Referee report on the project

"Construction of the Spin Physics Detector for studying spin effects in nuclear interactions"

The accelerator complex NICA is intended for studies of dense baryonic matter in heavy-ion collisions and for investigation of the nucleon structure and polarization phenomena. The project under consideration related to the latter. It is devoted to development of the Spin Physics Detector (SPD) which will provide a unique possibility to study the spin structure of protons and deuterons and their gluon content. From the theoretical point of view, these studies will have a great importance for understanding fundamental properties of strong interactions at low energies. The present status of research in this field is quite controversial and can be described by the term "spin crisis". In spite of the continuous progress in theoretical studies of low-energy QCD, in particular with the help of lattice simulations, we are still far from a clear understanding of the confinement phenomenon and the origin of the nucleon mass. With this respect, it is very important to analyze the role of gluons inside nucleons. The SPD at NICA will allow to access details of the gluon distributions. It is very important that due to beam polarization one will study not only the ordinary collinear gluon parton density functions but also transverse momentum dependent (TMD) and polarization-dependent ones. The experiment will get information about the gluon helicity, gluon Sivers and Boer-Mulders functions, and other TMD PDFs in the proton and deuteron via the measurement of specific single and double spin asymmetries. Some tensor asymmetries will be also studied. The forthcoming SPD results will complimentary to the ones of current and future experiments at RHIC, LHC, and EIC. The basis of the SPD experiment is the unique capability of the NICA complex for production intensive beams of polarized protons and deuterons.

To perform the ambitious SPD physical program, it is planed to analyze several signal processes, including prompt photons, charmonium production, and creation of D-meson pairs. In fact these processes are quite sensitive to the gluon content of nucleons. Studies of such processes requires advanced systems of particle detection and data analysis. And the SPD project does adequately respond to the challenge. It is planned to build a modern detector system based on advanced technologies. The proposed detector structure will allow to have a 4π geometry, an advanced particle tracking and identification. The high resolution of the silicon vertex detector will allow reconstruction of secondary D-meson vertices. The straw-based tracking system will provide the transverse momentum resolution of about 2% which is needed for accurate measurements of polarization asymmetries. The possibility to use aerogel-based Cherenkov detectors will be important for unambiguous particle identification. The beam-beam counters and calorimeters at zero degrees will provide polarimetry and luminosity control. In general, the proposed detector design is well suited for the intended measurements. An advanced data acquisition system, offline computing system, online monitoring, and data processing software are foreseen and described in the project. During last years also the physical program of SPD has been considerably improved [Prog.Part.Nucl.Phys. 119 (2021) 103858]. In particular, topics for the first stage of SPD operation has been selected. The conceptual design report was published [arXiv:2102.00442].

It is important to note that the SPD is really an international collaboration unites the efforts of more than 200 scientists from 35 institutes situated in different countries. The financial budget is adequate to the project aims. I propose to approve the project "Construction of the Spin Physics Detector for studying spin effects in nuclear interactions" and support it with the first priority for the next period of 2025-2029 years.

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