Student report

Daniel Lohner

Outline

I) TRD PID:

dEdx normalization in experimental data

II) Azimuthal anisotropy of the π^0 yield

v2 and R_{AA} & Discovery of Jet Quenching at RHIC

Method to determine v2 for π^0

Reaction Plane Angle Ψ

Reaction Plane Resolution

π^0 reconstruction via photon conversions

π^0 yield and R_{AA} w.r.t. reaction plane -> v2

Status and Outlook

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TRD PID: dEdx normalization

- Q of tracklet = Accumulated Q of attached clusters
- 2 options to normalize:
  - Based on geometrical track length in drift volume
  - Normalize Q for every cluster by the 'space' which is occupied by the cluster (depends strongly on calibration)
- We have to handle the loss of clusters correctly
  - Due to energy fluctuations?
  - Due to systematic effects?

We observed systematic loss (TRD weekly meeting, 13.01.2011)

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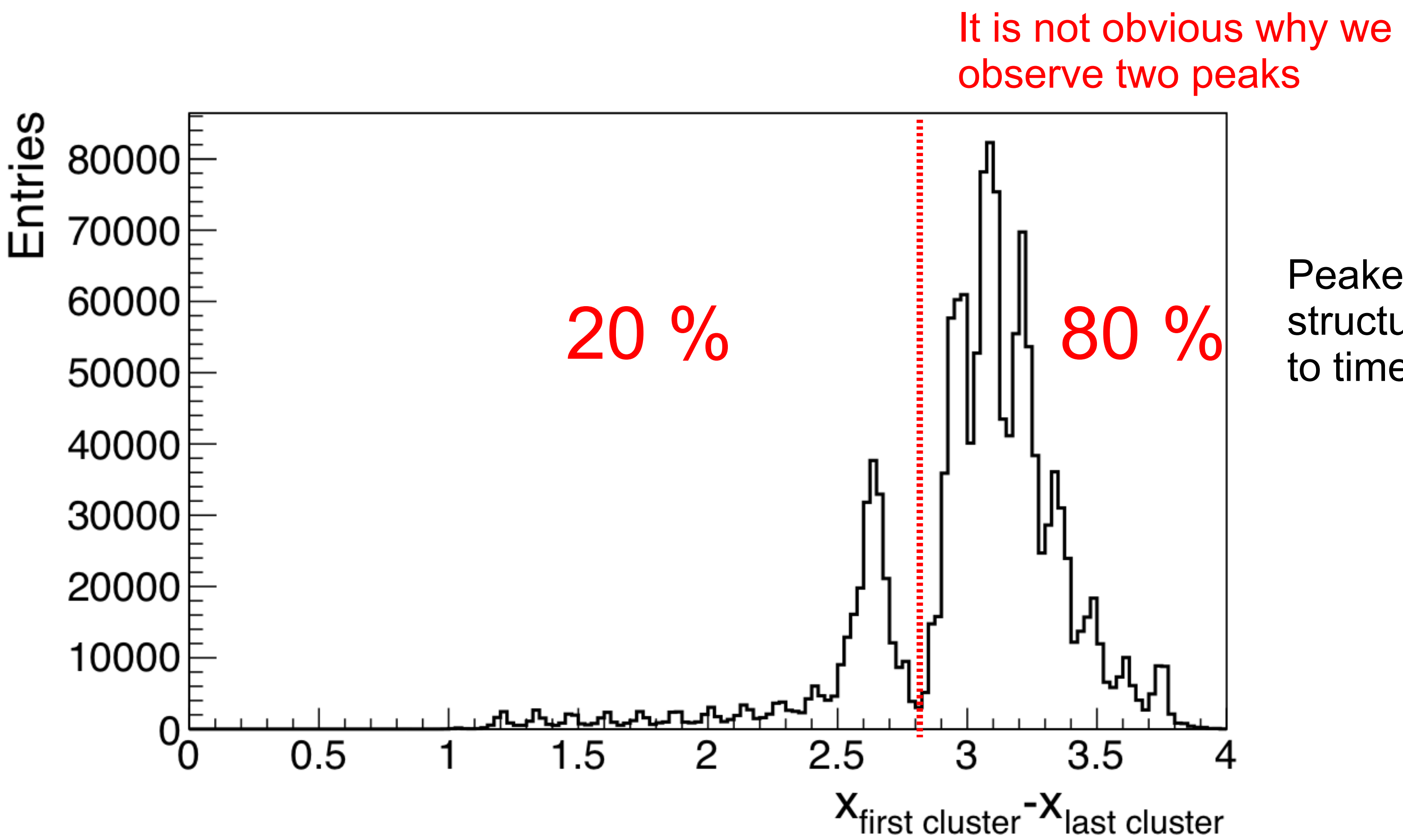
What is the length of the tracklets?

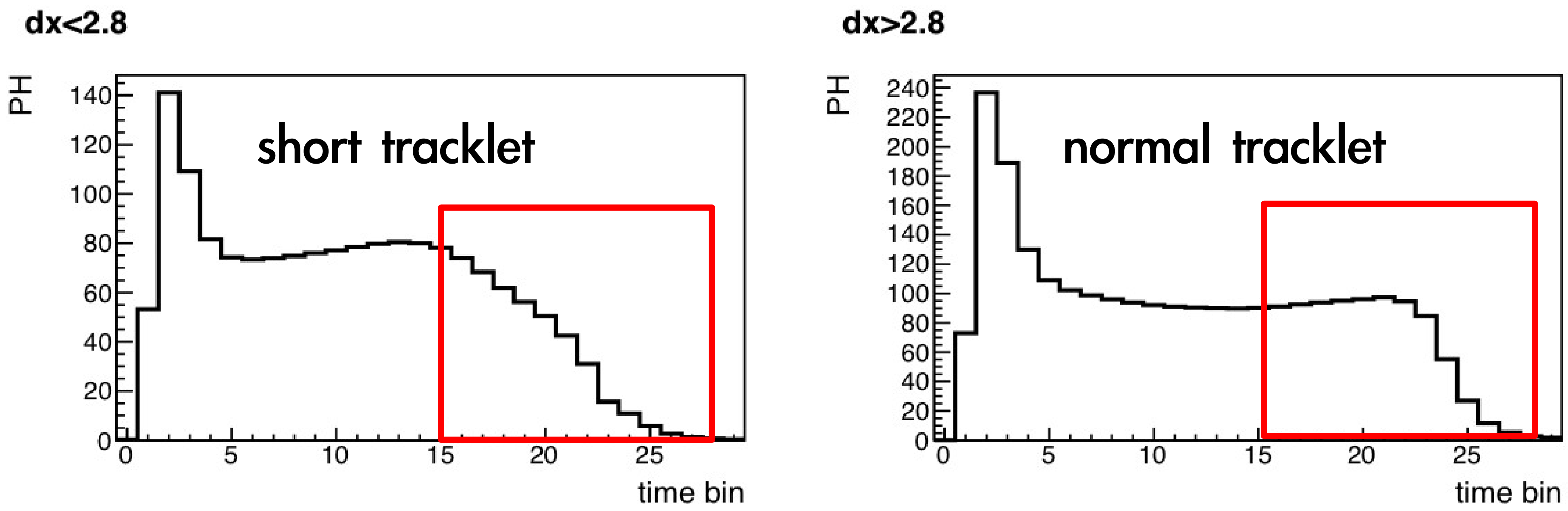


Peaked structure due to time bins

==> Two classes of tracklets

PH distribution shows that we lose signal at large drift times

- Besidesnormal tracklets we observed 'shorter' tracklets with systematic loss
  - Those make up 20 % off all reconstructed tracklets



- We need to understand these observations

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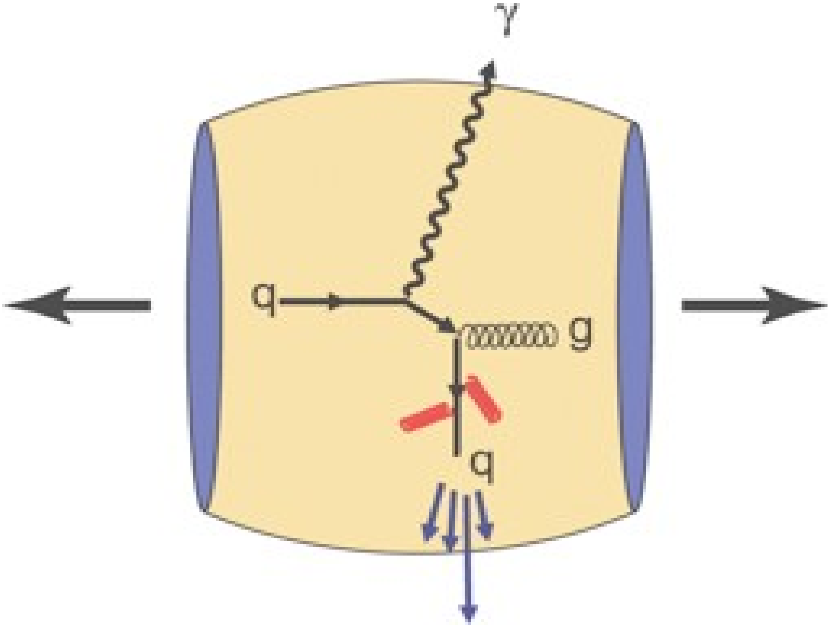
Jet Quenching describes the in-medium energy loss of high momentum partons

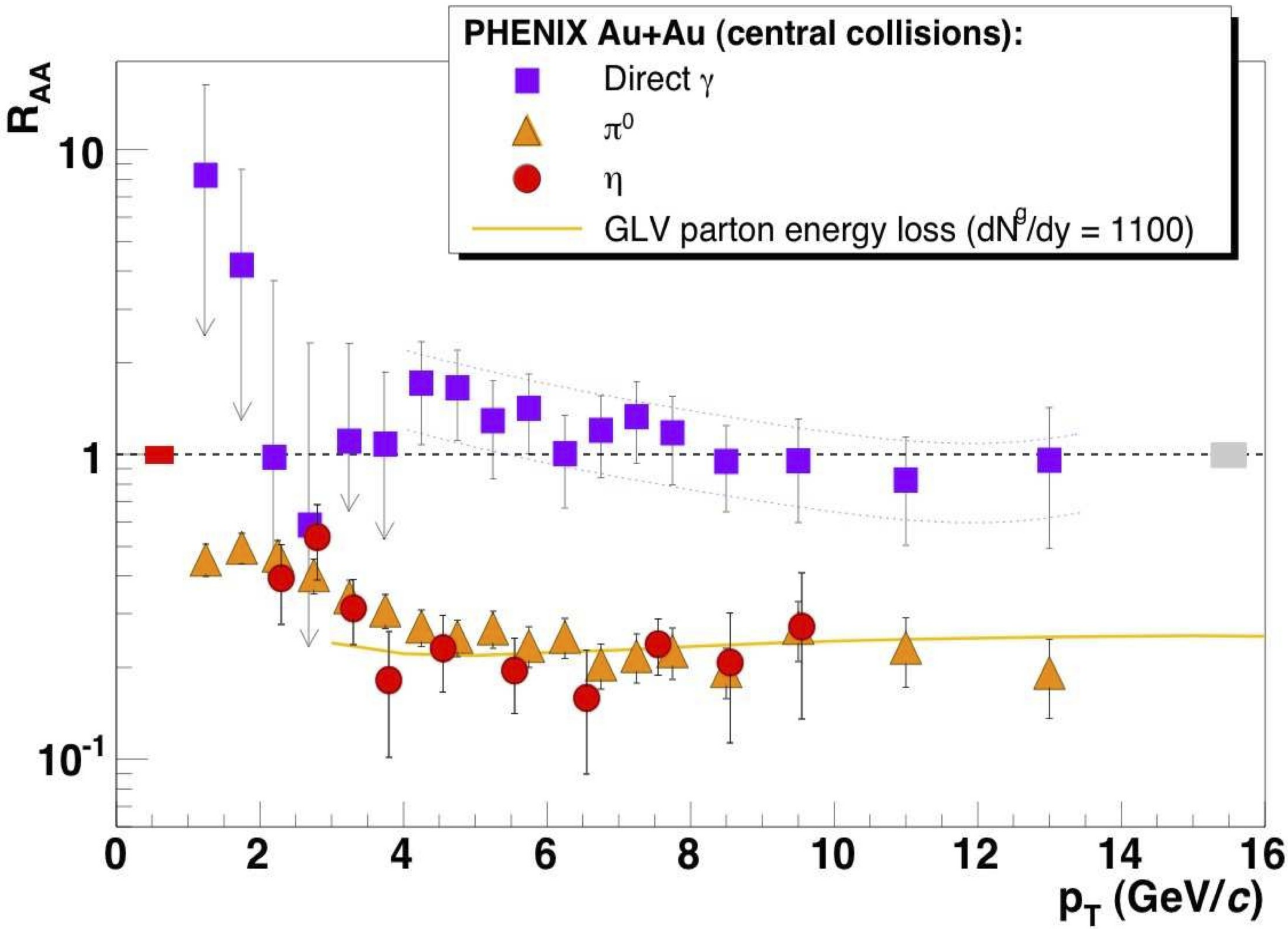
$$R_{AA} = \frac{dN_{AA}/dp_t}{N_{coll}\, dN_{pp}/dp_t}$$

- No energy loss for γ in QGP
  - Linear Scaling of the direct photon yield from pp to AuAu collisions
  - $R_{AA}=1$
- Jet quenching = Energy loss of partons in the QGP
  - Suppression of i.e. the π^0 yield in AuAu collisions at large momenta
  - $R_{AA}<1$



Klaus Reygers

Discovery of Jet Quenching at RHIC



(PHENIX Collaboration, S.S. Adler et al., Phys. Rev. Lett. 96, 202 301 (2006))

- No suppression of direct Photons $R_{AA}=1$
- Suppression of π^0 and η yield $R_{AA}<1$

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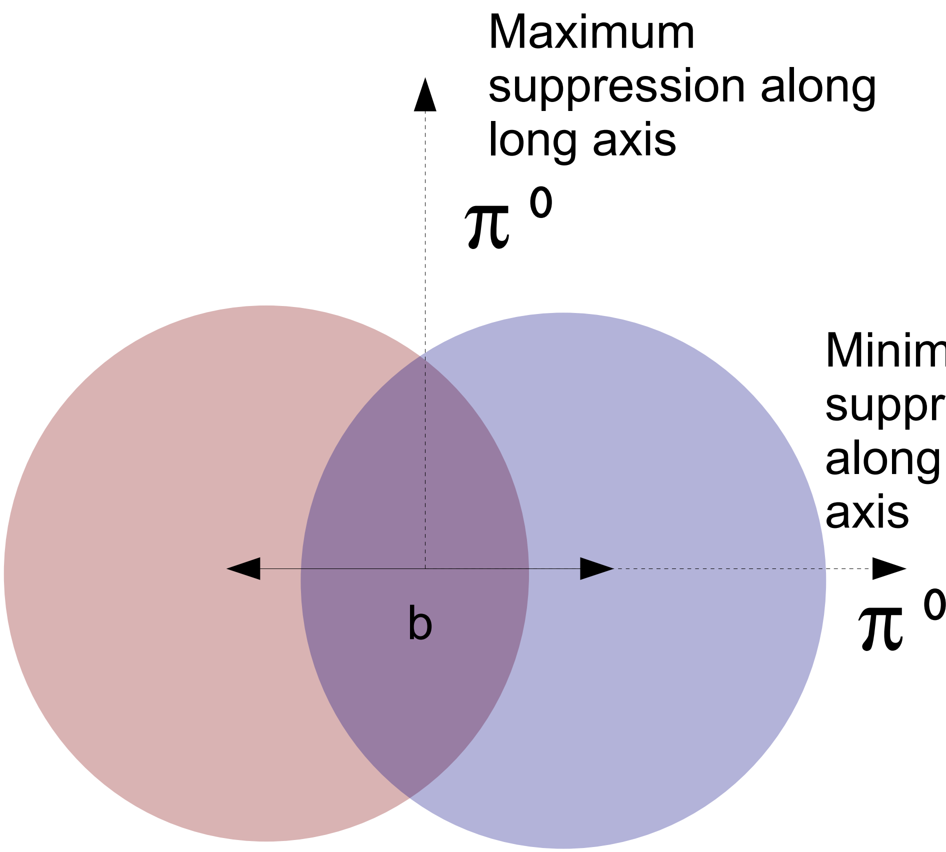
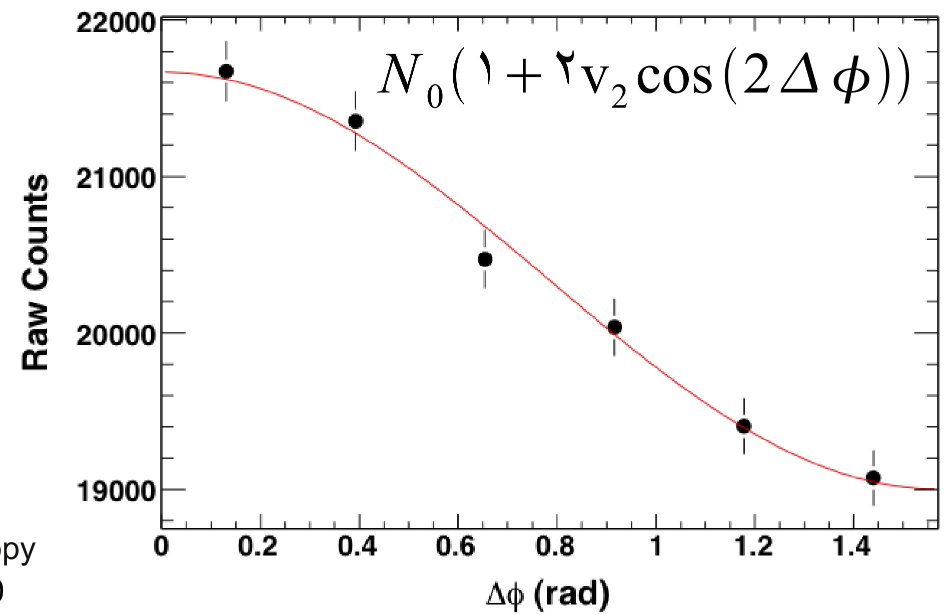
Path length dependent π^0 suppression



- Suppression of the absolute π^0 yield ($R_{AA}<1$)
- Asymmetric reaction plane --> anisotropic π^0 production ($v2>0$)



Rui Wei, High pT Azimuthal Anisotropy in Au Au collisions at 200 GeV, 2010

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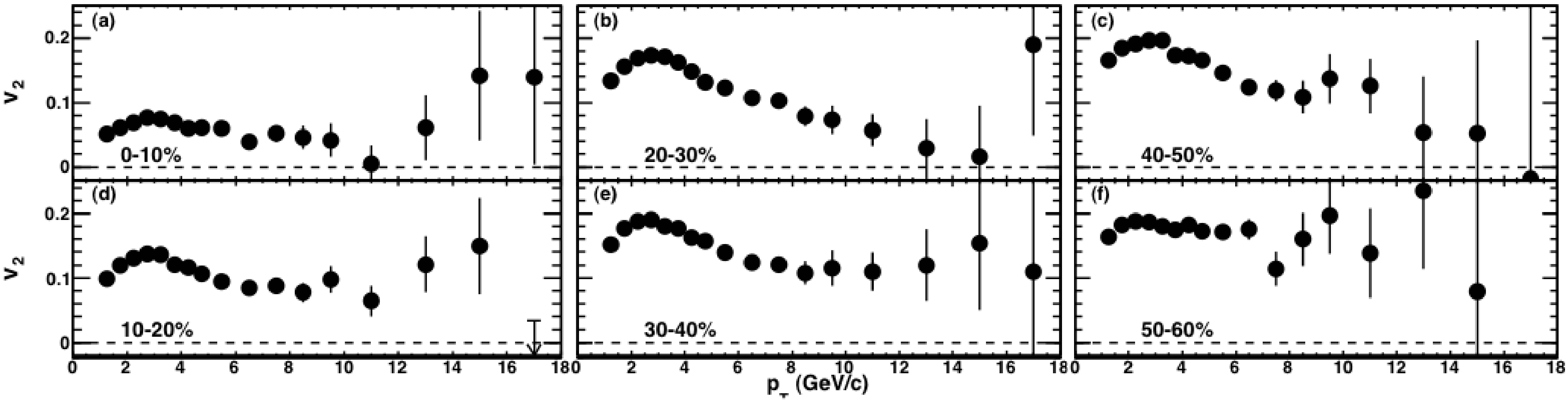
Anisotropy of the π^0 yield observed at RHIC



(PHENIX Collaboration, A. Adare et al., Phys. Rev. Lett. 105, 142 301 (2010))

- v2 is a measure of the magnitude of the anisotropy
- v2 increases with decreasing centrality
  - Low momenta: Collective flow
  - Higher momenta: Path length dependent jet quenching

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Reaction Plane Determination

- Calculate Q vector from AOD tracks (weight=pt)

$$
\begin{aligned}
Q_x &\equiv Q_n \cos(n\Psi_n) = \sum_i^M w_i \cos(n\phi_i), \\
Q_y &\equiv Q_n \sin(n\Psi_n) = \sum_i^M w_i \sin(n\phi_i), \\
\Psi_n &= \frac{1}{n} \tan^{-1}\left(\frac{Q_y}{Q_x}\right),
\end{aligned}
$$

- Select TPC tracks for the RP angle calculation

Phenix AN: “Measurements of elliptic and hexadecapole f ow in Au+Au collisions at s = 200 GeV”

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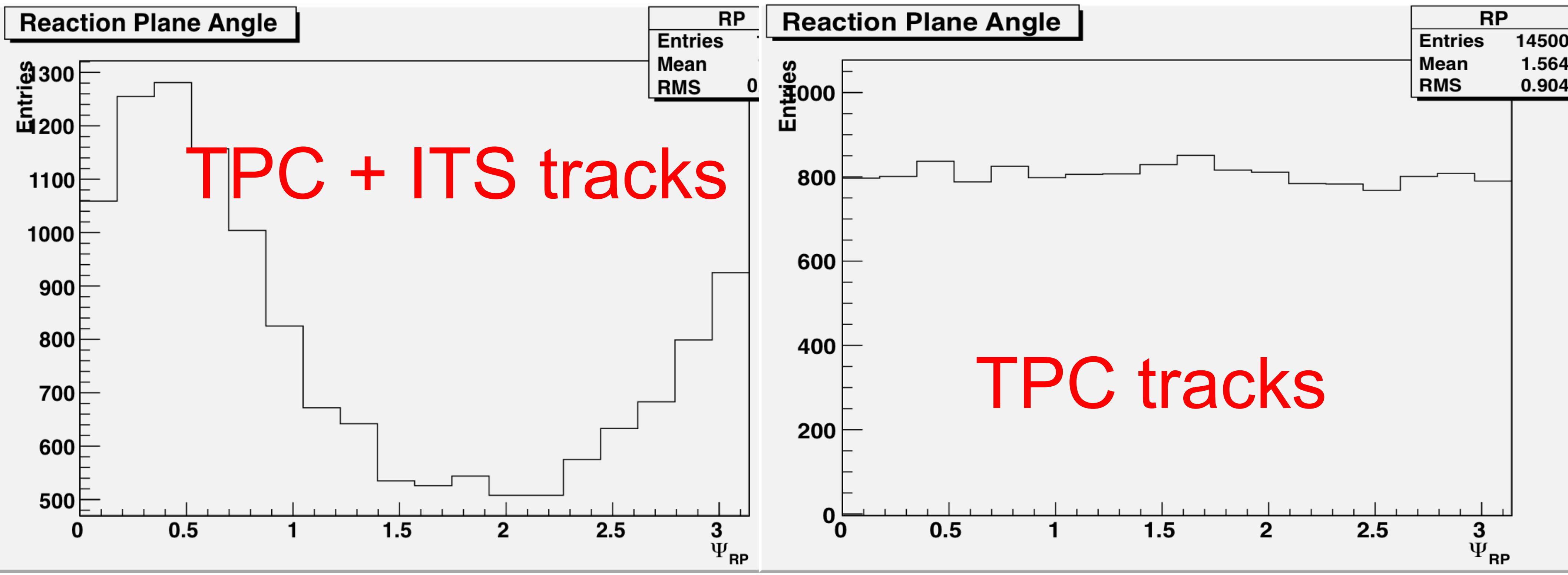
RP angular distribution



- Acceptance (holes) in ITS

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Calculate Reaction Plane Resolution with two subevent method

- Need RP resolution to correct measured v2: $v_2 = \frac{v_{2,raw}}{\sigma_{RP}}$
- Divide event into 2 subevents (e.g. by random)

1. option $$\langle \cos(2(\Psi_2^{S(N)} - \Psi_{RP})) \rangle = \sqrt{\langle \cos(2(\Psi_2^S - \Psi_2^N)) \rangle}$$

2. option $$\frac{dN}{d\Delta\phi_R} = \frac{e^{-\chi_I^2}}{2} \left[\frac{2}{\pi}(1 + \chi_I^2) + z(I_0(z) + L_0(z)) + \chi_I^2(I_1(z) + L_1(z)) \right]$$

$$\langle \cos(km(\Psi_m - \Psi_{RP})) \rangle = \frac{\sqrt{\pi}}{2\sqrt{2}} \chi_m \exp(-\chi_m^2/4) \left[I_{\frac{k-1}{2}}(\chi_m^2/4) + I_{\frac{k+1}{2}}(\chi_m^2/4) \right]$$

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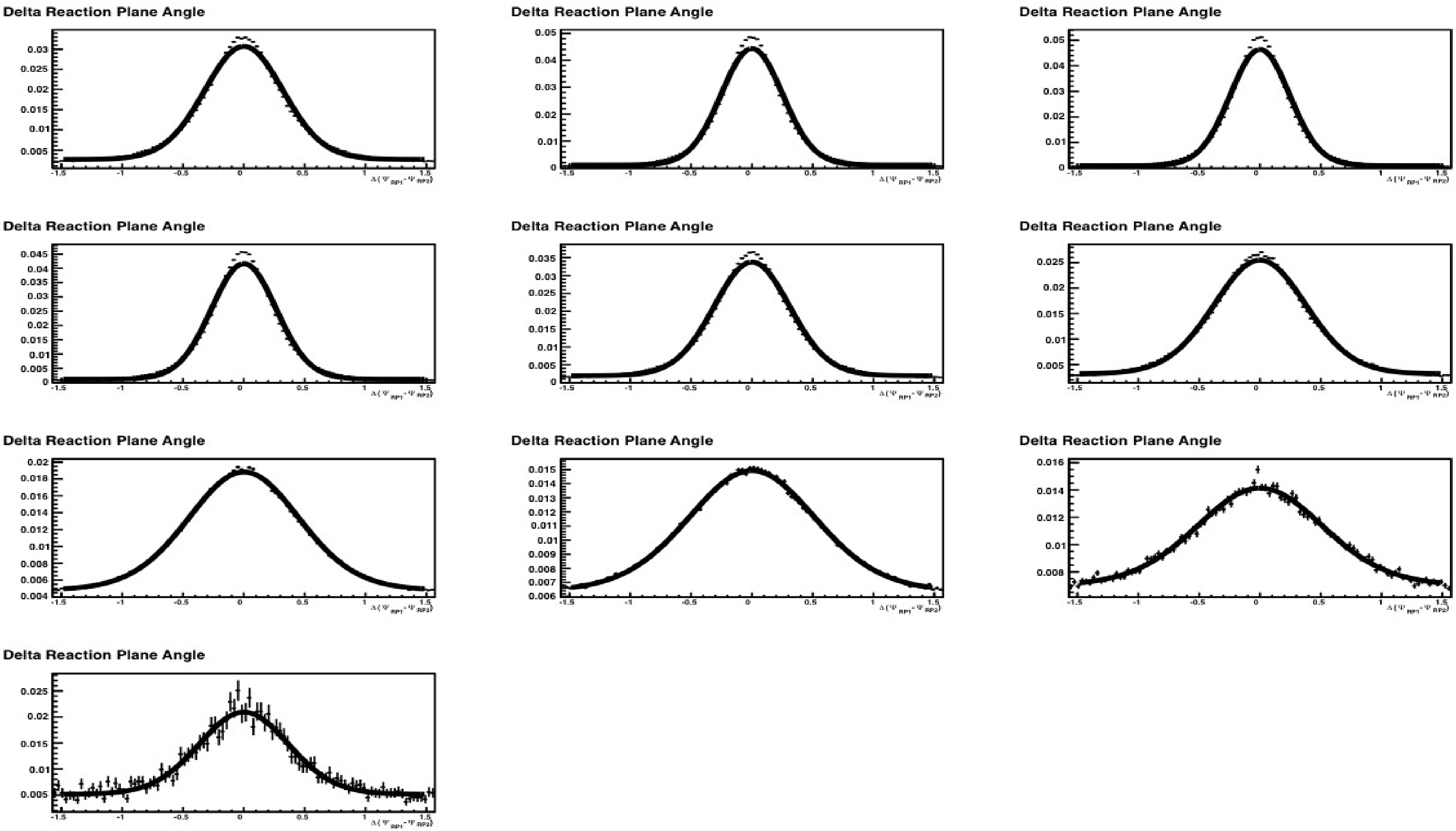
RP Resolution Fit



There is some “background” which is here handeled by additional parameter

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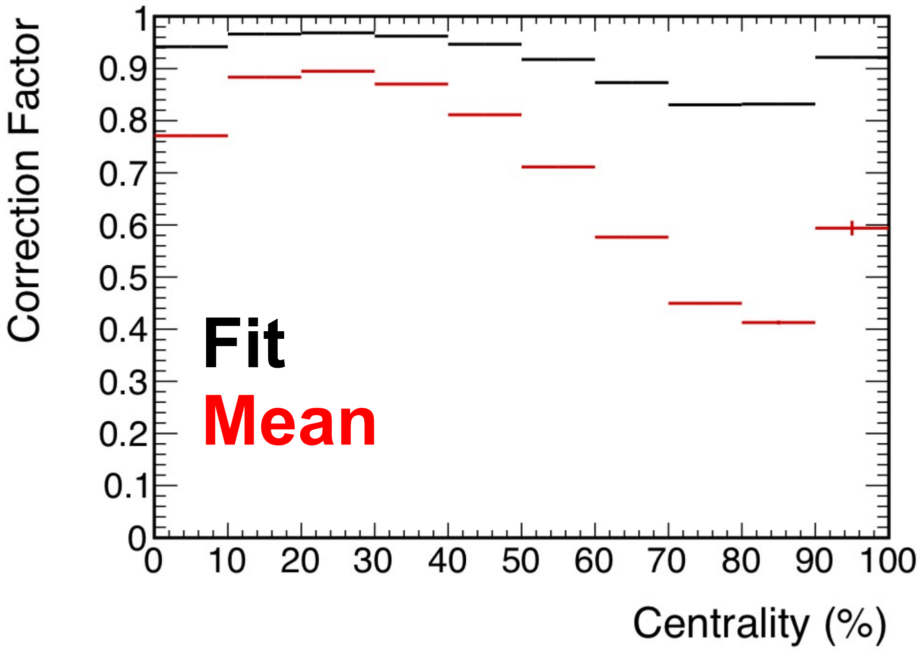
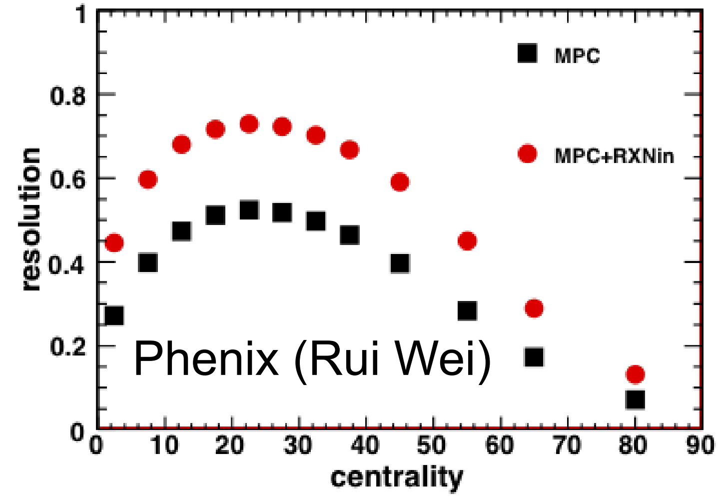
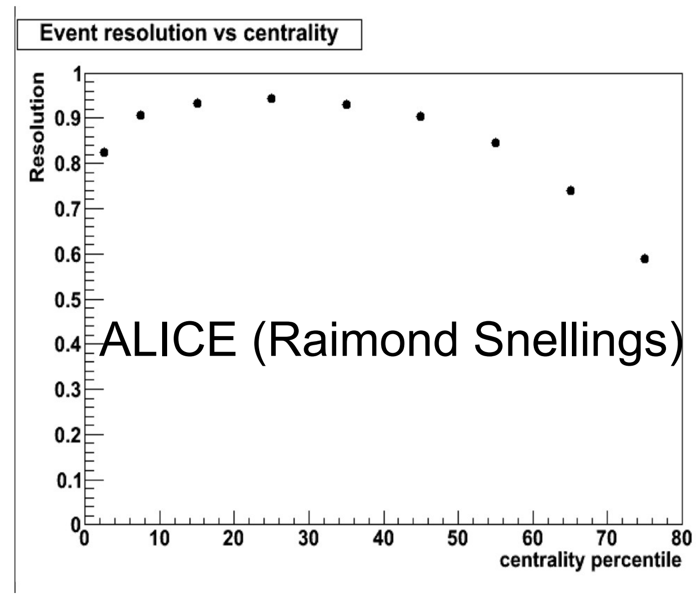
RP Resolution Correction Factor







- Compared to Phenix 2π acceptance instead of π
- Difference between Fit and Mean due to "background" mentioned before

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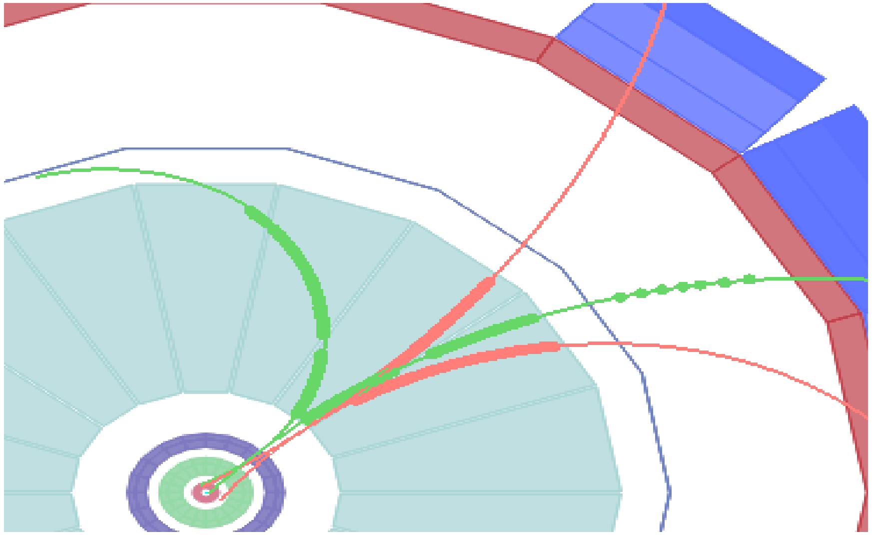
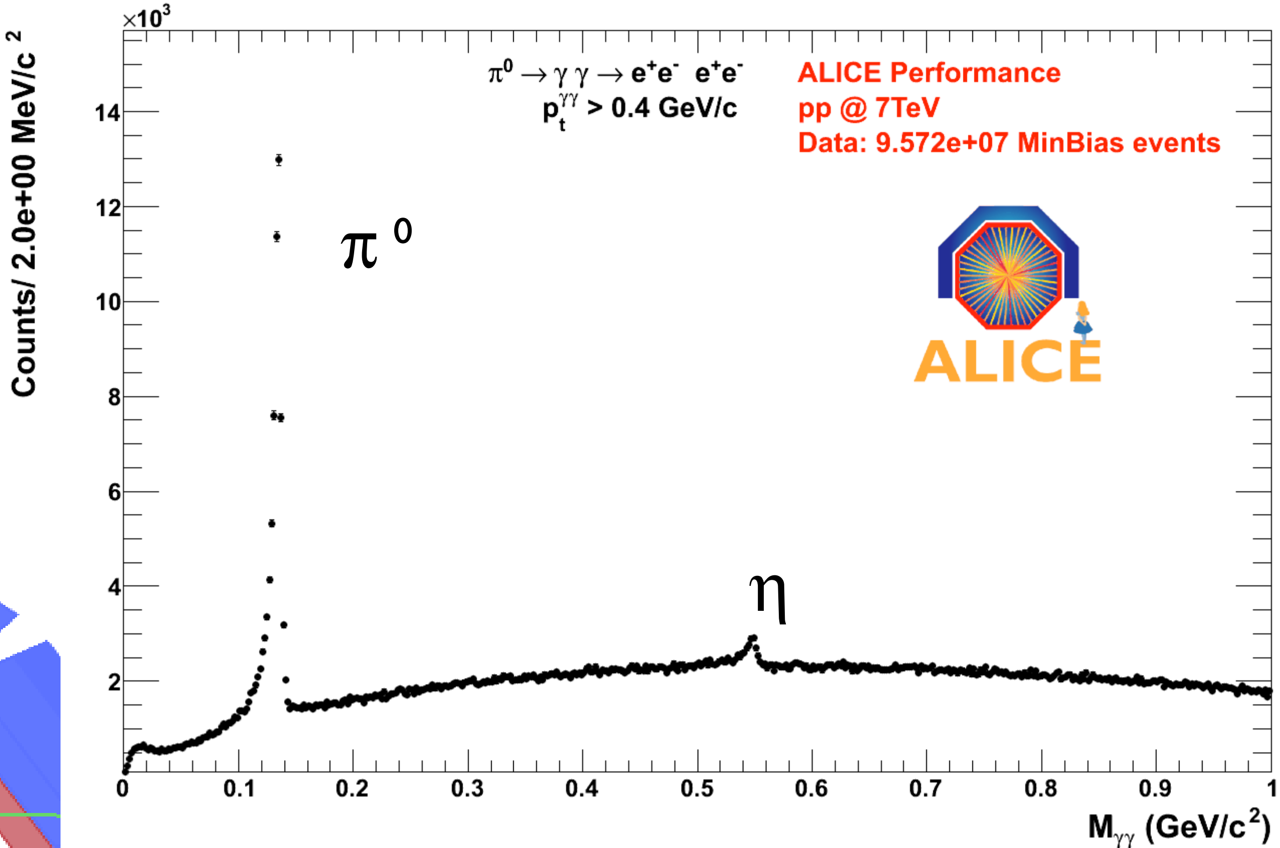
π^0 Reconstruction in pp

- $\pi^0 \rightarrow 2\gamma$ (99%)
- π^0 decays at primary vertex ($c\tau$ = 25.1 nm)

$\pi^0 \rightarrow \gamma\gamma \rightarrow e^+e^-e^+e^-$



ALICE Collaboration, Kathrin Koch, hard probes 2010



ALICE Collaboration, Kathrin Koch, hard probes 2010

- Reconstruct γ conversions into e^+e^- (conversion probability X_0=8 %)

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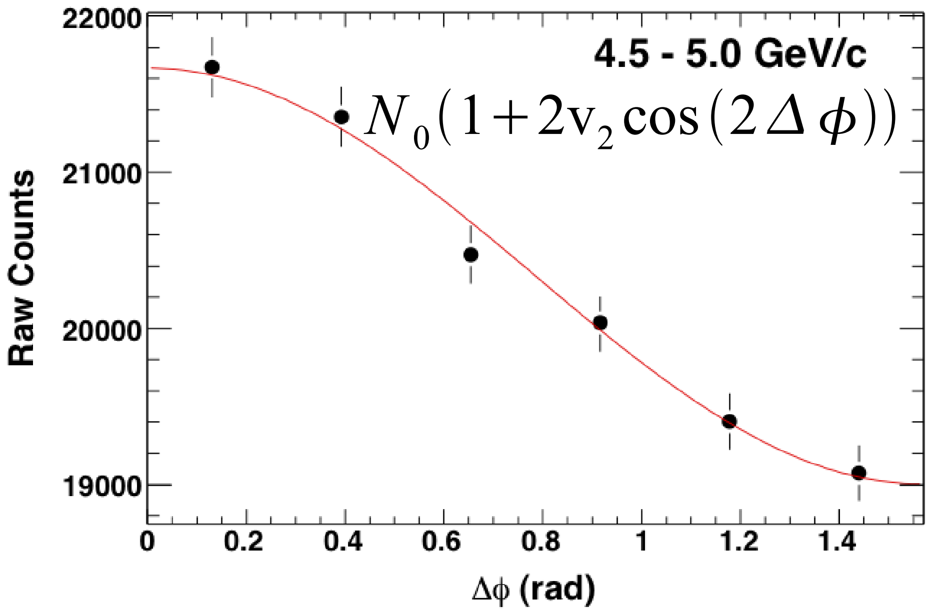
I) The dN/d ϕ Method

1) Fill Inv. Mass Histograms with different bins for pt,centrality and (6) bins for Δϕ(ϕ w.r.t. reaction plane) Same for background

2) Extract π^0 yield in each Δϕ bin at given centrality and pt

3) Fit v2 (see figure)

4) Correct v2 by the reaction plane resolution factor



Rui Wei, High pT Azimuthal Anisotropy in Au Au collisions at 200 GeV, 2010

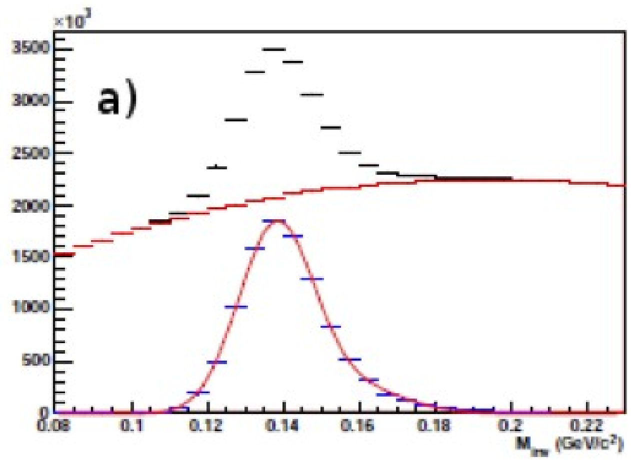
II) The Invariant Mass Method

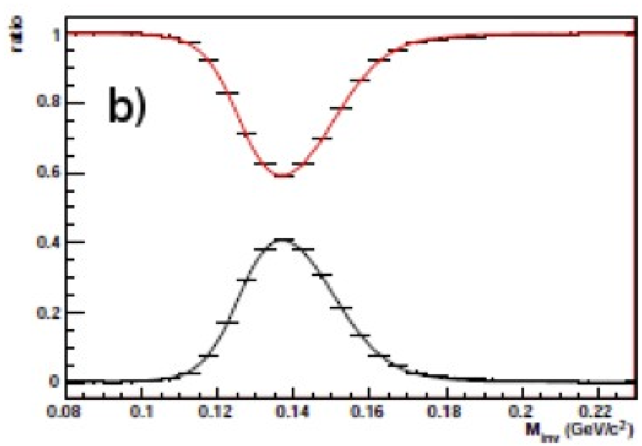
1) Fill Inv. Mass Histograms with different bins for pt and centrality

2) Decomposition: $N^{pair}(M_{Inv}) = N^{BG}(M_{Inv}) + N^{\pi 0}(M_{Inv})$

$$N^{pair}(M_{Inv})\, v_2^{pair} = N^{\pi^0}(M_{Inv})\, v_2^{\pi^0} + N^{BG}(M_{Inv})\, v_2^{BG}$$

Rui Wei, High pT Azimuthal Anisotropy in Au Au collisions at 200 GeV, 2010





$N^{BG}/N^{pair}(M_{Inv})$

$N^{\pi 0}/N^{pair}(M_{Inv})$

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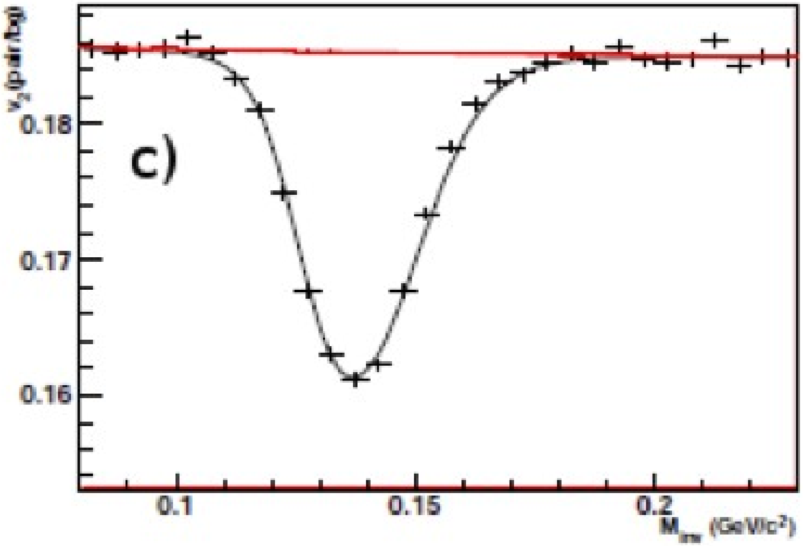
II) The Invariant Mass Method (2)

3) Fill $\Delta\phi(M_{Inv})$ and extract the Fourier coefficient

$v_2^{pair}(M_{Inv}) = \langle\cos(2\Delta\phi)\rangle(M_{Inv})$

(for Signal + Background)



4) Linear Fit for v_2^{BG} (red line)

5) Fit

$$v_2^{pair}(M_{Inv}) = v_2^{\pi^0}\frac{N^{\pi^0}}{N^{pair}}(M_{Inv}) + v_2^{BG}\frac{N^{BG}}{N^{pair}}(M_{Inv})$$

(black curve) and extract $v_2^{\pi 0}$

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- Implementation
  - Ongoing for ESDs
  - Missing Parameters for photon reconstruction in AODs
    - External Track Parameters missing in AOD V0s
  - Pi0 v2 analysis implemented for Gamma Conversion AOD Satellites
    - Tests with Rosella's AOD production (GSI LHC10h):
      - About 200k pi0s in 5.5 Mio Events
      - Already observation of v2 in collective flow momentum range
      - Very low statistics in the momentum range of interest for jet quenching (pt>6 GeV/c)

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