



Absolute and relative polarimeters for the SPACHARM experiment

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Outline

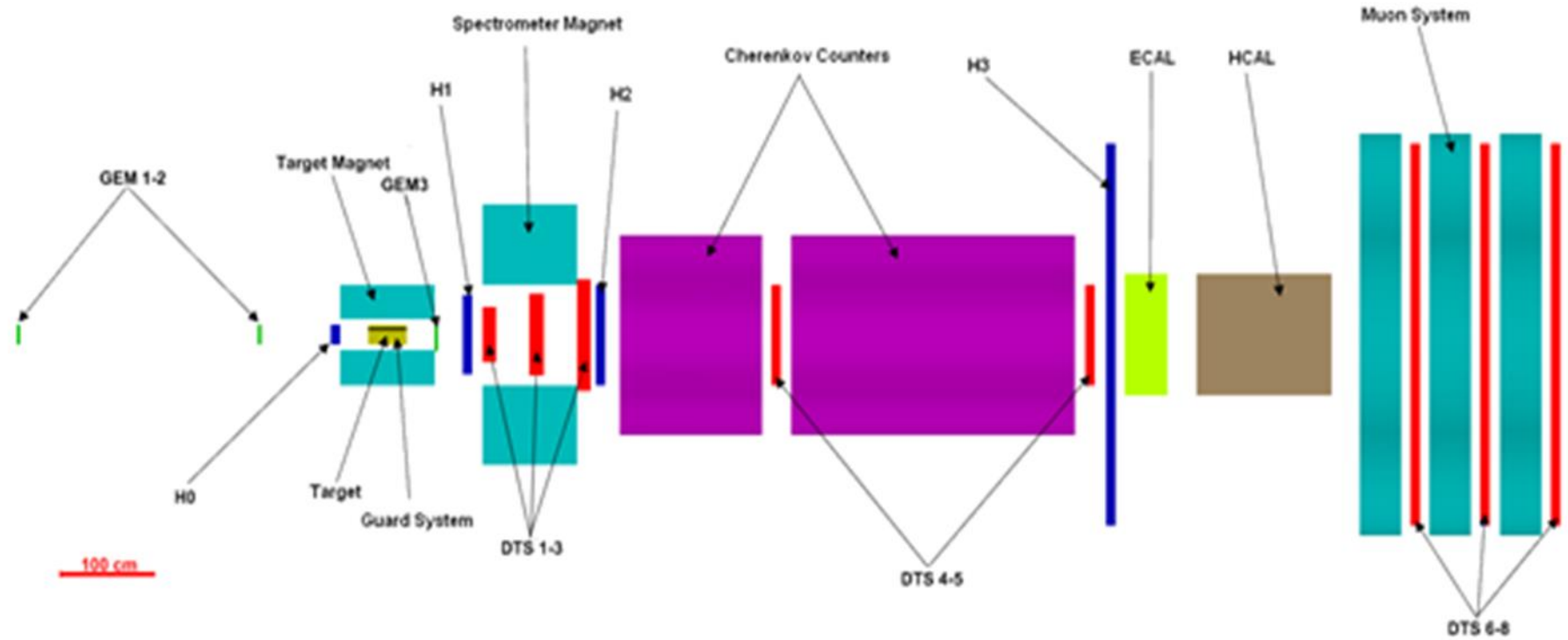


- SPASCHARM experiment and detector
- Polarized proton (anti-proton) beam
- Beam tagging system
- SPASCHARM absolute polarimeters
- Conclusion



- **Systematic study of the strong interactions spin dependence and nucleon spin structure**
- **Single-spin asymmetries: inclusive and exclusive reactions, including elastic, of the light hadrons in the beam fragmentation region with polarized beam or target**
- **Double-spin asymmetry A_{LL} in charmonium production to study gluon polarization $\Delta G/G(x)$ at large x_F**
- **Wide aperture allows to study dependence of the polarization effects on kinematic values in a wide range $0 < x_F < 1$, $0 < p_T < 2.5$ GeV/c**
- **The hyperon and vector mesons polarization and depolarization**
- **And many more - details will given in the talk of V.Mochalov (section Parallel-VI S11) at this conference**

SPASCHARM Detector Setup



SPASCHARM polarized beam



- Polarized hadron beam for the SPASCHARM experiment will be produced from the internal target at the line 24A of the U70 accelerator complex at Protvino
- Polarization will be created from Λ -hyperon decay using standard technique

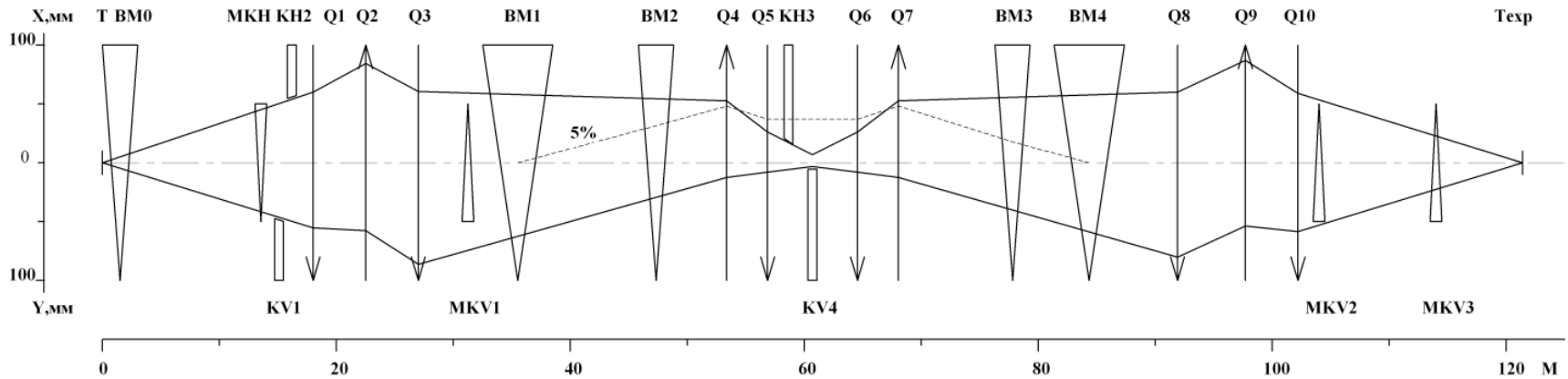
Protons at 45 GeV/c

Primary intensity protons per cycle	10^{13}
Pol. Protons Intensity	10^6
Polarization	39%
$\Delta P/P$	4.5%
Beam size	13x11 mm ²

Anti-protons at 14 GeV/c

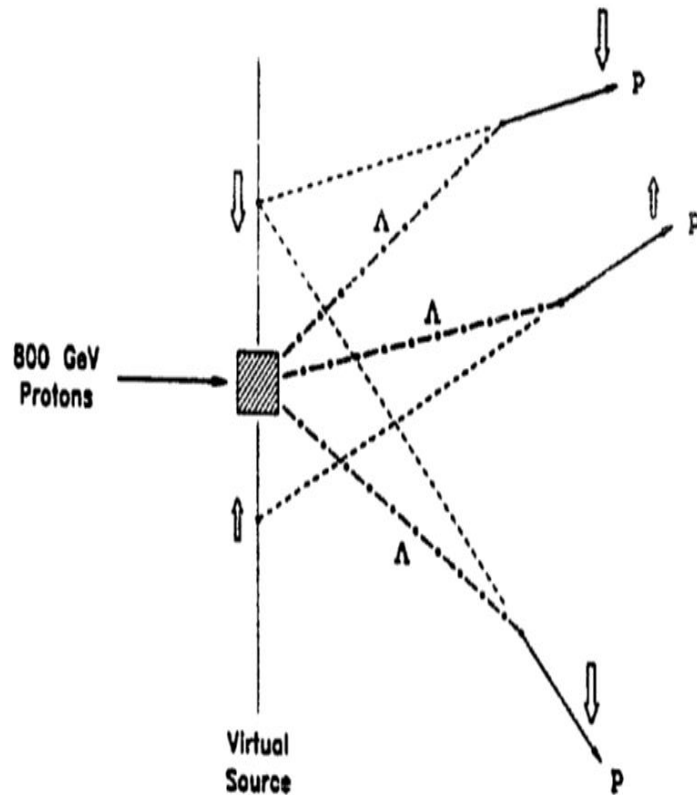
Pol. Anti-Protons Intensity	1.4×10^5
$\Delta P/P$	5.5%
Beam size	18x19 mm ²

Beam optics of the 24A beam line



***Q** – quads, **M** – dipoles **K** – collimators, **T**, **Texp** – targets
(channel and experiment)*

Beam tagging system



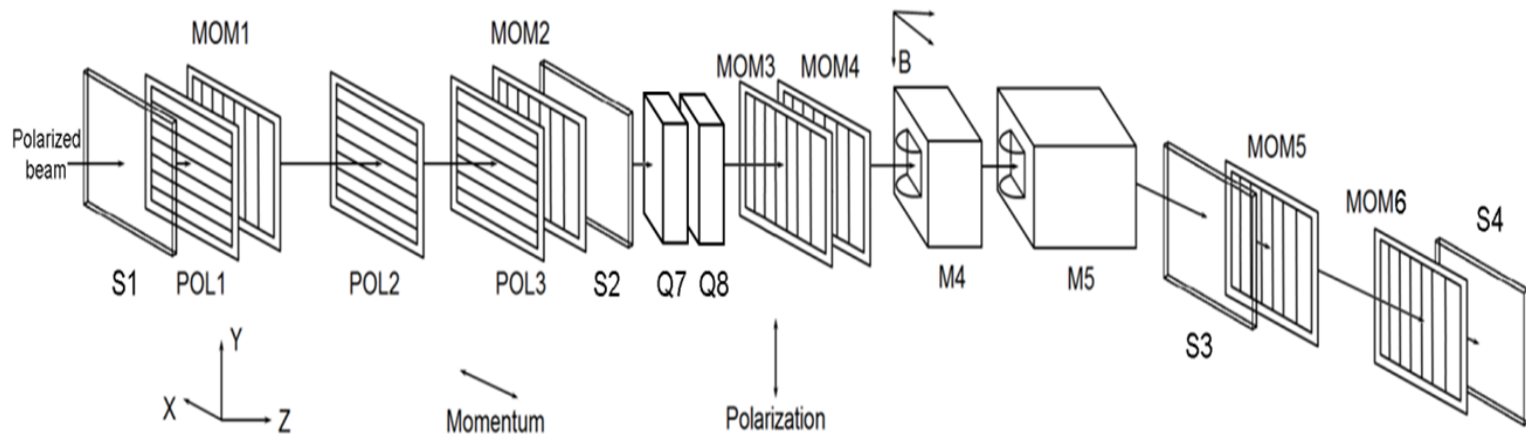
- Λ - hyperon decay produces the longitudinally polarized proton aligned with proton momentum (in Λ rest frame)
- **Protons will have transverse spin component in lab. frame depending on proton emission angle. Therefore the spin states of protons are separated in space**
- This method was successfully used in E-704 (FNAL) and FODS (IHEP, Protvino) experiments
- **Base for the beam polarization tagging system**

Polarization dependence on virtual source vertical position



Y(mm)	P($\Delta p/p=1\%$)	P($\Delta p/p=5\%$)
-40.	-57.9	-52.9
-30.	-53.9	-50.0
-20.	-47.7	-43.7
-15.	-43.6	-38.6
-10.	-35.7	-30.1
-5.	-18.8	-16.1
0.	0.	0.
5.	18.8	16.1
10.	35.7	30.1
15.	43.6	38.6
20.	47.7	43.7
30.	53.9	50.0
40.	57.9	52.9

SPASCHARM tagging system



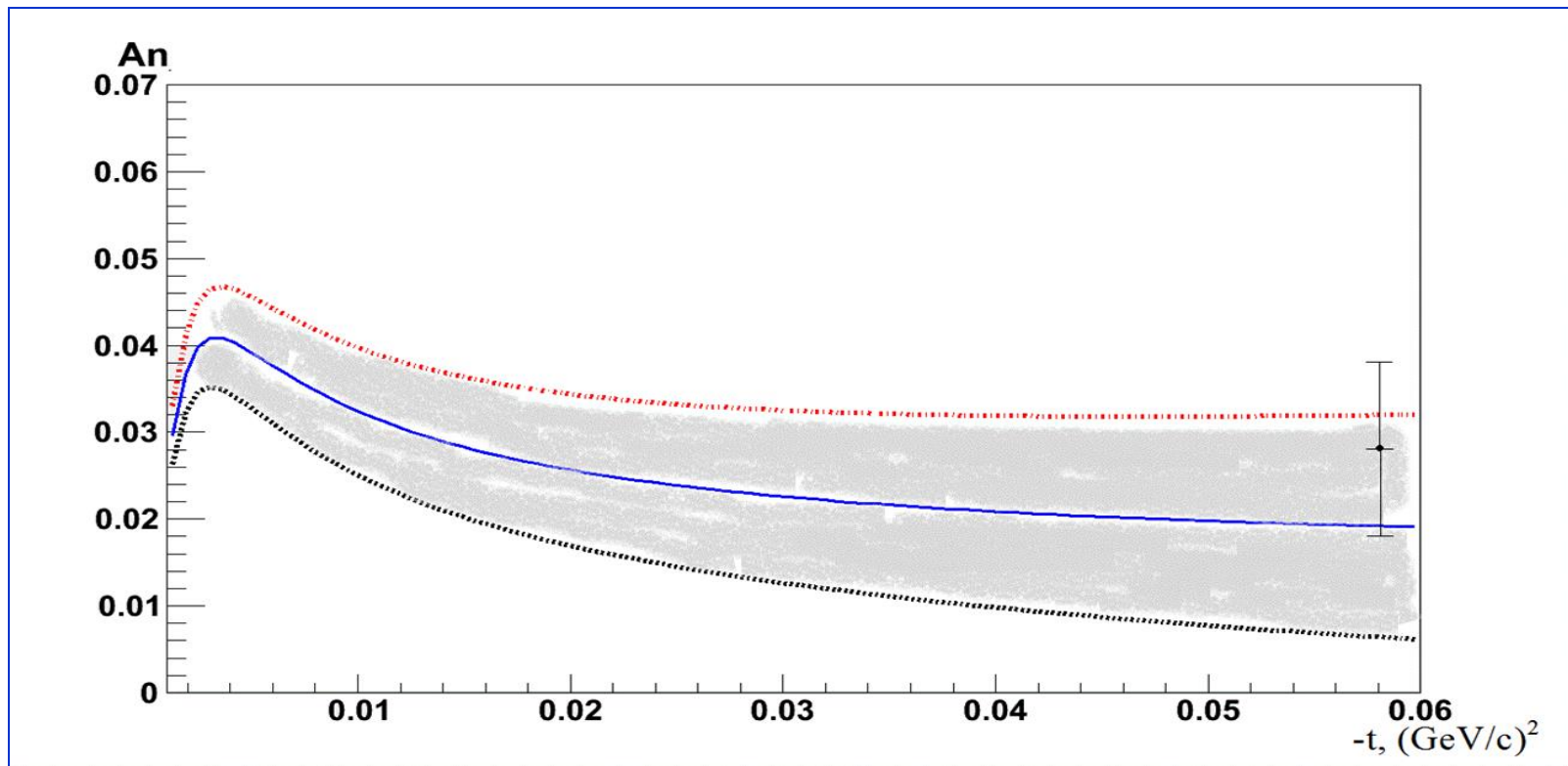
- Tagging system similar to the one used in E704
- Scintillator hodoscopes in vertical direction will be used to measure position of the virtual source (polarization), horizontal – to measure the beam momentum with a precision of $\sim 1\%$
- 3 planes of overlapped scintillating counters covering $70 \times 130 \text{ mm}^2$ to measure virtual source position (48 channels)
- Interesting feature – due to beam turn on by 160 mrad , central part of the polarized beam, which is usually not used in the measurements because of almost zero transverse polarization get spin precessed in horizontal plane. Since SPASCHARM setup has full azimuthal coverage this can be used to reduce systematics (left-right asymmetry)



- Calibration of the relative polarimeter
- Polarimeter based on pp elastic scattering in CNI region. $0.002 \leq |t| \leq 0,05 \text{ (GeV/c)}^2$.
- **Polarimeter based on pp elastic scattering $0.04 \leq |t| \leq 0,5 \text{ (GeV/c)}^2$. Diffraction cone**
- Combined polarimeter $0.002 \leq |t| \leq 0,5 \text{ (GeV/c)}^2$.



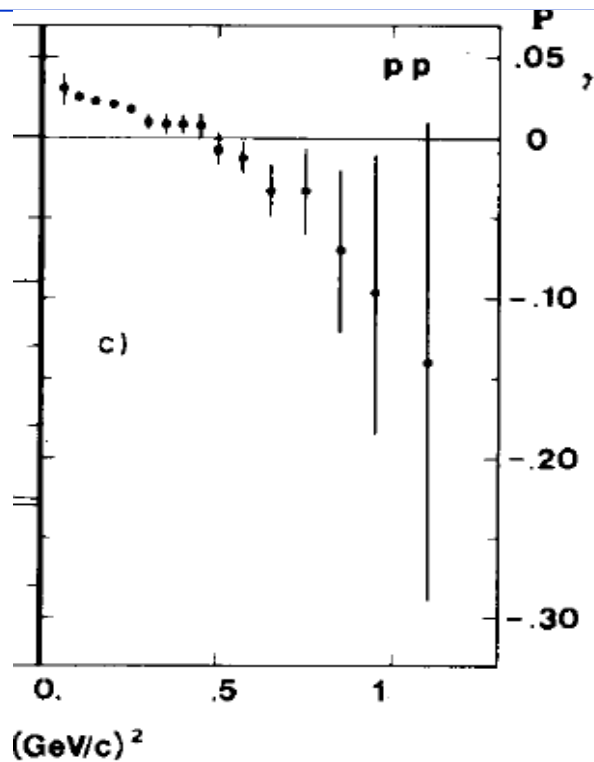
- CNI data from RHIC can be interpolated to 45 GeV
- Less than 100 hours required for 10% accuracy



Diffraction polarimeter

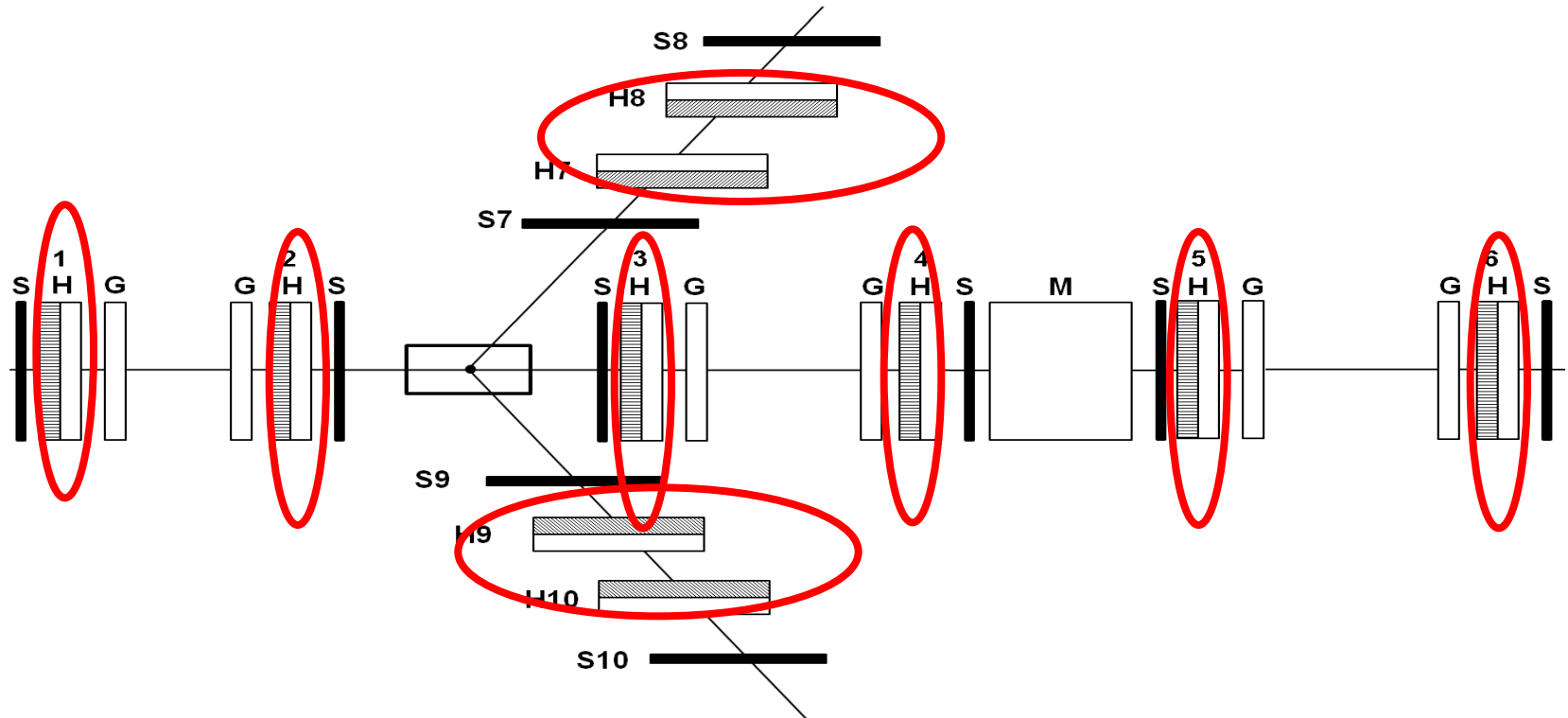


- Polarization has been measured at U70 for pp elastic scattering at 45 GeV/c. (A. Gaido et al., Phys. Lett. 61B (1976)104)
- Calculations show background contribution is less 20%
- 10% accuracy measurements of the polarization requires less than 100 hours assuming U70 24A beam line parameters



Interval of $-t$ (GeV/c) ²	$P(\text{pp})$
0.040 – 0.075	0.030 ± 0.010
0.075 – 0.125	0.026 ± 0.002
0.125 – 0.175	0.023 ± 0.002
0.175 – 0.225	0.022 ± 0.002
0.225 – 0.275	0.016 ± 0.003
0.275 – 0.325	0.021 ± 0.004
0.325 – 0.375	0.009 ± 0.005
0.375 – 0.425	0.009 ± 0.005
0.425 – 0.475	0.009 ± 0.008
0.475 – 0.525	-0.007 ± 0.010
0.525 – 0.600	-0.012 ± 0.010
0.600 – 0.700	-0.032 ± 0.017
0.700 – 0.800	-0.032 ± 0.027
0.800 – 0.900	-0.070 ± 0.051
0.900 – 1.000	-0.096 ± 0.088
1.000 – 1.200	-0.140 ± 0.150

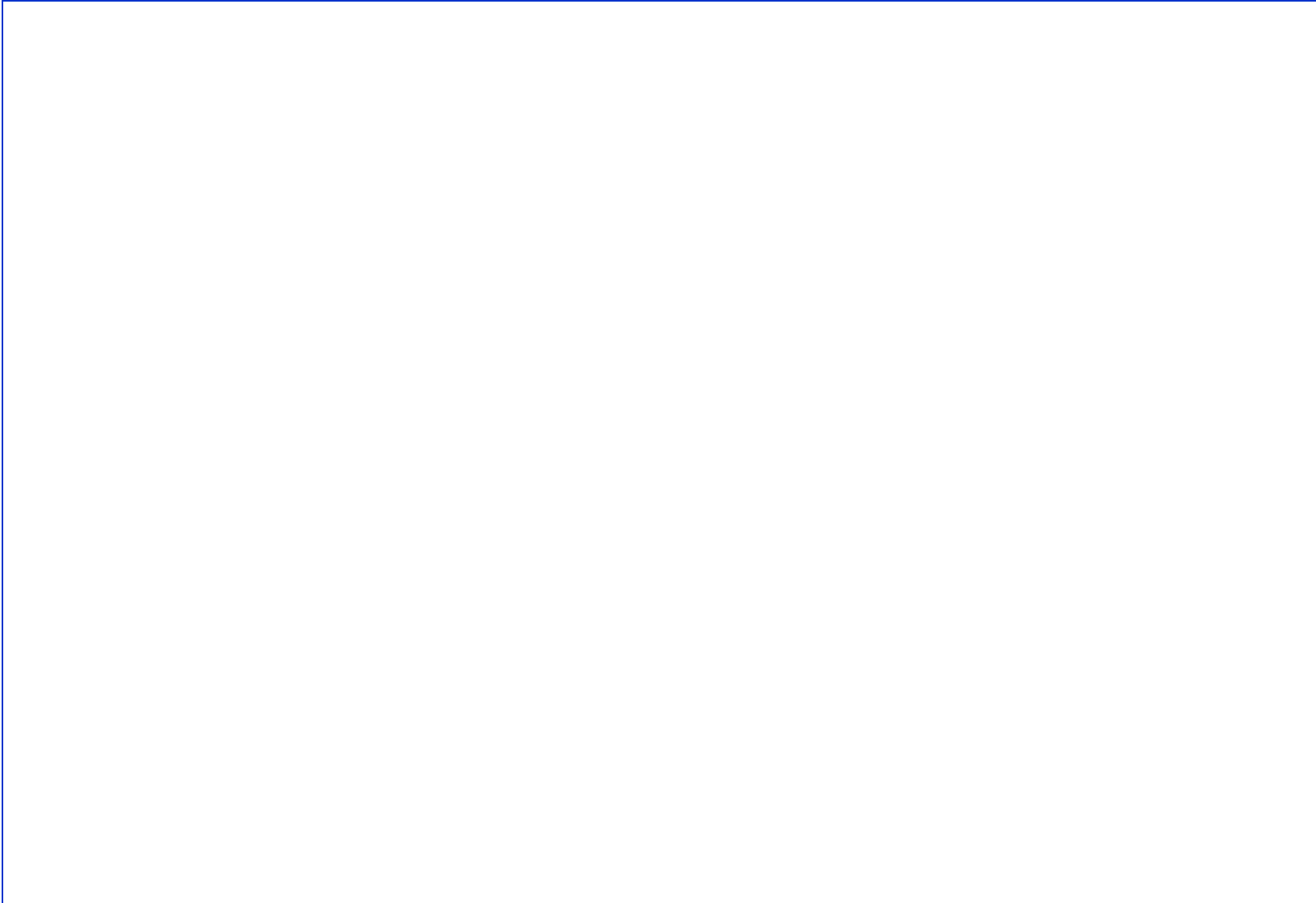
Combined polarimeter. Diffraction part



CONCLUSIONS



- **The SPASCHARM experiment at IHEP plans to perform the polarization measurements with the use of the polarized proton and antiproton beams.**
- **To detect beam polarization the tagging system similar to hodoscope system used in E581/E704 experiment at Fermilab and allowed to measure beam online polarization with accuracy $\pm 5\%$ is going to be used**
- **The beam tagging system will be calibrated by the combined polarimeter based on CNI and diffraction cone type and provided absolute polarization measurements in the region of $0.002 \leq |t| \leq 0,5$ (GeV/c)²**

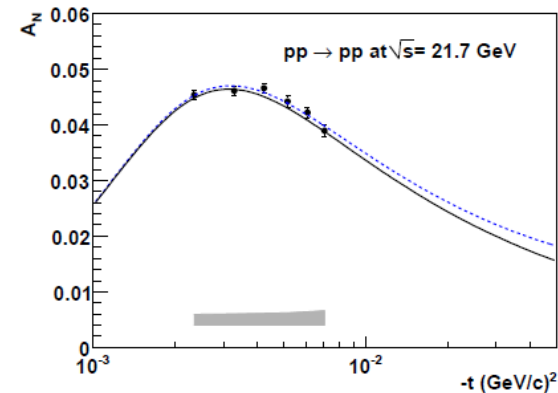
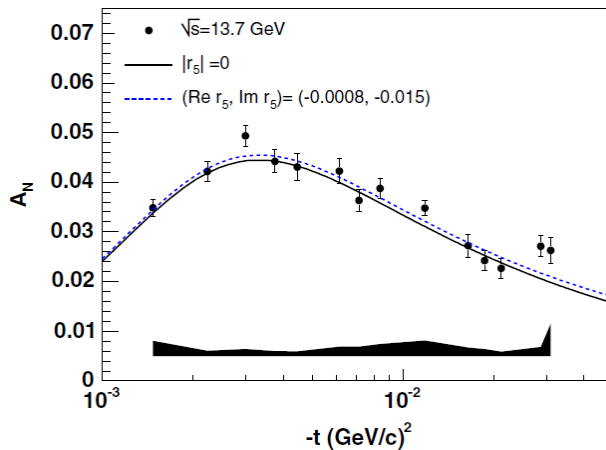
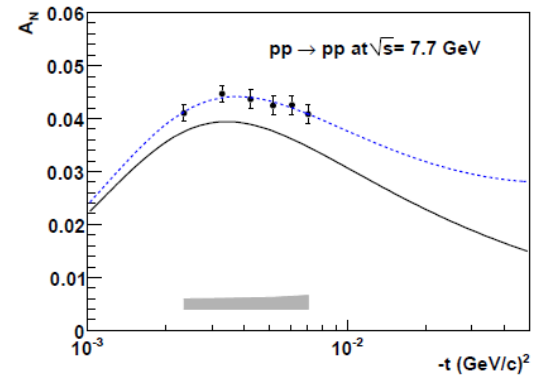
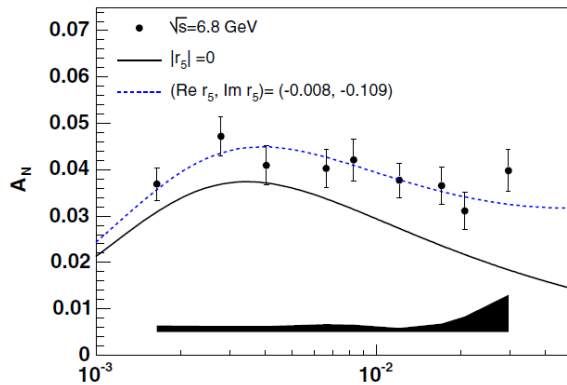


Backup slides



CNI polarimeter

- Polarization at 45 GeV/c ($\sqrt{s}=9.3$ GeV) was not measured in CNI region. Data from STAR experiment at RHIC BNL at $\sqrt{s}=6,8, 7,7, 13,7, 21,7$ GeV.



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Alekseev I G *et al* Phys. Rev. D 79 094014