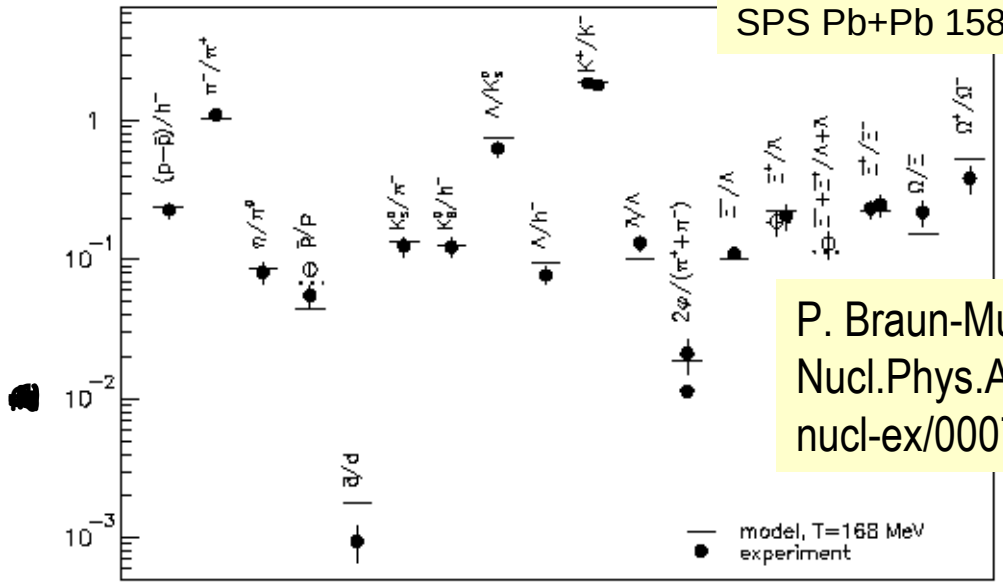
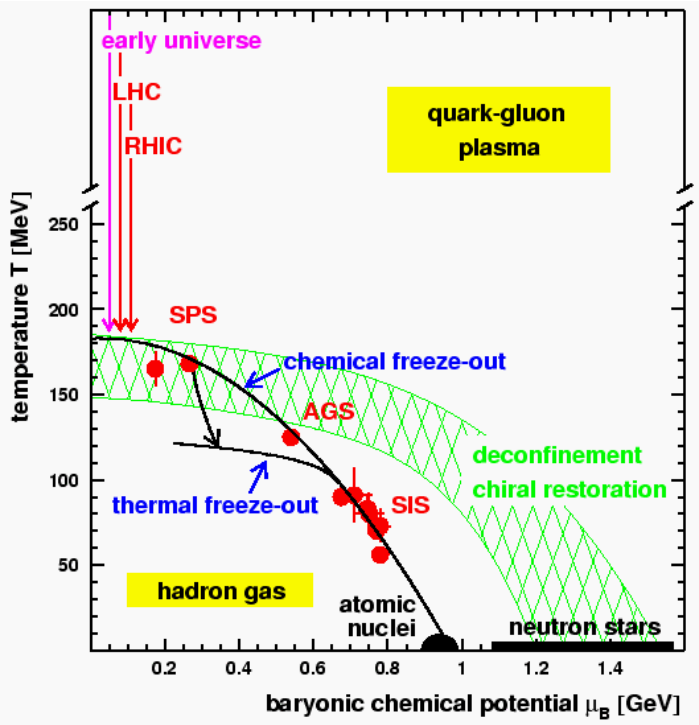
Motivation



P. Braun-Munzinger
Nucl.Phys.A681:119-123(2001)
nucl-ex/0007021

-:Model
T=168MeV

- Result from SPS and AGS
  - In agreement with predictions of a thermal model assuming chemical equilibration.
- Is the chemical equilibrium at RHIC energy?
  - If there, how about temperature and chemical potential.



From previous experiment

- SPS : T_{ch} ~ 170MeV
  m_B ~ 270MeV
- AGS : T_{ch} ~ 130MeV
  m_B ~ 500MeV

Particle-ratio

Particle Density

$$\rho = \gamma^{|s|}\frac{g}{2\pi^2}\int_0^\infty \frac{p^2 dp}{\exp\left[(E-\mu)/T_{ch}\right] \pm 1}$$

$$\mu = B\mu_B + s\mu_s$$

γ : Strangeness suppression factor
g : spin-isospin freedom

B : Baryon number
s : Strange quantum number
μ_B : Baryon chemical potencial
μ_s : Strange chemical potencial

Particle Ratio

Example:

$$\frac{\bar{p}}{p} = \exp(-2m_B/T_{ch})$$

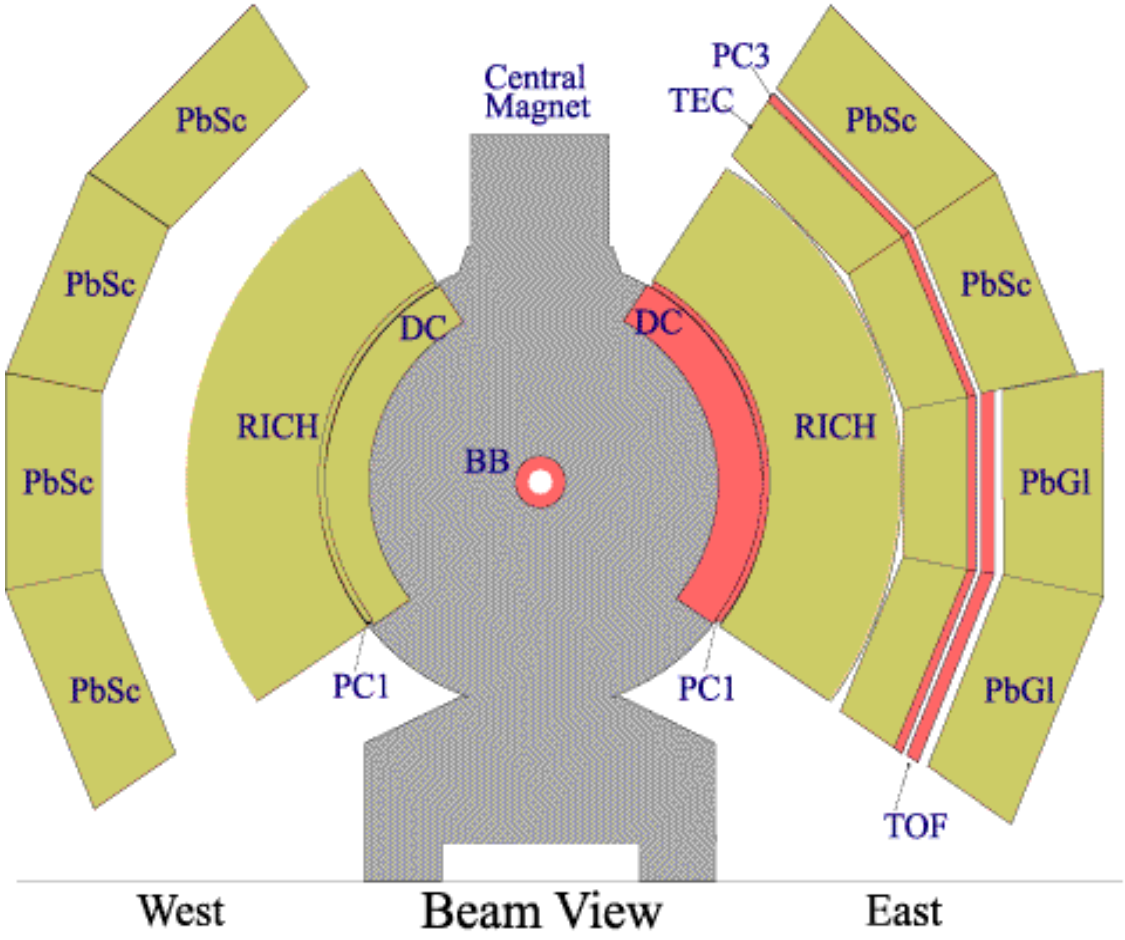
$$\frac{K^-}{K^+} = \exp(-\tfrac{2}{3}m_B/T_{ch})\exp(2m_s/T_{ch})$$

$$\frac{\Lambda^-}{\Lambda^+} = \exp(-\tfrac{4}{3}m_B/T_{ch})\exp(-2m_s/T_{ch})$$

- What do we learn from particle ratio?
  - **Chemical freeze-out Temperature T_{ch}**
  - **Chemical potential m_B, m_s**
  - **Degree of baryon stopping power**

Ratios contain basic information about collision dynamics

PHENIX Experiment



In this analysis, we use

- Beam-Beam Counter (BBC)
  - *z vertex, start timing for TOF*
- Time-of-Flight (TOF)
  - *stop timing measurement*
- Drift Chamber (DC)
  - *momentum, flight path length*
- Pad Chamber 1 (PC1)
  - *additional track z information to Dch*

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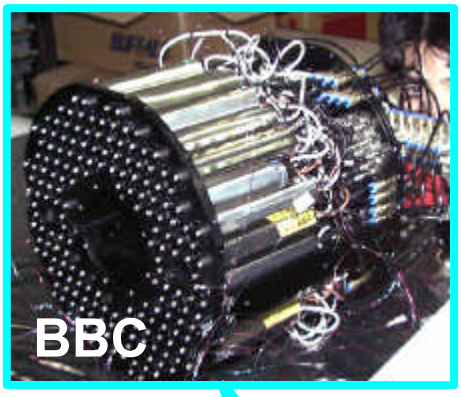
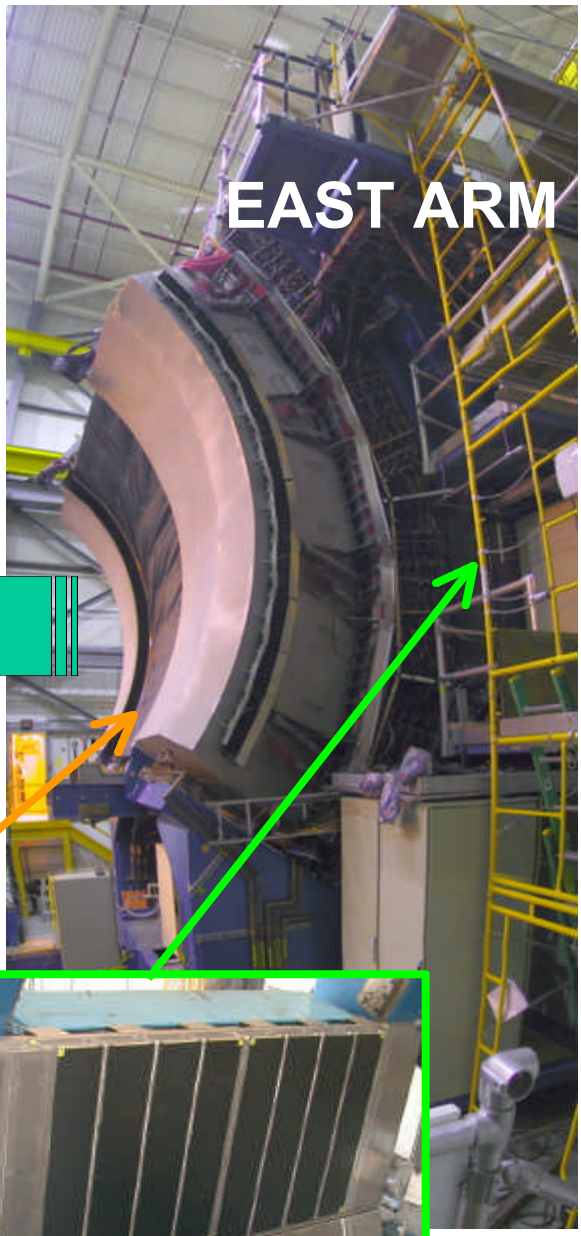
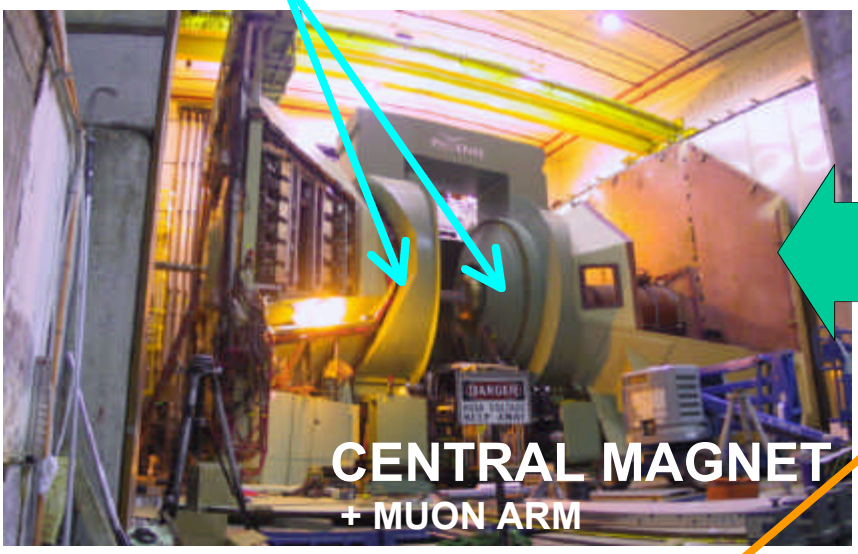
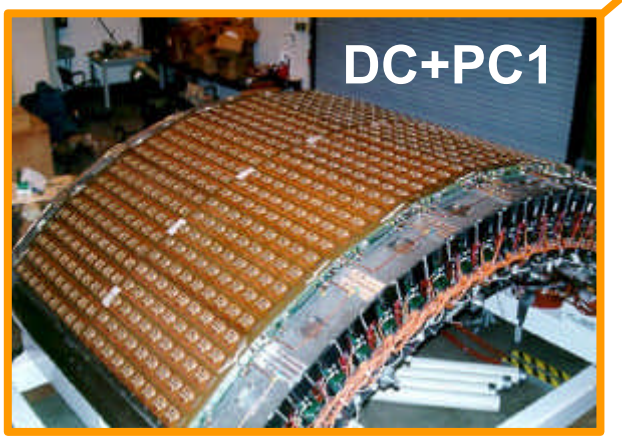
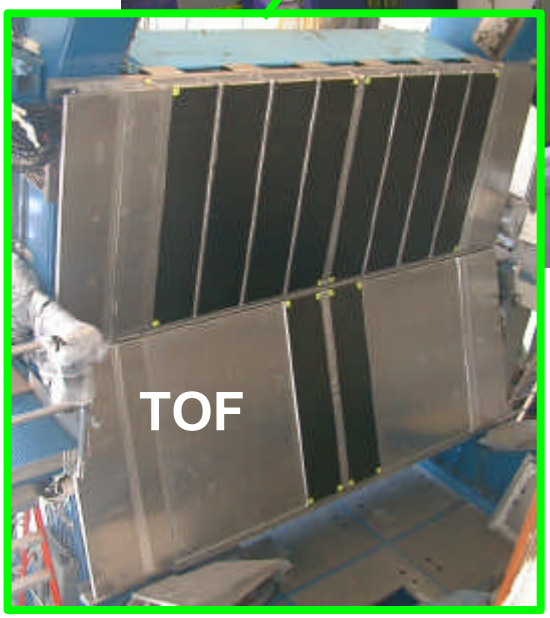
Reality of PHENIX











PID devices

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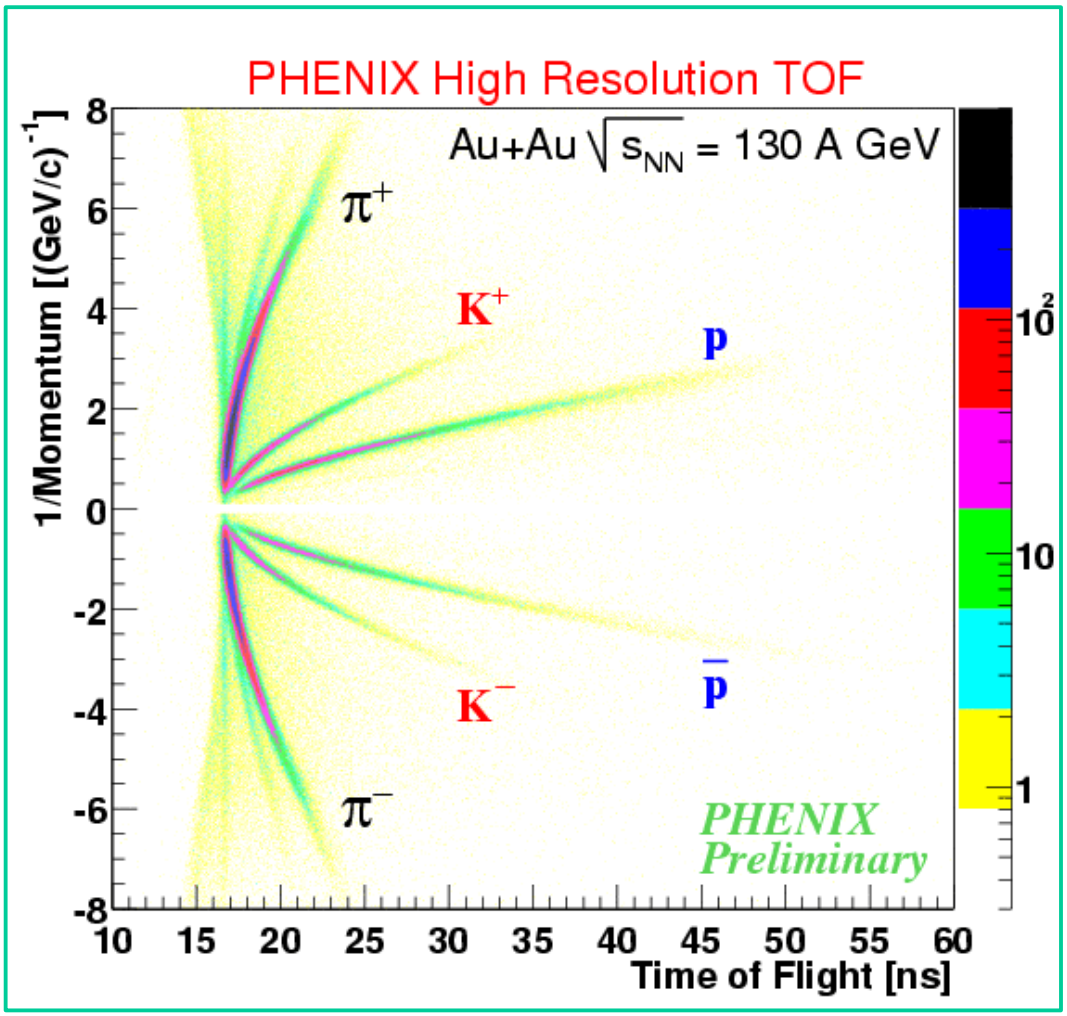
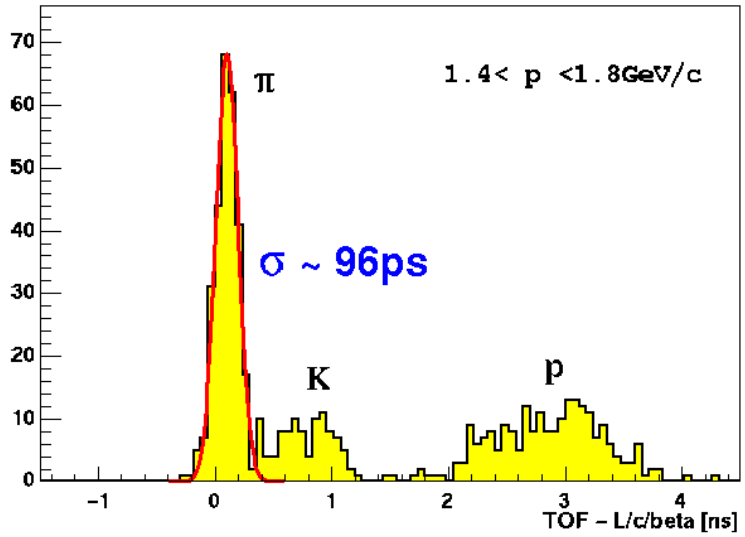
Particle Identification by TOF





- We can see clear π,K,p separation
- Particle separation
  - p/K < 2.0GeV/c
  - K/p < 3.5GeV/c

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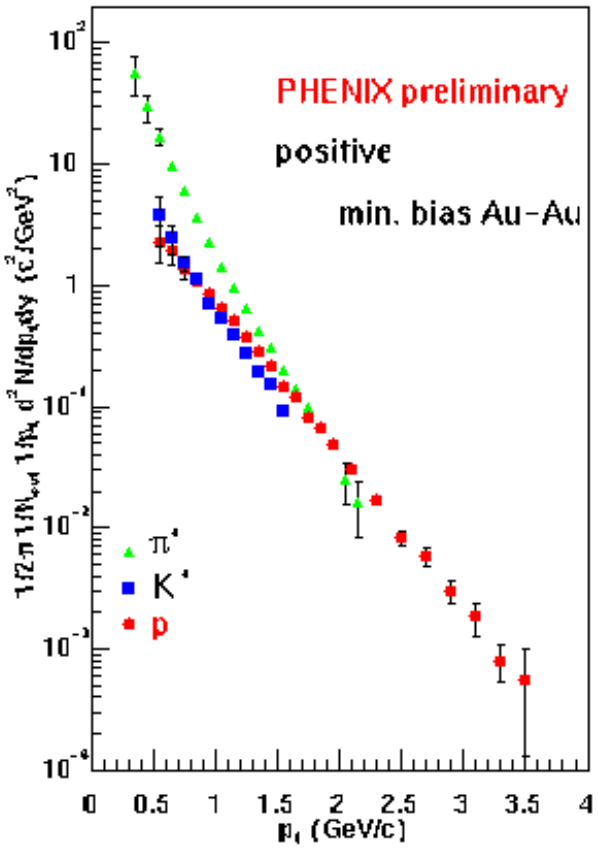
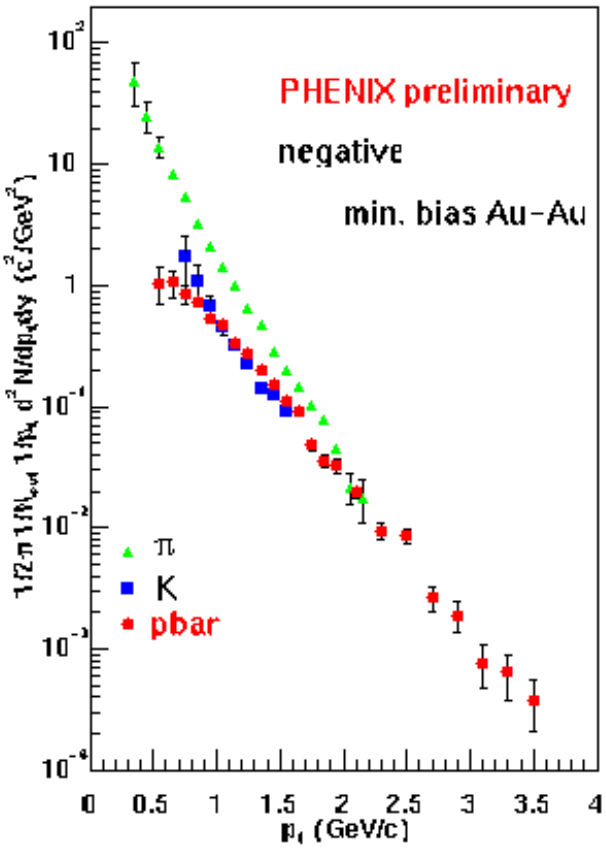
Identified Particle Spectra





- Single particle spectra of pion, kaon, proton and their anti particles.

- Au+Au collisions at $\sqrt{s_{NN}} = 130\text{GeV}$
  - Minimum bias data.

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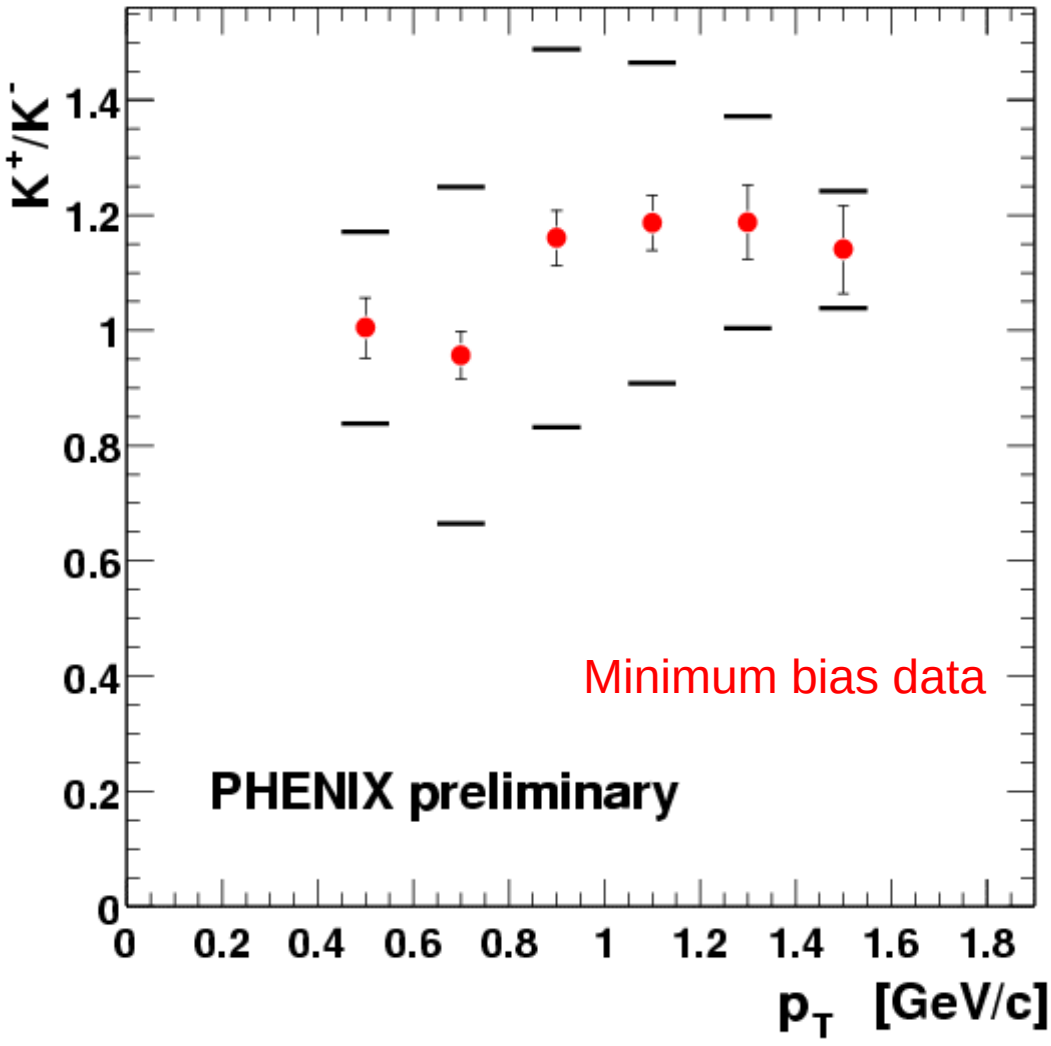
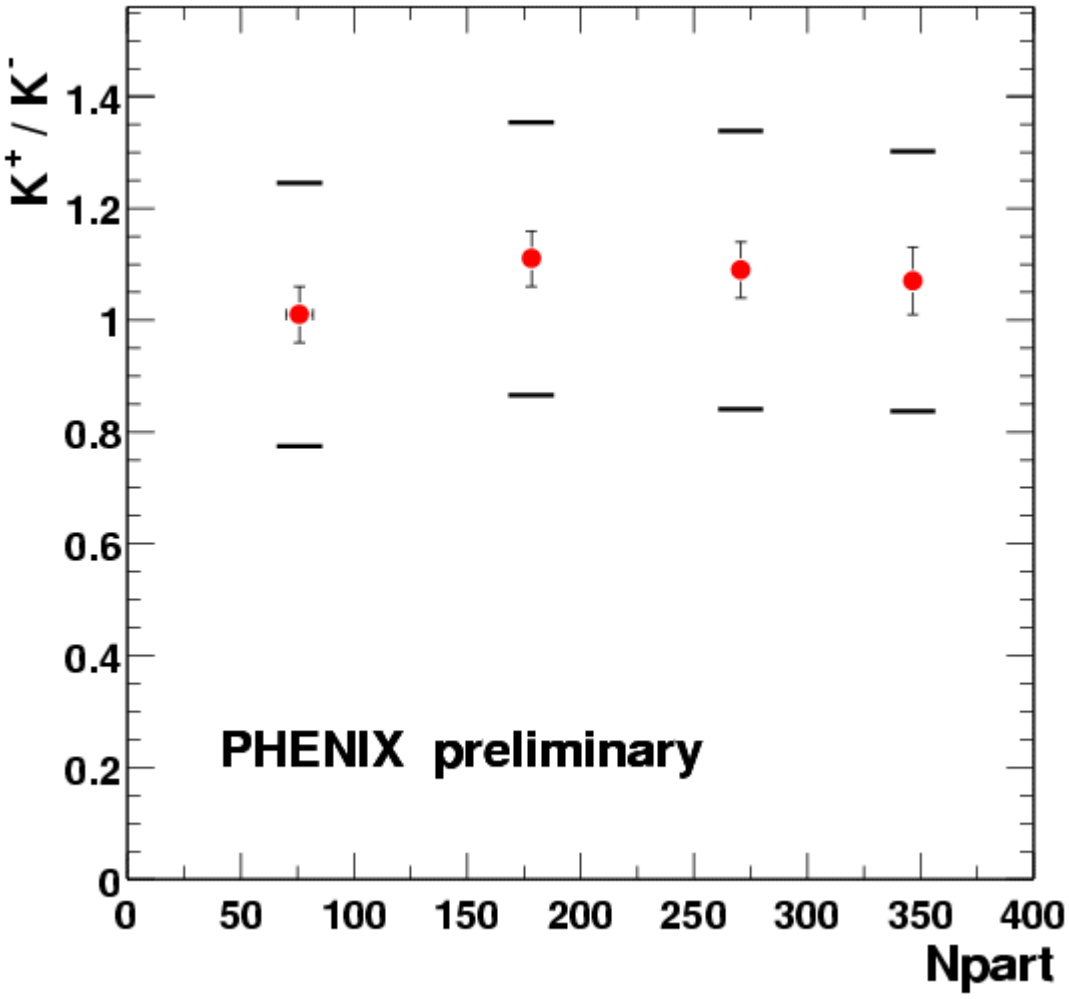
K^+/K^- ratio as a function of p_T



- No clear dependence as a function of p_T within the systematic errors.

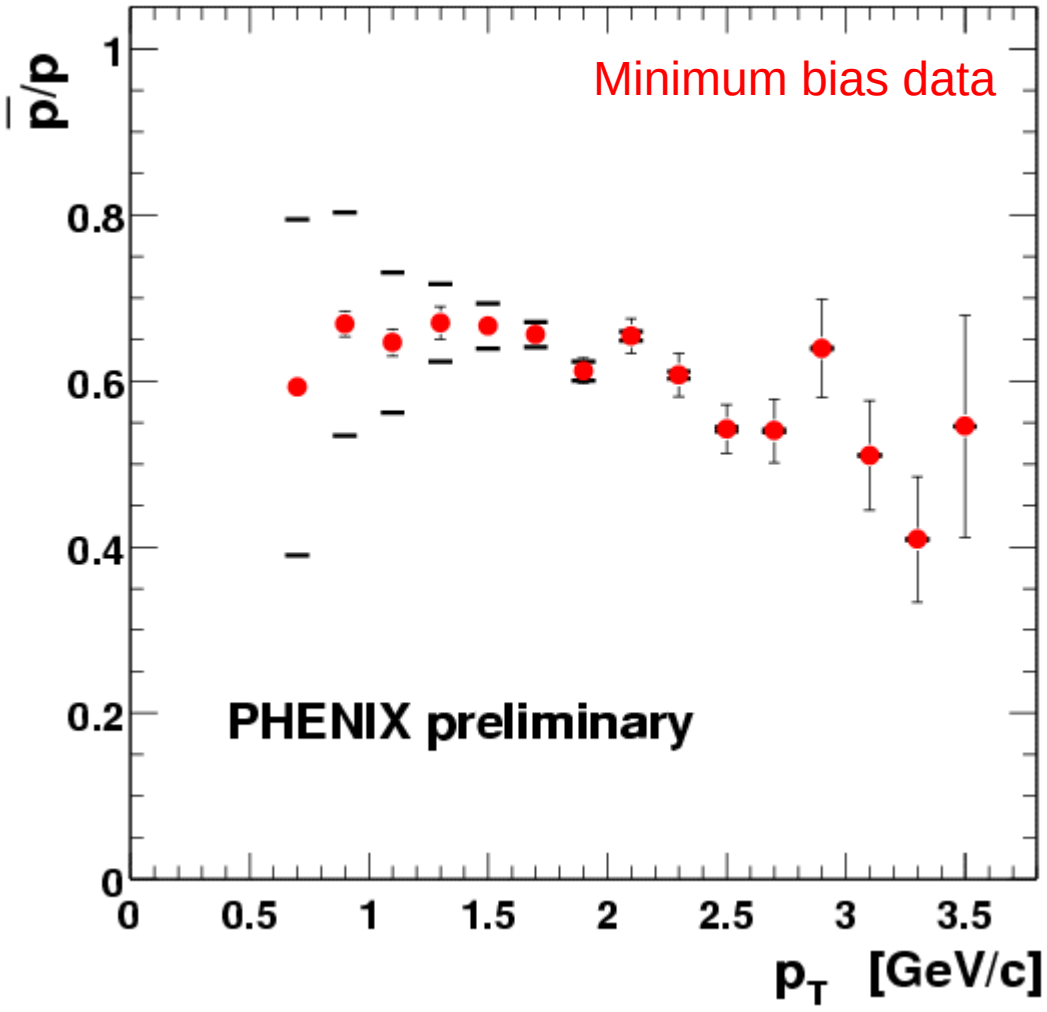
K^+/K^- ratio as a function of centrality



- No clear dependence as a function of centrality.

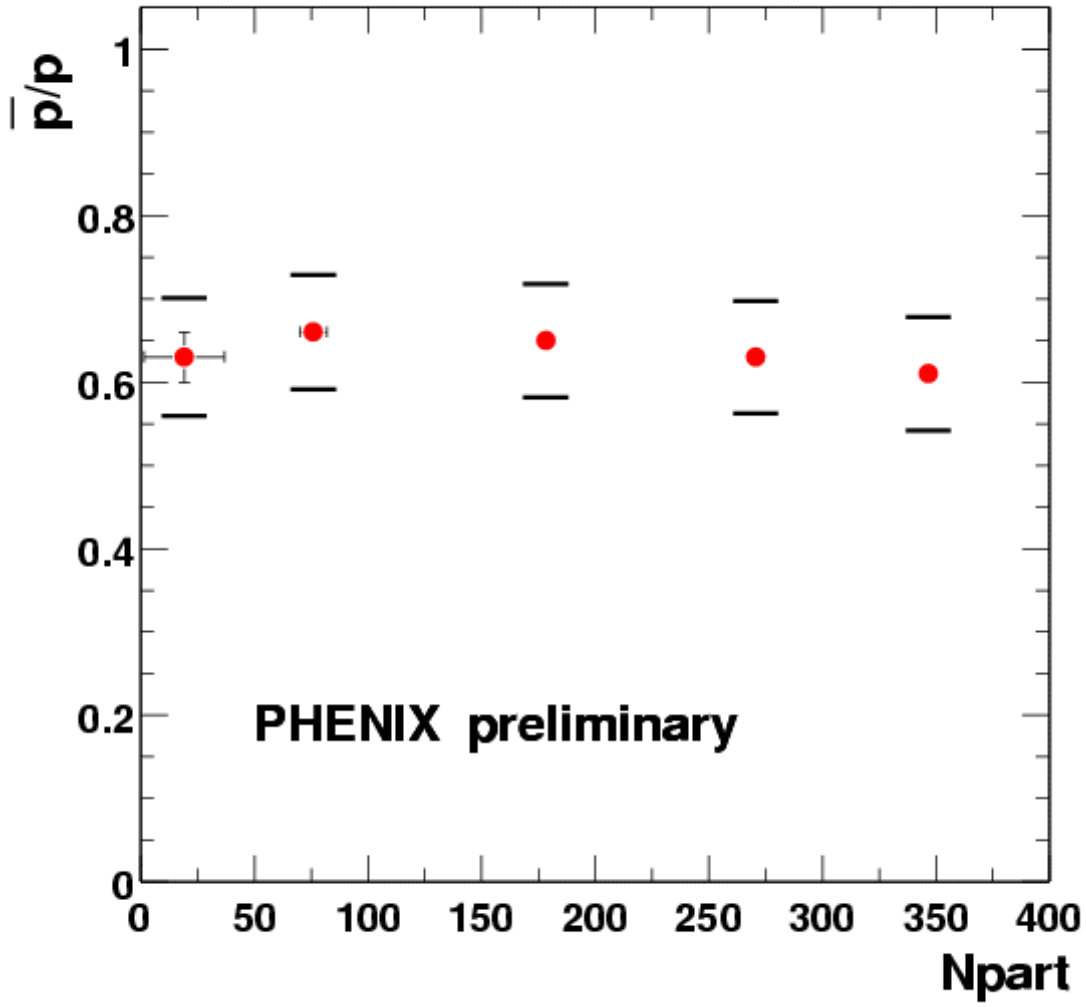
- K^+/K^- @Min.Bias = 1.08 ±0.03(stat.) ±0.22(syst.)

`p/p ratio as a function of p_T



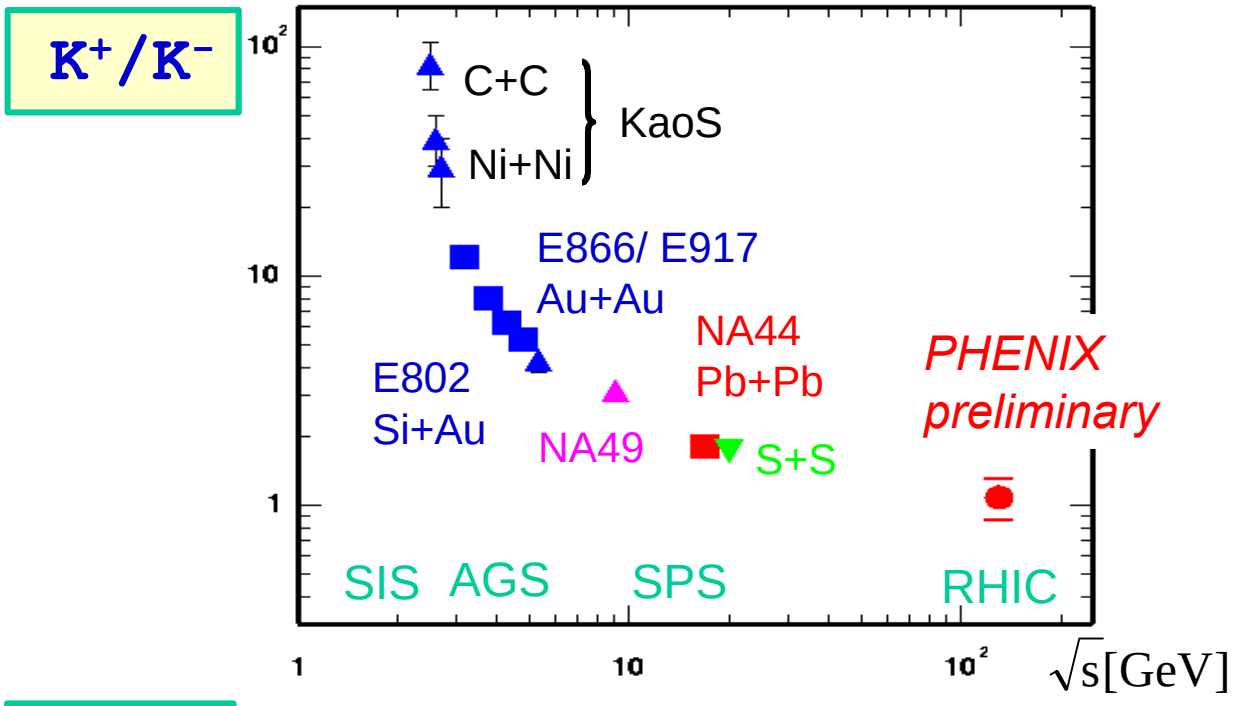
- No clear dependence on p_T over the measured range.
- It is very hard to extract p_T above 3GeV/c due to small statistics.

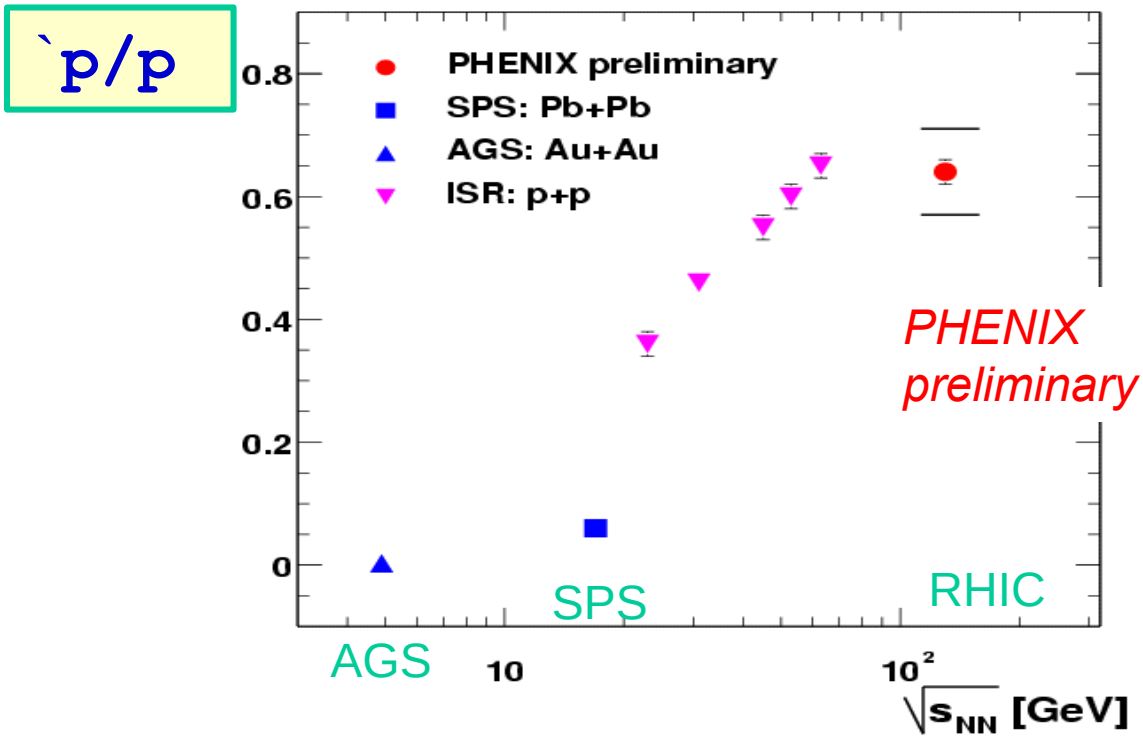
`p/p ratio as a function of centrality



- No clear dependence as a function of centrality.
- `p/p@Min.Bias = 0.64 ± 0.01(stat.) ± 0.07(sys.)

Beam energy dependence





- Both ratios are getting close to 1.0 from AGS, SPS to RHIC energy.

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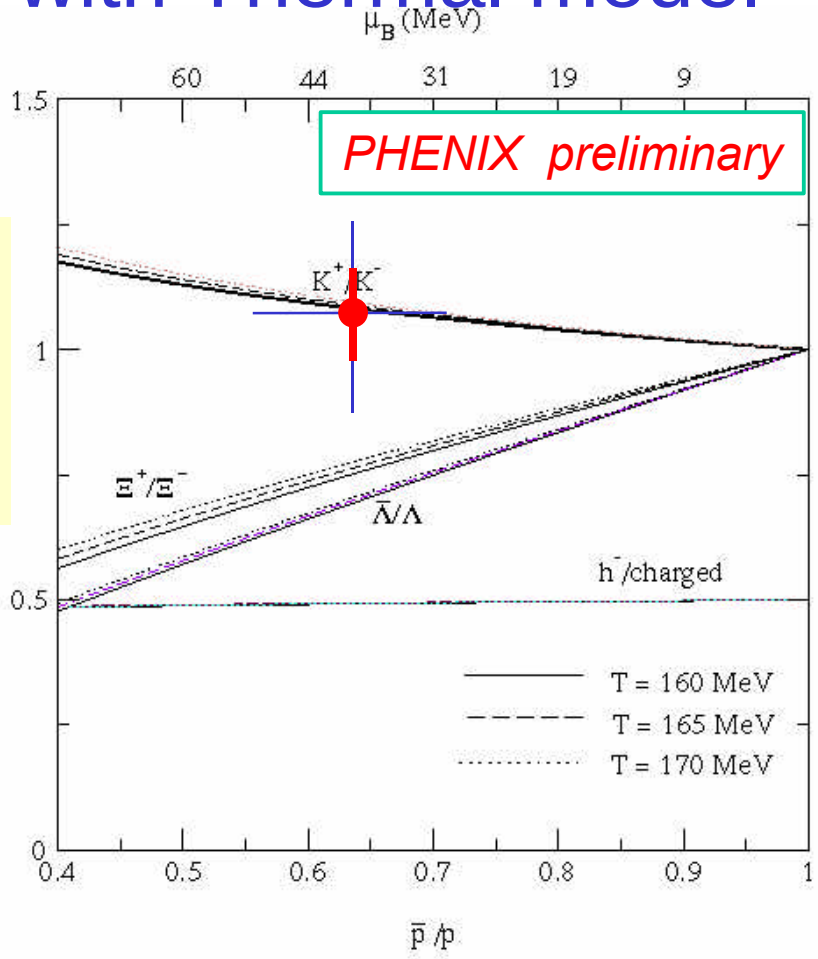
Comparison with Thermal model

Statistical thermal model

F.Becattini et al.
Phys.Rev.**C60**,024901(2001)
hep-ph/0002267

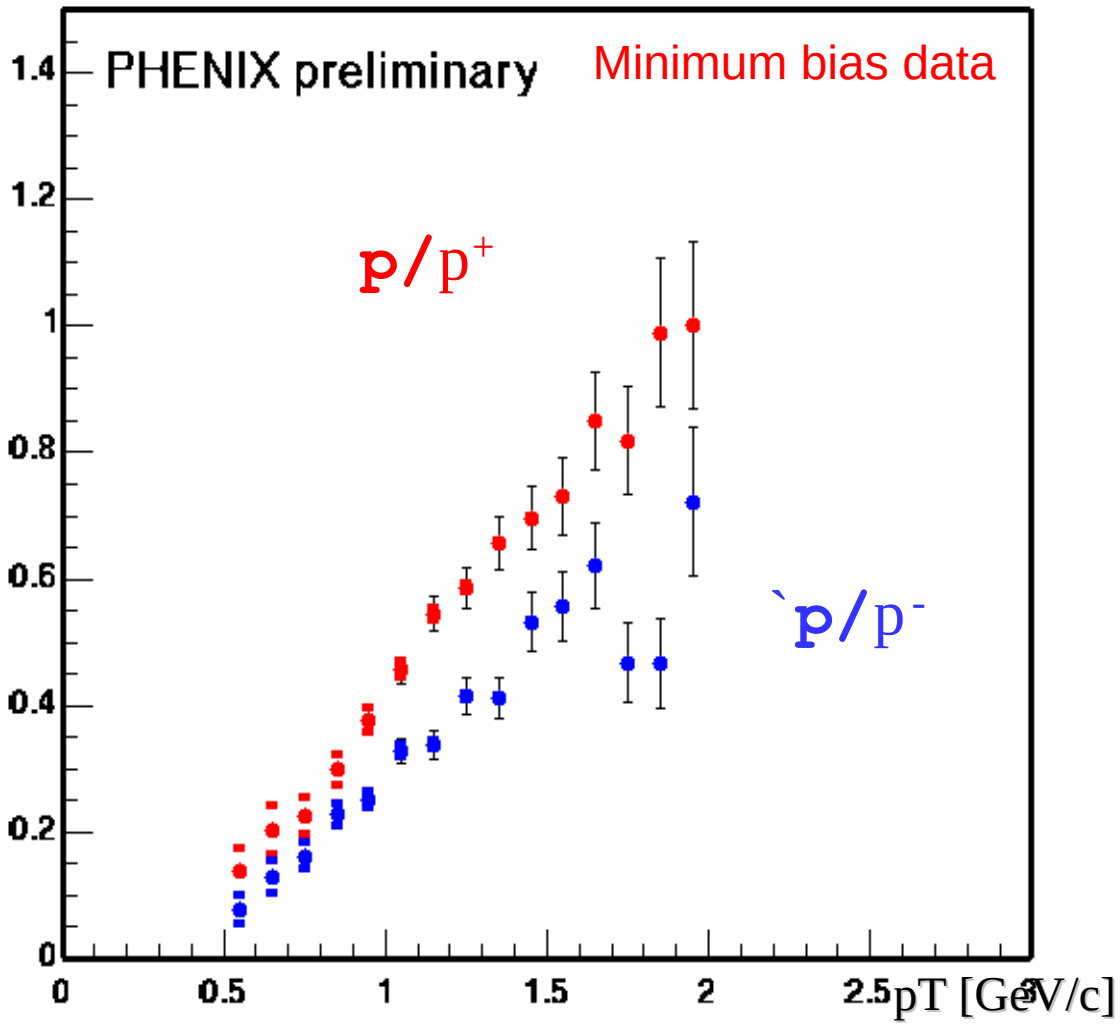


- **PHENIX Minimum bias at** $\sqrt{s_{NN}} = 130\text{GeV}$
  - **K^+/K^- = 1.08 ±0.03(stat.) ±0.22(syst.)**
  - **$\bar{p}/p$ = 0.64 ± 0.01(stat.) ± 0.07(sys.)**

Thermal model tells us …

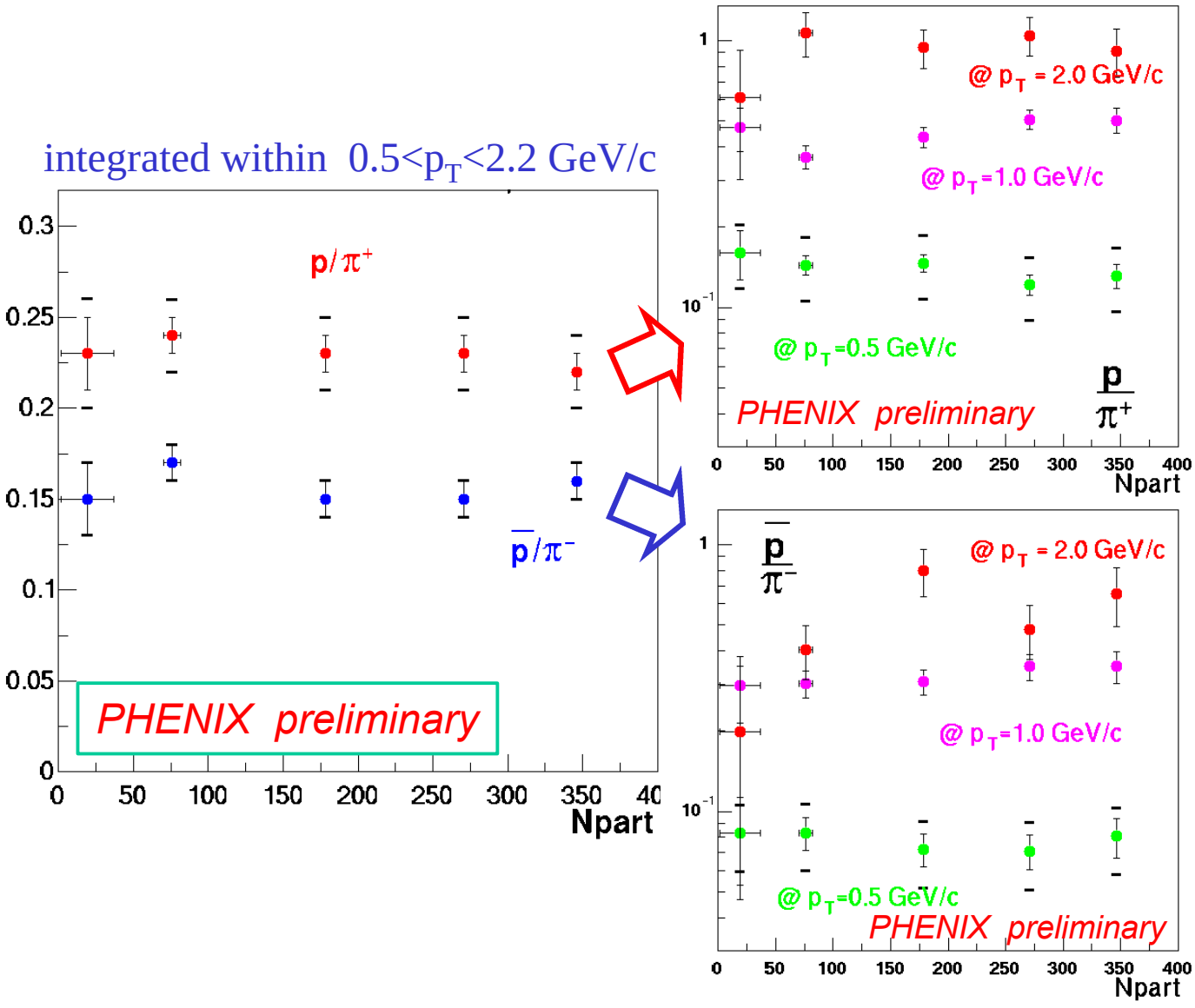
- Baryon chemical potential ~40MeV
- Not baryon free (μ_B != 0).

$\bar{p}/p^+$ and $\bar{p}/p^-$ as a function p_T



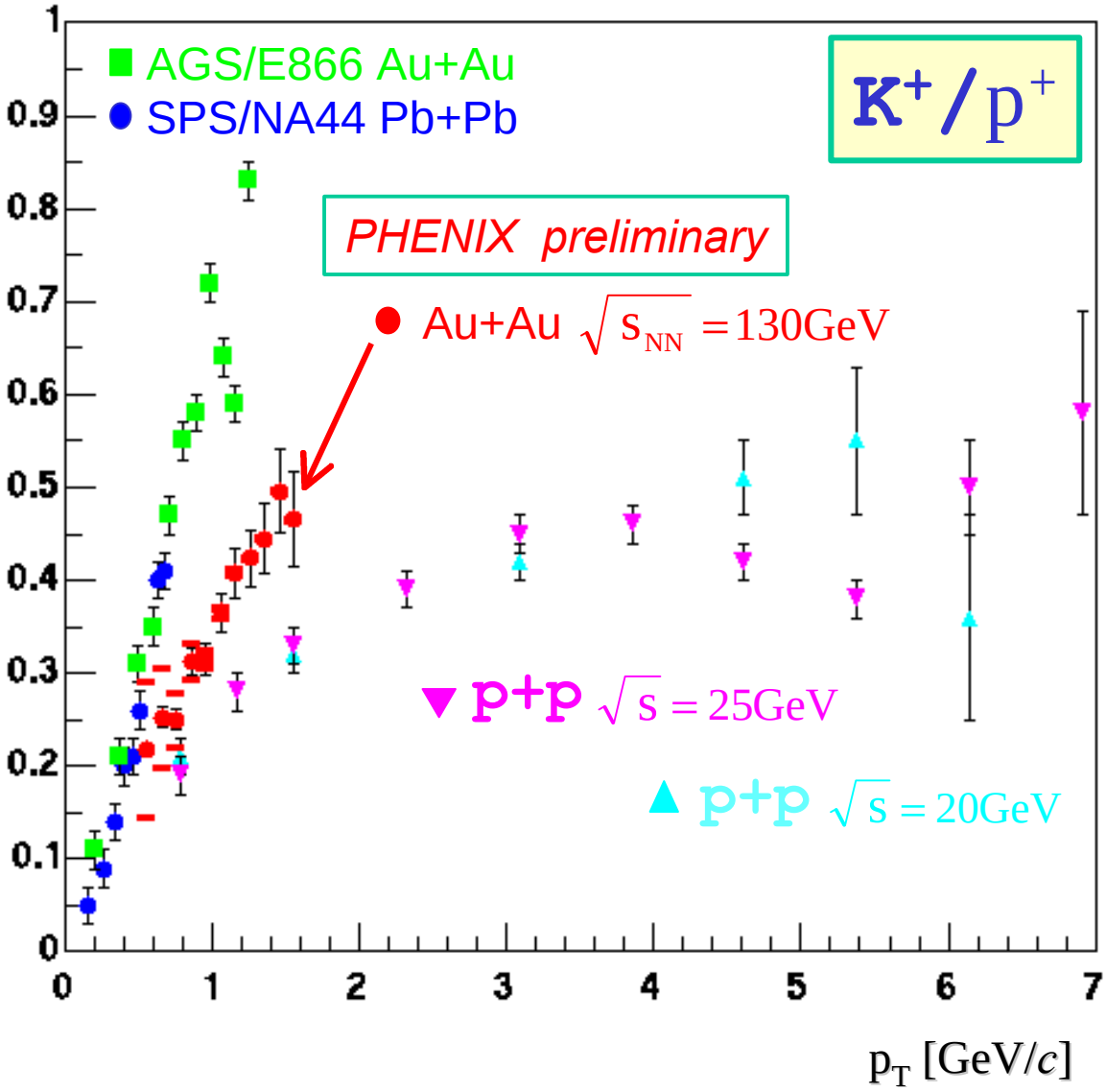
- $\bar{p}/p^+$ and $\bar{p}/p^-$ ratios increase as a function of p_T

$\bar{p}/p^+$ and $\bar{p}/p^-$ as a function of centrality



- $\bar{p}/p^+$ and $\bar{p}/p^-$ ratio @ p_T=2.0 GeV/c decreases at small number of participants.

K^+/p^+ ratio



- PHENIX preliminary data appear between AGS/SPS and p+p data.

Conclusion

- Particle ratios in Au+Au collisions at $\sqrt{s_{NN}} = 130\text{GeV}$ are presented.

- No clear centrality dependence is seen in K^+/K^- and $\bar{p}/p$ ratio within errors.
- No clear p_T dependence are seen in K^+/K^- and $\bar{p}/p$ ratio within errors.
- Particle ratio at minimum bias event, at mid rapidity
  - $K^+/K^- = 1.08 \pm 0.03(\text{stat.}) \pm 0.22(\text{sys.})$
  - $\bar{p}/p = 0.64 \pm 0.01(\text{stat.}) \pm 0.07(\text{sys.})$
- K^+/K^- and $\bar{p}/p$ ratios are close to 1.0 from AGS, SPS to RHIC energy.
- K/p and $\bar{p}/p$ ratios increase as a function of p_T.

- Baryon density at RHIC is much less than AGS and SPS, but not baryon free at mid rapidity.
  - Baryon chemical potential m_B ~ 40MeV