Neutral pion production in $\sqrt{s_{NN}}$ = 200GeV Au+Au collisions at RHIC-PHENIX

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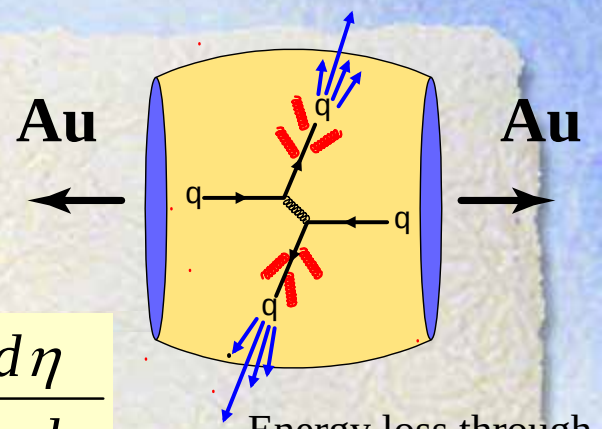
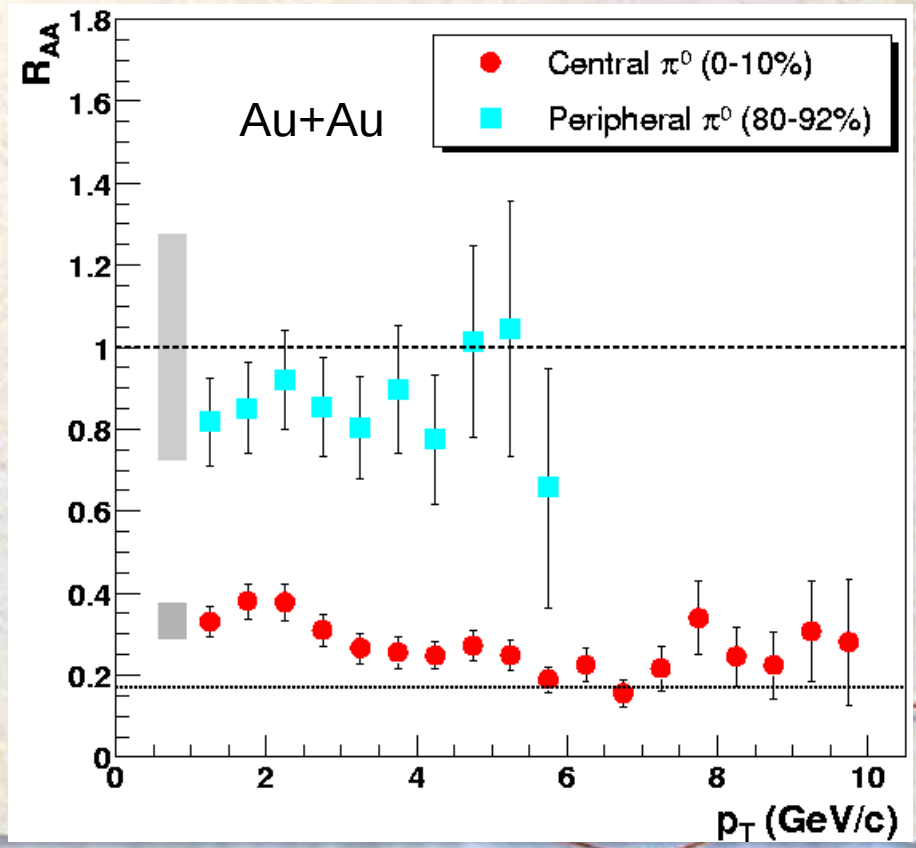
Physics motivation

- Suppression of neutral pions at high transverse momentum in central Au+Au collisions
- Energy loss of hard scattered partons in hot and dense matter
  - **Jet quenching**
- Understanding of the energy loss mechanism quantitatively
  - tell us property of dense matter
  - pT independent suppression
  - Due to mixture of nuclear effects
- How about higher pT region?
  - R_{AA}, v2

$$R_{AA}(p_T) = \frac{d^2N^{AA}/dp_T d\eta}{T_{AA}\, d^2\sigma^{NN}/dp_T d\eta}$$

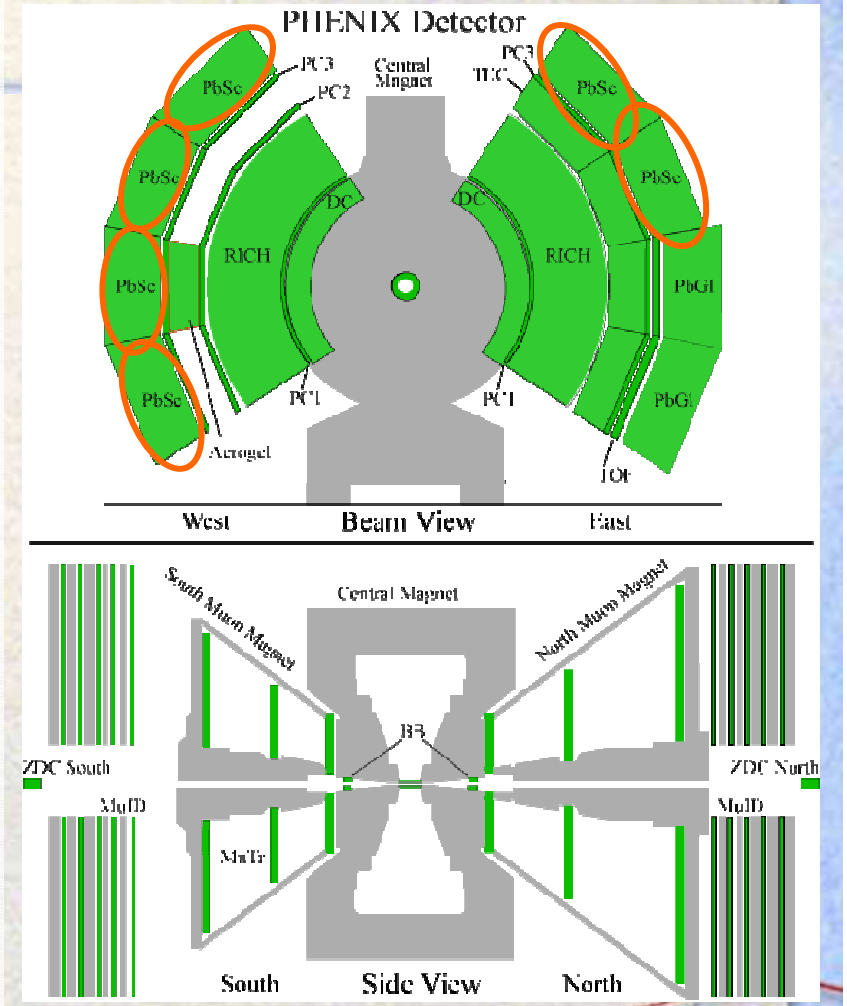


Energy loss through gluon radiation



π^0 measurement at RHIC-PHENIX

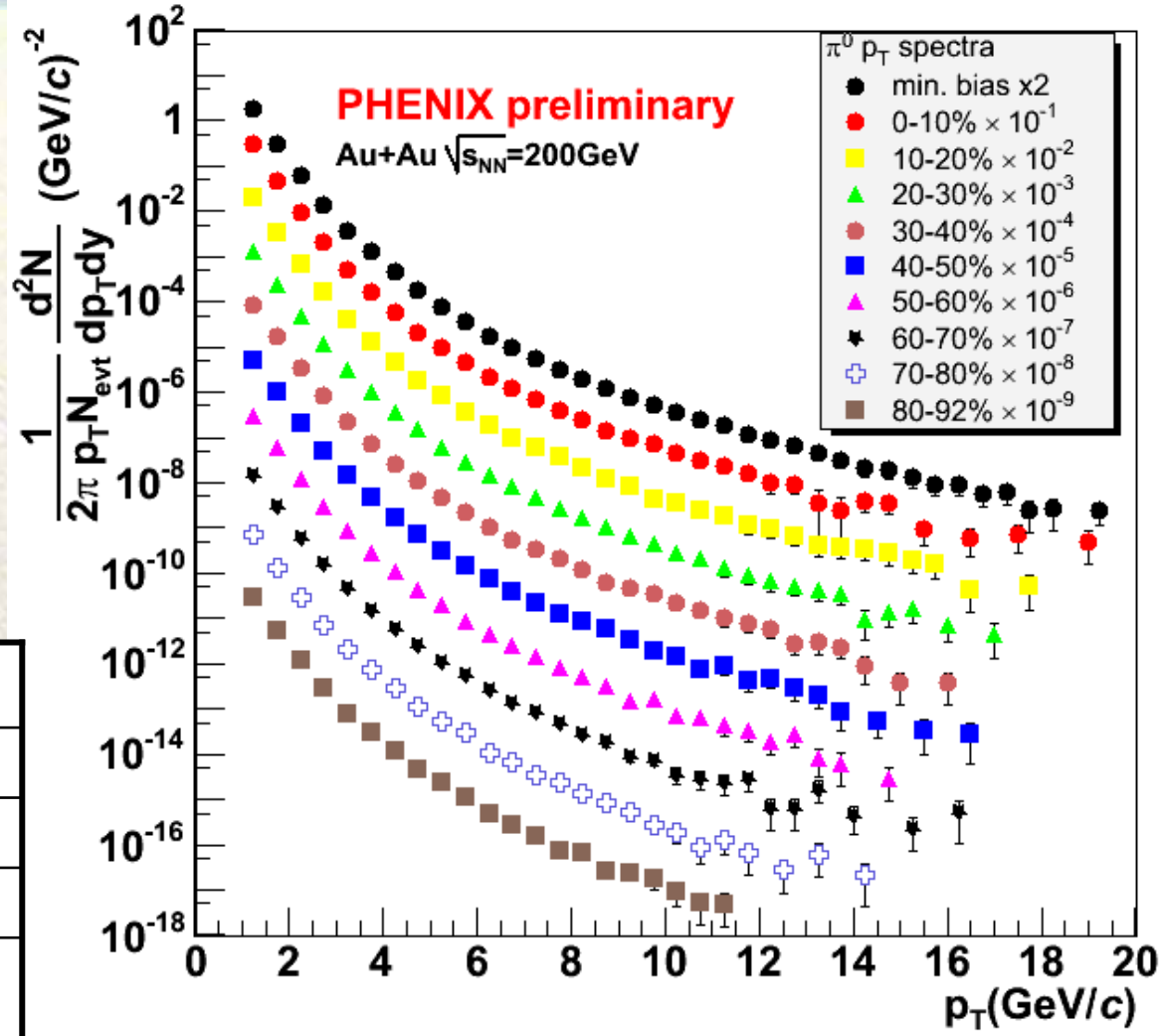
- **RHIC-PHENIX Au+Au 200 GeV run at Year-4**
  - Sampled Luminosity 241μb-1 (1.5B events)
- $\pi^0 \rightarrow 2\gamma$
- **Measurement using Electro Magnetic Calorimeter (EMCal)**
  - Distance from vertex point: 5m
    - $|\eta|<0.35$ $\phi = 2*90°$
  - 2 arm × 4 sectors
    - Lead Scintillator Type (PbSc)
      - 6sectors (15552 channels)
      - Radiation length: $18X_0$
    - Lead Glass Type (PbGl)
      - 2 sectors (9216 channels)
      - Radiation length: $16X_0$
  - measurement of E.M. clusters using PbSc type EMCal
- **Min. Bias trigger from BBC-ZDC coincidence**
  - Also used for Centrality determination
    - 0%: central, 100%: peripheral collision



Result (pT spectra, R_{AA}, v2)

π^0 pT spectra

- π^0 pT spectra up to 20GeV.
  - Run2: up to 12 GeV.
  - 10GeV/c π^0 even at most peripheral events

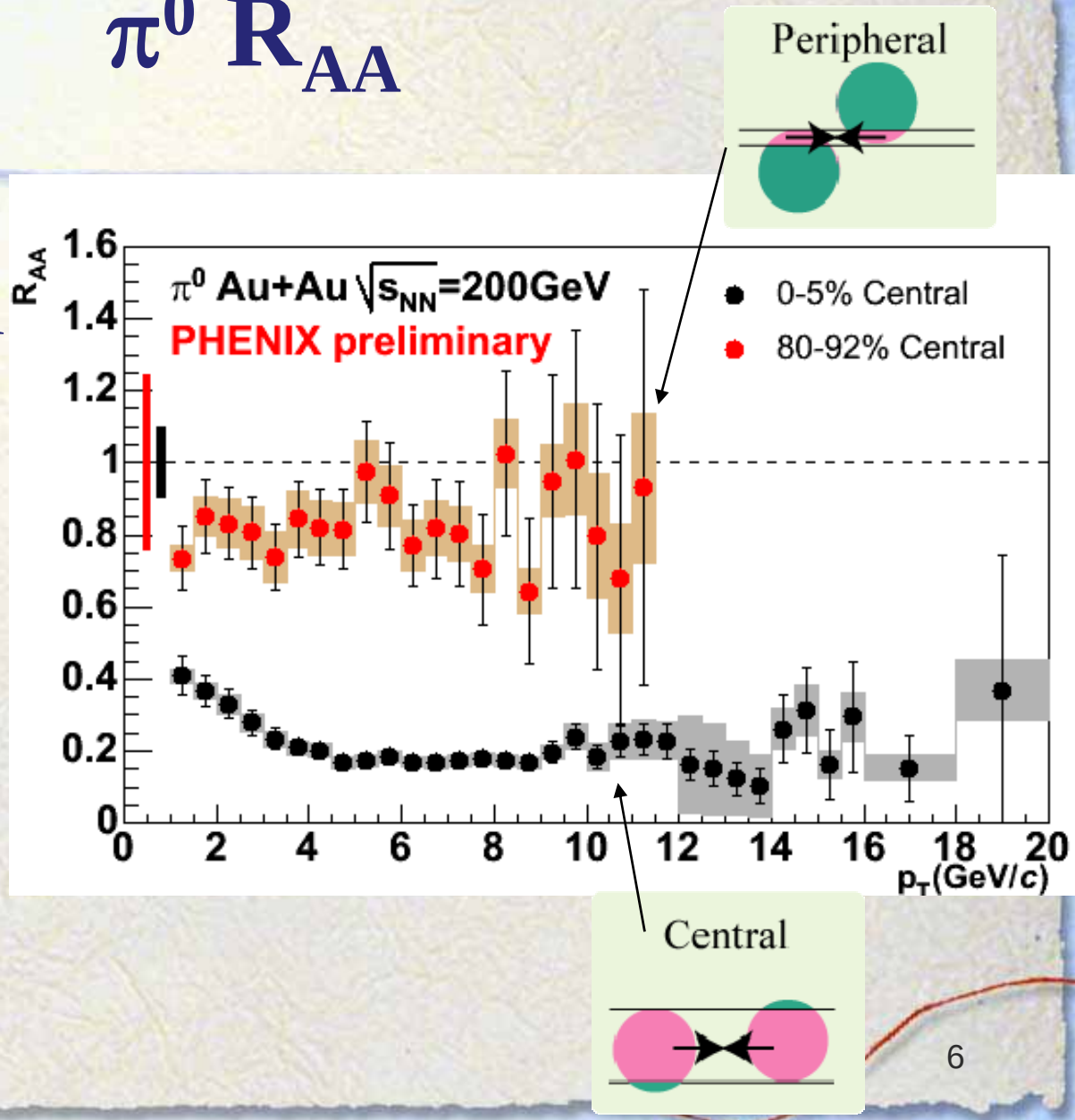


Summary of systematic error

Energy scale	6-8%	pT-corr.
Pid efficiency	10%	pT-uncorr.
Merging	0-25%	pT-corr.
π^0 extraction	6%	pT-uncorr.
Off-vertex pi0 and g conv.	3%	pT-uncorr.

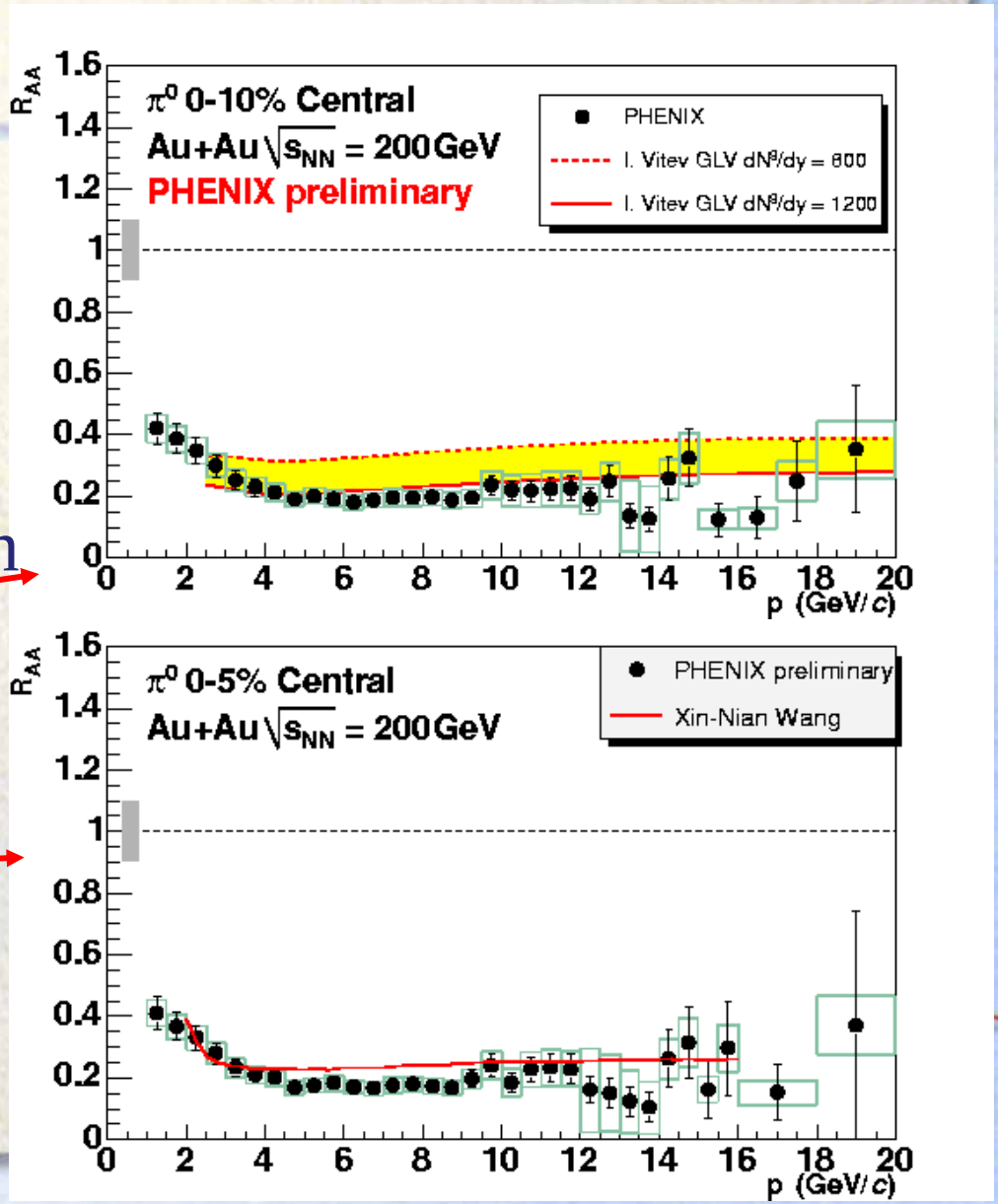
π^0 R_{AA}

- Use Run3 p+p π^0 data as reference.
- Strong suppression is seen even at very high pT.
- Almost flat up to 20GeV.
- Constancy for pT>4GeV/c for all centralities

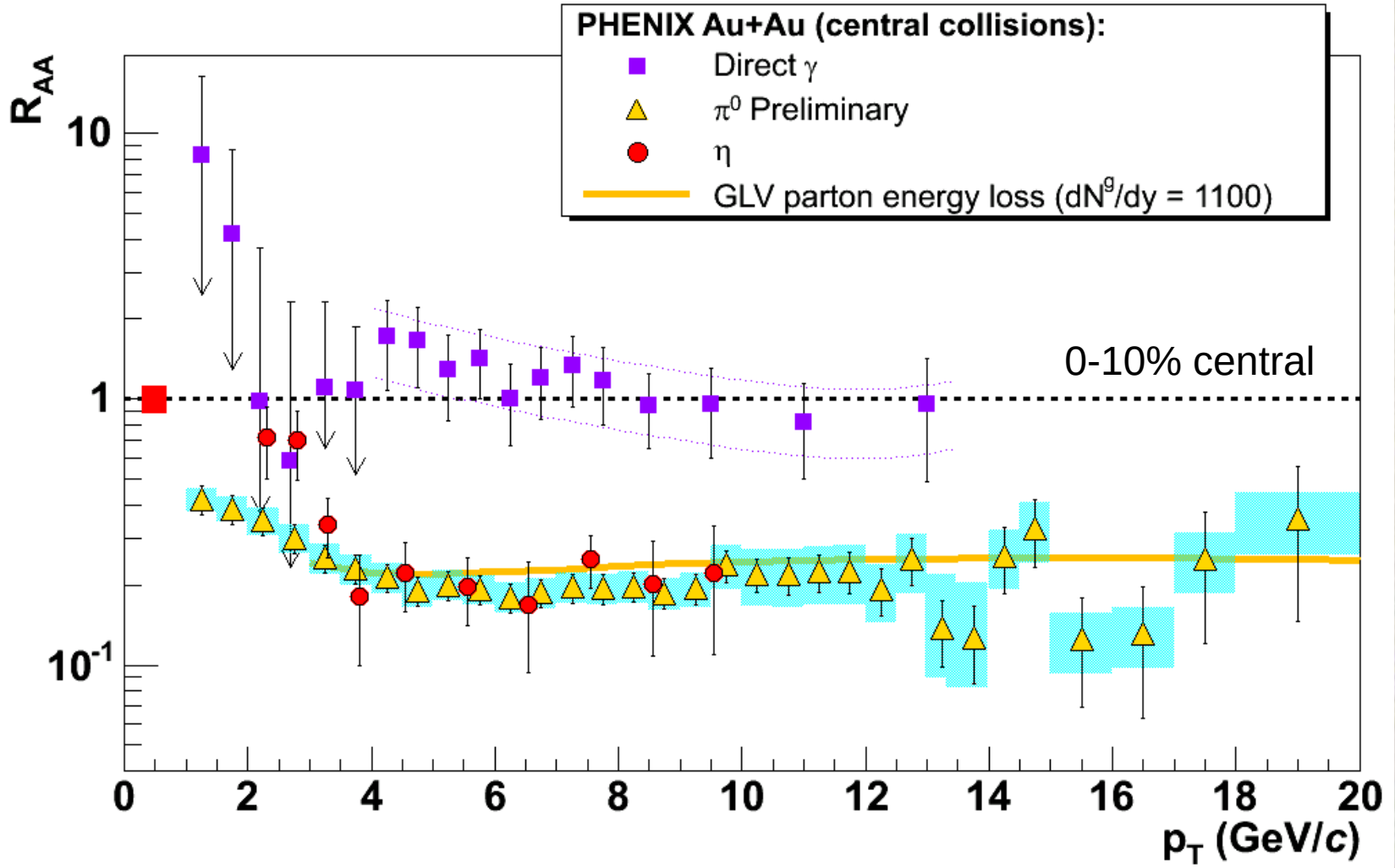


Theoretical comparison

- flat R_{AA} is mixture of nuclear effects.
  - Jet quenching
  - Cold nuclear effect
    - Nuclear shadowing
    - Cronin effect
- 1+1D Bjorken expansion
- I. Vitev
  - Phys. Rev. Lett. 89, 252301,2002
- X.N. Wang
  - Phys.Lett.B595:165-170,2004



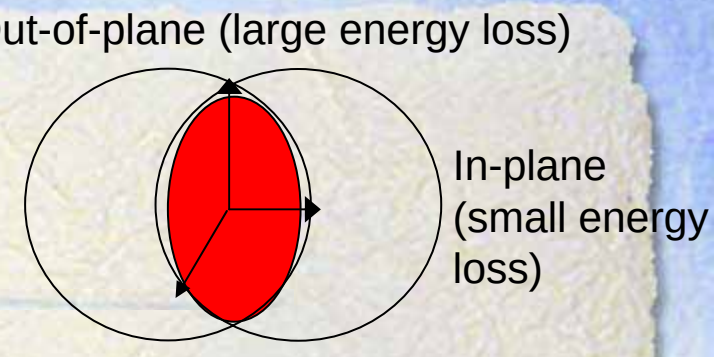
Comparison with η and direct γ R_{AA}



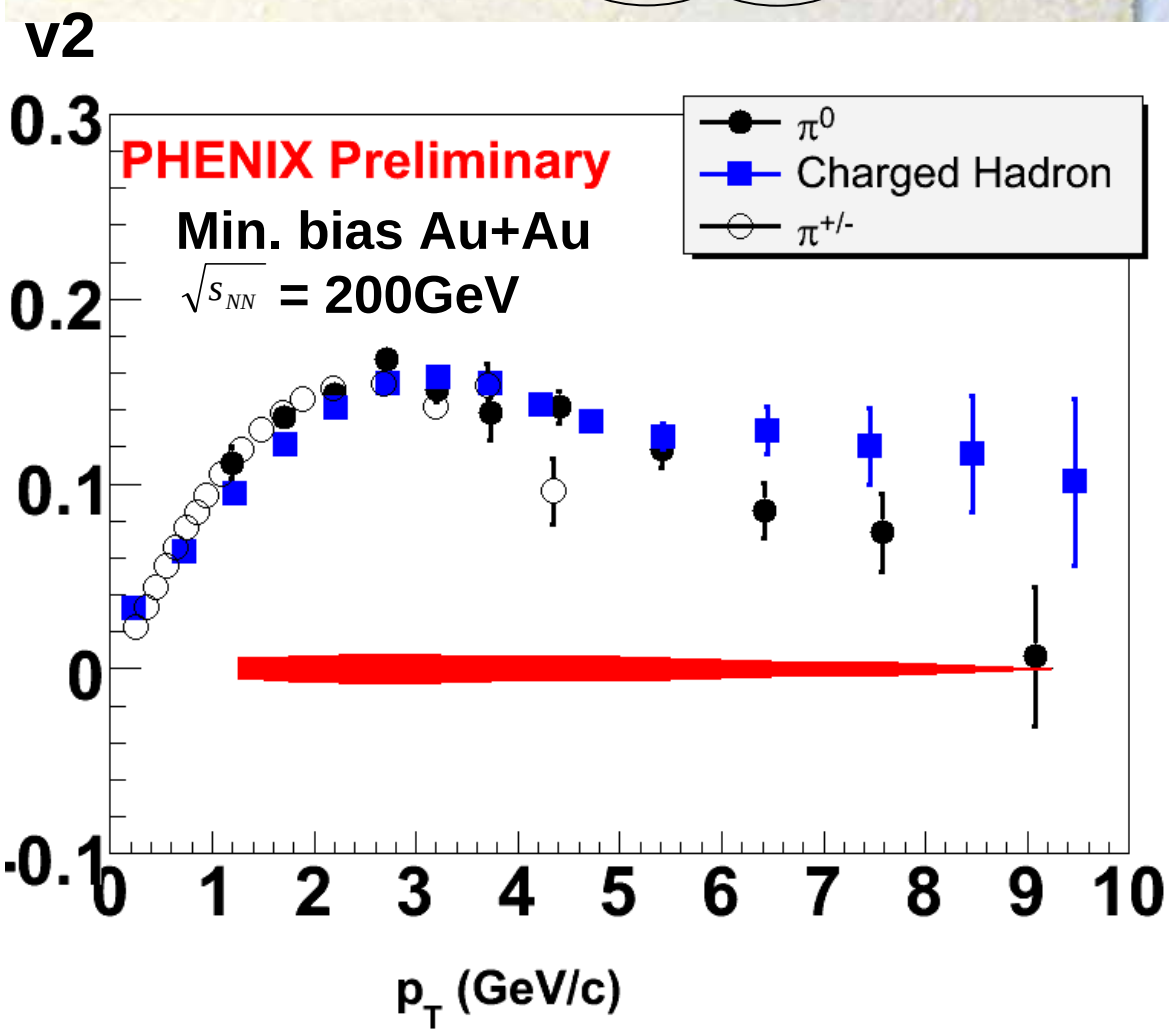
✓η suppression is similar to π^0 (indicates partonic level)

✓Direct photon is not suppressed (Ncoll scaling properly)

π^0 v2



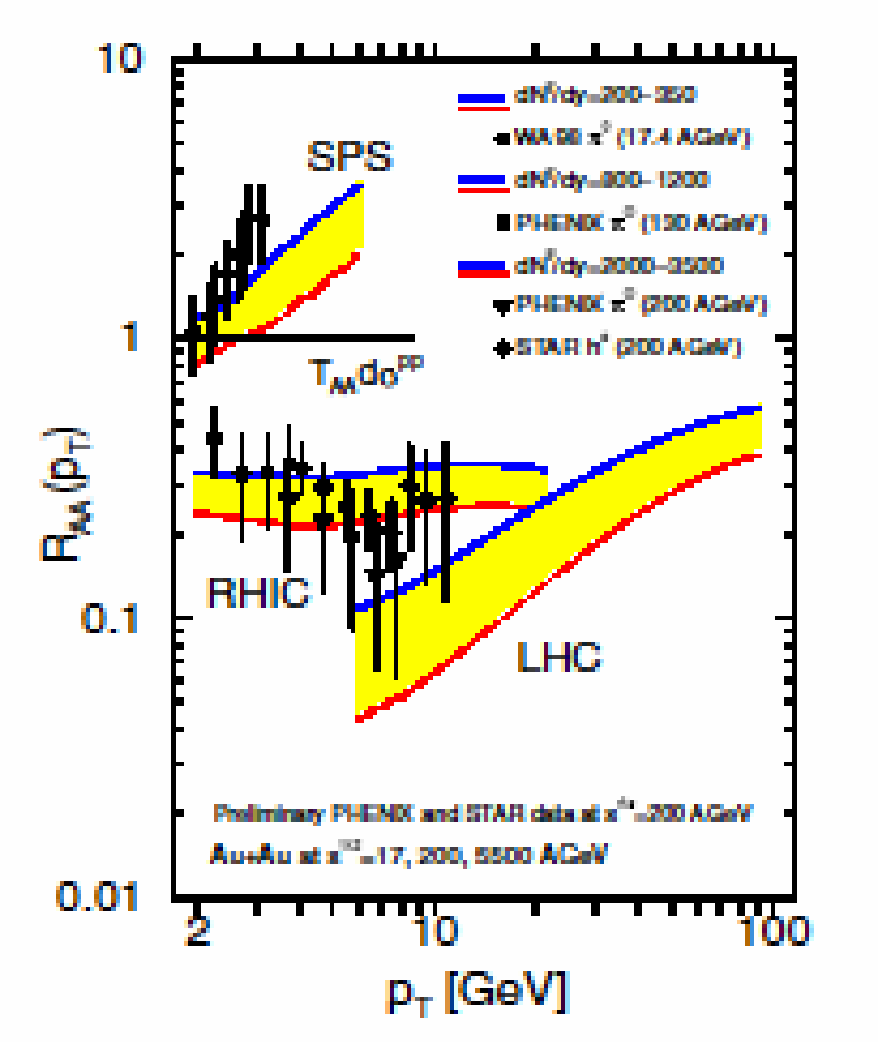
- Measured up to pT:10GeV/c
- v2 at high pT
  - azimuthal variation in energy loss
- Observation of v2 peak at pT = 2-3GeV/c and decreasing v_2 at high p_T
- Approach for understanding energy loss mechanism
  - So far, we observe integrated yield
  - π^0 production respect to reaction plane
    - energy loss as a function of pass length
  - given by D. Winter Session KG



Summary

- Measurement of π^0 production at $\sqrt{s_{NN}}$ = 200GeV Au+Au collision.
  - Spectra, R_{AA} (up to 20GeV)
    - Measured R_{AA} shows little variation with p_T
  - v2 (up to 10GeV)
    - decreasing v_2 at high p_T
- Good agreement with theoretical Jet quenching prediction.
  - $dN^g/dy>1100$

backup


10
1
0.1
0.01
2
10
100
SPS
RHIC
LHC
$T_{AA}d\sigma^{pp}$
$R_{AA}(p_T)$
p_T [GeV]
Preliminary PHENIX and STAR data at $\sqrt{s_{NN}}$=200 AGeV
Au+Au at $\sqrt{s_{NN}}$=17, 200, 5500 AGeV

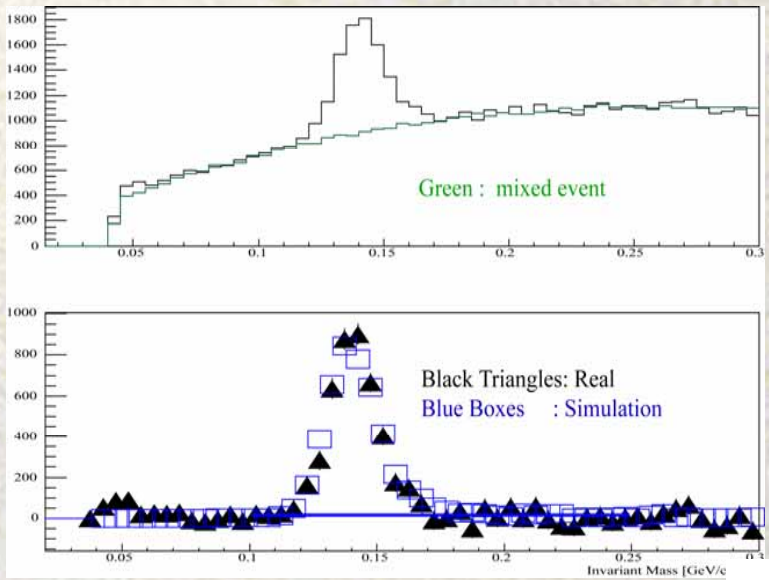
Analysis Overview

- π^0 reconstruction ($\pi^0 \rightarrow 2\gamma$)
  - Energy Asymmetry cut

$$\left|\frac{E_{\gamma 1} - E_{\gamma 2}}{E_{\gamma 1} + E_{\gamma 2}}\right| < 0.8$$

  - Reconstruction of background with "Event mixing" method.
- Calculation of π^0 reconstruction efficiency
  - Using single photon simulation result
  - with simple Monte-Carlo
  - with pi0 embedding

π^0 inv. mass spectra



GeV/c^2