TWO PARTICLE CORRELATION MEASUREMENTS AT PHENIX

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Contents

- Higher harmonic event plane and flow(v_n)
- Correlations with v_n subtractions
- Correlations relative to event plane
  - At high and intermediate p_T
- Summary

Motivations

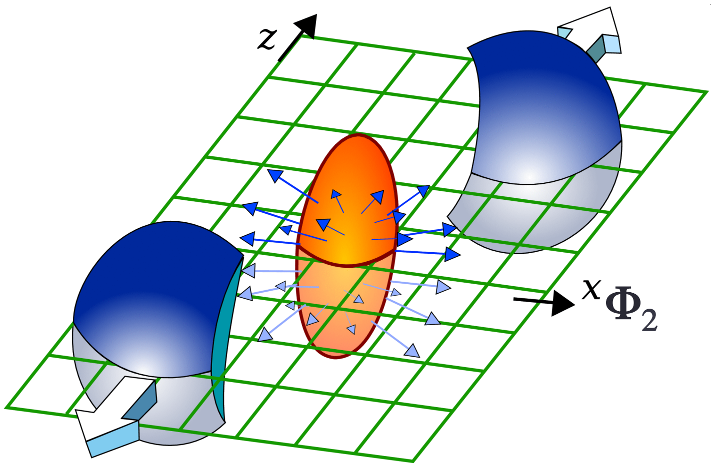
- Dissect possible interplay of hard-scattered partons & hot dense medium

- To have definitive answer what remains in correlations after v_n subtractions

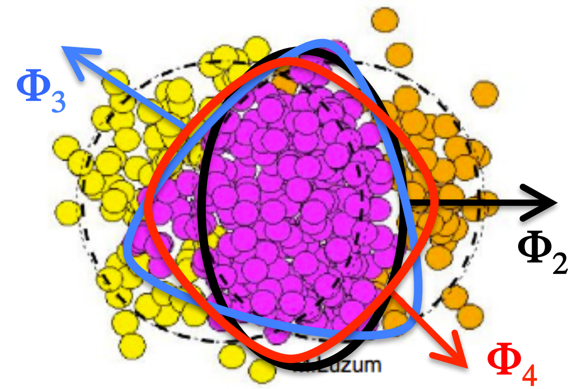
- To test path length dependence of parton energy loss via correlations relative to event plane

Initial state of collisions

Smooth picture



Fluctuating picture



- Initial collision geometry
  - Smooth to Fluctuating picture
- Azimuthal particle distribution
  - $v_{n(even)}\{\Phi_2\}$ only $\longrightarrow$ $v_{n(even)}\{\Phi_n\}$ + $v_{n(odd)}\{\Phi_n\}$

$$dN/d\phi = 1 + \sum 2v_n \cos n(\phi - \Phi_n)$$

Charged Hadron v_n at PHENIX

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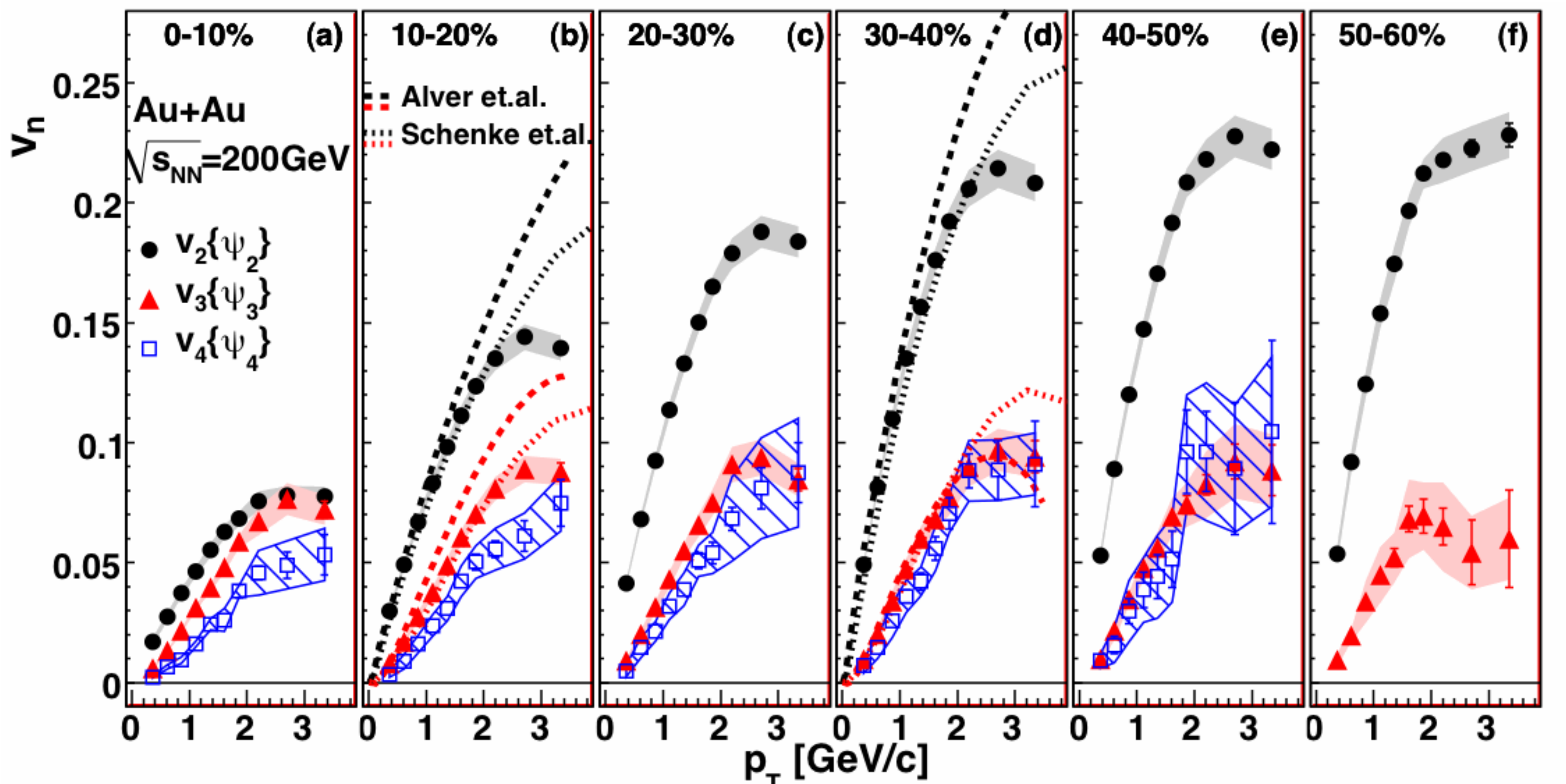
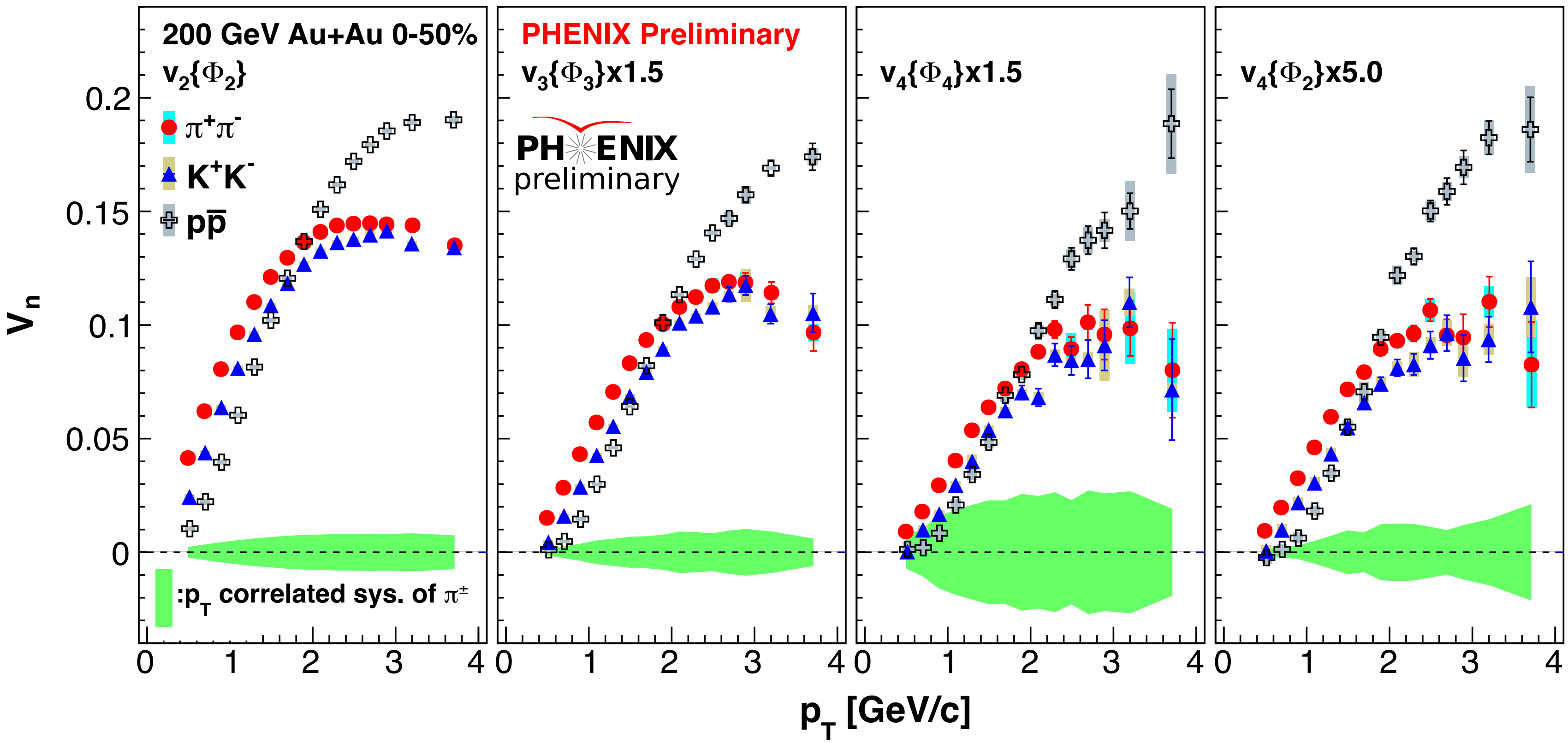


Charged particle v_n : $|\eta|<0.35$
Event plane Φ_n : $|\eta|=1.0\sim2.8$

- v_3 is comparable to v_2 at 0~10%
- v_2 evolution as centrality increment, no evolution in v_3
- $v_4\{\Phi_4\} \sim 2 \times v_4\{\Phi_2\}$

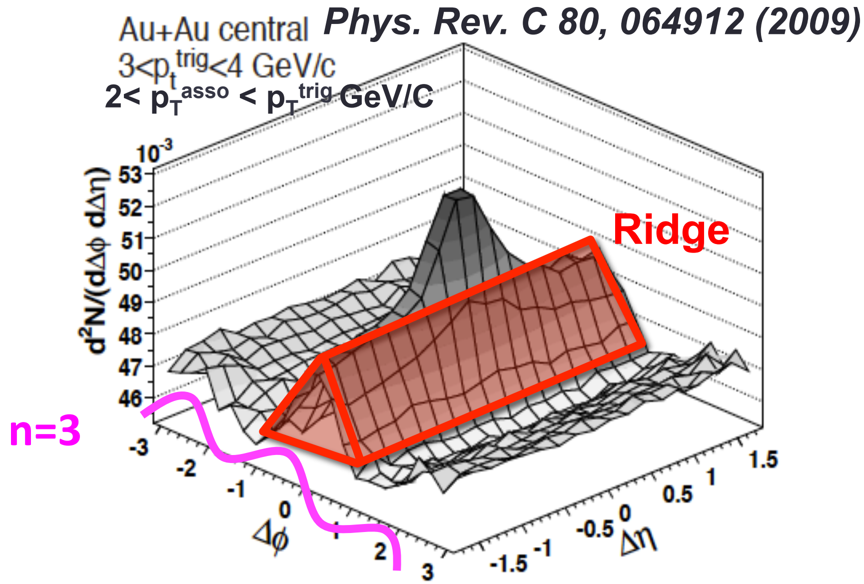
Identified Particle v_n

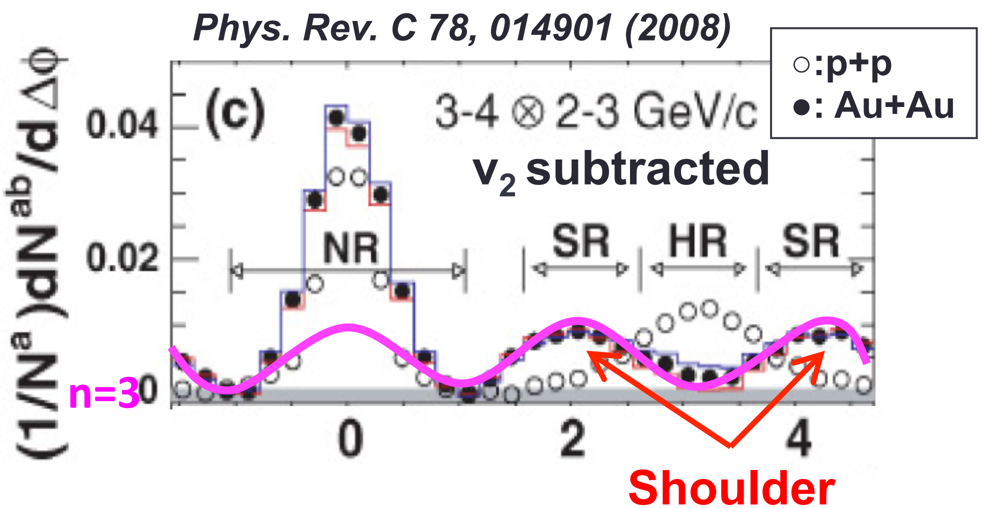


- Mass dependence at low p_T : Hydrodynamics
- Baryon/Meson diff. at mid p_T: Quark Coalescence

v_n contributions in correlations

$$\boxed{Jet(\Delta\phi) = CF(\Delta\phi) - b_0 Flow(\Delta\phi)}$$





- Contributions from v_n : $\sim b_0 2 v_n^{trig} v_n^{asso} \cos n\Delta\phi$
- Ridge & Shoulder positions : Agree with v_3 peaks
- v_n subtractions needed to get real jet correlations

Correlations with $\Delta\eta$ gap

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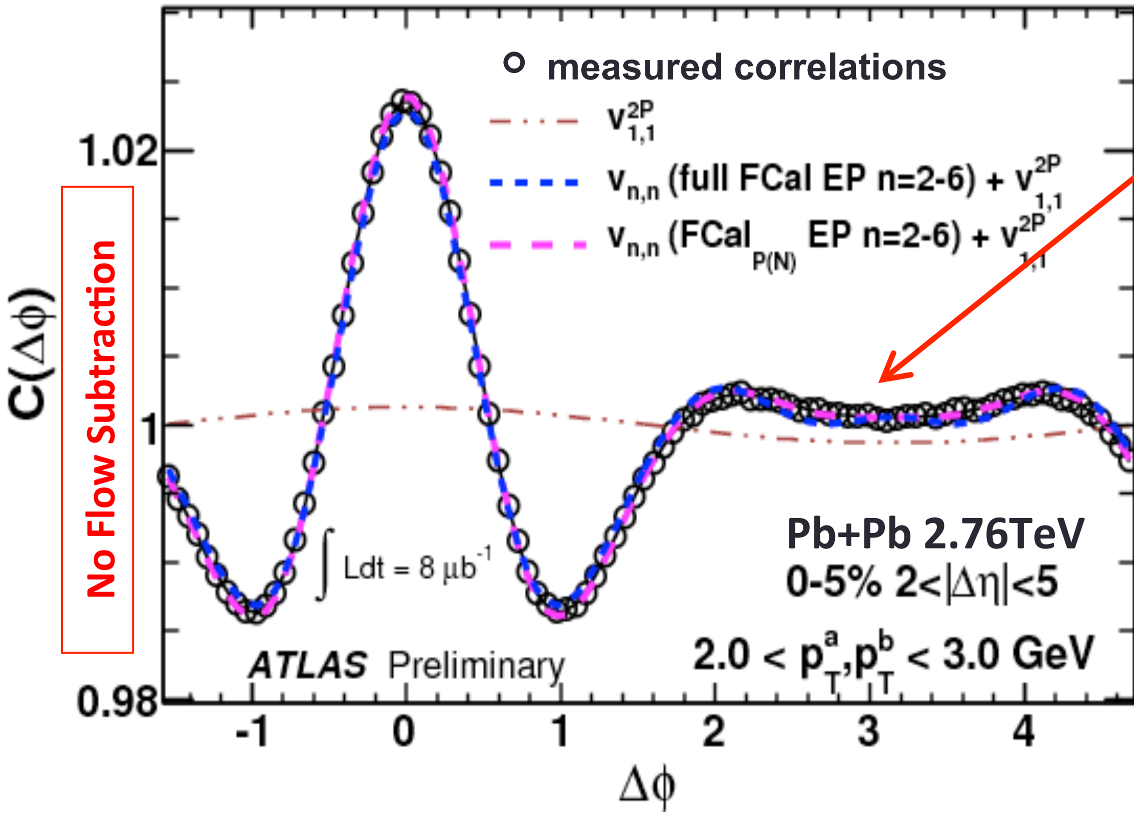
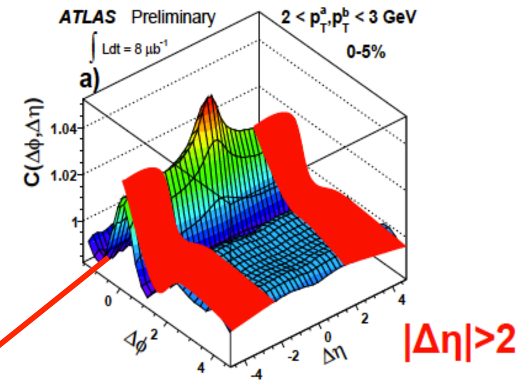
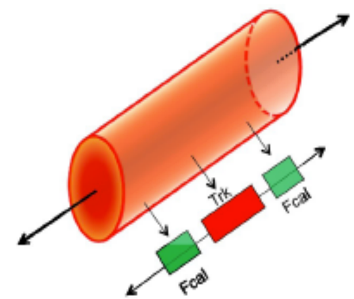
$$C(\Delta\phi) = b^{2P}\left(1 + 2v_{1,1}^{2P}\cos\Delta\phi + 2\sum_{n=2}^{6} v_n^{EP} v_n^{EP}\cos n\Delta\phi\right)$$

From 2PC method From EP method





v_n with EP Method



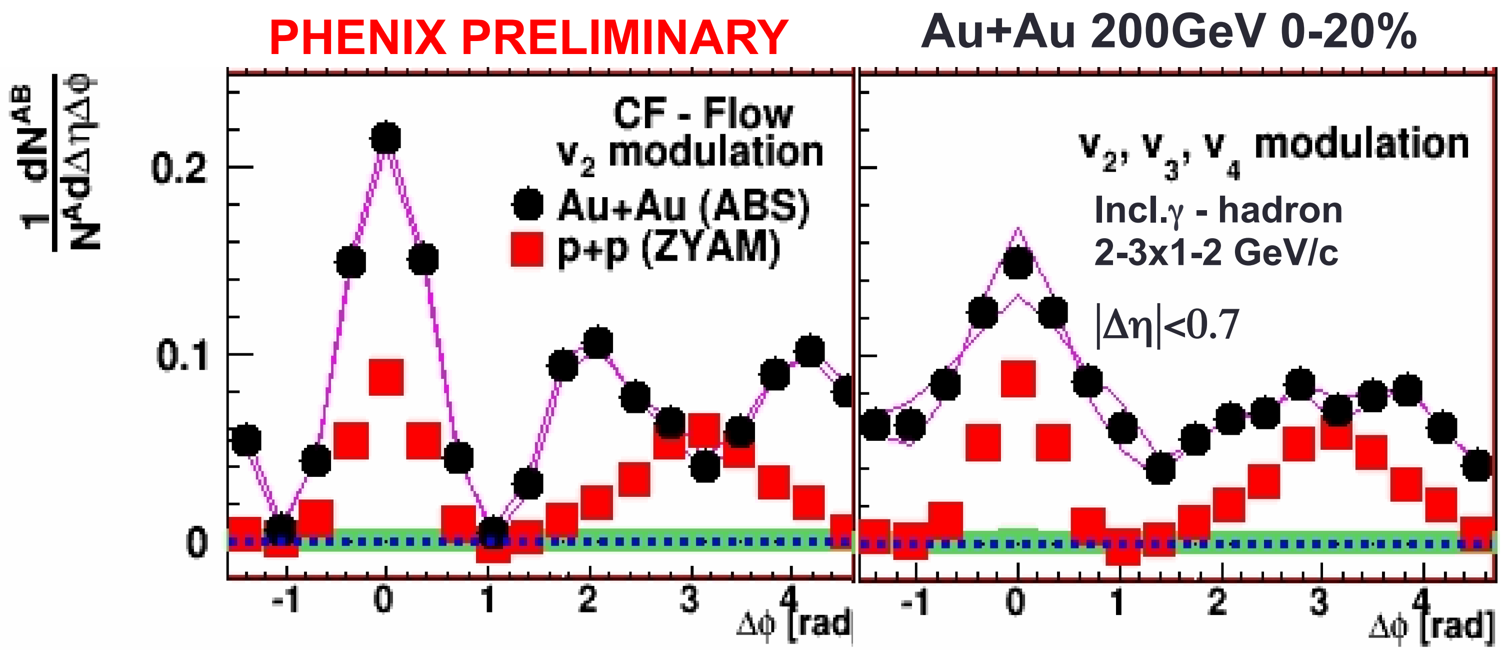
Track at |η|<2.5 with EP from full FCAL 3.3<|η|<4.8

v_n with 2Par. Cor Method

Charged particle pair with large rapidity gap e.g. |Δη|>2

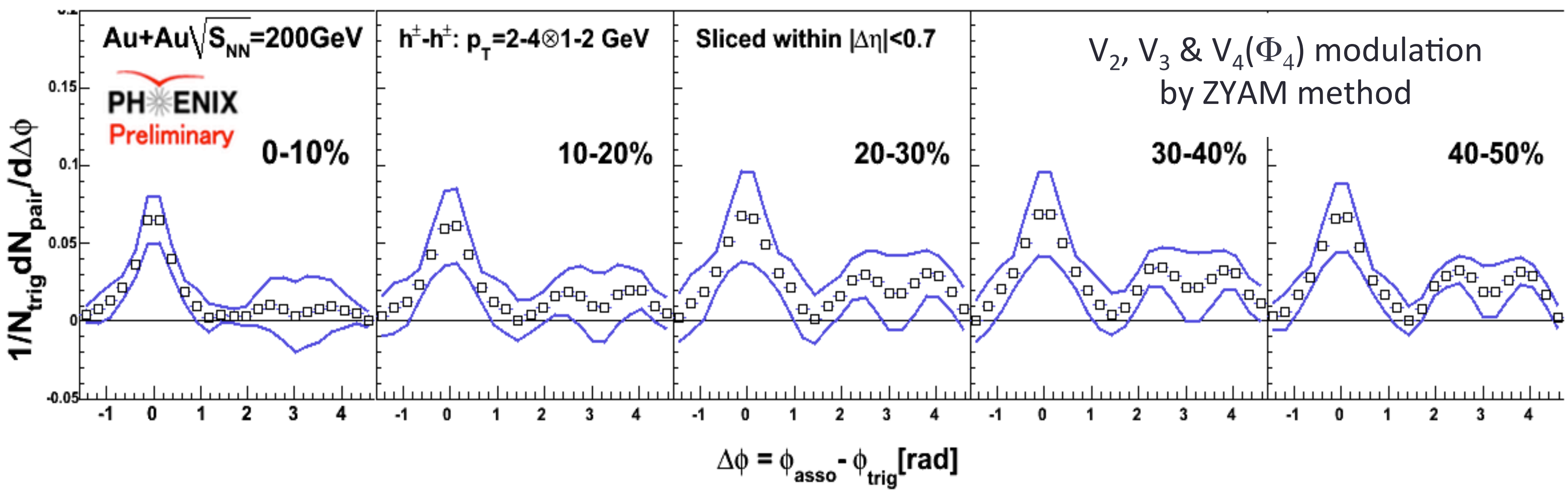
- v_n reproduce Ridge & Shoulder at 0-5%

Correlations without $\Delta\eta$ gap



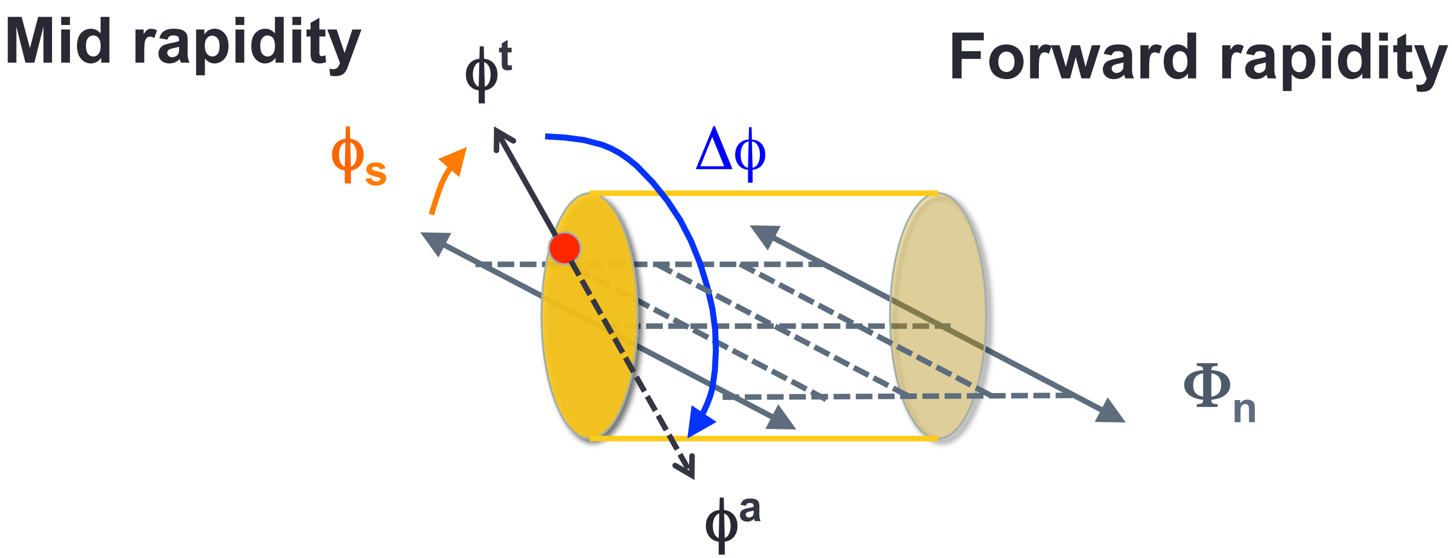
- Away side shoulders are almost gone in most-central collisions 0-20%

Correlations up to centrality 50%



- Away side shoulders
  - Canceled in most-central collisions : 0-10%
  - Remain in mid-central collisions : 20-50%
- To Do : Include v1 term to v_n modulation for definitive answer

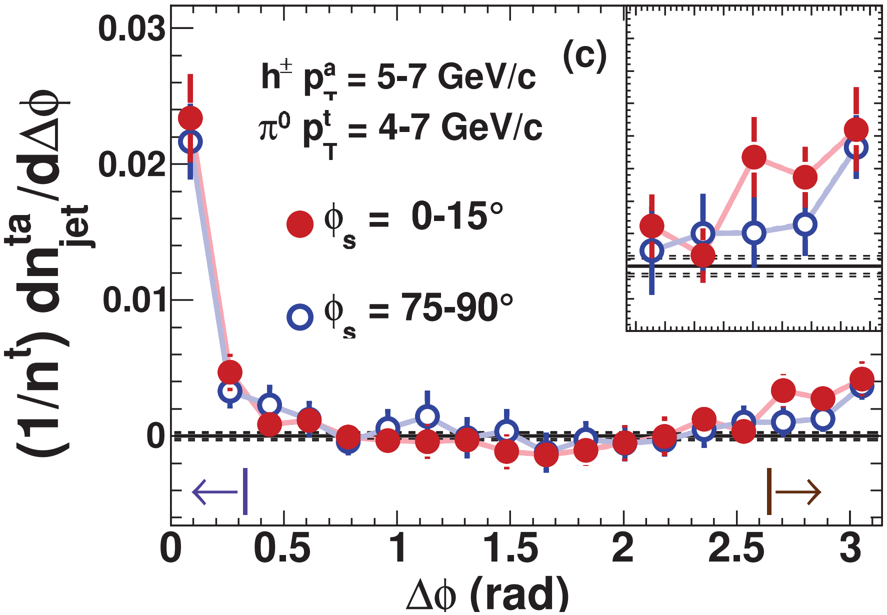
Correlations relative to event plane

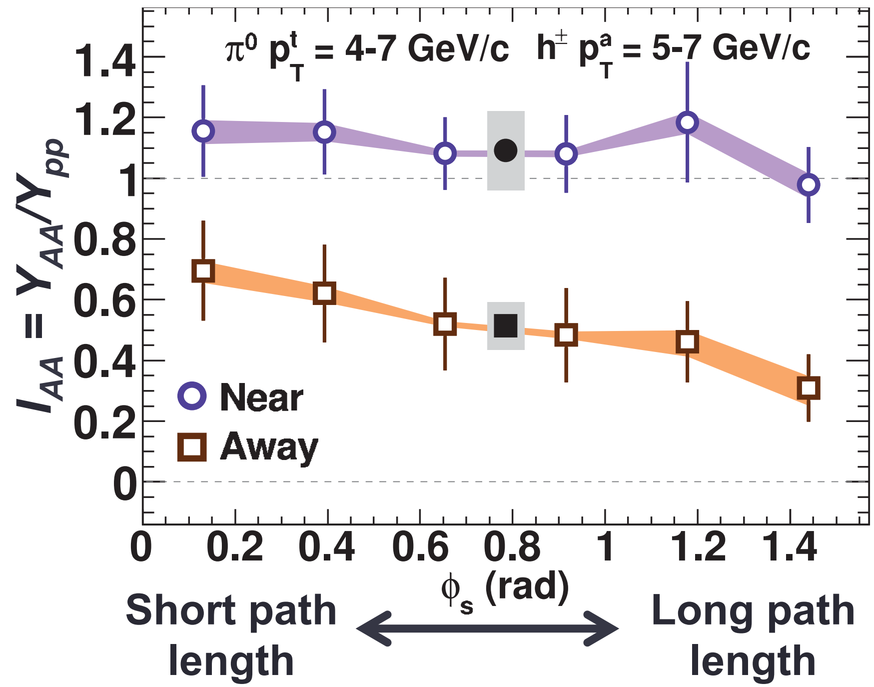


- Control parton path length
  - By selecting trigger relative to forward event plane
  - Reduce autocorrelations of jet itself

High p_T range

Au+Au 200GeV 20-60% **v_2 & $v_4\{\Phi_2\}$ modulated** ***PRC.84.024904***



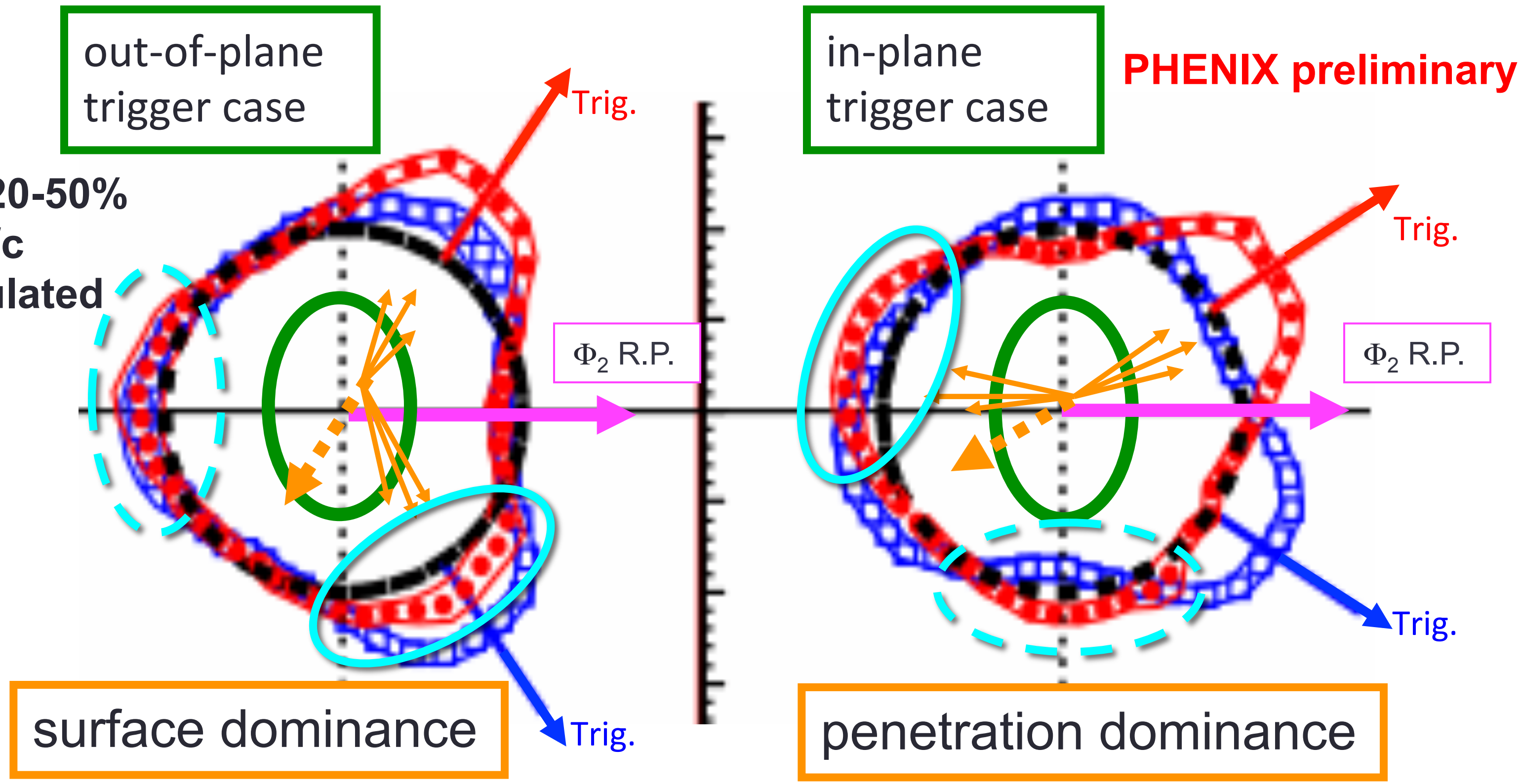


- Near side yield : No suppression
- Away side yield : Monotonic decrease

Intermediate p_T range

Au+Au 200GeV 20-50%
h-h :2-4x1-2GeV/c
v_2 & $v_4\{\Phi_2\}$ modulated

Flow subtracted yield is shown radially with base line. ▪▪▪▪▪▪



- Constant suppression of back-to-back jet
- Two competitive effects seen

Summary

- Higher harmonic flow v_n has been measured
- By v_n modulation to correlations,
  - Shoulders almost gone in most-central collisions
  - Shoulders remain in mid-central collisions
- Correlations relative to event plane
  - Monotonic away side suppression at high p_T
  - Constant suppression of di-jet & Two competitive effects at intermediate p_T
- Fully v_n modulated analyses are in progress

Backup Slides

$\Phi_i - \Phi_j$ correlations

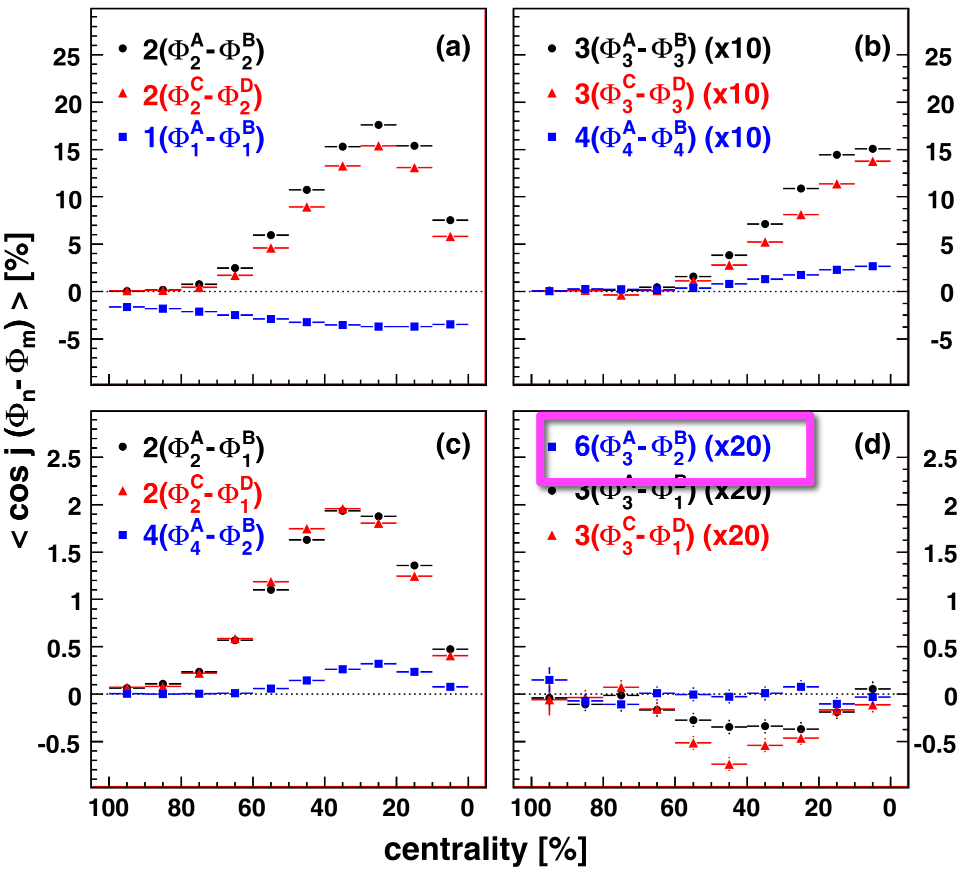


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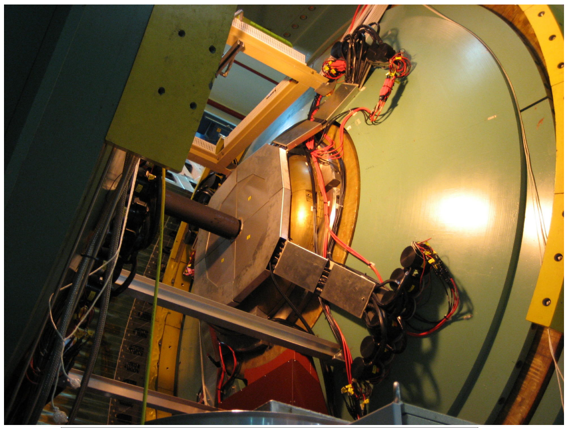
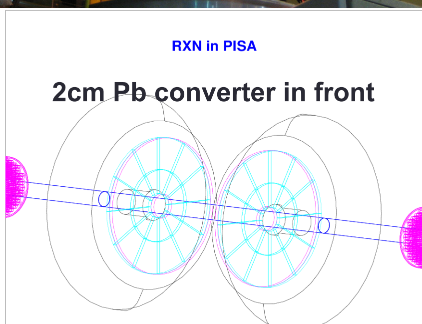
FIG. 1 (color online). Raw correlation strengths $\langle\cos(j[\Phi_n^A - \Phi_m^B])\rangle$ and $\langle\cos(j[\Phi_n^C - \Phi_m^D])\rangle$ of the event planes for various detector combinations as a function of the collision centrality, binned in percentages of the total cross section, where 0% corresponds to impact parameter = 0. Panels (a) and (b) show the two subevent correlations for $m = n$; (c) and (d) show the two subevent correlations for $m \neq n$. The detectors in which the event plane is measured are: A: RXN North, B: BBC South, C: MPC North, and D: MPC South. Data in (b) and (d) have been scaled by factors of 10 and 20, respectively.

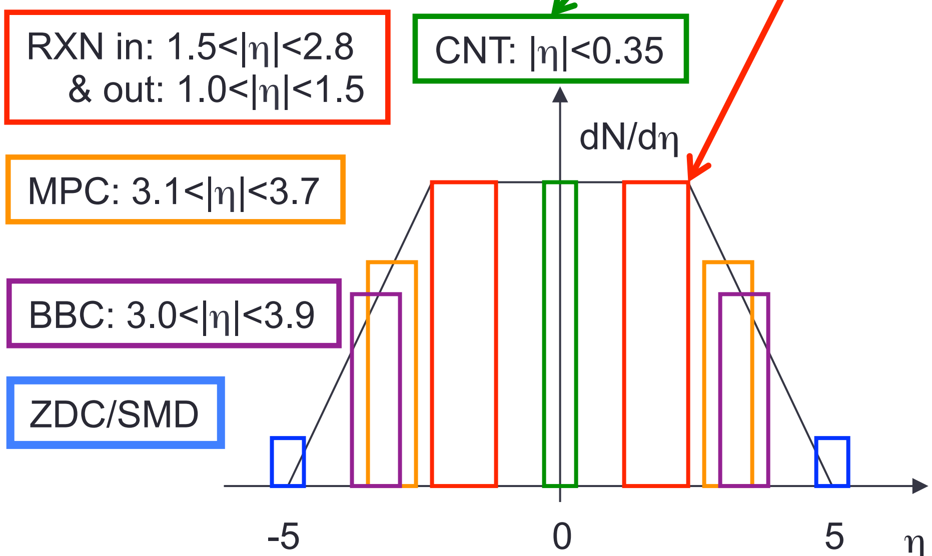
v_n via event plane method

RXN





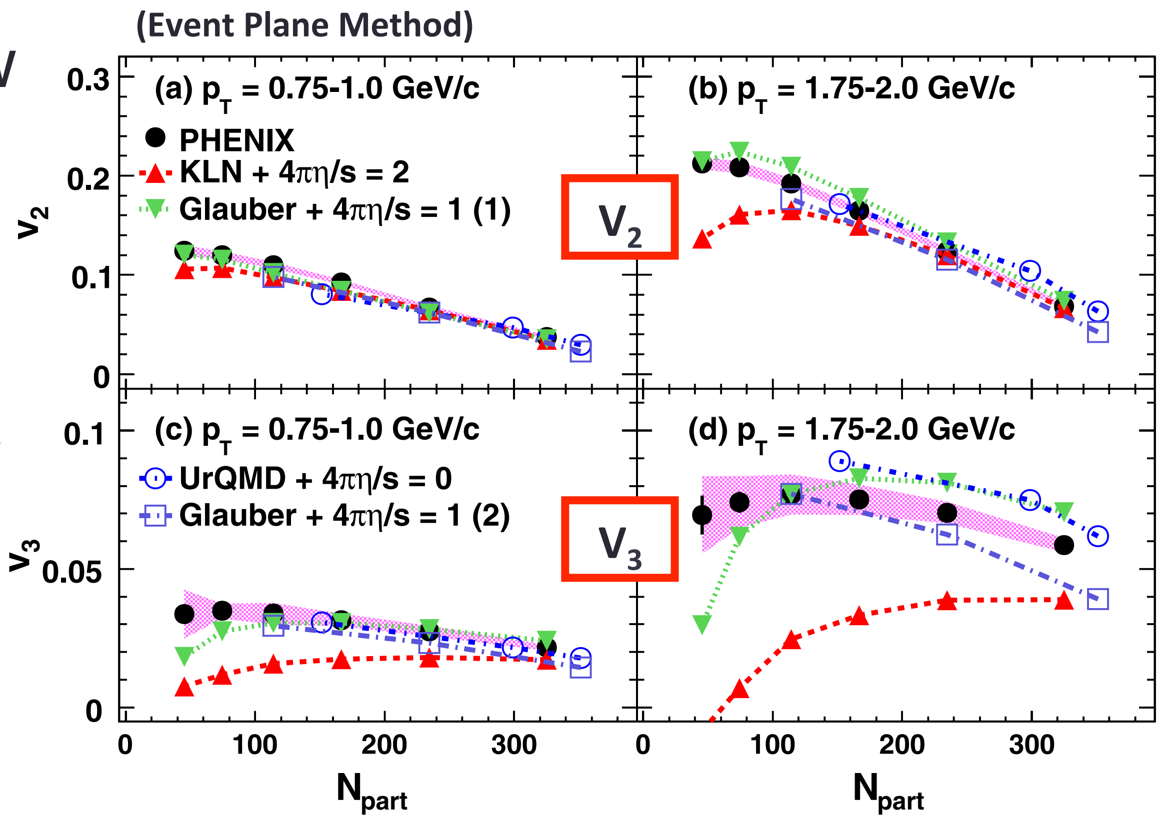
$$v_n = < \cos n(\boxed{\phi} - \boxed{\Phi_n}) >$$



- Mid rapidity particle anisotropy relative to forward event planes

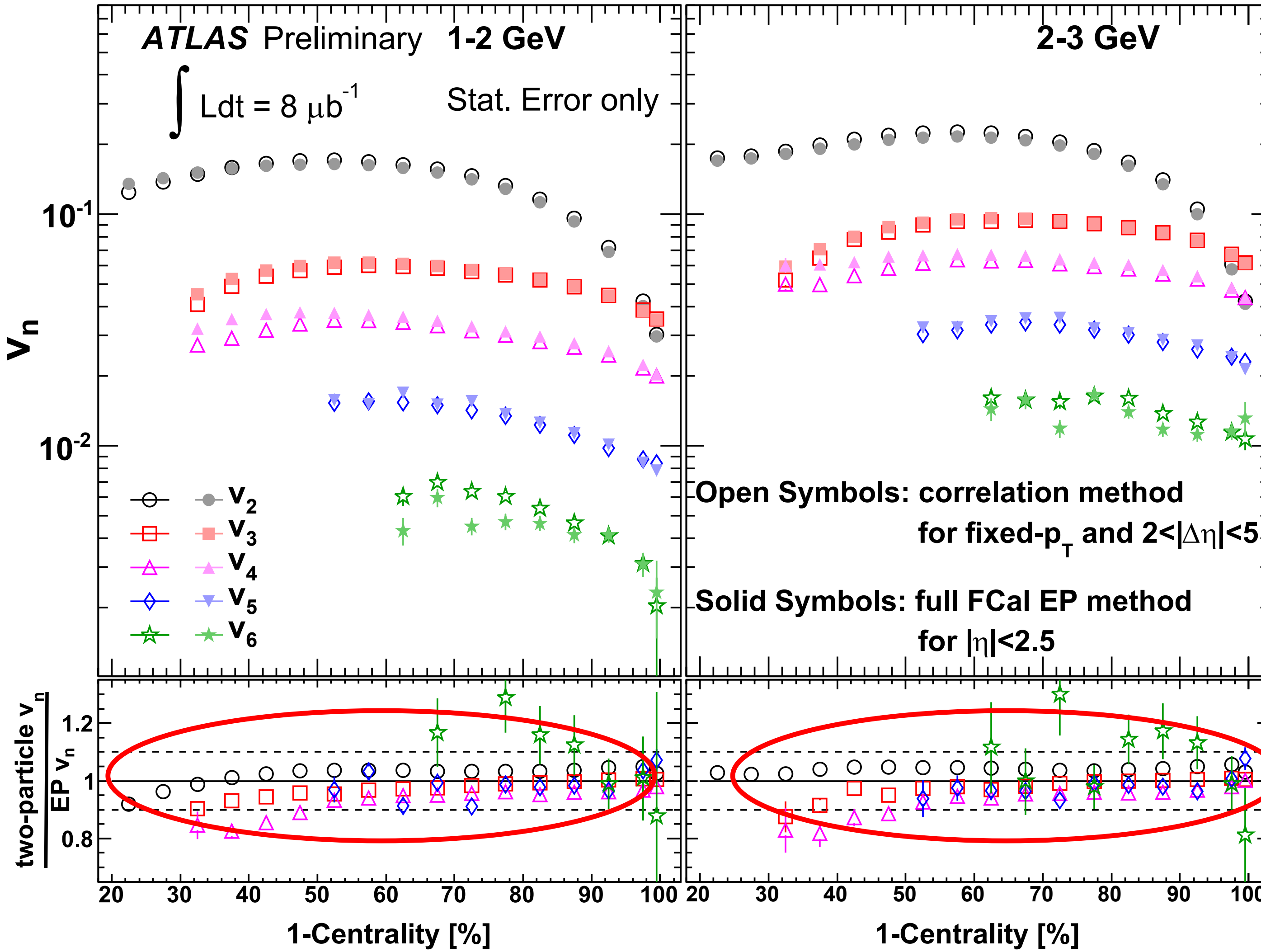
Degeneracy among models disentangled by v_3

- v_3 seems to prefer low viscosity
  - Glauber+$4\pi\eta/s = 1$ works better
  - CGC-KLN+$4\pi\eta/s = 2$ failed
- More constraints to hydrodynamics calculations



PRL.107.252301 (ppg132)
B. Alver et. al., PRC82, 034913(2010).
B. Schenke et. al., PRL106, 042301(2011).
H. Petersen et. al., PRC82, 041901(2010).

Compare with the Event Plane method



Consistent between the 2PC and full FCal EP method (Similar for $FCal_{P(N)}$).

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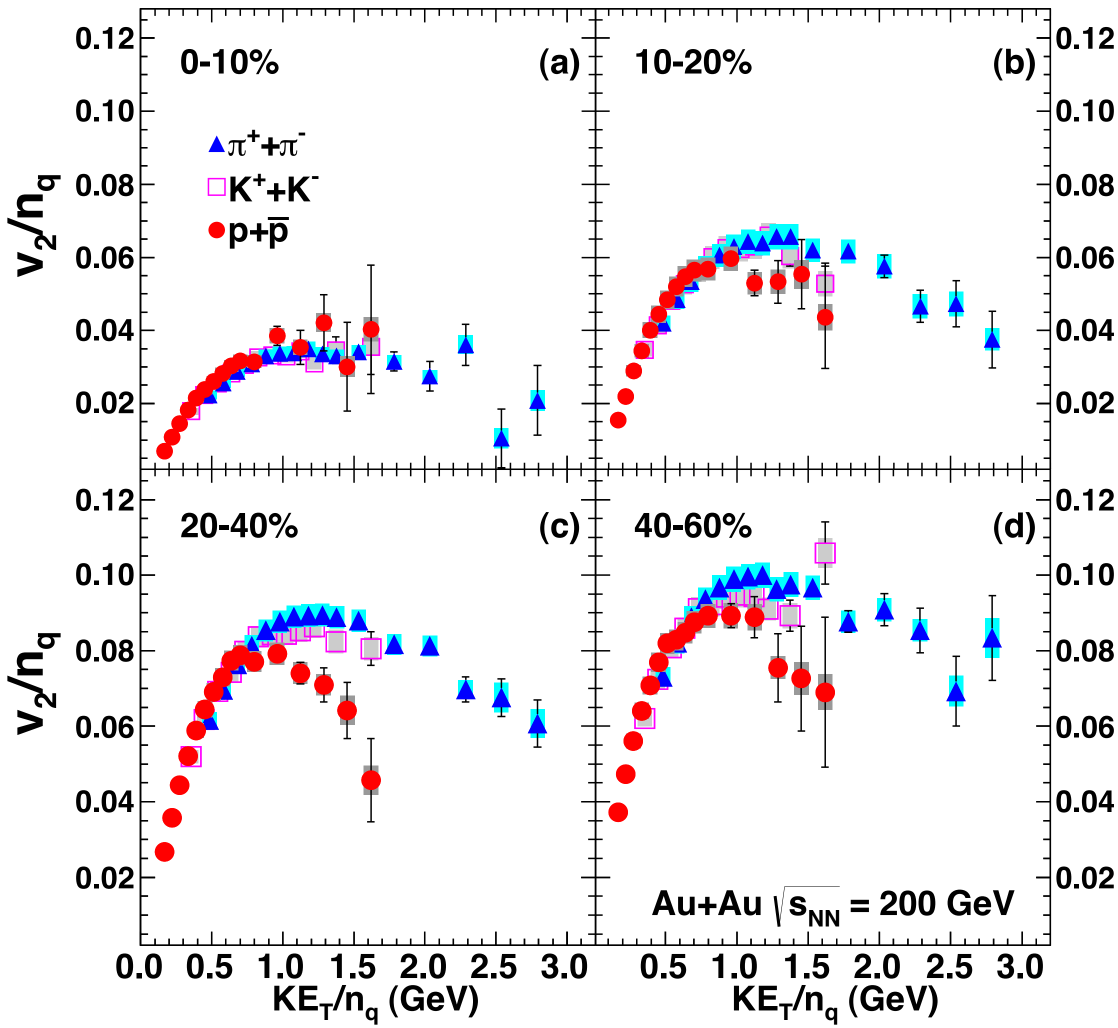
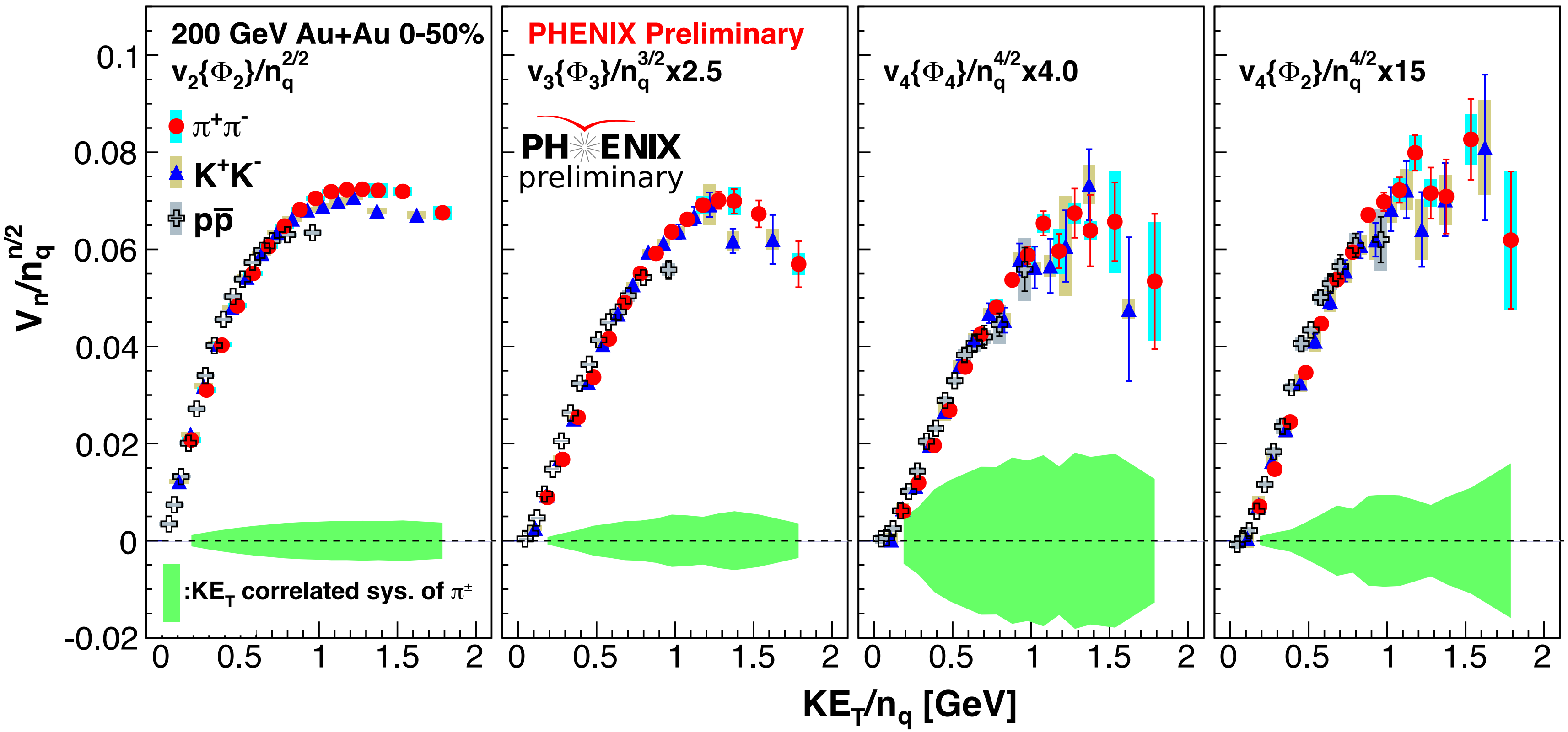
Scaling property of v_2

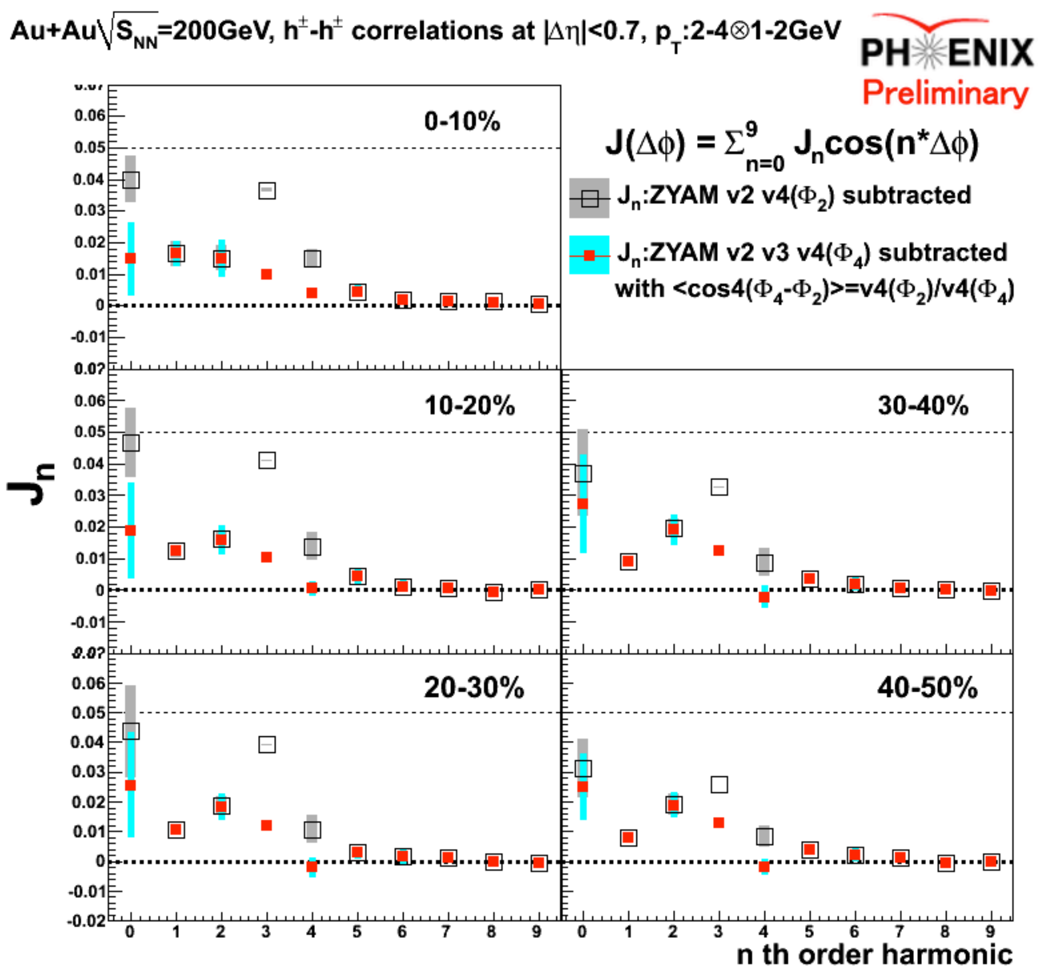


Scaling property of v_n



- $v_n(KE_T/n_q)/n_q$ failed on v_3, v_4 & $v_4\{\Phi_2\}$
- $v_n(KE_T/n_q)/n_q^{n/2}$: need correction power

Fourier decomposition of flow subtracted correlations



Correlations relative to Φ_3