

Measurements of the Deuteron and Proton Beam Polarizations at Nuclotron

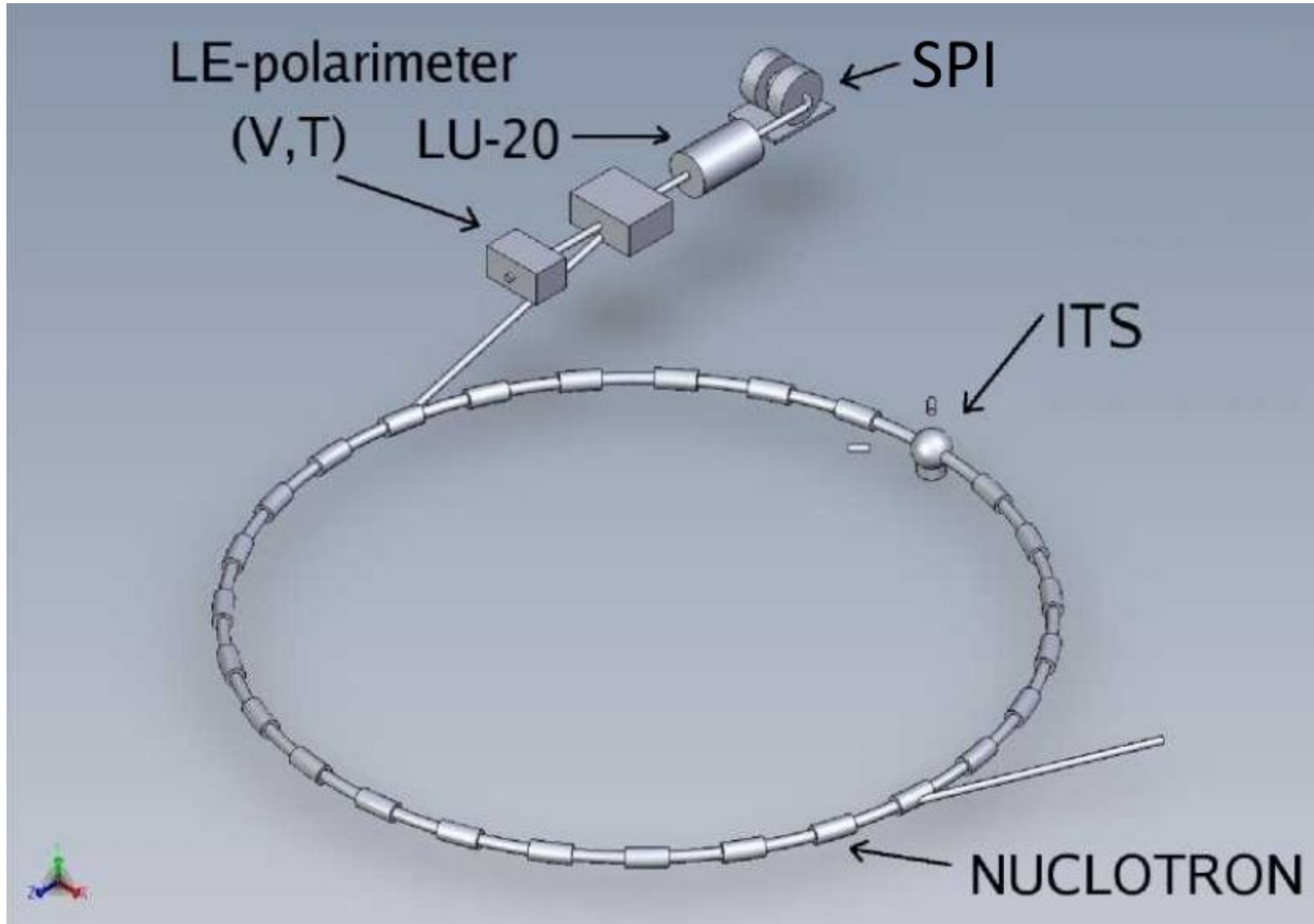
Volkov Ivan

DSS Collaboration, LHEP JINR

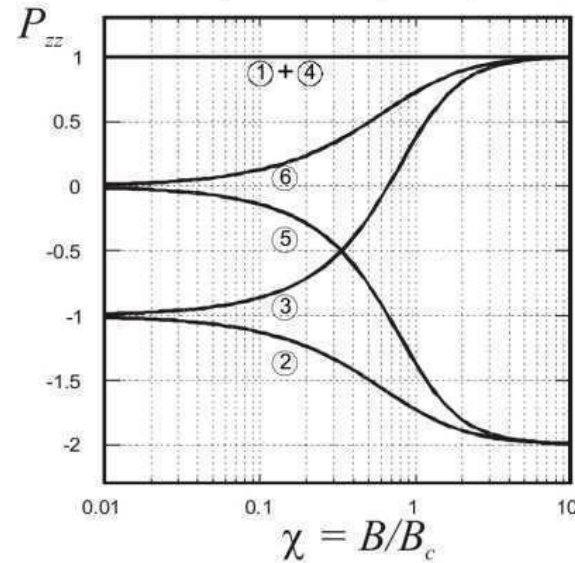
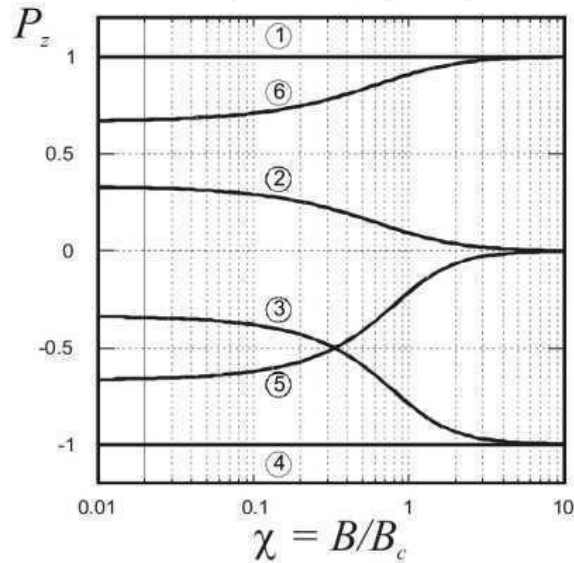
Motivation

1. The measurement of **vector polarization** of the polarized **deuteron** and **proton beams** at energies up to 650 MeV/n using quasi-elastic proton-proton scattering;
2. First result of the **polarization** measurement for the run with polarized **proton beam**.

Scheme of the experiment at NUCLOTRON



Deuteron beam polarization



3 modes of the ion source were used:

(P_z, P_{zz})

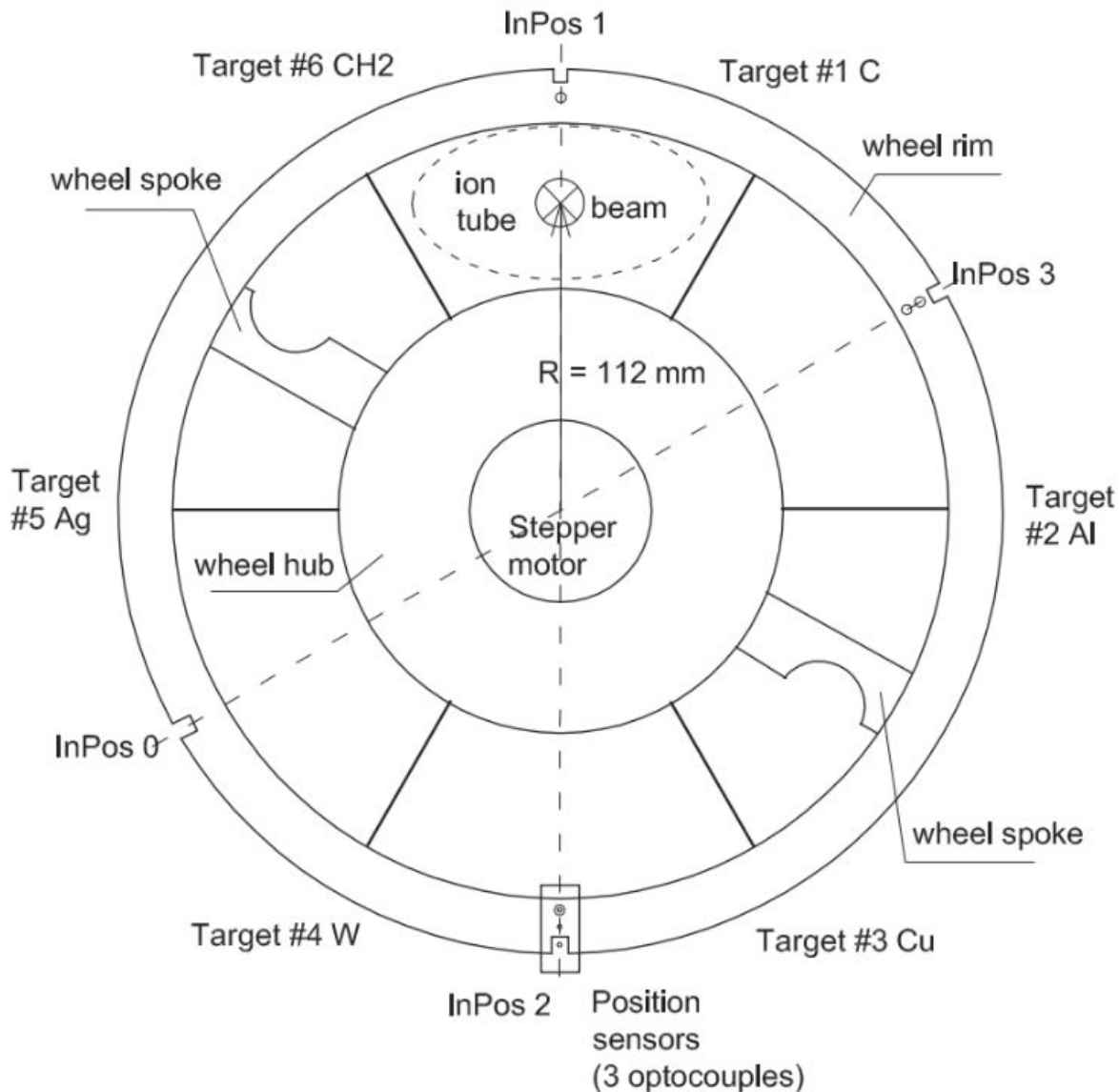
"2-6"	"+"	$(1/3, +1)$
"3-5"	"-"	$(1/3, -1)$
Unpolarized	"0"	$(0, 0)$

Vector polarization values obtained with dp elastic scattering at 135 MeV/n

	P_z^+	ΔP_z^+	P_z^-	ΔP_z^-
500, 650 MeV/n	0.231	0.008	0.245	0.006
200, 550 MeV/n	0.211	0.007	0.239	0.005

~70% of the ideal values!

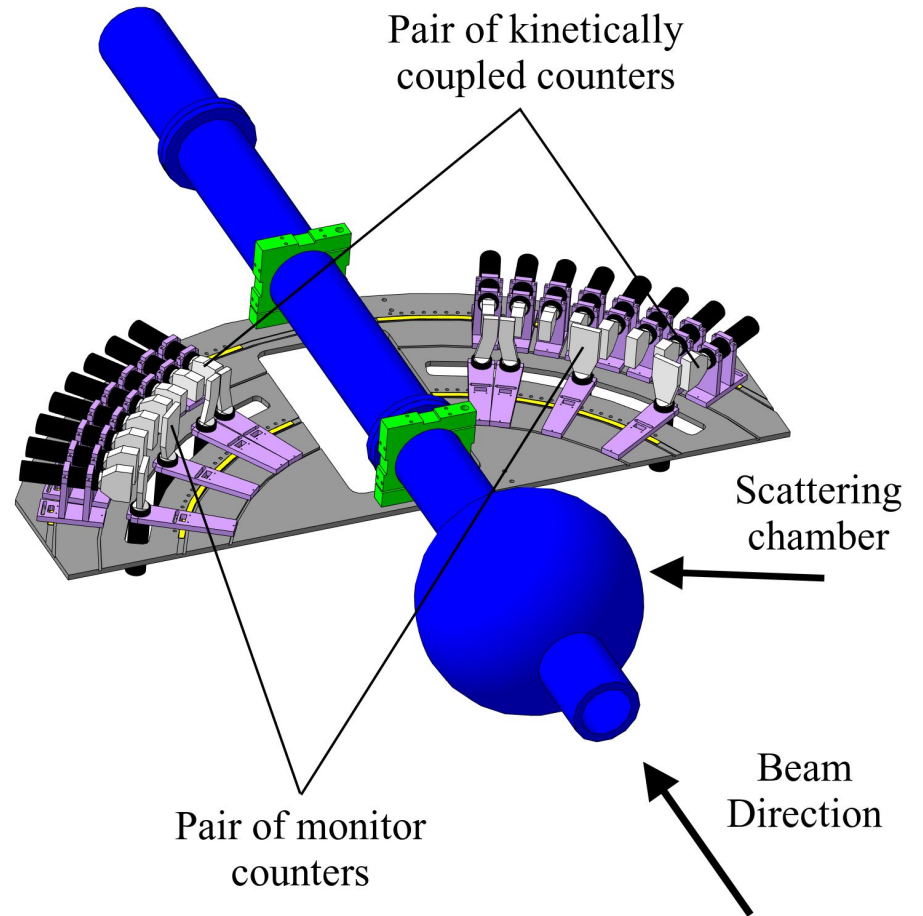
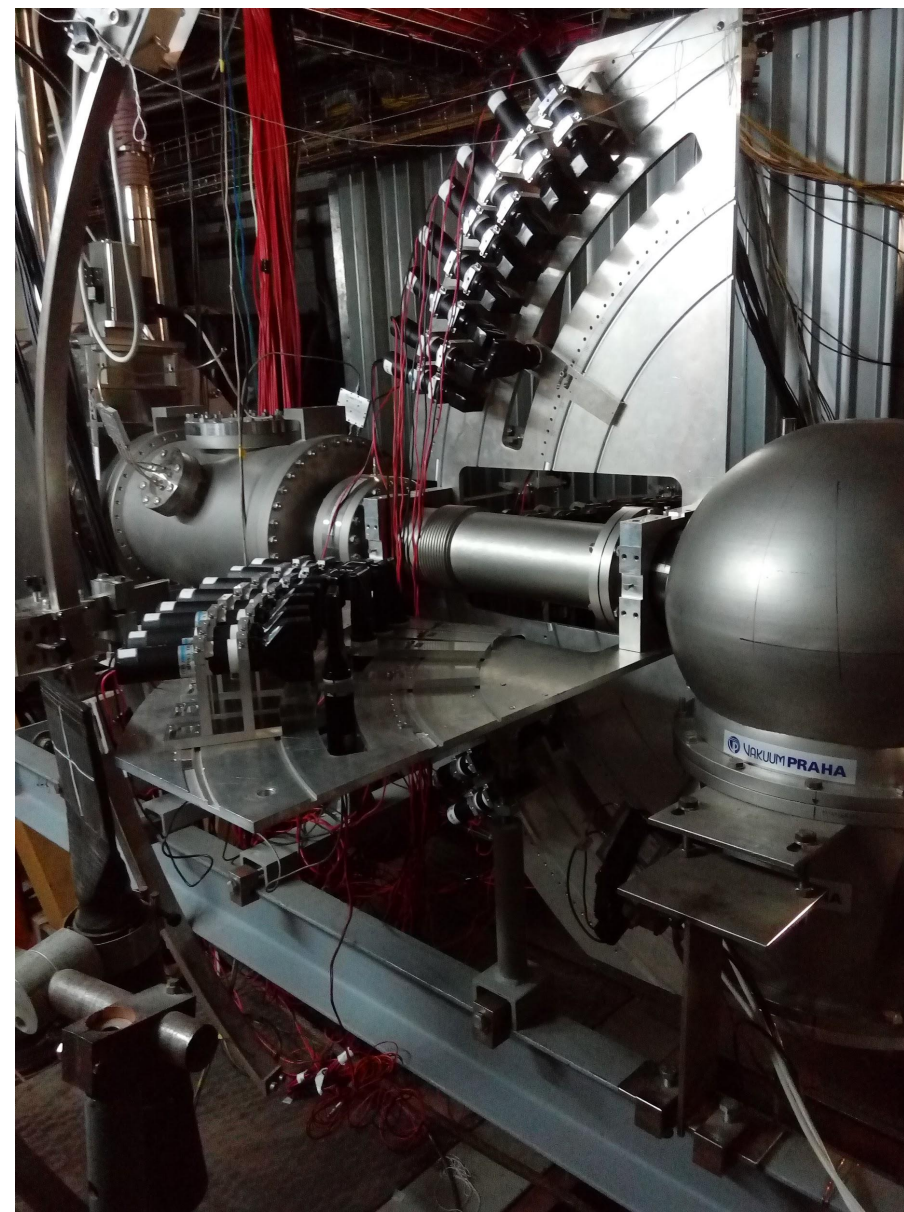
Target Changing System



In the experiment were used:

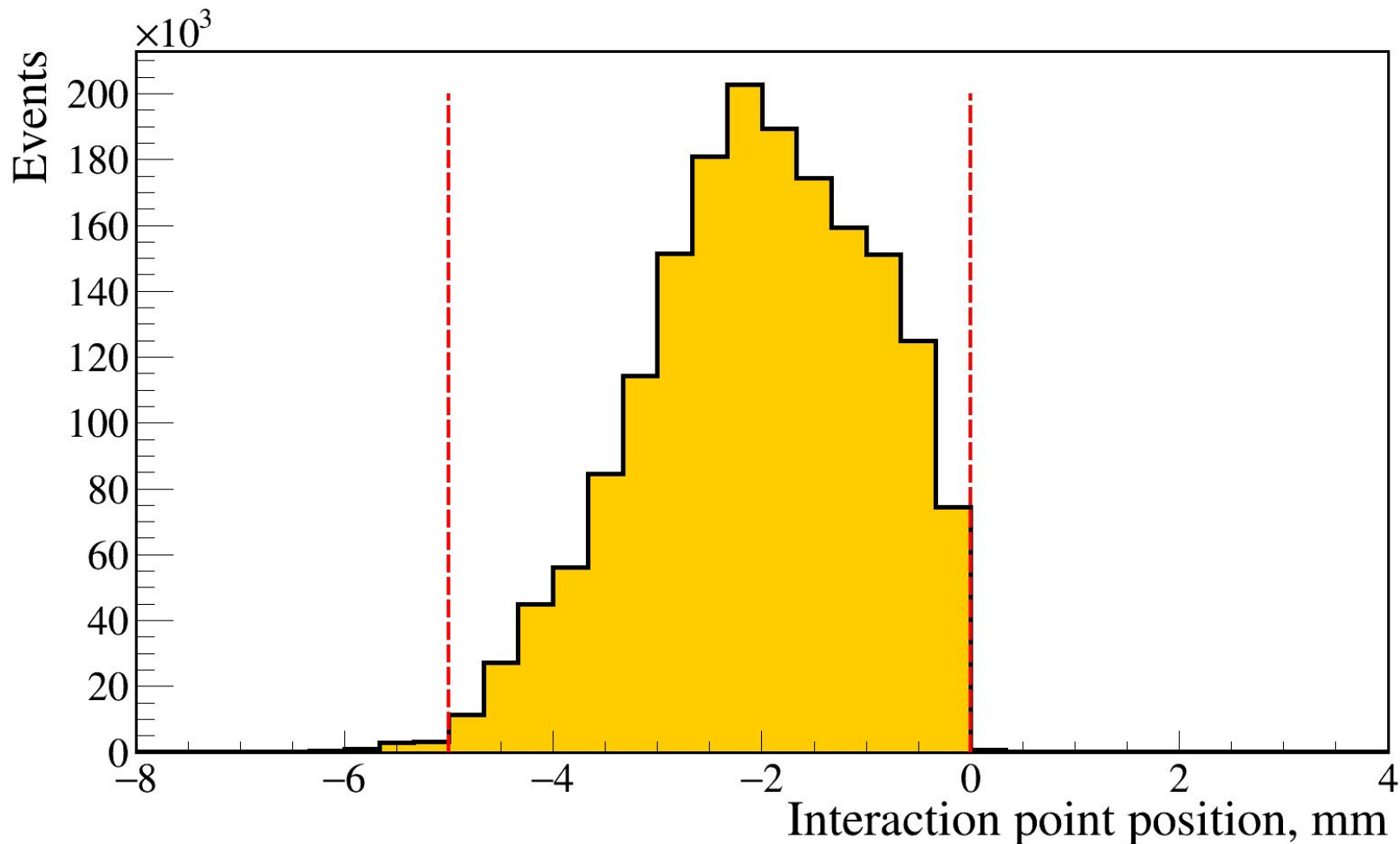
- Target #6 CH2. Film with $10 \mu\text{m}$ thickness.
- Target #1 C. Filament from 10 threads with each $8 \mu\text{m}$ thickness.

The DSS Setup



- 6 pairs to the left, 6 pairs to the right;
from 55° to 85° in the CM system;
- 1 pair to 90° in CM;
- pp -elastic kinematics.

Selection of useful data by the event position of the target inside the ion tube. Deuteron beam

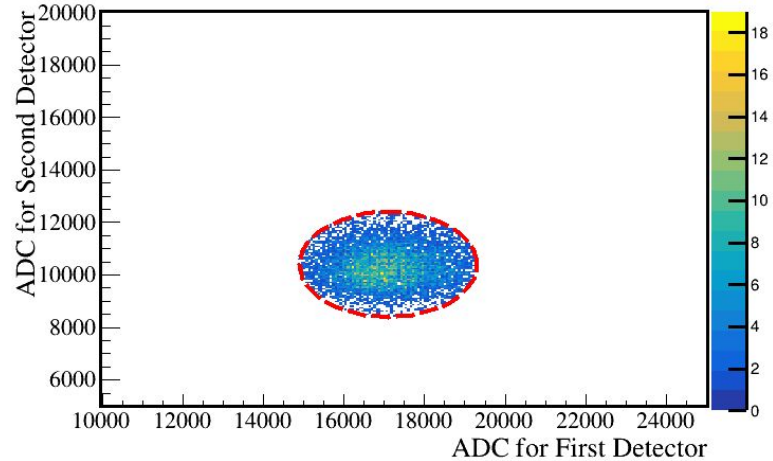
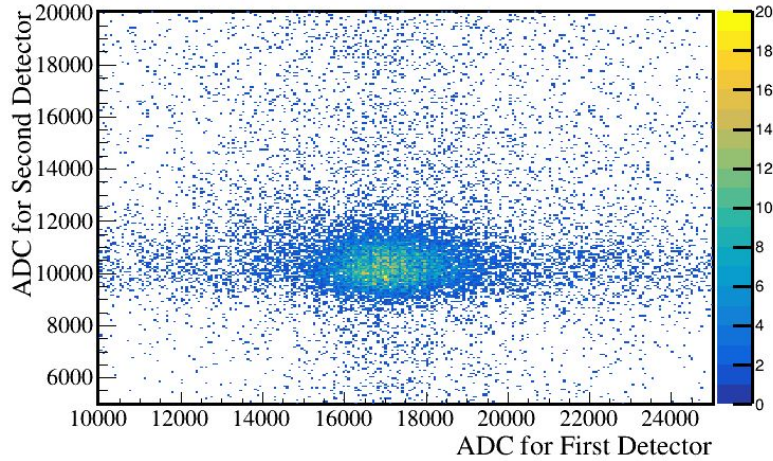


Based on the rotation of the target changing system wheel.
Data from the stepper motor.

Selection of useful data.

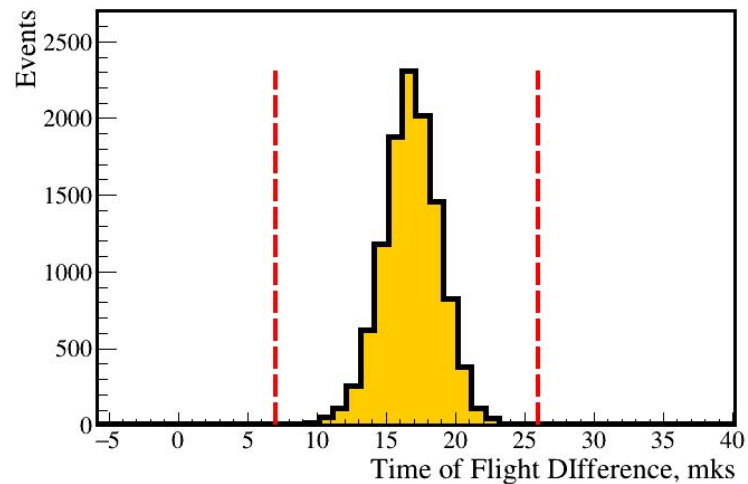
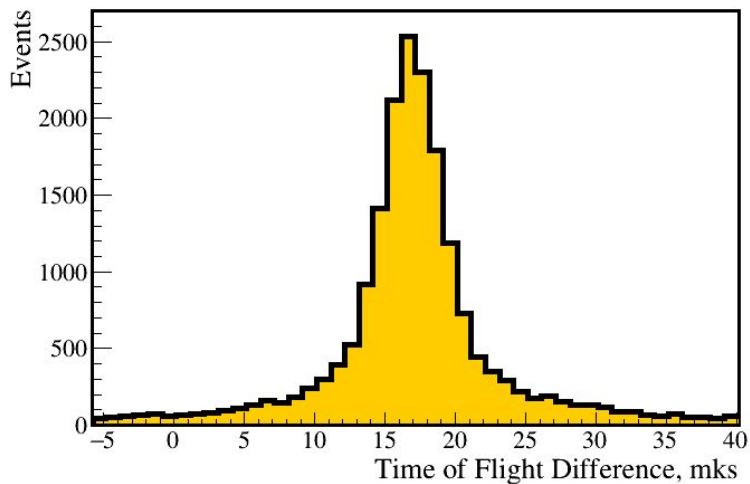
Deuteron beam

Ionization loss correlation for the counters pair



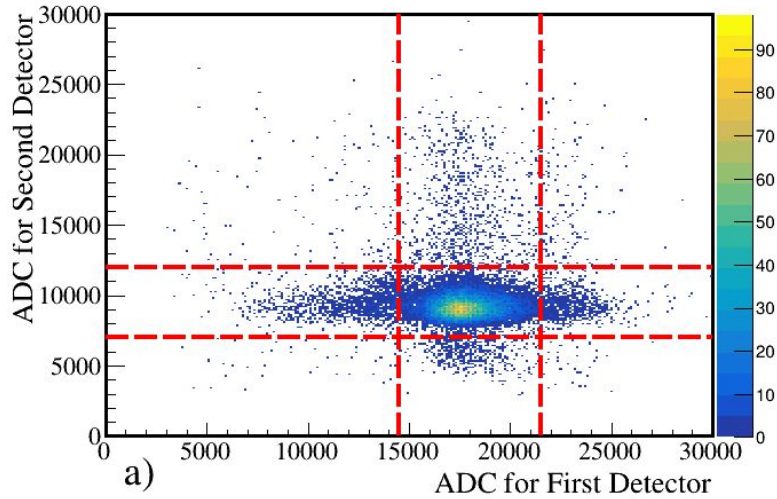
Cuts
applied one
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better result

Time-of-flight difference for the pair

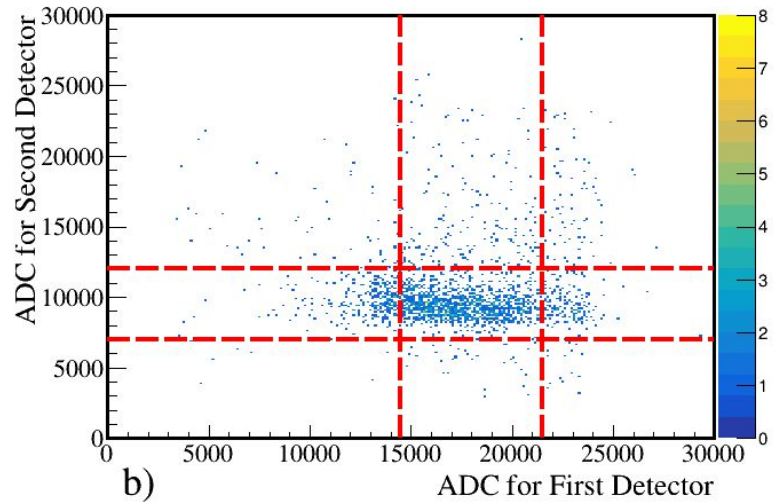


Background subtraction procedure.

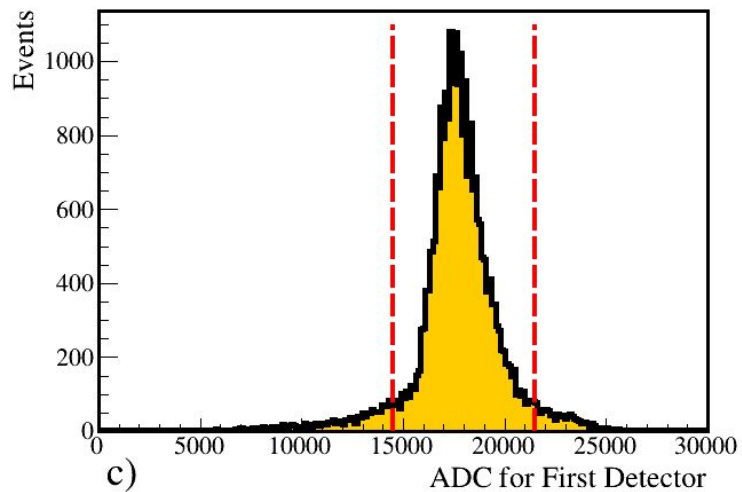
Deuteron beam



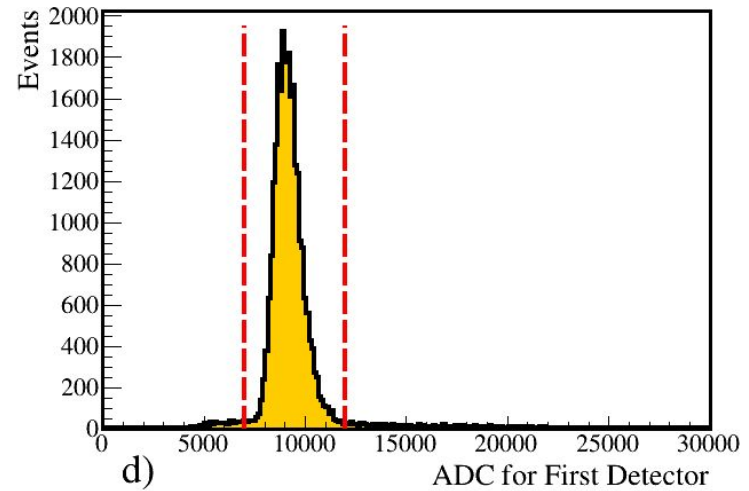
Polyethylene



Carbon

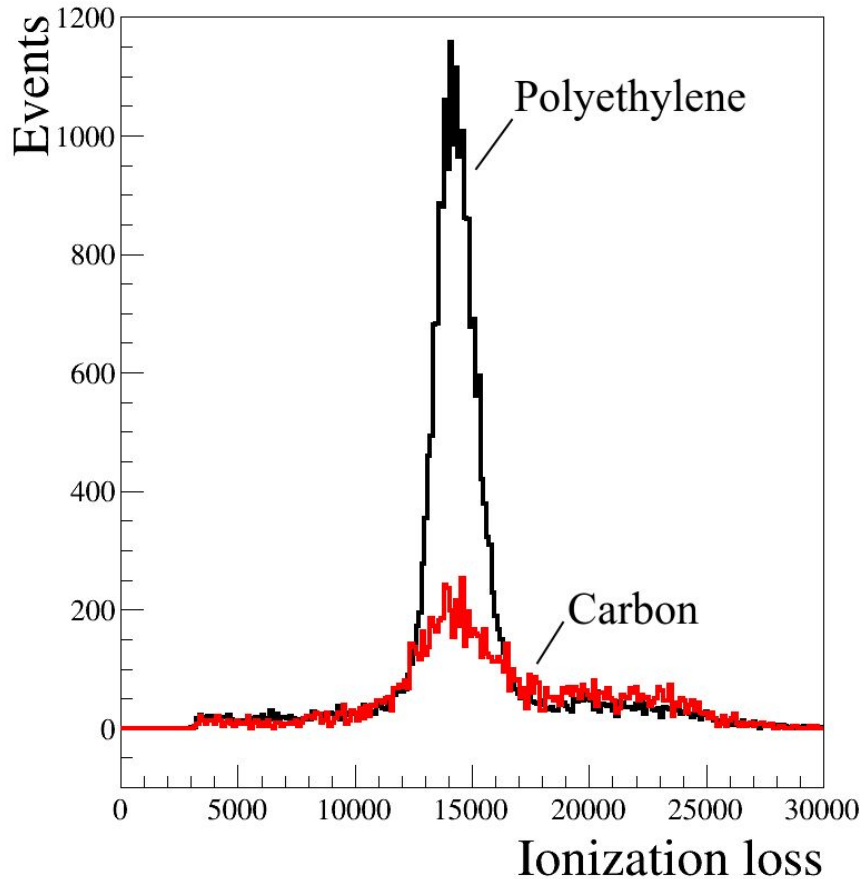


X polyethylene projection

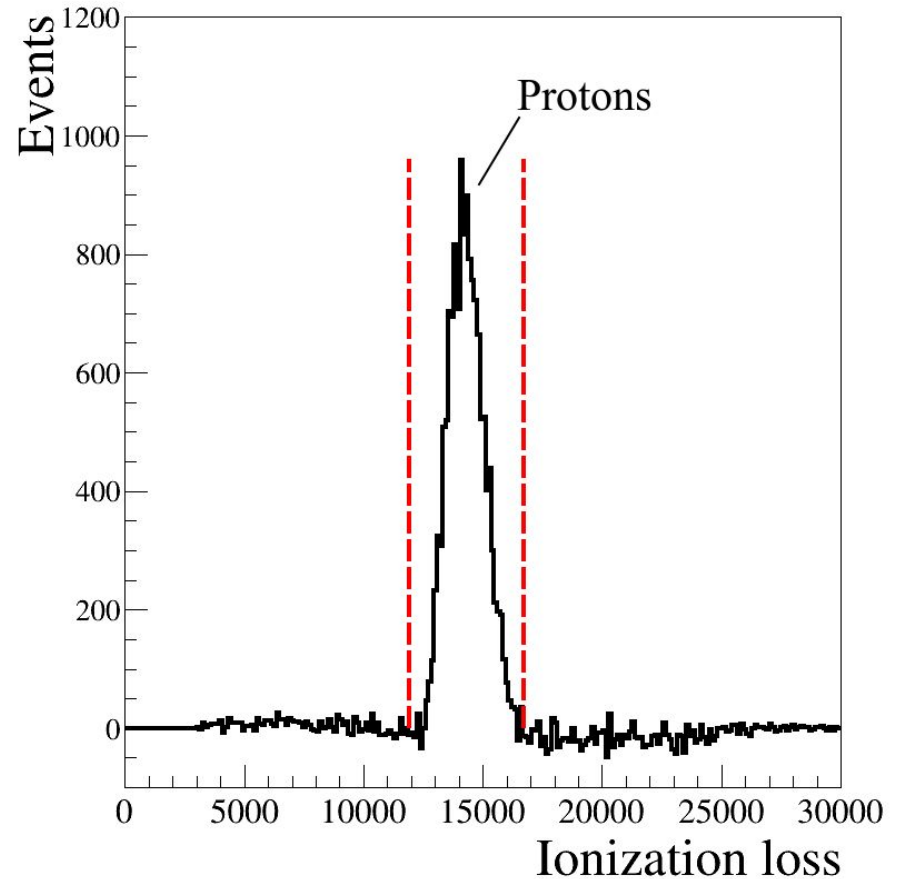


Y polyethylene projection

The result of the background subtraction. 500 MeV/n, 85° in CM system

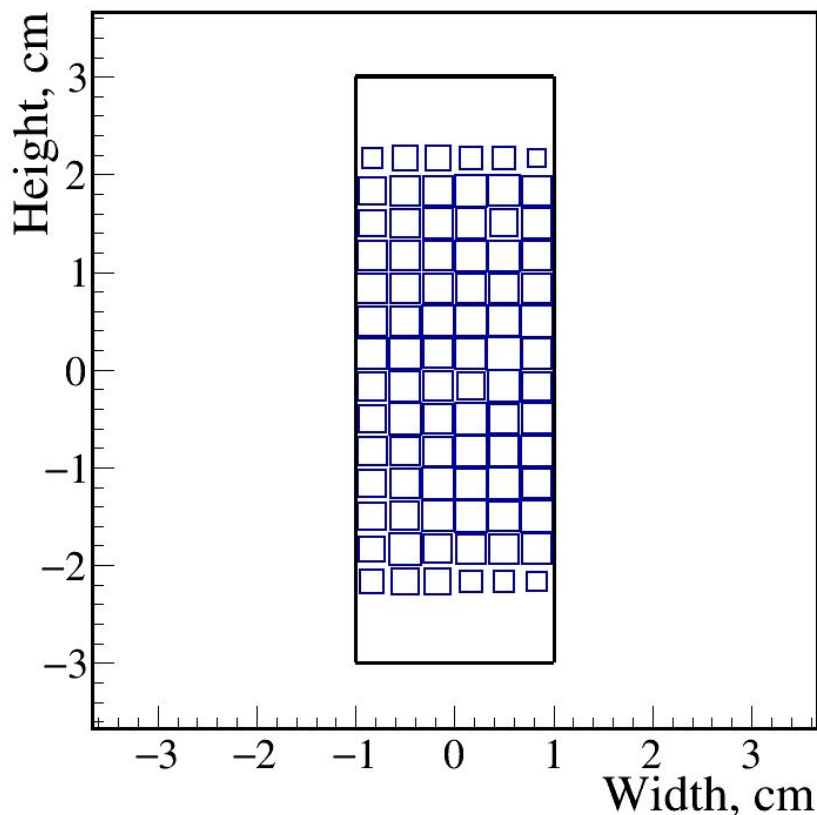


~50% of events is background.
Unpolarized data

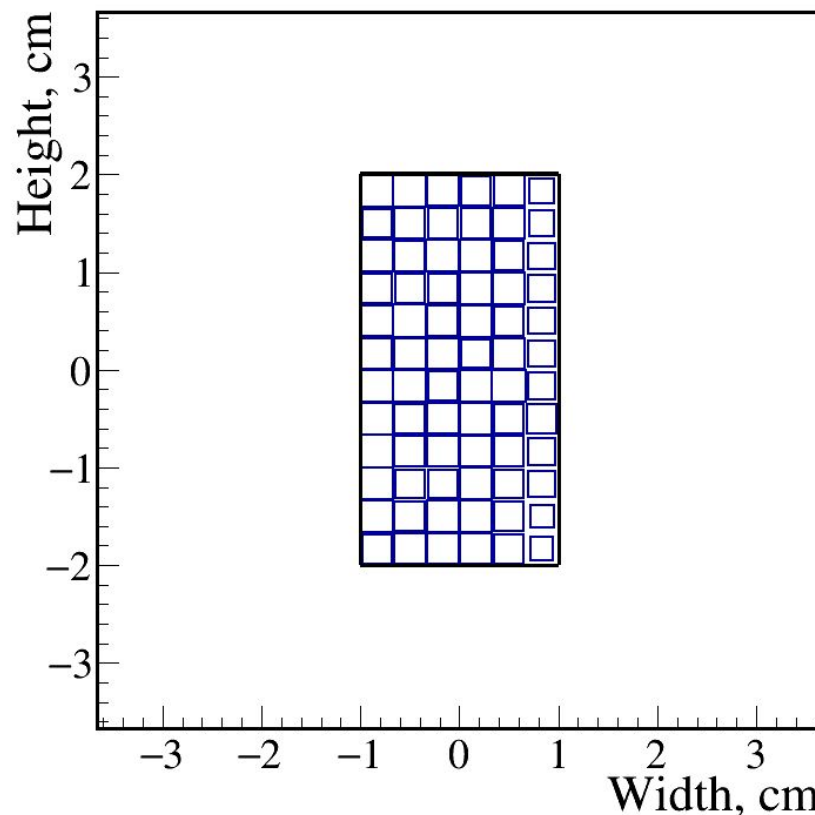


Red lines - cut on ADC.

Coincidence hits distribution in the detectors from the simulation. 500 MeV/n, 85° in CM system



Left detector

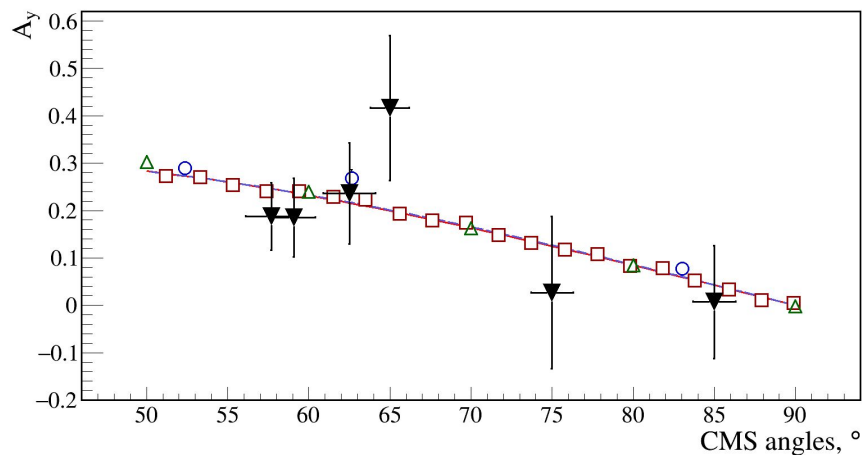


Right detector

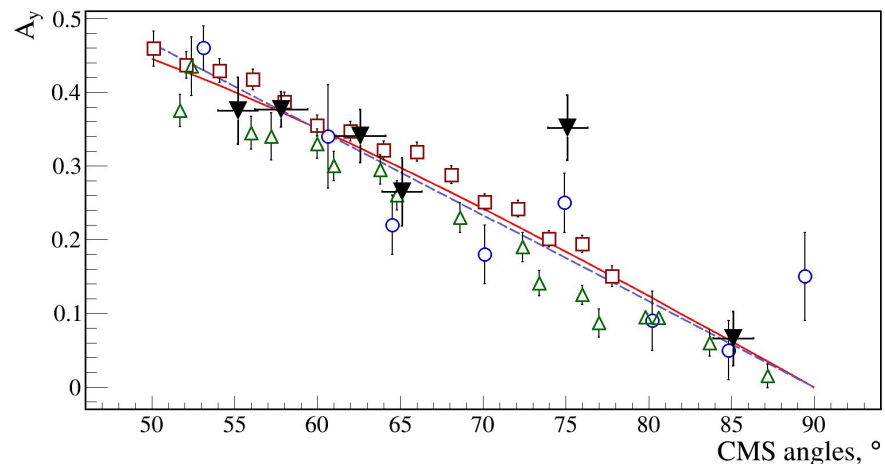
It needs to correct angles at which events were recorded via the beam shift. Pluto Generator for ROOT Framework was used. *pp* elastic scattering has been simulated.

The vector analyzing power

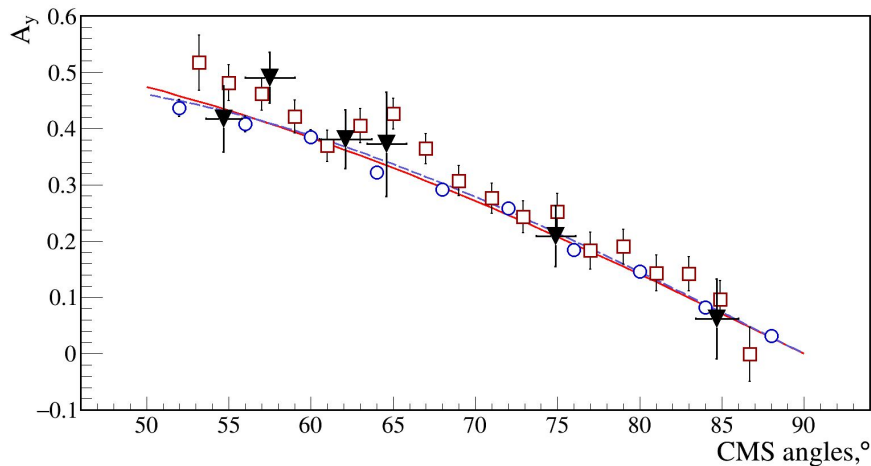
200 MeV/n



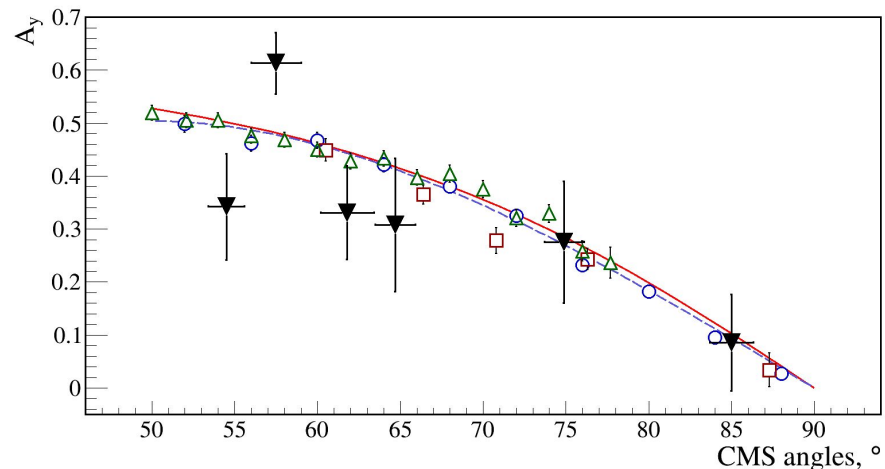
500 MeV/n



550 MeV/n



650 MeV/n



Our data - filled triangles ▼

—

SAID SP07

- - -

Fit, 3rd degree polynomial

The vector polarization definition formulas

"2-6"

$$P_y^+ = \frac{\frac{N_L^+ M^0}{N_L^0 M^+} - \frac{N_R^+ M^0}{N_R^0 M^+}}{2A_y},$$

"3-5"

$$P_y^- = \frac{\frac{N_L^- M^0}{N_L^0 M^-} - \frac{N_R^- M^0}{N_R^0 M^-}}{2A_y}$$

P_y^+ and P_y^- - the vector polarization for the SPI mode "2-6" and "3-5".

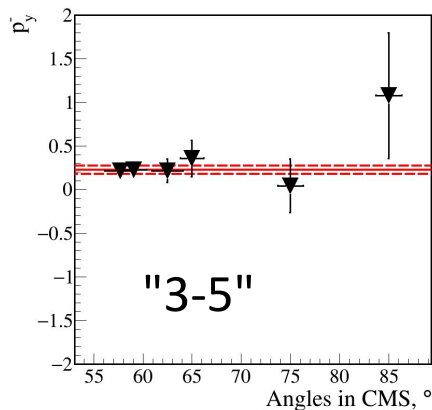
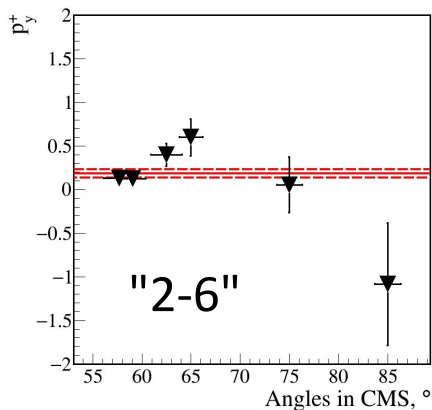
N - number of events for the particular angle. L to the left, R to the right.

M - number of events in the monitor counters.

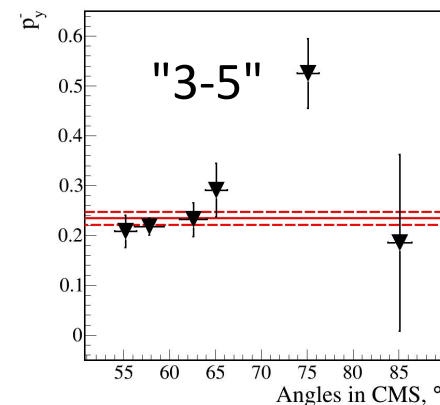
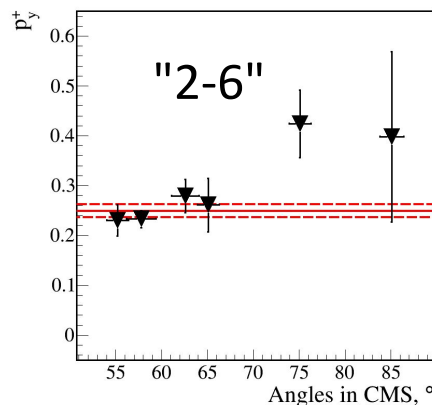
A_y - vector analyzing power for the particular angle.

The deuteron beam polarization values

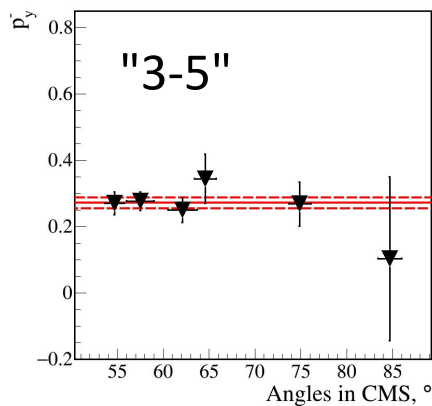
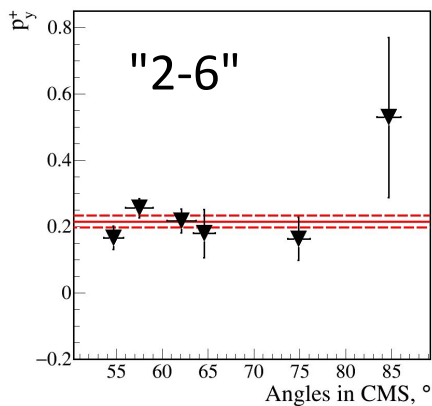
200 MeV/n



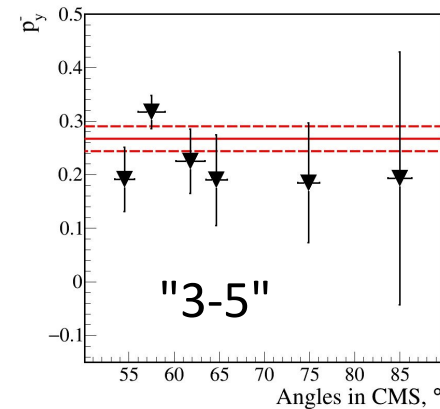
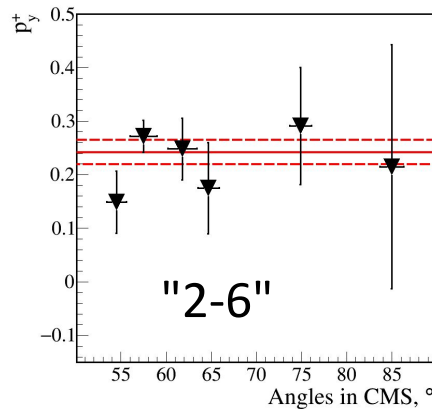
500 MeV/n



550 MeV/n



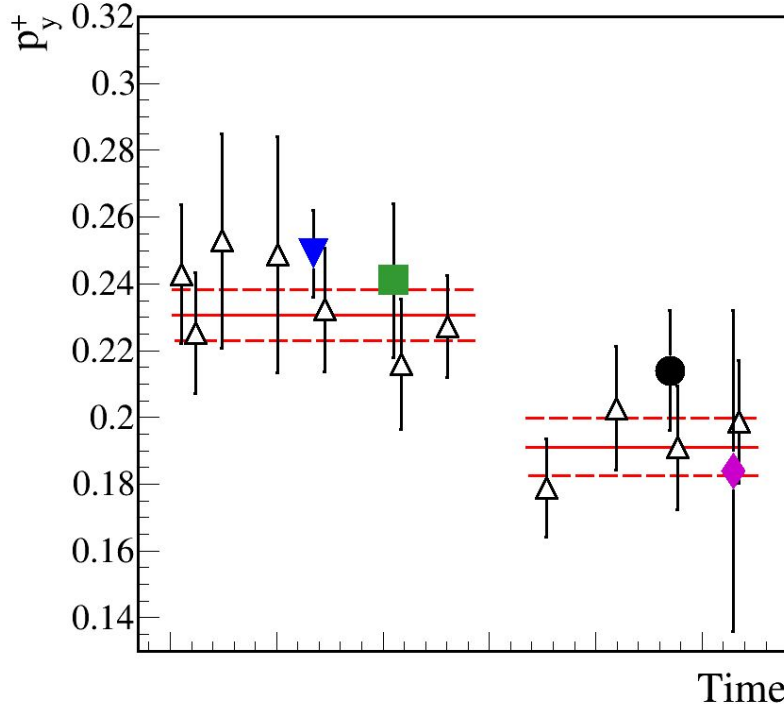
650 MeV/n



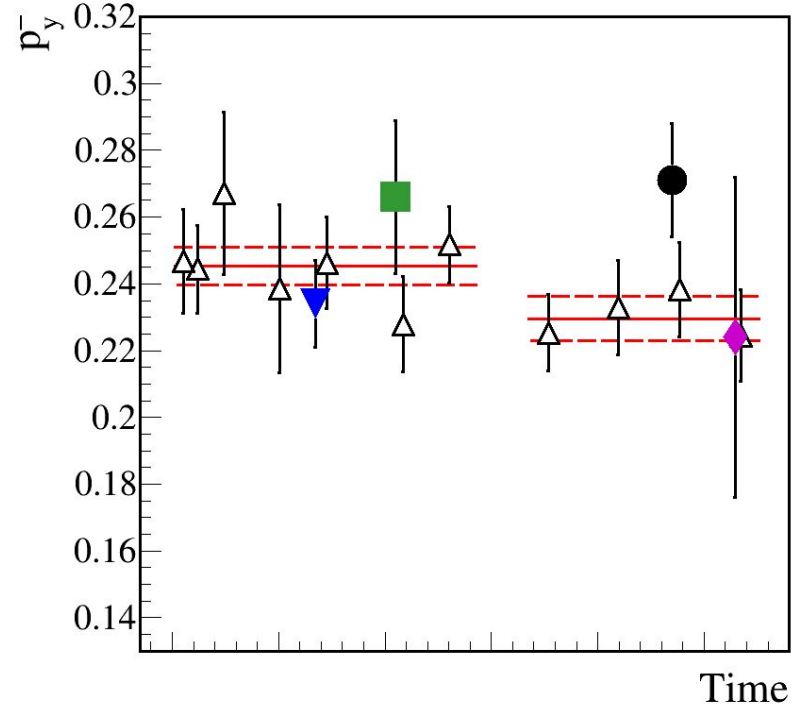
Values for each angle (detectors pair) in CM system.
Red lines - weighted average.

The averaged deuteron beam polarization values

"2-6"



"3-5"

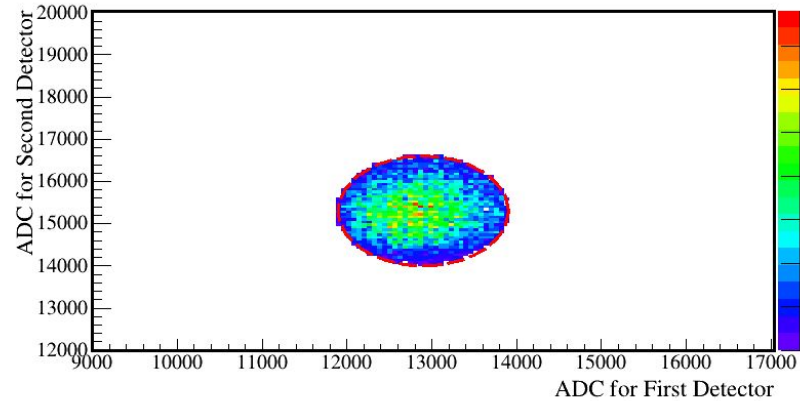
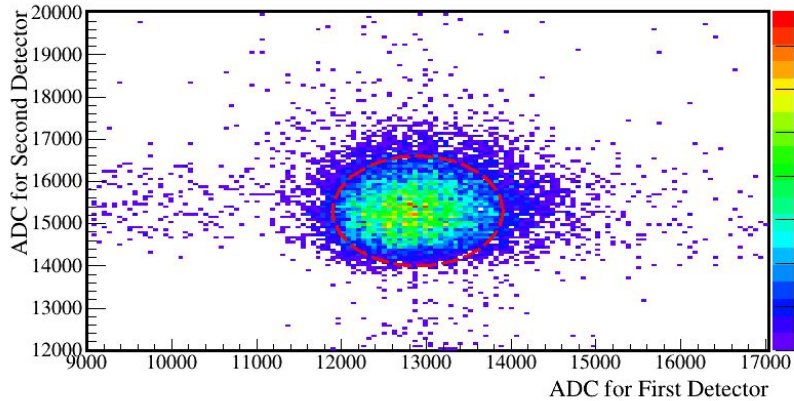


- \triangle - polarization values for dp elastic scattering (135 MeV/n)
- \blacktriangledown - polarization values for pp quasi-elastic scattering (500 MeV/n)
- \blacksquare - polarization values for pp quasi-elastic scattering (650 MeV/n)
- \bullet - polarization values for pp quasi-elastic scattering (550 MeV/n)
- \square - polarization values for pp quasi-elastic scattering (200 MeV/n)

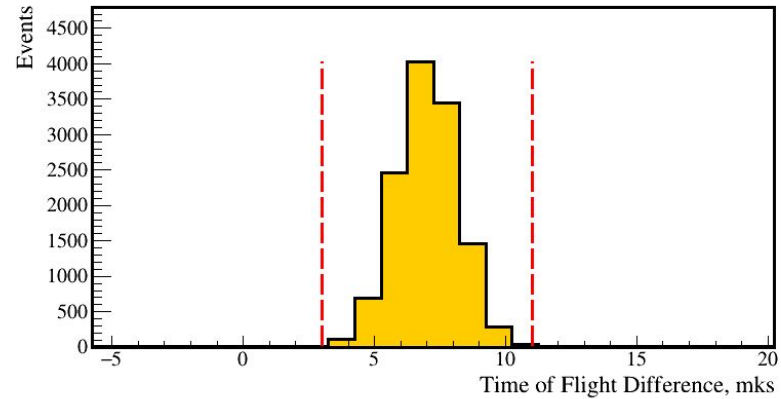
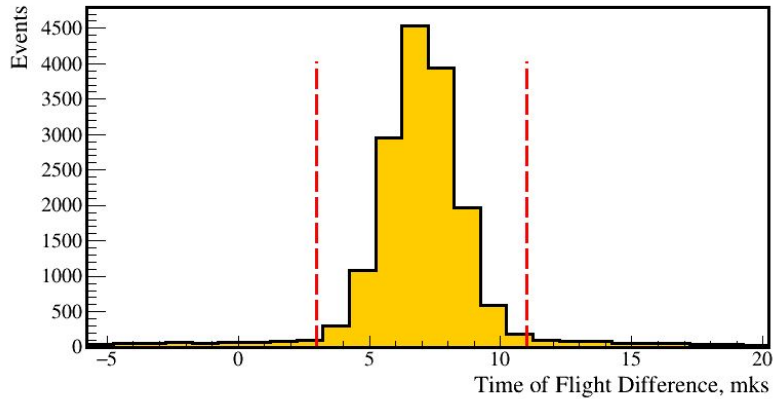
Selection of useful data.

Proton beam

Ionization loss correlation for the counters pair



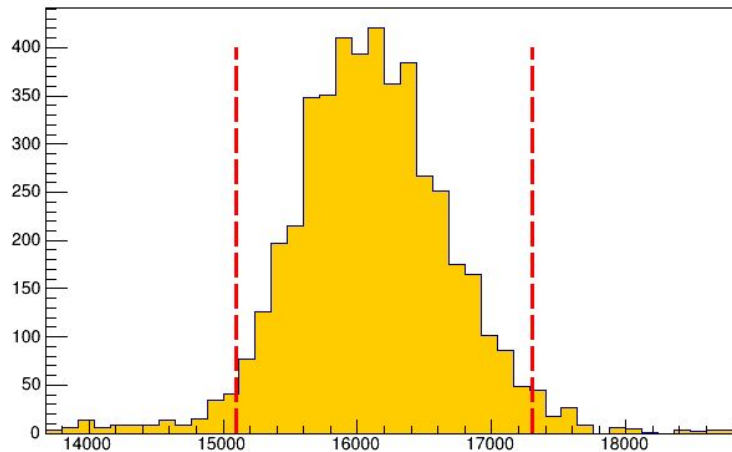
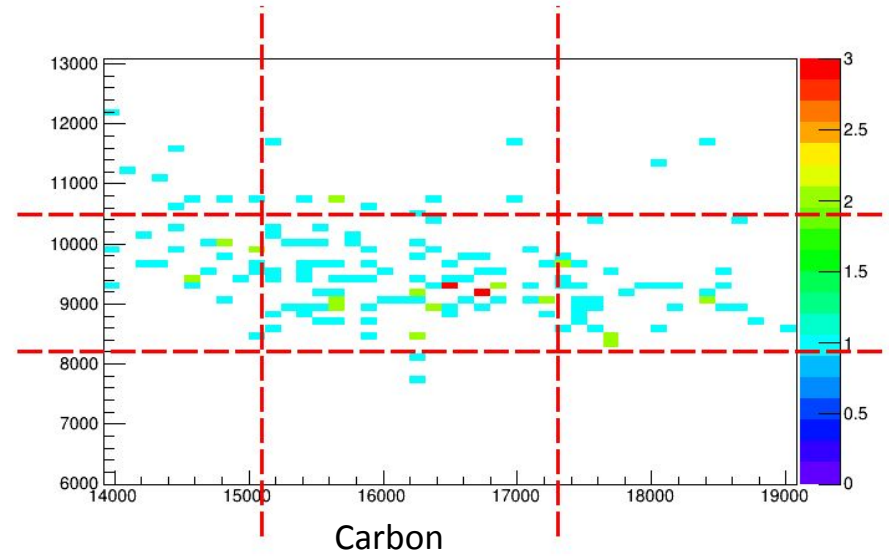
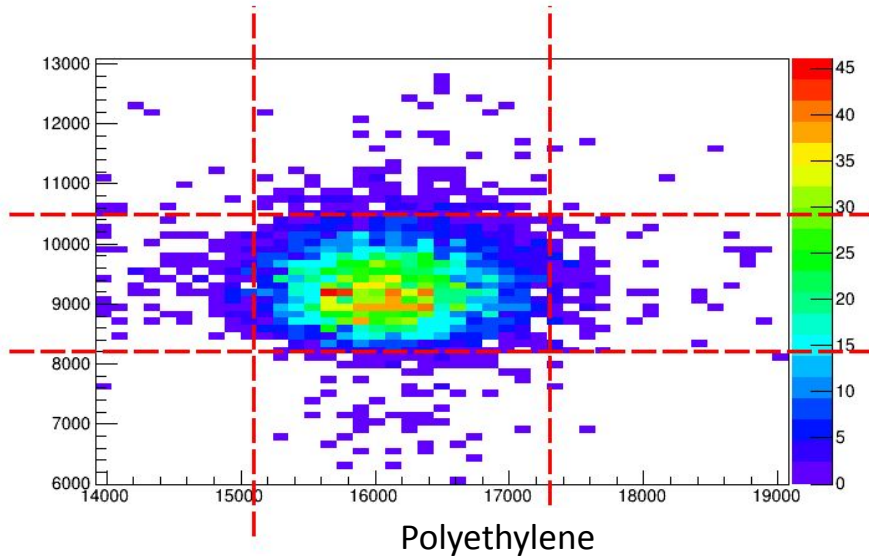
Time-of-flight difference for the pair



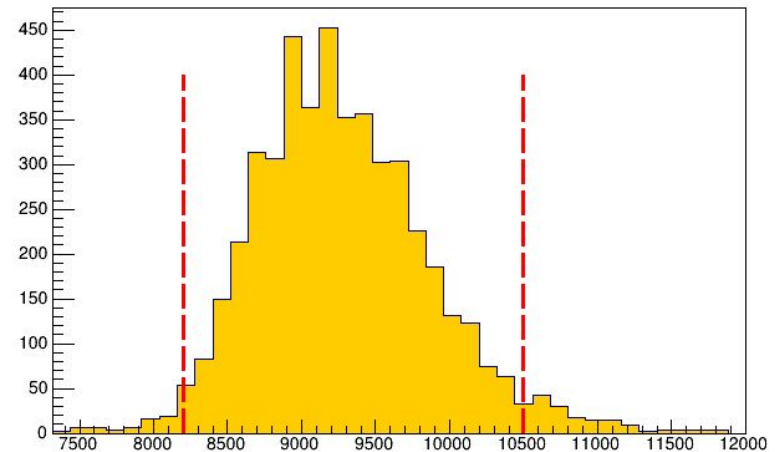
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Background subtraction procedure.

Proton beam



X polyethylene projection

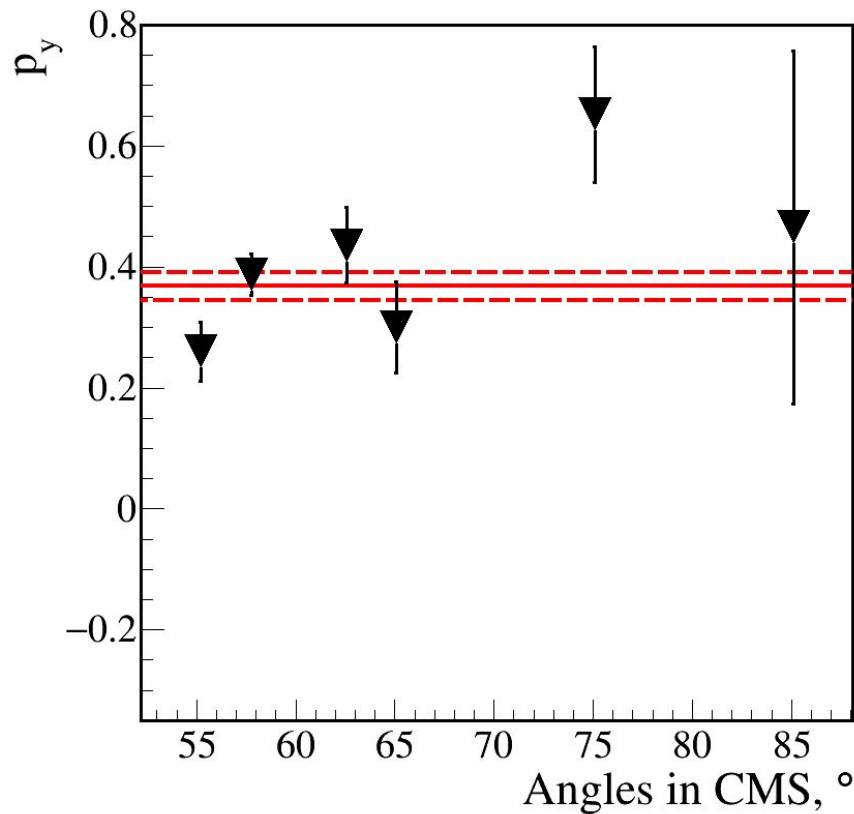


Y polyethylene projection

The proton beam polarization values. 500 MeV

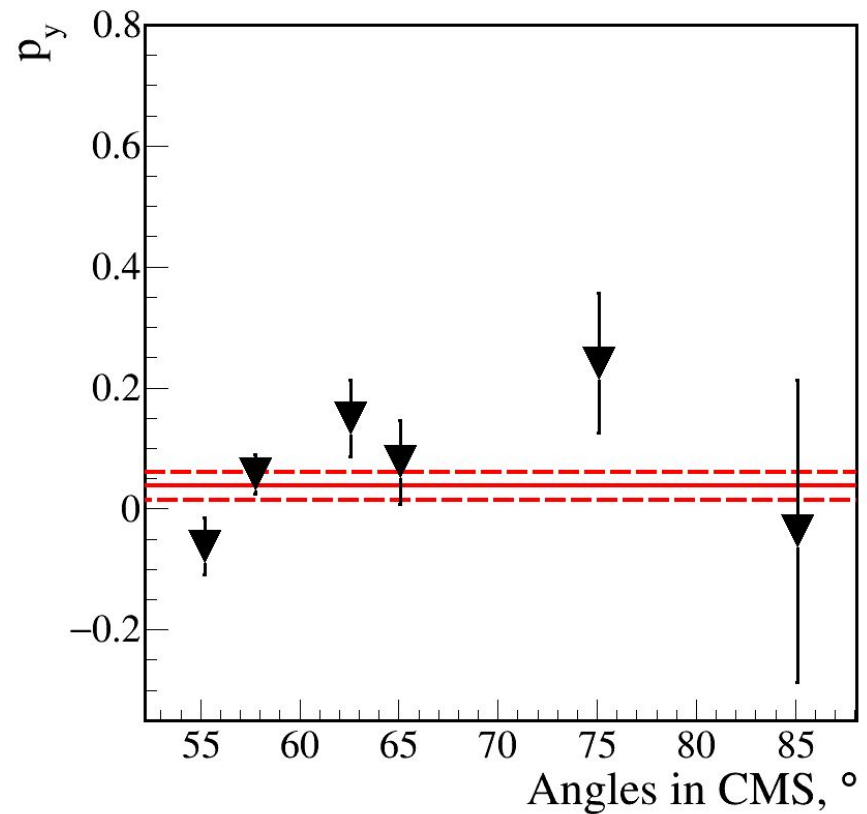
Polarized beam, "1-3" mode of SPI

$$p_y = 0.368 \pm 0.023$$



Unpolarized beam

$$p_y = 0.038 \pm 0.023$$



Conclusion

- The **vector polarization** values of the **deuteron beam** at modes "2-6" and "3-5" were obtained at the beam energies of **200, 500, 550** and **650 MeV/n**;
- The **vector polarization** values are in **good agreement** with the polarization values that were obtained using *dp* elastic scattering at the beam energy of **135 MeV/nucleon**;
- The **polarization** values of the **proton beam** at mode "1-3" and unpolarized were obtained at the energy of **500 MeV**;
- The **vector analyzing power** values of the *pp*-quasielastic scattering reaction were obtained using the same asymmetry. They are in **good agreement** with the world data and SP07.
- The experimental setup is **suitable** for the **deuteron** and **proton** beam **polarimetry**.

**Thank you for
your attention!**