Measuring Transversity from Pion Pairs using a Longitudinally Polarized Target

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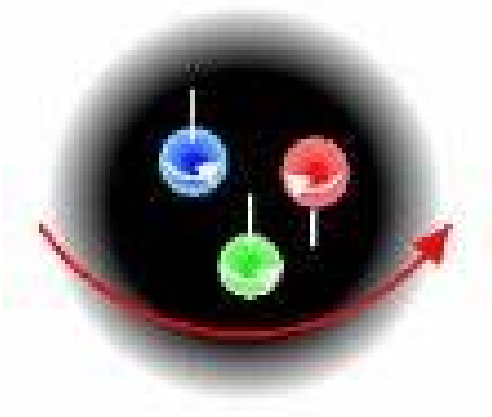
Proton Spin Crisis

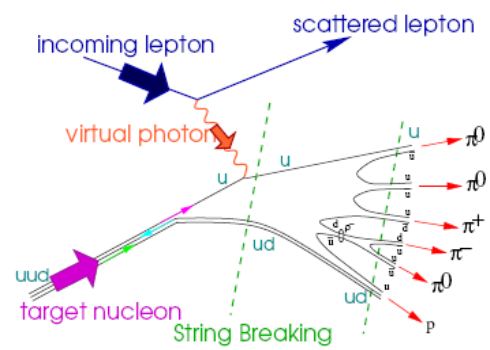
- Naïve Quark Model



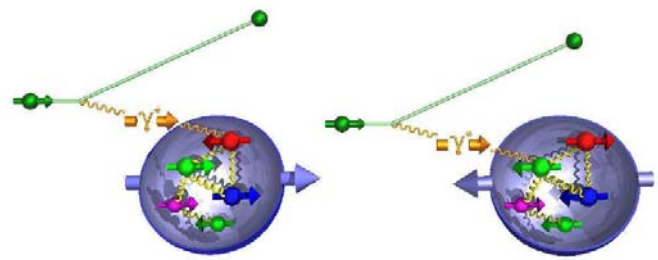
- Late 80s, quarks contribute 12% - 16%

- $$\frac{1}{2} = \frac{1}{2}\Delta\Sigma + \Delta G + L_Z$$

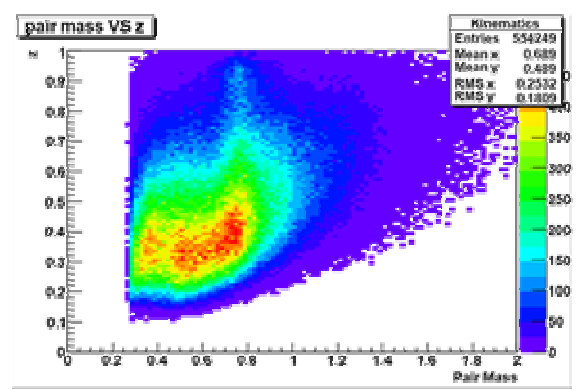
Transversity and DIS



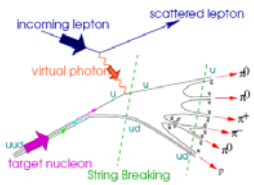
Get asymmetry from data

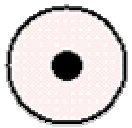


Look for ways to improve resolution and reduce background

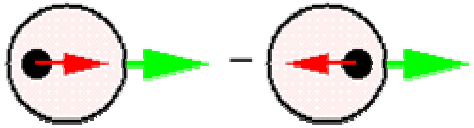


What is transversity?

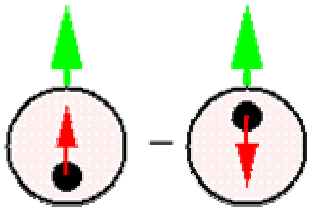


$q(x)=f_1(x)=$ 

probability of finding a quark with momentum fraction x

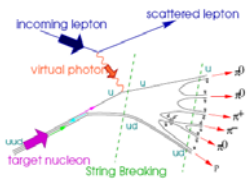
$\Delta q(x)=g_1(x)=$ 

difference of probabilities:
in a longitudinal polarized hadron
right–handed quark minus left–handed quark

$\delta q(x)=h_1(x)=$ 

difference of probabilities:
in a transversely polarized hadron
quark polarization along hadron polarization
minus quark polarization opposite

Theoretical Model

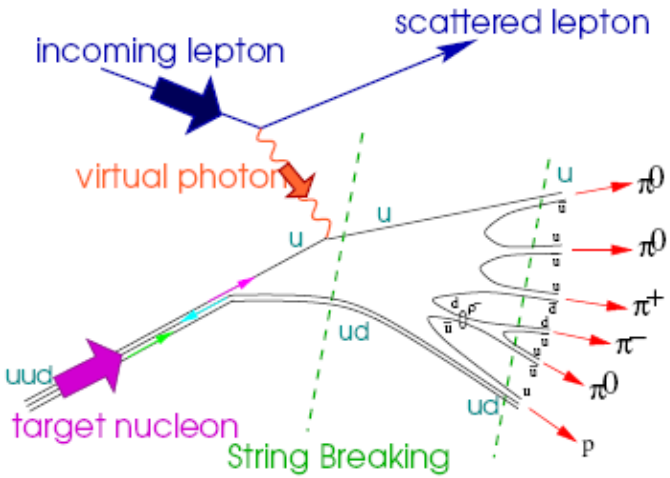


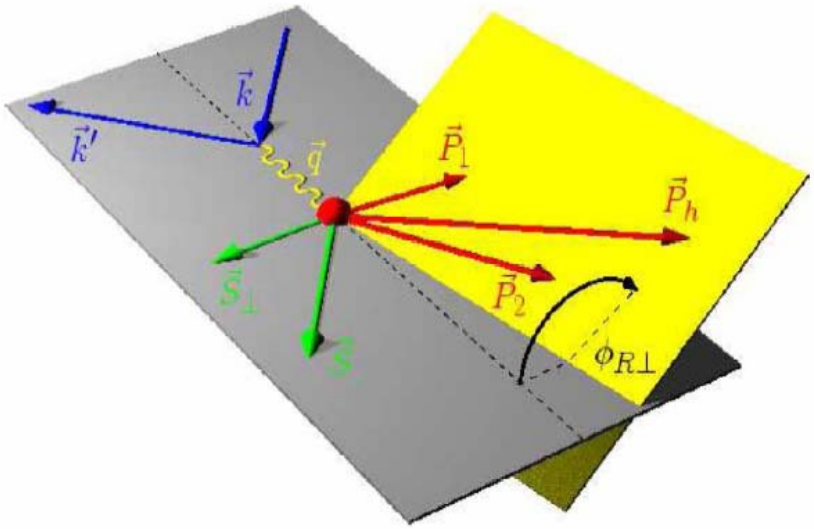
A. Bacchetta, M. Radici (2004)

$$A'_{UT} \sim B(y)\sin(\phi_{R\perp} + \phi_S) h_1 H_1^{\sphericalangle} + (\ldots).$$

$$A'_{UL} = V(y)\sin(\phi_{R\perp})\frac{M}{Q}(h_1 H_1^{\sphericalangle} + g_1 \tilde{G}^{\sphericalangle}).$$

Semi inclusive DIS with a pion pair in the final state





$$e^- + p \rightarrow e^- + \pi^i + \pi^j + X$$

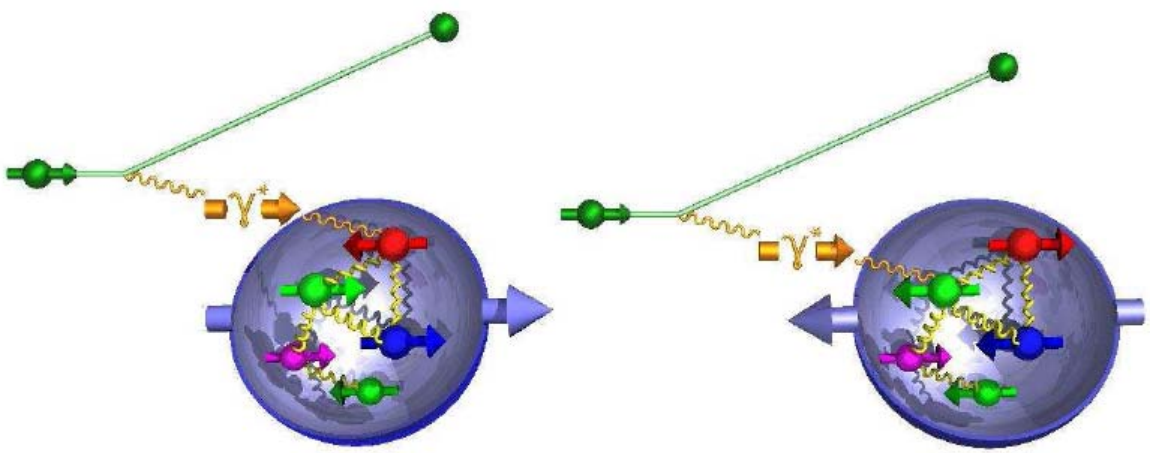
Where *i* and *j* run over +, - and 0 charges

EG1b run period from CLAS in Hall B with a 5.7 GeV beam energy

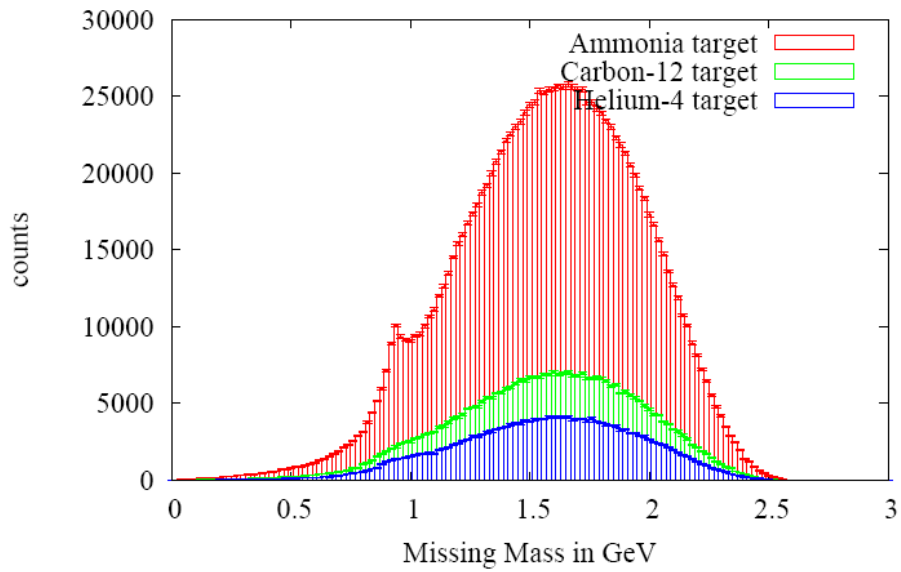
Experimental Asymmetry

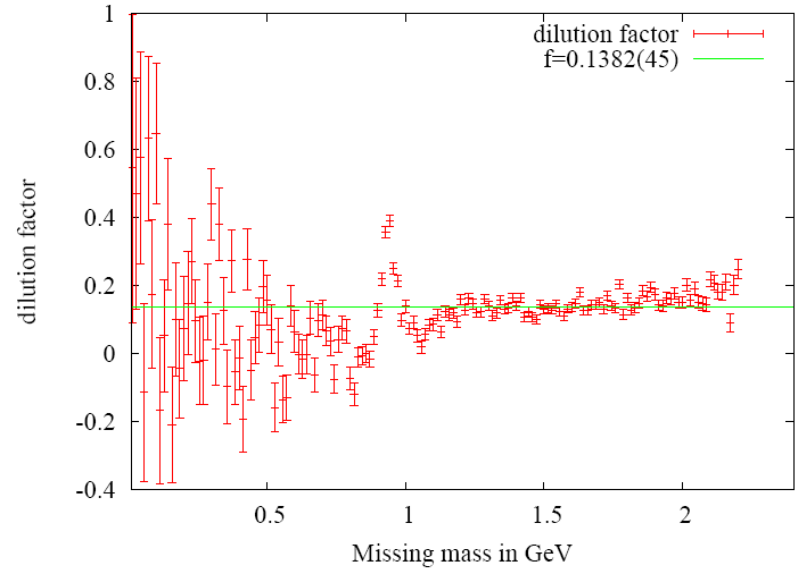
$$A = \frac{n^{\uparrow}(\phi_{R\perp}) - n^{\downarrow}(\phi_{R\perp})}{n^{\uparrow}(\phi_{R\perp}) + n^{\downarrow}(\phi_{R\perp})}$$

$$A_{UL}(\Phi_{R\perp}) = \frac{1}{f} \frac{N^{\uparrow}(\phi_{R\perp}) - N^{\downarrow}(\phi_{R\perp})}{\langle P^{\downarrow} \rangle N^{\uparrow}(\phi_{R\perp}) + \langle P^{\uparrow} \rangle N^{\downarrow}(\phi_{R\perp})}$$



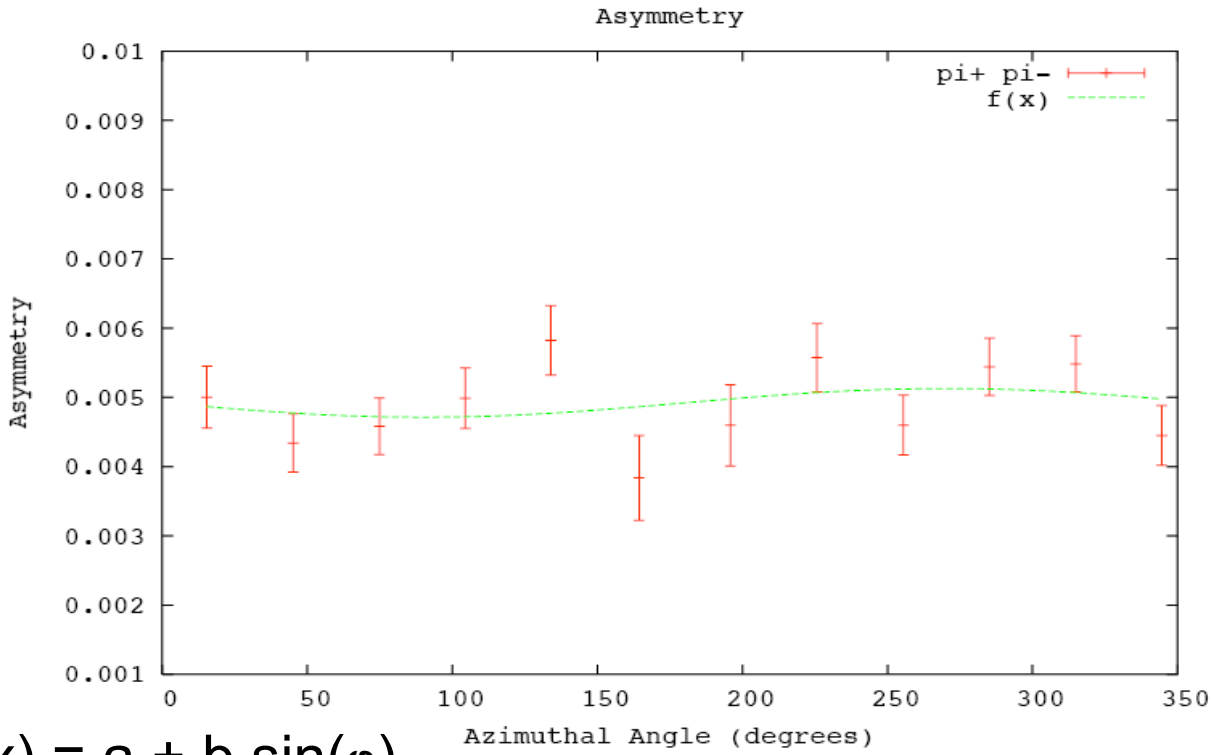
Dilution factor due to $^{15}NH_3$ target





$$f = \frac{\sigma_{H_3}}{\sigma_{^{15}NH_3}}. \qquad f = \frac{\sigma_{^{15}NH_3} - \sigma_{^{15}N}}{\sigma_{^{15}NH_3}} = \frac{\sigma_{^{15}NH_3} - r_f \sigma_{^{12}C}}{\sigma_{^{15}NH_3}}.$$

Extract sinφ moment from asymmetry

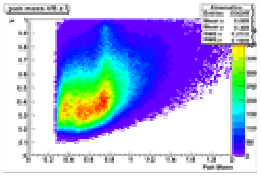


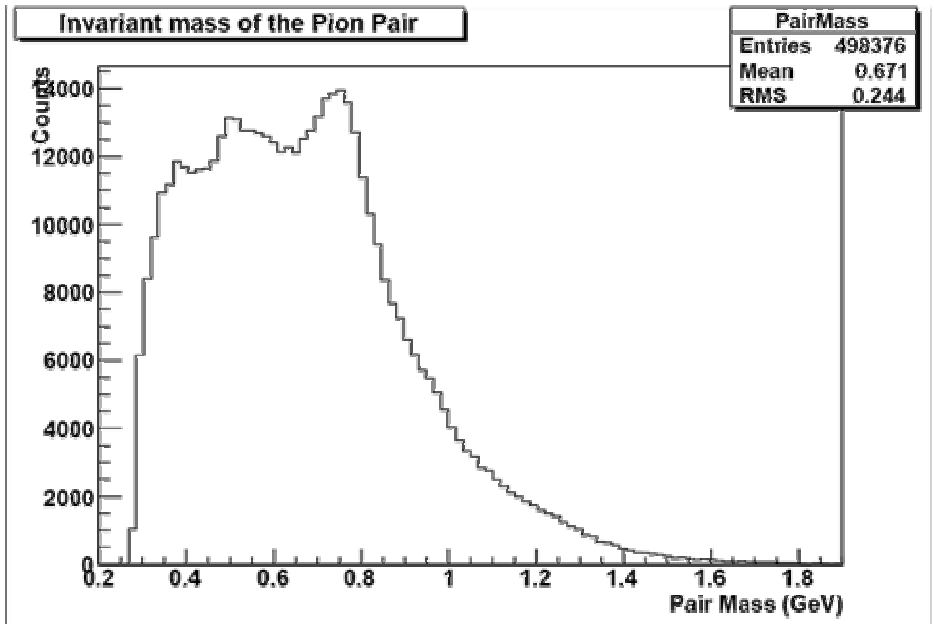
$f(x) = a + b \sin(\varphi)$

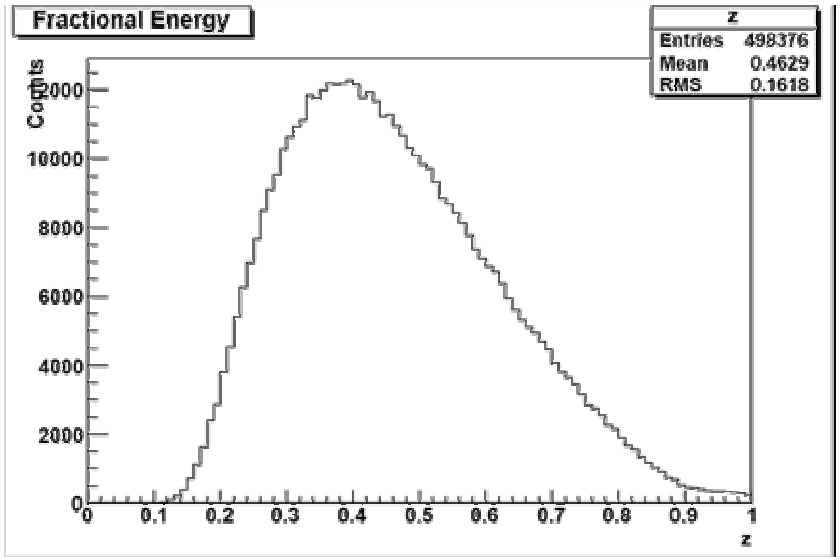
a = 0.004920 (0.000159)

b = Asymmetry (error) = -0.0002074 (0.0002147)

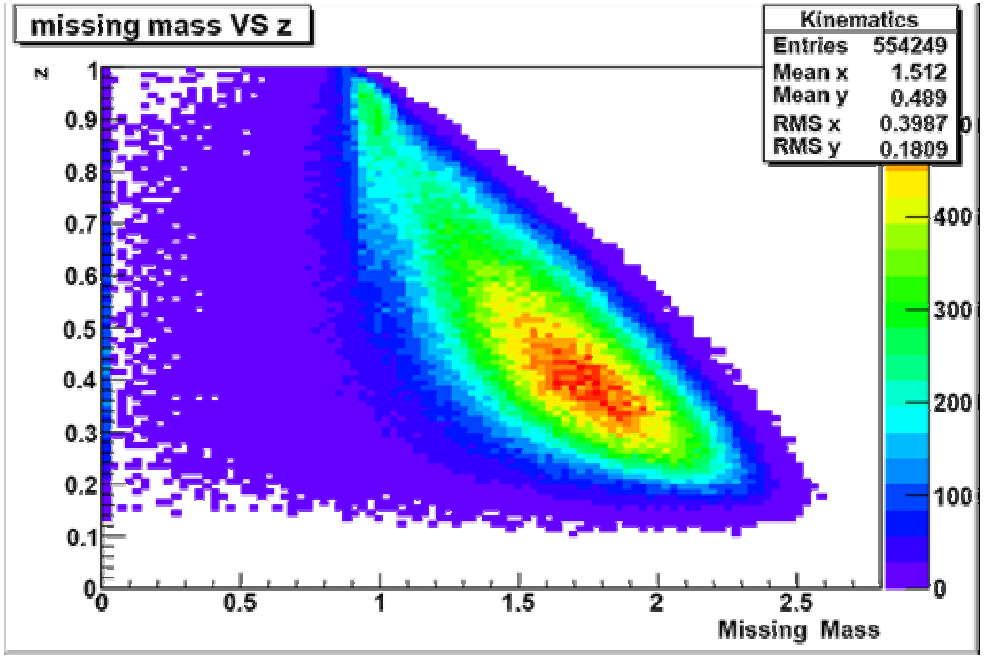
Plot pair mass vs z and missing mass spectrum

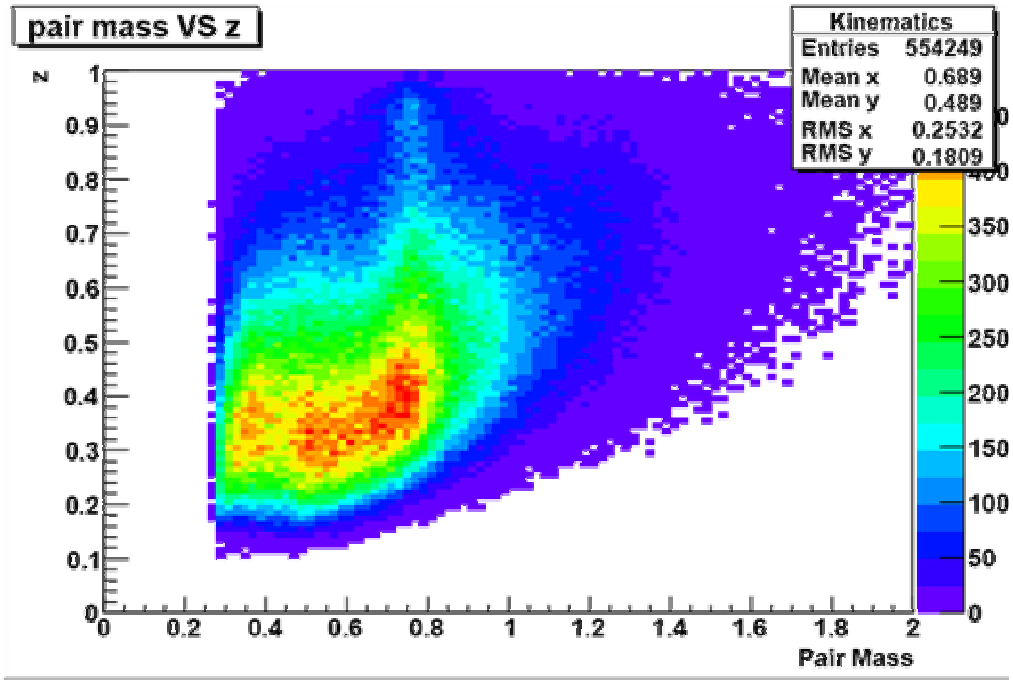




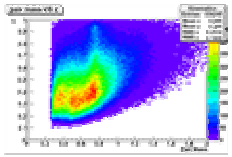


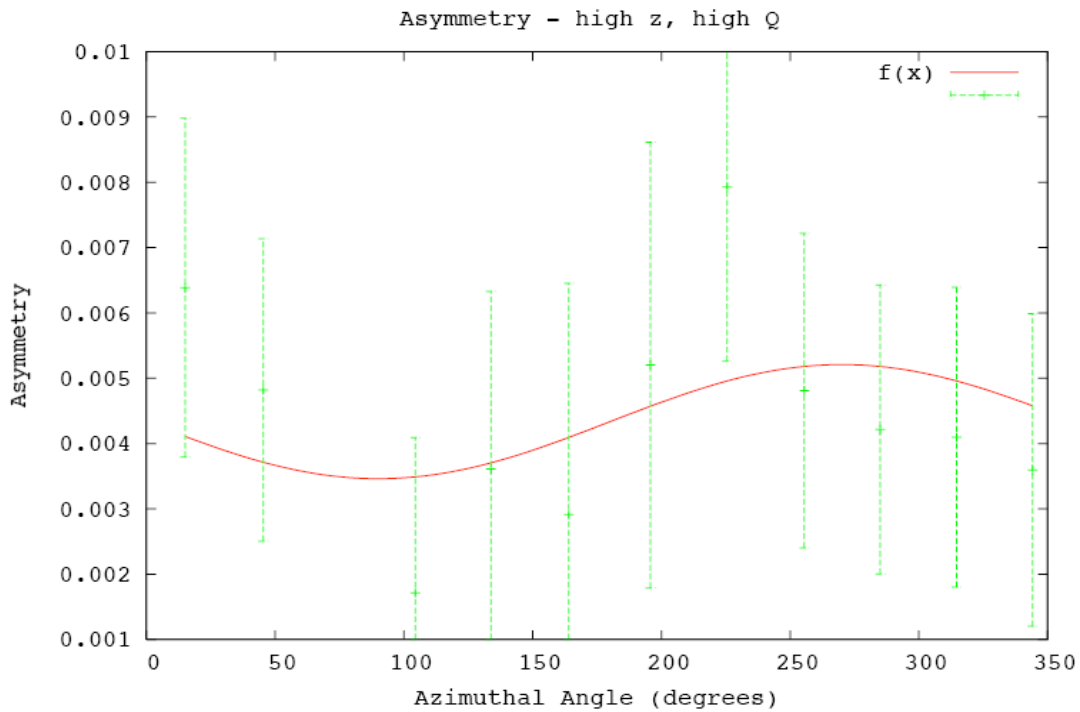
Missing mass and pair mass dependence on *z*





Asym values for bins of high z and low Q^2





$f(x) = a + b \sin(\varphi)$

a = 0.004333 (0.000484)

b = Asymmetry (error) = -0.0008738 (0.000669)

HERMES – DESY Mar 16, 2008
arXiv:0803.2367

- Transverse Target
- Asymmetry measured as a function of azimuthal angle for dihadron prod.
- $A_{UT\sin\varphi} = 0.018(0.005)_{stat}$
- Additional 8.1% scale uncertainty, target polarization

Summary

- Calculated transverse momentum distribution using a longitudinal component
- Extracted sin φ moment to get value for $h_1(x)H_1(z)$
- Small value of asymmetry but with large errors
- Look at higher statistics