**Work plan on the large research infrastructure (LRI) “Development of the FLNR Accelerator Complex and Experimental Setups (DRIBs-III)” and projects within the framework of this LRI for 2024**

The scientific program of the Flerov Laboratory of Nuclear Reactions in heavy-ion physics includes experiments on the synthesis and study of properties of heavy, superheavy and light exotic nuclei using ion beams of stable and radioactive isotopes, study of the nuclear reactions mechanism. The development of accelerator technology and the FLNR experimental setups is a continuous task of the Laboratory.

1. **The project “The U-400R Accelerator Complex”**

**Reconstruction of the U-400 accelerator complex.** These works are included into the subproject “The U-400R Accelerator Complex”. The goal is the creation of the U-400R accelerator complex for detailed study of mechanisms of nuclear reactions with stable heavy-ion beams (fusion-fission, quasifission, multinucleon transfer, etc.), production of new nuclides with the use of those reactions as well as decay spectroscopy of nuclei of interest.

The subproject includes the construction of a new Experimental Hall, the upgrade of the U-400 cyclotron and the construction of new separators and ion guides for beam transportation.

The construction of the Experimental Hall with a total area of ​4,566 square meters is carried out by the general contractor JSC “Electrocentromontazh” since June 2023. All preparatory work has been carried out, including drilling and pouring of the foundation piles of the building including 763 bored piles, each 18 meters high, which took more than 4,000 cubic meters of high-strength concrete to fill (Fig.1), which allows you to start the main construction stage, starting with the concrete pouring of the building foundation.



**Fig. 1**. The Experimental Hall construction site

The upgrade of the U-400 cyclotron is planned to begin at the end of 2024, after commissioning the U-400M cyclotron. Today equipment configuration is updated, additional specifications and documentation are issued for ion beam extraction and transportation systems.

The new separators- the kinematic separator and the SCIF-D spectrometer are under development. The kinematic separator will be dedicated for studying the characteristics of the multi-nucleon transfer reactions (MNT) reactions and properties of radioactive decay of neutron-rich isotopes of heavy elements formed in MNT reactions. The separator is intended for operation with high beam intensity to provide reliable separation of heavy and superheavy nuclei at high background suppression.

The SCIF-D spectrometer will make it possible to measure the cross sections of various processes, mass-energy, charge, and angular distributions of reaction fragments and evaporation residues. It is planned to conduct experiments using high-intensity beams varying from Ne to U and actinide targets*.* In addition, simultaneous measurement of all kinematic characteristics of nuclear reaction fragments will make it possible to determine their excitation energy, which is extremely important for estimating their survival during deexcitation process, and can also provide information on the reaction time.

1. **The project “Development of the experimental setups for the study of chemical and physical properties of superheavy elements”**

**Subproject I*.* Superconducting gas filled separator GASSOL*.***

Magnetic gas-filled separator (GASSOL) is intended for the study of atomic properties and chemical behavior of superheavy elements including those with rather short half-lives: T1/2< 0.5 s. The design of the setup is based on the use of a superconducting solenoidal magnet. The main task of the separator, apart from effective separation of reaction products, is focusing nuclei of interest into the spot of the diameter less than 1 cm2. We expect delivery of the separator parts to JINR and start of assembly in 2024.

**Subproject II*.* Multi-reflection TOF mass spectrometer*.***

A dedicated high resolution mass spectrometer is intended for the measurement of the masses of superheavy elements with Z=104-118 and A=266-294 and their radioactive decay products with the accuracy <100 keV. Operating principle of the spectrometer is based on the use of multi-reflection time of flight (MR TOF) technique. In 2024 we intend to continue development of the working project of the set-up and contracting its manufacture.

1. **Commissioning of the U-400M cyclotron.** The main part of installation works were finished in 2023. The autonomous commissioning of the cyclotron systems (vacuum leak testing, RF system testing, testing of ECR ion sources and injection system, testing of safety systems) has to be performed in the beginning of 2024. The acceleration of the testing ion beams and preparation of the first experiment on the ACCULINNA-2 fragment separator is planned in the first half of 2024.
2. **Construction and launching the DC-140 cyclotron for applied research**

The construction and launching of the DC-140 cyclotron is aimed at creation of the accelerator complex for basic research and application of heavy ion beams in the fields of solid state physics, surface modifications of materials, production of track membranes, testing of electronic component base components (ECB) on single radiation effects (SEE). This includes creation of the specialized compact heavy ion accelerator with multi-charge ion injector based on an ion source of the ECR type and having three specialized channels.

The project of the DC-140 accelerator complex is on its final stage of implementation. It is expected that the complex will be commissioned in 2024.

