Experimental investigation of the quasielastic scattering of polarized protons on nuclei at the JINR VBLHE synchrophasotron

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Formalism 1

Analyzing power (single spin asymmetry)

$$\sigma(\varphi,\vartheta)=\sigma_0(\vartheta)(1+A(\vartheta)(\vec{P}\cdot\vec{n}))$$

$\vec{P}$ **- polarization**

$\vec{n}$ **- normal to the reaction plane**

Analyzing power description for proton-nucleus scattering

$$A=\frac{A_{El}\sigma_{El}+A_{Qe}\sigma_{Qe}+A_{Inel}\sigma_{Inel}}{\sigma_{El}+\sigma_{Qe}+\sigma_{Inel}}$$

El **- elastic scattering (small momentum transfer)**

Qe **- quasielastic scattering (proton or neurtron knockout)**

$Inel$ **- inelastic scattering (new particle (mainly pions) production)**

and
a scattering on the intranuclear clasters
(d, α)

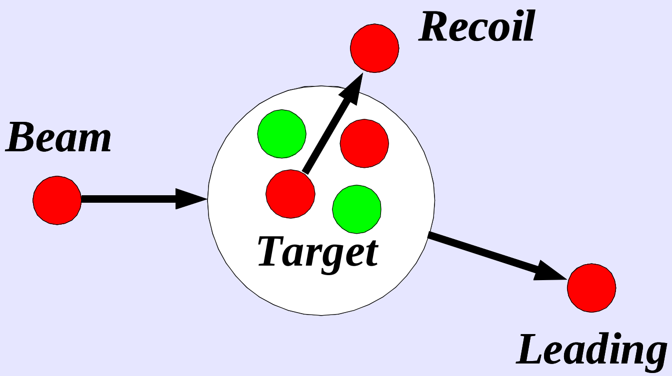
Formalism 2

Analyzing power reduction at the scattering on the intranuclear nucleons (in a comparison with the one on the free nucleons)

Two types of the experimental performance

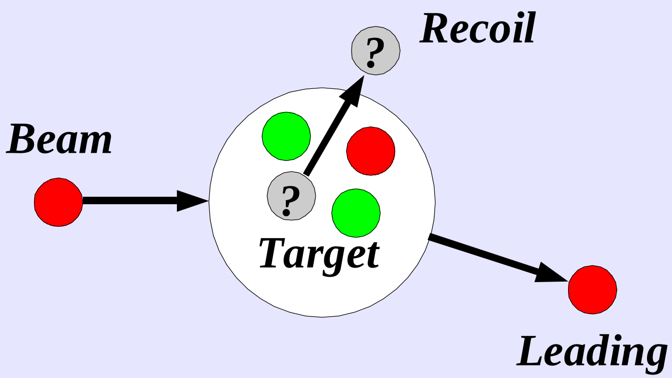
Under recoil and leading proton detection (p,2p)

$$R_{pN}(T)=\frac{A_{Qe}^{\ p}(T)}{A_{pp}(T)}$$



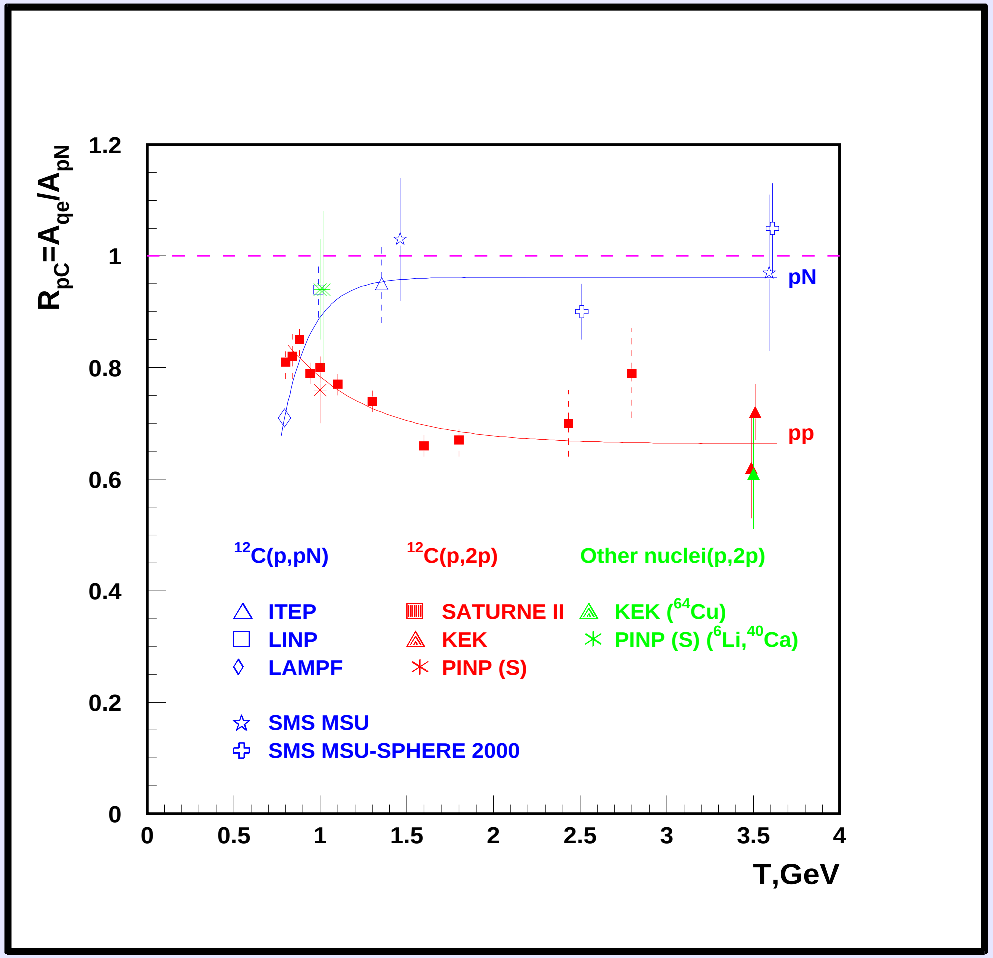
Under leading proton detection only (p,pN)

$$R_{pN}(T)=\frac{2\cdot A_{Qe}(T)}{A_{pp}(T)+A_{pn}(T)}$$



Prehistory

World data compilation by 2001



There was an indication of unexpected different behavior of the R(T) at the two types of measurements in the GeV energy region:

$R(p,2p) \sim 0.67$

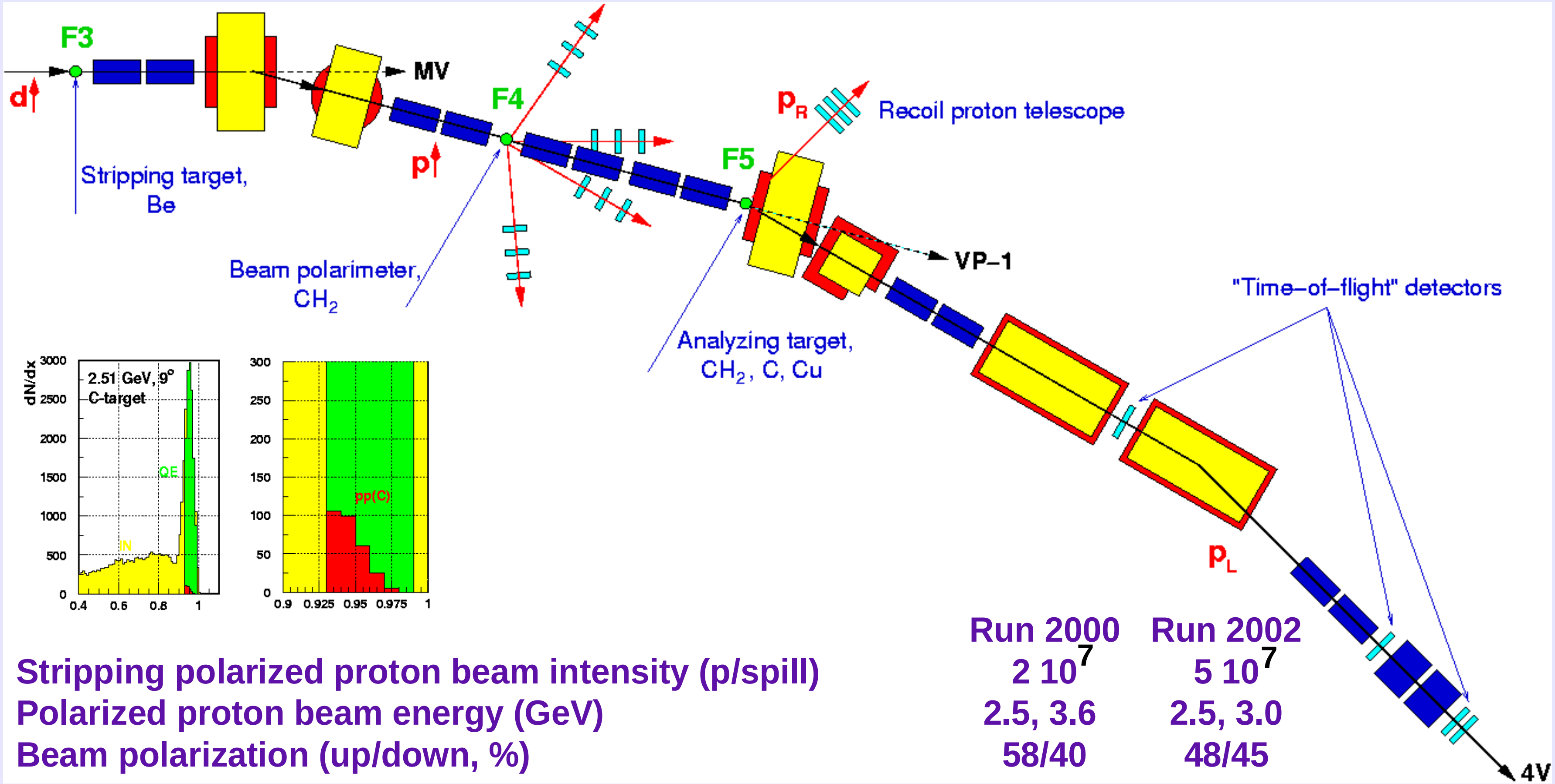
$R(p,pN) \sim 0.95$

The discrepancy looked unexplainable using simple conceptions and significant for physical (intranuclear nucleon state) and methodic (nuclear polarimetry) problems.

But there were not the measurement of both consided parameters in the framework of the same experiment.

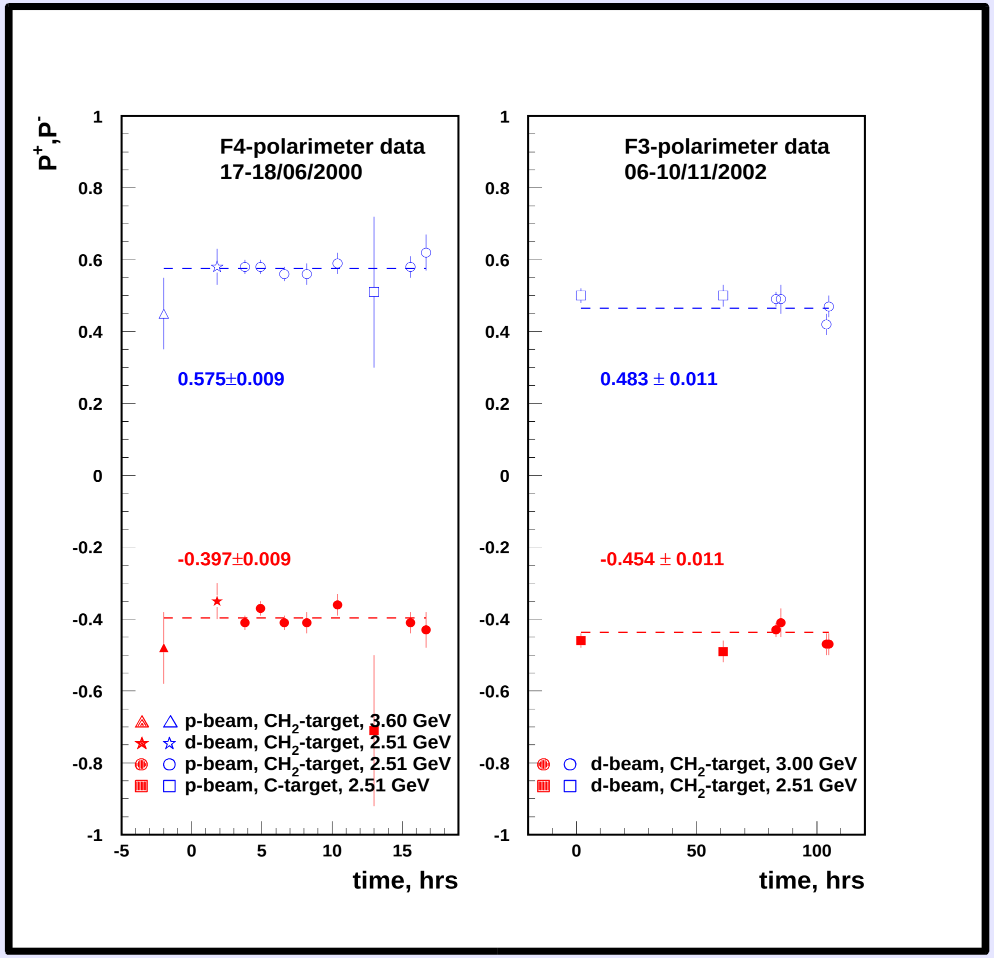
Experimental setup

"SMS-MSU SPHERE" experimental setup and beam parameters



	Run 2000	Run 2002
Stripping polarized proton beam intensity (p/spill)	$2\ 10^7$	$5\ 10^7$
Polarized proton beam energy (GeV)	2.5, 3.6	2.5, 3.0
Beam polarization (up/down, %)	58/40	48/45

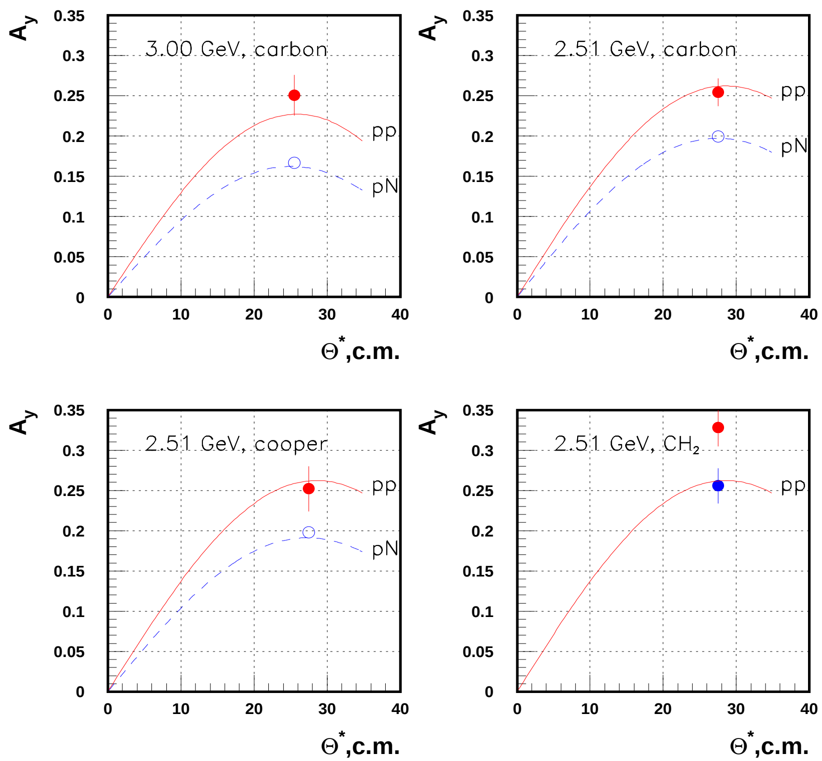
Beam polarimeter data



The double arm beam polarimeter was operating at the initial deutron and stripping proton beams. Polarization stability was confirmed during the all time of the Runs.

Run	P(+)	P(-)
2000	0.575	0.397
2002	0.483	0.454

The results of the analyzing power measurement



Run 2000 data

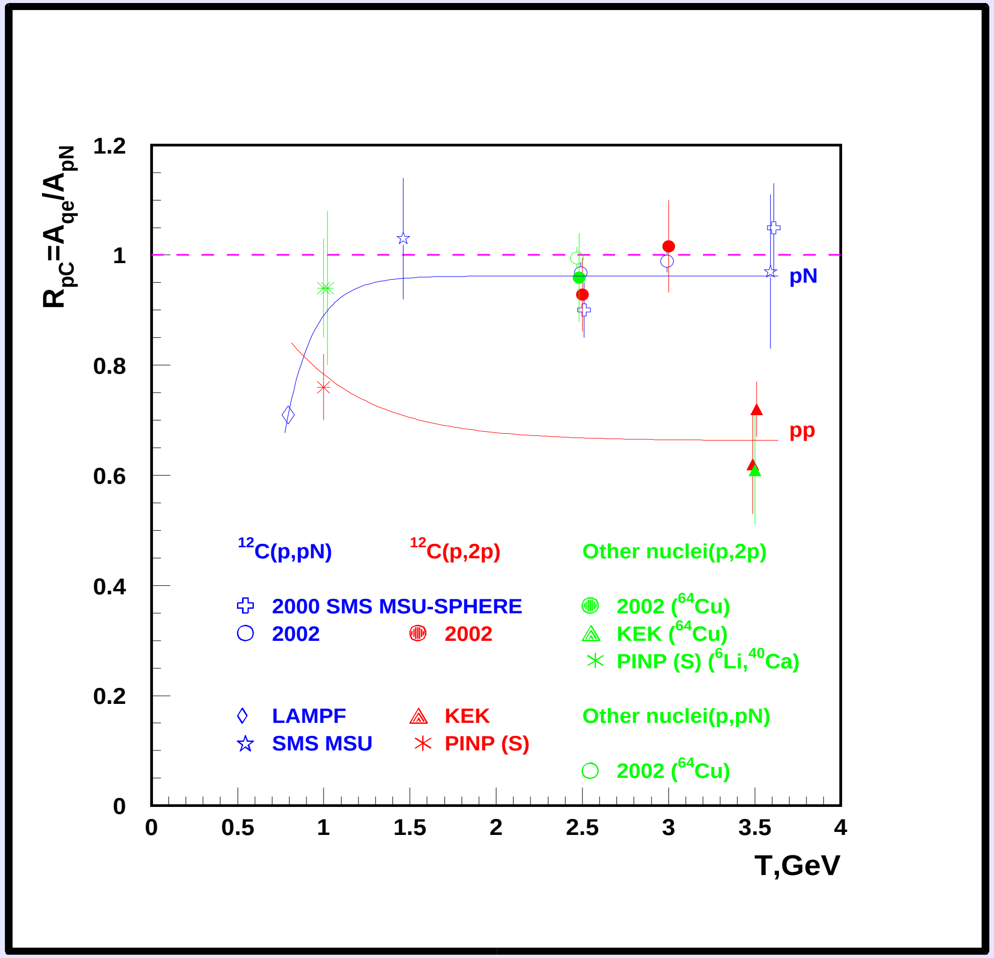
Reaction	T,GeV	Θ	A(qe), %	Err, %	P(free)
C(d,pN)	2,51	9	16,9	2	19,7
C(p,pN)	2,51	9	17,8	1	19,7
C(d,pN)	3,6	6,7	8,7	1,9	13
C(p,pN)	3,6	6,7	13,7	1	13
CH(p,pN)	2,51	9	19,5	1	
H(p,2p)	2,51	9	22,6	3,3	19,7

Run 2002 data

Reaction	T,GeV	Θ	A(qe), %	Err, %	P(free)
C(p,pN)	2,51	9,1	19,1	0,4	19,7
C(p,2p)	2,51	9,1	24,3	1,8	26,2
Cu(p,pN)	2,51	9,1	19	0,4	19,1
Cu(p,2p)	2,51	9,1	25,1	2,1	26,2
C(p,pN)	3	7,9	16	0,3	16,2
C(p,2p)	3	7,9	23,1	1,9	22,7
CH(p,pN)	2,51	9,1	20,9	0,7	
H(p,2p)	2,51	9,1	24,8	2,8	26,2
CH(p,2p)	2,51	9,1	30,5	2,1	
H(p,2p)	2,51	9,1	31,1	2,5	26,2

Results and discussions

Analyzing power reduction R(T)



There is no signifcant difference between:

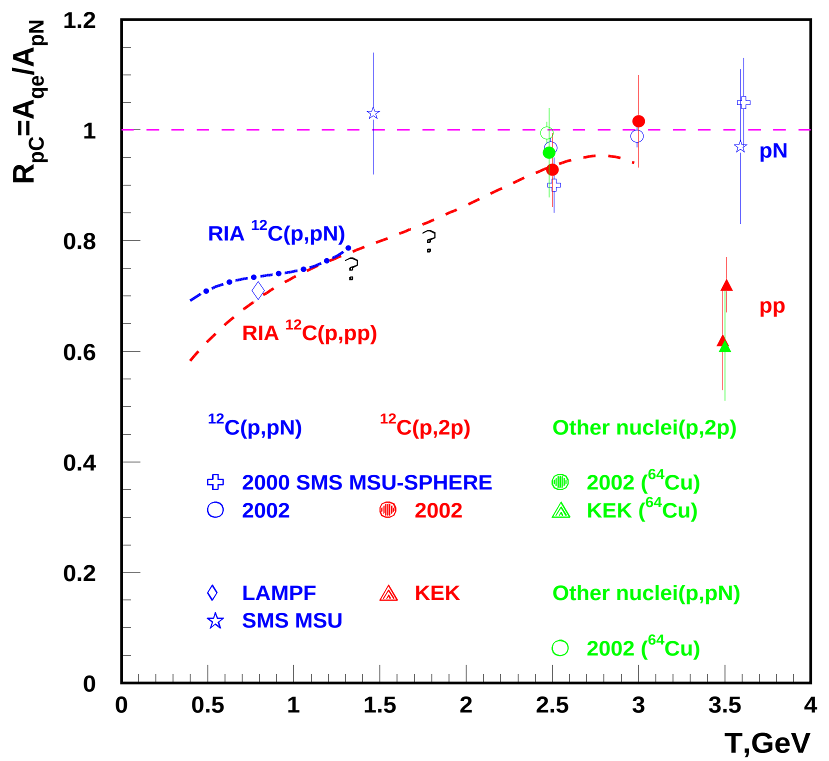
- R(C(p,pN)) and R(C(p,2p)) at 2.5 & 3.0 GeV;
- R(Cu(p,pN)) and R(C(p,pN)),
- R(Cu(p,2p)) and R(C(p,pN)), at 2.5 GeV.

R(T) is close to 1 at few GeV for all investigated reactions.

Possible reason of the contradiction between KEK data and presented ones: much stronger "kinematically fixed" target proton in the KEK (and SATURNE) experiment.

Plans for 2005

Comparison with the RIA estimations



There is an agreement with the predictions of the RIA model based on the nucleon mass modification in nuclear media (M*=0.8M)?
To undestand better we need the measurements at 1 – 2 GeV.

The other guidelines:
- **investigation of the factor of the "kinematic fixation" of intranuclear proton;**
- **A-dependence of the phenomenon;**
- **direct measurement of R(A(p,pn)).**

Sinchrophasotron died?
Long live Nuclotron!

Conclusions

Analyzing power of proton-nucleus quasielastic scattering has been measured in the experiment at the polarized beam of JINR sinchrophasotron under separation of the (p,2p) and (p,pN) channels at 2.5 and 3.0 GeV.

The main results are:

- there is not an indication of the anomalous reduction of analyzing power of inclusive quasielastic scattering - important for nuclear polarimetry;

- the consided polarization data are close for the scattering on carbon and copper target - argument for peripheral picture of interaction;

- data are in a good agreement with the estimation of R(T) behavior in the framework of RIA calculations based on the Dirac spinor modification in nuclear matter, but we need a measurement at 1 - 2 GeV.