PR07-015, JLAB PAC31

Measurement of Double-Spin Asymmetries on a Transversely Polarized Proton Target in Semi-Inclusive DIS

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Goal: provide the first data of double-spin asymmetries A_{LT} through $p^{\uparrow}(\vec{e}, e'\pi^+)$ reaction.

Extract u-quark transverse-momentum dependent parton distribution function $g_{1T}^u(x, Q^2)$.

- A non-vanishing double-spin asymmetry A_{LT} has never been established in SIDIS. Many models predicted rather large asymmetries ($5 \sim 10\%$).
- A non-zero A_{LT} arises from the quark transverse momentum dependent (TMD) parton distribution g_{1T}, which is a direct result of quark transverse motion (thus its angular momentum).
- This experiment will be the first one to discover a non-vanishing $g_{1T}(x, Q^2)$
- Request 25 days of 6 GeV beam in Hall C, using existing equipments in an identical setup as in SANE and semi-SANE.

g_{1T}: Transverse momentum dependent parton distribution

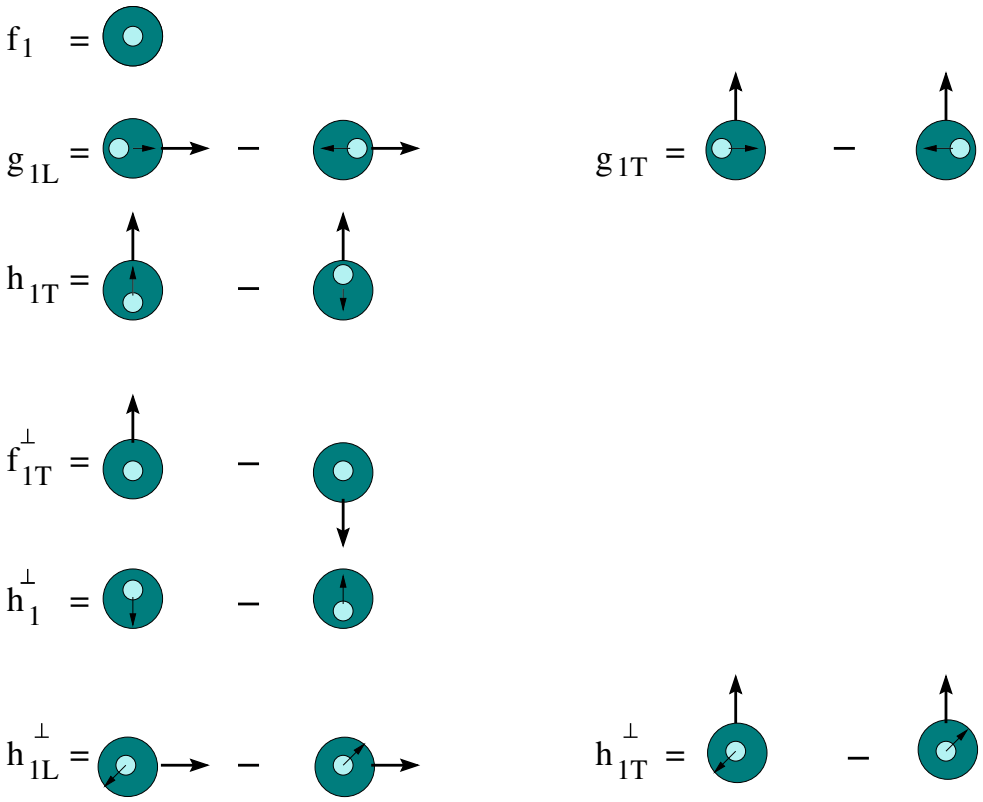
A leading-twist k_T dependent distribution:

- Never been measured before. No clue on its size. $g_{1T} \equiv 0$ if quark angular momentum $L_q = 0$.
- Linked through Lorentz invarience: $g_2(x) = -\frac{d}{dx} g_{1T}(x)$.
- Some calculation expect a large asymmetry (Yuan, Gamberg).
- Positivity limit link g_{1T} with $f_{1T}^{\perp}$.
- One expects g_{1T}^u / g_{1T}^d behave like g_1^u / g_1^d ?

On the experiment side:

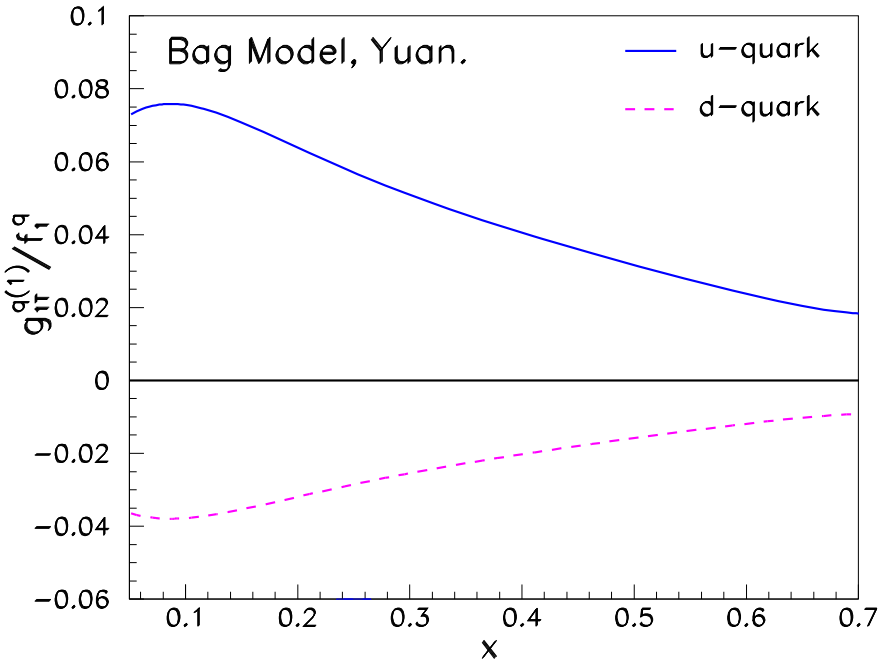
- One of the easiest SIDIS observable to measure at Jefferson Lab.

Will we have suprises on g_{1T} ? What're our expectations on g_{1T} to start with ?



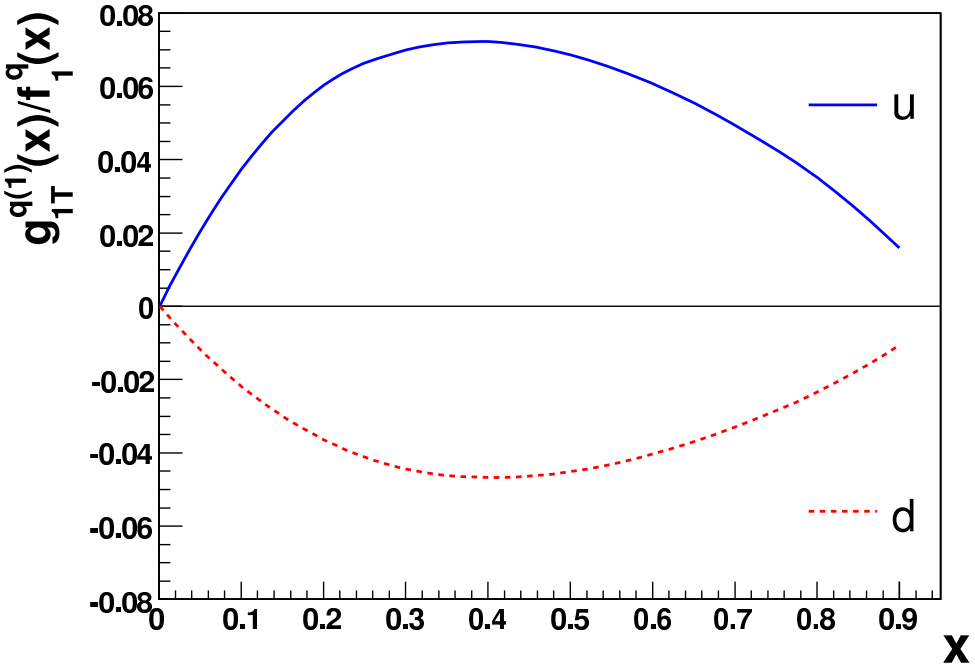
- 8 TMDs.

Expectations on g_{1T}



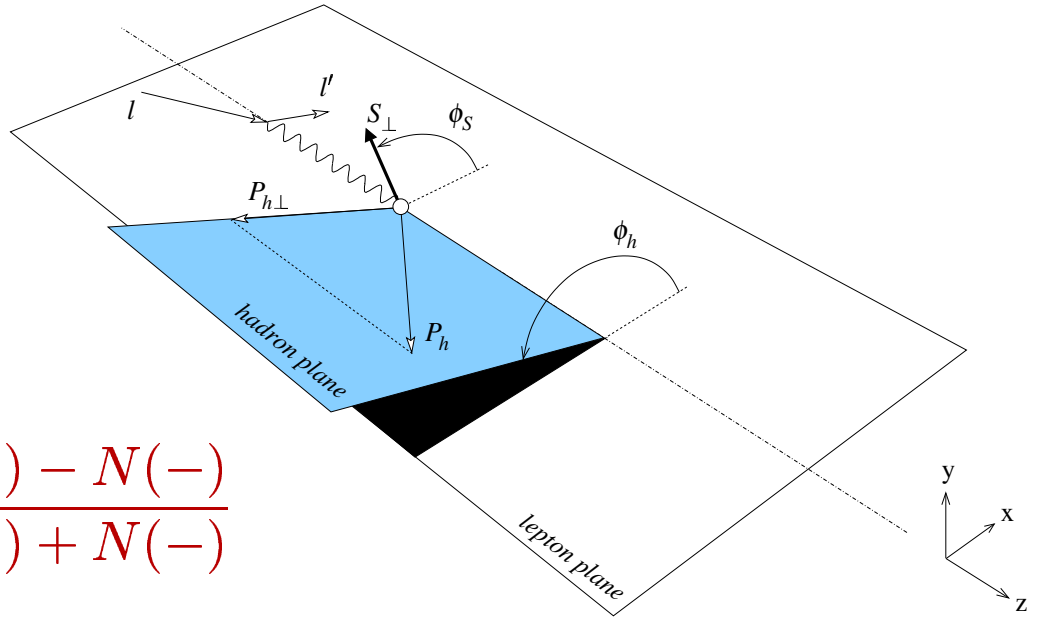
- F. Yuan. Bag model calculation.

Expectations on g_{1T}



- Kotzinian *et al*, followed the Lorentz invariance relation.

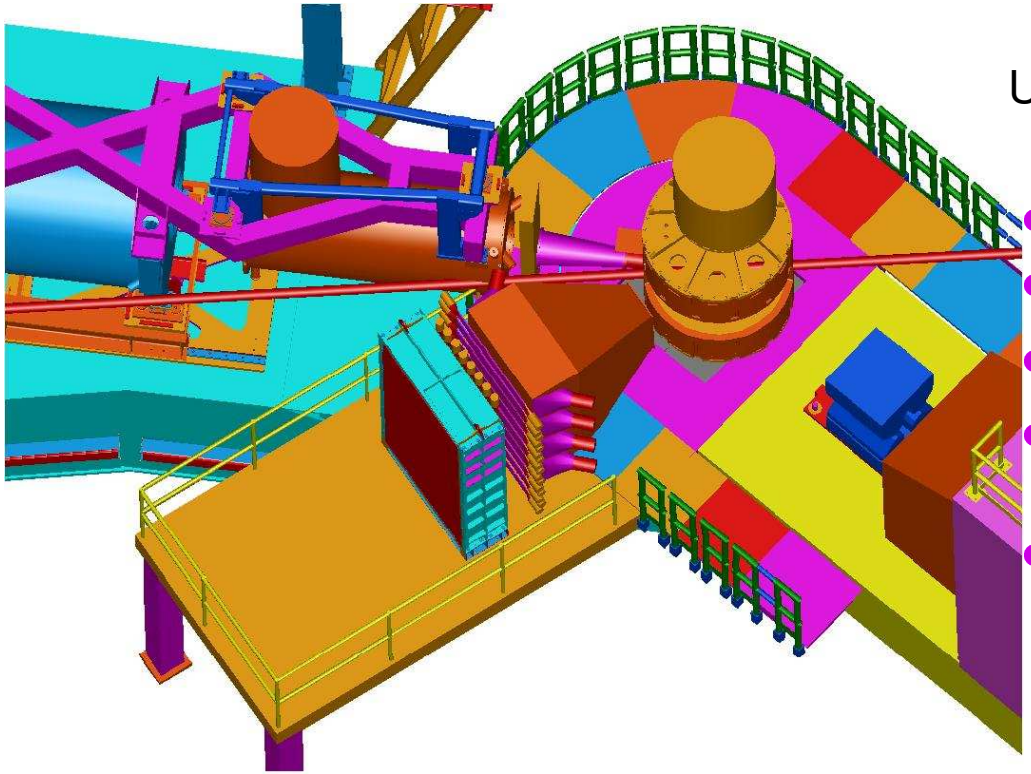
PR07-015: Transverse Double-Spin Asymmetry in $p^{\uparrow}(\vec{e}, e'\pi^+)$



$$A_{LT} = \frac{N(+) - N(-)}{N(+) + N(-)}$$

$$\sigma_{LT} \quad \propto \quad \lambda_e S_T \cdot y(1 - \frac{1}{2}y)\, \cos(\phi_h^\ell - \phi_S^\ell) \cdot \sum e_q^2\, g_{1T}^q(x) \otimes D_{1q}^h(z, P_{h\perp}^2)$$

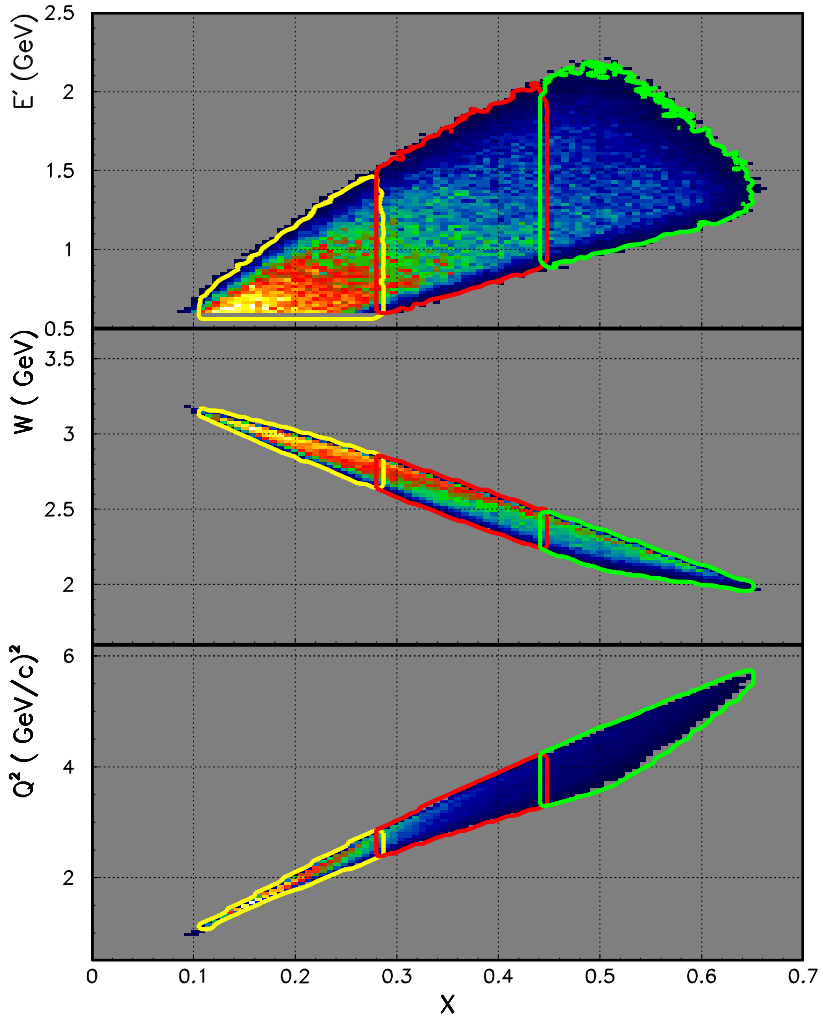
This experiment: $\phi_h^\ell - \phi_S^\ell \approx 0°$.

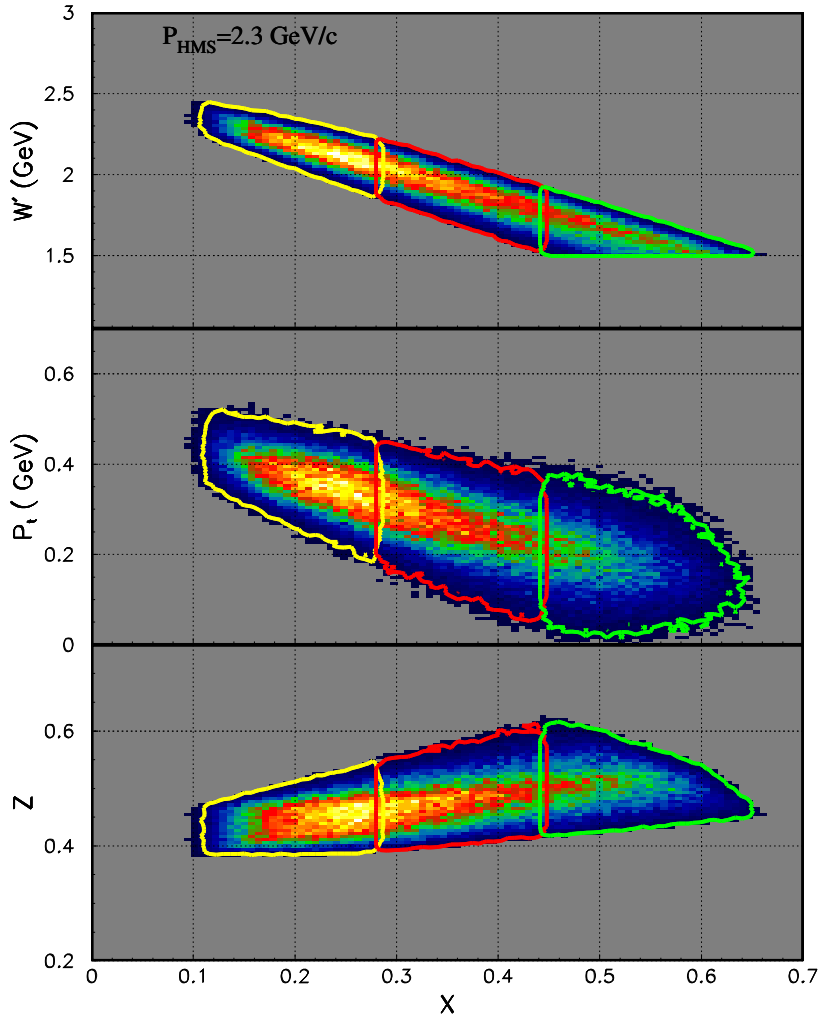


Use existing equipments in Hall C.

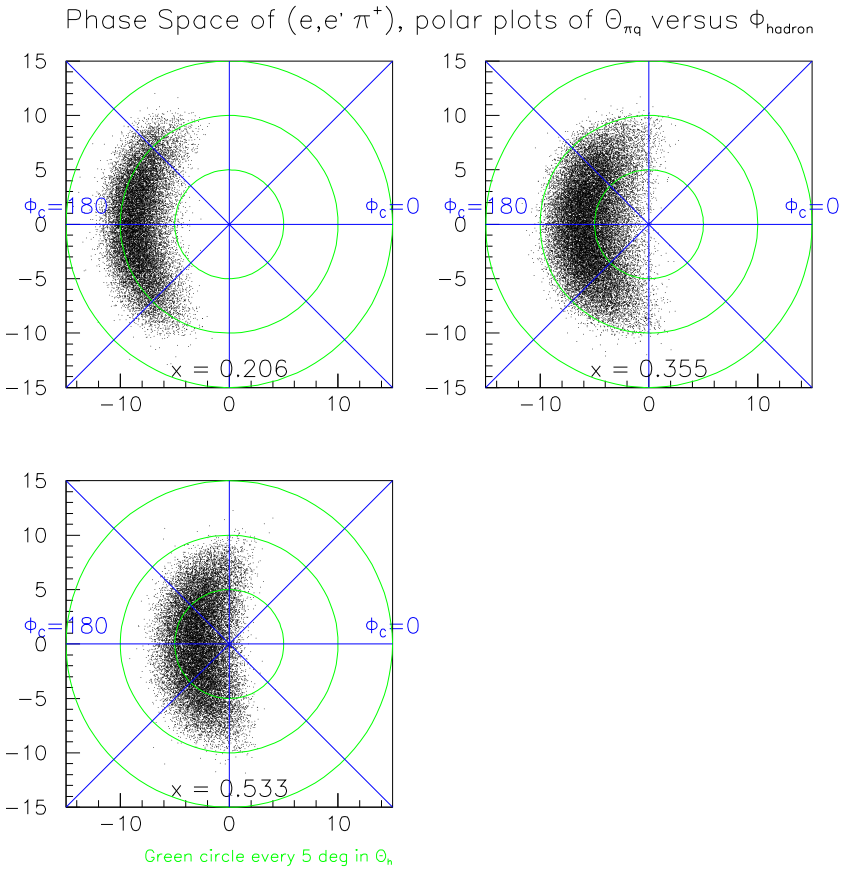
- Identical setup as in SANE/semi-SANE.
- Two charge particle coincidence trigger.
- UVa/Hall-C polarized target.
- HMS$_L$ at 14° as h-arm.
  $p_h = 2.3$ GeV/c, $z = 0.5$.
- BigCal at 40° as e-arm.
  Identical detector configuration as in SANE/semi-SANE.

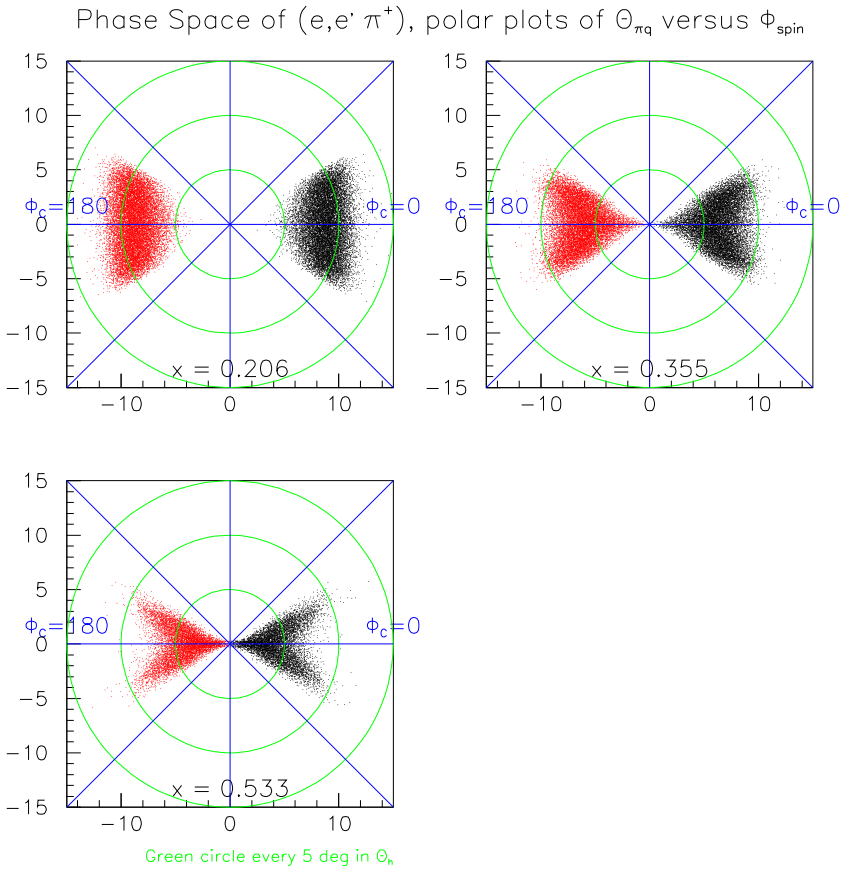
Phase Space Coverage one setup covers three x-bins:



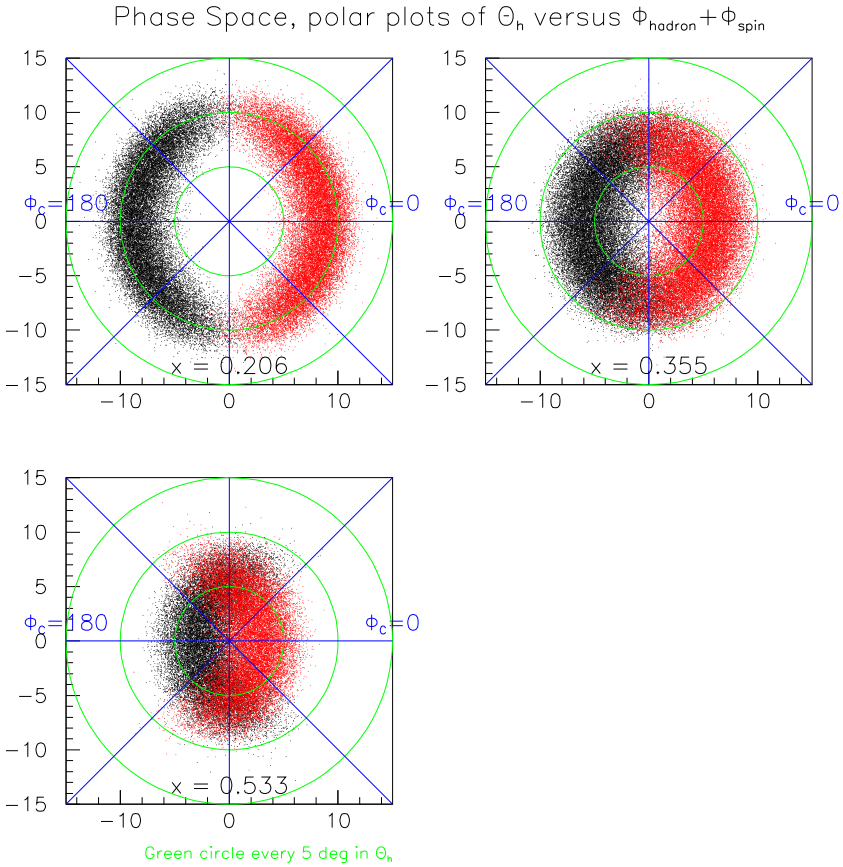


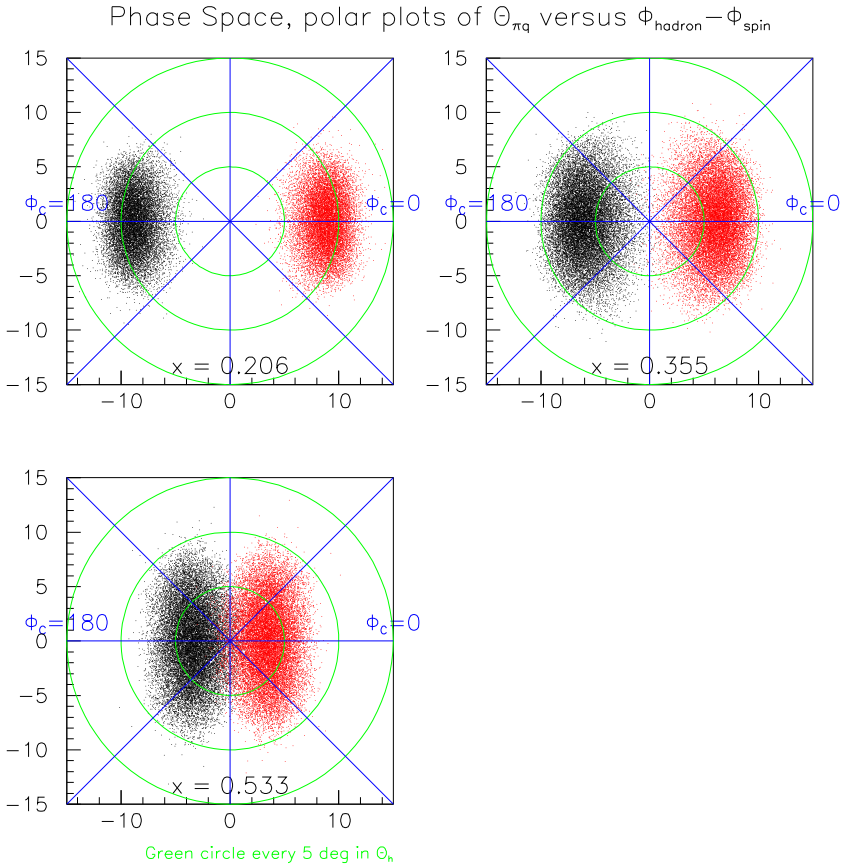
Azimuthal Angle Coverage: ϕ_{hadron} and ϕ_{Spin}





$\phi_{Collins} = \phi_h + \phi_S$ **and** $\phi_{Sivers} = \phi_h - \phi_S$



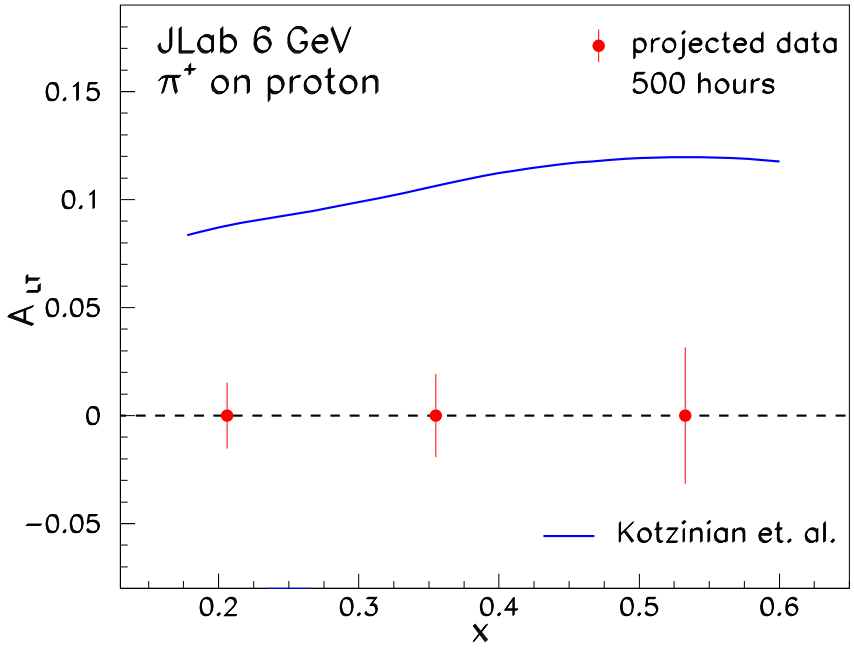


Beam Time Request: 25 days

One setting, nothing changes.

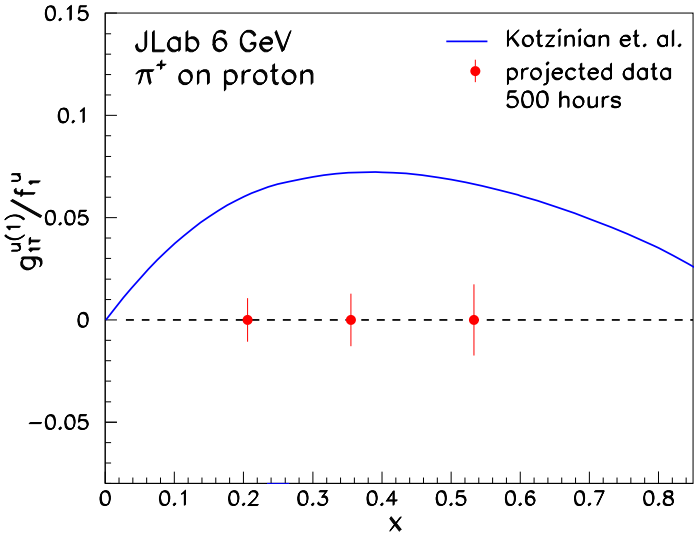
Beam on polarized NH_3 target	**500** hour
Target overhead, Möller runs and ^{12}C target runs.	**100** hour
Total Time Request	**600 (25 days)**

Expected Results: Proton Double-Spin Asymmetry $A_{LT}^{p\pi^+}$



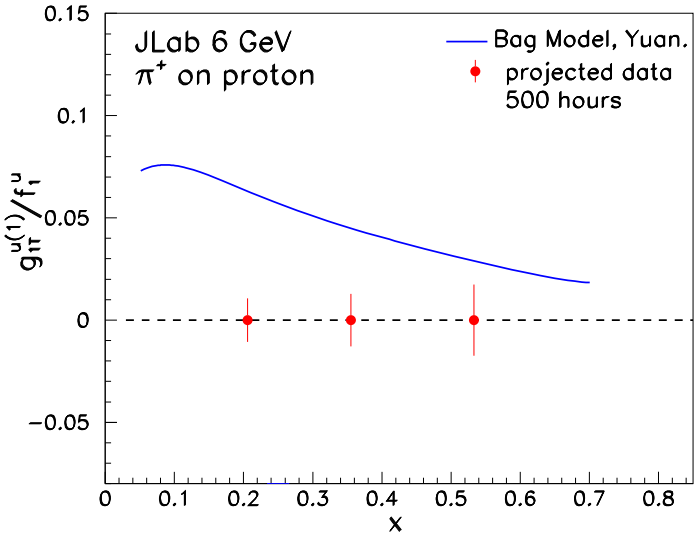
- First data on A_{LT}
- At high-x.
- Statistical uncertainty dominates.

Extract u-quark g_{1T}/f_1 and Compared with Expectations



- Be the first to establish a non-vanishing g_{1T}.

... and Compared with Expectations



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