

*XX-th Workshop on High Energy Spin Physics (DSPIN-2025)
7-11 September 2026, Dubna, Russia*

Status of the SPRINT@NICA project

V.P. Ladygin [on behalf of SPRINT@NICA group](#)

SPRINT@NICA mission

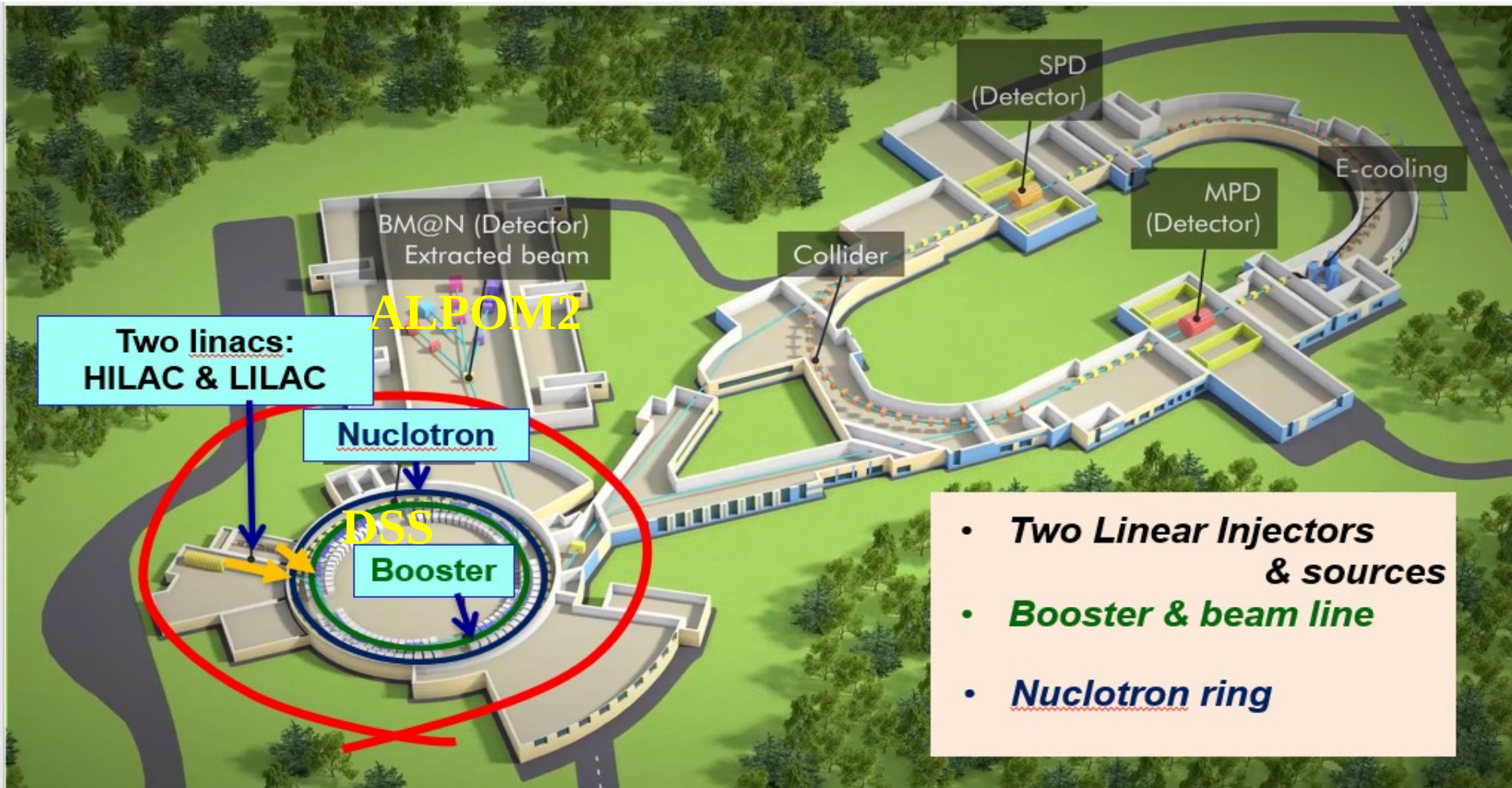
The main goal of the **SPRINT@NICA** (Spin Physics Research Infrastructure and Technologies @ NICA) project is to provide the research infrastructure and to develop the technologies for the current and planned spin studies at Nuclotron/NICA.

Main directions of planned developments are:

- high intensity polarized beams of deuterons and protons
- beam polarimetry (LE, HE, CNI, APol, local etc.)
- techniques of the spin manipulation to provide Spin Transparency (ST) mode at Nuclotron/NICA
- secondary polarized beams (neutrons, protons, HI)
- polarized targets (^3He)
- preparation of the high precision spin experiments (dichroism/birefringence, axionlike particles search, EDM etc.)

Working group: JINR, MIPT, ITP, INR RAS, INP BSU

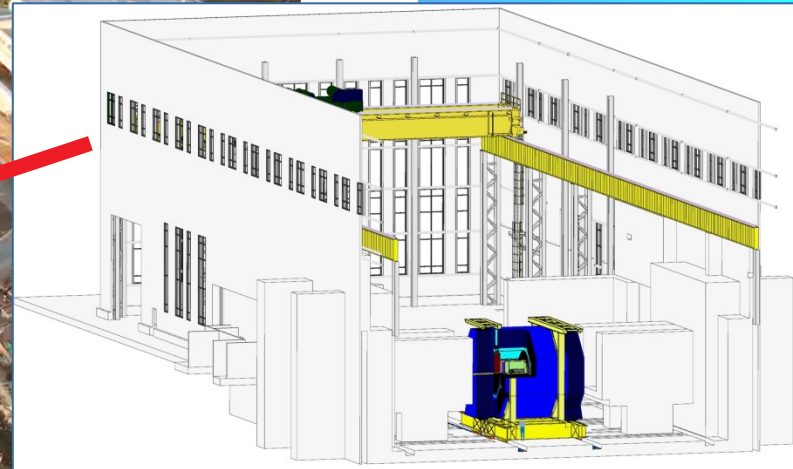
NICA in 2025-2026



Injection complex is already in commissioning for few years (FT mode).
Run 2025-2026 achievements:

**$n \cdot 10^8$ ^{124}Xe ions at 1.6-3.8 GeV/n at Nuclotron,
Simultaneous circulation in both rings at NICA is achieved!**

SPD at NICA in 2026

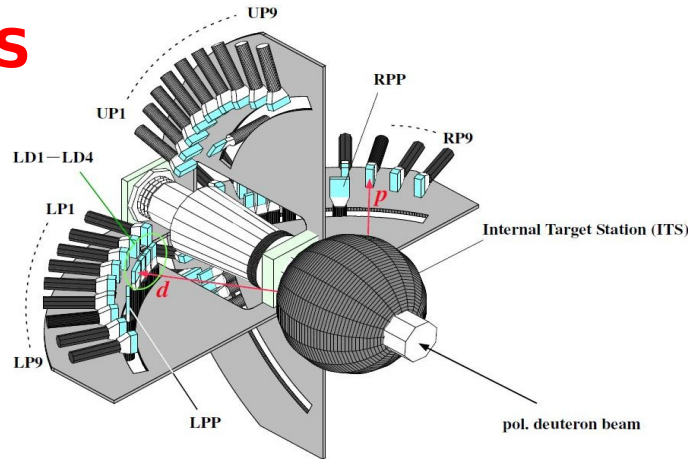


SPD hall

There are plans to study the detector prototypes at the SPD collision point in the fixed target mode (**Au** -target) in current run with HI beam. These studies will be continued in the collider mode (perhaps, including deuterons **-test of local polarimetry -A.Terekhin**).

Requirements of Fixed Target experiments to polarized beam facility

DSS



Intensity:

$\sim 5 \cdot 10^9$ ppp for CH_2 target

$\sim 5 \cdot 10^{10}$ ppp for nuclear targets

Beams polarizations

Deuterons

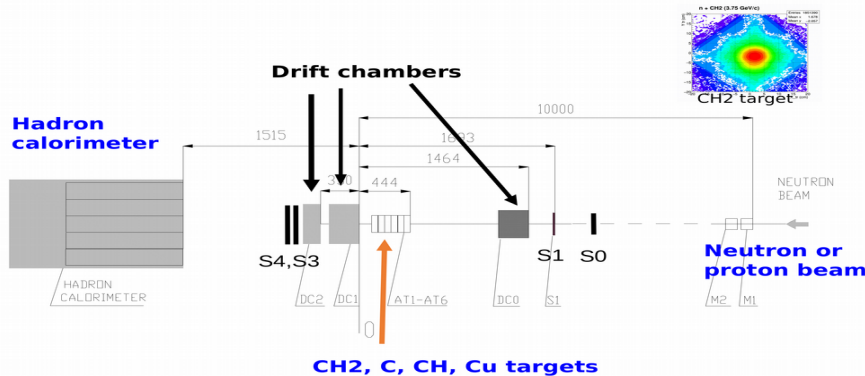
$P_{zz} = -1.4, +0.8$

$P_z = \pm 0.75$

Protons

$P = \pm 0.75$

ALPOM-2



Intensity:

$\sim 10^{11}$ ppp

Beams polarizations:

Deuterons

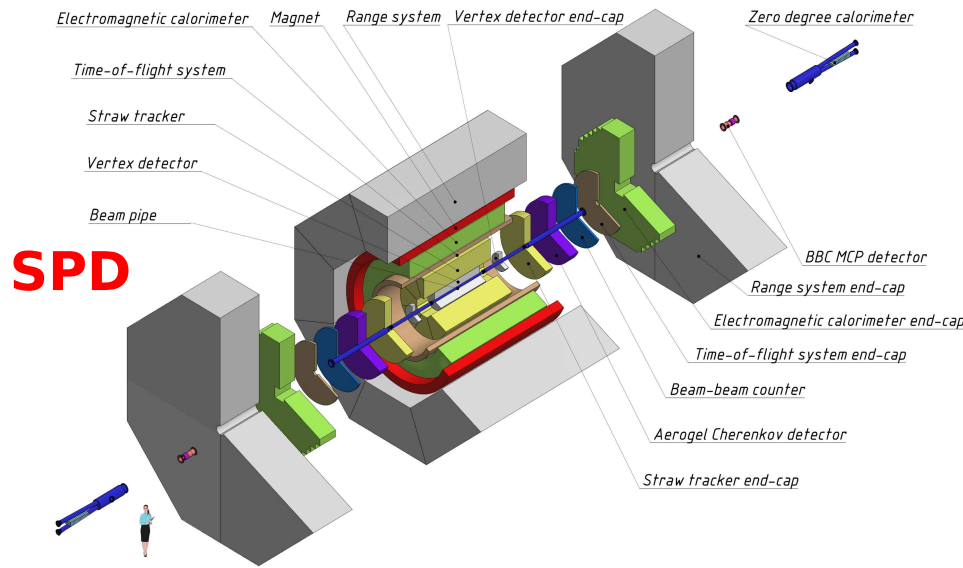
$P_z = \pm 0.55-0.75$

Protons

$P = \pm 0.75$

Goals are to increase the beams intensities and proton beam polarization. Possibility to have sideway components of the polarization in future.

SPD requirements to polarized beam facility



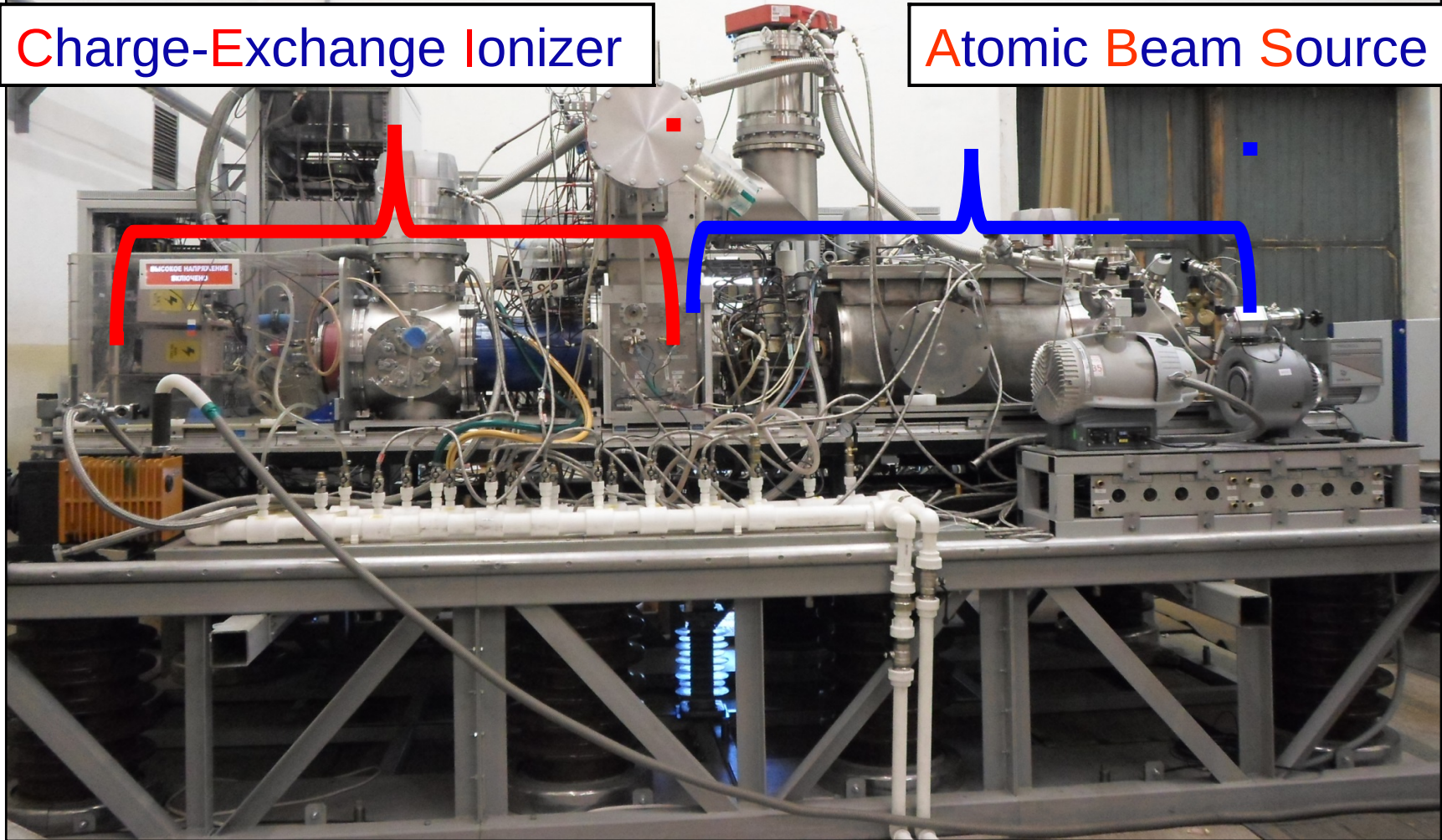
- **polarized and nonpolarized pp- , dd-collisions**
- **$p\uparrow p\uparrow(p)$ at $\sqrt{s}_{pp} = 12 \div 27$ GeV**
- **$d\uparrow d\uparrow(d)$ at $\sqrt{s}_{NN} = 4 \div 13$ GeV**
- **$L_{av} \approx 10^{+32} \text{ cm}^{-2}\text{s}^{-1}$ (at $\sqrt{s}_{pp} \geq 27$ GeV)**
- **sufficient lifetime and polarization degree (few hours, ~70%)**
- **longitudinal and transverse polarization at the SPD IP**
- **pd- collision mode should be available**

The facility operation in pp - mode at $\sqrt{s}_{pp} = 27$ GeV reaching average luminosity of $10^{+32} \text{ cm}^{-2}\text{s}^{-1}$ remains the first priority task for coming years.

General View of SPI

Charge-Exchange Ionizer

Atomic Beam Source



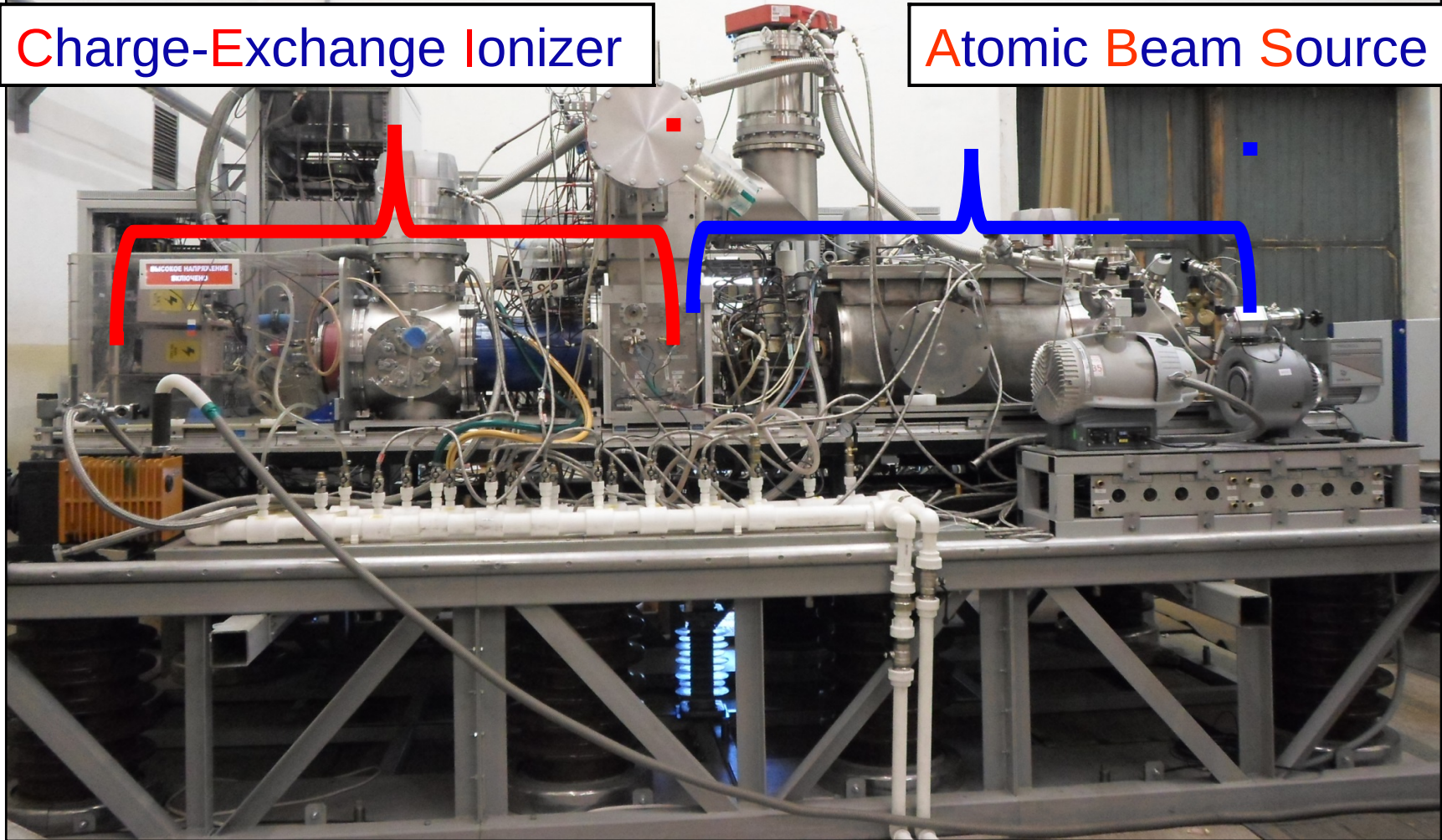
SPI was put into operation in 2016-2017 with deuterons (tested with protons).
SPI current and polarization (for deuterons) are ~ 3 mA and 70-75%.

Plans are to increase the current up to ~ 10 mA. (K.Ivshin, A.Belov, N.Dunin)

General View of SPI

Charge-Exchange Ionizer

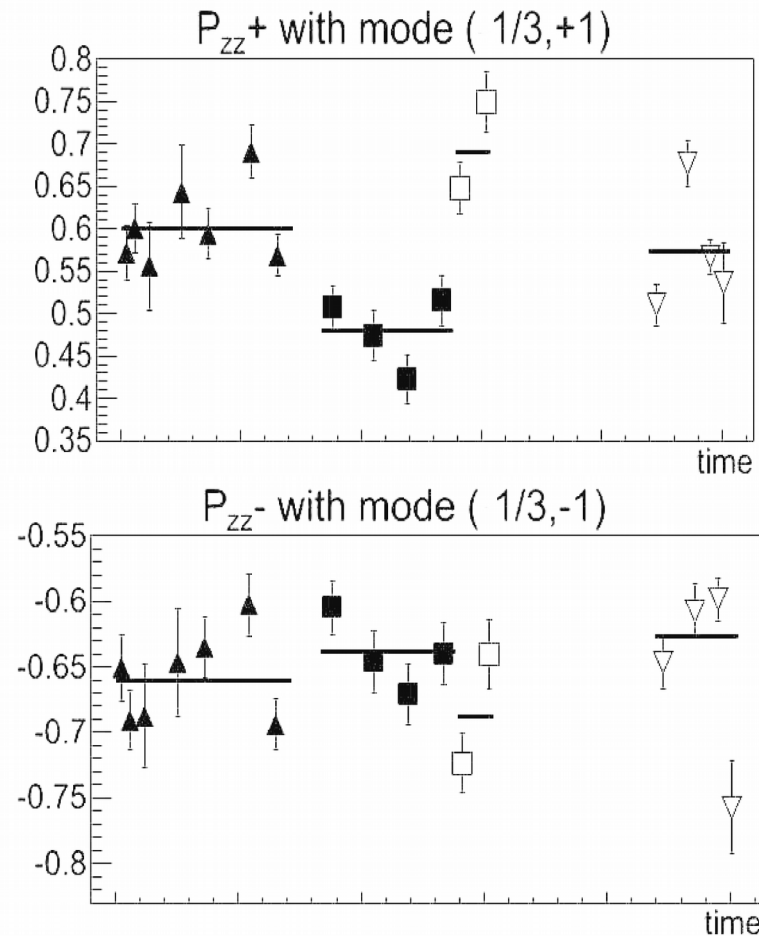
Atomic Beam Source



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Plans are to increase the current up to ~ 10 mA. (K.Ivshin, A.Belov, N.Dunin)

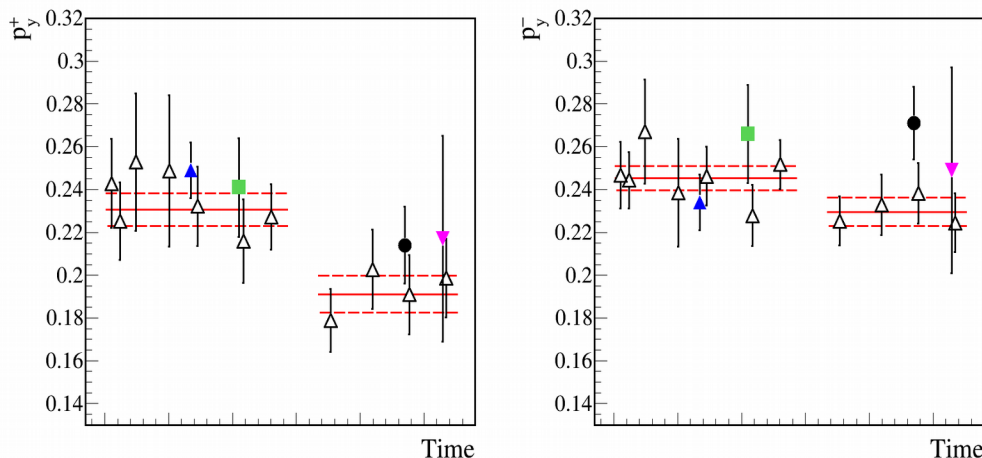
Vector and tensor deuteron beam polarizations using **dp**- elastic scattering at **270 MeV** at ITS



**P.K.Kurilkin et al.,
NIM A642 (2011) 45.**

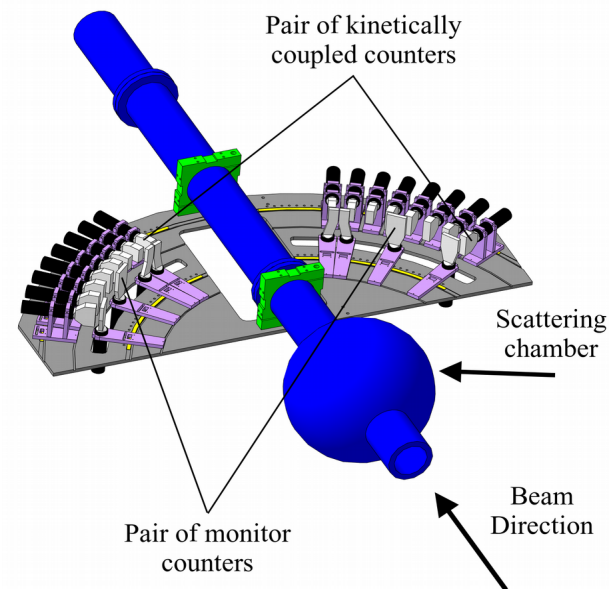
SPI was tuned for 6 spin modes $(p_z, p_{zz}) = (1/3, 1), (1/3, -1), (0, +1), (0, -2), (-2/3, 0), (+1, 0)$.

Vector polarization of the deuteron beam using **dp-** elastic scattering at **270 MeV** and **pp-** quasielastic scattering at ITS



- Vector component of the deuteron beam polarization has been measured at 500, 650, 550 and 200 MeV/nucleon using pp-quasielastic scattering.
- Detectors placed in the horizontal plane only were used.
- Analyzing power values from SAID were used to evaluate of the beam polarization values for the pp-quasi-elastic scattering measurements.

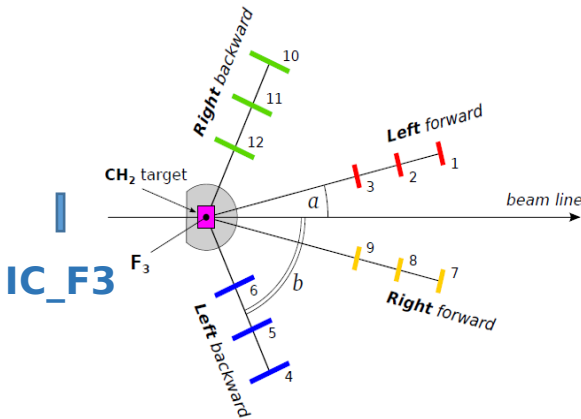
Both methods give similar results!



**I.S.Volkov et al.,
Phys.At.Nucl. 87 (2024) 459
Submitted to NIM A**

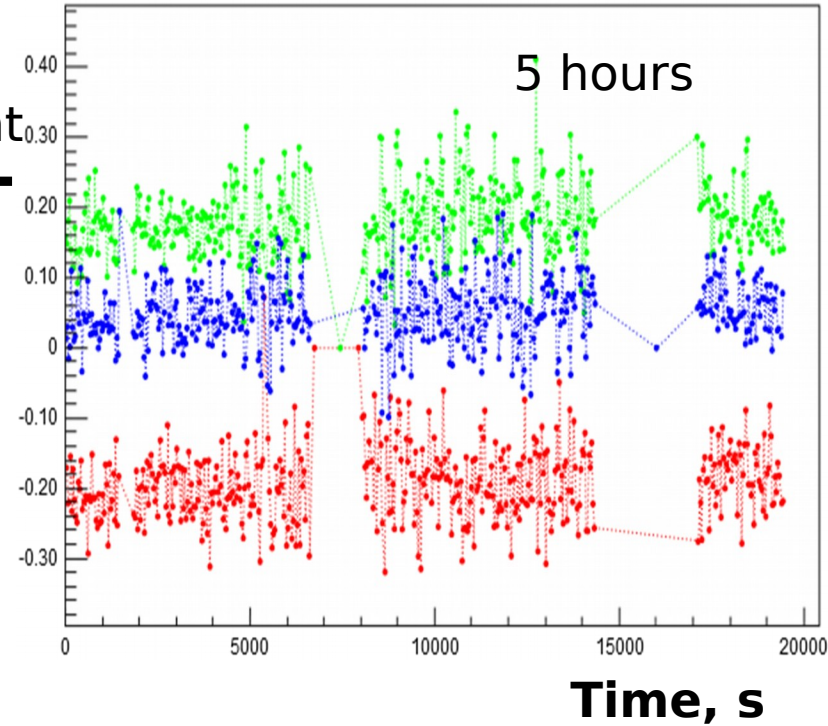
**Upgrade is in progress:
A.A.Terekhin et al.,
Phys.Part.Nucl. 54 (2023) 634**

Deuteron extracted beam polarization measurements (vector component) using **pp**- quasielastic scattering



each point corresponds to one spill.

Left-Right
IC_F3



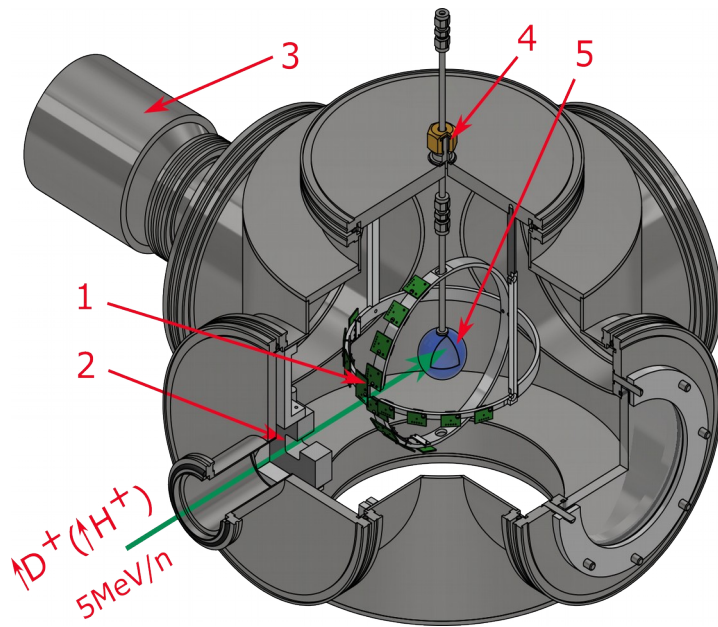
The polarization in **one mode** is two times lower than **the other one**

$$P(+)-P(-)=0.96\pm0.05$$

HE tensor polarimeter is needed!

Upgraded polarimeter:
L.S.Azhgirey et al., NIM A497 (2003)340.

LE polarimetry developments



- 1 - array of 16 silicon detectors with an active area of 5x20 mm each
- 2 - variable diaphragm
- 3 - turbomolecular pump
- 4 - gas inlet system
- 5 - a high-pressure (3 bar) mylar spherical target (150 μm)

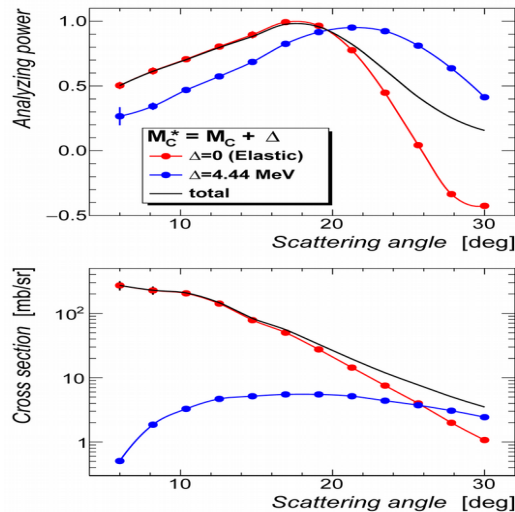
Under construction!
(A.Solovev)

Deuteron(proton) energy is 5 MeV/nucleon after RFQ&LINAC.

The ^3He target (3bar) enables to measure both the proton polarization using $^3\text{He}(p,p)^3\text{He}$ elastic scattering reaction and the vector and tensor polarizations of deuterons using $^3\text{He}(d,d)^3\text{He}$ elastic scattering as well as $^3\text{He}(d,p)^4\text{He}$ reaction.

The detection of the secondary particles will be provided by the silicon detectors. The detector positions can be adjusted according reaction kinematic.

Absolute proton polarimetry developments



APol 3D view



1. Proton-carbon elastic scattering at 200 MeV at the scattering angle of 16.2° in lab. has very large analyzing power close to an absolute value

$$A = 0.993 \pm 0.003$$

Elastic events will be selected using sets of scintillation detectors with absorbers.

The polarimeter can be installed at the Nuclotron ITS.

2. Since for pp- elastic scattering beam and target analyzing powers equal:

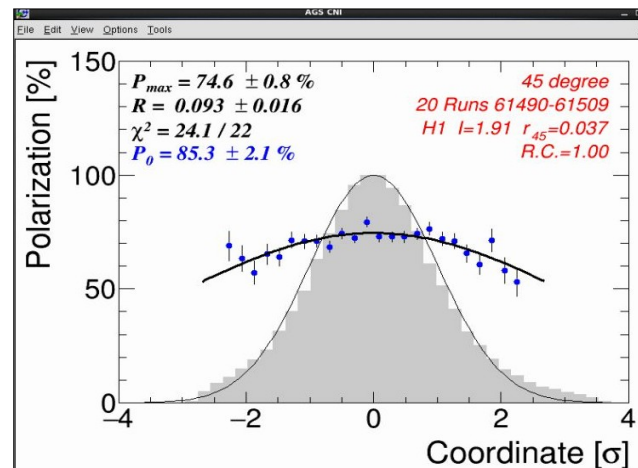
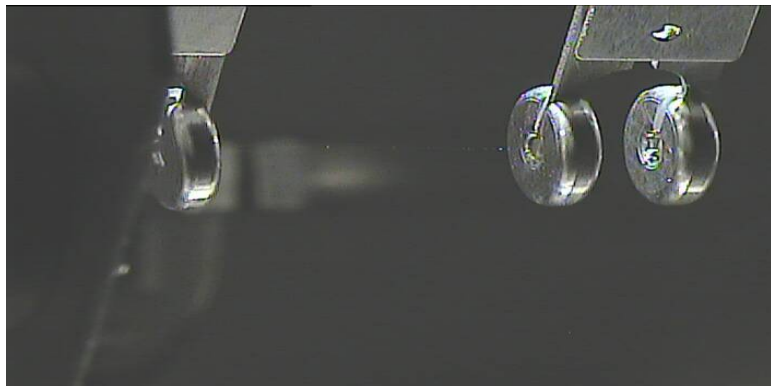
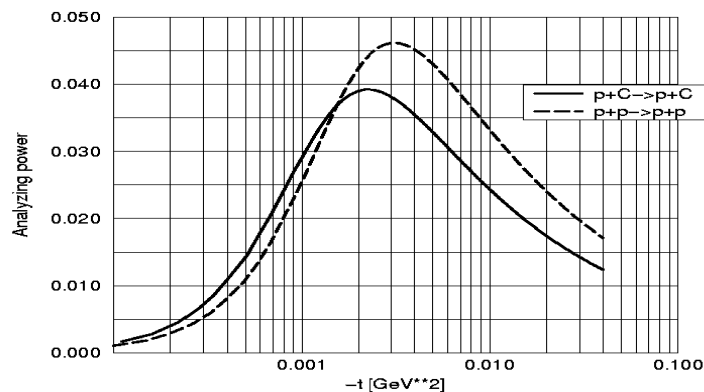
$$A_{\text{beam}} = A_{\text{target}}$$

the polarization of the proton beams can be obtained using left-right asymmetry from polarized H-jet target by an absolute method.

The ABS is ready, chamber and detection system are under construction.

V.Larionov

CNI proton polarimetry developments

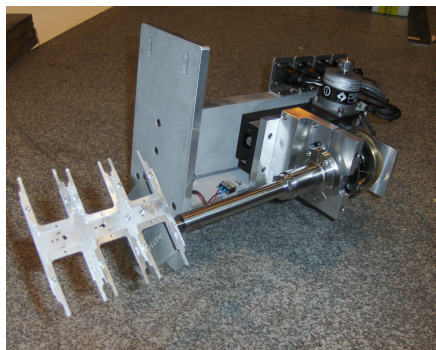


CNI proton polarimetry at NICA energies is not an absolute method because of non-zero spin-flip hadron amplitude (AGS results).

The selection of the events will be provided by the detection of the recoil carbon using SSD.

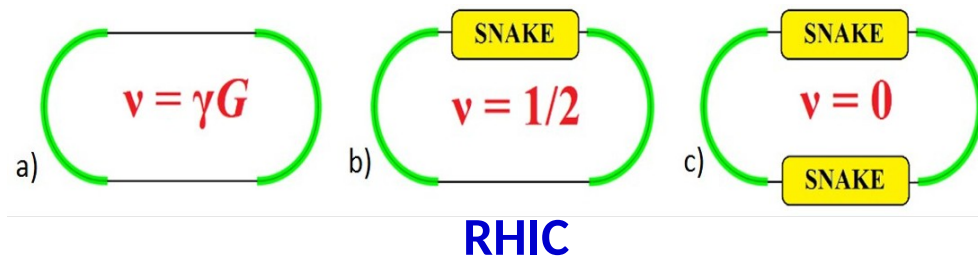
CNI polarimeters will be able to measure the proton beam polarization profiles using advanced ribbon target.

A.N.Zelenski

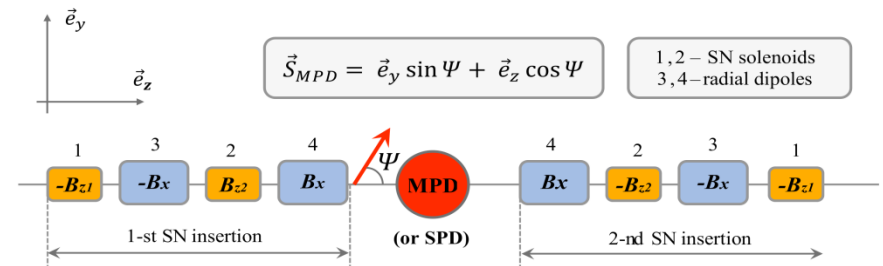
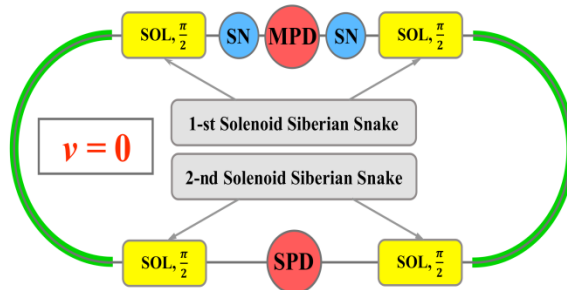


Very thin carbon strip target-20um x 25 nm

Proton spin manipulation at NICA



LE-regime



Spin transparency (ST) mode with $v=0$ is very well suited to the SPD physics tasks.

Realistic scenario.

LE-regime: ST up to $\sqrt{s_{pp}} = 6-7$ GeV using ~ 12 T·m Siberian snakes in each ring.

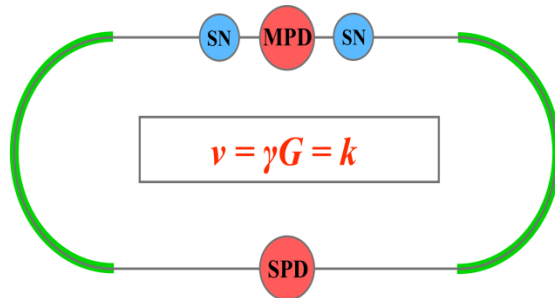
HE-regime: ST at the integer resonances k at $\sqrt{s_{pp}} > 6-7$ GeV ($E_p = 0.108 + k \cdot 0.523$ GeV).

Details:

Yu.N.Filatov, Phys.Part.Nucl.56 (2025) 363.

E.M.Syresin et al., Phys.Part.Nucl.52(2021) 997.

HE-regime

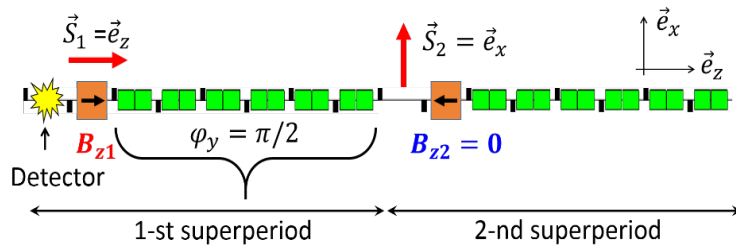


Proton spin manipulation at Nuclotron

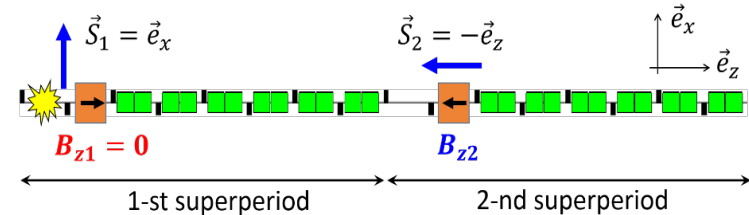
Stage 1.

Nuclotron with Spin Navigator based on 2 additional weak solenoids

Experimental verification of the ST mode at integer spin resonance $\gamma G=2$ (108 MeV)



Longitudinal polarization at the detector



Radial polarization at the detector

Stage 2.

Nuclotron with Spin Navigator based on regular correction dipoles

Experimental verification of the ST mode at integer spin resonance $\gamma G=7$ (2723 MeV)

Stage 3.

Modernized Nuclotron with $\sim 12 \text{ T}\cdot\text{m}$ solenoidal Siberian snake

ST mode up to proton energy of 13.5 GeV

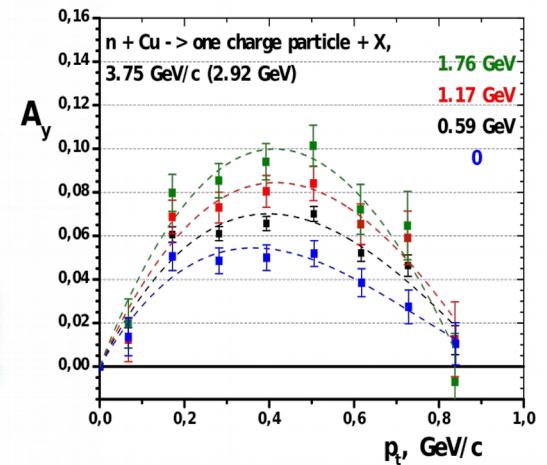
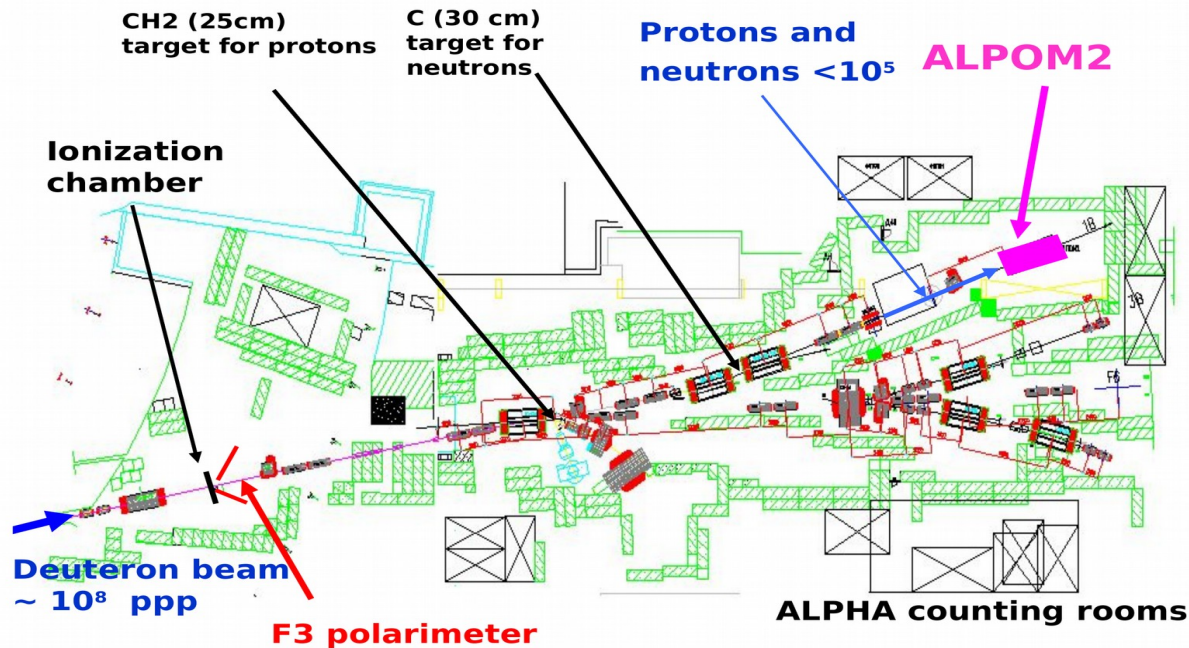
Experimental proof of ST
requires serious upgrade of
the proton beam polarimetry
at Nuclotron

Yu.N.Filatov, A.M.Kondratenko+ team

Supported by:

RFBR 20-02-00808, RSF 22-42-04419, RSF 25-72-30005

Secondary proton and neutron polarized beam at Nuclotron

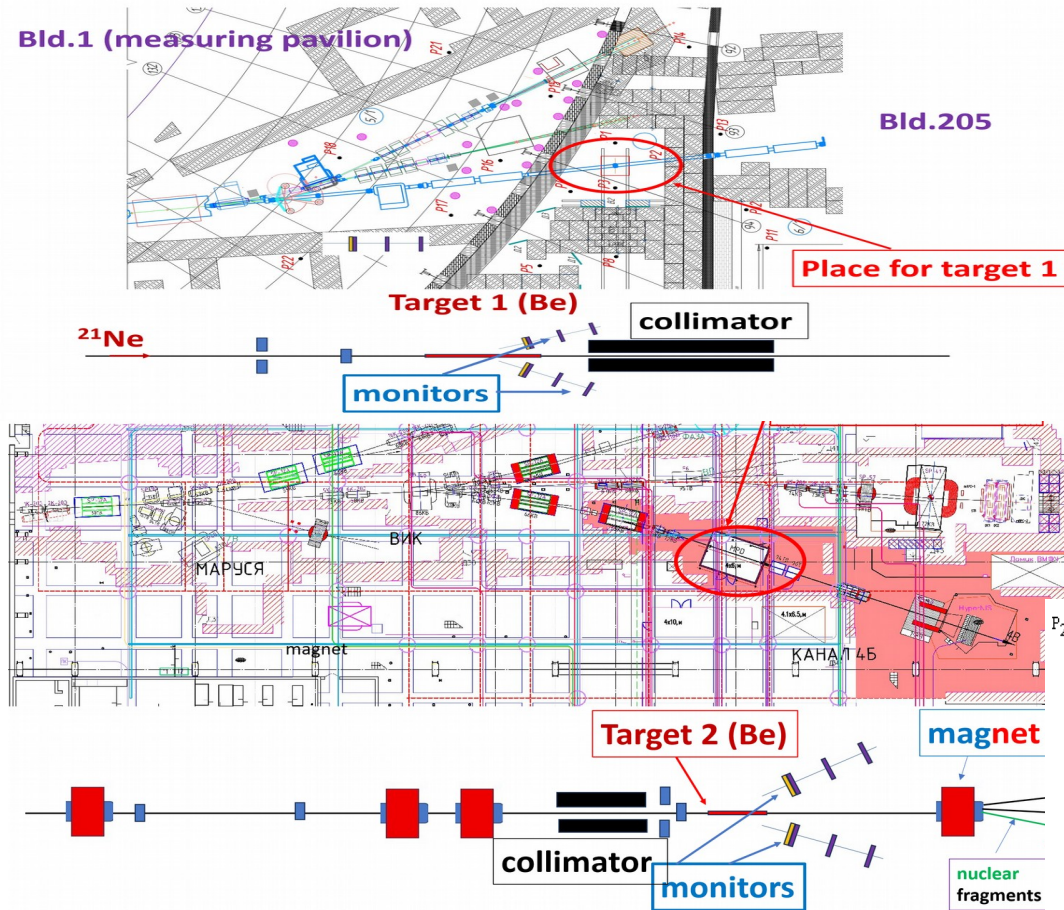


**S.N.Basilev et al.,
Eur.Phys.J.A 56
(2020) 26**

Required intensity for physics is $\sim 10^{11}$ ppp

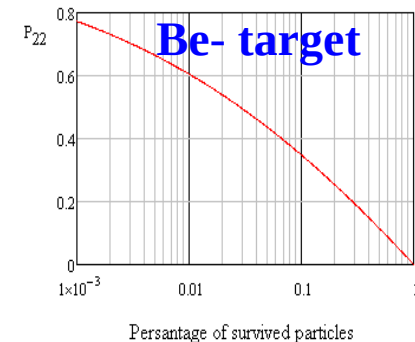
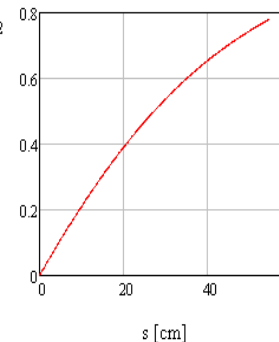
The beam line was built for spin correlation **np**- scattering experiment:
the upgrade of existing polarized target is under consideration.

Tensor polarized ^{21}Ne beam at Nuclotron



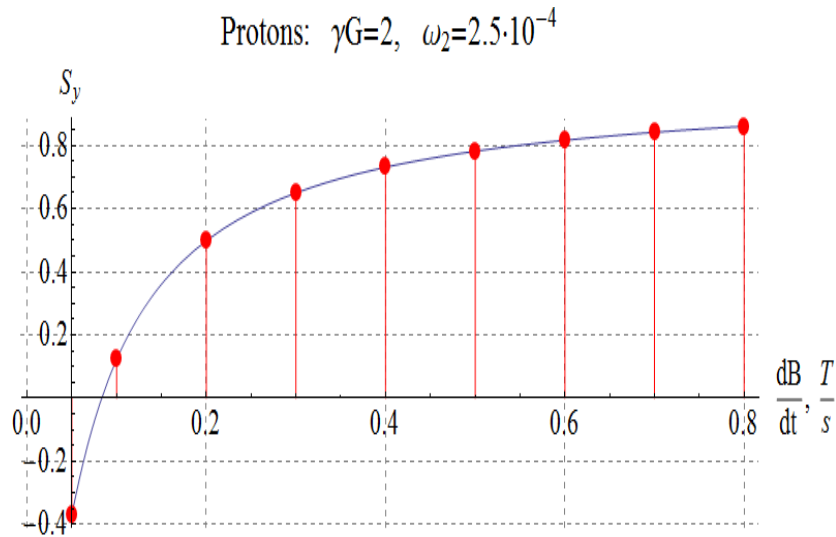
-Method is based on the large quadrupole deformation of ^{21}Ne ($\beta_2=0.463$).

-Tensor polarization appears after passing through the thick nuclear target (Be-20cm).



$\sim 10^7$ - 10^8 ^{21}Ne ions/spill with the tensor polarization ~ 0.4 will be available for physics.

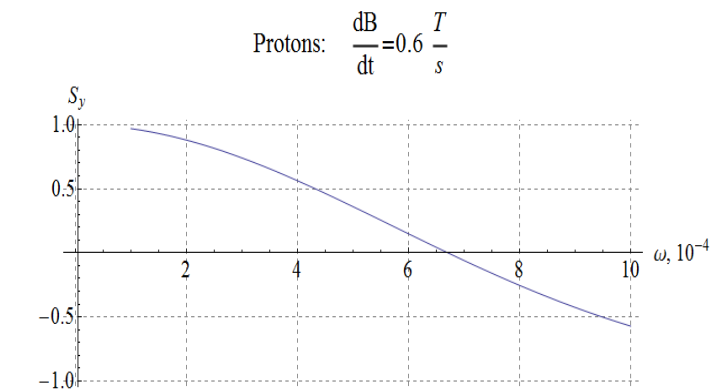
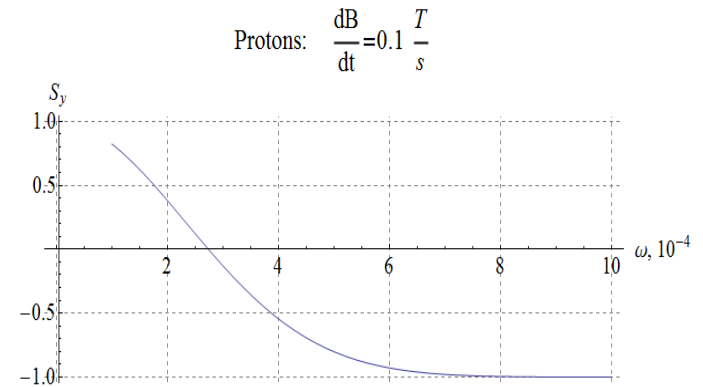
New experiments on the proton spin manipulation



Measurements of the integer resonance $\gamma G=k=2$ strength ($T_{kin}=108$ MeV)

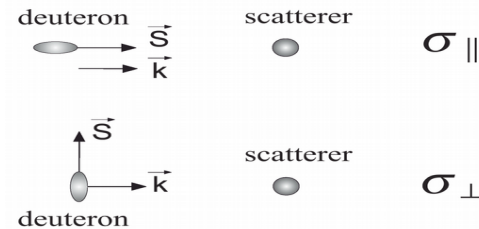
Measurements of the proton beam polarization at 100 and 120 MeV at different dB/dt

The final goal is to prove the possibility of Spin- Transparency mode at integer resonances (for **SPD at NICA**)



**Yu.N.Filatov et al.,
JETP Lett. 116 (2022) 413;
JETP Lett. 118 (2023) 387.**

Deuteron spin dichroism at Nuclotron at 270 MeV

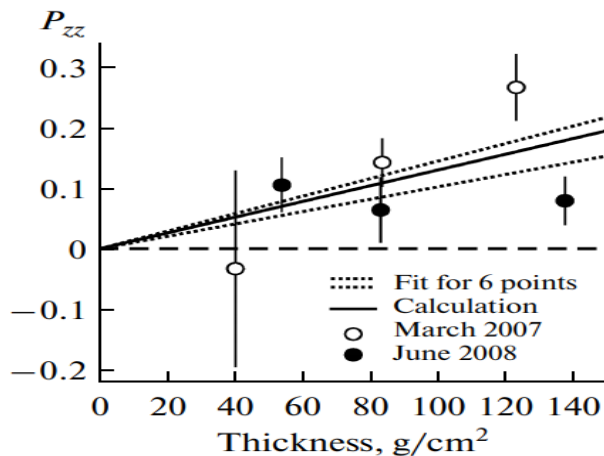


-Spin dichroism effect is one of the phenomena acquiring by the deuteron beam passing through the nonpolarized target.

$$p_{zz}(l) = \frac{I_{+1}(l) + I_{-1}(l) - 2 \cdot I_0(l)}{I_{+1}(l) + I_{-1}(l) + I_0(l)} \approx \frac{2}{3} \rho l (\sigma_0 - \sigma_1) = -\frac{8\pi}{3} \rho l \frac{\text{Im}(d_1)}{k}$$

-The method is the measurement of the tensor polarization acquiring by a nonpolarized deuteron beam moving in Nuclotron and passing through the internal target.

-The polarization measurements will be provided by the vector-tensor deuteron polarimeter based on the measurements of dp- elastic scattering at 270 MeV.



S.Anischenko

Nuclotron results with the extracted 5 GeV/c deuteron beam.

Deuteron EDM studies at 270 MeV

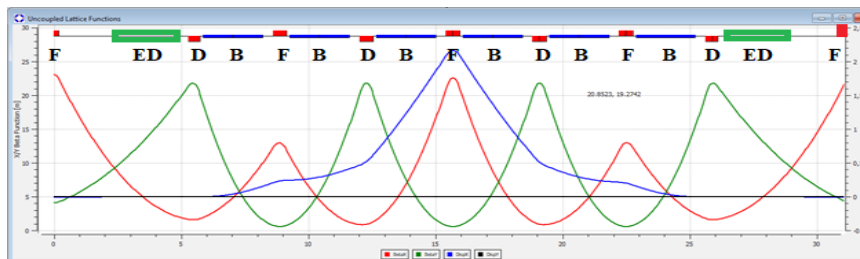
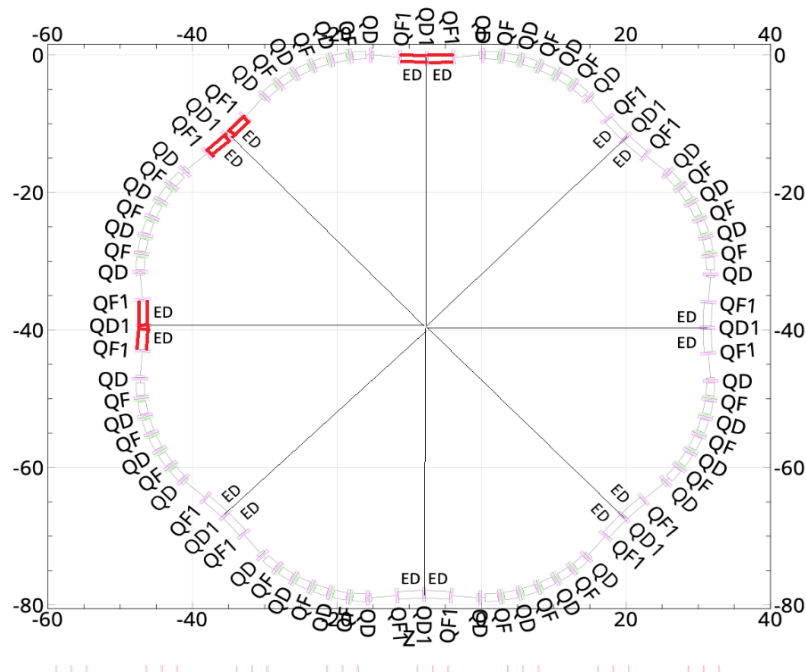
-Search for EDM of nucleons and nuclei is necessary to understand the origin of CP violation and baryogenesis in the Universe.

-The method is the measurement of the transverse polarization appearing for the longitudinally polarized particles.

-Several options of the magnetic optics are under consideration:

- NICA with bypasses,
- modernized Nuclotron ring,
- separate low energy (~ 300 MeV) ring.

-The polarization measurements must be provided by the 2π -deuteron polarimeter based on the measurements of dC scattering at 270 MeV.



Option for Nuclotron in “quasi-frozen spin” mode with electrostatic deflectors (ED)

N.N.Nikolaev, Yu.V.Senichev+team

SPRINT@NICA group

JINR: V.V.Fimushkin, A.V.Butenko, E.A.Butenko, N.V.Dunin, K.A.Ivshin, M.V.Kulikov, S.A.Kostromin, V.P.Ladygin, V.E.Laryonov, E.M.Syresin, A.N.Solovev, I.S.Volkov, V.A.Lebedev, E.E.Donets, V.V.Bleko, N.M.Piskunov, A.Ya.Silenko, O.V.Teryaev, Yu.N.Uzikov

MIPT: Yu.N.Filatov, A.N.Zelenski, S.V.Vinogradov, S.N.Zhabin, I.S.Yudin, A.A.Chernikova, E.D. Tsyplakov, I.V. Lilienberg, A. I. Chernyshov, A.B. Borisov

INR RAS: A.E.Aksentiev, A.S.Belov, Yu.V.Senichev, S.D.Kolokolchikov, A.A.Melnikov, P.Palamarchuka

ITP: N.N.Nikolaev

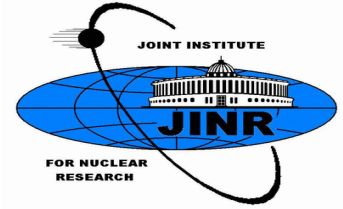
STL Zaryad: A.M.Kondratenko, M.A.Kondratenko

INP BSU: V.G.Baryshevsky, S.V.Anischenko, A.A.Gurinovich

BINP SB RAS: D.K.Toporkov

The group is growing.

New peoples with their ideas are welcome.



1. Spin Physics Research INfractrucrure and Technologies at NICA (SPRINT@NICA)

V.P. Ladygin *on behalf of SPRINT@NICA group*

Talk 26-th International Spin Symposium (SPIN-2025)
22-26 September 2025, Qingdao, China, **PoS(SPIN2025) 152**



2. Several talks at RuPAC'25

15-19 September 2025, St.Petersburg, RF
Accepted in **Phys.Part.Nucl.Lett.**

3. Several reviews in Natural Sci.Rev.

V.V.Fimushkin et al., *Natural Sci.Rev.* 3 (2026) 200608

V.G.Baryshevsky, *Natural Sci.Rev.* 3 (2026) 200607

B.Gou et al., *Natural Sci.Rev.* 3 (2026) 200802

Yu.N.Filatov et al., *submitted to Natural Sci.Rev.*

SPRINT@NICA steps

Meetings:

- 1. Beam Polarimetry at Nuclotron/NICA**
12.11.2025, LHEP JINR -done, minutes are uploaded.
- 2. Spin Manipulation Techniques at Nuclotron/NICA**
26.11.2025, LHEP JINR -done, minutes are uploaded.
- 3. Polarized Beams, Sources and Targets at Nuclotron/NICA**
18.02.2026, LHEP JINR -done, minutes are uploaded.
- 4. High Precision Spin Experiments at Nuclotron/NICA**
(must include also first test experiments)
04.03.2026, LHEP JINR -done, minutes are uploaded.

Draft of the SPRINT@NICA CDR -end 2026

SPRINT@NICA at DSPIN- 2026

5 Plenary talks:

V.Ladygin

Yu.Filatov

Yu.Senichev

N.Nikolaev

A.Zelenski

About 20 talks at parallel sections.

Special parallel section at 9.09.2026

Conclusion

SPRINT@NICA project is devoted to developments of the research infrastructure and the technologies for the current and planned spin experiments at Nuclotron/NICA.

Several fixed target experiments are already working at Nuclotron using polarized beams provided by new [SPI](#). Part of research infrastructure is ready. They are the drivers of the SPRINT developments together with SPD at least up to 2030.

Main directions of planned activity within SPRINT@NICA are further development of the high intensity polarized beams and corresponding beam polarimetry, experimental verification of Spin Transparency mode and preparation of the high precision spin experiments.

Thank you for the attention!