Status of the pp2pp Experiment

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June 17, 2002

for
RHIC Spin Collaboration Meeting X
RIKEN BNL Research Center

Status of the pp2pp Experiment

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For the pp2pp Collaboration

- Introduction
- Formalism
- Experimental Setup
- Silicon Detector Performance
- Preliminary Results
- Planning for Year-2003 Running

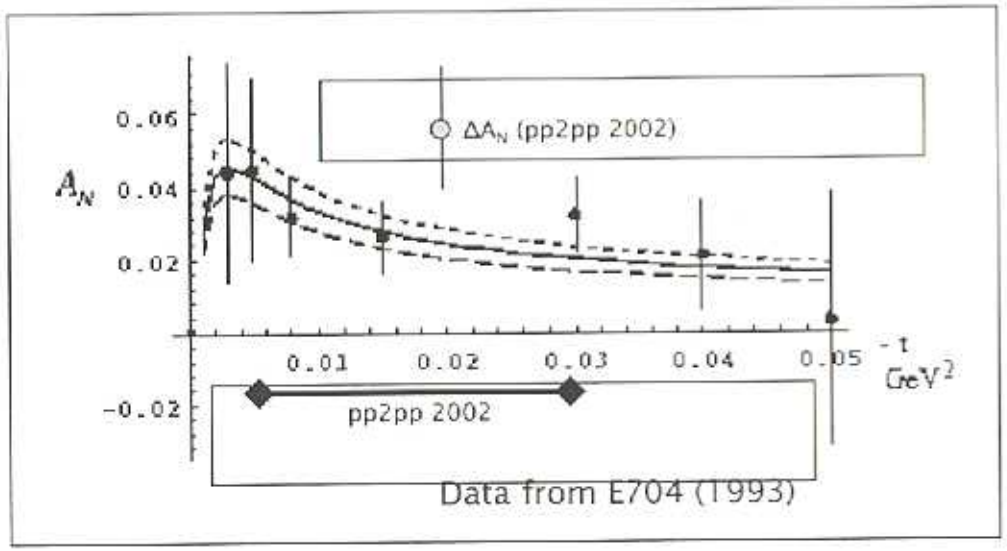
RHIC Spin Collaboration Meeting June 17, 2002

Spin Physics with pp2pp (2)

Single spin asymmetry A_N may be used for polarimetry in RHIC

Measure t- and φ-dependence later also s-dependence

$$A_N(t) = \frac{1}{P_{blue} \cdot \cos\varphi} \frac{N_{\uparrow\uparrow}(t) - N_{\downarrow\downarrow}(t) + N_{\uparrow\downarrow}(t) - N_{\downarrow\uparrow}(t)}{N_{\uparrow\uparrow}(t) + N_{\downarrow\downarrow}(t) + N_{\uparrow\downarrow}(t) + N_{\downarrow\uparrow}(t)}$$



$$N(t) = \frac{dN}{dt}$$

φ = Azimuth

P_{blue} = Beam Polarization

N.H. Buttimore, B.Z. Kopeliovich, E. Leader, J. Soffer, T.L. Trueman, "The Spin Dependence of High-Energy Proton Scattering", PRD 59, 114010 (1999)

Principle of Measurement

Transport of beam and scattered protons defined by transport matrix

$$\begin{pmatrix} x \\ x' \end{pmatrix} = M_x \begin{pmatrix} x_0 \\ x_0' \end{pmatrix} = \begin{pmatrix} a_{11} & L_{eff} \\ a_{12} & a_{22} \end{pmatrix} \begin{pmatrix} x_0 \\ x_0' \end{pmatrix}$$ (one for each coordinate: x, y)

This results in two equations (where x_0 can be eliminated)

$$x = a_{11}\, x_0 + L_{eff}\, x_0'$$ → Optimize so that a_{11} small and L_{eff} large

$$x' = a_{12}\, x_0 + a_{22}\, x_0'$$

Design $$M_x = \begin{pmatrix} -0.75 & 6.98 \\ -0.06 & -0.73 \end{pmatrix}$$

$$M_y = \begin{pmatrix} 0.02 & 23.29 \\ -0.04 & -0.66 \end{pmatrix}$$

x : Position at Detector
x' : Angle at Detector
x_0 : Position at Interaction Point
x_0' : Scattering Angle at IP

Principle of Measurement (3)

Measurement of x and x' at Roman Pot location enables determination of scattering angle x_0' without knowledge of x_0 :

$$x_0' = \frac{x - (a_{11}/a_{12})\,x'}{L_{eff} - (a_{11}/a_{12})\,a_{22}}$$

But, need two Roman Pot stations at both tunnel locations :

With x_0' (min) = 0.6 mrad $\rightarrow$ x' ≈ 0.4 mrad

$\rightarrow \Delta x > 1.2$ mm for a distance of ~ 3 m between stations

x : Position at Detector
x' : Angle at Detector
x_0 : Position at Interaction Point
x_0' : Scattering Angle at IP

Roman Pot Stations at RHIC

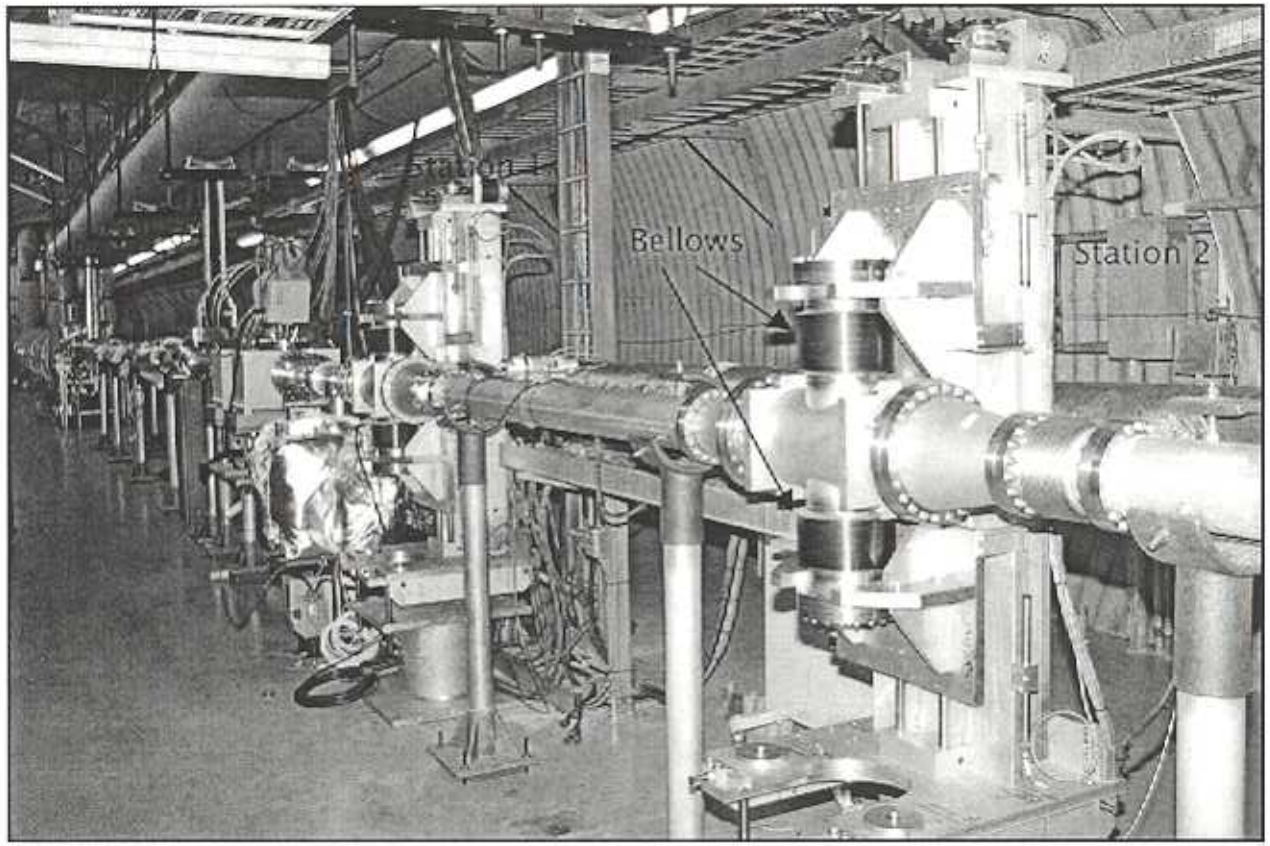
Detector Package consists of

2 x-silicon planes

2 y-silicon planes

1 trigger scintillator

Active area of silicon covers 7.5 x 4.5 cm^2



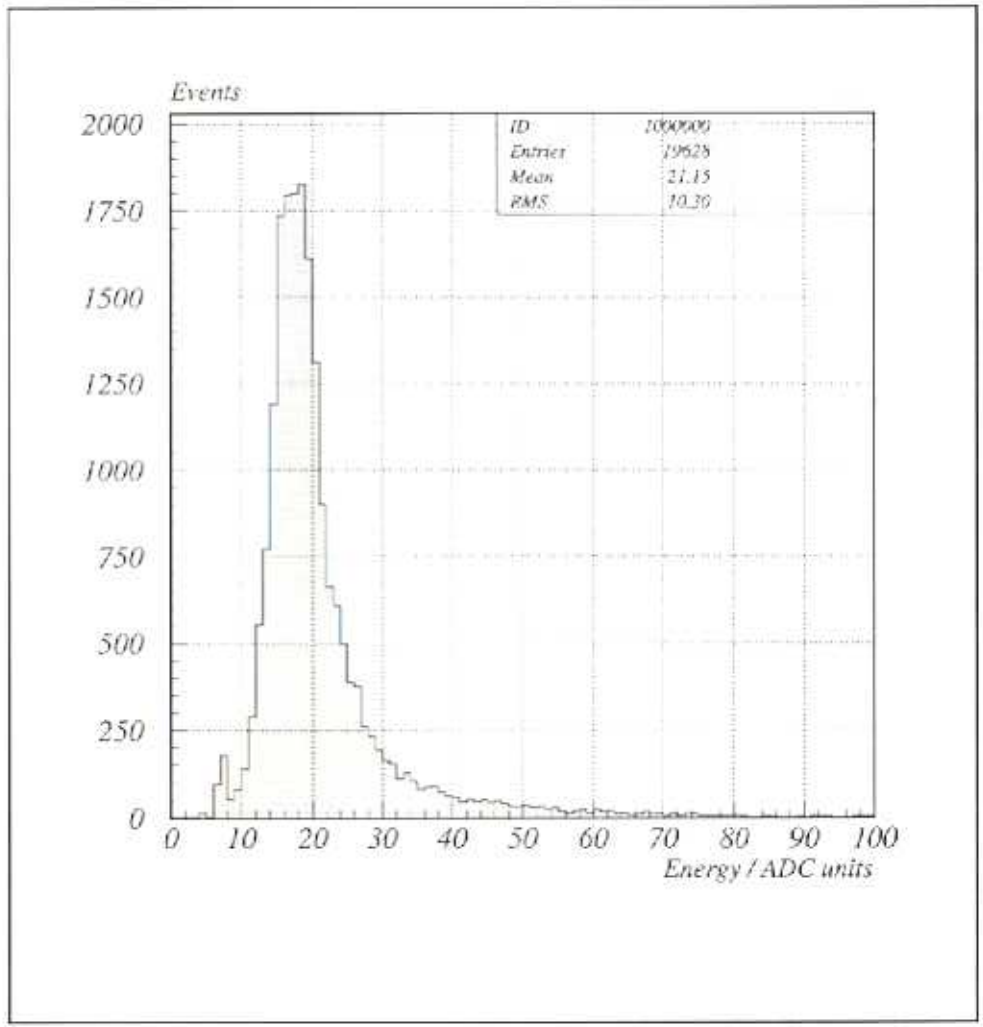
Two Roman Pot Stations installed in each Sector
(One Station equipped with Detector Package)

Silicon Microstrip Detector

100 GeV proton loses about 200 keV in silicon

Corresponds to 58,000 electron–hole pairs

SN ratio ≈ 11
(for detector shown on right)

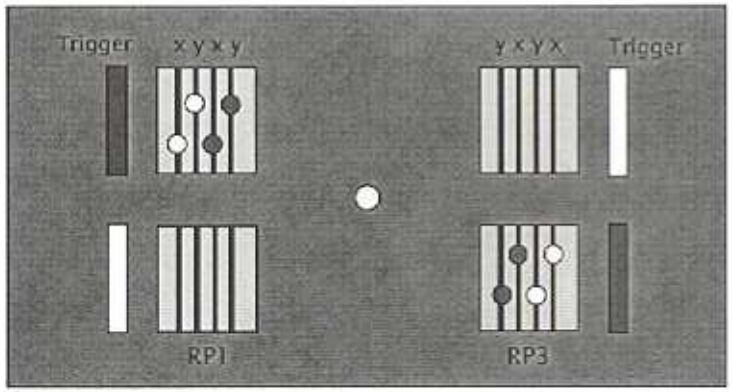


Elastic Event Selection Criteria

Exactly one hit for each coordinate one either side of IP in one of the two elastic arms

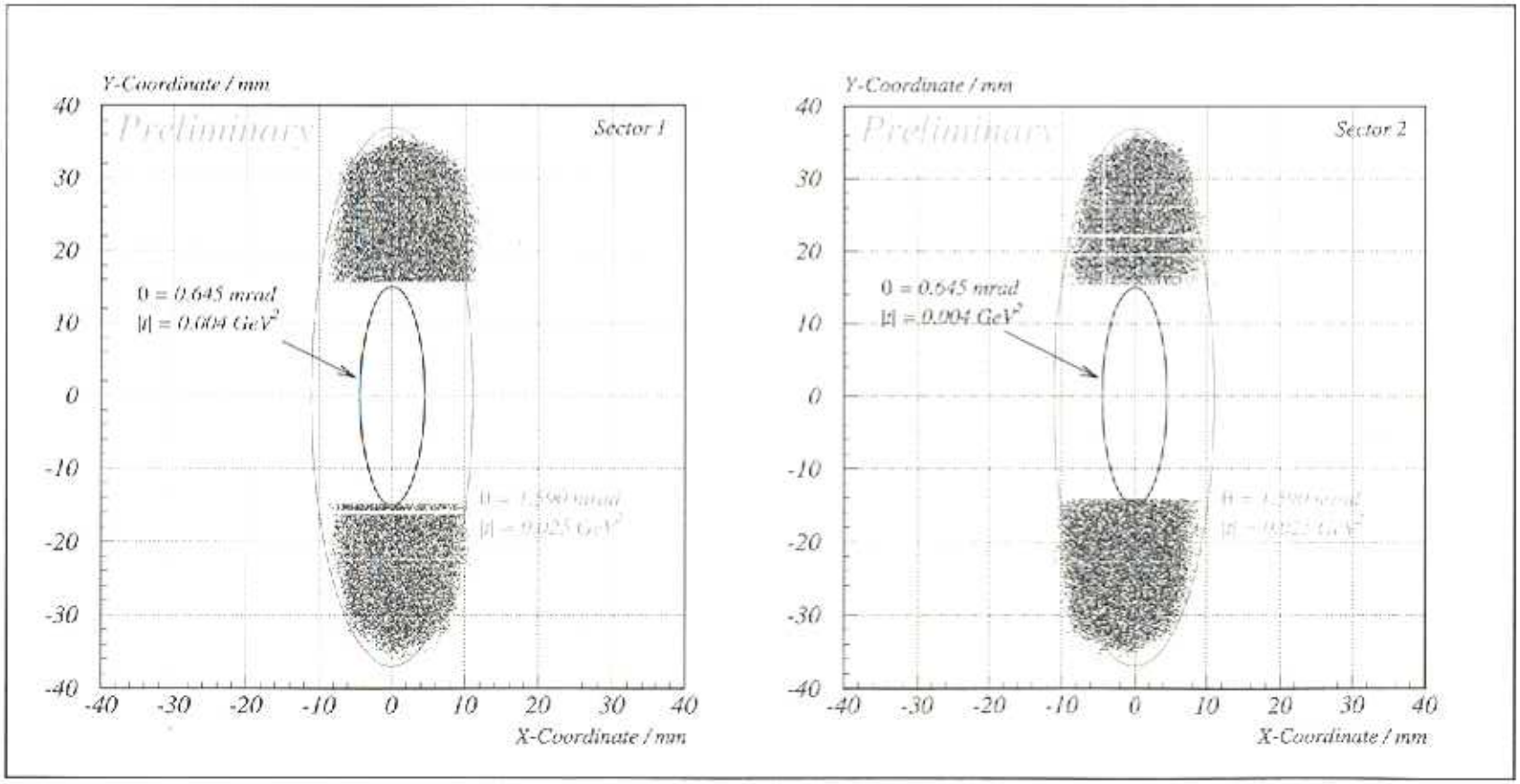
Cuts

- Difference between each coordinate within RP less than 1.5 strips
- No veto counter with hit
- No elastic trigger from diagonal elastic arm
- Less than 3 hits in silicon planes of diagonal elastic arm



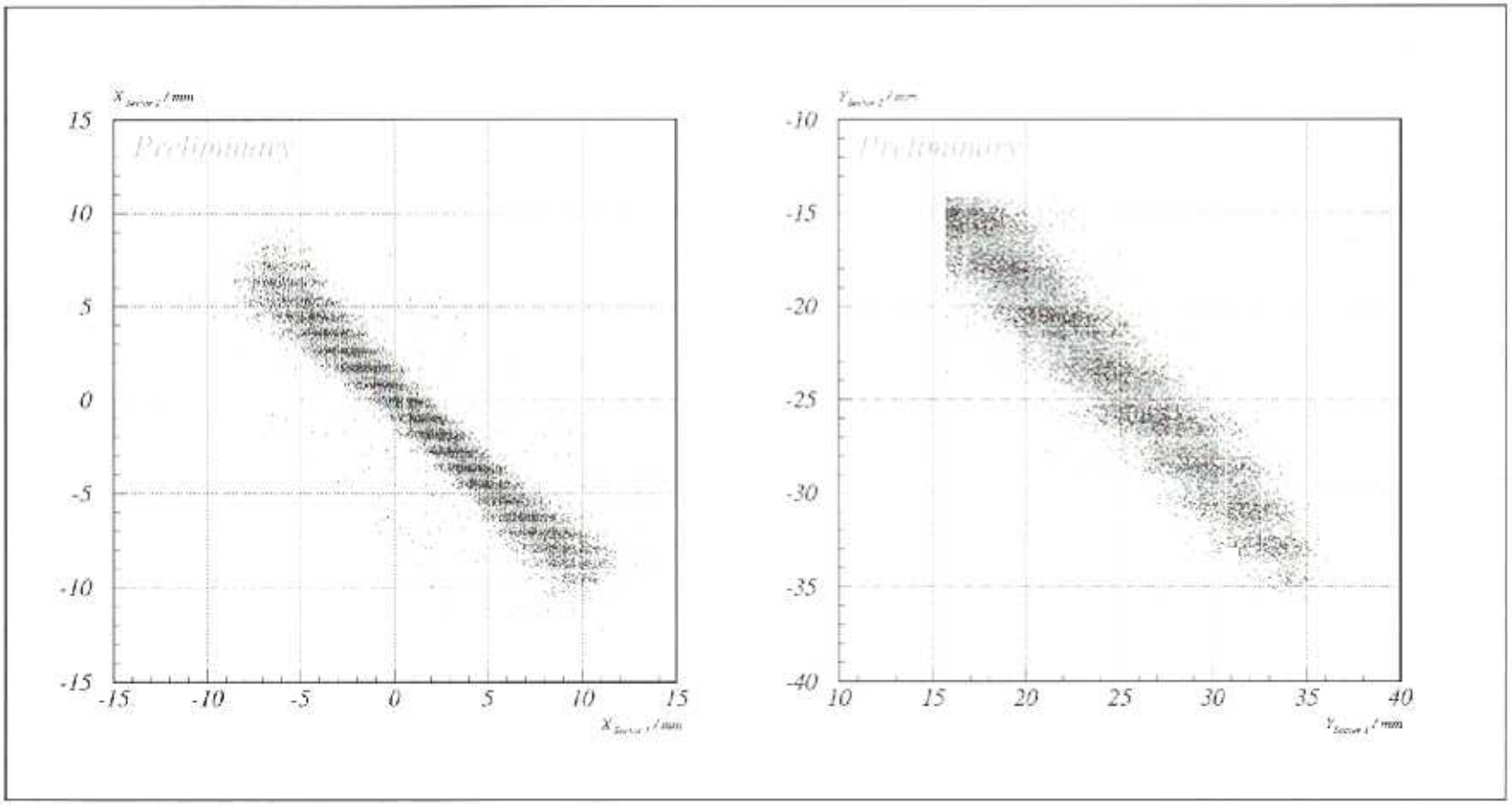
Elastic Hit Pattern

Raw hit distribution without final alignment



Collinearity Plots

Elastic arm with higher efficiency



Running Conditions in 2002

Closest approach of first detector strip to beam about

$15\sigma_{beam} \rightarrow t_{min} = -4 \cdot 10^{-3}\ \mathrm{GeV}^2$

Observed count rate $\dot{N}_{elastic} = \sigma_{el} \cdot \mathcal{L} \cdot \Delta\varphi = 12\ \mathrm{sec}^{-1}$

with $\sigma_{el} \approx 1.8$ mb $\quad (5 \cdot 10^{-3}\ \mathrm{GeV}^2 \leq |t| \leq 2.5 \cdot 10^{-2}\ \mathrm{GeV}^2)$

$$\mathcal{L} = \frac{3}{2} \frac{\nu N_B N^2}{\epsilon \beta^*} (\beta\gamma) = 1.1 \cdot 10^{28} \frac{1}{\mathrm{cm}^2\ \mathrm{sec}}$$

$\Delta\varphi = 0.60$ Integrated azimuthal coverage

$\beta^* = 10$ m
$N_B = 55$ bunches
$\nu = 78.2$ kHz
$\beta\gamma = 106.6$
$N = 7.8 \cdot 10^9\ p^-$/bunch
$\epsilon = 12\pi \cdot 10^{-6}$ rad m

Conclusions

We had a successful engineering run in 2002

Next Steps in Analysis Effort

- Full Simulation of Beam Transport to
  - Understand Elastic Event Hit Pattern
  - Calculate Acceptance
- Efficiency Calculation
- Asymmetries and Slope B

Next Steps for Experiment Preparation

- Need Full Roman Pot Station Setup