Identified and charged particle azimuthal anisotropy in PHENIX at RHIC

ShinIchi Esumi for the PHENIX collaboration

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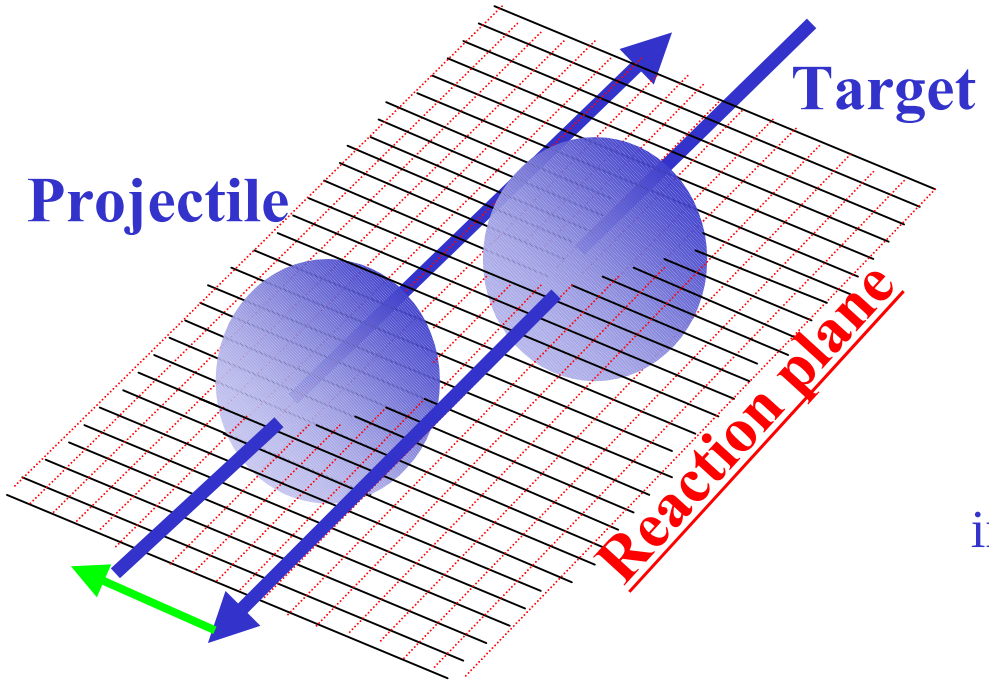
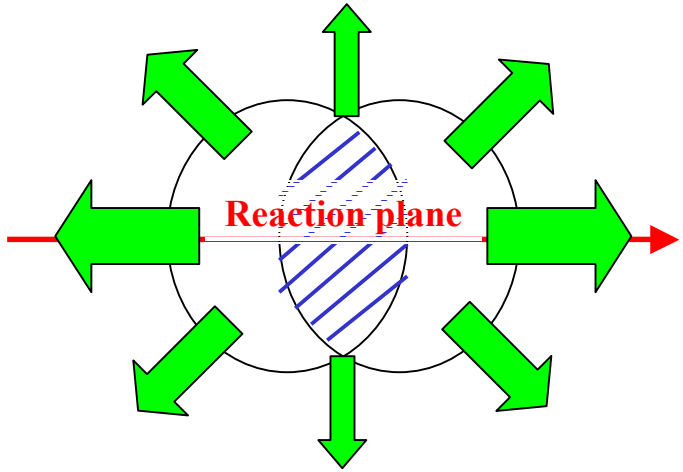
(2) method
(3) centrality and p_T dependences
(4) identified particle anisotropy

Introduction



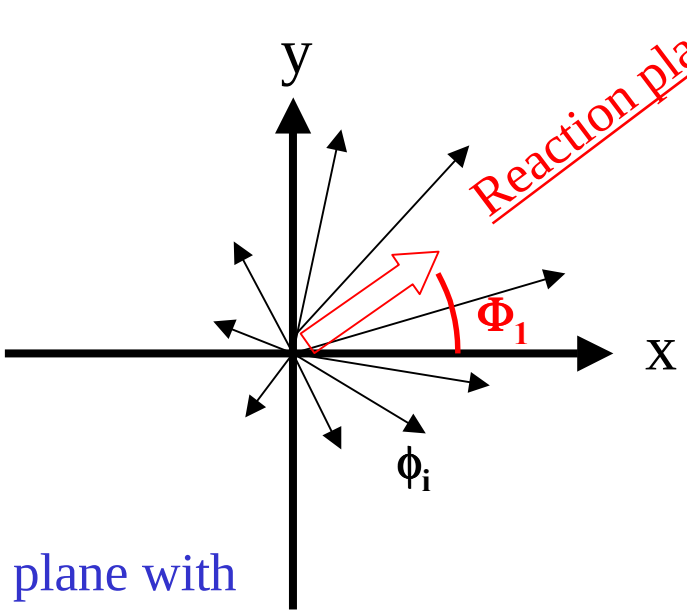


initial geometry → final momentum anisotropy

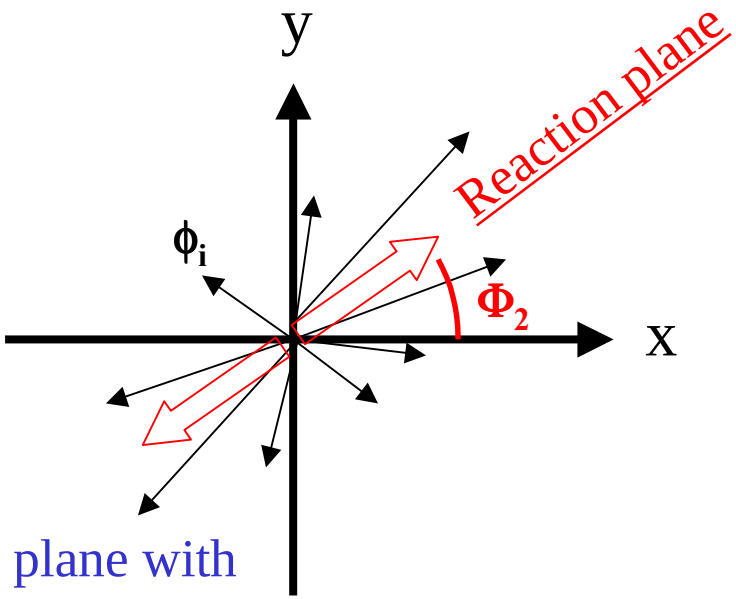
b:impact parameter

Relation to QGP, hard processes,
Jet-quenching and HBT radii,
v1,v2 for different particle species
and their p_T, rapidity, centrality
dependences

Reaction plane definition



plane with
the directed moment



plane with
the elliptic moment

$$\tan(\Phi_1) = \frac{\Sigma\, w_i * \sin(\phi_i)}{\Sigma\, w_i * \cos(\phi_i)}$$

$$\tan(2\Phi_2) = \frac{\Sigma\, w_i * \sin(2\phi_i)}{\Sigma\, w_i * \cos(2\phi_i)}$$

(w_i: 1 or p_T)

reaction plane based analysis

$$dN/d(\phi-\Phi) = N\,(1 + \Sigma\, 2v_n{}'\cos(n(\phi-\Phi)))$$

ϕ : azimuthal angle for measured particles

Φ : reaction plane angle

$v_n{}'$: raw anisotropy parameter

$v_n = v_n{}'/F$: corrected anisotropy parameter

F : reaction plane resolution

pair wise correlation analysis

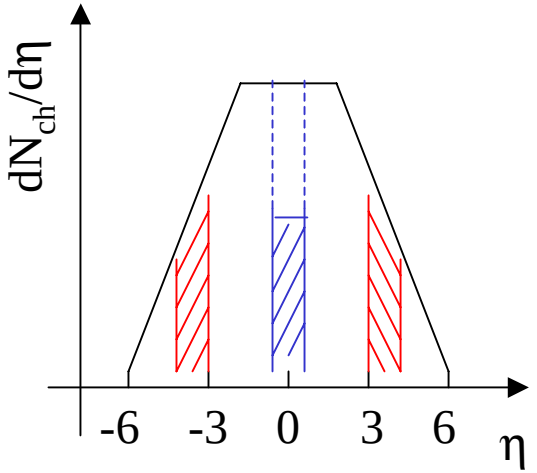
$$N^{real}(\Delta\phi)/N^{mixed}(\Delta\phi) = N\,(1 + \Sigma\, 2v_n{}^2\cos(n(\Delta\phi)))$$

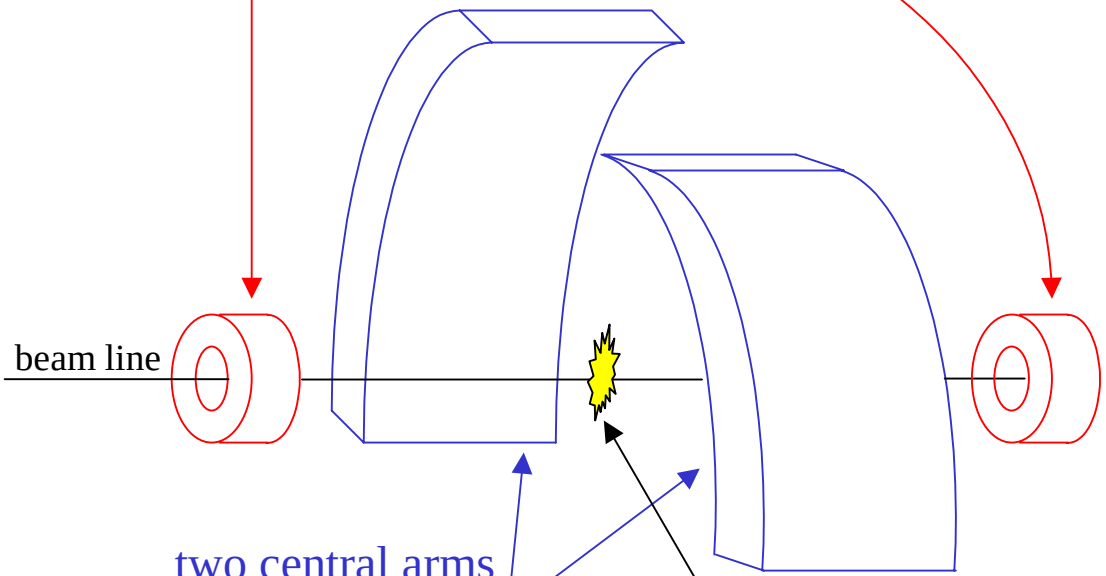
$\Delta\phi : \phi_i - \phi_j$

$$F(x) = A\exp(-0.5(x/\sigma)^2) + B\,(1+2v_2{}^2\cos(2x))$$

Gauss term is to account for some of the non-flow contribution.

Beam-beam counter
(BBC) $|\eta|$=**3~4**
64pmts in each BBC
charged particles

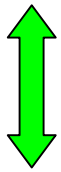




two central arms
(CNT) $|\eta|$<**0.35**
Dch,PCs,TOF,EMCAL
tracking, momentum, PID

collision point

Reaction plane determination is at 3 units of rapidity away from the mid-rapidity, therefore less non-flow contributions.

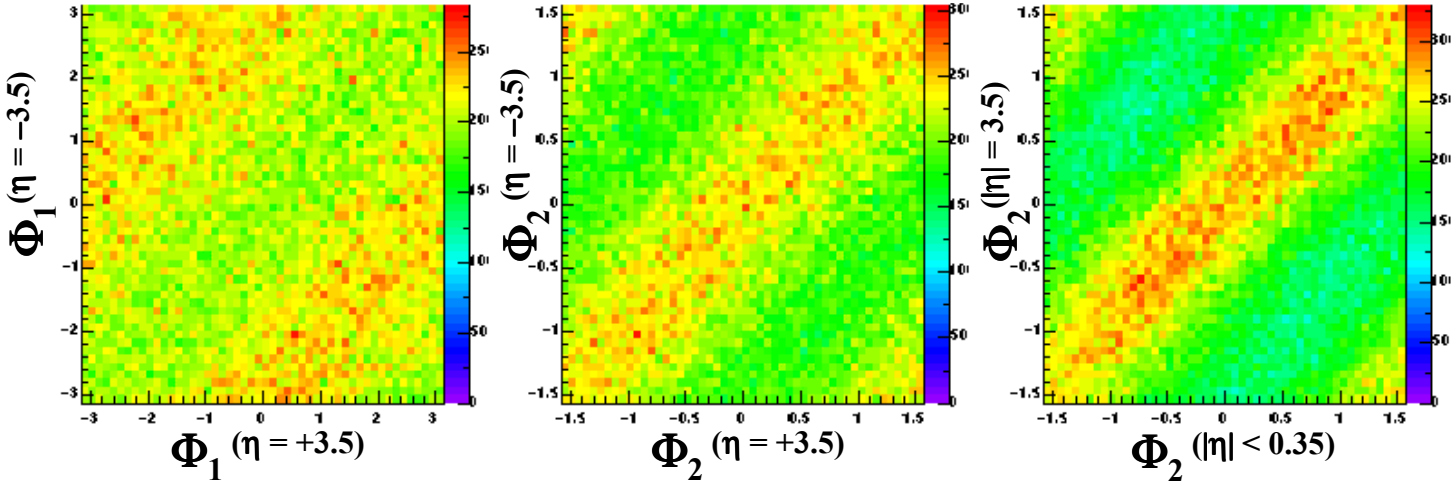


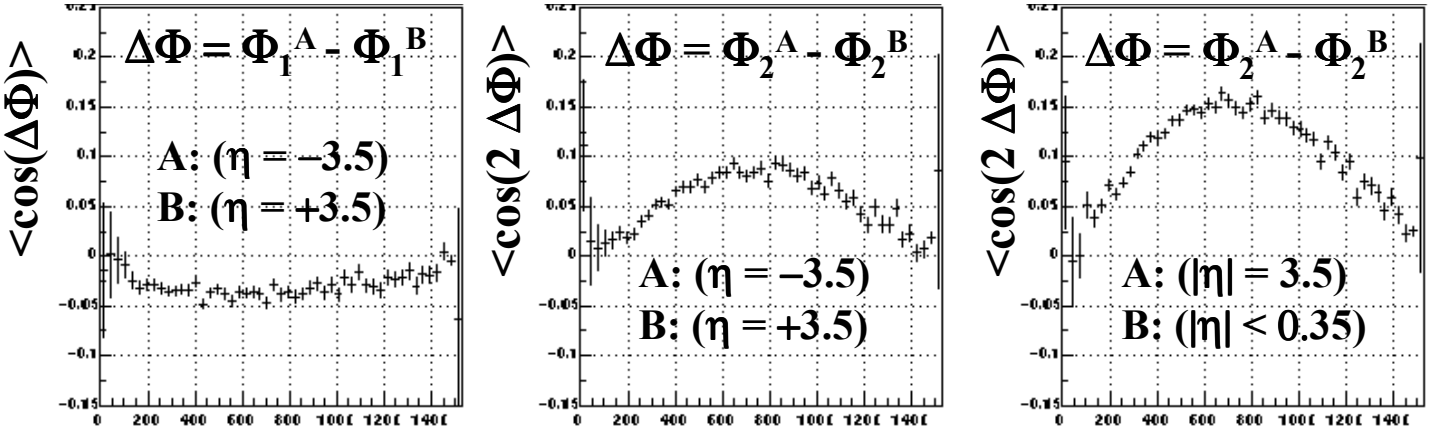
Pair correlation analysis uses charged tracks at mid-rapidity.

$\eta = -3.5$ vs $\eta = +3.5$
(directed : n=1)

$\eta = -3.5$ vs $\eta = +3.5$
(elliptic : n=2)

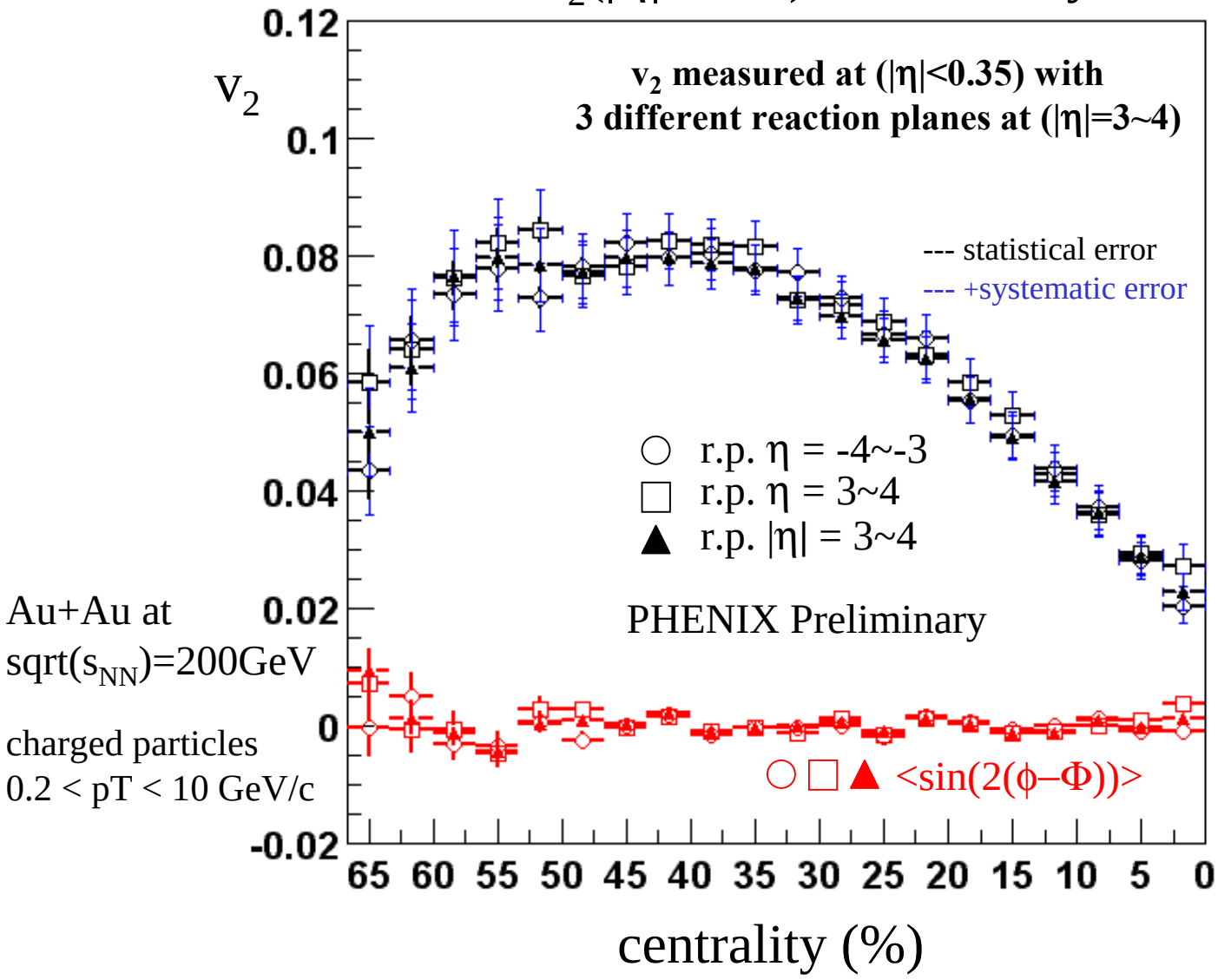
$|\eta|=3.5$ vs $|\eta| < 0.35$
(elliptic : n=2)





charged multiplicity ⟶

$v_2(|\eta|<0.35)$ vs centrality

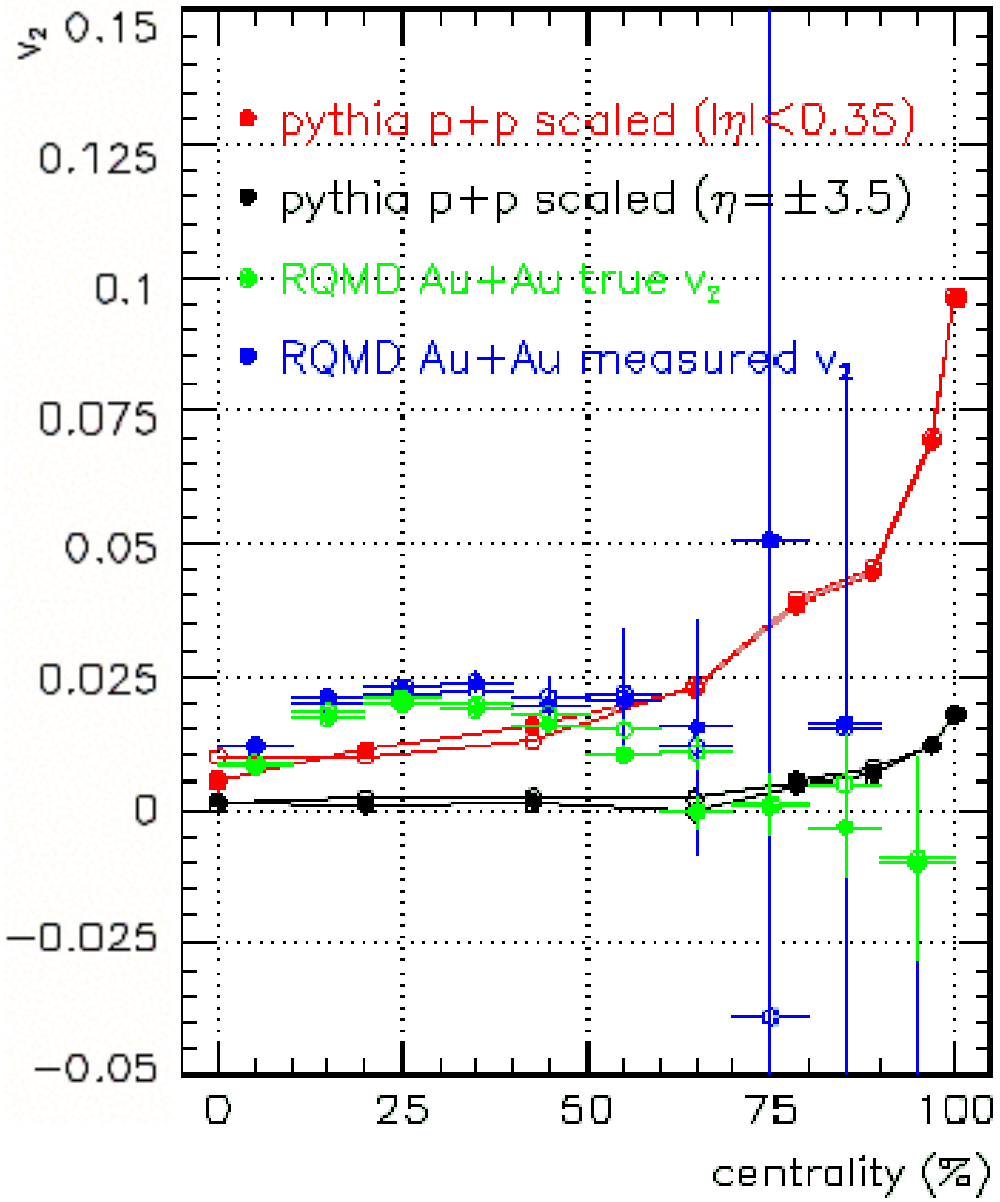


Au+Au at
sqrt(s_{NN})=200GeV

charged particles
0.2 < pT < 10 GeV/c

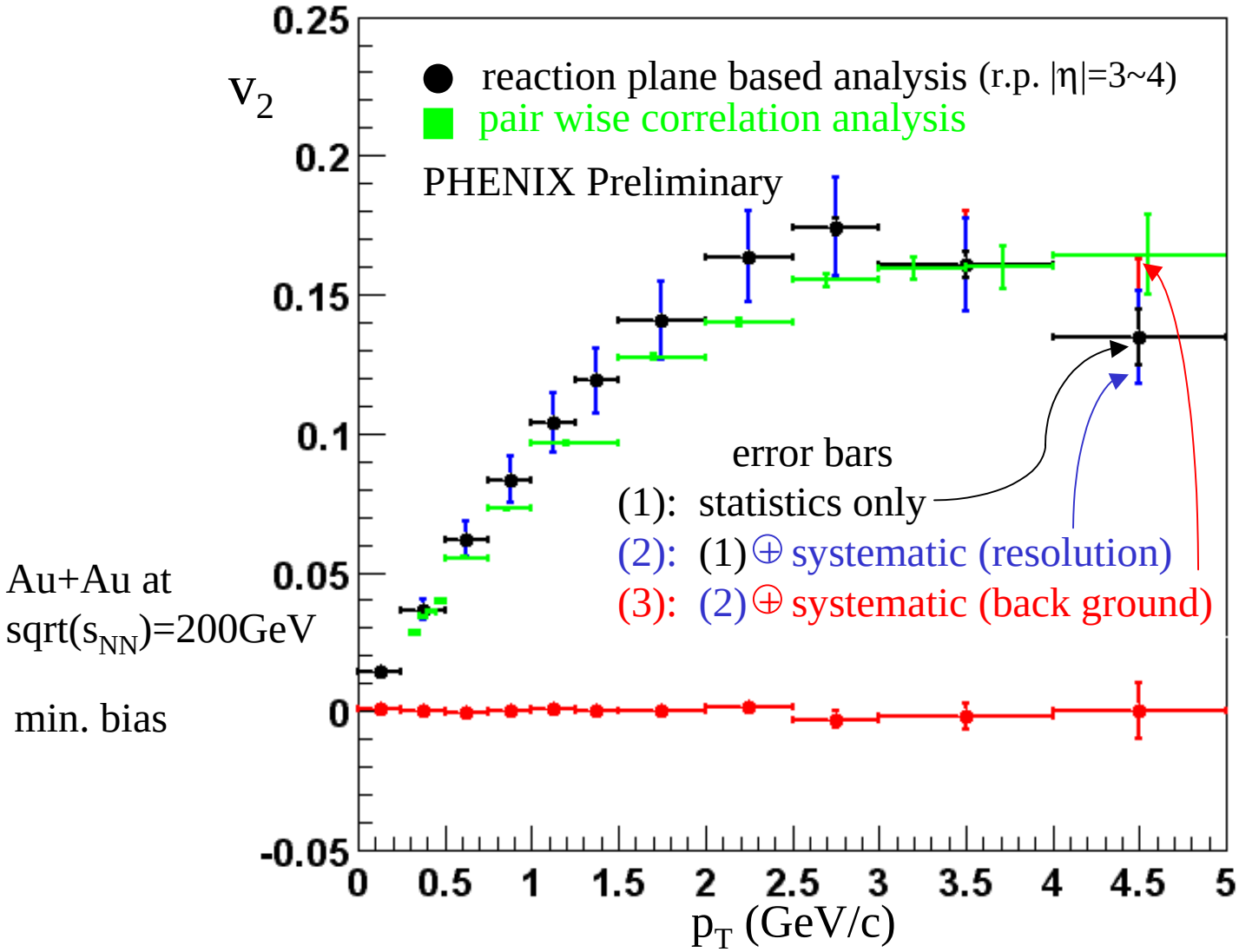
Comparison of v2
with rqmd_v2.4
and pythia

simulation

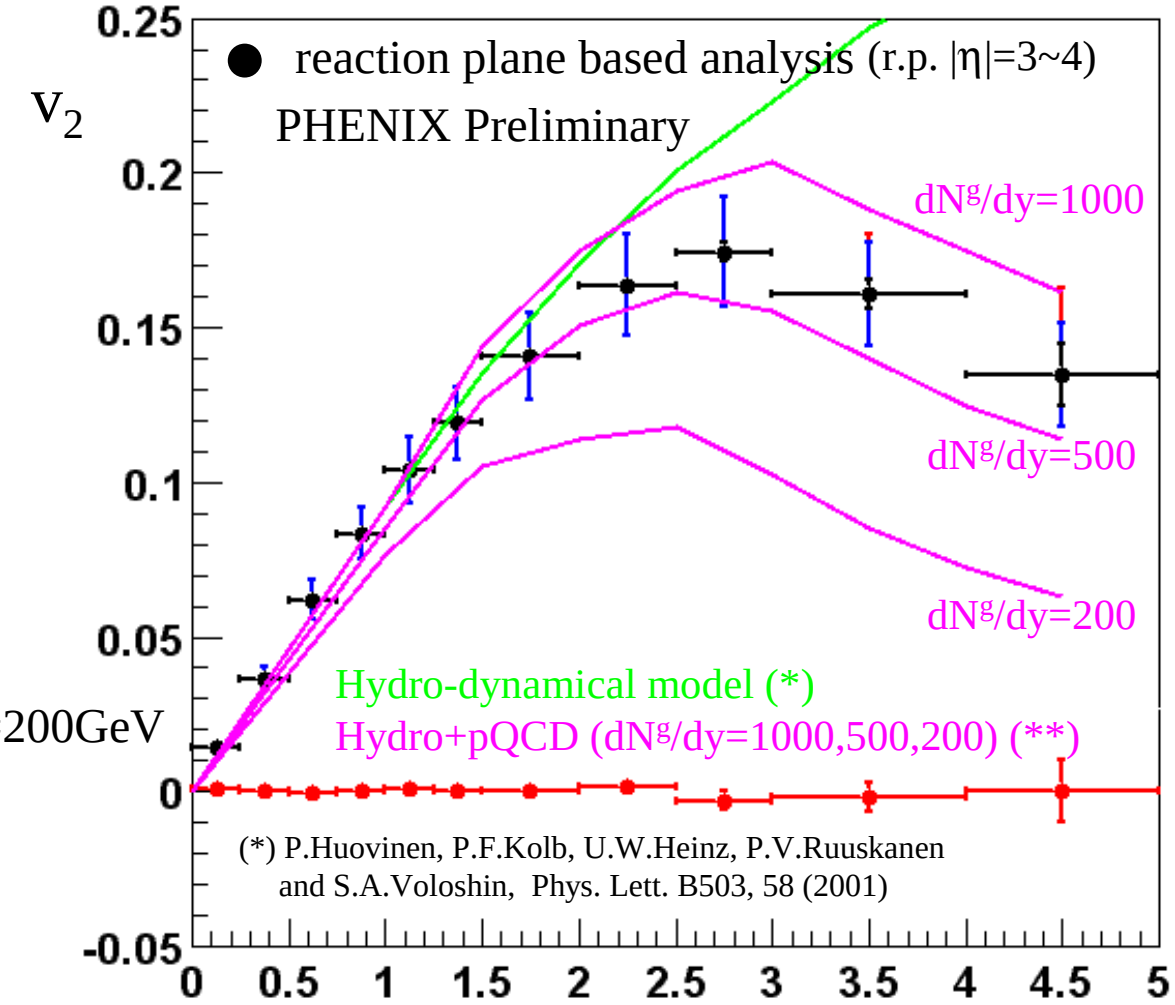


v2 in p+p is zero
by definition.

v_2 vs transverse momentum



v_2 vs transverse momentum

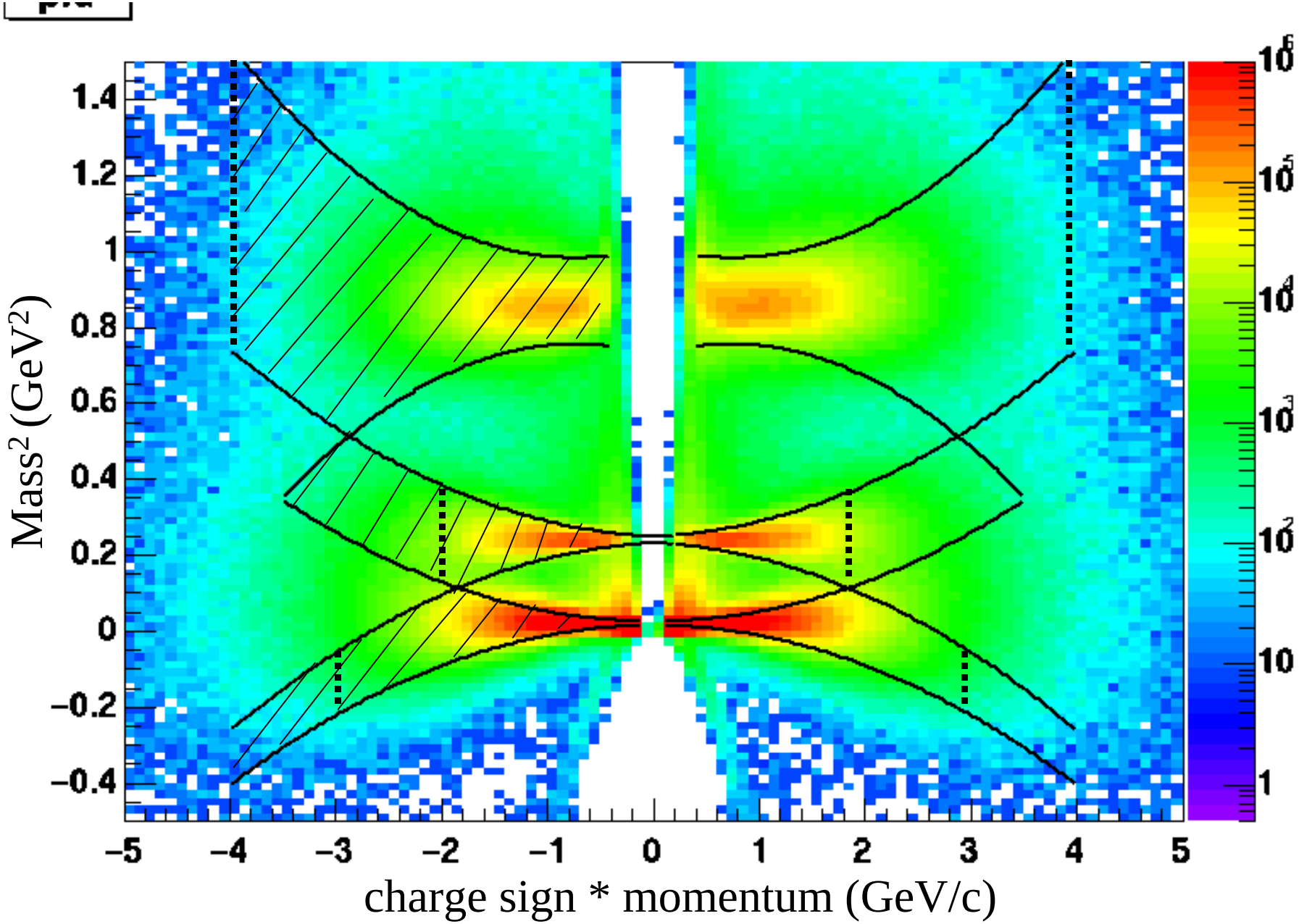


Au+Au at sqrt(s_{NN})=200GeV

min. bias

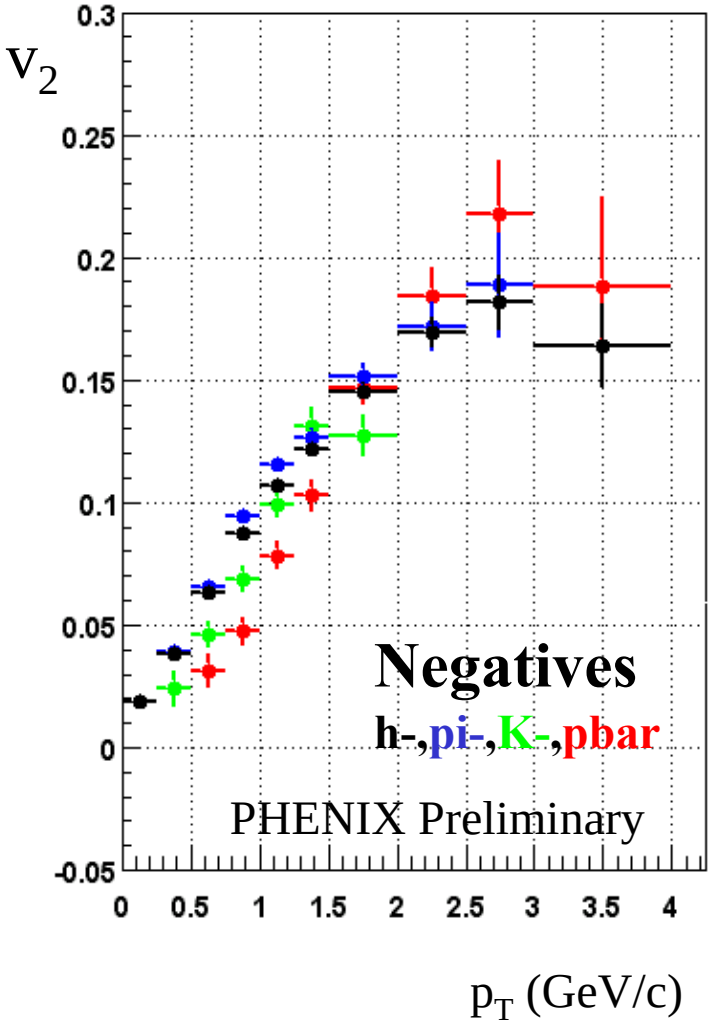
(*) P.Huovinen, P.F.Kolb, U.W.Heinz, P.V.Ruuskanen and S.A.Voloshin, Phys. Lett. B503, 58 (2001)

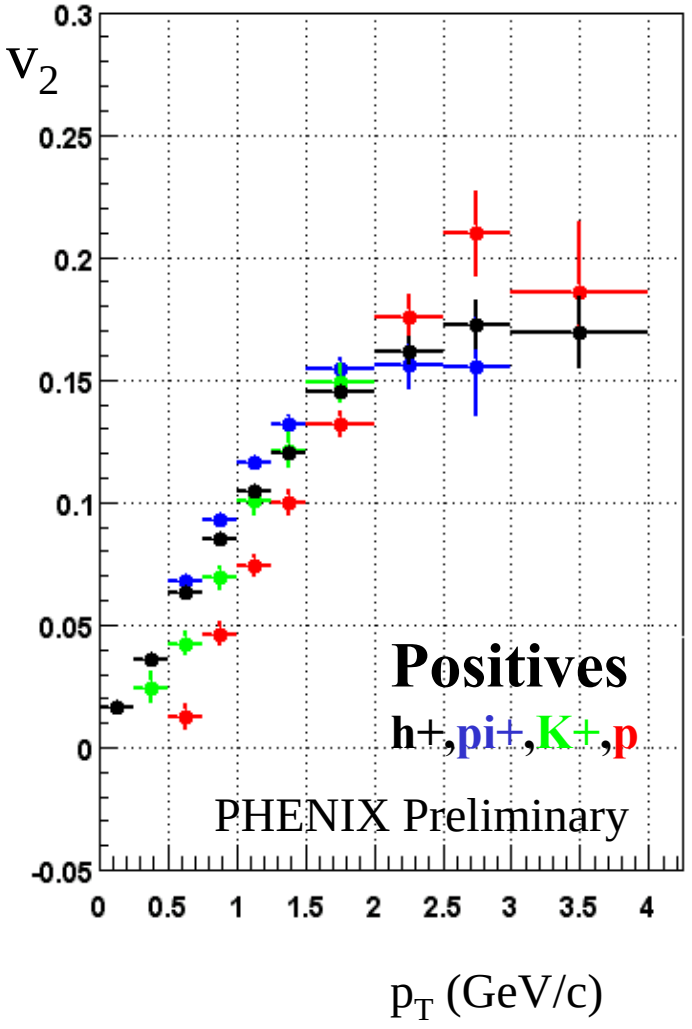
(**) M.Gyulassy, I.Vitev and X.N.Wang, Phys. Rev. Lett. 86, 2537, (2001)


Mass^2 (GeV^2)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−5
−4
−3
−2
−1
0
1
2
3
4
5
charge sign * momentum (GeV/c)
10^6
10^5
10^4
10^3
10^2
10
1

v_2 of identified hadrons

Au+Au at sqrt(s_{NN})=200GeV
min. bias r.p. |η|=3~4





v_2 of identified hadrons

Au+Au at sqrt(s_{NN})=200GeV
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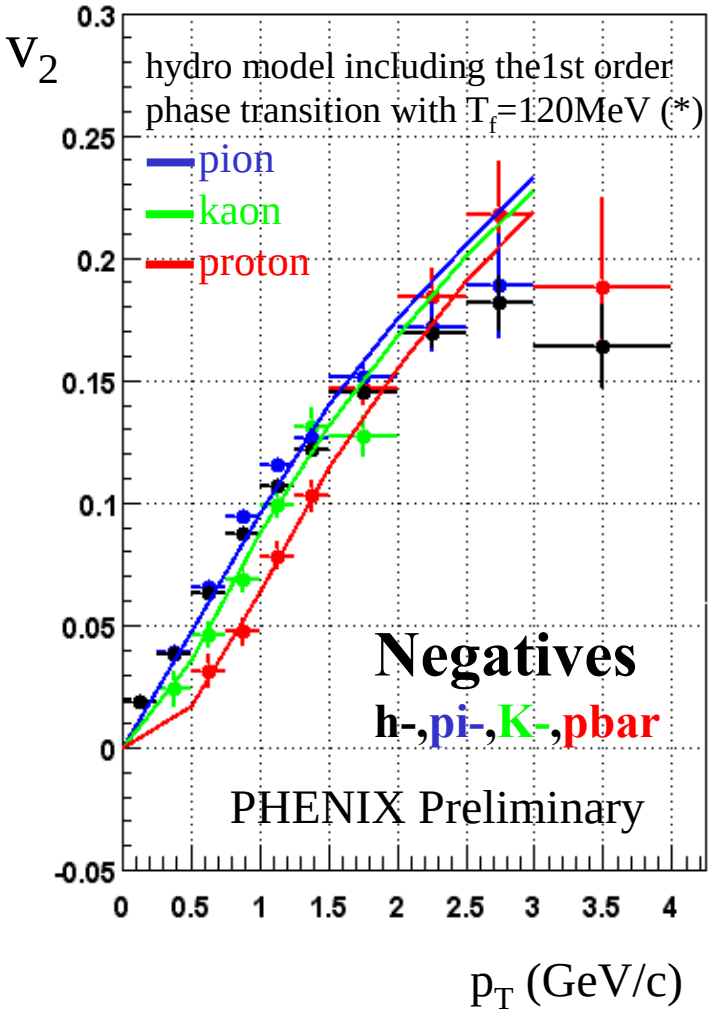

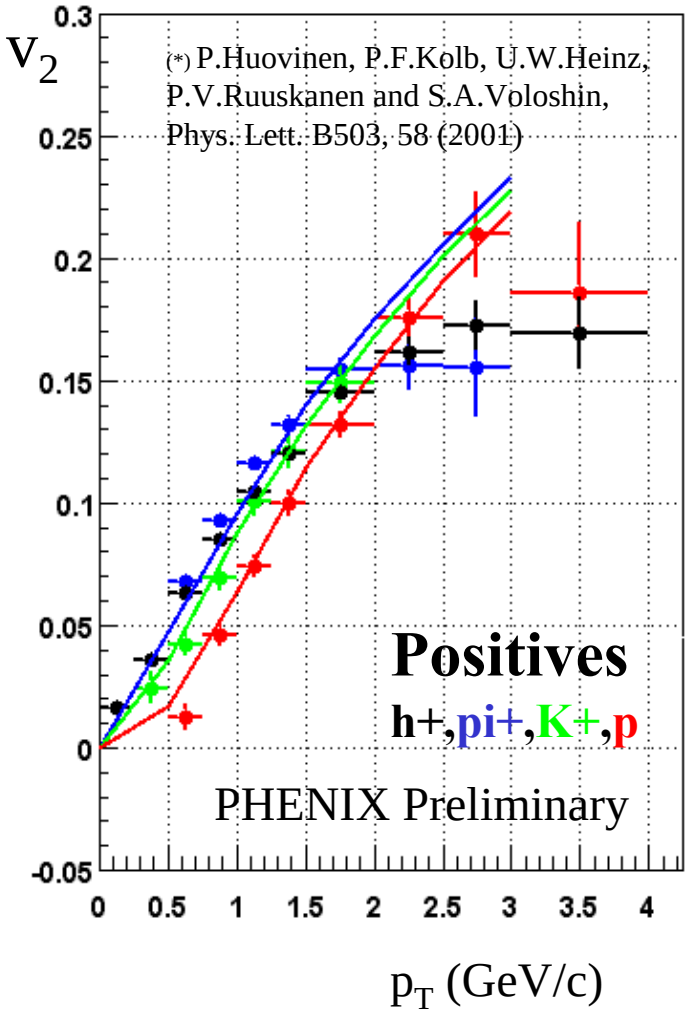

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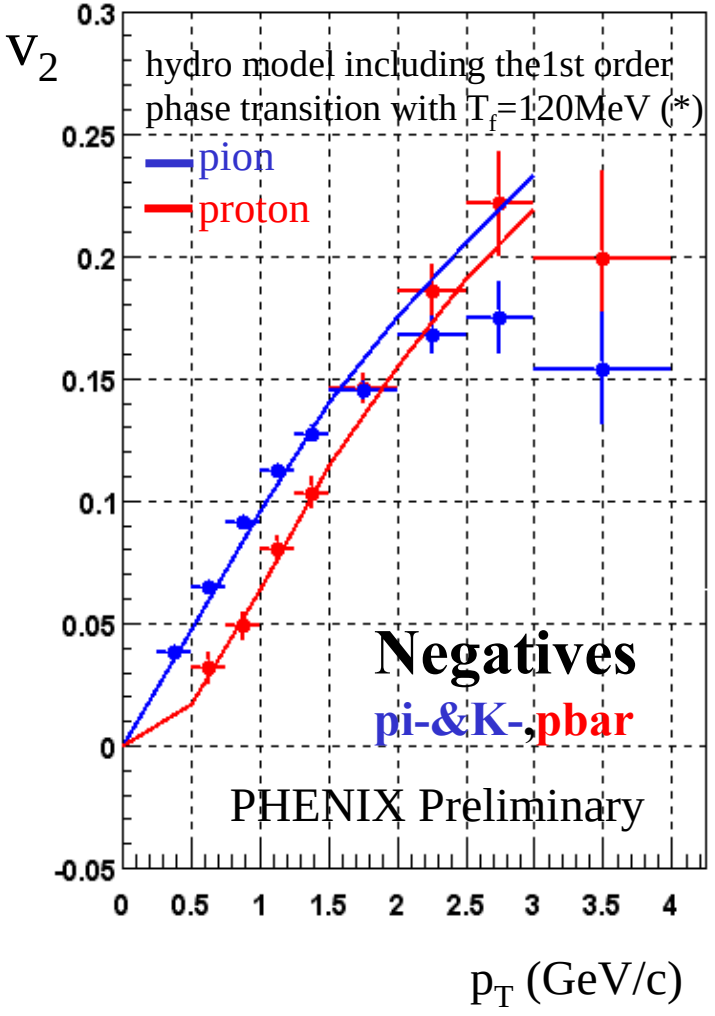
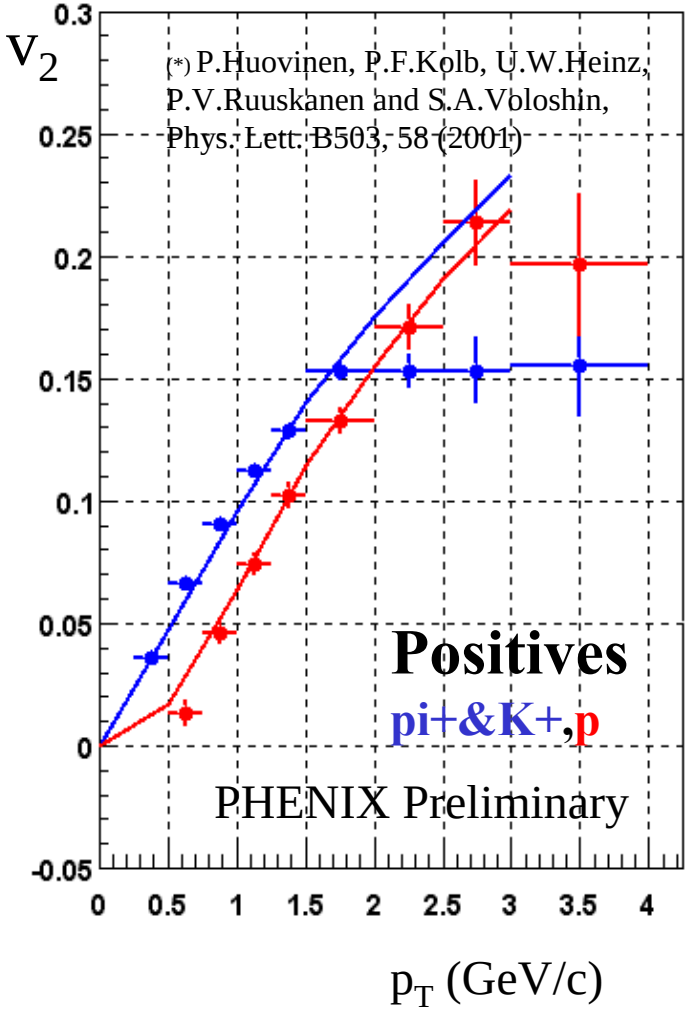
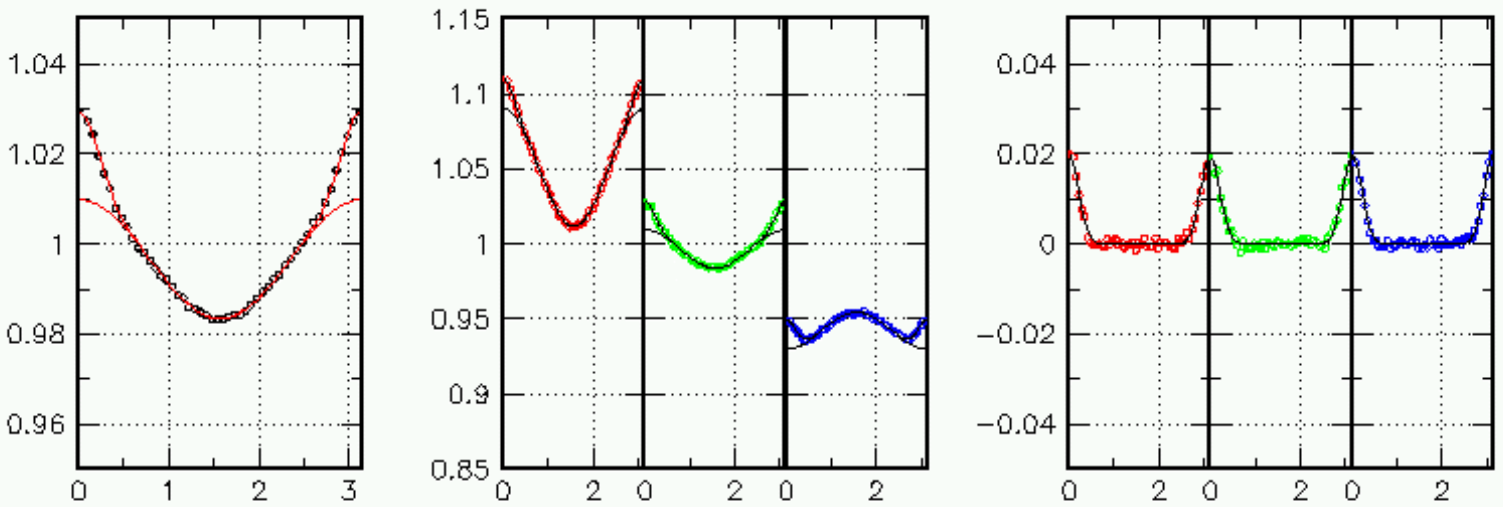
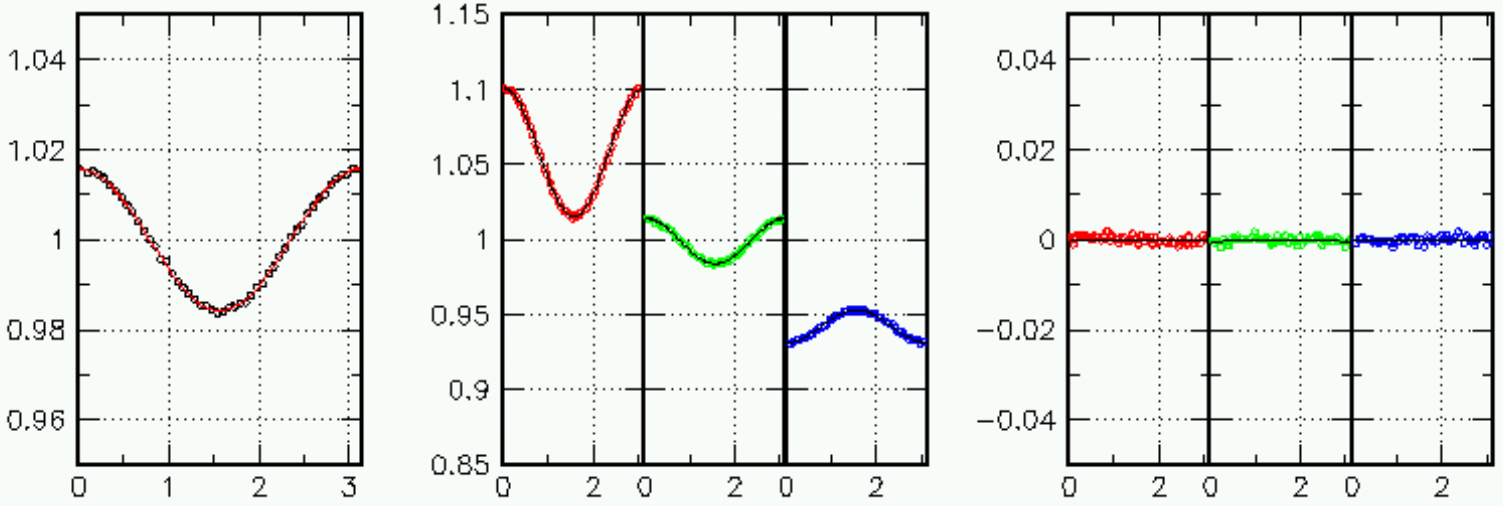




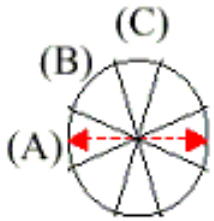
simulation



flow + independent back-to-back jets case



flow only case



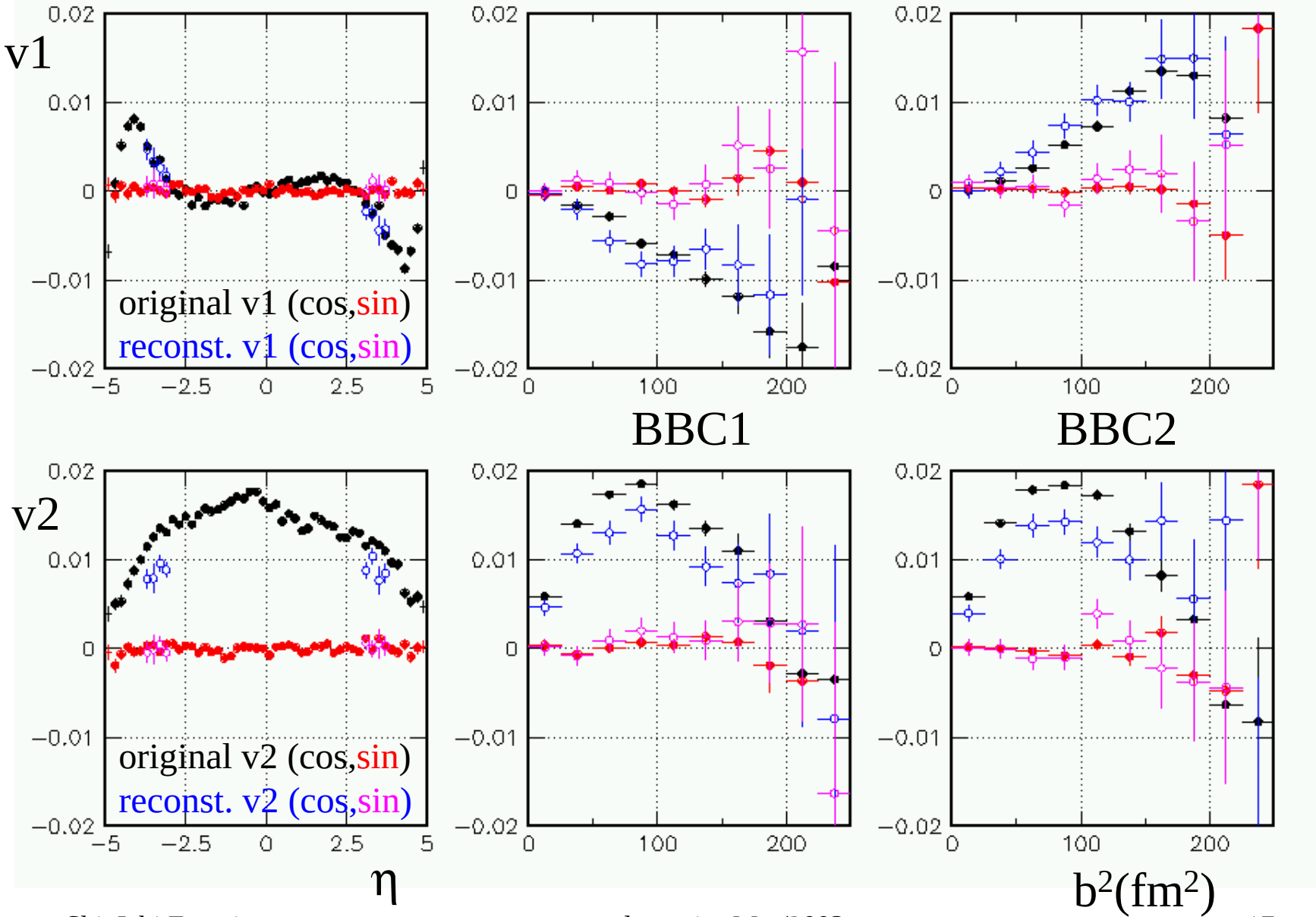
reaction plane (BBC)

Higher pT particle in a pair is within region (A), (B) or (C).

summary

(1) The reaction plane based event anisotropy analysis has started at PHENIX.
(2) Different techniques to extract anisotropy are compared and the results are consistent.
(3) Identified particles (π+/−,K+/−,p,pbar) v2 parameters are measured and there is clear mass dependence on v2 which is expected by a hydro-dynamical expansion.
(4) There is some indication of v2(p,pbar) > v2(π+/−) for p_T>2.0GeV/c, where the hydro-type model always predicts v2(p,pbar) < v2 (π+/−)

RQMD flow + PISA simulation



TEST flow + PISA simulation