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# **Spectra and NO Angular Correlations of high momentum charged particle in PHENIX**

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Quark Matter 2001

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for the PHENIX Collaboration

## **Outline**

- Motivation
- Setup and data set
- Physics Results
- Summary and Outlook

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## Motivation

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- New Energy regime:
  - (Mini-)Jet Production contributes to particle Yield
  - Investigate the early and hot phase of the collision using hard scattering processes as a probe
- Predictions:
  - In the ultra-high-density medium partons experience energy loss: 'Jet Quenching'
- Observables:
  - Reduced yield of high momentum particles
  - Enhanced acoplanarity

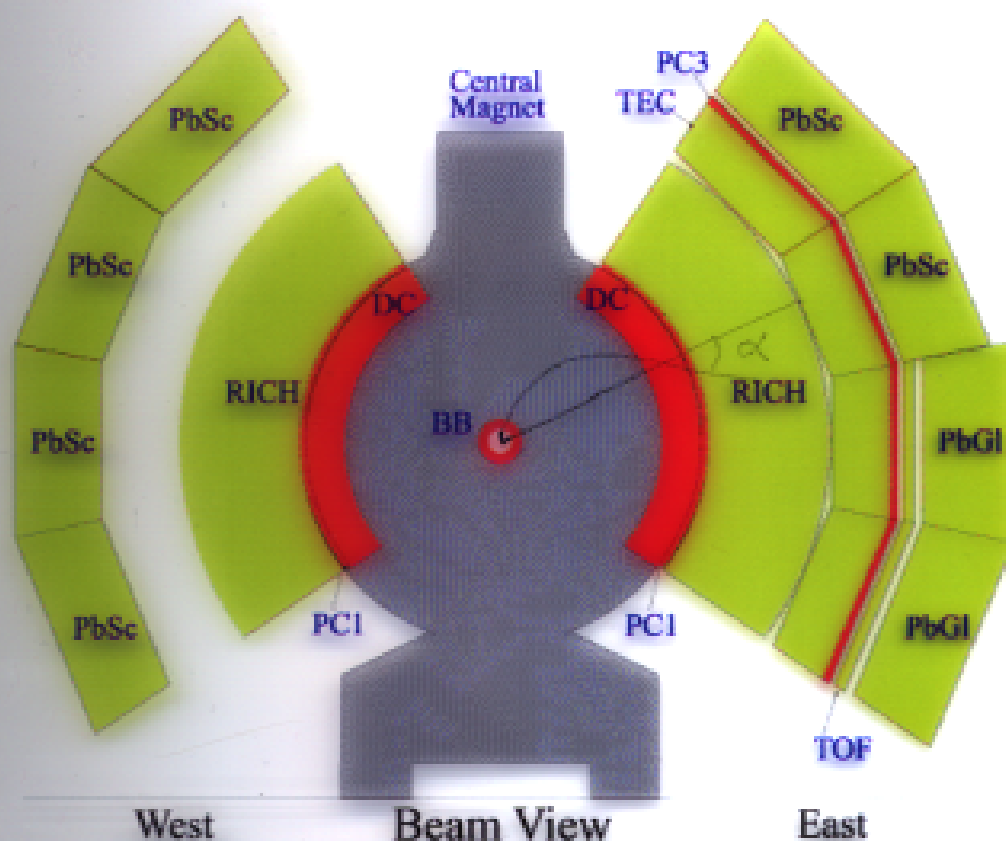
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## Data Set

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- 1.5M Minimum Bias events: total of 115M Tracks
- For this analysis:
  - EAST arm: DCH, PC1 and PC3
  - $\Delta\phi = 90^\circ$  and  $\Delta\eta = 0.7$
  - Deflection angle of the track with respect to a straight trajectory (from the vertex).
  - Momentum Resolution (at present):

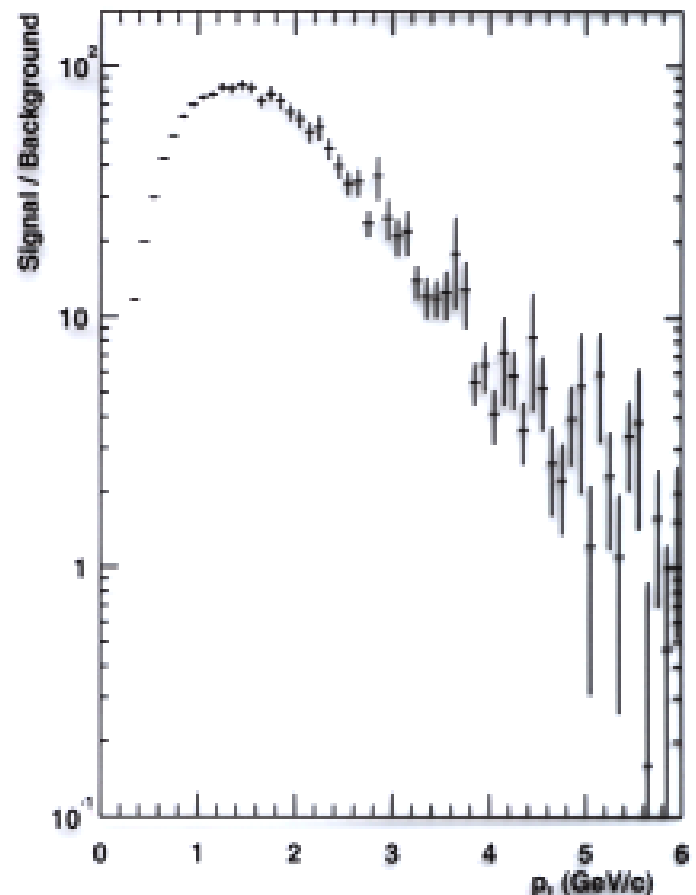
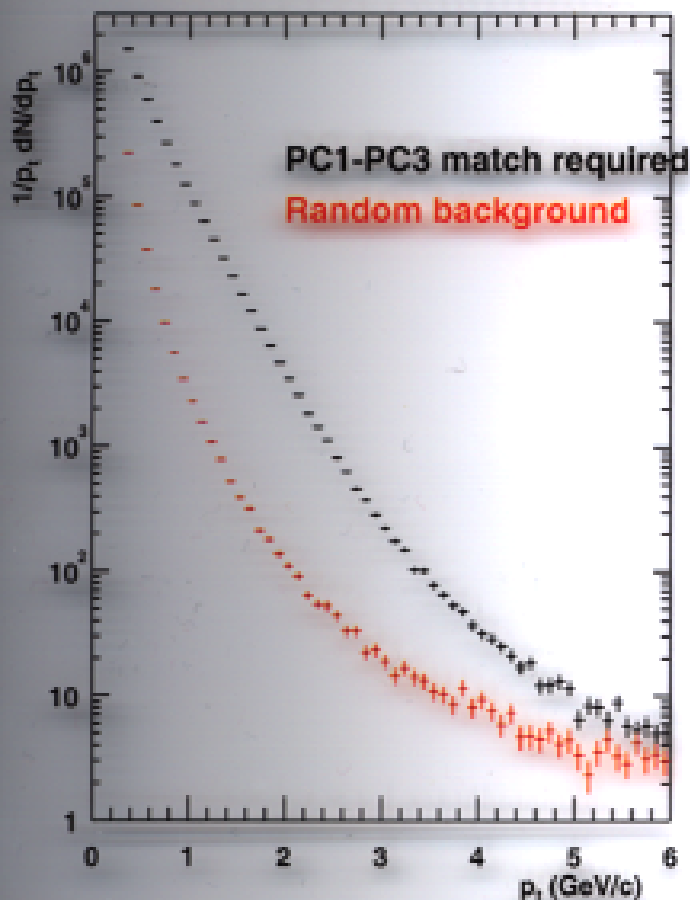
$$\frac{\sigma_p}{p} = \frac{\sigma_{\Delta\phi}}{\Delta\phi} = 3.5\% \cdot p \text{ (GeV/c)}$$



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## Uncorrected Distribution

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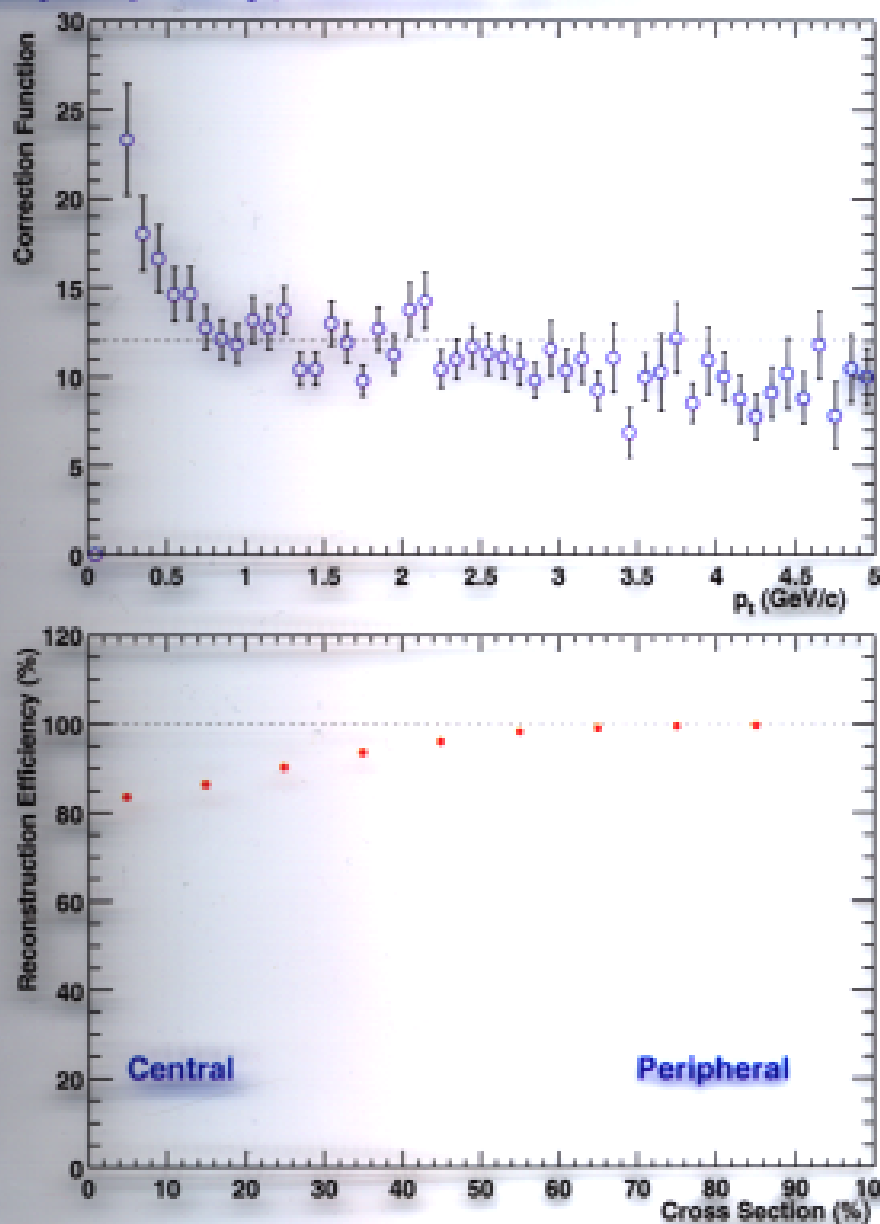
- Background:  
Products of decays and albedo reconstructed as high momentum particles
- Rejection:  
use vertex (BBC) and outer detectors: PC1(2.5mm) and PC3(5mm) match to reject particles not coming from vertex.
- Measure and subtract remaining background

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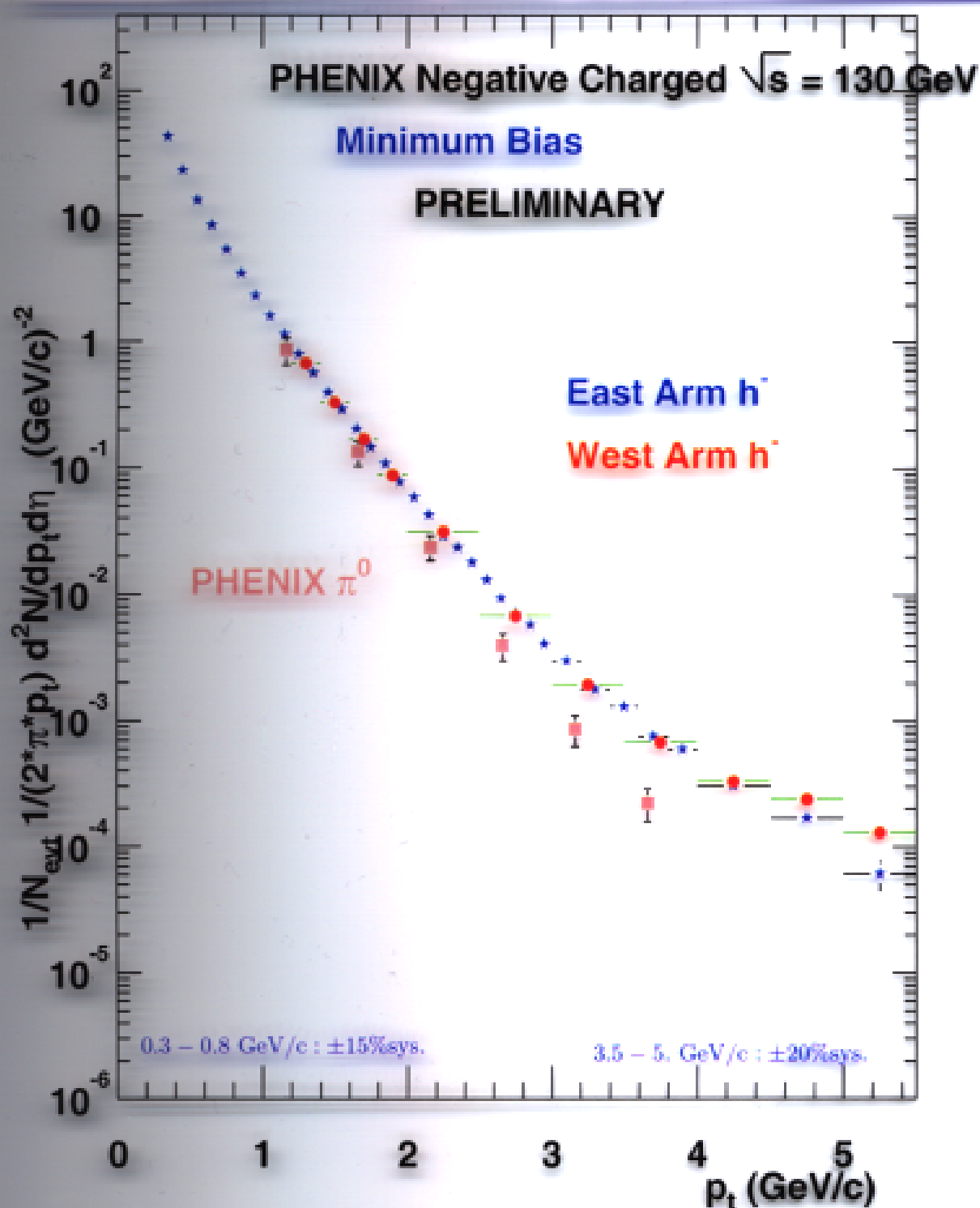
# Corrections

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- using single particle Monte-Carlo tracks
- embedding in real events
- plateau given by geometrical acceptance and efficiency corrections
- distorsion due to momentum resolution:  
correction at 5 GeV/c is 20% – 40%
- Multiplicity and  $p_t$  corrections factorize

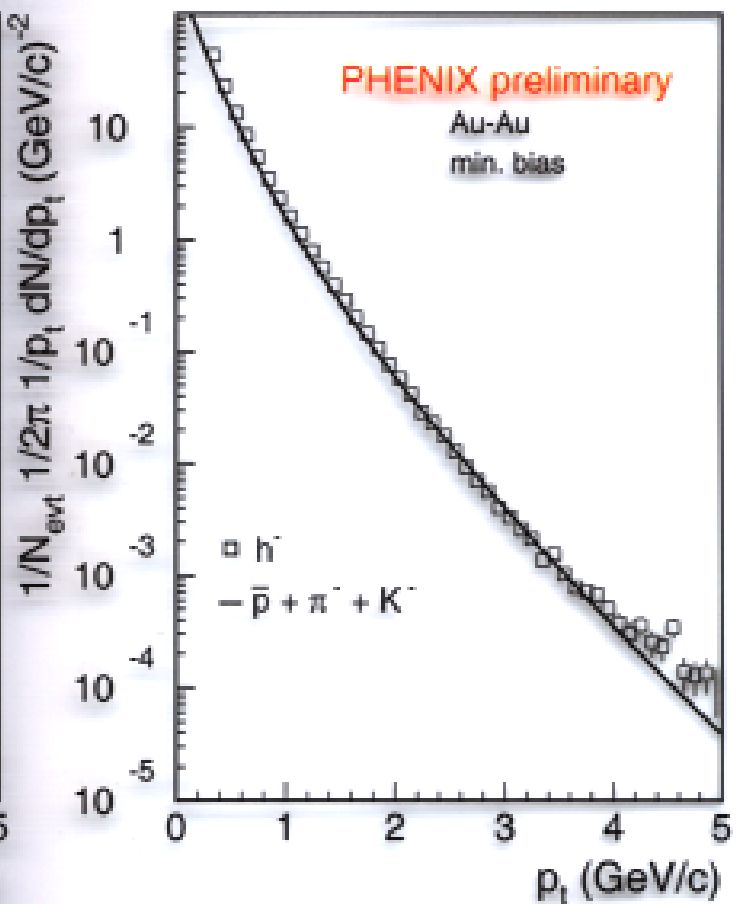
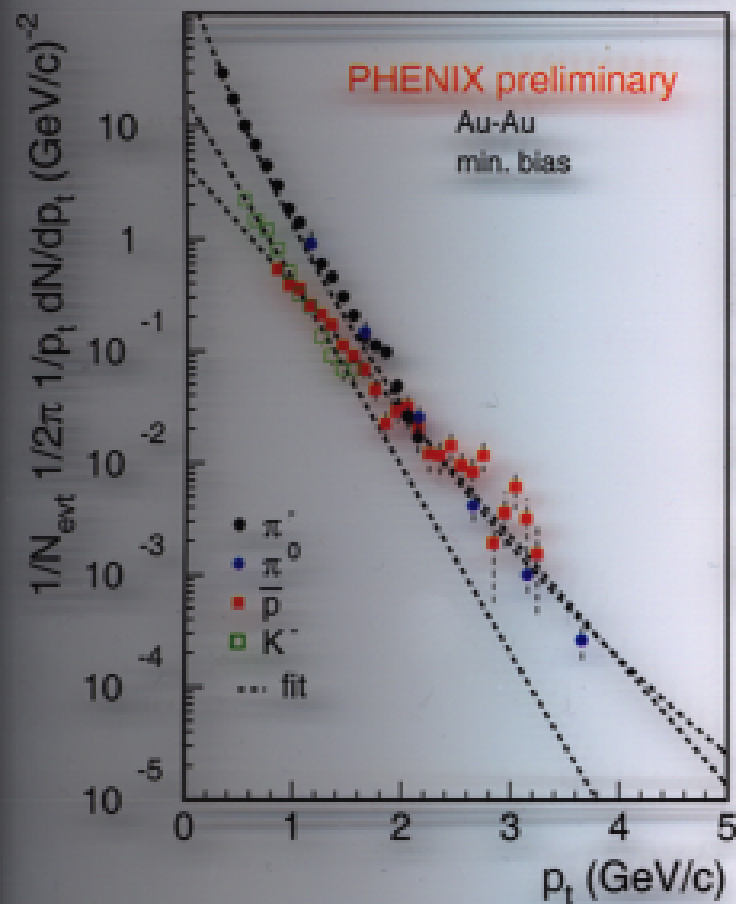


## Minimum Bias Distribution



Absolute Normalization :  $\pm 20\%$  sys.

# Particle Identification



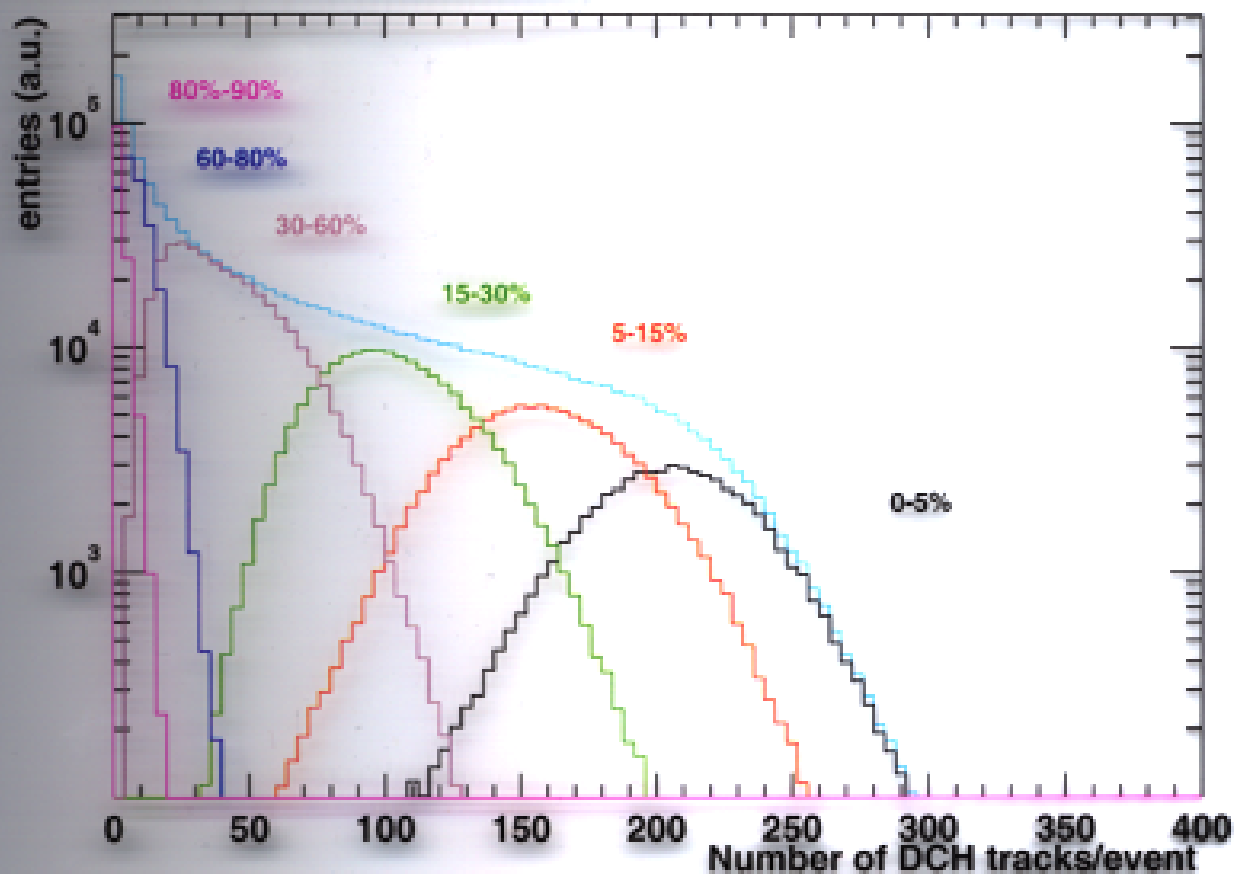
- identified  $\pi^-$ ,  $\pi^0$ ,  $k^-$ ,  $\bar{p}$
- relevant contribution of  $\bar{p}$
- summing all the terms  $\Rightarrow$  good agreement with negative spectra

## Centrality Selection

Bin	Cross Section	$dN_{ch}/d\eta$	NCollisions	NParticipant
1	0 – 5%	622	$945.2 \pm 15\%$	$346.7 \pm 15\%$
2	5 – 15%	455	$673.4 \pm 15\%$	$270.75 \pm 15\%$
3	15 – 30%	288	$382.9 \pm 15\%$	$178.33 \pm 15\%$
4	30 – 60%		$122.76 \pm 15\%$	$76 \pm 15\%$
5	60 – 80%		$19.32 \pm 60\%$	$19.02 \pm 60\%$
6	80 – 92%		$3.7 \pm 60\%$	$5.025 \pm 60\%$

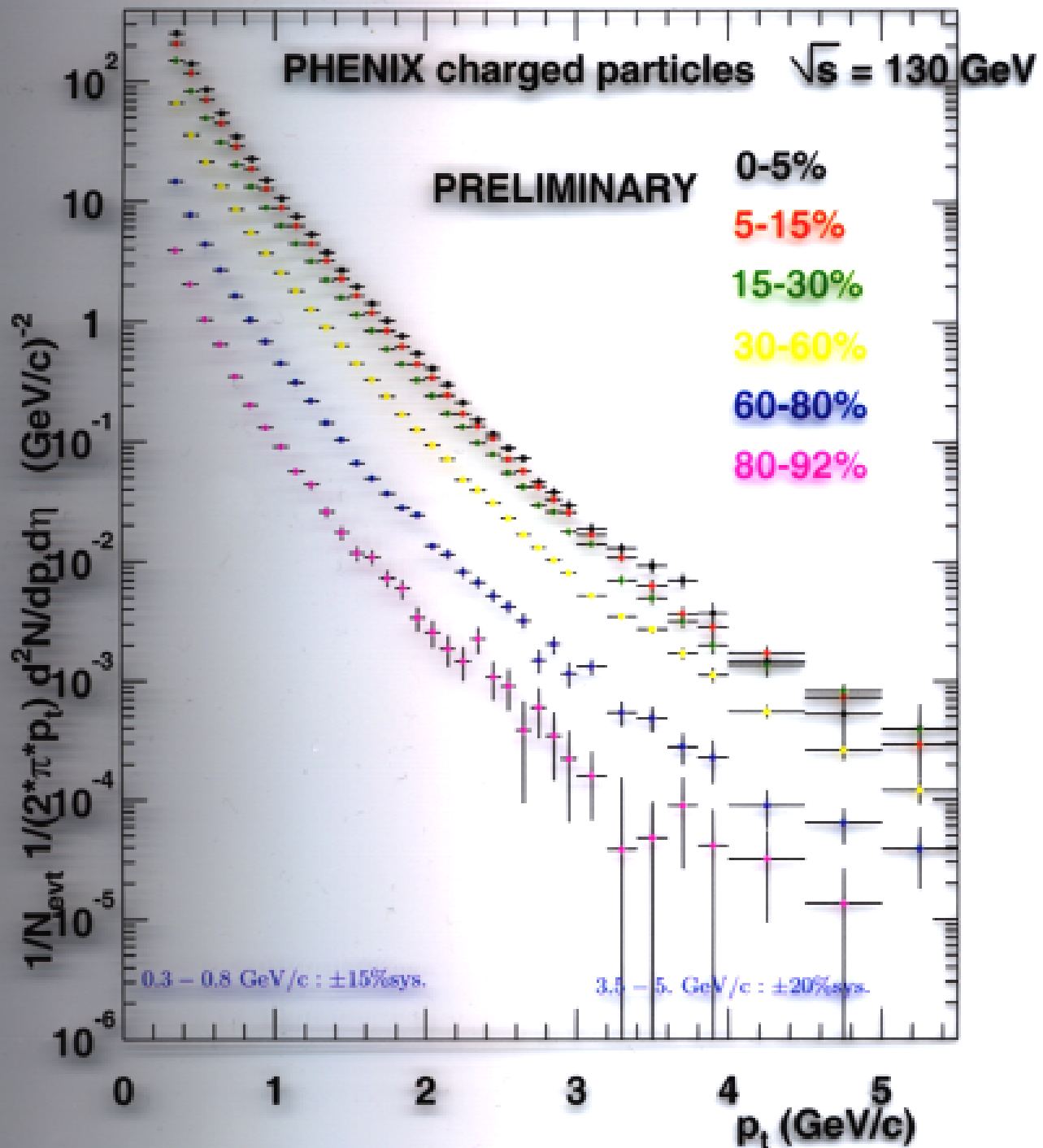
Ref:nucl-ex/0012008

### Raw multiplicity Distribution





## Momentum Distributions



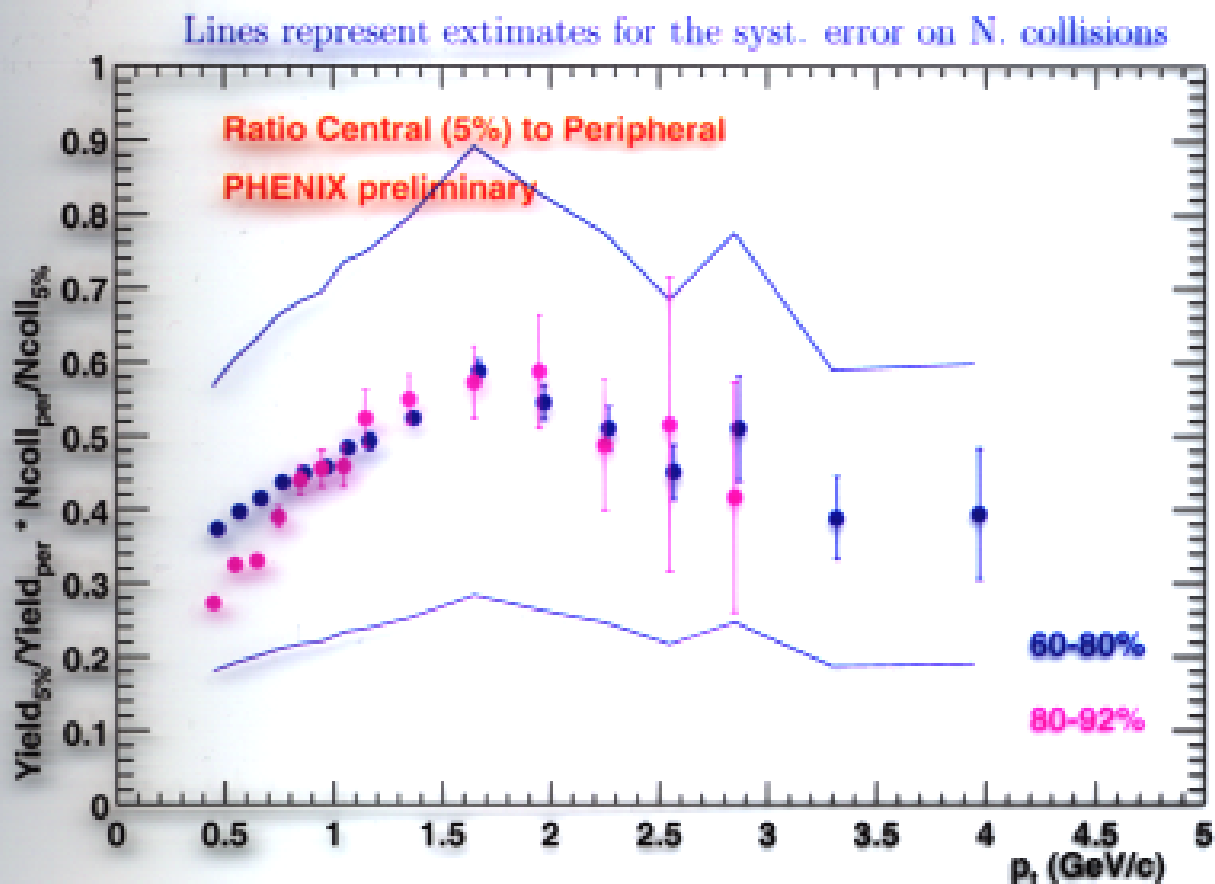
Absolute Normalization :  $\pm 20\%$ sys.

## Central<sub>Au–Au</sub> / Peripheral<sub>Au–Au</sub>

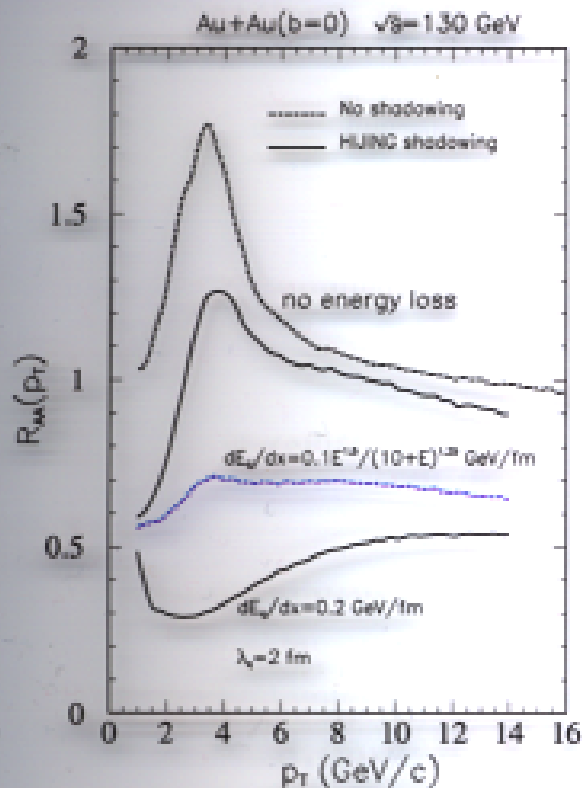
- many systematics cancel
- for hard processes:  
Ratio normalized per N Binary collisions  $\Rightarrow 1$ .

We observe:

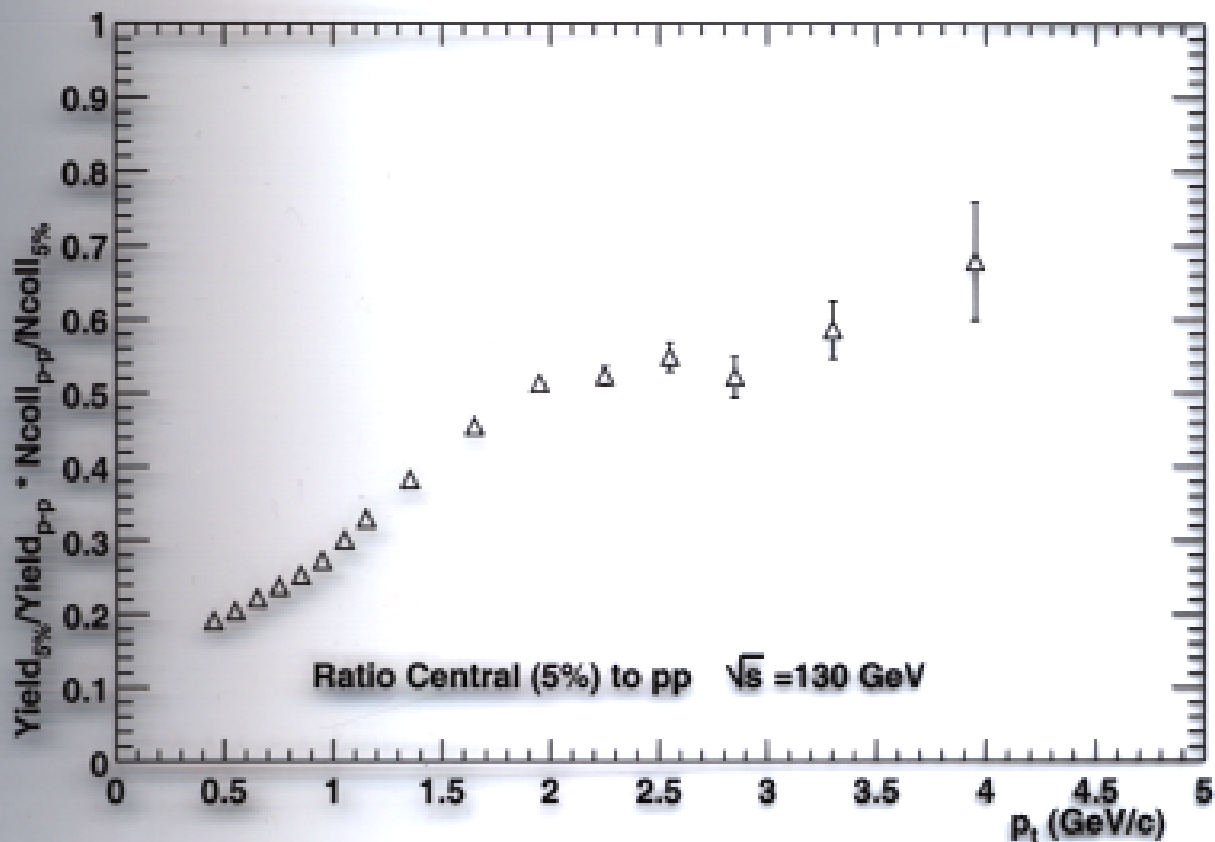
- Ratio  $< 1$ .
- Tendency to decrease for  $p_t > 1.5$  GeV/c



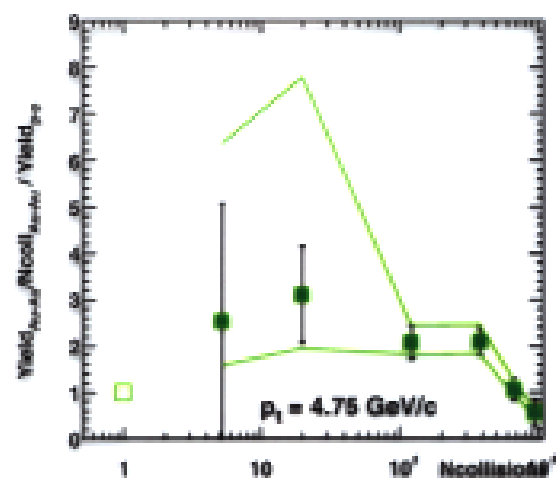
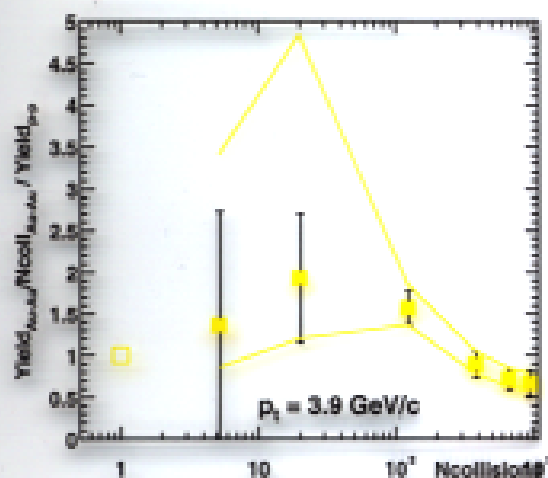
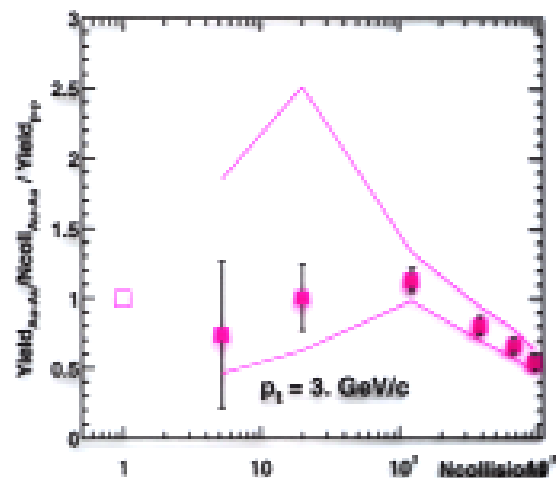
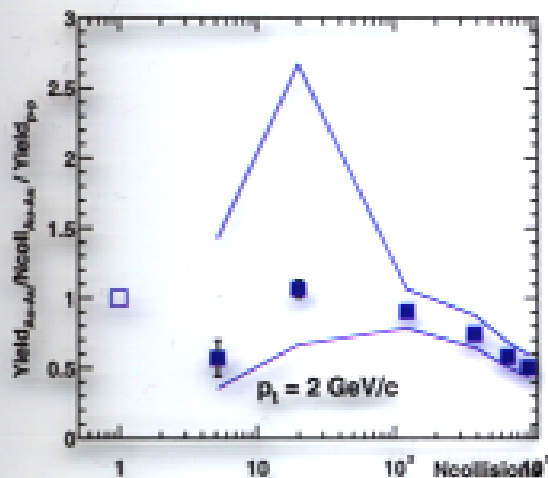
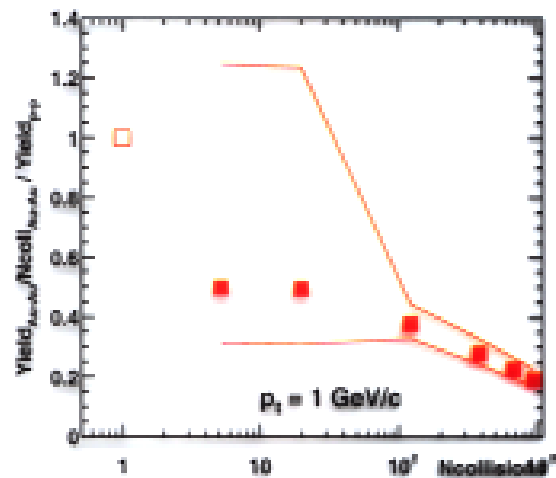
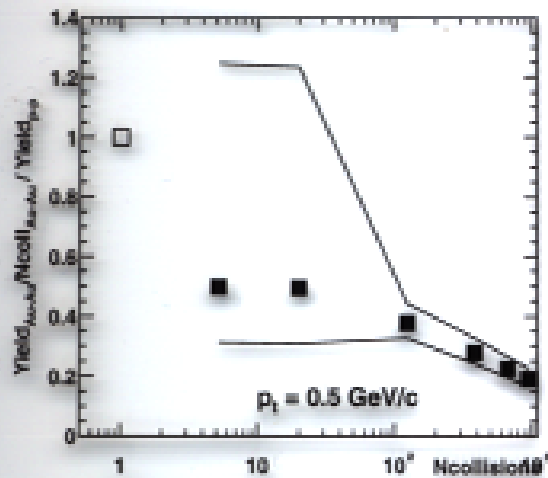
# Central $Au-Au$ / $p-p$



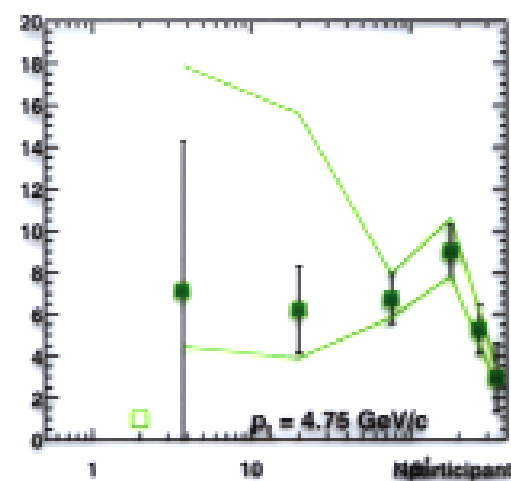
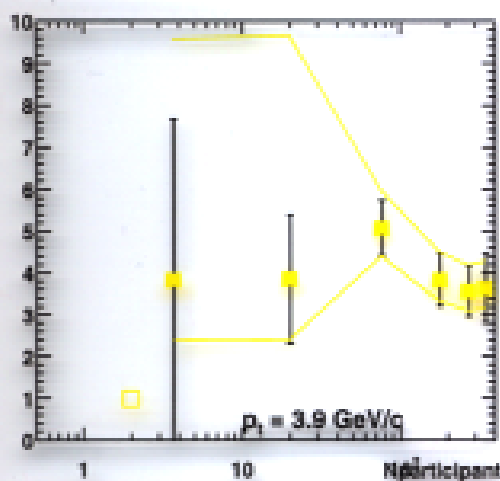
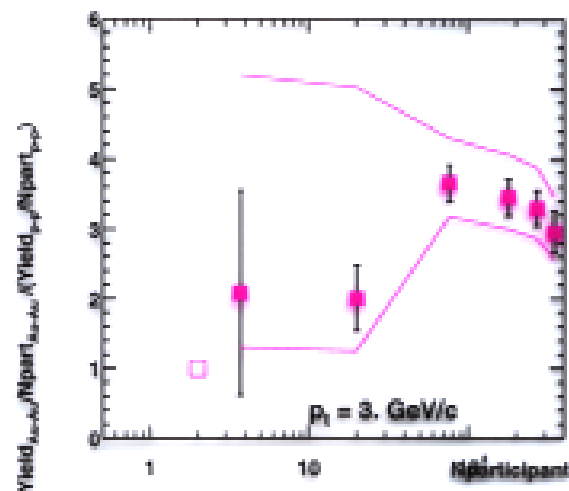
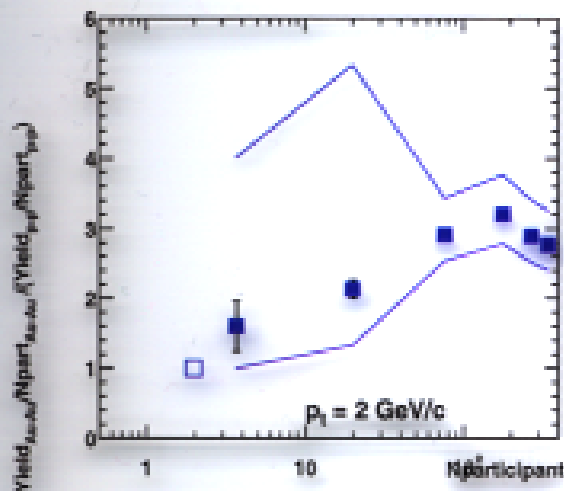
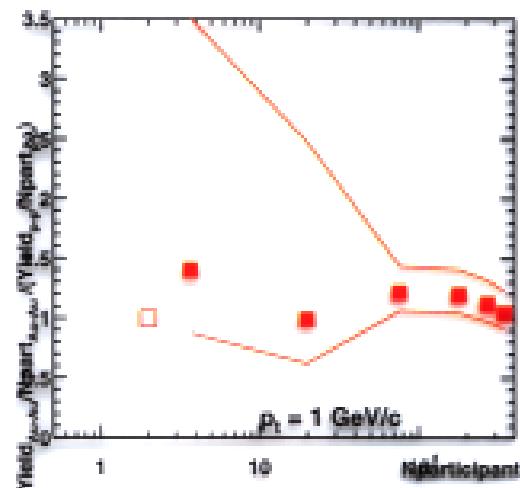
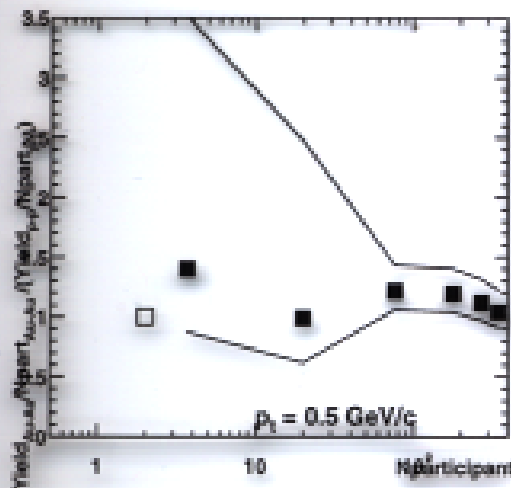
X.Y. Wang calculation :  
ratio of charged hadron spectra  
in central  $Au-Au@130$  GeV over  
 $p-p$  collisions normalized by  
average number of binary collisions



# Yield vs Number of Collisions



# Yield vs Number of Participants



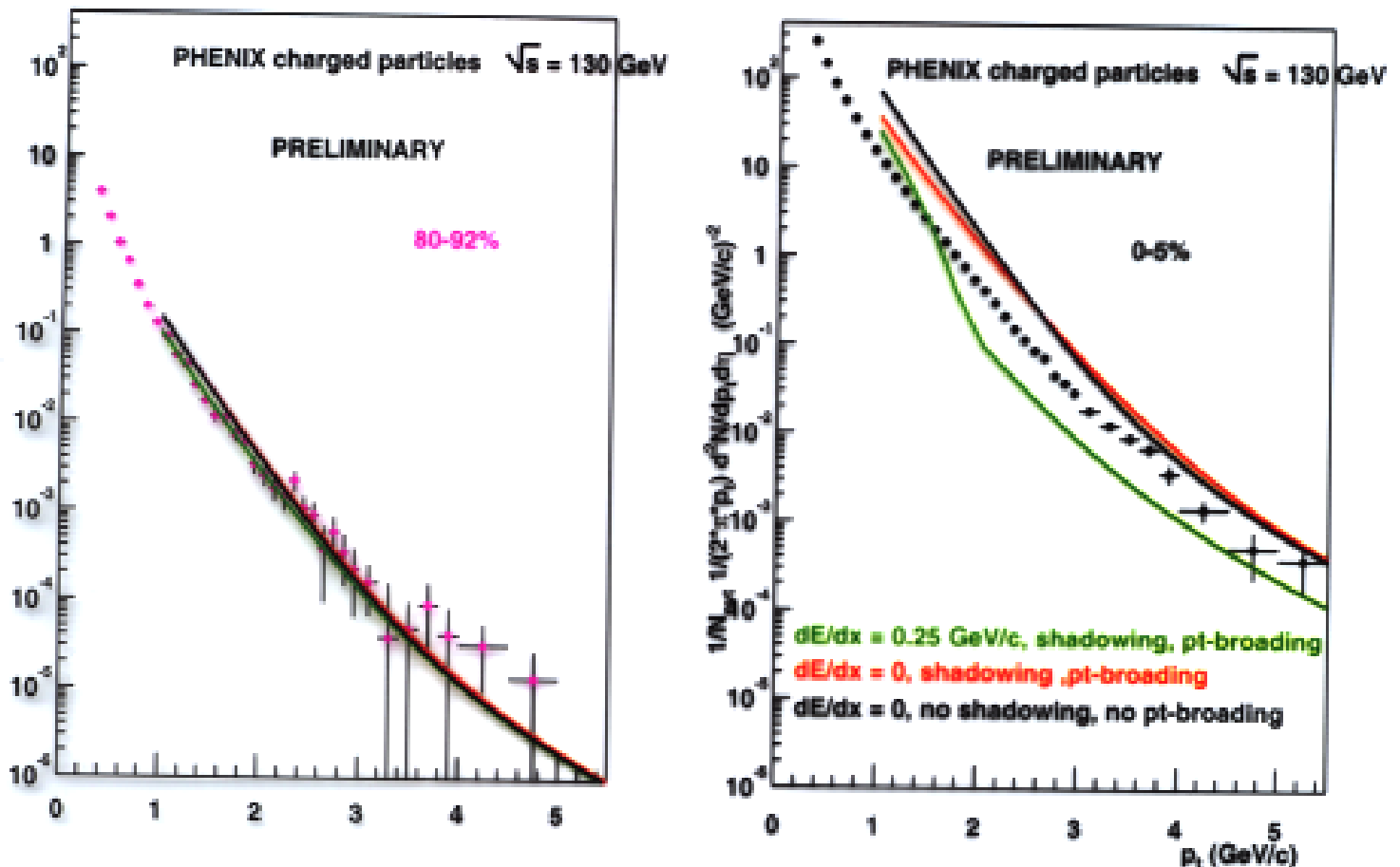
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# Summary

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- Negative Charged Particle Distribution (Minimum Bias)
  - excellent agreement with  $h^-$  distribution from West Arm.
  - good agree up to 2 GeV/c with  $\pi^0$
  - contribution from  $\bar{p}$  is important
- Centrality Dependence of Charged Particle Distributions
  - Peripheral collisions similar to p – p
  - Ratio Central to peripheral and/or to p – p < 1.
  - At small  $p_t$  distributions scale as  $N_{part}$
  - At High  $p_t$  (in peripheral) scale as  $N_{coll}$
  - At High  $p_t$  in central and semi-central (30%) DO NOT scale as  $N_{coll}$
- Comparison with Theory
  - Data fall below the No Energy Loss curve
- A new run is just behind the corner:
  - Need higher  $p_t$  and angular correlations to make a more definitive conclusion

# Theory predictions

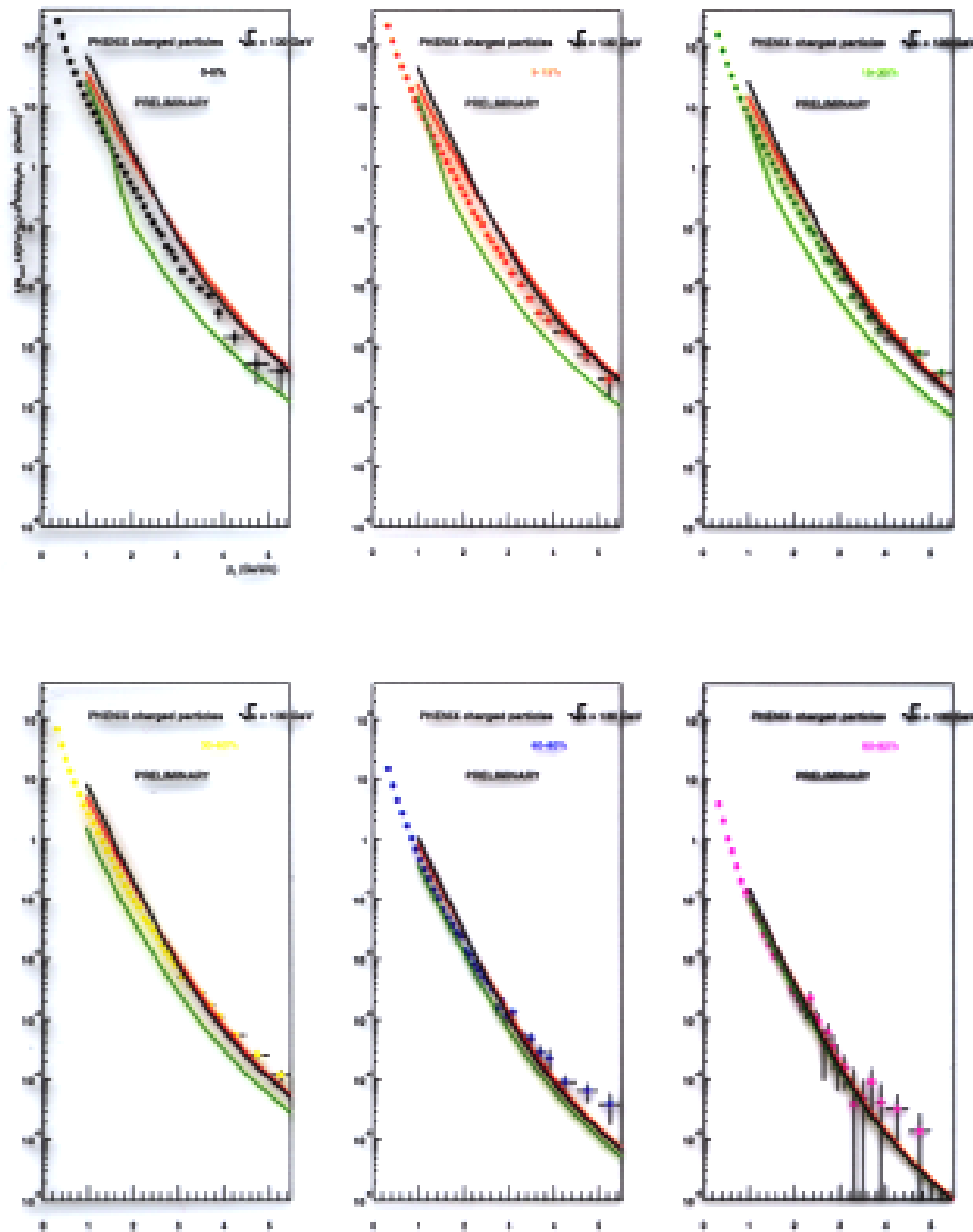


Ref: X.-N. Wang, Phys. Rev. C61, 064910 (2000)

Ref: X.-N. Wang, nucl-th/0009019

- Charged particle calculation for different centralities
- Good Agreement in describing the peripheral collisions
- For central
  - Data are not consistent with calculation without Energy Loss;
  - Data fall above curve for  $dE/dx = 0.25 \text{ GeV}/\text{fm}$
  - Missing contributions of  $p$  and  $\bar{p}$  ?

# Theory predictions

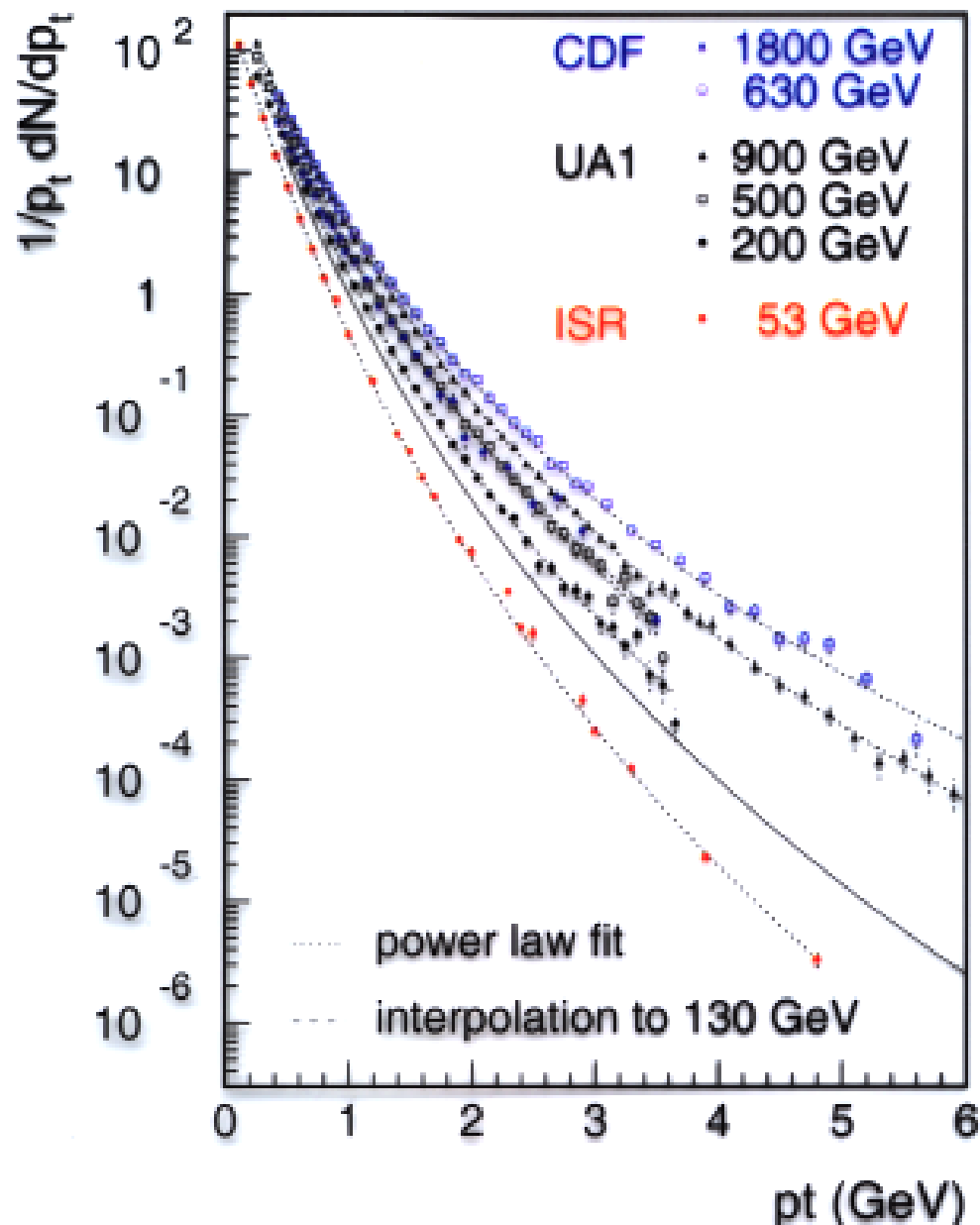


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## Energy Dependence



- fit with power-law function:

$$\frac{1}{p_t} \cdot \frac{dN}{dp_t} = \frac{b}{(p_t + p_0)^n}$$

- interpolation at  $\sqrt{s} = 130$  GeV/c:

–  $p_0 = 1.68$  (GeV/c) and  $n = 12.26$

## Local Inverse Slope

- Inverse slope changes vs centrality and  $p_t$

