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Local Polarimetry at STAR Using the Zero Degree Calorimeter Shower Maximum Detector

Alice Bridgeman, ANL

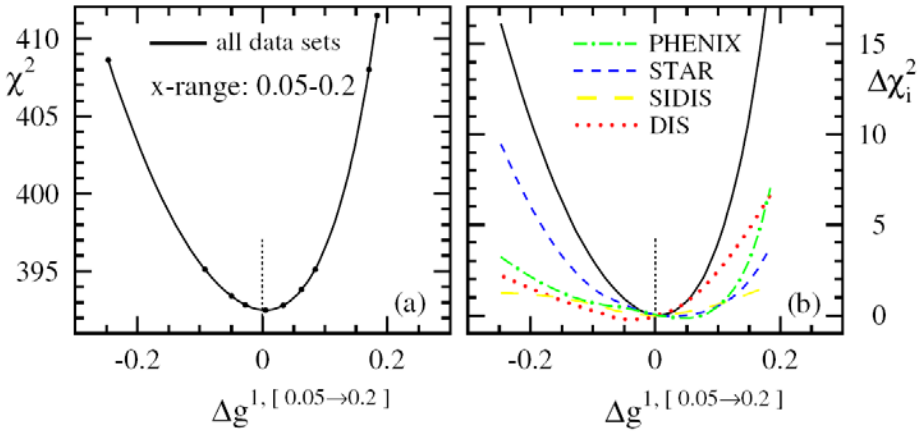
on behalf of the STAR Collaboration

Outline

- RHIC polarized protons and polarimetry
- STAR local polarimetry
- Analysis Details
- Results
- Future

The Polarized Proton Program at RHIC

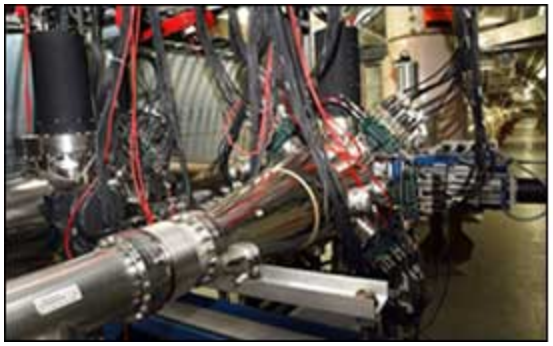
- RHIC is the world's only polarized proton collider
- Proton beams have been collided at 62, 200, and 500 GeV
- Polarized collisions directly probe $\Delta g(x,Q^2)$



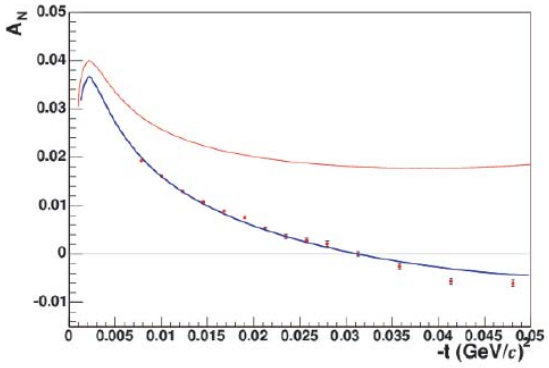
deFlorian, et al., PRL 101, 072001

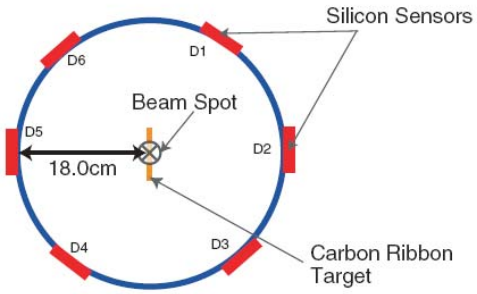
Polarimetry at RHIC

- Polarimeters located at 12 o'clock
  - Hydrogen-Jet (H-Jet) measures *absolute* polarization
  - Proton-carbon (pC) measures *relative* polarization
- Transverse beam polarization components measured at STAR IR



CERN Courier, Sep 29, 2005

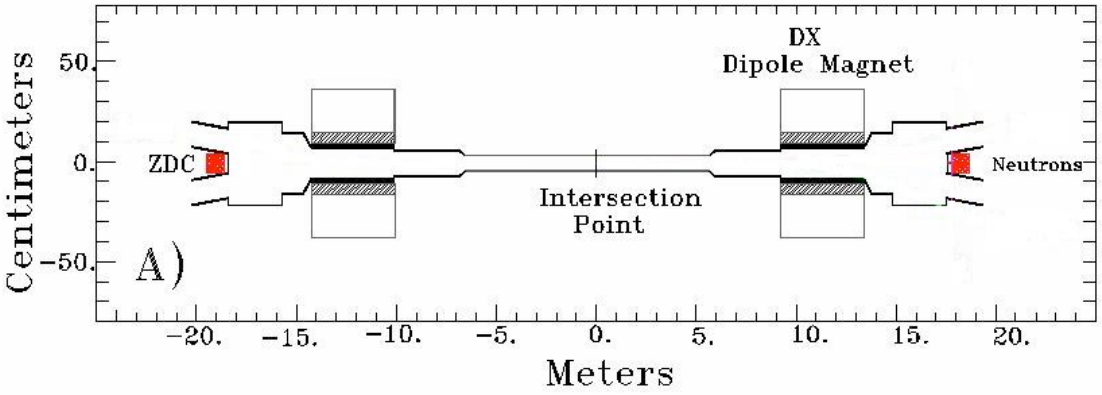




Eur. Phs. J. Special Topics 162, 259-265 (2008)

Local Polarimetry at STAR

Zero **D**egree **C**alorimeter

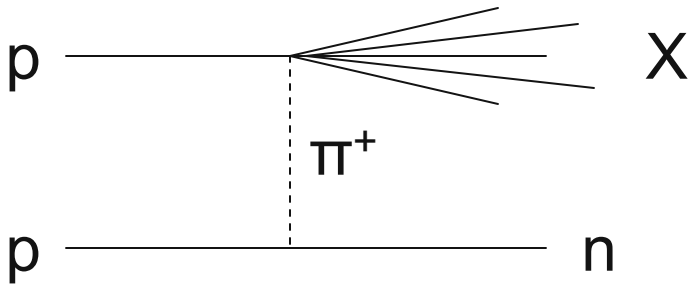


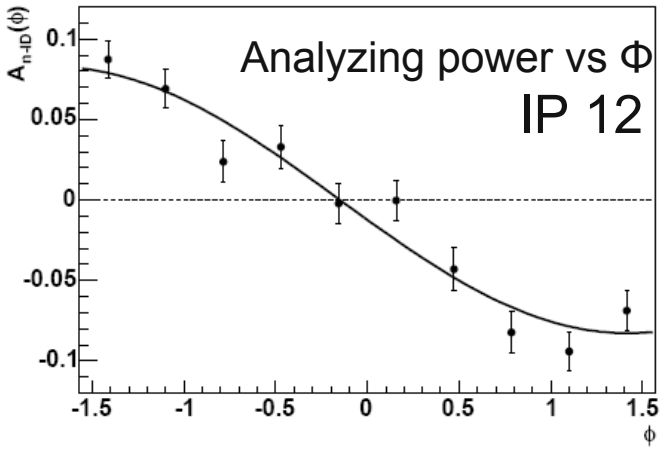
Vertex **P**osition **D**etector & **B**eam-**B**eam **C**ounter

Detector	|z| (cm)	|η| Range
BBC	374	3.3, 5
VPD	568	4.2, 5
ZDC	1800	6.5, 7.5

Lead Neutron Production

- The ZDC detects very forward neutrons
  - Small contamination from K_L^0, photons
    - *IP 12 experiment measured photon A_N consistent with 0*
    - *K_L^0 fraction ~3-4%*
- Cross section of forward neutrons is understood
- However, source of spin asymmetry is not well understood



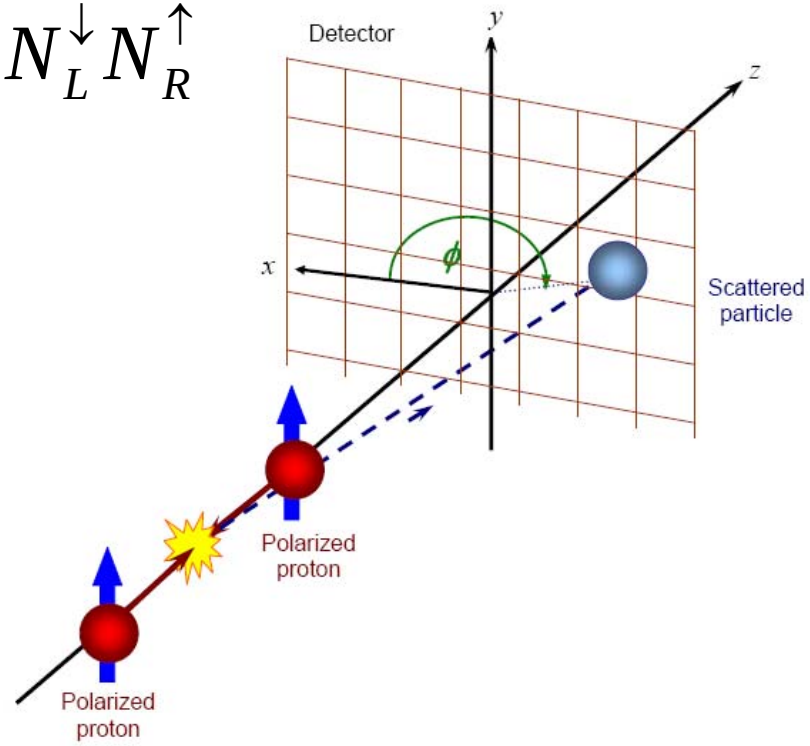


Phys. Let B 650, 325-330 (2007)

Single Spin Asymmetry

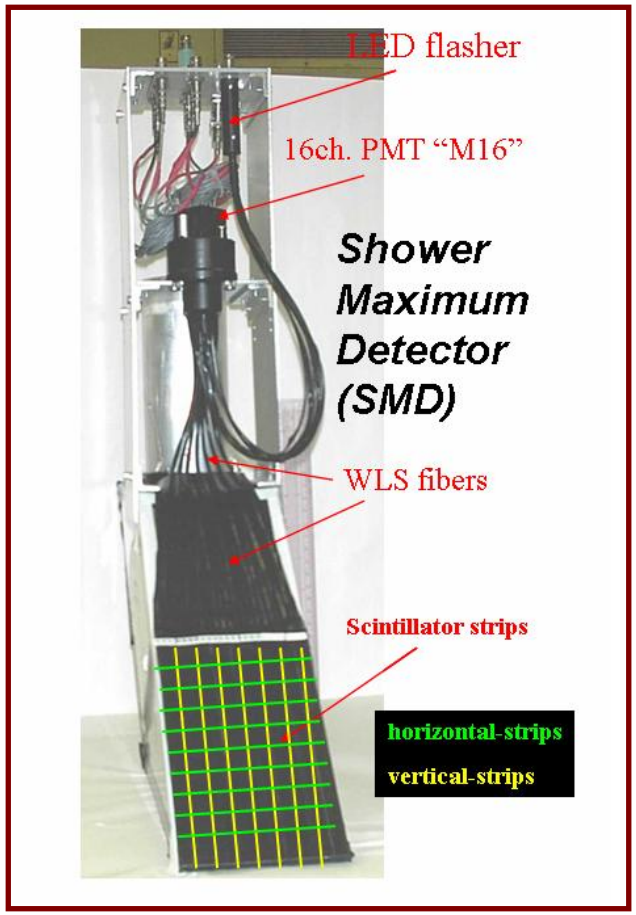
$$\varepsilon_{phys} = \frac{\sigma^{\uparrow} - \sigma^{\downarrow}}{\sigma^{\uparrow} + \sigma^{\uparrow}} \approx \frac{\sqrt{N_L^{\uparrow} N_R^{\downarrow}} - \sqrt{N_L^{\downarrow} N_R^{\uparrow}}}{\sqrt{N_L^{\uparrow} N_R^{\downarrow}} + \sqrt{N_L^{\downarrow} N_R^{\uparrow}}}$$

$$A_N = \frac{\varepsilon_{phys}}{P}$$



Analysis

- Dedicated trigger requires BBC coincidence and high energy deposit in front and back ZDC calorimeter modules
- SMD ADC counts are pedestal-subtracted and gain-matched
- Require coincidence of vertical & horizontal slats above pedestal and count the single highest hit
- RHIC CNI polarization measurements used in evaluating A_N

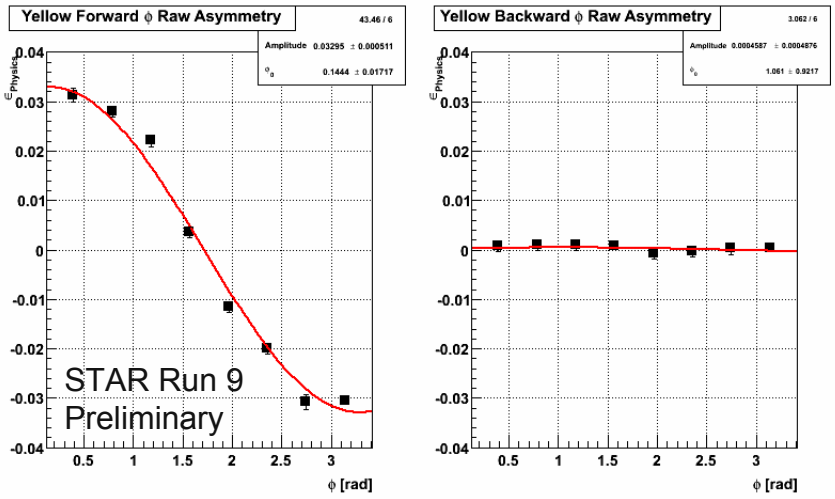


SMD located between ZDC calorimeter modules. It is composed of 8 horizontal slats and 7 vertical slats. Total area ~ 10 cm X 10 cm in transverse plane.

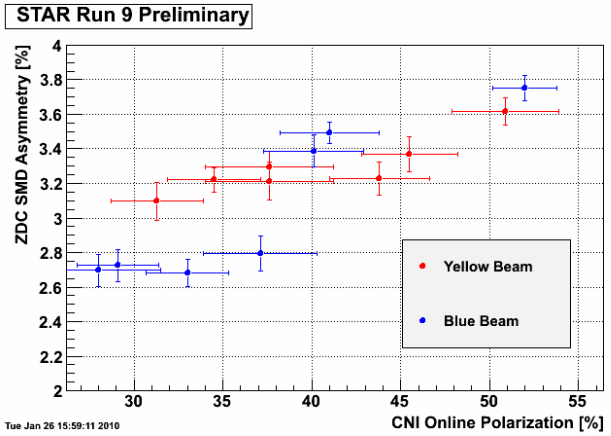
Results

- ZDC SMD commissioned at √s = 200 GeV in 2004
- Further development in 2009 √s = 500 GeV running
  - Will be the source of local polarization measurements for analysis
  - Online monitoring of asymmetries
- $A_N^{ZDC} \sim 8\%$

Physics asymmetry vs Φ for yellow beam

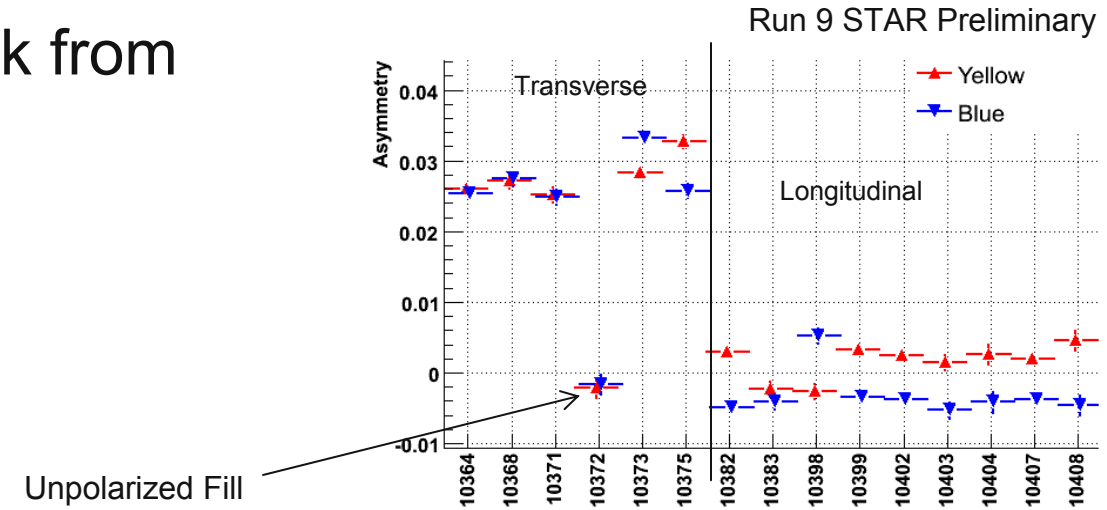


ZDC SMD asym. vs RHIC CNI asym.



Future

- Investigation of the source of the asymmetry underway
- Study ways to improve analysis
  - Trigger conditions
  - Algorithm
- Implement ZDC into STAR scaler system
  - No longer requires dedicated runs
  - Constant feedback from online monitoring



Summary

- ZDC SMD is an important component of the STAR local polarimetry system, especially at $\sqrt{s}$ = 500 GeV
- Large analyzing powers observed at $\sqrt{s}$ = 200 and 500 GeV
- Physics mechanism(s) of large asymmetry is being studied

Thank you to everyone in the STAR collaboration who contributed to this work!