Study of Charged Particle Ratio at RHIC-PHENIX experiment

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    - K^+/K^- ratio
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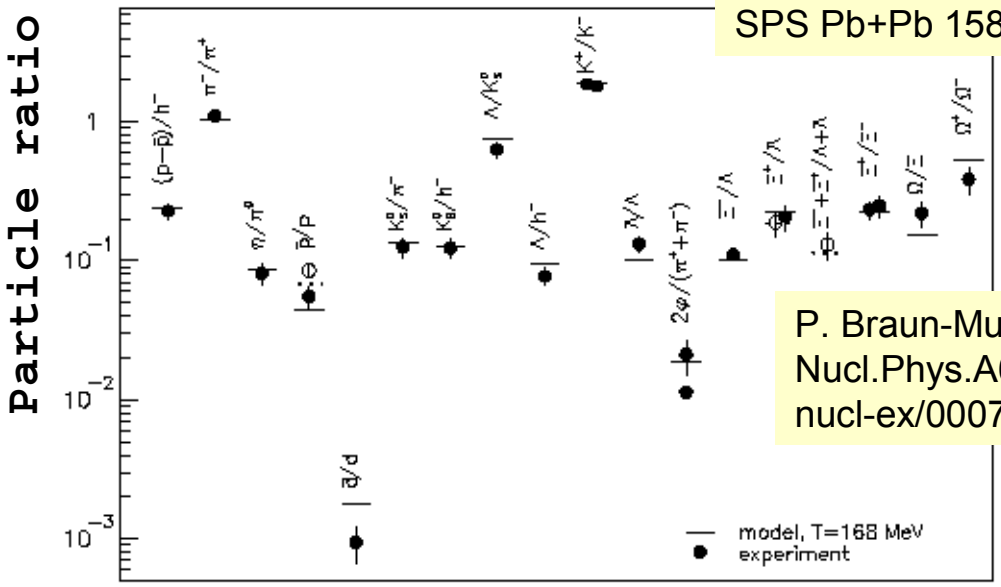
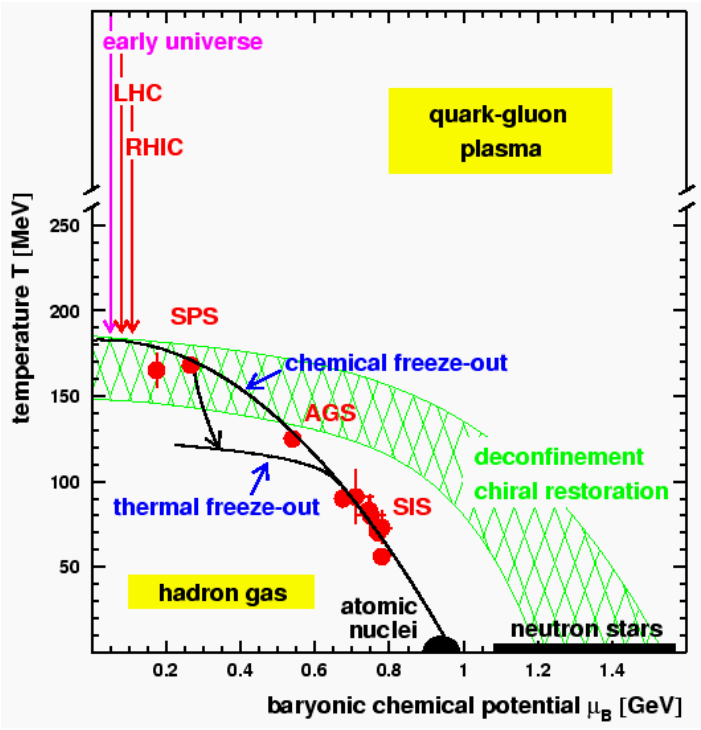
Motivation



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



From previous experiment

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

Particle-ratio

Particle Density

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

γ : Strangeness suppression factor
ɡ : spin-isospin freedom

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

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

Particle Ratio

Example:

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

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

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

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

  - Ratios contain basic information about collision dynamics

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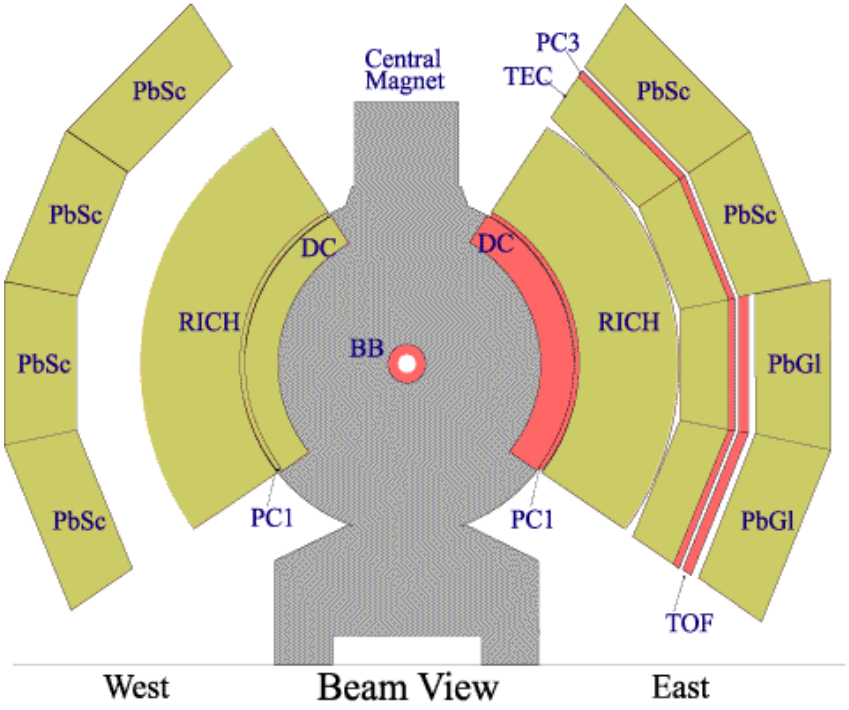
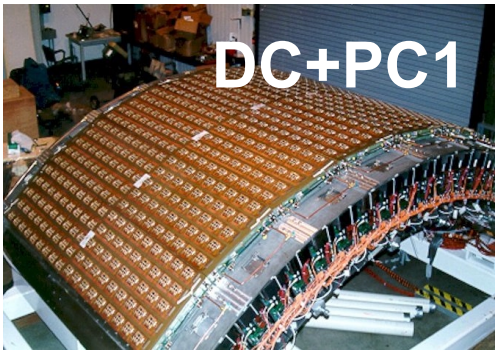
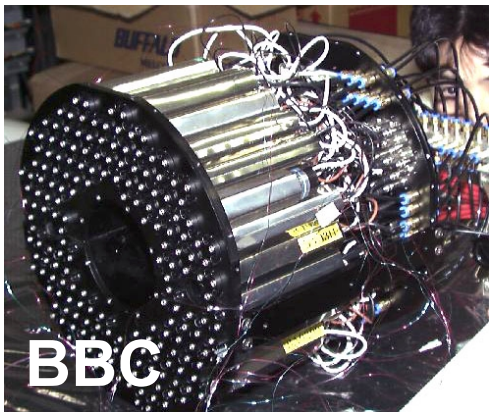
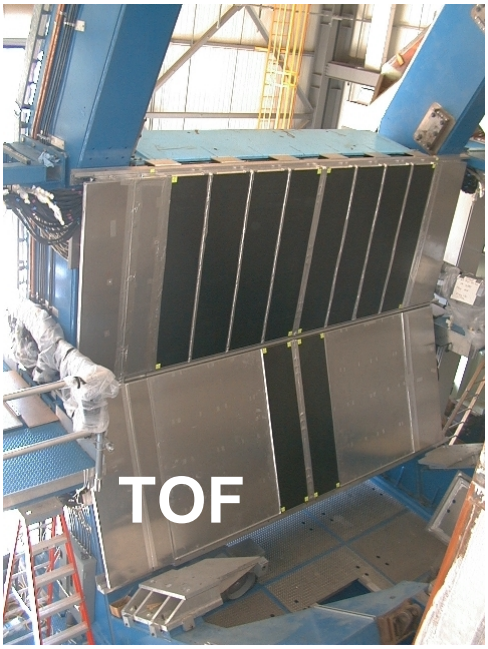
PHENIX Experiment









- Au+Au at $\sqrt{s_{NN}} = 130\text{GeV}$
- Acceptance $|y| < 0.35$

- Tracking System
  - DC, PC1
- PID device
  - BBC,TOF
- Time-of-Flight resolution
  - 110~120ps

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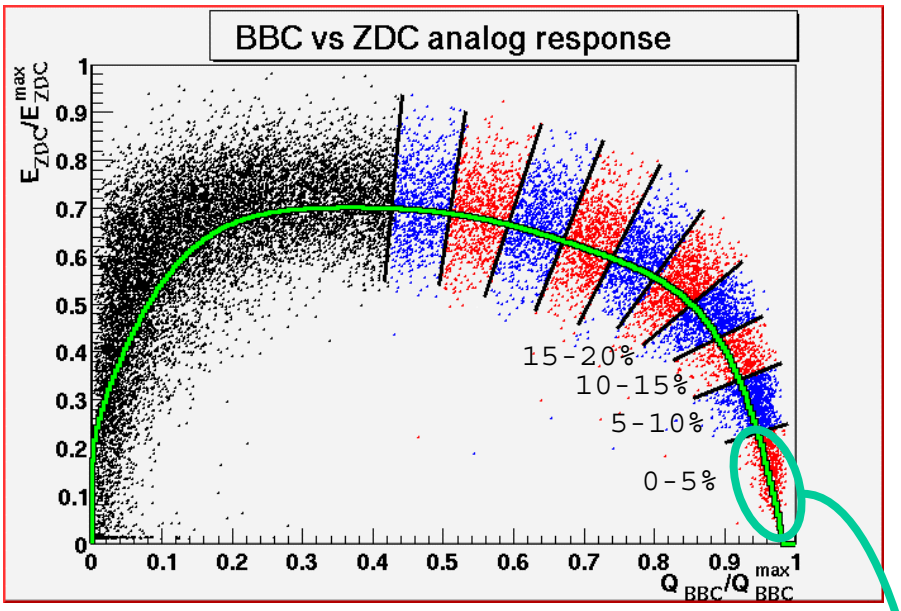
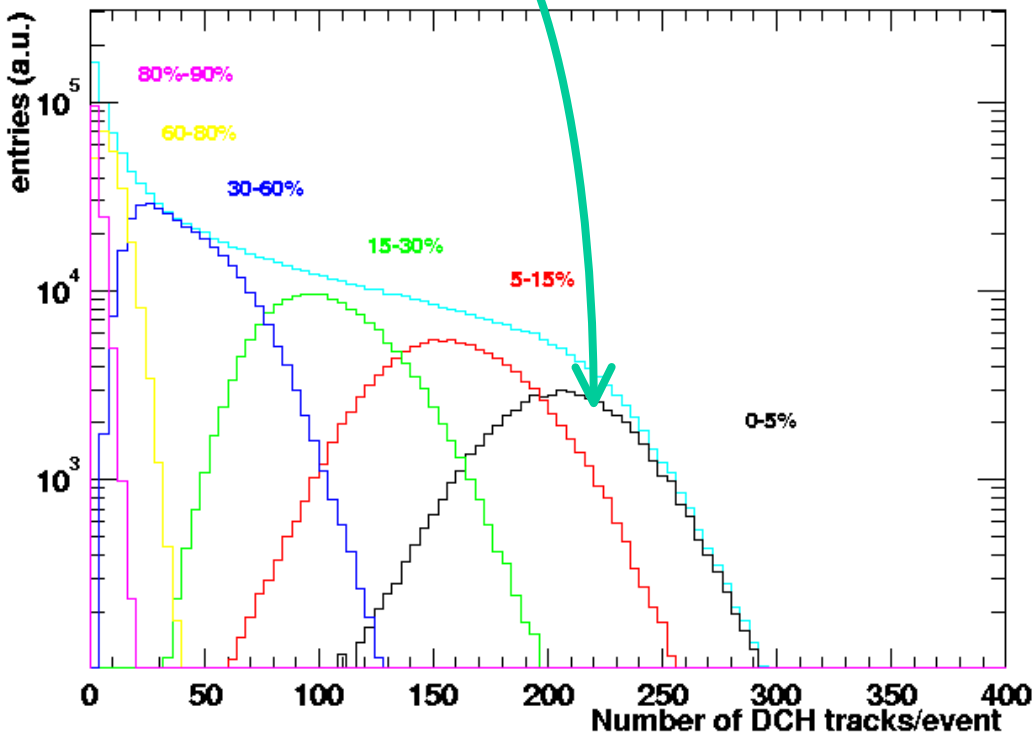
Centrality Selection

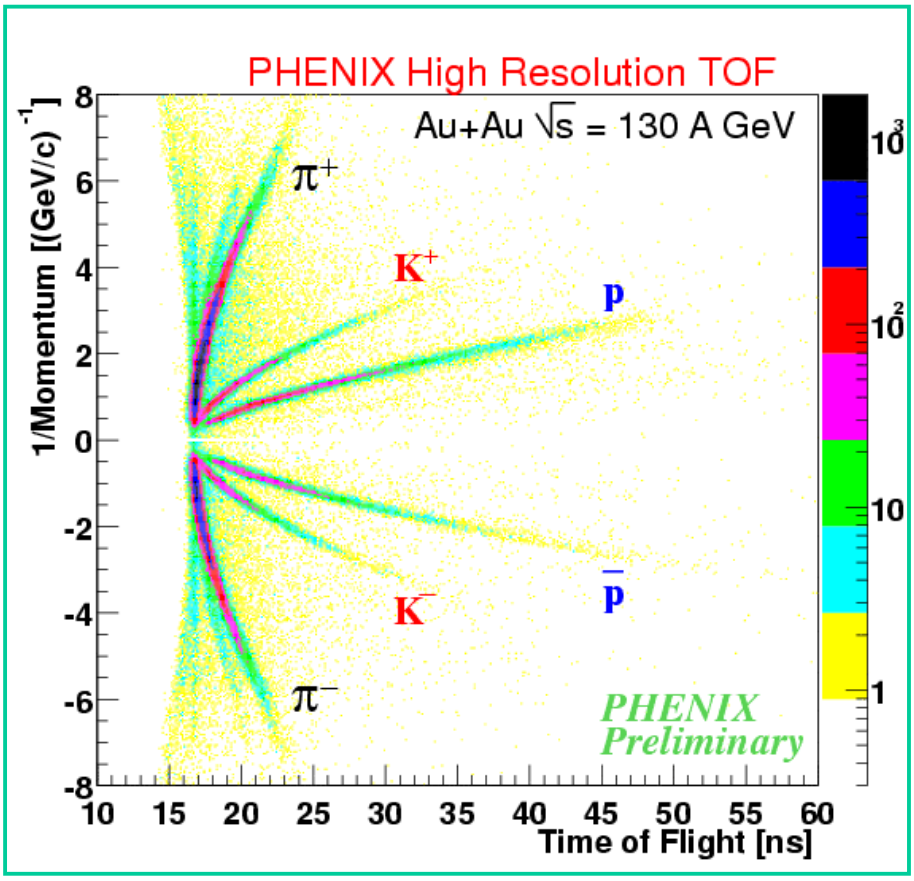


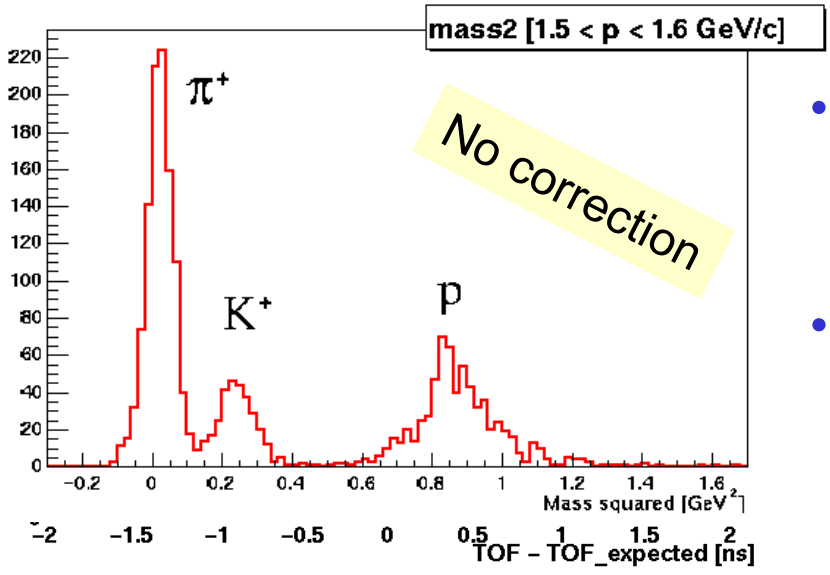
Centrality	Participants
0-5%	347 ± **15%**
5-15%	271 ± **15%**
15-30%	178 ± **15%**
30-60%	76 ± **15%**
60-80%	19 ± **60%**
80-92%	5 ± **60%**



- Use combination of BBC charge and ZDC energy.
- Extract N_{part} based on Glauber model.

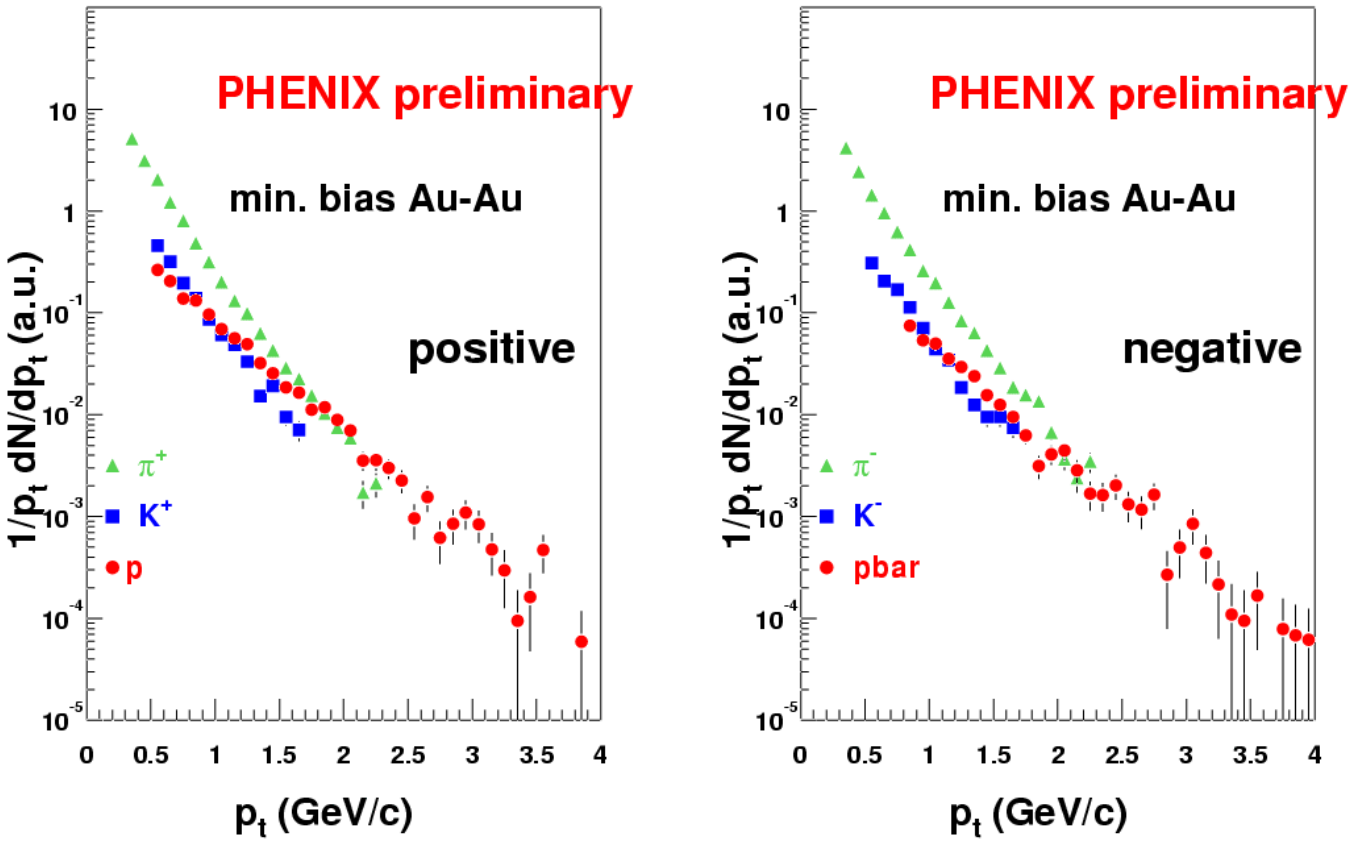
Particle Identification





- We can see clear π,K,p separation
- Particle separation
  - π/K < 1.6GeV/c
  - K/p < 3.5GeV/c

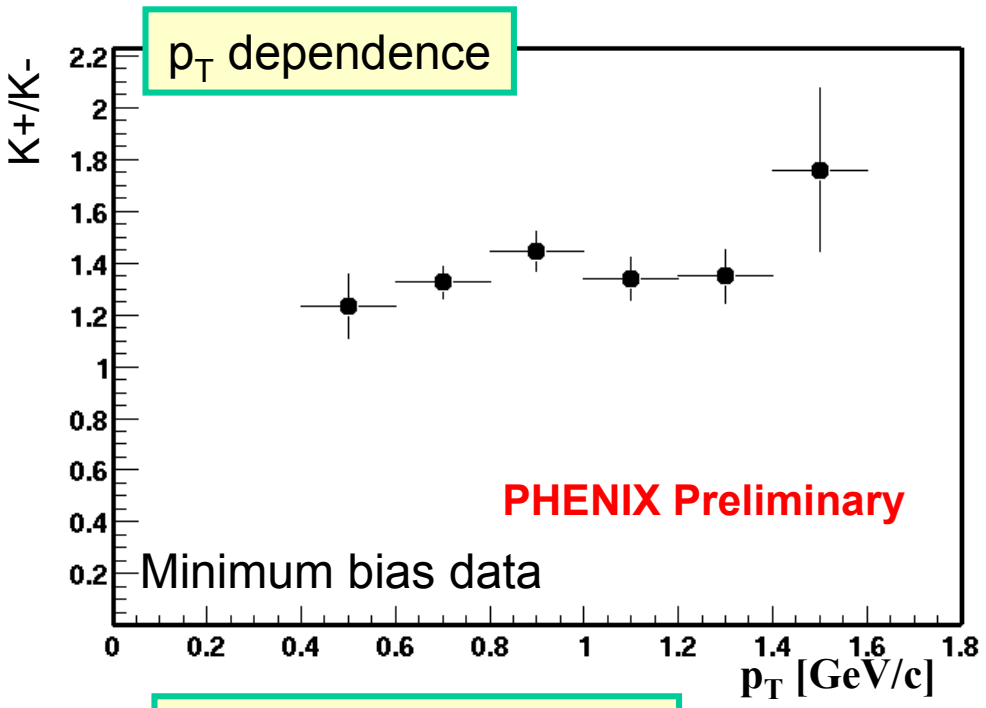
Identified Particle Spectra

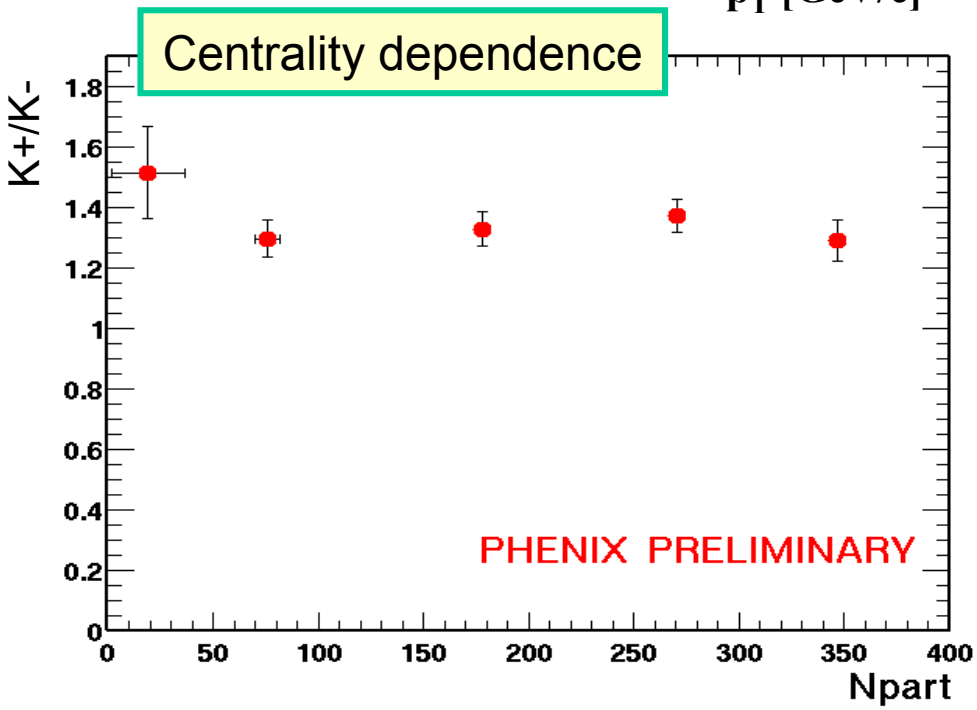


- Single particle spectra of pion, kaon, proton and their anti particles.

- Corrections
  - Tracking efficiency
  - Decay correction
  - Geometrical acceptance
  - Etc…

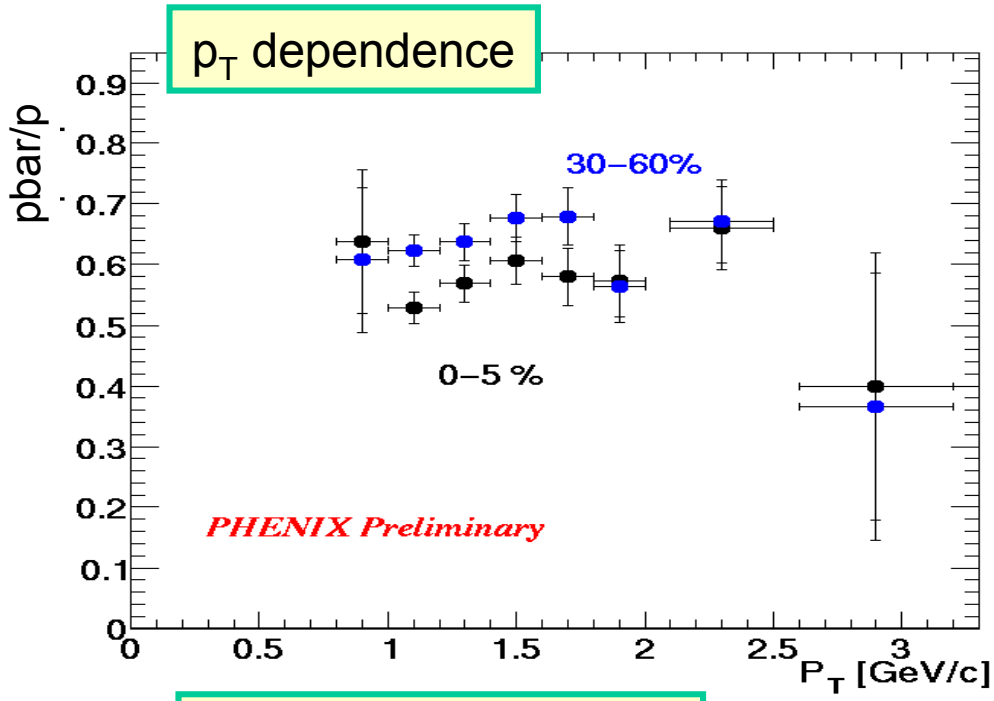
K^+/K^- ratio

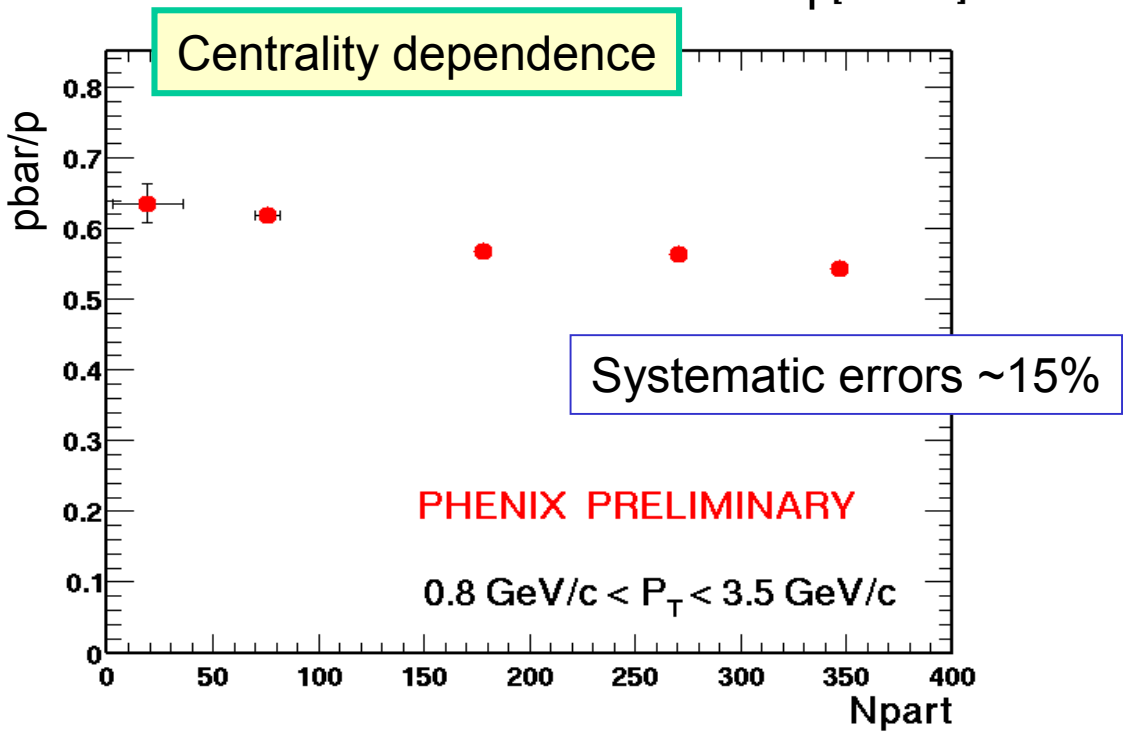




- No clear dependence as a function of p_T and centrality.
- K^+/K^- @5%central = 1.29 ±0.07(stat.) ±0.19(syst.)

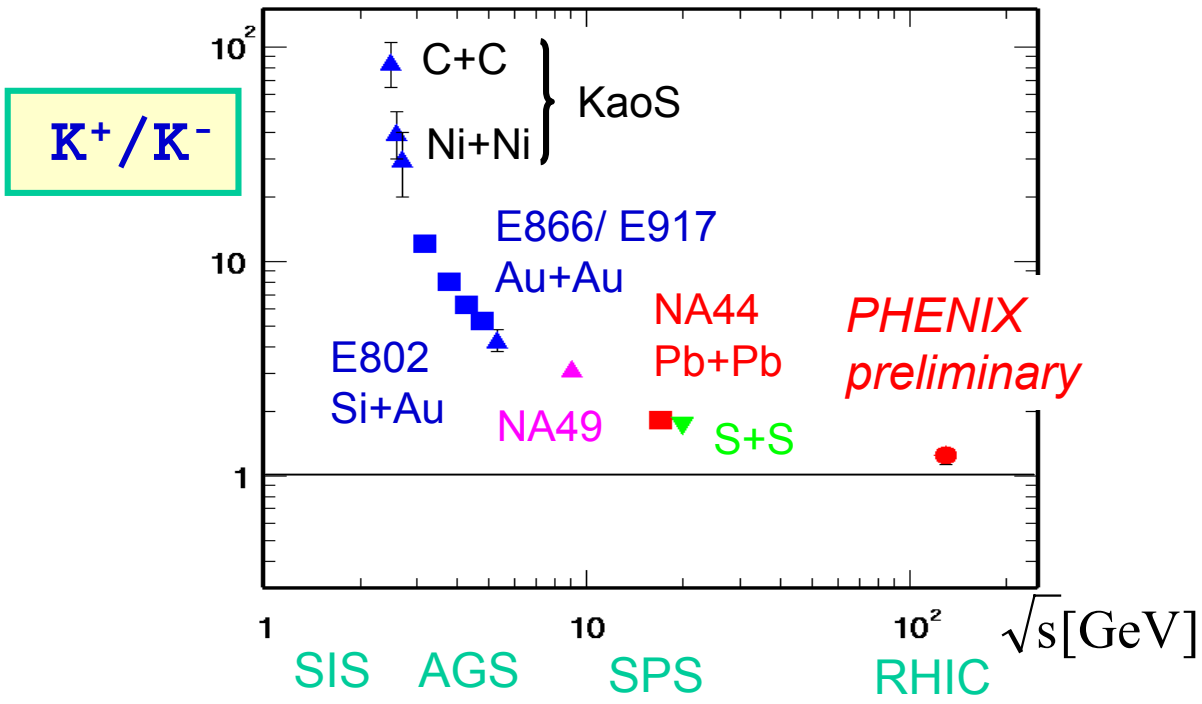
$\bar{p}/p$ ratio

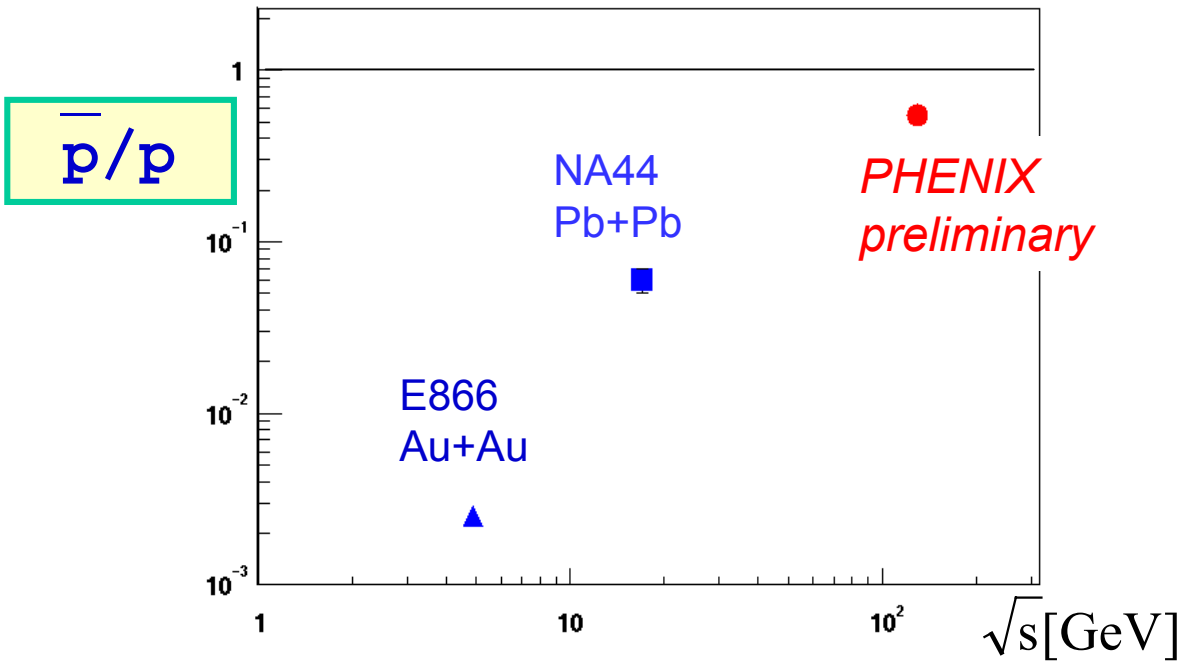




- No clear dependence on p_T over the measured range.
- Slightly decreasing as a function of centrality.
- $\bar{p}/p$@5%central = 0.54 ± 0.01(stat.) ± 0.08(sys.)

Beam energy dependence

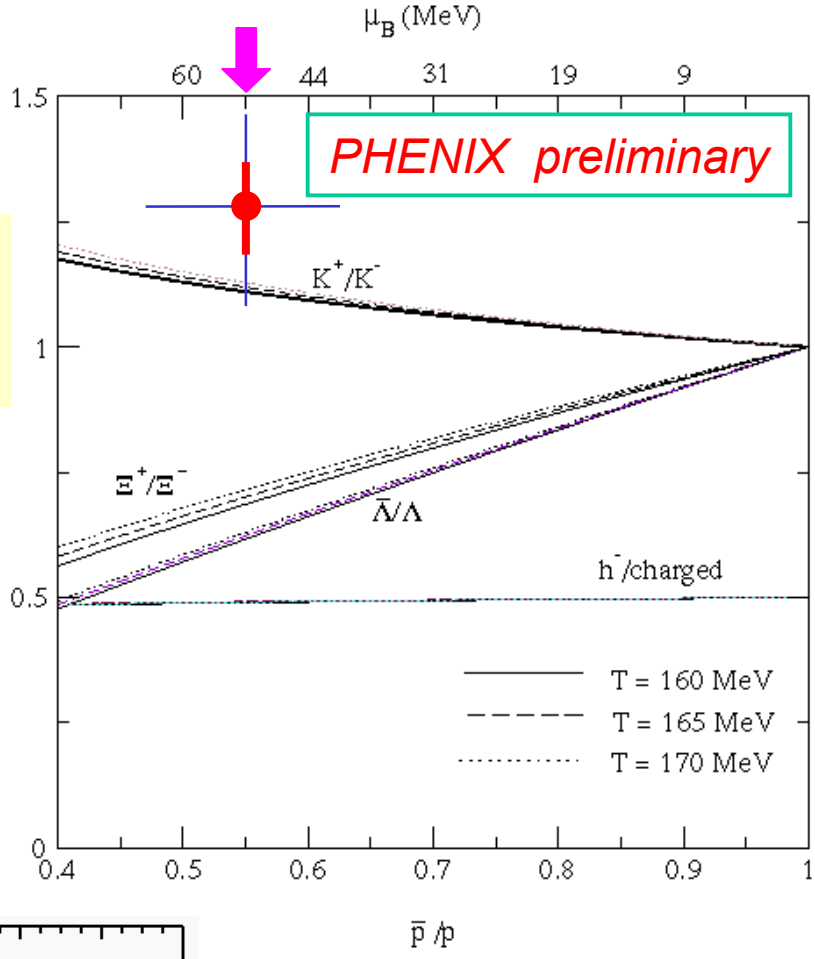


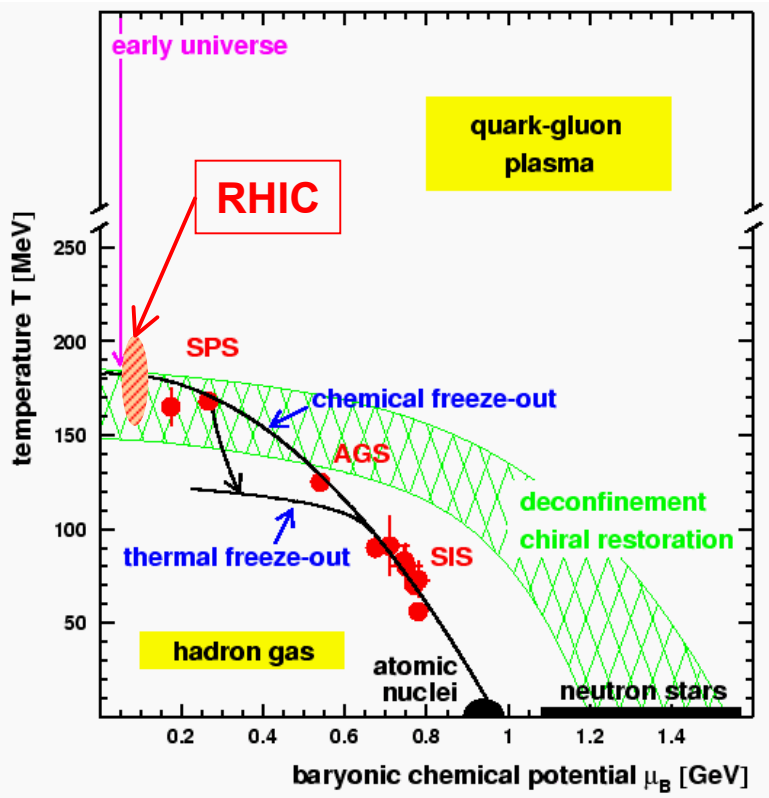


- Both ratios are getting close to 1.0 from AGS,SPS to RHIC energy

Comparison with Thermal model

Statistical thermal model
hep-ph/0002267
F.Becattini et al.





Thermal model tells us …

- Baryon chemical potential ~50MeV
- Not baryon free (μ_B=0).

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Conclusion

- No clear centrality dependence are 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 5% most central event
  - **$K^+/K^- = 1.29 \pm 0.07(stat.) \pm 0.19(sys.)$**
  - **$\bar{p}/p = 0.54 \pm 0.01(stat.) \pm 0.08(sys.)$**
- K^+/K^- and $\bar{p}/p$ ratios are closing to 1.0 from AGS, SPS to RHIC energy.
- Baryon density at RHIC is much less than AGS and SPS, but not baryon free at mid rapidity.
  - Baryon chemical potential $\mu_B \sim 50$MeV