π^0-Charged Particle Correlations at $2.5 < \eta < 4.0$ from $p^{\uparrow}+p$ Collisions at $\sqrt{s} = 200$ GeV

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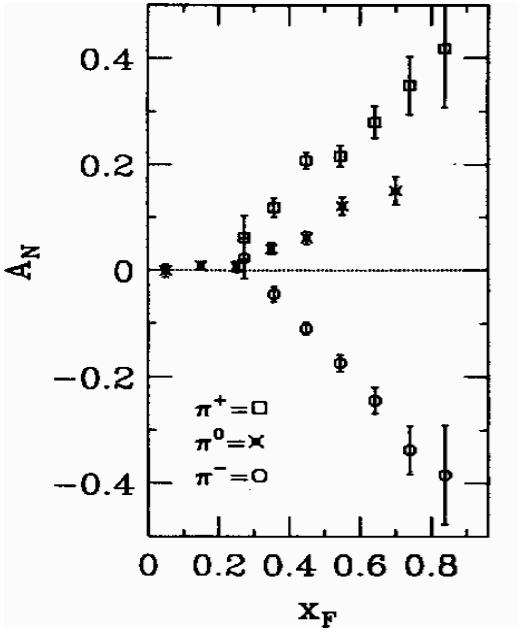
For the STAR collaboration

OUTLINE

- Background
- Event Description
- Spin-effects
- Summary

Setting the Stage: Inclusive Asymmetries



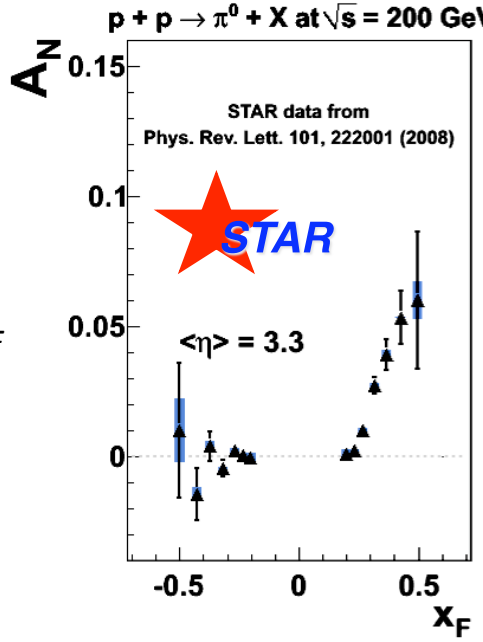
E704 showed *large* A_N for large x_F pion production at $\sqrt{s} \approx 20$ GeV.

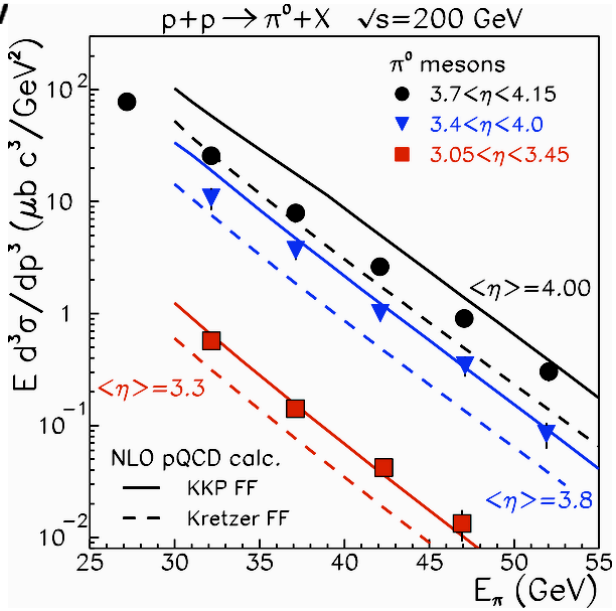
Observed cross-sections *large* compared to pQCD predictions

Phys. Lett. B 261, 201; 264, 462 (1991)

Eur. Phys. Journ. C36, 371 (2004)

STAR observed *large* A_N for $\sqrt{s}$ = 200 GeV $p^{\uparrow}+p \rightarrow \pi^0+X$ at forward angles in region where the pQCD cross-section provides a ***reasonable description of the data***

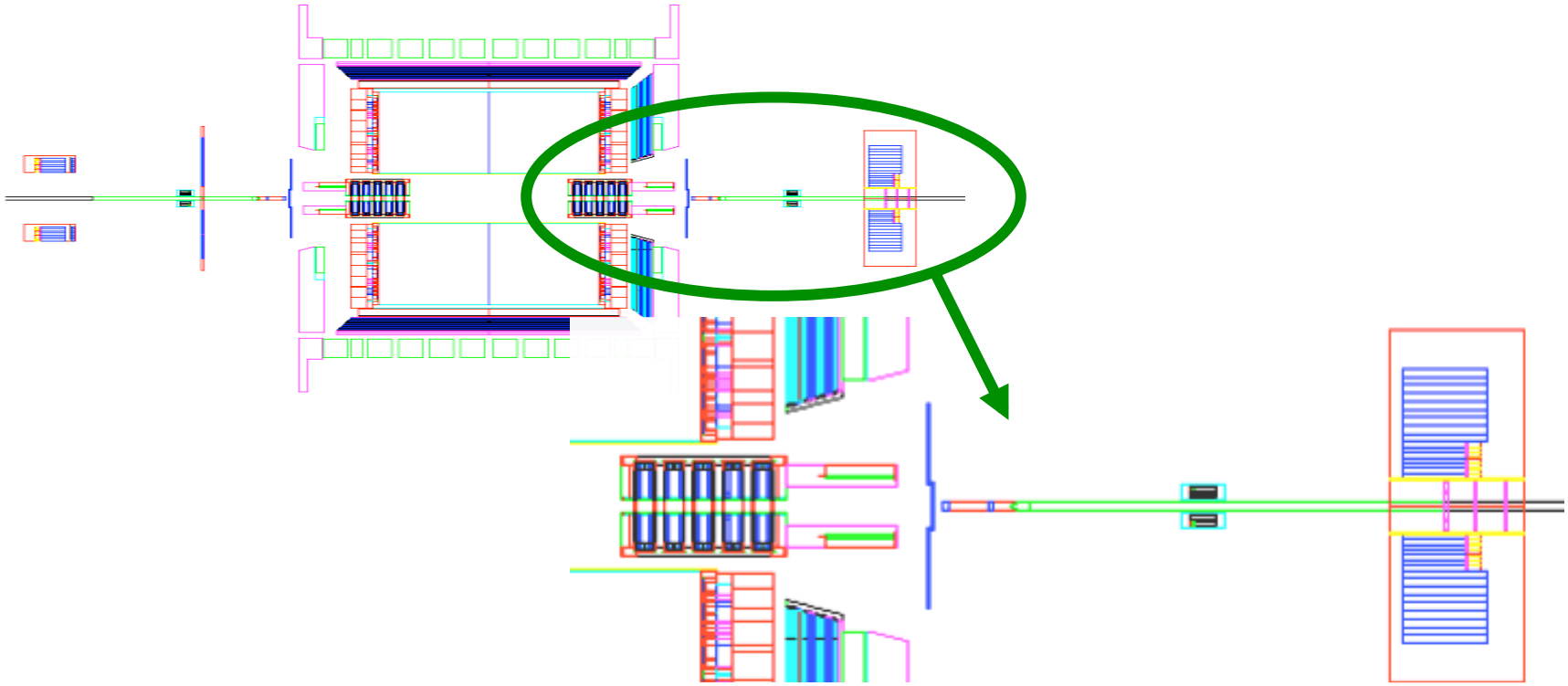




Phys. Rev. Lett. **97**, *152302 (2006)*

To discriminate between dynamical contributions we need to go beyond π^0 detection. This talk focuses on ***correlations***

Separating Dynamical Contributions

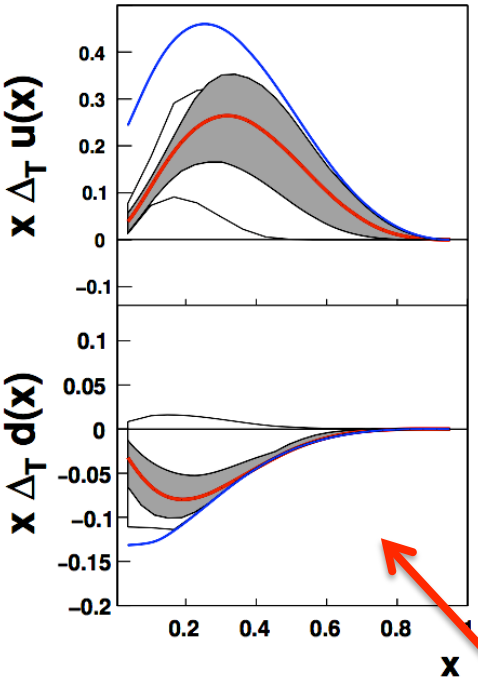


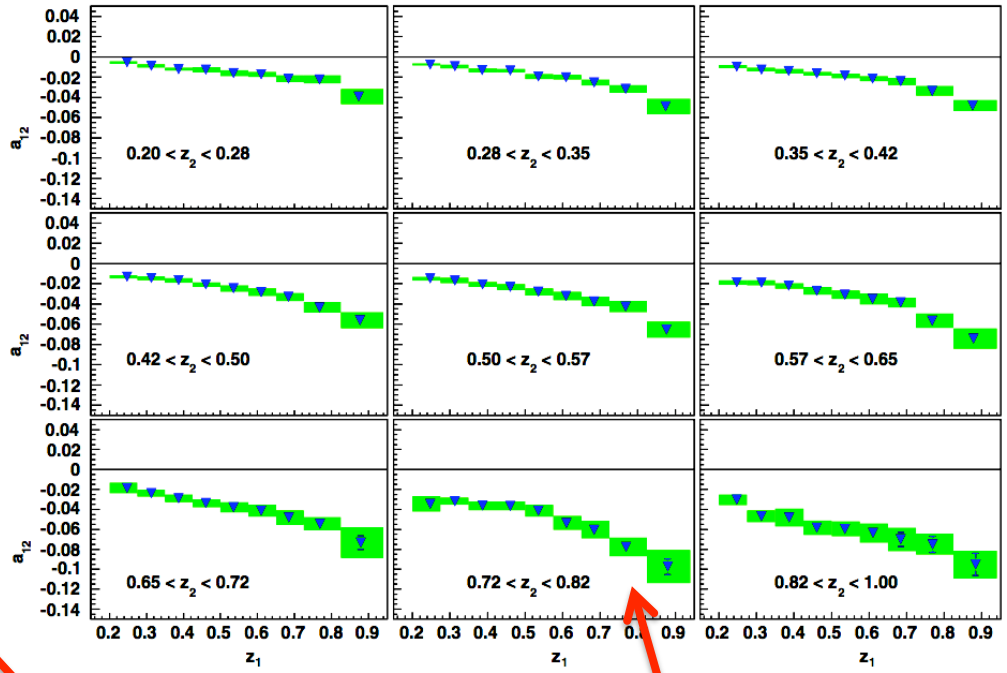
***FTPC*: charged particle tracks** ***FMS*: energy deposition**

FMS and FTPC subtend $2.5 < \eta < 4.0$

Look at ***Interference Fragmentation Functions (IFF)*** and ***Sivers*** measurements for forward π^0-h^+ and π^0-h^- pairs ***in a region with large inclusive π^0 asymmetries***

Expectations for IFF Asymmetry





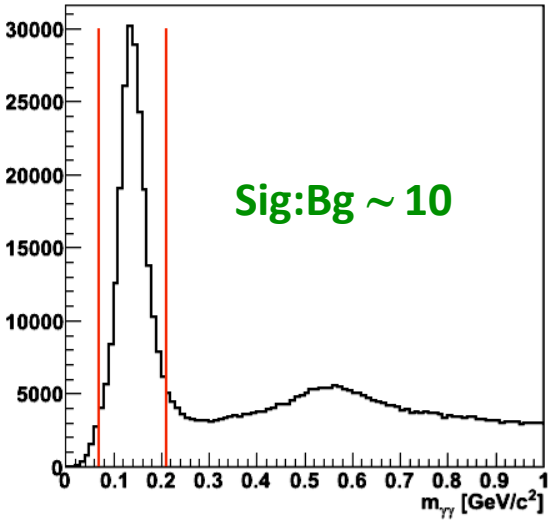
Anselmino et al., Nucl. Phys. B Proc. Suppl. 191, 98 (2009)

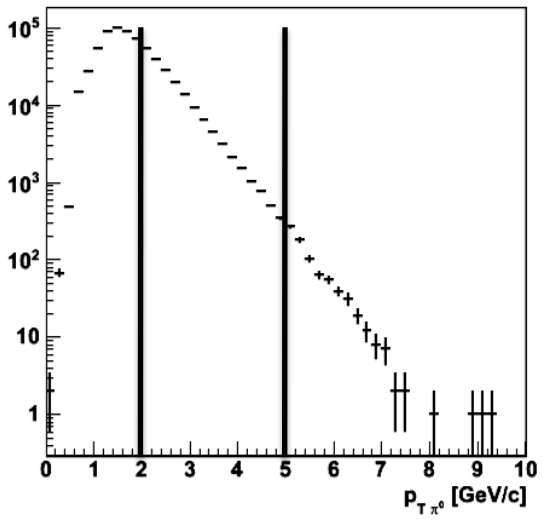
Vossen et al., Phys. Rev. Lett. ***107****, 072004 (2011)*

$$A_N \sim f_1(x_a)\, h_1(x_b)\, \frac{d\Delta\hat{\sigma}_{ab^\uparrow \to c^\uparrow d}}{d\hat{t}}\, H_1^{\angle c}$$

- Considering BELLE IFF measurements for π^+-π^-, not π^0-$\pi^\pm$
- Expected IFF effect for π^0-π^+: ≈15%
- Expected IFF effect for π^0-π^-: ≈-7%

π^0 and Charged Particle Distributions

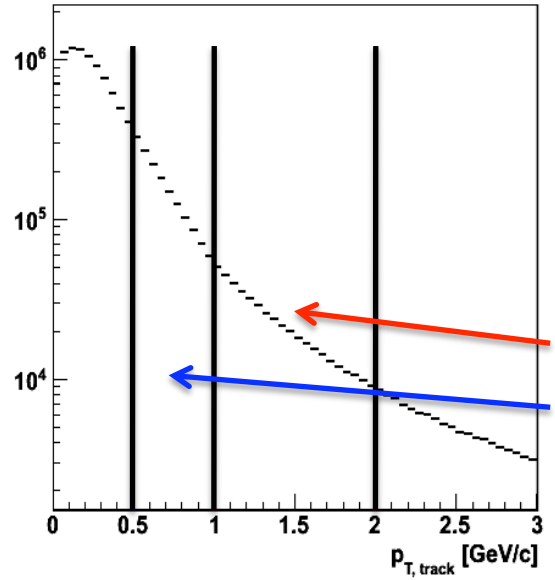




π^0 requirements:

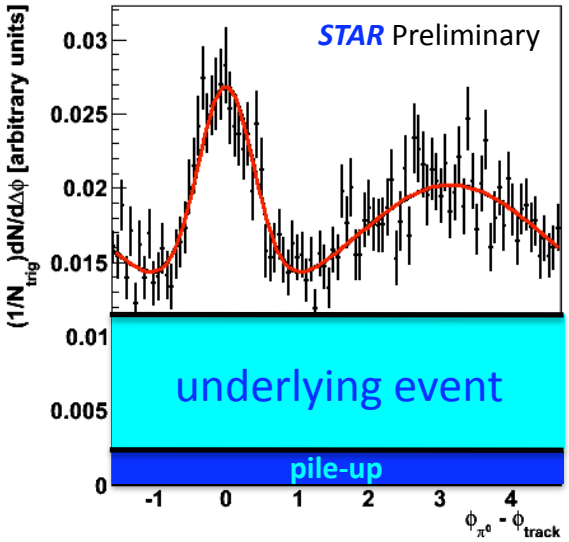
- Satisfy trigger
- $0.07 < m_{\gamma\gamma} < 0.21$ GeV/c^2
- $z_{\gamma\gamma} = |\Delta E_{1,2}|/\Sigma E_{1,2} < 0.80$
- **$2.0 < p_T < 5.0$ GeV/c**

Raw Spectra

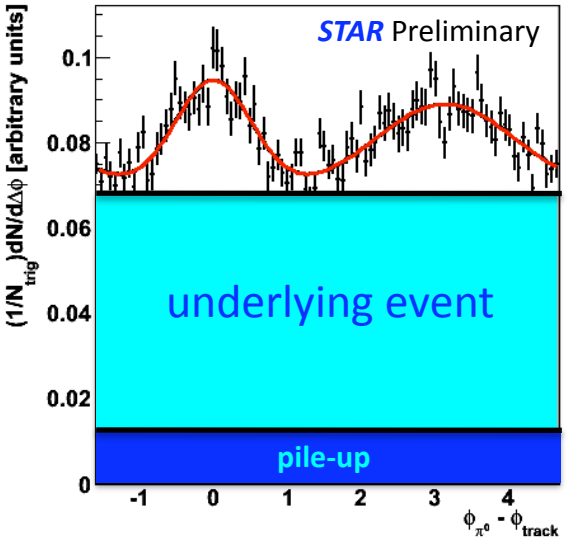


- Track quality
- **Pile-up Reduction:** Distance of closest approach (DCA) to collision vertex restriction
- **$1.0 < p_{T,\,ch} < 2$ GeV/c**
- **$0.5 < p_{T,\,ch} < 1$ GeV/c**

π^0-Charged-Particle Correlations

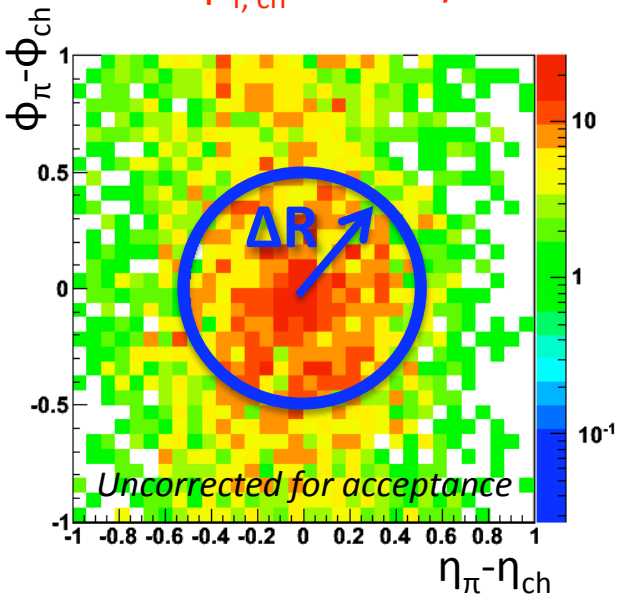


$1 < p_{T,\,ch} < 2$ GeV/c



$0.5 < p_{T,\,ch} < 1$ GeV/c

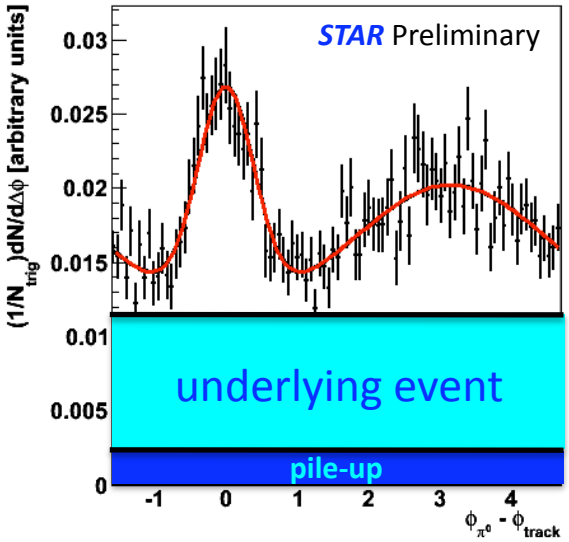
19% pile-up component of continuum determined from luminosity dependence



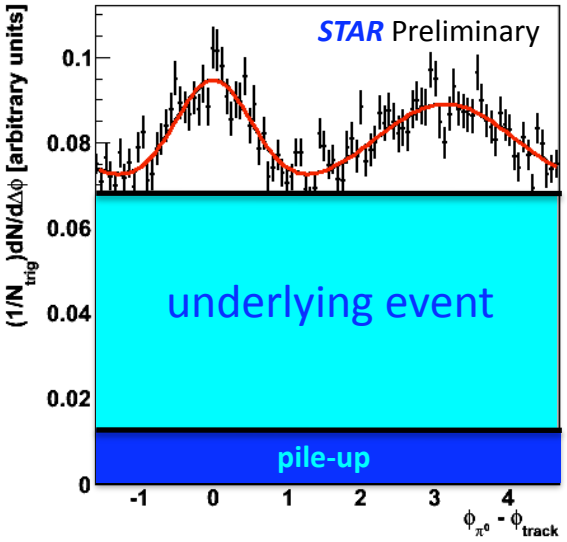
Events are required to satisfy cut on

$\Delta R = \sqrt{(\eta_\pi - \eta_{ch})^2 + (\phi_\pi - \phi_{ch})^2}$

π^0-Charged-Particle Correlations



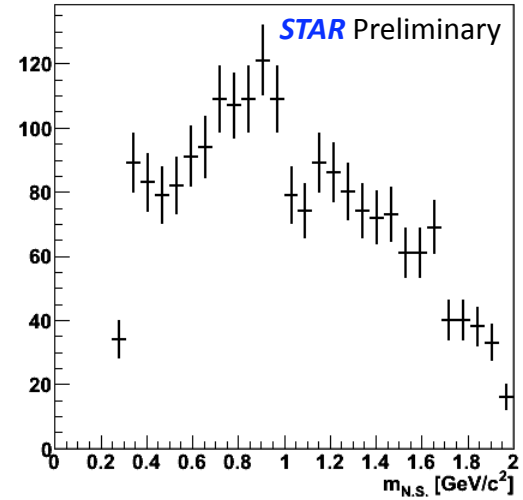
$1 < p_{T,\,ch} < 2$ GeV/c



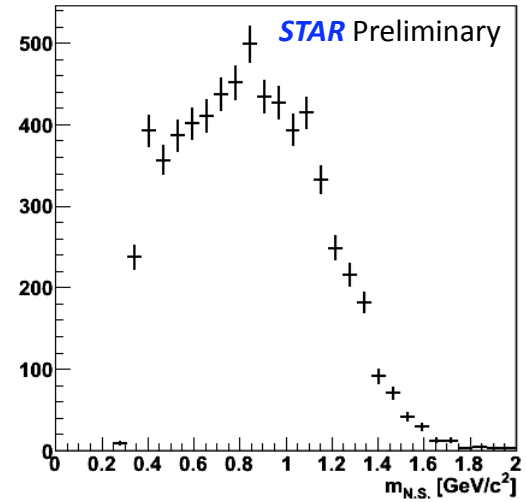
$0.5 < p_{T,\,ch} < 1$ GeV/c

19% pile-up component of continuum determined from luminosity dependence

charge > 0

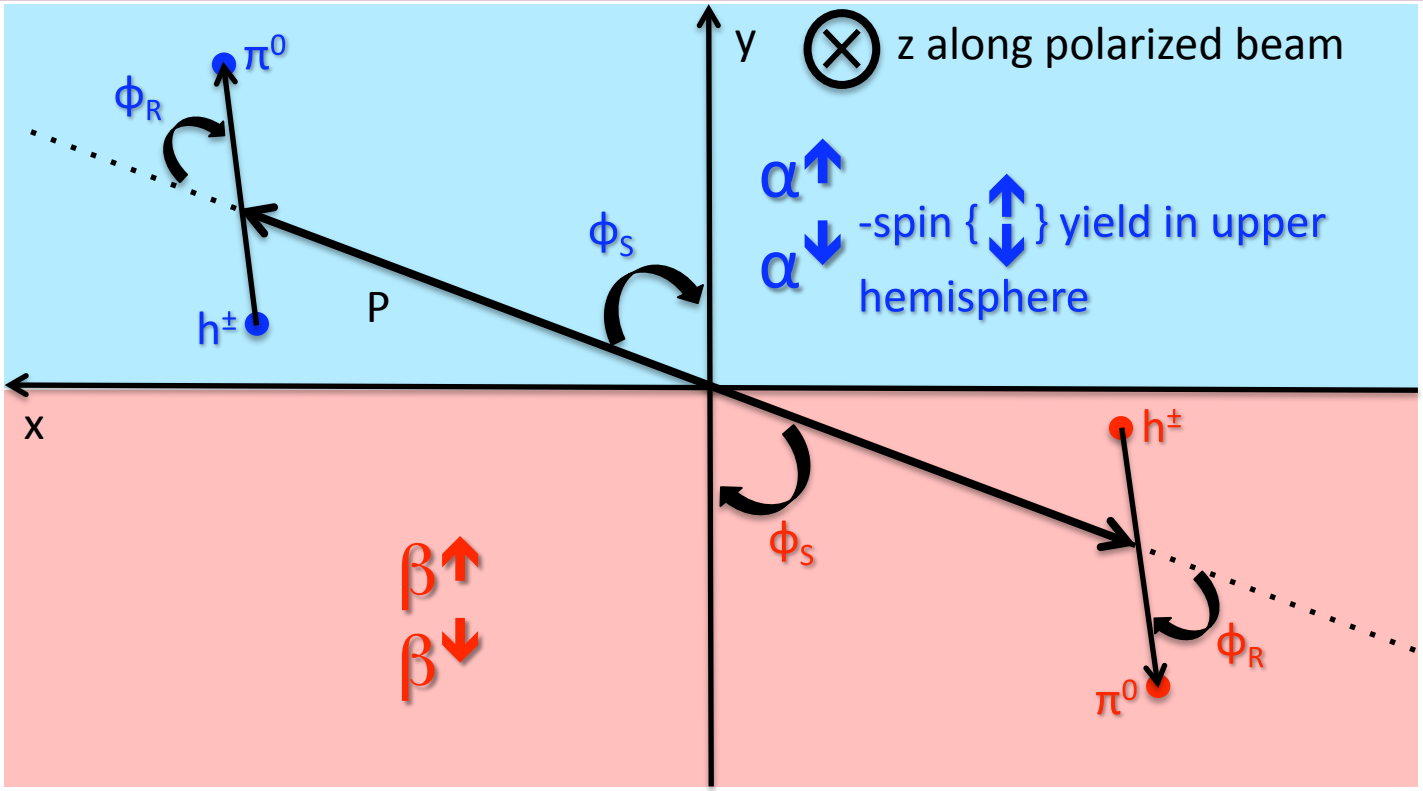


charge < 0



- Near-side invariant mass for $\Delta R_{max} = \pi/3$ shows signal for ρ
- Events are not dominated by ρ-production suggesting sensitivity to "jet-like" events

Definitions

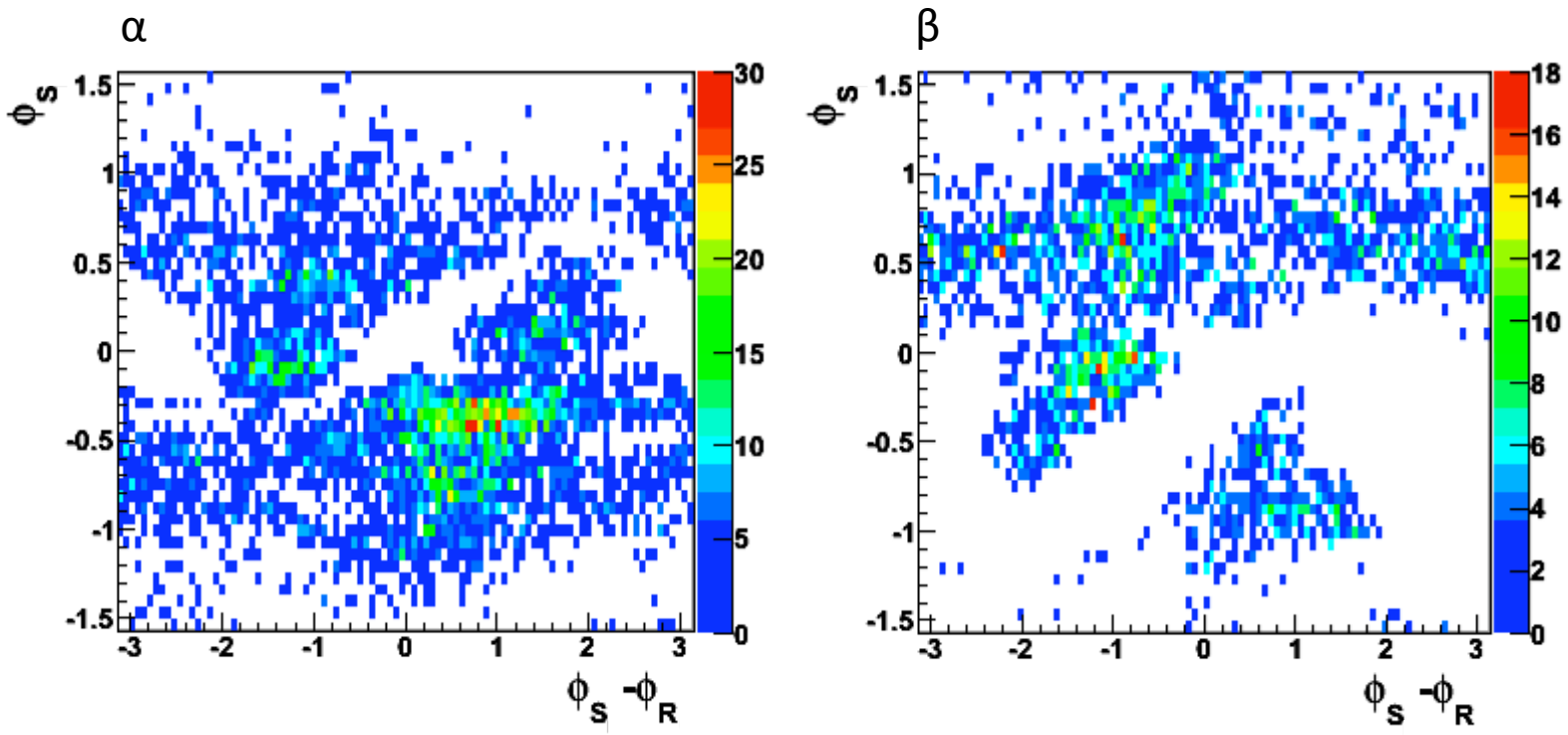


α and β yields are functions of $\{ \begin{matrix} \Delta\phi = \phi_S - \phi_R \\ \phi_S \end{matrix} \}$ integrated over $\{ \begin{matrix} \phi_S \\ \Delta\phi \end{matrix} \}$

$$\text{Cross-ratio} = \frac{\sqrt{\alpha^\uparrow\beta^\downarrow} - \sqrt{\alpha^\downarrow\beta^\uparrow}}{\sqrt{\alpha^\uparrow\beta^\downarrow} + \sqrt{\alpha^\downarrow\beta^\uparrow}}$$

For uniform acceptance, cross-ratio$\{ \begin{matrix} \Delta\phi \\ \phi_S \end{matrix} \} = \{ \begin{matrix} A_{IFF}\sin\Delta\phi \\ A_{sivers}\sin\phi_S \end{matrix} \}$

Non-Uniform Acceptance

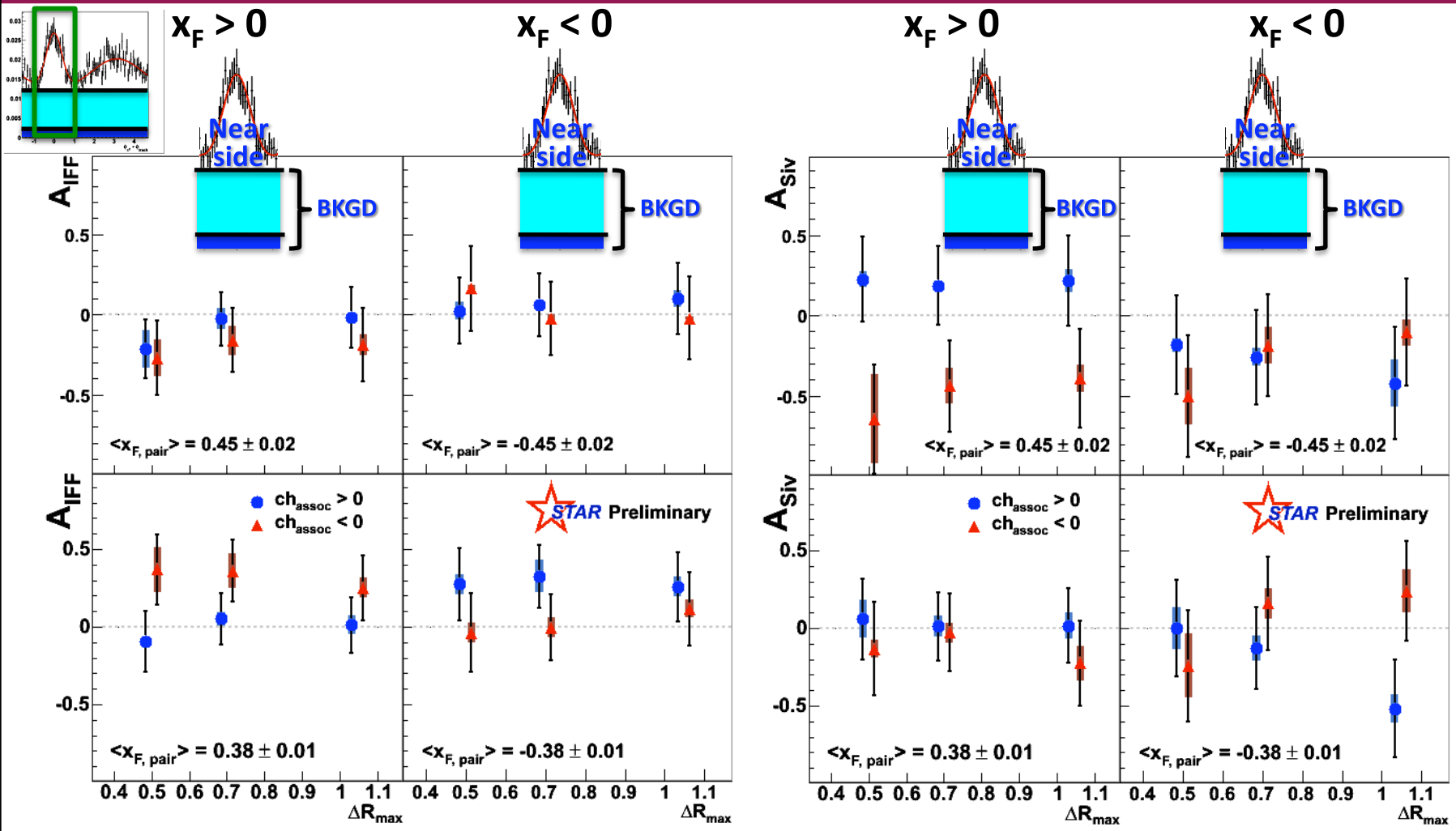


Non-uniform acceptance allows IFF and Sivers effects to mix

One can measure "leak through" from

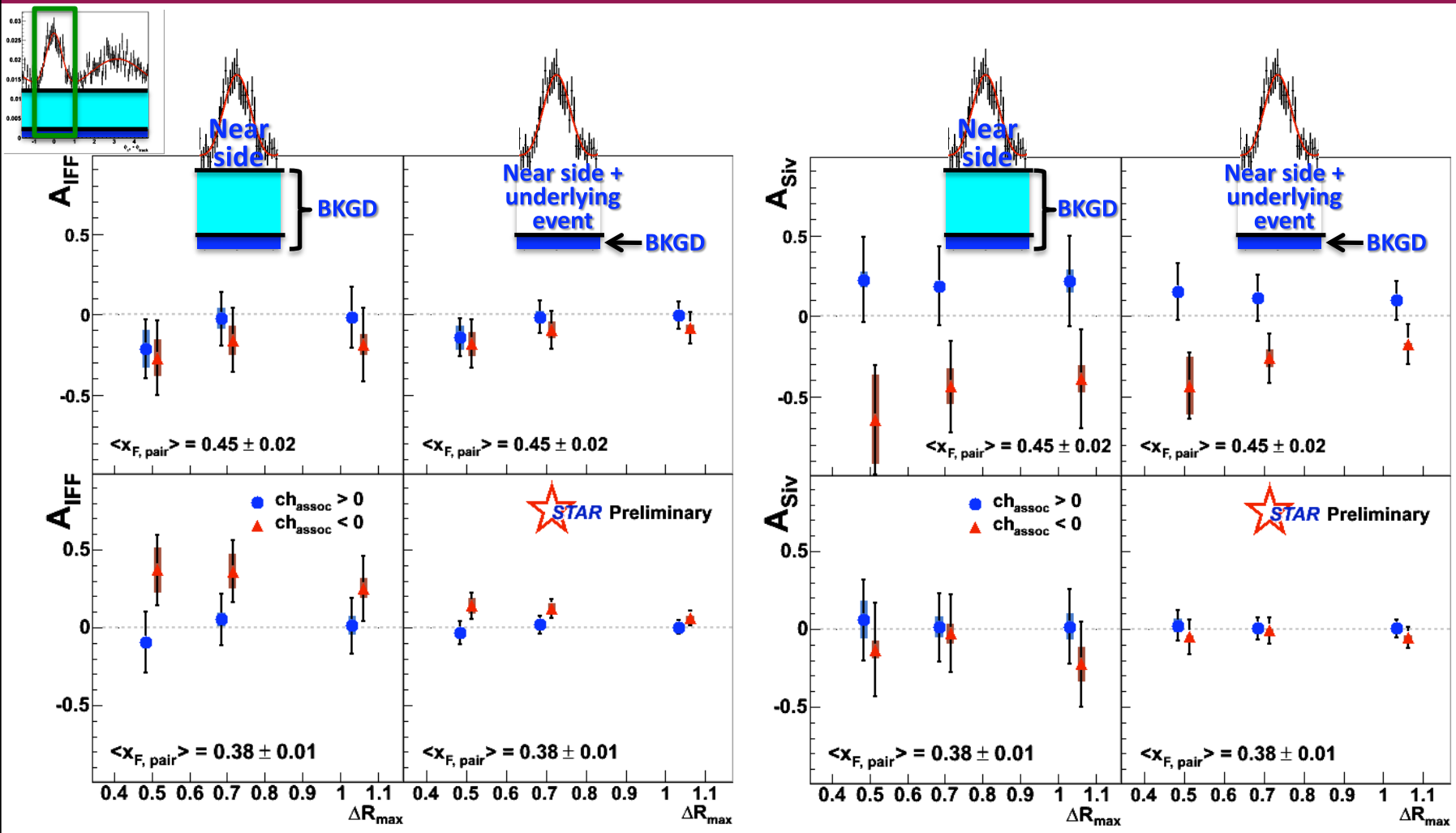
unpolarized yields and an *event-weighting technique*

IFF and Sivers Asymmetries



Asymmetries corrected for pile-up and underlying-event background:
Sivers pile-up correction includes inclusive pion asymmetry
No asymmetry assumed for underlying-event background
Systematics (shaded boxes) account for reconstruction, background correction, and yield fractions

IFF and Sivers Asymmetries



Asymmetries seem less sensitive to pair radius after correcting for continuum dilution, but ***limited statistics*** preclude a firm conclusion.

Summary

- Forward di-hadron transverse single-spin asymmetries from $p^{\uparrow}+p$ at $\sqrt{s}$ = 200 GeV calculated
- Data are statistics-limited, making conclusions difficult
- Further investigation at STAR depends on forward tracking upgrade