged particles of different energies.
21. To continue mathematical modeling of the dynamics of a tumor cell population after ionizing radiation exposure in the presence of DNA synthesis inhibitors.
22. To continue molecular dynamics modeling of structure and function impairments in synaptic receptor proteins.
23. To continue mathematical modeling of radiation-induced neurogenesis and gliogenesis impairments and neuroinflammatory processes in CNS structures.
24. To perform mathematical modeling of chromosomal aberration induction in mammalian and human cells by ionizing radiations with different characteristics.
25. In cooperation with the RAS Institute of Space Research, to continue testing the tagged proton method at the DLNP Phasotron.
26. To ensure the conduction of radiobiological experiments at JINR's accelerators.
27. To participate in the design and fabrication of the SIMBO station at ARIADNA applied beams of the NICA complex.
28. To develop a project of a space radiation simulator for Nuclotron's applied beams.
29. To measure the radiation environment (neutron fields) around the NICA booster during commissioning.

List of projects

	Project	Leader	Priority (period of realisation)
1.	Research on the biological effects of heavy charged particles with different energies	E.A. Krasavin A.N. Bugay	1 (2009-2023)

List of Activities

	Activity or Experiment Laboratory or other Division of JINR	Leaders Main researchers	Status
1.	**Radiobiological research at charged particle beams**	**E.A. Krasavin**	Data taking Realization Modeling
	LRB	T.N. Bazlova , T.Zh. Bezhanyan, A.V. Boreyko, N.N. Budennaya, V.N. Chausov, O.O. Chernyak, K. Erzhan, K.N. Golikova, E.V. Ilyina, M.D. Isakova, T.S. Khramko, A.N. Kokoreva, I.A. Kolesnikova, N.A. Koltovaya, O.V. Komova, V.L. Korogodina, I.V. Koshlan, N.A. Koshlan, M.A. Kovalenko, R.A. Kozhina, E.A. Kulikova, M.E. Krupnova, P.V. Kutsalo, E.A. Kuzmina, M. Lalkovičova, P.-O. Lkhasuren, K.N. Lyakhova, O.N. Matchuk, L.A. Melnikova, Yu.V. Melnikova, E.A. Nasonova, S.S. Negovelov, A. Nurkasova, M.A. Ostrovsky, D.V. Petrova, E.V. Pronskikh, Yu.S. Severyukhin, D.D. Shamina, N.V. Shvaneva, E.V. Smirnova, S.I. Tiunchik, D.M. Utina, V.S. Vinogradova, Yu.V. Vinogradova, M.G. Zadneprianetc, I.A. Zamulaeva, N.I. Zhuchkina	
2.	**Radiation research**	**G.N. Timoshenko**	Preparation Data taking Modeling
	LRB	L.G. Beskrovnaya, Budenny S.A., K.A. Chizov, D.V. Davydov, I.S. Gordeev, V.A. Krylov, E.N. Lesovaya, E.E. Pavlik	
3.	**Mathematical modeling of radiation-induced effects**	**A.N. Bugay**	Data taking Modeling
	LRB	S.V. Aksenova, A.S. Batova, A.V. Chizhov, E.B. Dushanov, I.M. Enyagina, A.A. Glebov, E.A. Kolesnikova, B. Lkhagva, B. Munkhbaatar, M.S. Panina, A.Yu. Parkhomenko, M. Piotrowski, M.A. Vasilyeva	
4.	**Training activity**	**E.A. Krasavin** **A.N. Bugay** **S.Z. Pakuliak** (UC)	
	LRB	L.G. Beskrovnaya, A.V. Boreyko, N.N. Budennaya, V.N. Chausov, A.V. Chizhov, E.B. Dushanov, I.M. Enyagina, I.V. Koshlan, E.N. Lesovaya, Yu.S. Severyukhin, G.N. Timoshenko, M.G. Zadneprianetc	

Collaboration

Country or International Organization	City	Institute or Laboratory
Armenia	Yerevan	YSU
Belarus	Minsk	IBCE NASB
		Inst. Physiology NASB
		SPMRC NASB

Bulgaria	Sofia	IE BAS
		Inst. Microbiology BAS
		NCRRP
Cuba	San Jose de las Lajas	CENTIS
Czech Republic	Brno	IBP CAS
Germany	Darmstadt	GSI
Italy	Naples	Unina
	Udine	Uniud
Mongolia	Ulaanbaatar	NUM
Poland	Krakow	INP PAS
	Szczecin	US
Romania	Bucharest	IFIN-HH
		UMF
	Cluj-Napoca	UBB
	Iasi	IBR
Russia	Moscow	FMBC
		IBMC
		IBMP RAS
		IHNA Ph RAS
		IKI RAS
		MSU
		NRC KI
		SF IPh
		SINP MSU
	Obninsk	NMRRC
	Sochi	SRI MP
Serbia	Belgrade	INS "VINCA"
		Univ.
Slovakia	Bratislava	CU
	Kosice	IEP SAS
Uzbekistan	Tashkent	INP AS RUz
Vietnam	Hanoi	INPC VAST
		VINATOM

04-9-1112-2013/2023		Priority:	1

Status: Being concluded

Research on Cosmic Matter on Earth and in Nearby Space; Research on the Biological and Geochemical Specifics of the Early Earth

Leaders: E.A. Krasavin
A.Yu. Rozanov
V.N. Shvetsov

Participating countries and international organizations:

Italy, Russia, USA.

Issues addressed and main goals of research:

1. Study of microfossils and organic compounds in meteorites and ancient terrestrial rocks.
2. Research on the synthesis of complex prebiotic compounds from formamide under the action of radiation in the presence of meteorites and terrestrial rocks as catalysts.

Expected results upon completion of the Theme stages or projects:

1. To expand ideas about the diversity of fossils in meteorites.
2. To carry out the synthesis of prebiotic compounds from formamide using terrestrial rocks as catalysts and compare the results with those obtained earlier, where meteorites were used.

Expected results in the current year:

1. To continue the search for and study of microfossils in meteorites and terrestrial rocks using electron microscopy.
2. To continue research on the synthesis of complex prebiotic compounds from formamide under the action of accelerated ions using meteorites and minerals of terrestrial origin as catalysts.
3. To continue collection and processing of data on microfossils in meteorites (electronic microscopy and energy-dispersive X-ray spectroscopy images).

List of projects

	Project	Leader	Priority (period of realisation)
1.	Research on cosmic matter on Earth and in nearby space; research on the biological and geochemical specifics of the early Earth	E.A. Krasavin Scientific leader: A.Yu. Rozanov	1 (2013-2023)

List of Activities

	Activity or Experiment	Leaders	Status
	Laboratory or other Division of JINR	Main researchers	
1.	**Studies of biofossils in meteorites and ancient terrestrial rocks**	**A.Yu. Rozanov** **E.A. Krasavin**	Data taking Realization Modeling
	LRB	A.N. Afanasyeva, A.K. Rymin	

2.	**Research on the synthesis of complex prebiotic compounds from formamide**	**R. Saladino**	Data taking Realization Modeling
	LRB	M.I. Kapralov, E.A. Saprykin	

Collaboration

Country or International Organization	City	Institute or Laboratory
Italy	Viterbo	UNITUS
Russia	Borok	IPE RAS
	Moscow	IBMP RAS
		IGEM RAS
		INMI RAS
		PIN RAS
	Novosibirsk	BIC SB RAS
	Puschino	IPCBP SS RAS
USA	Athens, AL	ASU

04-2-1132-2017/2023		Priority:	1

Status: Being concluded

Biomedical and Radiation-Genetic Studies Using Different Types of Ionizing Radiation

Leaders: G.V. Mitsyn
S.L. Yakovenko

Deputy: S.V. Shvidky

Participating countries and international organizations:

Belgium, China, Czech Republic, Moldova, Poland, Romania, Russia, South Africa.

Issues addressed and main goals of research:

Biomedical and clinical research of proton radiotherapy for cancer treatment. Formation of the experimental data base in the field of radiation mutagenesis in animal germ cells.

Expected results in the current year:

1. Evaluation of effectiveness of conducted radiation treatment of different neoplasms.
2. Increase of functional capability of the developed 3D treatment planning software.
3. Design and construction of prototype equipment for dynamic conformal irradiation of deep-seated tumours with the proton beam.
4. Development and improvement of detectors and tools for clinical dosimetry of medical hadron beams.
5. Continuation of research to determine forms of fibroblast cell death depending on the dose of ionizing radiation.
6. Study of mechanisms of functional and neurochemical disorders in the central nervous system during exposure to radiation with different linear energy transfer.
7. Mastering of new methods for evaluation of effectiveness of cytotoxic activity of nanoparticles on tumour cells.
8. Studies of difference in radiobiological reactions for normal and cancer cells irradiated by flash technique.
9. Continuation of the molecular analysis of gamma- and neutron-induced intragenic structural changes in germline cells.
10. Continuation of the sequence analysis of inherited DAN changes at the genome level of the offspring.
11. Continuation of the work on the analysis of the transcriptome in somatic cells differing in radiosensitivity.
12. Determination of the secondary structure of the Dsup protein using SAXS, DLS, and circular dichroism methods.
13. Transcriptome analysis of D.melanogaster strains and human cell line HEK293 expressing Dsup protein.
14. Assessment of metabolic activity (MTT-test) and apoptosis induction (according to caspase-3/7 activity) in human HEK293 culture cells expressing Dsup, determination of the level of reactive oxygen species in cells.
15. Development of a project of a specialized isochronous cyclotron for proton therapy.
16. Measurements of the magnetic field of the MC1 bending magnet for the transport line of the AIC-144, Krakow, Poland.

List of projects

	Project	Leader	Priority (period of realisation)
1.	Further development of methods, technologies, schedule modes and provision of radiotherapy	G.V. Mitsyn	1 (2017-2023)
2.	RADIOGENE: Molecular genetics of radiation-induced changes at the gene, genome and transcriptome level in Drosophila melanogaster	K.P. Afanasyeva Deputy: A.E. Rusakovich	1 (2017-2023)
3.	Study of the radioprotective properties of the Damage supressor (Dsup) protein on a model organism D.melanogaster and the human cell culture HEK293	E.V. Kravchenko	1 (2021-2023)

List of Activities

	Activity or Experiment Laboratory or other Division of JINR	Leaders Main researchers	Status
1.	**Further development of methods, technologies, schedule modes and provision of radiotherapy**	**G.V. Mitsyn**	R&D
	DLNP	A.V. Agapov, O.V. Belov, I.V. Alexandrova, G.A. Andreev, K. Belokopytova, V.M. Breev, G.V. Donskaya, V.N. Gaevsky, Ye.A. Gritskova, Ye.I. Luchin, I.I. Klochkov, I. Khosenova, I.Ye. Miller, A.G. Molokanov, S.A. Pisareva, A.V. Rzyanina, K.N. Shipulin, S.V. Shvidky	
2.	**RADIOGENE: Molecular genetics of radiation-induced changes at the gene, genome and transcriptome level in Drosophila melanogaster**	**I.D. Alexandrov**	R&D
	DLNP	M.V. Alexandrova, K.P. Afanasyeva, N.E. Kharchenko, S.V. Korablinova, L.N. Korovina, N.V. Orlova, A.N. Rusakovich, O.P. Solodilova	
3.	**Study of the radioprotective properties of the Damage supressor (Dsup) protein on a model organism D.melanogaster and the human cell culture HEK293**	**E.V. Kravchenko**	R&D
	DLNP	T.O. Azorskaya, O.A. Kuldoshina, A.V. Rzyanina, A.S. Yakunenko, M.P. Zarubin, R.A. Tarasov, A.S. Yakhnenko	
	FLNR	T.N. Murugova	
4.	**Development of methods and programs for creating cyclotron-type accelerators. Development and upgrade of cyclotrons for medical application**	**G.A. Karamysheva**	Realization
	DLNP	K.S. Bunyatov, A.F. Chesnov, S.B. Fedorenko, R.V. Galkin, A.L. Gibinsky, S.V. Gursky, S.N. Dolya, G.G. Kazakova, O.V. Karamyshev, I.N. Kiyan, O.E. Lepkina, O.V. Lomakina, I.V. Lyapin, V.A. Malinin, D.S. Petrov, D.V. Popov, G.D. Shirkov, S.G. Shirkov, V.L. Smirnov, A.S. Vorozhtsov, S.B. Vorozhtsov	
	MLIT	I.V. Amirhanov, T.V. Karamysheva	

Collaboration

Country or International Organization	City	Institute or Laboratory
Belgium	Louvain-la-Neuve	IBA
China	Hefei	IPP CAS
Czech Republic	Prague	ADVACAM
		PTC
	Rez	UJV
Moldova	Chisinau	MSU
Poland	Krakow	INP PAS
	Otwock (Swierk)	NCBJ
	Poznan	GPCC
Romania	Bucharest	IFIN-HH
	Cluj-Napoca	UBB
	Iasi	UAIC
Russia	Moscow	FMBC
		IBMP RAS
		VIGG RAS
	Puschino	ITEB RAS
	Rostov-on-Don	SFedU
	Saratov	SSU
South Africa	Somerset West	iThemba LABS

04-2-1126-2015/2023		Priority:	1

Status: Being concluded

Development of scientific DLNP infrastructure for research using semiconductor detectors, laser metrology, electrons, positrons and cryogenic technology

Leaders: V.V. Glagolev
G.A. Shelkov

Deputy: V.A. Rozhkov

Participating countries and international organizations:

Armenia, Belarus, Canada, CERN, Croatia, Cuba, Czech Republic, Egypt, Germany, Israel, Italy, Japan, Poland, Romania, Russia, South Africa, Switzerland, Ukraine, United Kingdom, USA, Uzbekistan, Vietnam.

Issues addressed and main goals of research:

Conducting scientific and methodological studies of high-resolution hybrid matrix detectors for high-energy physics and the atomic nucleus.
Development of scientific cooperation with research institutes to study the possibility of using the developed detectors in other fields of science and technology (primarily in the field of healthcare and mining).
Development of infrastructure for studies of properties of semiconductor detectors, including particle beam tests for use by JINR groups and institutes of the Member States.
Creating a network of Compact Presicion Laser Inclinometers (CPLI); creating a prototype of an amplitude interferometric length meter for a length of 16 m; creating a prototype of a laser reference line for a length of 128 v; creating a prototype of a seismic-stabilized research platform based on the CPLI.
Study of resolution of the CPLI when determining kinematic and dynamic parameters of wave processes in the seismological observation system of the Center for Geophysical Monitoring of the National Academy of Sciences of Belarus.
Study of formation of defects in materials as a result of various physical influences.
Extension of the existing experimental base of PAS.
Creation of facilities and experiments on accelerators to obtain new information to verify theoretical ideas in processes of strong, weak, and electromagnetic interactions of elementary particles and light nuclei at intermediate energies.
Creating a setup for carrying out measurements with test electron beams.

Expected results in the current year:

1. Development of a prototype and software for the “head” tomograph.
2. Development of prototype detectors, electronics based on FPGA and software for Timepix4.
3. Development and creation of an absolute length meter with micron resolution for a length of 1-10 m. Determining the sensitivity of the meter on a length of 0.1 m. R&D of a 128-meter laser reference line with the ability to measure the spatial position of the Measured Point on a controlled object (nondestructive testing). Measurement of microseismic activity at the MPD and assessment of the effect of microseisms on the luminosity of the NICA collider.
4. Installation of CPLI in stationary conditions of a geophysical observatory, preparation and testing of an instrumentation complex to carry out complex observation of seismic event detection and to determine angular oscillations of the Earth surface; connection of the CPLI hardware complex to the automated workplace of shift operator; organizing collection and storage of CPLI data in a geophysical monitoring service.
5. Completion of the ordering system of the monochromatic positron beam and commissioning of the PALS spectrometer with a monochromatic positron beam.
6. Testing the method of ion etching on the created etching system and applying it to study thin-film multilayer materials.
7. Conducting experiments with Active Target (GDH).
8. Commissioning of the LINAC-200.

List of projects

	Project	Leader	Priority (period of realisation)
1.	Novel semiconductor detectors for fundamental and applied research	G.A. Shelkov V.A. Rozhkov	1 (2015-2023)
2.	Presicion laser metrology for accelerators and detector complexes	V.V. Glagolev M.V. Lyablin	1 (2016-2023)
3.	Development of experimental techniques and applied research with slow monochromatic positron beams (PAS)	A.A. Sidorin Scientific leader: I.N. Meshkov	1 (2016-2023)
4.	GDH&SPASCHARM	Yu. Usov A. Kovalik	1 (2011-2023)

List of Activities

	Activity or Experiment	Leaders	Status
	Laboratory or other Division of JINR	Main researchers	
1.	**Project "Novel semiconductor detectors for fundamental and applied research"**	**G.A. Shelkov** **V.A. Rozhkov**	Realization
	DLNP	S. Abdelshakur, A. Gongadze, V.G. Kruchonok, N. K. Kuznetsov, A.V. Lapkin, I.N. Potrap, R.V. Sotensky, T.O. Rudenko, S.Yu. Porokhovoy	
	FLNR	A.T. Isatov, S. Mitrofanov, Yu.G. Teterev	
	FLNP	A.A. Ahmedov, Yu.N. Kopach, D.A. Telezhniko	
2.	**Presicion laser metrology for accelerators and detector complexes**	**V.V. Glagolev** **M.V. Lyablin**	Technical Proposal Realization
	DLNP	I.V. Bednyakov, Yu.I. Davidov, S.M. Kolomoets, A.A. Pluzhnikov, A.V. Sazonova, S.N. Studenov, G.T. Torosyan, O.S. Atanova, Yu.V. Klemeshov, R.V. Ni, S.A. Bednyakov, A.M. Kuzkin	
	BLTP	A.N.Baushev	
	GA&C	G.V. Trubnikov	
3.	**Project "Development of experimental techniques and applied research with slow monochromatic positron beams (PAS)"**	**A.A. Sidorin** **I.N. Meshkov**	Realization
	DLNP	E.V. Akhmanova, O.S. Orlov, A.Yu. Rudakov, A.A. Sidorin, L.V. Soboleva, V.I. Hilinov, S.L.Yakovenko	
	FLNR	F.V. Skuratov	
	FLNP	M. Kulik	
	VBLHEP	V.V. Kobets	

4. GDH&SPASCHARM Project	**Yu. Usov** **A. Kovalik**	Data taking Data processing
DLNP	N.S. Borisov, N.A. Bazhanov, A.S. Dolzhenkov, A.N. Fedorov, I.V. Gapienko, I.S. Gorodnov, V.A. Kashevarov, A.B. Lazarev, A.B. Neganov, Yu.A. Plis, A.B. Sadovsky	
FLNP	S.B. Gerasimov, S.S. Kamalov	
5. Construction of the setup for measurements with electron testbeams in DLNP (LINAC-200)	**V.V. Kobets** **M.I. Gostkin** **G.D. Shirkov**	Realization
DLNP	E. Acosta, V.Yu. Baranov, A.E. Brukva, Yu.I. Davydov, D.L. Demin, I. N. Garanzha, K.I. Gritsay, V.V. Glagolev, A.V. Krasnoperov, V.G. Kruchonok, A.A. Nozdrin, E.V. Malinina, S.Yu. Porokhovoy, S.A.Smirnov, D.S.Shokin, A.N. Trifonov, K.E. Yanenko, A.S. Zhemchugov, P.P. Zhuravlev, O.L. Seroshtanov, A.N. Yapeeva, A.A. Ulankin, A.V. Afanasyev, D. Chokheli	
UC	D.S. Belozerov, K.B. Gikal, M.A. Nozdrin, K.A. Varlamov, D.A. Zlydenny	
VBLHEP	N.I. Garanzha, A.G. Sorokin, V.G. Shabrotov	

Collaboration

Country or International Organization	City	Institute or Laboratory
Armenia	Garni	GGO
Belarus	Minsk	BSTU
		CGM NASB
Canada	Halifax	SMU
	Regina	U of R
	Sackville	MAU
CERN	Geneva	CERN
Croatia	Zagreb	RBI
Cuba	Havana	CEADEN
Czech Republic	Prague	CTU
Egypt	Cairo	NRRA
	New Borg El-Arab	E-JUST
Germany	Bochum	RUB
	Bonn	UniBonn
	Giessen	JLU
	Hamburg	DESY
	Mainz	JGU
Israel	Jerusalem	HUJI
Italy	Pavia	INFN
Japan	Tsukuba	KEK
Poland	Krakow	AGH
		INP PAS
Romania	Magurele	ISS
Russia	Arkhangelsk	NArFU
	Belgorod	BelSU
	Dubna	Dubna State Univ.
	Moscow	ITEP
		MSU
		NNRU "MEPhI"

	Moscow, Troitsk	INR RAS
	Protvino	IHEP
	St. Petersburg	NWRSCC
		SPbSPU
	Tomsk	TPU
South Africa	Somerset West	iThemba LABS
Switzerland	Basel	Uni Basel
Ukraine	Kharkov	IERT NASU
		NSC KIPT
United Kingdom	Glasgow	U of G
	London	QMUL
	York	Univ.
USA	Amherst, MA	UMass
	Kent, OH	KSU
	Los Angeles, CA	UCLA
	Seattle, WA	UW
Uzbekistan	Tashkent	AS RUz
		IS AS RUz
Vietnam	Ho Chi Minh City	CNT VINATOM

Networking, Computing, Computational Physics (05)

05-6-1118-2014/2023

Priority:	1

Status: Being concluded

Information and Computing Infrastructure of JINR

Leader: V.V. Korenkov

Deputy: T.A. Strizh

Participating Countries and International organizations:

Armenia, Azerbaijan, Belarus, Bulgaria, CERN, China, Czech Republic, Egypt, France, Georgia, Germany, Italy, Kazakhstan, Moldova, Mongolia, Poland, Romania, Russia, Serbia, Slovakia, South Africa, Sweden, Taiwan, Ukraine, USA.

Issues addressed and main goals of research:

The purpose of the theme is to develop the network, information and computing infrastructure of JINR for the research and production activities of the Institute and its Member States on the basis of state-of-the-art information technologies in accordance with the Seven-Year Plan for the development of JINR. A particular direction within the theme is the development of the JINR MLIT Multifunctional Information and Computing Complex (MICC) presented as a Project.

Expected main results in the current year:

1. Provision of the stable, safe and integral functioning of the JINR information and telecommunication network (backbone network (2x100 Gbps); transport network of the NICA megaproject (8x100 Gbps); MLIT mesh network (100 Gbps); backbone external telecommunication channels (3x100 Gbps); Wi-Fi network at the Institute's sites.

   Provision of the full-scale and optimal operation of the guaranteed power supply and climate control systems of the MICC computing infrastructure. Commissioning of a new fire safety system of the MICC infrastructure.

   Expansion of the performance and storage system of the MICC basic components, i.e., Tier1 center at JINR, Tier2/CICC, EOS system. Support and maintenance of user work with the EOS system. Development of the system of access to the home directories of JINR users (AFS), of the unified storage and access system for the MICC common software (CVMFS), transition to a new software system for working with tape robots (CTA). Creation and update of a polygon for debugging and testing new software for the uppermost components of the MICC.

   Extension of the computing capacities of the cloud service for scientific and engineering computing due to integration with some cloud infrastructures of institutes of the Russian Federation collaborating with JINR and of other JINR Member States. Expansion of the number of users and participants of the DICE on the basis of the cloud resources of the JINR Member States' organizations. Enlargement of the resources of the MICC cloud, including at the expense of the resources acquired by the Baikal-GVD, JUNO, NOvA/DUNE experiments, and their maintenance.

   Development of low-level software for automating the process of data transfer both between the layers of the hierarchical data processing and storage system of the "Govorun" supercomputer and between computing sites included in the distributed environment to model and reconstruct events for the NICA experiments.

   Support and maintenance of the operation of the WLCG virtual organizations, the NICA, COMPASS, NOvA, ILC and other experiments, local user groups on the MICC Tier1 and Tier2 resources.

   Putting into trial operation and development of SPD experiment systems for: management of processing physical events mass simulation data; data management implementing the model and policy of working with them; data processing infrastructure monitoring. Connection to the load management system of the computing resources of the SPD collaboration: PNPI, St. Petersburg State University, Samara University, SPD Online Filter (prototype).

   Expansion of the DIRAC-based distributed information and computing platform. Integration of new computing and storage resources.

   Development and support of the current MICC monitoring and accounting system, inclusion of monitoring the parameters of new computing and engineering elements in the list of monitored services and hardware.

Creation of a prototype of an integrated system for monitoring and managing the MICC services and hardware on the basis of new technological approaches, including Big Data analytics. Deployment of the prototype of a Big Data user infrastructure to solve JINR's urgent tasks.

2. Development and maintenance of the systems EDS "Dubna", APT EVM for NICA, ADB2, ISS, HR LHEP, CERNDB, EDS "Advance reports", JINRex at the request of end users. Development and commissioning of a new version of the PIN system. Maintenance of the JINR Information System for Scientific Certification (ISSC) and "Document Base". Transition of the functionality of the "Document Base" system into the EDS "Dubna". Trial operation of the localized server of scientific publications based on the Invenio-JOIN2 software program, provision of interaction with the PIN IS at the level of bibliographic metadata.

   Transition of the "Dubna" program library to double precision and inclusion of the programs in the JINRLIB mathematical program library.

   Modernization of the information and software support of central information servers, portals and databases to ensure the MLIT and JINR activities: maintenance and update of the MLIT portals, of the website of the JINR PEPAN and "PEPAN Letters" journals on top of the Open Journal Systems (OJS) software for managing the editorial process, of the websites "JINR Dissertation Councils", INDICO, "JINR Photo Archive", "Special Assessment of Working Conditions (SAWC)-Expert", etc. Creation and support of websites, including in hosting mode, at the request of the Institute's structural subdivisions.

   Commissioning and further development of user services of the web-based information and analytical system for managing network and other types of software licenses at MLIT.

   Implementation of the hierarchical data processing and storage system in the information and computing system for radiobiological research to accelerate experimental data processing, development of web services to ensure convenient user work with the results of data analysis.

   Trial operation of the "Personal Account" system of the account management service.

   Development of the concept and creation of the technological basis for the "JINR Digital Ecosystem" platform. Integration of several services of the corporate information system that are functioning at JINR into the platform.

3. Holding of special courses related to data processing and analysis for megascience experiments, including the NICA project. Organization of tutorials on solving applied tasks on the basis of machine and deep learning methods, including in the JINR Member States in accordance with international cooperation programs.

   Development of a polygon for intelligent cognitive robots and holding of laboratory workshops on robotics.

List of projects

	Project	Leader	Priority (period of realisation)
1.	MICC	V.V. Korenkov	1 (2017-2023)

List of Activities

	Activity or Experiment	Leaders
	Laboratory or other Division of JINR	Main researchers
1.	**MICC Project**	**V.V. Korenkov** **A.G. Dolbilov** **V.V. Mitsyn** **T.A. Strizh**
	MLIT	K.N. Angelov, A.I. Balandin, N.A. Balashov, A.V. Baranov, S.D. Belov, D.V. Belyakov, A.S. Bondyakov, Yu.A. Butenko, A.I. Churin, S.V. Chashchin, A.V. Evlanov, S.V. Gavrilov, A.P. Gavrish, T.M. Goloskokova, A.O. Golunov, E.N. Grafova, Eu.A. Grafov, N.I. Gromova, A.E. Gushchin, I.S. Kadochnikov,

		I.I. Kalagin, A.S. Kamensky, I.A. Kashunin, A.O. Kondratiev, G.A. Korobova, E.Yu. Kulpin, N.A. Kutovskiy, A.A. Lavrentiev, A.N. Mahalkin, S.B. Marchenko, M.A. Matveev, Ye. Mazhitova, S.V. Mitsyn, A.V. Nechaevsky, D.A. Oleynik, G.A. Ososkov, I.S. Pelevanyuk, A.Sh. Petrosyan, M.S. Plyashkevich, D.V. Podgainy, L.A. Popov, D.I. Pryakhina, Ya.I. Rozenberg, T.F. Sapozhnikova, R.N. Semenov, M.L. Shishmakov, I.A. Sokolov, O.I. Streltsova, V.V. Trofimov, N.N. Voitishin, A.S. Vorontsov, A.V. Uzhinskiy, A.Yu. Zakomoldin, P.V. Zrelov, M.I. Zuev
	VBLHEP	K.V. Gertsenberger, Yu.P. Minaev, A.N. Moshkin, O.V. Rogachevsky, I.P. Slepov, S.V. Shmatov
	FLNP	G.A. Sukhomlinov
	LRB	V.N. Chausov
	FLNR	A.S. Baginyan, A.G. Polyakov, V.V. Sorokoumov
	DLNP	V.A. Kapitonov, Yu.P. Ivanov, A.S. Zhemchugov
	BLTP	A.A. Sazonov
	UC	I.N. Semeniushkin
2.	**Information and software support of the research-and-production activity at JINR**	**P.V. Zrelov** **V.V. Korenkov** **I.A. Filozova** **S.D. Belov**
	MLIT	Eu.I. Aleksandrov, I.N. Aleksandrov, N.A. Balashov, D.V. Belyakov, O.V. Belyakova, N.E. Belyakova, V.F. Borisovsky, Yu. A. Butenko, N.A. Davyudova, T.M. Goloskokova, D.S. Golub, P. Jancik, A.V. Ilina, L.A. Kalmykova, A.A. Karlov, D.I. Karpova, D.V. Kekelidze, S.A. Kretova, L.D. Kuchugurnaya, S.V. Kunyaev, N.A. Kutovskiy, A.Yu. Lebedev, M.A. Lubimova, M.S. Plyashkevich, L.V. Popkova, A.V. Prikhodko, V.M. Pushkina, A.M. Raportirenko, T.F. Sapozhnikova, S.V. Semashko, R.N. Semenov, G.V. Shestakova, O.I. Streltsova, T.S. Syresina, T.V. Tyupikova, N.N. Vorobieva, A.V. Uzhinskiy, D.Yu. Usov, V.M. Yagafarova, A.V. Yakovlev, A.G. Zaikina, T.N. Zaikina, M.I. Zuev
	FLNP	I. Pavliková, M.V. Frontasyeva, W. Badawy, A. Yu. Dmitriev
	LRB	I.A. Kolesnikova, M.G. Lalkovicova
	DSOA	S.N. Nedelko
3.	**Development of the system for training and retraining of IT specialists based on the JINR MICC and its educational components**	**V.V. Korenkov** **T.A. Strizh** **O.I. Streltsova**
	MLIT	N.A. Balashov, S.D. Belov, V.V. Galaktionov, T.M. Goloskokova, N.I. Gromova, O.V. Ivantsova, I.S. Kadochnikov, M.H. Kirakosyan, N.A. Kutovskiy, Ye. Mazhitova, V.V. Mitsyn, S.V. Mitsyn, I.K. Nekrasova, A.V. Nechaevsky, D.A. Oleynik, A.Sh. Petrosyan, D.V. Podgainy, A.G. Reshetnikov, T.F. Sapozhnikova, R.N. Semenov, Sh.G. Torosyan,V.V. Trofimov, S.V. Ulyanov, A.V. Uzhinskiy, M.I. Zuev
	UC	S.Z. Pakuliak

Collaboration

Country or International Organization	City	Institute or Laboratory
Armenia	Yerevan	IIAP NAS RA
Azerbaijan	Baku	ADA
		IP ANAS
Belarus	Minsk	BSTU
		INP BSU
		JIPNR-Sosny NASB
		UIIP NASB
Bulgaria	Sofia	INRNE BAS
		SU
CERN	Geneva	CERN
China	Beijing	IHEP CAS
Czech Republic	Ostrava	VSB-TUO
	Prague	IP CAS
Egypt	Cairo	ASRT
	Giza	CU
France	Marseille	CPPM
Georgia	Tbilisi	GRENA
		GTU
		TSU
Germany	Darmstadt	GSI
	Frankfurt/Main	Univ.
	Hamburg	DESY
	Karlsruhe	KIT
	Zeuthen	DESY
Italy	Bologna	INFN
Kazakhstan	Almaty	INP
	Astana	BA INP
Moldova	Chisinau	IMCS
		MSU
		RENAM
Mongolia	Ulaanbaatar	NUM
Poland	Warsaw	IMGW-PIB
Romania	Bucharest	IFIN-HH
	Cluj-Napoca	INCDTIM
	Magurele	IFA
Russia	Chernogolovka	LITP RAS
		SCC IPCP RAS
	Dubna	Dubna State Univ.
		SCC "Dubna"
		SEZ "Dubna"
	Gatchina	NRC KI PNPI
	Moscow	FRC IM RAS
		IITP RAS
		ISP RAS
		ITEP
		KIAM RAS
		MPEI
		MSK-IX
		MSU

		NRC KI
		PRUE
		RCC MSU
		RSCC
		SINP MSU
	Moscow, Troitsk	INR RAS
	Novosibirsk	BINP SB RAS
		ICMMG SB RAS
		SKIF
	Pereslavl-Zalesskiy	PSI RAS
	Protvino	IHEP
	Puschino	IMPB RAS
	Samara	SU
	St. Petersburg	FIP
		ITMO Univ.
		SPbSPU
		SPbSU
	Vladikavkaz	NOSU
Serbia	Belgrade	Univ.
Slovakia	Kosice	IEP SAS
	Presov	PU
South Africa	Cape Town	UCT
Sweden	Lund	LU
Taiwan	Taipei	ASGCCA
Ukraine	Kharkov	NSC KIPT
	Kiev	BITP NASU
USA	Arlington, TX	UTA
	Batavia, IL	Fermilab
	Upton, NY	BNL

05-6-1119-2014/2023		Priority:	1

Status: Being concluded

Methods, Algorithms and Software for Modeling Physical Systems, Mathematical Processing and Analysis of Experimental Data

Leaders: Gh. Adam
P.V. Zrelov

Deputies: J. Busa
O. Chuluunbaatar

Participating Countries and International organizations:

Armenia, Belarus, Bulgaria, CERN, China, Egypt, France, Georgia, Germany, Israel, Italy, Kazakhstan, Mexico, Moldova, Mongolia, Poland, Romania, Russia, Serbia, Slovakia, South Africa, Tajikistan, United Kingdom, USA, Vietnam.

Issues addressed and main goals of research:

Carrying out paramount advanced research in computational mathematics and physics, directed to the creation of new mathematical methods, algorithms, and software for the numerical or symbolic-numerical solution of topics arising in experimental and theoretical physics studies. This subject area includes a wide spectrum of investigations approved for completion in JINR within the seven-year period 2017–2023 in high energy physics, nuclear physics, physics of condensed matter and of nanostructures, biophysics, information technologies, the solution of which is inseparable from the use of computing. Such subject matters of the outmost importance in JINR are the NICA project, the neutrino program, the superheavy and exotic nuclei physics, the neutron-based investigations. The needed numerical or symbolic-numerical computing will be done on the Multifunctional Information and Computing Complex (MICC), primarily the HybriLIT heterogeneous computing platform which involves the training and test cluster HybriLIT and the "Govorun" supercomputer and the emerging Big Data distributed infrastructure. The research teams include both experienced scientists with outstanding scientific achievements and enthusiastic young scientists and engineers. The requested financing will cover salaries, participations in scientific conferences, scientific visits and the acquisition of a minimal number of personal computers and licenses, within the approved resources for MLIT-JINR. A distinctive feature of this research is the close cooperation of the Meshcheryakov Laboratory of Information Technologies (MLIT) with research groups from all JINR laboratories and Member State institutions.

Expected main results in the current year:

1. Detailed three-dimensional numerical analysis of the main characteristics of superconducting magnets within the NICA and NEW NUCLOTRON projects. Simulation of the operating modes of the MSC230 future isochronous cyclotron.

   Development of methods and software packages for the symbolic-numerical research of: processes (expansion of matter, crater formation, ablation) in materials under the action of ultrashort laser pulses; nuclear interactions (calculation of their characteristics, comparison with experimental data and theoretical estimates); stochastic kinetic models; models of complex systems in condensed matter physics.

   Development of effective approximation, smoothing and numerical integration algorithms based on the basic element method (BEM).

   Simulation of 5CB and 8CB nematic liquid crystals under the influence of orienting forces.

   Development of techniques for modeling the irradiation of complex structure targets with high-energy particles on the basis of the complex optimization of parallel algorithms and programs of molecular dynamics and of the continuous-atomistic method.

   Adaptation and application of the separated formfactors method for the study of the vesicular structure of phospholipid-based nanodrugs from small-angle scattering data.

Simulation of the temperature evolution of neutron stars with strong magnetic fields, taking into account additional heat sources. Application of the Bayesian inference method for constructing the mass spectra of isolated neutron stars from multichannel astronomy data.

Investigation of the properties of diquarks and baryons in dense and hot nuclear matter, their effect on the birth of strangeness. Theoretical description and numerical simulation of $gg \to \pi\pi$ gluon scattering processes in heavy-ion collisions.

2. Geant4 package-based analysis of the strange particle yield in hadron-hadron and nucleus-nucleus collisions within the BM@N and MPD experiments. Modeling of pp interactions in the SPD experiment within the hadronic programs QGS and FTF of the Geant4 package, in particular, the production of charmed particles.

   Development and support of the Monte-Carlo generator of heavy-ion collisions, DCM-QGSM-SMM, and its application to the analysis of physical effects measured at the BM@N, SRC and MPD facilities.

   Algorithmic and software support for the MPD experiment: automation of the indication and removal of obsolete packages and of their dependencies during automated builds of nicadist for mpdroot. Polymorphic software for 3D-geometry – with application in linear tracking and vertexing, for the Inner Tracking System (ITS) upgrade at MPD.

   Algorithmic and software support for the BM@N experiment: modeling of detector signal responses, restoration of spatial coordinates, data reconstruction in new configurations of track detectors (runs 2022-2023); geometric alignment of detectors.

   Testing and debugging, in line with user requirements, and commissioning of the configuration, geometric information systems, and the database of physical event metadata, for the NICA experiments.

   Software support for the ATLAS experiment: refinement of the ATLAS Event Picking Service and commissioning of the second version of the service; adaptation of the CREST information system for work in the ATHENA software environment, development of operational monitoring of the TDAQ system based on GRAFANA9.

   Development and improvement of the algorithms and methods for reconstructing the trajectories of charged particles in the cathode-strip chambers, assessment of the spatial resolution of cathode-strip chambers in the CMS experiment Run3 data (2022–2023).

   Development of data processing system software for the Baikal-GVD project.

   Monte-Carlo simulation of the background counting of the scintillation-tungsten component of the OLVE-HERO detector.

   Development of the SAS software package for the primary processing of data obtained on the small-angle neutron scattering spectrometer with the multidetector system (modernization before the start of the reactor).

   Development of a web application designed to fit data obtained in the study of the crystallographic texture of various objects using neutron diffraction and other state-of-the-art methods of neutronography.

   Application of artificial neural networks and cellular automata in tasks of experimental data processing.

3. Development of neural network algorithms for the recognition, segmentation and classification of brain cells and behavioral patterns of laboratory animals.

   Development of machine and deep learning methods for: event reconstruction in the MPD, BM@N and SPD experiments; analysis of fine structures in the mass distribution of nuclear reaction products in experiments with transuranic elements; study of nanocomposite thin films using neutron and X-ray reflectometry methods; plant disease detection tasks; environmental monitoring.

   Further development of hp-adaptive high-precision methods for solving elliptic problems on multicore computers and development of highly scalable parallel algorithms for spatial problems of magnetostatics.

   Development of methods and programs for integrating multidimensional functions using neural networks in the case of functional limits.

   Calculation of the adsorption characteristics of superheavy atoms at the surface of gold by density functional theory methods using the AMS computing software package on the “Govorun” supercomputer.

   Development of algorithms to calculate sub-barrier fusion reactions of heavy nuclei within the channel coupling method.

Development of digital methods to assess the growth rate of rounding errors in a uniform metric using the REDUCE system on the "Govorun" supercomputer.

Development of methods and software tools to solve service and applied tasks using the technologies of Big Data processing and data mining.

Elaboration and development of methods for storage, processing and physical analysis of data for the experiments of the NICA megaproject within the Big Data approach.

4. Development of quantum algorithms and their implementation in the environment of quantum computing simulators for the investigation of the electron shells of superheavy element atoms, for experimental data processing and analysis, as well as for the intelligent control of different systems.

   Development of embedded quantum intelligent regulators for use as control modules of different robotic devices. Development of a prototype of a quantum intelligent regulator for the coordinated control of the pressure and consumption of nitrogen and helium during the automated cooling of a superconducting magnet (different emergency situations included).

   Development and testing of an intelligent system for controlling the modes of the high-frequency stations of the Nuclotron of the NICA accelerator complex on the basis of the principles of quantum software engineering.

   Modeling of quantum algorithms on simulators using classical computing architectures (CPU, GPU) to solve the problem of calculating the structure of the electronic spectrum of simple molecules.

   Numerical study of the role of collective information in networks of quantum agents.

   Development of algorithms for the constructive decomposition of quantum systems into subsystems using computer algebra methods and computational group theory.

   Derivation of criteria for the reducibility of polynomials to zero based on machine learning methods.

   Development of a software package for analytical computations of one-loop Feynman integrals entering the light-by-light scattering processes, gg→WW, hh→ZZ, hh→ZH, gg→hh.

   Simulation of the real time non-equilibrium evolution and quantum phase transitions in the two-dimensional quantum Ising model on a quantum computer.

   Creation of a software package for the fast generation of arbitrary rank random qudit density matrices.

   Modeling of quantum registers and quantum logic gates based on quantum dots of complex geometry.

List of Activities

	Activity or experiment	**Leaders**
	Laboratory or other Division of JINR	Main researchers
1.	**Mathematical and computation methods for simulation of complex physical systems**	**Gh. Adam** **J. Busa** **I.V. Puzynin**
	MLIT	S. Adam, P.G. Akishin, I.V. Amirkhanov, A.S. Ayriyan, E.A. Ayrjan, D.R. Badreeva, I.V. Barashenkov, M.V. Bashashin, A.A. Bogolubskaya, A.M. Chervyakov, N.D. Dikussar, H. Grigorian, M. Kakenov, Yu.L. Kalinovsky, T.V. Karamysheva, D.S. Kulyabov, K.V. Lukyanov, N.V. Makhaldiani, T.I. Mikhailova, E.G. Nikonov, R.V. Polyakova, T.P. Puzynina, V.S. Rikhvitsky, B. Saha, I. Sarkhadov, Z.A. Sharipov, N.Yu. Shirikova, Z.K. Tukhliev, A.V. Volokhova, O.O. Voskresenskaya, R.M. Yamaleev, E.P. Yukalova, E.V. Zemlyanaya, E.I. Zhabitskaya
	VBLHEP	G.N. Agakishiev, H.G. Khodzhibagiyan

BLTP	A.A. Donkov, A.V. Friesen, M. Hnatič, E.E. Kolomeitsev, A.S. Khvorostukhin, V.K. Lukyanov, A.B. Pestov, L.A. Sevastyanov, D.N. Voskresensky, V.I.Yukalov
FLNR	E. Batchuluun, M.N. Mirzaev, Yu.M. Sereda, V.A. Skuratov
FLNP	A.S. Doroshkevich, N. Kucherka, E.E. Perepelkin, E.P. Popov, Yu.N. Pepelyshev, E.P. Shabalin
DLNP	G.A. Karamysheva, O.V. Karamyshev, I.N. Kiyan, I.D. Lyapin, V.A. Malinin, D.V. Popov, K. G.D. Shirkov
2. Software complexes and mathematical methods for processing and analysis of experimental data	**P.V. Zrelov** **V.V. Ivanov**
MLIT	E.P. Akishina, E.I. Aleksandrov, I.N. Aleksandrov, D.A. Baranov, J. Buša Jr., O.Yu. Derenovskaya, M. Dima, M.O. Dima, M.T. Dima, I.A. Filozova, S. Hnatič, A.I. Kazymov, B.F. Kostenko, M.A. Mineev, G.J. Musulmanbekov, V.V. Palichik, D.I. Pryakhina, V.S. Rikhvitsky, T.F. Sapozhnikova, I. Satyshev, G.V. Shestakova, Z.A. Sharipov,S.K. Slepnev, A.G. Soloviev, T.M. Solovieva, A.N. Sosnin, Z.K. Tukhliev, V.V. Uzhinsky, N.N. Voitishin, A.V. Yakovlev, V.B. Zlokazov
VBLHEP	Yu. V. Bespalov, D. K. Dryablov, I.R. Gabdrakhmanov, A.S. Galoyan, K.V. Gertsenberger, I.A. Golutvin, N.V. Gorbunov, A.V. Gus'kov, A.Yu. Kamenev, M.N. Kapishin, V.Yu. Karzhavin, V.V. Lenivenko, A.M. Makan'kin, S.P. Merts, A.N. Morozov, D. N. Nikiforov, M. Patsyuk, V.V. Perelygin, Yu.P. Petukhov, O.V. Rogachevsky, M.M. Rumyantsev, S.V. Shmatov, S.S. Shimansky, V.N. Spaskov, A.V. Zarubin, V. Zhezher
BLTP	V.D. Toneev
FLNR	Yu.S. Tsyganov, V.K. Utenkov
FLNP	M. Balasoiu, A.I. Ivan'kov, A.H. Islamov, Yu.S. Kovalev, A.I. Kuklin, Yu.L. Rizhikov, A.V. Rogachov, V.V. Skoy
DLNP	I.A. Belolaptikov, A.E. Pan, B.A. Shaibonov, L.G. Tkatchev
UC	S.Z. Pakulyak
3. Numerical methods, algorithms and software for multicore and hybrid architectures and Big Data analytics	**Gh. Adam** **O. Chuluunbaatar** **P.V. Zrelov** **O.I. Streltsova**
MLIT	A.I. Anikina, A.S. Ayriyan, D.A. Baranov, S.D. Belov, D.V. Belyakov, J. Buša Jr., Yu.A. Butenko, G. Chuluunbaatar, P.V. Goncharov, H. Grigorian, A.A. Gusev, A.V. Ilina, J.N. ogly Javazade, I.S. Kadochnikov, Yu.L. Kalinosky, M.A. Matveev, A.V. Nechaevsky, D.A. Oleinik, G.A. Ososkov, V.V. Papoyan, I.S. Pelevanyuk, A.Sh. Petrosyan, R.N. Semenov, S.I. Serdyukova, A.V. Stadnik, A.V. Uzhinsky, O.I. Yuldashev, M.B. Yuldasheva
MLIT-MICC	V.V. Korenkov, V.V. Mitsyn, T.A. Strizh
FLNR	N.V. Aksenov, A.A. Astahov, A.V. Karpov, Yu.Ts. Oganesyan, Yu.V. Pyatkov, V.V. Samarin
BLTP	Yu.B. Ivanov, S. Libing, Yu.V. Popov, I.R. Rahmonov, Yu.M. Shukrinov, S.I. Vinitsky, D.N. Voskresensky
VBLHEP	K.V. Gertsenberger
DLNP	A.S. Zhemchugov

FLNP	M.V. Avdeev, W. Badavy, M.V. Frontaseva, M.F. Kiselev, T.V. Tropin
LRB	I.A. Kolesnikova, K.N. Lyakhova, Yu.S. Severiukhin, D.M. Utina
4. Methods, algorithms and software of computer algebra and quantum computing	**D.V. Podgainy** **A.M. Khvedelidze** **P.V. Zrelov**
MLIT	V. Abgaryan, A.S. Bondyakov, M. Bures, O. Chuluunbaatar, A.A. Gusev, O.V. Ivancova, V.V. Kornyak, E.A. Kuznetsov, Yu. Palii, A.M. Raportirenko, A.G. Reshetnikov, A.R. Ryabov, N.V. Ryabov, I.A. Rogozhin, N. Saktaganov, S.V. Semashko, A.V. Stadnik, O.I. Streltsova, L.A. Syurakshina, O.V. Tarasov, A.G. Torosyan, S.V. Ulyanov, D.A. Yanovich, E.P. Yukalova, D.P. Zrelova, M.I. Zuev
BLTP	N.A. Tyurin, S.I. Vinitsky, V.I. Yukalov, V.Yu. Yushankhai
DLNP	M.S. Katulin
VBLHEP	O.I. Brovko, A.V. Butenko, G.P. Reshetnikov, O.V. Rogachevsky, E.V. Sedykh
LRB	A.V. Czhizhov

Collaboration

Country or International Organization	City	Institute or Laboratory
Armenia	Yerevan	Foundation ANSL
		RAU
		YSU
Belarus	Minsk	IM NASB
Bulgaria	Sofia	IMI BAS
		INRNE BAS
		SU
CERN	Geneva	CERN
China	Beijing	CIAE
Egypt	Giza	CU
France	Nancy	UL
	Saclay	IRFU
Georgia	Tbilisi	GTU
		TSU
		UG
Germany	Darmstadt	GSI
	Hamburg	Univ.
	Kassel	Uni Kassel
Israel	Tel Aviv	TAU
Italy	Genoa	INFN
Kazakhstan	Almaty	INP
		KazNU
Mexico	Mexico City	UNAM
Moldova	Chisinau	MSU
Mongolia	Ulaanbaatar	IMDT MAS

Poland	Krakow	INP PAS
		JU
		UEK
	Wroclaw	UW
Romania	Bucharest	IFIN-HH
		UB
	Cluj-Napoca	INCDTIM
	Magurele	IFA
		ISS
	Timisoara	UVT
Russia	Dolgoprudny	MIPT
	Dubna	Dubna State Univ.
	Irkutsk	ISU
	Moscow	ITEP
		MSU
		NNRU "MEPhI"
		PFUR
		PRUE
		RCC MSU
		RSTSREC
		SINP MSU
	Moscow, Troitsk	INR RAS
	Puschino	IMPB RAS
	Saratov	SSU
	St. Petersburg	NIIEFA
		SPbSU
	Tomsk	TSU
	Vladikavkaz	NOSU
Serbia	Belgrade	Univ.
Slovakia	Kosice	UPJS
South Africa	Cape Town	UCT
Tajikistan	Dushanbe	PHTI NAST
	Khujand	KSU
United Kingdom	Plymouth	Univ.
USA	Cambridge, MA	MIT
	Los Angeles, CA	UCLA
Vietnam	Hanoi	VNU
	Ho Chi Minh City	HCMUE

05-8-1037-2001/2024			
		Priority:	1
		Status:	In-progress

Analytical and Methodological Work to Assess the Prospects of Scientific Research and Cooperation in the Main Directions of JINR's Development. Organization of International Cooperation

Leaders: V. A. Matveev
S.N. Nedelko

Deputies: O.A. Culicov
D.V. Kamanin

Participating Countries and International organizations:

Member States of JINR, states participating in JINR activities on the basis of bilateral agreements, international organizations.

Issues addressed and main goals of research:

Development of analytical materials concerning prospects of scientific research. Preparation of scientific research plans. Development of science-organization and methodological materials for the special-purpose financing of research areas, themes and projects. Development and application of information systems for the analysis of results of theoretical and experimental research. Organization of international cooperation with the Member States of JINR, with states participating in JINR activities on the basis of bilateral agreements, and with scientific research institutions with which JINR has collaboration agreements.

Expected results in the current year:

1. Improvement of the organization and coordination of JINR scientific research work.
2. Analysis of the results of JINR activities for 2022 in the main research areas.
3. Update, administration and support of the electronic system for maintaining the Topical Plan for JINR Research and International Cooperation (Topical Plan). Preparation for the publication of the Topical Plan for the year 2024. Identification of JINR’s priority research directions for 2024.
4. Development of JINR’s grantmaking activities and participation in special-purpose programmes for financing scientific research in 2023.
5. Preparation of analytical materials for ministries and agencies.
6. Development and promotion of JINR’s information resources on the Internet. Support of the system of accounting of protocols on scientific and technological cooperation.
7. Promotion of realization of JINR’s right to independently confer academic degrees. Support of the operation of JINR’s dissertational councils.
8. Preparation for the publication of the JINR Annual Report for 2022. Preparation of materials for the INIS system.
9. Scientific and organizational support and preparation of materials of JINR’s governing and advisory bodies.
10. Prompt interaction with representatives of Member States and states participating in the activities of JINR on the basis of bilateral agreements in the fields of scientific research. Organization and holding of meetings of cooperation committees. Interaction with international organizations.
11. Organization and holding of contests for JINR Prizes, preparation of materials for nominating candidates for memberships in academies of sciences, for conferring honorary titles, for awarding medals and other decorations.

List of Activities

Activity or experiment Laboratory or other Division of JINR	Leaders Main researchers
1. Preparation for the publication of the Topical Plan for 2023	**S.N. Nedelko** **O.A. Culicov** **A.S. Zemchugov**
DSOA	N.A. Boklagova, D.S. Korobov, N.I. Sissakian
2. Support and improvement of the operation of JINR's governing and advisory bodies	**S.N. Nedelko** **O.A. Culicov** **D.V. Kamanin**
DSOA	N.A. Boklagova, T.B. Ivashkevich, D.S. Korobov, N.I. Sissakian
ICD	O.N. Belova, N.M. Dokalenko, O.M. Korotchik, A.A. Kotova, E.N. Rusakovich
3. Preparation of analytical materials for ministries and agencies	**S.N. Nedelko** **O.A. Culicov** **A.S. Zhemchugov** **D.V. Kamanin**
DSOA	N.A. Boklagova, S.V. Degtyarev, T.B. Ivashkevich, D.S. Korobov, N.I. Sissakian
ICD	A.A. Kotova, A.E. Vasiliev
STL	E.V. Ivanova, V.V. Litsitis
4. Development of JINR's grantmaking activities and participation in special-purpose programmes for financing scientific research	**S.N. Nedelko** **O.A. Culicov** **D.V. Kamanin**
DSOA	N.A. Boklagova, D.S. Korobov. N.I. Sissakian
5. Support for the operation of JINR's dissertation councils	**S.N. Nedelko** **A.S. Zhemchugov**
DSOA	T.B. Ivashkevich, N.I. Sissakian
VBLHEP	O.V. Belov
6. Organizational support for JINR's activities under Russian and international protocols and agreements	**S.N. Nedelko** **O.A. Culicov** **D.V. Kamanin**
DSOA	S.V. Degtyarev, L.I. Kalinina, N.I. Sissakian
ICD	T.V. Keselis, A.A. Kotova
7. Provision for the operation and development of JINR's Internet resources	**S.N. Nedelko** **D.V. Kamanin**
DSOA	N.A. Boklagova, A.Yu. Chigireva, D.S. Korobov, K.P. Moisenz, A.G, Nanev, N.I. Sissakian,
IDA	N.V. Zaikina, I.N. Suleymanv

SCSS SID	B.M. Starchenko
Editorial office of the weekly newspaper "Dubna: science, community, progress"	E.M. Molchanov
UC	S.Z. Pakulyak, A.A. Suschevich
8. Preparation for the publication of JINR Annual Reports. Preparation of materials for the INIS system	**S.N. Nedelko** **A.S. Zhemchugov**
SCSS SID	S.N. Kruglova, Yu.G. Shimanskaya, B.M. Starchenko
DSOA	N.A. Boklagova, S.V. Degtyarev, D.S. Korobov, O.V. Krupa
9. International cooperation	**D.V. Kamanin** **S.N. Nedelko**
ICD	O.N. Belova, T.V. Keselis, A.A. Kotova, M.G. Loschilov, Yu.N. Polyakova, A.E. Vasiliev
DSOA	N.A. Boklagova, O.A. Culicov, D.S. Korobov, A.S. Zhemchugov

Educational Programme (06)

06-0-1139-2019/2023

Priority:	1

Status: Being concluded

Organization, Support and Development of the JINR Human Resources Programme

Leaders: G.V. Trubnikov
V.A. Matveev
S.Z. Pakuliak

Participating Countries and International organizations:

Armenia, Azerbaijan, Belarus, Bulgaria, CERN, Cuba, Czech Republic, Egypt, Kazakhstan, Moldova, Mongolia, Poland, Romania, Russia, Serbia, Slovakia, South Africa, Ukraine, Uzbekistan, Vietnam.

Issues addressed and main goals of research:

Development of the human resources training programmes at JINR aimed at further employment of the trainees as scientific and engineering specialists of the Institute; creation of appropriate conditions for students and PhD students from universities of the Member States to enable them to work on their qualification theses based on the research conducted in the laboratories of the Institute; support of the educational process for students of the JINR-based departments at the universities of the Russian Federation, as well as participation in the development of network training programmes; cooperation with the branch of Moscow State University in Dubna; organisation and running of international student practices and schools for young people from the JINR Member States; training of students, PhD students, and interns on the basis of cooperation agreements with the universities of the JINR Member States and international organisations; building and maintenance of the laboratory environment intended for hands-on training in scientific and engineering disciplines; support and further development of the system of training courses aimed at gaining or improving professional skills and qualifications of JINR technical and engineering personnel; development of the JINR educational portal (edu.jinr.ru) and interactive exposition “JINR main facilities”; further development of the set of e-learning courses on the main areas of research conducted at JINR in the official languages of the Institute and by its leading experts; development of virtual and real laboratories allowing students to be trained using modern experimental equipment; development of the JINR outreach programme and promotion of modern science achievements among school students and teachers, organisation of excursions and online tours of the JINR basic facilities; participation in science festivals, exhibitions, and forums promoting JINR; development of cooperation and communication with educational centres for school students; design and production of information materials for the JINR information centres, administration of the UC groups in the social media.

Expected results upon completion of the activities:

1. Participation in the development of lecture courses and seminars for students and PhD students of the JINR-based departments of the Russian universities.
2. Support of the system of assigning Institute employees to JINR for preparation of their PhD theses without completing the academic programme of the PhD course. Participation in the Institute system of attestation of scientific personnel.
3. Organisation and running of the JINR student programme "START", online programme "INTEREST", international student schools and practices.
4. Training of students and PhD students at JINR on the basis of cooperation agreements with the universities of the JINR Member States and other countries.
5. Maintenance of the laboratories intended for hands-on training in scientific and engineering disciplines (Engineering and Physics Training): accelerator, vacuum, and RF technology, radio electronics, dosimetry, pixel detectors.
6. Further development of the licensed system of training courses aimed at gaining or improving professional skills and qualifications of the technical and engineering personnel of the Institute.
7. Development of a set of virtual laboratory works and e-learning courses in nuclear physics, particle physics, condensed matter physics, and radiobiology.
8. Further development of the system of virtual laboratories enabling intergation of the latest results of scientific research into the educational process.

9. Further development of cooperation with CERN in the implementation of advanced training programmes for school teachers from the JINR Member States.
10. Development of cooperation with the Educational Foundation "Talent and Success" to implement joint programmes on science outreach on the basis of the Sirius Educational Centre in Sochi.
11. Participation in extracurricular programmes of the autonomous non-commercial educational organisation "Physics and Mathematics Lyceum named after Academician V.G. Kadyshevsky" in Dubna.
12. Support of Dubna Interschool Physics and Mathematics Open Classroom, other educational institutions, and science programmes for school students.
13. Development of printed and electronic popular-science informational materials promoting the Institute and modern scientific achievements.
14. Provision of JINR partner universities and information centres in the Member States with electronic and printed informational materials.

Expected major results in the current year:

1. Support and supervision of the educational process at the JINR-based departments of the Russian universities.
2. Support of the system of assigning young researchers to JINR laboratories for preparation of their PhD theses.
3. Organisation and running of the International Student Practices in JINR Fields of Research for students of the JINR Member States' universities.
4. Organisation and running of the JINR student programme "START" and online programme "INTEREST".
5. Development of an information system on the preparation of qualification theses by students and PhD students from universities of the JINR Member States in the Institute laboratories.
6. Organisation and running of the Engineering and Physics Training hands-on activities for students and PhD students from the JINR Member States, further development of the existing laboratory works, development of a laboratory work on dosimetry.
7. Organisation of scientific schools for physics teachers from the Institute Member States at CERN and JINR.
8. Further development of virtual tours of JINR basic facilities and video-conferences with educational institutions of the JINR Member States. Organisation and guidance of group visits to JINR for school and university students.
9. Development of a set of e-learning courses in nuclear physics, particle physics, condensed matter physics, and the basic facilities of the Institute.
10. Promotion of modern educational resources in the JINR Member States.
11. Organisation of the participation of JINR in science festivals on the basis of Russian universities.
12. Development of the language courses programme aimed at teaching Russian as a foreign language and English to JINR personnel.
13. Participation of JINR in an interdisciplinary social educational project "Summer School-2023”, organisation and running of the Physics Workshop "105th element".
14. Participation in the design and production of printed, video, and exhibition information materials intended for the JINR information centres. Cooperation with JINR information centres in the fields of science outreach and education (online lectures and excursions, internships and practices).
15. Running of popular science events in schools (city festival "Physics Days - 2023", lectures, demonstrations of chemical and physical experiments, quizzes, quests, excursions, meetings with scientists, vocational orientation events, and competitions for school and university students).
16. Organisation of the participation of JINR in career forums at universities.

List of projects

	Project	Leader	Priority (period of realisation)
1.	Open information and educational environment for supporting fundamental and applied multidisciplinary research at JINR	Yu.A. Panebrattsev	1 (2021-2023)

List of Activities

	Activity or experiment	Leaders
	Laboratory or other Division of JINR	Main researchers
1.	**Organization of the Educational Process at JINR**	**V.A. Matveev** **S.Z. Pakuliak** **A.Yu. Verkheev**
	DLNP V.A. Bednyakov D.V. Naumov	A.G. Olshevskiy, A.S. Zhemchugov
	BLTP D.I. Kazakov A.P. Isaev A.B. Arbuzov	Yu.M. Shukrinov, A.A. Vladimirov
	FLNP V.N. Shvetsov E.V. Lychagin O.A. Culikov	M.V. Avdeev, A.V. Belushkin
	VBLHEP N.A. Strokovsky O.V.Belov	D.K. Dryablov, D.O. Ponkin, I.V. Shirikov
	FLNR S.I. Sidorchuk A.V. Karpov A.G. Popeko	A.A. Voinov, K.B. Gikal
	MLIT V.V. Korenkov T.A. Strizh O.Yu. Derenovskaya	I.S. Pelevanyuk
	LRB A.N. Bugay E.A.Krasavin I.V. Koshlan	G.N. Timoshenko
	Directorate V.D. Kekelidze L.Kostov B.N. Gikal	B.Yu. Sharkov, E.D. Uglov
	ICD D.V. Kamanin	A.A. Kotova

2.	**Developing of modern educational projects**	**Y.A. Panebrattsev**
	VBLHEP	G.N. Agakishiev, E.I. Golubeva, R.V. Klygina, Yu.D. Orlova, M.P. Osmachko, G.D. Semchukov, N.E. Sidorov, N.I. Vorontsova, G.A. Yarygin
3.	**Outreach and JINR promotion**	**A.A. Suschevich**
	DLNP	N.V. Anfimov, M.V. Shirchenko
	BLTP	A.V. Andreev, A.V. Frizen
	FLNP	M.V. Bulavin, D.M. Chudoba, C. Khramko
	VBLHEP	D.K. Dryablov, D.I. Klimansky
	FLNR	K.B. Gikal, A.V. Karpov
	MLIT	I.S. Pelevanyuk
	LRB	T.S. Khramko, I.A. Kolesnikova, Yu.S. Severyukhin
	Universal JINR library	M.S. Pilipenko
4.	**Engineering and Physics Training**	**M.A. Nozdrin**
	VBLHEP	R.V. Pivin, K.G. Osipov
	DLNP	A.N. Trifonov, A.V. Chetverikov, A.S. Zhemchugov
	FLNR	D.S. Belozerov, A.Yu. Bodrov, V.A. Buzmakov, K.B. Gikal, A.M. Kapitonov, A.V. Khalkin, E.V. Melnik, K.V. Papenkov, A.V. Sabelnikov, K.A. Verlamov, V.Yu. Zhegolev, D.A. Zlydenny

Collaboration

Country or International Organization	**City**	**Institute or Laboratory**
Armenia	Yerevan	YSU
Azerbaijan	Baku	IP ANAS
Belarus	Gomel	GSU
	Minsk	BSTU
		INP BSU
Bulgaria	Sofia	INRNE BAS
		SU
CERN	Geneva	CERN
Cuba	Havana	ASC
Czech Republic	Prague	CTU
		CU
Egypt	Cairo	ASRT
Kazakhstan	Almaty	KazNU
	Astana	ENU
	Ust-Kamenogorsk	EKSU
Moldova	Chisinau	ASM

		MSU
Mongolia	Ulaanbaatar	MNUE
		NUM
Poland	Krakow	INP PAS
Romania	Bucharest	UB
Russia	Arkhangelsk	NArFU
		NSMU
	Belgorod	BelSU
	Dolgoprudny	MIPT
	Dubna	Dubna State Univ.
	Grozny	CheSU
	Irkutsk	ISU
	Ivanovo	ISU
	Kazan	KFU
	Kostroma	KSU
	Krasnodar	KSU
	Moscow	BMSTU
		MPEI
		MSU
		NNRU "MEPhI"
		NRU HSE
		PFUR
	Novocherkassk	SRSPU NPI
	Petropavlovsk-Kamchatsky	KSU
	Samara	SU
	St. Petersburg	SPbSU
		SPSFTU
	Tomsk	TPU
		TSU
	Tula	TSU
	Vladikavkaz	NOSU
	Vladivostok	FEFU
	Voronezh	VSU
	Yakutsk	NEFU
	Yaroslavl	YSU
	Yekaterinburg	UrFU
Serbia	Novi Sad	UNS
Slovakia	Bratislava	CU
	Kosice	STM
		UPJS
South Africa	Stellenbosch	SU
Ukraine	Kiev	BITP NASU
Uzbekistan	Tashkent	AS RUz
Vietnam	Hanoi	IOP VAST

Alphabetical List of Collaborators

Albania

Tirana

UT | University of Tirana | http://www.unitir.edu.al/, 1128

Argentina

Bariloche

CAB CNEA | Bariloche Atomic Centre National Atomic Energy Commission | http://www.cab.cnea.gov.ar/, 1143, 1140

Buenos Aires

CNEA | National Atomic Energy Commission | https://www.argentina.gob.ar/comision-nacional-de-energia-atomica/, 1135

Armenia

Garni

GGO | Garni Geophysical Observatory, 1126

Gyumri

IGES NAS RA | Institute of Geophysics and Engineering Seismology named after A. Nazarov | http://iges.am/, 1126

Yerevan

Foundation ANSL | A.I. Alikhanian National Science Laboratory Yerevan Physics Institute Foundation | http://www.yerphi.am/, 1135, 1137, 1138, 1081, 1083, 1065, 1087, 1088, 1142, 1143, 1133, 1119

IIAP NAS RA | Institute for Informatics and Automation Problems of the National Academy of Sciences of the Republic of Armenia | http://iiap.sci.am/, 1118

IMB NAS RA | Institute of Molecular Biology of the National Academy of Sciences of the Republic of Armenia | http://www.molbiol.sci.am/, 1131

Institute of Chemical Physics named after A.B. Nalbandyan of the National Academy of Sciences of the Republic of Armenia | https://ichph.am/, 1131

RAU | Russian-Armenian University | http://www.rau.am/, 1135, 1136, 1119

Shirak Technologies | “Shirac” Technological Company | http://www.shte.net/, 1126

SRCHCH | Scientific Research Center of the Historical and Cultural Heritage of the Ministry of Education, Science, Culture and Sport of RA (SN-CO) | https://armheritage.am/, 1128, 1142

YSU | Yerevan State University | http://www.ysu.am/, 1136, 1137, 1138, 1117, 1065, 1087, 1107, 1077, 1119, 1139

Australia

Melbourne, VIC

Univ. | University of Melbourne | http://unimelb.edu.au/, 1128

Perth, WA

UWA | University of Western Australia | http://www.uwa.edu.au/, 1138

Sydney, NSW

Univ. | University of Sydney | http://sydney.edu.au/, 1137, 1138, 1065

Austria

Innsbruck

Univ. | University of Innsbruck | http://www.uibk.ac.at/, 1128

Linz

JKU | Johannes Kepler University Linz | http://www.jku.at/, 1137

Vienna

HEPHY | Institute of High Energy Physics | http://www.hephy.at/, 1083

ITP TU Wien | Institute for Theoretical Physics Vienna University of Technology | http://www.itp.tuwien.ac.at/, 1117

SMI | Stefan Meyer Institute for Subatomic Physics of the Austrian Academy of Sciences | https://www.oeaw.ac.at/smi/home/, 1088

Azerbaijan

Baku

ADA | Azerbaijan Diplomatic Academy | https://www.ada.edu.az/, 1118

AzTU | Azerbaijan Technical University | http://aztu.edu.az/, 1142

BSU | Baku State University | http://bsu.edu.az/, 1135, 1128

IGG ANAS | Institute of Geology and Geophysics of the Azerbaijan National Academy of Sciences | http://gia.az/, 1128

IP ANAS | Institute of Physics of the Azerbaijan National Academy of Sciences | http://physics.mehdiyev.me/, 1135, 1081, 1142, 1118, 1139

IRP ANAS | Institute of Radiation Problems of the Azerbaijan National Academy of Sciences | http://irp.science.az/, 1066, 1100, 1128, 1105

NNRC | National Nuclear Research Center | http://www.mntm.az/, 1065, 1088, 1105

Bangladesh

Dhaka

DU | University of Dhaka | http://www.univdhaka.edu/, 1088

Belarus

Gomel

GSTU | Pavel Sukhoi State Technical University of Gomel | http://www.gstu.by/, 1135, 1117, 1081, 1086

GSU | Francisk Skorina Gomel State University | http://gsu.by/, 1135, 1136, 1081, 1083, 1086, 1131, 1139

Minsk

"INTEGRAL" | “INTEGRAN” JSC | http://www.integral.by/, 1086

“Radateh” | “Radateh” Ltd. | http://www.radateh.com/, 1086

BSTU | Belarusian State Technological University | http://www.belstu.by/, 1137, 1142, 1143, 1140, 1126, 1118, 1139

BSU | Belarusian State University | http://www.bsu.by/, 1135, 1144, 1128, 1141, 1131

BSUIR | Belarusian State University of Informatics and Radioelectronics | http://www.bsuir.by/, 1086, 1065, 1133

CGM NASB | Center for geophysical monitoring of National Academy of Sciences of Belarus | https://cgm.by/, 1126

IAP NASB | State Scientific Institution “Institute of Applied Physics of the National Academy of Sciences of Belarus | http://iaph.bas-net.by/, 1081, 1086, 1142

IBCE NASB | Institute of Biophysics and Cell Engineering NAS of Belarus | http://ibp.org.by/ru/, 1077

IM NASB | Institute of Mathematics of the National Academy of Sciences of Belarus | http://im.bas-net.by/, 1119

INP BSU | Institute for Nuclear Problems of Belarusian State University | http://www.new.inp.bsu.by/, 1135, 1123, 1081, 1144, 1096, 1083, 1086, 1065, 1127, 1107, 1128, 1142, 1143, 1118, 1139

Inst. Physiology NASB | Institute of Physiology of the National Academy of Sciences of Belarus | http://physiology.by/, 1077

IP NASB | B.I. Stepanov Institute of Physics of the National Academy of Sciences of Belarus | http://ifan.basnet.by/, 1135, 1136, 1137, 1081, 1144, 1108, 1086, 1065

ISEI BSU | International Sakharov Environmental Institute of the Belarusian State University | http://www.iseu.bsu.by/, 1107

JIPNR-Sosny NASB | State Scientific Institution "Joint Institute for Power and Nuclear Research - Sosny" of the National Academy of Sciences of Belarus | http://sosny.bas-net.by/, 1135, 1081, 1065, 1107, 1105, 1118

PTI NASB | Physical Technical Institute of the National Academy of Sciences of Belarus | http://www.phti.by/, 1065

RI PCP BSU | Research Institute for Physical Chemical Problems of the Belarusian State University | http://fhp.bsu.by/, 1107, 1142

SOL instruments | SOL instruments LTd. | http://solinstruments.com/, 1133

SPMRC NASB | Scientific and Practical Materials Research Centre of the National Academy of Sciences of Belarus | http://www.physics.by/, 1137, 1065, 1128, 1142, 1077

UIIP NASB | United Institute of Informatics Problems of the National Academy of Sciences of Belarus | http://www.uiip.bas-net.by/, 1118

Belgium

Antwerp

UAntwerp | University of Antwerp | http://www.uantwerpen.be/, 1083

Brussels

ULB | Université Libre de Bruxelles | http://www.ulb.ac.be/ VUB | Vrije Universiteit Brussel | http://www.ulb.be/, 1136, 1083

VUB | Vrije Universiteit Brussel | http://www.vub.ac.be/, 1083

Ghent

Ugent | Ghent University | http://www.ugent.be/, 1083

Leuven

KU Leuven | Catholic University of Leuven | http://www.kuleuven.be/, 1083, 1129, 1130

Louvain-la-Neuve

IBA | Ion Beam Applications | http://iba-worldwide.com/

UCL | Catholic University of Louvain | http://uclouvain.be/, 1132

UCL | Catholic University of Louvain | http://uclouvain.be/, 1136, 1096, 1083

Mons

UMONS | University of Mons | http://web.umons.ac.be/, 1083

Botswana

Palapye

BIUST | Botswana International University of Science and Technology | http://www.biust.ac.bw/, 1128

Brazil

Brasilia, DF

UnB | University of Brasilia | http://www.unb.br/, 1137

Campinas, SP

UNICAMP | State University at Campinas | http://www.unicamp.br/, 1088

Florianopolis, SC

UFSC | Federal University of Santa Catarina | http://ufsc.br/, 1136

Juiz de Fora, MG

UFJF | Federal University of Juiz de Fora | http://www2.ufjf.br/, 1138

Natal, RN

IIP UFRN | International Institute of Physics of the Federal University of Rio Grande do Norte | http://www.iip.ufrn.br/, 1137

Niteroi, RJ

UFF | Federal Fluminense University | http://www.uff.br/, 1136

Porto Alegre, RS

UFRGS | Federal University of Rio Grande de Sul | http://www.ufrgs.br/, 1088

Rio de Janeiro, RJ

CBPF | Brazilian Center for Physics Research | http://portal.cbpf.br/, 1083

UERJ | State University of Rio de Janeiro | http://www.uerj.br/, 1083

Santo Andre, SP

UFABC | University Federal of ABC | http://www.ufabc.edu.br/, 1117, 1088

Sao Jose dos Campos, SP

ITA | Aeronautics Institute of Technology | http://www.ita.br, 1136

Sao Paulo, SP

UEP | Unit of Professional Education Santa Case de São Paulo | http://www.santacasasp.org.br/), 1136
Unesp | São Paulo State University | http://www2.unesp.br/, 1083
USP | University of São Paulo | http://www5.usp.br/, 1137, 1138, 1117, 1088

Vitoria, ES

UFES | Federal University of Espirito Santo | http://www.ufes.br/, 1138

Bulgaria*

Blagoevgrad

AUBG | American University in Bulgaria | http://www.aubg.edu/, 1087
SWU | South-West University "Neofit Rilski" | http://www.swu.bg/, 1096, 1065

Plovdiv

PU | Plovdiv University "Paisii Hilendarski" | https://uni-plovdiv.bg/, 1137, 1096, 1065, 1100, 1128
UFT | University of Food Technologies-Plovdiv | http://uft-plovdiv.bg/, 1128

Sofia

ASCI Ltd | ASCI Ltd | http://www.asci.bg/, 1142
IAPS | Institute for Advanced Physics Studies | http://iaps.institute/, 1088
IE BAS | Academician Emil Djakov Institute of Electronics of the Bulgarian Academy of Sciences | http://www.ie-bas.org.bg/, 1128, 1142, 1077
IEES BAS | Institute of Electrochemistry and Energy Systems "Academic Evgeni Budevski" of the Bulgarian Academy of Sciences | http://iees.bas.bg/, 1142
IMech BAS | Institute of Mechanics of the Bulgarian Academy of Sciences | http://www.imbm.bas.bg/, 1137
IMI BAS | Institute of Mathematics and Informatics of the Bulgarian Academy of Sciences | http://math.bas.bg/, 1119
INRNE BAS | Institute for Nuclear Research and Nuclear Energy of the Bulgarian Academy of Sciences | http://www.inrne.bas.bg/, 1135, 1136, 1137, 1138, 1117, 1083, 1065, 1087, 1066, 1129, 1130, 1100, 1128, 1142, 1118, 1119, 1139
Inst. Microbiology BAS | Stephan Angeloff Institute of Microbiology of the Bulgarian Academy of Sciences | http://microbio.bas.bg/, 1087, 1077
ISSP BAS | Georgi Nadjakov Institute of Solid State Physics of the Bulgarian Academy of Sciences | http://www.issp.bas.bg/, 1137, 1065, 1142
LTD BAS | Laboratory for Technical Development of the Bulgarian Academy of Sciences | http://www.pronto.phys.bas.bg/, 1065
NBU | New Bulgarian University | http://www.nbu.bg/, 1136
NCRRP | National Centre of Radiobiology and Radiation Protection | http://ncrrp.org/, 1077
SU | Sofia University "St. Kliment Ohridski" | http://www.uni-sofia.bg/, 1135, 1137, 1138, 1117, 1081, 1144, 1096, 1083, 1065, 1087, 1066, 1088, 1118, 1119, 1139
TU-Sofia | Technical University of Sofia | http://tu-sofia.bg/, 1065, 1131
UCTM | University of Chemical Technology and Metallurgy | http://dl.uctm.edu/, 1097, 1142

Canada

Corner Brook

MUN | Memorial University of Newfoundland - Grenfell Campus | http://www.grenfell.mun.ca/, 1135

Edmonton

U of A | University of Alberta; Theoretical Physics Institute; Avadh Bhatia Physics Laboratory | http://www.ualberta.ca/, 1138, 1117

Halifax

SMU | Saint Mary's University | http://smu.ca/, 1126

Kingston, ON

Queen's | Queen's University | http://www.queensu.ca/, 1137

London, ON

Western | Western University - Canada | http://www.uwo.ca/, 1137

Montreal

Concordia | Concordia University Montreal | http://www.concordia.ca/, 1137, 1138
UdeM | University of Montreal | http://www.umontreal.ca/, 1135, 1117, 1081

Quebec

UL | Laval University | http://www.ulaval.ca/, 1137

Regina

U of R | University of Regina | https://www.uregina.ca/, 1126

Sackville

MAU | Mount Allison University | https://www.mta.ca/, 1126

Vancouver

TRIUMF | Canada's Sarticle Accelerator Centre | http://www.triumf.ca/, 1081, 1096, 1129
UBC | University of British Columbia | http://www.ubc.ca/, 1096

* The cooperation may be limited by the conditions adopted unilaterally by the State

CERN

Geneva

CERN | European Organization for Nuclear Research (Switzerland) | http://home.cern/), 1135, 1138, 1117, 1123, 1081, 1108, 1096, 1083, 1085, 1065, 1127, 1087, 1088, 1129, 1130, 1128, 1126, 1118, 1119, 1139

Chile

Arica

UTA | Universidad de Tarapaca | https://www.uta.cl, 1135

La Serena

ULS | University of La Serena | http://www.userena.cl, 1135

Valparaiso

UTFSM | Technical University Federico Santa Maria | http://www.usm.cl/, 1135, 1096, 1065

UV | University of Valparaiso | http://www.valpo.edu/, 1135

China

Beijing

"Tsinghua" | Tsinghua University | http://www.tsinghua.edu.cn/, 1083, 1065

CIAE | China Institute of Atomic Energy | http://www.ciae.ac.cn/, 1136, 1065, 1087, 1088, 1130, 1119

IHEP CAS | Institute of High Energy Physics of the Chinese Academy of Sciences | http://www.ihep.ac.cn/, 1123, 1099, 1083, 1065, 1087, 1128, 1118

ITP CAS | Institute of Theoretical Physics of the Chinese Academy of Sciences | http://english.itp.cas.cn/, 1136

PKU | Peking University | http://www.pku.edu.cn/, 1135, 1136, 1083, 1129, 1130, 1131

Hangzhou

ZJU | Zhejiang University | http://www.zju.edu.cn/english/, 1083

Harbin

HEU | Harbin Engineering University | http://www.hrbeu.edu.cn/ , 1142

Hefei

IPP CAS | Institute of Plasma Physics of the Chinese Academy of Sciences | http://english.ipp.cas.cn/, 1065, 1132

USTC | University of Science and Technology of China | http://www.ustc.edu.cn/, 1065, 1088

Hengyang

USC | University of South China | http://english.usc.edu.cn/, 1065

Huzhou

HU | Huzhou University | http://www.zjhu.edu.cn/, 1065

Jinan

SDU | Shandong University | http://en.sdu.edu.cn/, 1065

Lanzhou

IMP CAS | Institute of Modern Physics of the Chinese Academy of Sciences | http://www.imp.cas.cn/, 1135, 1136, 1065, 1129, 1130

Shanghai

Fudan | Fudan University | http://www.fudan.edu.cn/, 1065

SINAP CAS | Shanghai Institute of Applied Physics of the Chinese Academy of Sciences | http://english.sinap.cas.cn/, 1065, 1088

Wuhan

CCNU | Central China Normal University; Institute of Particle Physics | http://physics.ccnu.edu.cn/, 1065, 1087, 1088

HBUT | Hubei University of Technology | http://www.hbut.edu.cn/, 1088

WHU | Wuhan University | http://en.whu.edu.cn/, 1117

WIPM CAS | Wuhan Institute of Physics and Mathematics of the Chinese Academy of Sciences | http://english.wipm.cas.cn/, 1135

Xi'an

NINT | Northwest Institute of Nuclear Technology, 1128

Yichang

CTGU | China Three Gorges University | http://eng.ctgu.edu.cn/, 1065

Croatia

Split

Univ. | University of Split | http://www.unist.hr/, 1083, 1088

Zagreb

Oikon IAE Oikon OOO | Oikon Ltd. Institute for Applied Ecology | http://www.oikon.hr/, 1128

RBI | Rudjer Boskovic Institute | http://www.irb.hr/, 1135, 1083, 1088, 1128, 1126

UZ | University of Zagreb | http://www.unizg.hr/, 1088

Cuba

Havana

ASC | Academy of Sciences of Cuba | http://www.academiaciencias.cu/, 1139

CEADEN | Centre of Technological Applications and Nuclear Development | http://www.ceaden.cu, 1088, 1126

InSTEC | Higher Institute of Technologies and Applied Sciences | http://www.instec.cu/, 1065, 1142

San Jose de las Lajas

CENTIS | Center of Isotopes "CENTIS" | http://www.centis.cu/, 1077

Cyprus

Nicosia

UCY | University of Cyprus | http://www.ucy.ac.cy/, 1083

Czech Republic*

Brno

BUT | Brno University of Technology | http://www.vutbr.cz/, 1085, 1131

FEEC BUT | Faculty of Electrical Engineering and Communication of Brno University of Technology | https://www.fekt.vut.cz/, 1129

IBP CAS | Institute of Biophysics of the Czech Academy of Sciences | http://www.ibp.cz/, 1077

ISI CAS | Institute of Scientific Instruments of the Czech Academy of Sciences | http://www.isibrno.cz/, 1097

Liberec

TUL | Technical University of Liberec | http://www.tul.cz/, 1085, 1065

Olomouc

UP | Palacky University Olomouc | http://www.upol.cz/, 1137, 1065, 1130, 1131

Opava

SlU | Silesian University of Opava | http://www.slu.cz/, 1138

Ostrava

VSB-TUO | Technical University of Ostrava | http://www.vsb.cz/, 1128, 1118

Prague

ADVACAM | ADVACAM s.r.o. | http://advacam.com/, 1132

BC CAS | Biology Centre of the Czech Academy of Sciences | https://www.bc.cas.cz/, 1142

CEI | Czech Environmental Institute | http://www.ceu.cz/, 1128

CTU | Czech Technical University in Prague | http://www.cvut.cz/, 1135, 1138, 1117, 1144, 1086, 1065, 1097, 1087, 1088, 1130, 1100, 1128, 1142, 1126, 1139

CU | Charles University in Prague | http://www.cuni.cz/, 1135, 1136, 1081, 1144, 1099, 1096, 1083, 1085, 1086, 1065, 1097, 1087, 1066, 1142, 1131, 1139

FME CTU | Faculty of Mechanical Engineering of Czech Technical University in Prague | https://www.fs.cvut.cz, 1129

FNSPE CTU | Faculty of Nuclear Science and Physical Engineering of Czech Technical University in Prague | https://www.cvut.cz/, 1129

IG CAS | Institute of Geology of the Czech Academy of Sciences | http://www.gli.cas.cz/, 1142

IMC CAS | Institute of Macromolecular Chemistry of the Czech Academy of Sciences | http://www.irsm.cas.cz/, 1087

IP CAS | Institute of Physics of the Czech Academy of Sciences | http://www.fzu.cz/, 1135, 1066, 1088, 1142, 1118

PTC | Proton Therapy Center Czech s.r.o | http://www.ptc.cz/, 1132

VP | Vacuum PRAGUE | http://www.vakuum.cz/, 1065, 1129, 1130

Rez

CVR | Centrum výzkumu Řež - Research centre Řež | http://cvrez.cz/, 1128

NPI CAS | Nuclear Physics Institute of the Czech Academy of Sciences | http://www.ujf.cas.cz/, 1135, 1137, 1138, 1117, 1106, 1065, 1087, 1066, 1129, 1130, 1100, 1142, 1143, 1140

UJV | "ÚJV Řež, a.s." | http://www.ujv.cz/, 1097, 1088, 1132

Vitkovice

VHM | Vitkovice Heavy Machinery a.s. | http://www.vitkovice.cz/, 1065

Denmark

Copenhagen

NBI | Niles Bohr Institute of the University of Copenhagen | http://www.nbi.ku.dk/, 1088

Lyngby

DTU | Technical University of Denmark | http://www.dtu.dk/, 1137

Ecuador

Quito

USFQ | University of San Francisco, Quito | http://www.usfq.edu.ec/, 1137

Egypt

Alexandria

Univ. | Alexandria University | http://www.alexu.edu.eg/, 1128

Cairo

ASRT | Academy of Scientific Research and Technology | http://www.asrt.sci.eg/, 1118, 1139

ASU | Ain Shams University | http://www.asu.edu.eg/, 1142

EAEA | Egyptian Atomic Energy Authority | http://www.eaea.org.eg/, 1142

ECTP | Egyptian Center for Theoretical Physics | http://www.mti.edu.eg/, 1065

NRC | National Research Centre | http://www.nrc.sci.eg/, 1128

NRRA | Nuclear and Radiological Regulatory Authority, 1126

Giza

CU | Cairo University | http://cu.edu.eg/, 1136, 1137, 1065, 1129, 1128, 1142, 1118, 1119

Mansoura

MU | Mansoura University | http://www.mans.edu.eg/en/, 1128

New Borg El-Arab

E-JUST | Egypt-Japan University for Science and Technology | https://ejust.edu.eg/, 1126

Shibin El Kom

MU | Menoufia University | http://mu.menoufia.edu.eg/, 1129, 1130, 1128

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Tanta

Univ. | Tanta University | https://tanta.edu.eg/en/, 1130

Estonia

Tallinn

NICPB | National Institute of Chemical Physics and Biophysics | http://www.kbfi.ee/, 1083

Tartu

UT | University of Tartu | http://www.ut.ee/, 1138

Finland

Helsinki

HIP | Helsinki Institute of Physics | http://www.hip.fi/, 1083, 1088

UH | University of Helsinki | http://www.helsinki.fi/, 1135, 1137, 1083

Jyvaskyla

UJ | University of Jyväskylä | http://www.jyu.fi/, 1088, 1130, 1100, 1128

Lappeenranta

LUT | Lappeenranta-Lahti University of Technology | https://www.lut.fi/, 1083

Oulu

UO | University of Oulu; Microelectronics Instrumentation Laboratory | http://www.oulu.fi/, 1128

France

Annecy-le-Vieux

LAPP | Laboratory of Annecy-la-Vieux for Particles Physics of the National Institute for Nuclear Physics and Particles Physics of the National Centre for Scientific Research | http://lapp.in2p3.fr/, 1138, 1117

Cadarache

CC CEA | Centre de Recherche du Commissariat à l'Energie Atomique et aux Energies Alternatives Cadarache | http://cadarache.cea.fr/cad, 1128

Caen

GANIL | Grand National Heavy Ion Accelerator | http://www.ganil-spiral2.eu/, 1136, 1129, 1130

Clermont-Ferrand

LPC | Corpuscular Physics Laboratory Clermont-Ferrand of the Blaise Pascal University | http://clrwww.in2p3.fr/, 1081, 1088

Dijon

UB | University of Bourgundy | http://www.u-bourgogne.fr/, 1117

Grenoble

IBS | Institute of Structural Biology | http://www.ibs.fr/, 1142

ILL | Institute Laue-Langevin | http://www.ill.eu/, 1128, 1142, 1140

LPSC | Laboratore de Physique Subatomique et de Cosmologie | http://lpsc.in2p3.fr/, 1088, 1128

UGA | Université Grenoble Alpes | https://www.univ-grenoble-alpes.fr/, 1100

Lyon

ENS Lyon | Ecole Normale Supérieure de Lyon; Physics Laboratory | http://www.ens-lyon.fr/, 1138, 1117

IPNL | Institute of Nuclear Physics of Lyon | http://www.ipnl.in2p3.fr/, 1100

UCBL | Claude Bernard University Lyon 1 | http://www.univ-lyon1.fr/, 1135

UL | Universite de Lyon | http://www.universite-lyon.fr/, 1083, 1088

Marseille

CPPM | Centre de Physique des Particules de Marselle | http://cpmm.in2p3.fr/, 1118

CPT | Centre of Theoretical Physics | http://www.cpt.univ-mrs.fr/, 1137, 1138, 1117

UPC - III | University Paul Cézanne - Aix-Marseille III | https://www.univ-amu.fr, 1137

Metz

UPV-M | Paul-Verlaine University of Metz | http://www.univ-metz.fr/, 1135

Modane

LSM | Modane Underground Laboratory | http://www-lsm.in2p3.fr/, 1100

Montpellier

UM2 | University of Montpellier 2 | https://www.umontpellier.fr/, 1135

Nancy

UL | University of Lorraine | http://www.univ-lorraine.fr/, 1119

Nantes

SUBATECH | Subatomic Physics Laboratory and Associated Technologies; UMR/EMN/IN2P3/CNRS/University of Nantes | http://www-subatech.in2p3.fr/, 1138, 1117, 1065, 1066, 1088

Nice

UN | University Nice Sophia Antipolis | http://unice.fr/, 1137

Orsay

CSNSM | Center for Nuclear and Mass Spectrometry-IN2P3/CNRS | http://www.csnsm.in2p3.fr/, 1130, 1100

IJCLab | Irene Joliot-Curie Lab | https://www.ijclab.in2p3.fr/en/home/, 1136, 1088, 1129

IPN Orsay - IN2P3/CNRS | Institute of Nuclear Physics Orsay - IN2P3/CNRS | http://ipnwww.in2p3.fr/, 1106, 1097, 1129, 1130

LAL - 11 - IN2P3/CNRS | Linear Accelerator Laboratory of the University of Paris-Sid 11 - IN2P3/CNRS | http://www.lal.in2p3.fr/, 1081

Paris

ENS | École Normale Supérieure Paris | http://www.ens.fr/, 1138, 1117

IN2P3 | National Institute of Nuclear Physics and Physics Particles | http://www.in2p3.cnrs.fr/, 1144, 1083

LPTHE - IN2P3/CNRS | Laboratory of Theoretical Physics and High Energy of the Pierre et Marie Curie - IN2P3/CNRS | http://lpthe.jussieu.fr/, 1135, 1117
LUTH | Laboratory Universe and Theories, Observatory of Paris | http://www.luth.obspm.fr/, 1138
UPMC 6 | Pierre et Marie Curie University Henri Poincaré Institute Paris 6 | https://www.sorbonne-universite.fr/, 1135, 1137

Saclay

CEA | Alternative Energies and Atomic Energy Commission | http://www.cea.fr/, 1065, 1100
IRFU | Institute of Research into the Fundamental Laws of the Universe | http://irfu.cea.fr/, 1135, 1083, 1097, 1088, 1119
LLB | Léon Brillouin Laboratory CEA-CNRS | http://www-llb.cea.fr/, 1128, 1142
SPhN CEA DAPNIA | Nuclear Physics Division of the Commissariat for Atomic Energy | https://irfu.cea.fr/dphn/en/, 1135, 1085, 1130

Strasbourg

CRN - IN2P3/CNRS | Centre of Nuclear Research - IN2P3/CNRS | http://ireswww.in2p3.fr/, 1099, 1130
IPHC - IN2P3/CNRS | Hubert Curien Multidisciplinary Institute of the University of Strasburg - IN2P3/CNRS | http://www.iphc.cnrs.fr/, 1083, 1088, 1129, 1130, 1128

Tours

Univ.| University of Tours | http://www.univ-tours.fr/, 1138

Valenciennes

UVHC | University of Valenciennes and Hainaut-Combrésis | http://www.uphf.fr/, 1137, 1117

Vannes

SigmaPhi | Company SigmaPhi Accelerator Technologies | http://www.sigmaphi.fr/, 1129

Villeurbanne

CC IN2P3 | IN2P3 Computing Center | https://cc.in2p3.fr/, 1088

Georgia

Tbilisi

AIP TSU | Elevter Andronikashvili Institute of Physics of the Ivane Javakhishvili Tbilisi State University | http://www.aiphysics.tsu.ge/, 1065, 1128
GRENA | Georgian Research and Educational Networking Association | http://www.grena.ge/, 1118
GTU | Georgia Technical University | http://gtu.ge/, 1144, 1083, 1065, 1118, 1119
HEPI-TSU | High Energy Physics Institute of Ivane Javakhishvili Tbilisi State University | http://www.hepi.tsu.ge/, 1081, 1144, 1083, 1127
RMI TSU | Andrea Razmadze Mathematical Institute of the Ivane Javakhishvili Tbilisi State University | http://rmi.tsu.ge/, 1135
TSU | Ivane Javakhishvili Tbilisi State University | http://www.tsu.ge/, 1135, 1128, 1118, 1119
UG | University of Georgia | http://www.ug.edu.ge/, 1144, 1119

Germany*

Aachen

RWTH | Rheinisch-Westfaelische Technische Aachen University | http://www.rwth-aachen.de/, 1135, 1099, 1083

Berlin

FU Berlin | Free University of Berlin | http://www.fu-berlin.de/, 1135
HU Berlin | Humboldt University of Berlin | http://www.hu-berlin.de/, 1135
HZB | Helmholtz Berlin Centre for Materials and Energy of the Helmholtz Association | http://www.helmholtz-berlin.de/, 1136, 1143, 1140

Bielefeld

Univ. | Bielefeld University | http://www.uni-bielefeld.de/, 1135, 1136

Bochum

RUB | Ruhr University of Bochum | http://www.ruhr-uni-bochum.de/, 1135, 1085, 1097, 1142, 1126

Bonn

UniBonn | University of Bonn | http://www.uni-bonn.de/, 1135, 1136, 1138, 1117, 1096, 1085, 1088, 1142, 1126

Braunschweig

TU | Braunschweig Technical University | http://www.tu-braunschweig.de/, 1137

Bremen

Univ. | University of Bremen | http://www.uni-bremen.de/, 1137

Cologne

Univ. | University of Cologne | http://www.uni-koeln.de/, 1136

Darmstadt

FAIR | Facility for Antiproton and Ion Research | https://fair-center.eu/, 1106
GSI | Helmholtz-Centre for the Study of Heavy Ions of the Helmholtz Association | http://www.gsi.de/, 1135, 1136, 1137, 1108, 1106, 1065, 1088, 1129, 1130, 1128, 1143, 1131, 1077, 1118, 1119
TU Darmstadt | Technical University Darmstadt | http://www.tu-darmstadt.de/, 1135, 1136, 1137, 1106, 1065, 1087, 1088, 1142

Dortmund

TU Dortmund | Technical University of Dortmund | http://www.uni-dortmund.de/, 1135, 1137

Dresden

HZDR | Helmholtz-Zentrum Dresden-Rossendorf of the Helmholtz Association | http://www.hzdr.de/, 1136, 1106, 1128
IFW | Leibniz Institute for Solid State and Materials Research Dresden | http://www.ifw-dresden.de/, 1137

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ILK | Institute of Air Handling and Refrigeration of the Helmholtz Association | http://www.ilkdresden.de/, 1065
MPI PkS | Max Planck Institute for the Physics of Complex Systems | http://www.mpipks-dresden.mpg.de/, 1137
TU Dresden | Technical University of Dresden | http://tu-dresden.de/, 1136, 1097

Erlangen
FAU | Friedrich Alexander University of Erlangen-Nuremberg | http://www.fau.eu/, 1135, 1136, 1065

Frankfurt/Main
FIAS | Frankfurt Institute for Advanced Studies | http://fias.institute.de/, 1135, 1065, 1087, 1088
Univ. | Goethe University of Frankfurt on Main | http://www.uni-frankfurt.de/, 1136, 1108, 1106, 1065, 1087, 1088, 1118

Freiberg
TUBAF | Technical University Bergakademie of Freiberg | http://tu-freiberg.de/, 1085, 1142

Freiburg
FMF | Albert-Ludwig's University of Freiburg | http://www.uni-freiburg.de/, 1097

Geesthacht
Hereon | Helmholtz-Zentrum Hereon GmbH | https://www.hereon.de/, 1142

Giessen
JLU | Justus Liebig University Giessen | http://www.uni-giessen.de/, 1136, 1106, 1065, 1126

Halle
MLU | Martin-Luther University of Halle-Wittenberg | http://www.uni-halle.de/, 1142

Hamburg
DESY | Deutsches Elektronen-Synchrotron DESY of the Helmholtz Association | http://www.desy.de/), 1135, 1117, 1123, 1083, 1127, 1126, 1118
Univ. | University of Hamburg | http://www.uni-hamburg.de/, 1135, 1136, 1099, 1083, 1119

Hannover
LUH | Leibniz University of Hannover | http://www.uni-hannover.de/, 1138, 1117, 1123

Heidelberg
MPIK | Max Planck Institute for Nuclear Physics | http://www.mpi-hd.mpg.de/, 1129, 1130, 1100
Univ. | University of Heidelberg | http://www.uni-heidelberg.de/, 1135, 1106, 1066, 1088

Jena
Univ. | Friedrich-Schiller University of Jena | http://www.uni-jena.de/, 1135, 1137, 1117

Julich
FZJ | Research Centre Jülich of the Helmholtz Association | http://www.fz-juelich.de/, 1135, 1065, 1097, 1143, 1140

Kaiserslautern
TUK | Technical University of Kaiserslautern | http://www.uni-kl.de/, 1135

Karlsruhe
KIT | Karlsruhe Institute of Technology | http://www.kit.edu/, 1135, 1083, 1100, 1142, 1118

Kassel
Uni Kassel | University of Kassel | http://www.uni-kassel.de/, 1119

Kiel
IFM-GEOMAR | GEOMAR Helmholtz Centre for Ocean Research Kiel | http://www.geomar.de/, 1142

Kleve
HSRW | Rhine-Waal University of Applied Sciences | https://www.hochschule-rhein-waal.de/, 1128

Leipzig
UoC | University of Leipzig | http://www.uni-leipzig.de/, 1136, 1137, 1138, 1117

Magdeburg
OVGU | Otto-von-Guericke University Magdeburg | http://www.uni-magdeburg.de/, 1137

Mainz
HIM | Helmholtz-Institute Mainz | http://www.hi-mainz.de/, 1135
JGU | Johannes Gutenberg University of Mainz | http://www.uni-mainz.de/, 1135, 1136, 1096, 1085, 1065, 1130, 1100, 1128, 1126

Munich
LMU | Ludwig-Maximilians University of Munich | http://www.uni-muenchen.de/, 1135
MPI-P | Max Planck Institute for Physics of Munich | http://www.mpp.mpg.de/, 1117, 1081
TUM | Technical University of Munich | http://portal.mytum.de/, 1108, 1106, 1085, 1088, 1100, 1128

Munster
WWU | Westfalische Wilhelms-Universiry (University of Münster) | http://www.uni-muenster.de/, 1088

Oldenburg
IPO | Institute of Physics of the Cari von Ossietzky University of Oldenburg | http://www.uol.de/en/physics/, 1138

Potsdam
AEI | Max Planck Institute for Gravitational Physics Albert Einstein Institute | http://www.aei.mpg.de/, 1138, 1117

Regensburg
UR | University of Regensburg | http://www.uni-regensburg.de/, 1135, 1065

Rostock
Univ. | University of Rostock | http://www.uni-rostock.de/, 1135, 1136, 1137, 1117, 1142

Siegen
Univ. | University of Siegen | http://www.uni-siegen.de/, 1136

Stuttgart
MPI-FKF | Max Planck Institute for Solid State Research | http://www.fkf.mpg.de/, 1142

Tubingen

Univ. | Eberhard Karls University of Tübingen | http://uni-tuebingen.de/, 1135, 1065, 1097, 1088, 1130, 1100, 1128

Worms

ZTT | Center for Technology Transfer and Telecommunications of the University of Worms | https://www.hs-worms.de/, 1088

Wuppertal

UW | University of Wuppertal | http://www.uni-wuppertal.de/, 1135, 1137

Zeuthen

DESY | Deutsches Elektronen-Synchrotron DESY of the Helmholtz Association (Zeuthen) | http://www.desy.de/), 1135, 1117, 1081, 1118

Greece

Athens

INP NCSR "Demokritos" | Institute of Nuclear and Particle Physics of the National Centre for Scientific Research "Demokritos" | http://www.inp.demokritos.gr/, 1136, 1083

NTU | National Technical University of Athens | http://www.ntua.gr/, 1083

UoA | National and Kapodistrian University of Athens | http://www.uoa.gr/, 1138, 1117, 1083, 1088

Ioannina

UI | University of Ioannina | http://www.uoi.gr/, 1083

Rethymno

UoC | University of Crete | https://en.uoc.gr, 1135

Thessaloniki

AUTH | Aristotle University of Thessaloniki | http://www.auth.gr/, 1138

Hungary

Budapest

ELTE | Eötvös Loránd University | http://www.elte.hu/, 1135

GetGiro Kft | GetGiro IT Limited Liability Company | http://getgiro.com/, 1131

RKK OU | Rejto Sándor Faculty of Light Industry and Environmental Engineering of the Obuda University | http://rkk.uni-obuda.hu/, 1128

Wigner RCP | Institute for Particle and Nuclear Physics, Wigner Research Centre for Physics | http://wigner.mta.hu/, 1135, 1136, 1137, 1117, 1083, 1088, 1142, 1143, 1140

Debrecen

Atomki | Institute of Nuclear Research of the Hungarian Academy of Science | http://www.atomki.hu/, 1136, 1083

UD | University of Debrecen | http://www.unideb.hu/, 1083

IAEA

Vienna

IAEA | International Atomic Energy Agency | http://www.iaea.org/, 1128

ICTP

Trieste

ICTP | Abdus Salam International Centre for Theoretical Physics Italy | http://www.ictp.it/, 1135, 1138

India

Aizawl

MZU | Mizoram University | https://mzu.edu.in, 1133

Aligarh

AMU | Aligarh Muslim University | http://www.amu.ac.in/, 1088

Bhubaneswar

IOP Institute of Physics, Bhubaneswar | http://www.iopb.res.in/, 1135, 1088

Chandigarh

PU | Panjab University | http://puchd.ac.in/, 1136, 1083, 1088

Chennai

IMSc | Institute of Mathematical Science (National Institute for Research in the Theoretical Sciences) | http://www.imsc.res.in/, 1135, 1138

Guwahati

GU| Gauhati University | https://guportal.in/, 1088

Indore

IIT Indore | Indian Institute of Technology Indore | https://www.iitsystem.ac.in/, 1088

Jaipur

Univ. | University of Rajasthan | http://www.uniraj.ac.in/, 1087, 1088

Jammu

Univ. | University of Jammu | http://www.jammuuniversity.in/, 1088

Jatani

NISER | National Institute of Science Education and Research of the Department of Atomic Energy | http://www.niser.ac.in/, 1083, 1088

Kasaragod

CUK | Central University of Kerala | http://cukerala.ac.in/, 1136

Kolkata

BNC | S.N.Bose National Centre for Basic Sciences | http://www.bose.res.in/, 1138, 1117, 1088

IACS | Indian Association for the Cultivation of Science | http://www.iacs.res.in/, 1137, 1138

MIERE | Matrivani Institute of Experimental Research and Education, 1085

SINP | Saha Institute of Nuclear Physics | http://www.saha.ac.in/, 1083, 1088

UC | University of Calcutta | http://www.caluniv.ac.in/, 1088

VECC | Variable Energy Cyclotron Centre of the Department of Atomic Energy | http://www.vecc.gov.in/, 1135, 1088, 1130

Mumbai

BARC | Bhabha Atomic Research Centre of the Department of Atomic Energy | http://www.barc.gov.in/, 1083, 1087, 1088

IIT Bombay | Indian Institute of Technology Bombay | https://www.iitsystem.ac.in/, 1088

TIFR | Tata Institute of Fundamental Research | http://www.tifr.res.in/, 1083

New Delhi

IUAC | Inter-University Accelerator Center | http://www.iuac.res.in/, 1136

Patna

NIT Patna | National Institute of Technology Patna | http://www.nitp.ac.in/, 1142

Roorkee

IIT Roorkee | Indian Institute of Technology Roorkee | https://www.iitr.ac.in/, 1130

Rupnagar

IIT Ropar | Indian Institute of Technology Ropar | http://www.iitrpr.ac.in/, 1130

Varanasi

BHU | Banaras Hindu University | http://www.bhu.ac.in/, 1128

Indonesia

Jakarta

LIPI | Indonesian Institute of Sciences | http://lipi.go.id/, 1088

Iran

Tehran

IPM | Institute for Studies in Theoretical Physics and Mathematics of the Institute for Research Fundamental Sciences | http://www.ipm.ac.ir/, 1138, 1083

Zanjan

IASBS | Institute for Advanced Studies in Basic Sciences | http://iasbs.ac.ir/, 1136, 1137

Ireland

Dublin

DIAS | Dublin Institute for Advanced Studies | http://www.dias.ie/, 1138

UCD | University College Dublin | https://www.ucd.ie/, 1083

Israel

Jerusalem

HUJI | Hebrew University of Jerusaliem | http://www.huji.ac.il/, 1065, 1126

Rehovot

WIS | Weizmann Institute of Science | http://www.weizmann.ac.il/, 1117, 1081

Tel Aviv

TAU | Tel Aviv University | http://www.tau.ac.il/, 1138, 1085, 1065, 1119

Italy

Alessandria

DiSIT UPO | Department of Science and Technological Innovation of the University of Eastern Piedmont Amedeo Avogadro | https://www.disit.uniupo.it/, 1088

Assergi

INFN LNGS | Laboratory Nazionali del Gran Sasso of the National Institute for Nuclear Physics | https://www.lngs.infn.it), 1100

Bari

DIF | Interuniversity Department of Physics | https://www.uniba.it/, 1088

INFN | National Institute for Nuclear Physics, Section of Bari | http://www.ba.infn.it/, 1083, 1088

Poliba | Polytechnic University of Bari | http://www.en.poliba.it/, 1088

Bologna

INFN | National Institute for Nuclear Physics, Section of Bologna | http://www.bo.infn.it/, 1083, 1088, 1118

UniBo | University of Bologna | http://www.unibo.it/, 1088

Brescia

Forgiatura Morandini | Forgiatura Morandini | http://www.morandini.it/, 1065

UNIBS | University of Brescia | https://en.unibs.it/, 1088

Cagliari

INFN | National Institute for Nuclear Physics, Section of Cagliari | http://www.ca.infn.it/, 1088

UniCa | University of Cagliari | http://www.unica.it/, 1088

Catania

INFN | National Institute for Nuclear Physics, Section of Catania | https://www.ct.infn.it/it/, 1088

INFN LNS | National Institute for Nuclear Physics, National Laboratory of the South | http://www.lns.infn.it/, 1136, 1083

UniCT | University of Catania | http://www.unict.it/, 1137, 1088

Erice

EMFCSC | Ettore Majorana Foundation and Centre for Scientific Culture | http://www.ccsem.infn.it/, 1088

Ferrara

INFN | National Institute for Nuclear Physics, Section of Ferrara | http://www.fe.infn.it/, 1096

Fisciano

UNISA | University of Salerno | http://web.unisa.it/, 1137, 1117

Florence

INFN | National Institute for Nuclear Physics, Section of Florence | http://www.fi.infn.it/, 1096, 1083

Foggia
Unifg | University of Foggia | https://www.unifg.it/, 1088

Frascati
INFN LNF | National Institute for Nuclear Physics, National Laboratory of Frascati | http://www.lnf.infn.it/, 1138, 1117, 1144, 1096, 1083, 1088

Genoa
ASG | ASG Superconductors D.p.a. | http://www.as-g.it/, 1065

INFN | National Institute for Nuclear Physics, Section of Genoa | http://www.ge.infn.it/, 1108, 1083, 1119

UniGe | University of Genoa | https://unige.it/en, 1108

Legnaro
INFN LNL | National Institute for Nuclear Physics, Legnaro National Laboratories | http://www.lnl.infn.it/, 1088, 1130

Messina
UniMe | University of Messina | http://www.unime.it/, 1136, 1088, 1142

Milan
INFN | National Institute for Nuclear Physics, Section of Milan | http://www.mi.infn.it/, 1083

UNIMI | University of Milan | http://www.unimi.it/, 1099

Naples
INFN | National Institute for Nuclear Physics, Section of Naples | http://www.na.infn.it/, 1135, 1136, 1096, 1083

Unina II | University of Naples Federico II | http://www.unina.it/, 1130, 1077

Padua
INFN | National Institute for Nuclear Physics, Section of Padua | http://www.pd.infn.it/, 1083, 1088, 1129

UniPd | University of Padua | http://www.unipd.it/, 1135, 1138, 1117, 1088

Pavia
INFN | National Institute for Nuclear Physics, Section of Pavia | http://www.pv.infn.it/, 1135, 1117, 1083, 1126

UniPv | University of Pavia | http://www.unipv.it/, 1088

Perugia
INFN | National Institute for Nuclear Physics, Section of Perugia | http://www.pg.infn.it/, 1096, 1083

Pisa
INFN | National Institute for Nuclear Physics, Section of Pisa | http://www.pi.infn.it/, 1135, 1138, 1117, 1081, 1096, 1083, 1127

UniPi | University of Pisa | http://www.unipi.it/, 1144

Rome
"Tor Vergata" | University of Rome "Tor Vergata" | http://web.uniroma2.it/, 1096

CREF | Enrico Fermi Center for Study and Research | https://www.cref.it/, 1088

ENEA | Italian National Agency for New Technologies, Energy and Sustainable Economic Development | http://www.enea.it/, 1128

INFN | National Institute for Nuclear Physics, Section of Rome | http://www.roma1.infn.it/, 1096, 1083, 1088

Univ. "La Sapienza" | University of Roma "La Sapienza" | http://www.uniroma1.it/, 1088

Salerno
INFN | National Institute for Nuclear Physics, Section of Salerno | http://www.sa.infn.it/, 1099, 1088

Trento
ECT* | European Centre for Theoretical Studies in Nuclear Physics and Related Areas | https://www.ectstar.eu/, 1108

Trieste
INFN | National Institute for Nuclear Physics, Section of Trieste | http://www.ts.infn.it/, 1083, 1085, 1088

SISSA/ISAS | International School for Advanced Studies | http://www.sissa.it/, 1135, 1138, 1117

UNITR | University of Trieste | http://www.univ.trieste.it/, 1088

Turin
INFN | National Institute for Nuclear Physics, Section of Turin | http://www.to.infn.it/, 1096, 1083, 1085, 1065, 1088

Polito | Polytechnic University of Turin | http://www.polito.it/, 1088

UniTo | University of Turin | http://www.unito.it/, 1135, 1136, 1138, 1117, 1123, 1125, 1088

Udine
Uniud | University of Udine | http://www.uniud.it/, 1077

Vercelli
UPO | Amedeo Avogadro Piemonte Eastern University | http://www.unipmn.it/, 1088

Viterbo
UNITUS | University of Tuscia | http://www3.unitus.it/, 1112

Japan

Chiba
Chiba U | Chiba University | http://www.chiba-u.ac.jp/e/, 1135

CIT | Chiba Institute of Technology | http://www.it-chiba.ac.jp/, 1117

Fukuoka
Kyushu Univ. | Kyushu University | http://www.kyushu-u.ac.jp/, 1144, 1099

Hiroshima
Hiroshima Univ. | Hiroshima University | http://www.hiroshima-u.ac.jp/, 1097, 1088

Kobe
Kobe Univ. | Kobe University | http://www.kobe-u.ac.jp/, 1136

Kyoto
KSU | Kyoto Sangyo University | http://www.kyoto-su.ac.jp/, 1117, 1128

Kyoto Univ. | Kyoto University | http://www.kyoto-u.ac.jp/, 1135
RIMS | Research Institute for Mathematical Sciences of Kyoto University | http://www.kurims.kyoto-u.ac.jp/, 1117

Minato
Keio Univ. | Keio University - Minato | http://www.keio.ac.jp/, 1142

Morioka
Iwate Univ. | Iwate University | http://www.iwate-u.ac.jp/, 1136

Nagasaki
NiAS | Nagasaki Institute of Applied Sciences | https://nias.ac.jp/index.html/, 1088

Nagoya
Nagoya Univ. | Nagoya University | http://www.nagoya-u.ac.jp/, 1135, 1099, 1065

Nara
NWU | Nara Women's University | http://www.nara-wu.ac.jp/nwu/en/index.html/, 1088

Osaka
Osaka Univ. | Osaka University | http://www.osaka-u.ac.jp/, 1135, 1136, 1144
RCNP | Research Center for Nuclear Physics of Osaka University | http://www.rcnp.osaka-u.ac.jp/, 1136, 1086, 1088

Saga
Saga Univ. | Saga University | http://www.saga-u.ac.jp/, 1088

Tokai
JAEA | Japan Atomic Energy Agency | http://www.jaea.go.jp/, 1088, 1130

Tokyo
Keio Univ. | Keio University - Tokyo | http://www.keio.ac.jp/, 1138
Meiji Univ. | Meiji University | http://www.meiji.ac.jp/cip, 1135
Nihon Univ. | Nihon University | http://www.nihon-u.ac.jp/, 1065
Toho Univ. | Toho University | http://www.toho-u.ac.jp/, 1099
Tokyo Tech | Tokyo Institute of Technology | http://www.titech.ac.jp/, 1135
UT | University of Tokyo; Centre for Nuclear Study CNS; Institute for Cosmic Ray Research; Institute Centre for Elementary Particle Physics ICEPP | http://www.u-tokyo.ac.jp/, 1135, 1138, 1088
Waseda Univ. | Waseda University | http://www.waseda.jp/, 1142

Tsukuba
KEK | High Energy Accelerator Research Organization | http://legacy.kek.jp/, 1135, 1117, 1144, 1128, 1126
Univ. | University of Tsukuba | http://www.tsukuba.ac.jp/, 1087, 1088

Utsunomiya
UU | Utsunomiya University | http://www.utsunomiya-u.ac.jp/, 1137

Wako
RIKEN | RIKEN Wako Institute; Institute of Physical and Chemical Research | http://www.riken.jp/, 1125, 1097, 1088, 1130

Yamagata
Yamagata Univ. | Yamagata University | http://www.yamagata-u.ac.jp/, 1085

Kazakhstan

Almaty
FAPHI | Fesenkov Astrophysical Institute of the National Centre of Space Researches and Technologies | http://aphi.kz/, 1135
IETP KazNU | Institute of Experimental and Theoretical Physics of the Al-Farabi Kazakh National University | http://www.ietp.kz/, 1130
INP | Institute of Nuclear Physics of Ministry of Energy of the Republic of Kazakhstan | http://www.inp.kz/, 1135, 1136, 1144, 1129, 1130, 1100, 1128, 1142, 1133, 1118, 1119
KazNU | Al-Farabi Kazakh National University | http://www.kaznu.kz/, 1136, 1077, 1119, 1139
PhysTI | Physics - Techical Institute | http://www.sci.kz/, 1131

Astana
BA INP | Branch of the Astana Institute of Nuclear Physics of Ministry of Energy of the Republic of Kazakhstan | http://www.inp.kz/, 1135, 1129, 1130, 1131, 1118
ENU | L.N. Gumilyov Eurasian National University | http://www.enu.kz/, 1129, 1130, 1128, 1131, 1139
NU | Nazarbayev University | http://nu.edu.kz/, 1130, 1131

Kyzylorda
KazSRIRG | Kazakh Scientific Research Institute of Rice Growing named after I. Zhakhayev, 1128

Ust-Kamenogorsk
EKSU | Sarsen Amanzholov East Kazakhstan State University | http://www.vkgu.kz/, 1139

Latvia

Riga
ISSP UL | Institute of Solid State Physics of the University of Latvia | http://www.cfi.lu.lv/, 1142

Lithuania

Kaunas
VMU | Vytautas Magnus University | http://www.vdu.lt/, 1136

Vilnius
VU | Vilnius University | http://www.vu.lt/, 1138, 1083

Luxembourg

Luxembourg
Univ. | University of Luxembourg | http://wwwen.uni.lu/, 1138

Malaysia

Johor Bahru

UTM | University of Technology Malaysia | http://www.utm.my, 1100

Malta

Msida

UM | University of Malta | https://www.um.edu.mt/, 1088

Mexico

Cuernavaca

UNAM | National Autonomous University of Mexico Campus Morelos | http://www.unam.mx/, 1135

Culiacan

UAS | Autonomous University of Sinaloa | https://www.uas.edu.mx/, 1088

Mexico City

Cinvestav | Centre for Advanced Investigations and Studies of the National Polytechnical Institute | http://www.cinvestav.mx/, 1083, 1088

UNAM | National Autonomous University of Mexico (Mexico City) | http://www.unam.mx/, 1136, 1065, 1088, 1119

Puebla

BUAP | Autonomous University of Puebla | http://www.buap.mx/, 1125, 1083, 1065, 1088

San Luis Potosi

UASLP | Autonomous University of San Luis Potosi | http://www.uaslp.mx/, 1096

Moldova

Chisinau

ASM | Academy of Sciences of Moldova | http://www.asm.md/, 1139

IAP | Institute of Applied Physics of the Ministry of Education, Culture and Research of the Republic of Moldova | http://www.phys.asm.md/, 1136, 1065

IChem | Institute of Chemistry | http://ichem.md/, 1128

IMB ASM | Institute of Microbiology and Biotechnology of the Academy of Sciences of Moldova | http://www.imb.asm.md/, 1128

IMCS | Vladimir Andrunachievici Institute of Mathematics and Computer Science | http://www.math.md/, 1118

MSU | Moldova State University | http://usm.md/, 1065, 1131, 1132, 1118, 1119, 1139

RENAM | Research and Educational Networking Association of Moldova | http://www.renam.md/, 1118

Mongolia

Ulaanbaatar

CGL | Central Geological Laboratory | http://cengeolab.com/, 1128, 1131

IMDT MAS | Institute of Mathematics and Digital Technology of the Mongolian Academy | https://imdt.ac.mn/, 1119

IPT MAS | Institute of Physics and Technology of the Mongolian Academy of Sciences | https://ipt.ac.mn, 1135, 1137, 1065, 1087, 1100, 1142, 1105

MNUE | Mongolian National University of Education | http://mnue.mn/, 1139

NRC NUM | Nuclear Research Center of the National University of Mongolia | http://nrc.num.edu.mn/, 1129, 1128, 1131

NUM | National University of Mongolia | http://www.num.edu.mn/, 1137, 1077, 1118, 1139

Montenegro

Podgorica

Univ. | University of Montenegro | http://www.ucg.ac.me/, 1083

Netherlands

Amsterdam

AUAS | Amsterdam University of Applied Sciences | https://www.amsterdamuas.com/, 1088

NIKHEF | National Institute for Subatomic Physics | http://www.nikhef.nl/, 1081, 1088

Eindhoven

TU/e | Eindhoven University of Technology | https://www.tue.nl/en/, 1083

Utrecht

UU | Utrecht University | http://www.uu.nl/, 1088

New Zealand

Auckland

Univ. | University of Auckland | http://www.auckland.ac.nz/, 1137, 1083

Christchurch

UC | University of Canterbury | http://www.canterbury.ac.nz/, 1083, 1126

Hamilton

Univ. | University of Waikato | http://www.waikato.ac.nz/, 1135

North Macedonia

Skopje

UKiM | Ss. Cyril and Methodius University in Skopje | http://www.ukim.edu.mk/, 1128

Norway

Bergen

HVL | Western Norway University of Applied Sciences | https://www.hvl.no/en/, 1088

UiB | University of Bergen | http://www.uib.no/, 1136, 1088

Oslo

UiO | University of Oslo | http://www.uio.no/, 1136, 1117, 1088

Tonsberg

USN | University College of Southeast Norway | https://www.usn.no/english/, 1088

Trondheim
NTNU | Norwegian University of Science and Technology | http://www.ntnu.edu/, 1135, 1138

Pakistan

Islamabad
COMSATS | COMSATS University Islamabad | https://www.comsats.edu.pk/, 1088
PINSTECH | Pakistan Institute of Nuclear Science and Technology, 1088
QAU | Quaid-i-Azam University | http://www.qau.edu.pk/, 1083

Peru

Lima
PUCP | Pontifical Catholic University of Peru | https://www.pucp.edu.pe/, 1088

Poland*

Bialystok
BUT | Bialystok University of Technology | https://pb.edu.pl/, 1142
UwB | University of Bialystok | http://www.uwb.edu.pl/, 1138, 1142

Chorzow
Frako-Term | Frako-Term LTD Company is a Research and Development | http://frakoterm.pl/pl/, 1065

Gdansk
GUT | Gdańsk University of Technology | http://pg.edu.pl/, 1128

Katowice
US | University of Silesia in Katowice | http://www.us.edu.pl/, 1137, 1123

Kielce
JKU | Jan Kochanowski University of Kielce | http://www.ujk.edu.pl/, 1135

Krakow
AGH | University of Science and Technology | http://www.agh.edu.pl/, 1083, 1088, 1126
AGH-UST | AGH University of Science and Technology | http://www.agh.edu.pl/, 1083, 1142, 1105
INP PAS | Henryk Niewodniczański Institute of Nuclear Physics of the Polish Academy of Sciences | http://www.ifj.edu.pl/, 1135, 1136, 1123, 1087, 1088, 1129, 1130, 1100, 1128, 1142, 1077, 1132, 1126, 1119, 1139
JU | Jagiellonian University in Kraków | http://www.uj.edu.pl/, 1137, 1142, 1133, 1119
SIP | Marian Smoluchowski Institute of Physics of the Jagiellonian University | https://if.uj.edu.pl/, 1106
SOLARIS | SOLARIS National Synchrotron Radiation Centre | https://synchrotron.uj.edu.pl/, 1141
UEK | Cracow University of Economics | https://uek.krakow.pl/en/, 1119

Lodz
UL | University of Lódź | http://www.uni.lodz.pl/, 1135, 1138, 1087, 1128

Lublin
UMCS | Marie Curie-Sklodowska University in Lublin | http://www.umcs.pl/, 1136, 1128, 1142, 1131

Opole
UO | University of Opole | http://www.uni.opole.pl/, 1128

Otwock (Swierk)
NCBJ | National Centre for Nuclear Research | http://www.ncbj.gov.pl/, 1135, 1136, 1083, 1085, 1065, 1097, 1087, 1088, 1128, 1132

Poznan
AMU | Adam Mickiewicz University in Poznań | http://www.amu.edu.pl/, 1137, 1130, 1128, 1142, 1141
GPCC | Maria Skłodowska–Curie Greater Poland Cancer Center | http://www.wco.pl/, 1132
IMP PAS | Institute of Molecular Physics of the Polish Academy of Sciences | http://www.ifmpan.poznan.pl/, 1137

Szczecin
US | University of Szczecin | http://www.usz.edu.pl/, 1077
WPUT | West Pomeranian University of Technology in Szczecin | http://www.zut.edu.pl/, 1142

Torun
UMK | Nicolaus Copernicus University | http://www.umk.pl/, 1131

Warsaw
HIL UW | Heavy Ion Laboratory of Warsaw University | http://www.slcj.uw.edu.pl/, 1129, 1130
IEP WU | Institute of Experimental Physics of Warsaw University | http://en.ifd.fuw.edu.pl/, 1129
IMGW-PIB | Institute of Meteorology and Water Management, National Research Institute | https://www.imgw.pl) , 1118
INCT | Institute of Nuclear Chemistry and Technology | http://www.ichtj.waw.pl/, 1142, 1131
IPC PAS | Institute of Physical Chemistry of the Polish Academy of Sciences | http://ichf.edu.pl/, 1137
UW | University of Warsaw | http://www.uw.edu.pl/, 1136, 1117, 1083, 1087, 1130
WUT | Warsaw University of Technology | http://www.pw.edu.pl/, 1085, 1065, 1066, 1088

Wroclaw
ILT&SR PAS | Institute of Low Temperature and Structure Research of the Polish Academy of Sciences | http://www.intibs.pl/, 1065
ITP UW | Institute for Theoretical Physics of the University of Wroclaw | http://www.ift.uni.wroc.pl/, 1135
UW | University of Wroclaw | http://www.uni.wroc.pl/, 1138, 1117, 1065, 1128, 1142, 1119

* The cooperation may be limited by the conditions adopted unilaterally by the State

WUT | Wroclaw University of Science and Technology | http://www.pwr.edu.pl/, 1137

Portugal

Aveiro

UA | University of Aveiro | http://www.ua.pt/, 1138, 1085

Coimbra

UC | University of Coimbra | http://www.uc.pt/, 1135

Lisbon

LIP | Laboratory of Instrumentation and Experimental Particle Physics | http://www.lip.pt/, 1085

Republic of Korea

Cheongju

CBNU | Chungbuk National University | http://www.cbnu.ac.kr/, 1135, 1088

Daegu

KNU | Kyungpook National University | http://en.knu.ac.kr/, 1135, 1136

Daejeon

CTPCS IBS | Center for Theoretical Physics of Complex Systems of the Institute for Basic Science | https://pcs.ibs.re.kr/, 1137

IBS | Institute for Basic Science | http://www.ibs.re.kr, 1136, 1129, 1130

KAERI | Korea Atomic Energy Research Institute | http://www.kaeri.re.kr/, 1128

KFE | Korea Institute of Fusion Energy | https://www.kfe.re.kr/eng/index/, 1143

KIST | Korea Institute of Science and Technology Information | https://eng.kist.re.kr/kist_eng/main/, 1083, 1088

Gangneung

GWNU | Gangneung-Wonju National University | http://www.gwnu.ac.kr/, 1088

Gwangju

CNU | Chonnam National University | http://www.jnu.ac.kr/, 1083

Incheon

Inha | Inha University | https://eng.inha.ac.kr/, 1137, 1088

Jeonju

JBNU | JeonBuk National University | http://www.cbnu.edu/eng/, 1136, 1088

Pohang

PAL | Pohang Accelerator Laboratory | http://pal.postech.ac.kr/, 1128

Pusan

PNU | Pusan National University | http://www.pusan.ac.kr/, 1088

Seoul

Dawonsys “Dawonsys o., Ltd” | Company “Dawonsys o., Ltd” | http://www.dawonsys.com/, 1128

EWU | Ewha Womans University | http://www.ewha.ac.kr/, 1125

Konkuk Univ. | Konkuk University | http://www.konkuk.ac.kr/, 1088

KU | Korea University | http://www.korea.edu/, 1083

SJU | University of Sejong | https://eng.sejong.ac.kr/index.do/, 1083, 1088

SKKU | Sungkyunkwan University | http://www.skku.edu/, 1138, 1083

SNU | Seoul National University | http://www.en.snu.ac.kr/, 1135, 1136, 1083

Yonsei Univ. | Yonsei University | https://www.yonsei.ac.kr/, 1083, 1088

Romania*

Baia Mare

TUCN-NUCBM | Technical University of Cluj-Napoca - North University Center of Baia Mare | http://www.utcluj.ro/, 1128, 1142, 1131

Bucharest

CSSNT-UPB | Center for Surface Science and Nanotechnologe of the University Politehnica of Bucharest | http://cssnt-upb.ro/, 1131

IFIN-HH | Horia Hulubei National Institute of Physics and Nuclear Engineering | http://www.ifin.ro/, 1136, 1117, 1144, 1106, 1096, 1065, 1087, 1088, 1130, 1128, 1105, 1131, 1077, 1132, 1118, 1119

IGR | Geological Institute of Romania | https://igr.ro, 1128

INCDIE ICPE-CA | National Institute of Research and Development in Electrical Engineering ICPE-CA | http://www.icpe-ca.ro/, 1065, 1097, 1087, 1128, 1142, 1143, 1140

UB | University of Bucharest | http://www.unibuc.ro/, 1136, 1087, 1128, 1142, 1131, 1119, 1139

UMF | “Carol Davila" University of Medicine and Pharmacy Bucharest | http://www.umf.ro/, 1077

UPB | University Politehnica of Bucharest | http://www.upb.ro/, 1088, 1128, 1131

Cluj-Napoca

INCDTIM | National Institute for Research and Development of Isotopic and Molecular Technologies | http://www.itim-cj.ro/, 1128, 1142, 1143, 1118, 1119

RA BC-N | Romanian Academy Cluj-Napoca Branch | http://www.acad-cluj.ro/, 1142

UBB | Babeş-Bolyai University | http://www.ubbcluj.ro/, 1136, 1142, 1133, 1077, 1132

Constanta

MINAC | Museum of National History and Archeology in Constanța | https://www.minac.ro/, 1142

UOC | “Ovidius” University of Constanta | http://www.univ-ovidius.ro/, 1087, 1128

* The cooperation may be limited by the conditions adopted unilaterally by the State

Craiova
UC | University of Craiova | http://cis01.central.ucv.ro/, 1142

Galati
UG | University of Galaţi | http://www.ugal.ro/, 1128

Iasi
IBR | Institute of Biological Research Iaşi of the National Institute of Research and Development for Biological Sciences | http://www.dbioro.eu/, 1077
NIRDTP | National Institute of Research and Development for Technical Physics | http://www.phys-iasi.ro/, 1128, 1142
TUIASI | "Gheorghe Asachi" Technical University of Iaşi | http://www.tuiasi.ro/, 1142
UAI | University "Apollonia" of Iaşi | http://univapollonia.ro/, 1142, 1131
UAIC | Alexandru Ioan Cuza University of Iaşi | http://www.uaic.ro/, 1128, 1142, 1143, 1131, 1132
USAMV | University of Agricultural Sciences and Veterinary Medicine | http://www.uaiasi.ro/, 1142

Magurele
IFA | Institute of Atomic Physics | http://www.ifa-mg.ro/, 1118, 1119
INFLPR | National Institute for Laser, Plasma and Radiation Physics | http://www.inflpr.ro/, 1131
INOE2000 | National Institute for Research and Development in Optoelectronics | http://www.inoe.ro/, 1065
ISS | Institute for Space Sciences | http://www2.spacescience.ro/, 1099, 1125, 1087, 1088, 1128, 1126, 1119
NIMP | National Institute of Materials Physics | http://www.infim.ro/, 1128, 1142, 1133

Oradea
UO | University of Oradea | http://www.uoradea.ro/, 1128

Pitesti
ICN | Institute for Nuclear Research - Piteşti | http://www.nuclear.ro/, 1128
UPIT | University of Piteşti | http://www.upit.ro/, 1142

Ramnicu Valcea
I.C.S.I. | National Research and Development Institute for Cryogenics and Isotopic Technologies | http://www.icsi.ro/, 1128

Sibiu
ULBS | Lucian Blaga University of Sibiu | https://www.ulbsibiu.ro/ro/, 1128

Targoviste
UVT | Valahia University of Târgovişte | http://www.valahia.ro/, 1128, 1142, 1143

Timisoara
ICT | "Coriolan Drăgulescu" Institute of Chemistry | http://acad-icht.tm.edu.ro/, 1142
ISIM | National R&D Institute for Welding and Materials Testing - ISIM Timisoara | http://www.isim.ro/, 1142
LMF CCTFA | Laboratory of Magnetic Fluids of the Center for Fundamental and Advanced Technical Research of the Romanian Academy, Branch Timişoara | http://acad-tim.tm.edu.ro/cctfa, 1142
UVT | West University of Timişoara | http://www.uvt.ro/, 1137, 1128, 1142, 1131, 1119

Tulcea
DDNI | "Danube Delta" National Institute for Research and Development | http://www.ddni.ro/, 1142

Russia

Arkhangelsk
NArFU | Northern (Arctic) Federal University named after M.B.Lomonosov | http://narfu.ru/, 1128, 1126, 1139
NSMU | Northern State Medical University | http://www.nsmu.ru/, 1139

Belgorod
BelSU | Belgorod National Research State University | http://www.bsu.edu.ru/, 1135, 1137, 1065, 1097, 1087, 1126, 1139

Borok
IBIW RAS | Federal State Budgetary Institution of Science "I.D. Papanin Institute for the Biology of Inland Waters of the Russian Academy of Sciences" | http://ibiw.ru/, 1128

Chelyabinsk
SUSU | South Ural State University | https://www.susu.ru/ru/, 1142

Chernogolovka
BInEPCP RAS | Federal State Budgetary Institution of Science "Branch of the Institute of Energy Problems for Chemical Physics of the Russian Academy of Sciences" | http://binep.ac.ru/, 1131
ISMAN RAS | Federal State Budgetary Institution of Science "Institute of Structural Macrokinetics and Materials Science of the Russian Academy of Sciences" | http://www.ism.ac.ru/, 1087
ISSP RAS | Federal State Budgetary Institution of Science "Institute of Solid State Physics of the Russian Academy of Sciences" | http://issp.ac.ru/, 1086, 1142, 1131
LITP RAS | Federal State Budgetary Institution of Science "L.D. Landau Institute for Theoretical Physics of the Russian Academy of Sciences" | http://www.itp.ac.ru/, 1135, 1138, 1117, 1065, 1118
SCC IPCP RAS | Federal State Budgetary Institution of Science "Supercomputer Centre of the Institute of Problems of Chemical Physics of the Russian Academy of Sciences" | http://www.icp.ac.ru/, 1118

Dimitrovgrad
SSC RIAR | Joint Stock Company "State Scientific Centre Research Institute of Atomic Reactors" Rosatom State Nuclear Energy Corporation | http://www.niiar.ru/, 1130

Dolgoprudny
MIPT | Moscow Institute of Physics and Technology State University | http://mipt.ru/, 1136, 1117, 1083, 1065, 1128, 1142, 1119, 1139

Dubna

BMC | Biomedical Company LLC | https://bmc.ltd/, 1131

BSINP MSU | Branch of the Skobeltsyn Institute of Nuclear Physics of the Lomonosov Moscow State University | http://www.msu.dubna.ru/, 1107

Diamant | Diamant LLC | http://diamant-sk.ru/, 1128

Dubna State Univ. | Dubna State University | http://www.uni-dubna.ru/, 1100, 1128, 1142, 1143, 1126, 1118, 1119, 1139

Dubna-Biopharm | Dubna-Biopharm LLC | http://www.xentek.ru/, 1131

IAS “Omega” | Institute for Advanced Studies “Omega” | http://dubna-oez.ru/, 1107

IPTP | Institute of Physical and Technical Problems JSC | https://iftp.ru/, 1130

PELCOM | “Pelcom Dubna Mashinostroitelny Zavod” | http://pelcom.ru/, 1065

SCC “Dubna” | “Dubna” Satellite Communication Centre, Branch of the Federal State Unitary Enterprise “Russian Satellite Communication Company” | http://www.rscc.ru/, 1118

SEZ “Dubna” | Special Economic Zone of Technical-Innovative type "Dubna" | http://oezdubna.ru/, 1118

Fryazino

ISTOK | Joint Stock Company “Research and Production Corporation “ISTOK” named after Shokin” | http://www.istokmw.ru/, 1065

Gatchina

NRC KI PNPI | Federal State Budgetary Institution “B.P. Konstantinov Petersburg Nuclear Physics Institute” of the National Research Centre “Kurchatov Institute” | http://www.pnpi.spb.ru/, 1135, 1136, 1137, 1123, 1144, 1083, 1065, 1088, 1130, 1100, 1128, 1142, 1143, 1140, 1118

Grozny

CheSU | Kadyrov Chechen State University | https://chesu.ru/en/, 1139

CSPU | Chechen State Pedagogical University | https://chspu.ru/, 1128

Irkutsk

ISDCT SB RAS | Federal State Budgetary Institution of Science “Matrosov Institute for System Dynamics and Control Theory of the Siberian Branch of the Russian Academy of Sciences” | http://www.idstu.irk.ru/, 1135

ISU | Irkutsk State University | http://isu.su/, 1135, 1144, 1099, 1119, 1139

LI SB RAS | Federal State Budgetary Institution of Science “Limnological Institute of the Siberian Branch of the Russian Academy of Sciences” | http://www.lin.irk.ru/, 1128

RIAP ISU | Research Institute of Applied Physics of the Irkutsk State University | http://api.isu.ru/, 1125

Ivanovo

ICS RAS | Federal State Budgetary Institution of Science “Institute of Solution Chemistry of the Russian Academy of Sciences” | http://www.isc-ras.ru/, 1135

ISU | Ivanovo State University | http://ivanovo.ac.ru/, 1135, 1139

ISUCT | Ivanovo State University of Chemistry and Technology | http://isuct.ru/, 1128

Izhevsk

UdSU | Udmurt State University | http://udsu.ru/, 1128

Kaliningrad

IKBFU | Immanuel Kant Baltic Federal University | http://www.kantiana.ru/, 1142, 1131

Kazan

Compressormash | Open Joint Stock Company “Kazancompressormash” | http://compressormash.ru/, 1065

KFU | Kazan Volga Region Federal University | http://kpfu.ru/, 1135, 1137, 1138, 1142, 1139

KNRTU | Kazan National Research Technological University | http://www.kstu.ru/, 1142

Spetshmash | Ltd. “Research and Productio Enterprise Spetshmash” | http://spmsh.ru/, 1065

Khabarovsk

PNU | Pacific National University | http://pnu.edu.ru/, 1136

Kostroma

KSU | Kostroma State University | http://ksu.edu.ru/, 1139

Krasnodar

KSU | Kuban State University | http://kubsu.ru/, 1131, 1139

Krasnoyarsk

FRC KSC SB RAS | Federal Research Center "Krasnoyarsk Science Center of the Siberian Branch of the Russian Academy of Sciences" | https://ksc.krasn.ru, 1142

KIP SB RAS | Federal State Budgetary Institution of Science “Kirensky Institute of Physics, Siberian Branch of the Russian Academy of Sciences” | http://www.kirensky.ru/, 1142

SibFU | Siberian Federal University | http://www.sfu-kras.ru/, 1142

Moscow

"FOMOS-MATERIALS" | Open Joint Stock Company "FOMOS-MATERIALS" | http://newpiezo.com/, 1086

“Azimuth-Photonics” | “Azimuth-Photonics” | http://www.azimp.ru/, 1086

BMSTU | Bauman Moscow State Technical University | https://www.bmstu.ru/, 1139

Cryogenmash | Public Joint Stock Company “Cryogenmash” | http://cryogenmash.ru/, 1065

DMS RAS | Department of Medical Sciences, RAS | http://www.ras.ru/, 1132

FMBC | Russian State Research Center − Burnasyan Federal Medical Biophysical Center of Federal Medical Biological Agency | http://fmbafmbc.ru/, 1077, 1132

FRC IM RAS | Federal State Institution "Federal Research Center "Informatics and Management of the Russian Academy of Sciences" | http://www.frccsc.ru/, 1118

Geliymash | Open Joint Stock Company “Researching and Production Association "Geliymash" | http://geliymash.ru/, 1065

GIN RAS | Federal State Budgetary Institution of Science “Geological Institute of the Russian Academy of Sciences” | http://www.ginras.ru/, 1128

GPI RAS | Federal State Budgetary Institution of Science “General Physics Institute of the Russian Academy of Sciences” | http://www.gpi.ru/, 1128, 1133, 1131

HTDC | High-Tech Diagnostic Centre, 1129

IA RAS | Federal State Budgetary Institution of Science “Institute of Archaeology of the Russian Academy of Sciences” | http://archaeolog.ru/, 1128, 1142

IBMC | Federal State Budgetary Institution of Science Institute of Biomedical Chemistry | http://www.ibmc.msk.ru/, 1077

IBMP RAS | Federal State Budgetary Institution of Science “State Scientific Centre of the Russian Federation - Institute for Biomedical Problems of the Russian Academy of Sciences” | http://www.imbp.ru/, 1065, 1077, 1112, 1132

IBRAE | Federal State Budgetary Institution of Science “Institute for the Problems of the Safe Development of Atomic Energy of the Russian Academy of Sciences” | http://www.ibrae.ac.ru/, 1135

IC RAS | Federal State Institution "Federal Research Center " Crystallography and Photonics "of the Russian Academy of Sciences | https://kif.ras.ru/, 1142, 1131

ICP RAS | Semenov Institute of Chemical Physics of the Russian Academy of Sciences | http://chph.ras.ru/, 1142

IEPT RAS | Federal State Budgetary Institution of Science “Institute of Earthquake Prediction Theory and Mathematical Geophysics of the Russian Academy of Sciences” | http://www.mitp.ru/, 1142

IGEM RAS | Federal State Budgetary Institution of Science “Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry of the Russian Academy of Sciences” | http://www.igem.ru/, 1142, 1112

IGIC RAS | Federal State Budgetary Institution of Science “Kurnakov Institute of General and Inorganic Chemistry of the Russian Academy of Sciences” | http://www.igic.ras.ru/, 1142, 1131

IHNA Ph RAS | Federal State Budgetary Institution of Science “Institute of Higher Nervous Activity and Neurophysiology of the Russian Academy of Sciences” | http://www.ihna.ru/), 1077

IITP RAS | Federal State Budgetary Institute of Science “Institute for Information Transmission Problems (Kharkevich Institute) of the Russian Academy of Sciences” | http://iitp.ru/, 1118

IKI RAS | Federal State Budgetary Institution of Science “Space Research Institute of the Russian Academy of Sciences” | http://www.iki.rssi.ru/, 1128, 1077

IMET RAS | Federal State Budgetary Institution of Science “A.A. Baikov Institute of Metallurgy and Materials Science of the Russian Academy of Sciences” | http://www.imet.ac.ru/, 1142, 1131

IMM RAS | Federal State Budgetary Institution of Science “Institute for Mathematical Modeling of the Russian Academy of Sciences” | http://www.imamod.ru/, 1135

INEOS RAS | A.N. Nesmeyanov Institute of Organoelement Compounds of Russian Academy of Sciences| https://ineos.ac.ru/, 1130

INEUM | Institute of Electronic Control Computes named after I.S. Bruk | http://www.ineum.ru/, 1105

INMI RAS | Federal State Budgetary Institution of Science “Winogradsky Institute of Microbiology of the Russian Academy of Sciences” | http://www.inmi.ru/, 1142, 1112

Inst. Immunology | National Research Center – Institute of Immunology Federal Medical-Biological Agency of Russia | http://nrcii.ru/, 1142

IPCE RAS | Federal State Budgetary Institution of Science “A.N. Frumkin Institute of Physical Chemistry and Electrochemistry of the Russian Academy of Sciences” | http://www.phyche.ac.ru/, 1128

IPE RAS | Federal State Budgetary Institution of Science “Schmidt Institute of Physics of the Earth of the Russian Academy of Sciences” | http://www.ifz.ru/, 1142

ISP RAS | Federal State Budgetary Institution of Science “Ivannikov Institute for System Programming of the Russian Academy of Sciences” | http://www.ispras.ru/, 1118

ISPM RAS | Federal State Budgetary Institution of Science “Enikolopov Institute of Synthetic Polymeric Materials of the Russian Academy of Sciences” | http://www.ispm.ru/, 1131

ITEP | Federal State Budgetary Institution “Russian Federation State Scientific Centre - Alikhanov Institute for Theoretical and Experimental Physics” of the National Research Centre “Kurchatov Institute” | http://www.itep.ru/, 1135, 1137, 1138, 1117, 1081, 1144, 1106, 1083, 1065, 1087, 1066, 1088, 1129, 1100, 1128, 1126, 1118, 1119

ITT-Group | “ITT-Group”, 1129

KIAM RAS | Federal State Budgetary Institution of Science "Federal Research Center “Keldysh Institute of Applied Mathematics of the Russian Academy of Sciences” | http://www.keldysh.ru/, 1118

LPI RAS | Federal State Budgetary Institution of Science “P.N. Lebedev Physical Institute of the Russian Academy of Sciences” | http://www.lebedev.ru/, 1135, 1137, 1138, 1117, 1081, 1096, 1083, 1085, 1065, 1097, 1087, 1131

MAI | Moscow Aviation Institute | https://mai.ru/, 1131

MI RAS | Federal State Budgetary Institution of Science “Steklov Mathematical Institute of the Russian Academy of Sciences” | http://www.mi.ras.ru/, 1135, 1137, 1138, 1117

MIEM | A.N. Tikohonov Moscow Institute of Electronics and Mathematics | http://miem.hse.ru/, 1131
MIET | National Research University of Electronic Technology | http://www.miet.ru/, 1142
MIREA | Moscow State University Information Technology, Radioengineering and Electronics - Russian Technological University | http://www.mirea.ru/, 1137, 1065
MISiS | National University of Science and Technology "MISiS" | http://www.misis.ru/, 1135, 1142
MPEI | National Research University "Moscow Power Engineering Institute" | http://mpei.ru/, 1118, 1139
MSK-IX | Joint-stock company "Center of interaction of computer networks" MSK-IX " | https://www.msk-ix.ru/, 1118
MSU | Lomonosov Moscow State University | http://www.msu.ru/, 1135, 1136, 1138, 1117, 1081, 1065, 1087, 1129, 1130, 1128, 1142, 1133, 1131, 1077, 1126, 1118, 1119, 1139
NIKIET | Joint Stock Company "A.N. Dollezhal Research and Development Institute of Power Engineering" | http://www.nikiet.ru/, 1083
NMRC RB | National Medical Research Center for Rehabilitation and Balneology of the Ministry of Health of the Russian Federation | https://www.nmicrk.ru/, 1131
NNRU "MEPhI" | National Nuclear Research University "MEPhI" | http://www.mephi.ru/, 1136, 1137, 1144, 1125, 1106, 1083, 1086, 1065, 1066, 1088, 1129, 1130, 1100, 1142, 1126, 1119, 1139
NRC KI | National Research Centre "Kurchatov Institute" | http://www.nrcki.ru/, 1136, 1137, 1065, 1097, 1088, 1129, 1130, 1128, 1142, 1143, 1140, 1131, 1077, 1118
NRU HSE | National Research University Higher School of Economics | http://www.hse.ru/, 1137, 1117, 1139
OKSAT NIKIET | Department of Integrated Process Control Systems | http://www.nikiet.ru/, 1105, 1140
PC ITER RF | Institution "Project Center ITER" | http://www.iterrf.ru/, 1143
PFUR | Peoples' Friendship University of Russia | http://www.rudn.ru/, 1135, 1136, 1137, 1119, 1139
PIN RAS | Paleontological Institute of the Russian Academy of Sciences | http://www.paleo.ru/, 1142, 1112
PRUE | Plekhanov Russian University of Economics | https://www.rea.ru/, 1118, 1119
RCC MSU | Research Computing Center Lomonosov Moscow State University | http://www.srcc.msu.ru/, 1118, 1119
RSCC | Federal State Unitary Enterprise "Russian Satellite Communications Company" | http://www.rscc.ru/, 1118
RSTSREC | Popov Russian Scientific and Technical Society of Radio Engineering, Electronics and Communications | http://www.rntores.ru, 1119
SAI MSU | Sternberg Astronomical Institute of the M.V. Lomonosov Moscow State University | http://www.sai.msu.ru/, 1138, 1117
SC "IASRWA" | Interregional Agency for Scientific Restoration of Works of Art | http://mnrhu.ru/, 1128
SC "VNIINM" | Stock Company "A.A. Bochvar High-Technology Research Institute of Inorganic Materials" | http://www.bochvar.ru/, 1100, 1140
SCC RAS | Scientific Council for Cybernetics of the Russian Academy of Sciences | http://www.ras.ru/, 1135, 1117
Sechenov Univ. | I.M. Sechenov First Moscow State Medical University | https://www.sechenov.ru/, 1128, 1131
SF IPh | Federal State Budgetary Institution of Science "State Foundation Institute of Pharmacology" | http://www.academpharm.ru/, 1077
SIAS | State Institute for Art Studies | http://sias.ru/, 1128
SINP MSU | Skobeltsyn Institute of Nuclear Physics of the M.V. Lomonosov Moscow State University | http://www.sinp.msu.ru/, 1135, 1136, 1137, 1117, 1099, 1125, 1106, 1083, 1086, 1065, 1087, 1088, 1130, 1100, 1128, 1142, 1077, 1118, 1119
SSDI | Joint Stock Company "State Specialized Design Institute" | http://aogspi.ru/, 1105
SYSTEMATOM | Closed Joint Stock Company "Nuclear and Radiation Safety Systems" | http://www.systematom.ru/, 1105
VEI | Federal State Unitary Enterprise "All-Russian Electrotechnical Institute" | http://www.vei.ru/, 1065
VIGG RAS | Federal State Budgetary Institution of Science "Vavilov Institute of General Genetics of the Russian Academy of Sciences" | http://www.vigg.ru/, 1132
VNIIA | Federal State Unitary Enterprise "All-Russian Research Institute of Automatics" Russian Federal Atomic Energy Agency | http://www.vniia.ru/, 1128
VNIIMS | Federal Agency of Technical Regulating and Metrology National Metrology Institute All-Russian Research Institute of Metrological Service | http://www.vniims.ru/, 1117

Moscow, Troitsk

HPPI RAS | Federal State Budgetary Institution of Science "Institute for High Pressure Physics of the Russian Academy of Sciences" | http://www.hppi.troitsk.ru/, 1137, 1096, 1100, 1142
INR RAS | Federal State Budgetary Institution of Science "Institute for Nuclear Research of the Russian Academy of Sciences" | http://www.inr.ru/, 1135, 1136, 1138, 1117, 1144, 1125, 1106, 1096, 1083, 1065, 1097, 1087, 1088, 1129, 1100, 1128, 1142, 1143, 1140, 1126, 1118, 1119
LPP LPI RAS | "Laboratory of Photomeson Processes Department of High-Energy Physics" Federal State Budgetary Institution of Science "P.V. Lebedev Physical Institute of the Russian Academy of Sciences" | http://www.lebedev.ru/, 1097

Moscow, Zelenograd

RIMST | Joint Stock Company "Research Institute of Material Science and Technology" | http://www.niimv.ru/, 1086

Neutrino

BNO INR RAS | Baksan Neutrino Observatory Federal State Budgetary Institution of Science “Institute for Nuclear Research of the Russian Academy of Sciences” | http://www.inr.ru/bno//, 1130, 1100

Nizhny Novgorod

IAP RAS | Federal Research Center Institute of Applied Physics of the Russian Academy of Sciences | http://www.iapras.ru/, 1127, 1129

IPM RAS | Federal State Budgetary Institution of Science “Institute for Physics of Microstructures of the Russian Academy of Sciences” | http://ipmras.ru/, 1128, 1142

UNN | N.I. Lobachevsky State University of Nizhny Novgorod National Research University | http://www.unn.ru/, 1142

Novocherkassk

SRSPU NPI | South Russian State Polytechnic University (NPI) named after M.I. Platov | https://www.npi-tu.ru/, 1065, 1139

Novosibirsk

BIC SB RAS | Federal State Budgetary Institution of Science "Federal Research Center “Boreskov Institute of Catalysis of the Siberian Branch of the Russian Academy of Sciences” | http://www.catalysis.ru/, 1112

BINP SB RAS | Federal State Budgetary Institution of Science “Budker Institute of Nuclear Physics of the Siberian Branch of the Russian Academy of Sciences” | http://www.inp.nsk.su/, 1135, 1117, 1123, 1144, 1108, 1065, 1088, 1129, 1141, 1118

ICMMG SB RAS | Institute of Computational Mathematics and Mathematical Geophysics of Siberian Branch of the Russian Academy of Sciences | https://icmmg.nsc.ru, 1118

IM SB RAS | Federal State Budgetary Institution of Science “Sobolev Institute of Mathematics of the Siberian Branch of the Russian Academy of Sciences” | http://math.nsc.ru/, 1135

ISP SB RAS | Federal State Budgetary Institution of Science “A.V. Rzhanov Institute of Semiconductor Physics of the Siberian Branch of the Russian Academy of Sciences” | http://www.isp.nsc.ru/, 1137, 1131

NIIC SB RAS | Nikolaev Institute of Inorganic Chemistry SB RAS | http://www.niic.nsc.ru/, 1137

NSU | Novosibirsk State University | http://www.nsu.ru/, 1135, 1138, 1144, 1083

SKIF | Synchrotron Radiation Facility - Siberian Circular Photon Source "SKIF" Boreskov Institute of Catalysis of Siberian Branch of the Russian Academy of Sciences | https://srf-skif.ru, 1118

STL “Zaryad” | STL “Zaryad”, 1065

Obninsk

IPPE | Joint Stock Company “State Scientific Centre of the Russian Federation - Institute of Physics and Power Engineering” | http://www.ippe.ru/, 1128

NMRRC | A. Tsyb National Medical Research Radiological Center | https://mrrc.nmicr.ru/, 1077

REATRACK-Filter | REATRACK-Filter LLC | http://www.reatrack.ru/, 1131

Omsk

OB IM SB RAS | Federal State Budgetary Institution of Science “Institute of Mathematics of the Siberian Branch of the Russian Academy of Sciences” | http://ofim.oscsbras.ru/, 1108

OmSU | F.V. Dostoevsky Omsk State University | http://www.omsu.ru/, 1135, 1136

Pereslavl-Zalesskiy

PSI RAS | Federal State Budgetary Institution of Science “Aylamazyan Program Systems Institute of the Russian Academy of Sciences” | http://skif.pereslavl.ru/psi-info/, 1118

Perm

ICMM UrB RAS | Federal State Budgetary Institution of Science “Institute of Continuous Media Mechanics of the Russian Academy of Sciences Ural Branch” | http://www.icmm.ru/, 1142

ITCh UrB RAS | Federal State Budgetary Institution of Science “Institute of Technical Chemistry of the Russian Academy of Sciences Ural Branch” | http://www.itcras.ru/, 1142

PSNRU | Perm State National Research University | http://www.psu.ru/, 1135, 1137, 1128

Petropavlovsk-Kamchatsky

FRC GC RAS | Kamchatka branch of the Federal Research Center “Geophysical Service of Russian Academy of Sciences" | https://www.emsd.ru/, 1127

KSU | Kamchatsky State University named after Vitus Bering | https://www.kamgu.ru/, 1127, 1139

Protvino

IHEP | Federal State Budgetary Institution “Russian Federation State Scientific Centre - Institute for High Energy Physics” of the National Research Centre “Kurchatov Institute” | http://www.ihep.su/, 1135, 1137, 1138, 1117, 1081, 1108, 1096, 1083, 1085, 1086, 1065, 1087, 1066, 1088, 1126, 1118

Puschino

IMPB RAS | Federal State Budgetary Institution of Science “Institute of Mathematical Problems of Biology of the Russian Academy of Sciences” | http://www.impb.ru/, 1118, 1119

Institute of Physical, Chemical and Biological Problems of Soil Science of the Russian Academy of Sciences | https://issp.pbcras.ru, 1112

ITEB RAS | Federal State Budgetary Institution of Science "Institute of Theoretical and Experimental Biophysics of the Russian Academy of Sciences" | http://web.iteb.ru/, 1132

Rostov-on-Don

RIP SFU | Research Institute of Physics of the Southern Federal University | http://ip.sfedu.ru/, 1142

SFedU | Southern Federal University | http://www.sfedu.ru/, 1135, 1132

Samara

SSU | Samara State University | http://samsu.ru/, 1135
SU | Samara National Research University | http://www.ssau.ru/, 1135, 1137, 1065, 1118, 1139

Saratov

SSMU | Saratov State Medical University named after V. I. Razumovsky | http://www.sgmu.ru/, 1131
SSU | N.G. Chernyshevsky Saratov State University | http://www.sgu.ru/, 1135, 1136, 1137, 1117, 1132, 1119

Sarov

VNIIEF | Russian Federal Nuclear Centre - All-Russian Scientific Research "Institute of Experimental Physics" | http://www.vniief.ru/, 1135, 1087, 1088, 1129, 1130

Sevastopol

IBSS | Federal Research Center "A.O. Kovalevsky Institute of Biology of the Southern Seas of RAS" | http://imbr-ras.ru/, 1128

Smolensk

SSU | Smolensk State University | http://www.smolgu.ru/, 1087

Snezhinsk

VNIITF | Russian Federal Nuclear Centre - All-Russian Scientific Research Institute of Technical Physics | http://www.vniitf.ru/, 1083, 1129

Sochi

SRI MP | Federal State Budgetary Scientific Institution "Scientific Research Institute of Medical Primatology" | http://www.primatologia.ru/, 1077

St. Petersburg

Botanic garden BIN RAS | Federal State Budgetary Institution of Science "Botanic Garden of the V.L.Komarov Botanic Institute of the Russian Academy of Sciences" | http://botsad-spb.com/, 1128
CRISM "Prometey" | Central Research Institute of Structural Materials "Prometey" named after I.V. Gorynin of National Research Center "Kurchatov Institute" | http://www.crism-prometey.ru/en/, 1142
Electron | Joint Stock Company "National Research Institute "Electron" | http://www.electron.spb.ru/, 1083
ETU | Saint Petersburg State Electrotechnical University "LETI" | http://www.eltech.ru/, 1137
FIP | V.F.Fock Institute of Physics of the Saint Petersburg State University | http://www.niif.spbu.ru/, 1087, 1088, 1100, 1128, 1118
IAI RAS | Institute for Analytical Instrumentation of the Russian Academy of Sciences | http://iairas.ru/, 1129, 1130
IMC RAS | Federal State Budgetary Institution of Science "Institute of macromolecular Compounds of the Russian Academy of Sciences" | http://macro.ru/, 1142
Ioffe Institute | Federal State Budgetary Institution of Science "Ioffe Physicl Technical Institute of the Russian Academy of Sciences" | http://www.ioffe.ru/, 1137, 1130, 1128, 1142, 1131
ITMO Univ. | National Research University of Information Technologies, Mechanics and Optics | http://www.ifmo.ru/, 1137, 1118
KRI | V.G. Khlopin Radium Institute | http://www.khlopin.ru/, 1065, 1107, 1130, 1100, 1128
MMA | S.M. Kirov Military Medical Academy | https://vmeda.mil.ru, 1131
Neva-Magnet | Neva-Magnet S&E, Ltd | http://www.magnet.spb.su/, 1065
NIIEFA | D.V. Efremov Scientific Research Institute of Electrophysical Apparatus | http://www.niiefa.spb.su/, 1129, 1130, 1119
NWRSCC | North-West Regional Scientific and Clinical Center named after L.G. Sokolov Federal Medical and Biological Agency | https://med122.com/, 1126
PDMI RAS | Federal State Budgetary Institution of Science "St. Petersburg Department of V.A. Steklov Institute of Mathematics of the Russian Academy of Sciences" | http://www.pdmi.ras.ru/pdmi/, 1137, 1138
SPbSPU | Saint Petersburg Polytechnic University Peter the Great | http://www.spbstu.ru/, 1135, 1137, 1086, 1065, 1131, 1126, 1118
SPbSU | Saint Petersburg State University | http://spbu.ru/, 1135, 1136, 1137, 1065, 1066, 1130, 1142, 1118, 1119, 1139
SPMU | Saint Petersburg Mining University | https://www.spmi.ru/, 1128
SPSFTU | Saint Petersburg State Forest Technical University | http://spbftu.ru/, 1128, 1139

Sterlitamak

SB BSU | Sterlitamak branch of the Bashkir State University | http://strbsu.ru/, 1142

Syktyvkar

DM Komi SC UrB RAS | Federal State Budgetary Institution of Science "Department of Mathematics Komi Sciences Centre of the Russian Academy of Sciences Ural Branch" | http://www.komisc.ru/, 1086, 1065

Tomsk

IHCE SB RAS | Federal State Budgetary Institution of Science "Institute of High Current Electronics of the Siberian Branch of the Russian Academy of Sciences" | http://www.hcei.tsc.ru/, 1135
NPI TPU | Nuclear Physics Institute of the National Research Tomsk Polytechnic University | http://www.npi.tpu.ru/, 1065, 1100
TPU | National Research Tomsk Polytechnic University | http://tpu.ru/, 1136, 1138, 1117, 1096, 1083, 1085, 1087, 1107, 1129, 1126, 1139
TSPU | Tomsk State Pedagogical University | http://www.tspu.edu.ru/, 1138
TSU | National Research Tomsk State University | http://www.tsu.ru/, 1135, 1083, 1065, 1119, 1139

Tula
TSU | Tula State University | http://tsu.tula.ru/, 1128, 1142, 1139

Tver
TvSU | Tver State University | http://tversu.ru/, 1135

Tyumen
UTMN | University of Tyumen | https://www.utmn.ru/, 1142

Vladikavkaz
NOSU | North-Ossetian State University named after K.L.Khetagurov | http://www.nosu.ru/, 1081, 1065, 1087, 1128, 1118, 1119, 1139
VTC "Baspik" | Vladikavkaz Technological Centre "Baspik" | http://baspik.all.biz/, 1087

Vladimir
Vladisart | "Vladisart" | http://wwww.vladisart.ru/, 1131

Vladivostok
FEFU | Far Eastern Federal University | http://dvfu.ru/, 1136, 1065, 1139

Voronezh
VSU | Voronezh State University | http://www.vsu.ru/, 1137, 1130, 1100, 1128, 1139

Yakutsk
NEFU | North-Eastern Federal University in Yakutsk | http://www.s-vfu.ru/, 1139

Yaroslavl
YSU | P.G. Demidov Yaroslavl State University | https://www.uniyar.ac.ru, 1139

Yekaterinburg
IMP UB RAS | Federal State Budgetary Institution of Science "M.N.Mikheev Institute of Metal Physics of Ural Branch of the Russian Academy of Sciences" | http://www.imp.uran.ru/, 1137, 1142, 1143
UrFU | Urals Federal University named after the First President of Russia B.N. Yeltsin | http://urfu.ru/, 1128, 1142, 1139

Yoshkar-Ola
VSUT | Volga State University of Technology | http://www.volgatech.net/, 1135

Zhukovsky
MDB | Joint Stock Company "Myasishchev Design Bureau" | http://www.emz-m.ru/, 1083
TECHNOLOGY | LLC "TECHNOLOGY" | https://geliy24.ru/, 1065

Serbia

Belgrade
INS "VINČA" | "Vinca" Institute of Nuclear Sciences | http://www.vin.bg.ac.rs/, 1137, 1083, 1129, 1142, 1131, 1077
IPB | Institute of Physics Belgrade of the University of Belgrade | http://www.phy.bg.ac.rs/, 1136, 1117, 1128
Univ. | University of Belgrade | http://www.bg.ac.rs/, 1135, 1117, 1065, 1128, 1133, 1077, 1118, 1119

Novi Sad
UNS | University of Novi Sad | http://www.uns.ac.rs/, 1129, 1128, 1139

Slovakia*

Banska Bistrica
UMB | Matej Bel University | http://www.umb.sk/, 1117, 1086

Bratislava
CU | Comenius University in Bratislava | http://uniba.sk/, 1135, 1136, 1137, 1081, 1144, 1099, 1096, 1088, 1129, 1130, 1100, 1128, 1142, 1141, 1077, 1139
IEE SAS | Institute of Electrical Engineering of the Slovak Academy of Sciences | http://www.elu.sav.sk/, 1127, 1100, 1128
IMS SAS | Institute of Measurement Science of the Slovak Academy of Sciences | http://www.um.sav.sk/, 1065
IP SAS | Institute of Physics of the Slovak Academy of Sciences | http://www.fu.sav.sk/, 1135, 1136, 1081, 1144, 1097, 1087, 1129, 1130, 1128
PF SK | PROGRESA FINAL SK, s.r.o. | http://www.progresafinal.sk/, 1131

Kosice
IEP SAS | Institute of Experimental Physics of the Slovak Academy of Sciences in Košice | http://wwwnew.saske.sk/uef/, 1135, 1137, 1097, 1088, 1142, 1077, 1118
STM | Slovak Technical Museum | http://www.stm-ke.sk/, 1139
TUKE | Technical University of Košice | http://www.tuke.sk/, 1088
UPJS | Pavol Jozef Šafárik University in Košice | http://www.upjs.sk/, 1137, 1065, 1097, 1087, 1066, 1088, 1133, 1119, 1139

Nova Dubnica
EVPU | Electrotechnical Research and Projecting Company Nová Dubnica, j.s.c. | http://www.evpu.sk/, 1129

Presov
PU | University of Prešov | http://www.unipo.sk/, 1118

Zilina
UŽ | University of Žilina | http://www.uniza.sk/, 1065, 1097

Slovenia

Ljubljana
GeoSS | Geological Survey of Slovenia | http://www.geo-zs.si/, 1128
UL | University of Ljubljana | http://www.uni-lj.si/, 1137

* The cooperation may be limited by the conditions adopted unilaterally by the State

South Africa

Bellville

UWC | University of the Western Cape | http://www.uwc.ac.za/, 1128

Cape Town

UCT | University of Cape Town | http://www.uct.ac.za/, 1117, 1088, 1118, 1119

Johannesburg

UJ | University of Johannesburg | http://www.uj.ac.za/, 1065

WITS | University of the Witwatersrand | http://www.wits.ac.za/, 1136, 1065, 1088

Port Elizabeth

NMU | Nelson Mandela University | http://www.mandela.ac.za/, 1131

Pretoria

Necsa | South African Nuclear Energy Corporation | http://www.necsa.co.za/, 1142

UNISA | University of South Africa | http://www.unisa.ac.za/, 1137, 1128

UP | University of Pretoria | http://up.ac.za/, 1136, 1142, 1140, 1131

Somerset West

iThemba LABS | iThemba Laboratory for Accelerator Based Sciences | http://www.tlabs.ac.za/, 1136, 1065, 1088, 1129, 1130, 1132, 1126

Stellenbosch

SU | Stellenbosch University | http://www.sun.ac.za/, 1136, 1065, 1129, 1130, 1128, 1131, 1139

Spain

Barcelona

ICMAB-CSIC | Institute of Materials Science of Barcelona-CSIC | https://icmab.es/, 1142

IEEC-CSIC | Institute of Space Science of the Higher Research Council | http://www.ice.csic.es/, 1138

IFAE | Institute for High Energy Physics | http://www.ifae.es/, 1081

Bilbao

UPV/EHU | University of the Basque Country | http://www.ehu.eus/, 1138

Granada

UGR | University of Granada | https://www.ugr.es/en, 1135

Huelva

UHU | University of Huelva | http://www.uhu.es/, 1130

Leioa

BCMaterials | Basque Center for Materials, Applications and Nanostructures | https://www.bcmaterials.net/, 1142

Madrid

CENIM-CSIC | National Centre for Metallurgical Research of the Higher Research Council | http://www.cenim.csic.es/, 1142

CIEMAT | Centre for Energy, Environment and Technological Research | http://www.ciemat.es/, 1083

ICMM-CSIC | Materials Science Institute of Madrid of the Higher Research Council | http://www.icmm.csic.es/, 1137

UAM | Autonoma University of Madrid | http://www.uam.es/, 1117, 1083

Oviedo

UO | University of Oviedo | http://www.uniovi.es/, 1083

Palma

UIB | Illes Baleares University | http://www.uib.cat/, 1136

Santander

IFCA | Institute of Physics of Cantabria of the University of Cantabria | http://ifca.unican.es/, 1083

Santiago de Compostela

USC | University of Santiago de Compostela | http://www.usc.es/, 1135, 1138

Valencia

IFIC | Institute for Particle Physics of the University of Valencia | http://ific.uv.es/, 1138

UPV | Polytechnic University of Valencia | http://webific.ific.uv.es/), 1105

UV | University of Valencia | http://www.uv.es/, 1135

Valladolid

UVa | University of Valladolid | https://universityofvalladolid.uva.es/, 1138

Sri Lanka

Moratuwa

University of Moratuwa | https://uom.lk/, 1088

Sweden

Goteborg

Chalmers | Chalmers University of Technology | http://www.chalmers.se/, 1136, 1130

Lund

ESS ERIC | European Spallation Source ERIC Lund University | https://europeanspallationsource.se/, 1143, 1140

LU | Lund University | http://www.lu.se/, 1135, 1136, 1123, 1088, 1130, 1118

Stockholm

SU | Stockholm University | http://www.su.se/, 1065

Uppsala

TSL | Svedberg Laboratory of the Uppsala University | http://www.tsl.uu.se/, 1097

Switzerland

Basel

Uni Basel | University of Basel | http://www.unibas.ch/, 1126

Bern

Uni Bern | University of Bern | http://www.unibe.ch/, 1135, 1099

Geneva

UniGe | University of Geneva | http://www.unige.ch/, 1087

Villigen

PSI | Paul Scherrer Institute | http://www.psi.ch/, 1137, 1144, 1083, 1130, 1100, 1128, 1142, 1143

Zurich

ETH | Swiss Federal Institute of Technology Zurich | http://www.ethz.ch/, 1137, 1096, 1083

UZH | University of Zurich | http://www.uzh.ch/, 1083, 1100

Taiwan

Taipei

AS | Academia Sinica | http://www.sinica.edu.tw/, 1085

ASGCCA | Academia Sinica Grid Computing Certification Authority | http://ca.grid.sinica.edu.tw, 1118

IP AS | Institute of Physics of the Academia Sinica | http://www.phys.sinica.edu.tw/, 1137

NTU | National Taiwan University | http://www.ntu.edu.tw/, 1083

Taoyuan City

NCU | National Central University | http://www.ncu.edu.tw/, 1138, 1083

Tajikistan

Dushanbe

NAST | National Academy of Sciences of the Republic of Tajikistan | https://anrt.tj/en/, 1142

PHTI NAST | S.U. Umarov Physical-Technical Institute of the National Academy of Sciences of the Republic of Tajikistan | http://www.phti.tj/, 1142, 1119

TTU | Tajik Technical University named after academician M.S.Osimi | http://ttu.tj/en/main-en/, 1142

Khujand

KSU | Khujand State University | http://www.hgu.tj/, 1119

Thailand

Bangkok

KMUTT | King Mogkut's University of Technology Thonburi | https://global.kmutt.ac.th/, 1088

Chachoengsao

TMEC | Thai Microelectronics Center | http://tmec.nectec.or.th/, 1088

Hat Yai

PSU | Prince of Songkla University | http://www.psu.ac.th/, 1128

Nakhon Ratchasima

SLRI | Synchrotron Light Research Institute | https://www.slri.or.th/en/, 1088

SUT | Suranaree University of Technology | http://www.sut.ac.th/, 1088

Turkey

Adana

CU | Çukurova University | http://www.cu.edu.tr/, 1083

Ankara

METU | Middle East Technical University | http://www.metu.edu.tr/, 1099, 1083

Canakkale

ÇOMU | Çanakkale Onsekiz Mart University | http://www.comu.edu.tr/, 1128

Istanbul

BU | Boğaziçi University | http://www.boun.edu.tr/, 1117, 1083

Univ. | Istanbul University | http://www.istanbul.edu.tr/, 1088

YTU | Yuldiz Technical University | http://www.yildiz.edu.tr/en/, 1083, 1088

Konya

Karatay Univ. | KTO Karatay University | https://www.karatay.edu.tr/, 1088

Ukraine*

Berdyansk

BSPU | Berdyansk State Pedagogical University | http://bdpu.org/, 1128

Dnipro

DNU | Oles Honchar Dnipro National University | http://www.dnu.dp.ua/, 1135

Donetsk

DonIPE | Donetsk Institute for Physics and Engineering named after A.A.Galkin | http://www.donfti.ru/, 1128, 1142

DonNU | Donetsk National University | http://donnu.ru/, 1142

Kharkov

IERT NASU | Institute of Electrophysics and Radiation Technologies of the National Academy of Sciences of Ukraine | http://www.iert.kharkov.ua/, 1126

ISMA NASU | Institute for Scintillation Materials of the National Academy of Sciences of Ukraine | http://www.isma.kharkov.ua/, 1144, 1065, 1128

KhNU | V.N. Karasin Kharkov National University | http://www.univer.kharkov.ua/, 1138, 1065

LTU | Company “LED, Technologies Ukraine” | http://ltu.ua/, 1065

NSC KIPT | National Science Centre - Kharkov Institute of Physics and Technology | http://www.kipt.kharkov.ua/, 1135, 1138, 1065, 1088, 1128, 1126, 1118

Kiev

BITP NASU | N.N. Bogolyubov Institute for Theoretical Physics of the National Academy of Sciences of

* The cooperation may be limited by the conditions adopted unilaterally by the State

Ukraine | http://bitp.kiev.ua/, 1135, 1138, 1117, 1086, 1065, 1088, 1118, 1139

DonIPE NASU | Donetsk Institute for Physics and Engineering named after A.A.Galkin of the National Academy of Sciences of Ukraine | http://www.donphti.kiev.ua/, 1142

KINR NASU | Kiev Institute for Nuclear Research of the National Academy of Sciences of Ukraine | http://www.kinr.kiev.ua/, 1136, 1130, 1128

NUK | Taras Shevchenko National University of Kyiv | http://www.univ.kiev.ua/, 1136, 1137, 1128, 1141

Lutsk

EENU | Lesya Ukrainka Eastern European National University | http://eenu.edu.ua/, 1135

Lviv

IAPMM NASU | Pidstryhach Institute for Applied Problems of Mechanics and Mathematics of the National Academy of Sciences of Ukraine | http://iapmm.lviv.ua/, 1135

ICMP NASU | Institute for Condensed Matter Physics of the National Academy of Sciences of Ukraine | http://www.icmp.lviv.ua/, 1137

IFNU | Ivan Franko National University of Lviv | http://www.lnu.edu.ua/, 1135

LPNU | Lviv Polytechnic National University | http://lp.edu.ua/, 1143

Sumy

SumSU | Sumy State University | http://sumdu.edu.ua/, 1135

Uzhhorod

IEP NASU | Institute of Electron Physics of the National Academy of Sciences of Ukraine | http://iep.org.ua/, 1128

United Kingdom

Birmingham

Univ. | University of Birmingham | http://www.birmingham.ac.uk/, 1096, 1088

Bristol

Univ. | University of Bristol | http://www.bris.ac.uk/, 1096, 1083

Cambridge

Univ. | University of Cambridge | http://www.cam.ac.uk/, 1138, 1117

Canterbury

Univ. | University of Kent | http://www.kent.ac.uk/, 1135, 1138

Coventry

Warwick | University of Warwick | https://warwick.ac.uk/, 1137

Daresbury

DL | Daresbury Laboratory; Council for the Central Laboratory of the Research Councils | http://www.cclrc.ac.uk/Activity/DL, 1088

Derby

Univ. | University of Derby | https://www.derby.ac.uk/, 1088

Didcot

RAL | Rutherford Appleton Laboratory; Science and Technology Facilities Council | http://www.stfc.ac.uk/, 1144, 1083, 1142, 1143

Durham

Univ. | Durham University | http://www.dur.ac.uk/, 1138, 1117

Glasgow

U of G | University of Glasgow | http://www.gla.ac.uk/, 1138, 1096, 1097, 1126

Guildford

Univ. | University of Surrey | http://www.surrey.ac.uk/, 1136

Lancaster

LU | Lancaster University | http://www.lancaster.ac.uk/, 1096

Leeds

UL | University of Leeds | http://www.leeds.ac.uk/, 1138

Liverpool

Univ. | University of Liverpool | http://www.liv.ac.uk/, 1088

London

Imperial College | Imperial College London | http://www.imperial.ac.uk/, 1135, 1138, 1117, 1144, 1083

QMUL | Queen Mary of the University of London | http://www.qmul.ac.uk/), 1135, 1126

UCL | University College London | http://www.ucl.ac.uk/, 1100

Manchester

UoM | University of Manchester | http://www.manchester.edu/, 1130, 1100

Nottingham

Univ. | University of Nottingham | http://www.nottingham.ac.uk/, 1138

Plymouth

Univ. | University of Plymouth | http://www.plymouth.ac.uk/, 1119

Southampton

Univ. | University of Southampton | http://www.soton.ac.uk/, 1117

York

Univ. | University of York | http://www.york.ac.uk/, 1117, 1126

USA

Amherst, MA

UMass | University of Massachusetts Amherst | https://www.umass.edu/, 1138, 1126

Arlington, TX

UTA | University of Texas Arlington | http://www.uta.edu/, 1118

Athens, AL

ASU | Athens State University | http://www.athens.edu/, 1112

Austin, TX
UT | University of Texas at Austin | http://www.utexas.edu/, 1088

Baltimore, MD
JHU | Johns Hopkins University | http://www.jhu.edu/, 1083

Batavia, IL
Fermilab | Fermi National Accelerator Laboratory | http://www.fnal.gov/, 1144, 1099, 1083, 1065, 1118

Berkeley, CA
Berkeley Lab | Lawrence Berkeley National Laboratory of the University of California | http://www.lbl.gov/, 1087, 1066, 1088
UC | University of California | http://www.universityofcalifornia.edu/, 1088, 1142

Bloomington, IN
IU | Indiana University Bloomington | http://www.iub.edu/, 1066

Boston, MA
BU | Boston University | http://www.bu.edu/, 1096, 1083
NU | Northeastern University | http://www.northeastern.edu/, 1083

Boulder, CO
CU | University of Colorado at Boulder | http://www.colorado.edu/, 1083

Buffalo, NY
UB | University at Buffalo of the State University of New York | http://www.buffalo.edu/, 1083

Cambridge, MA
Harvard Univ. | Harvard University | http://www.harvard.edu/, 1099
MIT | Massachusetts Institute of Technology | http://www.mit.edu/, 1083, 1065, 1119

Chapel Hill, NC
UNC | University of North Carolina at Chapel Hill | https://www.unc.edu/, 1100

Charlottesville, VA
UVa | University of Virginia | http://www.virginia.edu/, 1144, 1083

Chicago, IL
CSU | Chicago State University | https://www.csu.edu/, 1088
UIC | University of Illinois at Chicago | http://www.uic.edu/, 1083, 1066

Cincinnati, OH
UC | University of Cincinnati | http://www.uc.edu/, 1117

College Park, MD
UMD | University of Maryland | http://www.umd.edu/, 1135, 1138, 1117, 1083

Columbia, SC
UofSC | University of South Carolina | https://sc.edu/, 1099

Columbus, OH
OSU | Ohio State University | http://www.osu.edu/, 1083, 1088

Coral Gables, FL
UM | University of Miami | http://welcome.miami.edu/, 1138, 1117

Davis, CA
UCDavis | University of California, Davis | http://ucdavis.edu/, 1083

Detroit, MI
WSU | Wayne State University | http://wayne.edu/, 1083, 1088

Durham, NC
Duke | Duke University | http://www.duke.edu/, 1128

East Lansing, MI
MSU | Michigan State University | http://www.msu.edu/, 1135, 1129, 1130

Evanston, IL
NU | Northwestern University | http://www.northwestern.edu/, 1083

Fairfax, VA
GMU | George Mason University | http://www.gmu.edu/, 1096

Gainesville, FL
UF | University of Florida | http://www.ufl.edu/, 1083

Houston, TX
Rice Univ. | William Marsh Rice University | http://www.rice.edu/, 1083
UH | University of Houston | http://www.uh.edu/, 1088

Indianapolis, IN
IUPUI | Indiana University - Purdue University Indianapolis | http://www.iupui.edu/, 1099

Iowa City, IA
UIowa | University of Iowa | http://www.uiowa.edu/, 1083, 1087

Irvine, CA
UCI | University of California, Irvine | http://www.uci.edu/, 1137

Ithaca, NY
Cornell Univ. | Cornell University | http://www.cornell.edu/, 1083

Kent, OH
KSU | Kent State University | http://www.kent.edu/, 1126

Knoxville, TN
UTK | University of Tennessee of Knoxville | http://www.utk.edu/, 1083, 1088, 1131

Lawrence, KS
KU | University of Kansas | http://www.ku.edu/, 1083

Lemont, IL
ANL | Argonne National Laboratory | Argonne, IL http://www.anl.gov/, 1135, 1081, 1066

Lexington, KY
UK | University of Kentucky | http://www.uky.edu/, 1144

Lincoln, NE
UNL | University of Nebraska-Lincoln | http://www.unl.edu/, 1083

Livermore, CA
LLNL| Lawrence Livermore National Laboratory | http://www.llnl.gov/, 1083

Long Beach, CA
CSULB | California State University, Long Beach | https://www.csulb.edu/, 1135

Los Alamos, NM
LANL | Los Alamos National Laboratory; Meson Physics Facility LAMPF | http://www.lanl.gov/, 1088, 1128

Los Angeles, CA
UCLA | University of California, Los Angeles | http://www.ucla.edu/, 1083, 1126, 1119

Louisville, KY
U of L | University of Louisville | http://lousville.edu/, 1137

Lubbock, TX
TTU | Texas Tech University | http://www.ttu.edu/, 1083

Madison, WI
UW-Madison | University of Wisconsin-Madison | http://www.wisc.edu/, 1083

Manhattan, KS
KSU | Kansas State University | https://ksiteonline.com/, 1083

Menlo Park, CA
SLAC | SLAC National Accelerator Laboratory is Operated by Stanford University | http://www6.slac.stanford.edu/, 1096

Merced, CA
UCMerced | University of California, Mered Madison | http://www.ucmerced.edu/, 1096

Minneapolis, MN
U of M | University of Minnesota | http://twin-cities.umn.edu/, 1135, 1117, 1083

Nashville, TN
VU | Vanderbilt University | http://www.vanderbilt.edu/, 1083, 1129, 1130

New Brunswick, NJ
RU NB | Rutgers University New Brunswick | https://newbrunswick.rutgers.edu/, 1083

New Haven, CT
Yale Univ. | Yale University | http://www.yale.edu/, 1066, 1088

New York, NY
CUNY | City University of New York | http://www2.cuny.edu/, 1135, 1137, 1138, 1117
RU | Rockefeller University | http://www.rockefeller.edu/, 1135, 1083
SUNY | State University of New York | http://www.suny.edu/, 1138, 1065, 1066

Newport News, VA
JLab | Thomas Jefferson National Accelerator Facility; Southeastern Universities Research Association SURA | http://www.jlab.org/, 1135, 1117, 1097

Norfolk, VA
NSU | Norfolk State University | http://www.nsu.edu/, 1097

Norman, OK
OU | University of Oklahoma | http://www.ou.edu/, 1135, 1138

Notre Dame, IN
ND | University of Notre Dame | http://www.nd.edu/, 1136, 1083

Oak Ridge, TN
ORNL | Oak Ridge National Laboratory | http://www.ornl.gov/, 1088, 1129, 1130, 1128

Omaha, NE
Creighton Univ. | Creighton University | https://www.creighton.edu/, 1088

Oxford, MS
UM | University of Mississippi | http://www.olemiss.edu/, 1083

Pasadena, CA
Caltech | California Institute of Technology | http://www.caltech.edu/, 1137, 1083

Philadelphia, PA
Penn | University of Pennsylvania | http://www.upenn.edu/, 1135, 1117

Piscataway, NJ
Rutgers | Rutgers University-State University of New Jersey | http://www.rutgers.edu/, 1138, 1117

Pittsburgh, PA
CMU | Carnegie Mellon University http://www.cmu.edu/, 1083

Princeton, NJ
PU | Princeton University; Joseph Henry Laboratories of Physics | http://www.princeton.edu/, 1083

Providence, RI
Brown | Brown University | https://www.brown.edu/, 1083

Riverside, CA
UCR | University of California, Riverside | http://www.ucr.edu/, 1083

Rochester, NY
UR | University of Rochester | http://www.rochester.edu/, 1137, 1138, 1117, 1083

Salt Lake City, UT
U of U | University of Utah | http://www.utah.edu/, 1117

San Diego, CA
SDSU | San Diego State University | http://www.sdsu.edu/, 1135, 1083

San Luis Obispo, CA
Cal Poly | California Polytechnic State University | California Polytechnic State University | https://www.calpoly.edu/, 1088

Santa Barbara, CA
UCSB | University of California, Santa Barbara | https://www.universityofcalifornia.edu/, 1083

Seattle, WA
UW | University of Washington | http://www.washington.edu/, 1126

Stanford, CA
SU | Stanford University | http://stanford.edu/, 1131

Tallahassee, FL
FSU | Florida State University | http://www.fsu.edu/, 1137, 1083

Tempe, AZ
ASU | Arizona State University | http://www.asu.edu/, 1138

Tuscaloosa, AL
UA | University of Alabama | http://www.ua.edu/, 1083, 1100

University Park, PA
Penn State | Pennsylvania State University | http://www.psu.edu/, 1135, 1136, 1066

Upton, NY
BNL | Brookhaven National Laboratory | http://www.bnl.gov/, 1096, 1065, 1097, 1087, 1066, 1118

Urbana, IL
I | University of Illinois at Urbana-Champaign | http://illinois.edu/, 1085

Wako, TX
BU | Baylor University | http://www.baylor.edu/, 1083

West Lafayette, IN
Purdue Univ. | Purdue University | http://www.purdue.edu/, 1083, 1088

Williamsburg, VA
W&M | College of William & Mary | http://www.wm.edu/, 1097

Uzbekistan

Jizzakh
JSPI | Jizzakh State Pedagogical Institute named after A.Kadri | http://jspi.uz/, 1087, 1133

Namangan
NamMTI | Namangan Institute of Engineering and Technology | http://nammti.uz/, 1136

Samarkand
SSU | Samarkand State University named after Alisher Navoi | http://www.samdu.uz/, 1081, 1087

Tashkent
AS RUz | Academy of Sciences of the Republic of Uzbekistan | http://www.academy.uz/, 1126, 1139
Assoc.“P.-S.” PTI | Physical Technical Institute Association “Physics-Sun” named after S.A. Azimov of the Academy of Sciences of the Republic of Uzbekistan | http://www.fti.uz/, 1136, 1137, 1097, 1087
IAP NUU | Institute of Applied Physics of the National University of Uzbekistan named after Mirzo Ulugbek | http://nuu.uz/, 1135, 1136
INP AS RUz | Institute of Nuclear Physics of the Academy of Sciences of the Republic of Uzbekistan | http://www.inp.uz/, 1136, 1083, 1097, 1107, 1100, 1128, 1142, 1143, 1140, 1077
IS AS RUz | Institute of Seismology named after G. A. Mavlyanov of the Academy of Sciences of the Republic of Uzbekistan | https://www.seismos.uz/, 1126
NUU | National University of Uzbekistan named after Mirzo Ulugbek | http://nuu.uz/, 1135, 1100

Vietnam

Da Nang
DTU | Duy Tan University | http://www.daytan.edu.vn/, 1142

Hanoi
IMS VAST | Institute of Material Science of the Vietnam Academy of Science and Technology | http://ims.vast.ac.vn/, 1137
INPC VAST | Institute of Natural Products Chemistry of the Vietnam Academy of Science and Technology | http://vast.ac.vn/, 1077
IOP VAST | Institute of Physics of the Vietnam Academy of Science and Technology | http://www.iop.vast.ac.vn/, 1135, 1117, 1130, 1128, 1142, 1131, 1139
VINATOM | Vietnam Atomic Energy Institute of the Ministry of Science and Technology | https://vinatom.gov.vn/en/, 1077
VNU | Vietnam National University Hanoi | http://www.vnu.edu.vn/, 1128, 1119

Ho Chi Minh City
CNT VINATOM | Center for Nuclear Techniques, VINATOM | https://vinatom.gov.vn/en/, 1126
HCMUE | Ho Chi Minh City University of Education | https://hcmue.edu.vn/en/, 1119