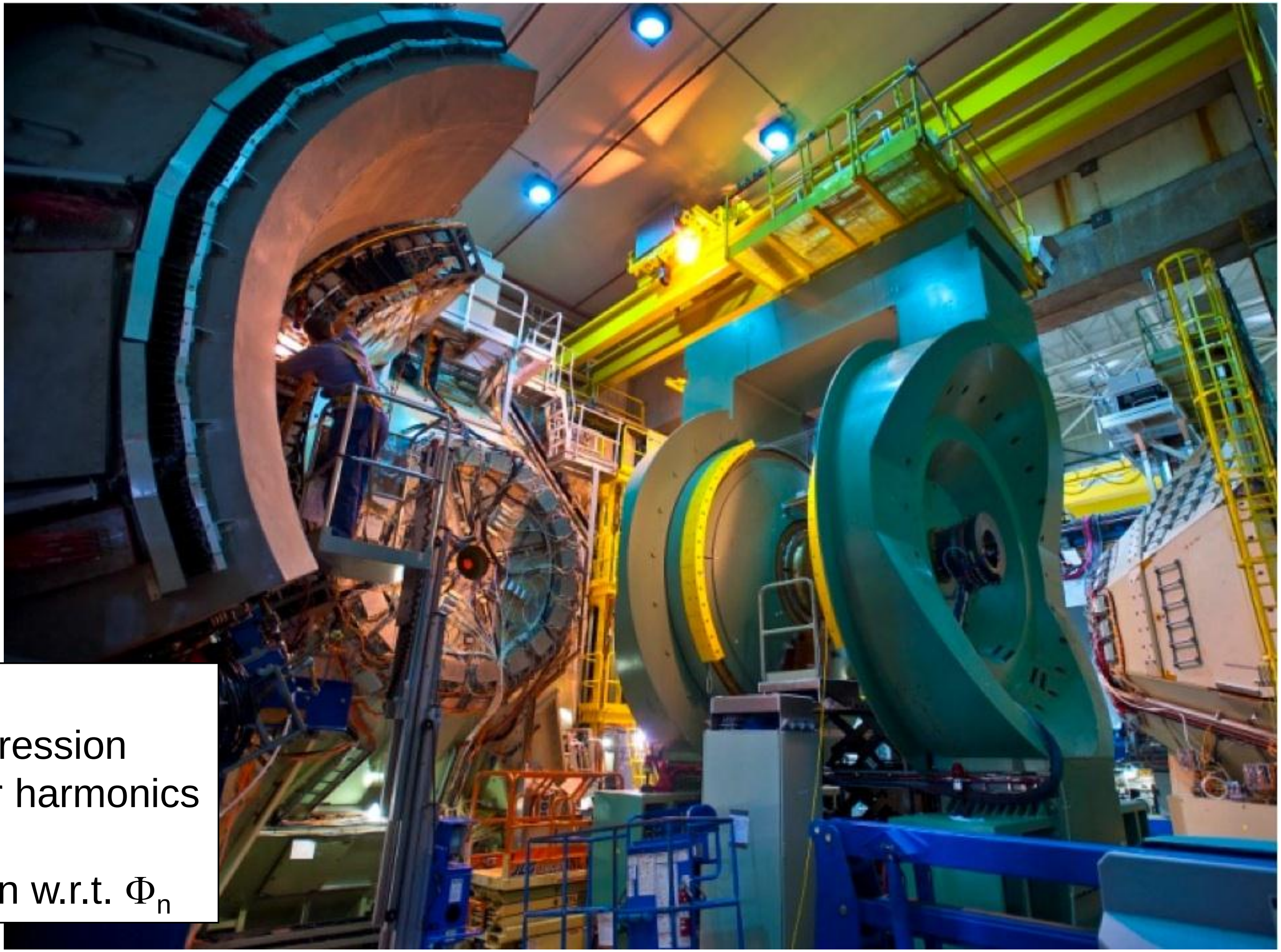
High p_T suppression and v_2 from PHENIX

ShinIchi Esumi, Univ. of Tsukuba



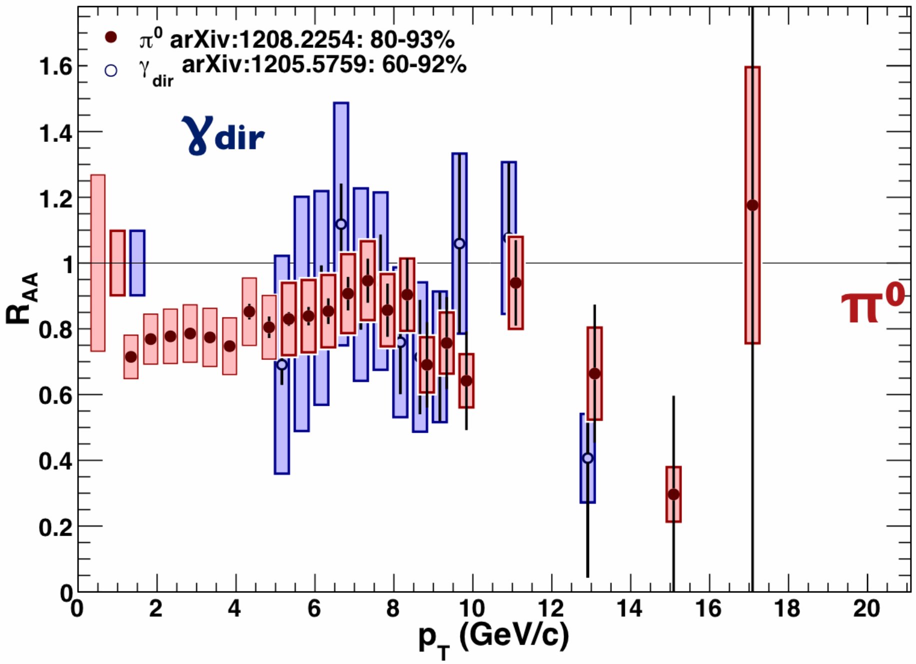
Contents

- High p_T suppression
- v_2 and higher harmonics
- HBT w.r.t. Φ_n
- Jet correlation w.r.t. Φ_n

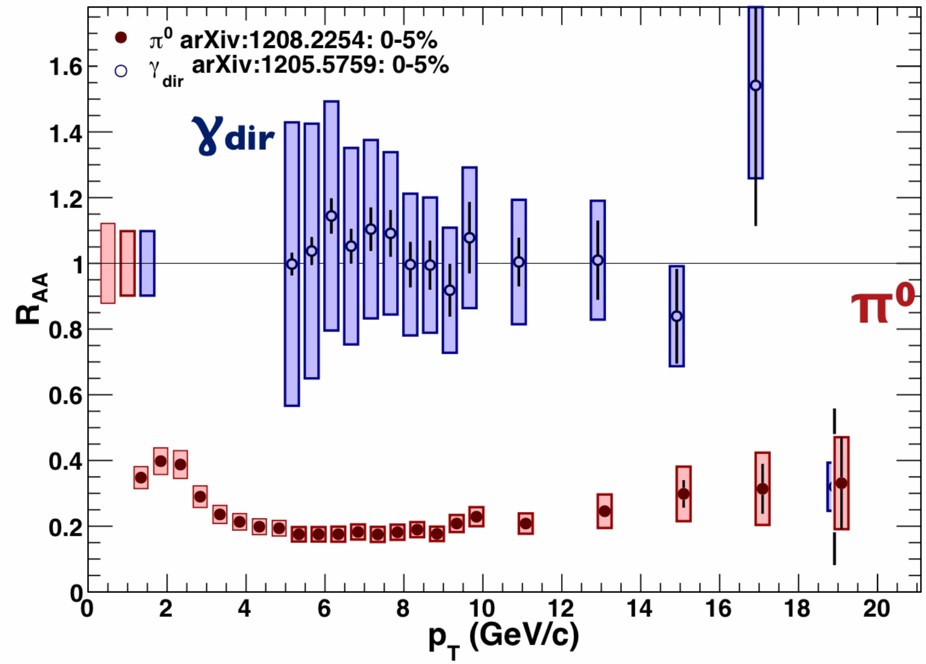
(Non-) suppression of hadron (direct-photon)

arXiv: 1208.2254
arXiv: 1205.5759

peripheral Au+Au



central Au+Au

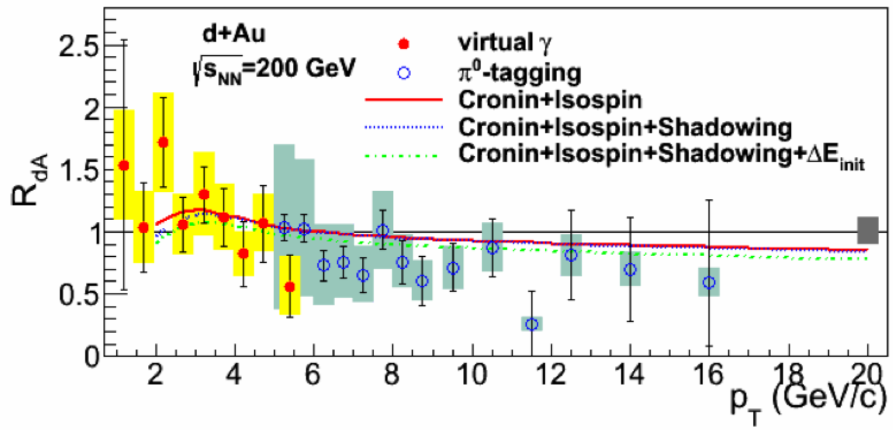


- strong suppression of hadrons
- no suppression of direct photons at high p_T

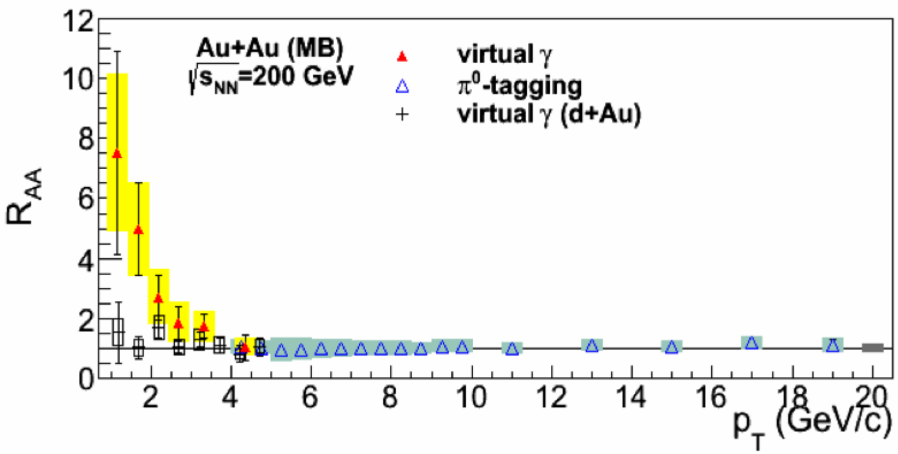
Thermal photons and their Flow

d+Au

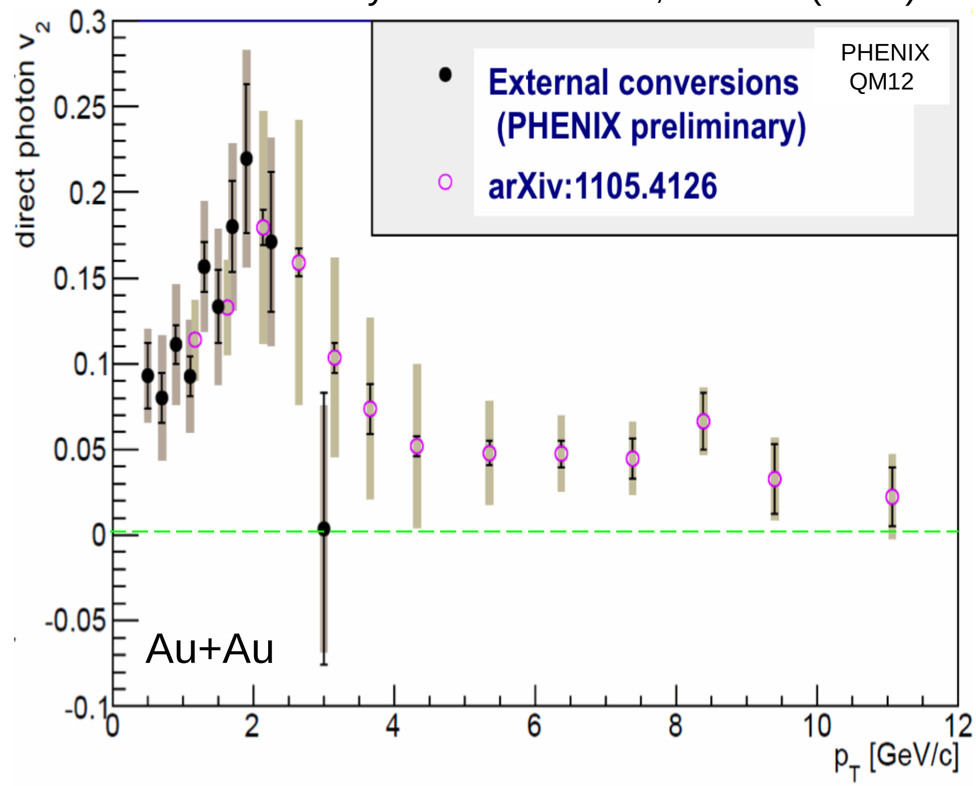
arXiv: 1208.1234



Au+Au



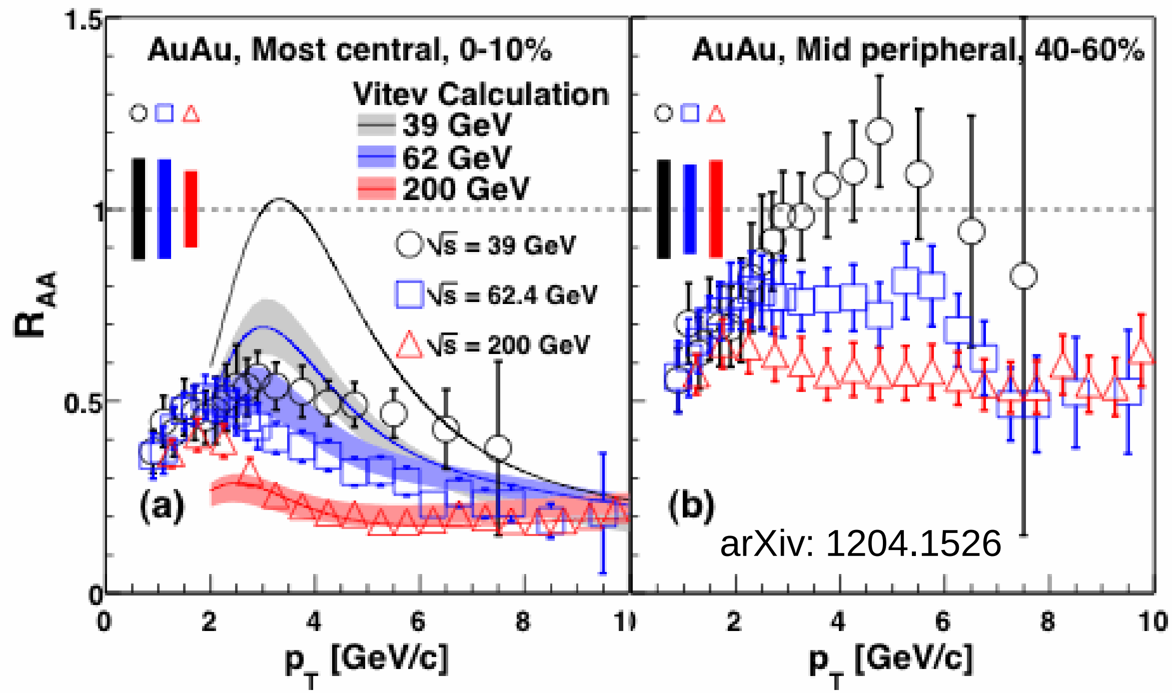
arXiv: 1105.4126
Phys. Rev. Lett. 109, 122302 (2012)

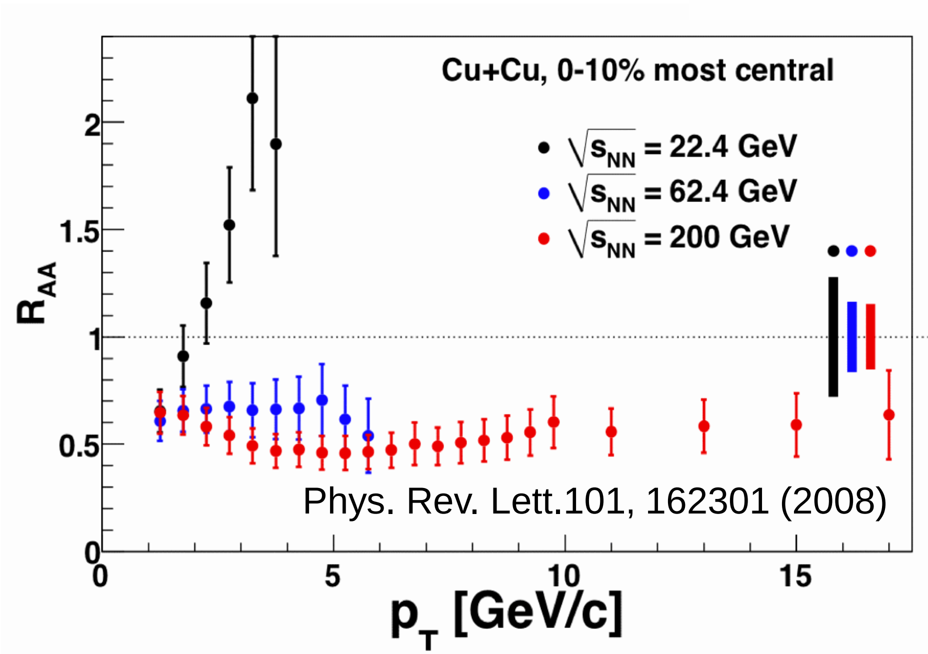


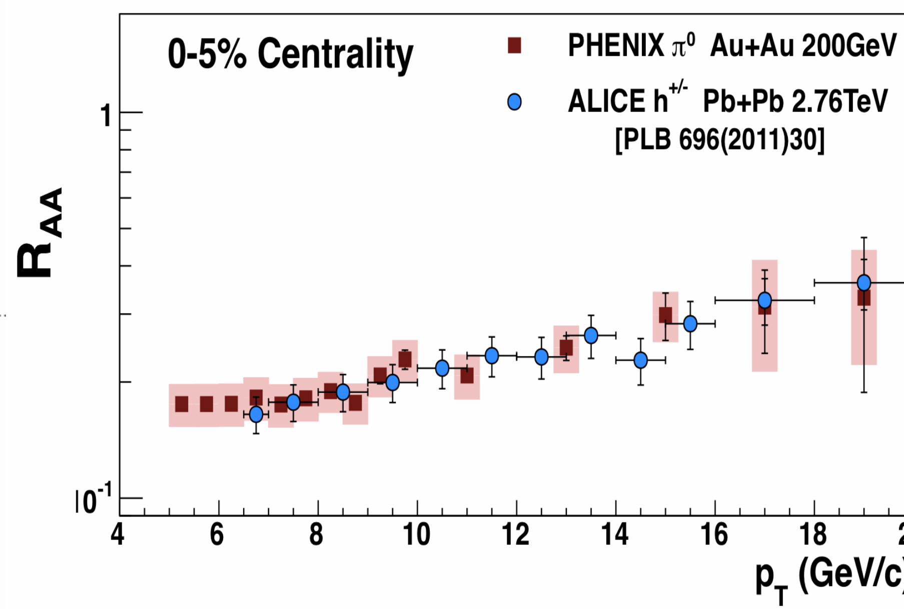
- significant low p_T photon excess
- comparable v_2 with hadrons

Energy dependence of hadron suppression from low RHIC energy to LHC energy

- smaller suppression (or enhancement) at low energy
- saturation at high energy

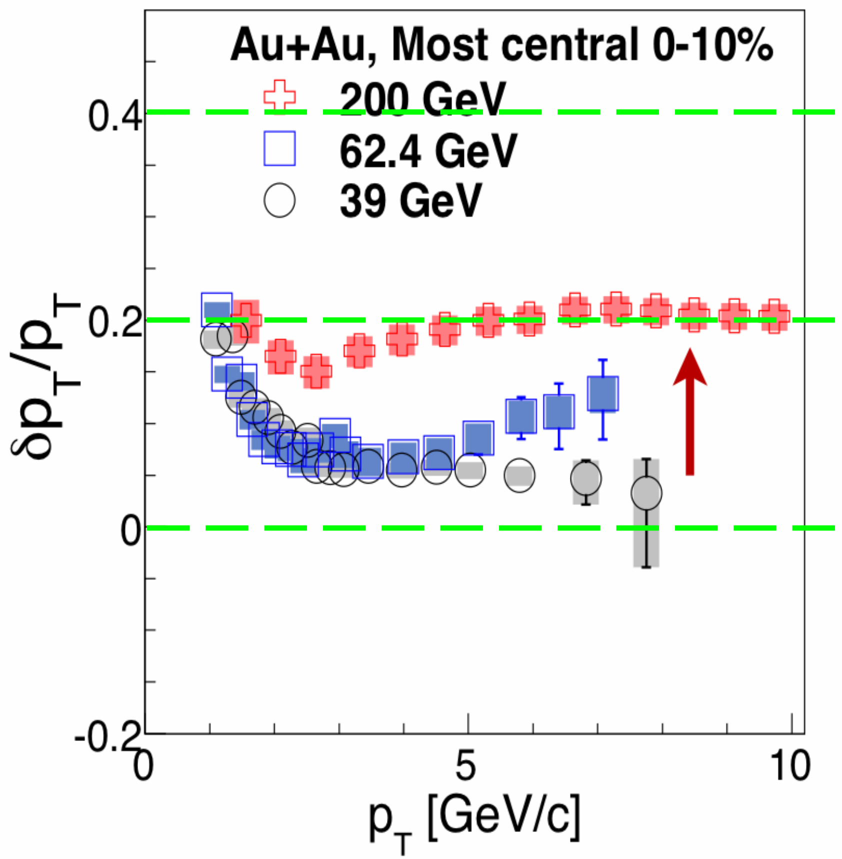




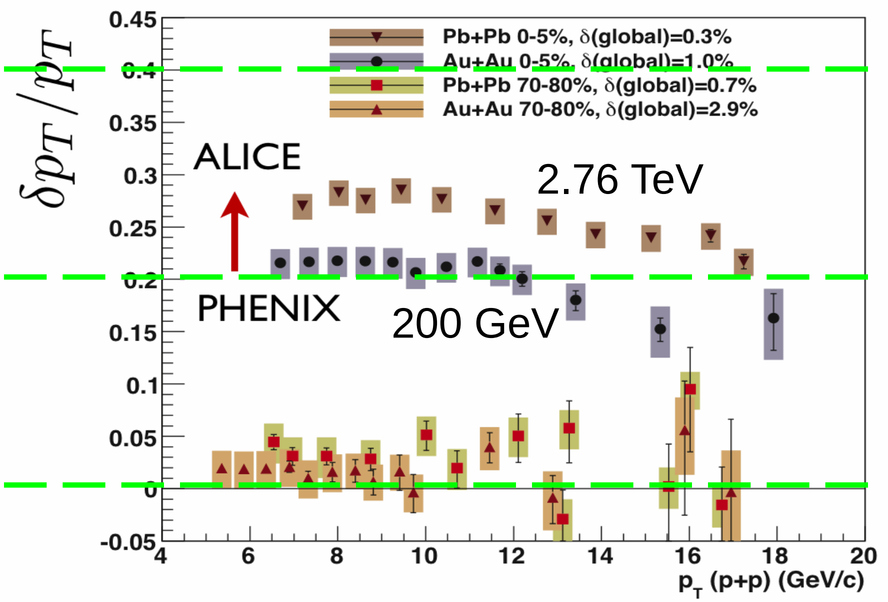


Fractional energy loss

arXiv: 1204.1526



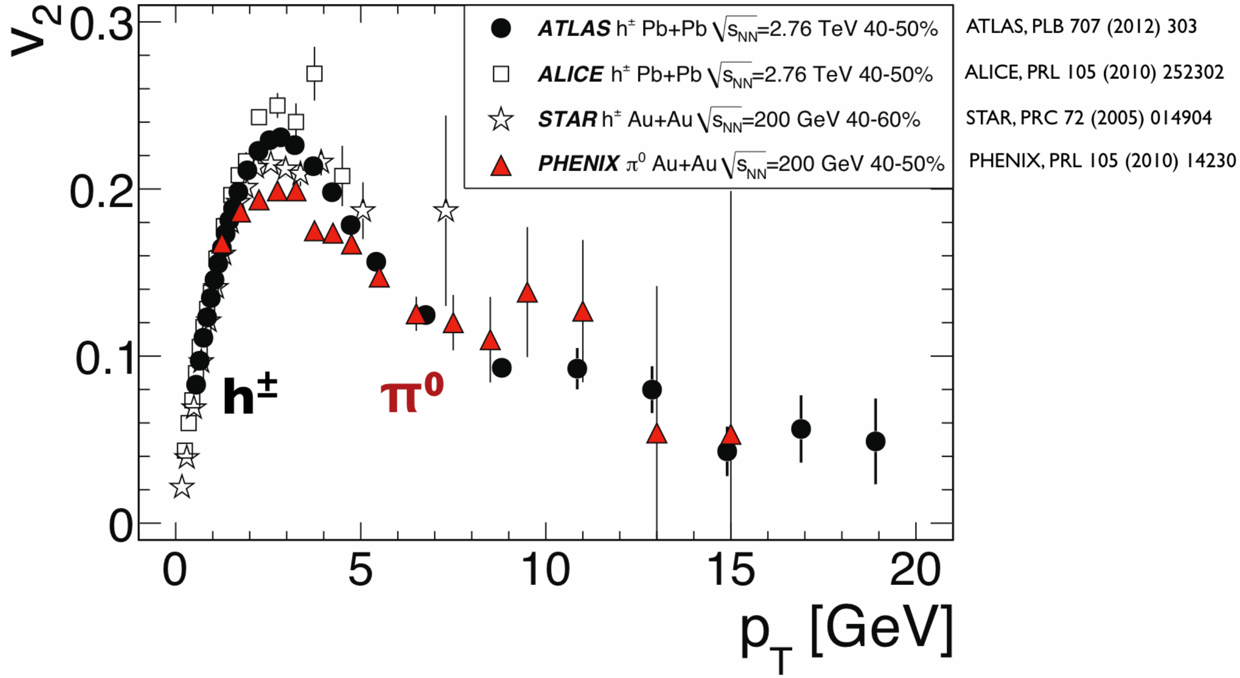
arXiv: 1208.2254

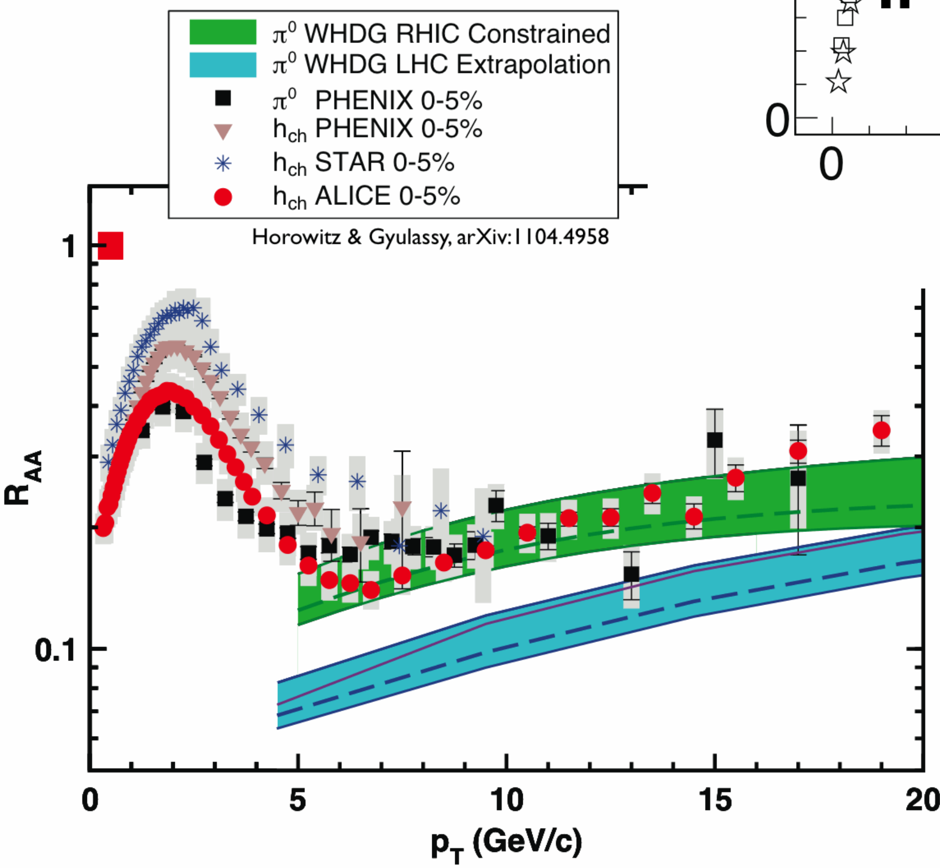


- continuous increase of energy loss in terms of fractional energy loss in p_T (coming from slope changes)

R$_{AA}$ and v$_2$

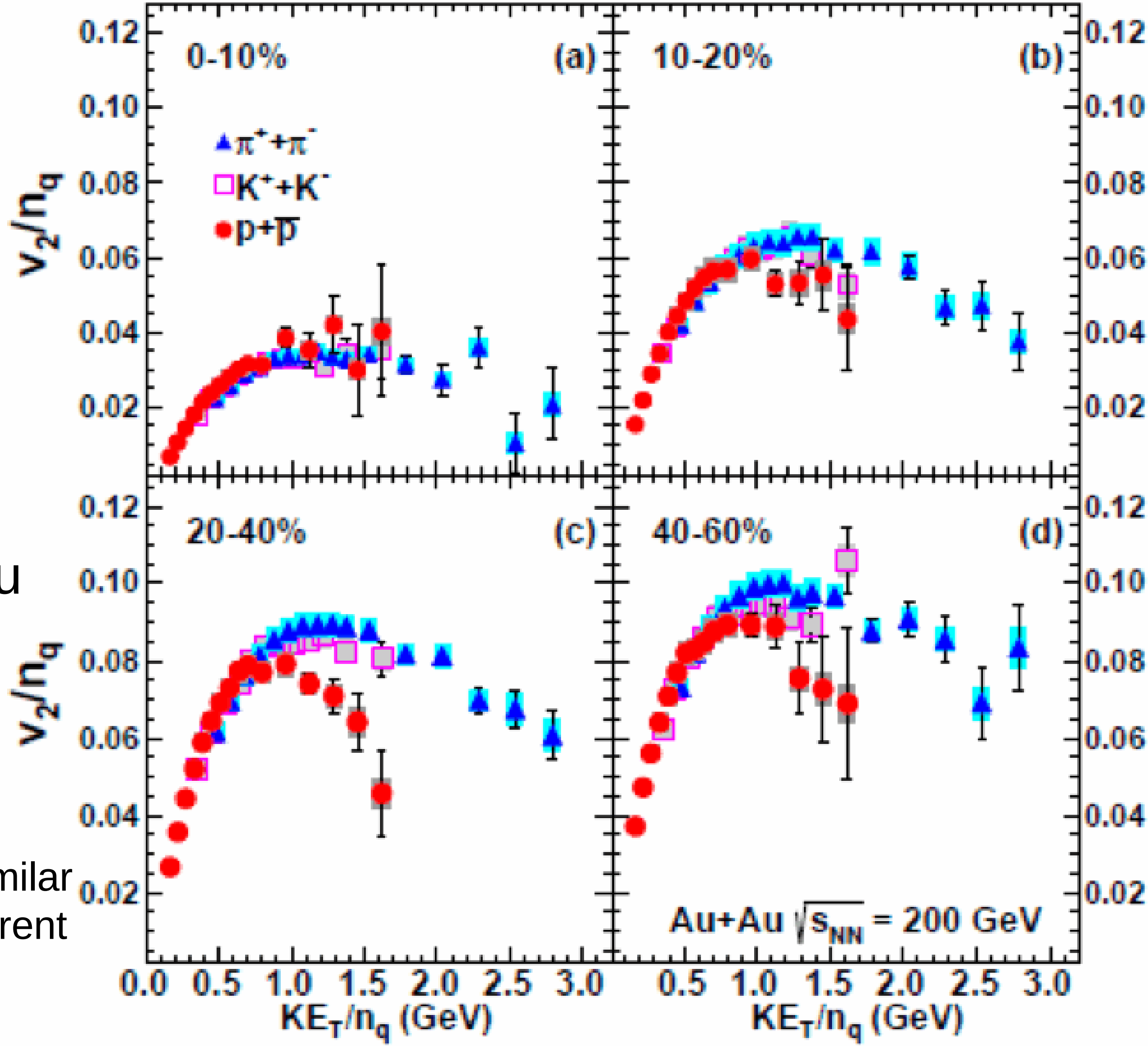
from RHIC to LHC





- no simple solution to describe R$_{AA}$ and v$_2$ for both RHIC/LHC simultaneously

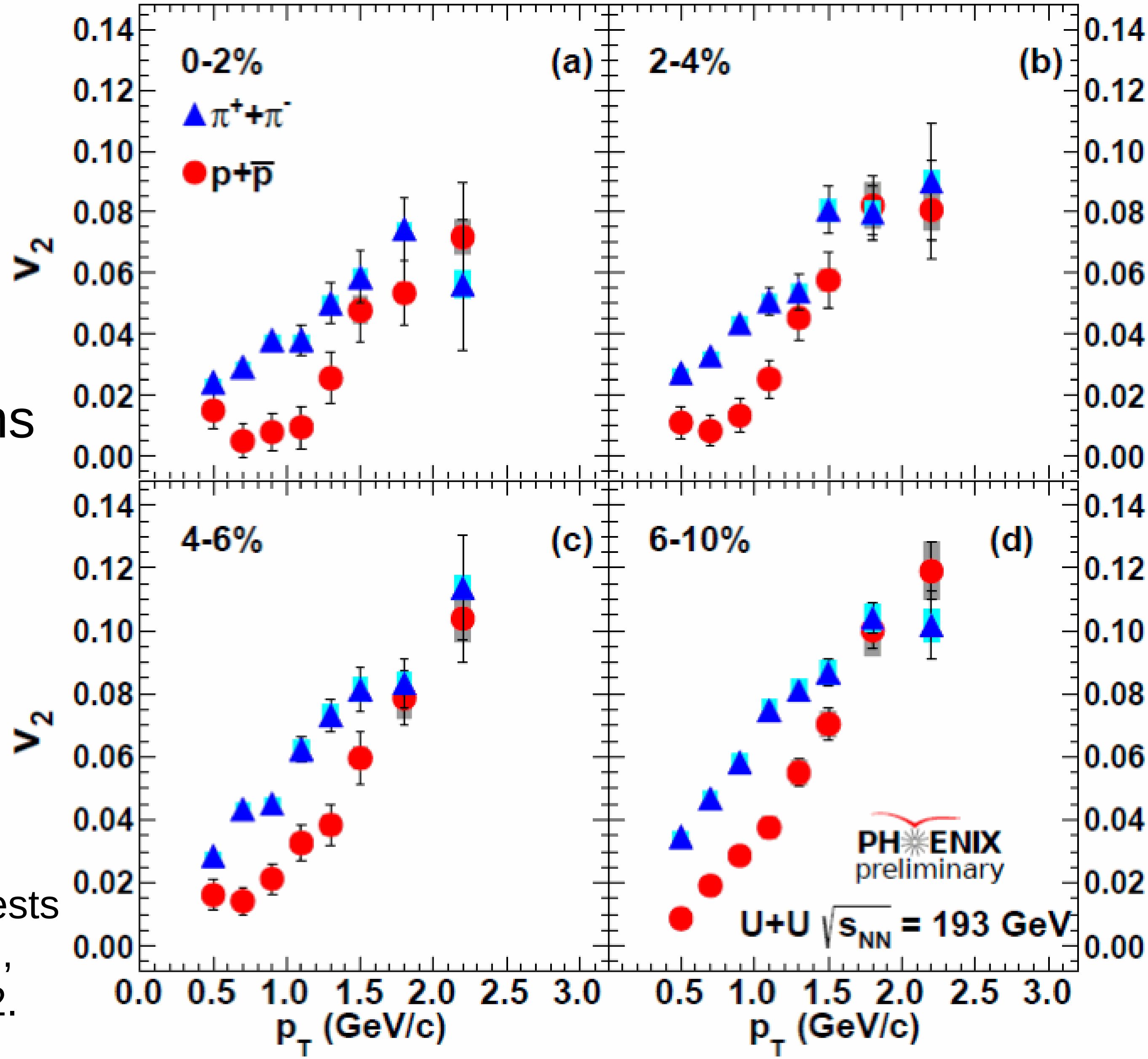
Phys. Rev. C 85, 064914 (2012)



Deviation from n_{CQ} scaling at 200GeV Au+Au

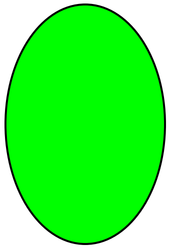
- consequence of similar v_2 at high p_T for different particle species

PHENIX, QM12

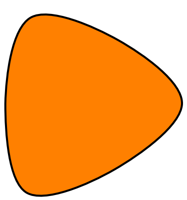


Central collisions (193GeV U+U) at RHIC

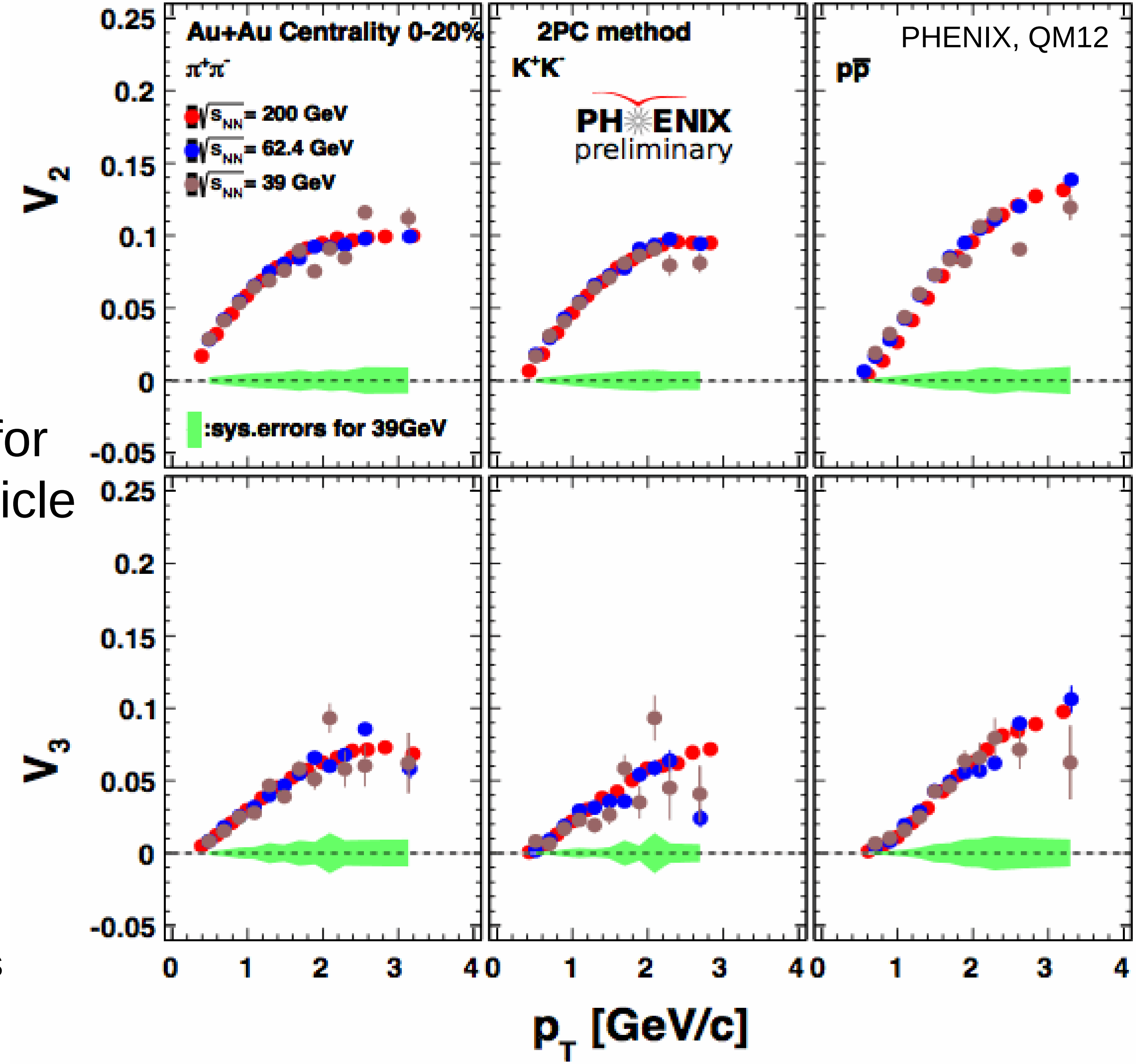
- larger radial flow
- various geometry tests on going with Cu+Au, U+U data from run12.



Beam energy dependence for identified particle v_2 and v_3



- similar for all particle species



Blast Wave fitting and n_{CQ} scaling of identified particle v_n

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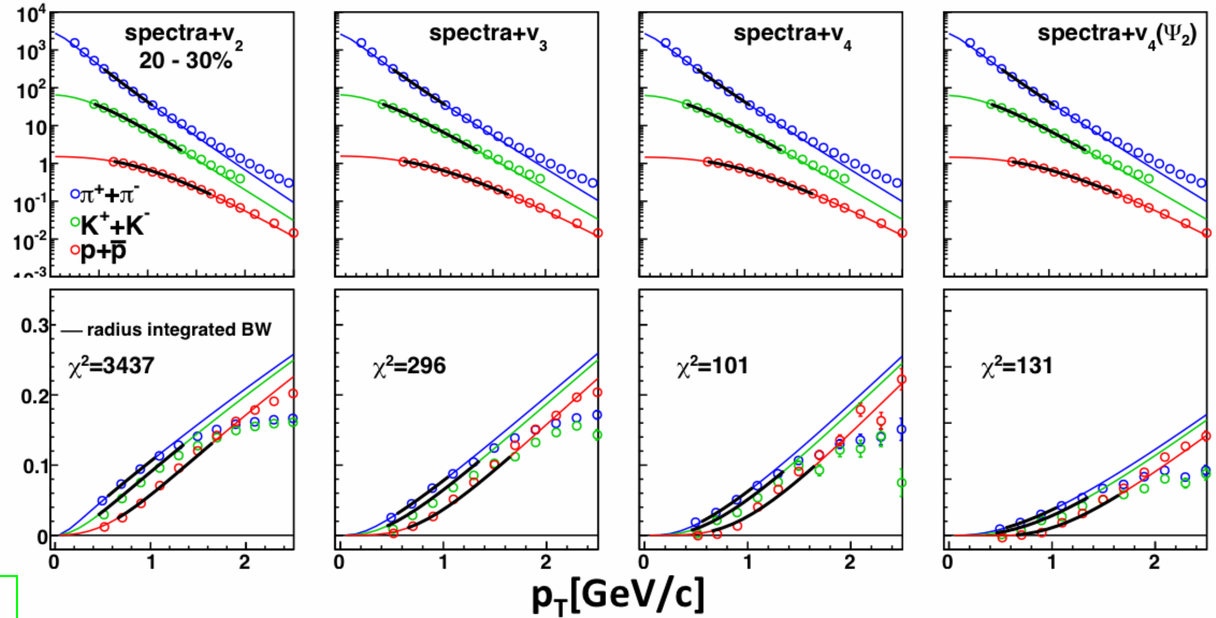
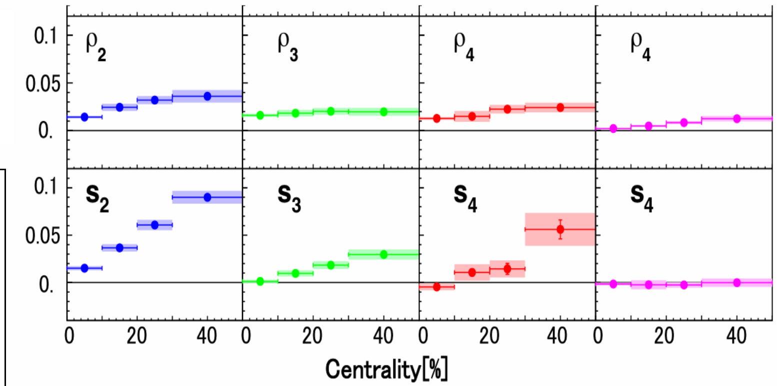
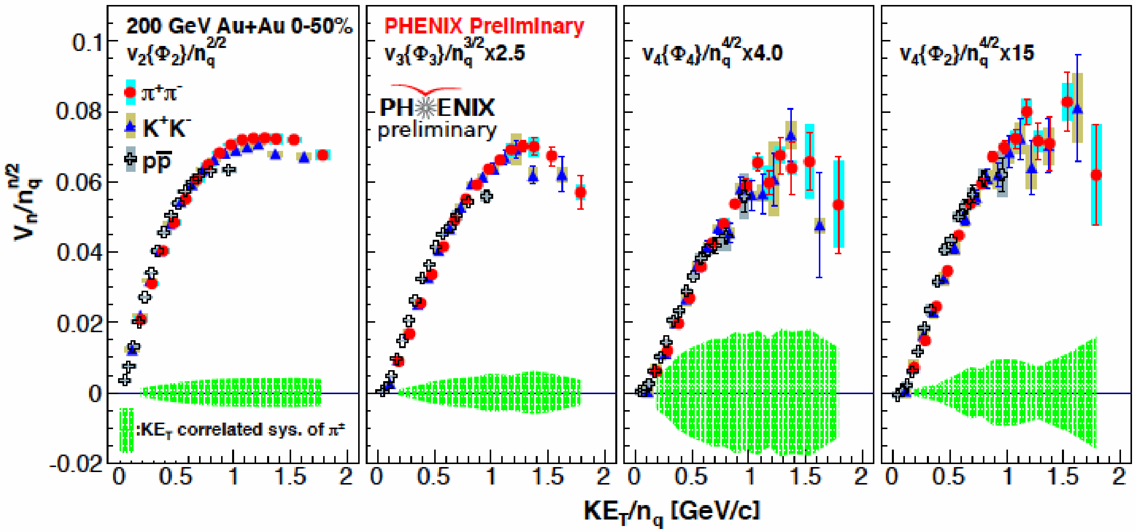


(a) : ~ v_2 / n_{CQ}
(b) : ~ $v_n^{1/n}$
(a)+(b) : ~ v_n / $n_{CQ}^{n/2}$

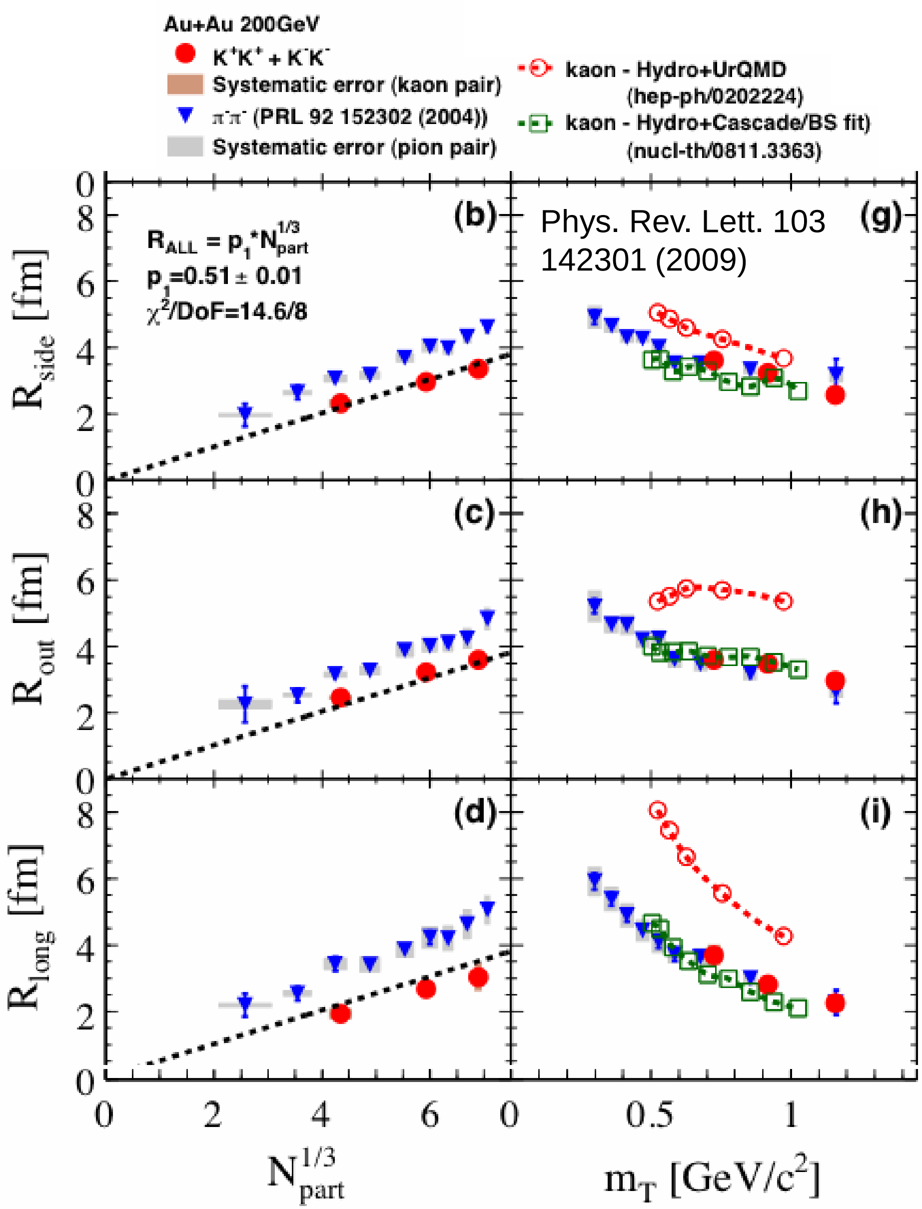


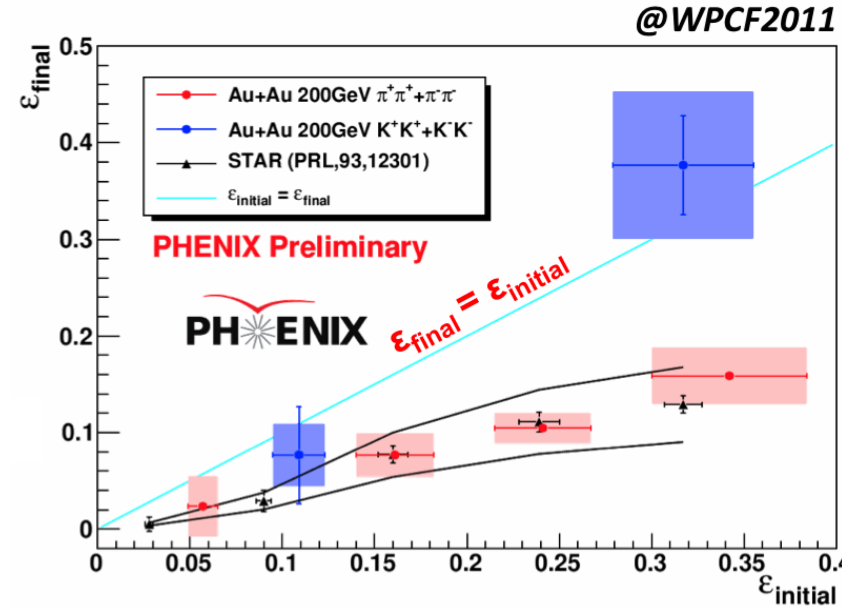


- anisotropy in velocity, coordinate
- T_f and ρ_0 constrained by spectra

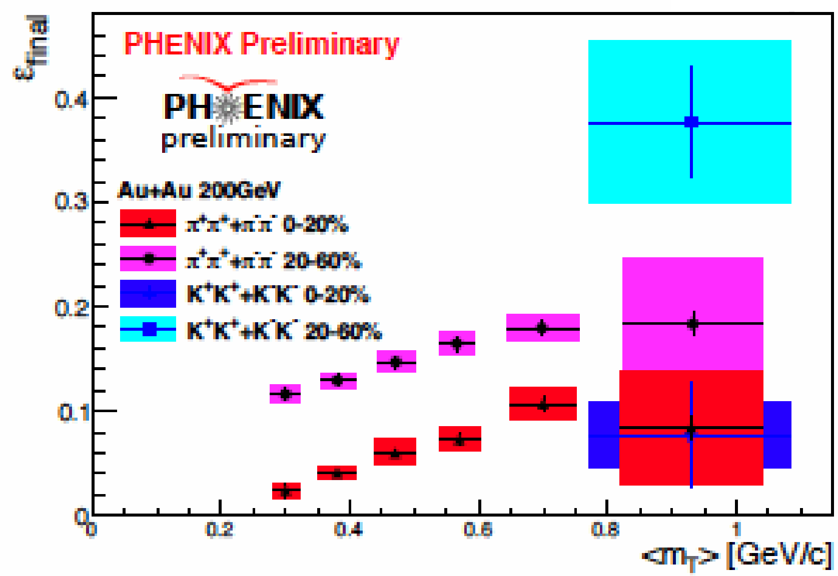
T_f : temperature at freeze-out
ρ_0 : average velocity
ρ_n : anisotropic velocity
s_n : spatial anisotropy

Azimuthal HBT of ππ, KK

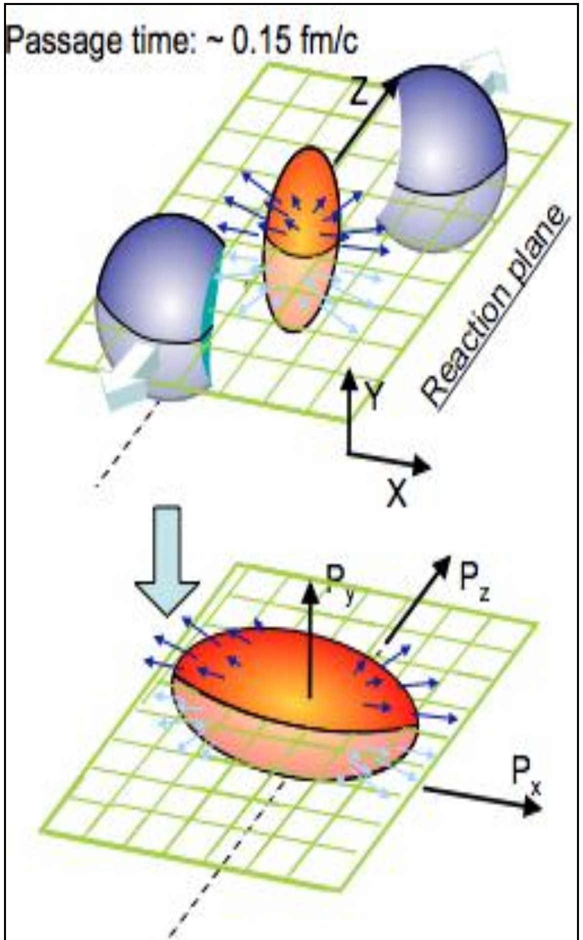


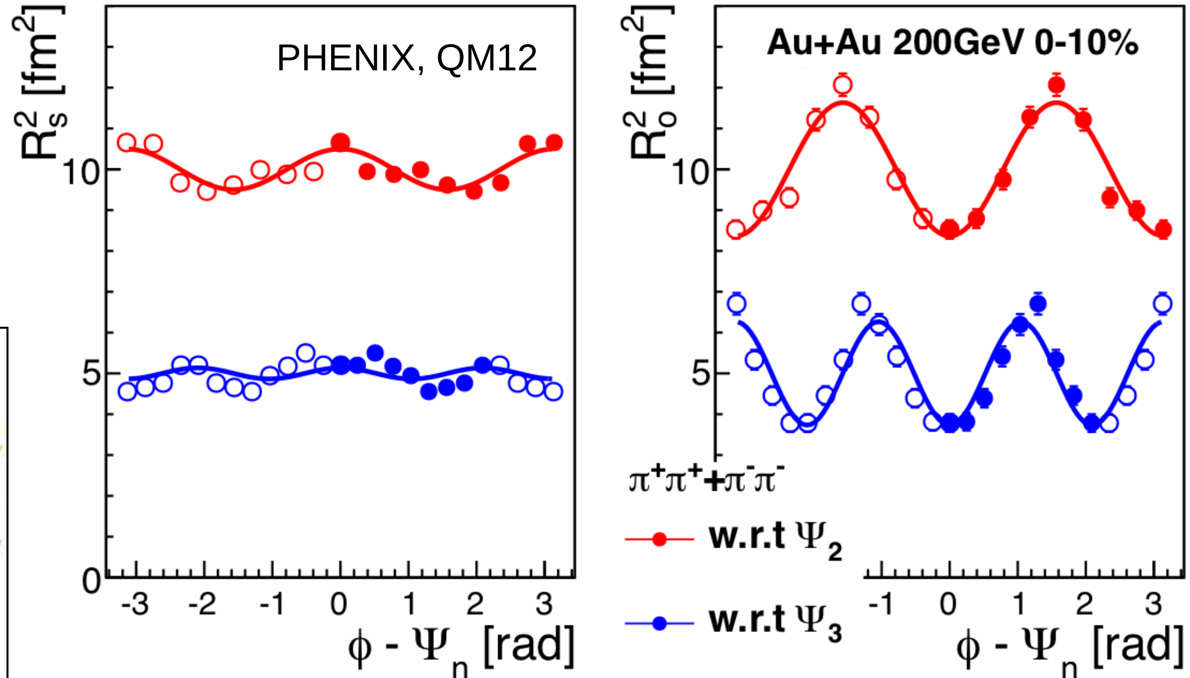


ε_2^{init} & p_T dependence of ε_2^{final}
--- $R_{T\text{-}side}^{oscill.}$ --- $v_2(p_T)$ & $R_{HBT}(p_T)$

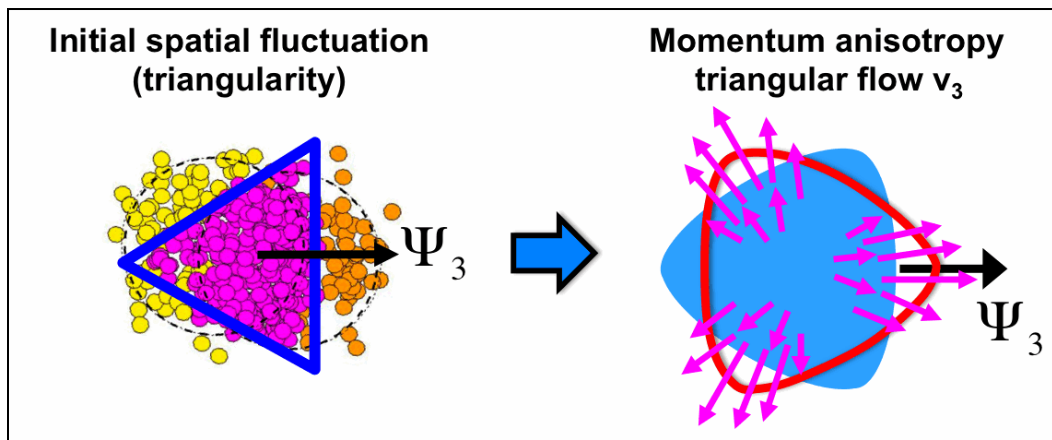


$R_{T\text{-side}}, R_{T\text{-out}} (\phi - \Phi_2)$
$R_{T\text{-side}}, R_{T\text{-out}} (\phi - \Phi_3)$





$R_{T\text{-side}}^{\text{oscill.}} < R_{T\text{-out}}^{\text{oscill.}}$ for n=2,3 (central)



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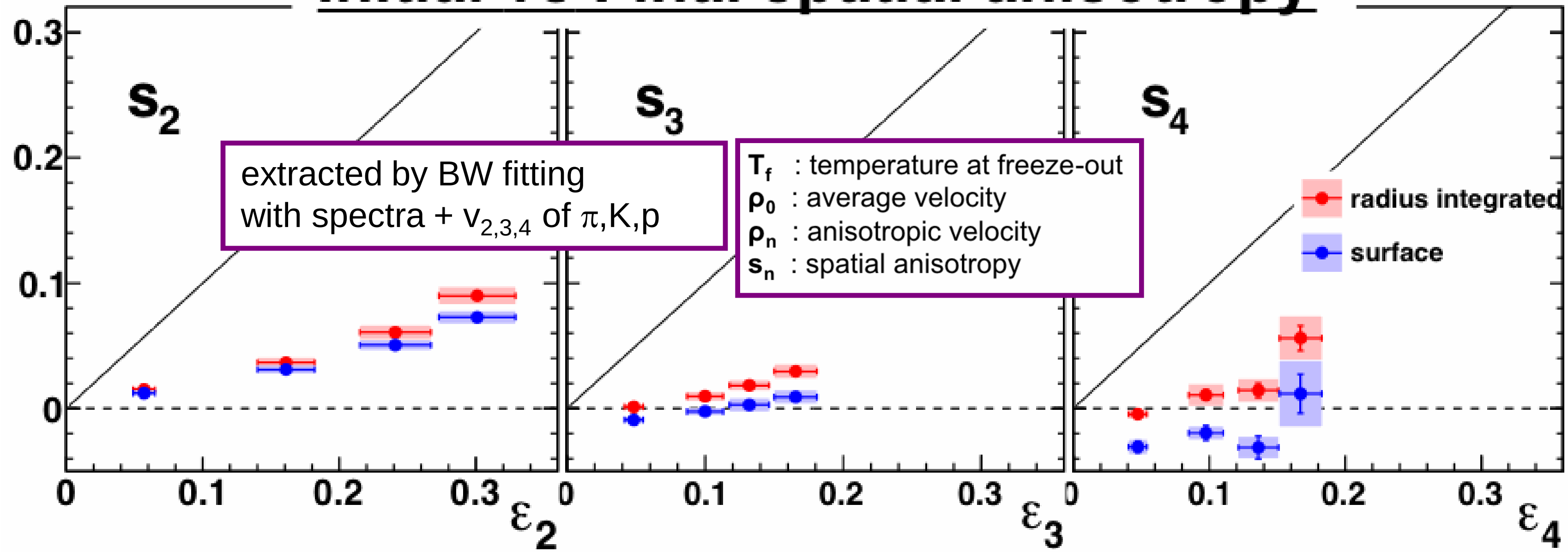
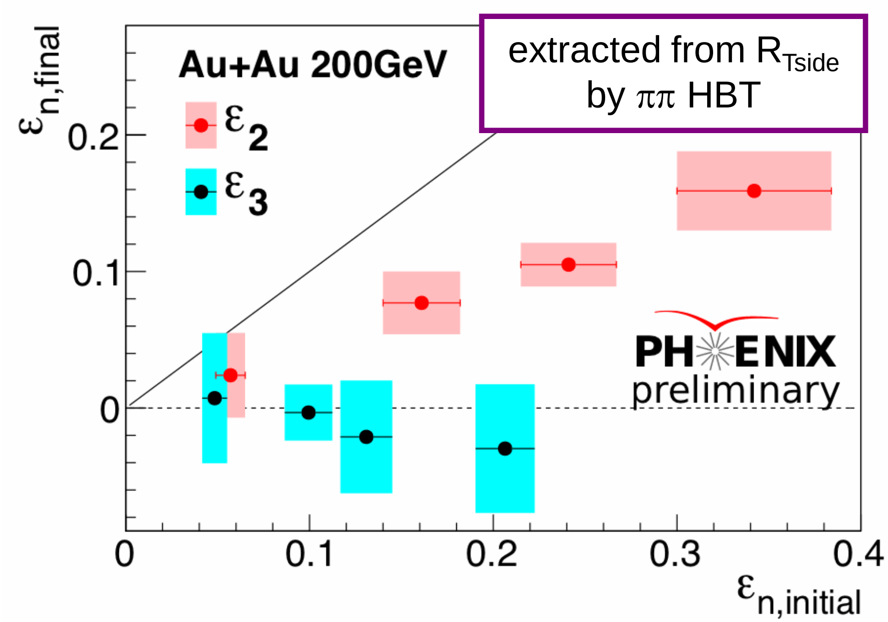
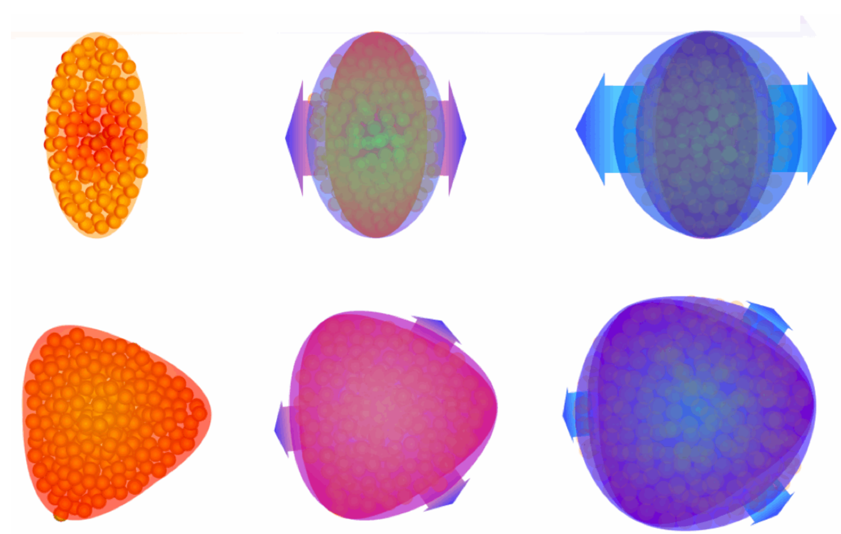
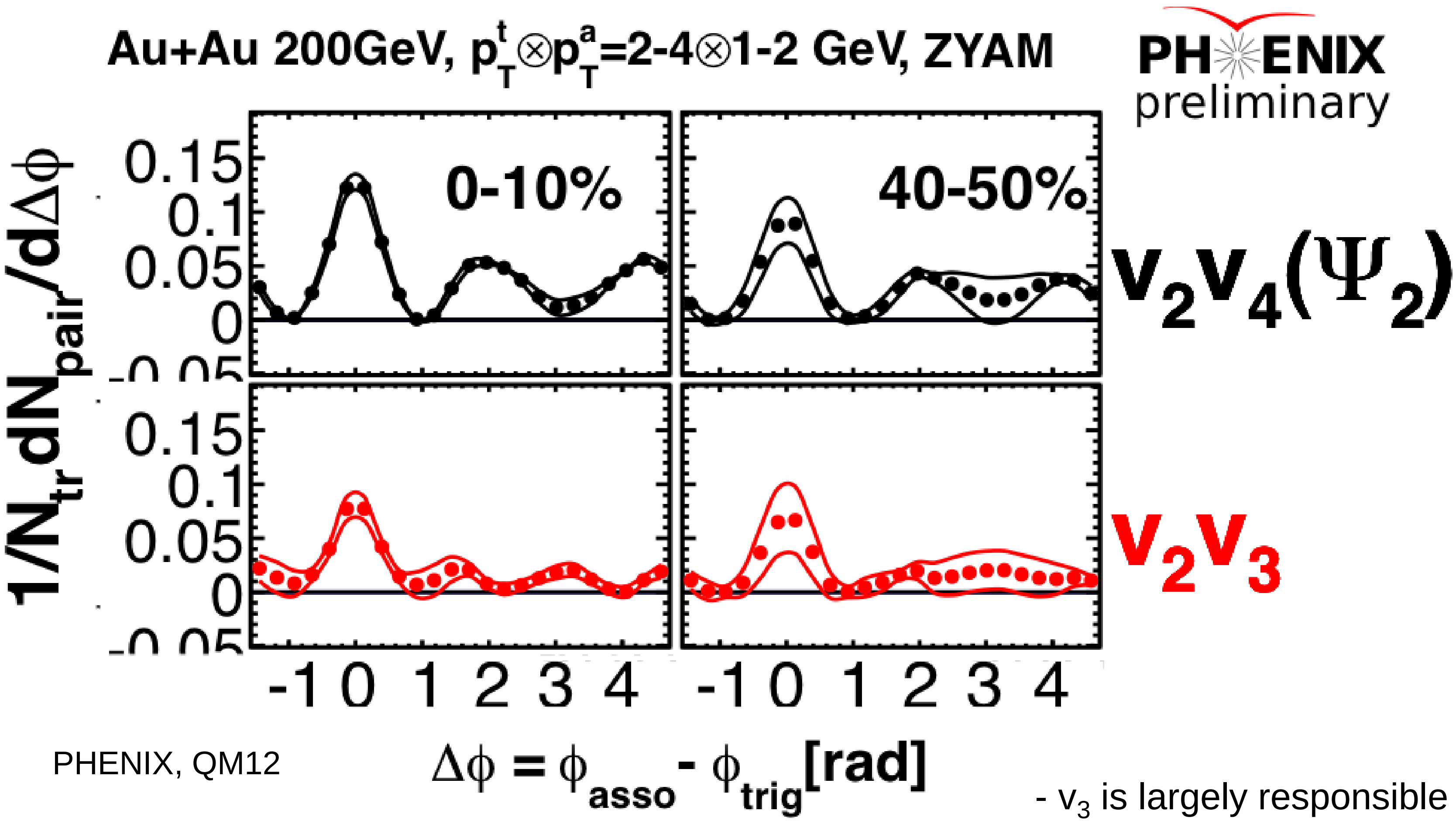
Initial vs Final spatial anisotropy







2-part. $\Delta\phi$ correlation with various flow subtraction (1)



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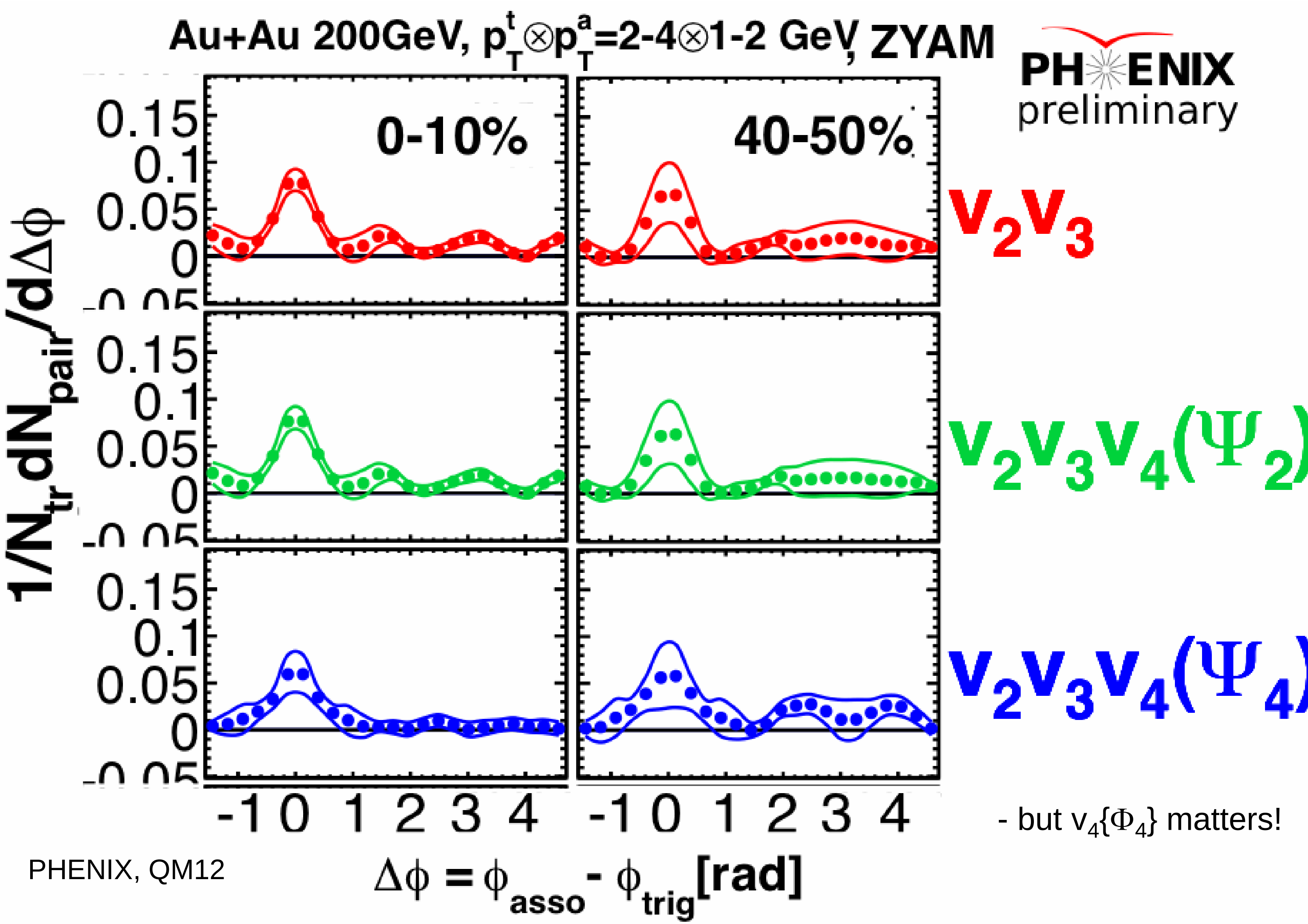
- v_3 is largely responsible for away side "mach-cone" like shape

2-part. Δϕ correlation with various flow subtraction (2)



- but $v_4\{\Phi_4\}$ matters!

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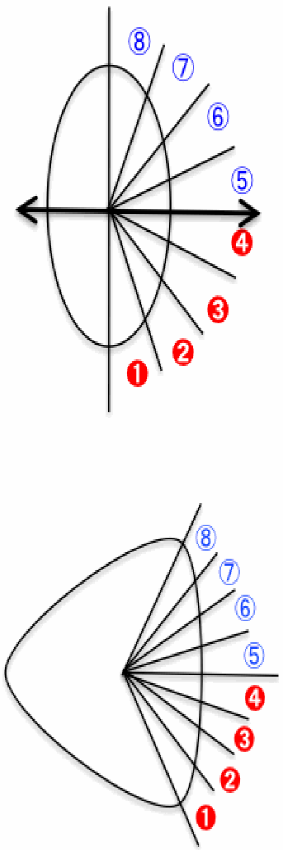
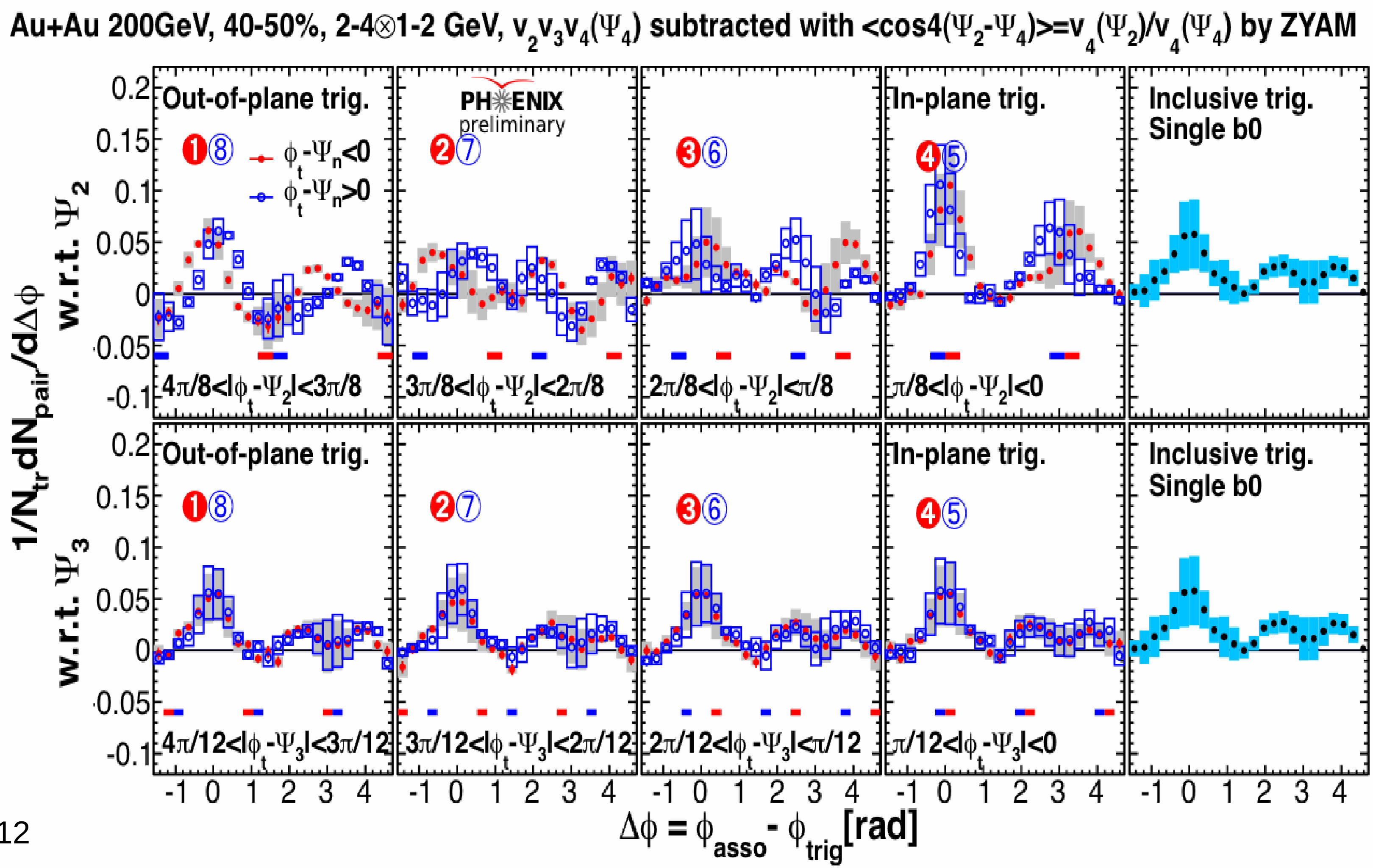
Correlations relative to Ψ_2 & Ψ_3, 40-50%





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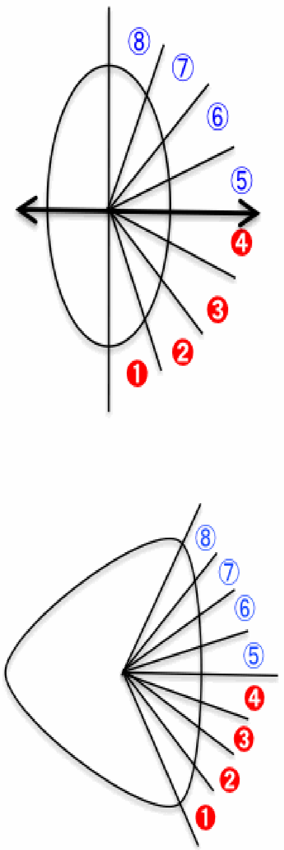
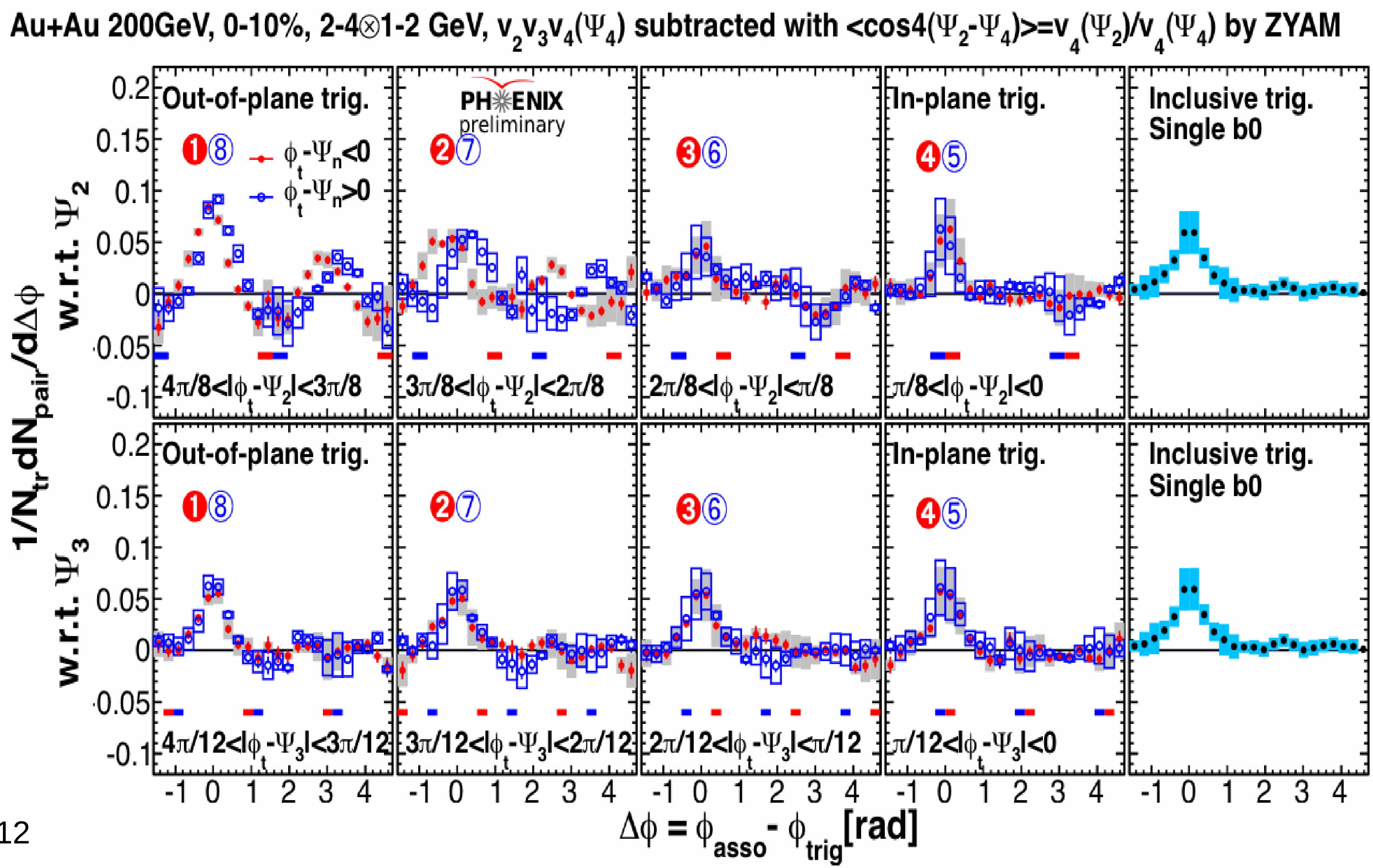
mid-central

- strong Φ_2 dependence and left/right asymmetry coupling with geometry and/or expansion
- almost no Φ_3 dependence (poor Φ_3 resolution)

Correlations relative to Ψ_2 & Ψ_3, 0-10%



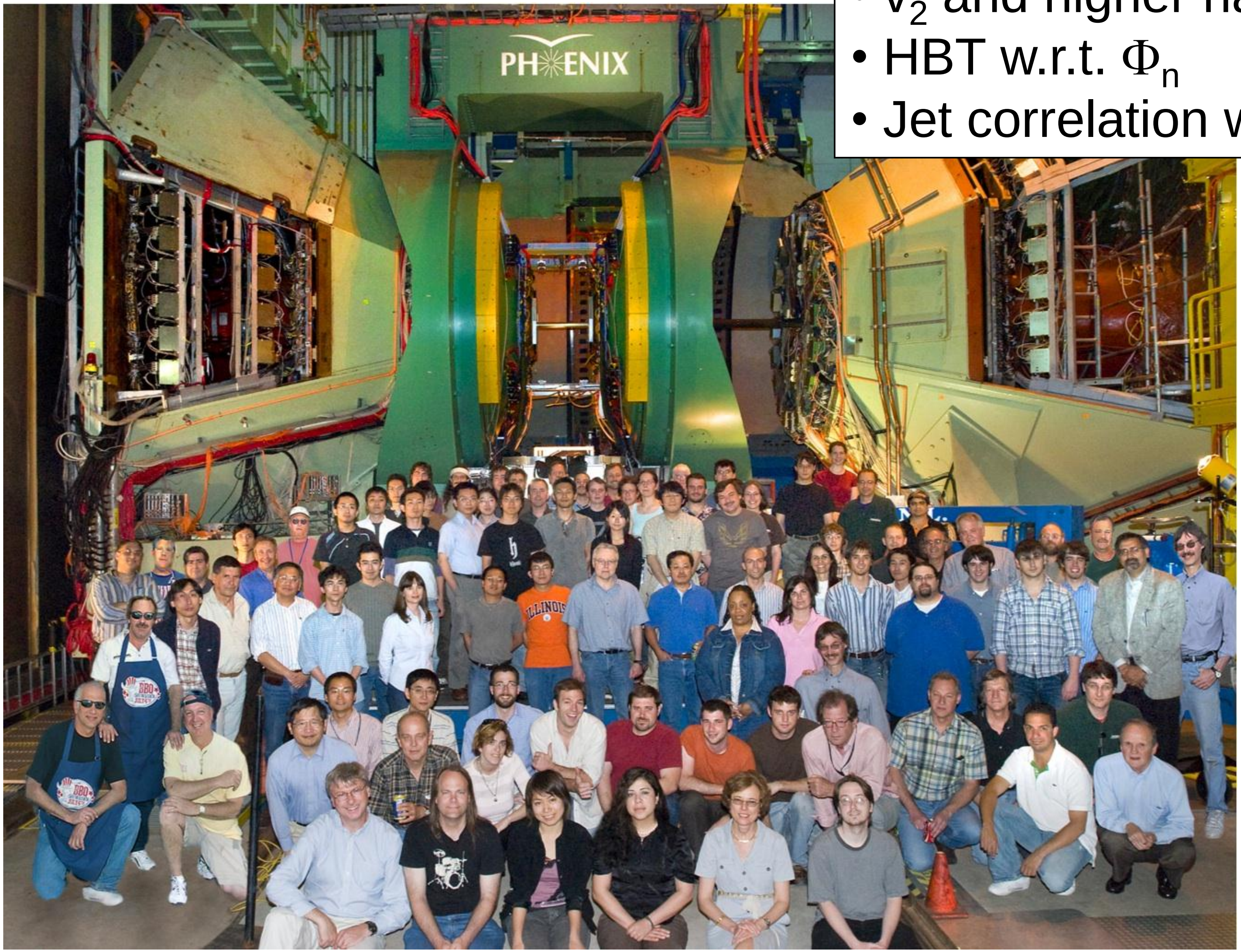


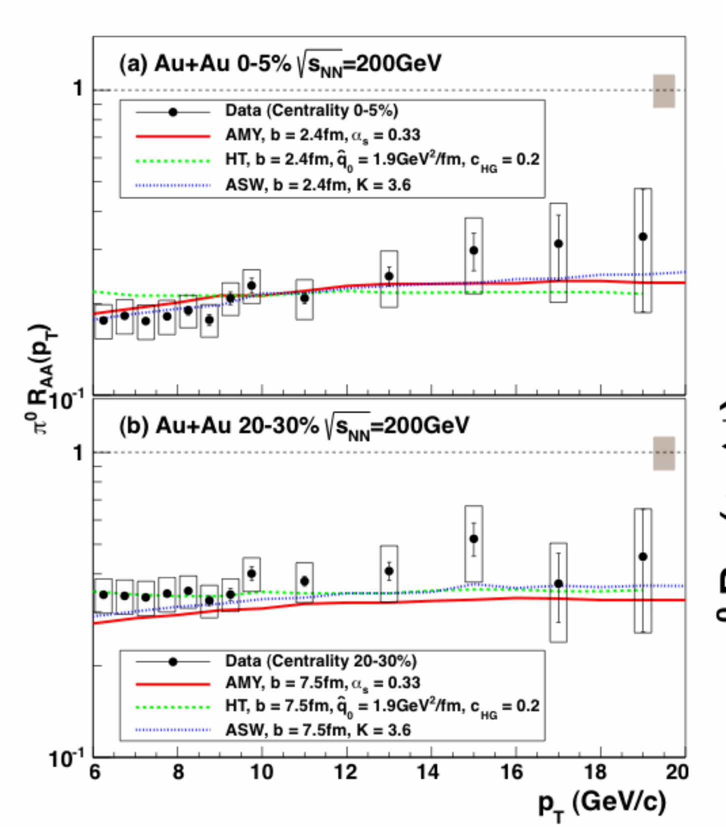
PHENIX, QM12

central	- out-of-plane correlation enhanced (strong jet quenching and collective expansion) - some weak Φ_3 dependence

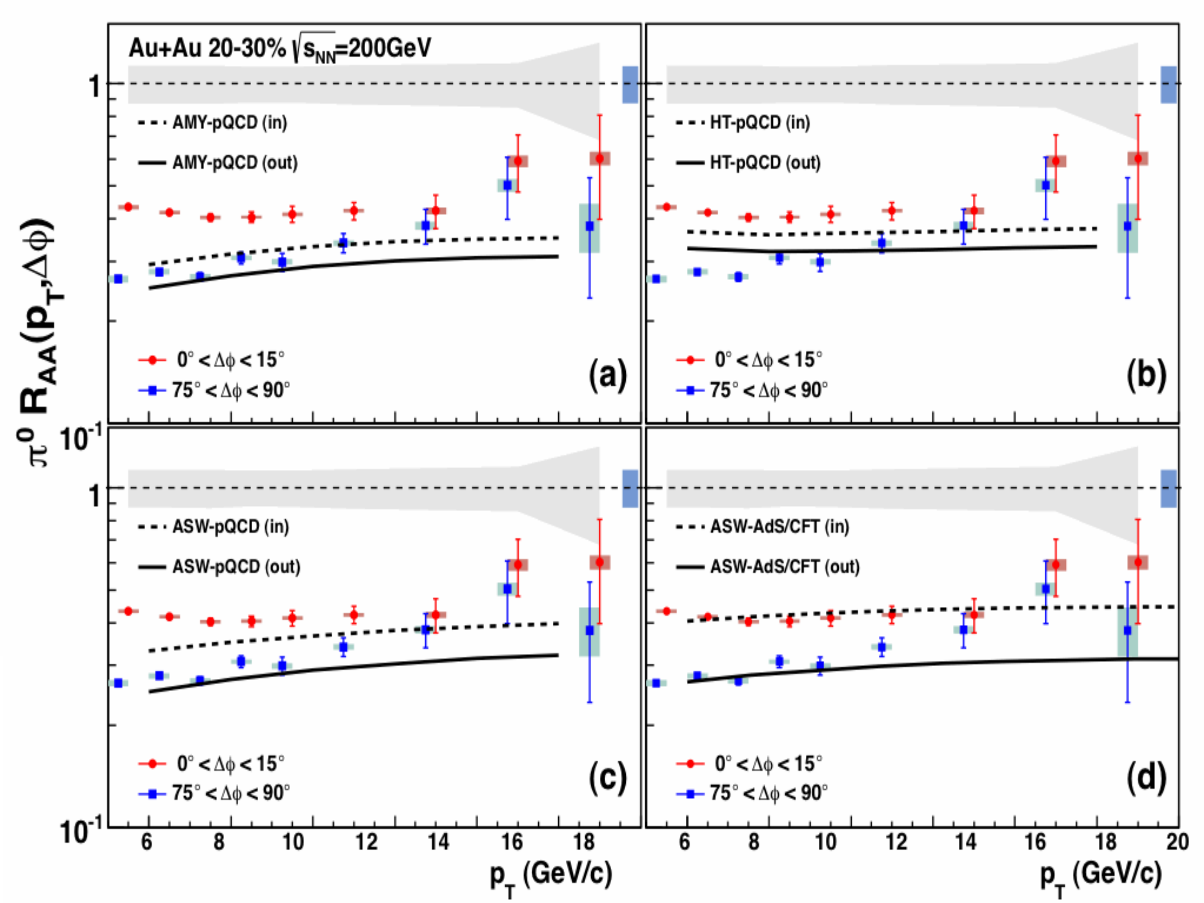
Summary

- High p_T suppression
- v_2 and higher harmonics
- HBT w.r.t. Φ_n
- Jet correlation w.r.t. Φ_n

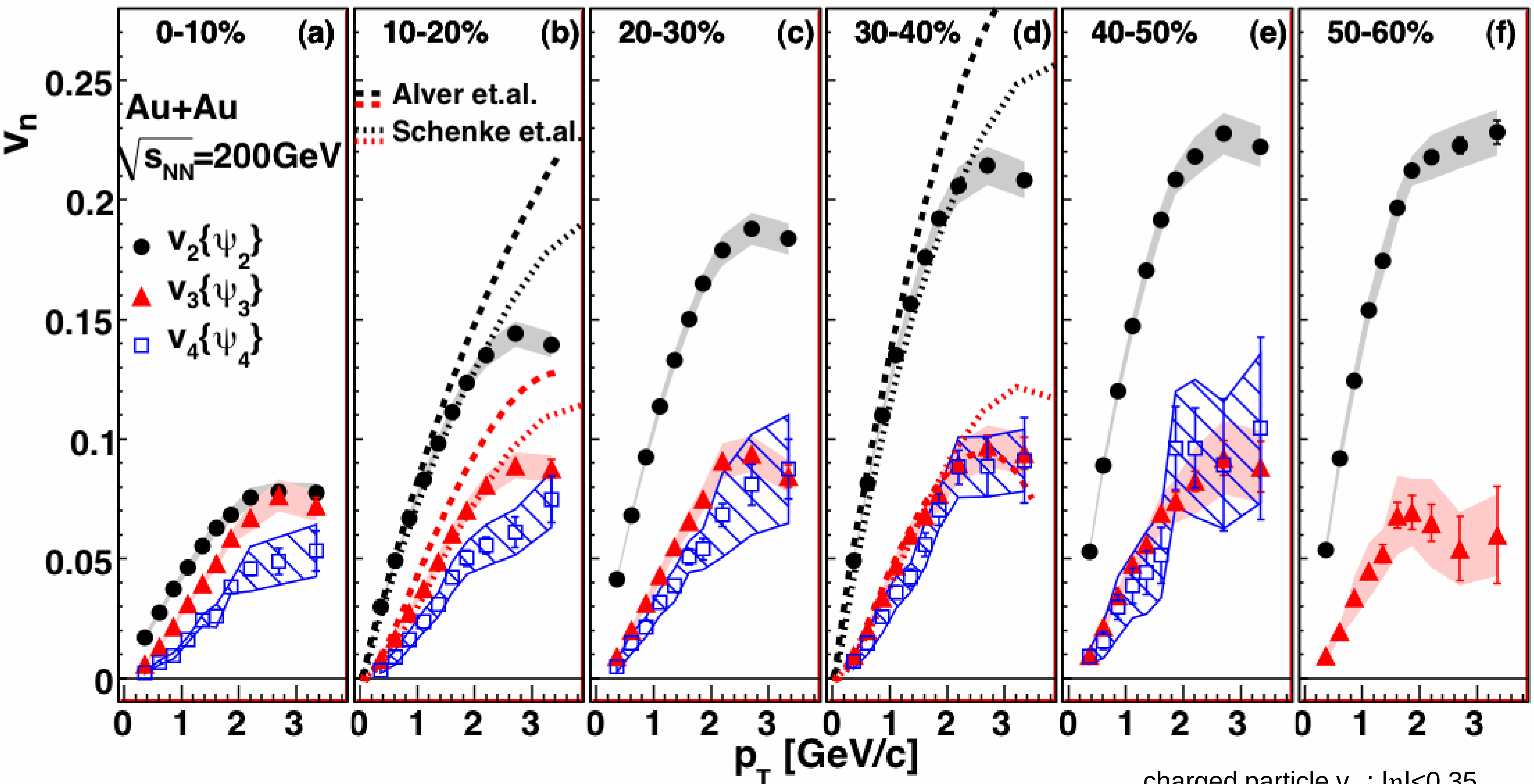




arXiv: 1208.2254



Centrality and p_T dependences of v_n at 200GeV Au+Au

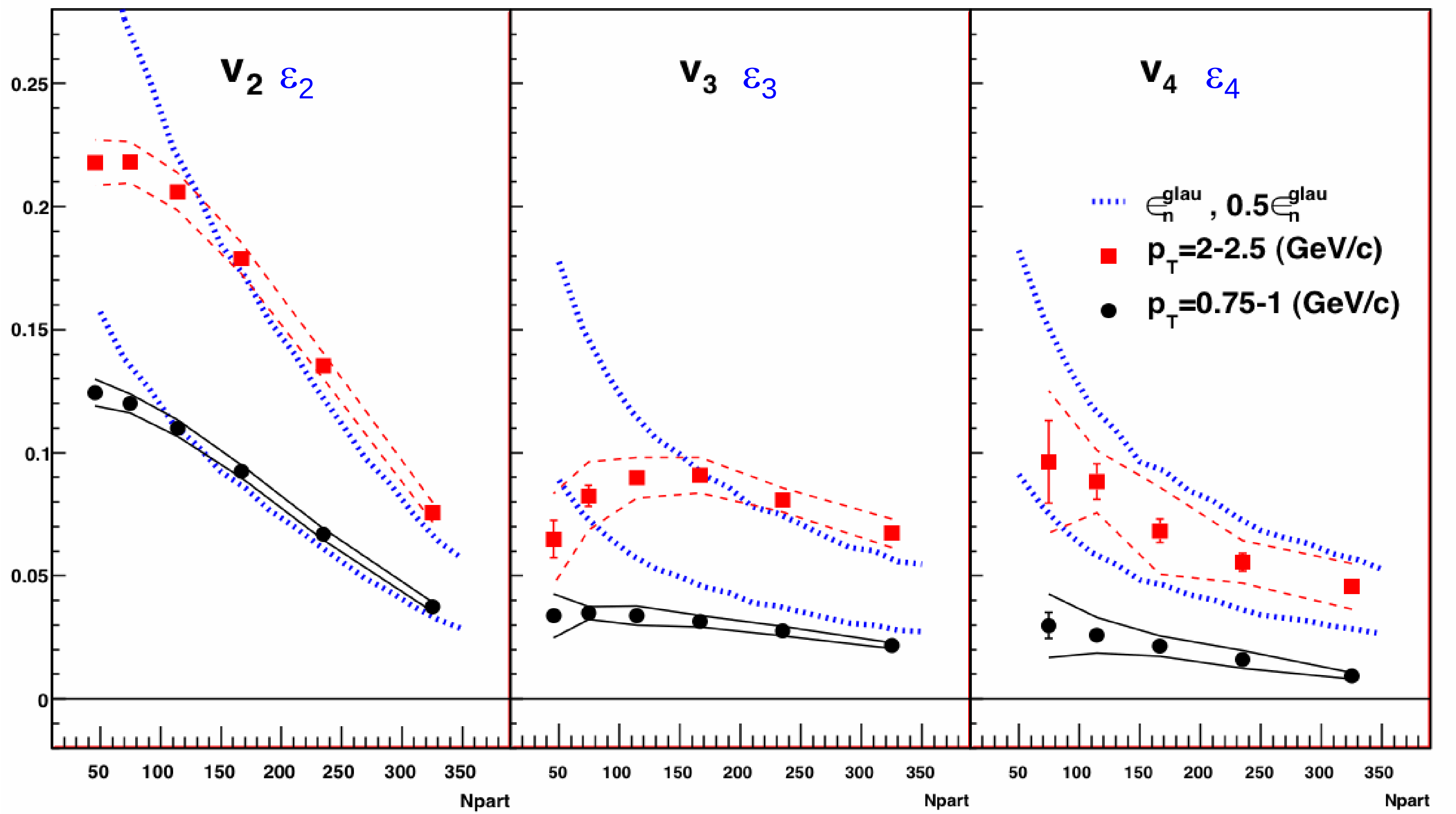


charged particle v_n : $|\eta|<0.35$
reaction plane Φ_n : $|\eta|=1.0\sim2.8$

v_3 is comparable to v_2 at 0~10%
weak centrality dependence on v_3
$v_4\{\Phi_4\} \sim 2 \times v_4\{\Phi_2\}$

All of these are consistent with initial fluctuation.

Centrality dependences of v_n (ε_n) at 200GeV Au+Au

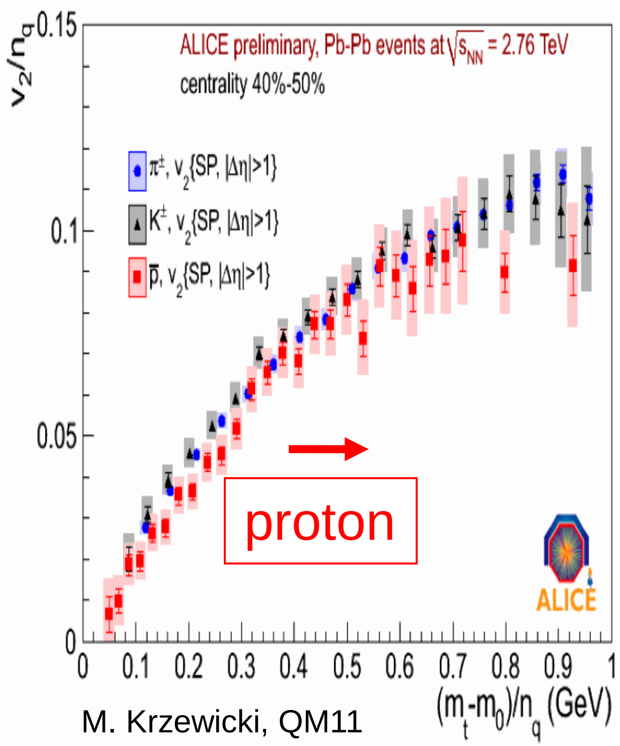


$N_{part.}$

How the initial geometrical anisotropy was transformed into the final momentum anisotropy?

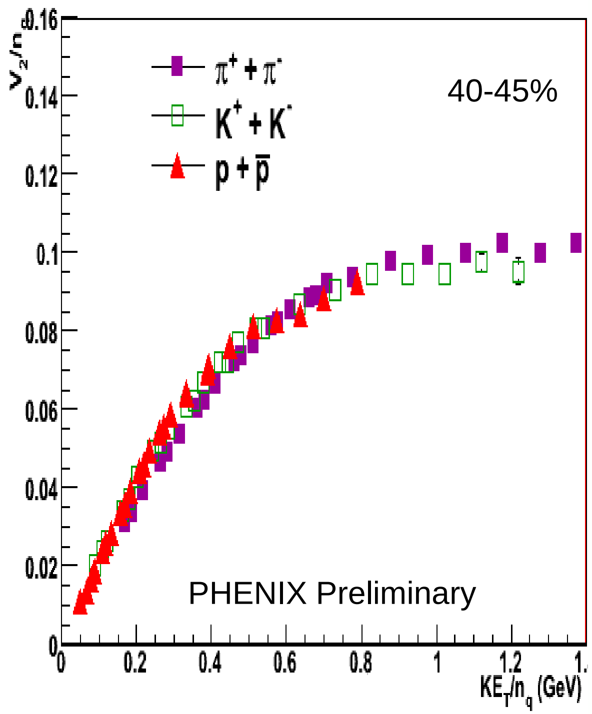
Small deviations in $(m_T-m_0)/n_q$ scaled v_2

Pb+Pb 2.76TeV

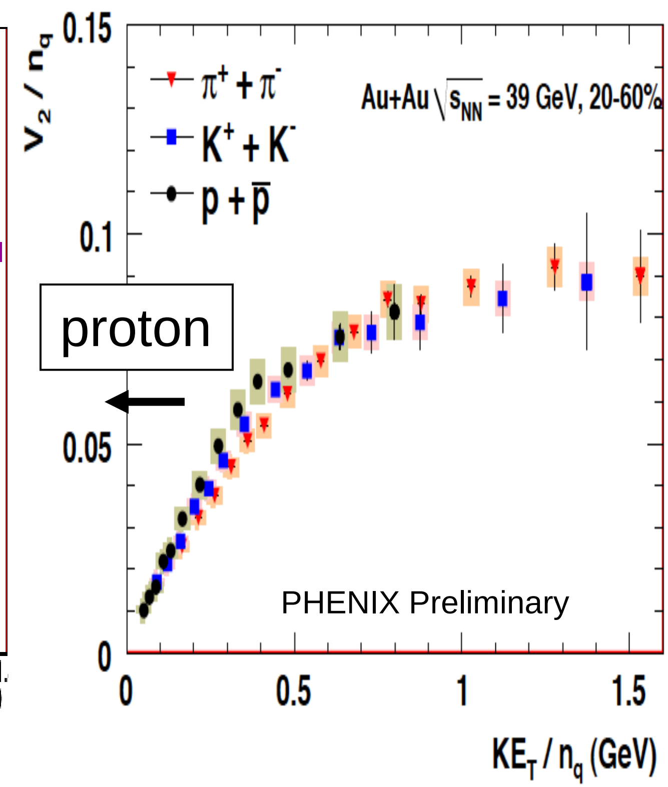


M. Krzewicki, QM11
J. Phys. G38, (2011) 124047

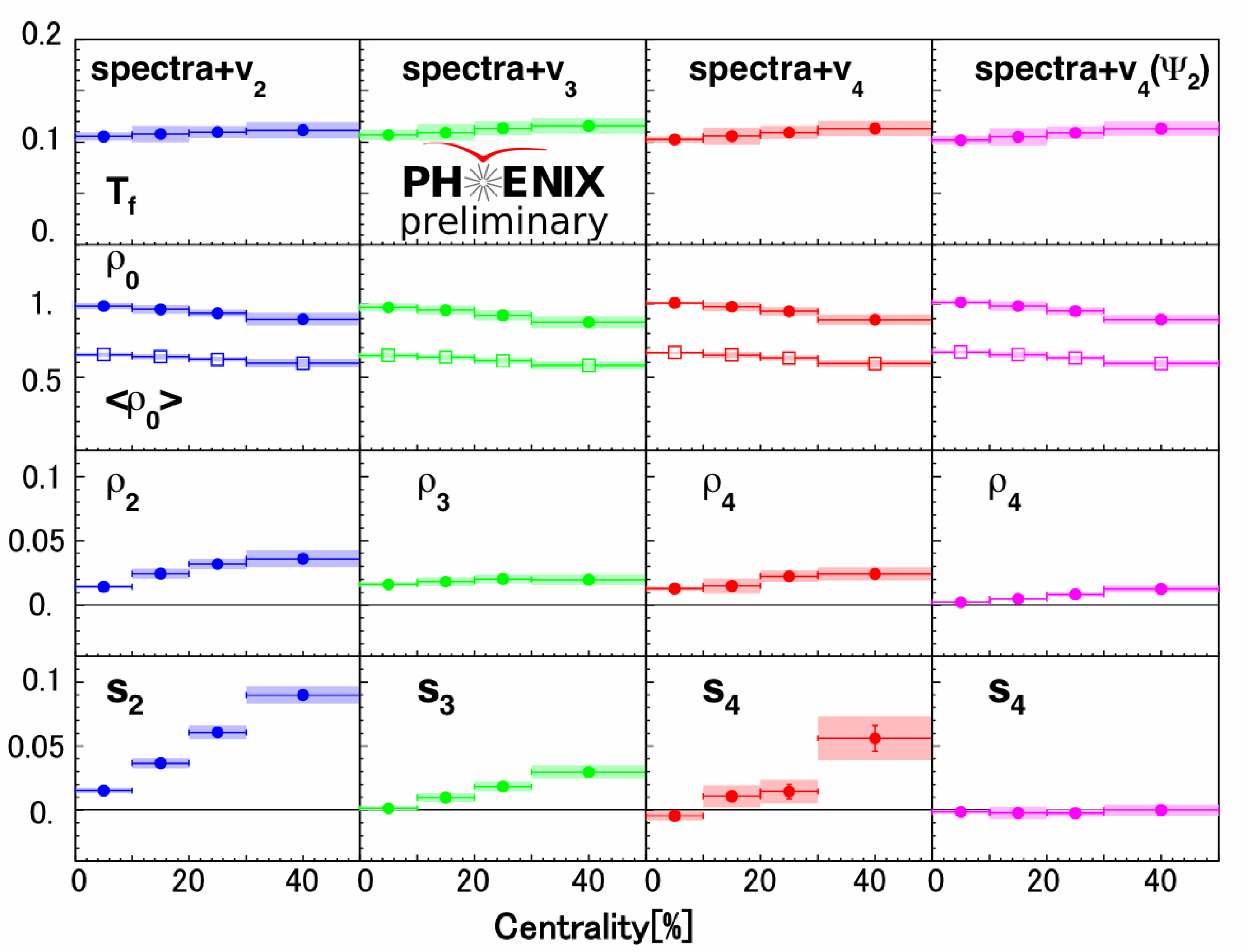
Au+Au 200GeV

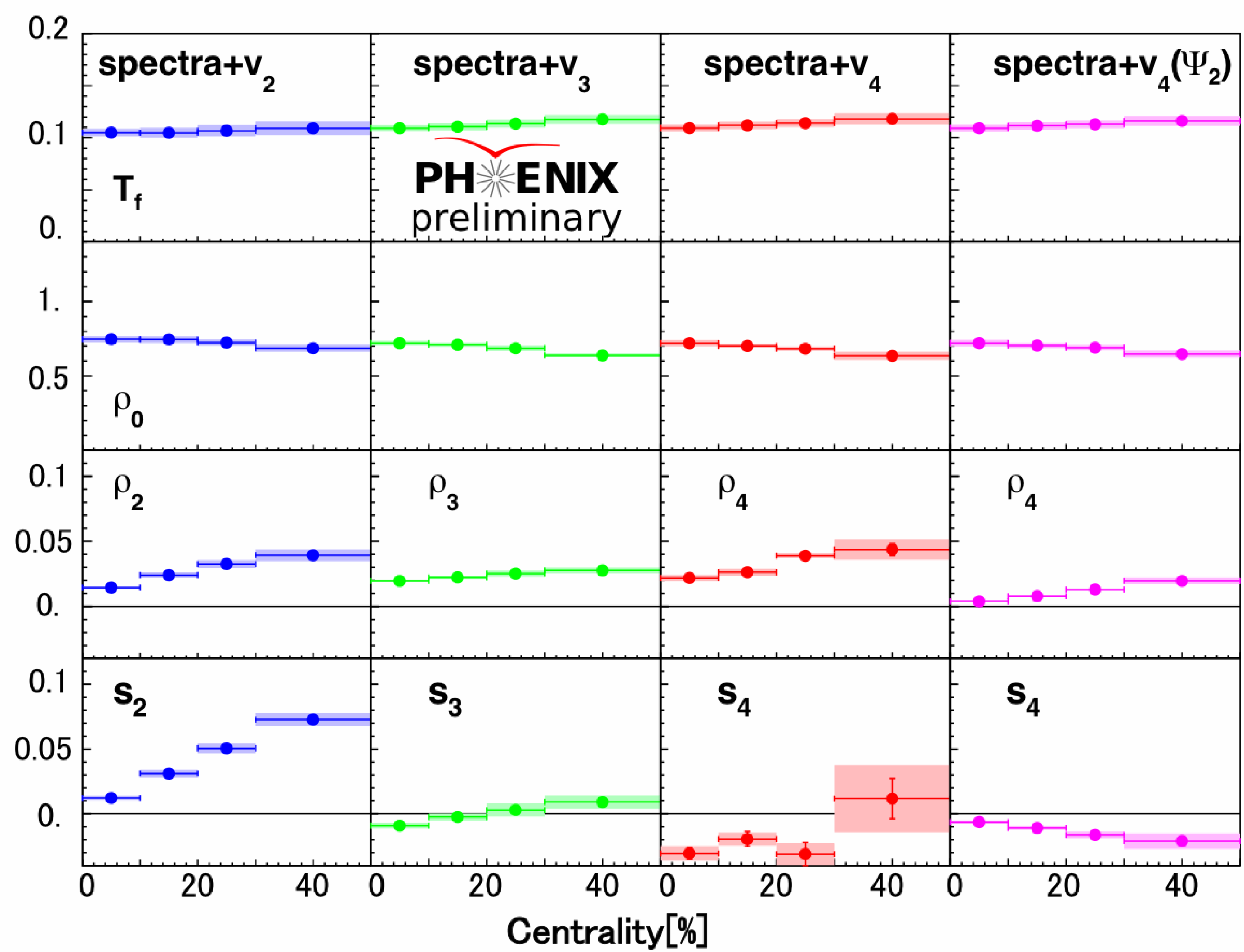


Au+Au 39GeV

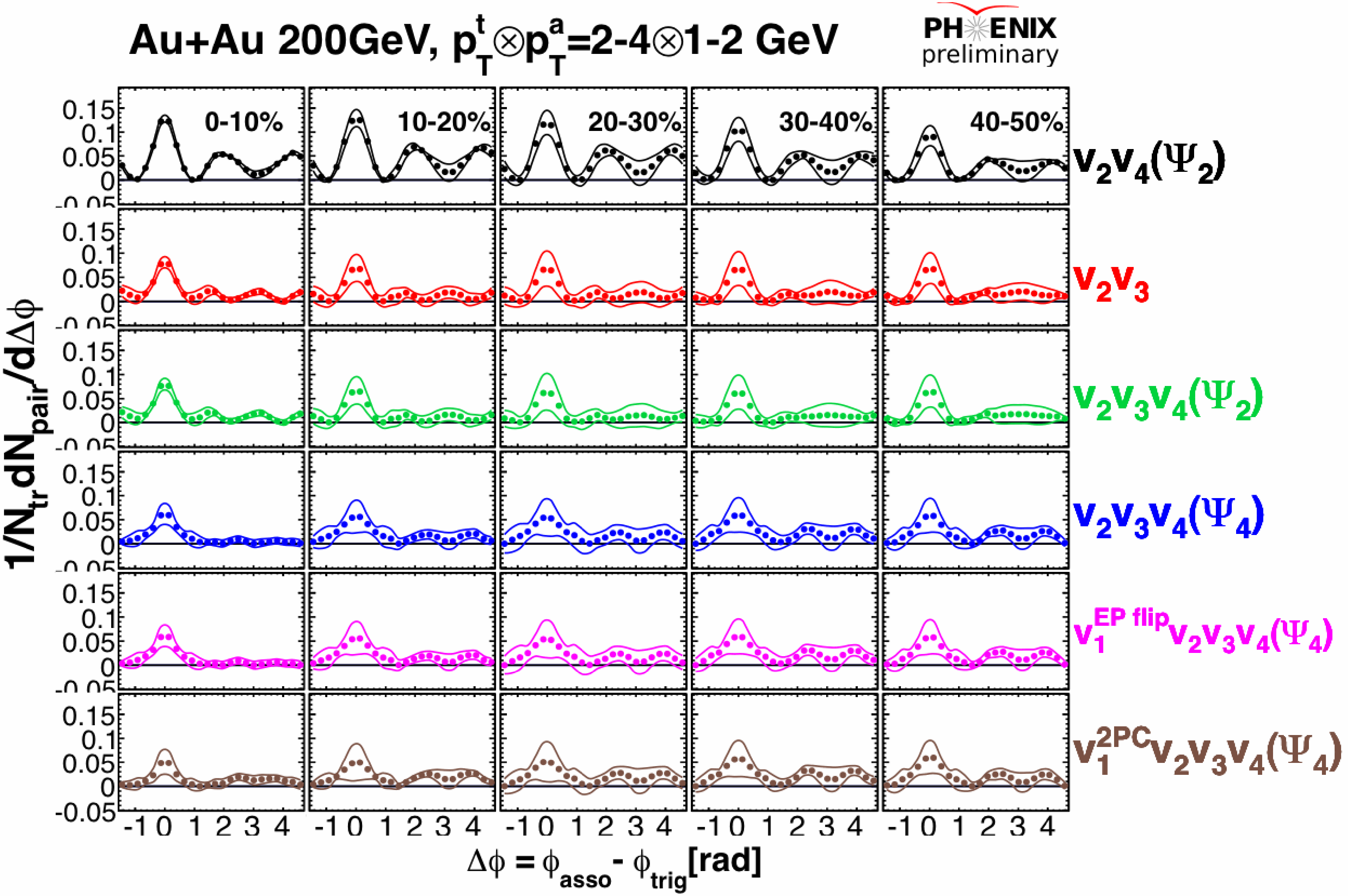


roughly $(m_T-m_0)/n_q$ scaled for all energies
larger p_T shift for heavier particles
radial flow increases with energy


spectra+v2
spectra+v3
spectra+v4
spectra+v4(Ψ2)
Tf
PHENIX preliminary
ρ0
<ρ0>
ρ2
ρ3
ρ4
ρ4
s2
s3
s4
s4
0.2
0.1
0.
1.
0.5
0.1
0.05
0.
0.1
0.05
0.
0
20
40
Centrality[%]



spectra+v2
spectra+v3
spectra+v4
spectra+v4(Ψ2)
Tf
PHENIX preliminary
ρ0
ρ2
ρ3
ρ4
ρ4
s2
s3
s4
s4
Centrality[%]


Au+Au 200GeV, $p_T^t \otimes p_T^a$=2-4⊗1-2 GeV
PHENIX preliminary
0-10%
10-20%
20-30%
30-40%
40-50%
$v_2v_4(\Psi_2)$
v_2v_3
$v_2v_3v_4(\Psi_2)$
$v_2v_3v_4(\Psi_4)$
$v_1^{EP\ flip}v_2v_3v_4(\Psi_4)$
$v_1^{2PC}v_2v_3v_4(\Psi_4)$
$1/N_{tr}dN_{pair}/d\Delta\phi$
$\Delta\phi = \phi_{asso} - \phi_{trig}$[rad]

Correlations relative to Ψ_2 & Ψ_3 20-30%