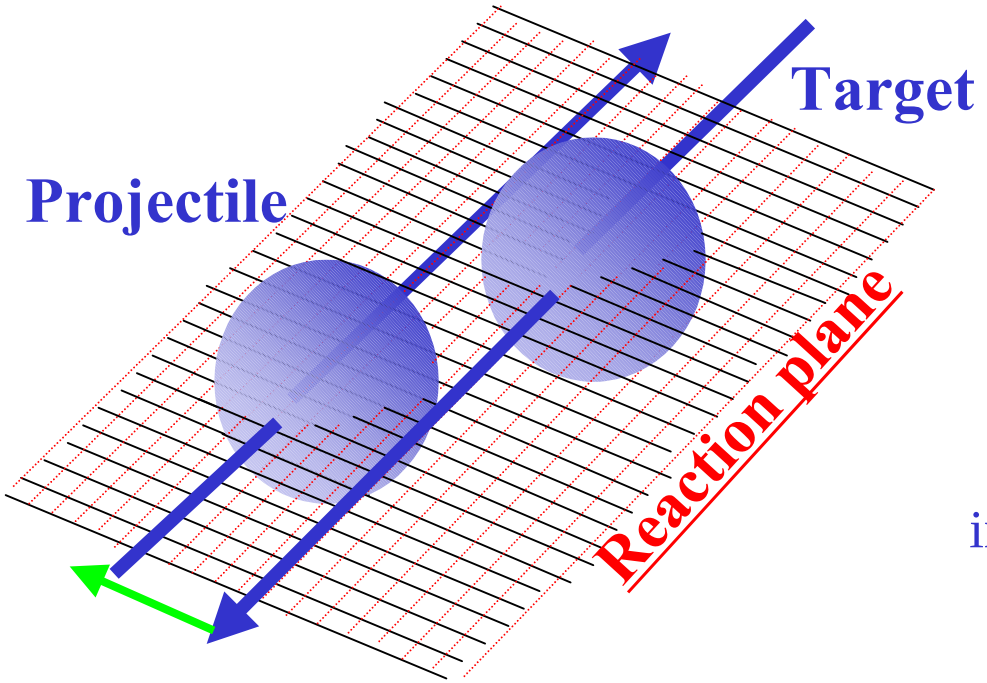
Identified and charged particle azimuthal anisotropy in PHENIX at RHIC

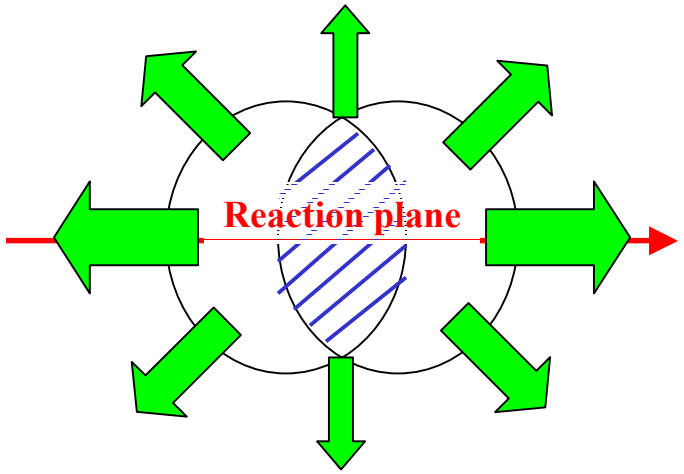
ShinIchi Esumi for the PHENIX collaboration

contents

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

Introduction



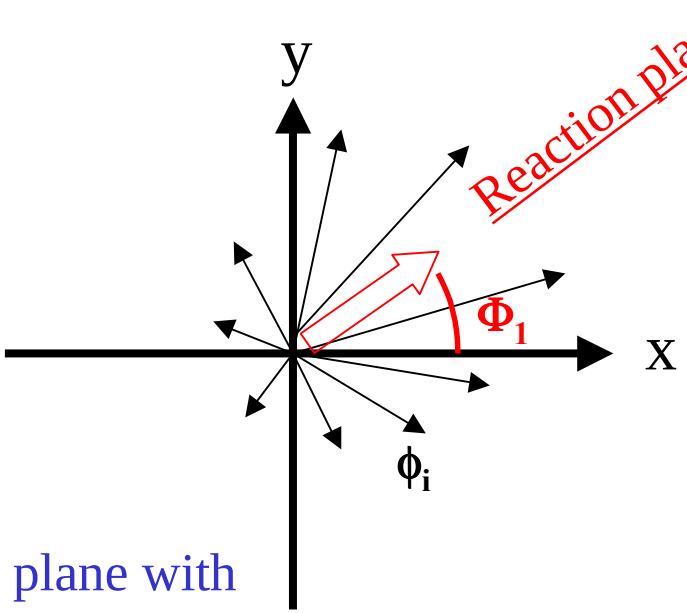


initial geometry → final momentum anisotropy

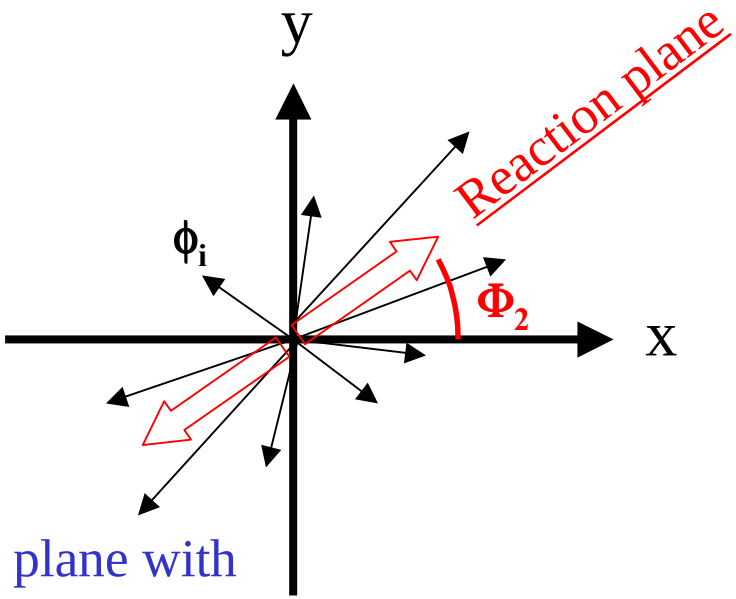
b:impact parameter

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.N.Ajitanand talk at high p_T parallel session

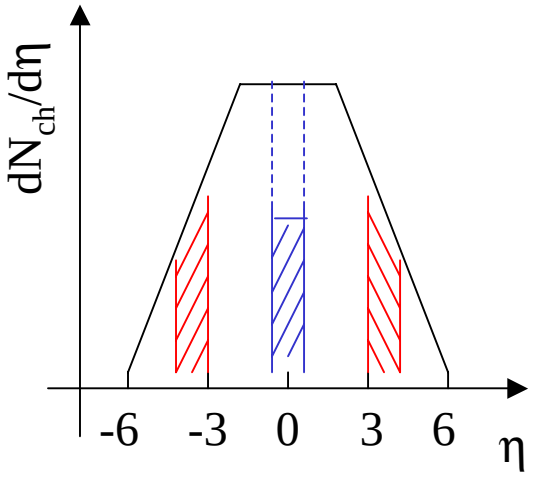
$$N^{real}(\Delta\phi)/N^{mixed}(\Delta\phi) = N\,(1 + \Sigma\, 2v_n{}^2\cos(n(\Delta\phi)))$$

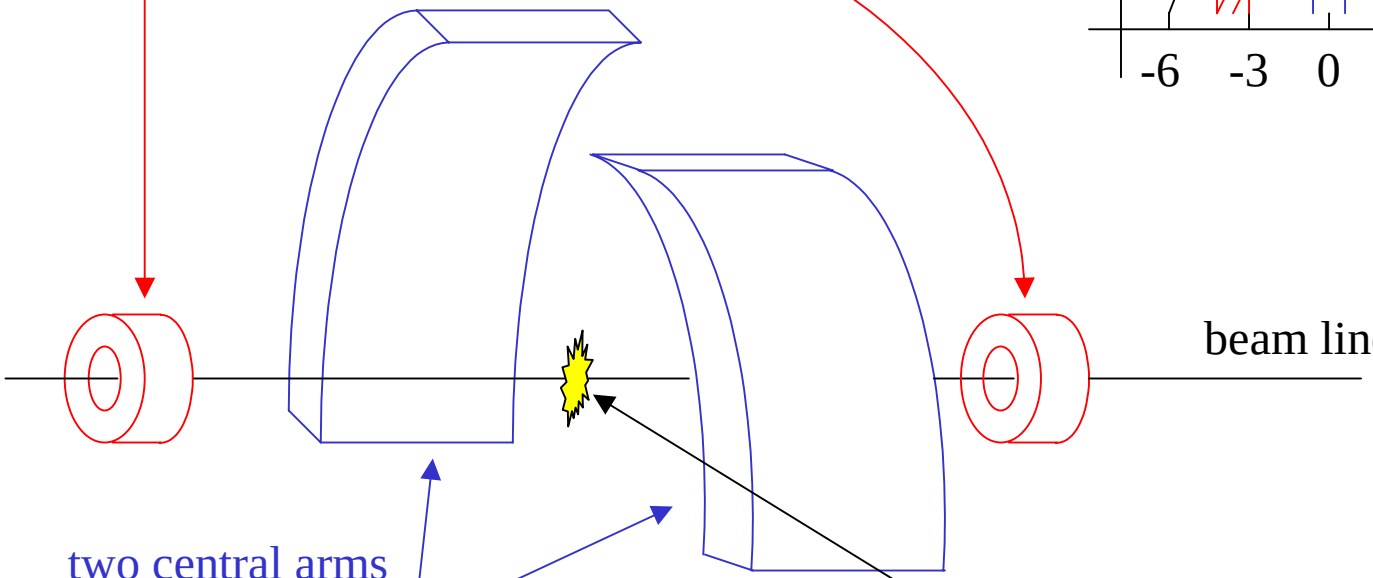
$\Delta\phi : \phi_i - \phi_j$

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

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

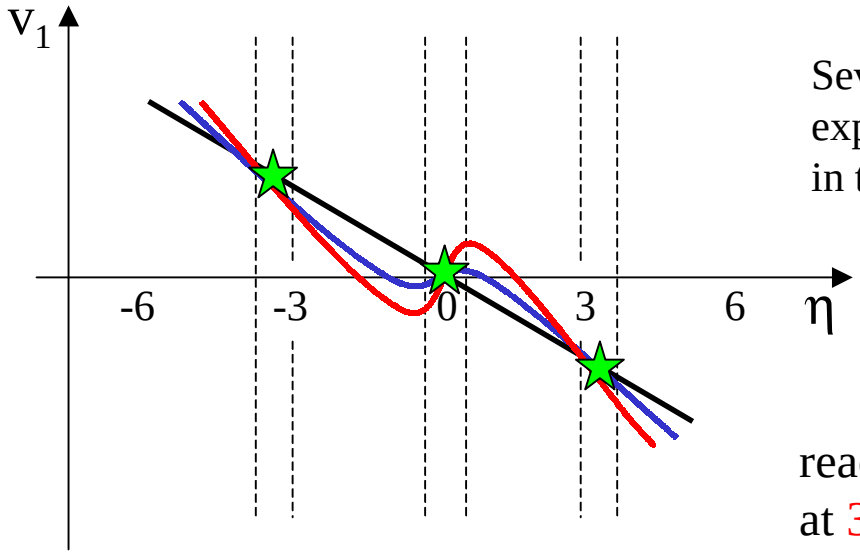
Beam-beam counter
(BBC) $|\eta|=3\sim4$
64pmts in each BBC
charged particles

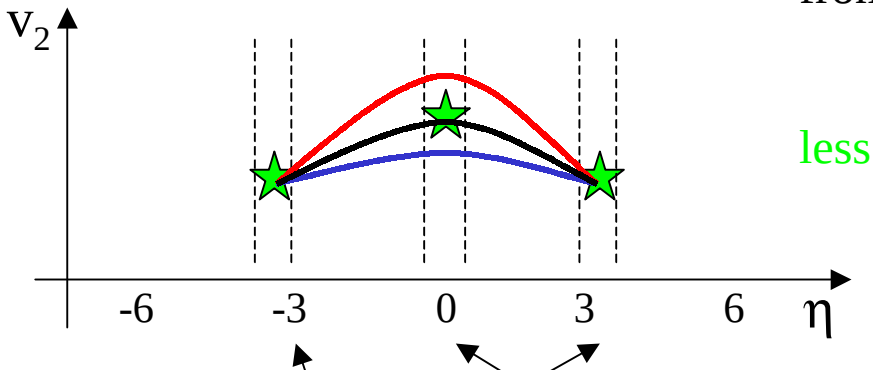




two central arms
(CNT) $|\eta|<0.35$
Dch,PCs,TOF,EMCAL
tracking, momentum, PID

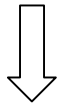
collision point





Several different scenarios are expected for v1and v2 as shown in the lines with different colors.

reaction plane determination at 3 units of rapidity away from the mid-rapidity,

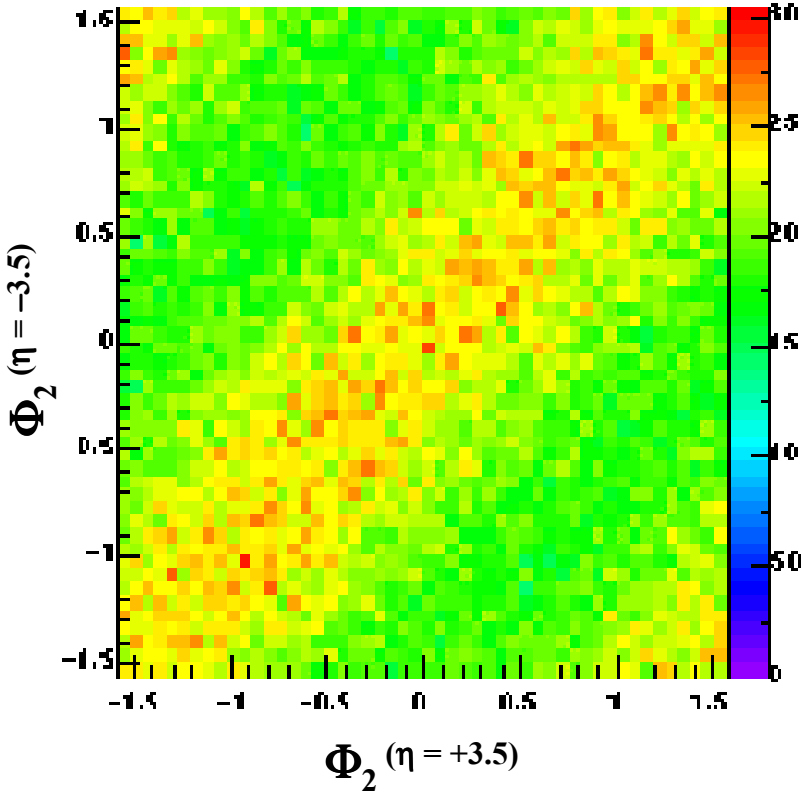


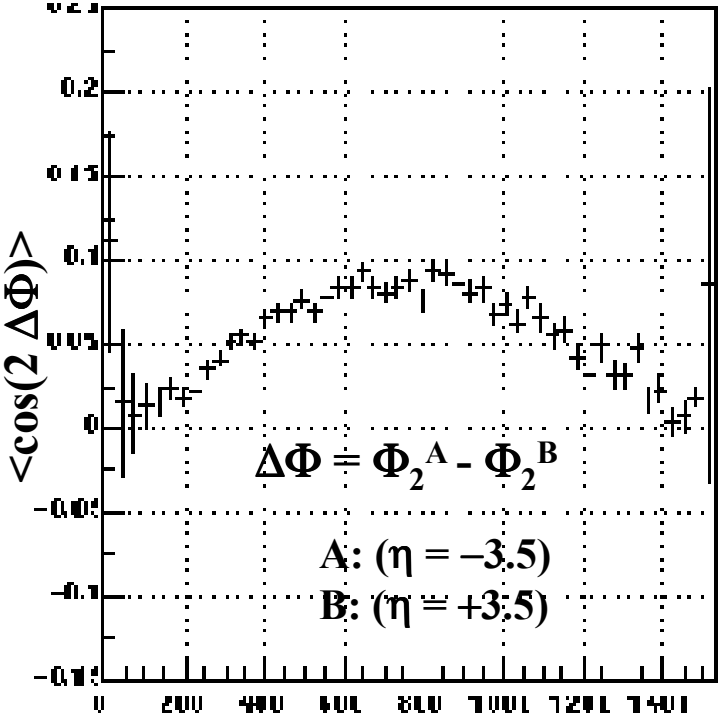
less non-flow contributions.

charged particle (|η|=3~4)
(centrality dependences)

identified particle (|η|<0.35)
(p_T, centrality dependences)

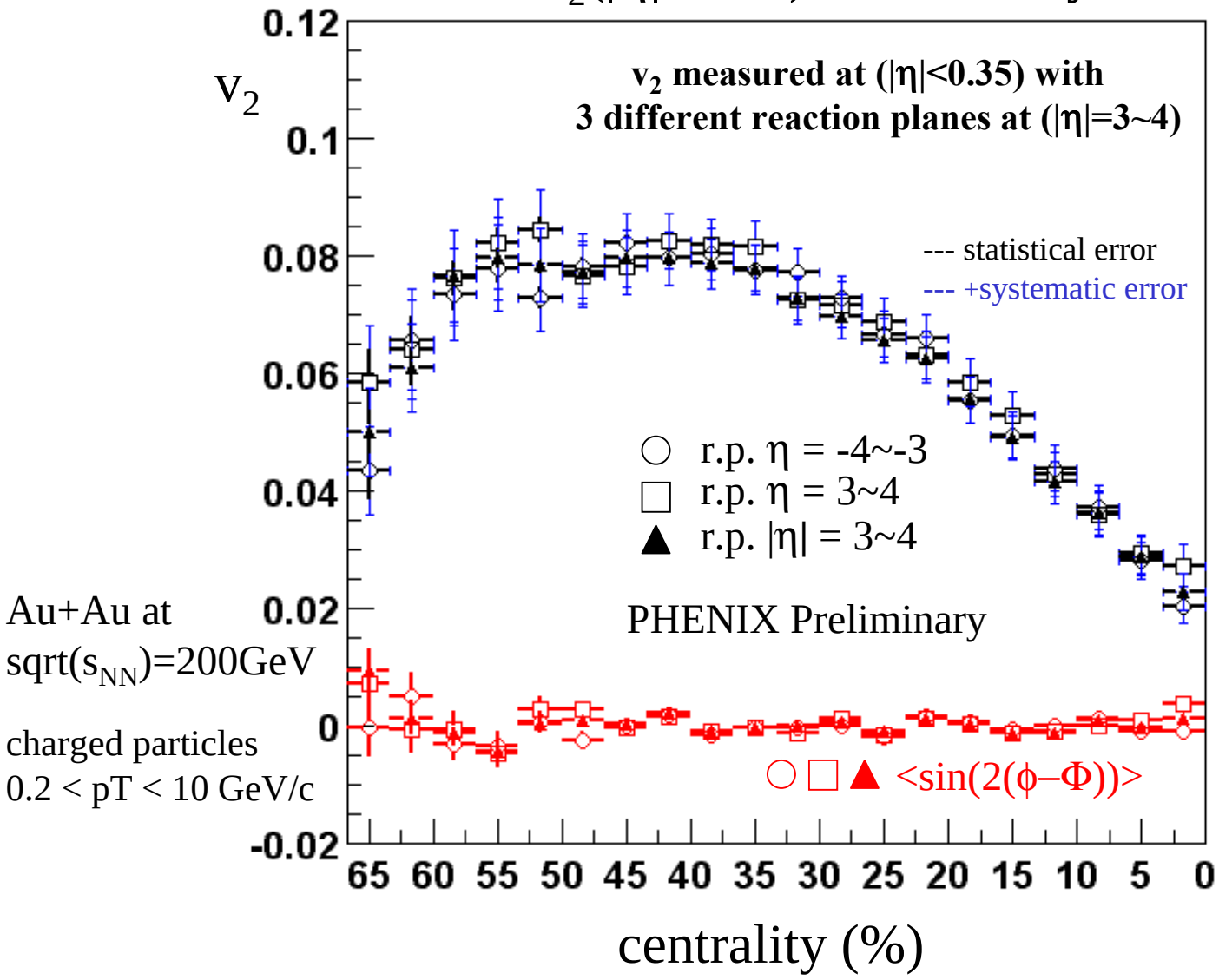
$\eta = -3.5$ vs $\eta = +3.5$
(elliptic : n=2)





charged multiplicity

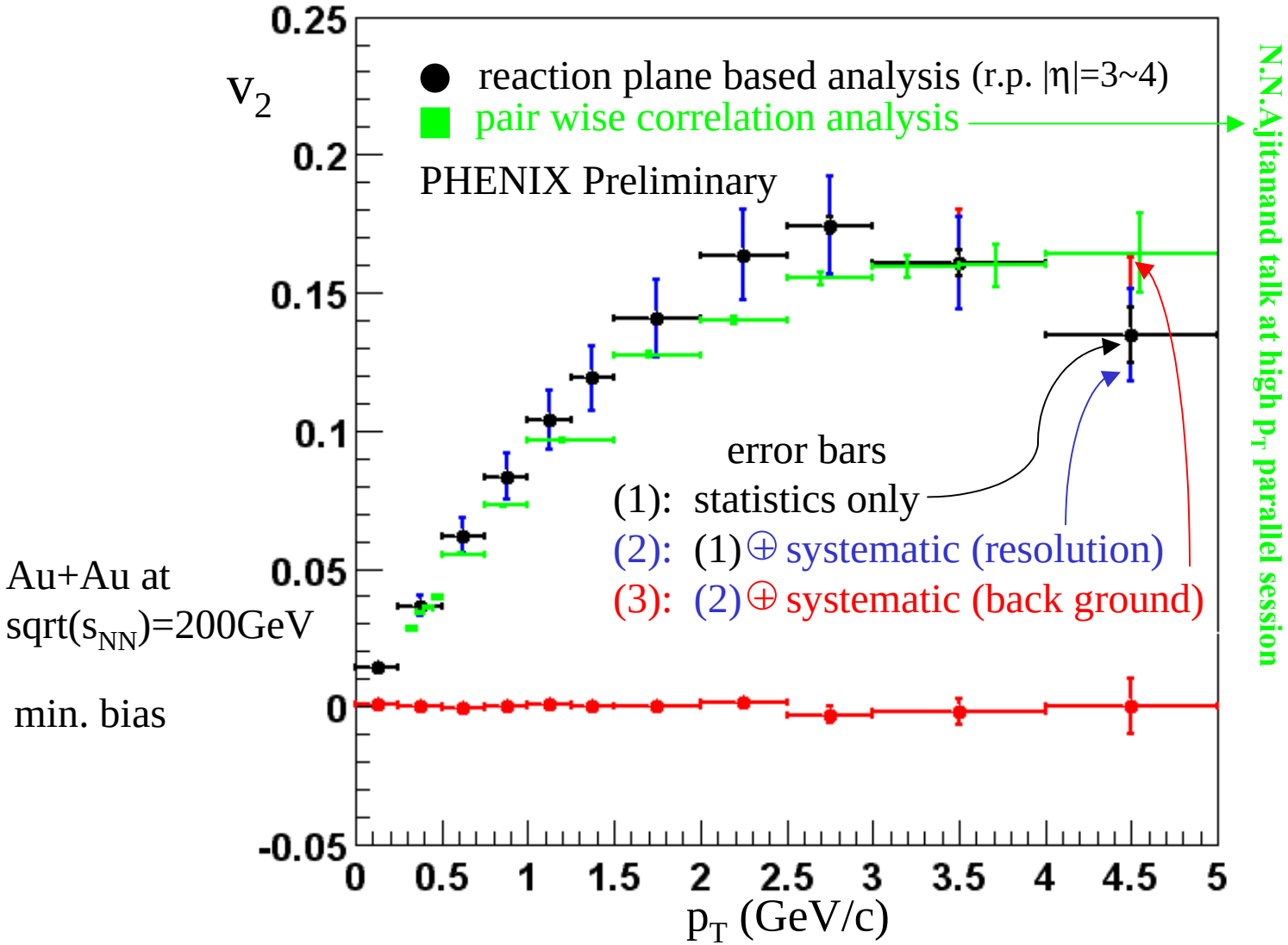
$v_2(|\eta|<0.35)$ vs centrality



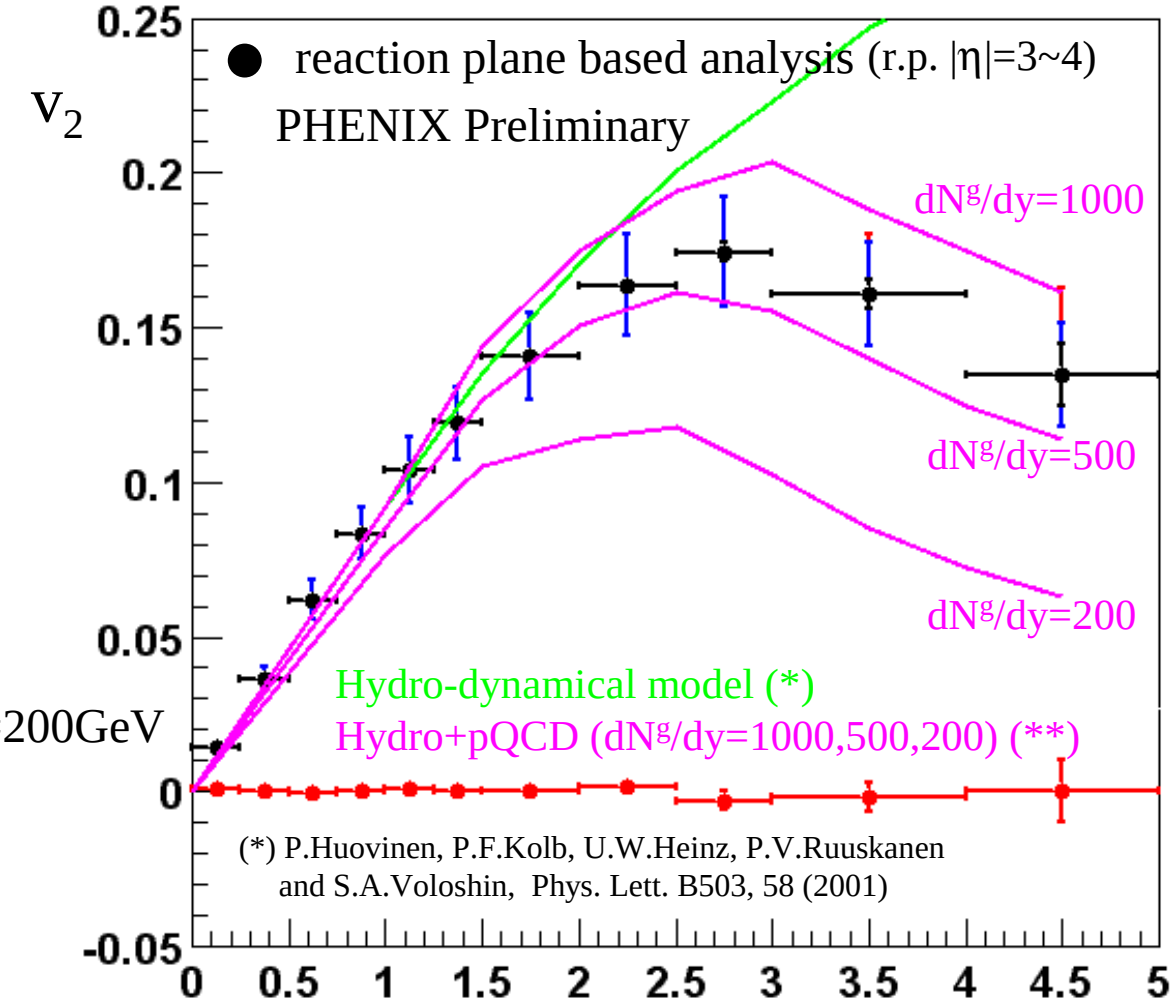
Au+Au at
sqrt(s_{NN})=200GeV

charged particles
0.2 < pT < 10 GeV/c

v_2 vs transverse momentum



v_2 vs transverse momentum

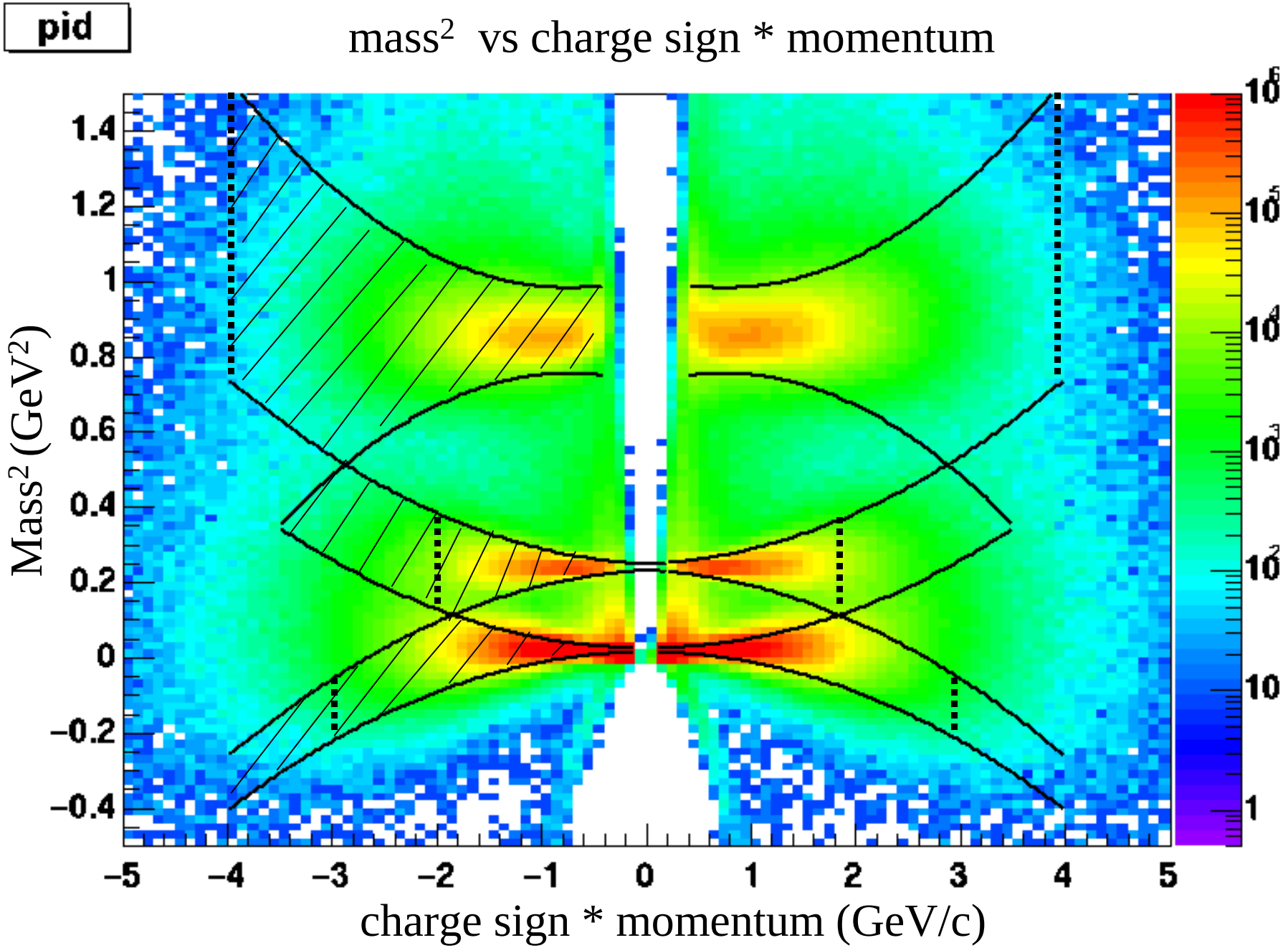


Au+Au at sqrt(s_{NN})=200GeV

min. bias

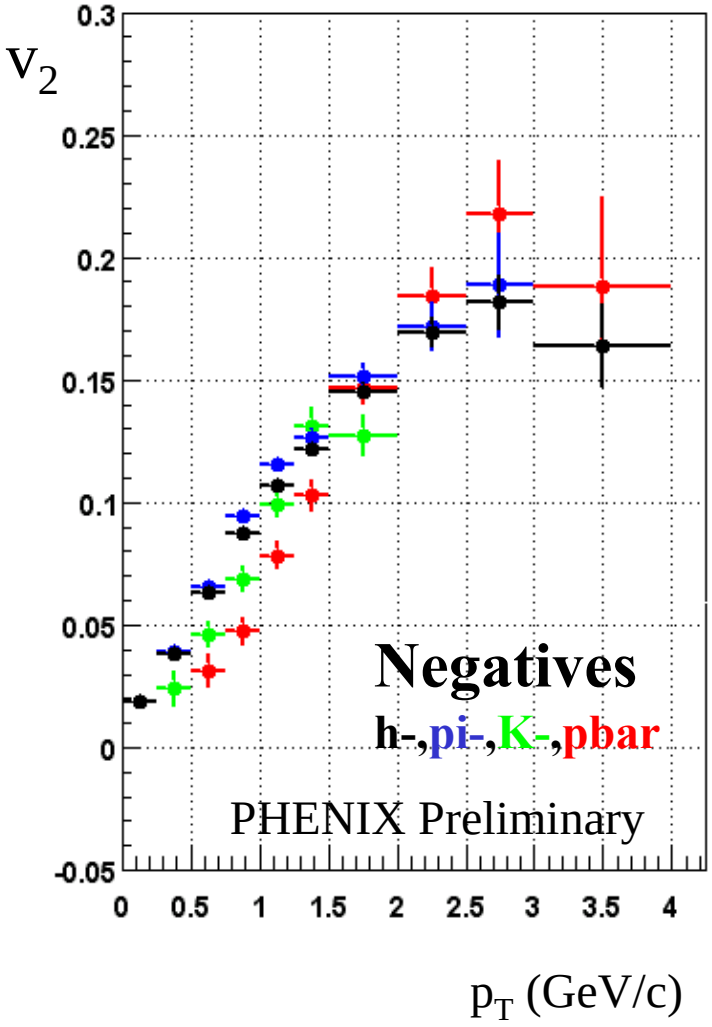
(*) P.Huovinen, P.F.Kolb, U.W.Heinz, P.V.Ruuskanen and S.A.Voloshin, Phys. Lett. B503, 58 (2001)

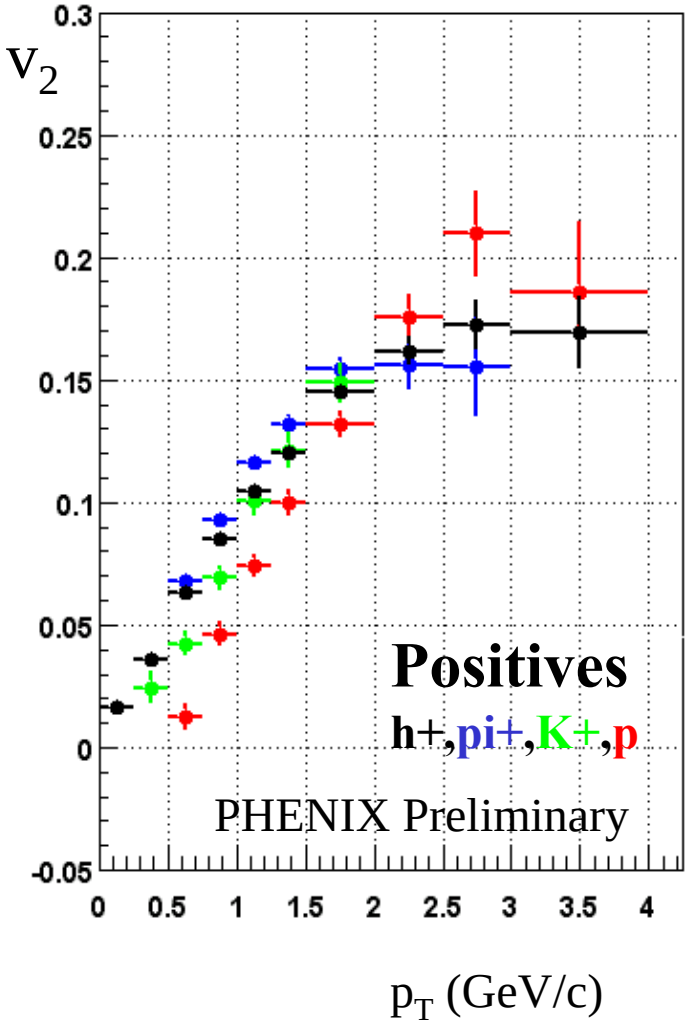
(**) M.Gyulassy, I.Vitev and X.N.Wang, Phys. Rev. Lett. 86, 2537, (2001)


pid
mass^2 vs charge sign * momentum
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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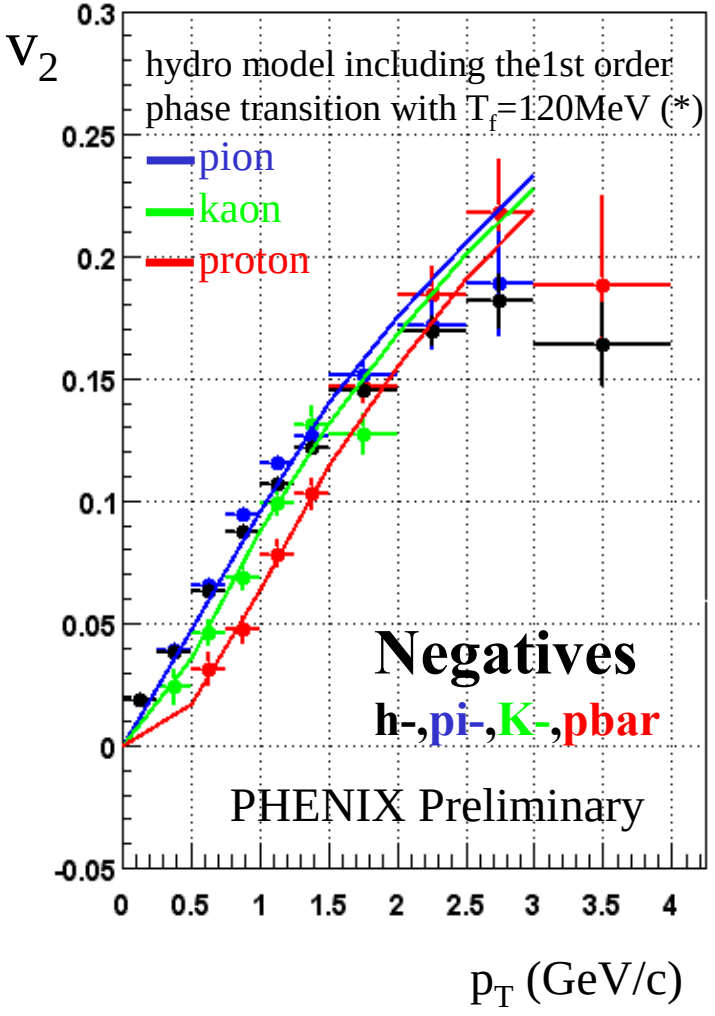

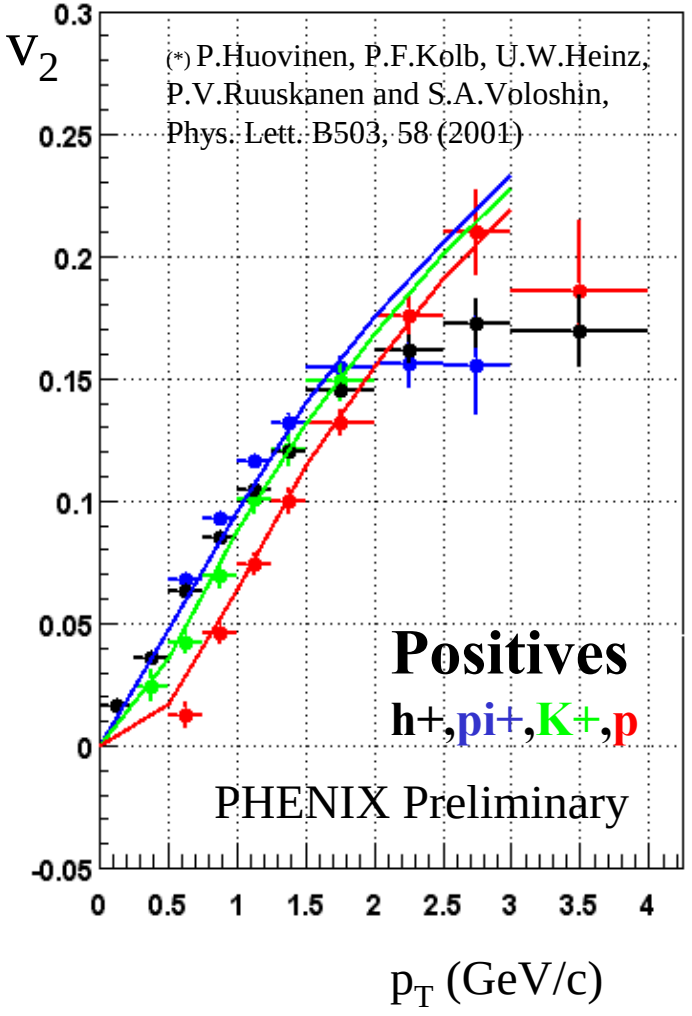

v_2 of identified hadrons

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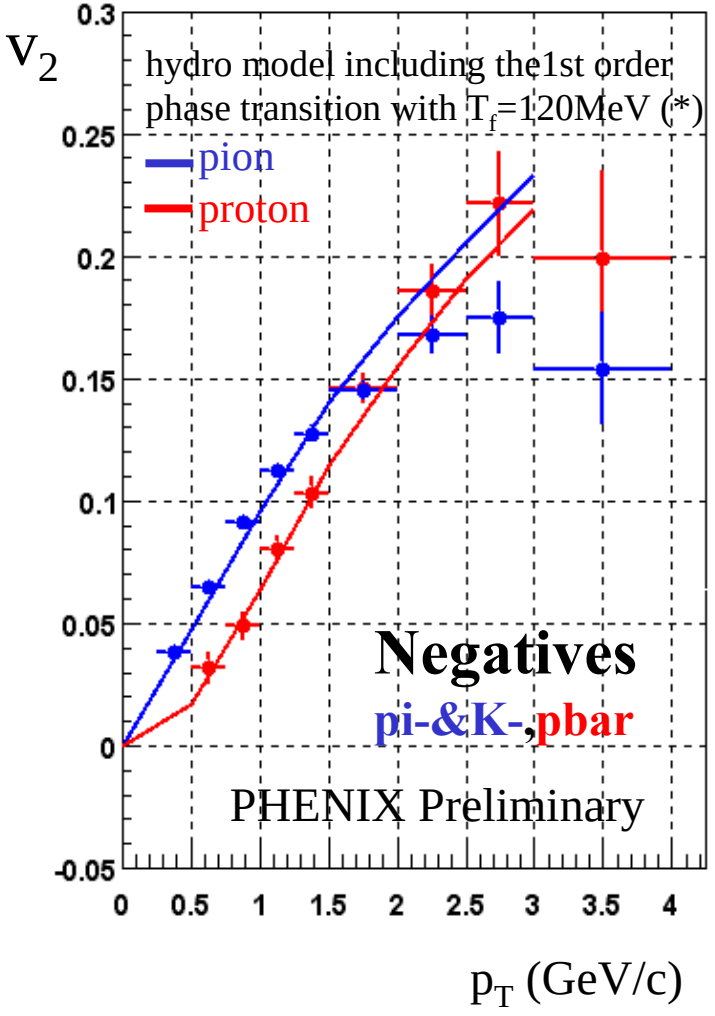
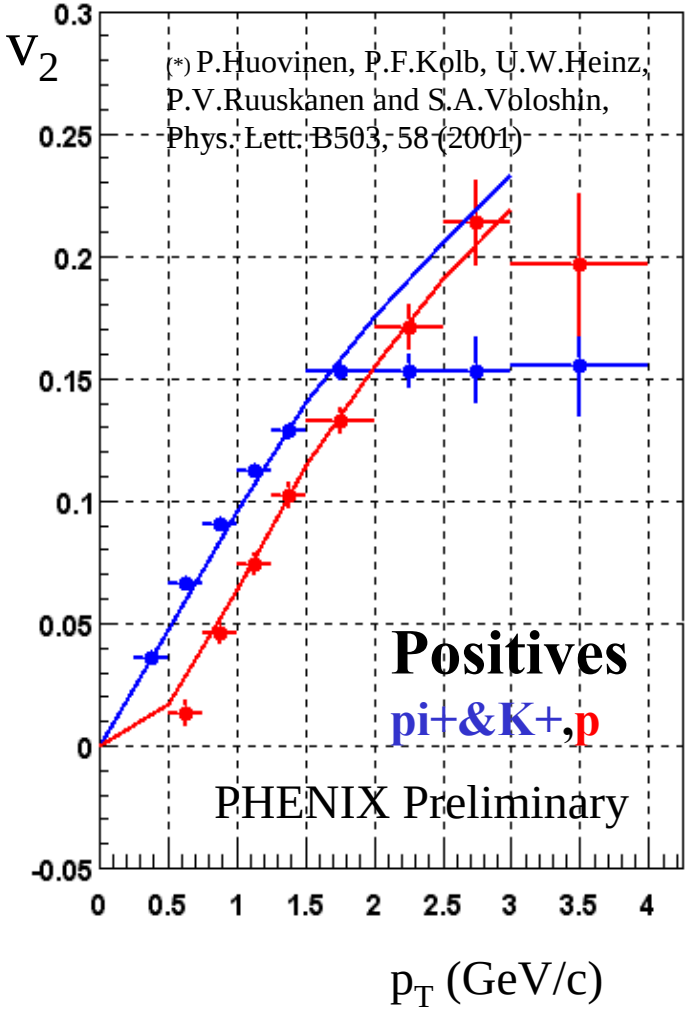
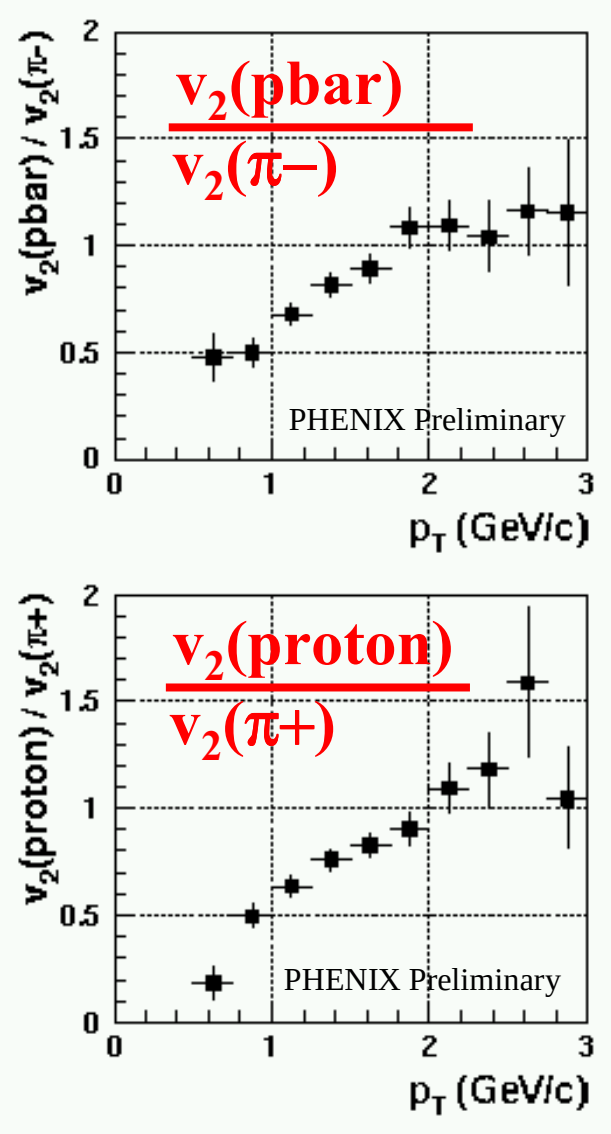
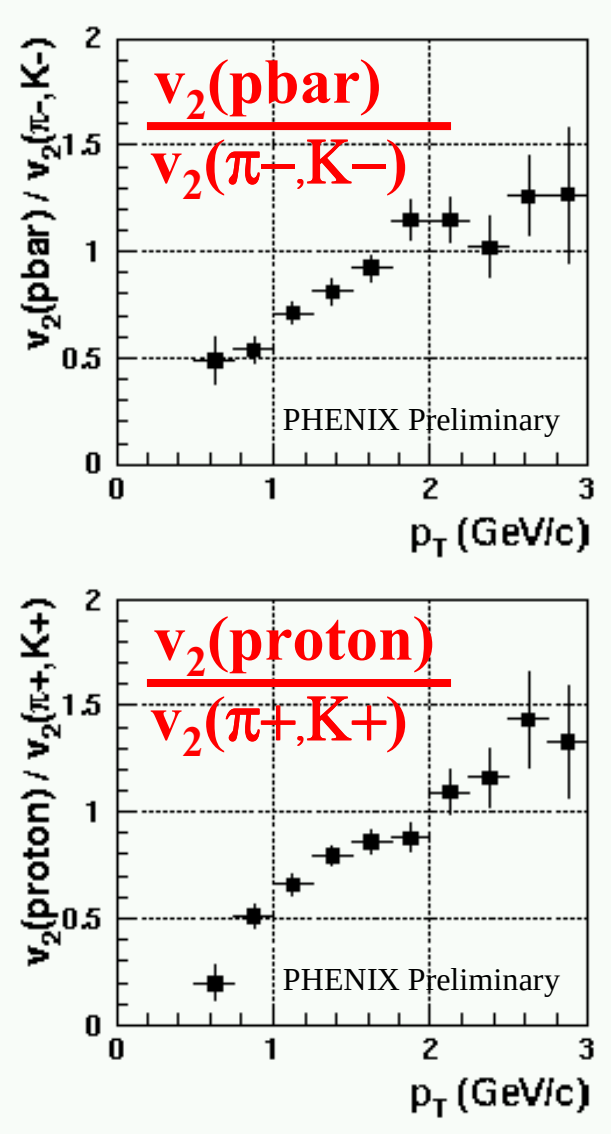




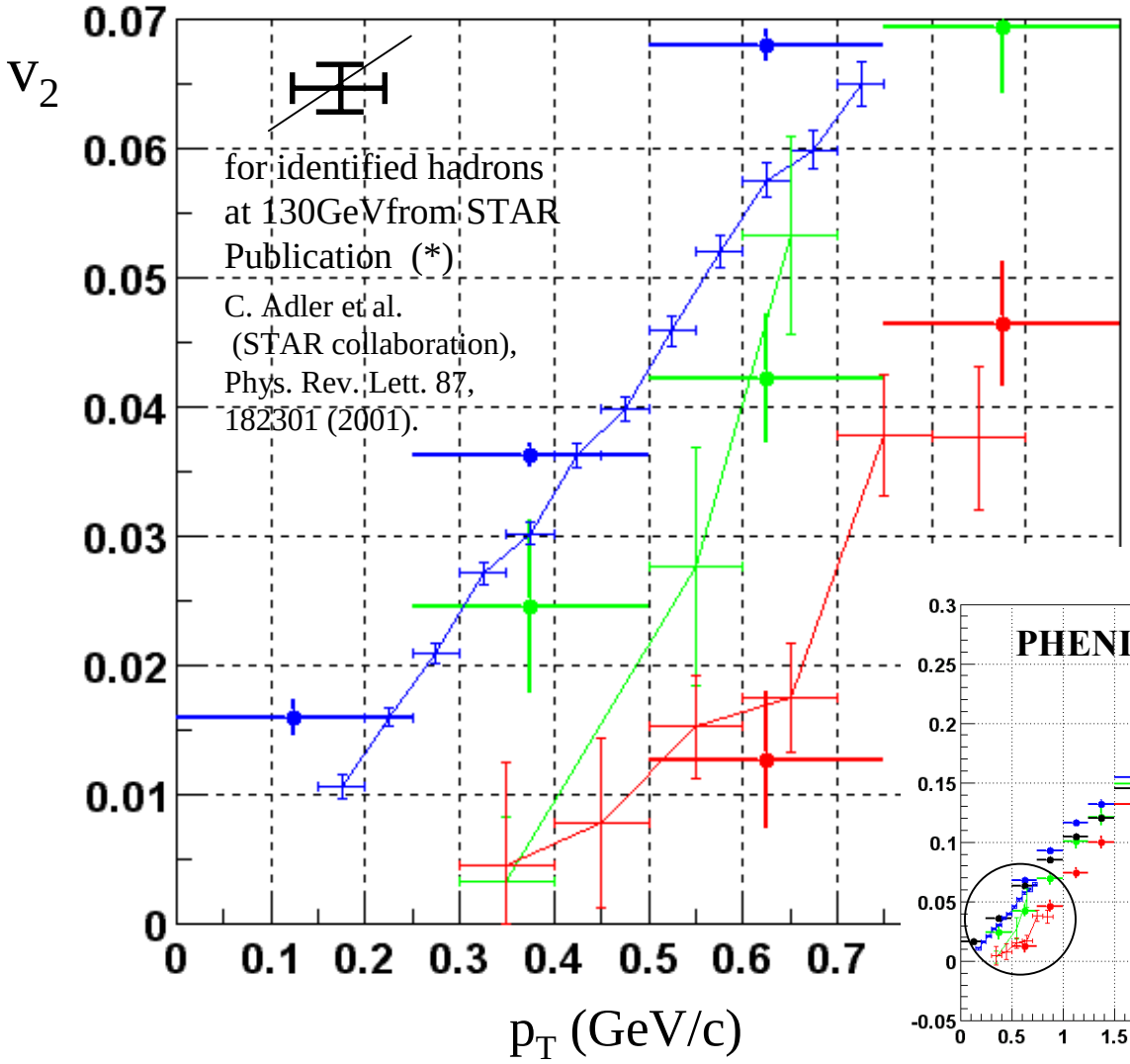
ratio of v_2 (p,pbar over π and/or K)





v_2 vs transverse momentum

comparison with published STAR data



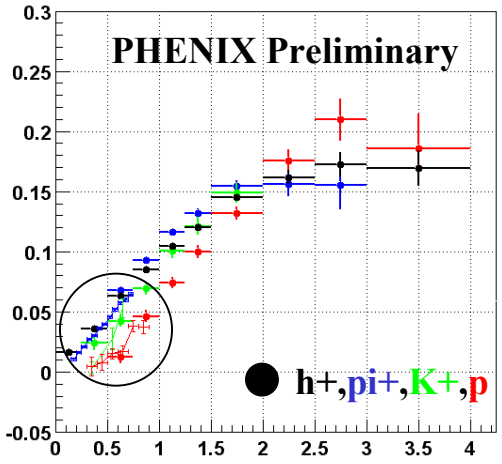
for identified hadrons at 130GeVfrom STAR Publication (*)

C. Adler et al. (STAR collaboration), Phys. Rev. Lett. 87, 182301 (2001).

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

min. bias

r.p. |η|=3~4



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+/−)

N.N.Ajitanand : talk at high pt parallel session
H.Masui : poster on details of reaction plane determination
S.Sakai : poster on details of analysis and results.