BROOKHAVEN NATIONAL LABORATORY

Transverse Single Spin Asymmetries And Cross-sections for Forward π^0 And η Mesons at STAR

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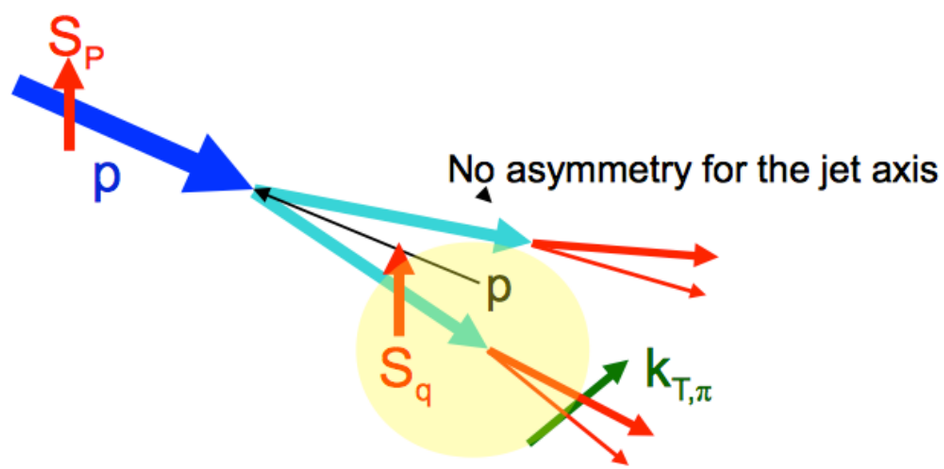
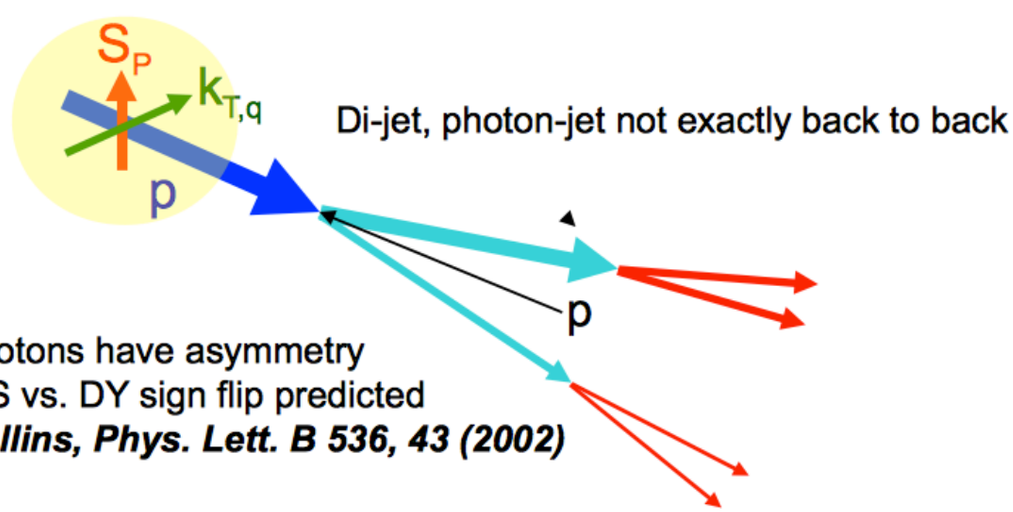
Transverse Single Spin Asymmetry

• **Collins effect**: asymmetry comes from the transversity and the spin dependence of jet fragmentation.

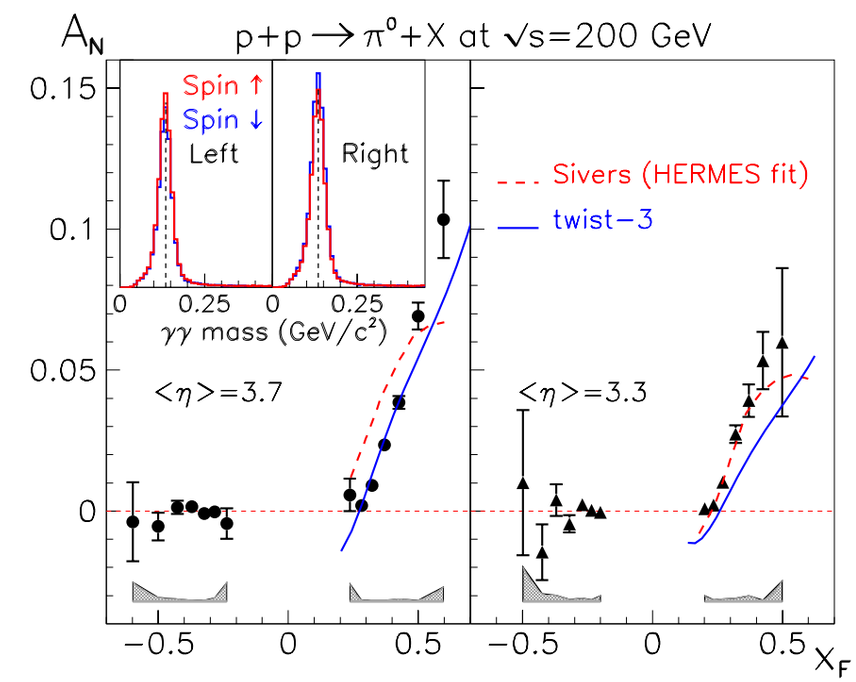


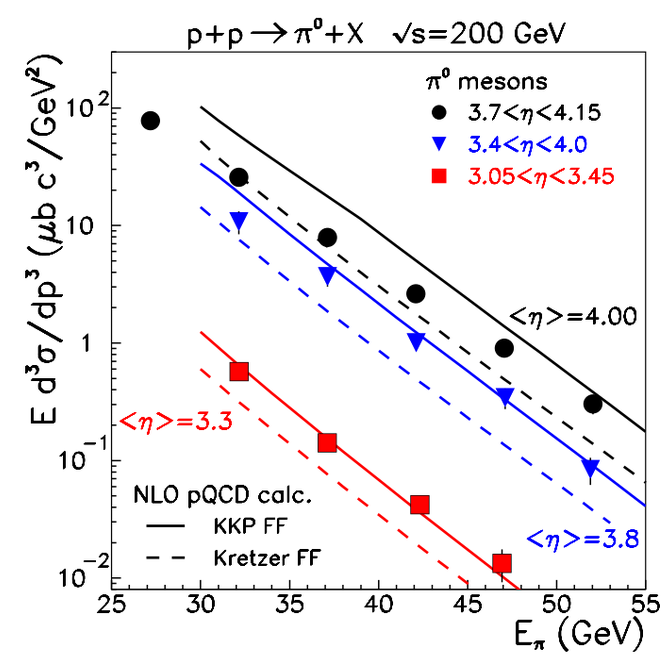
• **Sivers effect**: asymmetry comes from spin-correlated k_T in the initial parton distribution



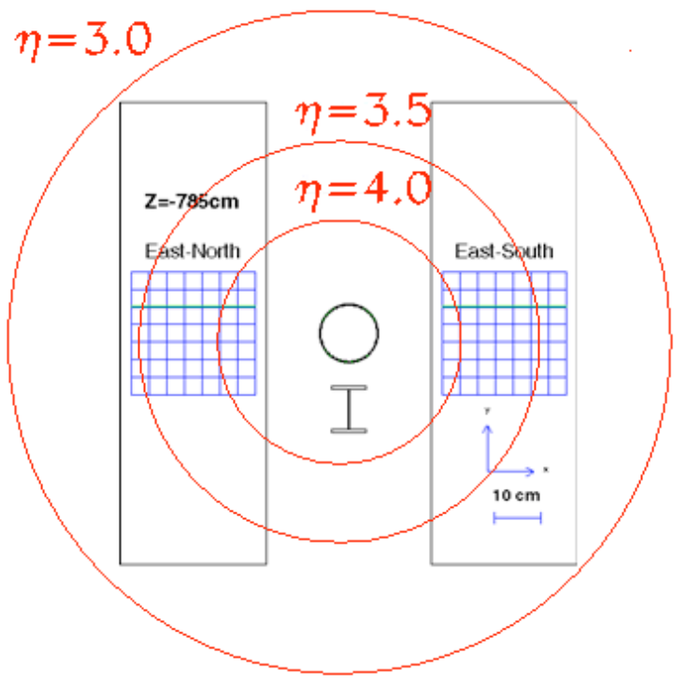
Photons have asymmetry
DIS vs. DY sign flip predicted
Collins, Phys. Lett. B 536, 43 (2002)

Previous STAR Measurement shows that π^0 asymmetry is large in the region where the production cross-section is reasonably well described by NLO pQCD prediction, up to x_F of ~0.5.



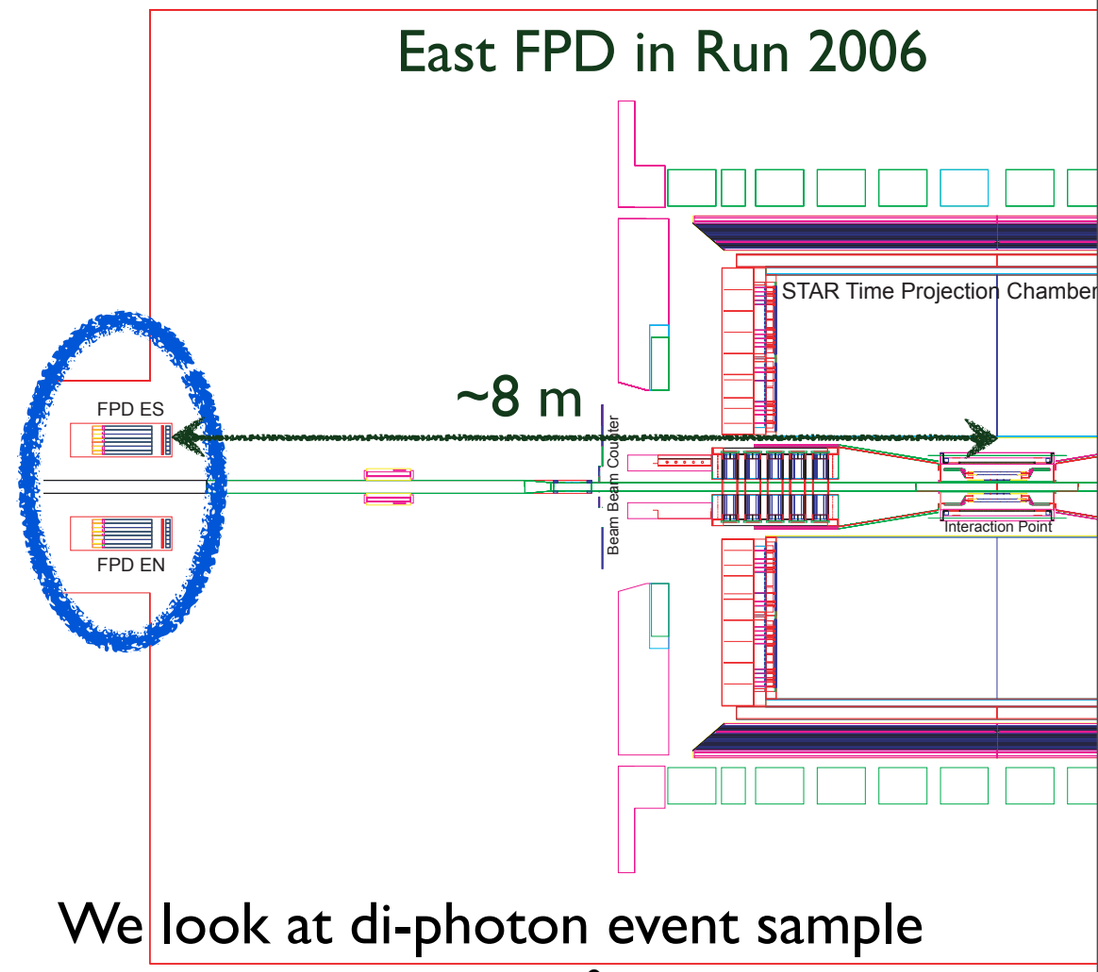


STAR Forward Pion Detector (FPD)

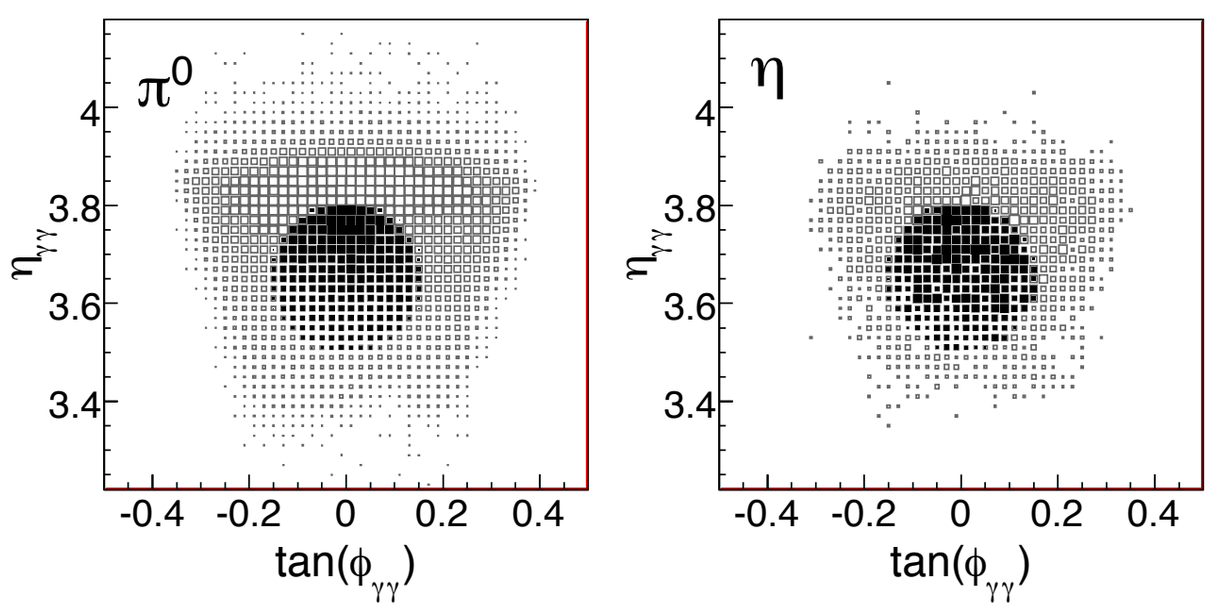


STAR FPD is a Pb-glass calorimeter in the very forward region of the STAR.

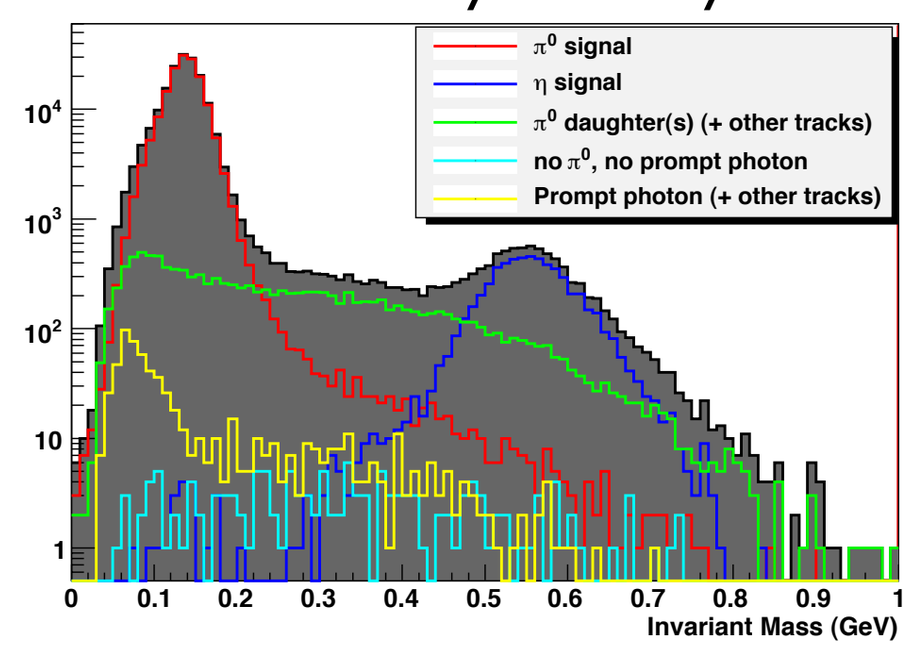
Each of the main modules, placed on either side of the beam line, consists of 49 Pb-glass cells, forming a 7X7 array.



For this analysis, we employed the "Center Cut", defined by $(\eta_{\gamma\gamma}-3.65)^2 + \Phi_{\gamma\gamma}^2 < 0.15$.



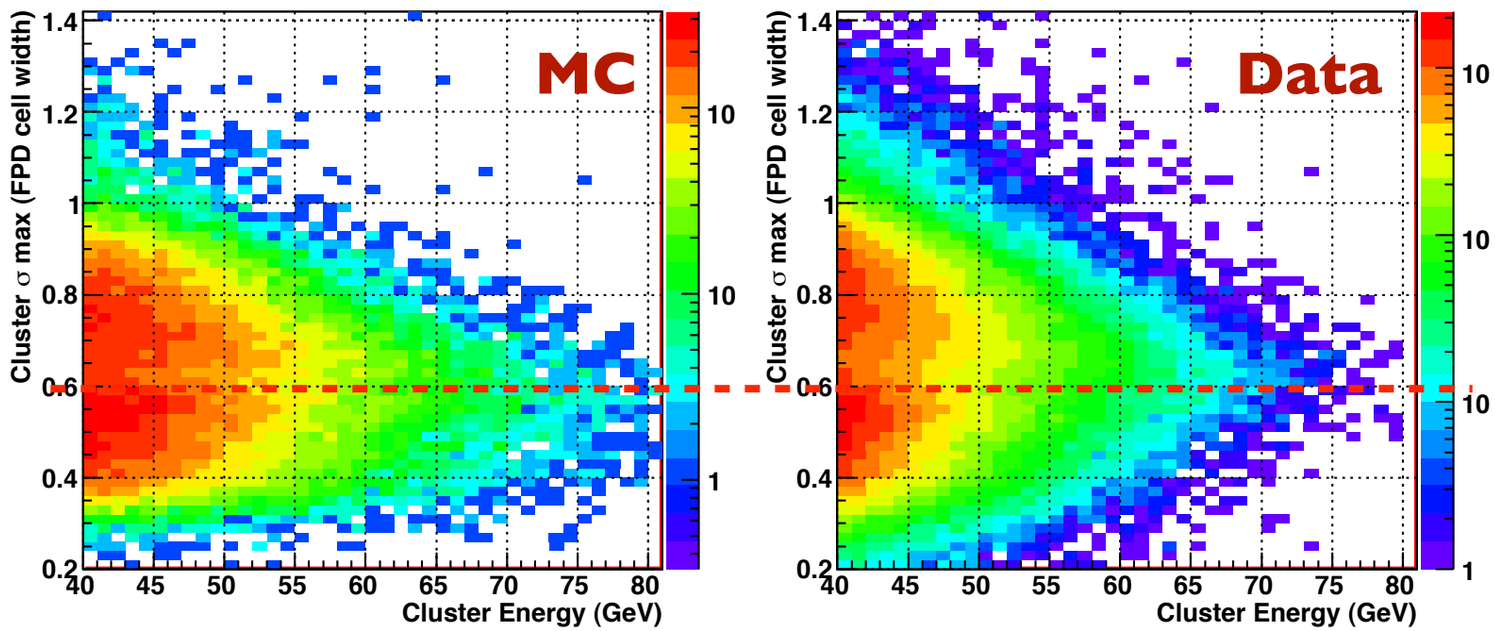
We look at di-photon event sample dominated by π^0 decays.



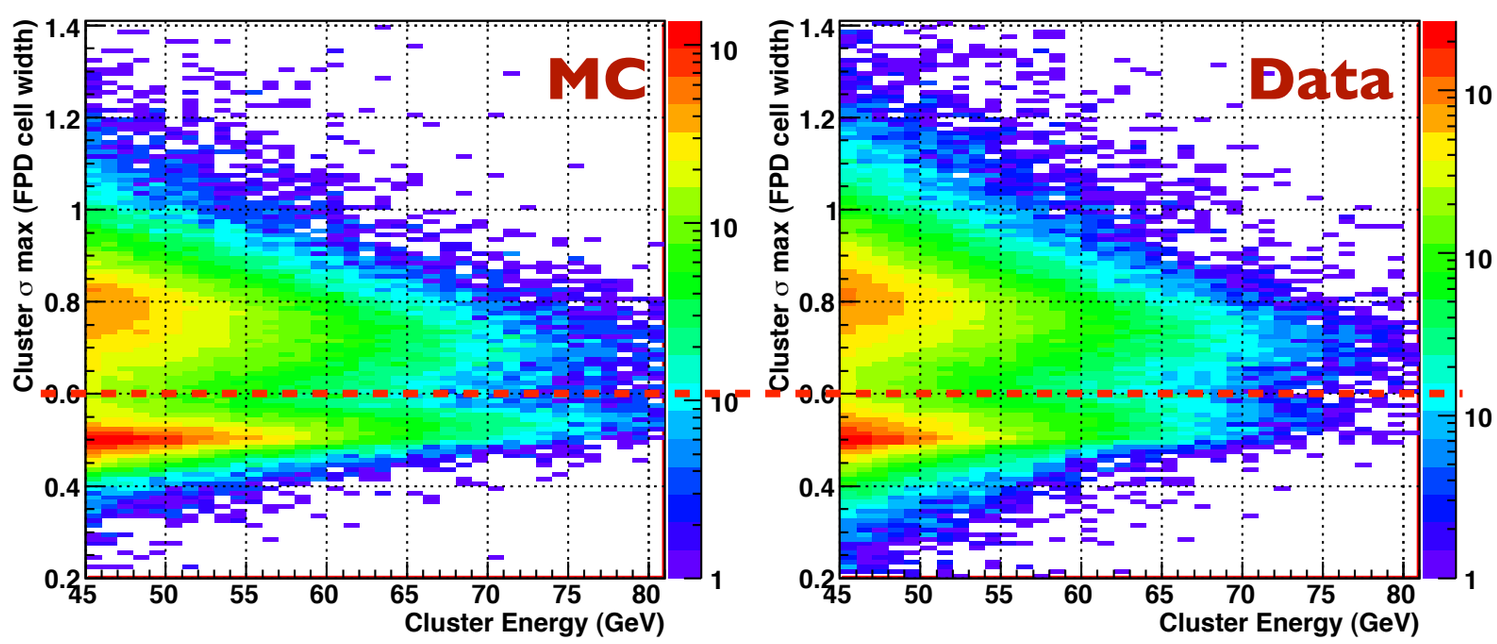
π^0 - γ Separation at high x_F

The separation between merged π^0 clusters and single photons is primarily achieved through studying the second moment of clusters vs. cluster energy.
Previously, the weighting function was simply the energy deposited in a cell.
Using logarithm of energy instead improves the separation at high x_F significantly.

OLD
Linear E



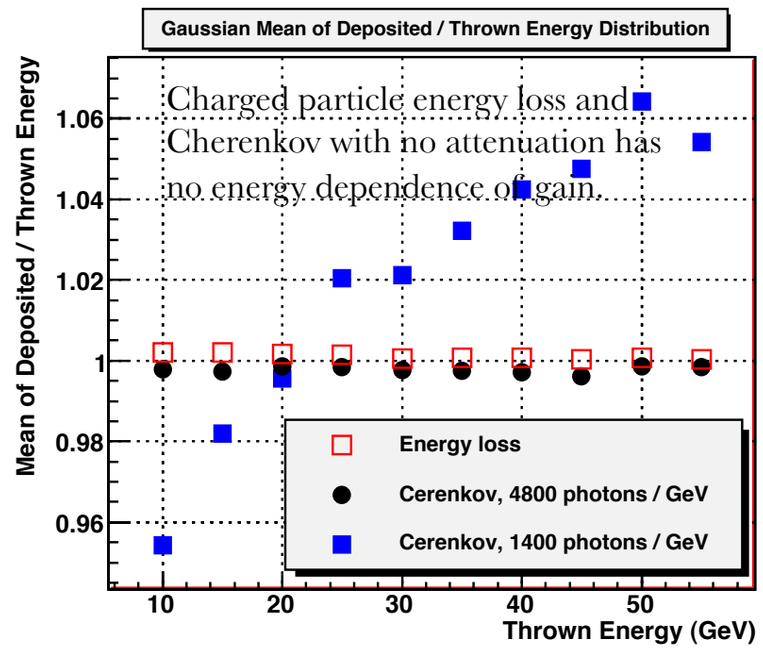
NEW
Log of E



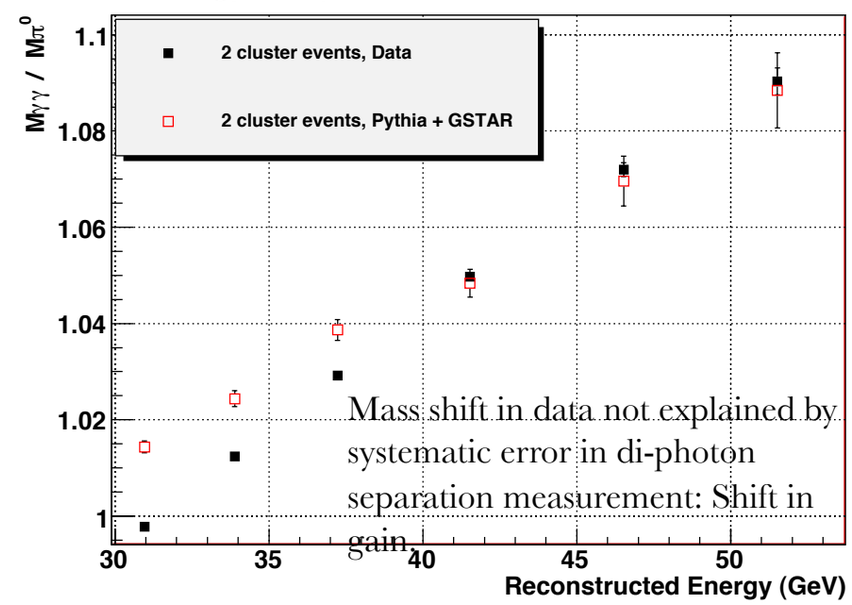
EM-Shower Modeling

Study of di-photon mass vs. E indicates that the gain increases with photon energy.

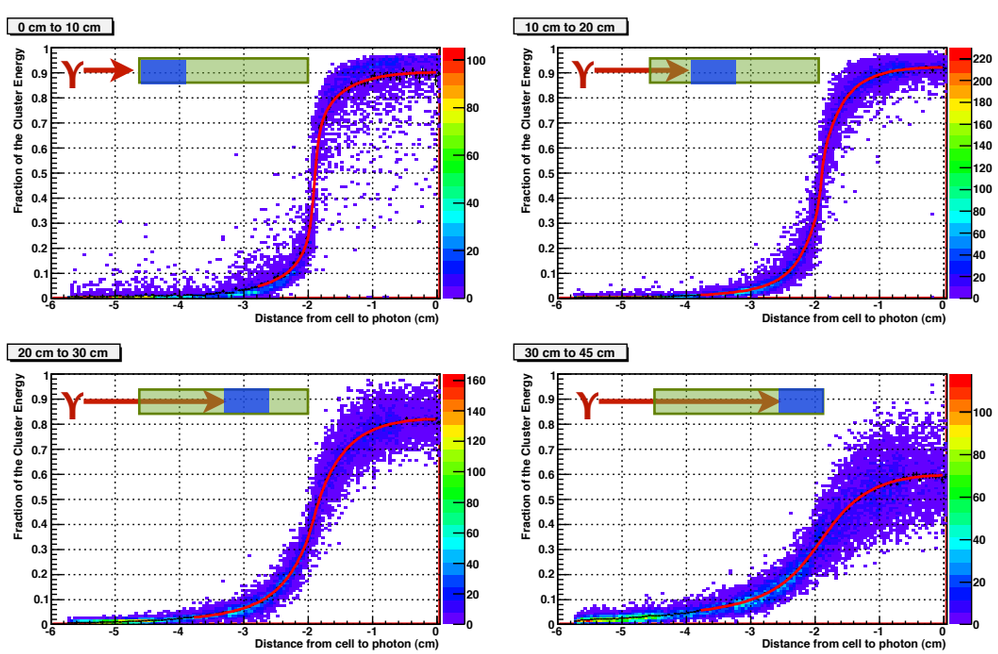
Cherenkov effect + attenuation of optical photons reproduces the observed mass shift vs. E.

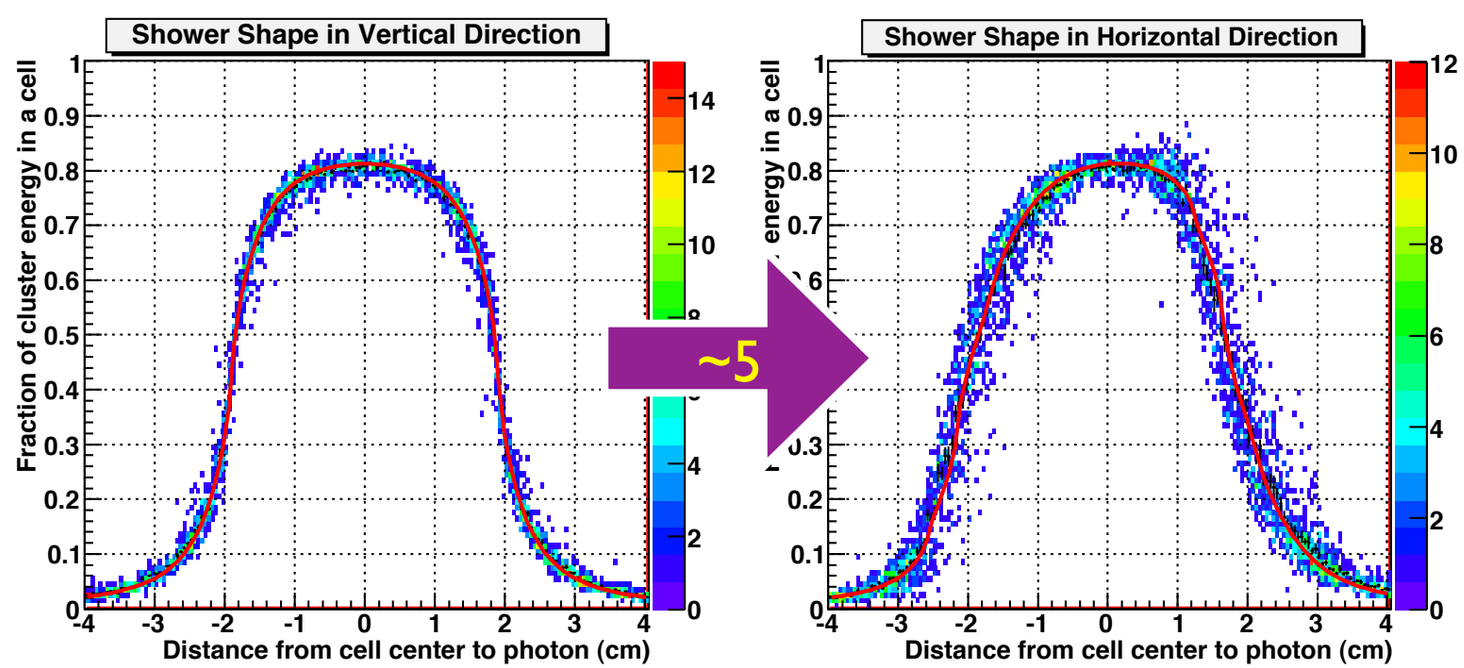


Energy Dependence of Invariant Mass



Incident angle (~5°) effect alters the shower shape. Superposition of 4 shower functions corresponding to 4 "z-slices" approximates the deformation.

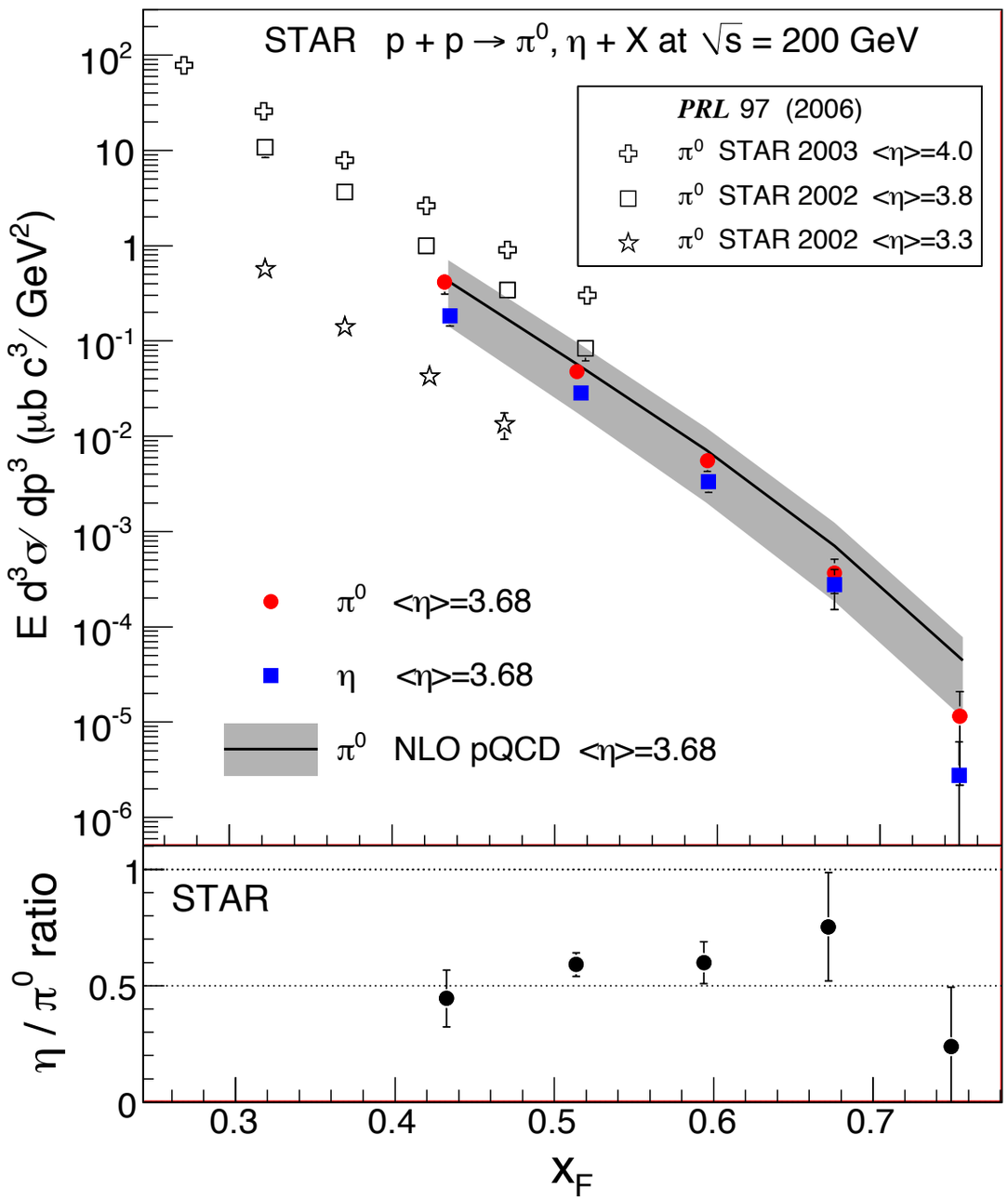




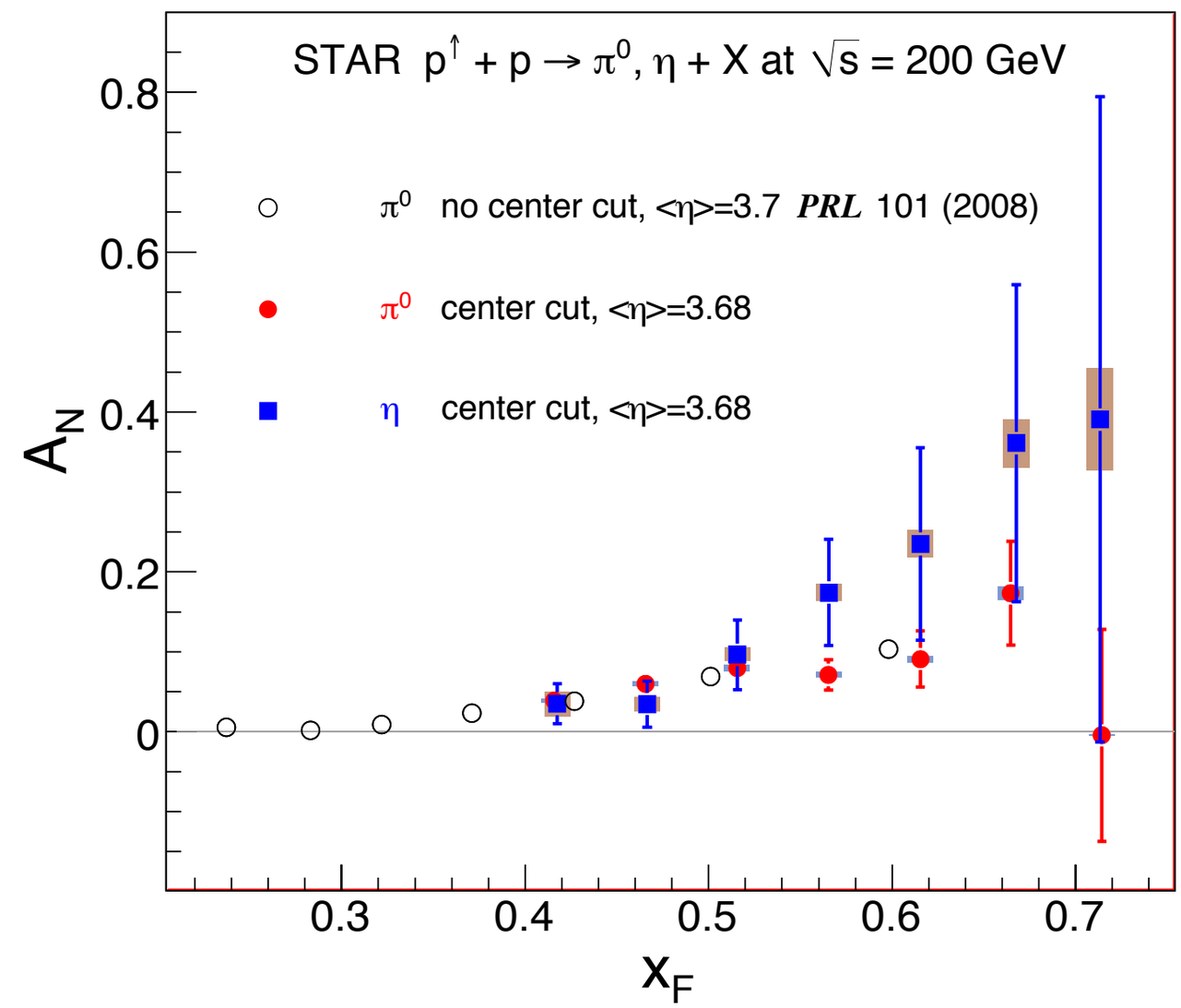
Physics Results

arXiv:1205.6826, recently submitted to PRD RC

Cross-sections for π^0 and η are consistent with expectations.



Transverse spin asymmetry for η is 2.2 sigma larger than that of the π^0 for $x_F > 0.55$



Summary

Transverse single spin asymmetry at RHIC, measured by STAR, PHENIX, and BRAHMS, provides a useful avenue to test the current understanding of the pQCD.

STAR has measured both the cross-section and the asymmetry of forward neutral pions up to x_F of 0.5. Cross-section is an important complimentary measurement that enables us to understand the spin measurement within the framework of pQCD.

We have made a number of improvements in analysis techniques to extend the xF reach of both cross-section and asymmetry measurements up to x_F of 0.75.

In addition to π^0, we also measured η-meson cross-section and asymmetry.

We find that the cross-sections are consistent with expectations based on pQCD + global fragmentation analysis.

The transverse spin asymmetry for the η is 2.2 standard deviation larger than that for the π^0.