DIFFERENTIAL CROSS SECTION AND VECTOR ANALYZING POWER in d p ELASTIC SCATTERING AT 2.0 GeV

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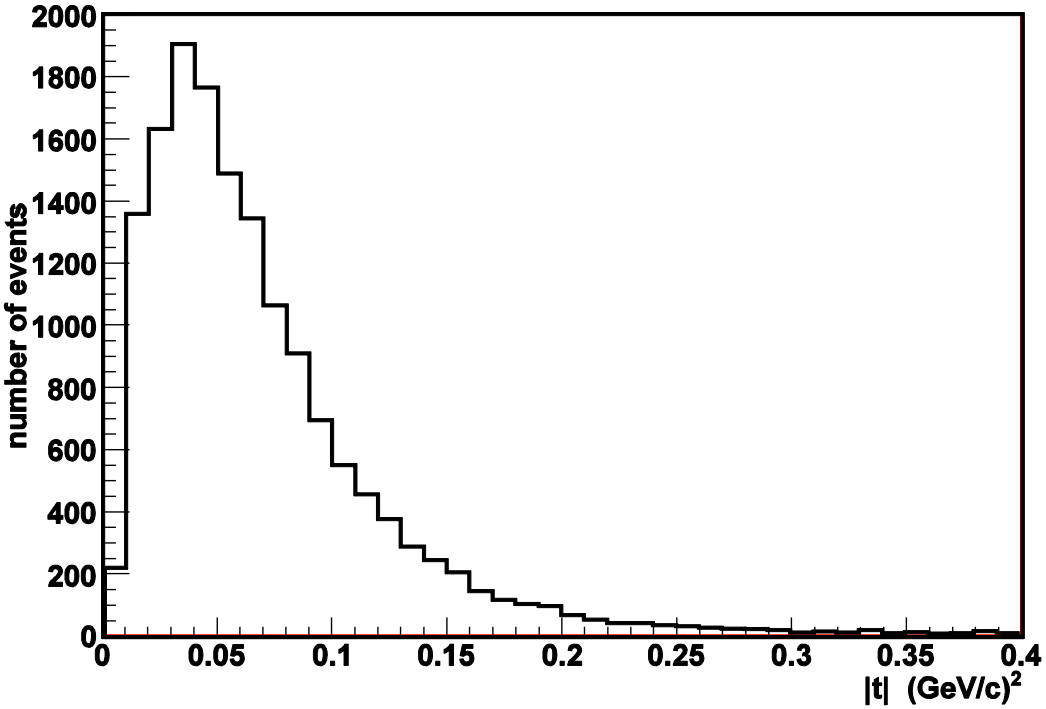
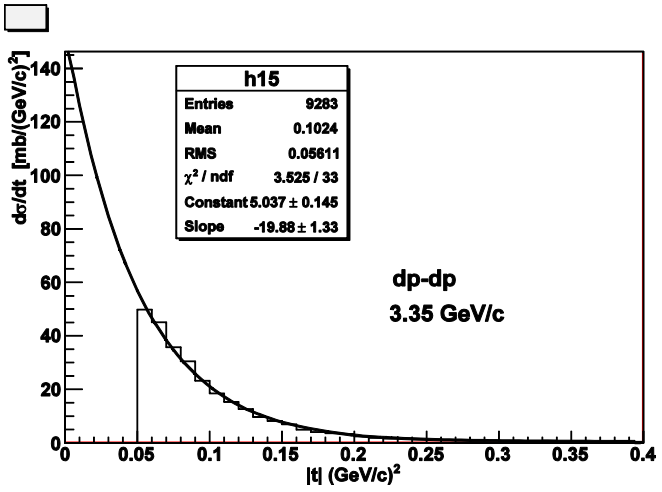
- Elastic deuteron-proton scattering. Features of the method and the loss of events. Millibarn-equivalent.
- Estimates of the polarization of the accelerated deuterons beam with momentum of 3.35 GeV/c on the reaction breakup of the deuteron ($dp \rightarrow ppn$).
- Results :
  1. Vector analyzing power
  2. The differential cross section for elastic dp-scattering.
- Theoretical interpretation of the results

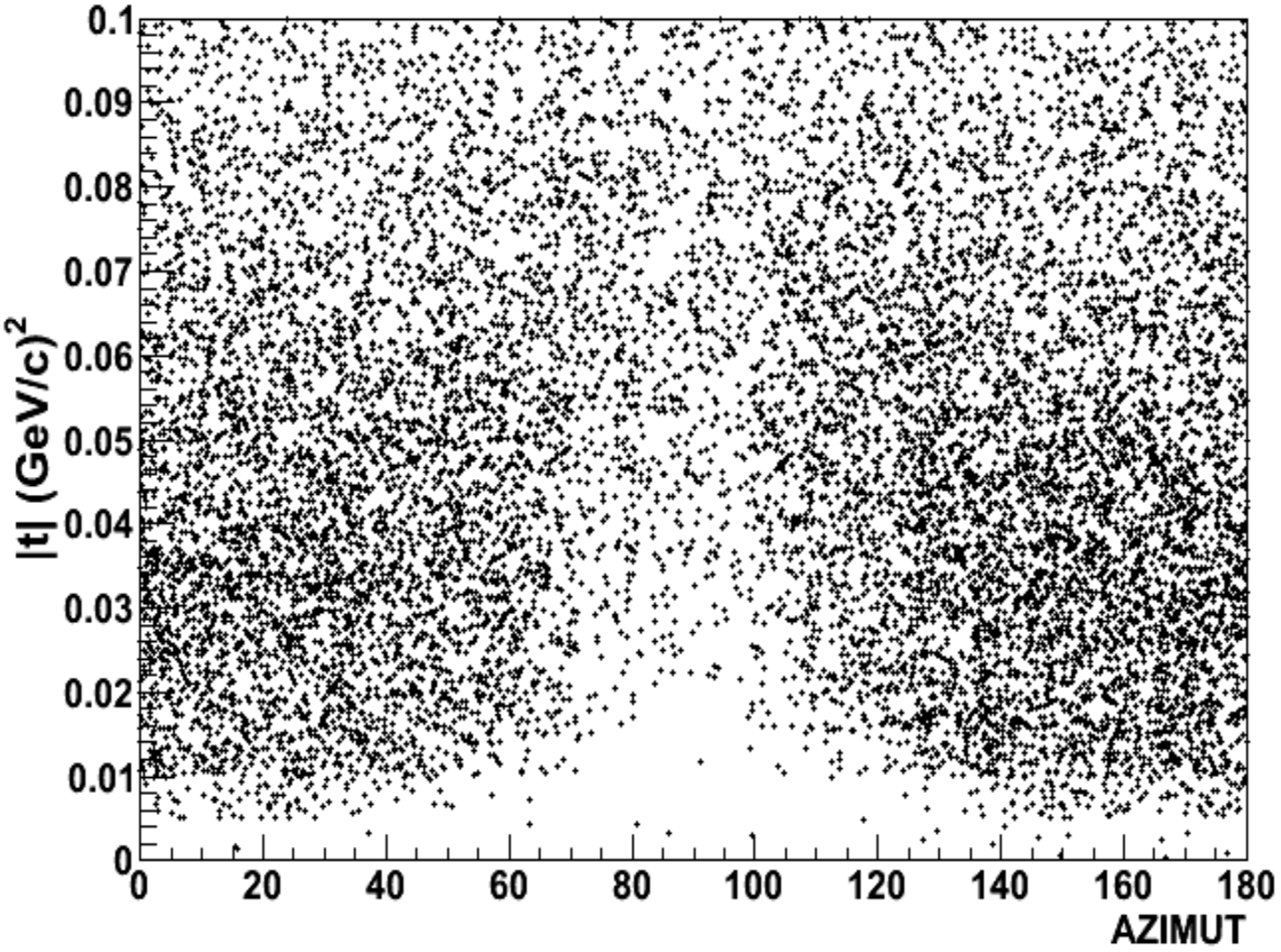
In connection with the modernization of Nuclotron and of anticipation of the introduction of a new source of polarized deuterons, we turned to a database of deuteron-proton research on a hydrogen bubble chamber, performed at a synchrotron. Some of these data were obtained in a beam of vector- polarized deuterons momentum 3.35 GeV/c from the source Polaris .

The object of the study was the elastic dp-scattering.
However, of all the deuteron-proton reactions, due to a number of methodical features, chosen by the reaction has the greatest losses in the region of small momentum transfers. They are related both to the impossibility of observation tracks of momentum less than 80 MeV/c and the orientation tracks on the direction of photography.
These effects are demonstrated in the following slides.

Loss events in the elastic dp-scattering on the t-distribution

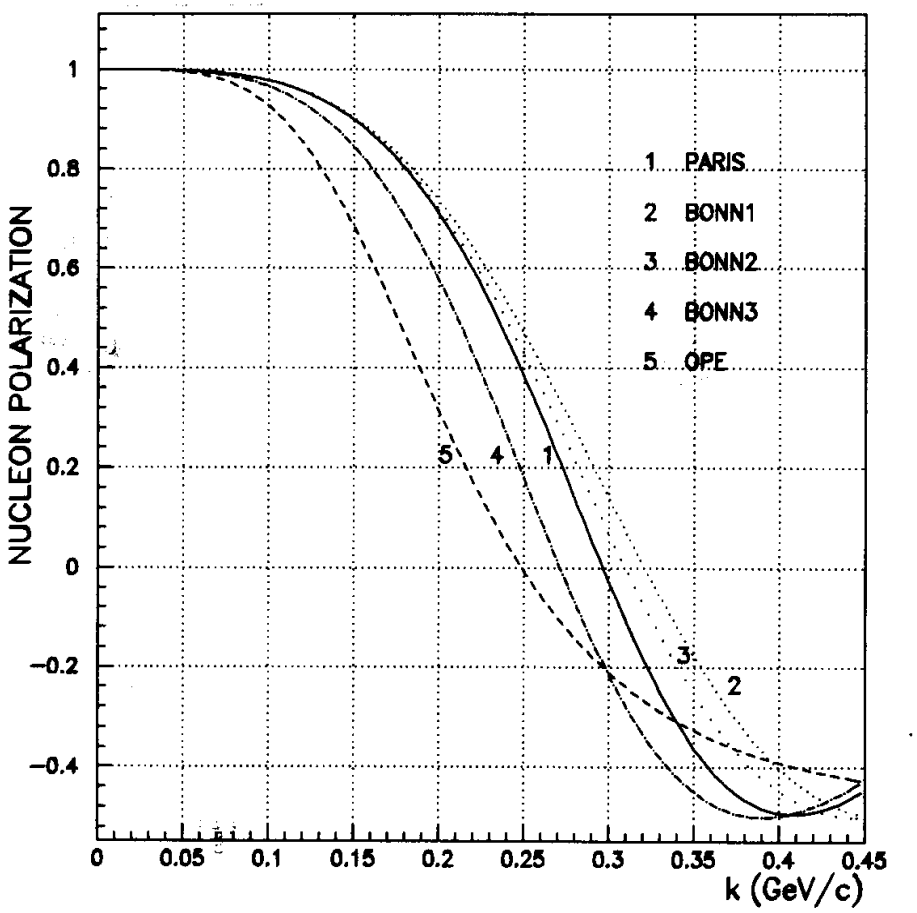





0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
|t| (GeV/c)^2
0
20
40
60
80
100
120
140
160
180
AZIMUT

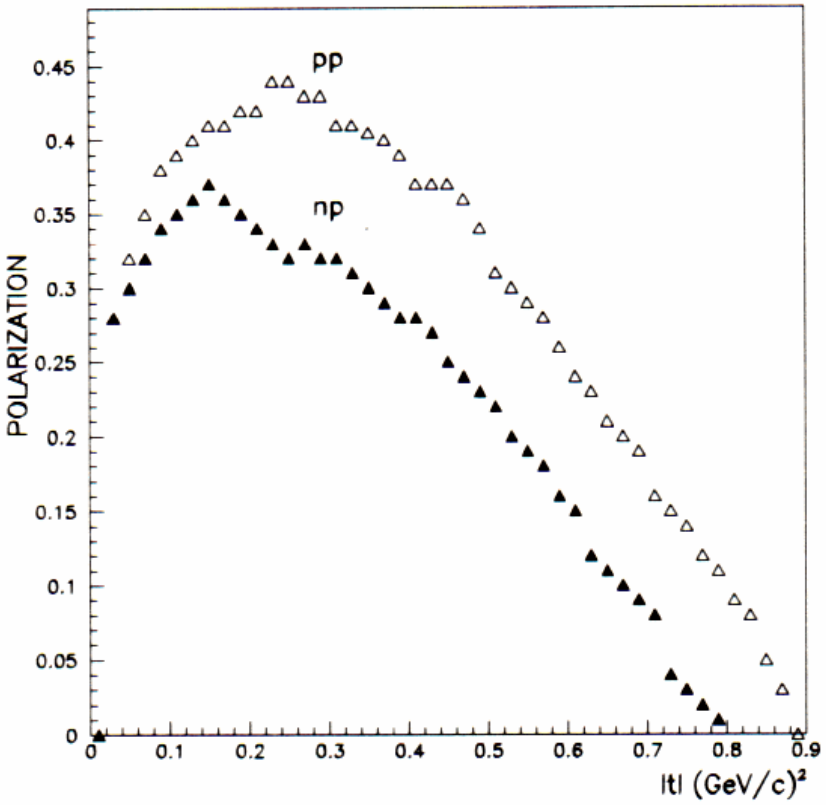
Losses in another reactions were negligible, that taking into account losses in the elastic scattering allowed us to estimate millibarn equivalent of the events as A = 0.0003342 ± 0.0000007 mb/event.

Evaluation of the polarization vector of an accelerated beam of deuterons was performed on the same data using the events of the reaction dp → ppn. It goes basically like quasielastic np-and pp-scattering with the nucleon - spectator. Theoretical estimates of the relative polarization of the nucleons in the deuteron show that, regardless of the type of wave function, for the spectator momentum less than 65 MeV / c polarization is 1.0. Knowing the data for analyzing power for elastic np-and pp-scattering at the corresponding energy, by measuring the azimuthal asymmetry of quasielastic scattering, and weighing the results with the number of events quasi-np and quasi-pp scattering, we estimated the deuteron beam polarization as: Py = 0.488 ± 0.061.



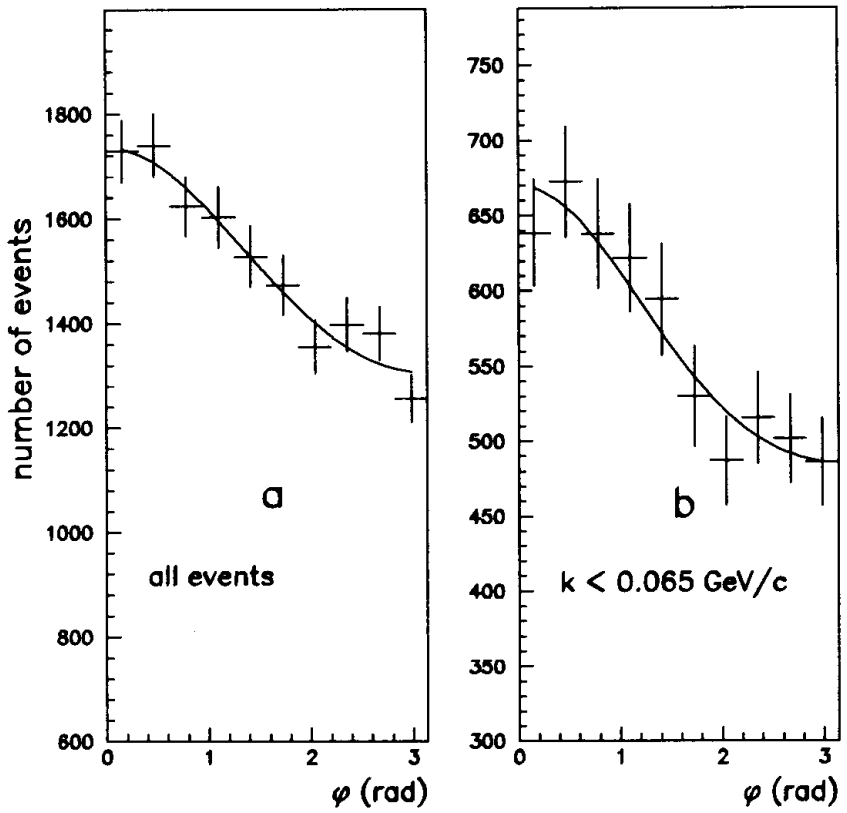
Relative polarization of the nucleons in the deuteron

Analyzing power for elastic np-and pp-scattering

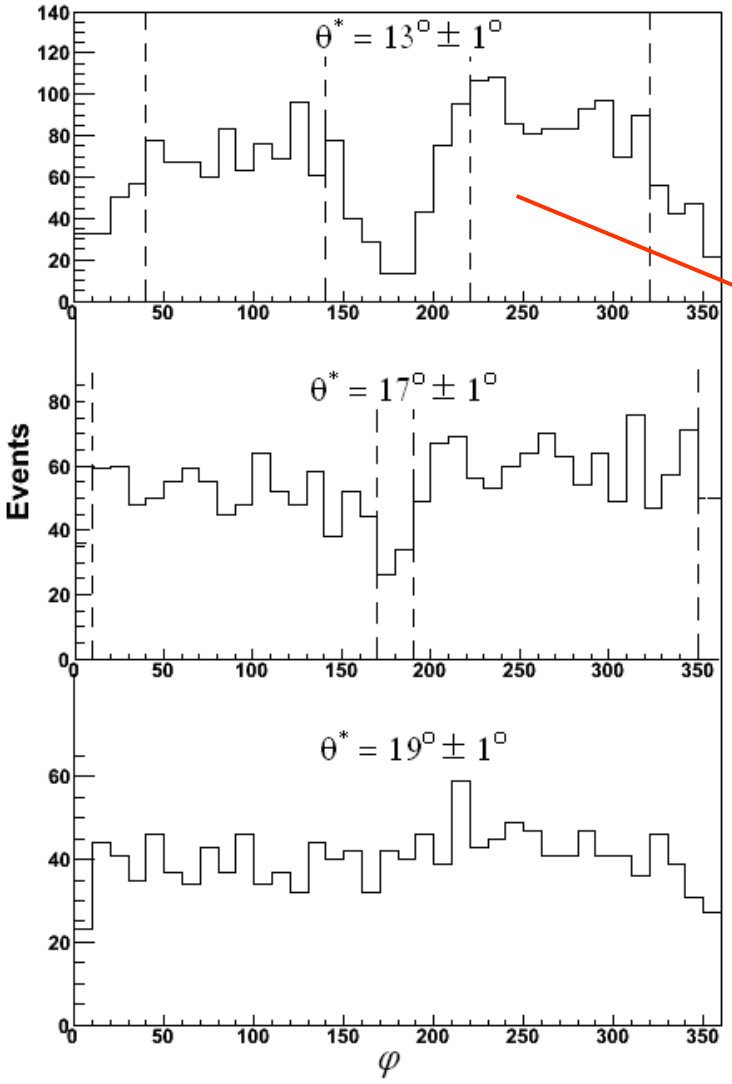


Marshak, M. et al.: Phys.Rev. CI8 (1978) 1 (ZGS,ANL), pp and np
Korolev G.A. et al., Phys.Lett. 165B (1985) 4,5,6 (SATURNE), np

Distribution of events over the azimuthal angle

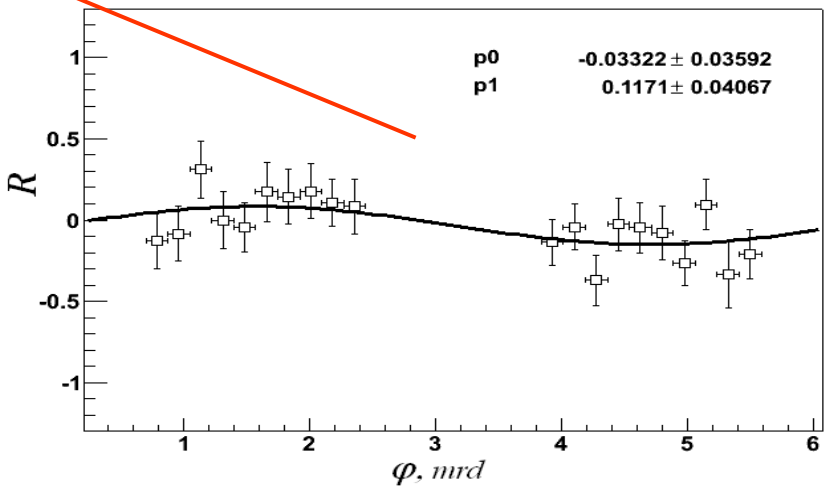


Glagolev V.V. et al. The deuteron D-state probability. Zeitchrift fur Physik A 356, 183-186 (1996)



$$R = \frac{N_1 - N_2}{N_1 + N_2}$$

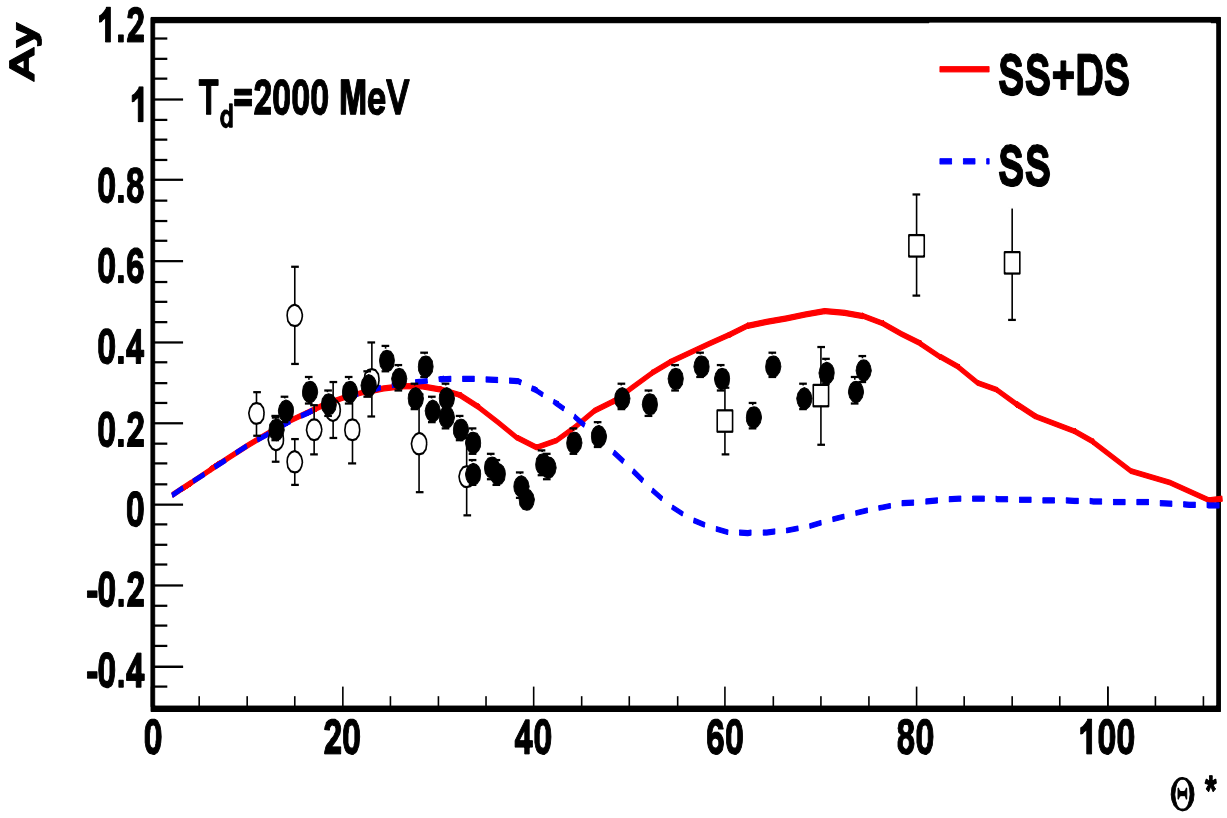
Example distribution of the value of R for the angular interval 12° <θ* <14° in cms



For each angular interval parameters of the function $p_0 + p_1 \sin(\varphi)$ was determined

$$A_y = \frac{2}{3}\frac{p_1}{p_y}$$

Analizing powers



The solid circles - data from the work M.Haji-Saied et al., Phys.Rev.C 36 (1987) pp.2010-2017.

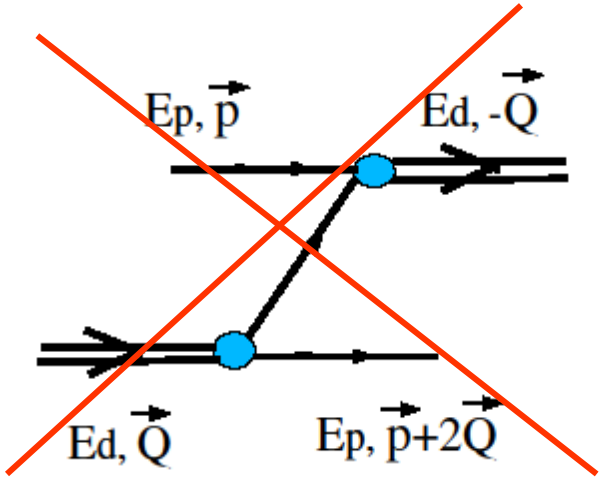
Empty squares - from the work "Analyzing powers measurement for d - p elastic scattering at the Internal Target Station of Nuclotron“, P.K. Kurilkin et al., Int.J.Mod.Phys. A24:530-533, 2009.

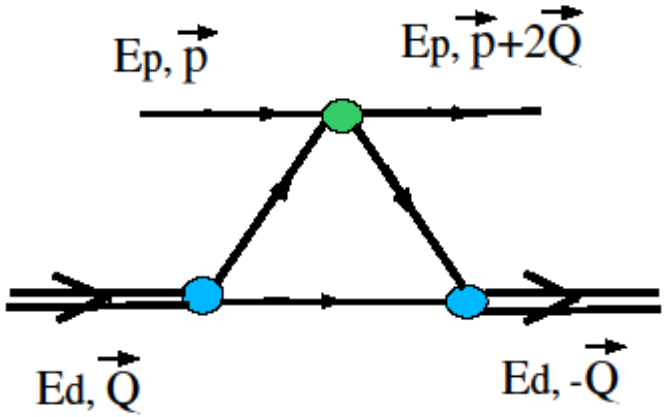
Empty circles – this work

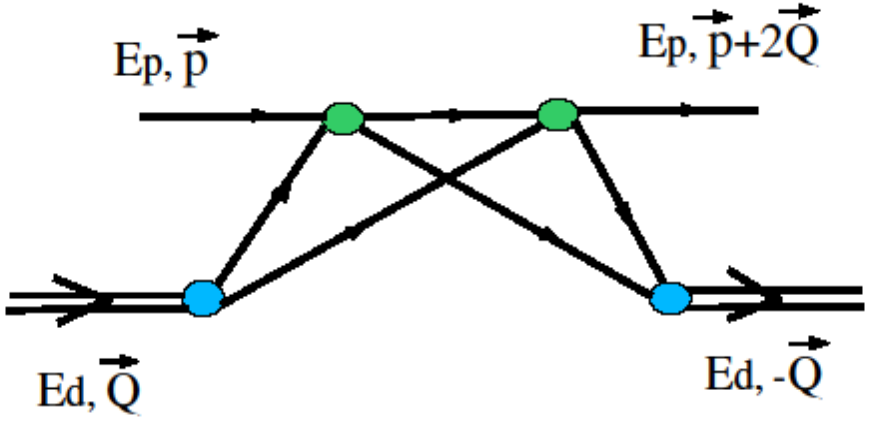
The theoretical predictions have been obtained in the multiple-scattering-theory frame. The single scattering and double scattering contributions into the reaction amplitude were taken into account. Since ONE term gives considerable contribution only at backward angles, this term was not included into consideration.

All calculations were performed with the CD Bonn deuteron wave function.

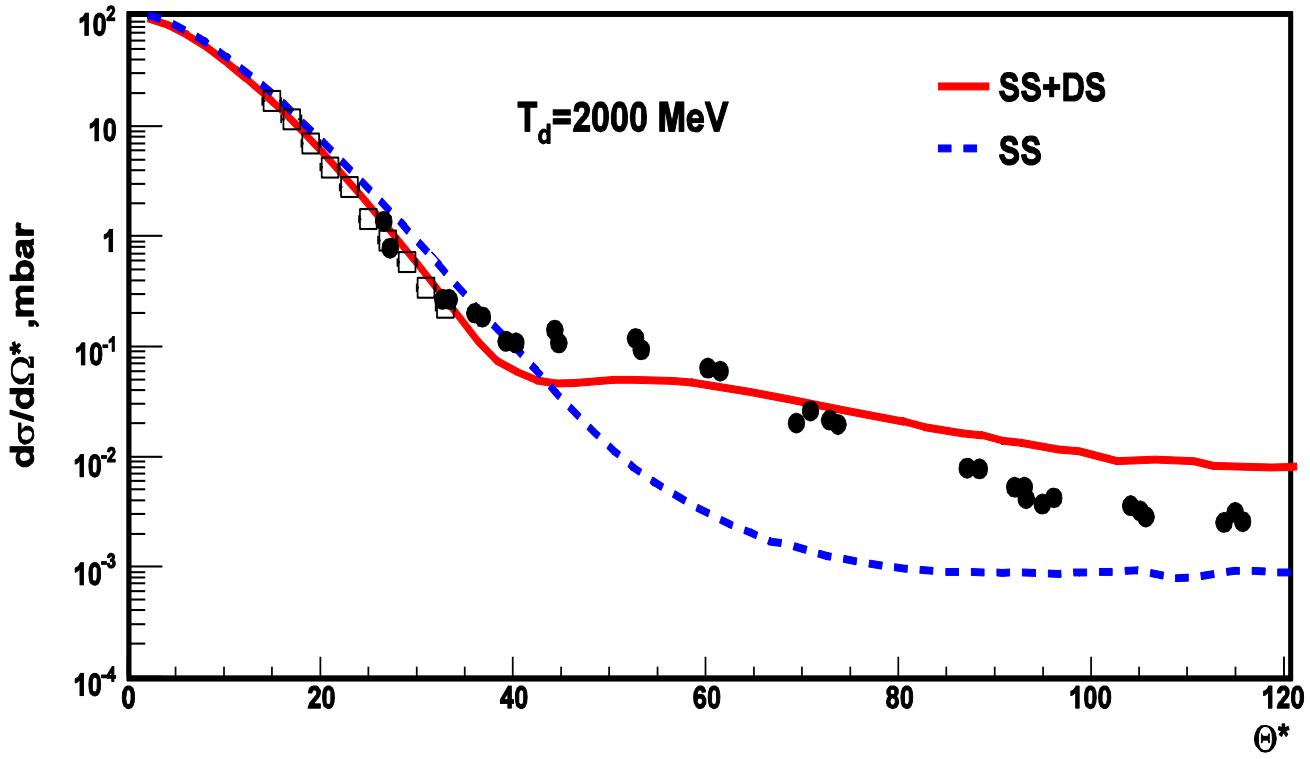
The details of the theoretical description are given in talk of N.B. Ladygina at this conference.


Ep, $\vec{p}$
Ed, -$\vec{Q}$
Ed, $\vec{Q}$
Ep, $\vec{p}$+2$\vec{Q}$


Ep, $\vec{p}$
Ep, $\vec{p}$+2$\vec{Q}$
Ed, $\vec{Q}$
Ed, -$\vec{Q}$


Ep, $\vec{p}$
Ep, $\vec{p}$+2$\vec{Q}$
Ed, $\vec{Q}$
Ed, -$\vec{Q}$

Differential cross section



The solid circles – data from the work Bennett G. W. et al. Phys. Rev. Lett. 1976. V.19 P. 387-390.

Empty boxes - this work.

Conclusion

From the database of the deuteron-proton interactions in a hydrogen bubble chamber at a deuteron momentum of 3.35 GeV/c results on the differential cross-section of elastic scattering and vector analyzing power were obtained .

Data agree well with measurements in Argonne (ZGS).

The experimental data agree quite well with the calculations of multiple scattering theory taking into account the double scattering.