

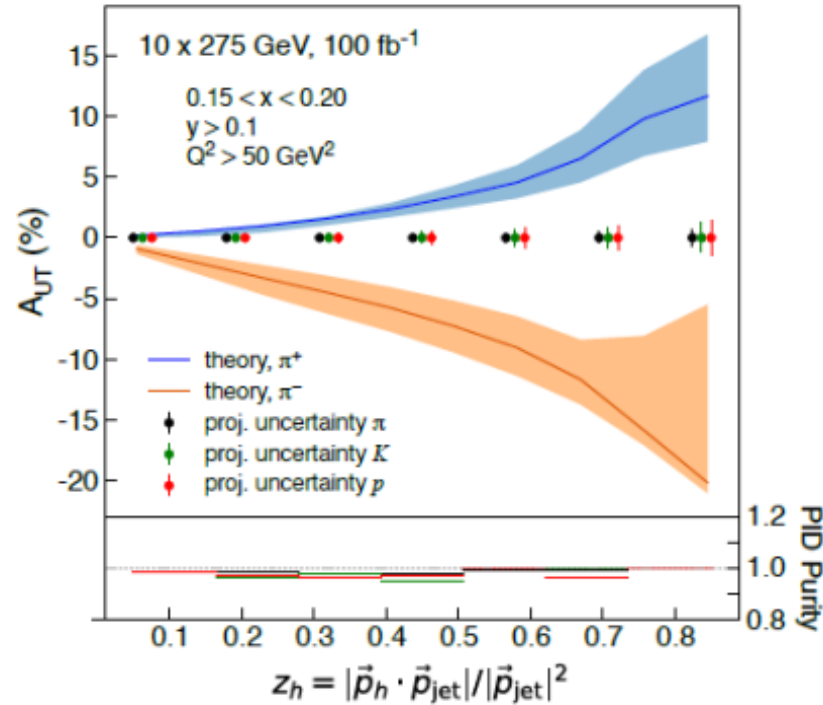
# Hadron-In-Jet Collins for TDR

Kevin Adkins, Morehead State University

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# Target Plot:



**Figure 35:** Projection for hadron-in-jet Collins asymmetry measurement for charged pions, kaons and protons. This is representative of the class of jet substructure measurements (FastSim).

# Introduction

- Collins effect connects initial proton spin to final state azimuthal distribution of hadrons in a jet (pions, kaons, protons)
- Simulation is without polarization
  - Randomly assigned a spin state for use in calculating the angles that appear in the sinusoidal modulation
    - $\phi_S$  is related to the jet scatter direction
    - $\phi_H$  is the azimuthal angle of a hadron in the jet
    - $\phi_C = \phi_S - \phi_H$  is the “Collins angle”

$$d\sigma \approx F_{UU} \left\{ 1 + A_{UT}^{\sin(\phi_S - \phi_H)} \sin(\phi_S - \phi_H) \right\}$$

# Introduction Cont.

- Isolate the asymmetry by exploiting the full  $2\pi$  azimuthal coverage with the “cross ratio method”

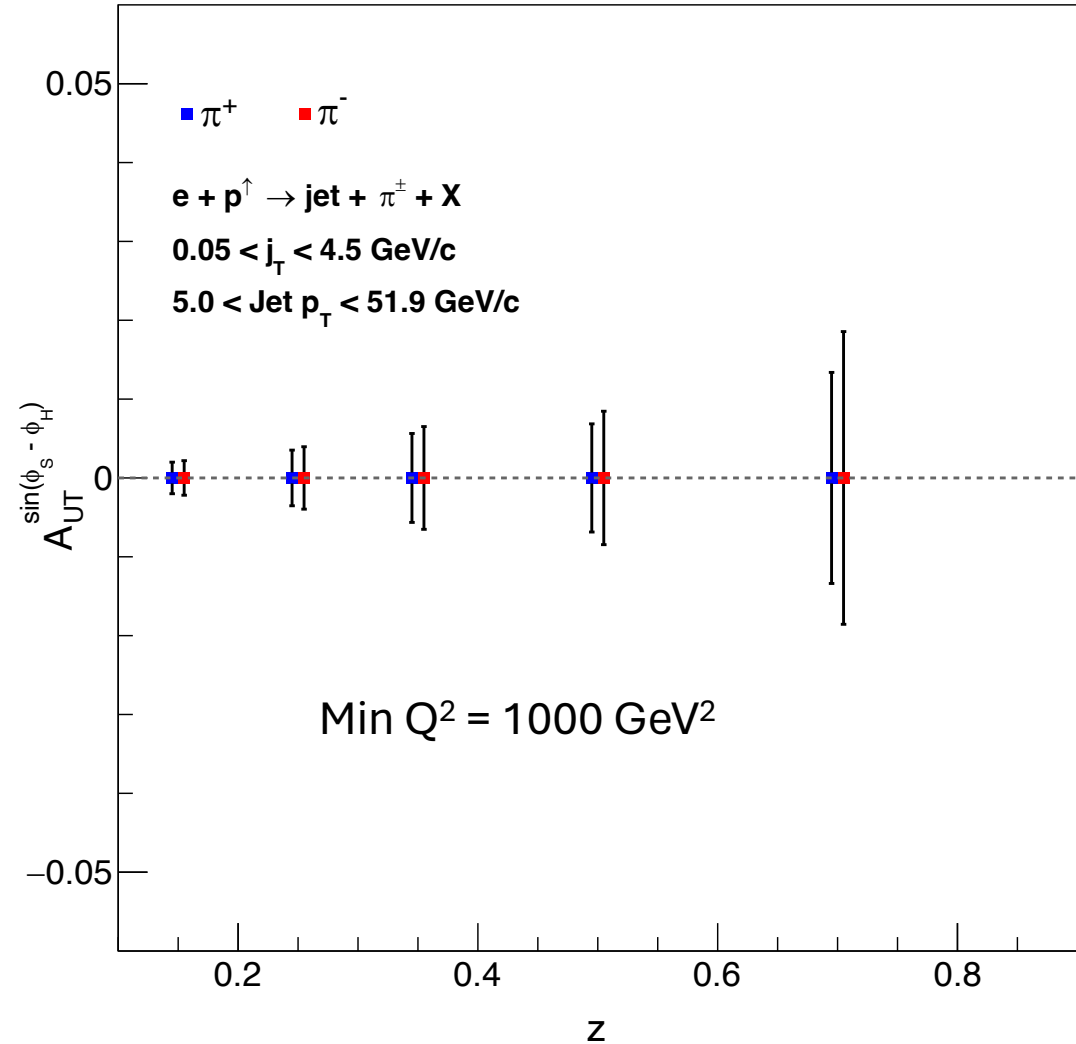
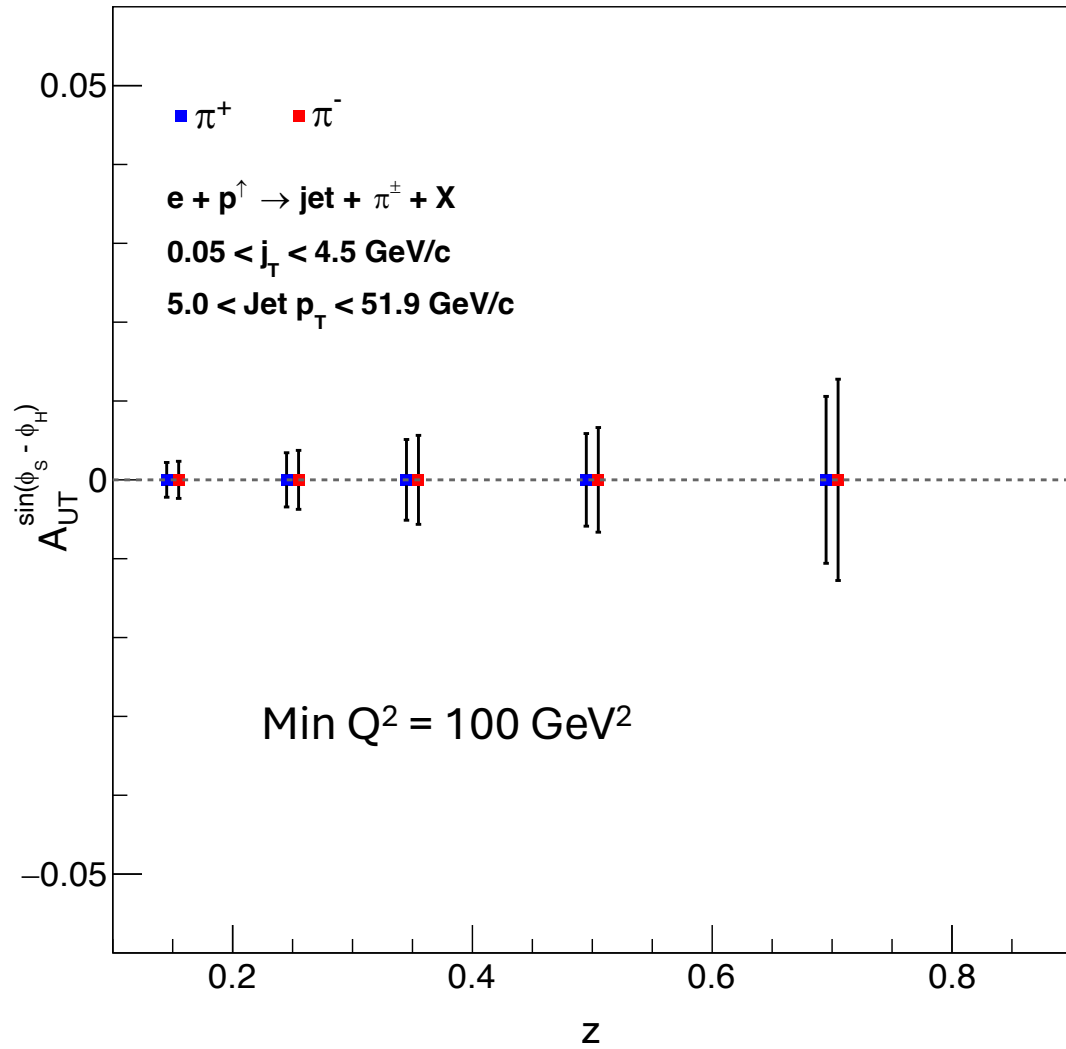
$$\epsilon = P \times A_{UT}^{\sin(\phi_S - \phi_H)} = \frac{\sqrt{N_U^+ N_D^-} - \sqrt{N_U^- N_D^+}}{\sqrt{N_U^+ N_D^-} + \sqrt{N_U^- N_D^+}}$$

- N is the number of hadrons that scatter into the upper (U) and lower (D) halves of the detector resulting from protons with spin up (+) and down (-)
- Each N is binned in two dimensions:  $\phi_C$  and  $\{z, j_T, \text{jet } p_T\}$

# Analysis Basics

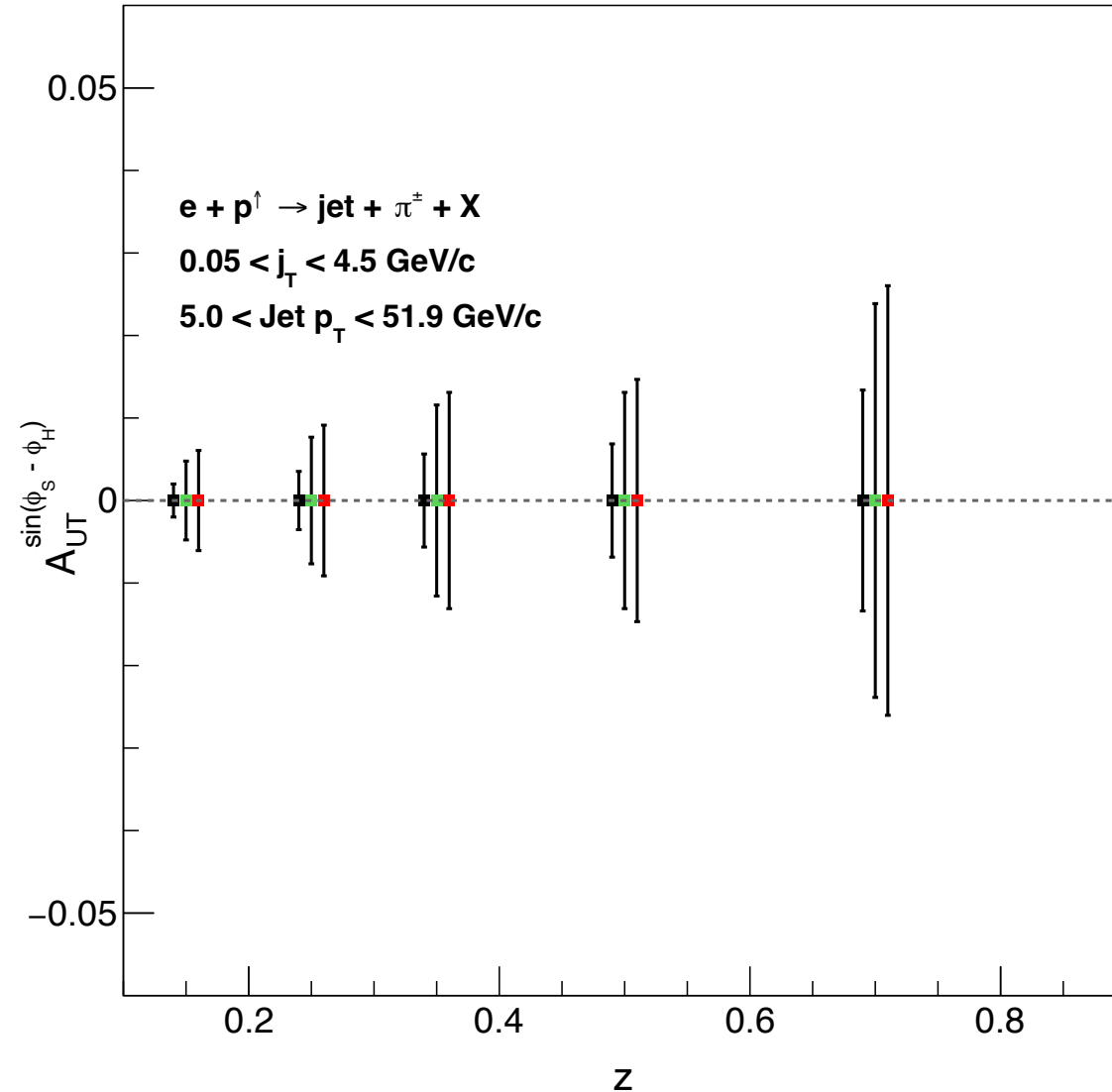
- Sample: 18x275 GeV, campaign: 23.12.0, NCDIS
- 1M events for minimum  $Q^2 = 100 \text{ GeV}^2$  and  $Q^2 = 1000 \text{ GeV}^2$
- Basic cuts:
  - Jet  $E > 5 \text{ GeV}$
  - $5 < \text{Jet } p_T < 51.9 \text{ GeV}/c$  (binning may need to be adjusted for final plot, started with previous STAR binning)
  - $|\eta| < 2.5$
  - $0.05 < j_T < 4.5 \text{ GeV}/c$
  - $0.1 < z < 0.8$
  - Jets containing the original electron are rejected

# Status of TDR Plots (as of March 6, 2024)



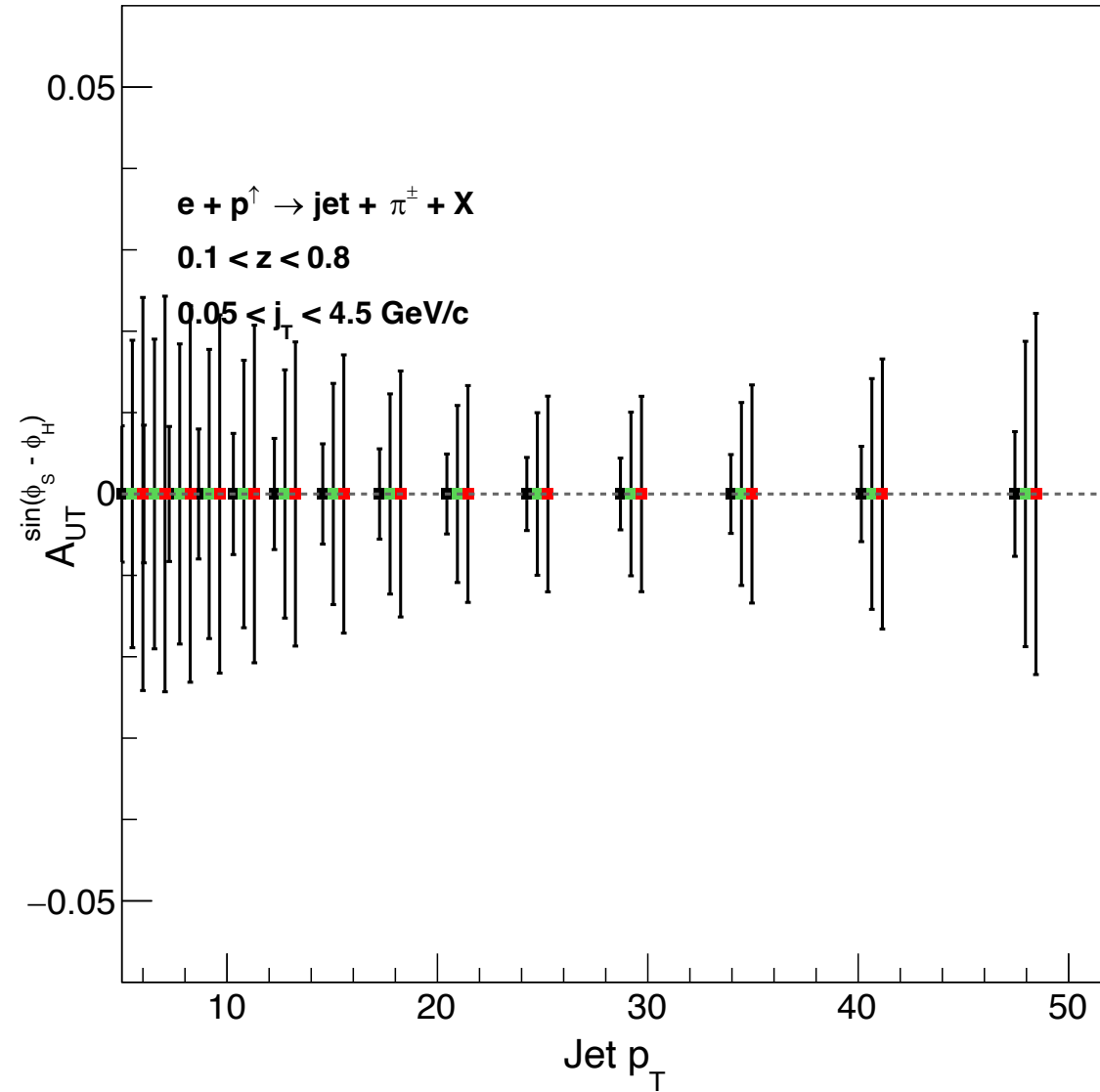
# Update (April 3, 2024)

Black: Pions  
Green: Kaons  
Red: Protons  
Positive charge only



# Update (April 3, 2024)

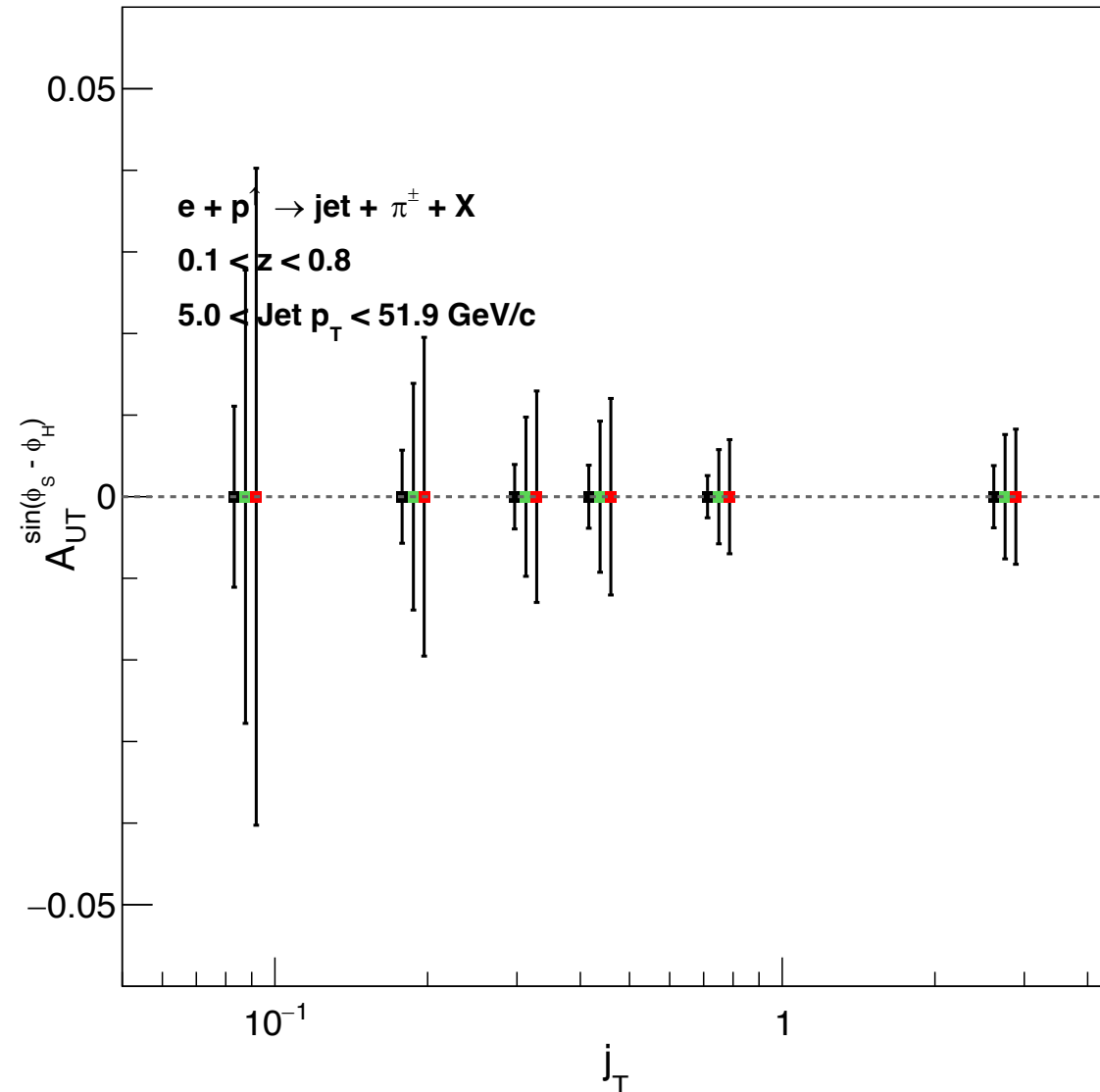
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# To Do

1. Email Miguel about the yellow report plot (combine charges, or + only?)
2. Make the plots “pretty”
3. Run over min- $Q^2$  of 10 and 100  $\text{GeV}^2$
4. Combine samples by luminosity weighting (more from Brian today)
5. Add theory curves