**Annex 3.**

***Form of opening (renewal) for Project /***

***Sub-project of LRIP***

 **APPROVED**

 **JINR DIRECTOR**

 **/**

 **" " 202 г.**

**PROJECT PROPOSAL FORM**

Opening/renewal of a research project/subproject of the large research infrastructure project within the Topical plan of JINR

**1. General information on the research project of the theme/subproject of the large research infrastructure project (hereinafter LRIP subproject)**

* 1. **Theme code / LRIP** (for extended projects) - *the theme code includes the opening date, the closing date is not given, as it is determined by the completion dates of the projects in the topic.*

01-3-1117-2024

**1.2 Project/LRIP subproject code** (for extended projects)

01-3-1117-2024/2028

**1.3 Laboratory**

Bogoliubov Laboratory of Theoretical Physics

**1.4 Scientific field**

Theoretical Physics

**1.5 Title of the project/LRIP subproject**

Dubna International Advanced School of Theoretical Physics

**1.6 Project/LRIP subproject leader(s)**

D.I. Kazakov, I.G. Pirozhenko

**2 Scientific case and project organization**

**2.1 Annotation**

The Dubna International School of Modern Theoretical Physics (DIAS-Th) is a scientific and educational project that is successfully developing at the N.N. Bogolyubov Laboratory of Theoretical Physics since 2003.

The project is aimed, firstly, at training senior students, post-graduate students and young scientists on topical research topics of the Laboratory of Theoretical Physics, priority scientific areas of JINR research and modern areas of physics. For this purpose, schools of various levels are regularly held for students, postgraduates and young scientists from the JINR Member States and other countries, and lectures are published. In addition, review lectures on problems of modern physics are organized for JINR staff. Both employees of JINR laboratories and internationally recognized scientists from Russian Federationn and foreign scientific centers are involved in giving lectures. The lectures given by the world's leading experts at DIAS schools stimulate the emergence of new areas of research at BLTP. The project provides in-depth training in the field of modern theoretical and mathematical physics. To this end, the project participants cooperate with JINR University Center, as well as with the JINR-based Departments at Dubna State University, Moscow Institute of Physics and Technology, Moscow State University.

Secondly, the project is aimed at dissemination of scientific knowledge, namely, informing schoolchildren and people who are not professionally engaged in science about the achievements of modern theoretical physics, in particular, about current research in BLTP. In addition, one of the objectives of the project is to encourage young scientists to cooperate with BLTP JINR.

**2.2 Scientific case** (aim, relevance and scientific novelty, methods and approaches, techniques, expected results, risks)

The scientific and educational project Dubna International Advanced School of Theoretical Physics was founded at the N.N. Bogolyubov Laboratory of Theoretical Physics on the initiative of Prof. A.T. Filippov in 2003. Over the past years, 17 winter schools and about 40 summer schools for students, graduate students and young scientists have been organized. More than 3 thousand people from Russian Federation, the JINR Member States and many other countries of the world took part in them.

In general, the main direction of activity within the framework of the project is in-depth training in the field of modern theoretical and mathematical physics. In particular, the aim of the project is to educate senior students, graduate students and young scientists in the areas of advanced research of the Bogiliubov Laboratory of Theoretical Physics and on JINR priority topics. One of the objectives of inviting the world's leading experts to lecture at DIAS schools is to stimulate the emergence of new areas of research at BLTP.

The project is also aimed at dissemination of scientific knowledge, namely, informing schoolchildren and people who are not professionally engaged in science about the achievements of modern theoretical physics, in particular, about current research in BLTP. In addition, one of the objectives of the project is to encourage young scientists to cooperate with BLTP JINR.

The scientific subject of the project reflects the directions of research at the Bogoliubov Laboratory of Theoretical Physics, and more generally, advanced research conducted and planned at JINR.
Within the framework of the DIAS project, one can single out several series of schools with a common direction.

In the field of nuclear physics, the series of schools "**Nuclear Theory and Astrophysical Applications**" (2005,2007,2011, 2014,2017) covers the following topics: nuclear structure and nuclear reactions, neutrinoless double beta decay, superfluidity in nuclei and neutron stars, terrestrial experiments for astrophysics, interaction of neutrinos with nuclei (nuclear matter), condensation and phase transitions in dense matter.

In the field of heavy ion physics at the schools "**Dense Matter in Heavy Ion Collisions and Astrophysics**" (2006), "**Matter under Extreme Conditions in Heavy-Ion Collisions and Astrophysics**" (2018), the equation of state and phase transitions in QCD are considered. Also discussed at these schools are the transport properties of dense quark-gluon matter, hadronization and freezing out in heavy ion collisions, astrophysics of compact stars and their mergers, modeling of dense quark-gluon matter, collisions of heavy ions and compact stars, dense matter in a strong electromagnetic field, experiments and monitoring programs. These schools are focused on the physics program of the NICA collider.

The series “**Hadron Structure, Hadronic Matter and Lattice QCD**” (2017, 2011) is devoted to the structure of hadrons and hadron spectroscopy. It gives theoretical introduction to gauge field theories on a lattice, including at nonzero temperature and baryon number density. Students have the opportunity to independently perform lattice simulations for some problems in hadron physics. Applications of lattice field theory beyond QCD are also considered. Much attention is also paid to the holographic approach to QCD.

A series of schools "**Physics of heavy quarks"** (2005,2008,2013,2015) evolved and changed its name to "**Quantum physics of limit states: from strong fields to heavy quarks**" (2019,2016). Target audience of these schools are graduate students and young scientists working in the high energy physics. The schools cover the main topics of heavy flavor physics, in particular, with a special focus on the latest results in heavy quark physics obtained in all four experimental groups at the LHC. (ATLAS, CMS, LHCb, ALICE) and at the B-factory in KEK. The second focus lies on the high-intensity frontier and extreme states of matter as probed by current and upcoming high-power laser and high-Z ion facilities all around the world. Leading experts in these fields are invited to give lectures devoted to theoretical predictions and analyses of experimental results

In the field of high-energy physics, we mention the schools “**Calculations for Modern and Future Colliders**” (2006,2009,2012,2015,2018). They are devoted to precision theoretical calculations for collider experiments. Participants of these schools get acquainted with the methods of multiloop calculations and resummation, computer codes for calculations in high energy physics, and modern methods for calculating scattering amplitudes. These schools also include lectures on physics beyond the Standard Model.

In the field of condensed matter physics, the series of schools "**Complex Systems and Advanced Materials**" is devoted to the following topical areas: superconductivity and devices; heterostructures; topological materials; graphene and 2D materials; Josephson nanostructures; quantum transport.

The School "**Advanced Methods of Modern Theoretical Physics: Integrable and Stochastic Systems**" was originally a project of the Czech group at BLTP, and has been held at JINR annually since 2013. Currently, the subject of this school is at the intersection of statistical mechanics, the theory of condensed matter, quantum field theory and modern mathematical physics. The lecture program touches upon the issues of stochastic systems, integrability, supersymmetry, quantum mechanics, quantum field methods of the condensed matter theory and a number of other issues of theoretical physics.

Schools held annually from 2003 to 2010 were devoted to modern mathematical physics. Initially, the topics of these schools were very broad and covered supersymmetry, supergravity, superstrings, noncommutative geometry, selected issues of gravity and cosmology, and integrable systems. Later schools of a narrower focus were held, such as "**Partition functions and automorphic forms**" (2018), "**Supersymmetry and integrability**" (2022).

In addition, the DIAS project hightlighted the cycle of schools "**Cosmology, strings and new physics**" (2013, 2016, 2019) and "**Actual cosmology**" (2021) with a program covering modern cosmology, inflation theory, problems of dark matter and dark energy, modified gravitaty models, modern astrophysical observations. The speakers at these schools were outstanding scientists: V.A. Rubakov (INR RAS), A.A. Starobinsky (Landau Institute of Physics and Technology), K.A. Postnov (GAISH MGU), Mukhanov (University of Munich), A.D. Dolgov (Novosibirsk and BLTP JINR), I.A. Arefiev (MI RAS).

A number of schools were organized jointly with other scientific centers: "**Perspective methods of modern theoretical physics: integrable and stochastic systems**" with the participation of the Czech Technical University in Prague, "**Statistical sums and automorphic forms**" (2018) together with the National Research University Higher School of Economics, "**Moscow International School of Physics**" (2022) together with FIAN, NRU HSE, SkolTech. Over the past years, schools have repeatedly received financial support from UNESCO (ROSTE), the Russian Federationn Foundation for Basic Research, the Dynasty Foundation, the Helmholtz Association of German Research Centers (Helmholtz Gemeinschaft) and others.

Within the framework of the project "Dubna International School of Modern Theoretical Physics"

*in educational activities* it is supposed

- to continue organizing regular schools on JINR priority topics and modern scientific areas for schoolchildren, students, post-graduate students and young scientists from the JINR Member States and other countries;

- to continue preparing review lectures on problems of modern physics for JINR staff;

- to continue/renew cooperation with Russian Federationn and foreign scientific organizations, higher educational institutions in educational activities;

- to participate in the educational activities at the JINR-based departments of Moscow State University, MEPhI, MIPT, Dubna State University together with JINR University Center;

- to organize schools for students, graduate students and young scientists in cooperation with Moscow Institute of Physics and Technology, Yerevan Institute of Physics, etc.;

- to take part in international scientific and educational projects.

*In physics knowledge dissemination it is planned to collabotate*
- with other projects promoting popular science, such as Post Nauka;
- with Russian Federationn foundations (Russian Federationn Science Foundation, Federal Target Programs) and international foundations in organizing and conducting international schools for students, graduate students and young scientists.

*It is also planned*
- to support the DIAS-TH website;
- to provide video broadcasting of lectures;
- to record the video of the lectures, and to support the digital archive of DIAS-TH.

**2.3 Estimated completion date**

2023-2028

**2.4 Participating JINR laboratories**

BLTP, UC, LIT

**2.4.1** **MICC resource requirements**

|  |  |
| --- | --- |
| **Computing resources** | **Distribution by year** |
| 1st year | 2nd year  | 3rd year | 4th year  | 5th year  |
| Data storage (TB)- EOS- Tapes |  |  |  |  |  |
| Tier 1 (CPU core hours) |  |  |  |  |  |
| Tier 2 (CPU core hours) |  |  |  |  |  |
| SC Govorun (CPU core hours)- CPU- GPU |  |  |  |  |  |
| Clouds (CPU cores) |  |  |  |  |  |

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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  **Organization** | **Country** | **City** | **Participants** | **Type** **of agreement** |
| Yerevan Physics Institute  | Armenia | Yerevan | Manvelyan R. | Visit exchangeCollaboration |
| ГГБТУ | Belarus | Gomel | Solovtsova O.P.  | Collaboration |
| University | Germany | Muniсh | Mukhanov V. | Collaborations |
| ITEP | Russian Federation | Moscow | Morozov A.Yu | Visit exchange |
| MSU | Russian Federation | Moscow | Galtsov D. | Visit exchange Collaboration |
| Steklov Mathematical Inst, RAS | Russian Federation | Moscow | Aref’eva I.A. Sergeev A. | Visit exchange |
| Lebedev Physical Institute | Russian Federation | Moscow |  Barvinsky A. Vasiliev M.A.Danilov M.V.Pakhlov P. | Visit exchange |
| MIPT | Russian Federation | Долгопрудный | Akhmedov E.T.Musaev E.T. | Collaboration |
| NSU | Russian Federation | Novosibirsk | Dolgov A.D. | Visit exchange |
| Sternberg Astronomical Institute MSU | Russian Federation | Moscow | Postnov K.A.Toporensky A.V. | Visit exchange |
| SINP MSU | Russian Federation | Moscow | Boos E. Tetereva T.V. | Visit exchange |
|  NRU HSE | Russian Federation | Moscow | Gritsenko V. | Visit exchange |
|  IHEP | Russian Federation | Protvino | Bornyakov V.  | Visit exchange |
|  INR RAS | Russian Federation | Troitsk | Gorbunov D.S. Babichev E. | Visit exchange |
| Saint Petersburg State University | Russian Federation | Saint Petersburg | Yakovlev C.L.Yarevsky E.A.  | Visit exchange |
| Skoltex | Russian Federation | Skolkovo | Marshakov A.V. | Visit exchange |
| Saratov State University | Russian Federation | Saratov | Smolyansky S.A.  | Visit exchange |
| Kazan Federal University | Russian Federation | Kazan | Sushkov S.Popov А. | Visit exchange |
| Landau Institute for Theoretical Physics | Russian Federation | Chernogolovka | Belavin A.Kamenshchik A. Yu. | Visit exchange |
| Nis University  | Serbia | Nis | Djordjevic G. | Visit exchange |
| Technical University | Czech Republik | Prague | Burdic Ch. | Visit exchangeCollaboration |

**2.6. Key partners** *(those collaborators whose financial, infrastructural participation is substantial for the implementation of the research program. An example is JINR's participation in the LHC experiments at CERN).*

**3. Manpower**

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

|  |  |  |  |
| --- | --- | --- | --- |
| **№№****n/a** | **Category of personnel** | **JINR staff,** **amount of FTE** | **JINR Associated** **Personnel,****amount of FTE** |
| 1. | research scientists | 2.4 (6 part-time employees ) |  |
| 2. | engineers | 0.2 (1 part-time employees ) |  |
|  | **Total:** |  |  |

**3.2. Available manpower**

**3.2.1. JINR staff**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **No.** | **Category of personnel** | **Full name** | **Division** | **Position**  |
| 1. | research scientists | Pirozhenko, I.G | BLTP | Leading researcher |
|  |  | Isaev, A.P. | BLTP | Leading researcher |
|  |  | Starobinskii A.A. | BLPT | Chief Researcher |
|  |  | Zhuravlev V.I. | BLTP | Scientific Secretary |
|  |  | Davydov E.A. | BLTP | Senior Researcher |
|  |  | Baushev A.N, | BLTP | Leading researcher |
| 2. | engineers | Klimenko O.P. | BLTP |  Engineer in Electronics |
| 3. | specialists |  |  |  |
| 4. | technicians |  |  |  |
|  | **Total:**  |  |  |  |

**4. Financing**

The project will be funded under the theme "Dubna International Advanced School of Theoretical Physics (DIAS-Th)"

**Project (****LRIP subproject) Leader** \_\_\_\_\_\_\_\_\_\_/\_\_\_\_\_\_\_\_\_\_\_/

**APPROVAL SHEET FOR PROJECT / LRIP SUBPROJECT**

TITLE OF THE PROJECT/LRIP SUBPROJECT

SHORT DESIGNATION OF THE PROJECT / SUBPROJECT OF THE LRIP

PROJECT/LRIP SUBPROJECT CODE

THEME / LRIP CODE

NAME OF THE PROJECT/ LRIP SUBPROJECT LEADER

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
| AGREED |  |  |  |
| JINR VICE-DIRECTOR  | \_\_\_\_\_\_\_\_\_\_\_SIGNATURE | \_\_\_\_\_\_\_\_\_NAME | \_\_\_\_\_\_\_\_\_DATE |  |
| CHIEF SCIENTIFIC SECRETARY | \_\_\_\_\_\_\_\_\_\_\_SIGNATURE | \_\_\_\_\_\_\_\_\_NAME | \_\_\_\_\_\_\_\_\_DATE |  |
| CHIEF ENGINEER | \_\_\_\_\_\_\_\_\_\_\_SIGNATURE | \_\_\_\_\_\_\_\_\_NAME | \_\_\_\_\_\_\_\_\_DATE |  |
| LABORATORY DIRECTOR | \_\_\_\_\_\_\_\_\_\_\_SIGNATURE | \_\_\_\_\_\_\_\_\_NAME | \_\_\_\_\_\_\_\_\_DATE |  |
| CHIEF LABORATORY ENGINEER | \_\_\_\_\_\_\_\_\_\_\_SIGNATURE | \_\_\_\_\_\_\_\_\_NAME | \_\_\_\_\_\_\_\_\_DATE |  |
| LABORATORY SCIENTIFIC SECRETARYTHEME / LRIP LEADER | \_\_\_\_\_\_\_\_\_\_\_ SIGNATURE | \_\_\_\_\_\_\_\_\_NAME | \_\_\_\_\_\_\_DATE |  |
| PROJECT / LRIP SUBPROJECT LEADER | \_\_\_\_\_\_\_\_\_\_SIGNATURE | \_\_\_\_\_\_\_\_\_NAME | \_\_\_\_\_\_\_\_\_DATE |  |
|  |  |  |  |  |
| APPROVED BY THE PAC  | \_\_\_\_\_\_\_\_\_\_\_SIGNATURE | \_\_\_\_\_\_\_\_\_NAME | \_\_\_\_\_\_\_\_\_DATE |