SIDIS Dihadron Measurements with CLAS12

CLAS12 First Experiment Analysis Review

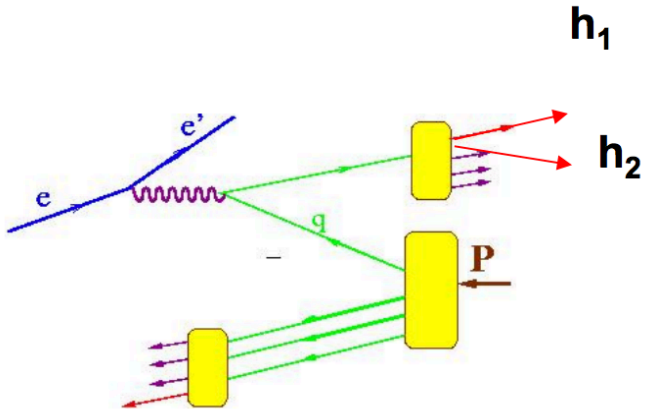
Timothy B. Hayward

WILLIAM & MARY
CHARTERED 1693

Dihadron Fragmentation Functions

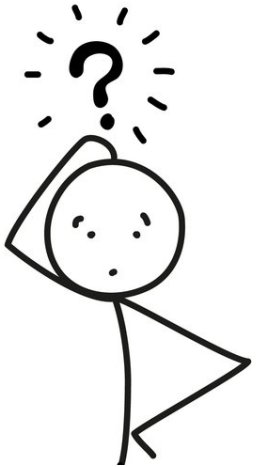
- Similar to single hadron formalism

- Additional degree of freedom (relative momentum) allows for numerous advantages
  - Separate contributions to asymmetries
  - Existence of fragmentation functions with no single hadron correlation



What to measure?

- Precision measurements of the cross section
- Unpolarized form factors
- e(x), higher twist-collinear PDF for quark-gluon correlations
  - E12-09-008B, S. Pisano and A. Courtoy
- h_1, transversity distribution of polarized quarks
  - PR12-12-009, H. Avakian, S. Anefalos Pereira, A. Courtoy, K. Griffioen
- $G_1^{\perp}$, ϕ dependence of unpolarized hadrons on the initial quark helicity
  - "*possible*" proposal from A. Vossen, H. Avakian, T. Hayward



Unpolarized-Unpolarized Cross Section

- Measurement of multiplicities of hadron pair production
- D_1, the unpolarized fragmentation function is multiplied by the well known PDF f_1
- Can be isolated from the ϕ-dependent terms
- e‘$\pi^+\pi^-$X / e‘X should follow z-dependence of the fragmentation function

$$
\begin{aligned}
d^9\sigma_{OO} = \sum_a \frac{\alpha^2 e_a^2}{2\pi Q^2 y} \Bigg\{ & \boxed{A(y)\,\mathcal{I}\left[f_1\, D_1\right]} - B(y)\,\frac{|\vec{R}_T|}{M_h}\cos(\phi_h+\phi_R)\,\mathcal{I}\left[\frac{\vec{p}_T\cdot\hat{P}_{h\perp}}{M}\,h_1^\perp\,\bar{H}_1^\sphericalangle\right] \\
& + B(y)\,\frac{|\vec{R}_T|}{M_h}\sin(\phi_h+\phi_R)\,\mathcal{I}\left[\frac{\hat{P}_{h\perp}\wedge\vec{p}_T}{M}\,h_1^\perp\,\bar{H}_1^\sphericalangle\right] \\
& - B(y)\cos(2\phi_h)\,\mathcal{I}\left[\frac{2(\vec{p}_T\cdot\hat{P}_{h\perp})(\vec{k}_T\cdot\hat{P}_{h\perp})-\vec{p}_T\cdot\vec{k}_T}{MM_h}\,h_1^\perp\,H_1^\perp\right] \\
& + B(y)\sin(2\phi_h)\,\mathcal{I}\left[\frac{(\vec{p}_T\cdot\hat{P}_{h\perp})(\hat{P}_{h\perp}\wedge\vec{k}_T)+(\vec{k}_T\cdot\hat{P}_{h\perp})(\hat{P}_{h\perp}\wedge\vec{p}_T)}{MM_h}\,h_1^\perp\,H_1^\perp\right]\Bigg\}
\end{aligned}
$$

Bachetta, Radici. hep-ph/0212300

Event Generator

- Stephen Gliske (HERMES) developed object-oriented generator "TMDGen"
- Includes SIDIS dihadron models for angular dependence
- No beam polarizations or longitudinally polarized target cross sections programmed for dihadrons

Distribution Functions	Model Identifier
f_1	CTEQ [74]
f_1	LHAPDF [75]
f_1	BCR08 [76]
f_1	GRV98 [77]
g_1	GRSV2000 [78]
f_{1T}, $h_{1T}^{\perp}$, h_1	Torino Group [79, 80, 81, 82, 83]
f_1, g_1, g_{1L}, g_{1T}, f_{1T}, h_1, $h_1^{\perp}$, $h_{1T}^{\perp}$	Pavia Spectator Model [31]

Table 3.1: Models of distribution function available in `TMDGen`.

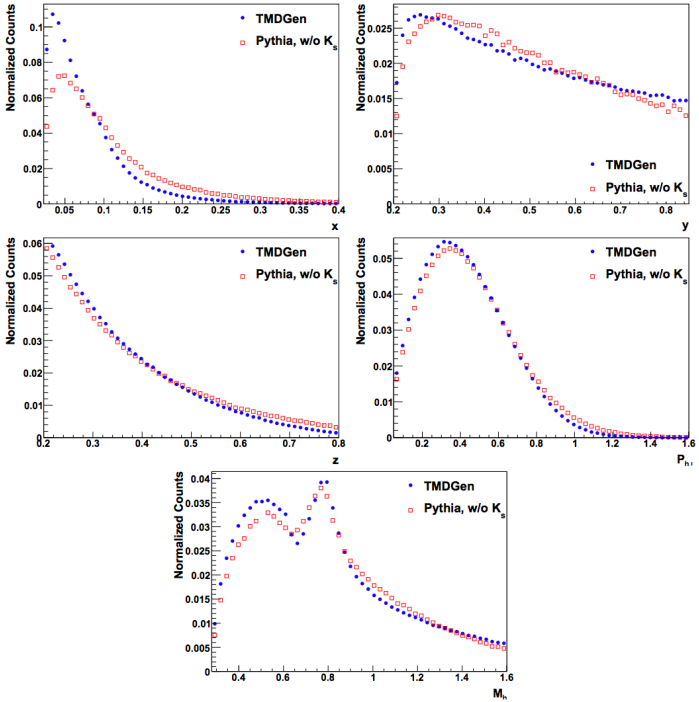
Frag. Functions	Final State	Model Identifier
D_1	pseudo-scalar	fDSS [84, 85]
D_1	pseudo-scalar	Kretzer [86]
D_1, $H_1^{\perp}$	dihadron	Spectator Model (Section 2.4)
D_1, $H_1^{\perp}$	dihadron	Set given partial wave proportional to any other partial wave

Table 3.2: Models of fragmentation function available in `TMDGen`.

Gliske thesis (HERMES)

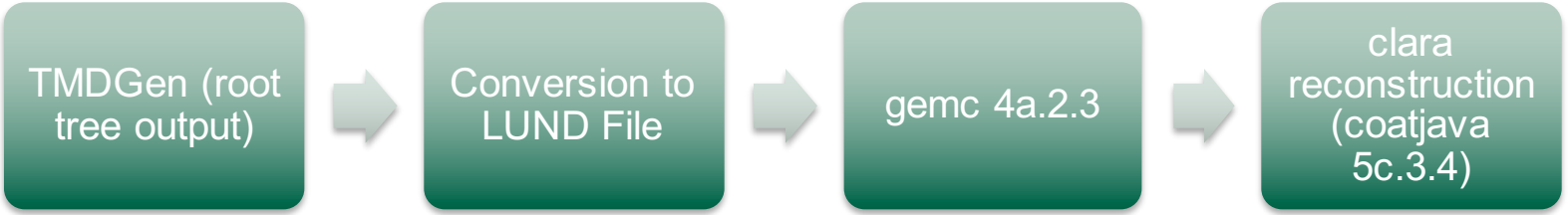
Event Generator

- Gliske comparisons between Pythia and TMDGen for e' $\pi^+\pi^-$X



Gliske thesis (HERMES)

Reconstruction Chain

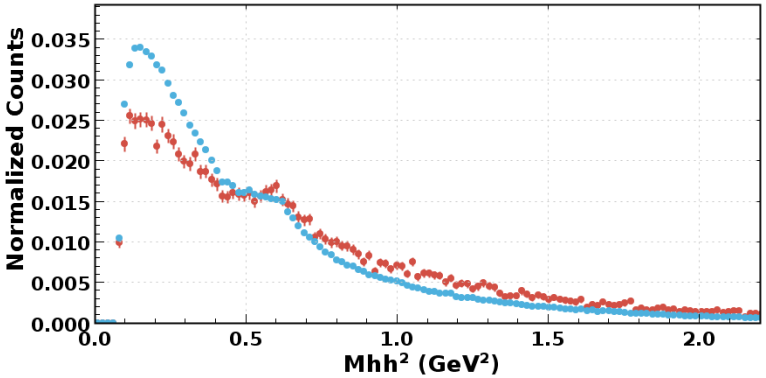


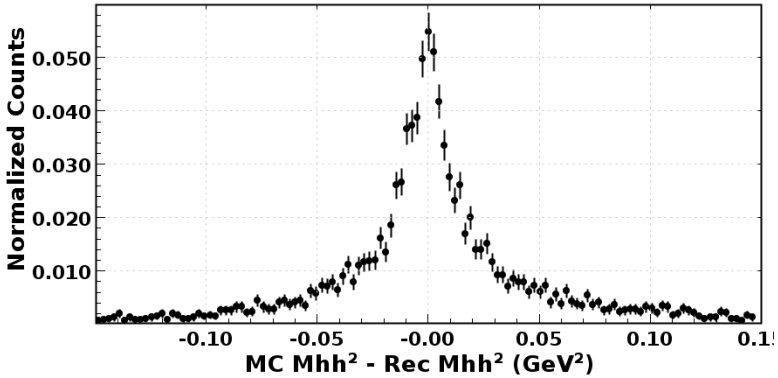
- This was really hard!
- Generated 701947 ep > e‘$\pi^+\pi^-$X events
- EventBuilder reconstructed 37158 events (5.294%)

Monte Carlo Analysis

- SIDIS dihadron variables generally used in the cross section:
  - M_{hh}^2 (pair mass of the hadron pair)
  - $z = E_{hh}/\nu$ (fraction of the virtual photon energy carried by the hadron system)
  - $P_{h\perp}$ (projection of the hadron pair momentum perpendicular to the virtual photon direction)

MC
Reconstructed





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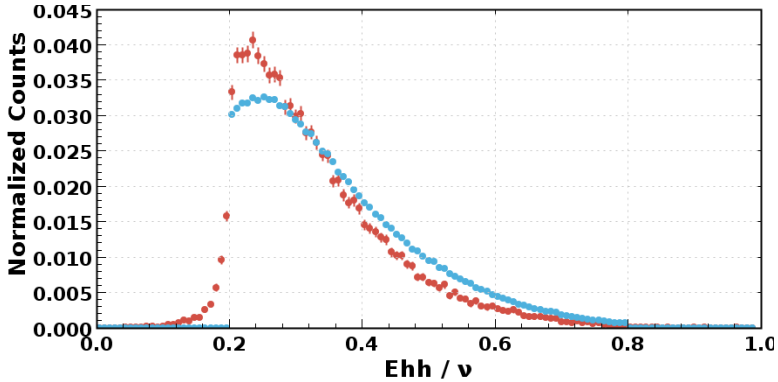

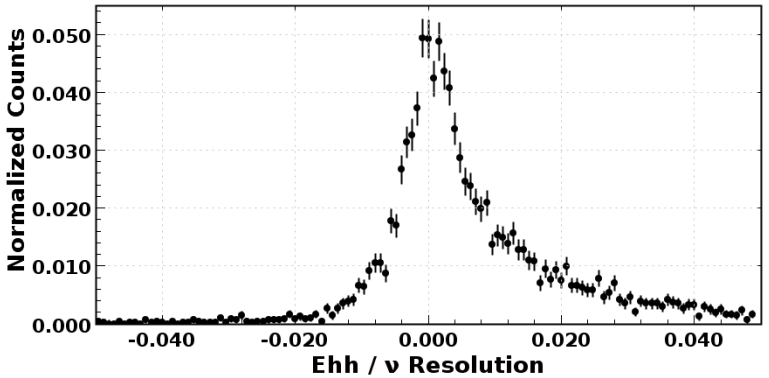

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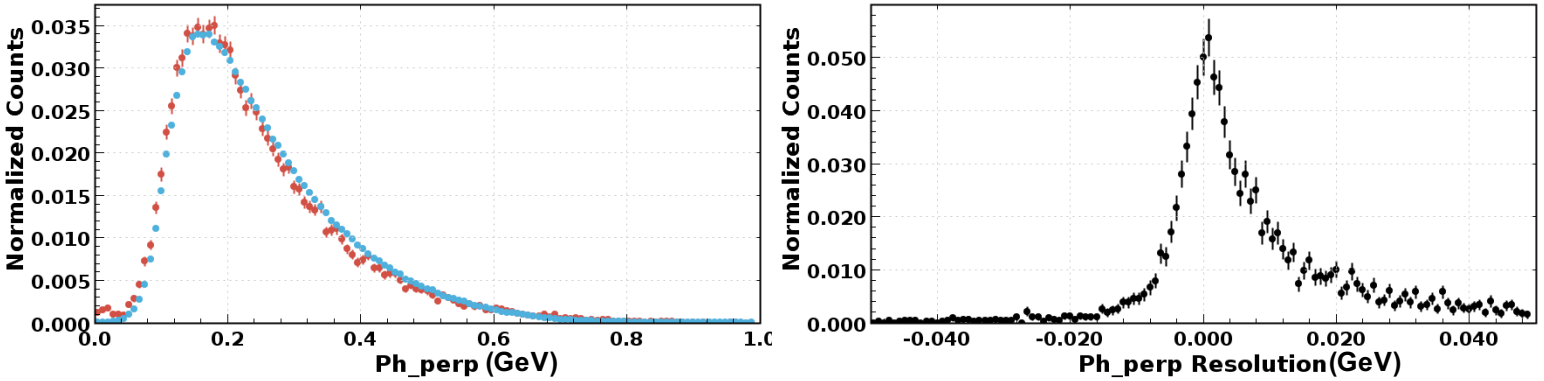
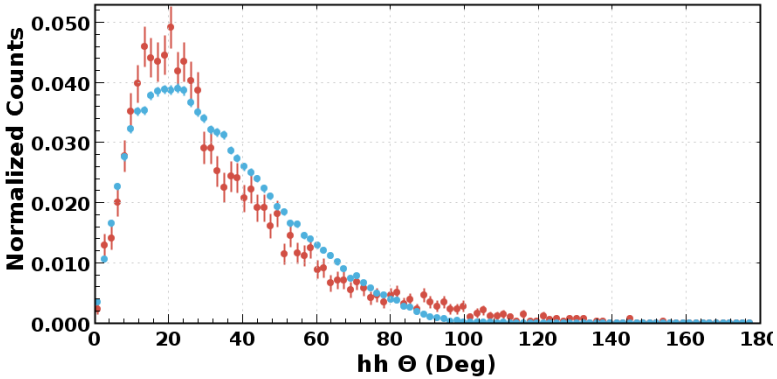
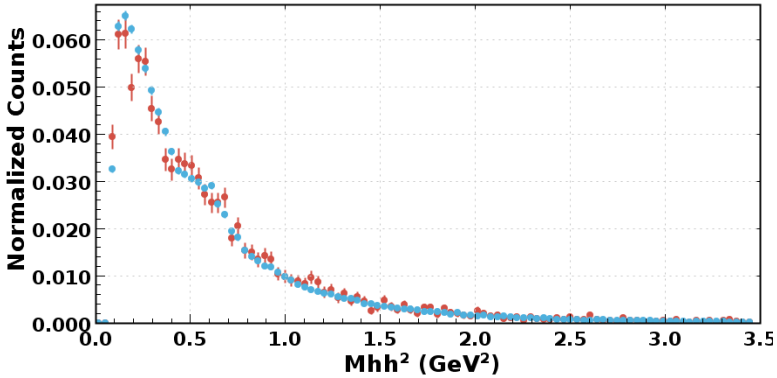


Incipient Data Analysis

- Chose run 3222 (25 nA, 10.6 GeV, torus +1.00, solenoid -1.00) cooked with coatjava 5b.3.3
- Used EventBuilder REC::Particle to find e' pi+ pi- X events
- **Only** cut applied is $Q^2 > 1.0$ GeV^2.

MC
Experimental





To Do

- Develop PID cuts, implement fiducial cuts
- Compare with other generators
- Model the e‘$\pi^+\pi^-$X / e‘X ratio (need e‘X generator)
- Reconstruction chain for unpolarized-tangentially polarized events (farm job running as we speak)
- Maybe implement polarized beam and longitudinally polarized target cross sections in TMDGen

Questions?