The Spin Physics Detector at NICA

The Spin Physics Detector (SPD) is a future multipurpose experiment foreseen to run at the Nuclotron-based Ion Collider fAcility (NICA), which is currently under construction at the Joint Institute for Nuclear Research. The main purpose of the experiment is the test of basics of the QCD via the study of polarized structure of proton and deuteron and spin-related phenomena in collision of longitudinally and transversely polarized protons and deuterons at the center-of-mass energy up to 27 GeV and luminosity up to 10^{32} cm^{-2} s^{-1} (pp-collisions).

The Spin Physics Detector is planned to operate as a universal facility for comprehensive study of the unpolarized and polarized gluon content of the nucleon at large Bjorken-x, using different complementary probes such as: charmonia, open charm and prompt photon production processes. The experiment aims to provide access to the gluon helicity, gluon Sivers and Boer-Mulders PDFs in the nucleon, as well as the gluon transversity distribution tensor PDFs in the deuteron, via the measurement of specific single and double spin asymmetries. Polarized quark distributions and fragmentation functions can be accessed via the production of high-p_T hadrons. The results expected to be obtained by the SPD will play an important role in the general understanding of the nucleon content and will serve as a complementary input to the ongoing and planned studies at RHIC, and future measurements at the EIC (BNL) and fixed-target facilities at the LHC (CERN). Other polarized and unpolarized physics is possible especially at the first stage of NICA operation with reduced luminosity and collision energy of proton and ion beams.

The general concept of the SPD project was approved by the JINR Program Advisory Committee for Particle Physics in Jan, 2019. At the moment the Conceptual and Technical Design Reports of the SPD project are under preparation. Physics running of the SPD experiment is expected after 2025.

The SPD experimental setup is being designed as a universal 4π detector with advanced tracking and particle identification capabilities based on modern technologies. It will include such subsystems as a silicon vertex detector, a gaseous main tracker, a time-of-flight system, an electromagnetic calorimeter, a range system for muon identification and instruments for local polarimetry and luminosity control. To minimize possible systematic effects it will be equipped with a triggerless DAQ system.

Extensive studies and tests of the detector and electronics prototypes are planned for the next years. The miniSPD cosmic ray facility for the comprehensive study of the main types of the detectors planned to be used at SPD is in operation

while the SPD Test Zone at extracted Nuclotron is under construction and will be put into operation in 2021. A series of tests will be performed at the SPD interaction point as soon as the collider begins to operate in 2022.

High collision rate (up to 4 MHz) and a few hundred thousand detector channels pose a significant challenge to the DAQ system, the online monitoring, the offline computing system and data processing software. Sophisticated computing algorithms will be applied for simulation of the detector response, finding and reconstruction of tracks, primary and secondary vertices, calorimeter clusters and for particle identification including the machine learning approach.

Establishing of the SPD international collaboration is going on. The SPD physics and detector construction programs are open for exciting and challenging ideas from theorists, experimentalists, engineers and computing specialists worldwide. More information could be found at the project webpage http://spd.jinr.ru.

The SPD working group

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