Project review

"Multi-purpose detector (MPD) for studying the properties of hot and dense baryonic matter at the NICA Collider complex"

(team of authors)

The main goal of the project is to create a detector in the basic configuration to begin studying the properties of hot and dense baryonic matter formed when nuclei collide (up to gold) at energies of 4-11 GeV/nucleon. The project started in 2010. During this time, Technical projects were prepared on the main systems of the experimental installation. Along with this, the list of authors and participating institutions has expanded significantly. Currently, 475 physicists and engineers from 38 institutes and 11 countries participate in the project.

This project is the flagship and largest in the history of the Institute. For the first time, based on the MPD project, a large international collaboration has been formed in JINR.

The project consists of three parts: a physical motivation, a description of the detector design, and a request for funding. Installing MPD in the basic current configuration includes the following systems: Time-projection chamber (TPC), Time-of-flight system (TOF), including a Forward fast detector (FFD), Forward hadron calorimeter (FHCal), and Electromagnetic calorimeter (ECal). Unfortunately, due to limited funding from Chinese partners, it is planned to create and install about 40% of all sectors of the Electromagnetic calorimeter.

For the period from 2021-2022, complex works are planned to integrate all elements into the MPD installation. Assembly of the magnetic core is planned for April-May 2020. The superconducting Solenoid is now assembled, and after testing at the temperature of liquid nitrogen at the manufacturer's plant in June-July this year, it is planned to be transported to JINR.

The MPD magnet is designed to create a uniform magnetic field in its volume with a nominal magnetic induction value of 0.5 T (the limit value is 0.57 T). Structurally, the magnet consists of a superconducting solenoid surrounded by a polyhedral yoke that closes the magnetic flux and participates in the formation of a uniform magnetic field.

It should be noted that the MPD Magnet is designed and manufactured with very high requirements for the uniformity of the magnetic field in the working volume of the TPC. The integral of the radial-to-longitudinal components ratio for the solenoid in the TPC region must be at least 1.5 mm. To create a high uniformity area of the magnetic field in the drift interval of the TPC, two correction coils are placed in the pole covers. To measure the magnetic field prior installing the systems inside the Solenoid, experts from CERN designed and manufactured a plotter for MPD. This plotter scans the TPC volume in three directions: Bx, By, and Bz, using 38 precision Hall sensors.

Completion of the basic configuration and start of work on colliding beams at the center-of-mass system energy of 7-9 GeV / nucleon is planned for the end of 2022. At the first stage, it is planned to operate a Collider with a luminosity of ~ 10^{25} /cm2 * sec for gold nuclei. After testing and calibration of the detector subsystems, it is planned to start a data taking run to obtaining the first physical results in accordance with the MPD physical program.

In the basic configuration, the apparatus allows you to measure the momentum of particles and identify them in the pseudo-rapidity range up to $|\eta|=1.2$. Tracking system, being the basis for solving most of the project tasks, has been fully developed to date. The proposed design of the

Time-projection chamber will allow measuring the momentum with an accuracy of about 3% in the range of 0.1 – 2.5 GeV/c. A year ago, a serious problem for TPC was the front-end electronics of proportional chambers. It simply did not exist, and development on its own on available production bases was a long, multi-iterative process without a guaranteed quick result. Thanks to the collaboration of the TPC MPD group in testing of front-end electronics based on newly developed SAMPA chips for TPC ALICE, it was possible to obtain a complete set of such chips from CERN. Presently, the full configuration of this electronics is being tested with the working version of the reading chamber. After completing (hopefully successful) the tests, mass production of electronics will start. To identify charged particles, in addition to TPC, a Time-of-flight system based on multi-gap resistive counters with a resolution of better than 100 psec is used. This identification system allows efficient separation of charged particles up to 2 GeV/c momenta.

The authors of this project, judging by the work done, undoubtedly have sufficient experience, and surely are able to solve technical and organizational problems that are inevitable in such a complex endevour. The construction schedule of the installation is very strict. And the creation of accelerator systems and experimental facility of such scale in extremely short time (until 2022) looks unprecedented.

The resources requested for creating the MPD installation look adequate to the task and correspond to the experience of building and financing of comparable experimental systems. I support the project and offer to extend it for 5 years with the first priority.

12.03.2020 G. D. Alexeev