The first results on the spin asymmetries in elastic *pp* scattering at sqrt{s}=200 GeV and small *t* at RHIC

Alexey Bogdanov on behalf of pp2pp collaboration.

OUTLINE

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- Results on single spin asymmetry AN
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- Summary

List of *pp2pp* collaborators

S. Bültmann, I. H. Chiang, R.E. Chrien, A. Drees, R. L. Gill, W. Guryn*, J. Landgraf, T.A. Ljubiиlи, D. Lynn, C. Pearson, P. Pile, A. Rusek, M. Sakitt, S. Tepikian, K. Yip

Brookhaven National Laboratory, USA

J. Chwastowski, B. Pawlik

Institute of Nuclear Physics, Cracow, Poland

M. Haguenauer

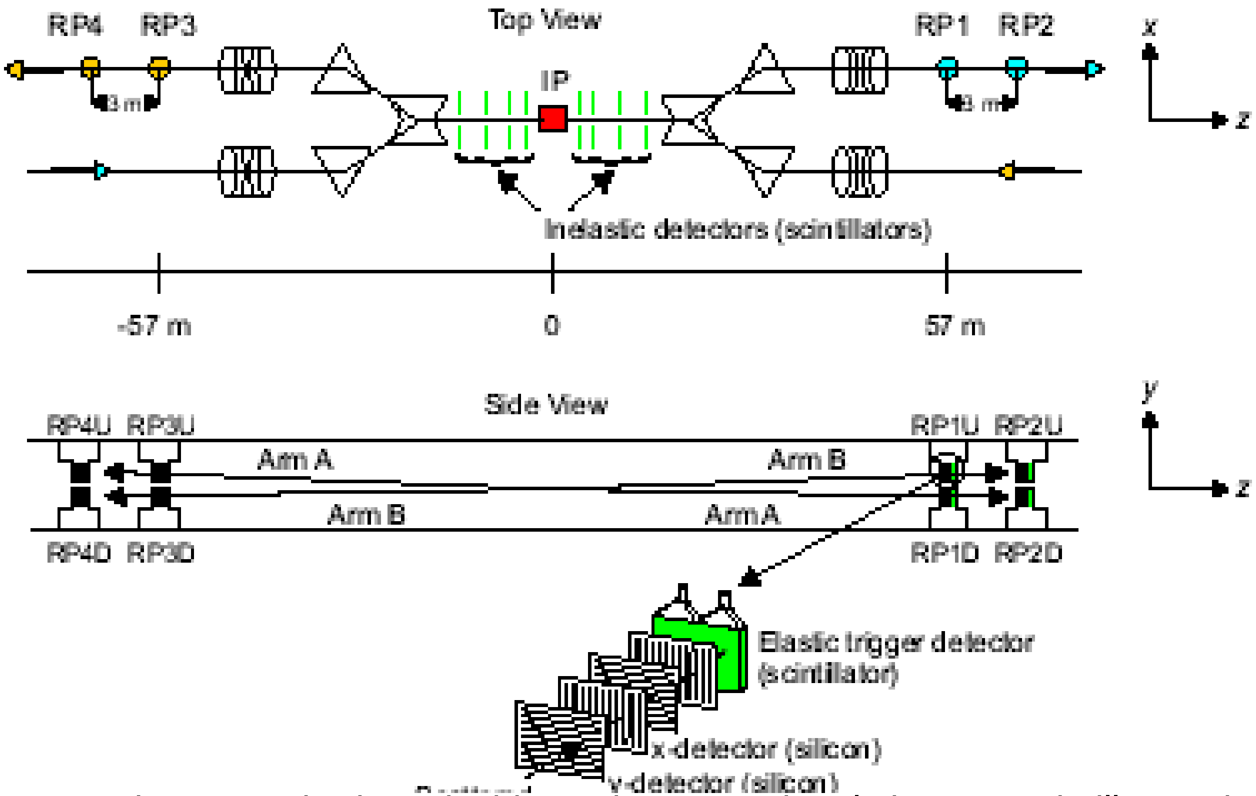
Ecole Polytechnique/IN2P3-CNRS, Palaiseau, France

A. **A. Bogdanov, S. B. Nurushev, M. F. Runtzo, M. N. Strikhanov**
B. **Moscow Engineering Physics Institute (MEPHI), Moscow, Russia**
C. **I. G. Alekseev, V. P. Kanavets, L. I. Koroleva, B. V. Morozov, D. N. Svirida**
D. **ITEP, Moscow, Russia**
E. **S. Khodinov, M. Rijssenbeek, L. Whitehead**
F. **SUNY Stony Brook, USA**
G. **K. De, N. Guler, N. Ozturk**
H. **University of Texas at Arlington, USA**
I. **A. Sandacz**
J. **Institute for Nuclear Studies, Warsaw, Poland**

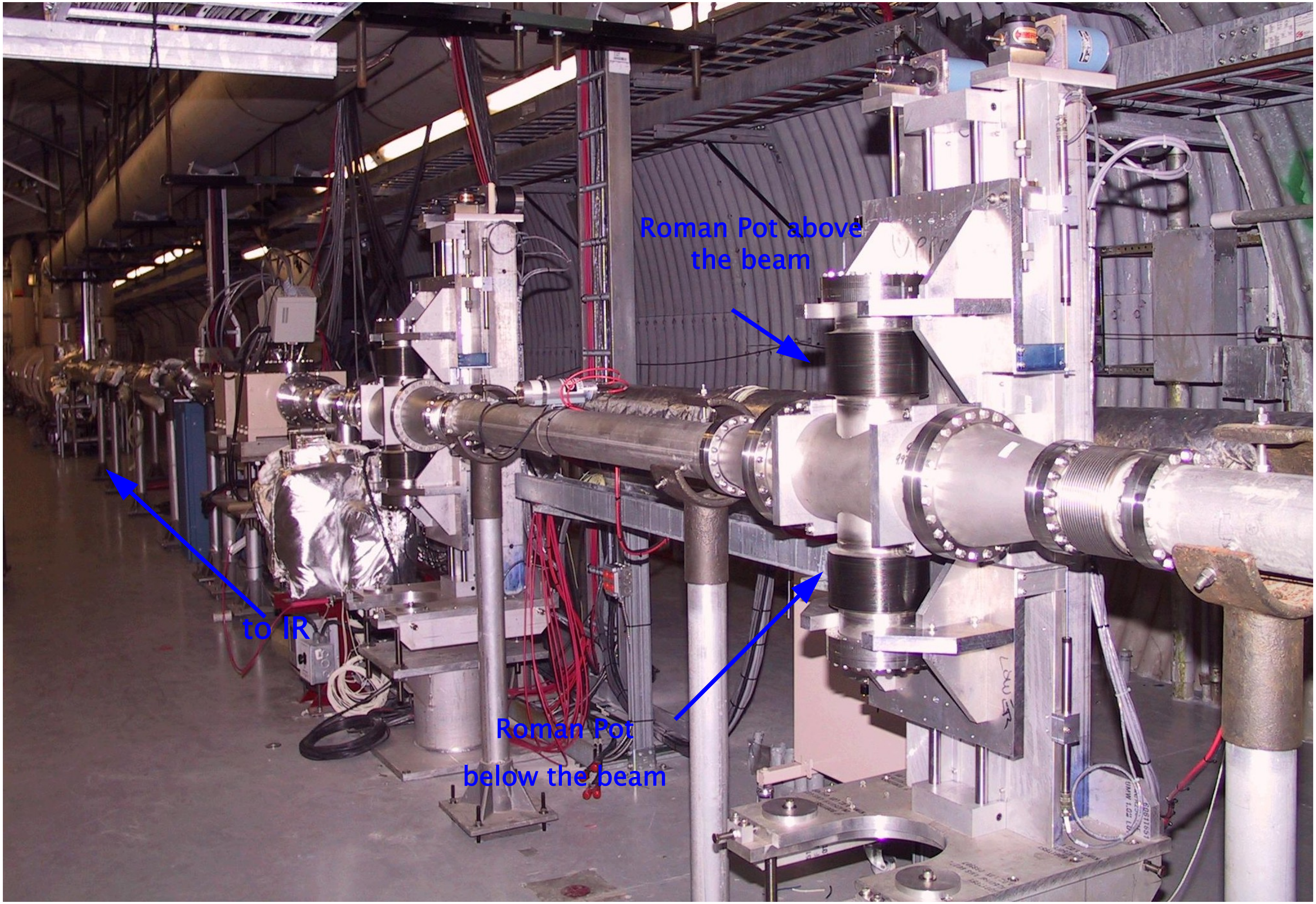
* spokesperson

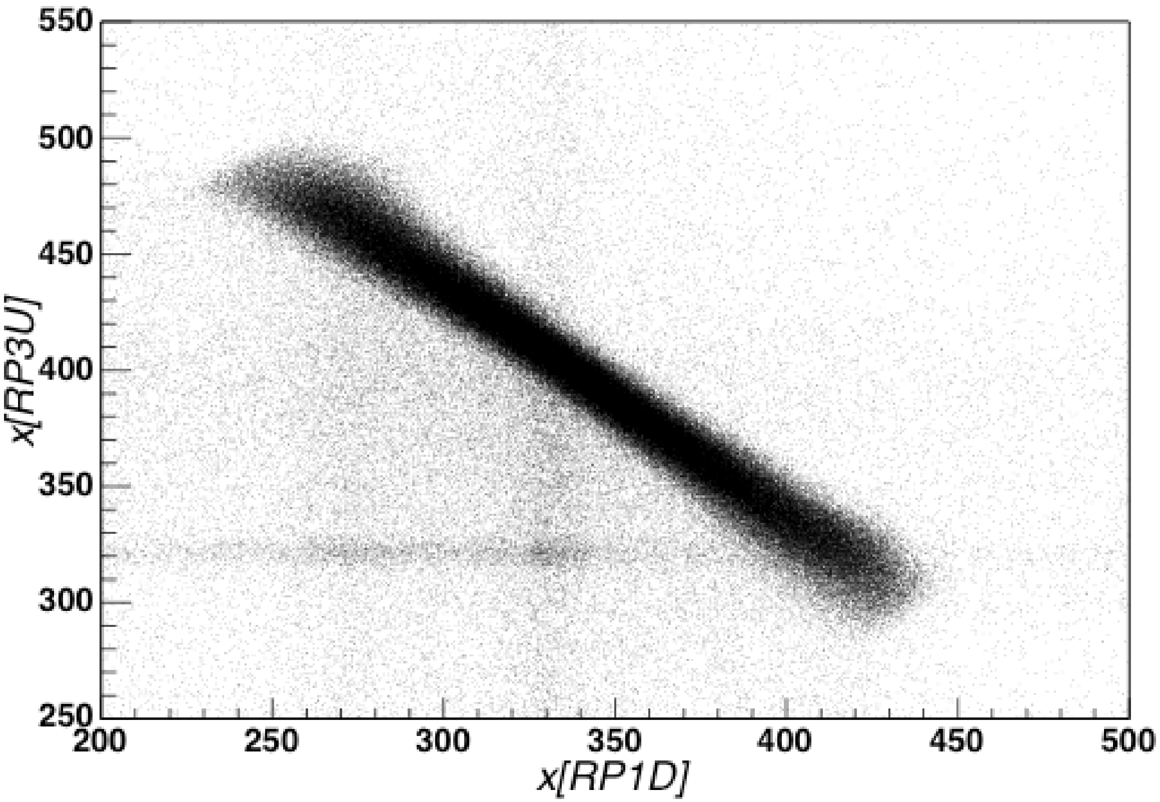
The Relativistic Heavy Ion Collider

Description of the experiment
The Setup



The elastic event trigger required a coincidence between signals in RP's scintillators, belonging either to arm A or arm B. For each arm the trigger counters in RP1 and RP3 were used. The overall trigger was the logical OR of a coincidence between up and down pots: (RP3U AND RP1D) OR ((RP3D AND RP1U) in coincidence with the beam crossing signal derived from the RHIC master clock.


Roman Pot above the beam
to IR
Roman Pot below the beam



Because of the colinearity of the scattered protons one has to require a correlation between coordinates measured on each side of the IP. An example of the correlation of the x-coordinates of the detected protons is shown on this Figure. Note the diagonal band of elastic events and relatively small background. The background appears enhanced because of the "saturation" of the main band. It is due mainly to beam halo and beam-gas interactions

Background sources: 1)inelastic interactions

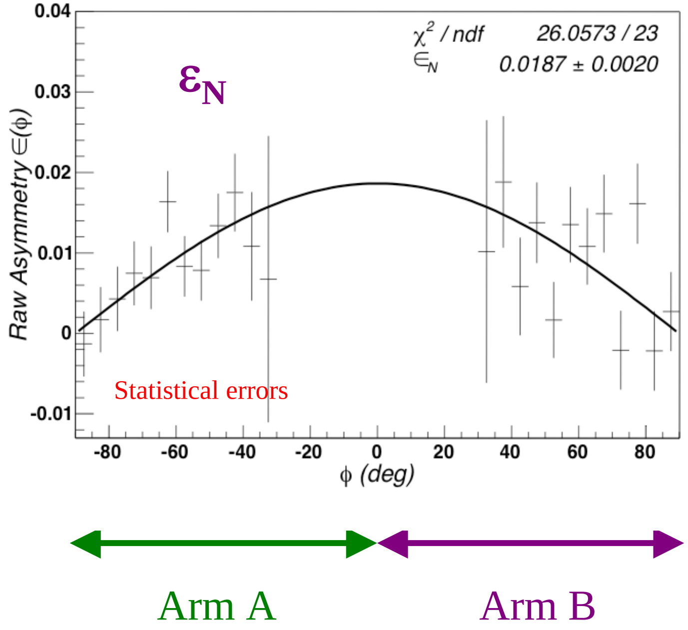
2) Beam halo particles

3) Beam-gas interactions.

Background fraction varies from 0.5% to 9% depending on the y-coordinate.
In our analysis y>30 strips, it mean that background not exceed 2%

Results on single spin asymmetry AN

Results: Full bin 0.01 < -t < 0.03 (GeV/c)**2**



$P_Y(++,--) = 0.345 \pm 0.066$

$P_B(++,--) = 0.532 \pm 0.106$

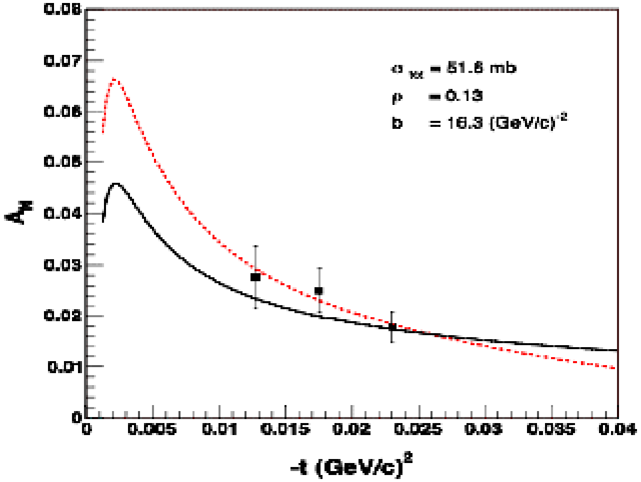
Azimuthall angle dependence of the cross section for the elastic collision of the vertically polarized protons is given by:

$$2\pi \frac{d^2\sigma}{dt\,d\phi} = \frac{d\sigma}{dt}\left(1 + (P_B + P_Y)A_N \cos\phi + P_B P_Y (A_{NN}\cos^2\phi + A_{SS}\sin^2\phi)\right)$$

Single spin raw asymmetry can be written as

$$\varepsilon(\phi) = \frac{(P_B + P_Y)A_N \cos\phi}{1 + P_B P_Y (A_{NN}\cos^2\phi + A_{SS}\sin^2\phi)}$$

$$= \frac{\sqrt{N^{\uparrow\uparrow}(\phi)N^{\downarrow\downarrow}(\pi-\phi)} - \sqrt{N^{\downarrow\downarrow}(\phi)N^{\uparrow\uparrow}(\pi-\phi)}}{\sqrt{N^{\uparrow\uparrow}(\phi)N^{\downarrow\downarrow}(\pi-\phi)} + \sqrt{N^{\downarrow\downarrow}(\phi)N^{\uparrow\uparrow}(\pi-\phi)}}$$



The values of AN obtained in this experiment and their errors are shown in this figure for the three t-intervals. The curves shown in the figure represent theoretical calculation using the formula for An in CNI region. N.H. Buttimore et al., Phys.Rev. D59, 114010 (1999).

$$A_N = \frac{\sqrt{-t}}{m} \frac{\left[k(1-\rho\delta) + 2(\delta \operatorname{Re} r_5 - \operatorname{Im} r_5)\right]\frac{t_c}{t} - 2(\operatorname{Re} r_5 - \rho \operatorname{Im} r_5)}{(\frac{t_c}{t})^2 - 2(\rho+\delta)\frac{t_c}{t} + (1+\rho^2)}$$

The solid curve corresponds to the calculation without hadronic spin-flip. To quantify a possible contribution of the single helicity-flip amplitude, this equation was fitted to the measured AN values with Rer5 and Im r5 as fit parameters. The results of the fit are following Re r5=-0.033+-0.035 and Im r5=-0.43+-0.56. The dashed line in figure represents the curve resulting from the fit.

Results on double spin asymmetries ANN and ASS

The double spin raw asymmetry is given by

$$\delta(\phi) = P_B P_Y (A_{NN}\cos^2\phi + A_{SS}\sin^2\phi) = \frac{N^{\uparrow\uparrow}(\phi)/L^{\uparrow\uparrow} + N^{\downarrow\downarrow}(\phi)/L^{\downarrow\downarrow} - N^{\uparrow\downarrow}(\phi)/L^{\uparrow\downarrow} - N^{\downarrow\uparrow}(\phi)/L^{\downarrow\uparrow}}{N^{\uparrow\uparrow}(\phi)/L^{\uparrow\uparrow} + N^{\downarrow\downarrow}(\phi)/L^{\downarrow\downarrow} + N^{\uparrow\downarrow}(\phi)/L^{\uparrow\downarrow} + N^{\downarrow\uparrow}(\phi)/L^{\downarrow\uparrow}}$$

where L^{ij} Is the relative luminosity for the sum of bunches with a given spin combination

Luminosity normalization is done using:

1.The machine bunch intensities:

$L^{ij} \sim \Sigma I^i_B \cdot I^j_Y$ over bunches with given i,j

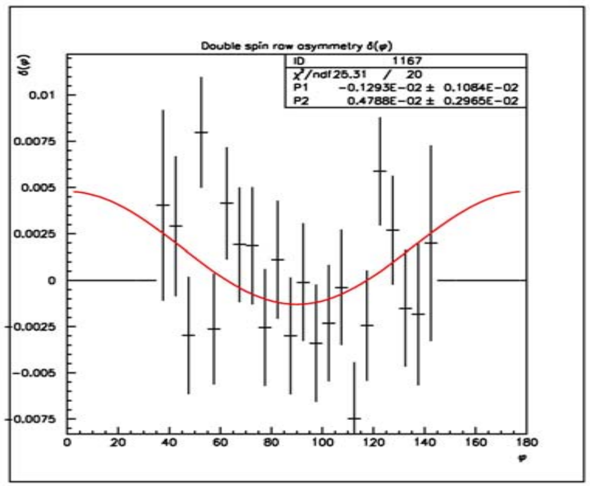
2.The inelastic counters

The two methods agreed.

Distributions $\delta(\varphi)$ were fitted with

$(P_1 \cdot \sin^2\varphi + P_2 \cdot \cos^2\varphi)$ where

$P_1 = P_B \cdot P_Y \cdot A_{SS}$ and $P_2 = P_B \cdot P_Y \cdot A_{NN}$



The results on the double spin asymmetries for the whole t-interval are presented in Table 1.

|t|-range, $(GeV/c)^2$	**<|t|>, $(GeV/c)^2$**	**A_{SS}**	**$\sigma_{Ass\ (stat.+norm.)}$**	**A_{NN}**	**$\sigma_{Ann\ (stat.+norm.)}$**
0.010-0.030	**0.019**	**0.0035**	**0.0081**	**0.0298**	**0.0166**

$$r_2 = \phi_2/(2\cdot \mathrm{Im}\phi_+),\ \ where\ \ \phi_+ = \frac{1}{2}(\phi_1+\phi_3)$$

$\mathrm{Im}\ r_2 = 0.0019 \pm 0.0052$ $\mathrm{Re}\ r_2 = -0.025 \pm 0.065$

Summary

1. **We have measured the single spin analyzing power AN in polarized pp elastic scattering at √s = 200 GeV, highest to date, in t-range [0.01,0.03] (GeV/c)2.**
2. **The fitted r5 is compatible, at about one σlevel, with the hypothesiss of no hadronic spin flip.**
3. **Result on *ANN*, *ASS* have been obtained.**
4. **Our results on the t-dependence of ASS support predictions which assume none or a weak spin coupling of the Odderon.**
5. **The program of elastic scattering and inelastic diffraction will continue within STAR experiment at RHIC.**

Acknowledgments

I deeply thank to the local organizing committee and personally prof A.V. Efremof for opportunity to participate in this DUBNA Spin workshop 2007.

Thank all of you for your attention.