Referee report on the "Conceptual and technical design of the Spin Physics Detector"

Problem of studying of spin structure of nucleons - one of essential problems of modern of particle physics. Experiments already conducted led to radical revision of existing models and emergence of new ideas. Overwhelming majority of these experiments were executed with unpolarized particle beams that did not give the chance to obtain a lot of essentially important data. In realized now the NICA project it becomes possible to create polarized particle beams that in turn, will lead to the possibility of obtaining new, previously inaccessible data.

The "Conceptual and technical design of the Spin Physics Detector" project is dedicated to the development of a physical program and preparation to build the experimental set-up at the 2nd interaction point of the NICA collider. The main purpose of this experiment is the study of the nucleon spin structure with high intensity polarized proton and deuteron beams. The design of the collider can allow us to reach a very high collision proton (deuteron) energy up to $\sqrt{s} \sim 26$ (12) *GeV* with the average luminosity up to 10^{32} (10^{31}) cm^2/s. Both proton and deuteron beams will be effectively polarized. All these advantages can give us unique possibilities to investigate the polarized phenomena and nucleon spin structure. The comprehensive program of these studies is presented. The main physical tasks proposed for spin program at NICA are as follows:

-Drell-Yan (DY) pair production;
-Prompt photon processes with longitudinally and transversely;
-Extraction of unknown (poor known) parton distribution functions (PDFs) from J/ψ production processes;
-Spin effects in baryon, meson and photon production;
-Different effects in various exclusive reactions;
-Diffractive processes;
-Cross sections, helicity amplitudes and double spin asymmetries (Krisch effect) in elastic reactions;
-Spectroscopy of quarkonia.

Now the quark-parton structure of nucleons and respectively the quark-parton model of nucleons are becoming more and more complicated. In Quantum Chromo Dynamics (QCD), PDFs depend not only on x, but also on Q^2, four-momentum transfer. Partons can have an internal momentum, k, with possible transverse component, k_T. A number of PDFs depends on the order of the QCD approximations. Measurements of the collinear (integrated over k_T) and Transverse Momentum Dependent (TMD) PDFs, the most of which are not well measured or not studies yet. And so it is very important to perform such measurements on the experimental in the collider mode.

The conceptual design of the set-up deserves special attention. It is important to note the modularity of the set-up, and the possibility to perform spin measurements in a wide range of collider beams energies (5-15 GeV) and for various types of reactions, including a number of

exclusive processes.

The modularity of the detector is based on an individual magnet system for each part of them: the endcaps - solenoidal coils, the barrel – toroidal ones. The main detector systems are as follows: Range System (for muon identification and energy measurement), Electromagnetic Calorimeter, PID/Time-of-Flight system, Main Tracker and Vertex Detector. The proposed three-module design gives a possibility for upgrade and modification of each of the main detector subsystems and for performing measurements in different detector configurations.

An important part of the project is a plan to build a test zone, which can be the main basis for the development of the technical project of the SPD.

One should be noted the complexity of the proposed measurements, in particular a very difficult experimental task is to measure the processes of Drell-Yan without the use of hadron absorber (usually done in other experiments for muon decay mode), which can lead to very complex background conditions of measurements.

The proposal on measurements of asymmetries in production of J/Ψ and prompt photons is very important and interesting which permit to get new data on gluon polarization in the nucleon and on the quark-parton model of nucleons at the QCD twist-2 level.

The financial request is mainly adequate to the project objectives, although the costs of scientific travels should be increased. And I would like also to note that it is necessary to intensify efforts to involve external groups in the project and actively prolong the creating an international collaboration.

Based on the above, I have no doubt to propose to open a new "Conceptual and technical design of the Spin Physics Detector" project in the framework of theme 1065 for a period 2019-2023 years with the first priority, and support and possibly increase the request for resources to carry out the tasks of this project.

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