π^0 v_2 analysis in $\sqrt{s_{NN}}$ = 200GeV Au+Au collisions

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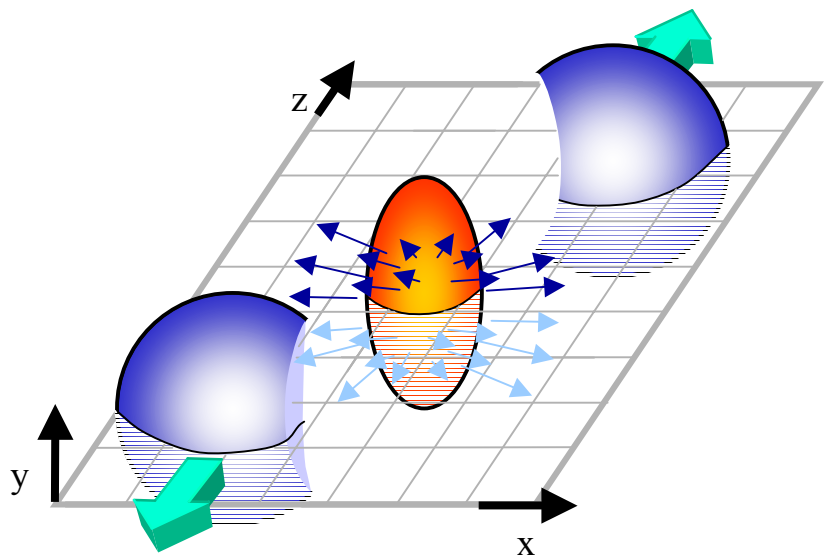
Why Event Anisotropy?

- Because of sensitive to collision geometry
  - In low p_T (~<2 GeV/c)
    - Pressure gradient of early stage
    - Hydrodynamical picture is established
  - In high p_T (>~2 GeV/c)
    - Energy loss in dense medium (Jet Quenching)
    - Partonic flow(?)

Here we focus on ellipticity of azimuthal momentum distribution, v_2 (second Fourier coefficient)



Method of π^0 v_2 Measurement

- Define reaction plane by charged multiplicity on Beam-Beam Counters
- π^0 reconstruction from gamma measured by Electro-Magnetic Calorimeter (EMC)
  - For each p_T, azimuthal angle, centrality
- Combine both information
  - Counting number of π^0 as a function of

$$E\frac{dN^3}{d^3p} = \frac{1}{2\pi}\frac{d^2N}{p_T\,dp_T\,dy}\left(1+\sum_{n=1}^{\infty}2\,v_n^{\,measured}\cos[n(\phi-\Psi_r)]\right) \quad \text{where } n=1,2,3,....$$

event anisotropy parameter measured

azimuthal angle of the particle

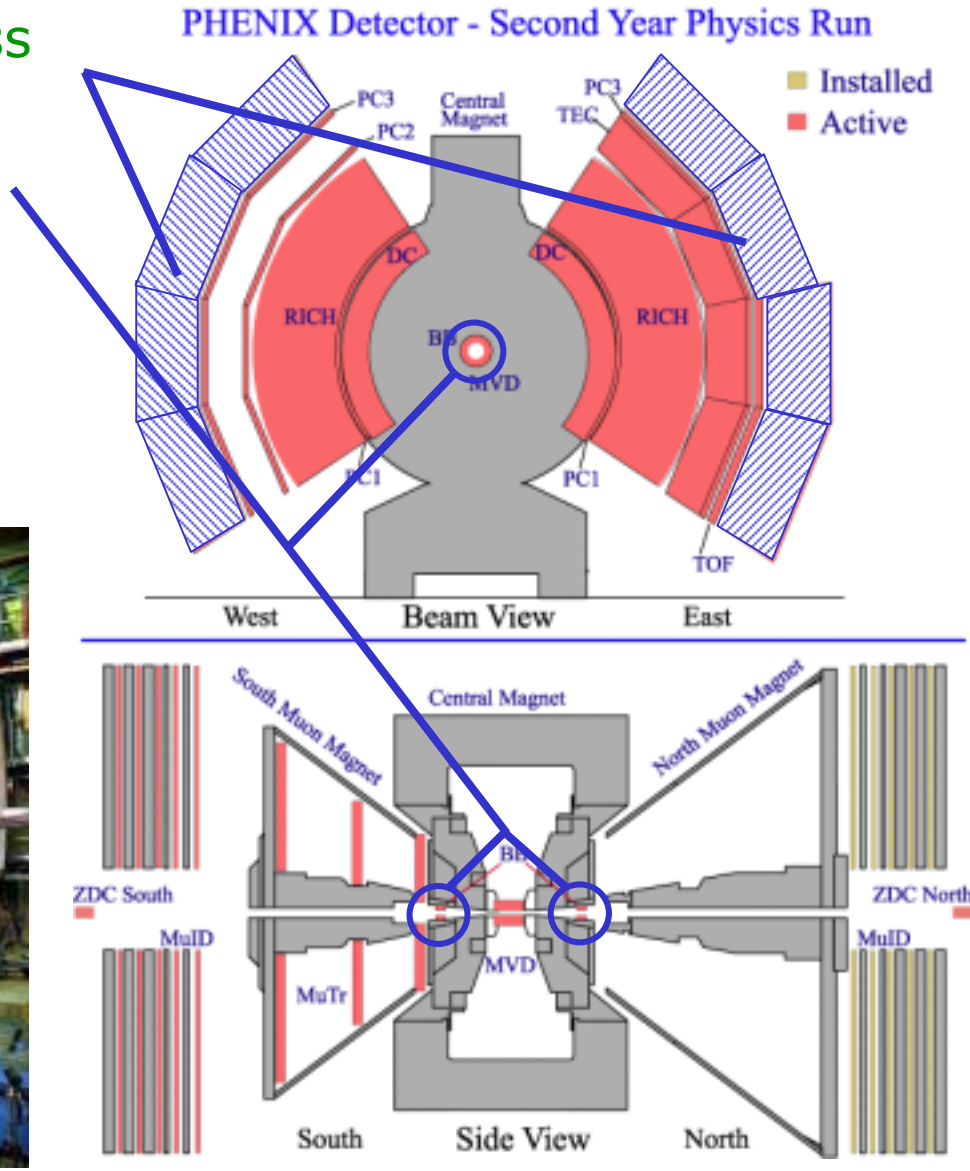
reaction plane angle

$$v_n^{\,real} = v_n^{\,measured} / (\text{reaction plane resolution})_n$$

Note: the detail of reaction plane definition will be found in **nucl-ex/0305013**

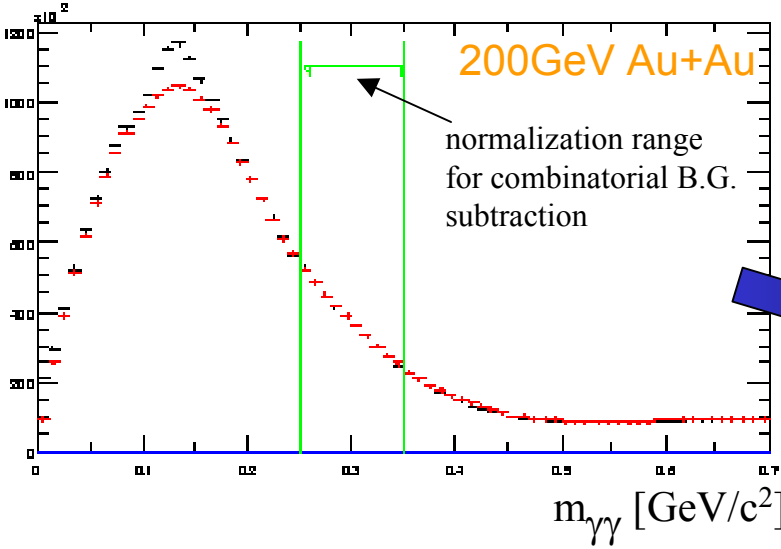
PHENIX experiment

- Lead Scintillator and Lead Glass EMCs
  - Gamma measurement ($\pi^0 \rightarrow \gamma\gamma$)
- BBCs and ZDCs
  - Collision centrality determination
- BBCs
  - Reaction plane determination and
  - Its resolution correction

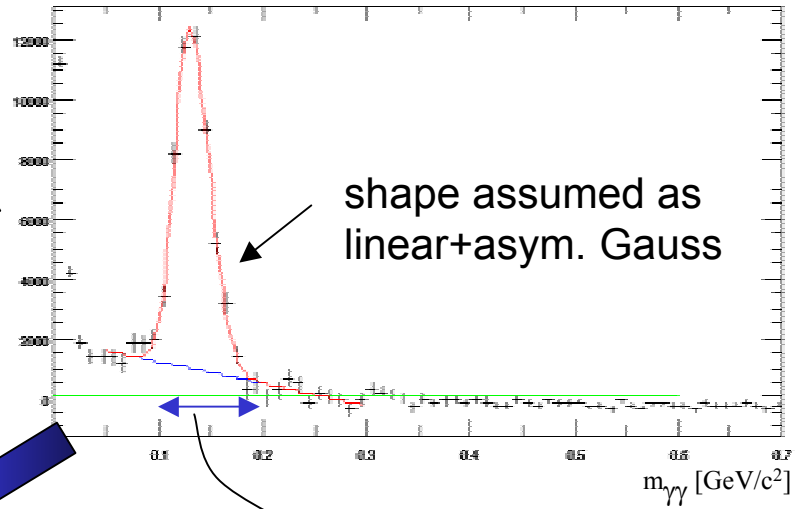


Example plots from the analysis procedure

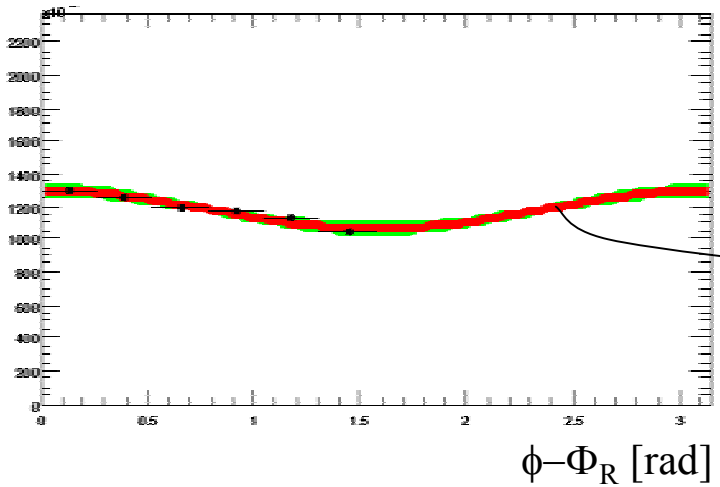
Invariant mass of $\gamma\gamma$ from same event and mixed event (classed by reaction plane, centrality, vertex position)



After subtraction, there is 2nd component of B.G. in p_T<2GeV/c region



count number of π^0 in a range after 2nd B.G. subtraction (not used the fit function)

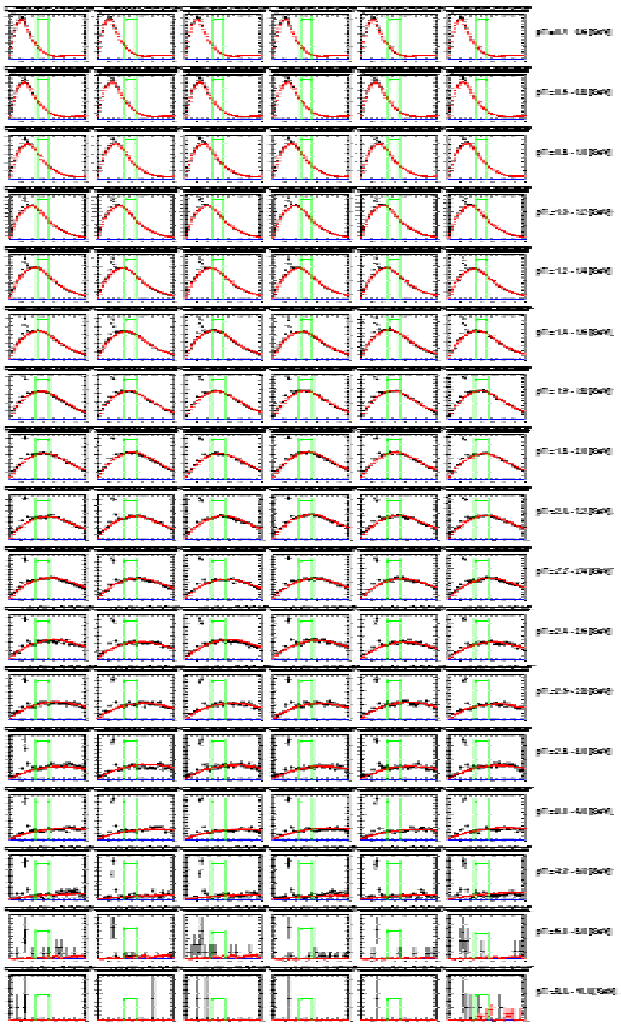


Fit function:
(average of π^0 count) × (1 + 2 v_2 cos[2(ϕ - Φ_R)])
Green lines : deviation by error of v_2

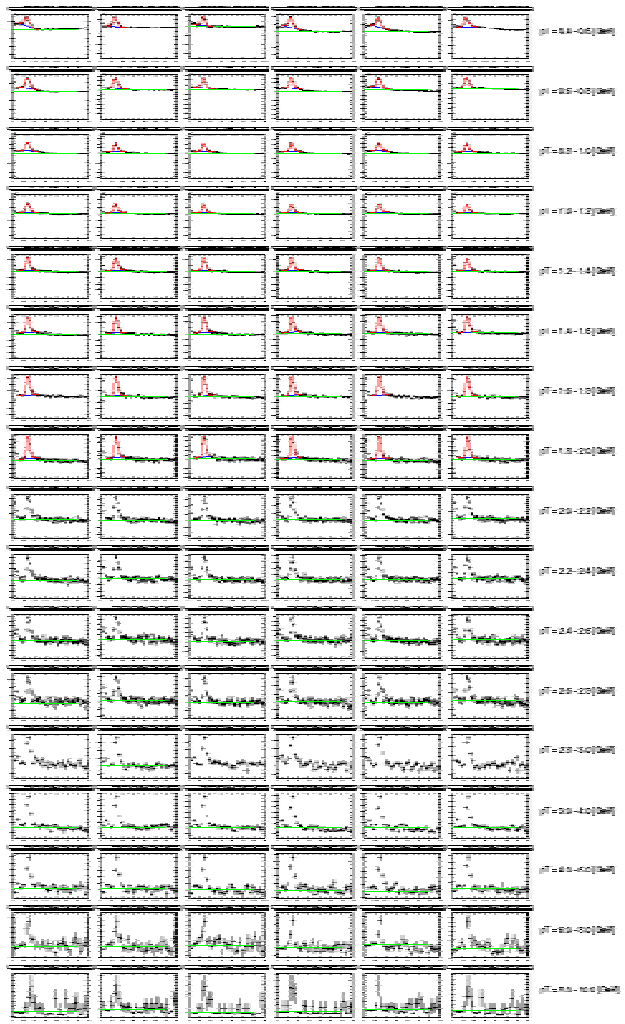
Tooooooooooooo many histograms checked

Example of invariant mass distributions for each p_T, ϕ-Φ_R in a centrality bin

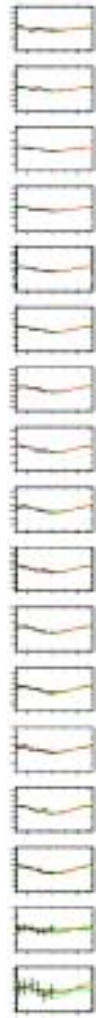
Before combinatorial background subtraction



After combinatorial background subtraction

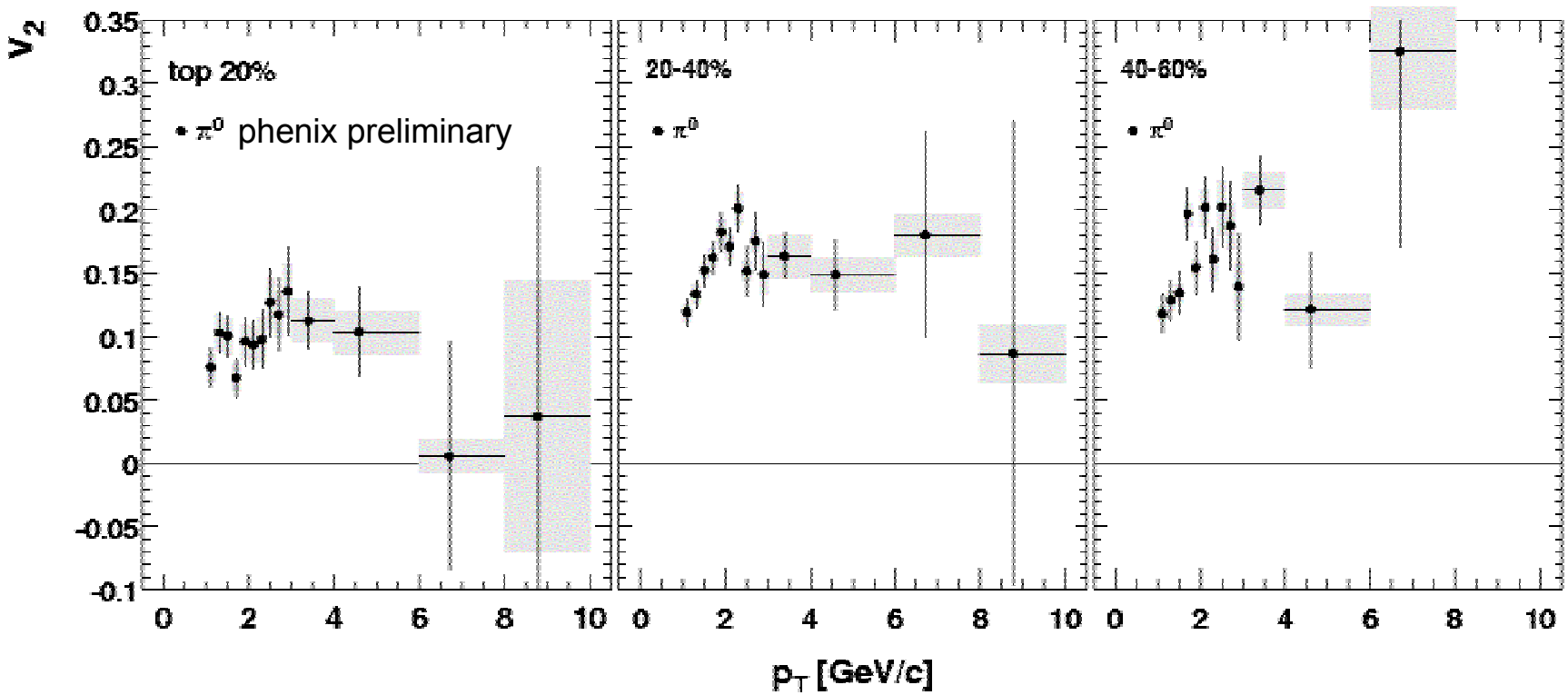


π^0 as a function of ϕ–Φ_{Rb}



v_2 vs. p_T vs. Centrality from 200GeV Au+Au

Statistical error is shown by error bar
Systematic error from π^0 count method and reaction plane determination is shown by gray box



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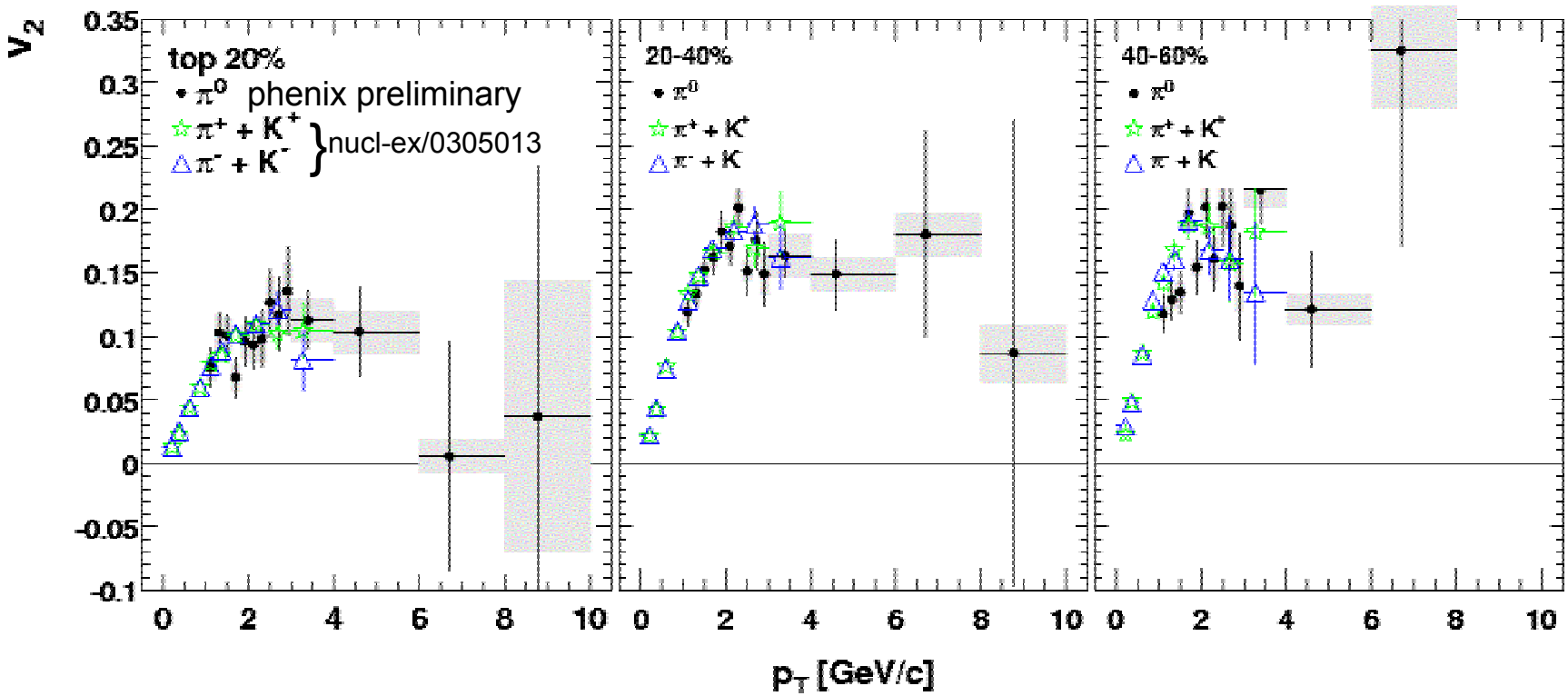
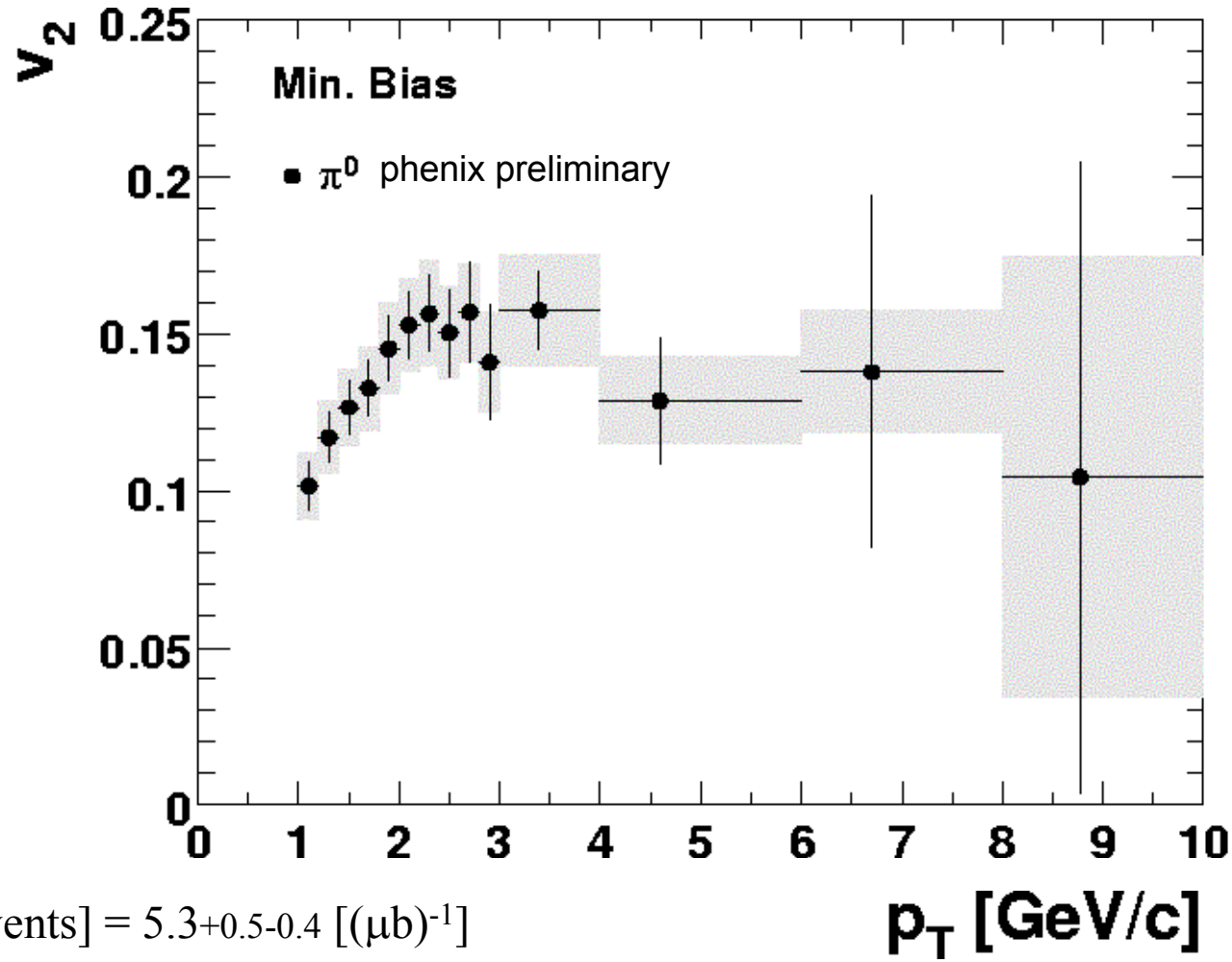
The charged π and K v_2 are shown only with statistical errors



- Charged π+K v_2 consistent with π^0 v_2 in p_T<4GeV/c

v_2 vs. p_T (Minimum Bias) from 200GeV Au+Au

- Identified particle v_2 up to p_T=10GeV/c



36.3×10^6 [events] = $5.3^{+0.5}_{-0.4}$ [$(\mu b)^{-1}$]

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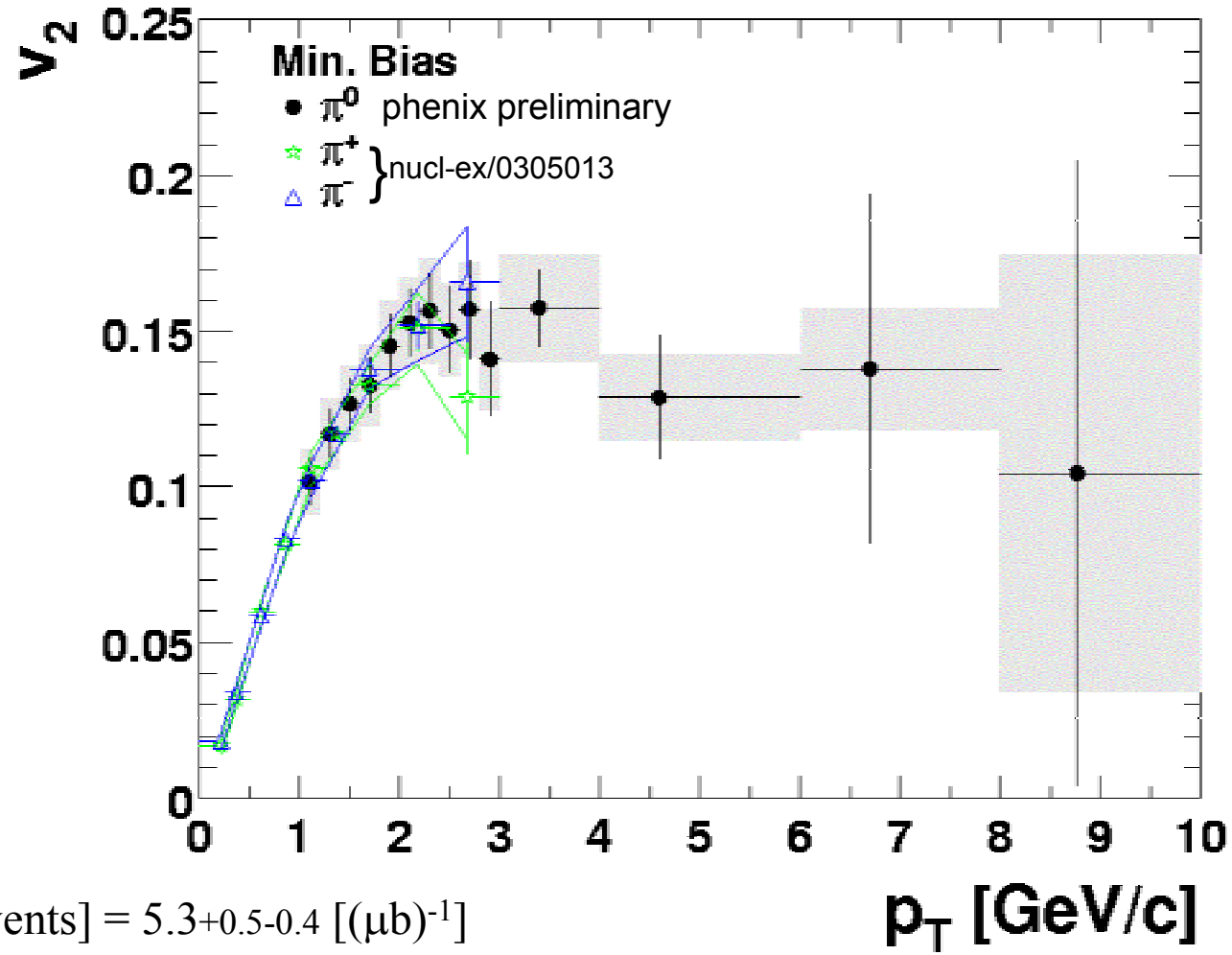

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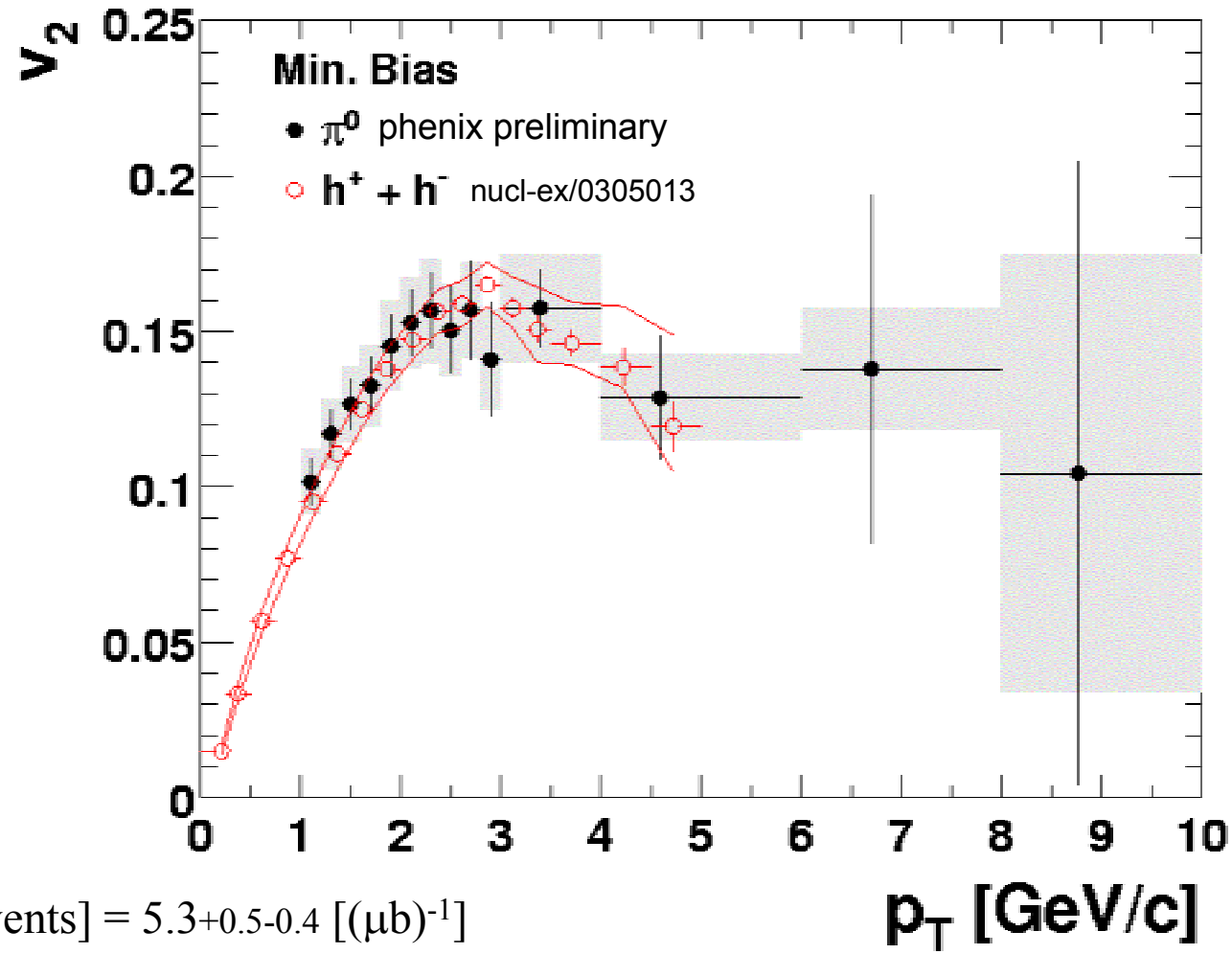

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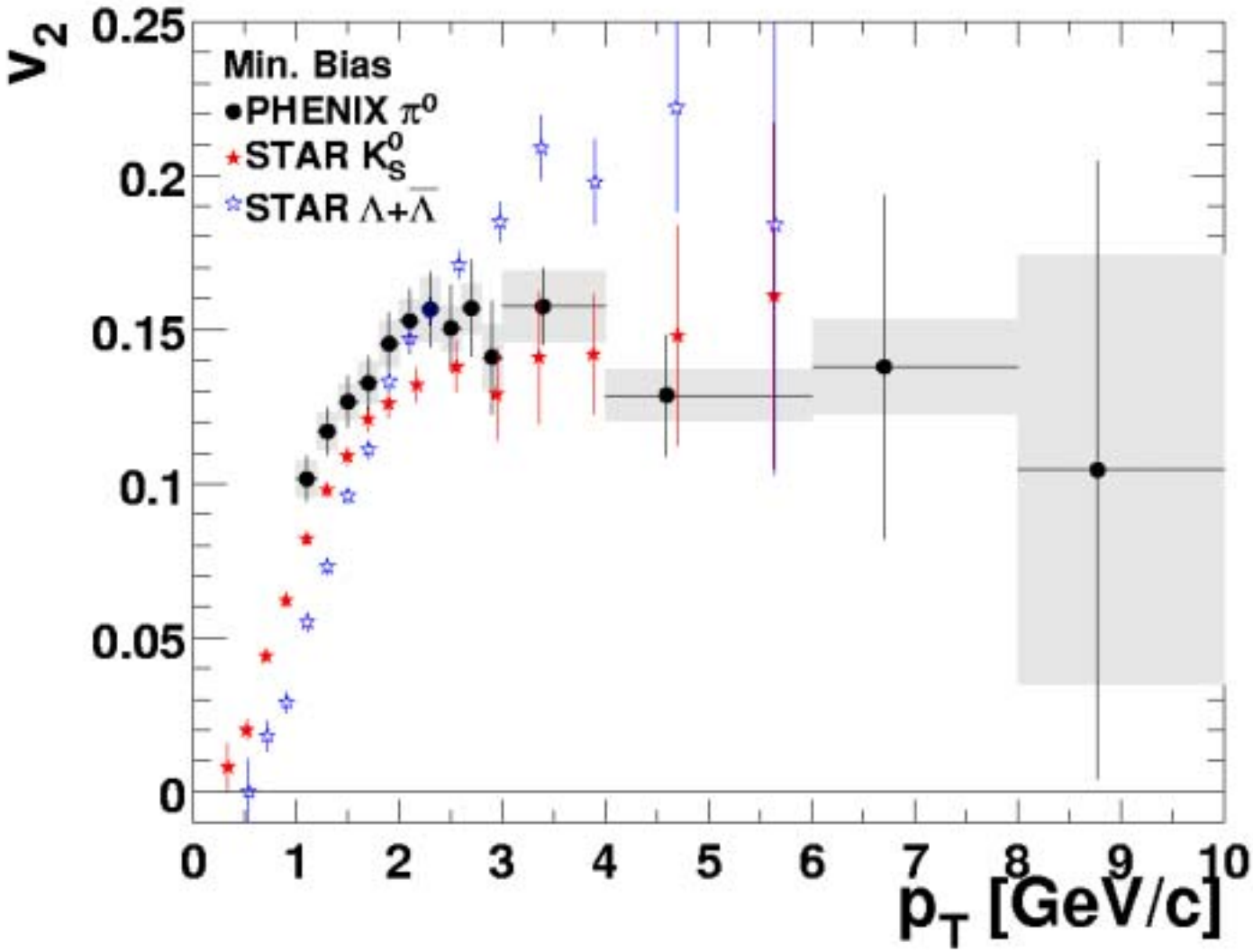
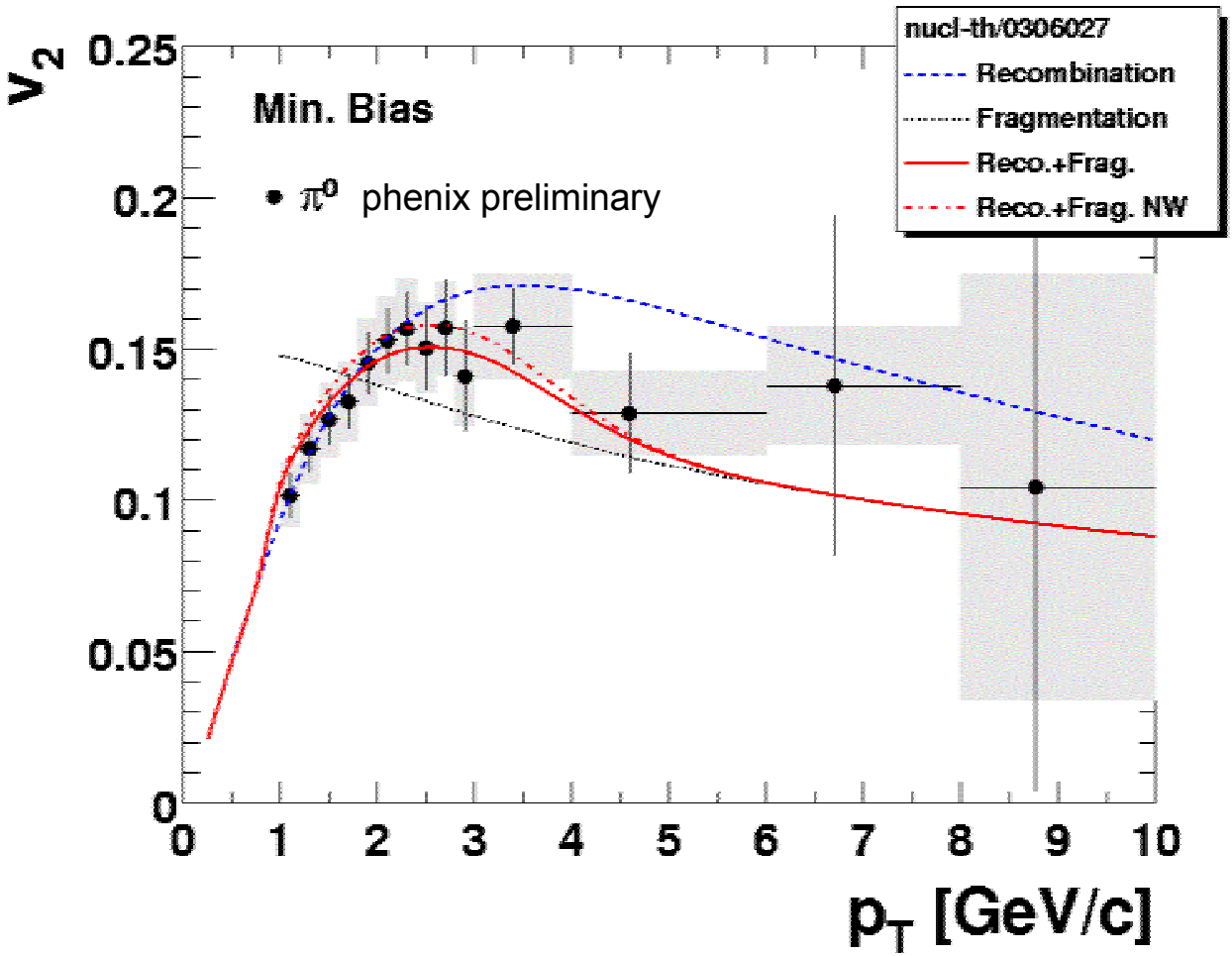
Comparison with K^0_s and Λ (STAR)



STAR data from nucl-ex/0306008

Comparison with a model



Special thanks to
C. Nonaka (one of authors)
of nucl-th/0306027 for
data of model calculation

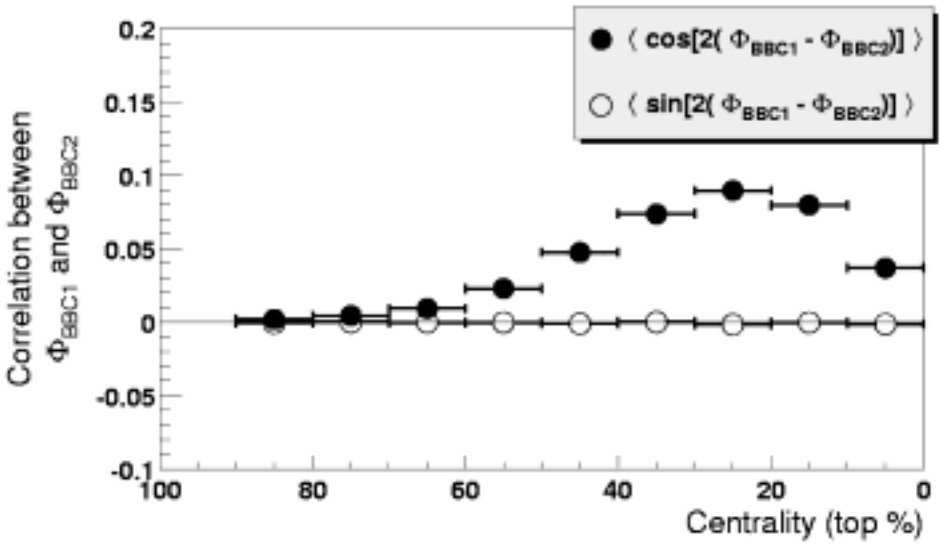
Comparison with a model which is described in nucl-th/0306027. Here we don't want to discuss which model can describe the data. To conclude which model can describe the data, we need much more statistics in high p_T region.

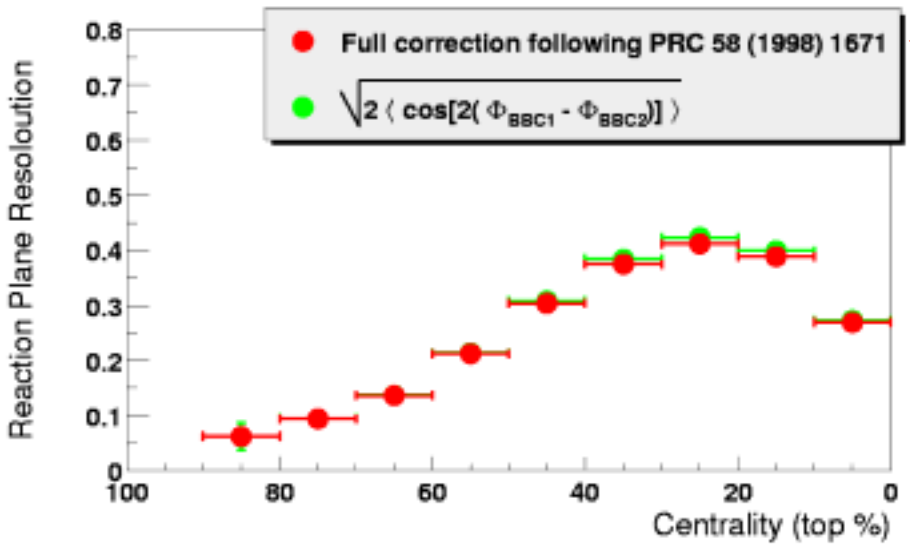
Summary

- First measurement of π^0 v_2 at RHIC
  - In p_T=1-10 GeV/c
- Charged π+K v_2 consistent with π^0 v_2
  - In p_T=1-4GeV/c
- Minimum bias data shows finite π^0 v_2
  - Up to p_T~8 GeV/c

- RHIC run4 Au+Au, it will be
  - Much more statistics
    - Detail study of v_2 shape around p_T=2-4GeV/c
  - Much higher p_T
    - We want to know where is end of finite v_2 in very high p_T

Reaction plane resolution





This values are used to correct measured v_2