Review

of the Project "MPD. Multipurpose detector"

The main goal of the Project is construction of a multipurpose detector MPD and study heavy-ion collisions at the accelerator complex NICA at JINR. The NICA/MPD experimental program is aimed at the experimental exploration of the properties of nuclear matter under extreme baryon density. The MPD will be focused on a study of the nuclear matter Equation Of State (EOS), on the properties of the phase transition and characteristics of the mixed phase (hadron gas and quark-gluon plasma - QGP), on the investigation of critical phenomena in dense baryonic matter, as well as on a manifestation of the partial chiral symmetry restoration. For this, an energy and system size scan will be performed by changing the collision energy and mass numbers of the colliding systems. New experimental data in the high μ_B-region of the QCD phase diagram are of great importance and, in this case, the accelerator NICA with its record luminosity parameters will possess the unquestionable advantage over the analogous programs at CERN and BNL.

The basic attractive characteristics of the project are:

- the energy range of the NICA collider (from 4 to 11 GeV in the center-of-mass system) allows creation in the laboratory nuclear matter of the highest net baryon densities, where the most intriguing QCD phenomena (deconfinement phase transition and chiral symmetry restoration) will be investigated under optimal conditions
- NICA will provide a wide nomenclature of the beams with the record luminosity for heavy ion beams (up to 10^{27} cm $^{-2}$ s^{-1} for Au^{79+}), thus allowing a very detailed energy and system size scan even for very rare probes as multi-strange hyperons, hypernuclei, and vector mesons.

The proposed experimental program is very extensive and well established. It is suggested a plenty of observables, for which detailed Monte Carlo simulation was performed. The program includes: measurements of the yields of electromagnetic probes (electrons and gammas), light mesons and hyperons, resonances, and (hyper)nuclei. In addition, analysis of flow, event-by-event fluctuations and correlations will be done. The necessarily of a large acceptance of the experimental setup is dictated by the nature of the selected physics processes. Measurements of collective flow of identifies particles and critical fluctuations require full azimuthal coverage in the pseudorapidity interval $|\eta| < 2$. Study of identified particle ratios on event-by-event basis requires a hadron selection with a high PID capability.

At present, of about 500 of physicists and engineers from roughly 40 scientific centers around the word are participating in the realization of this project. Recently the MPD Collaboration was formed, which is now well structured. The main activity of the MPD team during the past period (2015-2020) were the following: finalizing of the detector design and start of the mass-production of the elements of MPD sub-systems. In addition, a detailed MPD simulation for multiple physics signals was carried out. It is decided, that the MPD central detector for the first stage of the project realization consists of the main tracker - Time-Projection Chamber (TPC) and particle identification system based on time-of-flight measurements and electromagnetic calorimetry. A segmented forward calorimeter (FHCAL) is meant for off-line centrality determination, and arrays of quartz Cherenkov counters (FD) will provide fast signals for MPD triggering. At present, MPD construction is ongoing and the detector will ready for data taking by 2022. Furthermore, a list of key observables for the first period of data taking is defined, and MPD performance for them has been determined. In particular, based on realistic Monte Carlo tracking and particle ID characteristics of the setup were obtained, as well as MPD performance for hyperon reconstruction, flow coefficients determination, dilepton invariant mass spectra reconstruction, etc. The results of this activity have already been presented at many conferences, workshops and advising committees.

The team has a solid experience in preparation and carrying-out heavy-ion experiments at Nuclotron, SPS, LHC and RHIC. Their expertise covers all necessary fields needed for successful project realization, namely, construction and commissioning of particle detectors, maintaining of experimental setups, data analysis and simulation.

Time schedule of the project realization and requested resources for creating the detector are completely substantiated and it is sufficiently studied. The estimate of the cost of the project proposed is reasonable.

In conclusion, I support the project and recommend strongly that the Proposal of extension for the next 5 years be accepted.

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