Long-range two-particle correlations in DIS with CLAS12

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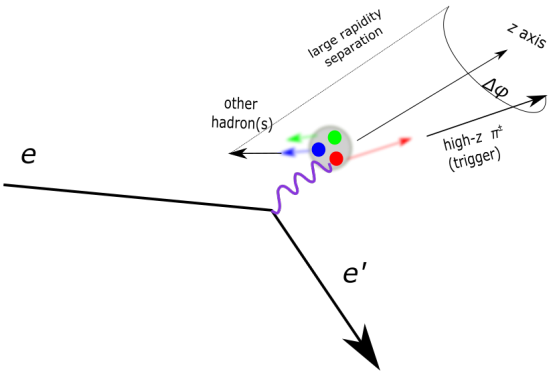
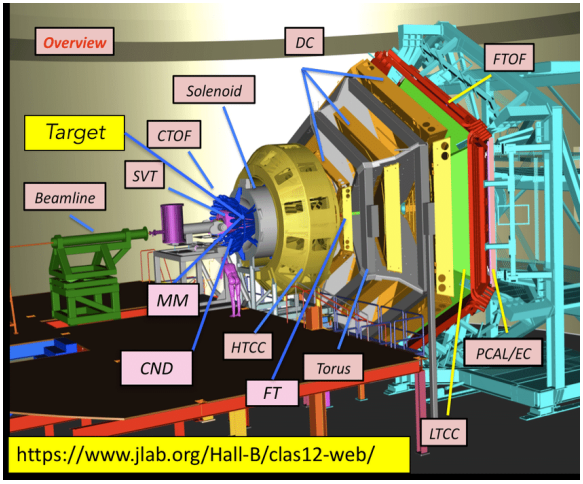
Introduction

- Correlations between particles in deep inelastic scattering (DIS) with large rapidity separation can be used to study correlations that occur early on in a reaction.
- Here we investigate the correlations in the azimuthal separation $\Delta\phi$ between pairs of particles produced in semi-inclusive DIS reactions in CLAS12.
- Numerous collider experiments have similarly been investigating $\Delta\phi$ correlations in (e^+e^-, ep, pp, pA, AA) [1, 2, 3, 4, 5].
- Large acceptance at CLAS12 makes it well suited for analogous studies, which probe extremely low multiplicities.



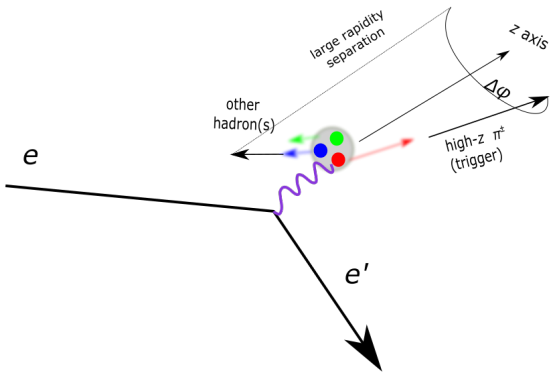
Experimental Setup

- Data taken using CLAS12 spectrometer
- $E_{beam} = 10.6$ GeV
- liquid hydrogen target
- Only tracks in forward detector $5^\circ < \theta < 45^\circ$ were used



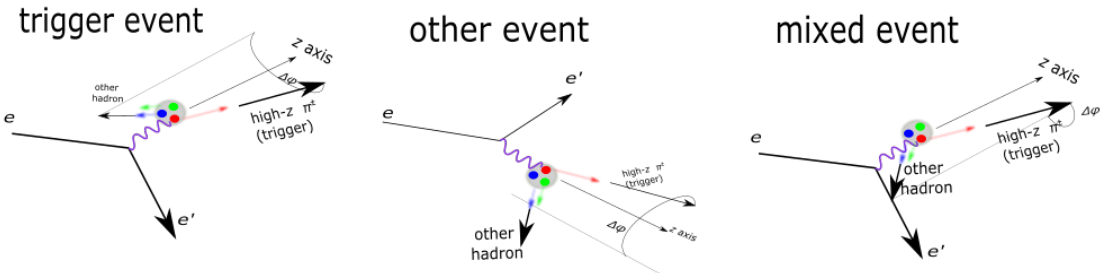
Kinematics and definitions

- We look at events with a scattered electron, a high-z pion (trigger) and another hadron (associated)
- Results are presented in the $\gamma^* p$ CM frame as a function of
  - $\Delta\phi$: difference in azimuthal angle
  - Δy: difference in rapidity ($y = \frac{1}{2} \ln \frac{E+p_z}{E-p_z}$)



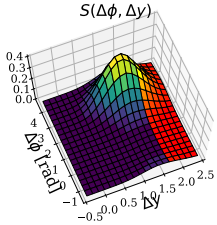
Pair-acceptance correction

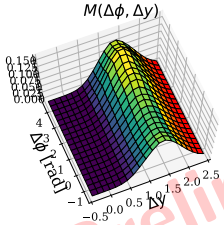
- Event mixing is performed to correct for pair-acceptance effects in a data-driven way.
- This method is tested with an independent, MC-based correction, providing similar results.

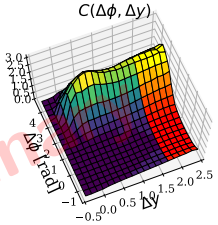


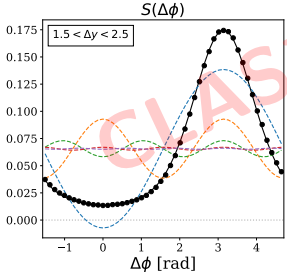
Correlation function from πp events

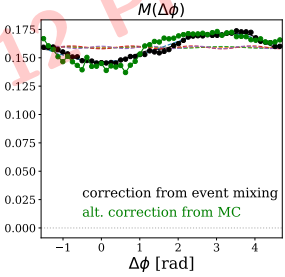
πp
$Q^2 > 1$ GeV^2
$W > 2$ GeV
$y_e < 0.85$
$z_1 > 0.4$
$p_T > 0.3$ GeV
$m_X(e\pi X) > 1.665$ GeV

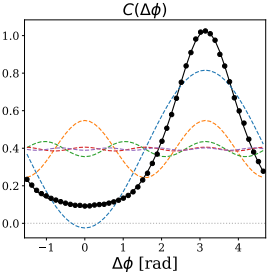






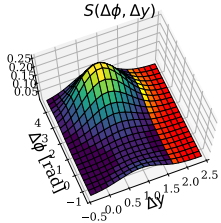


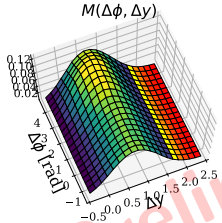


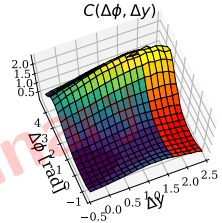


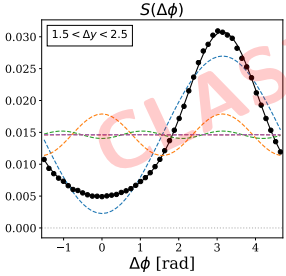
Correlation function from $\pi\pi$ events

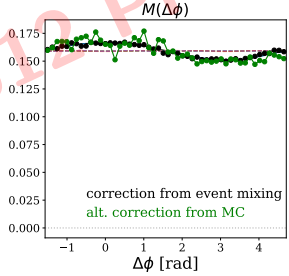
$\pi\pi$
$p_T > 0.3$ GeV
$Q^2 > 1$ GeV^2
$W > 2$ GeV
$y_e < 0.85$
$z_1 > 0.4$
$p_T > 0.3$ GeV

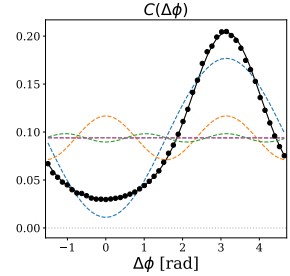






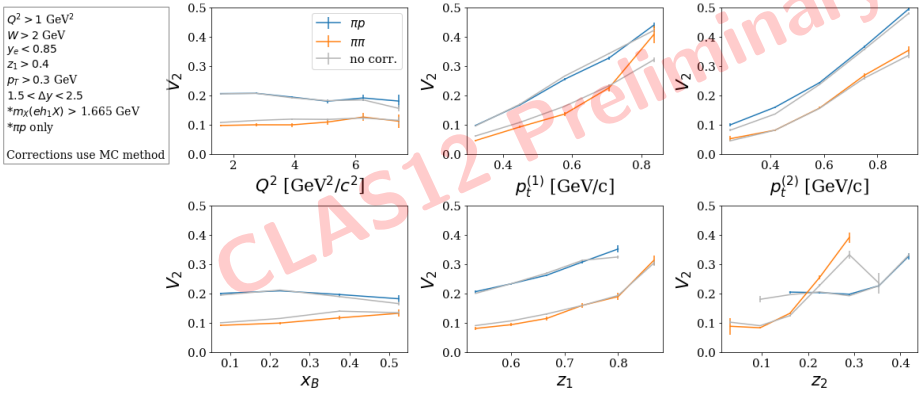






Fourier transform of correlation function

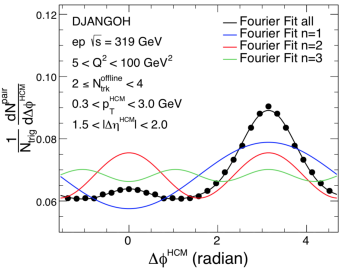
- Fourier fit: $C(\Delta\phi) = A(1 + 2\sum_n V_n \cos(n\Delta\phi))$
- These data can constrain target fracture functions.

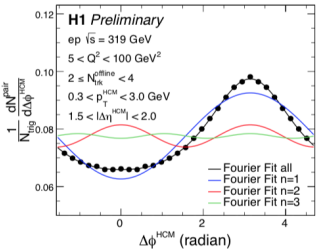


Large p_T and z dependence, weak x_B and Q^2 dependence.

Ridge search

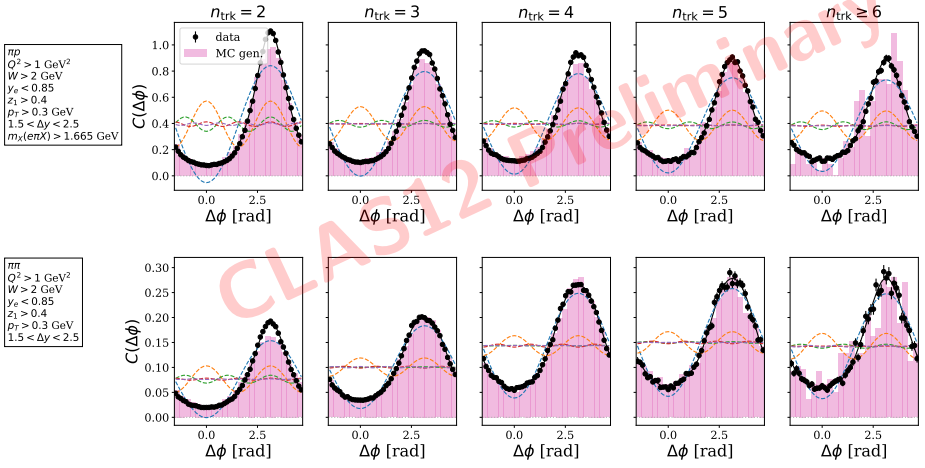
- In some other experiments (and predicted models), a secondary peak (the "ridge") is observed at $\Delta\phi = 0$, persisting at large rapidity separation
- Upper limits have been set/are being set at ALEPH [1], and HERA [2] for low multiplicity.



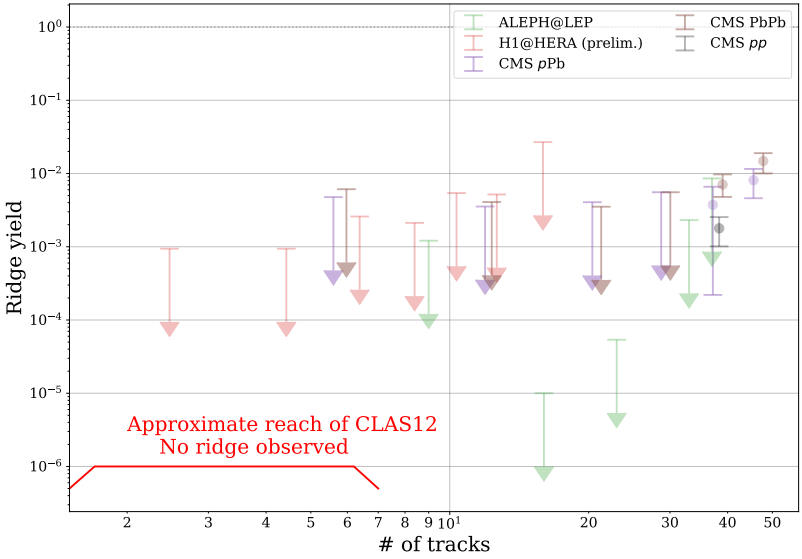


Track multiplicity dependence at CLAS-12

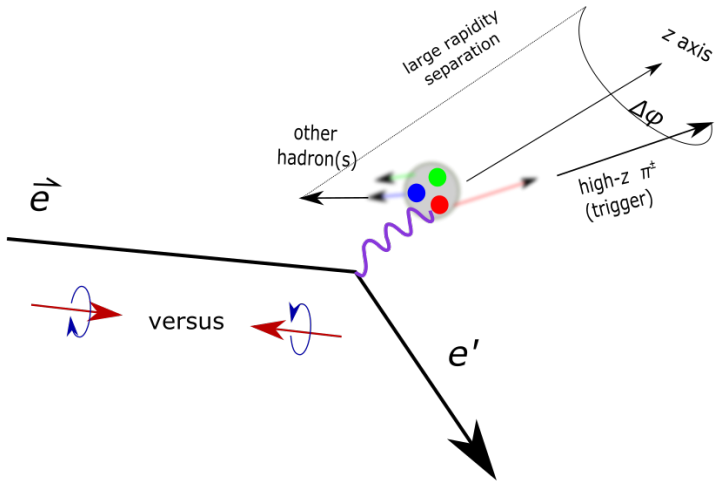
- Seach for "ridge", i.e peak at $\Delta\phi = 0$, in intervals of track multiplicity (tracks in range $3 < \theta < 40$). **No signal observed**



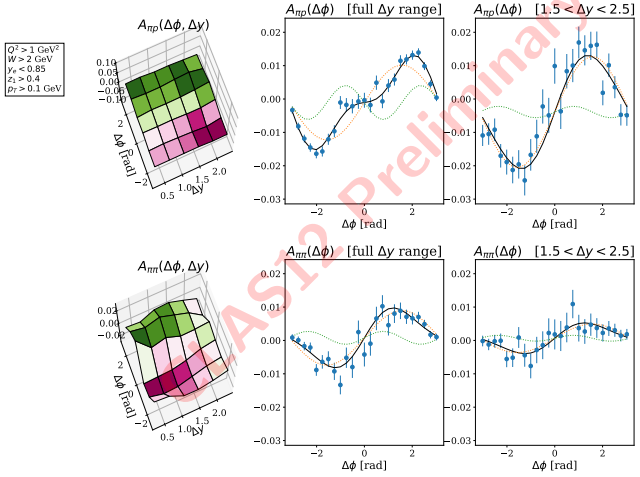
Prospects of limits on the “ridge” [1, 2, 3, 4, 5]



What happens if we use a polarized probe?



Helicity asymmetry $A = \frac{S_+ - S_-}{S_+ + S_-} / P_e$



- Long-range spin correlations between struck quark and proton remnant.
- Significant Δ y dependence.

Conclusions

- Azimuthal correlations in rapidity-separated πp and $\pi\pi$ pairs are a useful tool to study structure and fracture phenomena
- CLAS12 is well suited for such analyses due to its large acceptance and high luminosity.
- No "ridge" signal observed with CLAS12, complementing collider experiments.
- Significant long-range spin correlation observed in both πp and $\pi\pi$ channels.

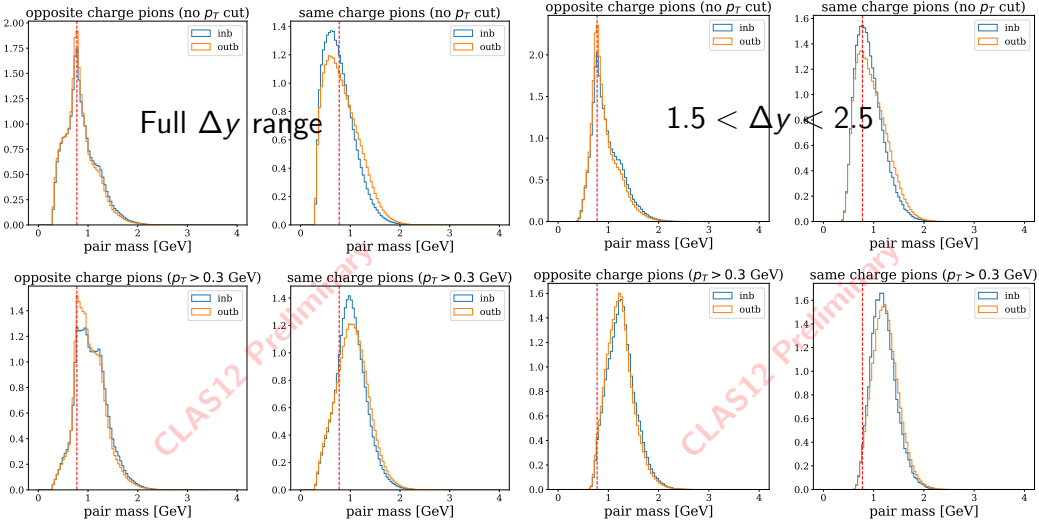
BACKUP SLIDES

Correction methods

Two methods of acceptance corrections are considered, and produce equivalent results:

- Event Mixing:
  - electrons and trigger hadrons from one event are combined with an associated hadron from another event.
  - the "same-event" yields are divided by the yield of mixed events to obtain correlation functions
- Monte-Carlo
  - generate DIS events and keep list of recon and generate particles in each event.
  - Correction factor is $N_{eh_1}/N_{eh_1h_2}$ where
    - N_{eh_1}: events per bin where electron and trigger hadron are reconstructed.
    - $N_{eh_1h_2}$: events per bin where electron and trigger hadron and associated hadron are reconstructed.

Dipion pair mass: Very little contribution from



References

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