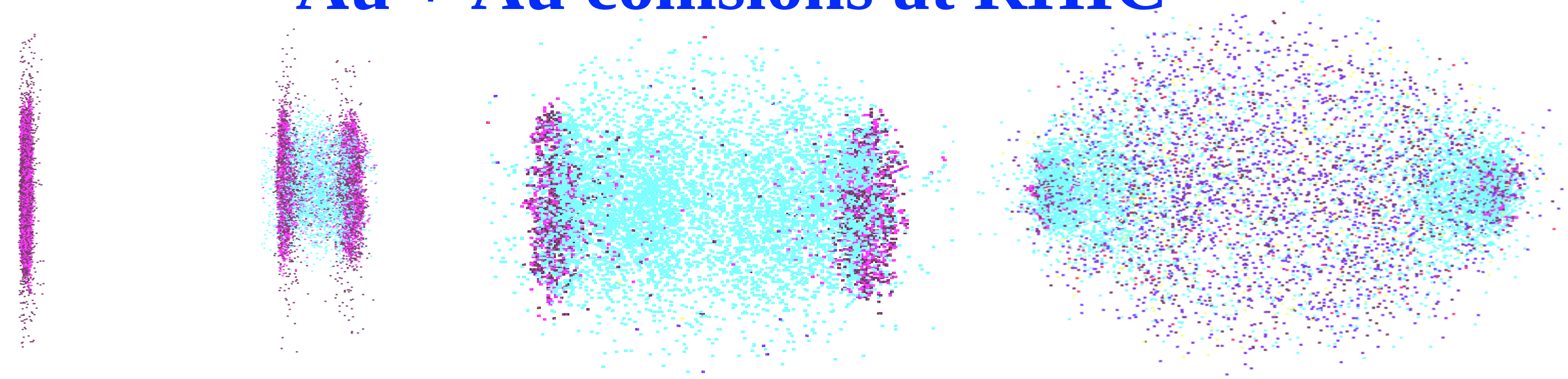
High momentum charged hadron spectra from Au + Au collisions at RHIC



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For the **PHENIX** Collaboration

- Motivation
- Experiment setup and analysis
- Physics result
- Summary

PHENIX @ RHIC

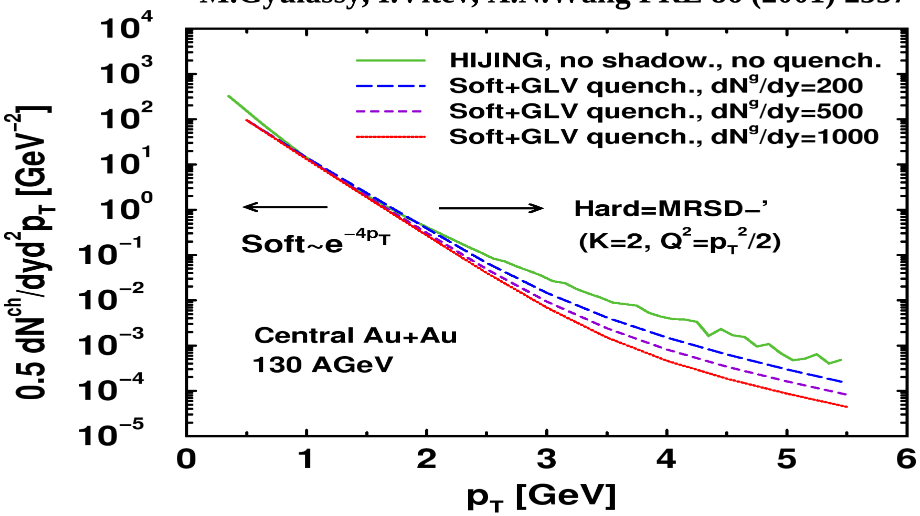
Charge Particle High p_T Physics

- Jet production dominates particle yields at high p_T
- Jet created early in collision
- Expect parton energy loss in presence of hot dense medium

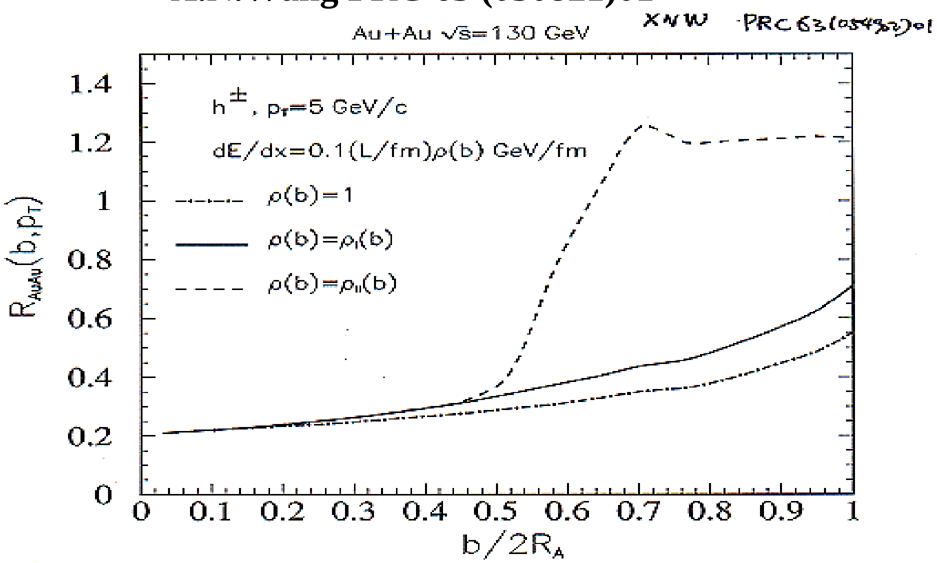
Jet quenching

- Suppression of high p_T spectra
- Strong centrality dependence

M.Gyulassy, I.Vitev, X.N.Wang PRL 86 (2001) 2557



X.N.Wang PRC 63 (050821)01

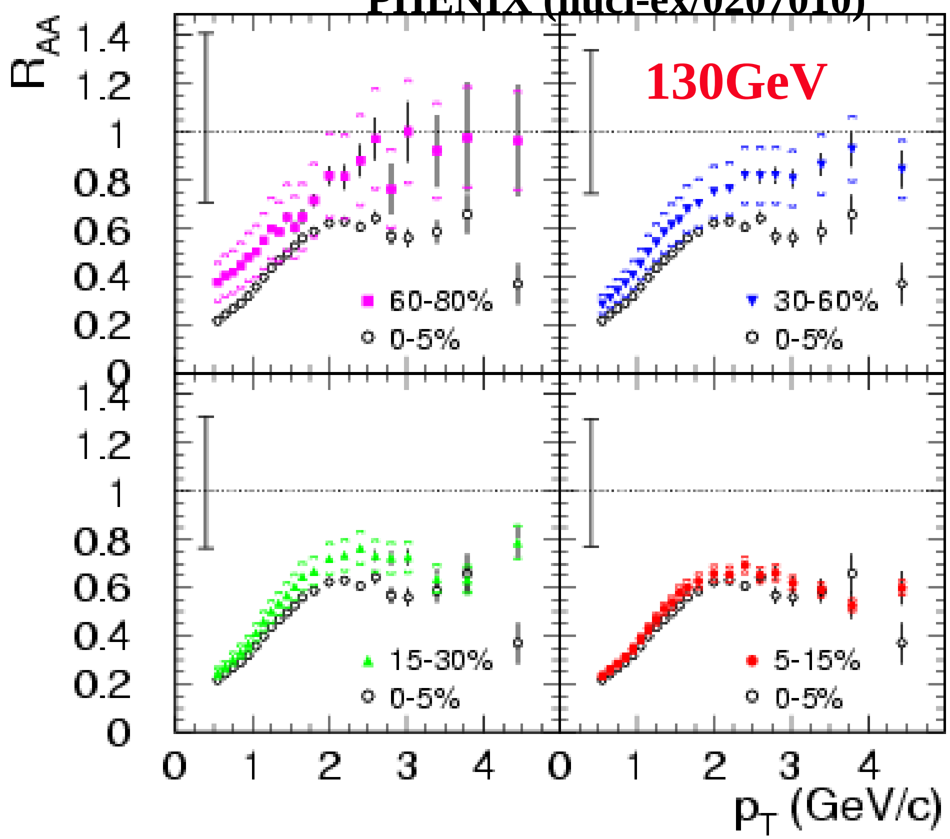


High pt suppression at 130 GeV

- First observation of high pt hadron suppression in Au+Au at 130 GeV
  - PHENIX collaboration PRL 88 (2002) 22301
- Quantify suppression by nuclear modification factor R_{AA}

$$R_{AA} = \frac{1/N_{evt} d^2N_{AA}/dp_T d\eta}{(\langle N_X \rangle / \sigma_{inel}^{NN}) d^2\sigma^{NN}/dp_T d\eta}$$

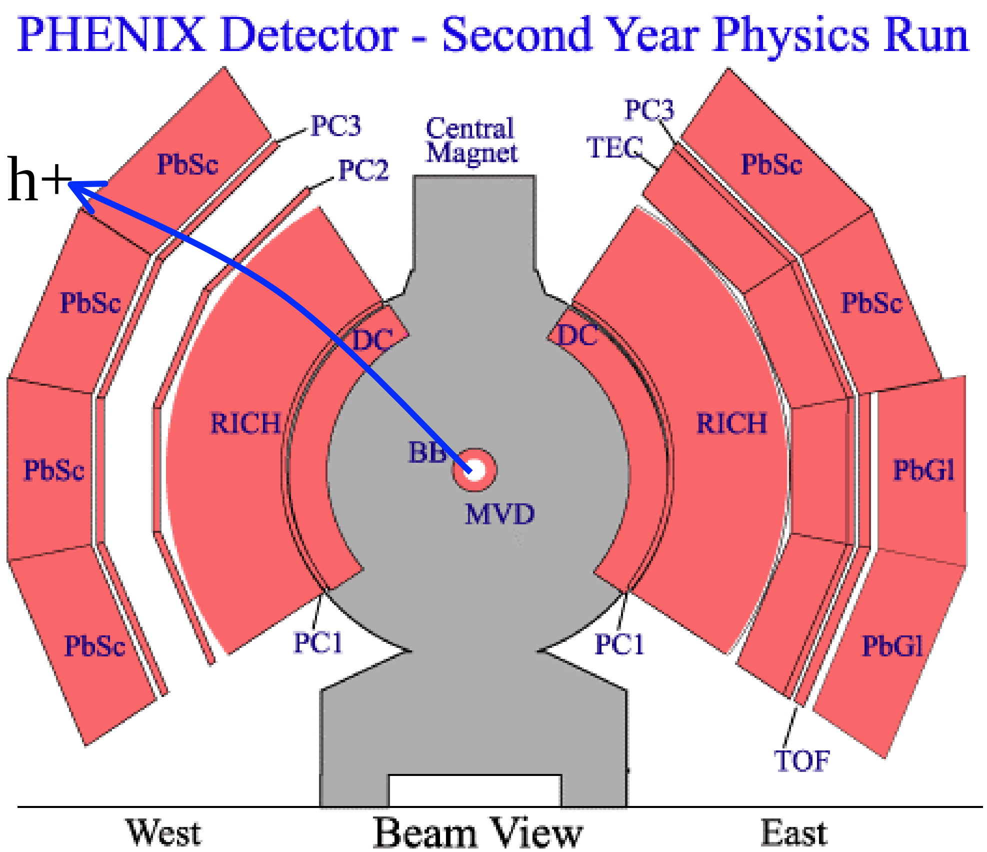
PHENIX (nucl-ex/0207010)



- Detailed p_T and centrality dependence
  - Peripheral $R_{AA} \to 1$
  - Central R_{AA} saturates ~ 0.6 at pt >2GeV/C

Consistent with STAR(nucl-ex/0206011)

PHENIX Experiment for Au+Au at 200 GeV

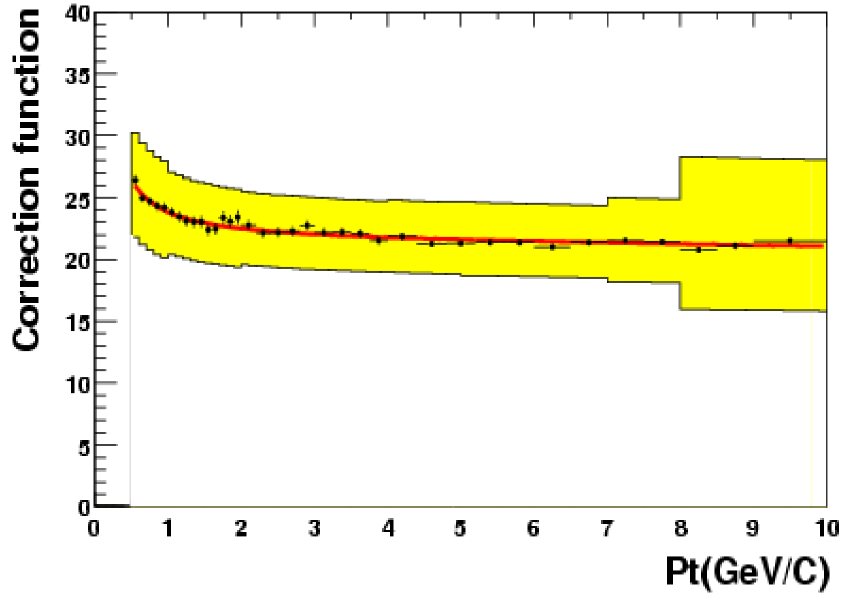


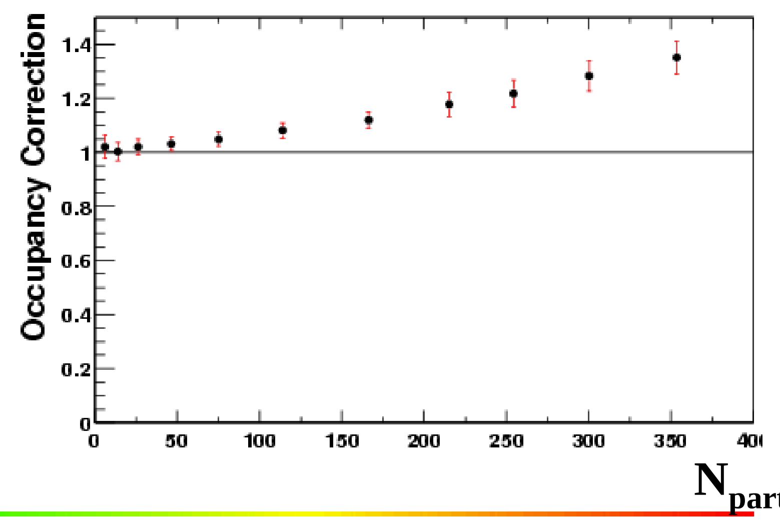
- **Data sample**
  - **27 million min. bias events**
- **Event centrality**
  - **Zero Degree Calorimeter**
  - **Beam Beam Counter**
- **Tracks in west arm**
  - **reconstructed by DC,PC1**
  - **momentum resolution**

    $\Delta p/p \sim 1\% \oplus 1\% p$ **GeV/c**
- **Background rejection**
  - **tight track match to PC2,PC3**
  - **remaining background measured and subtracted statistically**

Corrections

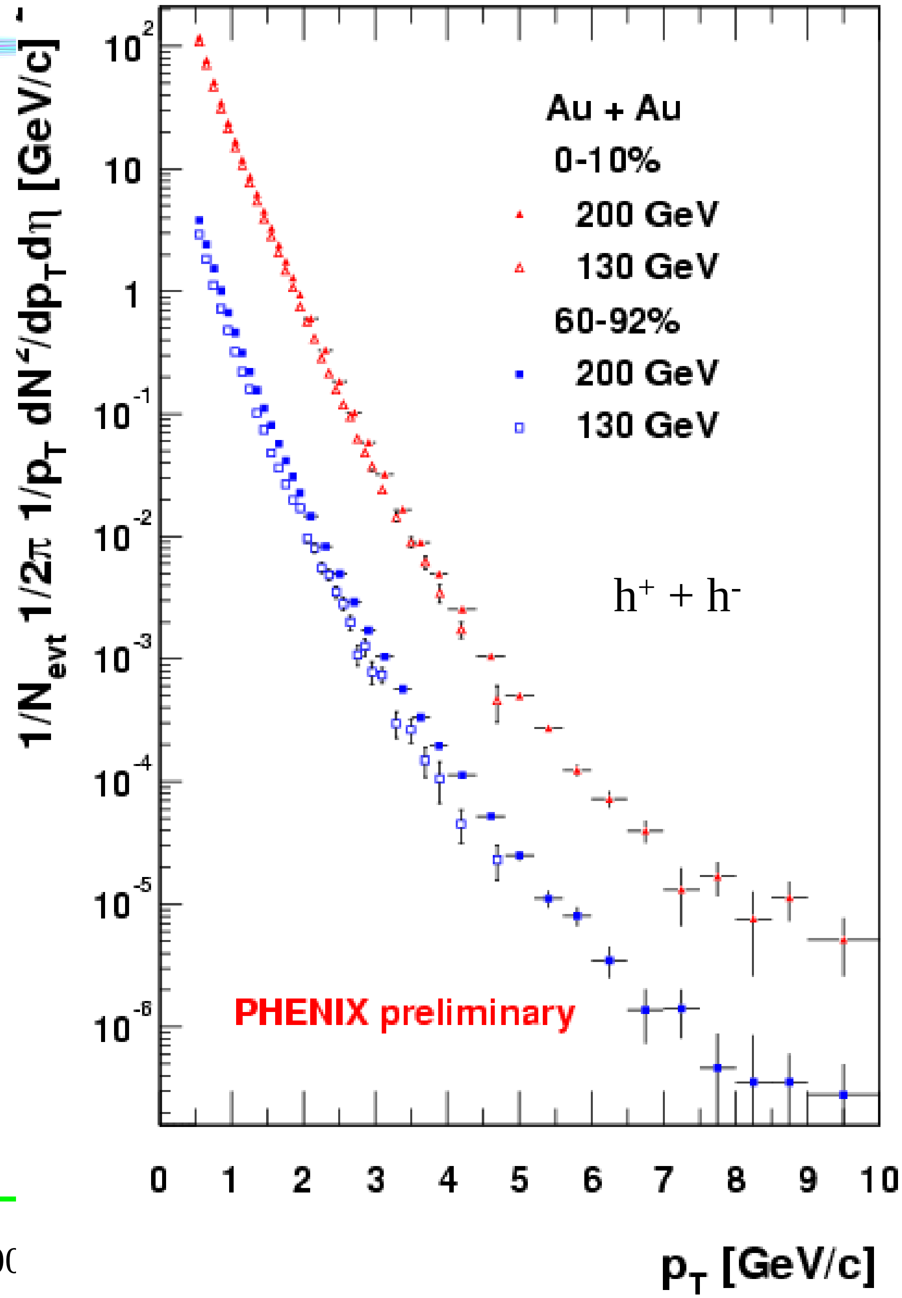
- Monte-Carlo simulation of single particles through PHENIX detector
- Plateau is given by geometrical acceptance and efficiency
  - yellow band show the systematic error
  - 15 % for $p_T < 8$ GeV/c
    30 % for $p_T < 10$ GeV/c
- Embed single particle into real events to estimate occupancy correction
  - correction for most central collision is 1.35 ± 6%
- p_T and centrality dependence factorize.





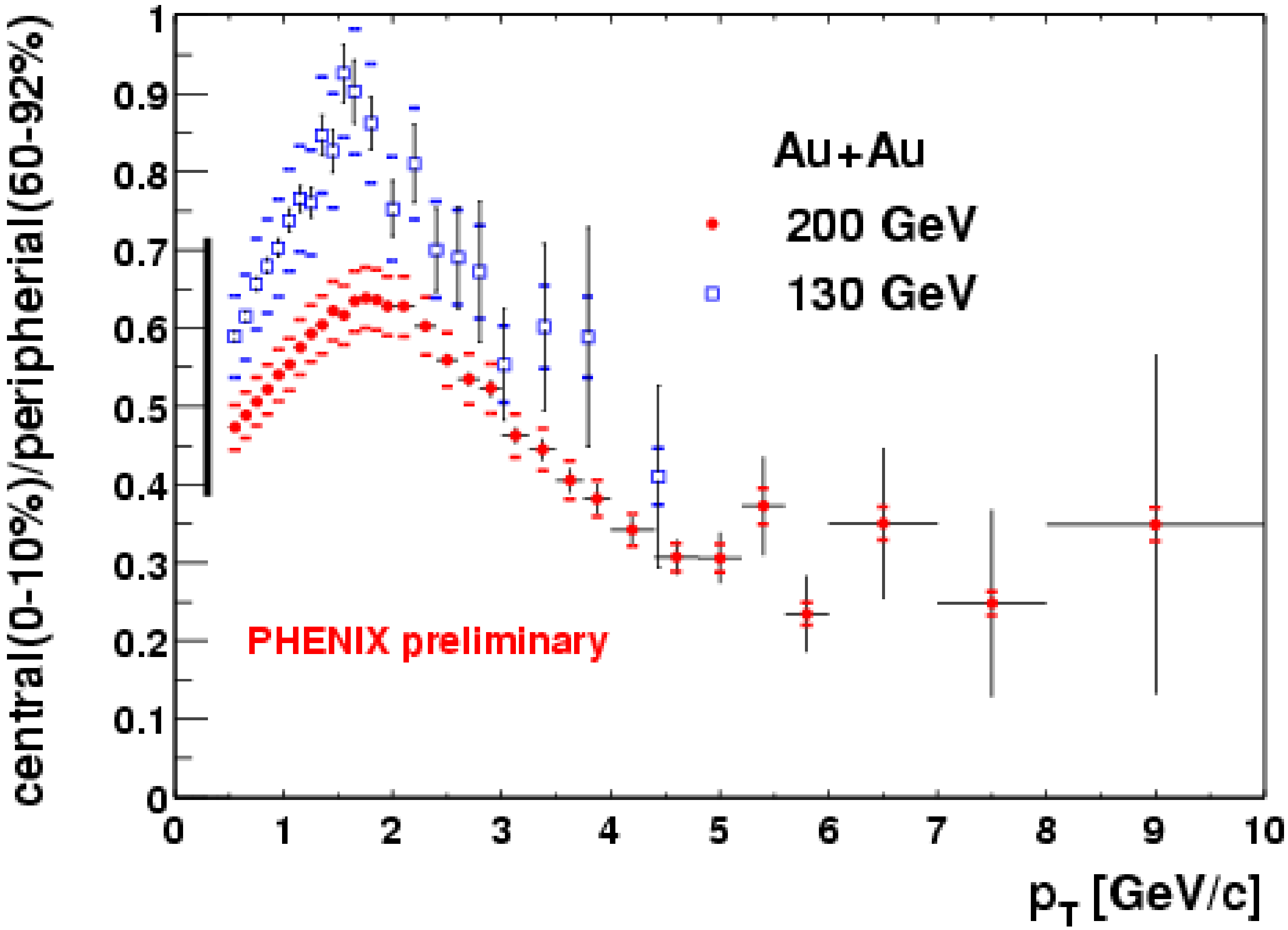
p_T spectra from Au+Au at 200 GeV

- Spectra measured up to 10 GeV/c
- Central and peripheral spectra have clear power shape
- Increased yield compare to 130 GeV



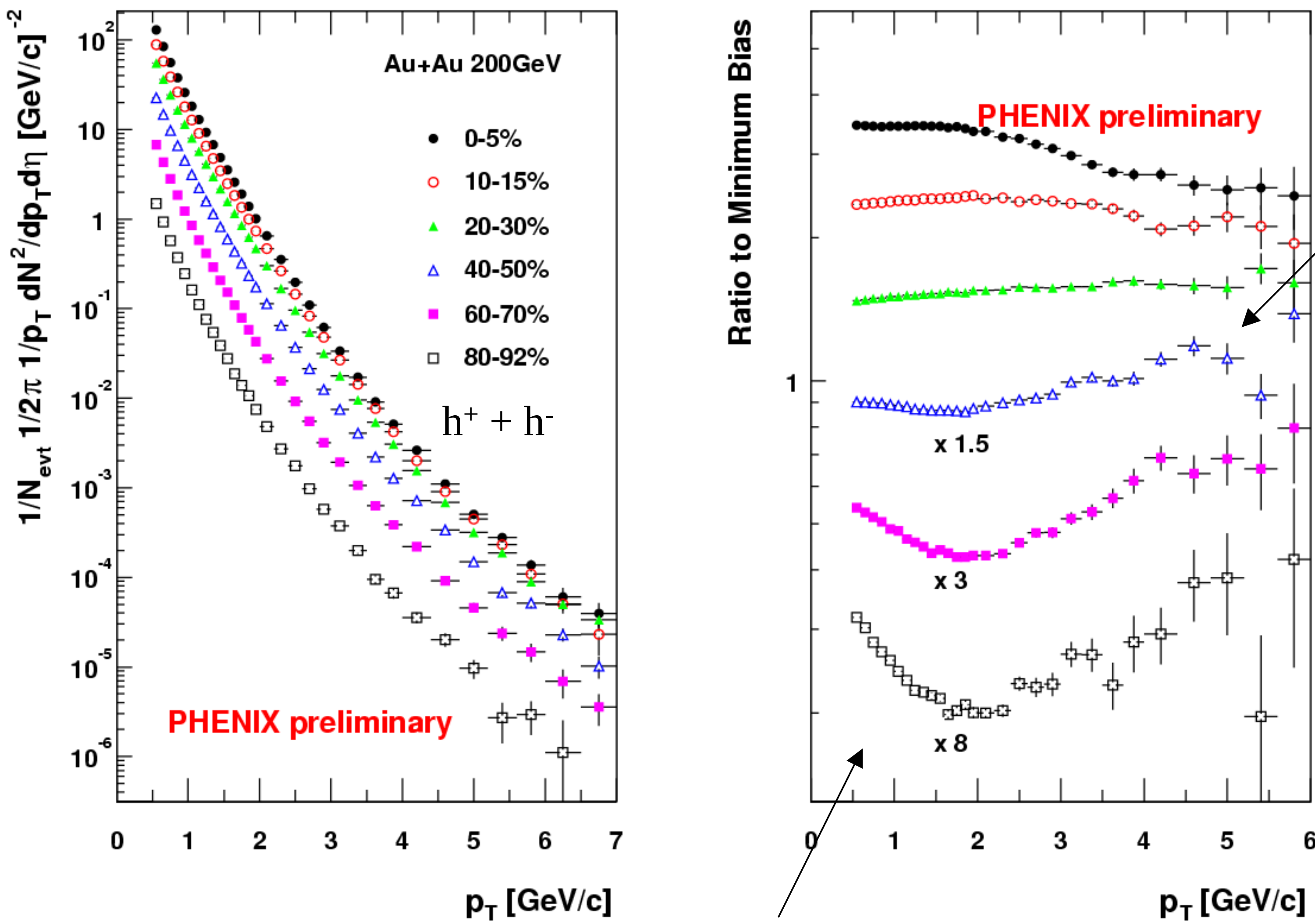
Ratio central/peripheral

colored bracket represent the systematic error.
thick black line is uncertainty of the scaling factor from N. collisions



- Lower ratio for 200 GeV
  - more suppression or change in proton yield?
- Similar shape for 130 and 200 GeV
  - increase to 2 GeV/c
  - decrease to 4 GeV/c
- appr. const above 4 GeV/c at 200GeV

Charged particle p_T spectra from 200 GeV

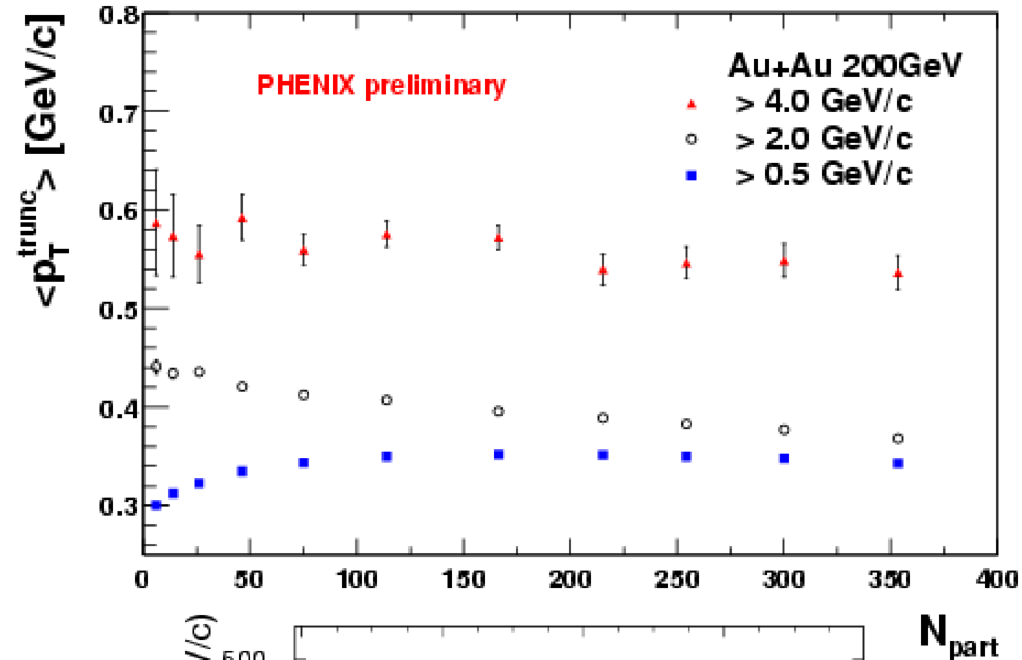


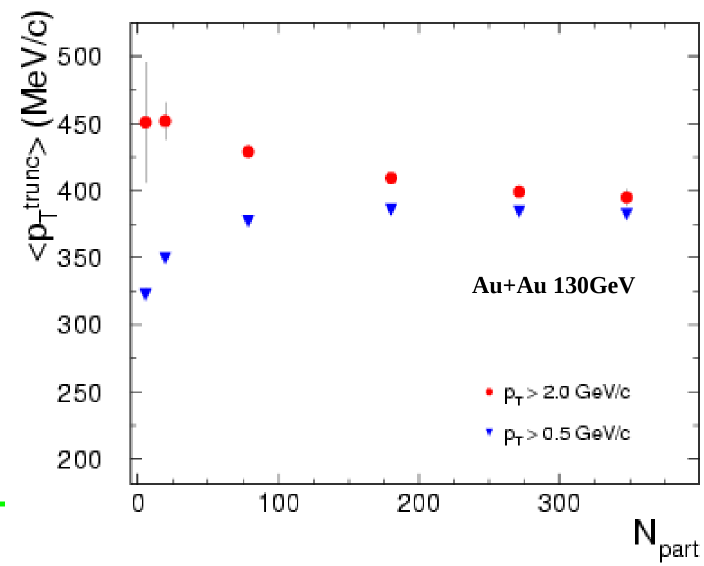
p_T >2 GeV/c, decrease of inverse slope → suppression

p_T <2 GeV/c, increase of inverse slope → flow

Centrality dependence of spectral shape

- **Analyze inverse slope :**
  $p_T^{trunc} = \langle p_T \rangle - p_T^{min}$
- **From peripheral to central:**
  - inverse slope increases for low p_T
  - it decreases for medium p_T
  - slight decrease for high p_T
- **Observed for both 130 and 200 GeV**



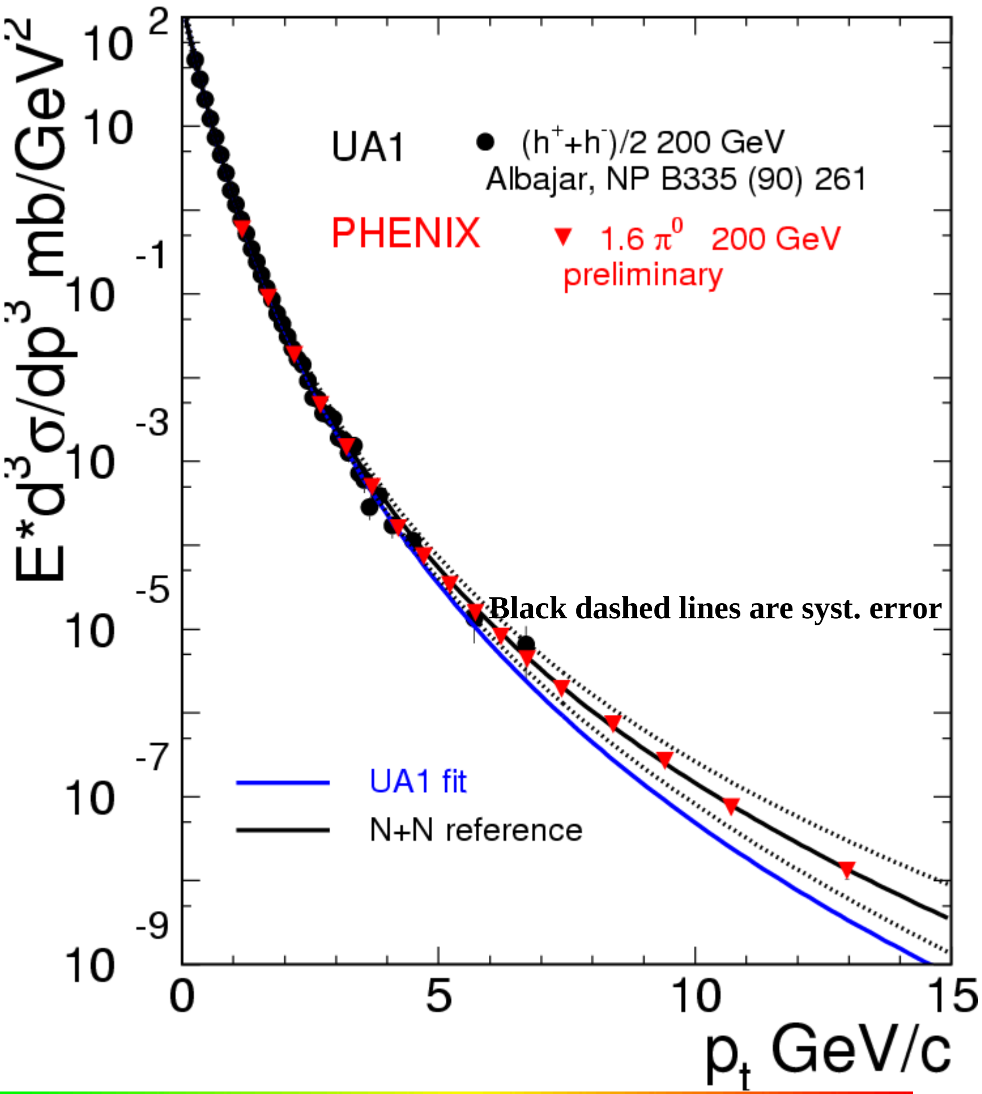


N+N reference

- **PHENIX p+p data at 200 GeV**
  - π^0 data out to 13 GeV/c
  - consistent with NLO pQCD calculation
  - charged hadron results not available yet
- **Comparison to fit of UA1 data**
  - UA1 data at 200GeV
  - PHENIX π^0 spectra scaled by 1.6
  - π^0 significantly above UA1 fit at high p_T
  - 30-40% correction $|\Delta\eta|<2.5 \rightarrow |\Delta\eta|<0.5$ at 6 GeV/c
  - π^0 spectra factor 2 above fit at 6GeV
- **Charged hadron N+N reference**
  - Use π^0 data to constrain fit
  - systematic uncertainty

    40% at 6 GeV/c

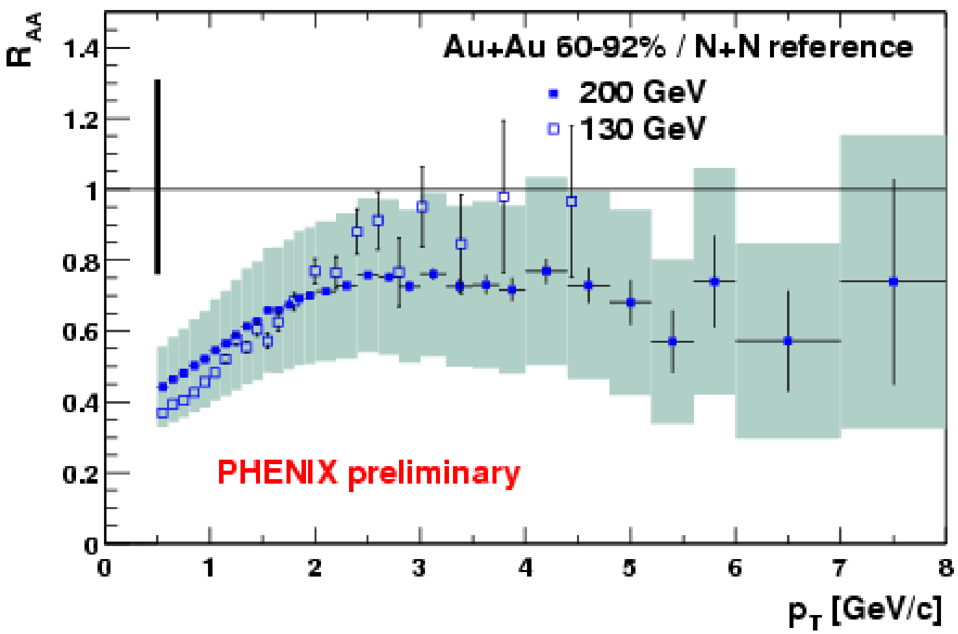
    80% at 10 GeV/c

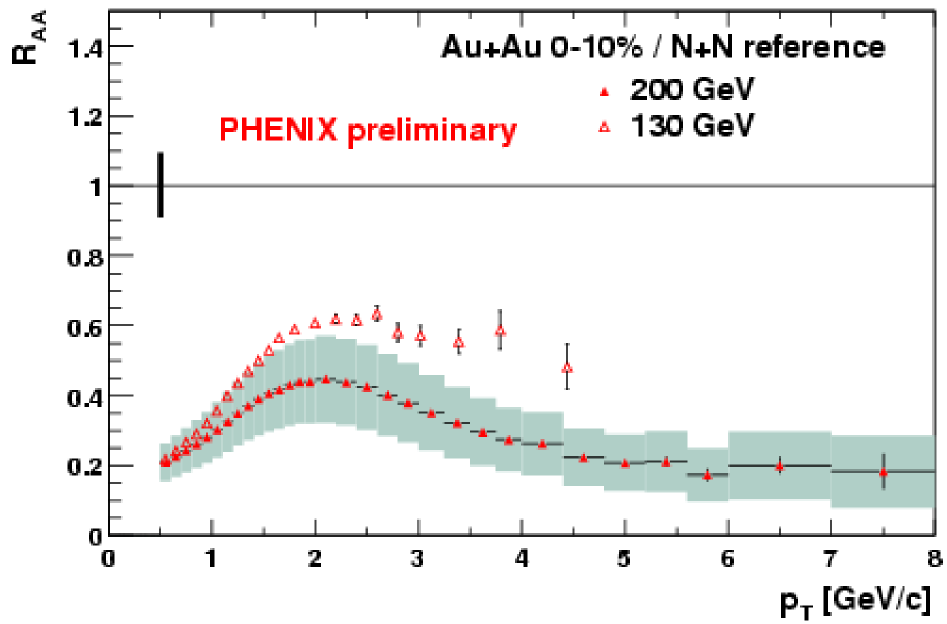


Comparison with NN references I

Calculate R_{AA}: divide data by NN references

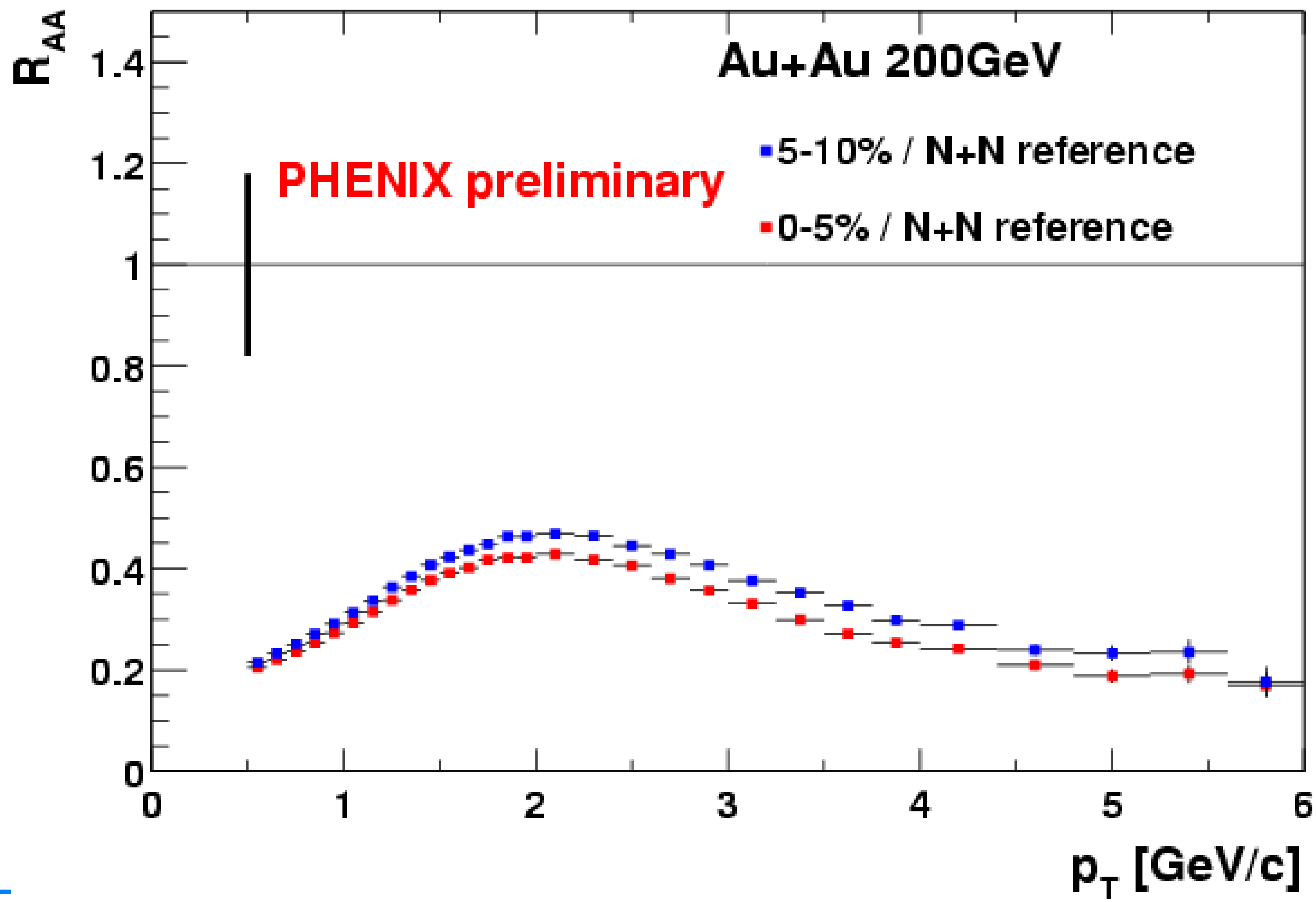
- **R_{AA} for peripheral collisions**
  - **~ 0.75 ± 0.3 for p_T>2GeV/c**
  - **consistent with 1**
  - **similar to 130 GeV**
- **R_{AA} for central collisions**
  - **significantly below 1**
  - **200 GeV below 130 GeV data**
  - **~ 0.2 ± 0.08 from 4 to 8 GeV/c**





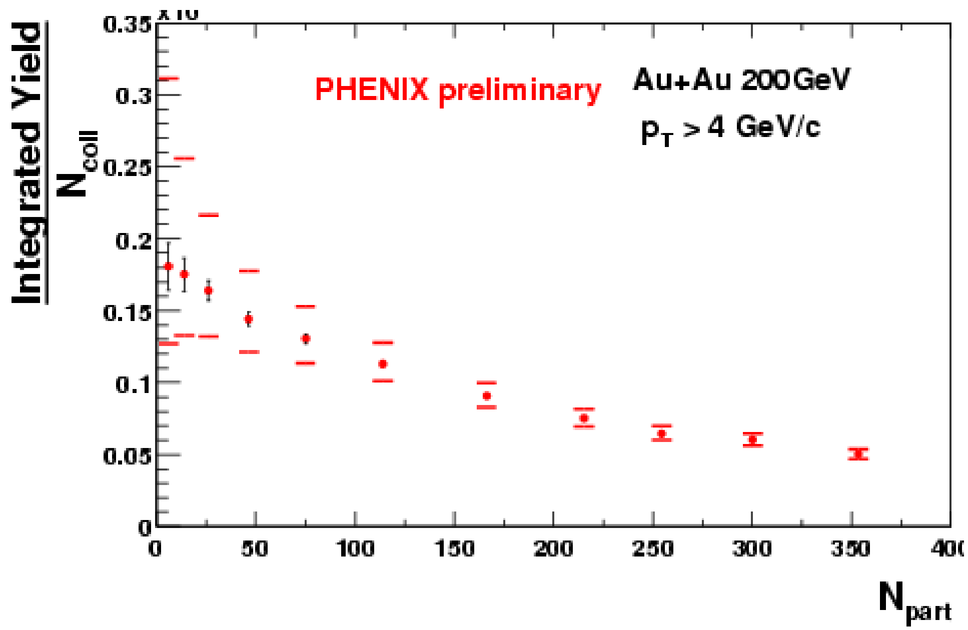
Comparison with N+N references II

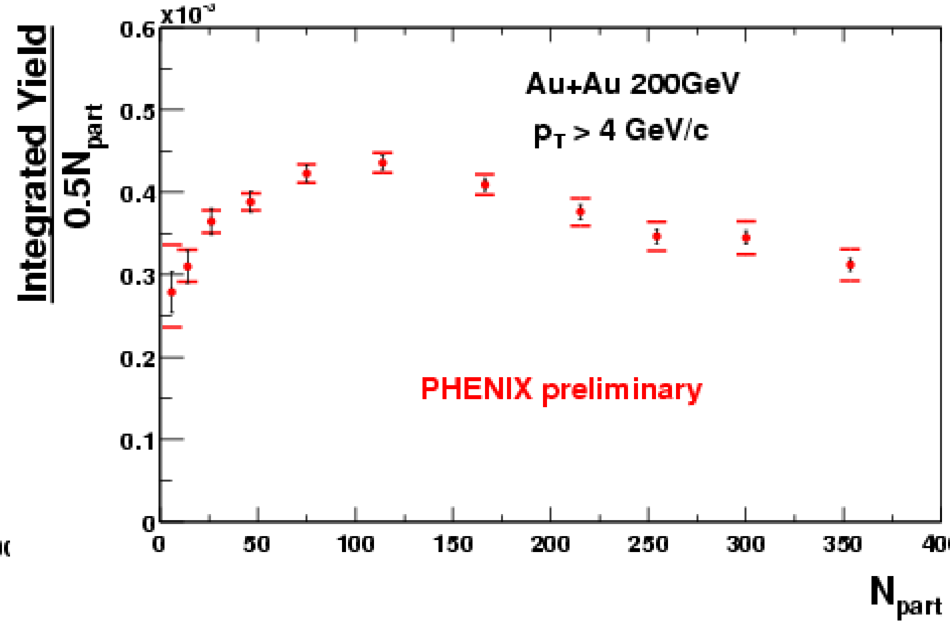
- Continues increases of suppression towards central collisions
- Suppression more pronounced at high p_T



Centrality dependence of particle yields at high p_T

- **Yield integrated above 4 GeV/c**
- **Normalized to number of binary collisions**
  - continuous decrease as function of centrality
  - factor ~ 3.5 decrease from peripheral to central collisions
- **Normalized to number of participants**
  - first increase, then decrease as function of centrality





Summary

- Charged hadron p_T spectra measured up to 10 GeV/c for Au+Au at 200 GeV
- Similar high p_T hadron suppression at 200 GeV compared to 130 GeV, but more pronounced
  - 11 centrality bins with increased pT range
- Spectra evolves gradually as function of p_T and centrality
  - For p_T >2 GeV/c inverse slope decreases with centrality
  - For peripheral collisions R_{AA} ~ 0.75 ± 0.3 at high p_T consistent with 1
  - For central collisions R_{AA} ~ 0.2 ± 0.08 at high p_T significantly below 1
  - R_{AA} and central/peripheral ratio approximately constant between 4 to 8 GeV/c
  - For p_T >4 GeV/c yield/Ncoll suppressed by factor ~ 3.5 in central compared to peripheral collisions
- Outlook
  - factor 2-3 more Au+Au statistics
  - improved systematic error
  - measure p+p charged hadron spectra