



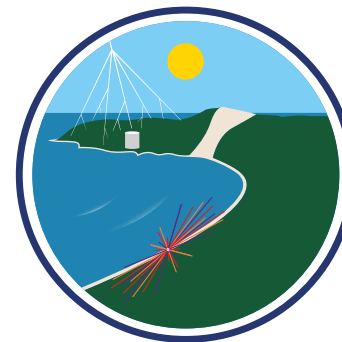
SPIN PHYSICS DETECTOR PROJECT AT NICA COLLIDER

Alexey Guskov

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on behalf of the SPD Collaboration**

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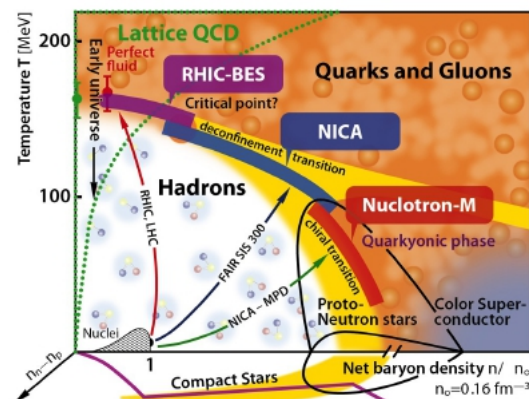
31.07.2026



ICHEP 2026
NATAL | BRAZIL

NICA facility at JINR

NICA (Nuclotron-based Ion Collider fAcility)

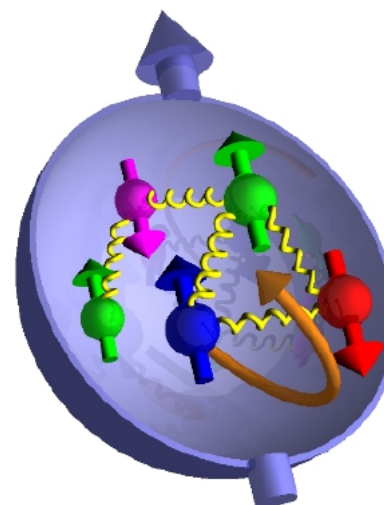


Stage 1

Hot hadronic matter in extremal conditions with heavy-ion beams

Stage 2

Proton and deuteron spin structure with polarized beams



Clean Room
(Detector Electronics)

BM@N (Detector)
Extracted beam

SPD
(Detector)

MPD
(Detector)

Collider

E-cooling

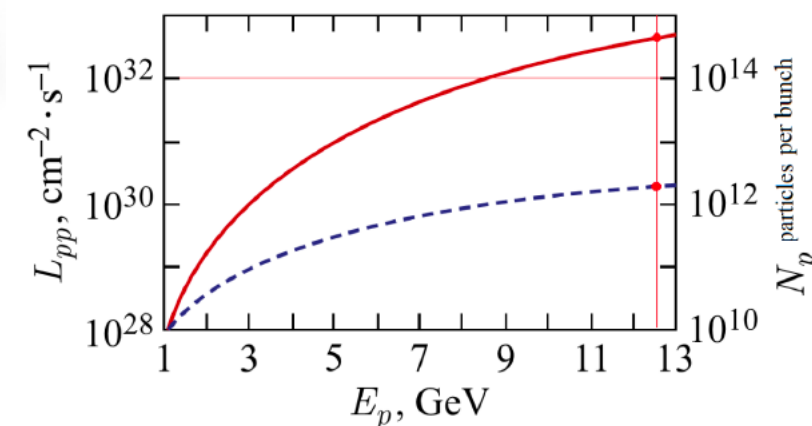
503 m

Polarized proton and deuteron beams:

$$p^\uparrow p^\uparrow : \sqrt{s} \leq 27 \text{ GeV}$$

$$d^\uparrow d^\uparrow : \sqrt{s} \leq 13.5 \text{ GeV}$$

$$U, L, T \quad |P| > 70\%$$



Internal target

Heavy Ion Linac

Ion source

LU-20

Booster

Nuclotron

Cryogenics

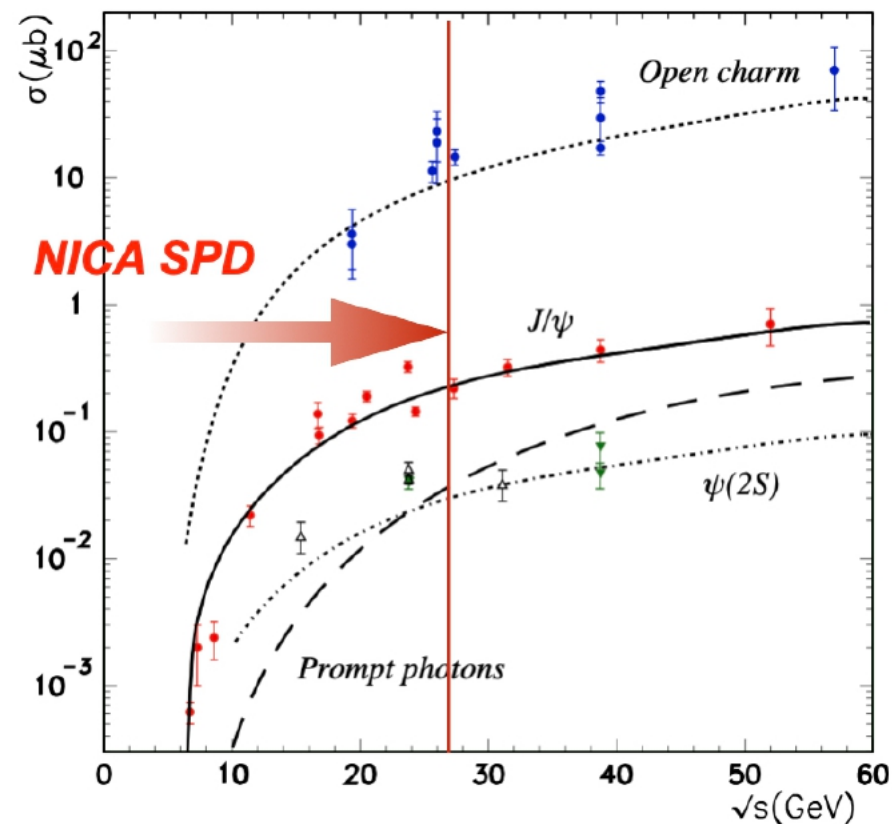
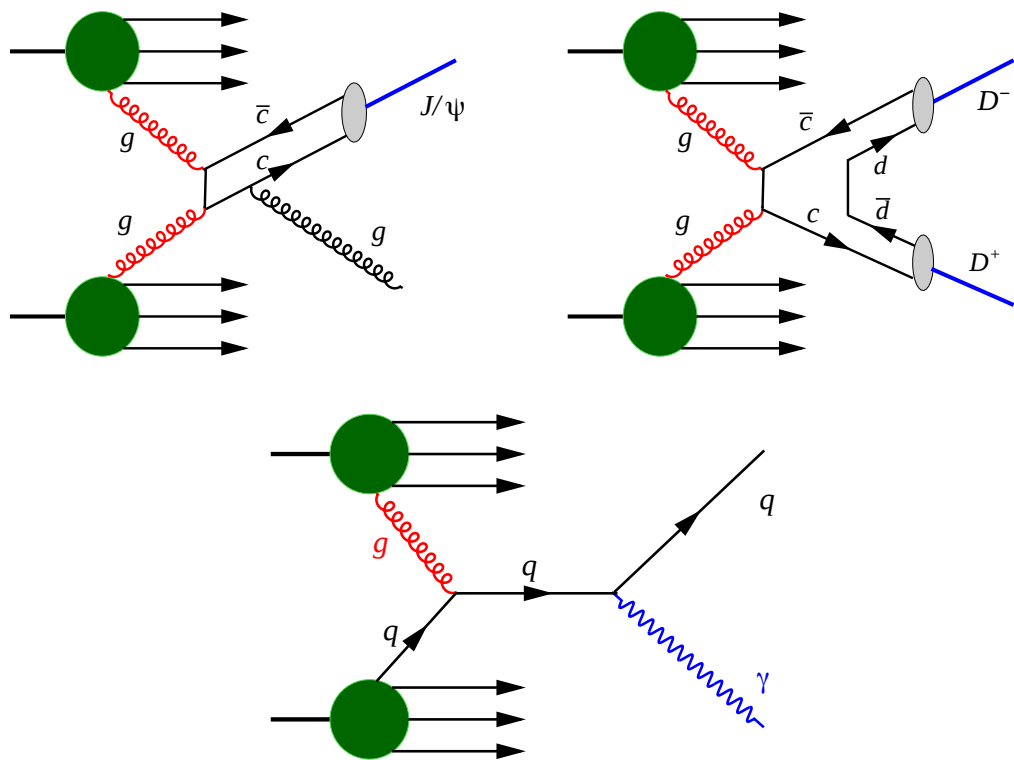
Magnet factory

NICA landscape



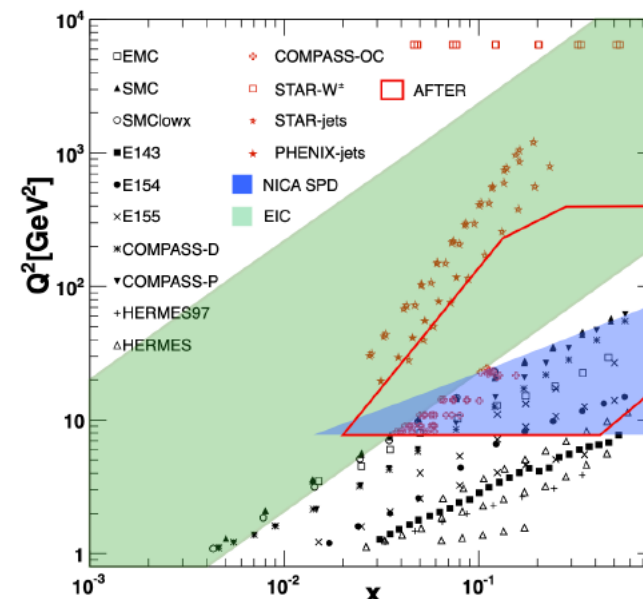
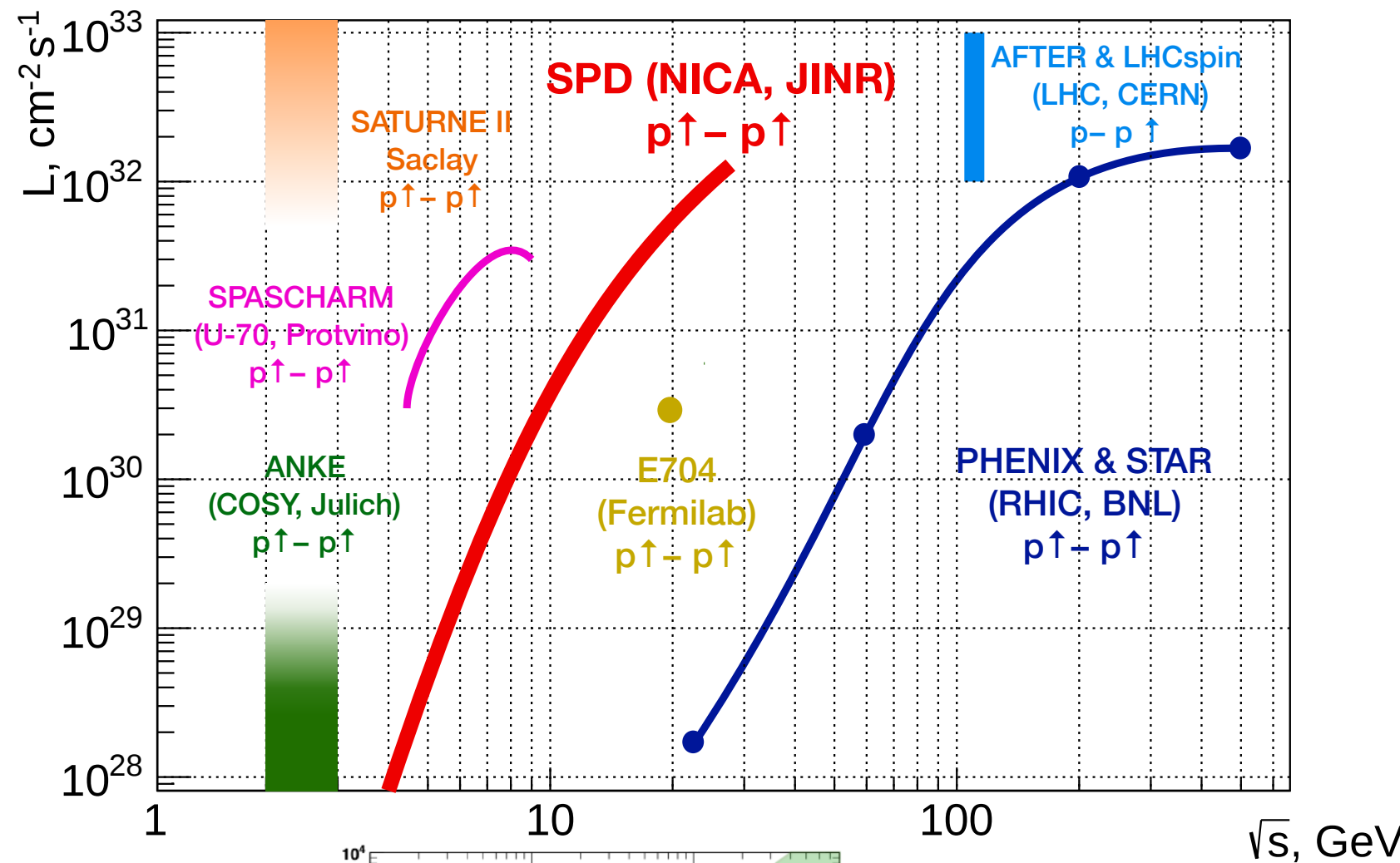
SPD and other polarized pp exps

Complimentary gluon probes



non-perturbative QCD

perturbative QCD



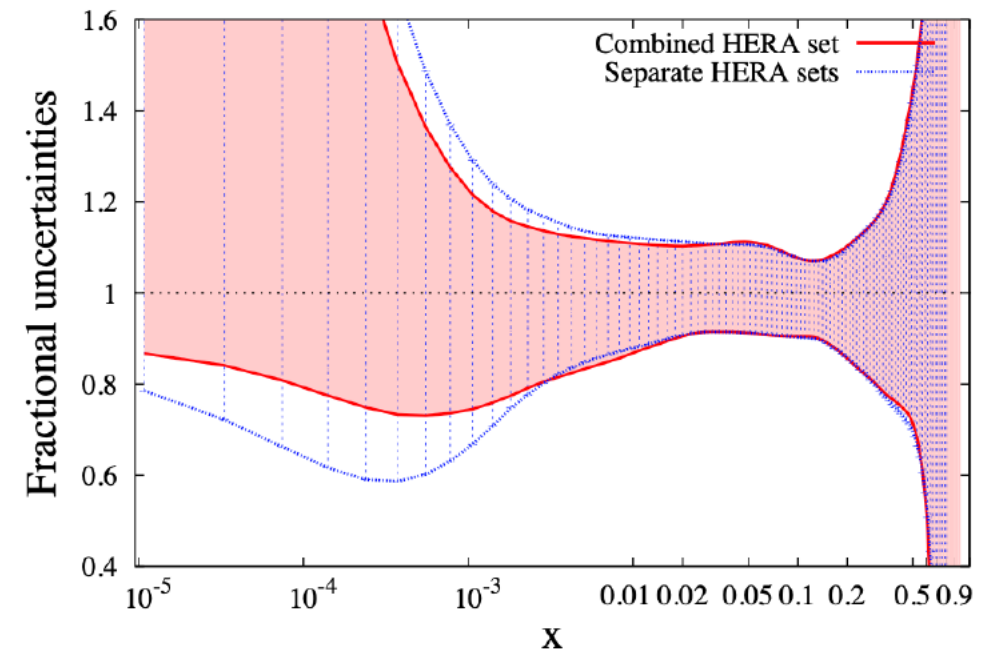
Partonic structure of proton

Nucleon Spin Polarization			
	U	L	T
U	f_1 Number Density		$f_{1T}^{q\perp}$ Sivers
L		g_{1L}^q Helicity	g_{1T}^q Worm-Gear T
T	$h_1^{q\perp}$ Boer-Mulders	h_L^q Worm-Gear L	h_1^q Transversity $h_{1T}^{q\perp}$ Pretzelosity

$$\sigma(x_F, p_T) \quad A_{LL}(x_F, p_T) \quad A_{TT}(x_F, p_T) \quad A_N(x_F, p_T)$$

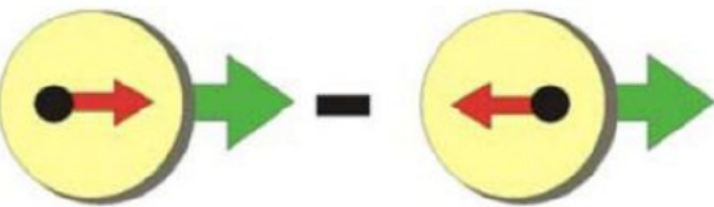
1) Unpolarized gluons in proton at high x :

$g(x, \mu)$ at $\mu = 2$ GeV

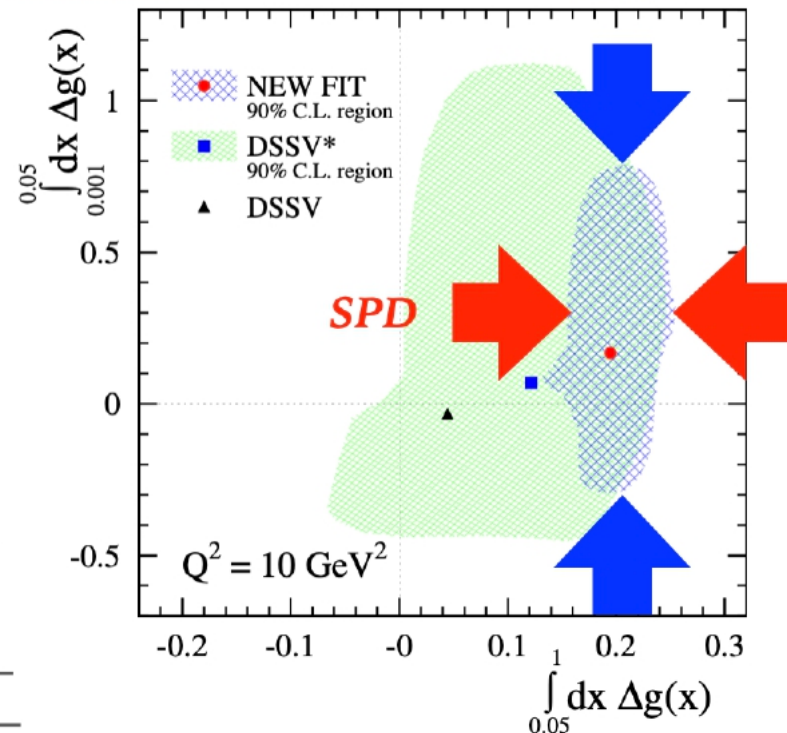


Spin crisis:

2) Gluon helicity



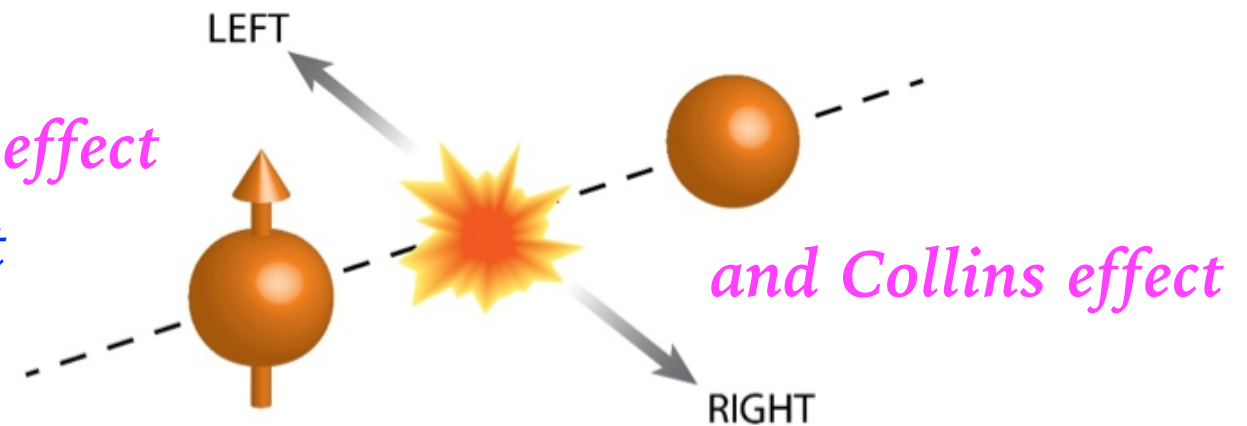
Phys.Rev.Lett. 113 (2014) 1, 012001 EIC



Sivers effect

4) Spin-dependent fragmentation functions

3) Gluon and quark TMD PDFs:



Prog.Part.Nucl.Phys. 119 (2021) 103858

arXiv:2011.15005

... and deuteron

$\sigma(x_F, p_T)$, vector and tensor angular asymmetries

Nonbaryonic content of deuteron:

$$|6q\rangle = c_1 |NN\rangle + c_2 |\Delta\Delta\rangle + c_3 |CC\rangle$$

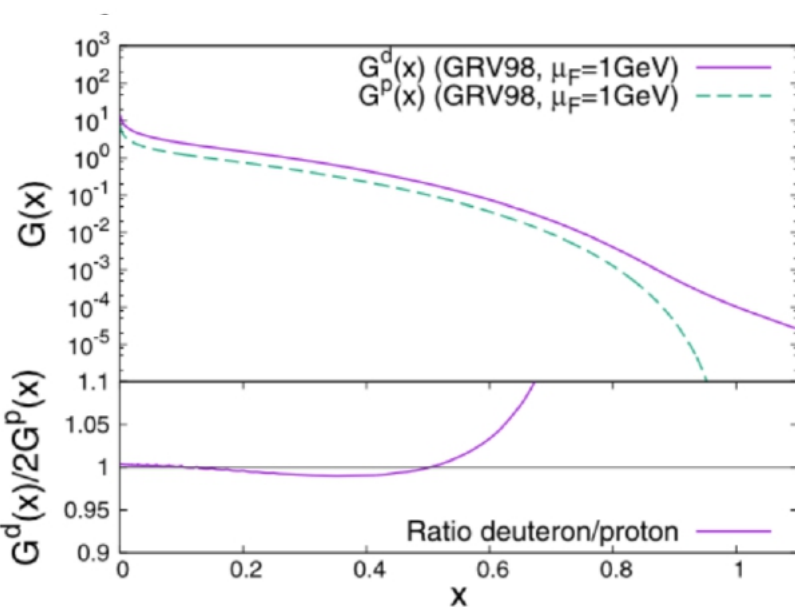
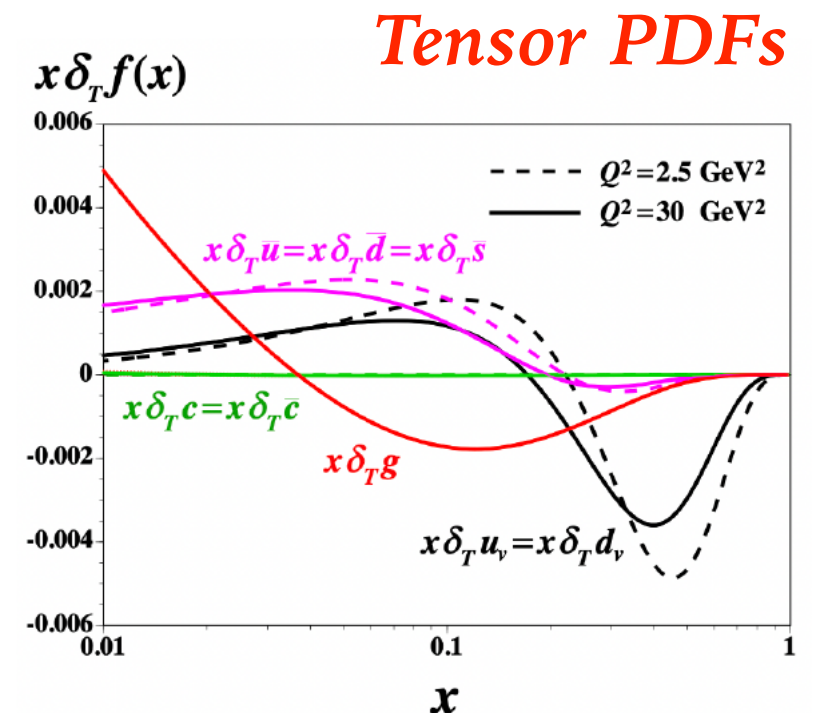
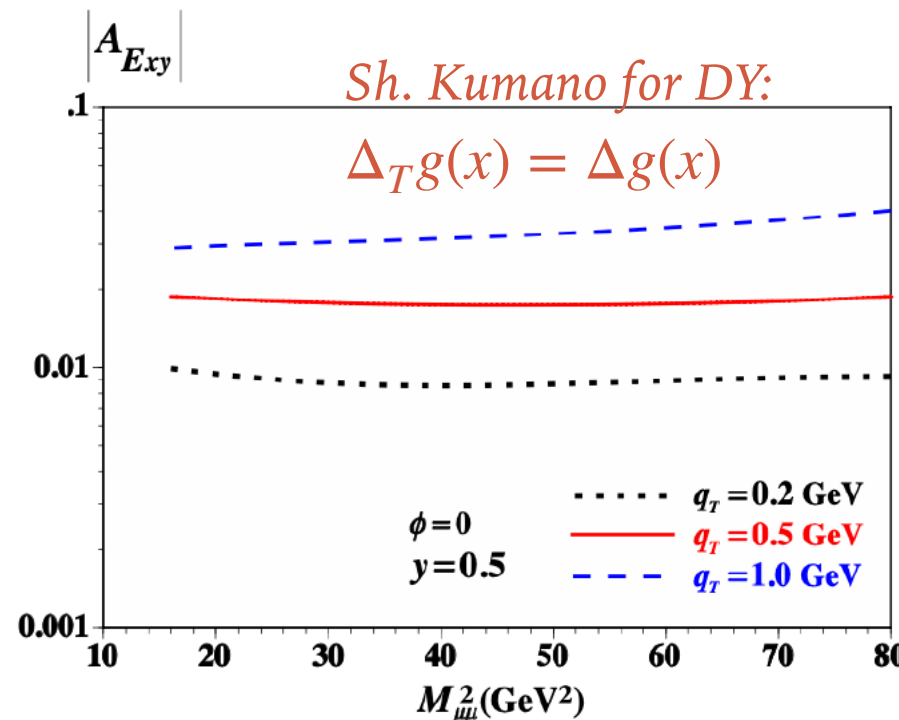
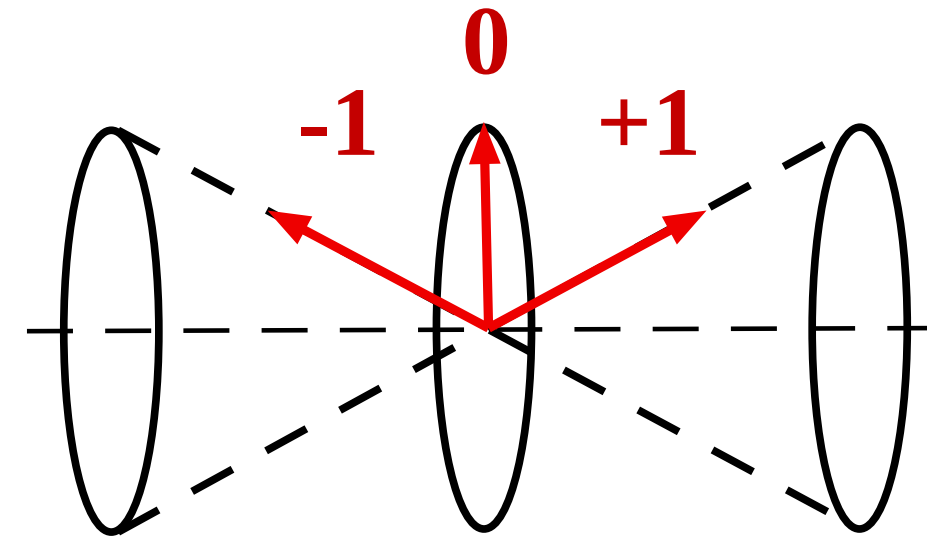
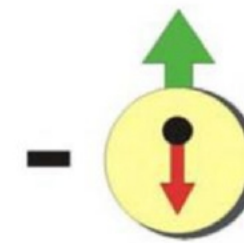
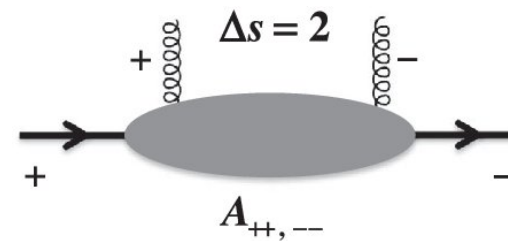


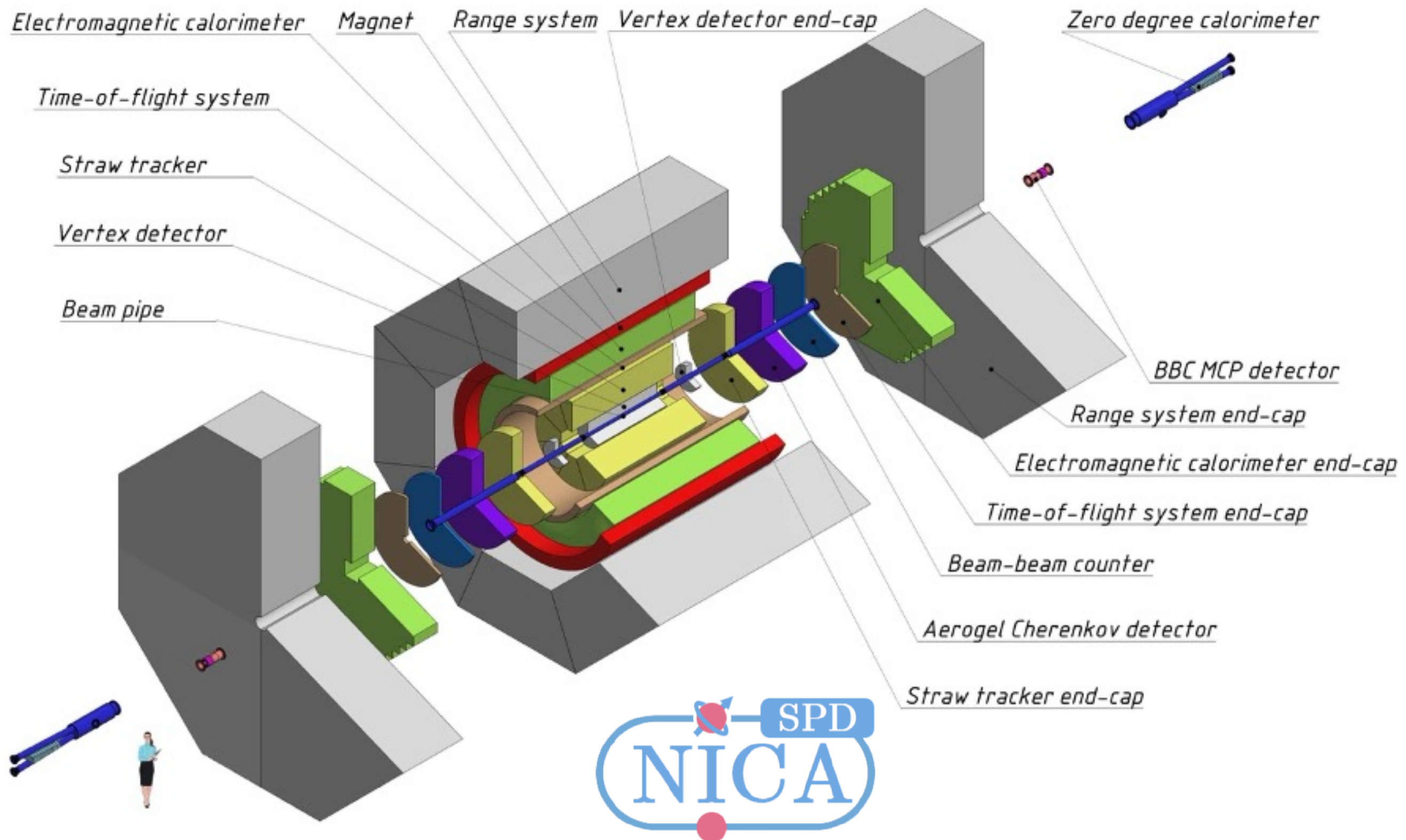
Fig. 6. Gluon PDF in the deuteron and in the nucleon.

Unpolarized
gluons at high x :

Gluon transversity

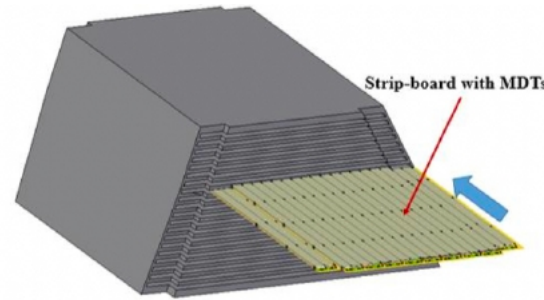
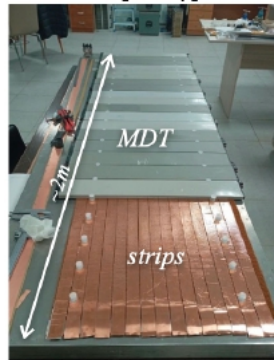


SPD setup



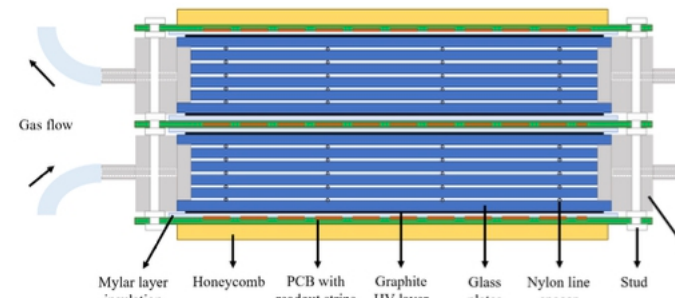
Features of the Detector

Range system for muon identification and rough hadron calorimetry ($\sim 4\lambda_I$)

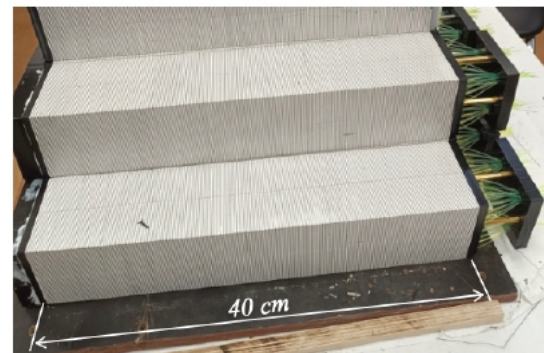


MRPC-based TOF system

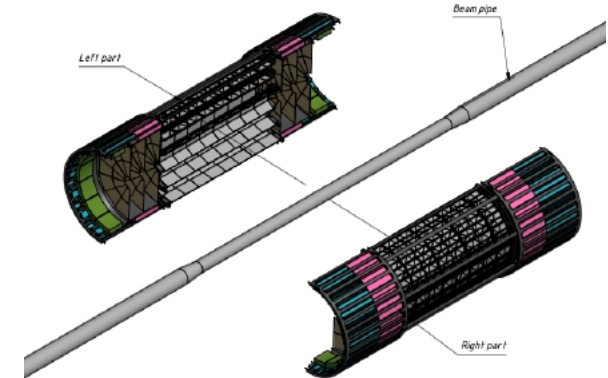
Schematic view of sealed MRPC
(B.Wang et al, JINST 15 (2020) 08, C08022)



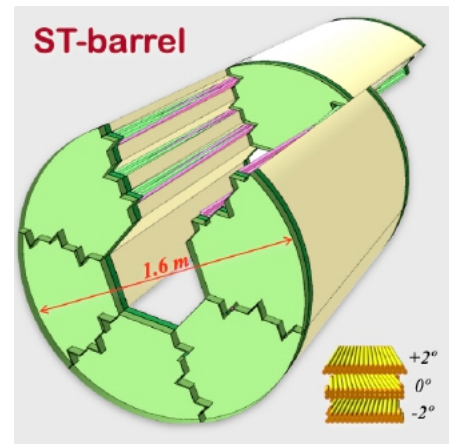
Shashlyk-type ECAL with resolution $\sim 5\%/\sqrt{E}$



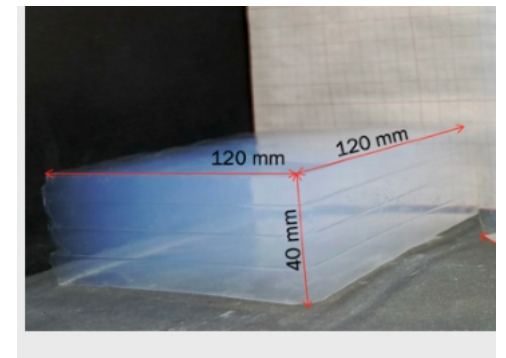
Silicon vertex detector (MAPS or DSSD)



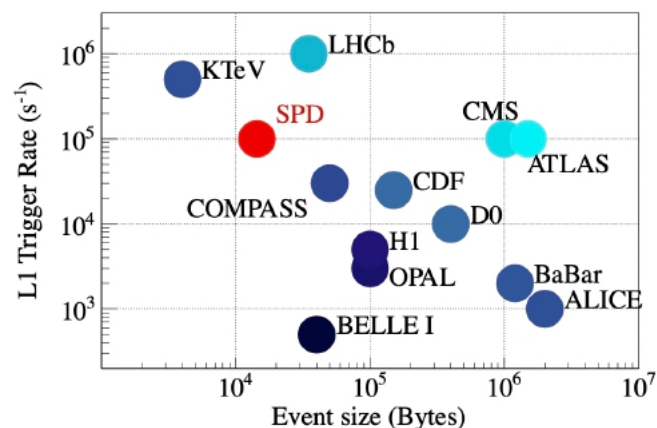
Straw-tube-based main tracker with dE/dx capability



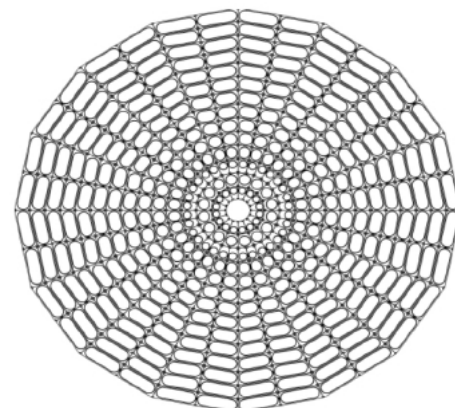
Focusing Aerogel RICH detector



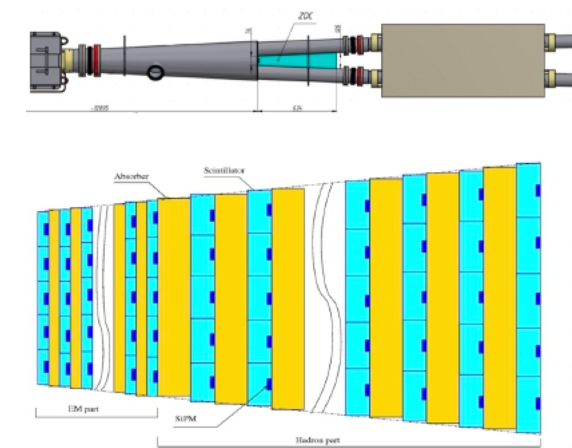
Free-running DAQ



2 × Beam-beam counter

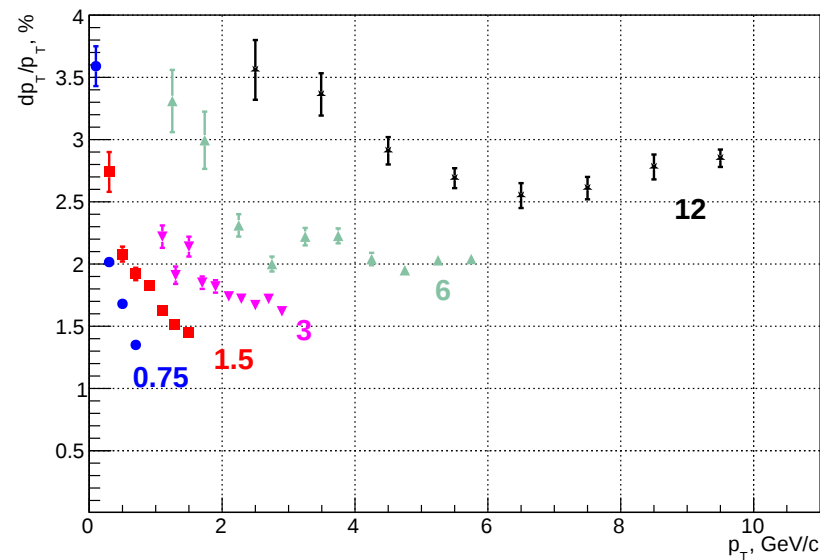


2 × Zero-Degree Calorimeter: forward n/γ detection

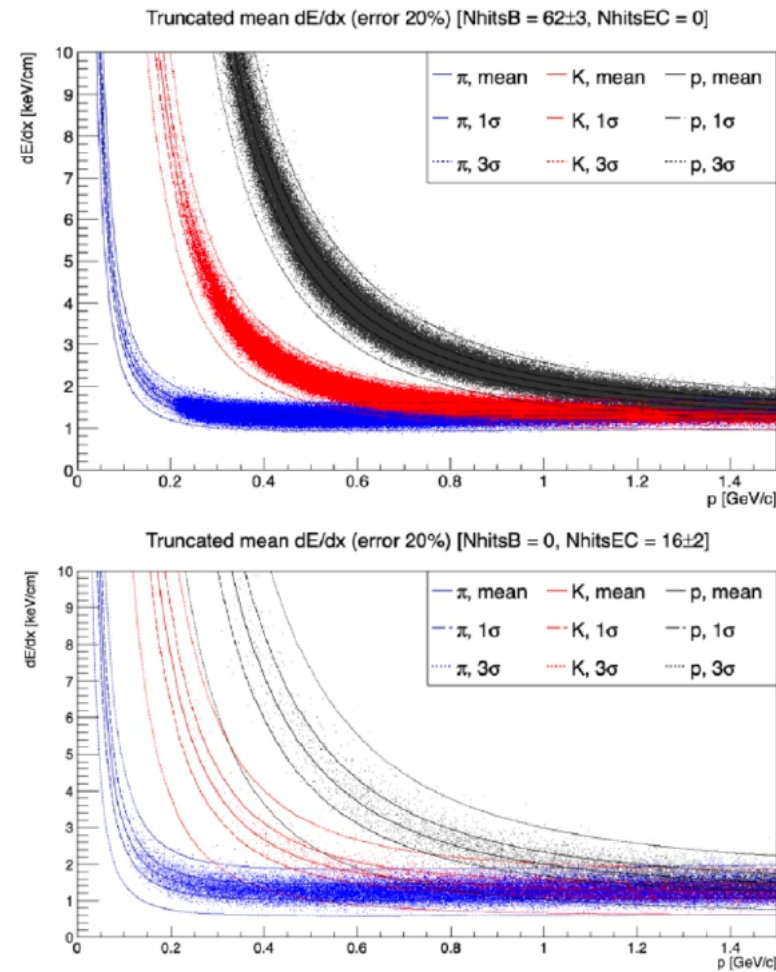


Detector performance

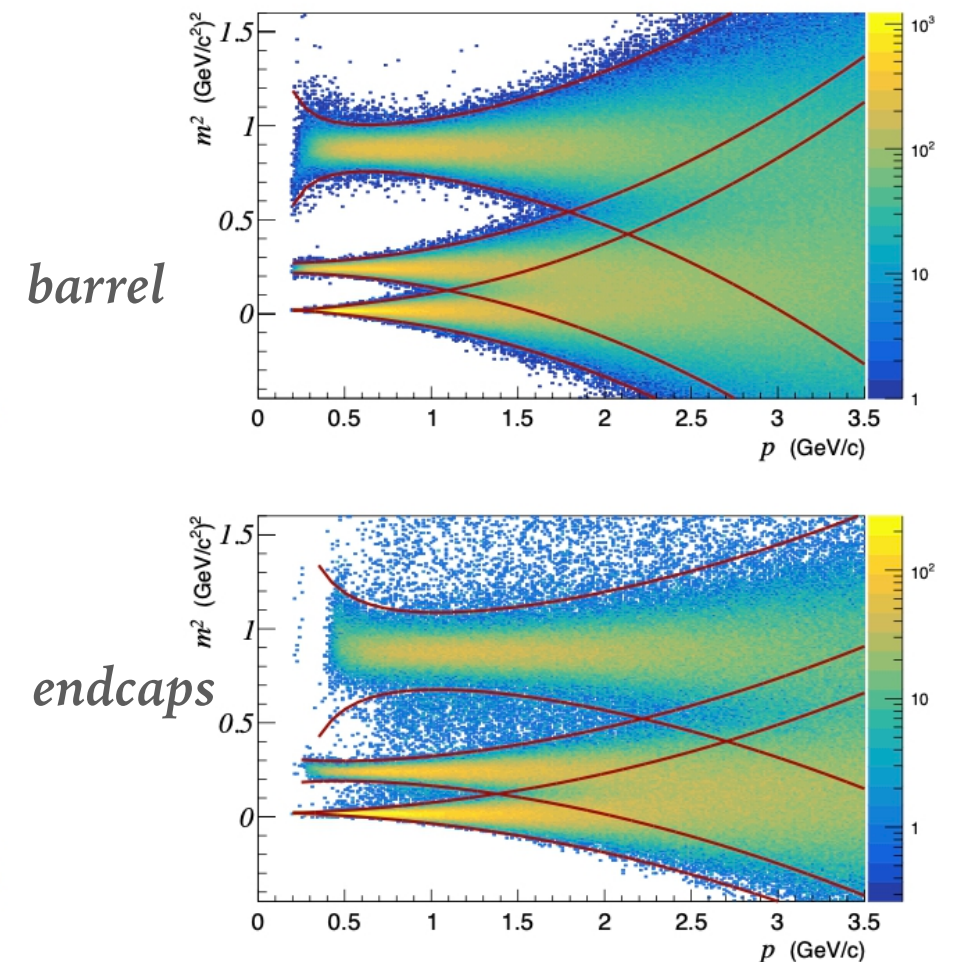
Momentum resolution



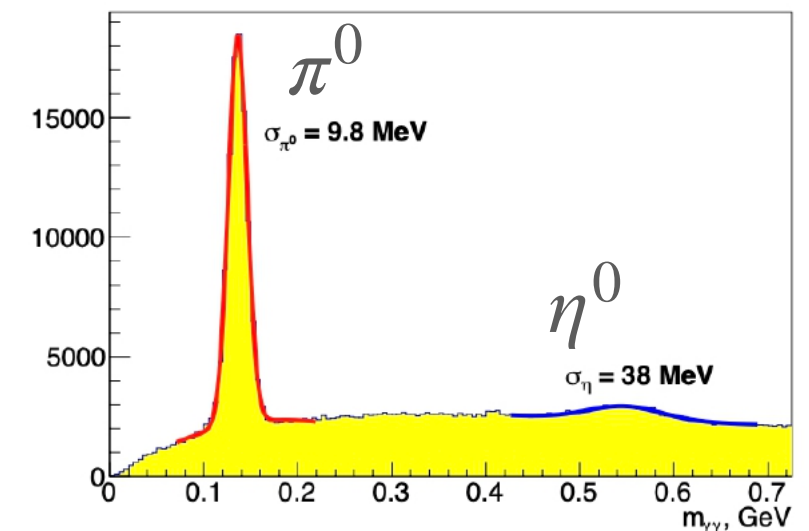
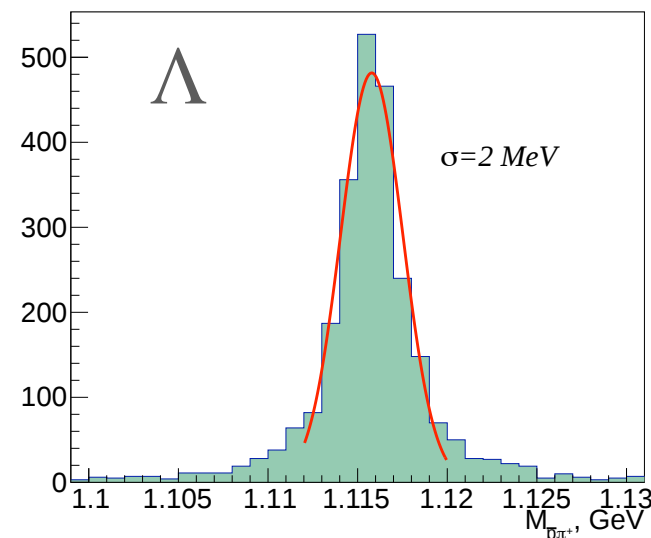
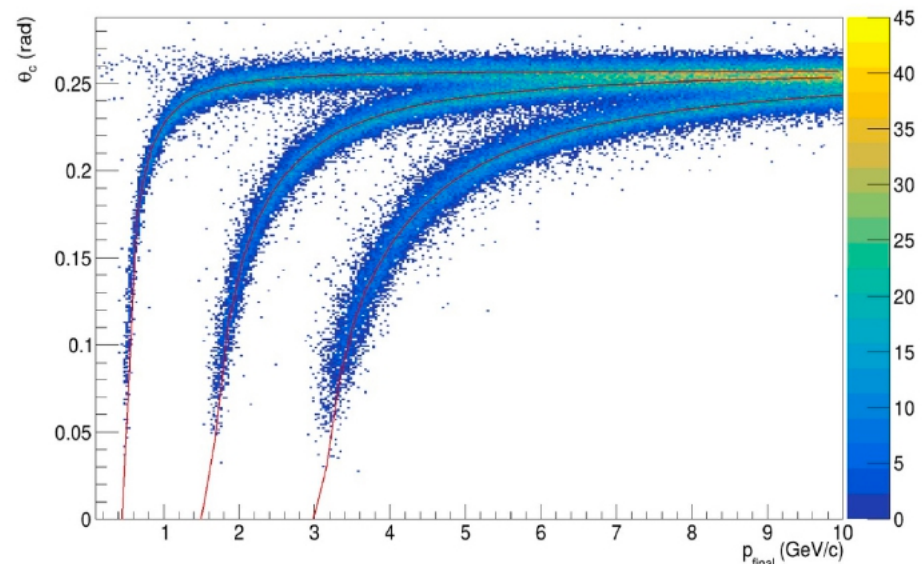
dE/dx in Straw tracker



TOF performance

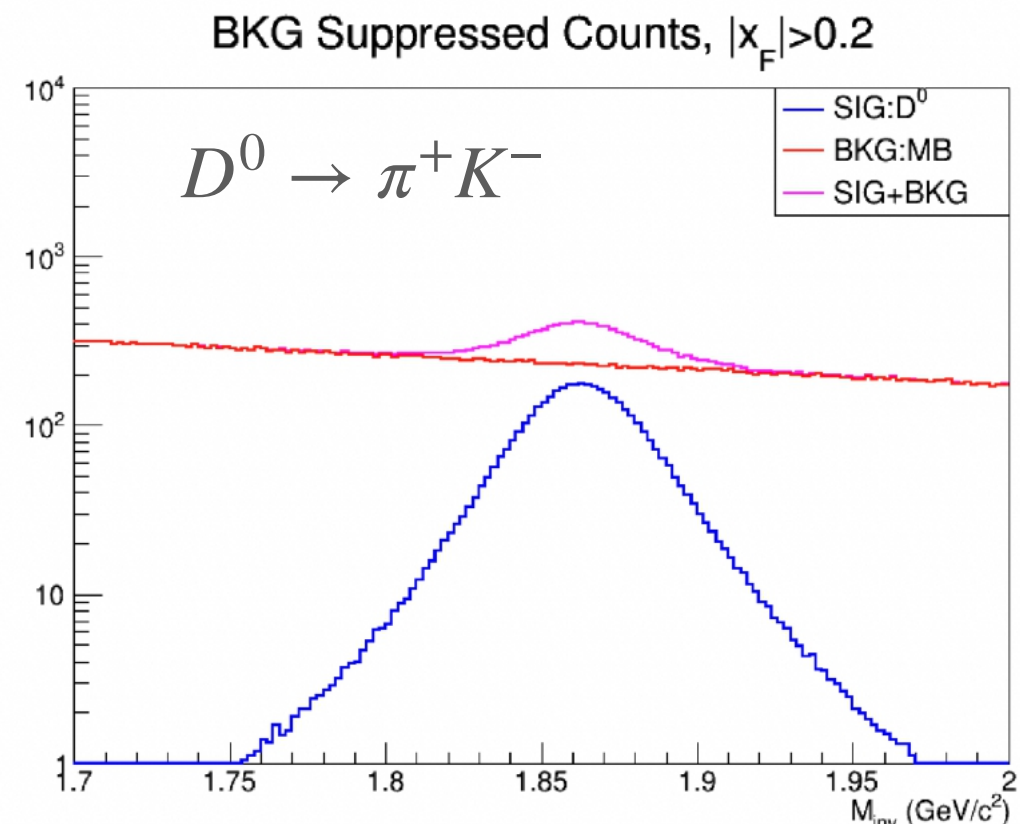
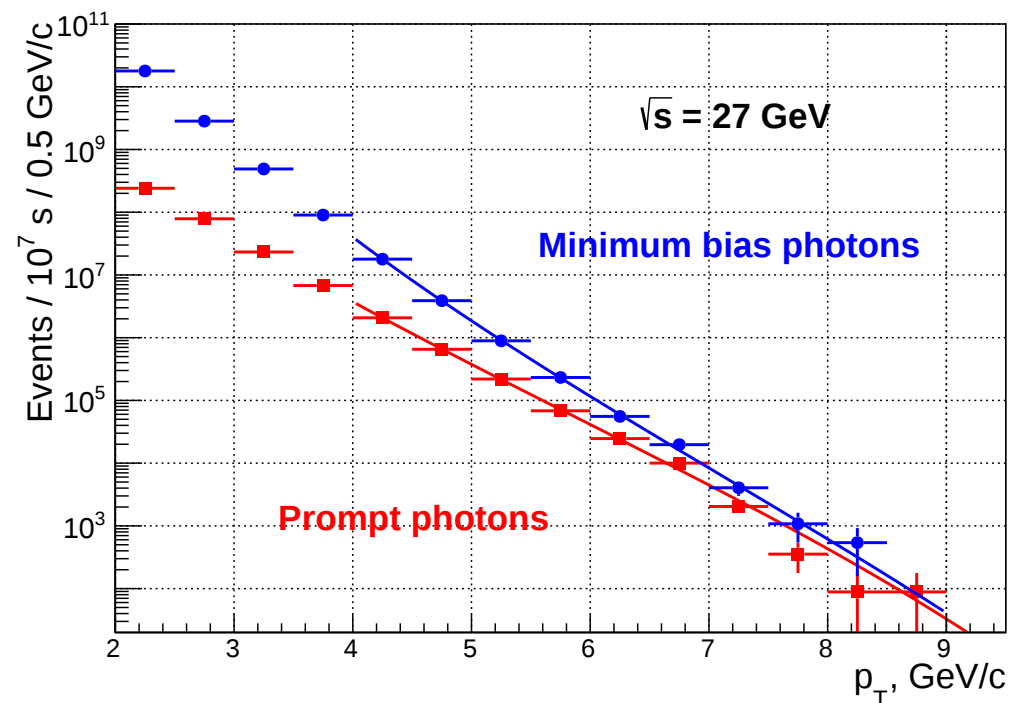
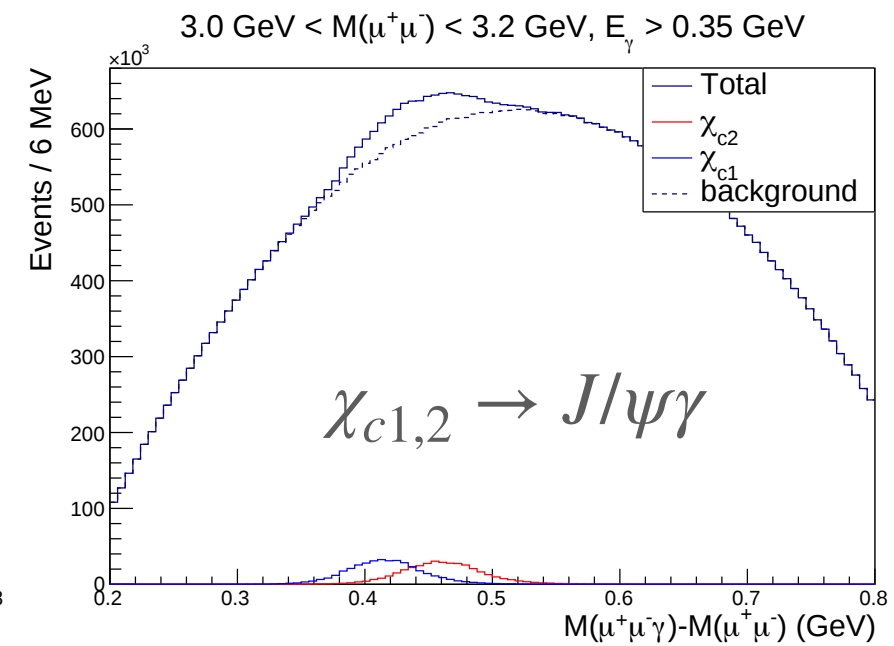
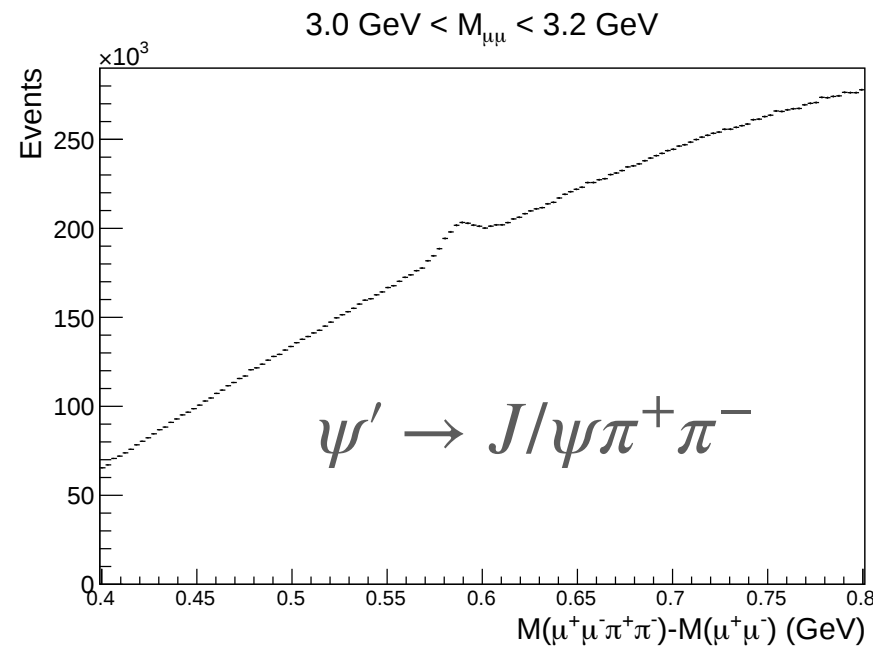
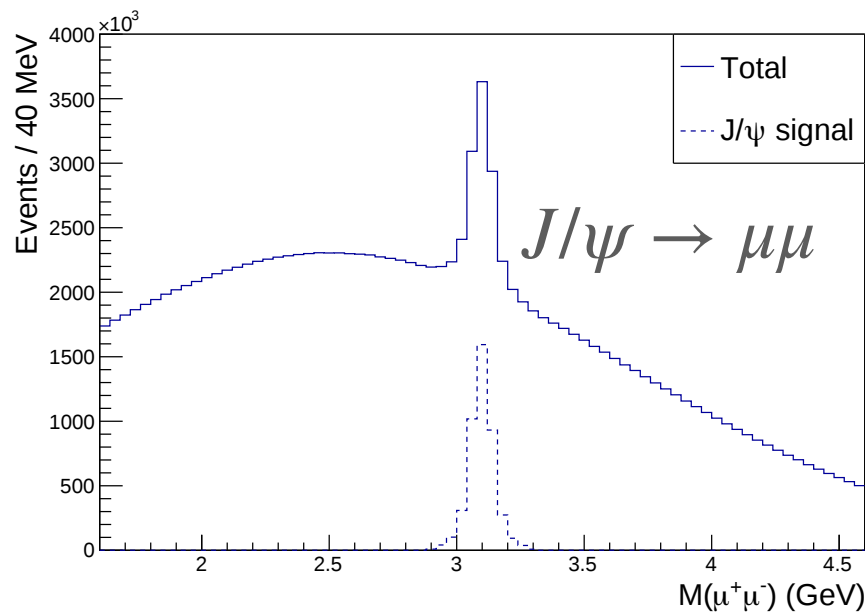


FARICH performance

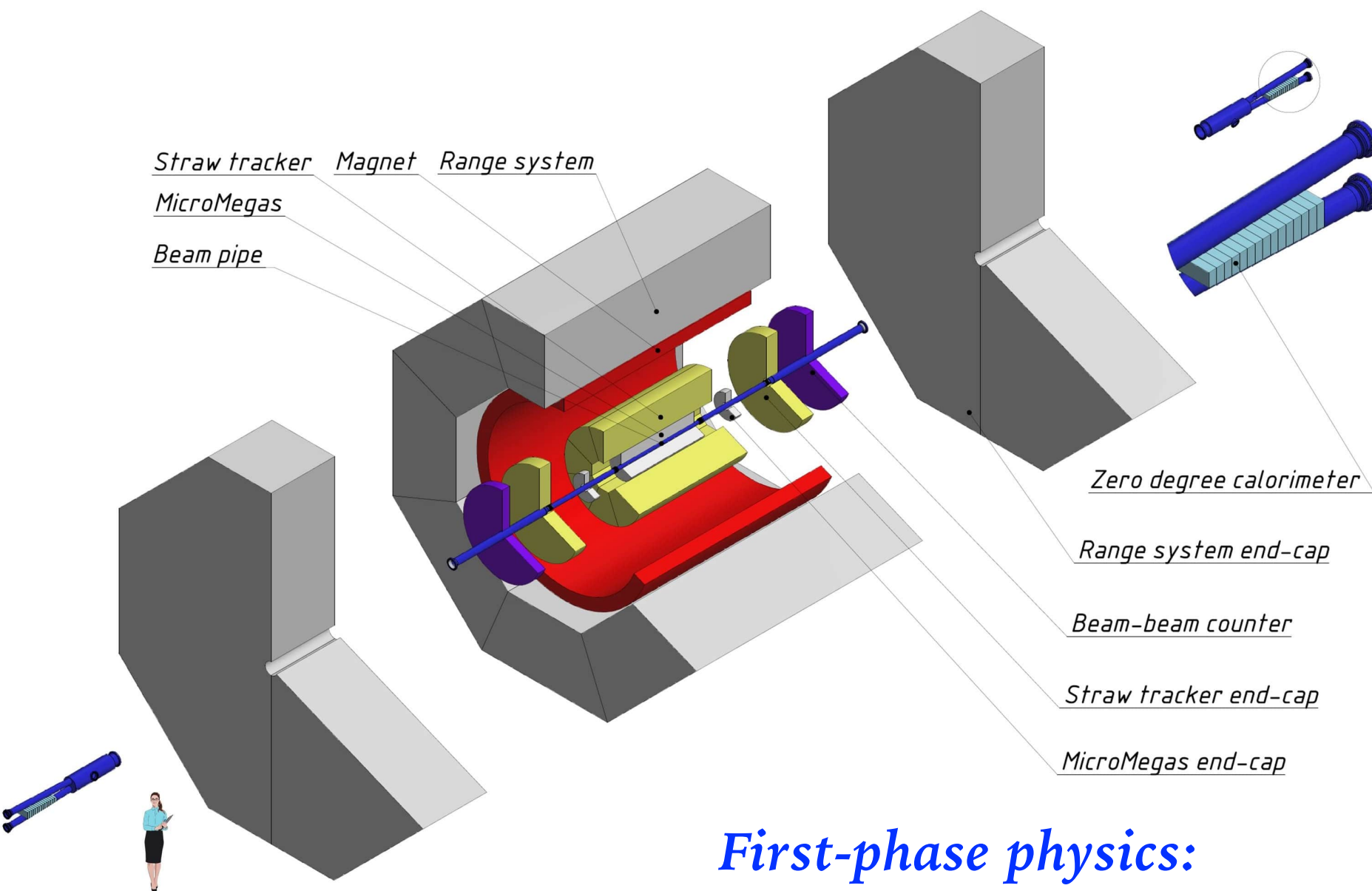


Physics performance: gluon probes

(1 year = 10^7 s, 27 GeV)



SPD setup: first phase



	p↑p↑	d↑d↑	AA
First phase			
$\sqrt{s_{NN}}$, GeV	< 9.4	< 4.5	< 4.5
L , 10^{30} cm^{-1}	< 10	< 1	< 0.001
Second phase			
$\sqrt{s_{NN}}$, GeV	< 27	< 13.5	
L , 10^{30} cm^{-1}	< 100	< 10	

First-phase physics:

- Spin effects in p-p, d-d elastic scattering
- Spin effects in hyperons production
- Multiquark correlations
- Auxiliary measurements for astrophysics
- Physics of light and intermediate nuclei collision
- Exclusive reactions
- Hypernuclei
- Dibaryon resonances
- Charm near threshold
- ...

Phys.Part.Nucl. 52 (2021) 6, 1044-1119

[arXiv:2102.08477](https://arxiv.org/abs/2102.08477)

Status of the SPD project

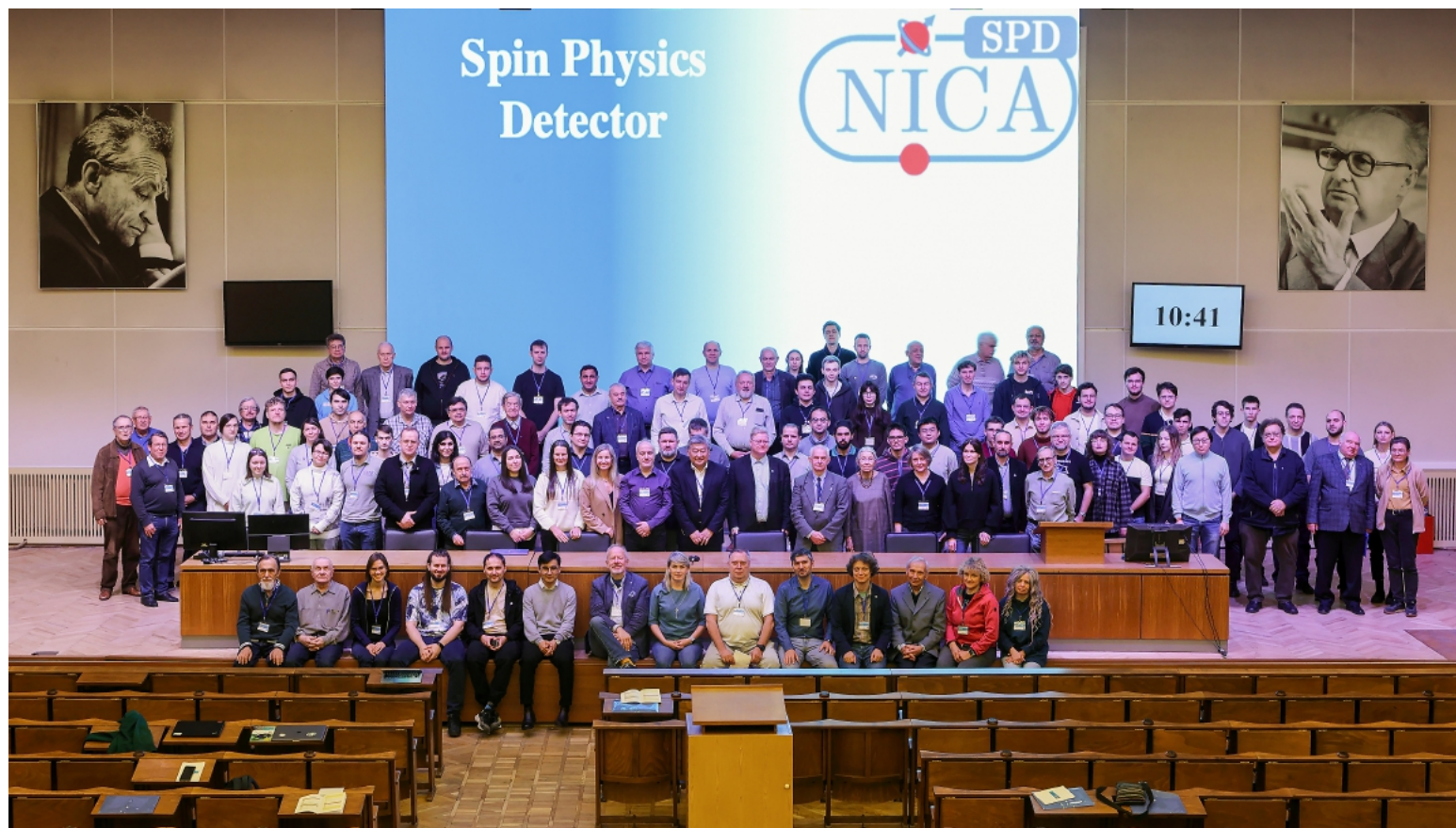
SPD Technical Design Report passed international expertise and published:

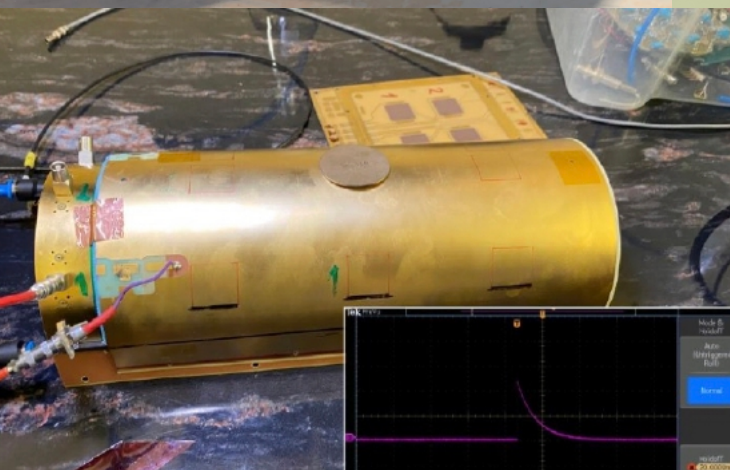
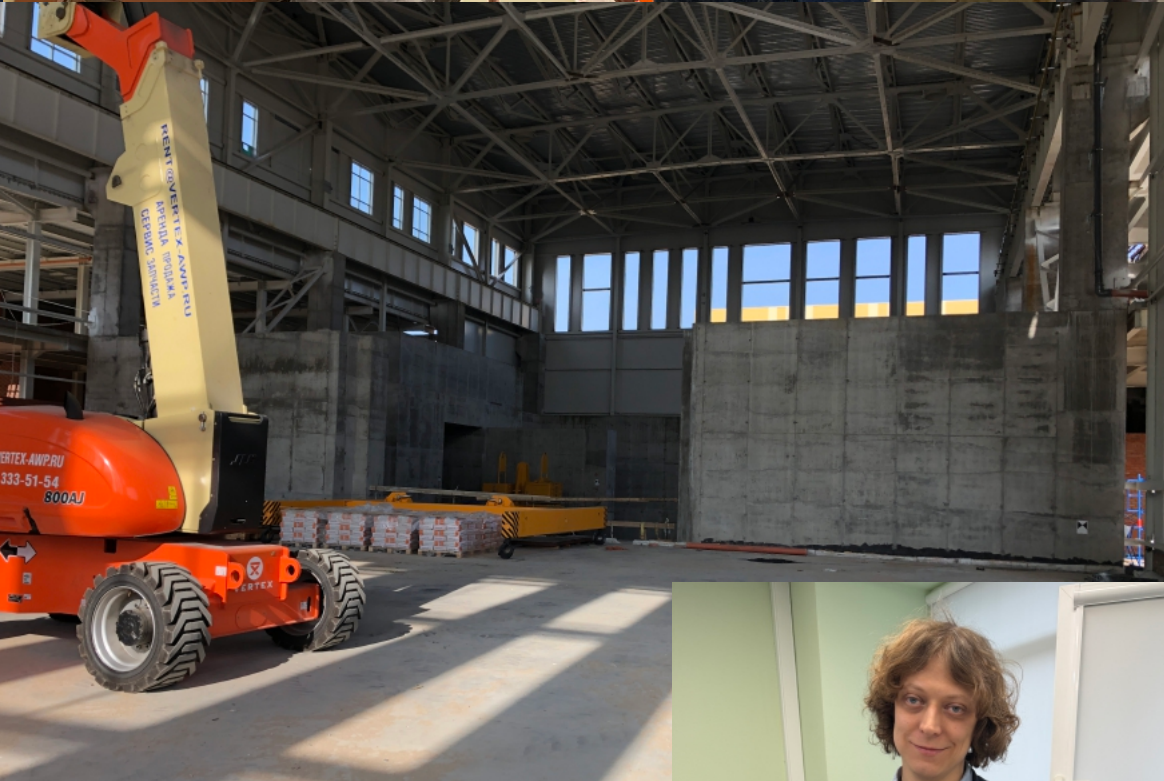
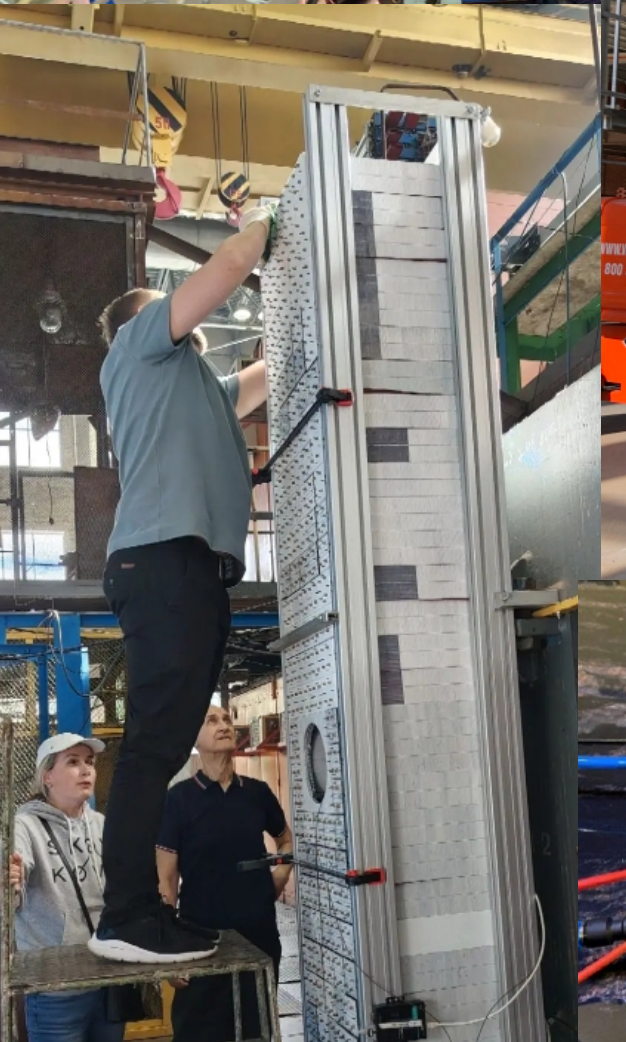
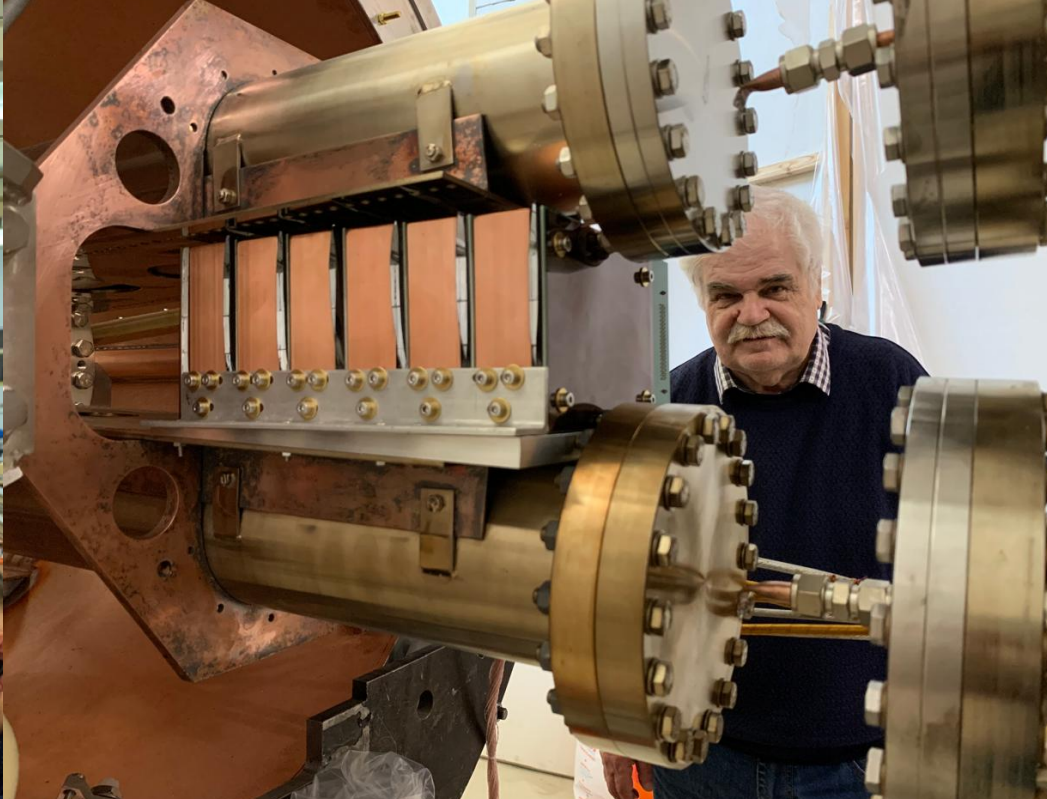
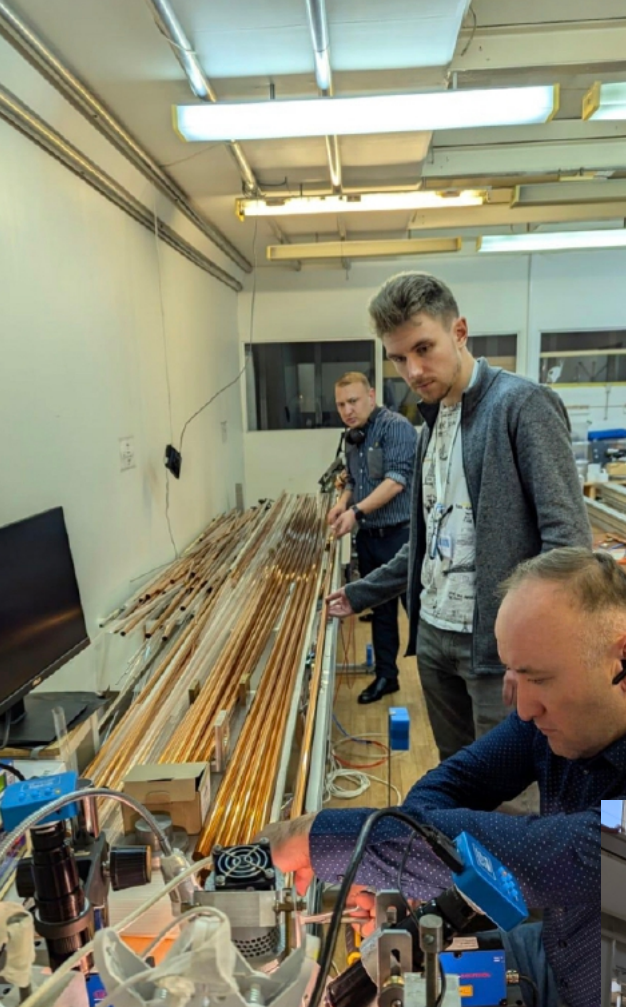
Natural Sci. Rev. 1 1 (2024) <https://arxiv.org/abs/2404.08317>

The **first phase** of the SPD project is included into the JINR's 7-year plan (2024-2030)

The **SPD collaboration** currently consists of about 40 institutes from 15 countries and more than 400 participants

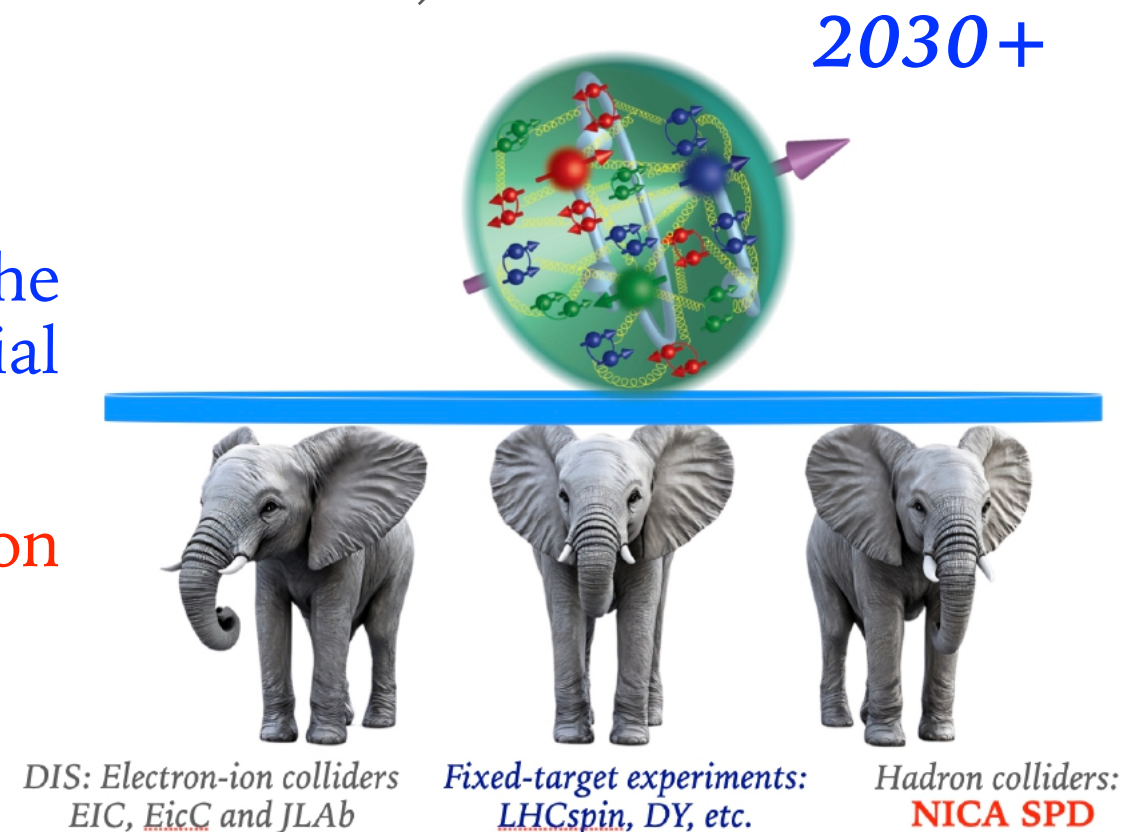
Construction of the first-phase detector configuration is ongoing





Summary

- The **Spin Physics Detector** at the NICA collider is a universal facility for comprehensive study of polarized and unpolarized **gluon content of proton and deuteron**; in polarized high-luminosity **p-p** and **d-d** collisions at $\sqrt{s} \leq 27 \text{ GeV}$;
- Complementing main probes such as **charmonia** (J/ψ and higher states), **open charm** and **prompt photons** will be used for that;
- SPD can contribute significantly to the investigations of:
 - gluon helicity;
 - gluon-induced TMD effects;
 - unpolarized gluon PDFs at high-x in proton and deuteron;
 - gluon transversity in deuteron;
 - other spin-related phenomena.
- We have completed all the approvals, got the funding, and started to construct the initial configuration of the Detector;
- We operate as an international collaboration and are open to cooperation!



DSPIN-26



XX Workshop on High Energy Spin Physics

JINR, Dubna, Russia, 7 – 11 September 2026

Topics and scopes:

- Recent experimental data on spin physics
- Nucleon spin structure, TMDs and GPD's
- Spin physics and QCD
- Spin physics in the Standard Model
- Fundamental symmetries beyond the Standard Model
- Polarization and heavy ion physics
- Spin in gravity and astrophysics
- Spin physics at NICA
- Polarimeters for high energy polarized beams
- Acceleration and storage of polarized beams
- New polarization technologies

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DSPIN

Dubna, Russia
September 7-11

Abstract submission: **Aug, 16**

Registration: **Aug, 30**

**Remote participation
is possible!**

<https://indico.jinr.ru/event/6047/>