Form No. 24

SPIN PHYSICS DETECTOR (SPD) AT THE NICA COLLIDER

CODE OF THEME 02-0-1065-2007/2023

LIST OF AUTHORS IN THE ALPHABETICAL ORDER WITH INDICATION OF INSTITUTES, COUNTRIES AND TOWNS OF LOCATION
(FOR JINR, INCLUDING LABORATORIES OF THE INSTITUTE)

NAMES OF PROJECT LEADERS: A. GUSKOV

NAME OF PROJECT DEPUTY LEADERS: V. LADYGIN

DATE OF SUBMISSION OF PROPOSAL OF PROJECT TO SOD _________

DATE OF THE LABORATORY STC _________ DOCUMENT NUMBER _________

STARTING DATE OF PROJECT 01.02.2019

Appendix 2

Form No. 25

PROJECT ENDORSEMENT LIST

SPIN PHYSICS DETECTOR (SPD) AT THE NICA COLLIDER

CODE OF THEME 02-0-1065-2007/2023

NAME OF PROJECT LEADER: A. GUSKOV

APPROVED BY JINR DIRECTOR	SIGNATURE	DATE
ENDORSED BY		
JINR VICE-DIRECTOR	SIGNATURE	DATE
CHIEF SCIENTIFIC SECRETARY	SIGNATURE	DATE
CHIEF ENGINEER	SIGNATURE	DATE
HEAD OF SCIENCE ORGANIZATION DEPARTMENT	SIGNATURE	DATE
LABORATORY DIRECTOR	SIGNATURE	DATE
LABORATORY CHIEF ENGINEER	SIGNATURE	DATE
PROJECT LEADER	SIGNATURE	DATE
PROJECT DEPUTY LEADERS	SIGNATURE	DATE
ENDORSED		
RESPECTIVE PAC	SIGNATURE	DATE

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Abstract

The Spin Physics Detector, a universal facility for studying the nucleon spin structure and other spin-related phenomena with polarized proton and deuteron beams, is proposed to be placed in one of the two interaction points of the NICA collider (JINR). At the heart of the project there is huge experience with polarized beams at JINR. The main objective of the proposed experiment is the comprehensive study of the unpolarized and polarized gluon content of the nucleon. Spin measurements at the Spin Physics Detector at the NICA collider have bright perspectives to make a unique contribution and challenge our understanding of the spin structure of the nucleon. The SPD international collaboration including more than 200 members from 30 institutes of 14 states is formed. The Conceptual Design Project was presented in Jan., 2021 to the Program Detector Advisory Committee and was approved in Jan., 2022. In the period 2023-2025 preparation to the detector construction will be completed and the production of the subsystems of the first phase of the experiment will begin. The requested resources for 2023 years correspond to 41 350 k$.

Introduction

The Spin Physics Detector is a planned experimental setup at the NICA collider is intended to study the spin structure of the proton and deuteron and the other spin-related phenomena with polarized proton and deuteron beams at a collision energy up to 27 GeV and a luminosity up to 10^{32} cm^{-2} s^{-1}. In the polarized proton-proton collisions, the SPD experiment will cover the kinematic gap between the low-energy measurements at ANKE-COSY and SATURNE and the high-energy measurements at the Relativistic Heavy Ion Collider, as well as the planned fixed-target experiments at the LHC. As for the possibility for NICA to operate

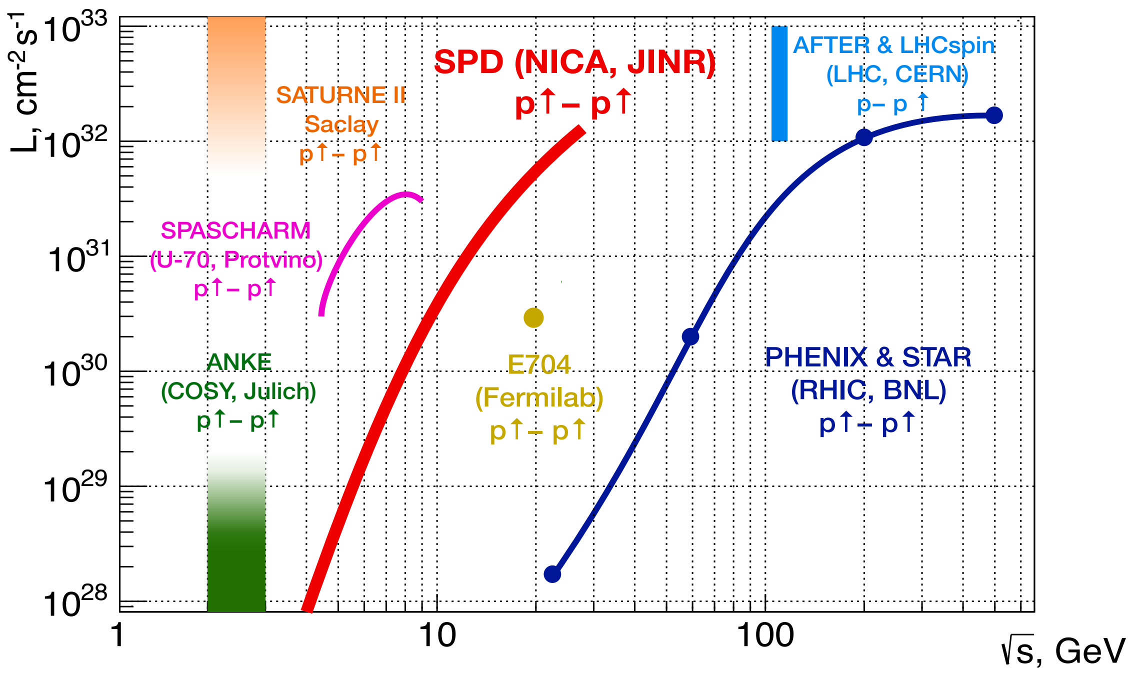

Fig 1. NICA SPD and the other past, present, and future experiments with polarized protons.

with polarized deuteron beams at such energies, it is unique.

SPD is planned to operate as a universal facility for comprehensive study of the unpolarized and polarized gluon content of the nucleon at large and moderate *x*, using different complementary probes such as: charmonia, open charm, and prompt photon production processes. The experiment aims at providing access to the gluon helicity, gluon Sivers, Boer-Mulders and other Transverse Momentum Dependent PDFs in the nucleon, as well as the gluon transversity distribution and tensor PDFs in the deuteron, via the measurement of specific single and double spin asymmetries. The results expected to be obtained by SPD will play an important role in the general understanding of the nucleon gluon 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). Simultaneous measurement of the same quantities using different processes at the same experimental setup is of key importance for minimization of possible systematic effects. Other polarized and unpolarized physics is possible, especially at the first stage of NICA operation with reduced luminosity and collision energy of the proton and ion beams. The proposed physics program covers at least 5 years of the SPD running.

Physic case

Quantum chromodynamics has a remarkable success in describing the high-energy and large-momentum transfer processes, where partons in hadrons behave, to some extent, as free particles and, therefore, the perturbative QCD approach can be used. Cross-section of a process in QCD is factorized into two parts: the process-dependent perturbatively-calculable short-distance partonic cross-section (the hard part) and universal long-distance functions, PDFs and FFs (the soft part). Nevertheless, a largest fraction of hadronic interactions involves low-momentum transfer processes in which the effective strong coupling constant is large and the description within a perturbative approach is not adequate. A number of (semi-)phenomenological approaches have been developed through the years to describe strong interaction in the non-perturbative domain starting from the very basic principles. They successfully describe such crucial phenomena, as the nuclear properties and interactions, hadronic spectra, deconfinement, various polarized and unpolarized effects in hadronic interaction, etc. The transition between the perturbative and non-perturbative QCD is also a subject of special attention. In spite of a large set of experimental data and huge experience in few-GeV region with fixed-target experiments worldwide, this energy range still attracts both experimentalists and theoreticians.

Gluons, together with quarks, are the fundamental constituents of the nucleon. They play a key role in generation of its mass and carry about half of its momentum in hard (semi)inclusive processes. The spin of the nucleon is also built up from the intrinsic spin of the valence and sea quarks (spin-1/2), gluons (spin-1), and their orbital angular momenta. Notwithstanding the progress achieved during the last decades in the understanding of the quark contribution to the nucleon spin, the gluon sector is much less developed. One of the difficulties is the lack of the direct probes to access gluon content in high- energy processes. While the quark contribution to the nucleon spin was determined quite precisely in semi-inclusive deep-inelastic scattering (SIDIS) experiments like EMC, HERMES, and COMPASS, the gluon contribution is still not well-constrained even so it is expected to be significant.

	Unpolarized	Circular	Linear
Unpolarized	g(x) density		$h_1^{\perp g}(x, k_T)$ Boer-Mulders function
Longitudinal		$\Delta g(x)$ helicity	Kotzinian-Mulders function
Transverse	$\Delta_N^g(x, k_T)$ Sivers function	Worm-gear function	$\Delta_T g(x)$ transversity (deuteron only), pretzelosity

Tab 1 Leading order TMD PDFs.

In recent years, the three-dimensional partonic structure of the nucleon became a subject of a careful study. Precise mapping of three-dimensional structure of the nucleon is crucial for our understanding of Quantum Chromodynamics (QCD). One of the ways to go beyond the usual collinear approximation is to describe nucleon content in the momentum space employing the so-called Transverse-Momentum-Dependent Parton Distribution Functions (TMD PDFs) [1–6] (see Tab. 1).

The most powerful tools to study TMD PDFs are the measurements of the nucleon spin (in)dependent azimuthal asymmetries in SIDIS [1, 4, 5, 7] and Drell–Yan processes [8, 9]. Complementary information on TMD fragmentation process, necessary for the interpretation of SIDIS data, is obtained from e^+e^- measurements [10]. Being an actively developing field, TMD physics triggers a lot of experimental and theoretical interest all over the world, stimulating new measurements and developments in TMD extraction techniques oriented on existing and future data from lepton-nucleon, electron-positron and hadron-hadron facilities at BNL, CERN, DESY, FNAL, JLab, and KEK. For recent reviews on experi- mental and theoretical advances on TMDs see Refs. [11–15]. While a lot of experimental measurements were performed (and are planned) and theoretical understanding was achieved for Leading Order (LO) (twist-2) TMD PDFs such as Sivers, transversity and Boer-Mulders functions of quarks, only few data relevant for the study of gluon TMD PDFs are available [16–21]. Example of the global fit results for the gluon Sivers function is presented in Fig. 3.

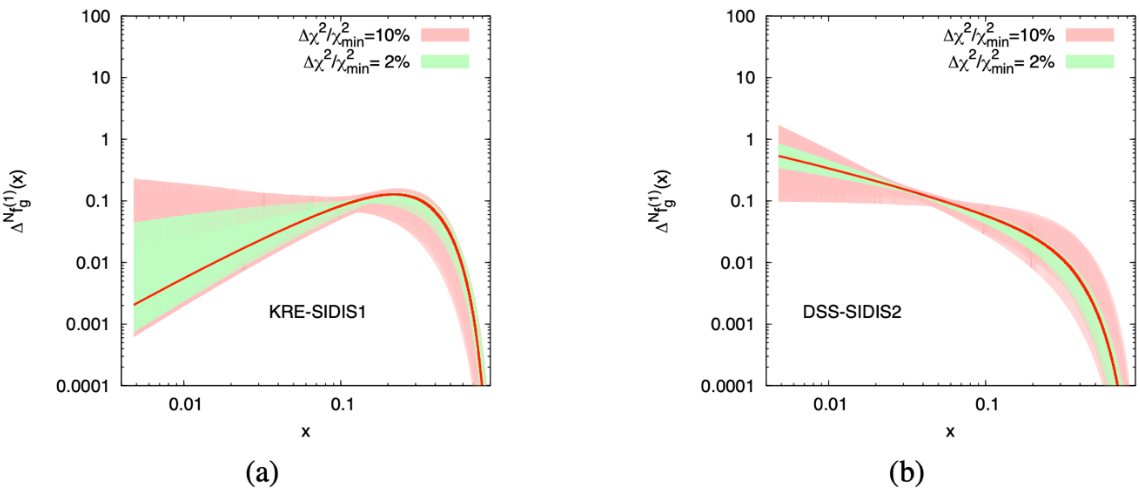

Fig. 2 The first k_T-moment of the gluon Sivers function for two different extractions of the quark Sivers functions.

The simplest model of the deuteron is a weakly-bound state of a proton and a neutron mainly in the S-wave with a small admixture of the D-wave state. This approach is not much helpful in the description of the deuteron structure at large Q^2. It failed to describe the HERMES experimental results on the b_1 structure function. A unique possibility to operate with polarized deuteron beams brings us to the world of the tensor structure of the deuteron. A possible non-baryonic content in the deuteron could play an important role in the understanding of the nuclear modification of PDFs (the EMC effect). Since the gluon transversity operator requires two-unit helicity-flip it does not exist for spin-1/2 nucleons [22]. Therefore, proton and neutron gluon transversity functions can not contribute directly to the gluon transversity of the deuteron. A non-zero deuteron transversity could be an indication of a non-nucleonic component or some other exotic hadronic mechanisms within the deuteron.

Most of the existing experimental results on spin-dependent gluon distributions in nucleon are obtained in the experiments at DESY (HERMES), CERN (COMPASS), and BNL (STAR and PHENIX). Study of polarized gluon content of the proton and nuclei is an important part of future projects in Europe and the United States such as AFTER@LHC and LHCSpin at CERN, and EIC at BNL [23–25]. Notwithstanding, the gluons in nucleon were successfully probed in SIDIS measurements, hadronic collisions have an important advantage since they probe the gluons at the Born-level without involving the EM couplings.

The detailed description of the physics tasks that will be addressed at SPD could be found at [26-28].

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Proposed measurements

The polarized gluon content of proton and deuteron at intermediate and high values of the *x-variable* is proposed to be investigated at SPD using three complementary dedicated probes: inclusive production of charmonia, open charm (both via gluon-gluon fusion gg→ccbar), and prompt photons qg→qγ (see Fig. 3). Study of these processes is complementary to such proven approaches to access the partonic structure of the nucleon in hadronic collisions as the inclusive production of hadrons with high transverse momentum and the Drell-Yan process. Unfortunately, the latter one is unlikely to be accessible at SPD due to the small cross-section and unfavourable background conditions. For effective registration of each aforementioned gluon probes, the SPD setup is planned to be equipped with a range (muon) system, an electromagnetic calorimeter, a time-of-flight system, straw tracker, and a silicon vertex detector. Nearly a 4π coverage of the setup and a low material

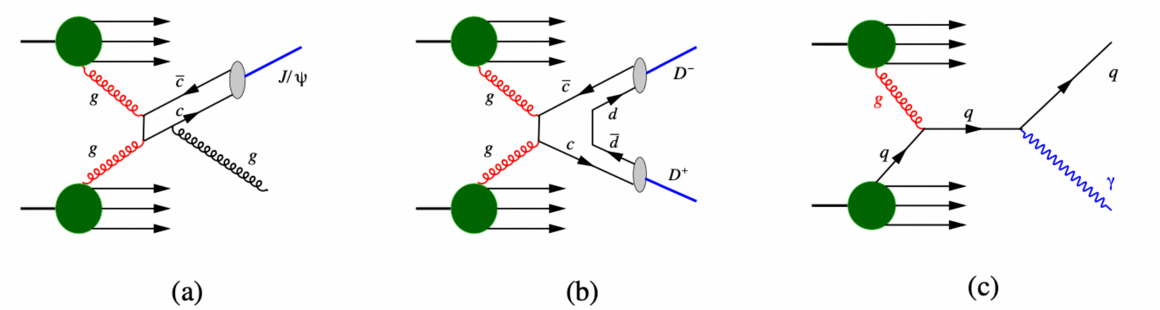

Fig. 3 Diagrams illustrating three probes to access the gluon content of proton and deuteron in po- larized collisions at NICA SPD: production of (a) charmonium, (b) open charm, and (c) prompt photons.

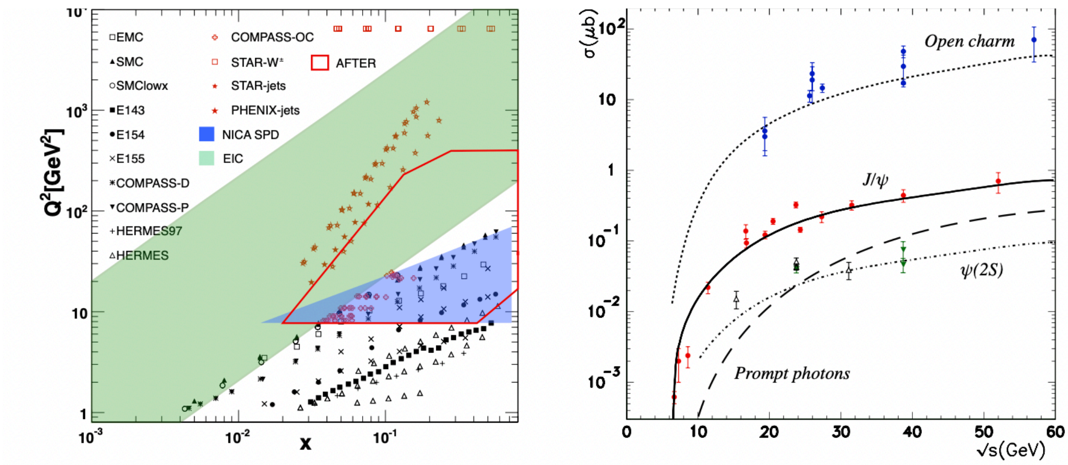

Fig. 4: (a) The kinematic coverage, in the (x, Q^2) plane, of the hadronic cross-section data for the processes commonly included in global QCD analyses of polarized quark (black) and gluon (red) PDFs. The kinematic domain expected to be covered by NICA SPD by charmonia, open charm and prompt-photon production is shown in blue. (b) The cross-section for the processes of open charm, *J*/ψ, ψ(2*S*) and prompt photons ($p_T > 3$ GeV) production as a function of center-of-mass energy.

budget in the inner part of the setup should provide a large acceptance for the detection of the desired final states.

Such gluon probe as inclusive production of neutral and charged pions and other light mesons, for which the $qg \rightarrow qg$ hard process dominates in a certain kinematic region and which have been successfully used to access the polarized gluon content of the proton at the RHIC experiments, can of course be used at SPD for this purpose. Registration of these processes does not impose additional specific requirements on the experimental setup and can be performed in parallel with the aforementioned main probes.

The experiment aims at providing access to the gluon helicity, gluon Sivers, Boer-Mulders functions, and other TMD PDFs in the proton and deuteron via the measurement of specific single and double spin asymmetries. Tensor asymmetries measured in polarized d-d collisions will be used to access the tensor PDFs for quarks and gluons. At the first stage of SPD operation in a basic configuration with a reduced beam energy and luminosity the attention will be paid to study of polarized and unpolarized phenomena in the nonperturbative region such as spin effects in p-p and d-d scattering, multiquark states and correlations, polarization of hyperons, hypernuclei, short-range correlations in collisions of light ions (up to Ca) etc.

A tentative running plan of the SPD experiment is presented in Tab. 2.

Physics goal	Required time	Experimental conditions
First stage		
Spin effects in p-p scattering dibaryon resonanses	0.3 year	$p_{L,T}$-$p_{L,T}$, $\sqrt{s}$ <7.5 GeV
Spin effects in d-d scattering hypernuclei	0.3 year	d_{tensor}-d_{tensor}, $\sqrt{s}$ <7.5 GeV
Hyperon polarization, SRC, ... multiquarks	0.3 year	ions up to Ca
Second stage		
Gluon TMDs, SSA for light hadrons	1 year	p_T-p_T, $\sqrt{s}$ =27 GeV
TMD-factorization test, SSA, charm production near threshold, onset of deconfinment, $\bar{p}$ yield	1 year	p_T-p_T, 7 GeV< $\sqrt{s}$ <27 GeV (scan)
Gluon helicity, ...	1 year	p_L-p_L, $\sqrt{s}$ =27 GeV
Gluon transversity, non-nucleonic structure of deuteron, "Tensor porlarized" PDFs	1 year	d_{tensor}-d_{tensor}, $\sqrt{s_{NN}} = 13.5$ GeV or/and d_{tensor}-p_T, $\sqrt{s_{NN}} = 19$ GeV

Tab. 2: Tentative running plan of the SPD experiment.

The physics goals dictate the layout of the detector. The SPD experimental setup (see Fig. 5) is being designed as a universal 4π detector with advanced tracking and particle identification capabilities based on modern technologies. The silicon vertex detector (VD) will provide resolution for the vertex position on the level of below 100 μm needed for reconstruction of secondary vertices of *D*-meson decays. The straw tube-based tracking system (ST) placed within a solenoidal magnetic field of up to 1 T at the detector axis should provide the transverse momentum resolution about 2% for a particle momentum of 1 GeV/*c*. The time-of-flight system (PID) with a time resolution of about 60 ps will provide 3σ π/*K* and *K*/*p* separation of up to about 1.2 GeV/*c* and 2.2 GeV/*c*, respectively. Possible use of the aerogel-based Cherenkov detector could extend this range. Detection of photons will be provided by the sampling electromagnetic calorimeter (ECal) with the energy resolution ~ 5%/√E. To minimize multiple scattering and photon conversion effects for photons, the detector material will be kept to a minimum throughout the internal part of the detector. The muon (range) system (RS) is planned for muon identification. It can also act as a rough hadron calorimeter. The beam-beam counters (BBC) and zero-degree calorimeters placed on both sides of the interaction region will be responsible for the local polarimetry and luminosity control. To minimize possible systematic effects, SPD will be equipped with a triggerless DAQ system. A high collision rate (up to 4 MHz) and a few hundred thousand detector channels pose a significant challenge to the DAQ, online monitoring, offline computing system, and data processing software.

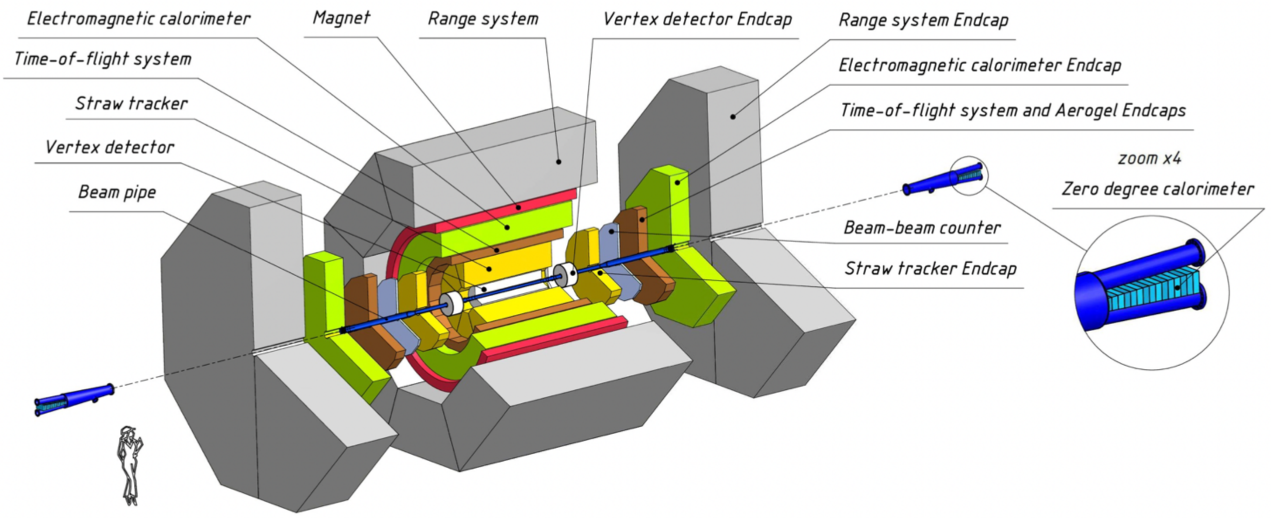

Figure 5 Layout of the SPD experimental setup.

The SPD operation could be started already in 2028 using the possibilities of polarized p-p and d-d collisions at √s<9.4 GeV and <4.5 GeV/nucleon, respectively, as well as A-A collisions. The starting configuration should consist of the range system, solenoidal magnet, straw tube-based tracking system, and the pair of zero-degree calorimeters and beam-beam counters. A simple micromegas-based central tracker will be installed in the central region instead of the sophisticated silicone vertex detector to keep the reasonable momentum resolution. The detailed description of the SPD setup can be found at [1].

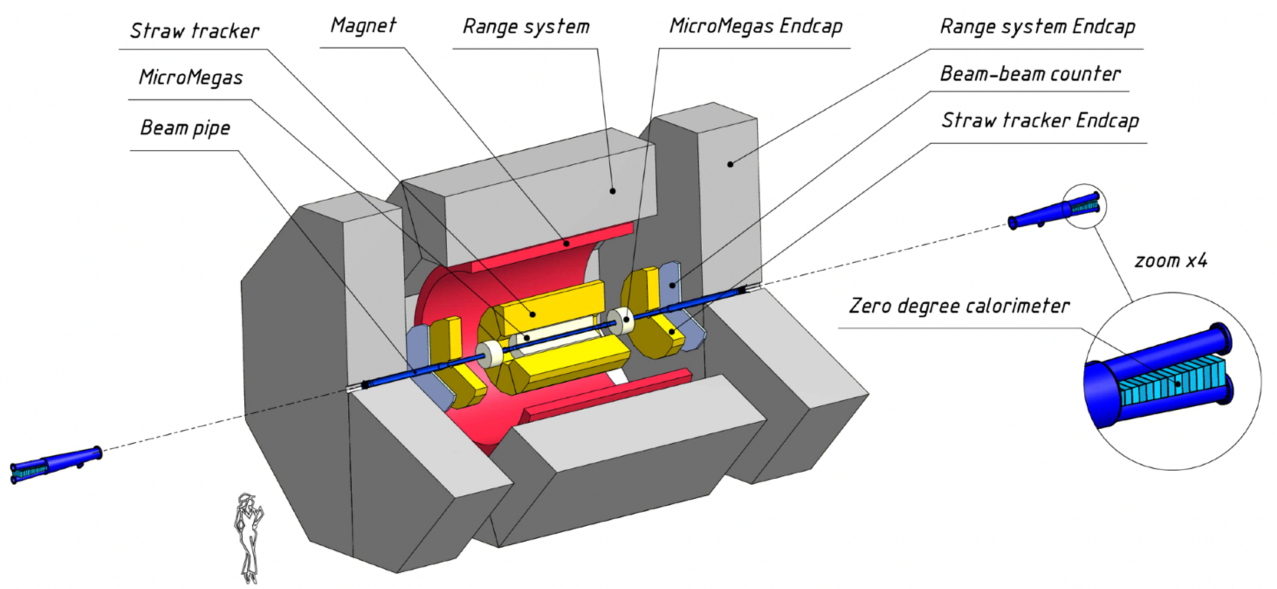

Figure 6. First-stage configuration of the SPD setup.

References

[1] SPD collaboration, Technical Design Report, 2022

The preliminary work plan for the SPD project is as follows:

- 2022: R&D for the main components of the SPD including infrastructure and computing. Tests of the detectors, electronics, DAQ and infrastructure with the Nuclotron beam at the SPD test zone. Presentation of the preliminary version of the Technical Project. Discussion of the Technical Project with the SPD Detector Advisory Committee.
- **2023: R&D for the main components of the SPD. Tests of the detectors, electronics, DAQ and infrastructure with the Nuclotron beam at the SPD test zone. Finalization of the technical project for the initial configuration of the SPD setup. Preparation to the production of the main SPD setup components (magnetic system, straw tracker, range system etc.) and corresponding infrastructure. Preparation of the SPD experimental hall infrastructure;**
- **2024-2025: Production of the SPD setup components for the first phase of the experiment: range system, magnet, straw tracker, micromegas detector, ZDC, and BBC. Work on DAQ, slow control and distributed computing infrastructure. Continuation of the R&D for the detectors of the second phase: ECAL, ToF, aerogel detector, and silicon vertex detector.**
- 2026-2027: Installation and commissioning of the magnetic system. Construction of the first-phase SPD configuration.
- 2028: Beginning of the SPD operation in its basic configuration.

Human resources

	Name	Laboratory	FTE	Activity
1	Abazov V.M.	DLNP	0.3	Range system
2	Afanasyev L.G	DLNP	1	DAQ
3	Akhunzyanov R.R.	VBLHEP	1	Physics / MC
4	Alexakhin V.Yu.,	VBLHEP	0.3	Physics / MC
5	Alexeev G.D.	DLNP	0.5	Range system
6	Anikin I.V.	BLTP	0.2	Physics / theory
7	Anosov V.A.	VBLHEP	1	Engineer
8	Azorskiy N.I.	VBLHEP	0.3	Ecal
9	Baldin A.A.	VBLHEP	0.7	Test zone
10	Baldina E.G.	VBLHEP	0.5	Test zone
11	Barabanov M.Yu.	VBLHEP	0.2	Physics / MC
12	Bautin V.V.	VBLHEP	0.5	Straw tracker
13	Belova A.P.	DLNP	1	Computing & software
14	Belyaev A.V.	VBLHEP	0.5	Test zone/ MC
15	Bleko V.V.	VBLHEP	0.5	Test zone
16	Bogoslovsky D.N.	VBLHEP	0.5	Test zone/ MCP
17	Boguslavsky I.V.	VBLHEP	0.5	Straw tracker-endcap, Test Zone
18	Buadze B.	DLNP	0.5	Micromegas
19	Burtsev V.E.	VBLHEP	0.5	Straw tracker
20	Chmil V.B.	VBLHEP	1	TOF
21	Datta A.	DLNP	1	Physics / MC
22	Dedovich D.V.	DLNP	0.5	Micromegas
23	Demichev M.A.	DLNP	0.5	Straw, electronics
24	Denisenko I.I.	DLNP	1	Physics / MC
25	Dunin V.B.	VBLHEP	0.2	Ecal
26	Enik T.L.	VBLHEP	0.7	Straw tracker
27	Fedorov A.N.	DLNP	0.2	Straw tracker
28	Filatov Yu.N.	VBLHEP	0.5	Polarized beams
29	Frolov V.N.	DLNP	0.7	DAQ
30	Gavrischuk O.P.	VBLHEP	0.7	ECAL
31	Galoyan A.S.	VBLHEP	0.5	Physics / MC
32	Goloskokov S.V.	BLTP	0.2	Physics / theory
33	Golovanov G.A.	DLNP	0.5	Range system
34	Golubykh S.M.	VBLHEP	0.7	ECAL
35	Goncharov P.V.	LIT	0.3	Computing & software
36	Gongadze A.	DLNP	0.5	Micromegas
37	Gridin A.O.	DLNP	0.5	Physics / MC
38	Gritsay K.I.	DLNP	0.5	DAQ
39	Gurchin Yu.V.	VBLHEP	0.5	BBC
40	Guskov A.V.	DLNP	0.7	Project leader
41	Gusakov Yu.V.	VBLHEP	0.3	Engineer
42	Ivanov A.V.	VBLHEP	1	Physics / MC
43	Ivanov N.Ya.	VBLHEP	0.5	Physics / theory
44	Isupov A.Yu.	VBLHEP	0.5	BBC/DAQ
45	Kambar Y.	VBLHEP	0.5	Straw tracker
46	Karpishkov A.V.	DLNP	1	Physics / theory
47	Kasianova E.A.	VBLHEP	0.5	Straw tracker
48	Kekelidze G.D.	VBLHEP	0.3	Straw tracker-endcap, Test Zone
49	Khabarov S.V.	VBLHEP	0.3	Vertex detector
50	Kharusov P.V	VBLHEP	0.5	Test zone/ MCP
51	Khrenov A.N.	VBLHEP	0.5	BBC, Test Zone
52	Klopot Ya.	BLTP	0.2	Physics / theory
53	Kokoulina E.S.	VBLHEP	0.2	Physics / MC
54	Komarov V.I.	DLNP	0.5	Physics / MC
55	Kopylov Yu.A.	VBLHEP	0.3	Vertex detector
56	Korovkin P.S.	VBLHEP	0.5	Test Zone/ MCP

57	Korzenev A.Yu.	VBLHEP	1	Technical coordinator
58	Kostukov E.V.	VBLHEP	0.5	Test Zone
59	Kovyazina N.A.	DLNP	0.5	Micromegas
60	Kozhin M.A.	VBLHEP	0.5	Physics / MC
61	Kramarenko V.A.	VBLHEP	0.5	Straw tracker-endcap, Test Zone
62	Kruglov V.N.	VBLHEP	0.5	Straw tracker-endcap, Test Zone
63	Kulikov A.V.	DLNP	1	DAQ
64	Kurbatov V.S.	DLNP	0.5	Physics / MC
65	Kurmanaliev Zh.	DLNP	1	Physics / MC
66	Kutuzov S.A.	DLNP	0.5	Range system
67	Ladygin E.A.	VBLHEP	0.5	Time-of-Flight system
68	Ladygin V.P.	VBLHEP	0.7	Deputy leader
69	Lapkin A.V.	DLNP	0.5	DAQ
70	Lebedev N.N.	DLNP	0.5	Range system
71	Lednicky R.	VBLHEP	0.2	Physics / theory
72	Livanov A.N.	VBLHEP	0.7	SPD hall coordinator
73	Lyashko I.	DLNP	0.5	Micromegas
74	Lysan V.M.	VBLHEP	0.5	Straw tracker-endcap, Test Zone
75	Makankin A.M.	VBLHEP	0.5	Straw tracker
76	Maltsev A.	DLNP	0.5	Physics / MC
77	Martovitsky E.V.	VBLHEP	0.5	Straw tracker
78	Minashvili I.	DLNP	0.5	Micromegas
79	Minko O.	VBLHEP	1	ECAL
80	Moshkovski I.V.	VBLHEP	1	Engineer
81	Nikiforov D.N.	VBLHEP	0.5	Cryogenics
82	Nagorny S.N.	VBLHEP	0.5	Time of Flight system
83	Nikitin V.A.	VBLHEP	0.2	Physics
84	Oleynik D.A.	LIT	0.5	Computing & software
85	Onuchin V.A.	DLNP	1	Computing
86	Ososkov G.A.	LIT	0.3	Computing & software
87	Parsamyan B.	DLNP	0.3	Physics / MC
88	Parzhitsky S.S.	VBLHEP	0.5	Straw tracker-endcap, Test Zone
89	Pelevanyuk I.S.	LIT	0.3	Computing & software
90	Pavlov V.V.	VBLHEP	0.5	Straw tracker-endcap, Test Zone
91	Perepelkin E.E.	VBLHEP	0.2	Magnetic system
92	Peshekhonov D.V.	VBLHEP	0.2	Physics
93	Petrosyan A.Sh.	LIT	0.5	Computing
94	Piskun A.A.	DLNP	0.5	Range system
95	Podgainy D.V.	LIT	0.3	Computing
96	Popov V.V.	VBLHEP	0.3	Physics / MC
97	Prokhorov I.K.	DLNP	0.5	DAQ
98	Pudin S.I.	VBLHEP	0.7	ECAL
99	Reznikov S.G.	VBLHEP	0.5	BBC, Test Zone
100	Rezvaya E.P.	DLNP	1	Computing & software
101	Rogacheva N.S.	VBLHEP	0.5	Physics / MC
102	Rymbekova A.	DLNP	1	Physics / MC
103	Safonov A.B.	VBLHEP	0.5	Test Zone
104	Salamatin K.M.	VBLHEP	0.5	Straw tracker
105	Saleev V.A.	BLTP	1	Physics / theory
106	Samartsev A.G.	DLNP	0.5	Range system
107	Savenkov A.A.	VBLHEP	0.3	Straw tracker-endcap, Test Zone
108	Sheremeteva A.I.	VBLHEP	0.3	Vertex detector
109	Shimanskii S.S.	VBLHEP	0.5	ZDC/Physics
110	Shipilova A.V.	DLNP	1	Physics / theory
111	Shtejer K.	DLNP	1	Physics / MC
112	Skachkova A.N.	DLNP	0.5	Physics / MC
113	Starikova S.Yu.	VBLHEP	0.5	Test Zone
114	Streletskaya E.A.	VBLHEP	0.3	Vertex detector
115	Strusik-Kotlozh D.	BLTP	0.5	Physics / theory
116	Sukhovarov S.I.	VBLHEP	0.5	Engineer

117	*Tarasov O.G.*	*VBLHEP*	*0.3*	Vertex detector / straw tracker
118	*Terekhin A.A.*	*VBLHEP*	*0.5*	*BBC, Test Zone*
119	*Tereschenko V.V.*	*DLNP*	*0.5*	DAQ
120	*Teryaev O.V.*	*VBLHEP/BLTP*	*0.4*	Physics / theory
121	*Tishevski A.V.*	*VBLHEP*	*0.5*	BBC
122	*Tkachenko A.*	*DLNP*	*1*	Computing & software
123	*Tokmenin V.V.*	*DLNP*	*0.5*	*Range system*
124	*Topilin N.D.*	*VBLHEP*	*0.2*	*Engineer*
125	*Topko B.L.*	*VBLHEP*	*0.3*	Vertex detector
126	*Trofimov V.V.*	*LIT*	*0.2*	Computing & software
127	*Troyan Yu.A.*	*VBLHEP*	*0.5*	Test zone
128	*Usenko E.A.*	*VBLHEP*	*0.5*	Time-of-Flight system
129	*Uzikov Yu.N.*	*DLNP*	*0.7*	Physics / theory
130	*Uzhinsky V.V.*	*LIT*	*0.5*	Physics / MC
131	*Vasilieva E.V.*	*VBLHEP*	*0.5*	Straw tracker-endcap, Test Zone
132	*Verkheev A.Yu*	*DLNP*	*0.3*	Range system
133	*Vertogradov L.S.*	*DLNP*	*0.5*	Range system
134	*Vertogradova Yu.L.*	*DLNP*	*0.5*	Range system
135	*Volchansky N.I.*	*BLTP*	*0.2*	Physics / theory
136	*Volkov I.S.*	*VBLHEP*	*0.5*	*BBC, Test Zone*
137	*Volkov P.V.*	*VBLHEP*	*0.5*	Straw tracker-endcap, Test Zone
138	*Yudin I.P.*	*VBLHEP*	*0.2*	Magnetic system
139	*Zuev M.I.*	*LIT*	*0.5*	Computing & software
140	*Zamyatin N.I.*	*VBLHEP*	*0.5*	Vertex detector
141	*Zel V.V*	*DLNP*	*0.5*	Range system
142	*Zemlyanichkina E.V.*	*VBLHEP*	*0.5*	Physics / MC
143	*Zhabitsky M.V.*	*DLNP*	*1*	Computing & software
144	*Zhemchugov A.S.*	*DLNP*	*0.5*	Computing & software
145	*Zhukov I.A.*	*VBLHEP*	*0.5*	Straw tracker-endcap, Test Zone
146	*Zhuravlev N.I.*	*DLNP*	*0.5*	Range system
147	*Zinin A.V.*	*VBLHEP*	*0.5*	Straw tracker-endcap, Test Zone
148	*Zubarev E.V.*	*VBLHEP*	*0.3*	Vertex detector
		VBLHEP	*41.3*	
		DLNP	*31.2*	
		LIT	*3.4*	
		BLTP	*2.5*	
	TOTAL		*78.4*	

Form No. 26

Schedule proposal and resources required for the implementation of the Project

SPIN PHYSICS DETECTOR (SPD) AT THE NICA COLLIDER

<table>
<tr><td colspan="3" rowspan="2">Expenditures, resources, financing sources</td><td rowspan="2">Costs (k$)
Resource requirements</td><td colspan="3">Proposals of the Laboratory on the distribution of finances and resources</td></tr>
<tr><td>1st year</td><td>2nd year</td><td>3rd year</td></tr>
<tr><td colspan="2" rowspan="3">Expenditures, $</td><td>Main units of equipment, work towards its upgrade, adjustment etc.</td><td>6750</td><td>450</td><td>3700</td><td>2600</td></tr>
<tr><td>Construction/repair of premises</td><td>800</td><td>100</td><td>500</td><td>200</td></tr>
<tr><td>Materials</td><td>32650</td><td>400</td><td>17 300</td><td>14 700</td></tr>
<tr><td>Required resources</td><td>Standard hour</td><td>Resources of
– Laboratory design bureau;
– JINR Experimental Workshop;
Laboratory experimental facilities division;
– accelerator;
– computer.
Operating costs.</td><td>45 MCPU*h
Nuclotron, h
900</td><td>10

300</td><td>15

300</td><td>20

300</td></tr>
<tr><td rowspan="2">Financing sources</td><td>Budgetary resources</td><td>Budget expenditures including foreign-currency resources.</td><td>1350</td><td>1350</td><td>22 000</td><td>18 000</td></tr>
<tr><td>External resources</td><td>Contributions by collaborators.
Grants.
Contributions by sponsors.
Contracts.
Other financial resources, etc.</td><td>250</td><td>50</td><td>100</td><td>100</td></tr>
</table>

PROJECT LEADER

Form No. 29

Estimated expenditures for the Project

SPIN PHYSICS DETECTOR (SPD) AT THE NICA COLLIDER

	Expenditure items	Full cost	1st year	2nd year	3rd year…
	Direct expenses for the Project				
1.	Nuclotron, h	900	300	300	300
2.	Computers (M CPU*h)	45	10	15	20
3.	Computer connection, k$				
4.	Design bureau, norm*h	45000	10000	15000	20000
5.	Experimental Workshop, norm*h				
6.	Materials	32 650 k$	450 k$	17 400k$	14 800k$
7.	Equipment	6 750 k$	450 k$	3 700 k$	2 600 k$
8.	Construction/repair of premises	800 k$	100 k$	500 k$	200 k$
9.	Payments for agreement-based research	920 k$	240 k$	340 k$	340 k$
10.	Travel allowance, including: a) non-rouble zone countries b) rouble zone countries c) protocol-based	480 k$ 360 k$ 90 k$ 30 k$	160 k$ 120 k$ 30 k$ 10 k$	160 k$ 120 k$ 30 k$ 10 k$	160 k$ 120 k$ 30 k$ 10 k$
	Total direct expenses	41 600$	1 400$	22100k$	18100k$

PROJECT LEADER

LABORATORY DIRECTOR

LABORATORY CHIEF ENGINEER-ECONOMIST

SWAT analysis

STRENGTHS

- The experience of the JINR team in spin and hadronic physics at similar energies at home projects and experiments in the world's leading laboratories;
- The JINR team has technologies to produce and experience to operate the most of the subdetectors like ECAL, Straw tracker, Range System;
- There is a good groundwork for the establishing of the International collaboration.

WEAKNESSES

- Critical dependence on the development of the polarized infrastructure for NICA;
- Dependence on foreign technology and equipment.

OPPORTUNITIES

- Possibility to perform excellent measurements complimentary to the planned studies at such projects as EIC and the polarized fixed-target projects at LHC.

THREATS

- High cost of the experimental setup can prevent to the full implementation of the proposed plans.
- Political situation in the world.