Beam spin asymmetries from hard exclusive π^+ electroproduction

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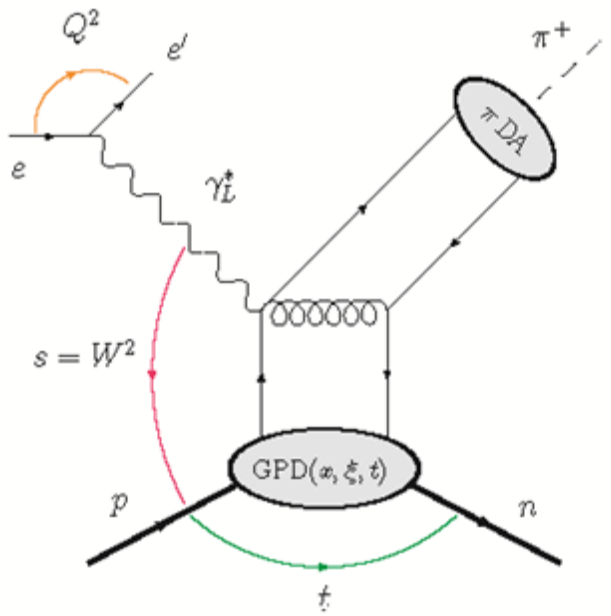
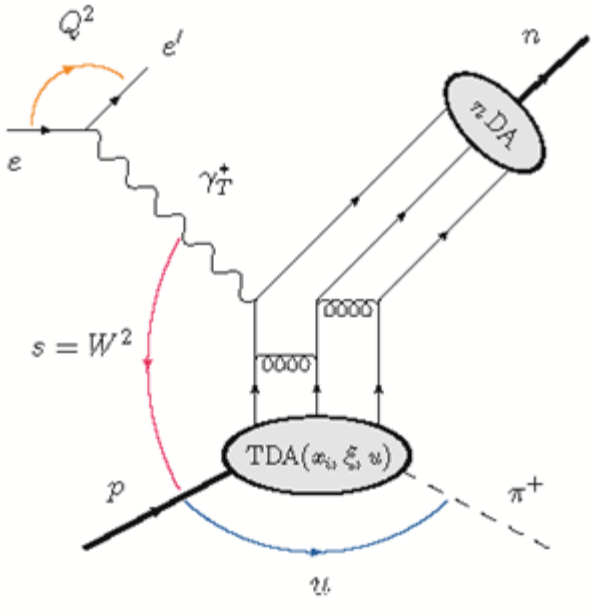
Physics motivation

Hard exclusive π^+ electroproduction

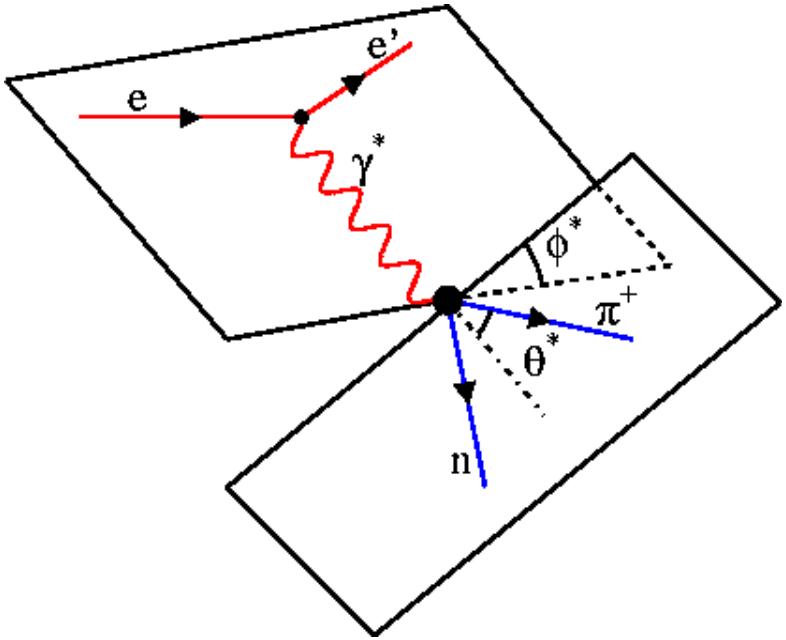


Near forward
Small t
Large u



Near backward
Small u
Large t

Hard exclusive π^+ electroproduction



$$\frac{d^4\sigma}{dQ^2 dx_B d\phi dt} \sim (\sigma_T + \epsilon_L \sigma_L + \epsilon \sigma_{TT} \cos 2\phi + \sqrt{2\epsilon_L(1+\epsilon)}\sigma_{LT} \cos\phi + h\sqrt{2\epsilon_L(1-\epsilon)}\sigma_{LT'} \sin\phi)$$

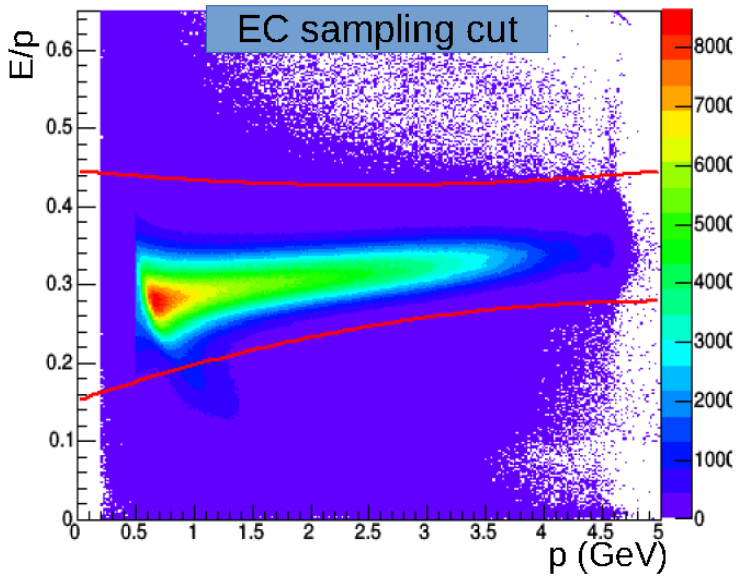
beam helicity

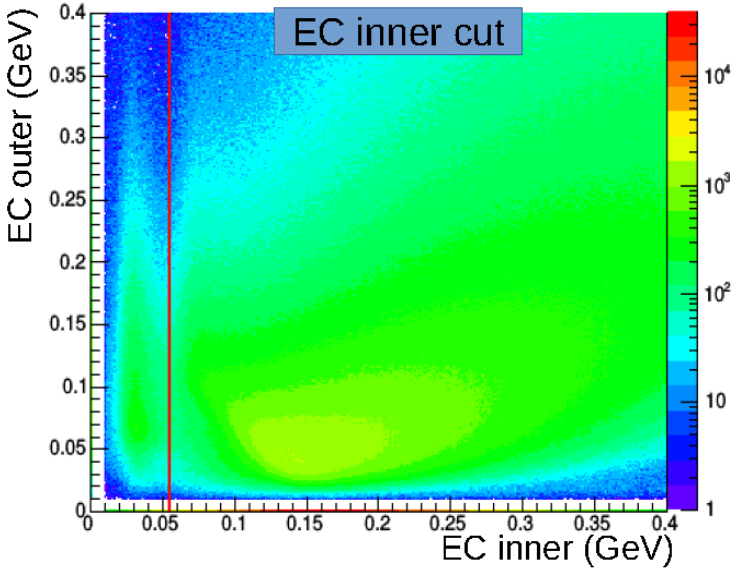
$$BSA = \frac{\sigma^+ - \sigma^-}{\sigma^+ + \sigma^-} \propto \frac{\sigma_{LT'}}{\sigma_T + \epsilon_L \sigma_L} \sin\varphi = \boldsymbol{A_{LU}^{\sin\varphi}} \sin\varphi$$

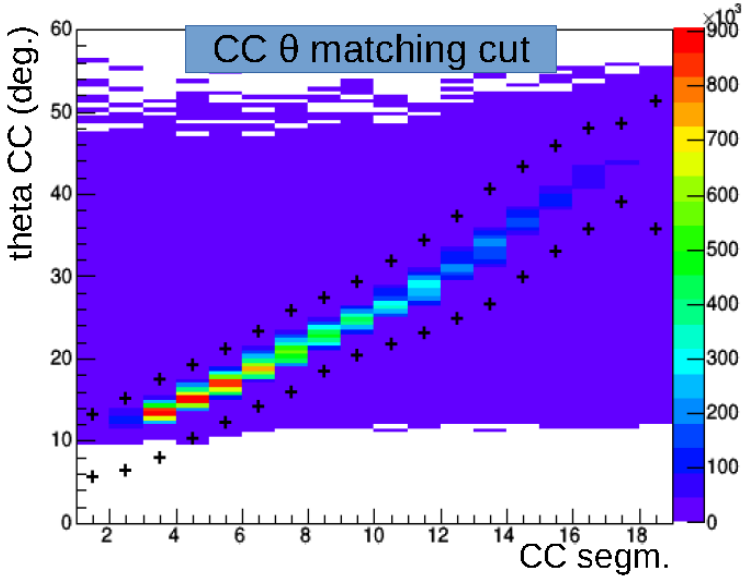
E1F-Run

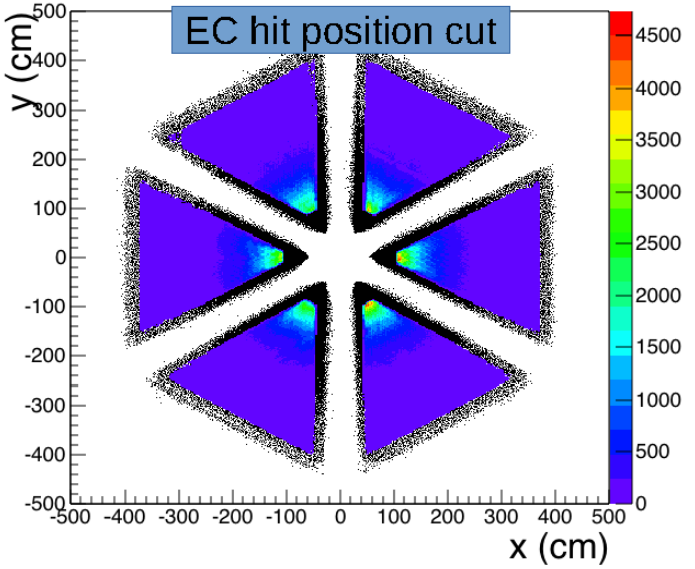
- 5.498 GeV electron beam with ~ 75% polarization
- Unpolarized liquid hydrogen target
- Torus magnetic field reduced to 60%
- Approximately 2 billion trigger events

Electron identification

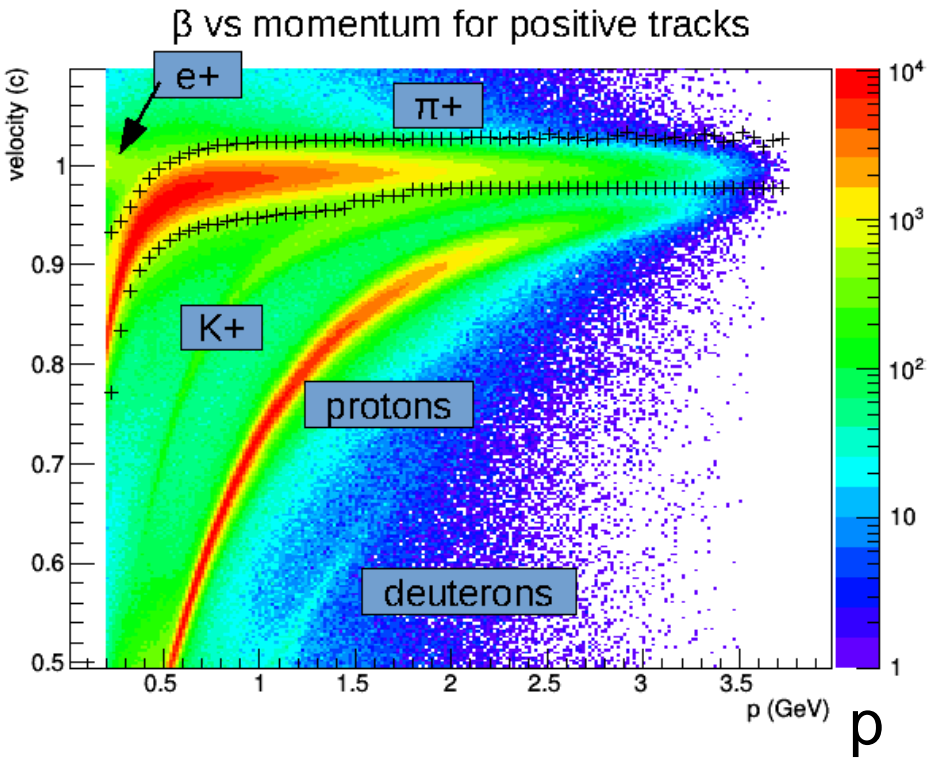






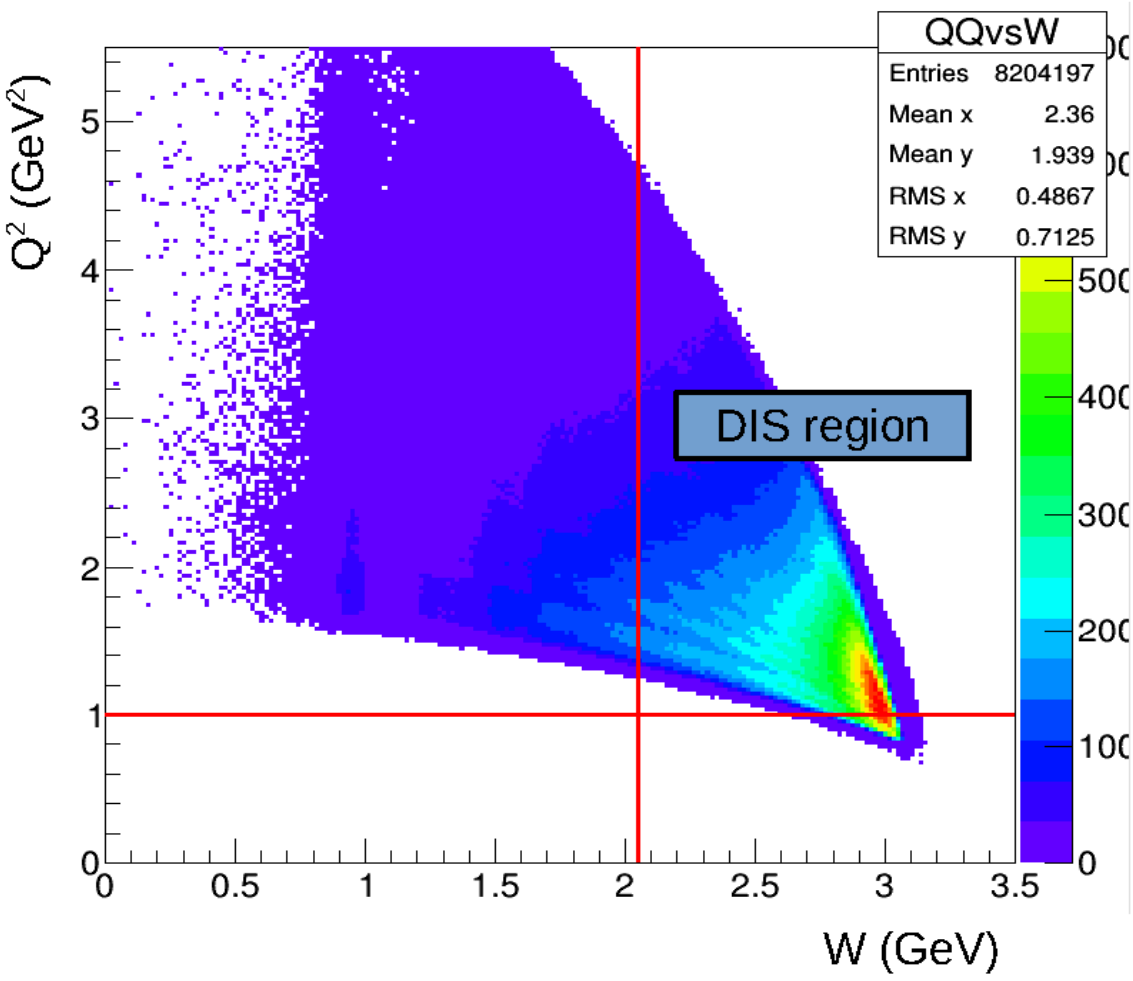


π^+ Particle identification



- β is calculated with timing and path length
- 70 vertical slices fit with gaussian
- 3 σ cut at low momenta
- Cut tapers in high momenta

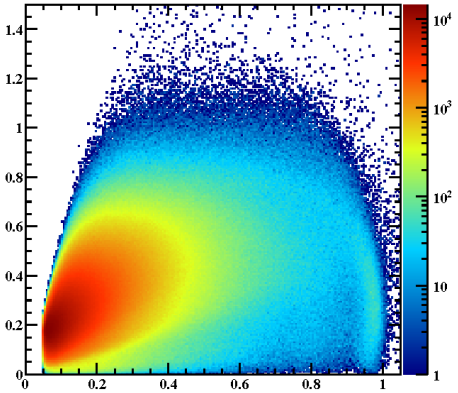
DIS Cuts


QQvsW
Entries 8204197
Mean x 2.36
Mean y 1.939
RMS x 0.4867
RMS y 0.7125
DIS region
Q^2 (GeV^2)
W (GeV)
0
0.5
1
1.5
2
2.5
3
3.5
1
2
3
4
5
100
200
300
400
500

P_t vs z for $ep \rightarrow e\pi^+X$

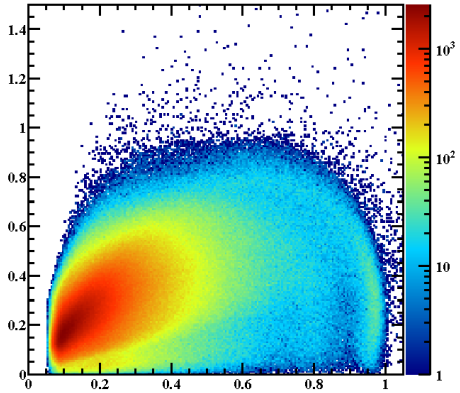
P_t

All W

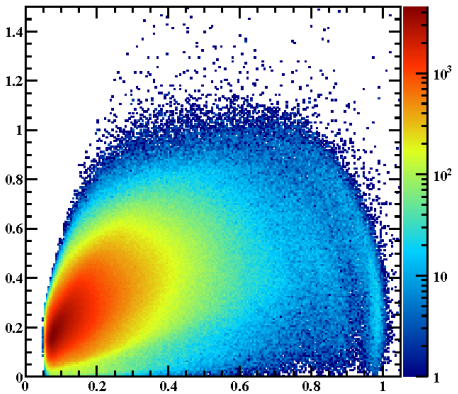


z

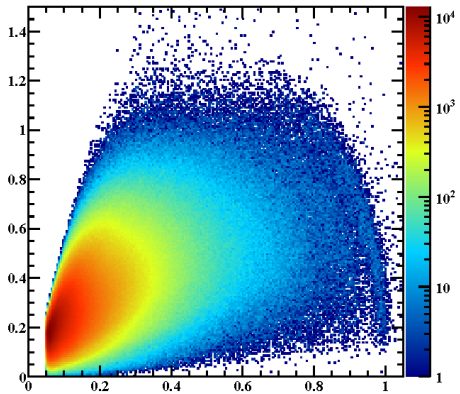
2.0<W<2.3



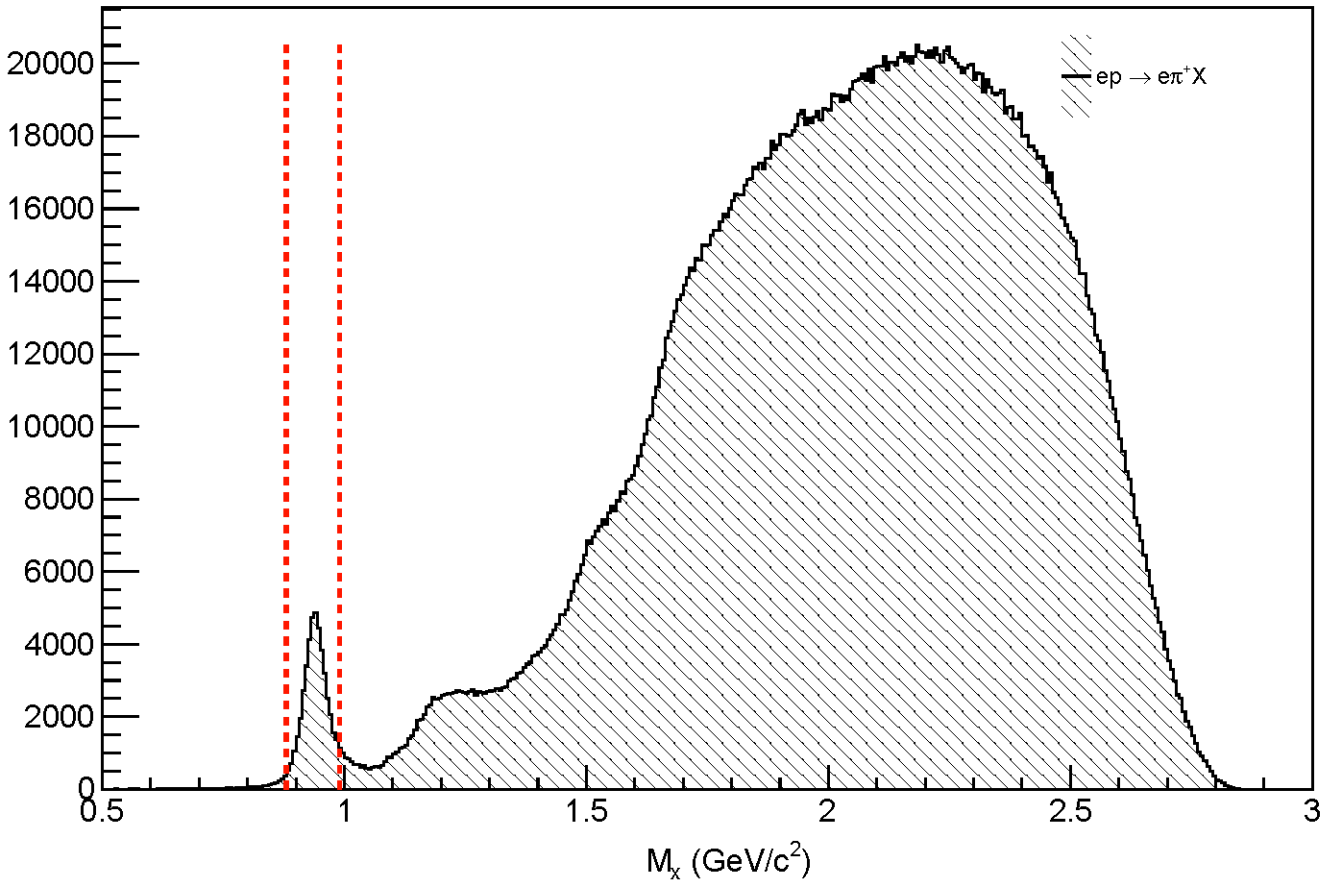
2.3<W<2.6



2.6<W<3.5



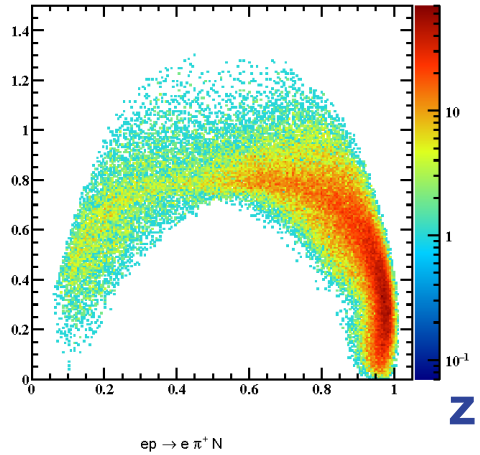
$ep \rightarrow e\pi^+X$



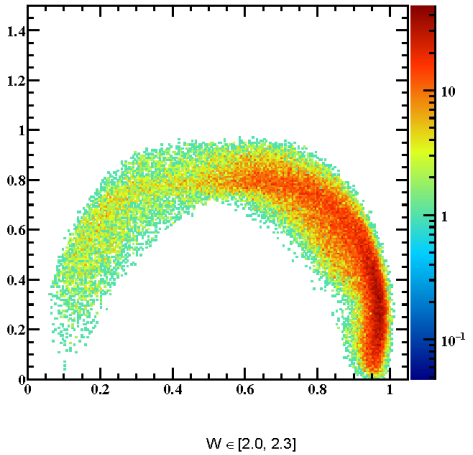
P_t vs z for $ep \rightarrow e\pi^+ n$

P_t

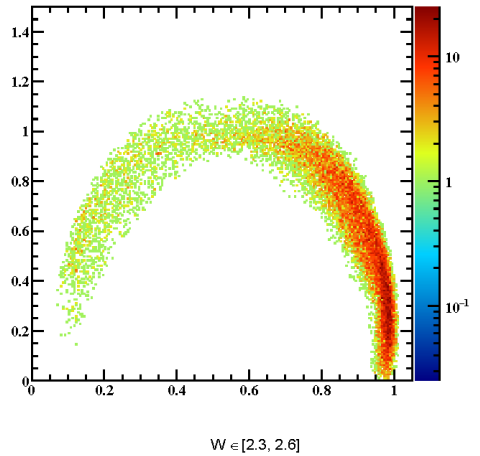
All W



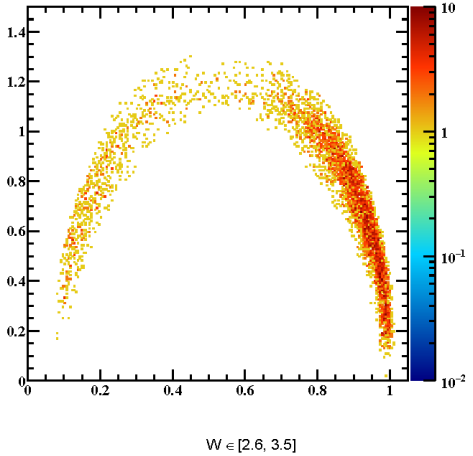
2.0<W<2.3



2.3<W<2.6

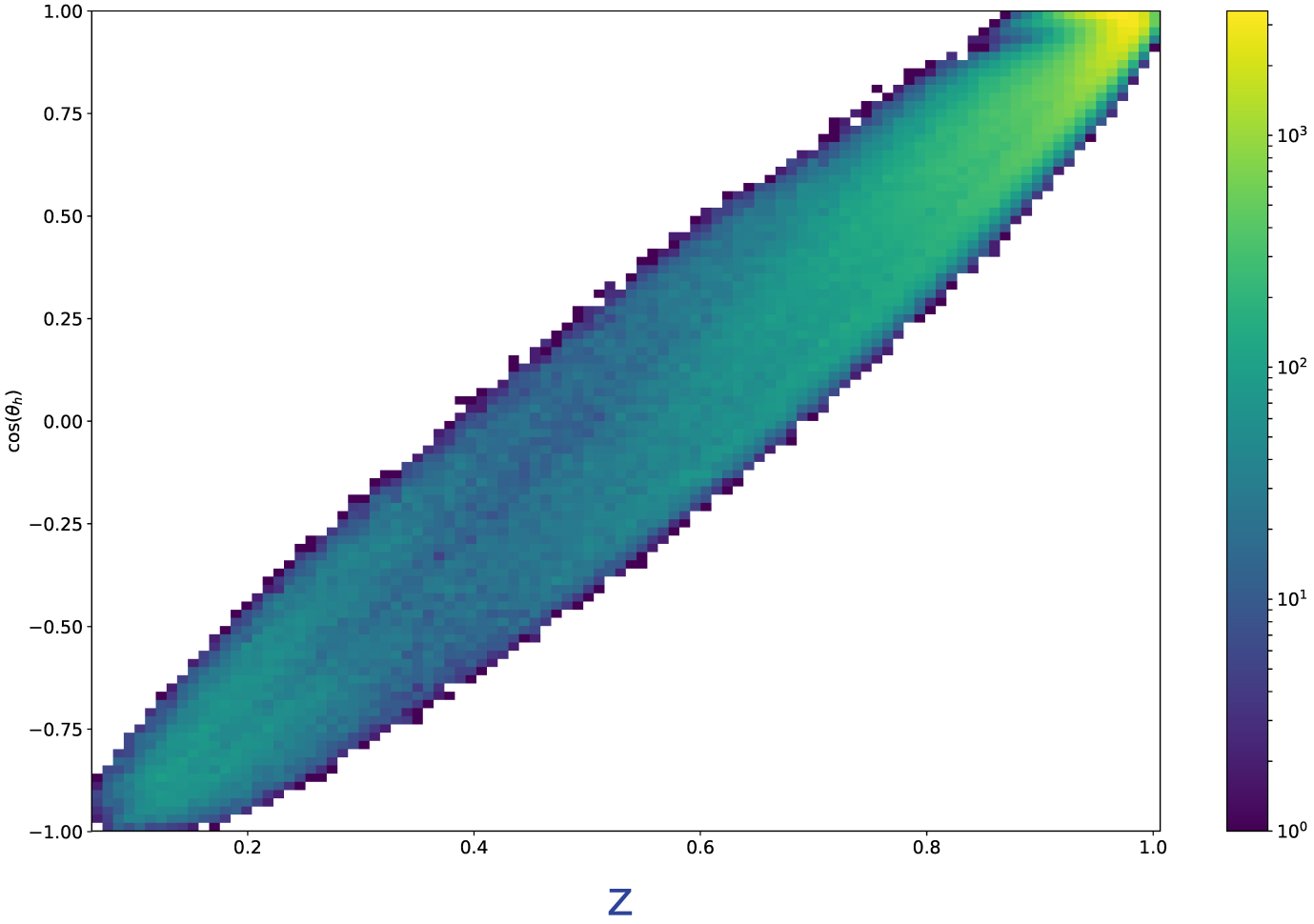


2.6<W<3.5

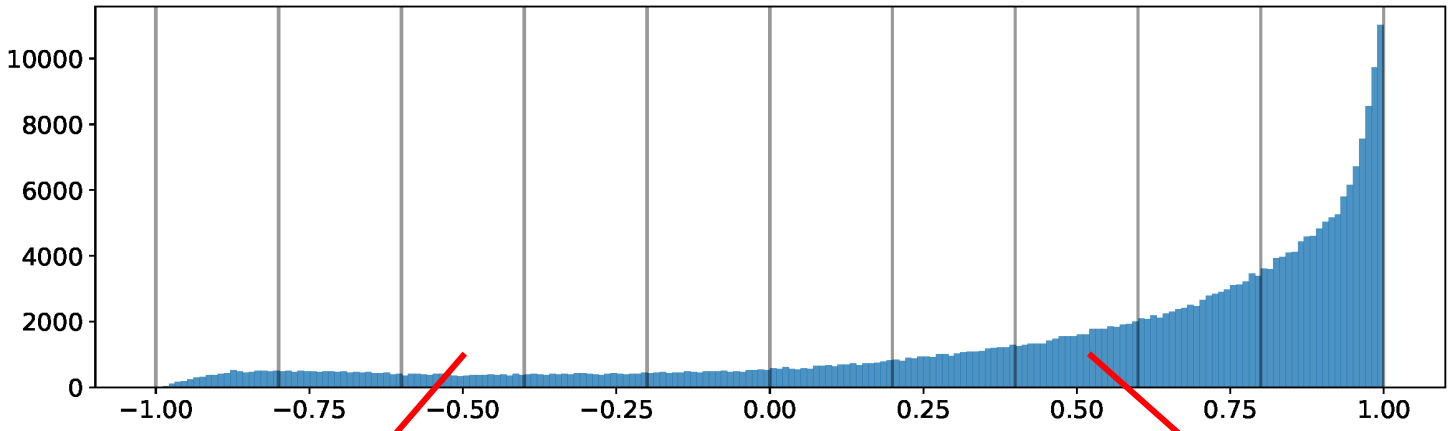


cosθ vs z for $ep \rightarrow e\pi^+ n$

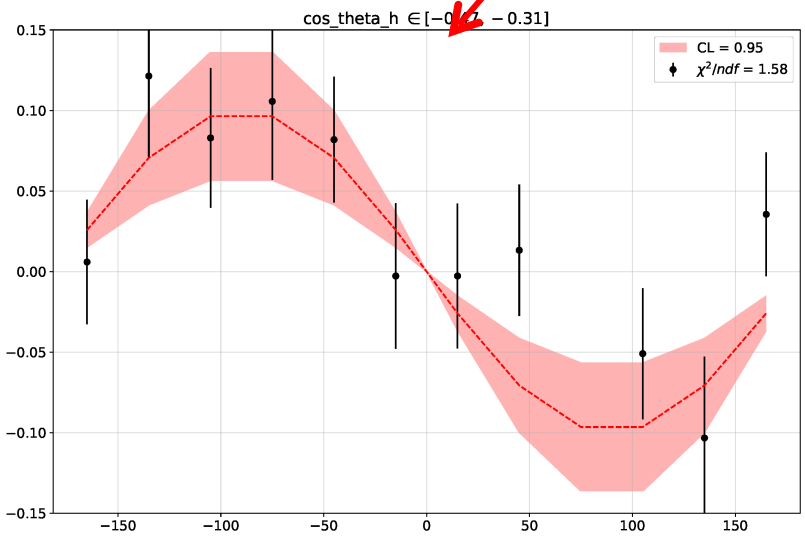
cosθ

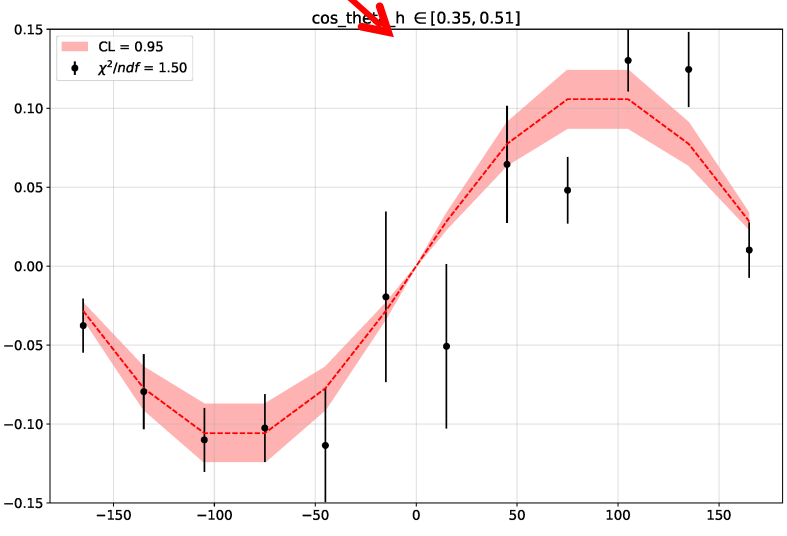


BSA for $ep \rightarrow e\pi^+ n$



cosθ



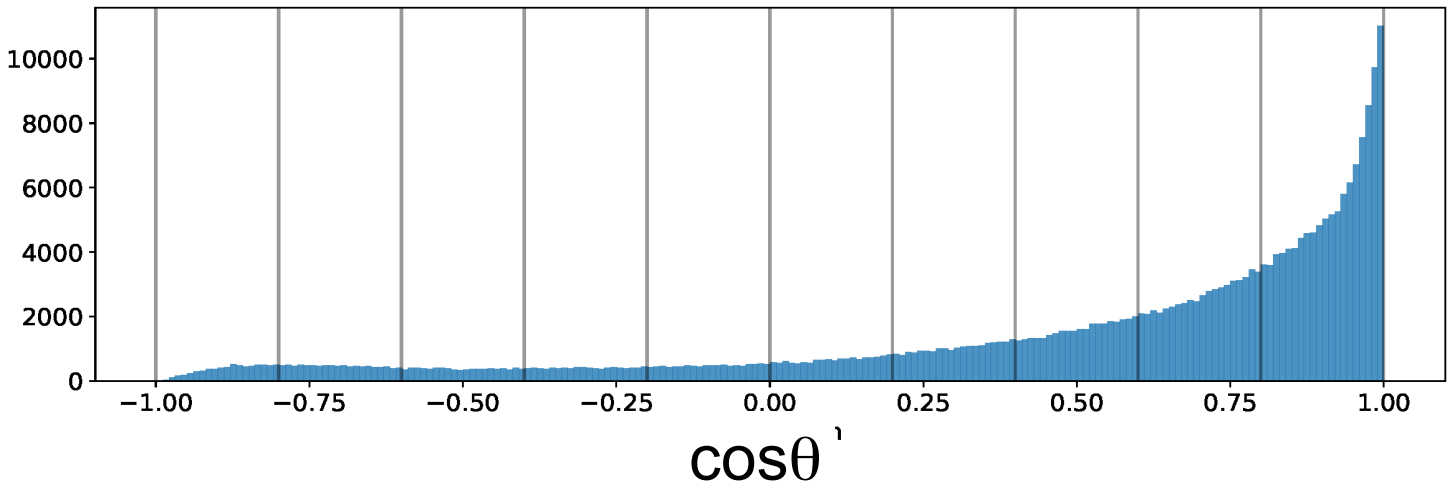


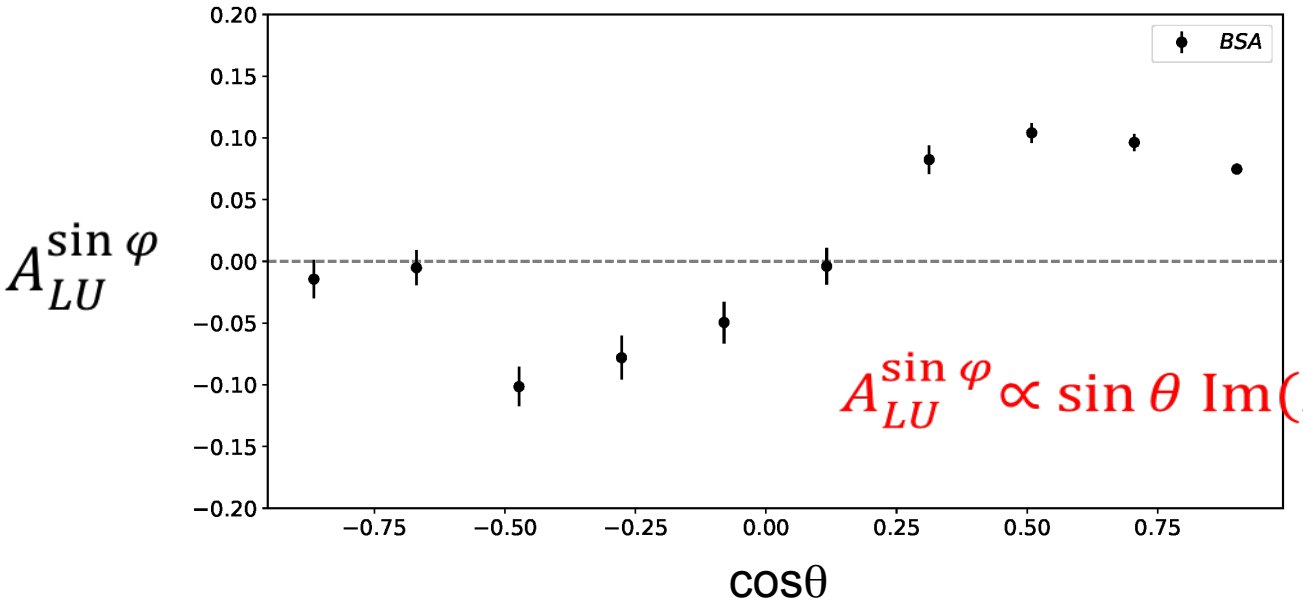
ϕ

$$\frac{\sigma^+ - \sigma^-}{\sigma^+ + \sigma^-} \propto A_{LU}^{\sin\varphi} \sin\varphi$$

ϕ

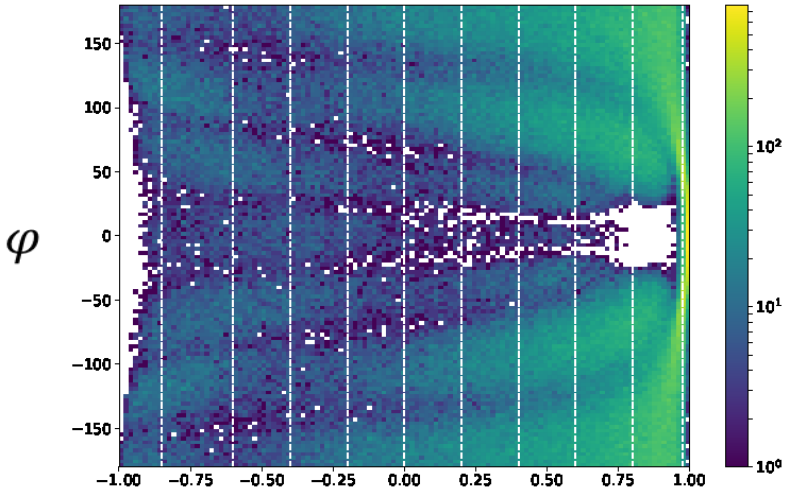
$A_{LU}^{\sin\varphi}$ for ep→eπ⁺n



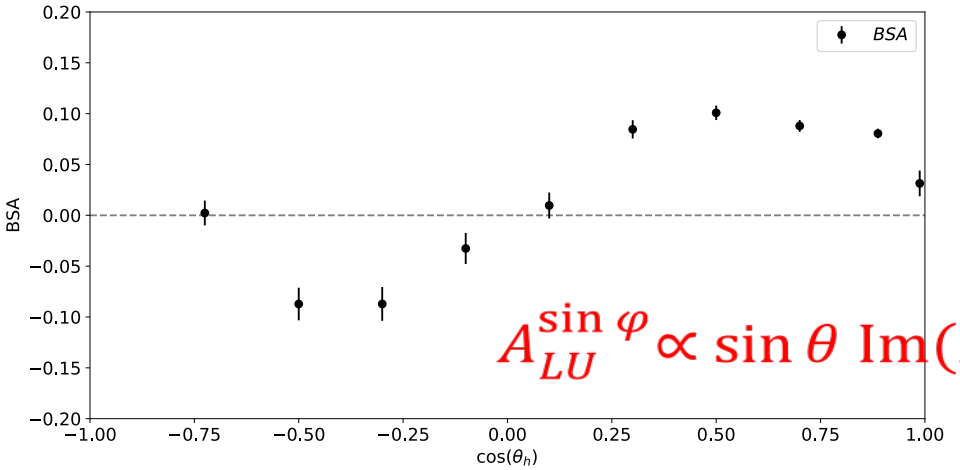


$$A_{LU}^{\sin\varphi} \propto \sin\theta \ \mathrm{Im}(F_{+0}^{++} + F_{+0}^{--})$$

$A_{LU}^{\sin\varphi}$ for $ep \rightarrow e\pi^+ n$



$A_{LU}^{\sin\varphi}$



$$A_{LU}^{\sin\varphi} \propto \sin\theta \ \mathrm{Im}(F_{+0}^{++} + F_{+0}^{--})$$

cosθ

Summary

- Measured beam spin asymmetries from near forward to near backward for hard exclusive π^+ electroproduction using E1F data.
- Showed 10% asymmetries in forward angles, and -10% in backward angles.
- Observed the sign change around 90 degree.
- Working on radiative corrections using “EXCLURAD”.
- Working on detailed systematic error studies.
- Will make the same measurements for π^+, π^0 and two pion ($\pi^-\Delta^{++}$) channels with CLAS12.
- Analysis note is under preparation and will be submitted to PRD rapid communications.