Deuteron beam vector polarization measurement using proton-proton quasielastic scattering at the energies from 200 to 650 MeV/nucleon

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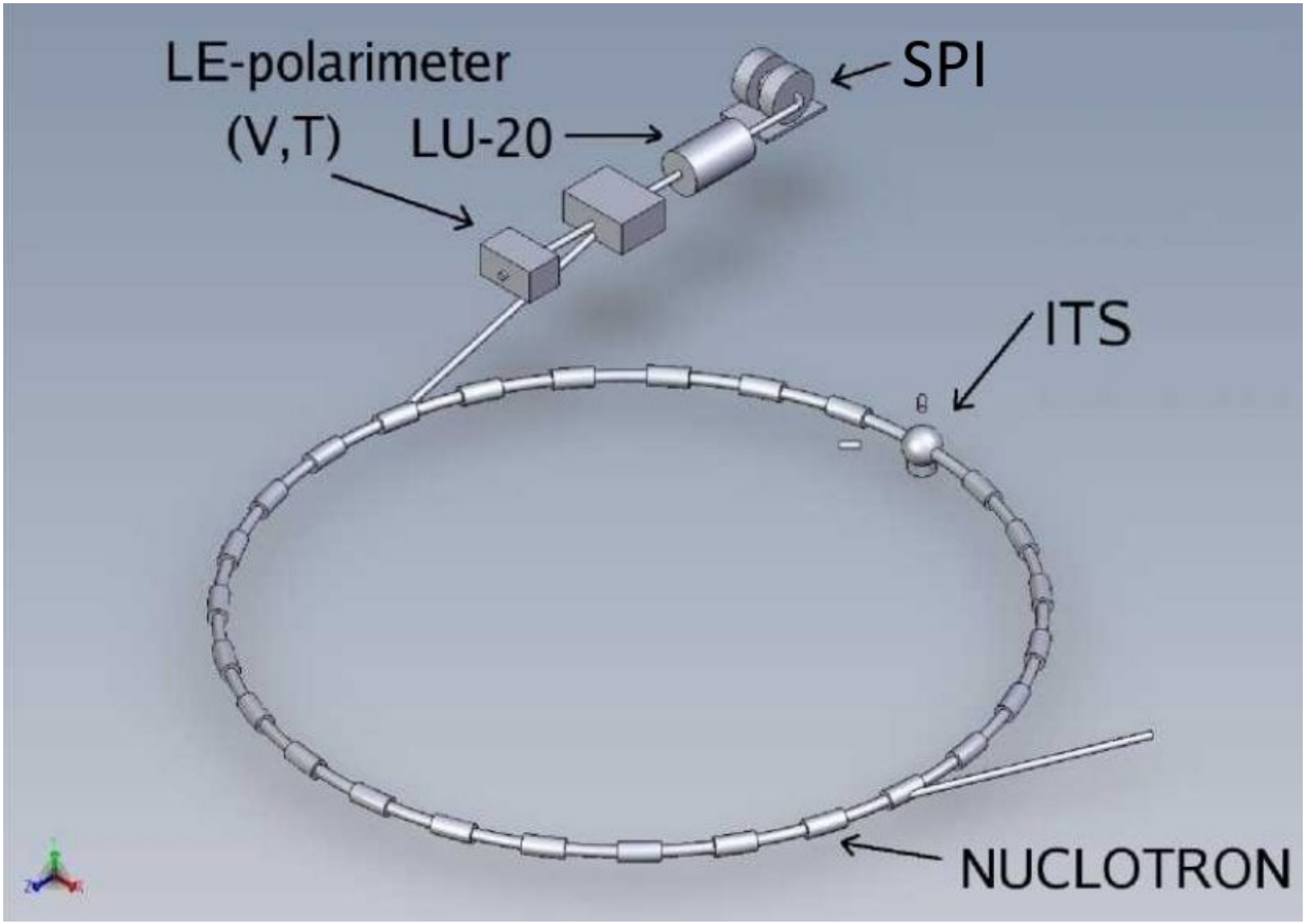
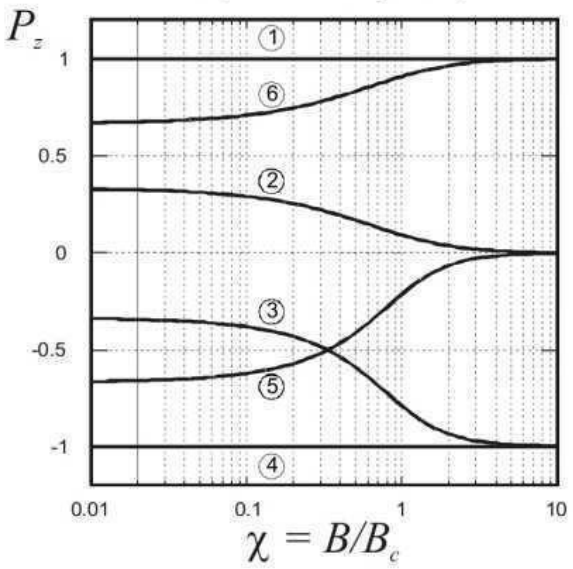
Motivation

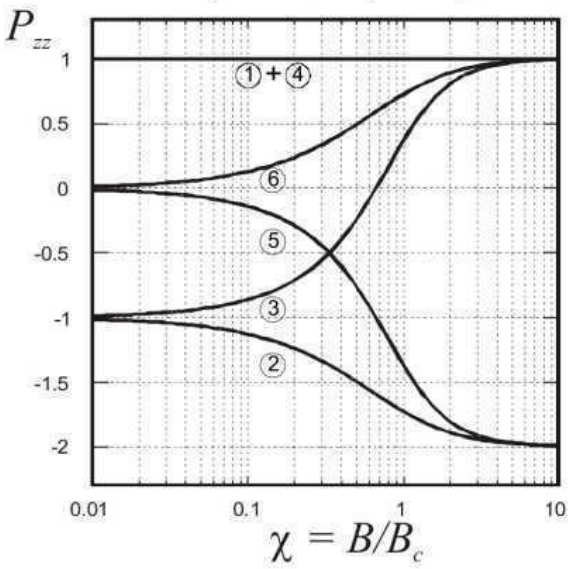
1. Obtaining new data for the proton-proton scattering to improve nucleon-nucleon interaction models;
2. Checking the possibility of using quasi-elastic proton-proton scattering to measure vector polarization values of the polarized deuteron beams at energies up to 1 GeV/n.

Scheme of the experiment at NUCLOTRON



Beam polarization





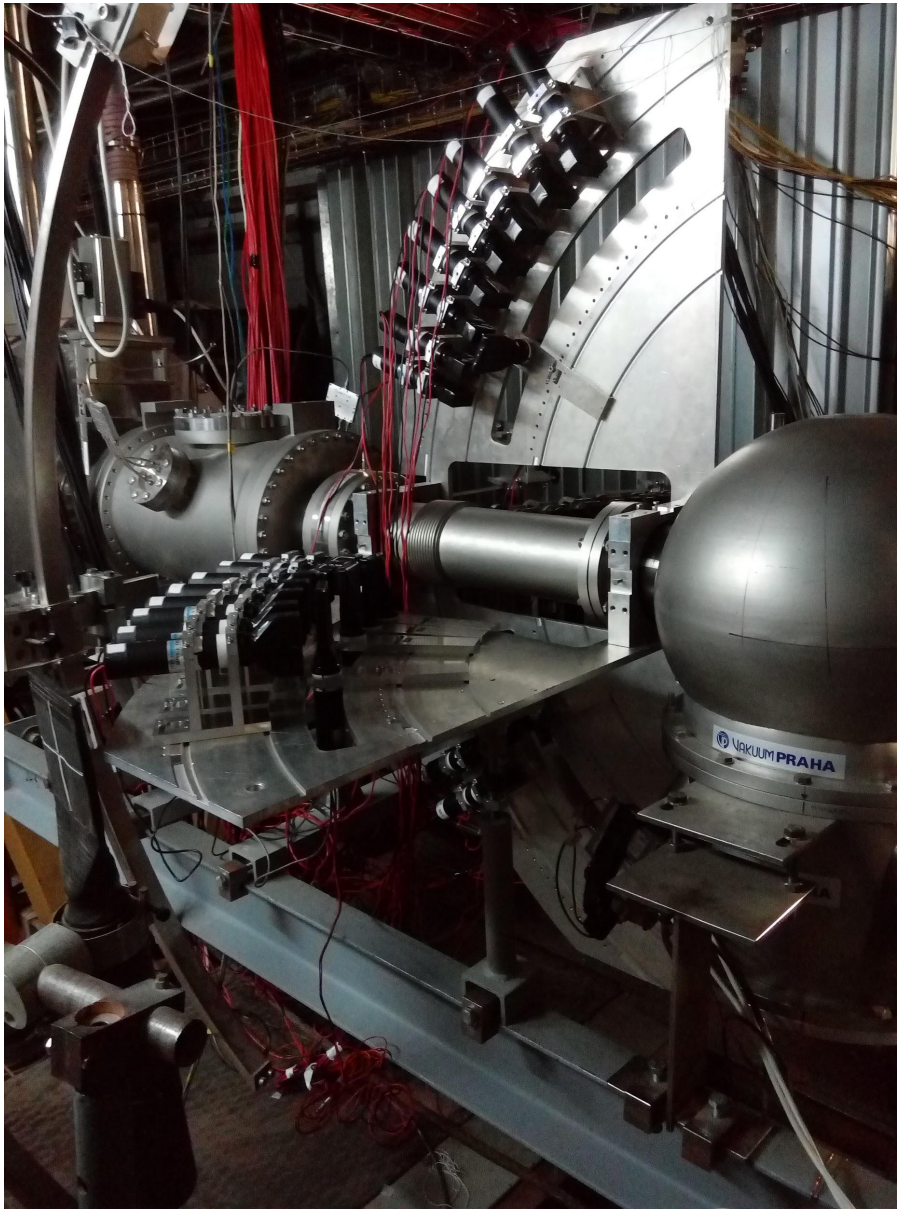
3 modes of the ion source were used:

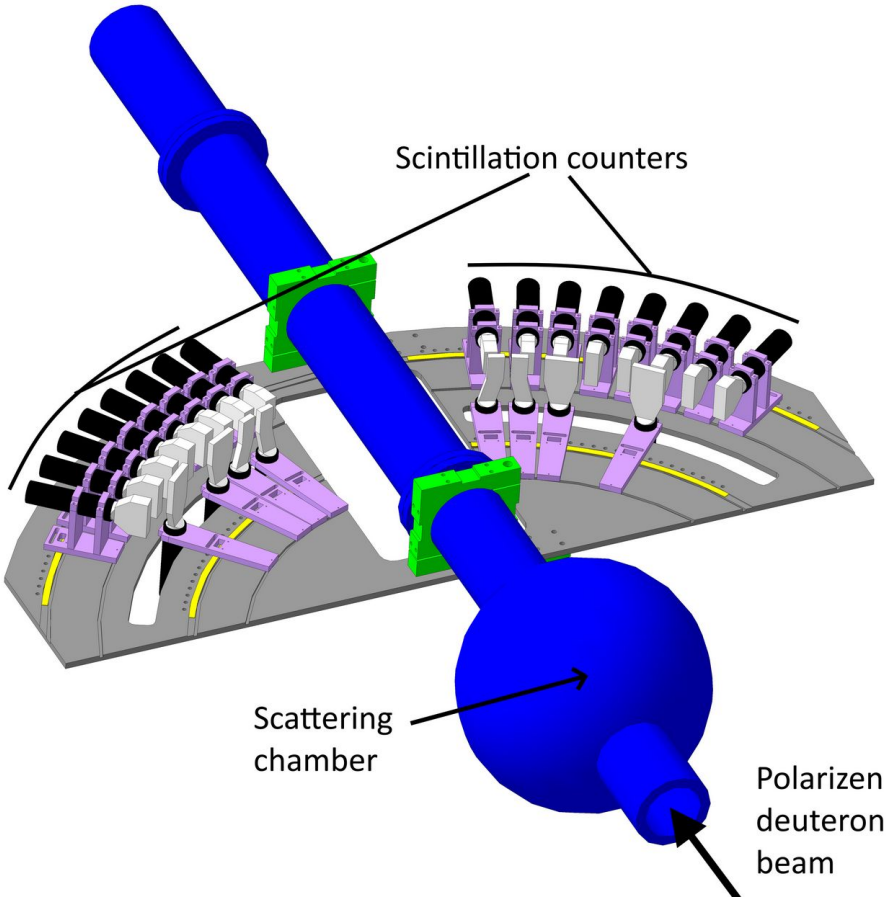
		(P_z, P_{zz})
"2-6"	"+"	(1/3, +1)
"3-5"	"-"	(1/3, -1)
Unpolarized	"0"	(0, 0)

Vector polarization values, that were used to obtain analyzing powers

P_{Z+}	ΔP_{Z+}	P_{Z-}	ΔP_{Z-}
0,231	0,008	0,245	0,006

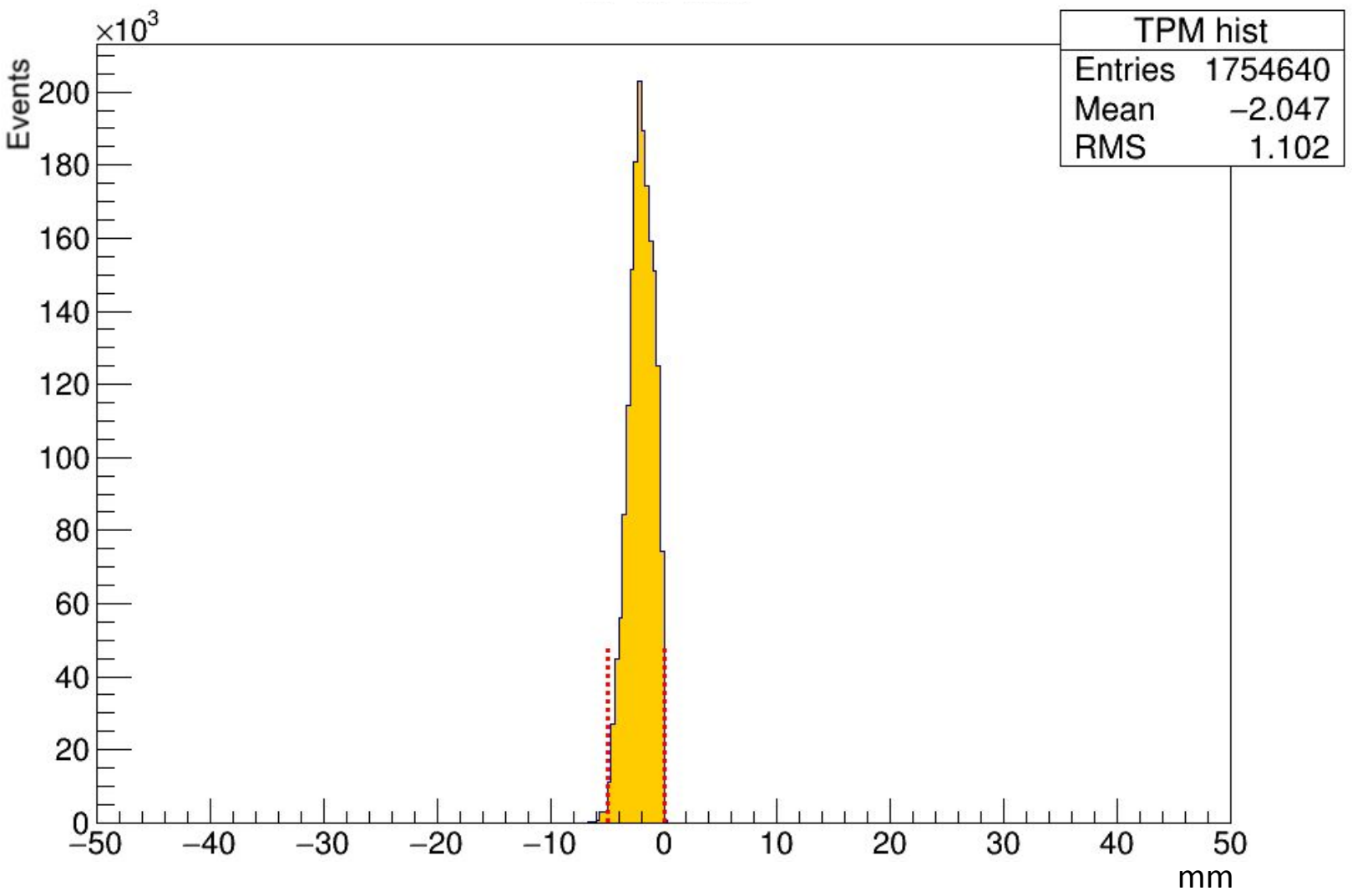
The DSS Setup



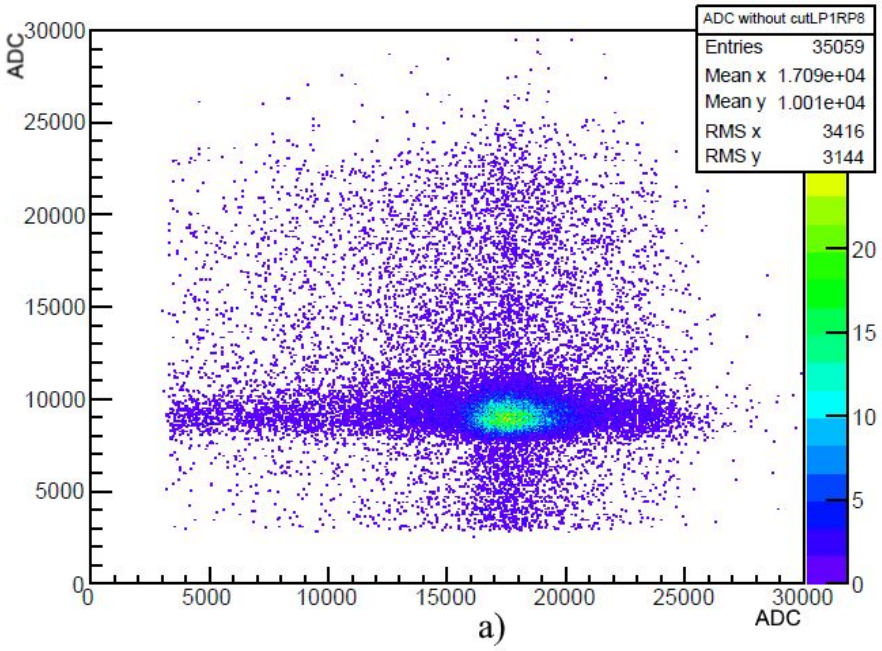


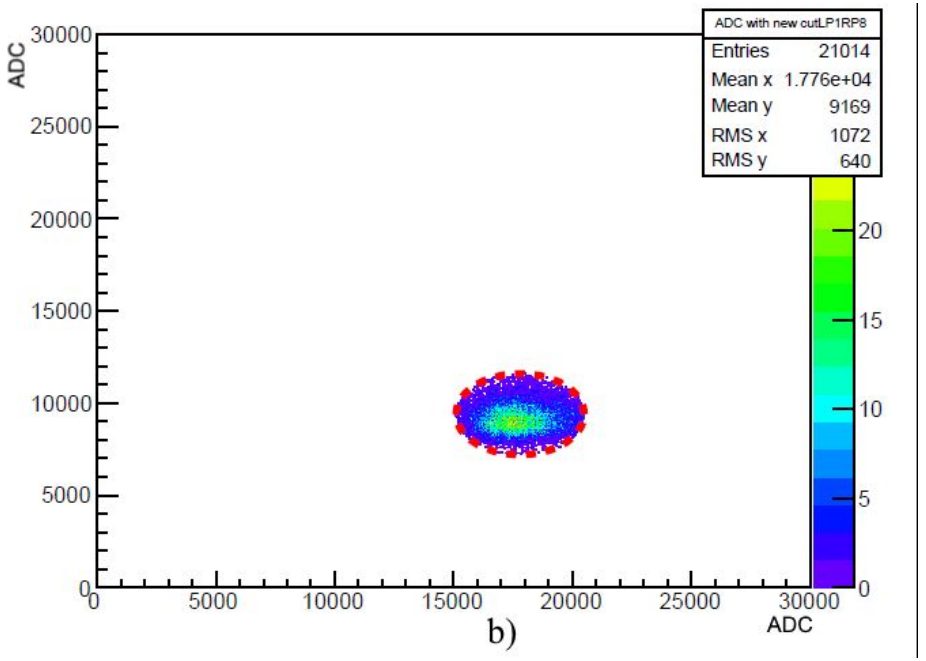
- 6 pairs to the left, 6 pairs to the right;
- from 55° to 85° in the CM system.

The dependence of the events yield on the position of the target inside the ion tube

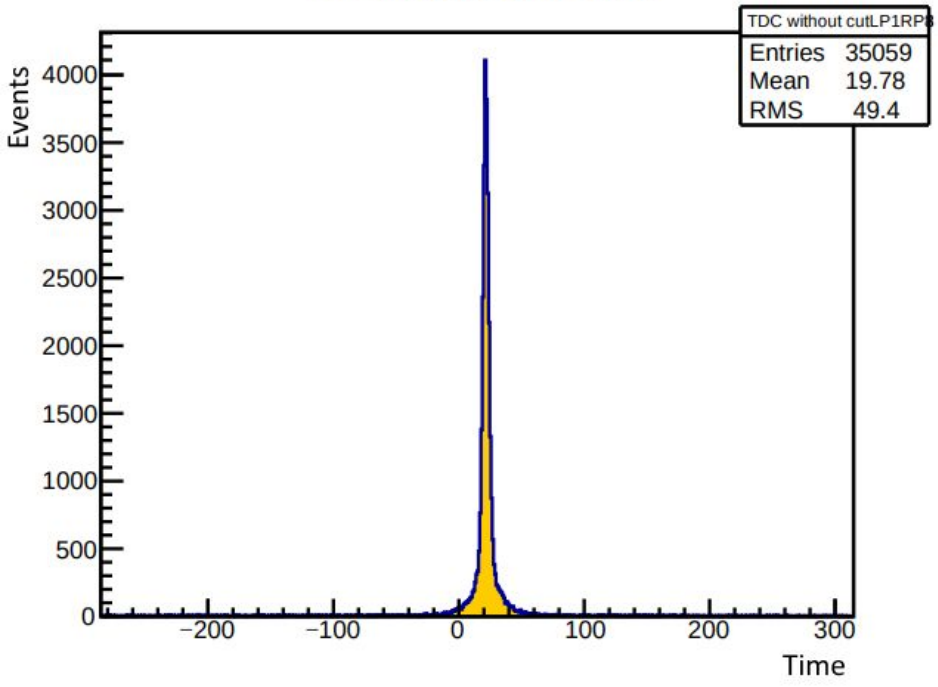


ADC correlation for the counters pair

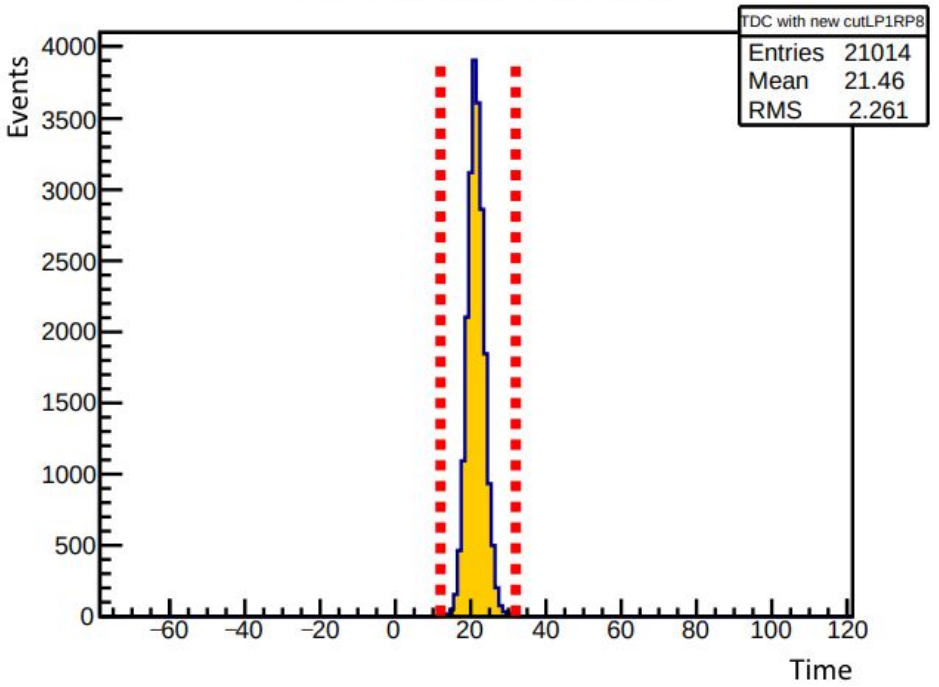




The time of flight difference for the counters pair

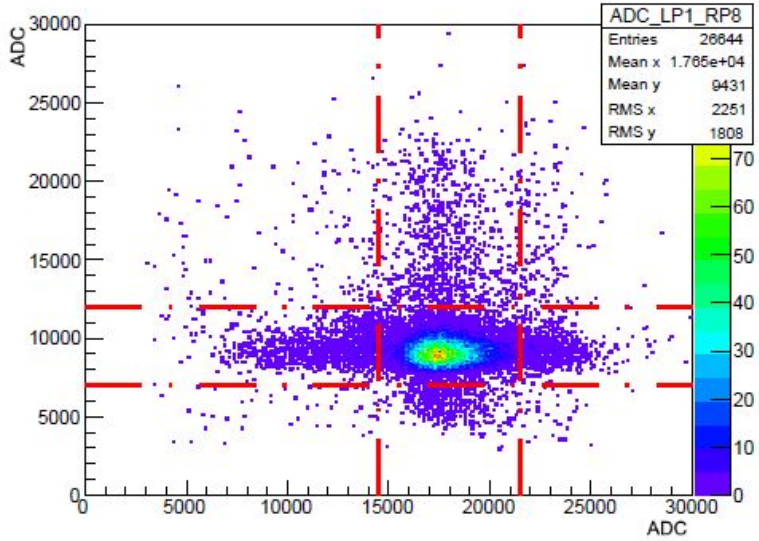


a)

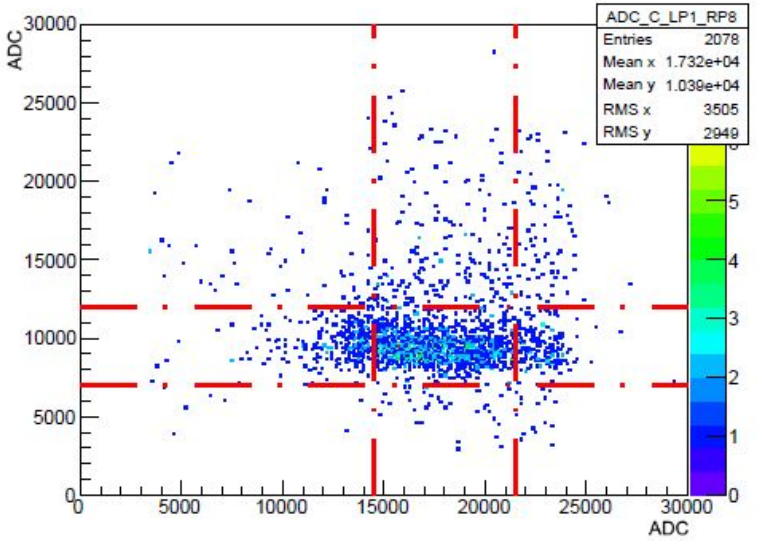


b)

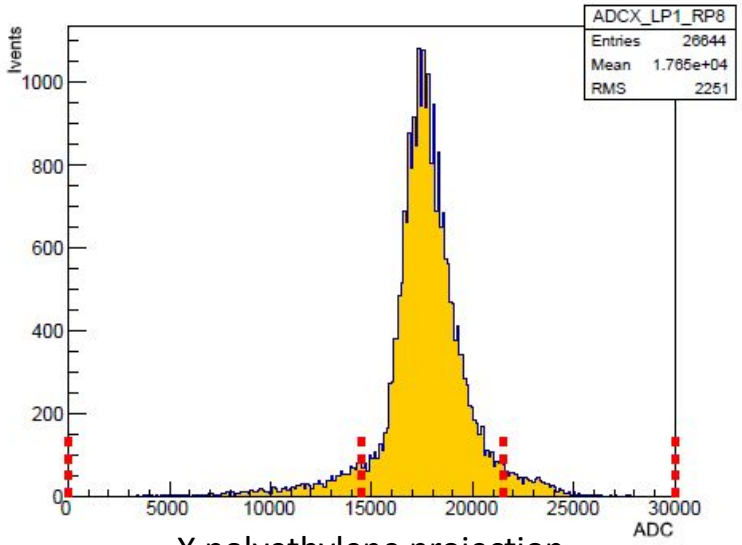
The process of setting up cuts for the CH2-C subtraction procedure



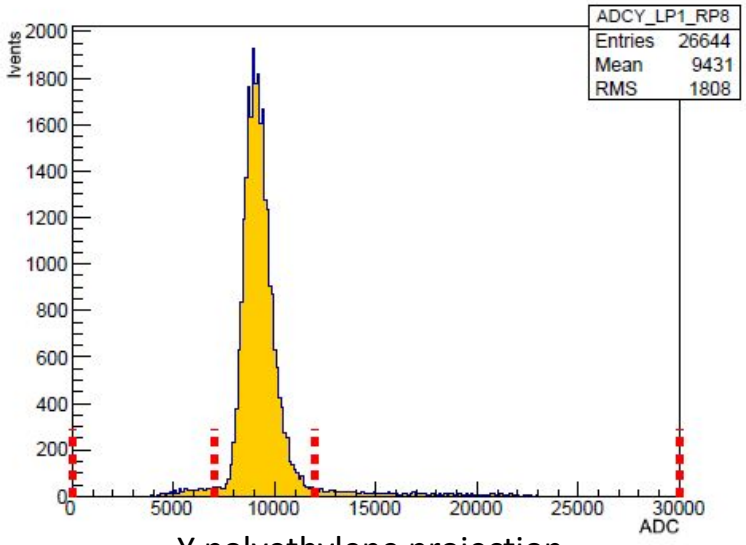
Polyethylene



Carbon



X polyethylene projection



Y polyethylene projection

Methods of the subtraction coefficient calculations

The integral method

$$n = \frac{\sum_i N_i^{(CH2)}}{\sum_i N_i^{(C)}}$$

The spectra fitting method

$$f(x) = ae^{\frac{(x-b)^2}{2c^2}}$$

The least squares method

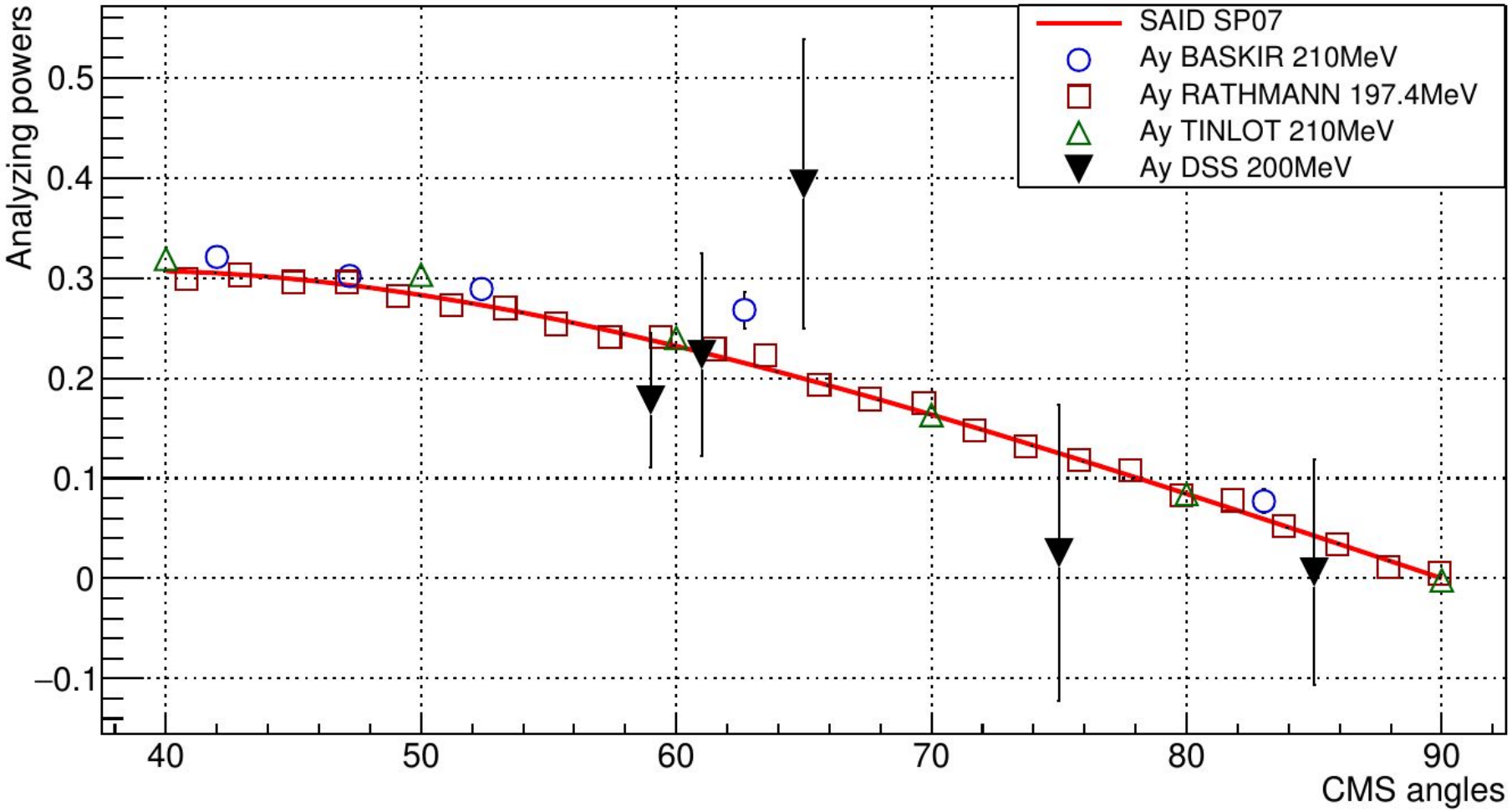
$$f(k) = \sum_i (N_{CH2} - kN_C)^2$$

The analyzing powers definition formulas

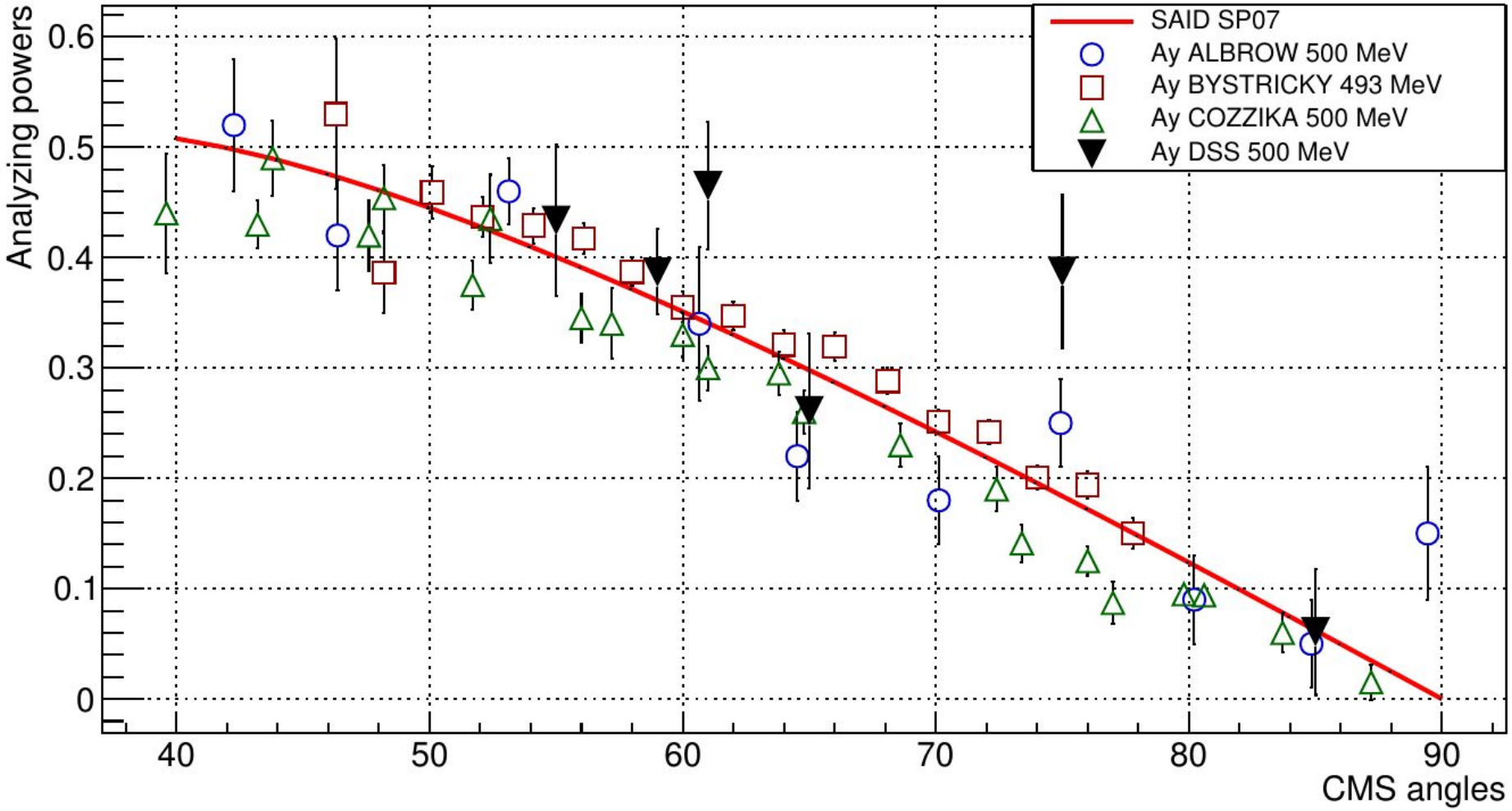
$$A_{yL} = \frac{\frac{N^{+}M^{0}}{N^{0}M^{+}} + \frac{N^{-}M^{0}}{N^{0}M^{-}} - 2}{2(P_z^{+} + P_z^{-})}$$

$$A_{yR} = -A_{yL}$$

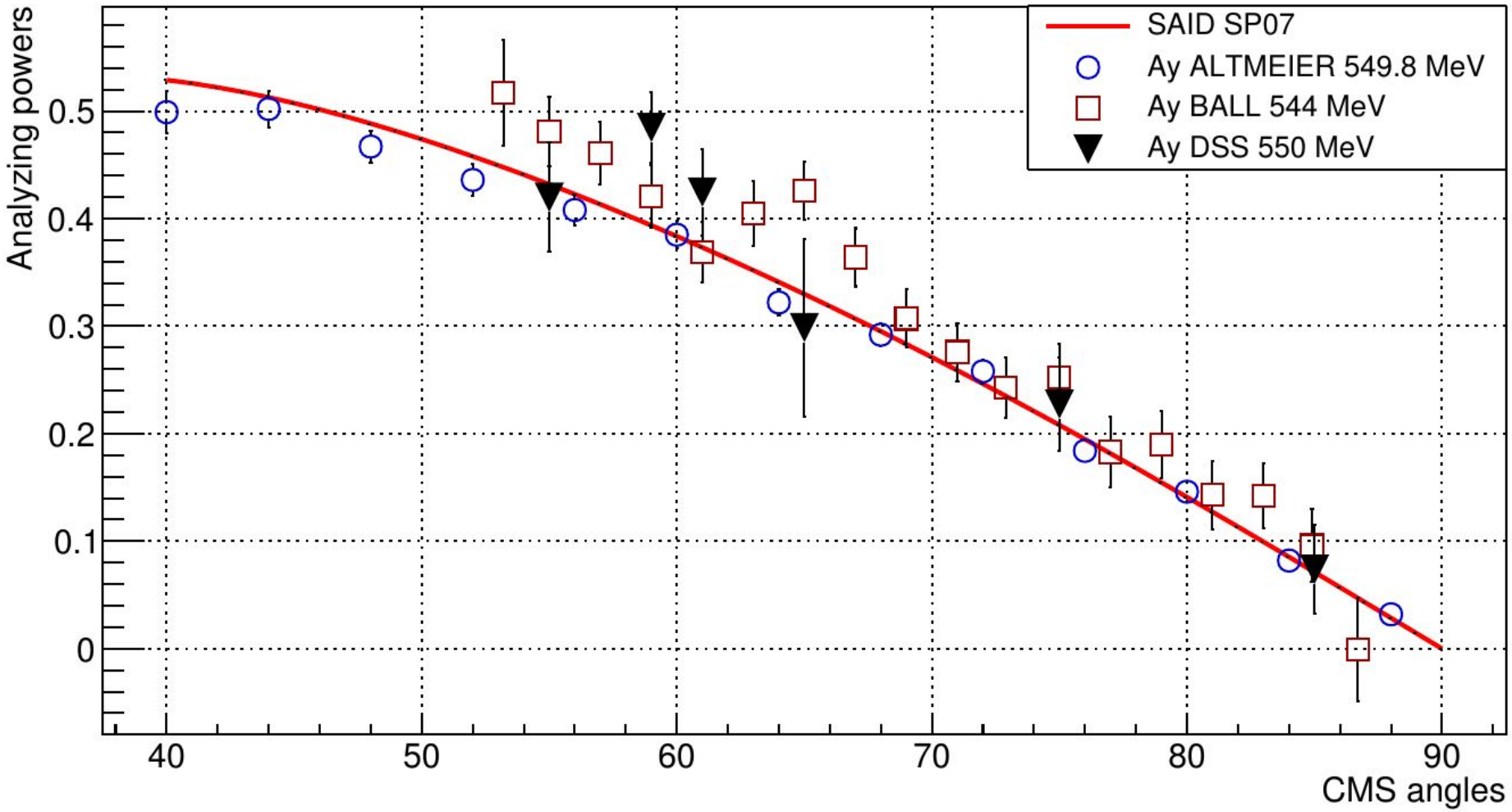
The vector analyzing power at the beam energy of 200 MeV/nucleon



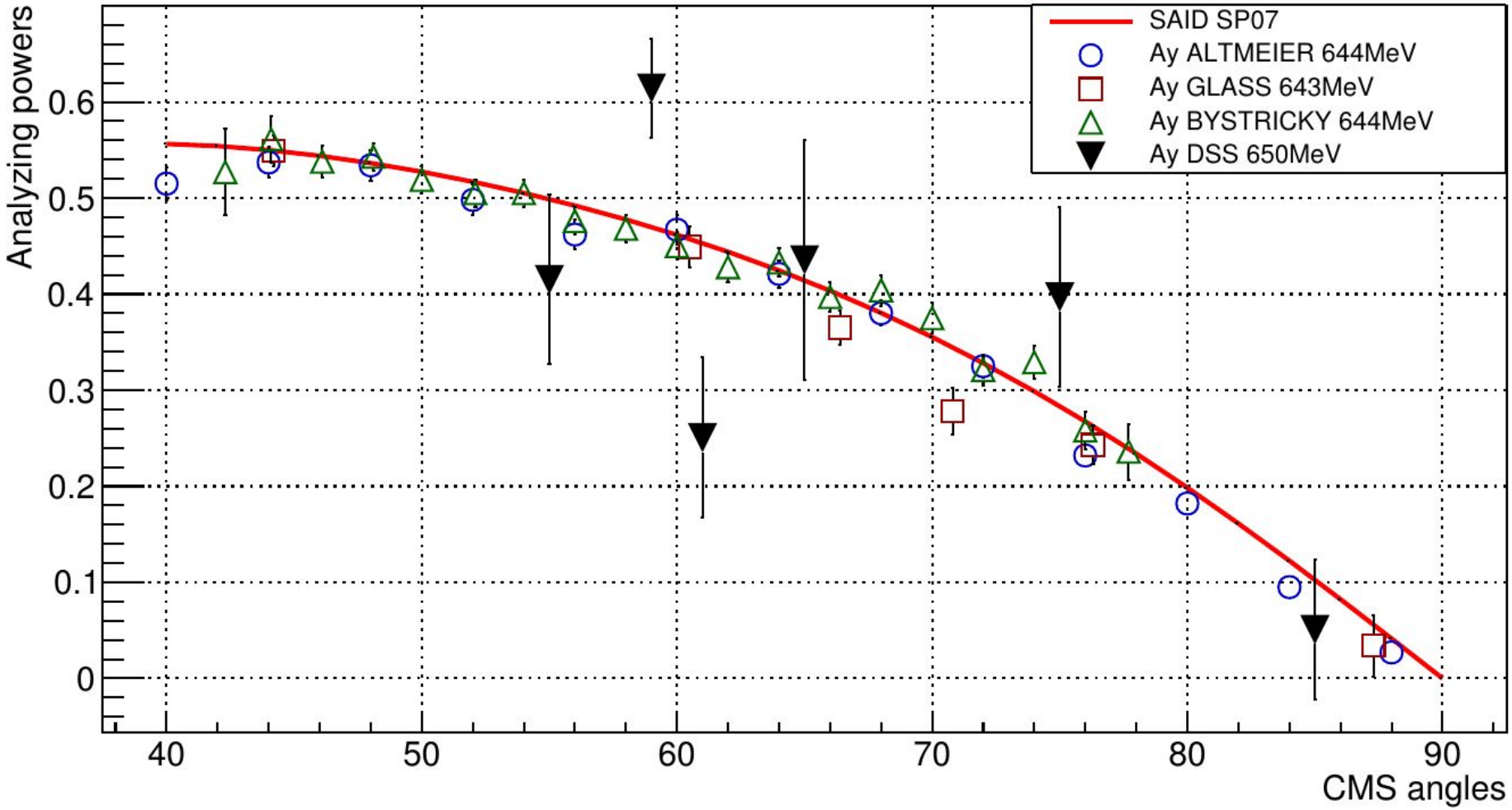
The vector analyzing power at the beam energy of 500 MeV/nucleon



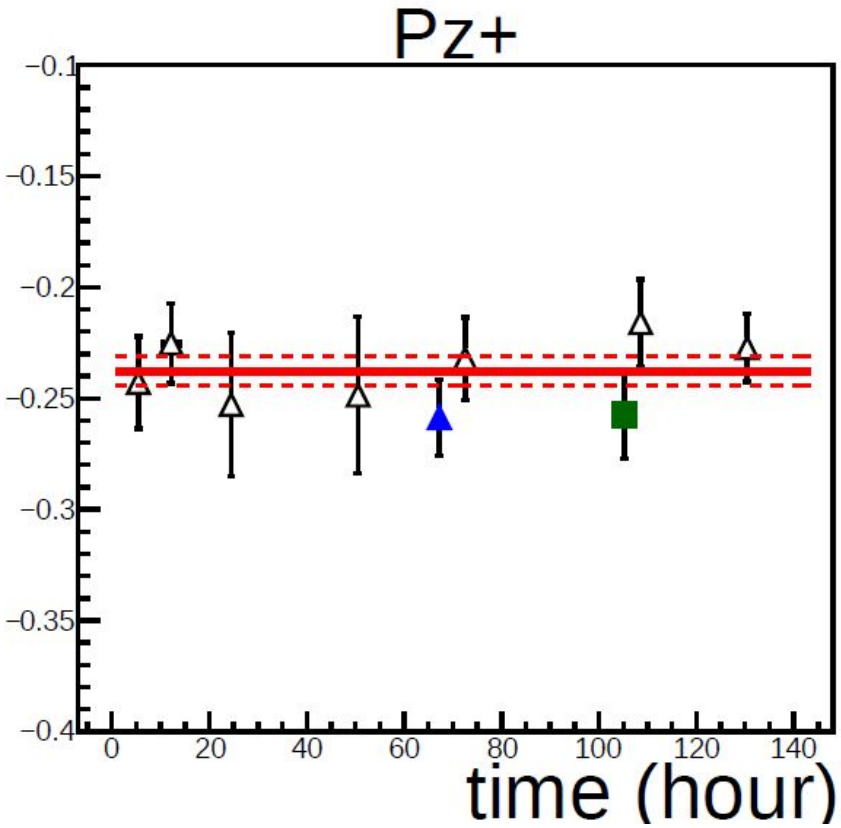
The vector analyzing power at the beam energy of 550 MeV/nucleon

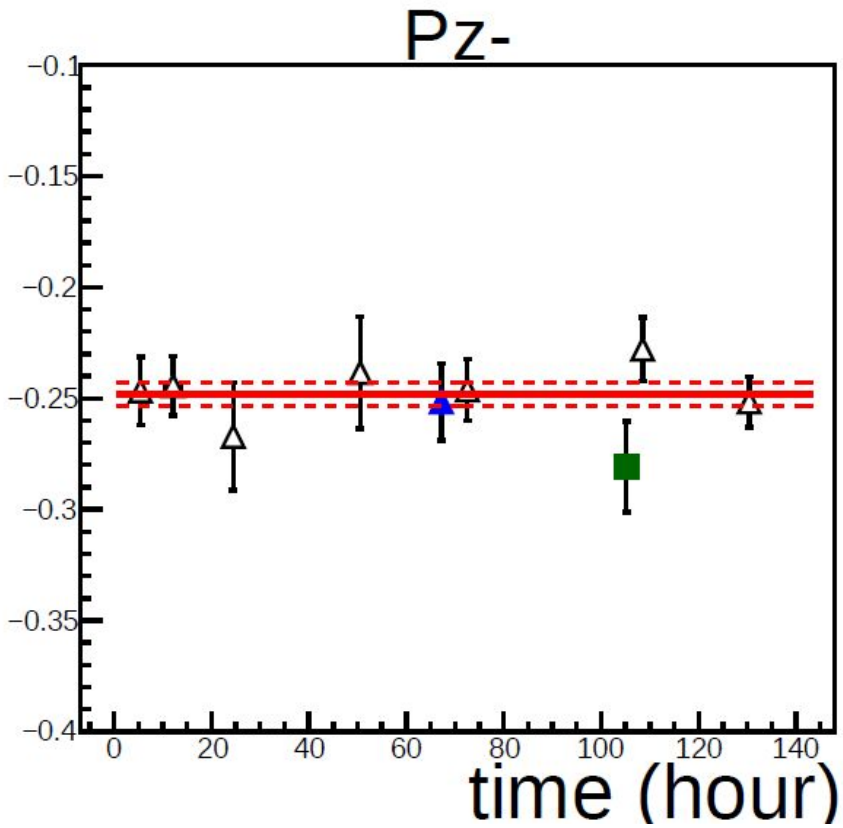


The vector analyzing power at the beam energy of 650 MeV/nucleon



The beam polarization values at the beam energies of 500 and 650 MeV/n





△ - polarization values for dp elastic scattering (270 MeV/n)

▲ - polarization values for pp quasi-elastic scattering (500 MeV/n)

■ - polarization values for pp quasi-elastic scattering (650 MeV/n)

Conclusion

- The vector analyzing power values of the pp-quasielastic scattering reaction were obtained at the deuteron beam energies of 200, 500, 550 and 650 MeV/n;
- The analyzing power values are in good agreement with the results of other researches;
- The vector polarization values of the deuteron beam were obtained at the beam energies of 500 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.

Thank you for your attention!