

Systematic Study of Identified Particle Production in PHENIX

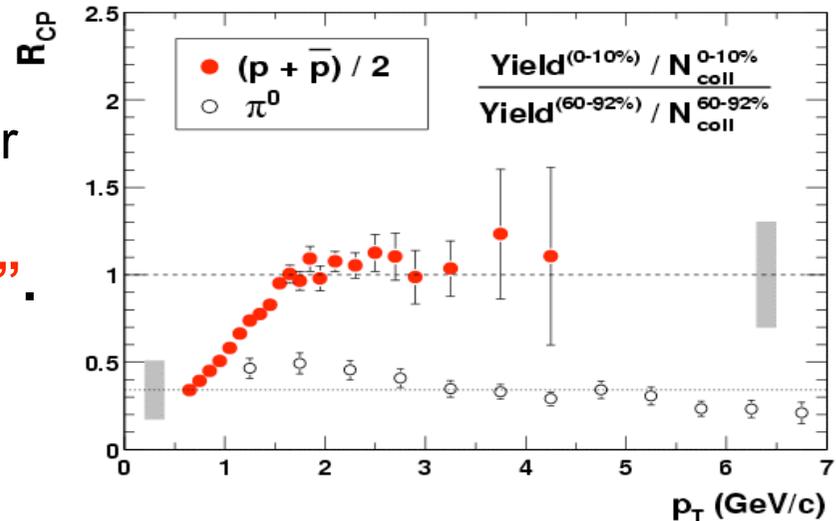
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- Physics Motivation
- Method
- New Data Set: Cu+Cu 200GeV
- Results and Comparisons:
 - Baryon Enhancement
 - Energy dependence
 - N_{part} Scaling (Particle Ratio)
 - N_{part} Scaling (R_{AA})
- Summary

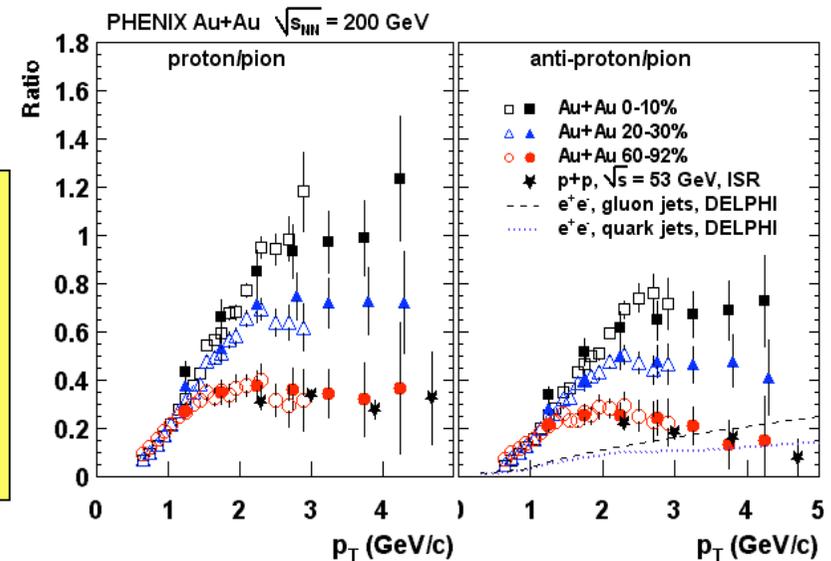
Physics Motivation

- Strong suppression of π^0 yields above p_T R_{CP}
 ~ 2 GeV/c at RHIC, but no suppression for
 proton and antiproton at intermediate p_T
 (2-5 GeV/c): **“Baryon Anomaly at RHIC”**.
- The possible explanations:
 Quark recombination,
 Baryon junction, Strong radial flow ...



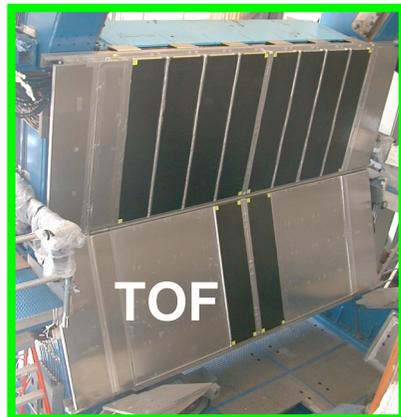
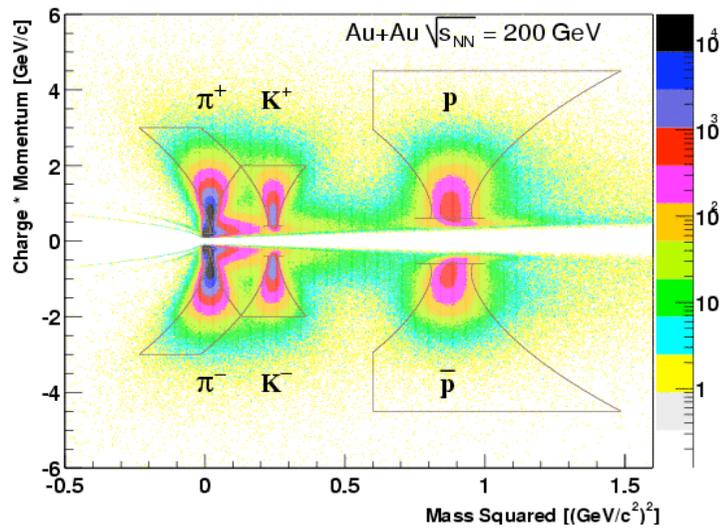
For Systematic Study:

- **Energy dependence**
 62.4 GeV vs. 200 GeV (Au+Au)
- **System Size dependence**
 Cu+Cu vs. Au+Au (200 GeV)

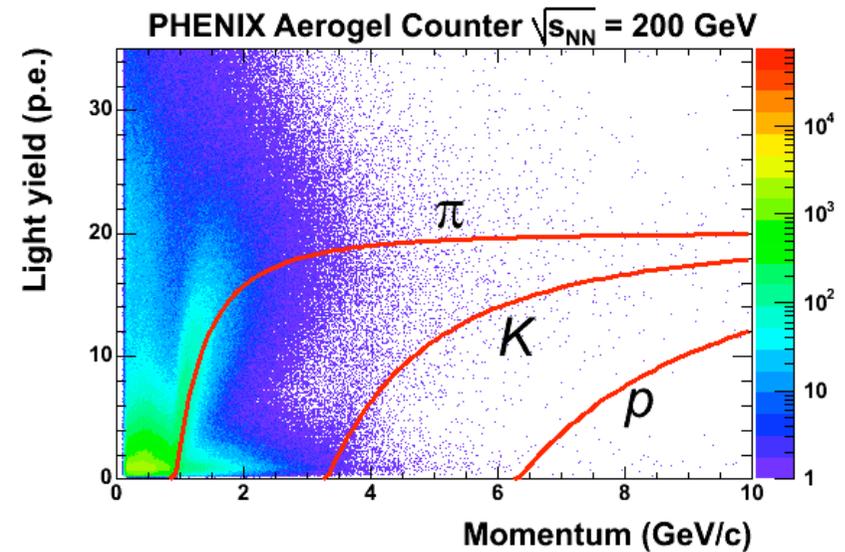


Method: Charged Hadron PID

Time of Flight ($\sigma=120\text{ps}$)



Aerogel Cherenkov ($n=1.011$)



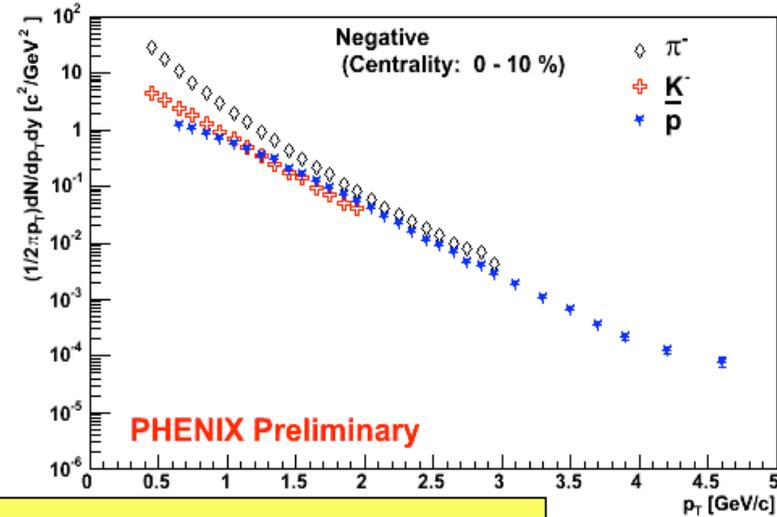
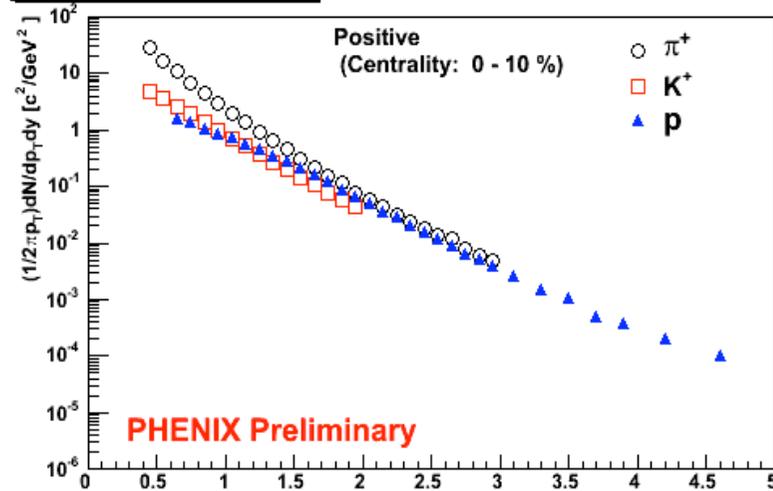
New Data Set: Cu+Cu 200 GeV

p_T Spectra

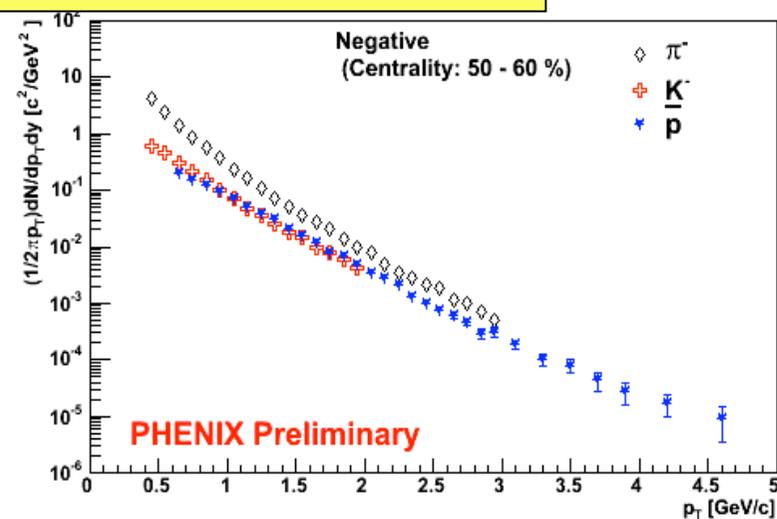
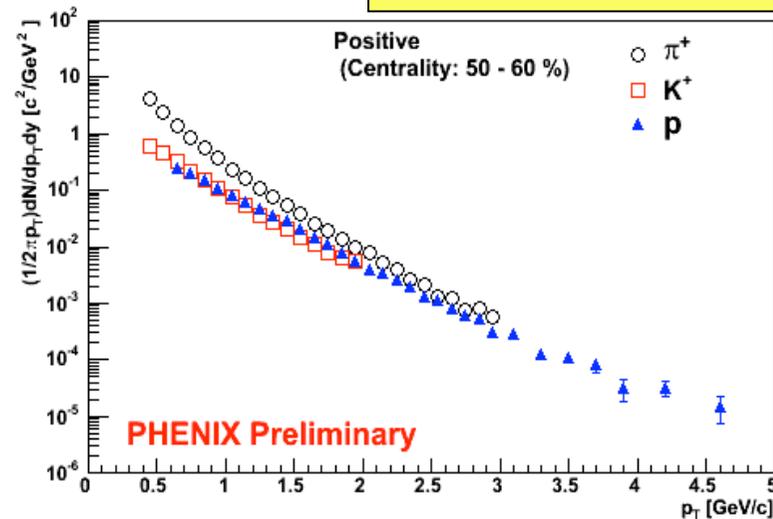
Cu+Cu 200 GeV



Cu+Cu $\sqrt{s_{NN}} = 200$ GeV



Similar shapes as those in Au+Au.



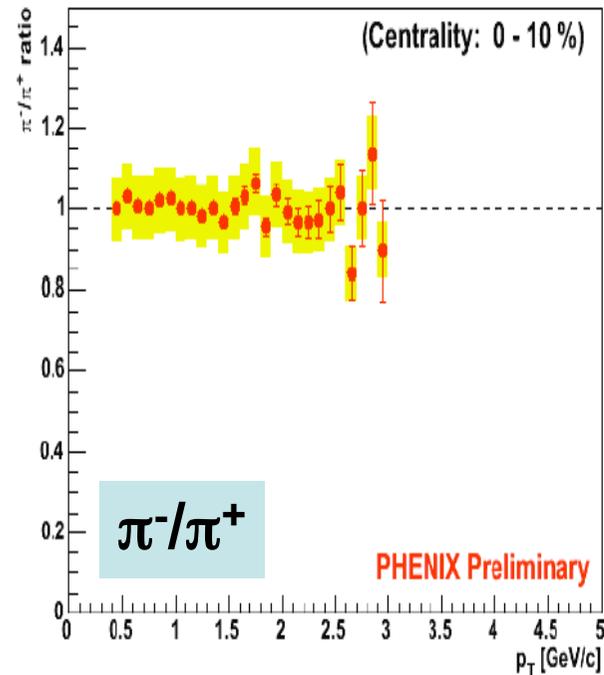
NOTE: No weak decay feed-down correction applied.

-/+ Ratios vs. p_T

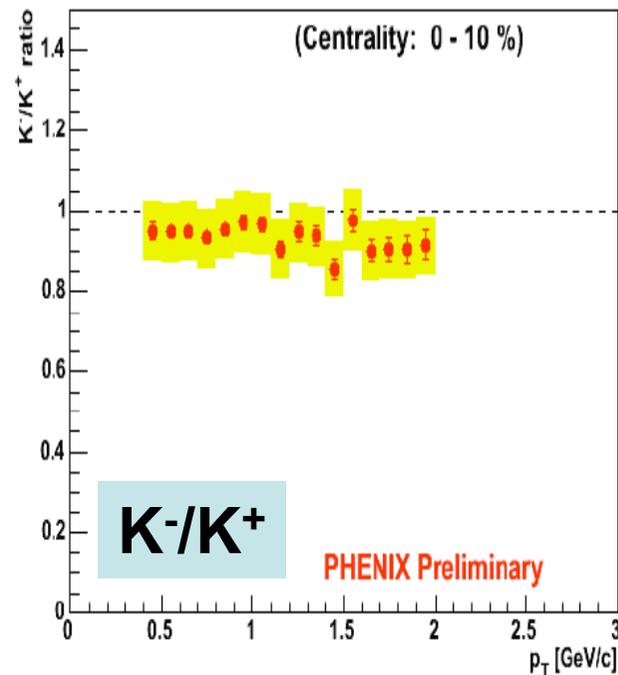
Cu+Cu 200 GeV



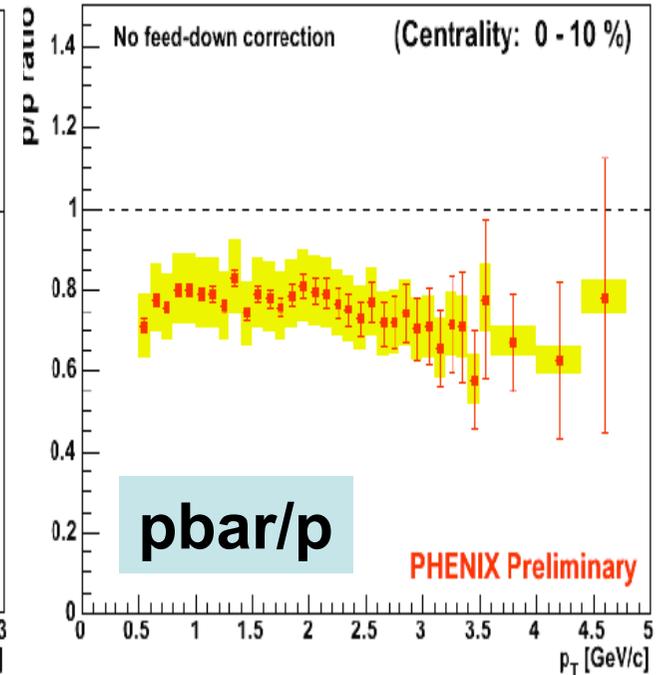
π^-/π^+ ratio (Cu+Cu $\sqrt{s_{NN}} = 200$ GeV)



K^-/K^+ ratio (Cu+Cu $\sqrt{s_{NN}} = 200$ GeV)



\bar{p}/p ratio (Cu+Cu $\sqrt{s_{NN}} = 200$ GeV)



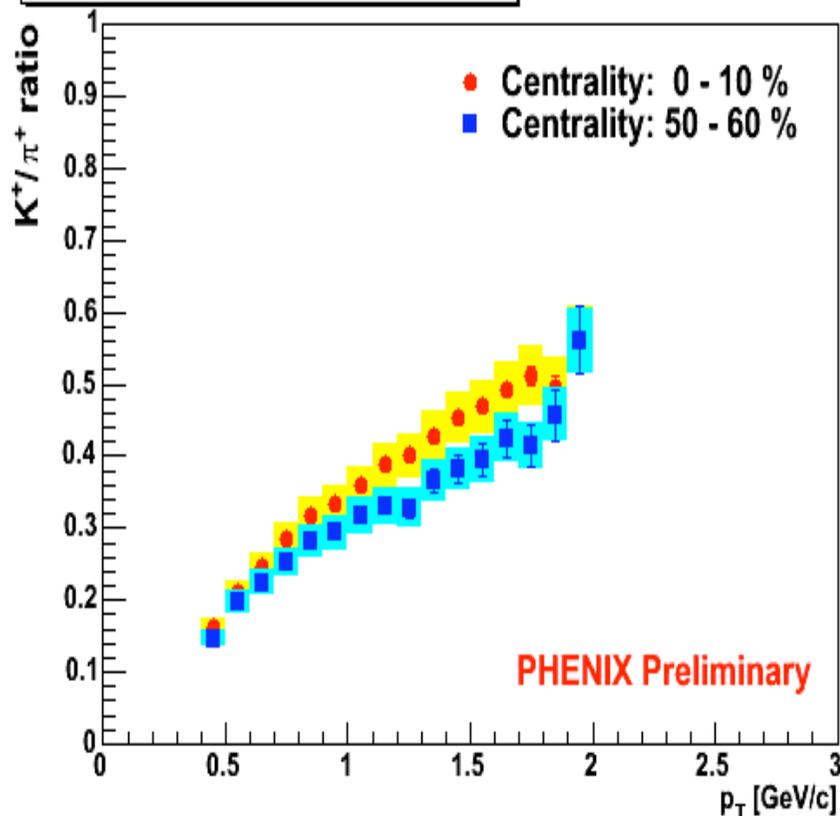
- Flat p_T dependence for pions, kaons.
- Slightly decreasing with p_T for protons.
- Flat centrality dependence also seen (0-60%).

K/π vs. p_T

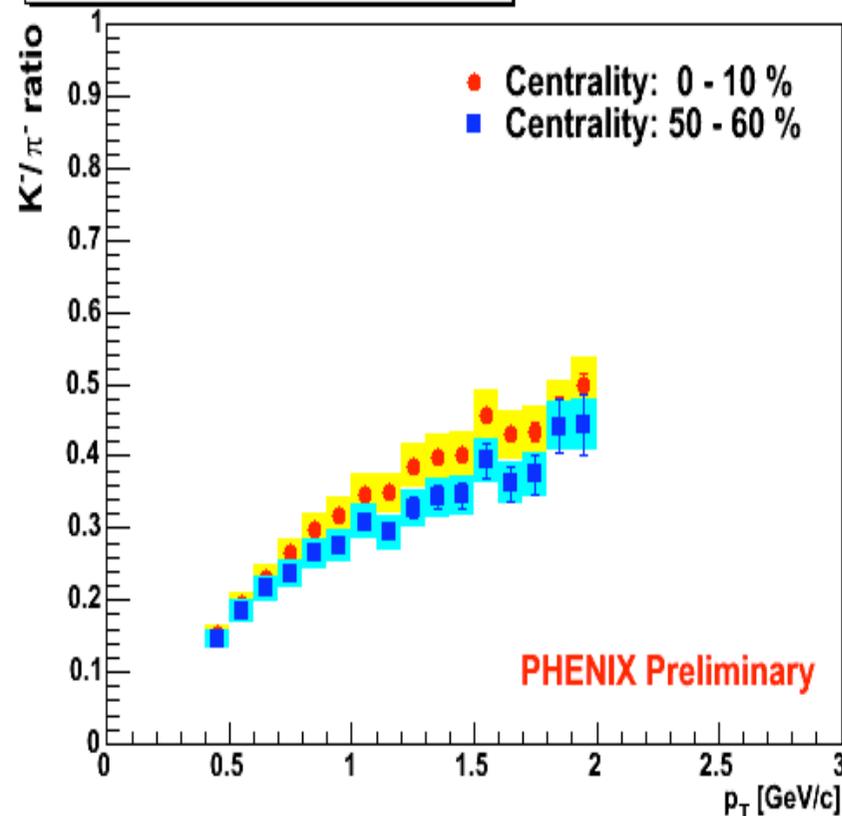
Cu+Cu 200 GeV



K^+/π^+ ratio (Cu+Cu $\sqrt{s_{NN}} = 200$ GeV)



K^-/π^- ratio (Cu+Cu $\sqrt{s_{NN}} = 200$ GeV)

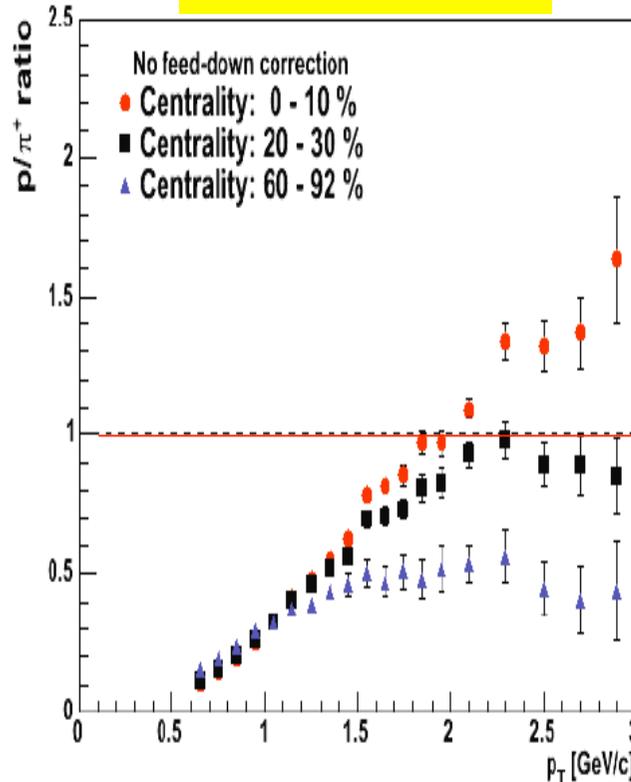


- Increasing steady with p_T .
- No apparent indication of saturation in this p_T region.

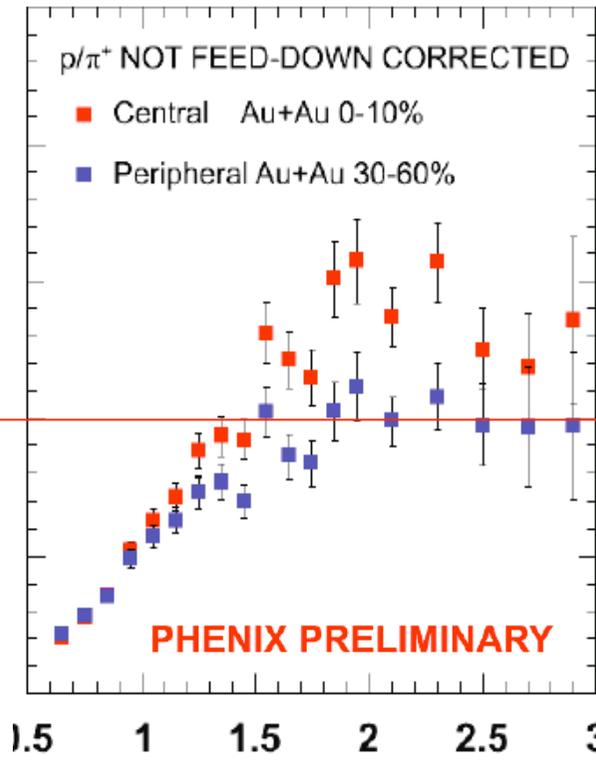
Baryon Enhancement

ρ/π^+ vs. p_T

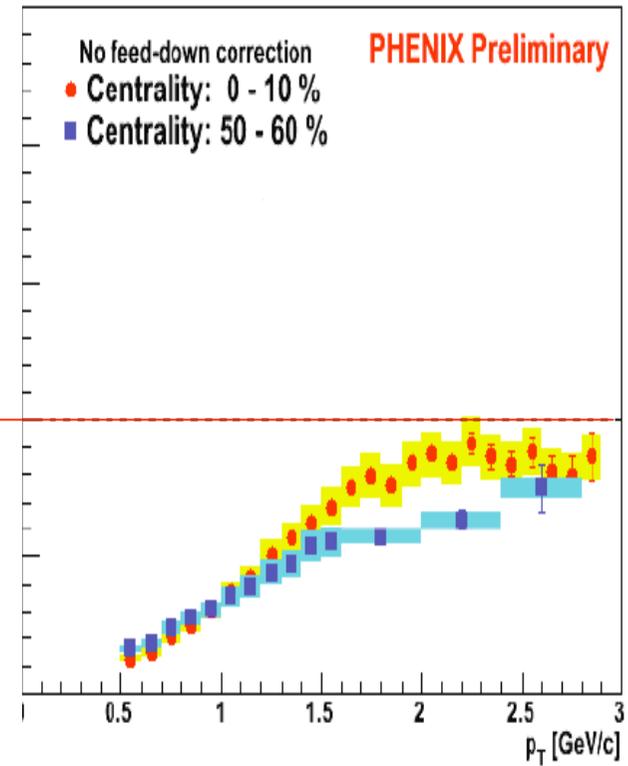
Au+Au 200GeV



Au+Au 62GeV



Cu+Cu 200GeV

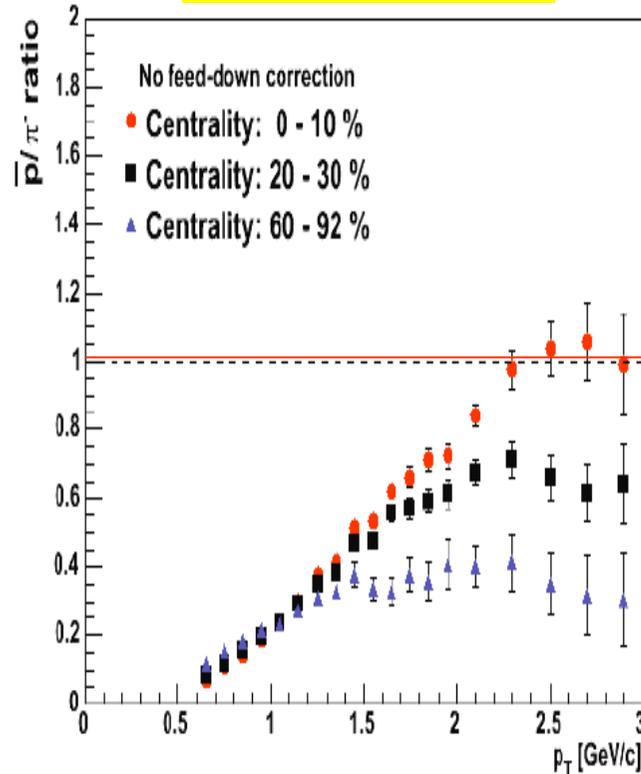


- Baryon enhancement observed in all collisions systems.
- Rapidly increasing with p_T for 62 GeV.
- p_T dependence in Cu+Cu is similar to that in Au+Au. (See N_{part} -scaling)
- Weaker centrality dependences (62GeV) than those of 200 GeV.

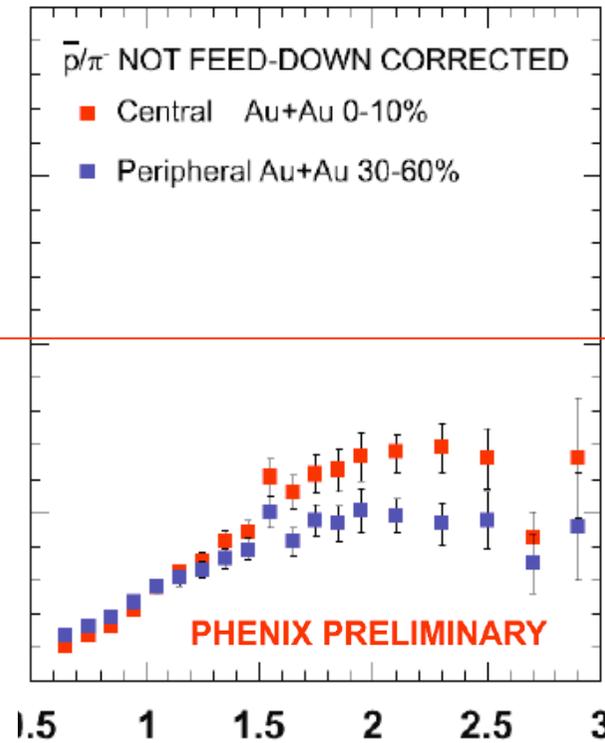
NOTE: No weak decay feed-down correction applied.

\bar{p}/π^- Ratios

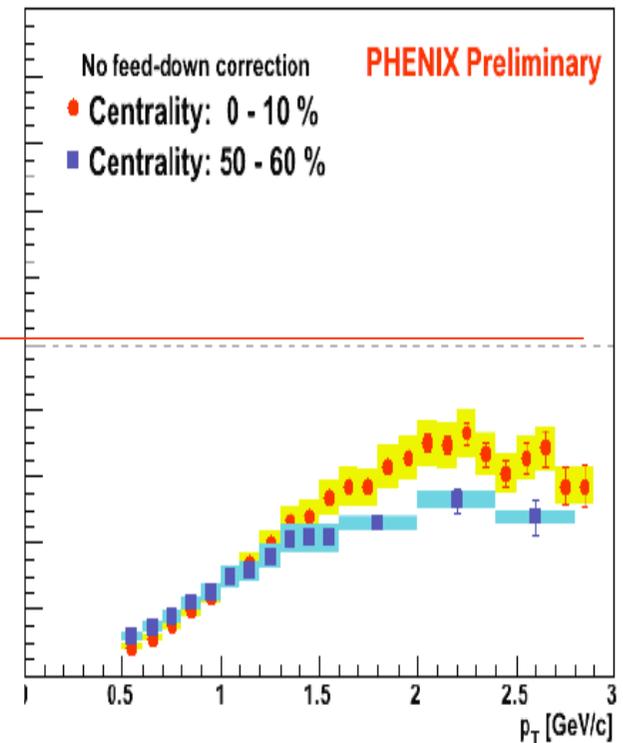
Au+Au 200GeV



Au+Au 62GeV



Cu+Cu 200GeV

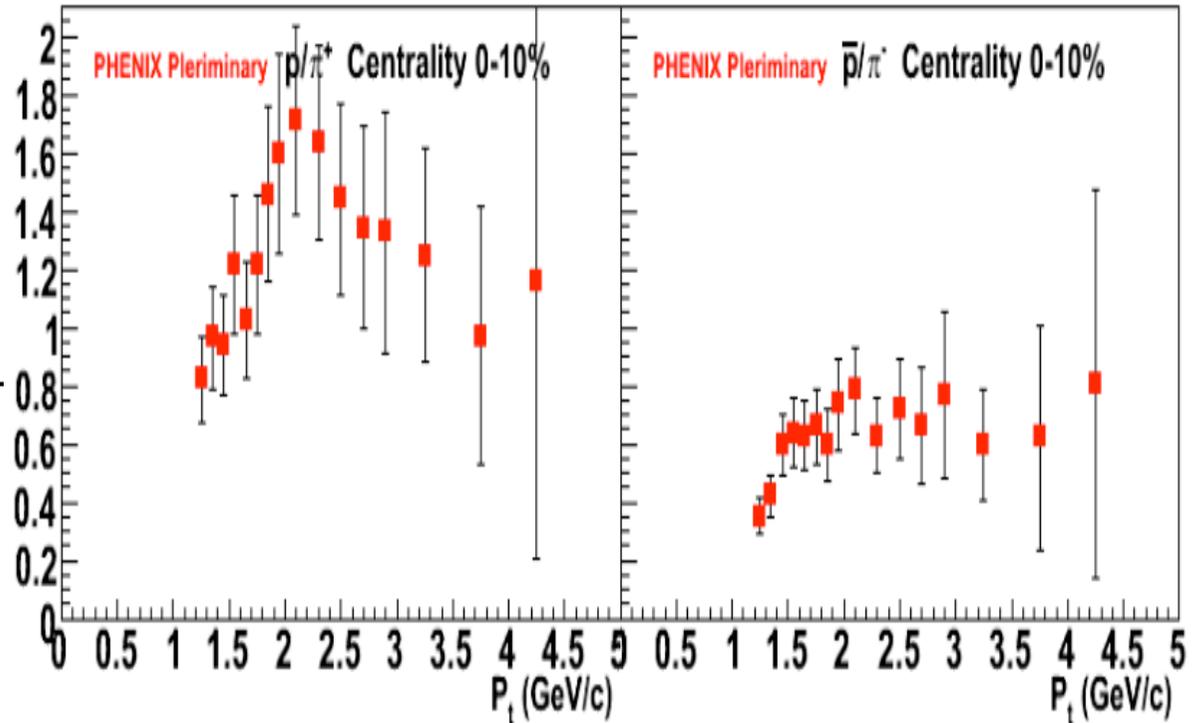


- Less for antiproton compared to proton for all systems
- Significant difference for p and pbar at 62 GeV
(Indicating more baryon transport and less p-pbar pair production at 62 GeV than 200 GeV.)

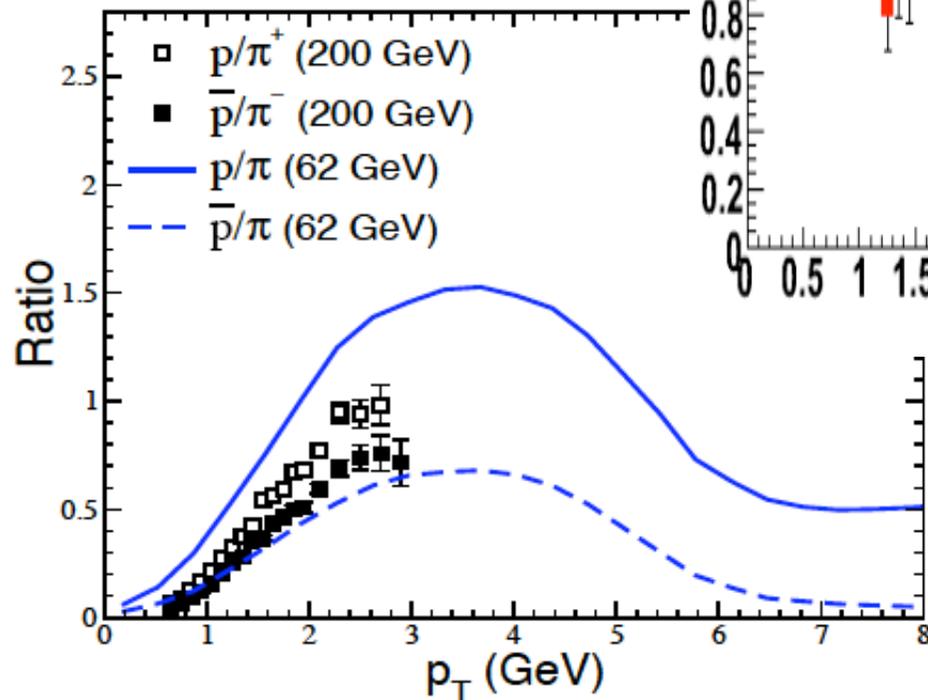
NOTE: No weak decay feed-down correction applied.

ρ/π Ratios (62 GeV)

Au+Au 62GeV



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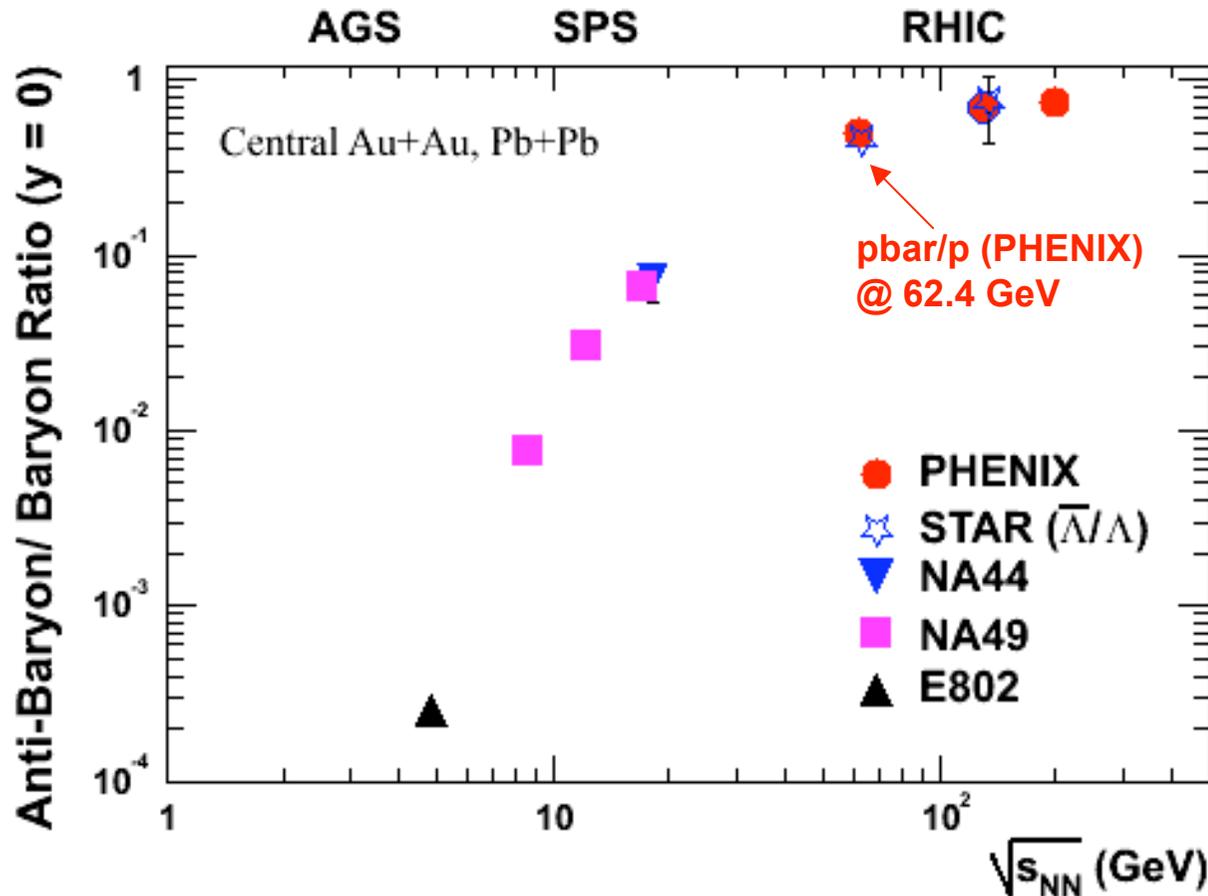


coalescence model

- Described by coalescence model:
 - p_T dependence
 - p and pbar difference

Energy dependence

Antibaryon/ baryon ratios vs. $\sqrt{s_{NN}}$



Experimental Data:

AGS:

- E802, 2650 PRL 83, (1998)

SPS:

- NA44: PRC 66, 044907 (2002)
- NA49: J. of Phys. G 30, S357 (2004)

RHIC:

- PHENIX

62 GeV (preliminary, no feed-down)

PRL 88, 242301 (2002), PRC 69, 034909 (2003), PRL 89 092302 (2002).

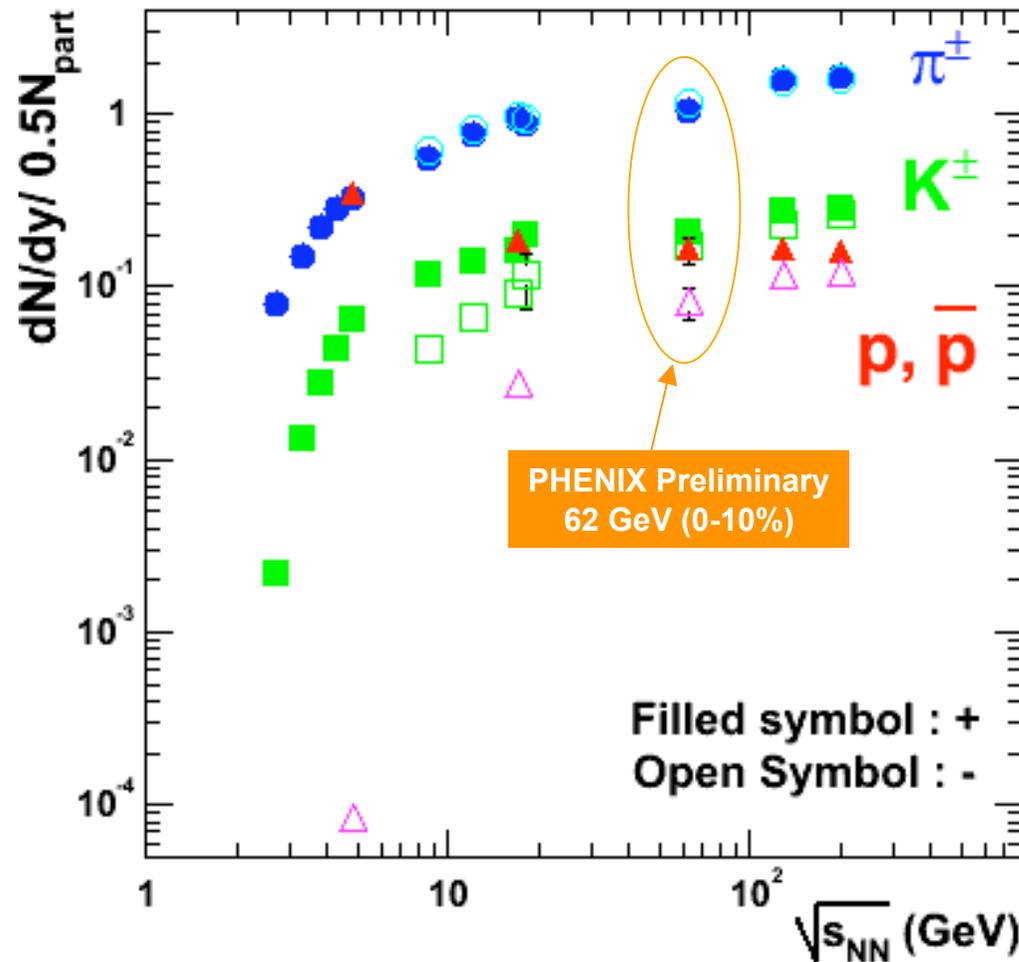
- STAR

62 GeV (Preliminary, HQ2004); 130 GeV PRL 89, 092301 (2002).

- Follow the smooth curve from SPS to RHIC.
- Consistent with $\bar{\Lambda}/\Lambda$ (STAR preliminary) at 62 GeV.

NOTE: No weak decay feed-down correction applied.

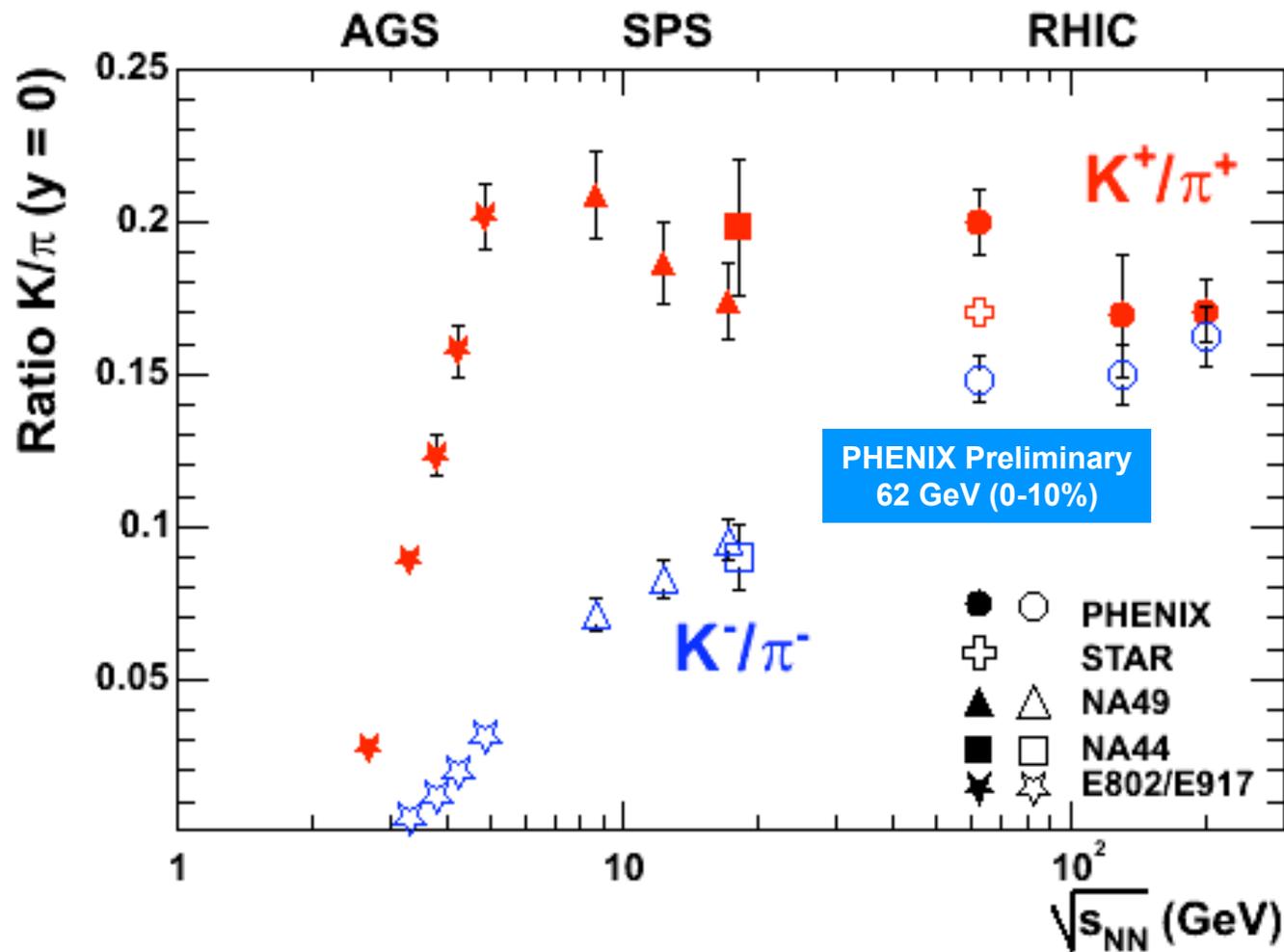
dN/dy vs. $\sqrt{s_{NN}}$ (central)



RHIC: PHENIX
SPS: NA44, NA49
AGS: E866, E917

dN/dy per N_{part} pair: smooth energy dependence from SPS to RHIC.

K/π vs. $\sqrt{s_{NN}}$

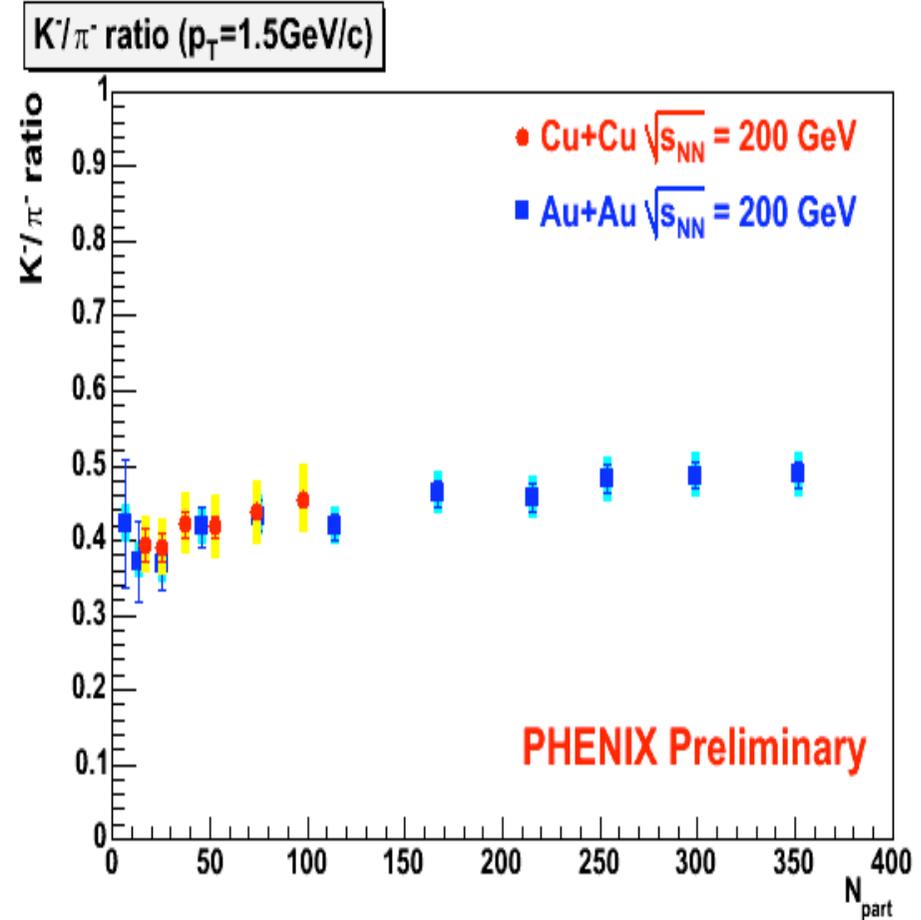
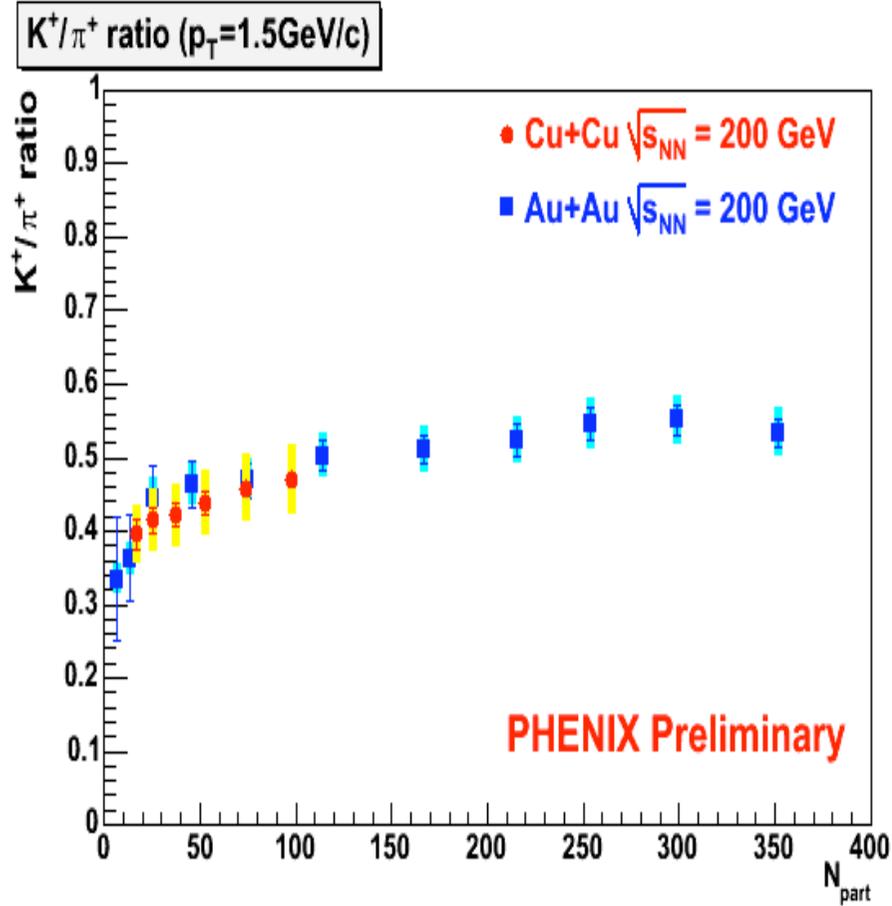


* STAR K^+/π^+ : preliminary data from SQM04, J. Takahashi

- K^-/π^- : follow the smooth curve from SPS to RHIC.
- K^+/π^+ : similar to SPS top energy.

N_{part} Scaling (Particle Ratio)

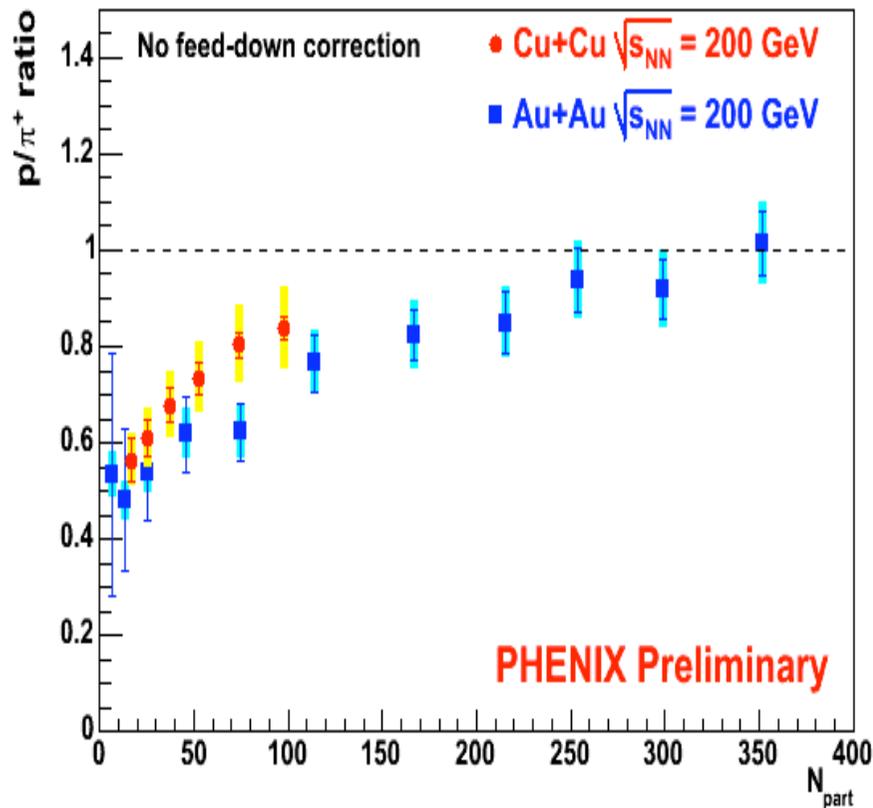
K/π vs. N_{part}



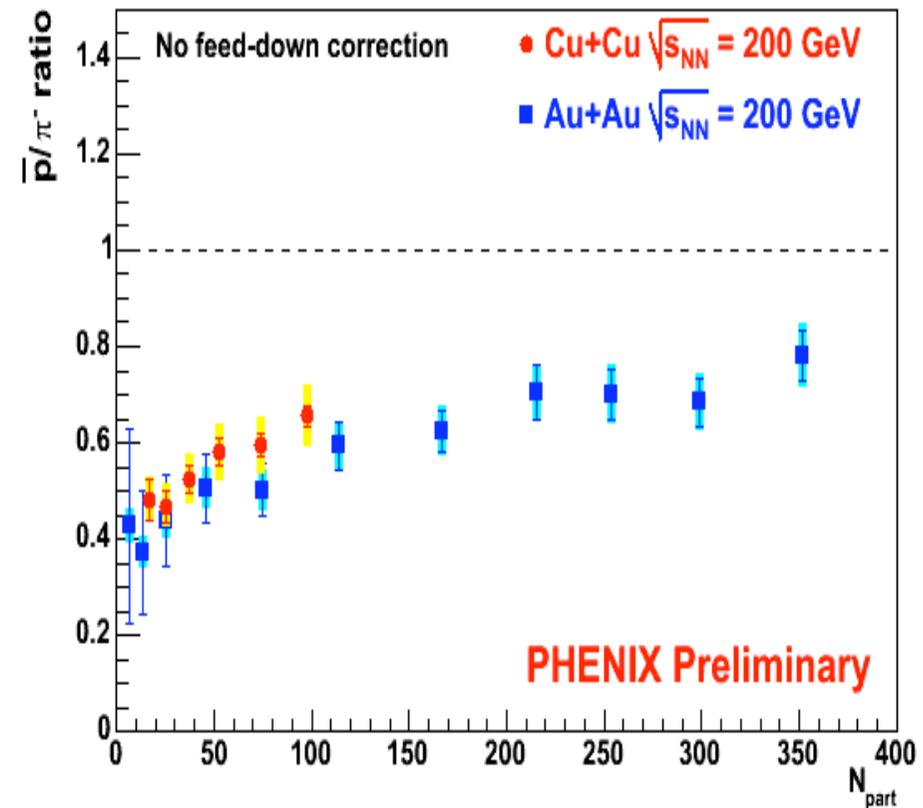
N_{part} dependence is almost same as in Au+Au.

ρ/π vs. N_{part}

ρ/π^+ ratio ($p_T=2\text{GeV}/c$)



$\bar{\rho}/\pi^-$ ratio ($p_T=2\text{GeV}/c$)

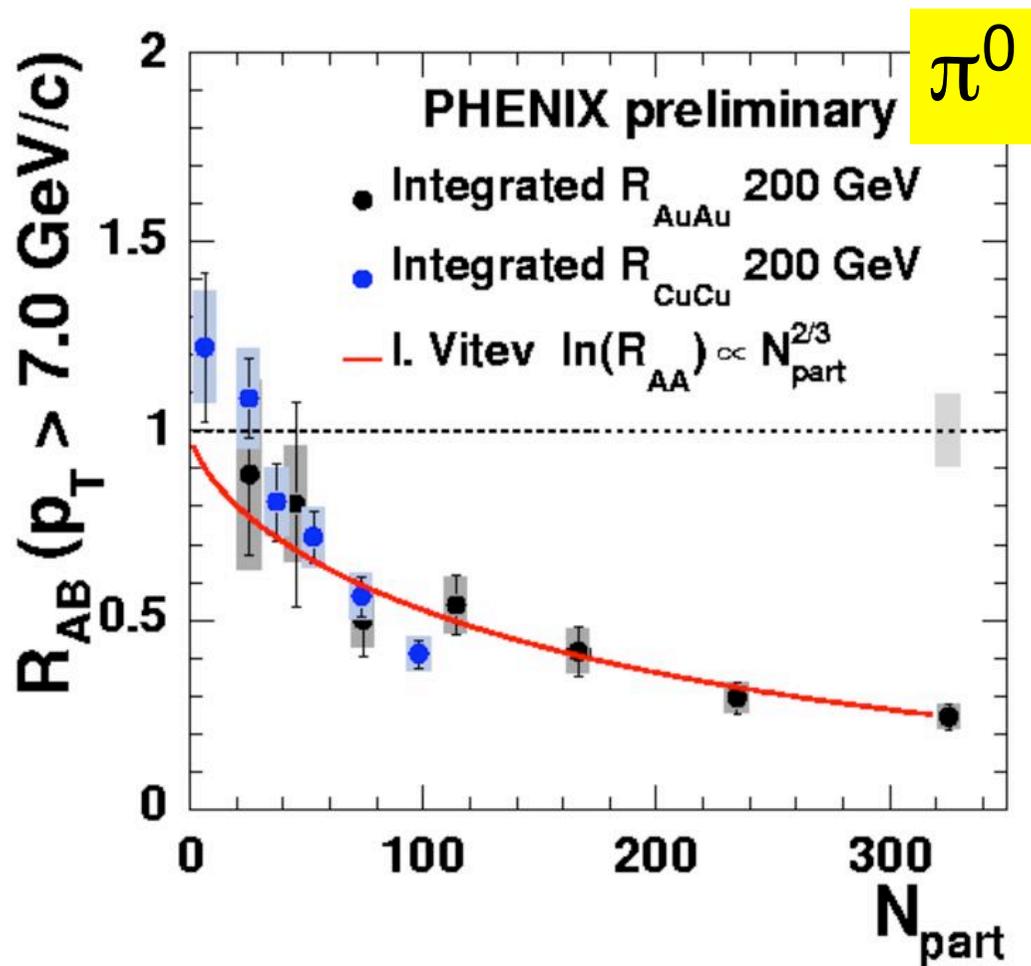


- N_{part} dependence looks similar to that in Au+Au.
- Slight difference in the magnitude seen.

NOTE: No weak decay feed-down correction applied.

N_{part} Scaling (R_{AA})

R_{AA} vs. N_{part}



Cu+Cu data follow the Au+Au data.

R_{AA} vs. p_T

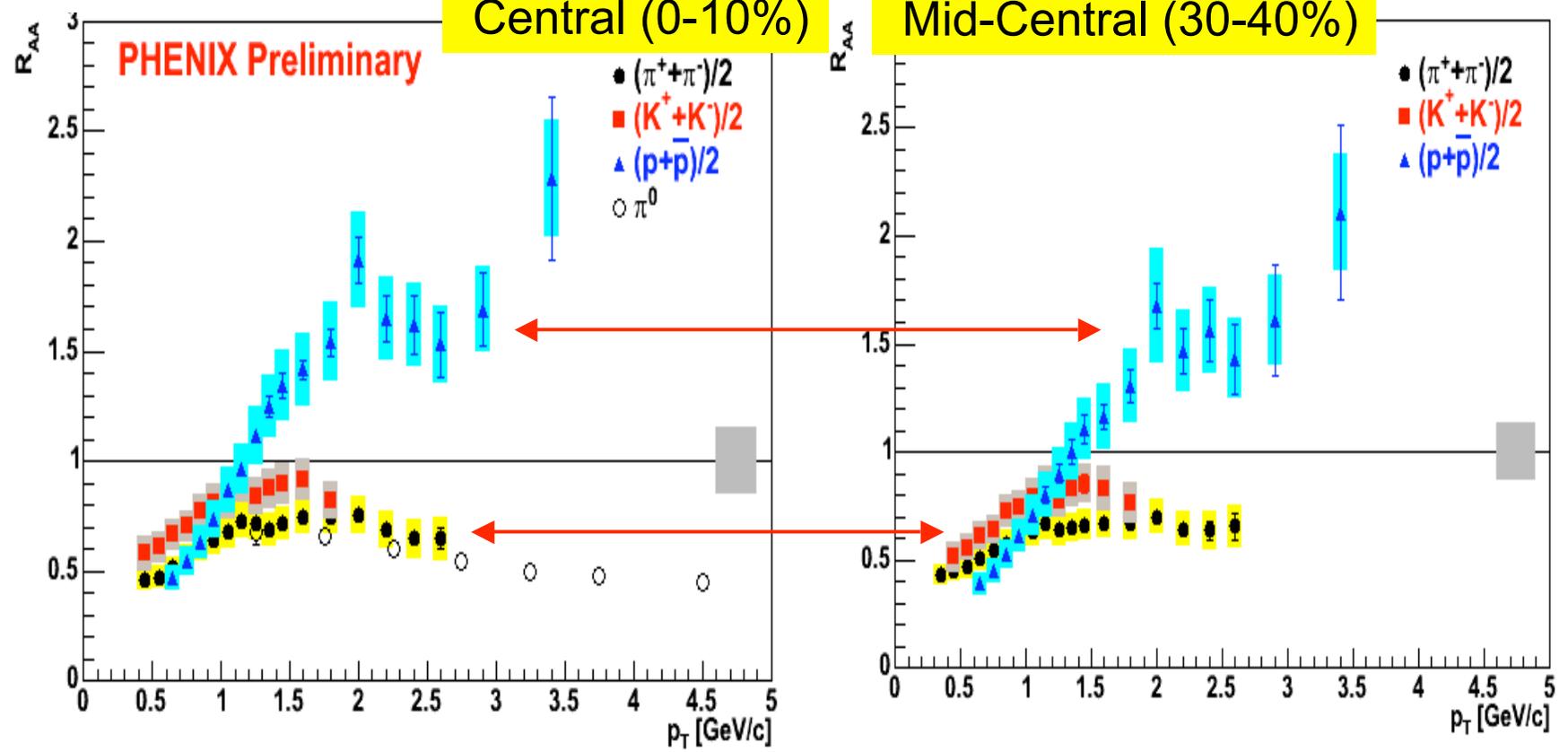
$N_{part} \sim 98$

$N_{part} \sim 114$



Cu+Cu 200 GeV
Central (0-10%)

Au+Au 200 GeV
Mid-Central (30-40%)



- Similarity seen in Cu+Cu and Au+Au:
 - The magnitude of enhancement/suppression
 - Particle type dependence

NOTE: No weak decay feed-down correction applied.

Energy dependence:

62.4 GeV vs. 200 GeV (Au+Au)

- Observed a large proton contribution at intermediate p_T , as seen in 200 GeV data, but less for antiprotons.
- Antiproton-to-proton ratio is ~ 0.5 at 62 GeV, which indicates less p-pbar pair production and relatively larger baryon transport than 200 GeV.
- Smooth excitation function for both yields and ratios from SPS to RHIC.

System Size dependence:

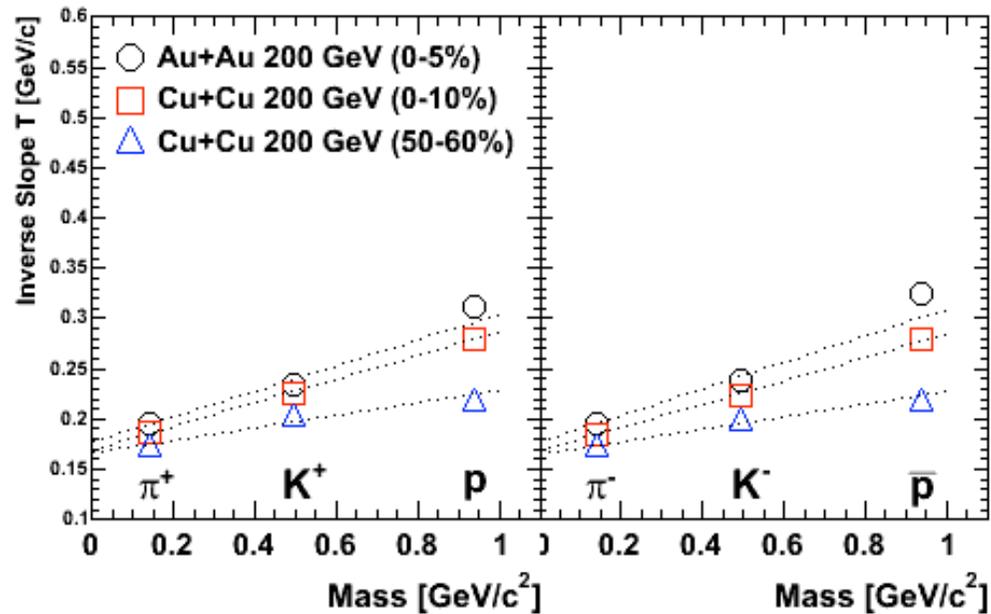
Cu+Cu vs. Au+Au (200 GeV)

- Observed a large p,pbar contribution at intermediate p_T , as seen in 200 GeV data.
- N_{part} dependences on particle ratios have similar trend as in Au+Au (N_{part} scaling).
- Similarity on R_{AA} seen in Cu+Cu and Au+Au (System size):
 - the magnitude and its particle dependence.

Backup

Inverse Slope T

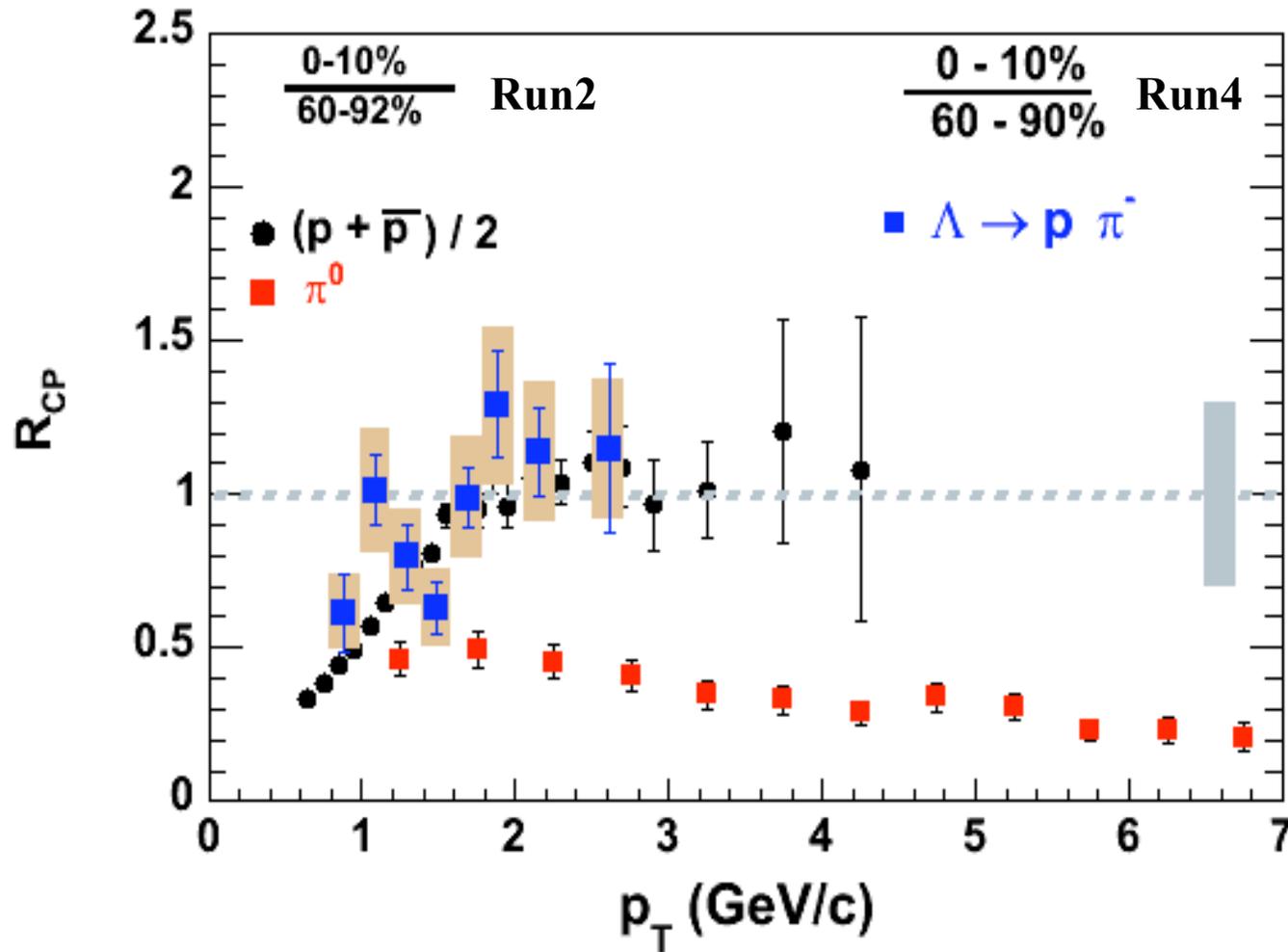
Cu+Cu 200 GeV



Fitted by m_T exponential function.

- Fit range:
 - π : 0.3(0.2) - 1.0 GeV/c².
 - p and K: 0.2(0.1) - 1.0 GeV/c².

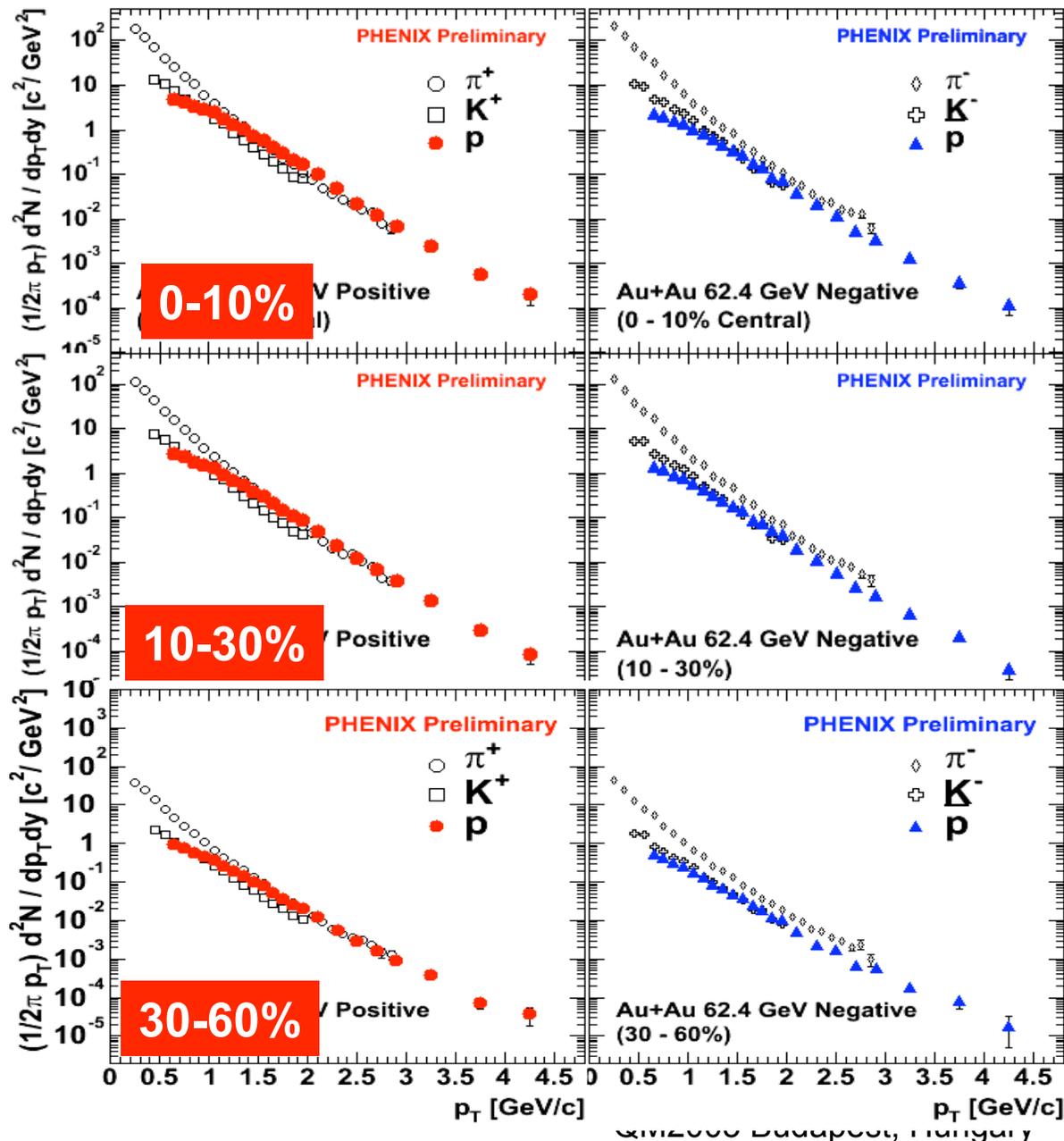
• Extracted inverse slopes



Rcp of Lambdas is similar to protons

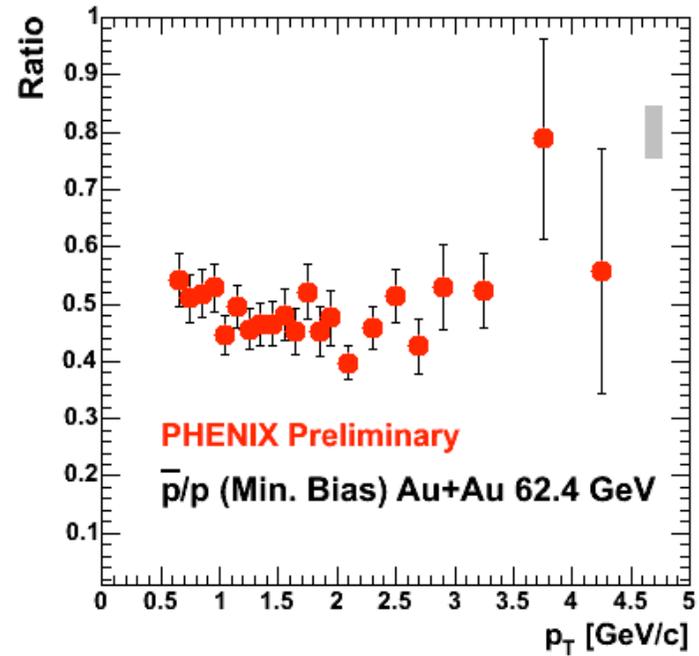
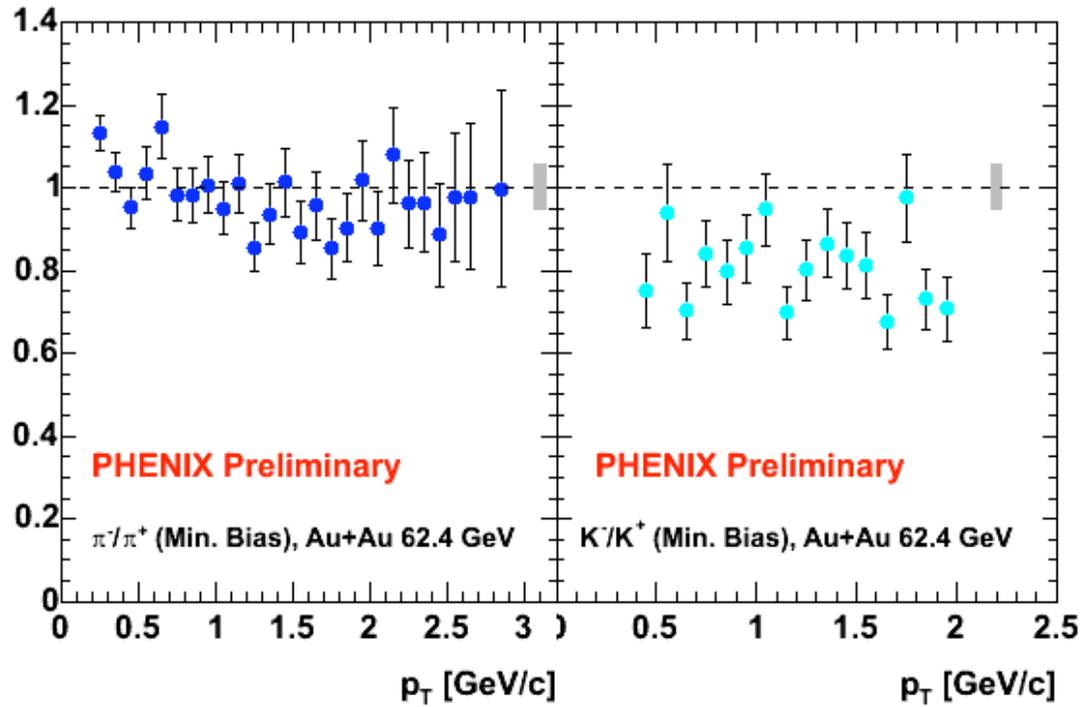
p_T Spectra

Au+Au 62 GeV



-/+ Ratios

Au+Au 62 GeV



-/+ Ratios (Centrality dep.)

Au+Au 62 GeV

