**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.*

**04-2-1126-2015**

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

**1.3 Laboratory** ***DLNP***

**1.4 Scientific field *Accelerator/Detector R&D, Applied research***

**1.5 Title of the project/LRIP subproject *Presicion laser metrology for accelerators and detector complexes***

**1.6 Project/LRIP subproject leader(s) *V.V.Glagolev, M.V.Lyablin***

**1.7 Project/LRIP subproject deputy leader(s) (scientific supervisor(s))**

**2 Scientific case and project organization**

**2.1 Annotation**

The implementation of the project is aimed at long-term monitoring of the behavior of the base of the collider (NICA) to track critical design changes that can cause beam deviations from the calculated orbits. Also, monitoring will make it possible to control the angular vibrations of the collider elements from microseismic noise of industrial and natural origin in order to identify sources of noise and frequencies that coincide with the resonant frequencies of the collider elements, which can lead to a decrease in luminosity.

An equally important component of the project is work on the creation of a compact inclinometer capable of measuring changes in the angles of inclination of the surface with an accuracy of about 10-8 radians throughout the year. And, further, building a network of such inclinometers in seismic regions to determine energy accumulation zones and potentially seismic areas.

The project presents a compact-sized precision laser inclinometer (CPLI) and the results of measurements of angular microseismic oscillations of the Earth's surface in the MPD NICA hall. The presented data indicate the importance of the metrological support of the NICA collider by deploying a network from the CPLI. This network will allow localizing the sources of potential industrial noise for the collider and determining their operation schedules.

Within the framework of the project, it is planned to manufacture the required number of CPLIs, install them in the tunnel of the NICA collider, synchronize the operation of the installed inclinometers, create the necessary computer programs, and online visualize the deformation of the Earth's surface by surface microseismic waves. A system for stabilizing the focuses of particle beams in the NICA collider to increase the luminosity can be created with the operational use of data from the CPLI network.

Another objective of the project is to create a modernized version of the CPLI, capable of uninterrupted operation of measuring the angles of inclination of the surface with an accuracy of about 10-8 radians throughout the year. Prototypes of such CPLIs are located in Armenia and Kamchatka, Belarus and Uzbekistan are next in line.

As an additional metrological activity, work is planned to develop a laser reference line (LRL) for the DLNP linear electron accelerator and a platform seismically isolated from angular vibrations of the Earth's surface.

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

During previous studies on the project "Precision Laser Metrology For Accelerators and Detector Complexes" 2016-2023, the range of near tasks for the use of the created inclinometers was determined:

• In colliders, the angular oscillations of the Earth's surface and changes in the landscape under the accelerator affect the trajectories of particles in colliders, which leads to a deterioration in focusing at the points of beam collisions and, accordingly, to a decrease in luminosity in collider experiments.

• Long-term measurement of the landscape of the Earth's surface will make it possible to determine areas of the Earth's surface with an accelerated change in its geometric parameters. This will make it possible to determine the zones of accumulation of seismic energy and advance in earthquake prediction.

• In interferometric gravitational antennas (IGA, VIRGO) there is an urgent need to reduce the influence of angular oscillations of the Earth's surface on the stability of interferometric element suspensions. Microseismic waves propagate along the Earth's surface, the frequency range of which intersects with the frequency range of the natural frequencies of the suspensions in the IGA. This feature complicates the work of the IGA and limits its sensitivity.

To solve the tasks set, it is proposed to use an innovative method for measuring the angular oscillations of the Earth's surface - a precision laser inclinometer (PLI). This technology was created and developed at the Joint Institute for Nuclear Research [1-22]. The small-sized PLI developed at JINR makes it possible to measure the angular oscillations of the Earth's surface in two orthogonal planes in the frequency range of 3x10-9-20 Hz with a sensitivity of 10-8÷10-9 rad. The dimensions of the CPLI are 20×20×20 cm3 and the weight is 15 kg.

To determine the deformation of physical objects that arise as a result of angular oscillations of the Earth's surface, it is proposed to use a distributed measuring network from CPLI. After determining the deformations of the Earth's surface, it is required to solve the problem of online compensation of their influence on accelerators/detectors.

In fact, it is required to determine the change in the geometry of the Earth's surface in three frequency ranges:

• 3·10-8-10-3 Hz - in this frequency range the measurement of changes in the landscape of the Earth's surface is required for the prediction of earthquakes and volcanism. In this range, a long-term measurement of the change in the deformation of the collider geometry is also required.

• 10-3-20 Hz - in this frequency range, it is required to measure the angular oscillations of the Earth's surface to take into account their influence on the noise oscillation of the suspensions of sensitive elements of gravitational antennas.

• 1-10 Hz - in this frequency range it is required to measure changes in the landscape of the Earth's surface to stabilize the focuses of the collider particle beams.

To achieve the goals of the project, it is necessary to create

• Network from CPLI

• software for the operation of the CPLI network,

• software for registration of changes in the landscape of the Earth's surface in real time

• data transfer to ensure online stabilization of elements of physical setups.

The solution of the tasks set is relevant, since it allows improving the operation of physical setups, reducing their noise and increasing the accuracy of measuring physical quantities. All the tasks set have scientific novelty.

**Methods and approaches, methods in the implementation of the project**

Precision Laser Inclinometer

The essence of the method is that the angular position of the laser beam reflected from the liquid surface

is measured. The change in the angular position of the laser beam is proportional to the slope of the

earth's surface. Figure 1 shows a cuvette with a laser, liquid and a position-sensitive photodetector

(PSPD). All elements of the inclinometer are fixed on a concrete base. Due to the phenomenon of

horizontalization of the liquid surface, when the earth's surface is tilted at an angle γ, the laser beam

reflected from the surface experiences an angular displacement of 2γ relative to the PCPD.

γ

γ

2γ

Horizontal liquid surface

Cuvette with a liquid

Laser

PSD

Before movement

After movement

Fig.1 Precision Laser Inclinometer Method

This method is complemented by the use of a thin layer of liquid in a cuvette.

A feature of the propagation of surface waves is the frequency dispersion of their propagation velocity. Figure 2 shows the change in the propagation velocity of a surface wave in the frequency range 0.1-5 Hz [13].

As can be seen from Fig. 2, the main change in the speed of the surface wave occurs in the frequency range of 0.1-1.5 Hz. The speed of propagation of a surface wave in this range varies from 2 km/s to 400 m/s. Starting from 2 Hz, the speed of a surface wave reaches a plateau of 400 m/s. In the frequency range of 2-5 Hz, we will take the average speed of propagation of the surface wave equal to 400 m/s.



Fig.2 Dependence of the speed of propagation of surface waves on frequency. The formula for the fit on the chart is applied in the frequency range of 0.2-5 Hz.

Figure 3 shows the Fourier analysis of the angular oscillations of the Earth's surface, registered at the DLNP Metrological Laboratory.

In the spectrum of angular oscillations (Fig. 3) of surface waves, two main activities are observed: "Microseismic Peak" in the frequency range from 0.1 - 1 Hz and oscillations of the Earth's surface caused by industrial noise in the frequency range of 1 - 5 Hz. It is the frequency range of industrial noise that will be of interest to us in further consideration.

 Fig.3 Characteristic spectrum of angular oscillations of the Earth's surface, measured with the help of MPLI in the metrological laboratory of the DLNP

**Measurement of the angular microseismic activity of the Earth's surface in the MPD hall of the NICA collider**

The objective of the project is to organize a network of inclinometers to register changes in the landscape of the Earth's surface under the influence of microseismic vibrations.

One of the goals of our project is to stabilize the position of the NICA collider particle beam focuses from the action of angular oscillations of the Earth's surface.

The NICA collider is located in a zone of intense industrial noise. These noises are mainly associated with the production cycle of enterprises surrounding the LHE and are a factor affecting the stability of the position of the particle beam focuses.

We have conducted a study of microseisms of the Earth's surface in the area of the NICA collider. The MPD hall was chosen as the measurement area. This room has a concrete recess for the location of the MPD detector at NICA. For maintenance of the detector and its installation, there are rails located at a distance of 6 m from each other. At the ends of these rails, we installed two CPLI. Daily angular microseismic monitoring of the activity of the Earth's surface was organized. Simultaneous operation of two CPLIs is necessary to control the quality of measurements.

The main task of monitoring is to determine the level of microseisms, their frequency range and amplitude during the day.

After the installation of two CPLIs in the MPD hall, daily monitoring of the angular inclinations of the earth's surface in two orthogonal directions began. The registration directions of one CPLI coincide with the second CPLI. Figure 4 shows the registration of the angular inclinations of the earth's surface for June 23, 2022 (Thursday).



Fig.4 Daily monitoring of angular microseismic activity in two orthogonal directions in the MPD hall on June 23, 2022 (Thursday).

As can be seen from Fig. 4, during the daily observation period, two time regions are distinguished with different values of the angular inclinations of the earth's surface. During the night period from 18:00 pm to 07:00 am, the average value of the change in angular oscillations in the frequency range 10-3 Hz-7 Hz of the MPD floor surface was 0.6 μrad. During the working period from 7-00 am to 18-00 pm was 3.7 μrad. Industrial noises that are present during the working period are clearly visible. Also, during the period of work from 16 to 24 hours, an anomalous value of narrow-band industrial noise with an amplitude of up to 1 μrad is observed.

Figure 5 shows the Fourier analysis of the angular oscillations of the Earth's surface based on the data in Figure 4.



Fig.5 Fourier analysis of the daily data set for 06/23/2022

Among the registered oscillations, oscillations of the “Microseismic Peak” type [0.1–1 Hz], irregular industrial noises [1–5 Hz], and an area of resonant industrial noises with frequencies of 6.44 Hz, 8.33 Hz, etc. are clearly distinguished. A signal from the Ivankovskaya hydroelectric power station is seen with frequency 1.6667Hz=5/3Hz

**Creation of a system for visualizing the angular oscillations of the earth's surface under the NICA collider**

It is proposed to create a system for visualizing the deformation of the Earth's surface under the NICA collider.

This system will make it possible to constantly monitor the stability of the position of the base of the collider and plan in advance measures to maintain the luminosity of the collider at the calculated level.

The creation of such a system will also make it possible to visualize the passage of microseismic waves. Based on the observational data, it will be possible to determine the influence of angular microseisms on the luminosity of the collider and, if necessary, create a feedback compensation system by transmitting information for the magneto-optical elements of the collider and/or using piezo stackers under the collider elements.

First, it is proposed to visualize the most intense angular oscillations in the frequency range of 1-4 Hz. In this frequency range, the surface wave length varies from 400 to 100 m.

**Development of the CPLI network in Russia, Armenia, Belarus and Uzbekistan**

Due to the long-term ability to register the angular oscillations of the Earth's surface using CPLI, it is possible to determine the change in the landscape of the Earth's surface using a distributed network from CPLI. According to the measurement data, it is possible to determine the zones of accelerated movement of sections of the earth's surface and thereby determine the zones of accumulation of seismic energy. In the future, by observing the seismic activity of the detected zones, advance in the prediction of future earthquakes. In fact, with a continuously growing database, it is possible to make forecasts of the intensity of a future earthquake and its possible timing.

On the territory of the Russian Federation, Armenia, Uzbekistan and Belarus, work is planned to create a network of CPLIs with the aim of long-term observation of changes in the landscape of the Earth's surface. CPLIs are already operating in Armenia and Kamchatka.

Further work is planned to be carried out in several stages:

• Determination of a long-term time interval of reliable measurements for CPLI. For these purposes, it is planned to place two CPLIs at the International Seismic Observatory in Garni and, in the future, two in Gyumri (Armenia). The consistency of the readings of a pair of instruments will ensure the reliability of the information received.

• Placing a trial network of several inclinometers and determining the deformation of the Earth's surface with this network.

• Creation of a software and hardware complex for synchronizing and receiving data from inclinometers. Creation of an on-line system for monitoring the operation of inclinometers. Data visualization. Development of software for determining seismic energy accumulation zones.

• Establishment of a full-scale network in seismic areas to accurately determine the zones of accumulation of seismic energy.

**Creation of a network of four CPLIs in Armenia for earthquake prediction**

|  |  |  |
| --- | --- | --- |
| Stages | Start | Finish |
| CPLI installation at the Garni International Geophysical Observatory | 2021 | 2022 |
| Monitoring of microseismic activity in the fault zone of the earth's crust in Garni | 2022 | 2028 |
| Production of 3 CPLI samples (subject to availability of funding) and their placement in geophysical centers in Armenia. | 2023 | 2025 |

Additionally, it is planned to monitor volcanic activity in Kamchatka with the help of CPLI. Carrying out research work on the study of correlations between the operation of inclinometers and other metrological equipment.

To create the necessary equipment within the framework of the project, it is planned to adapt the CPLI for the purposes of forecasting earthquakes, capable of operating for a long time at autonomous stations powered by solar panels.

**Associated metrological activity**

**seismically isolated platform**

As an accompanying metrological activity, we propose to continue work on the creation of a seismically isolated optical table (platform). Previous studies have shown the prospects of the developed direction.

Our task is to compensate for the angular inclinations of the optical table surface in the frequency range of 10-6-1 Hz.

**PC**

**Controller**

The CPLI measurement directions

**S**

**N**

The optical table

orientation directions

3m

**The optical table**

**A**

**C**

**B**

CPLI

Fig.6 Scheme of stabilization of the angular position of the optical table using CPLI

For the experiment, it is proposed to use the existing optical table 3 m long and 1.5 m wide (Fig. 6). The optical table is mounted on three support points: A, B and C, which change their position in height with the help of piezoelectric actuators, controlled by the E-727 Digital Multi-Channel Piezo Controller. On the optical table is a precision laser inclinometer, which is mounted on the center of the table. This inclinometer will indicate the degree of compensation for microseismic noise, which will be suppressed using feedback signals fed to the Digital Multi-Channel Piezo Controller from another inclinometer located on the floor next to the optical table.

**Laser reference line**

The laser reference line (LRL) is a key metrological tool that will allow you to set the detectors of a physical setup with high accuracy.

Previous studies, which were carried out at the DLNP Metrological Laboratory, showed the promise of its creation.

Concrete floor

The CPLI

The vacuum volume

The end PSD

The non-destructive testing system

The laser beam

The laser

The PSD

Fig.7 Scheme of laser reference line

Examples of a physical installation in which LRL can be used.

An electron accelerator 200 m long, which is being created at DLNP. For it, it is necessary to set the elements of the accelerator sections with an accuracy of 50 μm and subsequently have the possibility of online measurements of the position of the accelerator over a long period.

The LRL developed by us is able to measure the position of the accelerating elements of a linear accelerator with an accuracy of 10 μm and subsequently be able to check their location online.

**Expected results of the project "Precision laser metrology for accelerators and detector systems"**

The project is expected to be carried out over a period of 5 years.

For the specified period it is planned:

• Create and launch CPLI network for the NICA collider

• Create software to visualize changes in the position of the Earth's surface under the NICA collider.

• Creation of a hardware-software complex for synchronization, processing of CPLI readings and data transmission to compensate for fluctuations of the accelerator supports using magneto-optical elements of the NICA collider

• Modify the current version of the CPLI for long-term stable operation for 6-12 months with an accuracy of angular measurements of 10-7 rad. in the conditions of remote geodetic points powered by solar panels

• Carry out R&D on the creation of a new version of CPLI - interferometric PLI (IPLI), which has a weak temperature dependence and less costly production based on available components

• Create a series of modified CPLI and IPLI

• Based on the sets of modified CPLI and IPLI, conduct the stages of network deployment to determine the regions of seismic energy accumulation and monitoring objects on the territory of Kamchatka, Armenia, Belarus and Uzbekistan

• Create the necessary software for receiving data from the PLI network, online control, visualization of the Earth's surface by a controlled network, algorithms (including machine learning, neural networks) to determine areas of increased accumulation of seismic energy

For accompanying metrological activity:

• Carry out research and development work on the creation of a platform seismically compensated from angular vibrations of the Earth's surface.

• Carry out research on the creation of a laser reference line.

**Project risks**

• Sustained funding is required for the successful implementation of the project. Lack of funding is the main risk of this project. The lack of the possibility of purchasing optical components for the creation of CPLI. A number of CPLI elements are produced by foreign companies. There are difficulties in acquiring their equipment. To reduce this risk, we set up the manufacture of optics for CPLI by our own efforts, using a sputtering plant.

For a fundamental solution to this problem, we are developing a new type of CPLI made from equipment manufactured in the Russian Federation. This CPLI will have the same performance characteristics as those presented in the CPLI project.

• Problems with procurement of electronic equipment. This risk is associated with the difficulty of purchasing precision ADCs, microcircuits for the control board. To reduce this risk, we started our own production of CPLI control boards with electronic components available for purchase in the Russian Federation.

To reduce the dependence on precision ADCs, we switch to the photovoltaic method of recording signals from photodetectors in MPLI. This will allow the use of common less precision ADCs available for purchase in the Russian Federation.

**A possible / probable scenario for deploying the network in Armenia, Uzbekistan and other countries is the purchase of the necessary components by organizations cooperating with us in these countries and the assembly of inclinometers “in sitC”.**

Within the framework of the project, a group for the production and programming of control boards for CPLI was created. This will make it possible to completely concentrate the production of CPLI at JINR and thus provide the necessary equipment for the creation of a network of CPLI

**2.3 Estimated completion date**

Creation of a measuring network from CPLI for online visualization of the movement of the Earth's surface during the passage of surface microseismic waves of industrial and natural origin.

Creating a network consists of the following steps:

• Coordination of the installation locations of the CPLI at the NICA collider.

• Manufacture in the DLNP workshops of the required number of CPLI constructs.

• Manufacture of electronic boards for CPLI at DLNP JINR

• Assembly, configuration, calibration, CPLI installation and network launch.

• Creation of software for receiving, synchronizing data and online control of the network from CPLI

• Creation of software for online visualization of the movement of the Earth's surface by a network of CPLI.

The project is designed for a five-year period 2024-2028.

The main stages of creating a network of CPLI for the NICA collider.

|  |  |  |  |
| --- | --- | --- | --- |
| № | Stages | Start | Finish |
| 1 | Manufacturing CPLI | 2023 | 2027 |
| 2 | Installation of CPLI at the NICA collider | 2023 | 2028 |
| 3 | Creation of software for receiving, synchronizing data and online control of the network from CPLI | 2023 | 2024 |
| 4 | Creation of software for online visualization of the movement of the Earth's surface by a network of CPLI | 2024 | 2028 |

Development of the MPLI network in Russia, Armenia, Belarus and Uzbekistan

|  |  |  |  |
| --- | --- | --- | --- |
| № | Stages | Start | Finish |
| 1 | Modify CPLI for long-term stable operation for 6-12 months with an accuracy of angular measurements of 10-7 rad. in the conditions of remote geodetic points powered by solar panels | 2023 | 2024 |
| 2 | Creation of an interferometric PLI (IPLI) | 2023 | 2024 |
| 3 | Create a series of modified CPLI and IPLI | 2023 | 2028 |
| 4 | Testing the joint operation of two MPLI | 2024 | 2025 |
| 5 | Based on the sets of modified MPLI and IPLI, carry out the stages of deploying networks to determine the regions of seismic energy accumulation and monitoring objects on the territory of Kamchatka, Armenia, Belarus and Uzbekistan | 2023 | 2028 |
| 6 | Create the necessary software for receiving data from the PLI network, online control, visualization of the Earth's surface by a controlled network, algorithms (including machine learning, neural networks) to determine areas of increased accumulation of seismic energy | 2024 | 2028 |

**2.4 Participating JINR laboratories**

The following JINR Laboratories are involved in the work on the project:

Laboratory of Nuclear Problems, Laboratory of High Energy Physics, Laboratory of Theoretical Physics, Laboratory of Nuclear Reactions.

**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** |
| Institute of Geophysics and Engineering Seismology | Armenia | Gyumri | D.K. Karapetyan | Protocol 4869-2-19/23 |
| National Academy of Sciences of Belarus Center for Geophysical Monitoring | Belarus | Minsk | A.G.Aronov,  G.A.Aronov | Basic  Agreement  2023 |
| Institute of Seismology of the Academy of Sciences of the Republic of Uzbekistan | Uzbekistan | Tashkent | V.A. Rafikov | Protocol 4948 dated 09/17/2020 |
| Kamchatka branch of the "Unified Geophysical Service of the Russian Academy of Sciences", KamGU named after Vitus Bering | RUSSIA | Petropavlovsk-Kamchatsky | E.O. Makarov,  DI. Isprailov | Basic  Agreement  2022 |

**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 | 5.4 |  |
| 2. | engineers | 7 |  |
| 3. | specialists | 0.5 |  |
| 4. | office workers |  |  |
| 5. | technicians |  |  |
|  | **Total:** | **12.9** |  |

**3.2. Available manpower**

**3.2.1. JINR staff**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **No.** | **Category of personnel** | **Full name** | **Division** | **Position** | **Amount**  **of FTE** |
| 1. | research scientists | M.V. Lyablin  V.V. Glagolev  G.T.Torosyan  I.V. Bednyakov  A.V. Krasnoperov  V.V. Tereshchenko  K.S. Bunyatov | DLNP  DLNP  DLNP  DLNP  DLNP  DLNP  DLNP | Head of sector  DLNP Deputy Director  Senior scientist  scientist  Senior scientist  Head of sector  Deputy head of department |  |
|  |  |  |  |  |  |
| 2. | engineers | A.M. Kuzkin  S.N. Shilov  Yu.V.Klemeshov  R.V.Ni  A.A. Pluzhnikov  K.D.Polyakov  S.A. Bednyakov  S.V. Tereshchenko | DLNP  DLNP  DLNP  DLNP  DLNP  DLNP  DLNP  DLNP | senior engineer  senior engineer  Engineer  Engineer  Engineer  Engineer  Engineer  engineer |  |
|  |  |  |  |  |  |
| 3. | specialists | S.N. Studenov | DLNP | Radio equip. installer |  |
| 4. | technicians |  |  |  |  |
|  | **Total:** |  |  |  |  |

**3.2.2. JINR associated personnel**

|  |  |  |  |
| --- | --- | --- | --- |
| **No.** | **Category of personnel** | **Partner organization** | **Amount of FTE** |
| 1. | research scientists |  |  |
| 2. | engineers |  |  |
| 3. | specialists |  |  |
| 4. | technicians |  |  |
|  | **Total:** |  |  |

**4. Financing**

**4.1 Total estimated cost of the project/LRIP subproject**

The total cost estimate of the project (for the whole period, excluding salary).

The details are given in a separate table below.

*550 (thousand dollars)*

**4.2 Extra funding sources**

Expected funding from partners/customers – a total estimate.

*50 (thousand dollars)*

**Project (****LRIP subproject) Leader** V.V. Glagolev /\_\_\_\_\_\_\_\_\_\_\_/

M.V. Lyablin /\_\_\_\_\_\_\_\_\_\_\_/

Date of submission of the project (LRIP subproject) to the Chief Scientific Secretary: \_\_\_\_\_\_\_\_\_

Date of decision of the laboratory's STC: \_\_\_\_\_\_\_\_\_ document number: \_\_\_\_\_\_\_\_\_

Year of the project (LRIP subproject) start: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(for extended projects) – Project start year: \_\_\_\_\_\_\_

**Proposed schedule and resource request for the Project / LRIP subproject**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Expenditures, resources,**  **funding sources** | | | **Cost (thousands**  **of US dollars)/**  **Resource requirements** | **Cost/Resources,**  **distribution by years** | | | | |
| 1st year | 2nd year | 3rd year | 4th year | 5th year |
|  | | International cooperation | 200 | 40 | 40 | 40 | 40 | 40 |
| Materials | 100 | 20 | 20 | 20 | 20 | 20 |
| Equipment, Third-party company services | 200 | 40 | 40 | 40 | 40 | 40 |
| Commissioning |  |  |  |  |  |  |
| R&D contracts with other research organizations |  |  |  |  |  |  |
| Software purchasing |  |  |  |  |  |  |
| Design/construction |  |  |  |  |  |  |
| Service costs (*planned in case of direct project affiliation)* |  |  |  |  |  |  |
| **Resources required** | **Standard hours** | Resources |  |  |  |  |  |  |
| * the amount of FTE, |  |  |  |  |  |  |
| * accelerator/installation, |  |  |  |  |  |  |
| * reactor,… |  |  |  |  |  |  |
| **Sources of funding** | **JINR Budget** | JINR budget *(budget items)* | 500 | 100 | 100 | 100 | 100 | 100 |
| **Extra fudning (supplementary estimates)** | Contributions by  partners  Funds under contracts with customers  Other sources of funding | 50 | 10 | 10 | 10 | 10 | 10 |

Project (LRIP subproject) Leader V.V. Glagolev M.V.Lyablin

Laboratory Economist \_\_\_\_\_\_\_\_\_/\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_/

**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 SECRETARY  THEME / LRIP LEADER | \_\_\_\_\_\_\_\_\_\_\_  SIGNATURE | \_\_\_\_\_\_\_\_\_  NAME | \_\_\_\_\_\_\_  DATE |  |
| PROJECT / LRIP SUBPROJECT LEADER | \_\_\_\_\_\_\_\_\_\_  SIGNATURE | \_\_\_\_\_\_\_\_\_  NAME | \_\_\_\_\_\_\_\_\_  DATE |  |
|  |  |  |  |  |
| APPROVED BY THE PAC | \_\_\_\_\_\_\_\_\_\_\_  SIGNATURE | \_\_\_\_\_\_\_\_\_  NAME | \_\_\_\_\_\_\_\_\_  DATE | |