

Implementation of the SPD project

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SPD project



The purpose of the SPD experiment is the study of the nucleon spin structure in collisions of polarized protons and deuterons and other spin-related as well as unpolarized phenomena at \sqrt{s} up to 27 GeV and luminosity up to $10^{32}cm^{-2}s^{-1}$



Gluon TMD PDFs will be accessed via 3 complementary processes.

Non-perturbative QCD





The project is planned to be implemented in two phases

Perturbative

2

Experimental setup, stage 1



Our efforts

- Load-bearing structure of the detector / yoke
- Supeconducting magnet
- Engineering infrastructure / communications
- First-stage detectors (trackers, muon (range), BBC, ZDC, part of ECAL) - manufacture
- Second-stage detectors (ToF, FARICH, vertex detector) R&D
- DAQ & computing infrastructure
- Update of the first-stage physics program

Platform for equipment



Engineering communications



Thermal analysis

MISIS group



INP BSU group





Load-bearing structure of the detector / RS



RS detector layer prototype





Injection molding machine for MDTs plastic



details

Straw



Production site



2025







012-502 052-052 017-602 051-004 051-004 051-004 051-004 051-004 051-004 051-004 051-004 051-004 051-004 051-004 051-004 051-004 051-005 051

Gas system



Endcap prototype with electronics

A rectangular hole $14 \times 15 \text{ cm}^2$ was added to the prototype of $\emptyset=1\text{m}$

Dimentional mockup



BBC



The optical cables prototype test





reduced prototype wheel (x2) (at the 1-st stage)



FEE & Readout system:





- Tests of the new electronics showed reasonable results
- The upgraded version of FEE with FPGA KINTEX-7 based readout system are under development
- The cables prototype with clear fiber produced by Kuraray has been developed and tested

Plans:

- I. The R&D phase for optical and transmission connectors, as well as methods of express sector checking to be continued.
- II. The manufacture of **reduced BBC wheels** (128 tiles each) for SPD Phase 0 is planned to the mid of 2025.

ECAL

A part of one ECAL end-cap should be ready for the first stage (mainly for local polarimetry)



Assembly of modules is ongoing in LHEP



- 200 modules (1000 cells) will be assembled in LHEP in 2025
- It is planned to assemble 500 modules in "Uniplast" in 2026
- Front-end electronics is being developed in LNP (N.Anfimov, I.Kreslo)

FARICH

Aerogel optimization

- <u>4-layer aerogel</u> optimized for 6x6 mm² pixel size
- $L_{sc} \ge 60 \ mm$ for all aerogel tiles





- Samples were manufactured in 2024
- Plan to test with beams in 2025

FEE development



MCP PMT development



Agreement between AANL and JINR on the establishment of a joint laboratory for testing of aerogel Cherenkov counters for SPD was signed in February.

ZDC prototype installation







First ZDC prototype is already installed at the SPD IP The second one will be installed soon

DAQ & computing infrastructure

A dedicated EOS storage for SPD is deployed at JINR MLIT

- Equipment was secured around mid-February 2025:
 - 18 servers
 - 3 head (metadata) nodes
 - 15 disk nodes (24 drives of 20TB each)
- 7.2 PB raw capacity (5.3 PB of usable space)
- Disk volume at JINR should be enough for next 3-4 years
- Longterm data storage policy should be agreed

SPD online filter

- Steady progress with middleware development:
 - Integration testing of subsystems working in cooperation, provides more input for tune of code and architecture of micro-services
 - "Load testing" (quite regular JINR Cloud VM's, simplified synthetic payload)
 - In progress purchasing of hardware for prototyping or compute cluster
- Not as planned with future NICA Computing data center, but in consideration with SPD

DAQ testbed.

• We expect to have 256 CPU Cores, 1TB RAM, 120TB HDD across four quite fat servers.

Production system

- under stable operation after test run in 2024

Monitoring and analysis system

- under consideration

From FAIRSOFT/FAIRROOT-based SPDROOT MC and reconstruction software to the GAUDI-based Sampo toolkit

Prototype of L2 concentrator card: ZYNQ UltraScale+ FPGA Development Board Z19-P form Alinx.



Troubling issues

- Delay with the SC magnet documentation preparation (BINP) and uncertainty in starting production
- Refusals to purchase electronics samples in China
- Strong ruble

Open workshop on first-stage physics



23.04.2025 Zoom only

We invite you for the discussion of existing elaborated SPD proposals



SPD first stage physics workshop

physics workshop





14 proposed measurements

>60 participants



IX SPD collaboration meeting



Erevan, AANL May, 12-17

In person: >60 participants 13 institutes 6 countries

SPD collaboration: new groups



Group Members intending to Join SPD

Physics interests:

- 3D spin structure of the nucleon at NICA energies
- A hyperon and vector meson polarization and spin transfer in pp/dd collisions at SPD

Intended contributions:

- Development of offline software, especially in Gaudi-based framework, tracking and PID algorithms with machine learning methods, etc.
- Monte Carlo simulation and physics potential studies
- Possible hardware contribution for one or more subsystems, e.g. calorimeter system







University of Science and Technology of China



Summary

- We are focused on the construction of the detector's load-bearing structure, engineering infrastructure, and the Phase 1 detectors. R&D continues for the Phase 2 subsystems. Consolidation of the Phase 1 physics program is underway.
- The SPD collaboration is in a good shape and developing dynamically.