PHENIX

Azimuthal anisotropy of high p_T hadrons via long-range two particle correlations in *d*+Au and *p*+*p* collisions by PHENIX

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Brett Fadem for the PHENIX Collaboration

Muhlenberg

I. Introduction

We present measurements of two-particle angular correlations between high-transverse-momentum ($2 < p_T < 11$ GeV/c) π^0 particles observed at midrapidity ($|\eta| < 0.35$) and particles produced either at forward ($3.1 < \eta < 3.9$) or backward ($-3.7 < \eta < -3.1$) rapidity in *d*+Au and *p*+*p* collisions at $\sqrt{s_{NN}} = 200$ GeV.

Azimuthal anisotropies reflect:

- Spatial anisotropies in initial geometry
- Hydrodynamic-like behavior in subsequent evolution of the medium

Those with a large rapidity gap reflect help isolate the true flow contribution

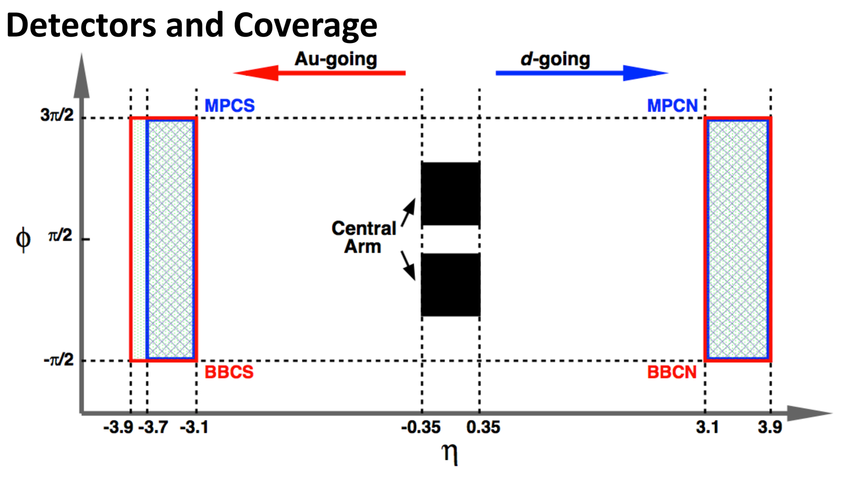
Azimuthal angle distribution of two particles A and B correlated to a reaction plane

$$\frac{dN^A}{d\phi^A} \propto 1+\sum_n 2v_n^A\cos(n(\phi^A-\Psi_n))$$
$$\frac{dN^B}{d\phi^B} \propto 1+\sum_n 2v_n^B\cos(n(\phi^B-\Psi_n))$$

Here, we report measurements of the c_n coefficients defined below

$$\frac{dN^{AB}}{d\phi^{AB}} \propto 1+\sum_n 2v_n^A v_n^B\cos(n(\phi^A-\phi^B))$$
$$\equiv 1+\sum_n 2c_n\cos(n(\phi^A-\phi^B))$$

Detectors and Coverage

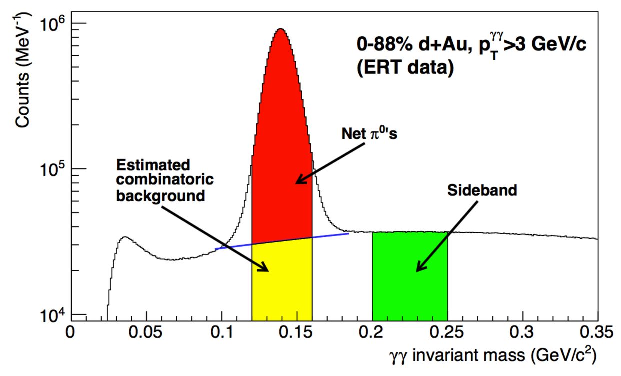


Forward/Backward Detectors:
Beam-Beam Counters (BBC)
BBC North (BBCN)
BBC South (BBCS)
Muon Piston Calorimeters (MPC)
MPC North (MPCN)
MPC South (MPCS)

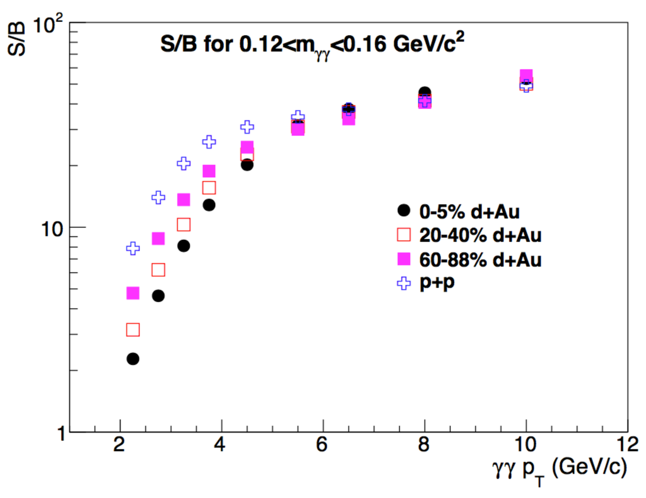
Central Arm Detector:
Electromagnetic Calorimeter (EMCal)

II. Analysis

High p_T π^0s in Central Arm EMCal



Invariant mass distribution for γγ pairs from *d*+Au collisions as measured in the PHENIX central arm EMCal



Centrality and γγ p_T dependence of the signal to combinatoric background ratio (S/B) for pairs in the $0.12 < m_{\gamma\gamma} < 0.16$ GeV/c² mass window

Correlations with MPC Hits

Initial Correlation functions: $S(\Delta\phi, p_T) = \dfrac{d(w_{\text{tower}} N^{\gamma\gamma(p_T)-\text{tower}}_{\text{Same event}})}{d\Delta\phi}$

where

$$w_{\text{tower}} = E_{\text{dep}}\sin(\theta_{\text{tower}})$$
$$\Delta\phi = \phi_{\gamma\gamma} - \phi_{\text{tower}}$$

But *S* is affected by detector acceptance, inefficiencies, and kinematic cuts

Create a mixed event (γγ pairs from one event, but MPC towers from another) : $M(\Delta\phi, p_T)$

Correct for instrumental effects: $C^X(\Delta\phi, p_T) = \dfrac{S^X(\Delta\phi, p_T)}{M^X(\Delta\phi, p_T)}\dfrac{\int M^X(\Delta\phi, p_T)\,d\Delta\phi}{\int S^X(\Delta\phi, p_T)d\Delta\phi}$

Further correct for background γγ pairs by using the above correlation function, but employ the sideband pairs indicated in green above. This produces a background correlation function. So there are now two corrected correlation functions:

$C^{S+B}(\Delta\phi, p_T)$ and $C^B(\Delta\phi, p_T)$

The formula for the true π^0 – MPC correlation function is, then

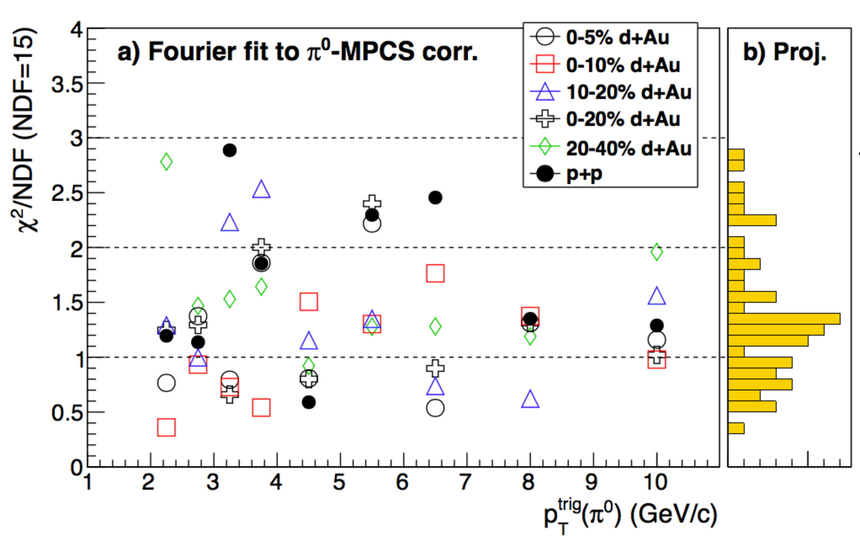
$$C(\Delta\phi, p_T) = \left(1+\frac{B}{S}\right)C^{S+B}(\Delta\phi, p_T) - \frac{B}{S}C^B(\Delta\phi, p_T) \longleftarrow$$

But, in practice, this correction is only a few percent for the lowest S/B cases

Harmonic expansion fitting

$$C(\Delta\phi, p_T) = B_0\left(1+\sum_{n=1}^{4} 2\,c_n(p_T)\cos(n\Delta\phi)\right)$$

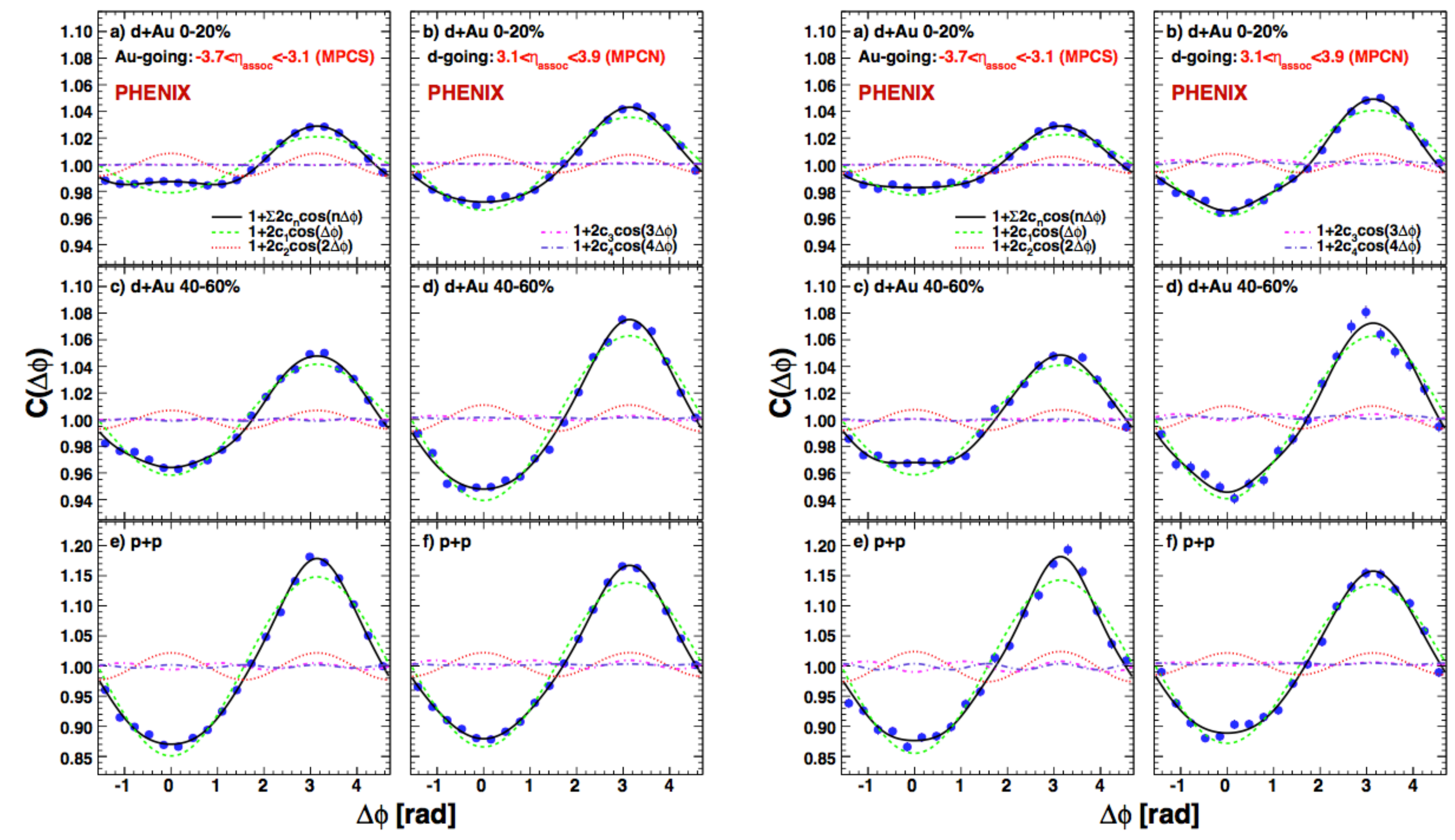
Goodness-of-fit parameter χ^2/NDF for the harmonic fits



Projection onto the y-axis

No particular structure seen with π^0 p_T or event class, and the distribution agrees with what would be expected for a χ^2 estimator

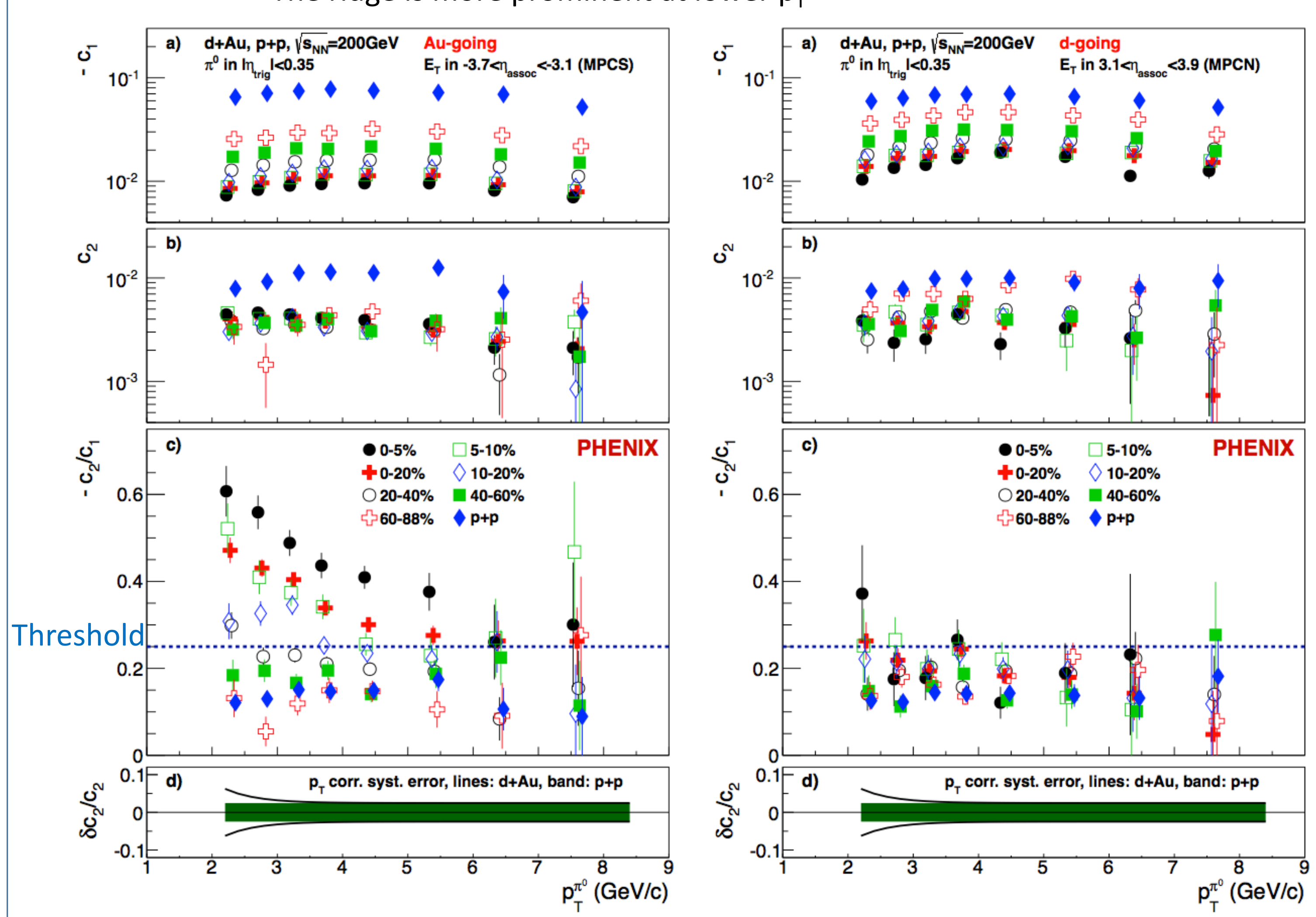
III. Results



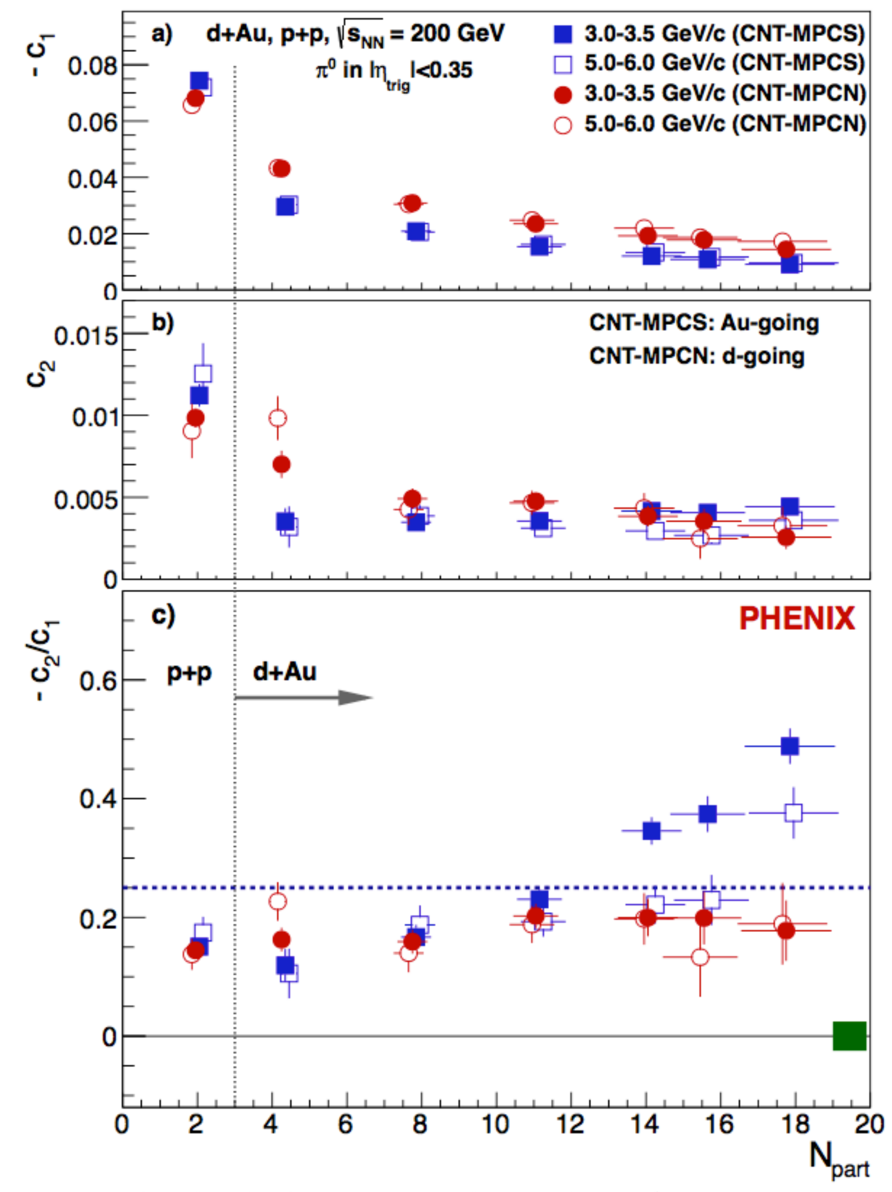
3 < p_T < 3.5 GeV/c　　5 < p_T < 6 GeV/c

Evolution of the Individual Fourier-components

- Correlation functions largely dominated by dipole (n=1) component
- Ridge structure apparent on Au-going side but not on *d*-going side and not in *p*+*p*
- The ridge is more prominent in the most central collisions
- The ridge is more prominent at lower p_T



- c_1 ordered by system size on both *d*-going and Au-going side
- The c_2 are small and decrease as a function of p_T; the quadrupole component is present
- Under the assumption that c_3 and c_4 are approximately zero
  - $-c_2/c_1$ > .25 for near side correlation with a local maximum
    - Au-going, more central, and lower p_T are above threshold
- $-c_2/c_1$ ordered by system size on Au-going side but not on *d*-going side
- No clear ordering of $-c_2/c_1$ on the *d*-going side



- $-c_1$ and c_2 both decrease with number of participants
- Ratio $-c_2/c_1$ goes above threshold for Au-going side above N_{part} ~ 13

IV. Summary

$-c_2/c_1$ values exhibit well-defined ordering with system centrality and decrease with increasing p_T in the Au-going direction, while the values are consistent over all systems and p_T in the *d*-going direction. This suggests that the ridge structure clearly exists in the Au-going direction, rather than the *d*-going direction, and ceases at high p_T in a fashion similar to hydrodynamical particle flow in A+A collisions.

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