



Status of the SPD first phase physics

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IX SPD Collaboration meeting in Armenia

SPD First Stage Physics Group

- Group was organized in September 2024.
- **Goals of the group:**
 - 1) Understand what exactly we have right now for the 1st SPD phase in terms of ideas, motivation of institute groups, effort expended, humanpower.
 - 2) Organize the effort (dedicated meetings, discussions/workshops, publications).
 - 3) Provide expertise and accelerate obtaining expected results using realistic conditions of SPD during 1st phase (beam mode, particles, energies; detector setup etc).
 - 4) Formulate the motivated request(s) to acceleration team, detector people from the physics group.
- **Intermediate result of this year** will be a comprehensive document, summarizing all realistic measurements for the 1st SPD phase, which are elaborated enough within the collaboration to provide some expectations (event counts, necessary integrated luminosities, etc).

Starting points

In 2021 SPD released a [paper](#) with the review of the possible studies at SPD during the first phase.

This physics program is preliminary, which relied on the detector and beam setups planned at that time, however it is a good base that we already have.

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Possible Studies at the First Stage of the NICA Collider Operation with Polarized and Unpolarized Proton and Deuteron Beams

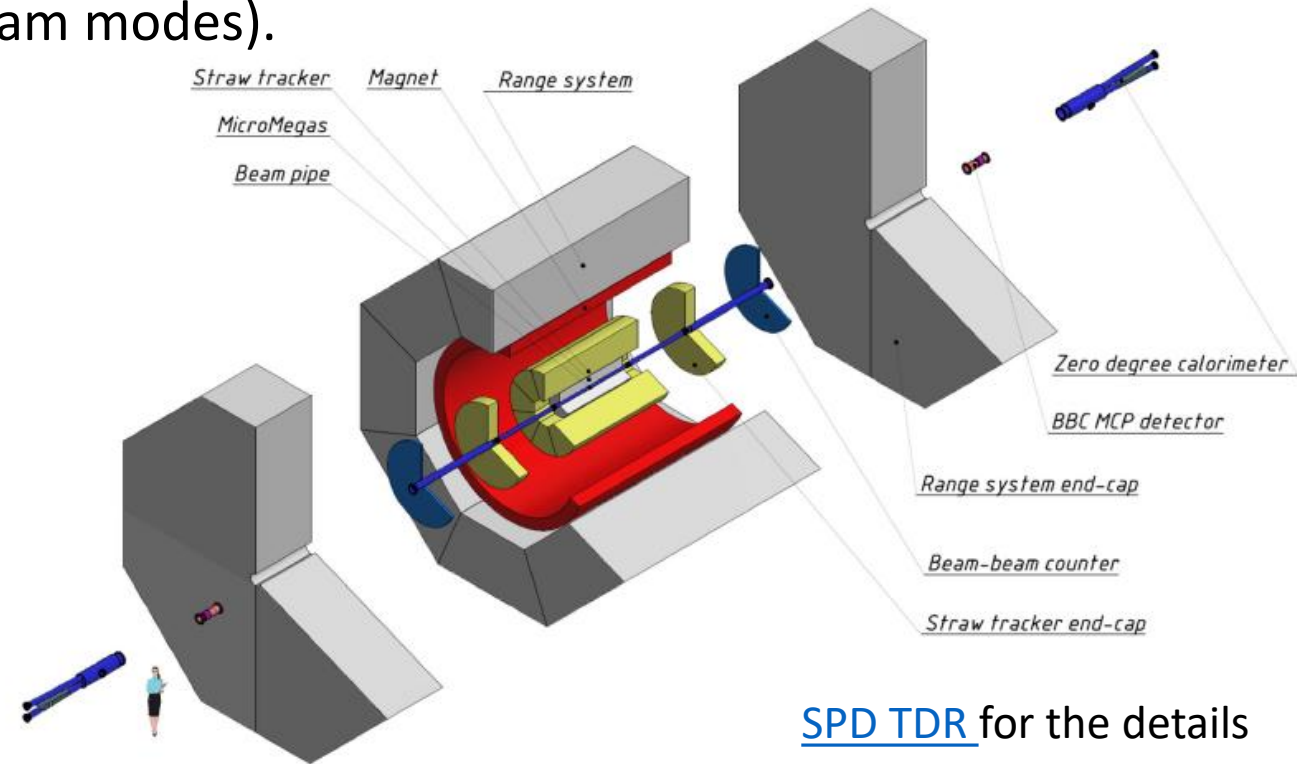
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N. N. Nikolaev^{p, z}, A. S. Popov^j, V. V. Polyanskiy^c, J.-M. Richard^q, S. G. Salnikov^j, A. A. Shavrin^r,
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Starting points: about the 1st phase

- 1st phase of SPD is planned for 2028 and its duration will be 2 years.
- The first stage will be devoted to the study of polarized and non-polarized phenomena at low energies and reduced luminosity using heavy ion (up to Ca) and polarized proton and deuteron beams (without asymmetric beam modes).

Minimum setup configuration is planned:

- *Straw tracker*
- *Micromegas*
- *Range system*
- *BBC*
- *ZDC*
- *Magnet*



[SPD TDR](#) for the details

- The absolute value of the beam polarization should be not less than 0.5 for protons and 0.6 for deuterons.
- Planned energy is up to $\sqrt{s} = 9.4$ GeV for protons and $E_{\text{tot}} = 4.5$ GeV/nucleon for deuterons. The corresponding luminosity is up to $10^{31} \text{ cm}^{-2} \text{ s}^{-1}$ and $10^{30} \text{ cm}^{-2} \text{ s}^{-1}$, respectively.

Meetings and communication

- Group meetings are held **biweekly on Tuesdays at 3pm Moscow time** under this [category](#).
- We had **10 topical meetings** of studies proposals for the first phase with one/two main presentations and discussion (typical attendance: 25-30 persons). Presentations contain the feasibility, significance and theoretical background of the study proposed, the status of the model, of MC samples. Also, they contain beam conditions and detector configuration, which is necessary for the study.
- We've collected formal proposals of the studies, which are planned to be done during 1st phase. At the moment we have **19 proposals** (details on the next slides).
- We had **1 [workshop](#)** with the detailed discussion of institute groups proposals.

Proposals collecting

- In February-March we've announced a call for proposals of physics studies to be done during the 1st stage
- Form was broadcasted. It includes brief information about the study: the abstract part, **general information**, **experimental requirements** and **expected performance**.

Observables:

Physics being addressed:

Theoretical motivation papers:

Competitiveness:

Complementarity:

Previous results:

Feasibility:

Importance:

Keywords:

Beam species:

Collision energy:

Luminosity:

Polarization:

Involved SPD subsystems:

Optimal duration of data taking:

Minimal duration of data taking:

Simulation information used:

Total statistics:

Statistical accuracy:

Main sources of systematics:

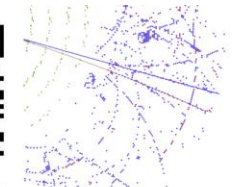
1st workshop “physics during the first SPD phase”

- People from the collaboration and beyond (~50 attendees)
- 5 minutes to present the proposal
- 10-15 minutes to discuss each proposal



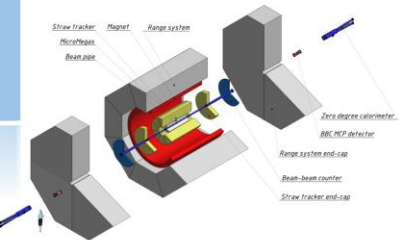
23.04.2025 Zoom only

We invite you for the discussion of existing elaborated SPD proposals



SPD first stage
physics workshop

физическое сотрудничество



zoom Workplace

Конференция

VB Эcran (Vladimir Baryshev)

Вход

Запись...

Звук оригинала для музыки

Участники (48)

Найти участника

ES Evgeny S... (Организатор, я)

VB Vladimir Baryshevsky

AB Alexander Bagulya

AK Alexander Korzenev

AG Alexandra Gurinovich

AL Alexei Larionov

AL Alexey Livanov

AD Amaresh Datta

AK Anatoly Kulikov

AG Andrei Gridin

AS Anishchenko Sergei

AS Anna Skachkova

A artem

BK Boris Kostenko

PowerPoint Slide Show - [Baryshevsky First Steps april 2025_fin] - PowerPoint

Stage 2: Beam-beam collisions at NICA

See the first slide. For measurement of beam polarization it would be useful to have the internal target station at the NICA ring.

Time interval T2 is convenient for effect measurement with the use internal target for polarization analysis

The minimal number of particles required for observation of the effect at acceptable signal-to-noise ratio is $N_{\min} > 1/\delta^2$, where $\delta = p_{zz}$ (detector efficiency is not considered).

In all the examples $N_{\text{particles}} \gg N_{\min}$

Figure 3.4: Cycle of the collider operation (design report)

Question: Is it possible to have internal target station at the

23/04/25

Звук

Видео

Участники 48

Чат

Отреagirовать

Поделиться

Инструменты организатора

Приложения

Сессия



- 14 proposals were discussed
- Slides and video of the workshop are [available](#)

Current status of proposals and summary

- Here is the summary of proposals received by us, which includes some comments about each of them.

Analysis	Submitter	Beam species	Polarization	E, GeV/u	L, 10 ³⁰	Duration, days	$\int L, 10^{35}$	Comments	Was presented on workshop?
Double φ	Berezhnoy/Dubinin	pp	desirable	5-13	10			No estimations with MC, no reco MC study	yes
Single φ	Berezhnoy 2	pp	desirable	5	10	3-120	30-1200	No problems, preliminary SPDRoot reco study exists	yes
Δ^{++}	Berezhnoy 3	pp		3.5-13	1-10	60-180	60-1800	No problems, preliminary SPDRoot reco study exists	yes
Elastic pp scattering	Berezhnoy 4	pp		3.5-13	1-10	21-60	21-600	No reco MC study, bad momentum resolution for small pt events	yes
Charmed baryons	Berezhnoy 5	pp	desirable	10	1	120	120	Absence of VD. We can try Protvino experimental technique	yes
Λ -pairs	Guskov	dd, pp	desirable	5-13	10	3-30	30-300	No problems, preliminary SPDRoot reco study exists	yes
Color transparency	Larionov	dd	desirable	7-8	2.7	7-42	20-180	No reco MC study. MC is not ready	yes
Centrality determination test	Larionova	lons		5-13	0.001			No MC reco study	yes
J/ ψ production	Larionova	lons, pp, dd		5-13	0.001-10	1-60	10-600	Impossible for ions during 1st phase, dd is possible	yes
Antiproton production	Reham El-Kholy	pp,dd		7-27	10	14-90	140-900	Not for phase1, since no PID for antiprotons	no

Current status of proposals and summary

Analysis	Submitter	Beam species	Polarization	E, GeV/u	L, 10 ³⁰	Duration, days	$\int L$, 10 ³⁵	Comments	Was presented on workshop?
Fluctons	Vechernin	dd		4-8	1	30-100	30-100	No MC model yet, no reco study	yes
Dichromism / spin precession	Baryshevsky	dd	yes	5-13	1-10	0.1	0.1-1	Recommend dedicated project?	yes
High-pT exotics	Kim	pp, dd		5-13	10	7-60	70-600	No reco MC study	yes
Dibaryons	Kurbatov	dd	desirable	5.5?	0.17	7-21	1.2-3.6	Under revision	no
Polarized SRC	Ladygin	dd	yes	<4.5	0.1	30-90	3-9	MC is not ready	no
Spin observables	Uzikov	dd	yes	2-6	0.05-10	3-30	0.15-300	MC is not ready, update will be shown by Amaresh on Thursday	yes
Dibaryons	Kostenko	dd		6-10	10	3	30	No estimations, no MC, only theoretical interest shown	yes
d*(2380) dibaryon resonance	Cyrkov	dd, pp		3.5-13	1-10	60-180	60-180	No detailed presentation, no reco MC	no
charged hadron/pi/K/p spectra	Nigmatkulov	lons, pp, dd		4-13	0.001-10	5-30	50-300	No detailed presentation, MC is not ready	no

- Most of the proposals are realistic and don't have major problems.
- Just **~3** of them are mature enough to have reconstruction level studies involving fool SPDRoot simulation.
- Only **3** of the proposals require polarization. Consider to require it on new proposals.
- Most of the proposals rely on MCT and ST subsystems. Just **3** of them require RS information and just **2** of them need ZDC information. Maybe it would be good to consider using more available subsystems in your proposals.

The call of proposals is still open!

Conclusions

- First half of year of the new SPD first stage physics group was quite fruitful:
 - We had 10 topical meetings with detailed presentation of proposals from the institute groups.
 - We've conducted the first workshop with detailed discussion of proposals with community beyond our collaboration.
 - Totally we've received ~20 physics proposals from institute groups, majority of them are realistic. However, there are a lot of them which are not elaborated enough.
 - The call of additional proposals is still open!

- We plan to work with the institute groups to provide help in order to develop their studies.

- Also, as a goal we will work on the document, summarizing all realistic measurements for the 1st SPD phase.

Back-up slides

Luminosities during the first phase

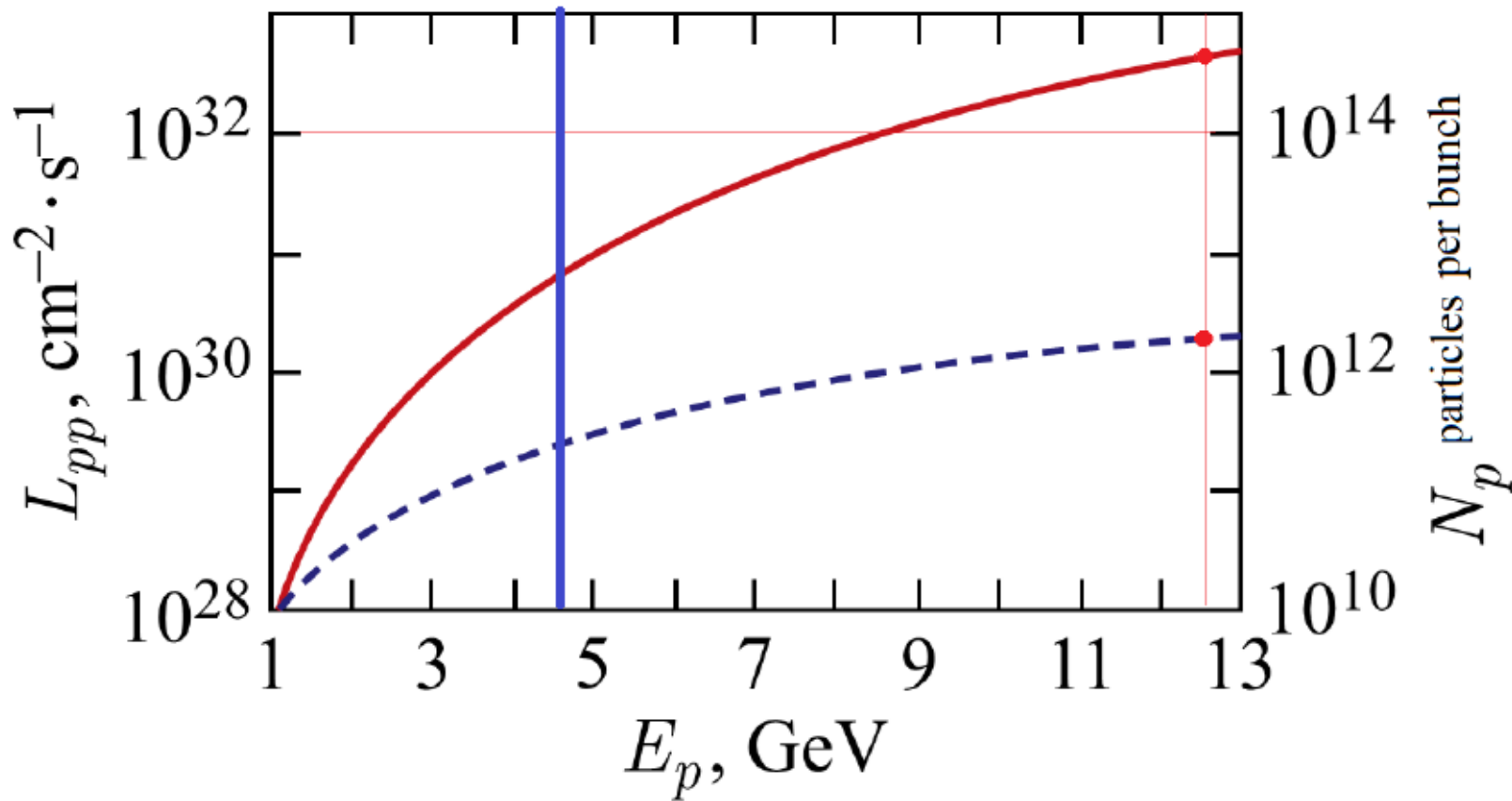
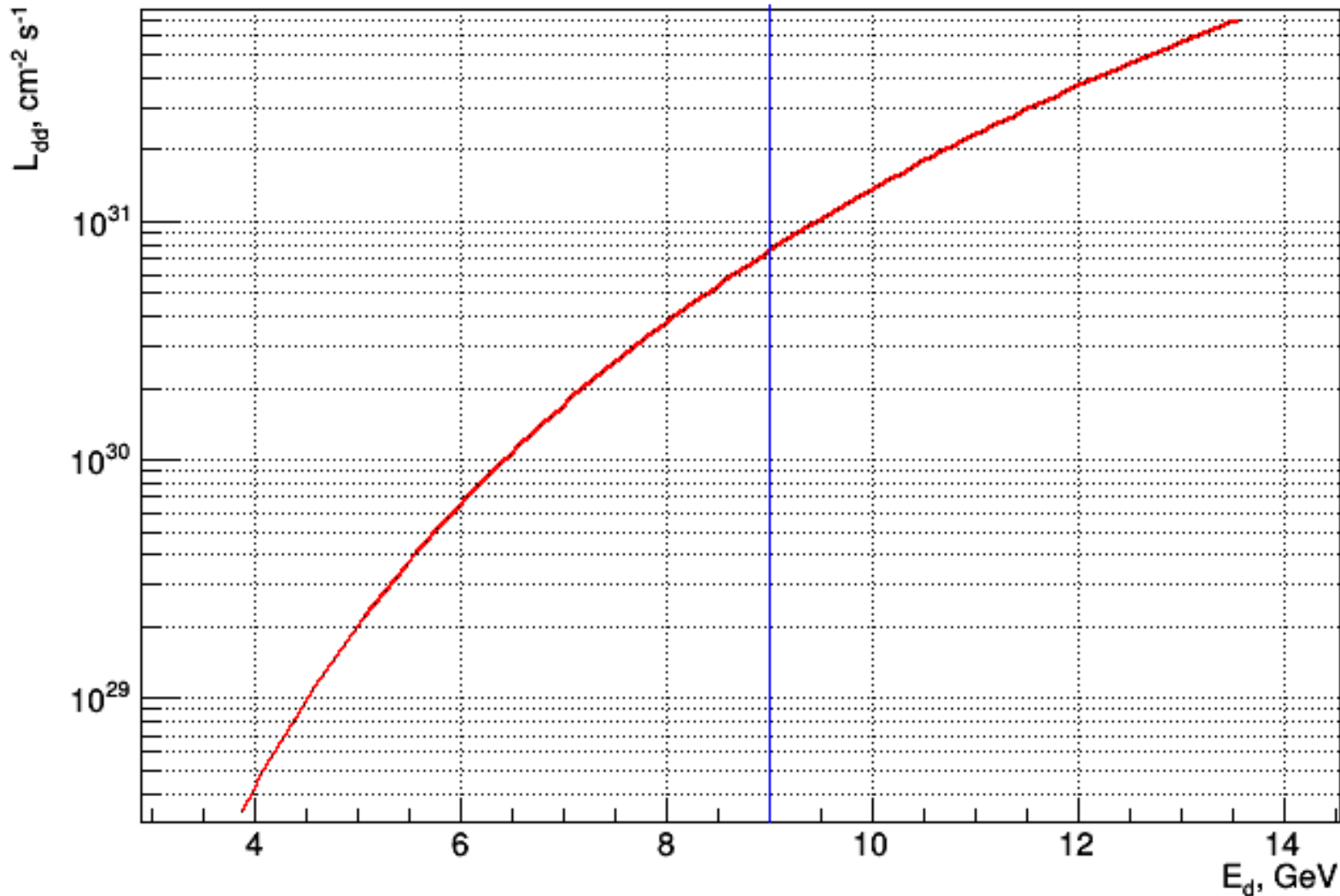


Figure 3.3: Normalized dependence of the luminosity L_{pp} (the red curve and the left scale) and the beam intensity N_p (the blue curve and the right scale) on the proton kinetic energy in the p - p collision [5].

- Blue vertical line on the plot is the maximal energy of p , which is possible during the 1st phase.

Luminosities during the first phase



- Blue vertical line on the plot is the maximal energy of d, which is possible during the 1st phase.
- As for **ion collisions**, we expect luminosity on the level of $10^{-27} \text{ cm}^{-2} \text{s}^{-1}$ and maybe up to $10^{-28} \text{ cm}^{-2} \text{s}^{-1}$ for very light nuclei like O or C.