Inclusive neutral-pion production in √s=200 GeV Au+Au and p+p collisions at PHENIX

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Kyoto Univ.

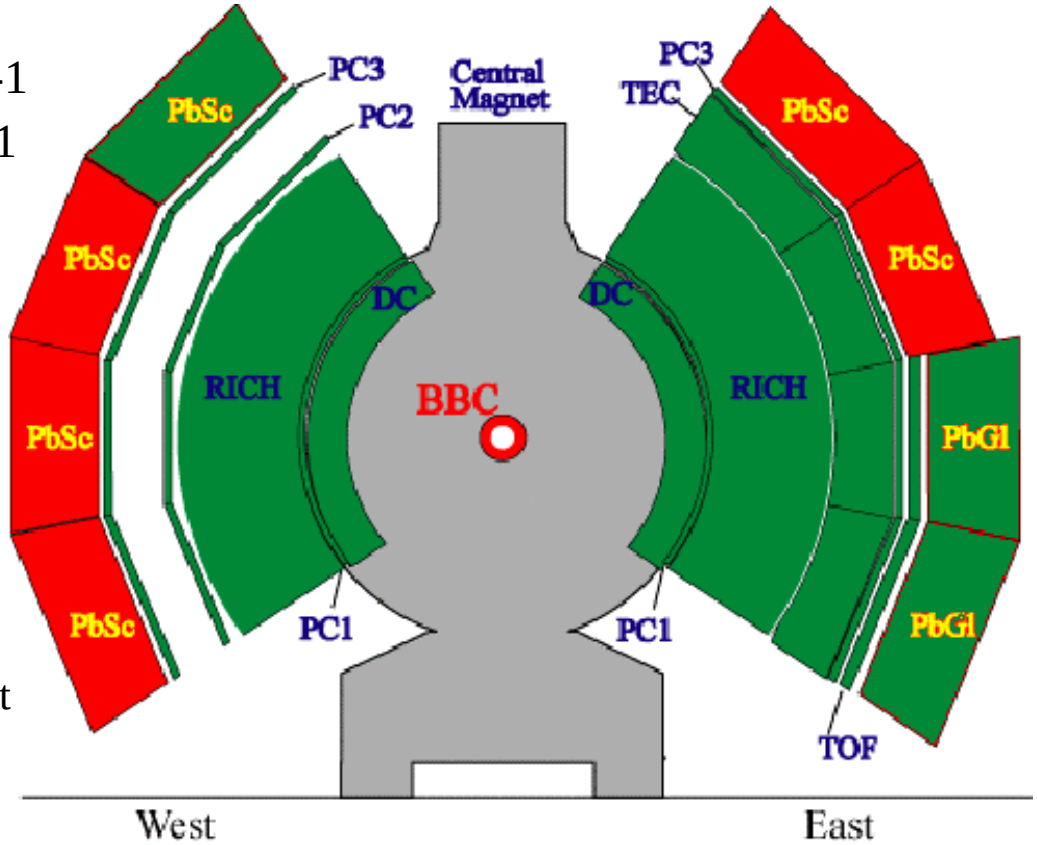
JPS Meeting at Rikkyo Univ.

Physics Motivation

- Measurement of pp π^0 cross section
  - Provide a testing ground for precision perturbative QCD
    - Baseline for future polarized pp collision analysis and asymmetry measurement
  - Data baseline for high p_T heavy ion physics
    - Compare with peripheral Au+Au collisions as consistency check
    - Compare with central Au+Au collisions
      - Especially for high p_T physics in Au+Au
- Measurement of AuAu π^0 spectrum
  - QGP search
    - Jet Quenching effect.
- In this talk, the π^0 cross section in pp and AuAu are shown and the above physics will be concluded.

RHIC-PHENIX

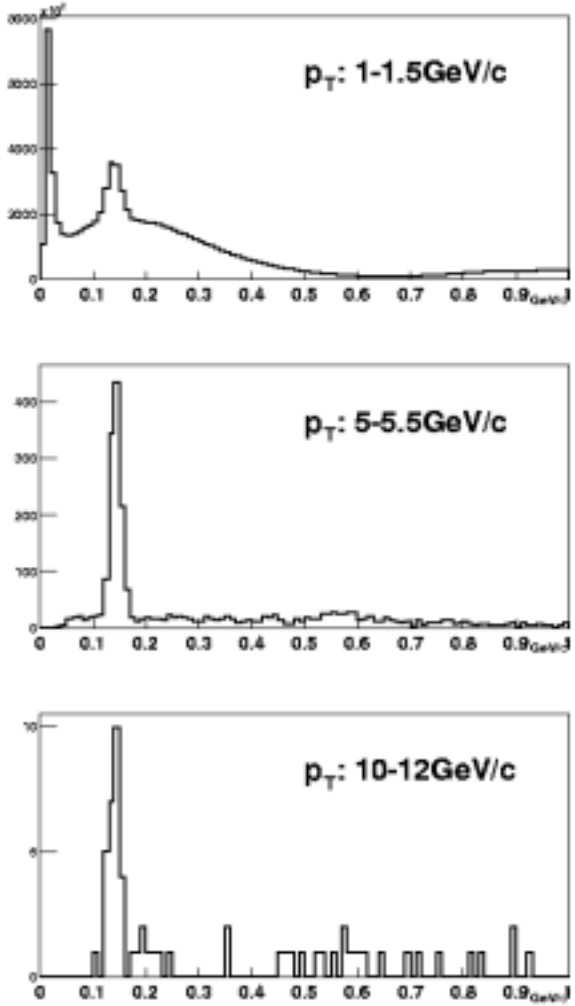
- RHIC run2002 pp run
  - Integrated luminosity 0.15pb-1
  - Analyzed luminosity 0.03pb-1
    - half of runs are analyzed.
    - Vertex position cut +-30cm
    - 140M events
- EMCalorimeter
  - 2 Arm × 4 sectors
    - Lead Scintillator(PbSc)
      6 sectors(15552 channels)
    - Lead Glass (PbGl)
      2sectors (9216 channels)
  - ~5m distance from collision point
    - $|\eta|<0.38$ $\phi = 180°$
- Analysis
  - pp : 5 sectors PbSc was used in this analysis
  - AuAu: 5 sectors PbSc and 2 sectors PbGl were used



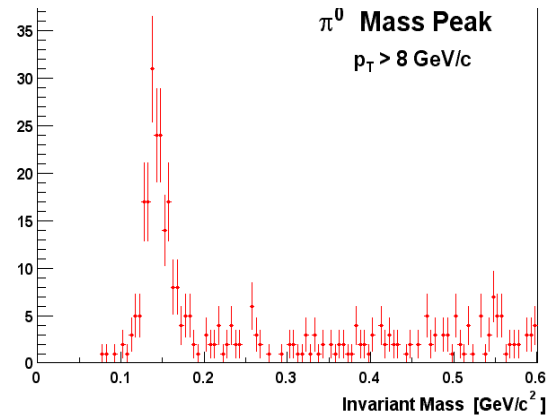
π^0 Measurement

- Invariant mass spectrum
- pp analysis shows the background is smaller than that of heavy ion collisions
  - 1-1.5GeV/c N/S = 200%
  - p_T>5GeV/c N/S = 10%
  - 2x2 trigger worked very well
    - Rejection Factor = 90
    - Measured 1-15GeV/c π^0
- AuAu data shows < 8GeV/c pi0

pp data



AuAu data MB



pp Correction & Systematic Error

- π^0 extraction

Run dependence	10%(Min. Bias)
	6%(2x2)
Background subtraction	5%
Excluded Hot/Bad towers	2-3%

- Acceptance/Smearing correction

Energy non-linearity	0-10%
Fast MC statistical error	1%
Edge tower	5%
Position resolution	0-1%
Energy absolute calibration	3-8%
Energy resolution	3%

- High pT trigger correction 10%
- Final systematic error

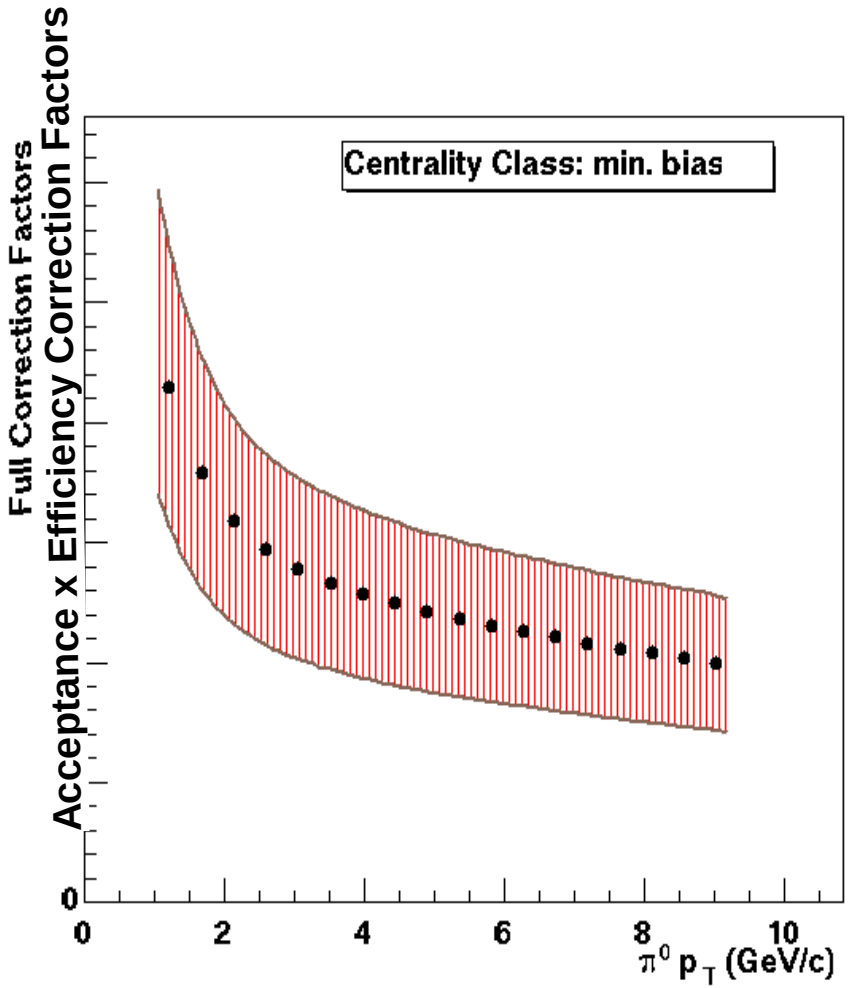
12-15%

AuAu Correction & Systematic Errors

- *Efficiency losses calculated with 2M simulated single π^0 embedded in real data*
- *Correction factors: x20.- x10.*
  - *Acceptance: ~1/0.25*
  - *Efficiency: ~1/[0.20- 0.30]*
- *Systematic errors (% yield):*
  - *π^0 extraction: ~15%*
  - *p_T smearing: ~10%*
  - *TOF cut : ~10%*
  - *Fiduc., asym., hot towers cuts: ~5%*
  - *Acceptance: ~3%*
  - *Off-vertex π^0 contribution: ~3%*
- *Final systematic error:*

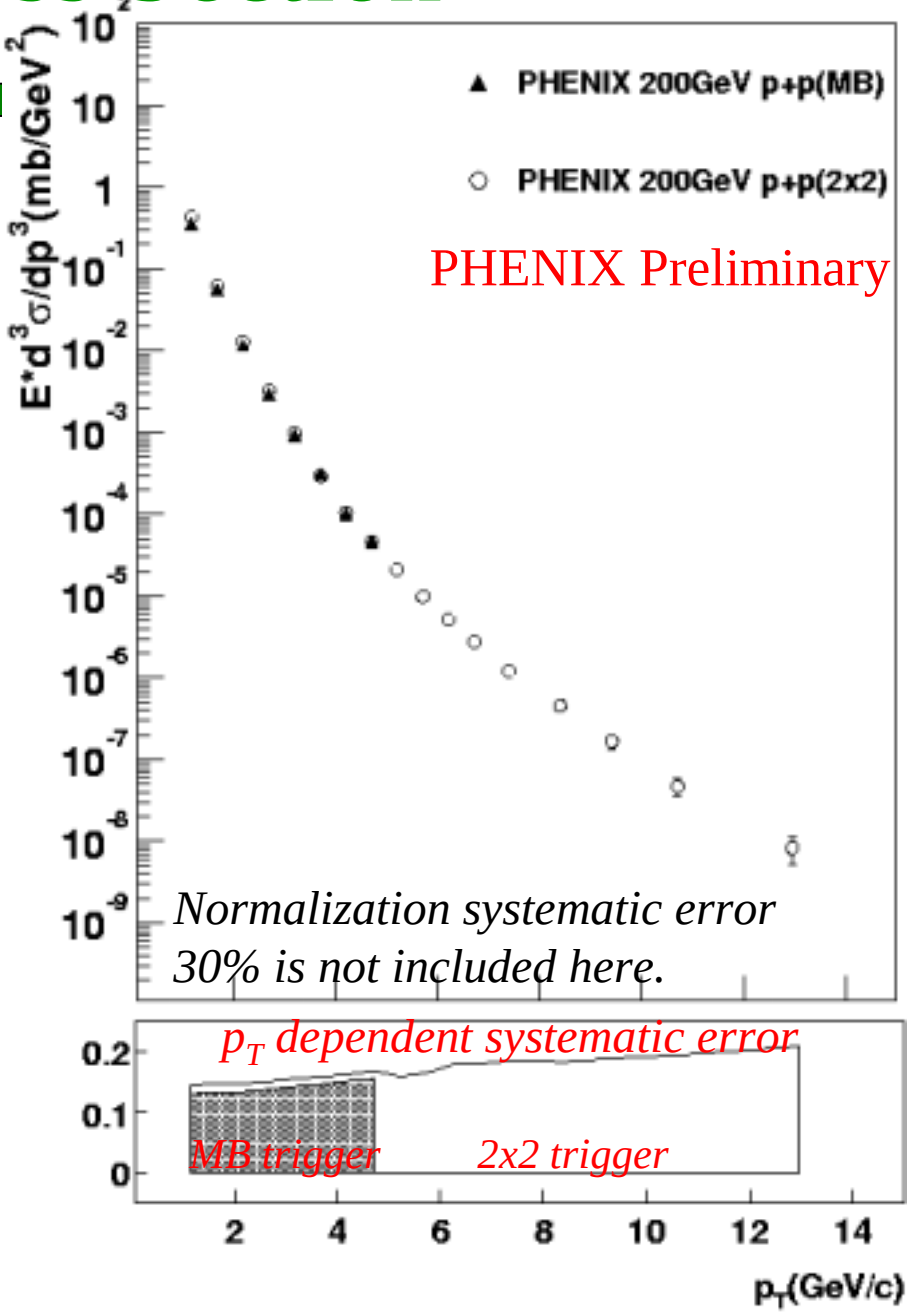
  ~20%- 30% (periph)

  ~23%- 33% (central) increasing with p_T



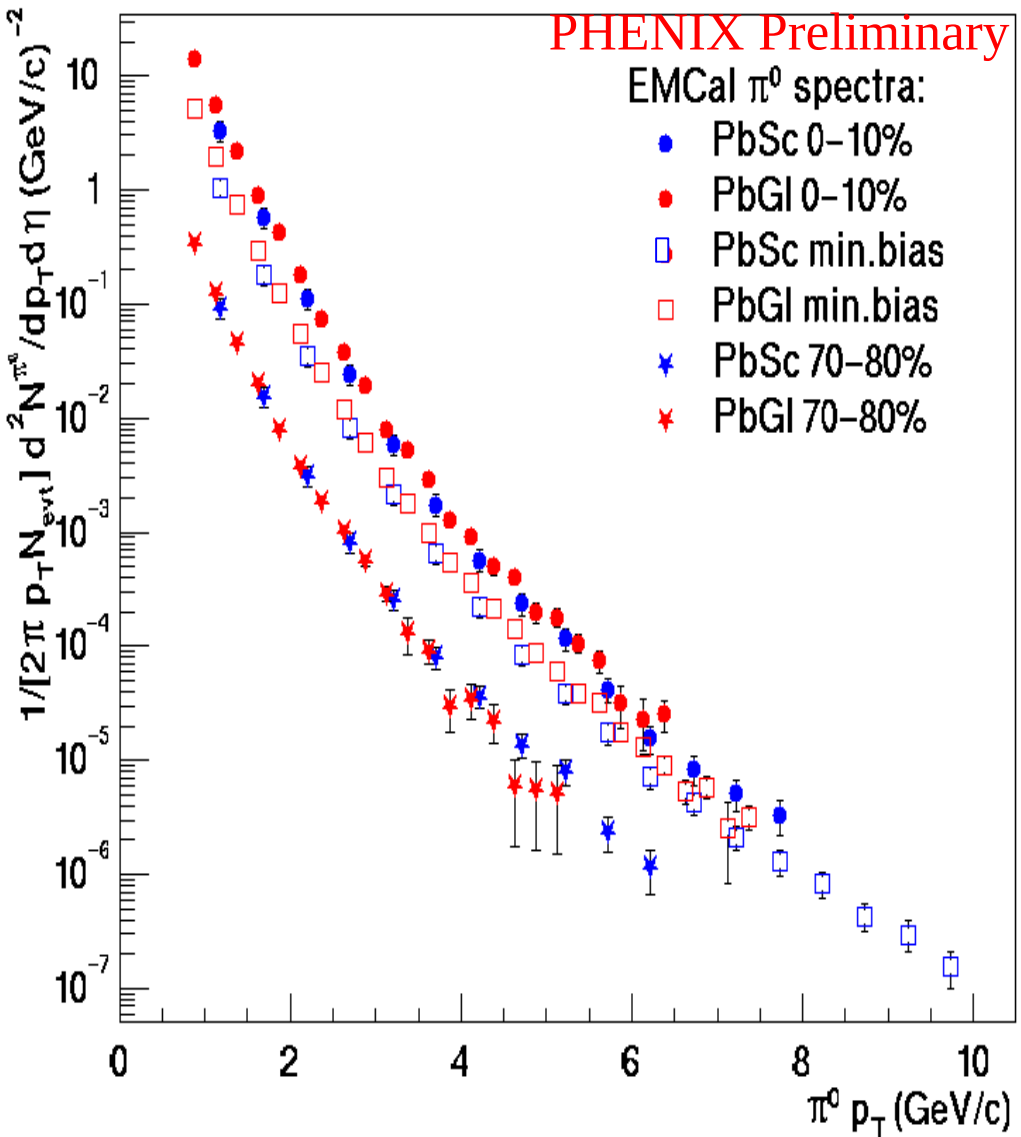
pp π^0 Inclusive Cross Section

- Cross section measured over 8 orders of magnitude.
  - 1-13GeV/c
- Two triggers
  - Minimum Bias(MB) trigger
  - 2x2 trigger
  - They are consistent within systematic error.



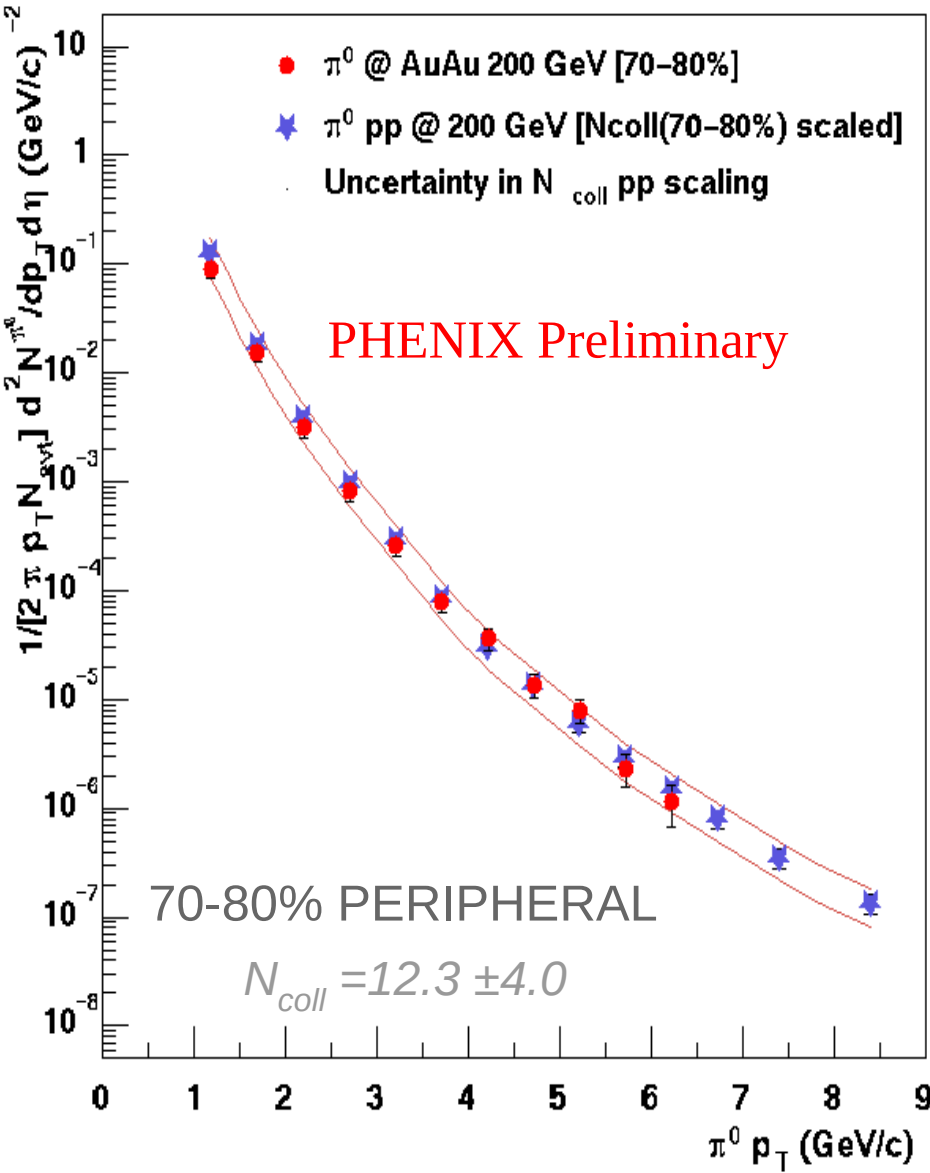
AuAu π^0 spectra

- Two different detectors, analysis, and systematic
- PbSc/PbGl consistent with systematic errors: <25%



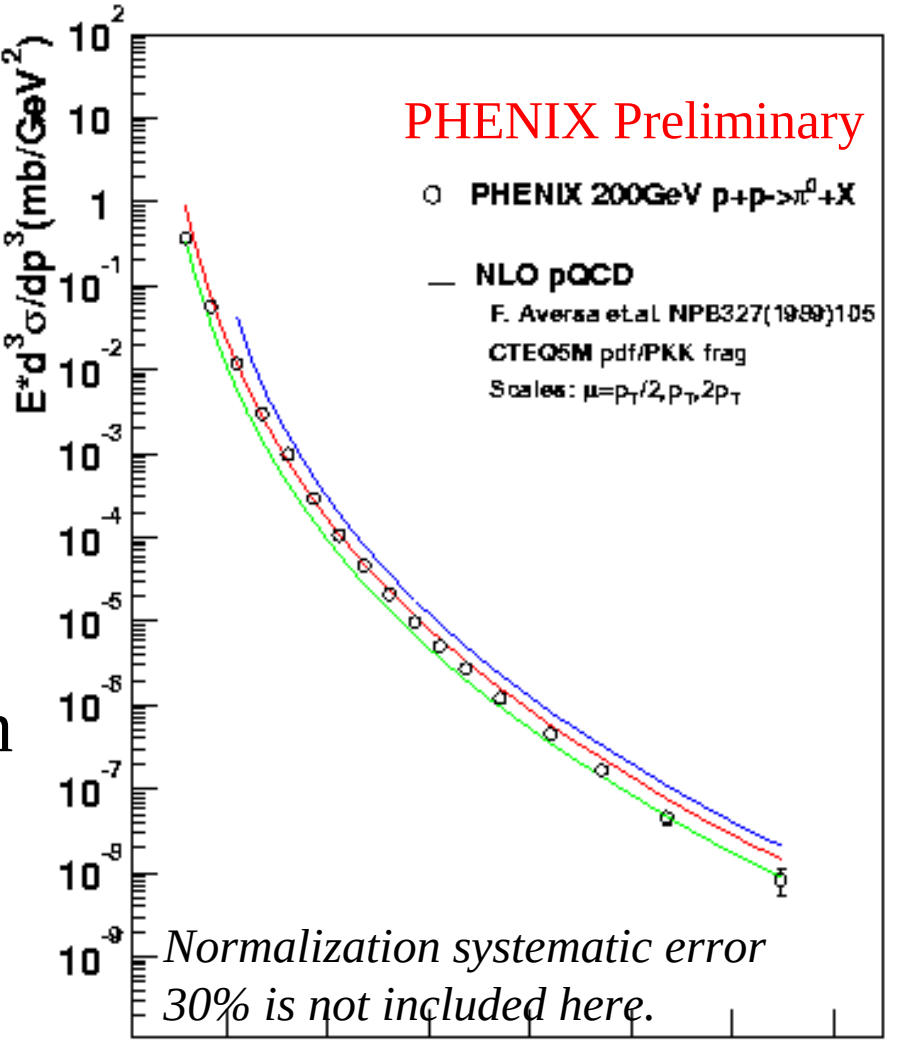
Consistency check pp and AuAu Peripheral

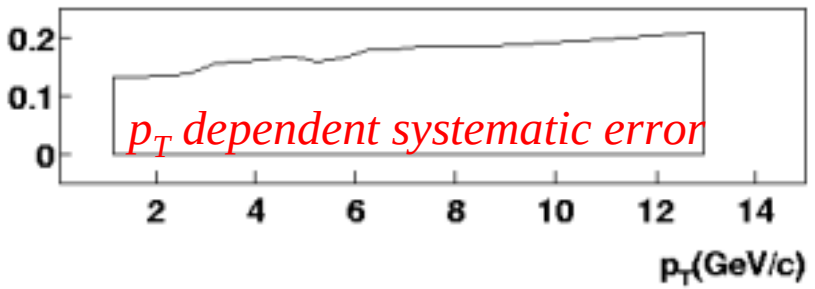
- AuAu 200GeV peripheral data is up to 6GeV/c
  - The pp data is scaled up by the number of collision.
- They are consistent within Ncoll scaling



Comparison with QCD Calculation

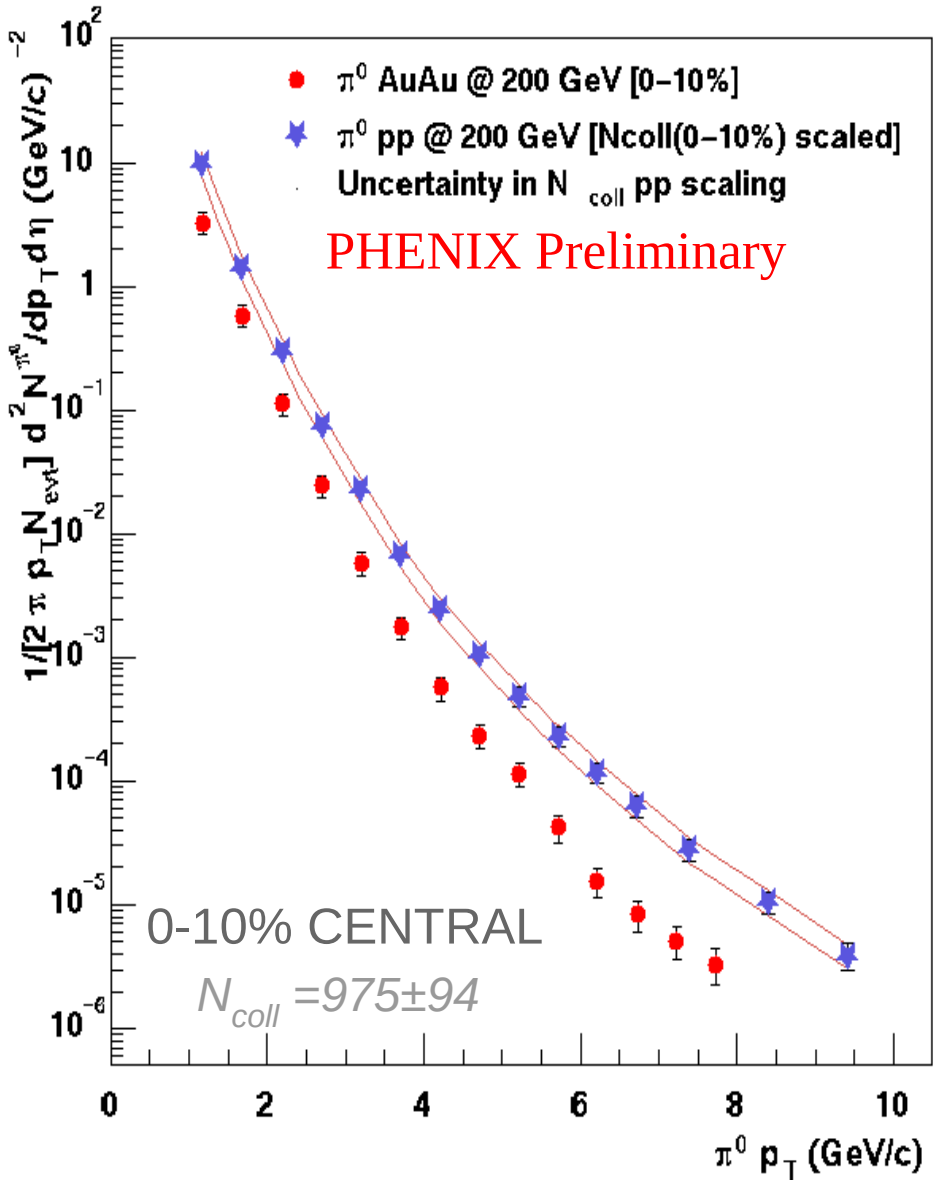
- NLO pQCD calculation
  - CTEQ5M pdf
  - Potter-Kniehl-Kramer fragmentation function
  - $\mu = p_T/2, p_T, 2p_T$
- Consistent with data within the scale dependence.





Comparison with pp and AuAu Central

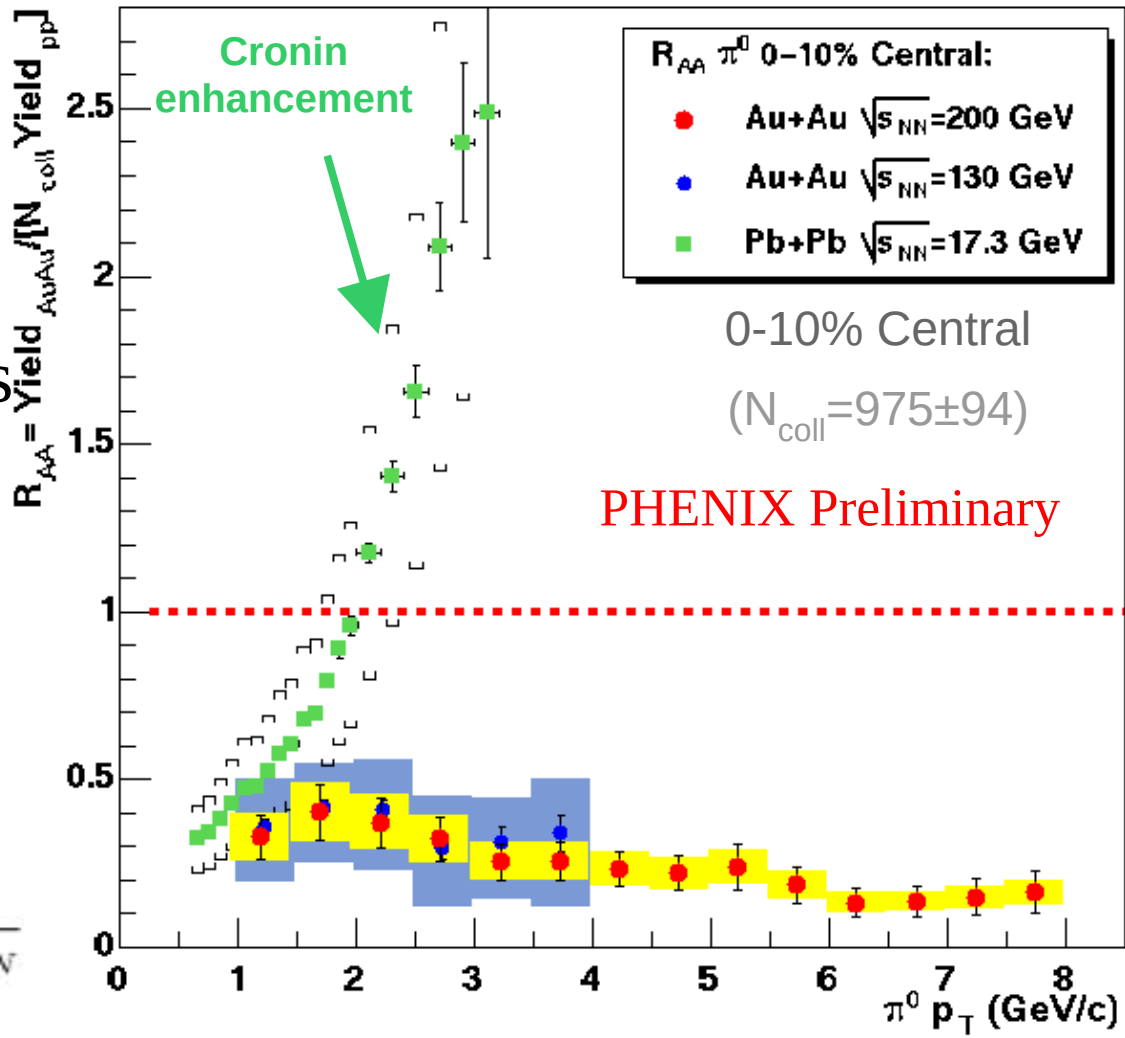
- AuAu 200GeV central data is up to 8GeV/c
  - The pp data is scaled up by the number of collision.
- AuAu data shows large suppression.
  - The suppression is dependent of pT
  - This might be understood by the jet quenching effect.



High p_T suppression

- Comparison of R_{AA}
  - RHIC 130/200GeV
  - CERN 17.3GeV
- Behavior at high pT is totally different
  - CERN: Enhance ment due to Cronin effect
  - RHIC : Large suppression

$$R_{AA}(p_T) = \frac{(dN/dp_T)_{AA}}{\langle N_{coll}\rangle (dN/dp_T)_{NN}}$$



Conclusion

- Measured π^0 cross section.
  - AuAu
    - 1-8GeV/c
  - pp
    - 8 orders of magnitude
    - 1-13GeV/c
- Internal consistency
  - pp from two triggers are consistent
  - pp and AuAu peripheral are consistent
  - AuAu PbSc and PbGl shows consistent
- Comparison with pQCD with NLO calculation and pp
  - pQCD calculation agree with data
- Large suppression in the AuAu central events
  - Consistent behavior with jet quenching

Backup Slides

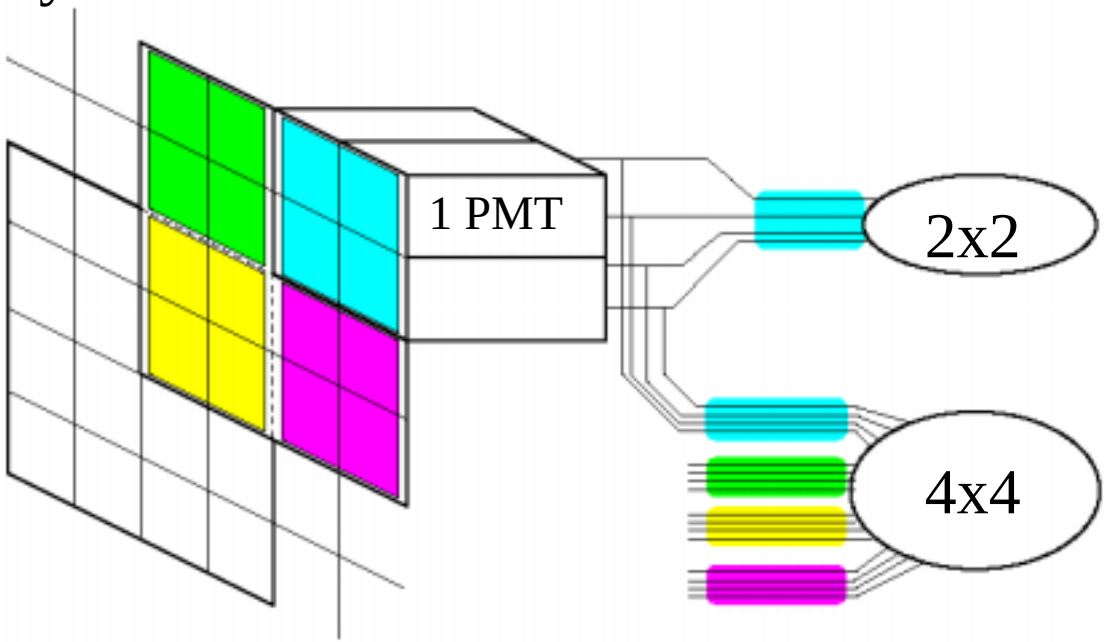
EMCal-RICH level 1 Trigger

EMCal part consists of two types of sum to collect photon shower

- 2x2 towers non-overlapping sum (threshold=0.8GeV)
- 4x4 towers overlapping sum (threshold=2 and 3GeV)

π^0 measurement with **<u>2x2 trigger</u>** will be shown in this talk

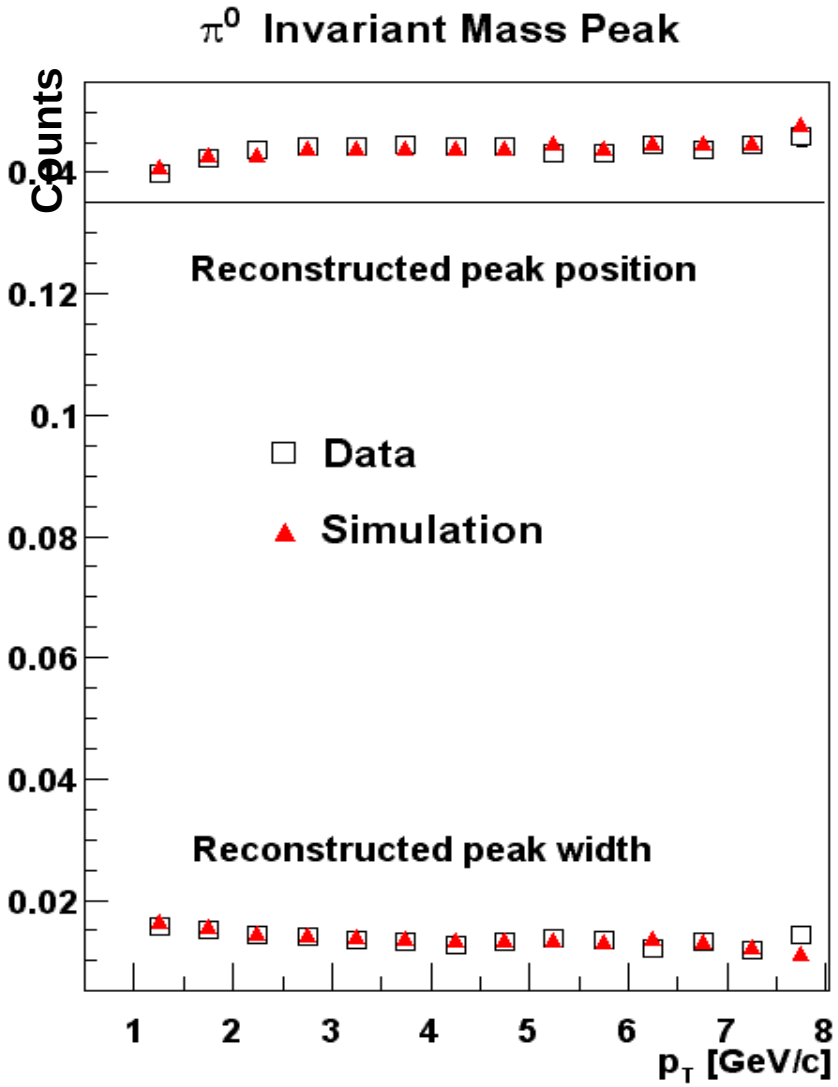
- Enhances high-p^T π^0 by a factor of 90



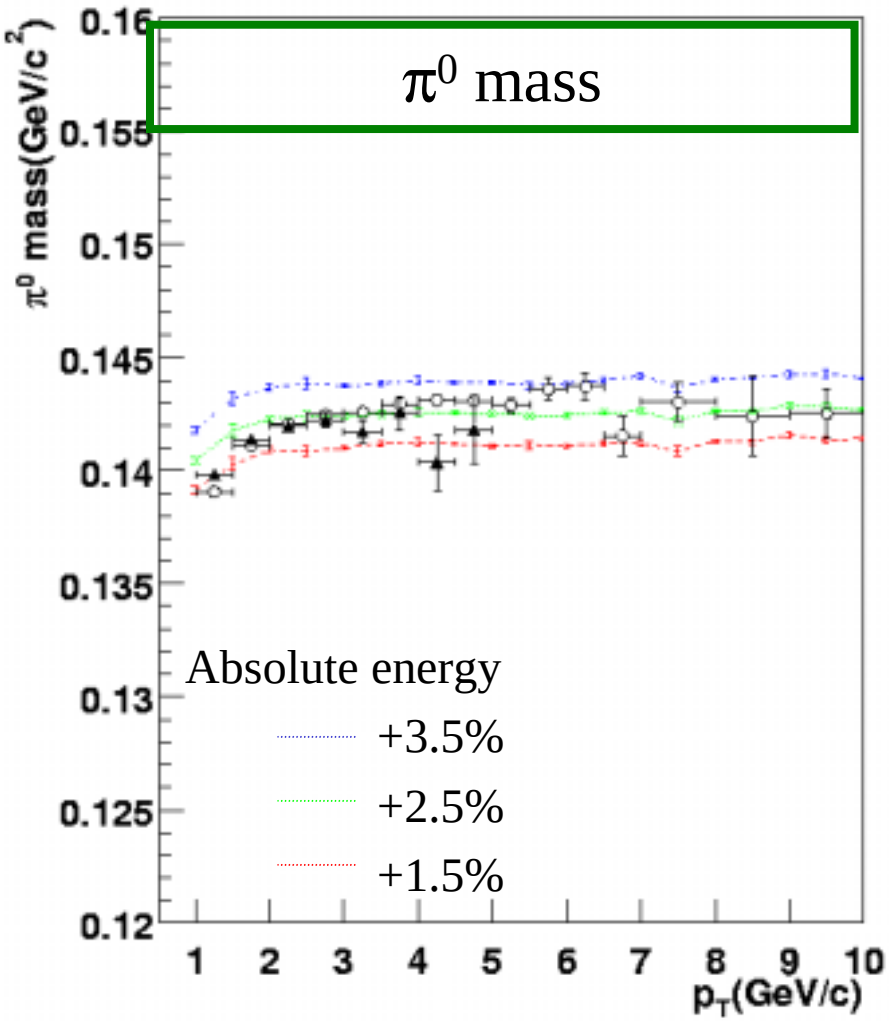
π^0 mass/width in AuAu analysis

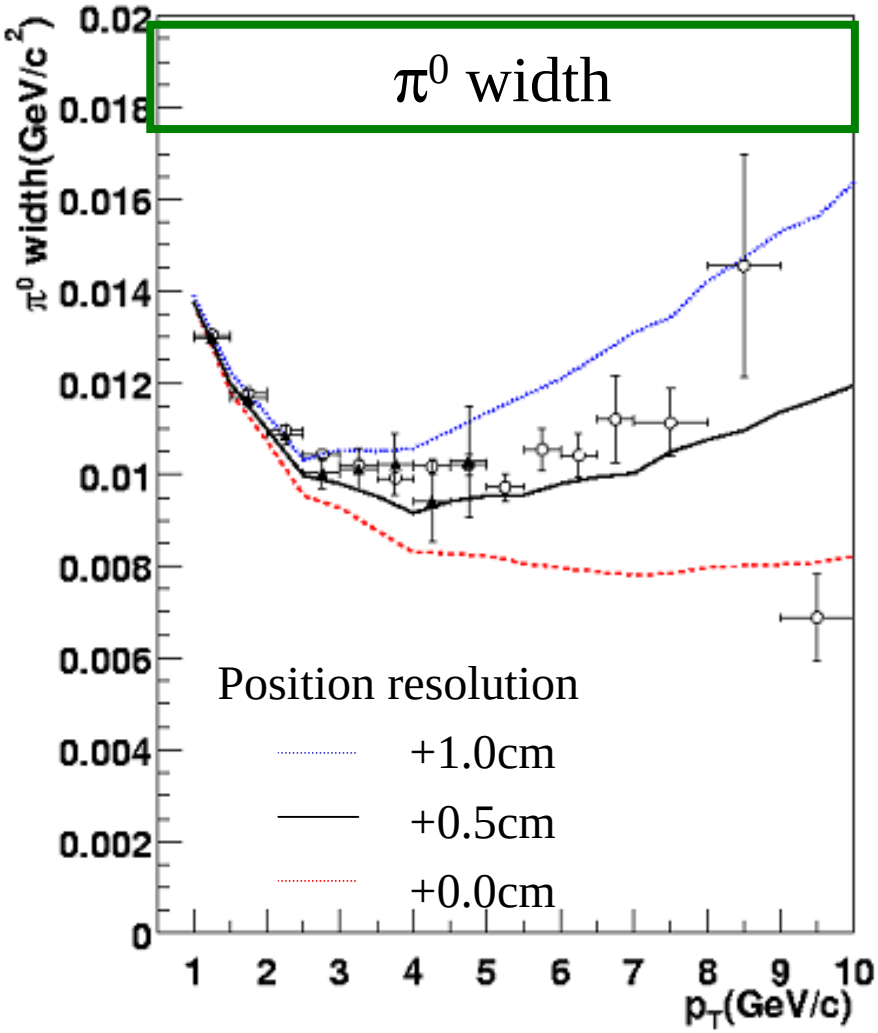
- peak at $p_T > 8$ GeV/c (min.bias)

(Excellent agreement real data and embedded singl π^0)



π^0 mass/width in pp analysis





Analysis Procedure

$\varepsilon^{(MB)}$ 51%

Minimum Bias(MB) Trigger efficiency

Luminosity normalization

$$\varepsilon_{\pi 0}^{(MB)}(p_T) = \frac{N_{\pi 0}^{(MB\&4\times4)}}{N_{\pi 0}^{(4\times4)}}$$

π^0 efficiency in Min. Bias trigger 75% flat

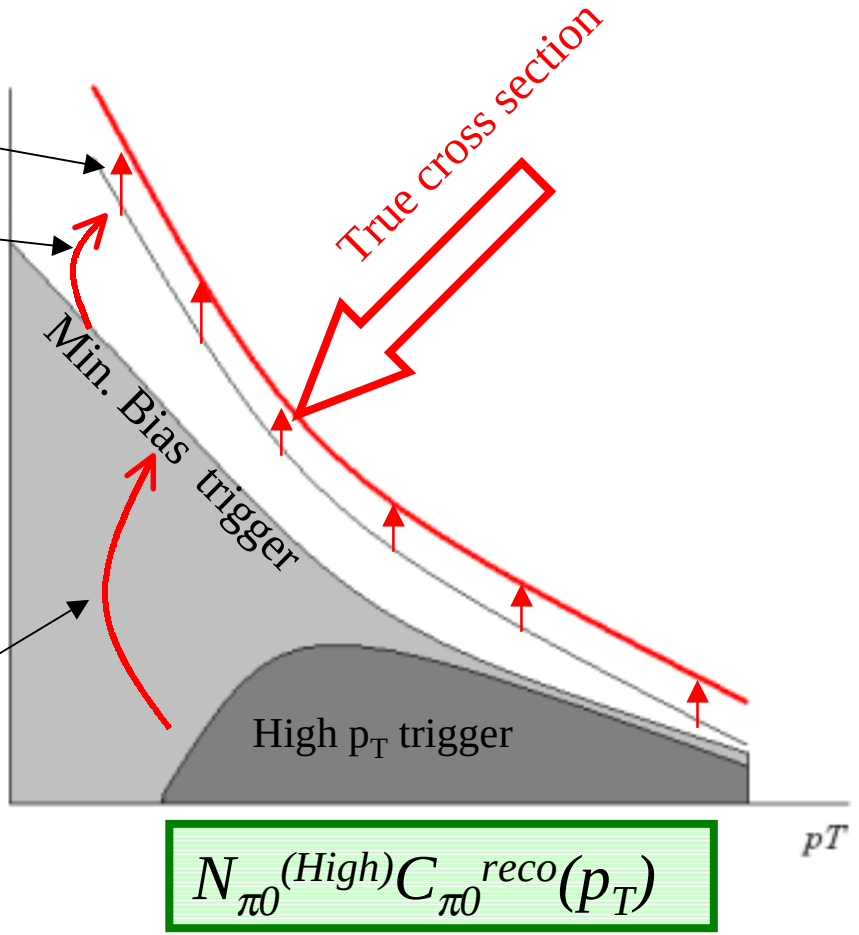
Slope correction for Min. Bias trigger

$$\varepsilon_{\pi 0}^{(High)}(p_T) = \frac{N_{\pi 0}^{(2\times2\&MB)}}{N_{\pi 0}^{(MB)}}$$

80% flat for $p_T > 3$GeV

π^0 efficiency in 2x2 trigger

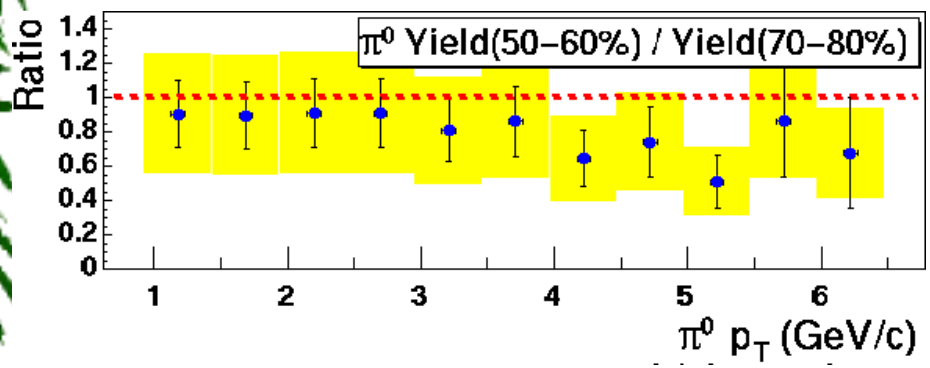
"turn-on" curve for trigger

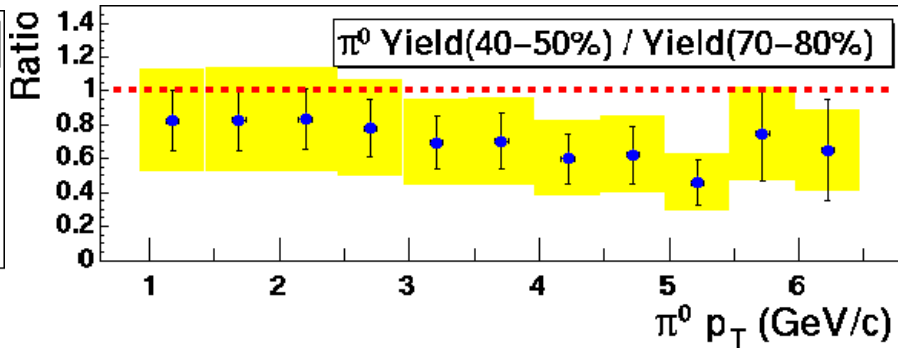


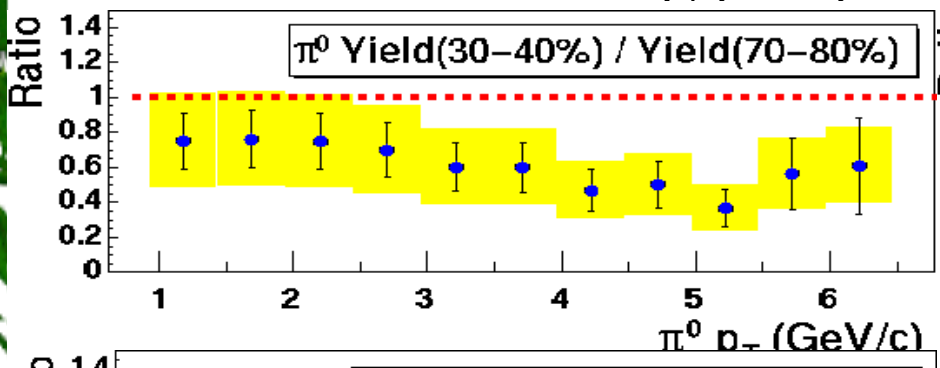
Ratios Central/Peripheral

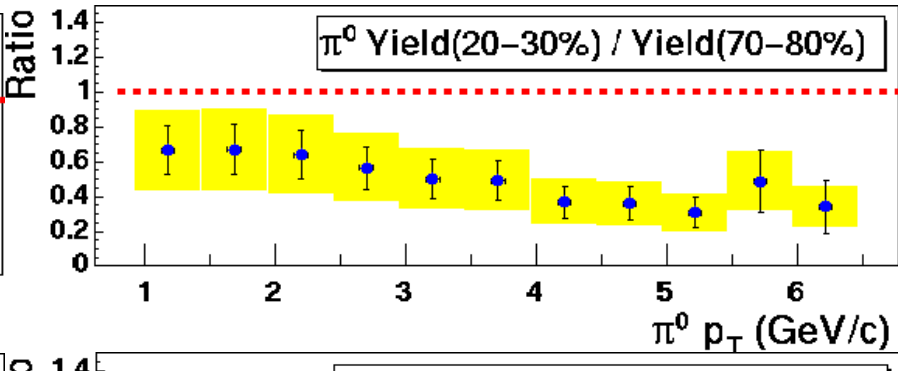
Ratio AuAu(different centralities) / AuAu(70-80%)

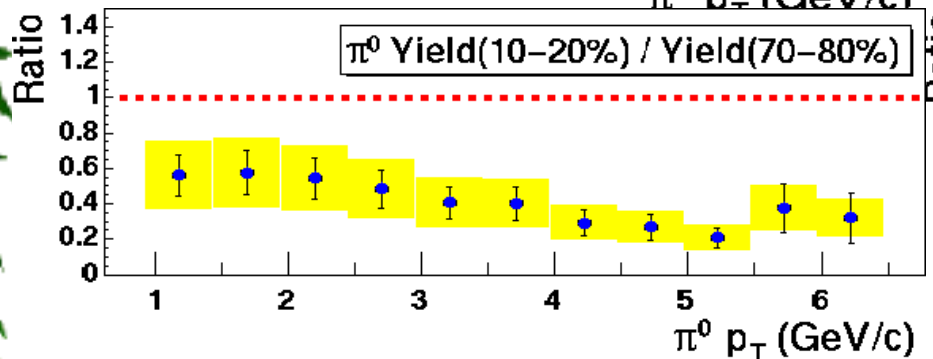
PHENIX Preliminary

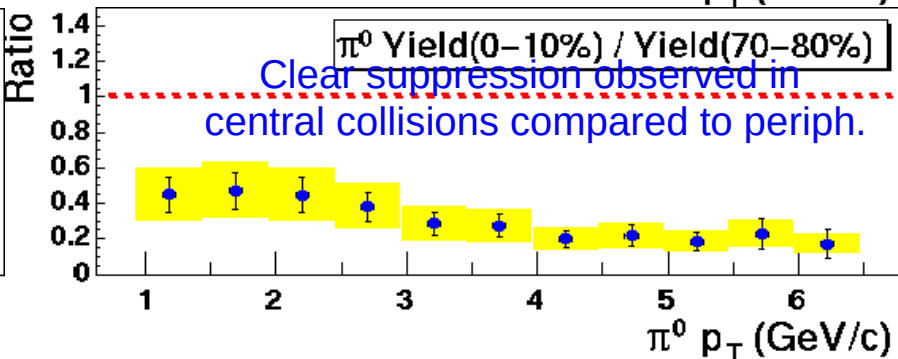












Clear suppression observed in central collisions compared to periph.

Comparison with QCD Calculation

- The deviation of the pQCD calculation is depicted
  - The pQCD calculation with one a set of PDF/FF is consistent within the systematic error of the data and the scale selection

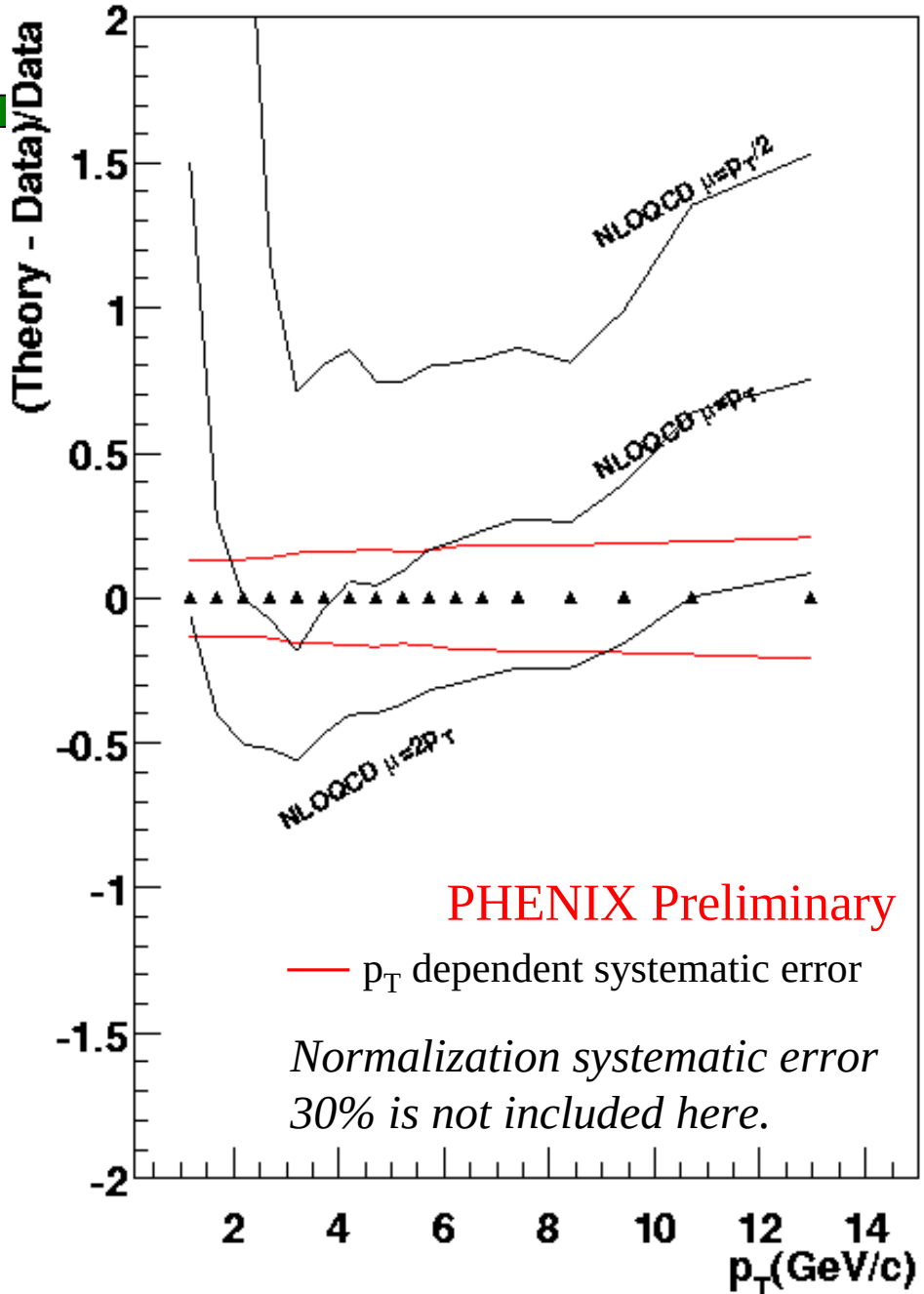
O.K. So everybody is happy!!!
Let's go to drink beer!!!

Wait!!!!!

What I want to say in this workshop is

"Our data might be one more reference point for study of PDF and FF."

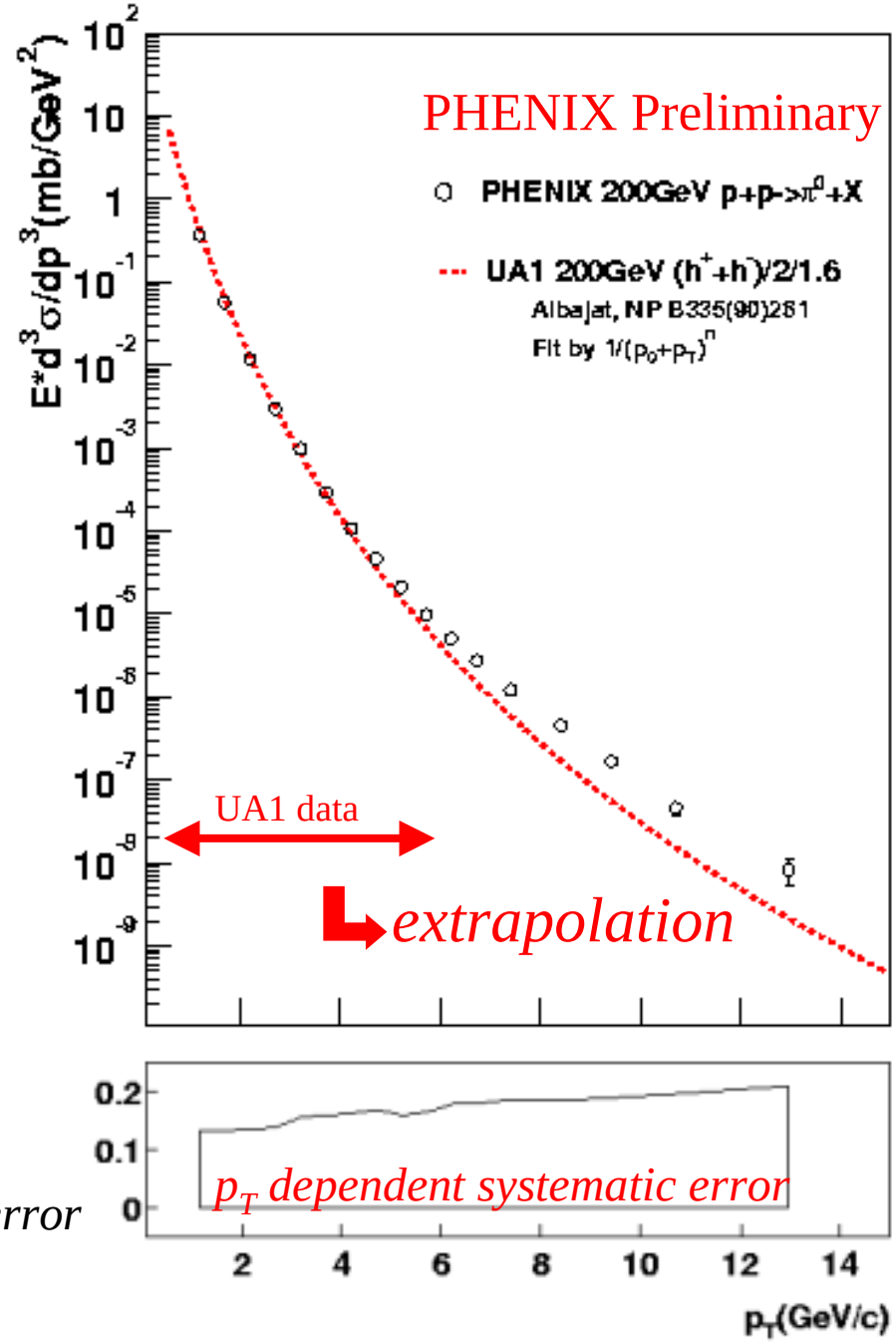
- Dear all, please don't stop your head and hand !!!



Comparison with UA1 Fitting

- UA1 data are only up to 6GeV/c and extrapolated to higher p_T
- The extrapolation is below our data at high p_T

→Now have pp data to use as important reference for Au+Au collision and jet quenching measurement.



Normalization systematic error 30% is not included here.

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