**Annex 1.**

**APROVED**

**JINR Vice-Director**

**“ “ \_\_ 2023 г.**

**SCIENTIFIC AND TECHNICAL REASONING FOR THE RENEWAL**

**OF THE THEME IN RESEARCH AREA**

**“THEORETICAL PHYSICS”**

**WITHIN THE TOPICAL PLAN FOR JINR RESEARCH**

**1. General information on the theme**

**1.1. Theme code 01-3-1136-2019**

**1.2. Laboratory BLTP**

**1.3. Scientific field Theoretical physics**

**1.4. The name of the Theme Theory of nuclear systems**

**1.5. Theme leader(s) Antonenko N. V., Dzhioev A. A., Ershov S. N.**

**2. Scientific rationale and organizational structure**

**2.1. Annotation**

The theme "Theory of Nuclear Systems" proposes to research and develop ways to solve actual problems in nuclear physics, relativistic nuclear physics, nuclear astrophysics and in the field of quantum few-body systems. The need for theoretical research is related to the planning of experimental programs and the explanation of experimental data. Researches under the theme "Theory of Nuclear Systems" will be closely coordinated with experimental programs at facilities that exploit high-intensity beams of stable and/or radioactive ions at JINR (SHE-factory, ACCULINA-2) and worldwide (FAIR, ISOL facility HIE-ISOLDE, SPES, SPIRAL2, FRIB, RAON, HIAF, iThemba LABS, ELI-NP). ). Studies of heavy-ion collisions at high energies will be related to the NICA project at JINR. Large-scale research is planned on the structure of exotic nuclei, the dynamics of nuclear reactions and astrophysical processes.

**2.2. Projects in the Theme**

1. Microscopic models for exotic nuclei and nuclear astrophysics

Voronov V. V., Dzhioev A. A.

2. Low-energy nuclear dynamics and properties of nuclear systems

Ershov S. N., Antonenko N. V.

3. Quantum few-body systems

Motovilov A. K., Melezhik V. S.

4. Relativistic nuclear dynamics and nonlinear quantum processes

Bondarenko S. G., Larionov A. B.

**2.3. Scientific justification**

The challenge of nuclear theory is to explain how the properties of atomic nuclei or - more generally - nuclear systems "arise" as a result of the strong interaction between protons and neutrons, to define limits of nuclear stability, to understand the formation of elements in nature, and to reveal the complex dynamics of nucleus-nucleus collisions.

Large-scale studies of the structure of exotic nuclei, dynamics of nuclear reactions, nuclear astrophysics, etc., are carried out at many large experimental facilities around the world. Nuclear theory is also involved in a variety of studies in related fields - particle physics, atomic physics, and statistical physics.

To understand the stability of the heaviest nuclei with *Z*>118, one should explore their shell structure. As shown, the parameters of the model adjusted to describe the structure of heavy nuclei result in *Z*=120-126 as a proton magic number. A systematic study of the properties of heavy nuclei within the Quasiparticle Phonon Model and Two-Center shell model will allow us to predict the alpha-decay spectra of these nuclei for future experiments. The alpha-decays and fission from the isomeric states have to be analyzed as well.

Microscopic calculations based on the state-of-the-art nuclear models that start from realistic effective interactions between nucleons (i.e., energy density functional (EDF) theory) provide us with a valuable tool to connect with experiments and develop a new approach to constructing EDF. To provide reliable predictions, the form and parameters of the EDF will be extrapolated far beyond the stability valley. Special attention will be paid to isovector properties which play a crucial role in nuclei with large neutron-proton asymmetry. The developed self-consistent EDF methods will be applied to study beta-decay process (especially in the context of astrophysical *r*-process) and nuclear matter properties in various astrophysical scenarios (supernova explosions, associated nucleosynthesis and neutrino production). One should investigate the effects of interaction of simple and complex configurations on both the properties of charge-exchange excitations, considering their resonance structure, and the characteristics of beta-decay of nuclei at the neutron dripline using a single set of parameters of the EDF. The interaction of neutrinos with matter is an important problem in various astrophysical phenomena, for example, supernovae, neutron star mergers, and the formation of the neutron star crust. Topical issues: the role of tensor interaction in describing the fragmentation of the Gamow-Teller resonance; beta-decay of neutron-rich nuclei; multi-neutron emission; beta-delayed gamma spectroscopy; the role of inelastic neutrino scattering on nuclei and magnetic field in the process of neutrino thermalization.

Studies of near-threshold effects demand a unified description of nuclear structure and reactions. The development of cluster models that allow us to understand the peculiarities in nuclear structure at extremes of the neutron-proton map will be a priority. The structures of light nuclei at the driplines and beyond will be the primary goal of our theoretical efforts. We are planning to further develop the fully quantum model for halo-nucleus breakup and investigate the Coulomb breakup of proton halo in light nuclei taking into account the effect of external field. Few-body systems provide us with important observables for testing and constraining nuclear forces. It would be desirable to make improvements in effective nucleus-nucleus potentials by using the microscopic inputs and perform an accurate treatment of breakup reactions with calculation of spectroscopic factors for each decaying configuration. It is necessary to perform a fully microscopic analysis of quasi-elastic scattering and decay reactions for neutron-rich nuclei and to determine the effect of the halo structure on the interaction of nuclei.

Investigating nuclear properties as a function of intrinsic excitation energy is crucial to reveal the effects beyond a mean-field description. With an increase in the excitation energy, the potential energy surface changes in such a way that the fission barrier decreases for superheavy nuclei. So, the study of the damping of shell effects with excitation is important to estimate the stability of excited heavy nuclei.

In nuclear reactions, one should reveal important dynamical features such as fusion, quasifission, multinucleon transfers, capture, and breakup. Investigating collisions with weakly bound nuclei, one can apply the Faddeev formalism, the continuum coupled-channels methods, and few-body reaction formalisms. The transfer reaction formalism can be improved by incorporating non-local interactions and pair or cluster transfers. It is desirable to improve the energy density functional to make it suitable for describing nucleus-nucleus interaction.

Fusion of nuclei involves the collision of two quantum many-body systems that form a hot compound nucleus following dissipation of their relative kinetic energy. The challenge for the theory is to incorporate dissipation and diffusion into models and retain the essence of the quantum many-body nature of the colliding nuclei. Since many reaction channels are coupled and overlap with each other, the fusion model should consider the evolution from a dinuclear system configuration to a compound nucleus and describe the contributions of each reaction channel. The methods of the theory of open quantum systems are useful for this. The quantum diffusion approach developed to consider the capture of colliding nuclei has to be extended to account for other degrees of freedom besides the internuclear distance. A further development of the theory of open quantum systems is required to study in detail the influence of the environment on the rate of astrophysical reactions. A method needs to be developed to describe sub-barrier fusion reactions taking into account low-energy dipole excitations which presumably play a prominent role in stellar nucleosynthesis.

The microscopically calculated transport coefficients and nucleus-nucleus potential will be used in the dinuclear system model for fusion of two nuclei. Exploring the formation of superheavy systems with Z=119 and 120 in fusion reactions must be intensified on the microscopic basis. The mass and TKE distributions of quasifission products will be studied and compared with those for fission products. The challenge is to find out the firm criteria to discriminate fission and quasifission products. New isotopes of heavy nuclei, which are not reachable in complete fusion reactions, can be produced in transfer reactions, which requires further theoretical analysis. Cluster transfers should be incorporated in the model. The study of the production of new isotopes of superheavy nuclei in charge particle evaporation channels must be continued to find out the most suitable reactions for future experiments.

An advantage of the cluster approach is the simultaneous description of *α-*decay and spontaneous fission from the ground state of both even-even and even-odd nuclei with the same set of parameters. One should study the fission from the isomeric states and induced fission. Success in describing experimental data will lead to a new look at the fission process.

There are many examples demonstrating phase transitions in nuclei with increasing excitation energy, angular momentum, and with changing nucleon numbers. These phase transitions are associated with the change of symmetry.

We are going to consider the peculiarities of symmetry breaking and symmetry transformations, as well as the related physical effects in finite quantum systems. A special type of symmetry transformation, characteristic only for finite systems, is the change of shape symmetry. All above phenomena also occur in mesoscopic systems, such as trapped atoms, quantum dots, atomic nuclei. The analysis of these systems combines classical and quantum ideas and methods. One of the research lines is to use the random matrix theory developed in nuclear physics to illuminate the role of statistical (random) components in properties of various many-body mesoscopic systems at different excitation energies. The application of nuclear physics methods for the development of nanoscience technology is another main aspect of our research.

The study of universal laws in the behavior of few-body systems at ultralow energies and numerical calculations of characteristics of ultra-cold three-atom systems in Efimov or pre-Efimov situations is of great interest. Universal features in the behavior of ultracold few-body systems manifest themselves in lower dimensions as well. One should study few-body systems also with the aim to describe resonant processes and model critical phenomena in nuclear and high energy physics. To develop more abstract theoretical tools, we will study variation of invariant subspaces of quantum-mechanical Hamiltonians under various perturbations that are not required to be small. We will look for optimal bounds on the speed of subspace evolution governed by time-independent and some time-dependent Hamiltonians.

At present, nuclear excitations above various thresholds, where several nuclear fragments are in a continuum spectrum, are attracting wide interest in the nuclear community. This kind of research involves the consideration of continuum many-body spectroscopy, which requires coincidence experiments and the development of methods for their theoretical analysis. This research also extends to theoretical studies of continuum nuclear systems beyond driplines, including problems of one- and multi-neutron radioactivity, heavy hydrogen and helium systems, etc.

To establish an interplay between atomic and nuclear physics, we will use the analysis of Compton ionization by a strong laser field as a method of dynamical spectroscopy of atoms and molecules. The dynamic-adiabatic theory and theory of hidden intersections of potential energy curves will be employed to study inelastic transitions in atomic collisions.

The color transparency (CT) phenomenon is the reduced interaction of color singlet quark configurations entering in or escaping from the hard interaction point with the surrounding nuclear medium. The search of the onset of CT is included in the research programs of JLab, [PANDA@FAIR](mailto:PANDA@FAIR), and NICA SPD. An observable sensitive to CT is nuclear transparency, i.e. the ratio of the production cross section on the nucleus to the one calculated in the impulse approximation. Thus, larger nuclear transparency as compared to the predictions of Glauber-like models may indicate the presence of CT. Using the eikonal approximation and taking into account CT one should compute nuclear transparency in *dd* collisions, which are accessible at NICA SPD, and the hard A(p,pp) proton knock-out with heavier nuclear targets where CT effects are expected to be more pronounced.

The 12C+*p→*10B*+pp+n* and 12C+*p→*10Be*+pp+p* reactions in the inverse kinematics with carbon beam at 48 GeV/c were measured by the [BM@N](mailto:BM@N) Collaboration at JINR. In these two reactions, the proton interacts with *pn* and *pp* short-range correlations, respectively, while the selection of the ground state 10A nucleus in the final state is aimed to reduce the initial- and final-state interactions. Starting from the known relative wave functions of the NN pair in spin-triplet (deuteron) and spin-singlet (pp-scattering at zero collision energy) states and the translationally-invariant shell-model calculation of the c.m. wave functions and spectroscopic factors for the *pn* and *pp* pairs, we will evaluate the effects of proton rescattering on the spectator of the correlated pair and on the nucleons of the residual 10A nucleus.

We will apply the model with quasideuteron short-range correlations to the cumulative production on heavier nuclear targets and compare its predictions with standard kinetic transport model (GiBUU) calculations. The role of thermal equilibrium on cumulative outputs will be elucidated.

In view of the development of the European ELI research center, investigations of non-linear quantum processes in very strong polarized electromagnetic fields, which are achieved in short high-frequency laser pulses, are of interest. In particular, particle production as a result of interaction of photons with such laser pulses will be studied.

Moreover, it is planned to explore the three-nucleon systems with the Bethe-Salpeter-Faddeev formalism. Their binding energies, electromagnetic form-factors and polarization observables will be calculated. The anomalous magnetic moment of the quark will be studied as well.

**2.4** **Participating JINR laboratories**

**BLTP in collaboration with FLNR, MLIT, DLNP, FLNP and LHEP**

**2.5. Participating countries, scientific and educational organizations**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **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 |  |  |  |  |  |
|  |  |  |  |  |  |  |  |

**3. Staffing**

**3.1. Staffing needs in the first year of implementation**

|  |  |  |  |
| --- | --- | --- | --- |
| **№№**  **n/a** | **Category**  **employee** | **Core staff, FTE amount** | **Associated personnel, FTE amount** |
| 1. | scientific staff | 62 | 3 |
| 2. | engineers | 0 | 0 |
| 3. | professionals | 5 | 0 |
|  | **Total:** | **67** | **3** |

**3.2. Human resources available**

**3.2.1. JINR BLTP core staff**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **№**№ **n/a** | **Category of**  **employees** | **Name** | **Должность** | **FTE** |
| 1. | scientific staff | Mardyban E. V. | j.r. | 100% |
| 2. |  | Rogov I.S. | j.r. | 100% |
| 3. |  | Valiolda D. | j.r. | 100% |
| 4. |  | Bezbakh A. N. | r. | 100% |
| 5. |  | Urazbekov B. | r. | 100% |
| 6. |  | Janseitov D. | r. | 50% |
| 7. |  | Koval E.A. | r. | 100% |
| 8. |  | Malykh A.V. | r. | 100% |
| 9. |  | Yur’ev S.A. | r. | 100% |
| 10. |  | Arsenyev N.N | s.r. | 100% |
| 11. |  | Molodtsova I.V. | s.r. | 100% |
| 12. |  | Severyukhin A.P. | s.r. | 100% |
| 13. |  | Kalandarov Sh.A. | s.r. | 100% |
| 14. |  | Kartavenko V.G. | s.r. | 100% |
| 15. |  | Pasca H. | s.r. | 100% |
| 16. |  | Rahmatinedzhad A. | s.r. | 100% |
| 17. |  | Sargsyan V.V. | s.r. | 100% |
| 18. |  | Shneidman T.M. | s.r. | 100% |
| 19. |  | Shulgina N.B. | s.r. | 50% |
| 20. |  | Kondratyev V.N. | s.r. | 100% |
| 21. |  | Popov Yu. V. | s.r. | 50% |
| 22. |  | Shadmehri S.A. | s.r. | 100% |
| 23. |  | Dorkin S.M. | s.r. | 25% |
| 24. |  | Parvan A.S. | s.r. | 100% |
| 25. |  | Frizen A.V. | s.r. | 100% |
| 26. |  | Balbutsev E.B. | l.r. | 100% |
| 27. |  | Borzov I.N. | l.r. | 50% |
| 28. |  | Ganev H.G. | l.r. | 100% |
| 29. |  | Kuz’min V.A. | l.r. | 100% |
| 30. |  | Malov L.A. | l.r. | 100% |
| 31. |  | Nesterenko V.O. | l.r. | 100% |
| 32. |  | Adamian G.G. | l.r. | 100% |
| 33. |  | Nazmitdinov R.G. | l.r. | 100% |
| 34. |  | Nasirov A.K. | l.r. | 100% |
| 35. |  | Vinitsky S.I. | l.r. | 100% |
| 36. |  | Kolganova E.A. | l.r. | 50% |
| 37. |  | Melezhik A.S. | l.r. | 100% |
| 38. |  | Pupishev V.V. | l.r. | 100% |
| 39. |  | Rakityanskiy S.A. | l.r. | 100% |
| 40. |  | Solov’ev E.A. | l.r. | 100% |
| 41. |  | Baznat M. | l.r. | 100% |
| 42. |  | Kaptari L.P. | l.r. | 100% |
| 43. |  | Larionov A.B. | l.r. | 100% |
| 44. |  | Vdovin A.I. | c.r. | 100% |
| 45. |  | Voronov V.V. | c.r. | 100% |
| 46. |  | Stratan G. | c.r. | 100% |
| 47. |  | Jolos R.V. | c.r. | 100% |
| 48. |  | Lukyanov V.K. | c.r. | 100% |
| 49. |  | Titov A.I. | c.r. | 100% |
| 50. |  | Toneen V.D. | c.r. | 100% |
| 51. |  | Dzhioev A.A. | h.s. | 100% |
| 52. |  | Ershov S.N. | h.s. | 100% |
| 53. |  | Motovilov A.K. | h.s. | 100% |
| 54. |  | Bondarenko S.G. | h.s. | 100% |
| 55. |  | Vishnevskiy P. | t.r. | 100% |
| 56. |  | Mardyban M. A. | t.r. | 100% |
| 57. | professionals | Torehan D. | s.a. | 50% |
| 58. |  | Hamitova D. R. | s.a. | 50% |
|  | **Total** | **50 p. – staff**  **8 p. - associated personal** |  |  |

**3.2.2. JINR associated personel**

|  |  |  |  |
| --- | --- | --- | --- |
| **№№**  **n/a** | **Category of employees** | **Partner organization** | **Amount of FTE** |
| 1. | scientific employees | SINP MSU | 3 |
| 2. | engineers |  |  |
| 3. | professionals |  |  |
|  | **Total:** |  | **3** |

**4. Financial support**

**4.1. The full estimated cost of the theme**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Items of expenditure** | **Full estimated cost** | **Estimated cost in**  **2024 г.** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** |
| **1** | **Salary** | 11538.3 | 1460.3 | 1520.0 | 1580.0 | 1643.0 | 1710.0 | 1777.0 | 1848.0 |
| **2** | **Social insurance contributions** | 3365.3 | 426.0 | 443.3 | 460.8 | 479.2 | 498.7 | 518.3 | 539.0 |
| **3** | **Social welfare fund** | 749.9 | 94.9 | 98.8 | 102.7 | 106.8 | 111.1 | 115.5 | 120.1 |
| **4** | **International cooperation** | 693.7 | 84.5 | 90.4 | 95.8 | 99.6 | 103.6 | 107.7 | 112.1 |
| **5** | **Materials** | 0.0 |  |  |  |  |  |  |  |
| **6** | **Equipment** | 0.0 |  |  |  |  |  |  |  |
|  | **SUBTOTAL:** | **16347.2** | **2065.7** | **2152.5** | **2239.3** | **2328.6** | **2423.4** | **2518.5** | **2619.2** |
| **8** | **BLTP infrastructure** | 3807.0 | 482.0 | 501.0 | 521.0 | 542.0 | 564.0 | 587.0 | 610.0 |
|  | **SUBTOTAL::** | ***20154.2*** | ***2547.7*** | ***2653.5*** | ***2760.3*** | ***2870.6*** | ***2987.4*** | ***3105.5*** | ***3229.2*** |
| **9** | **JINR infrastructure** | 15988.0 | 2023.0 | 2106.0 | 2190.0 | 2277.0 | 2369.0 | 2462.0 | 2561.0 |
|  | **TOTAL:** | **36142.2** | **4570.7** | **4759.5** | **4950.3** | **5147.6** | **5356.4** | **5567.5** | **5790.2** |

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**AGREED:**

**Chief Scientific Secretary Laboratory Director**

**/ \_\_\_\_\_\_\_/ / \_\_\_\_/**

**“ “ 202 г. “ “ 202 г.**

**Head of BERO Scientific Secretary of the Laboratory**

**/ \_\_\_\_\_\_\_/ / \_\_\_\_/**

**“ “ 202 г. “ “ 202 г.**

**Head of DSOA Laboratory Economist**

**/ \_\_\_\_\_\_\_\_\_\_/ / \_\_\_\_/**

**“ “ 202 г. “ “ 202 г.**

**Head of HRRMD Theme leader**

**/ \_\_\_\_\_\_\_\_\_\_/ /\_\_\_\_\_\_\_\_\_\_/**

**“ “ 202 г. “ “ 202 г.**