Transverse single spin asymmetries from muons at forward rapidity in polarized p+p collisions at √s= 200 GeV

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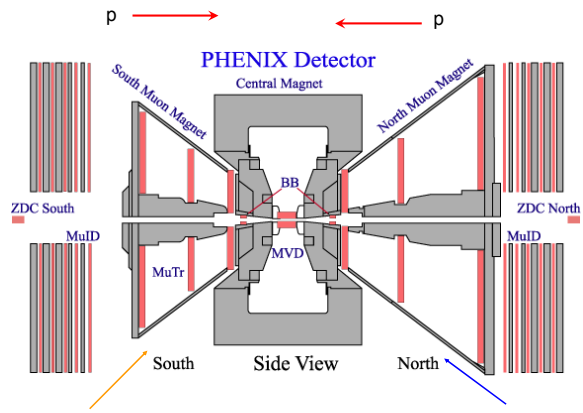
Motivation

•Large transverse single-spin asymmetries were observed in forward pion production by the E704 collaboration at Fermilab (√s= 200 GeV) and have been found by the STAR and BRAHMS experiments to persist at RHIC energies.
•Such large asymmetries were initially surprising because at leading order, perturbative quantum chromodynamics predicted only small effects.
•Transverse single spin asymmetries (A_N) have the potential to be an important tool in understanding the quark spin distributions in a polarized proton.
•Open charm measurement gives us a different probe that is more sensitive to gluon polarization compared to light quarks.

PHENIX: the side view

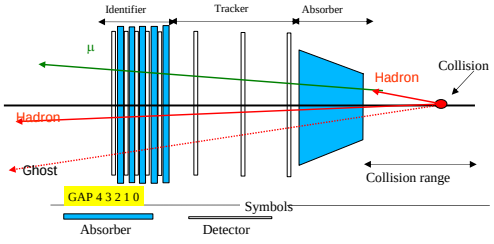


South Muon arm : $-2.2 < \eta < -1.2$

North Muon arm : $1.2 < \eta < 2.4$

Detecting muons

- PHENIX Muon arms can be used to detect muons by two methods:
  - Low p_T muons which penetrate partway into the MuID steel and stop.
  - High p_T muons which penetrate to the last layer of the MuID.

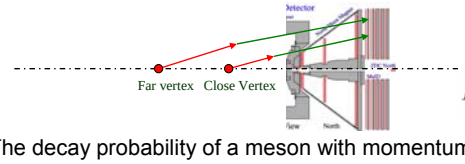


Major Sources of Background Tracks

1. π, K decays into muons.
2. High p_T hadronic punch-throughs which go the last Gap.
3. Ghost tracks (tracks due to misidentification of hits) in high multiplicity events.

Decay muons

Light hadrons (pi/K) can decay into muons before reaching the MuID.



$$P_{decay}(p, L) = 1 - e^{-\frac{L \cdot m}{\tau \cdot p}}$$

The decay probability of a meson with momentum p is proportional to the distance (L) between collision vertex and absorber.

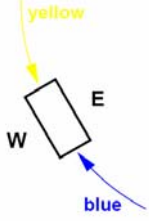
A_N: the single spin asymmetry

Single spin asymmetry is:

$$A_N = \frac{1}{P_b}\left(\frac{\sigma^{\uparrow} - \sigma^{\downarrow}}{\sigma^{\uparrow} + \sigma^{\downarrow}}\right) = \frac{1}{P_b}\left(\frac{N^{\uparrow} - RN^{\downarrow}}{N^{\uparrow} + RN^{\downarrow}}\right)$$

- P_b is the beam polarization.
- $\sigma\uparrow(\sigma\downarrow)$ is the production cross section for the polarized states.
- $N\uparrow(N\downarrow)$ is the experimental yield from up (down) polarized bunches.
- $R = L\uparrow / L\downarrow$ is the relative integrated luminosity of bunches of opposite polarization sign.

"Simply" look at left right asymmetry in particle multiplicity at the detectors.



Blue beam:	Left:	Particle detected in West arm
	Right:	Particle detected in East arm
Yellow beam:	Left:	Particle detected in East arm
	Right:	Particle detected in West arm

The square root formula simplifies some of the systematics related to the relative luminosity and serves as an important cross check.

$$A_N = \frac{1}{P_b}\left(\frac{\sqrt{N_L^{\uparrow} N_R^{\downarrow}} - \sqrt{N_L^{\downarrow} N_R^{\uparrow}}}{\sqrt{N_L^{\uparrow} N_R^{\downarrow}} + \sqrt{N_L^{\downarrow} N_R^{\uparrow}}}\right)$$

Current Status

This is an ongoing analysis. By using the PHENIX muon arms we can make this measurement at non zero values of X_F, complementing earlier mid-rapidity results for neutral pions and charged hadrons, thus allowing us to study A_N in different kinematical regimes. Good statistics from Run 5 should enable us to get a reasonable measurement for A_N for open charm.