

**SCIENTIFIC AND TECHNICAL JUSTIFICATION FOR EXTENSION OF THEME 1105
OF JINR TOPICAL PLAN for 2020-2022****Theme code 04-4-1105-2017/2019****Laboratory****FLNP****Departments****IBR-2, MTD, ETD, DB,
RPW, NS group****Field of research: «Condensed Matter Physics (04)»****Theme title: «Development of the IBR-2 Facility with a Complex of Cryogenic Neutron Moderators»****Brief annotation**

The main task of the theme is to increase the efficiency in the use of the IBR-2 research nuclear facility for implementation of the program of experimental investigations, to ensure operational reliability and safety of the reactor.

At present, in accordance with the Rostekhnadzor license, the IBR-2 research nuclear facility with an average power of up to 2 MW is in regular operation providing neutron beams for conducting physics experiments. The IBR-2 facility is equipped with modern safety control systems, systems of analysis and diagnostics of the reactor state, systems for radiation monitoring and control of radiation situation. A cryogenic neutron moderator CM 202 is used for physics experiments on beamlines 7,8,10,11.

In the framework of the theme, phased realization of the project "Construction of a complex of cryogenic moderators at the IBR-2 facility" continues. The unique complex of cryogenic moderators being constructed makes it possible to significantly increase the cold neutron flux for experimental condensed matter investigations.

The realization of the project "Construction of a complex of cryogenic moderators at the IBR-2 facility" enables the implementation of new technical solutions that increase the efficiency of cold moderators for physics research. The use of this complex at the IBR-2 reactor allows a significant reduction in the measurement time for a number of experiments due to an increase in the yield of cold neutrons from the moderator surface and ensures that the IBR-2 reactor will maintain its leading position in the world among high-intensity neutron sources for condensed matter investigations for the next 20-30 years.

During the period of duration of the theme, scientific and technical support services will be provided to ensure safe operation of the reactor, and a large amount of scientific and technical work and experimental studies related to the introduction into operation of a cryogenic moderator complex will be performed.

The currently operating movable reflector MR-3 was commissioned in 2004. As of April 1, 2019, MR-3 has reached about 50% of its expected mechanical service life (its specified design service life – 55000 hours). To ensure the reliable operation of the reactor until the end of its service life, a backup movable reflector MR-3R has been designed and constructed.

In the framework of the theme "Development of the IBR-2 Reactor with a Complex of Cryogenic Neutron Moderators", in the period of 2020-2022, it is planned:

1. to continue regular operation of the reactor at an average power of 2 MW and pulse repetition rate of 5 Hz to ensure the implementation of the physics research program on extracted neutron beams;

2. In the framework of the project “Construction of a Complex of Cryogenic Moderators at the IBR-2 Reactor” it is planned:

2.1. to continue work on the optimization of the system of automatic control and regulation of parameters, system of charging/discharging and transportation of the moderator material (frozen mesitylene pellets) in the working chambers and pipelines of the cryogenic complex.

2.2. until the end of 2019, to install a new cryogenic moderator CM-201 in its regular place and start its trial operation. The moderator is planned to be used in the direction of neutron beamlines № 1,4,5,6,9.

2.3. in 2020-2021, in order to ensure the most efficient use of the suite of IBR-2 instruments using cold neutrons, to commission the second Linde AG cryogenic refrigerator with a cooling power of 1200 W at 10 K (KGU 1200/10). By the end of 2022, it is planned to carry out the optimization of the operation of the cryogenic complex, develop requirements specification and project documentation for a cryogenic moderator CM-203 for beamlines 2 and 3.

3. In 2019-2021, it is planned to perform a large complex of activities on check assembling, adjustment and testing of the backup movable reflector MR-3R at the FLNP test bench; to carry out 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.

4. The nuclear-physical and operational characteristics of IBR-2 vary significantly in the process of its operation. To maintain a high level of nuclear, radiation and technical safety of the facility, and ensure control over the state of the reactor, it is necessary to conduct regular monitoring of the operating parameters of the movable reflector, basic technological equipment, materials and constructions of the core, vessel and other reactor equipment using modern hardware systems, computational and analytical methods of diagnostics and prognostics. In this regard, further work is planned on the 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 on the computational and experimental substantiation of the safe and reliable operation of IBR-2 under conditions of increasing radiation load and intensification of degradation processes in the core.

5. The Rostekhnadzor license for operation of the IBR-2 nuclear research facility will expire on September 30, 2022. In this regard, it is necessary to ensure the timely preparation of a package of documents for obtaining a new license and accomplishment of routine maintenance for the extension of the service life of equipment and components of the IBR-2 safety systems.

6. Phased replacement and upgrading of the basic technological and electrical safety-related equipment in accordance with the terms of the Rostekhnadzor license for operation of the IBR-2 nuclear research facility.

Main stages of theme

1. Project “Development of a Complex of Cryogenic Moderators at IBR-2”

Maintenance of operation of a stand of the cryogenic moderator CM 201. Installation of the cryogenic moderator CM 201 on its regular place and putting it into trial operation. Development of requirements specification and project documentation for a cryogenic moderator CM-203 for beamlines 2 and 3.

Commissioning of the second Linde AG refrigerator with a cooling power of 1200 W at a temperature of 10 K (KGU 1200/10).

Project leaders: Belyakov A.A., Mukhin K.A.

Executing personnel: Dolgikh A.V. + 40 pers.

2. Backup movable reflector MR-3R

7. 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 documentation of research data and test results.

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

Executing personnel: Belyakov A.A. + 15 pers.

3. Maintenance of safe operation of the reactor

Research activities to ensure safe operation of the reactor in design operating modes. Maintenance of regular operation of IBR-2 for physics experiments on extracted neutron beams. Phased replacement and upgrade of the basic technological and electrical safety-related equipment of the IBR-2 facility.

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

Executing personnel: Belyakov A.A., Pepelyshev Yu.N., Rudenko S.V., Trepalin V.A. + 80 pers.

Expected results upon completion of theme

Upon completion of activities under the theme, in JINR, the IBR-2 research nuclear facility will continue its operation for conducting investigations in the field of condensed matter and nuclear physics as a high-intensity world-class neutron source with improved safety and reliability. The reactor will be equipped with:

- ◆ cryogenic moderators that will provide the implementation of promising and highly-competitive physics research program;
- ◆ state-of-the-art safety-related systems and equipment, dosimetric control and radiation monitoring systems, systems for monitoring the operating parameters of the movable reflector, basic technological equipment using modern hardware systems for diagnostics and prognostics of the reactor state;
- ◆ to ensure reliable operation of the reactor, a backup movable reflector MR-3R will be fully prepared for operation.

№	Description of activities	Financing (items 5,6,9,10,18,19), k\$		
		2020	2021	2022
1.	Theme: <ul style="list-style-type: none"> • Project «Construction of a complex of cryogenic moderators at IBR-2» • Check assembling and testing of backup movable reflector MR-3R • Research activities under contracts to ensure safe operation of the reactor • Upgrade of safety-related equipment 	2179	2340	1956
2.	Operation and maintenance of the facility	594	832	725
Total:		2634	3080	2681

Exchange rate: 65.17 RUB/1 USD (as of 02.04.2019)

Participating Countries, Institutes and International organizations:

Country or International Organization	City	Institute or Laboratory	Participants	Status
Azerbaijan	Baku	IRP ANAS	Taibov L.	Collaboration
Mongolia	Ulaanbaatar	MUST	Sangaa D.+ 2 pers.	Collaboration
Poland	Krakow	AGH	Dzvinel V. + 2 pers.	Collaboration
Russia	Moscow	SSDI	Dvoryashin I.V. + 5 pers.	Contract
Russia	Moscow	NIKIET	Tretyakov I.T., Sizarev V.D. + 5 pers.	Contract
Russia	Moscow	SNIIP- SYSTEMATOM	Zaikin A.A.+ 10 pers.	Contract
Russia	Moscow	INEUM	Glukhov V.I. + 5 pers.	Contract
Romania	Bucharest	IFIN-HH	Dima O. + 2 pers.	Collaboration
Spain	Valencia	UPV	Tkachenko I.	Collaboration

Work execution period: 2020-2022.**Other financing sources:**

None.

APPROVED:**JINR Chief Scientific Secretary**

_____ **A.S.Sorin**
« ____ » _____ 2019

FLNP Director

_____ **V.N.Shvetsov**
« ____ » _____ 2019

Head of Planning Department

_____ **L.V.Uvarova**
« ____ » _____ 2019

FLNP Scientific Secretary

_____ **D.Chudoba**
« ____ » _____ 2019

Head of Scientific-Organization Department

_____ 2019
« ____ » _____

Economist of FLNP

_____ **L.S. Ovsyannikova**
« ____ » _____ 2019

Senior Research Scientist of Scientific-Organization Department

_____ 2019
« ____ » _____

Theme Leaders

_____ **A.V.Vinogradov**
« ____ » _____ 2019

_____ **A.V.Belushkin**
« ____ » _____ 2019

_____ **A.V.Dolgikh**
« ____ » _____ 2019

