Radial Flow Study from Identified Hadron Spectra in Au+Au collisions at $\sqrt{s_{NN}}$ = 200GeV

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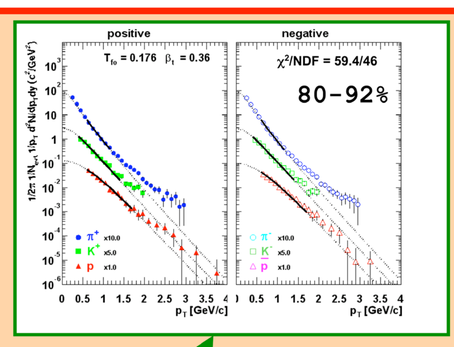
Study of Hydro-dynamical Collective Expansion Picture

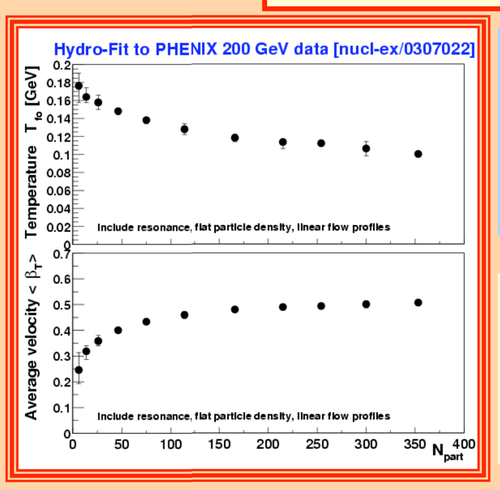
- Identified charged hadron spectra and yield
  - Spectra vs. centrality
  - Mean p_T vs. centrality
- Hydro-dynamical model fit
  - Radial flow velocity β_T and thermal freeze-out temperature T_{fo}
  - Hydro-dynamical model with resonance decay effect.

Results

Hydro-dynamical model fit to the spectra with resonance decay effect



Centrality dependence of T_{fo} and $<\beta_T>$

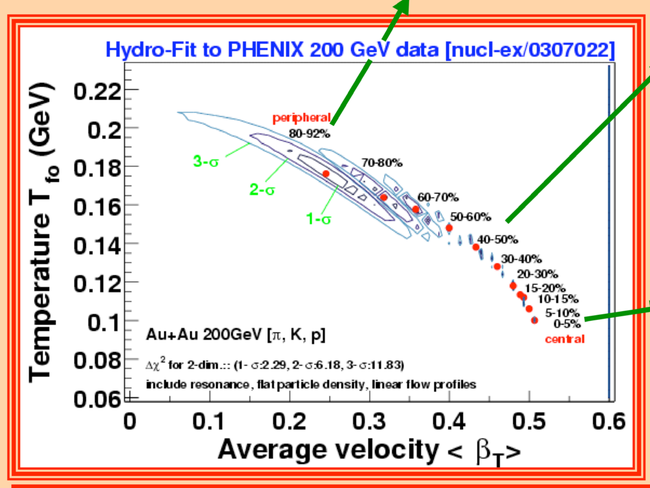


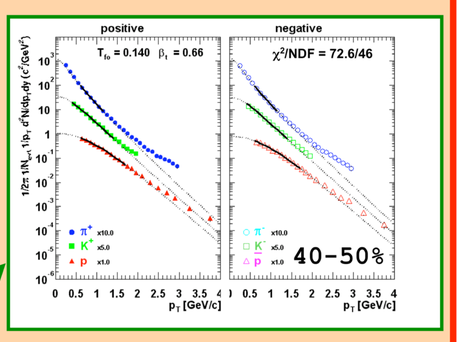
N_{part} dependence of expansion is observed.

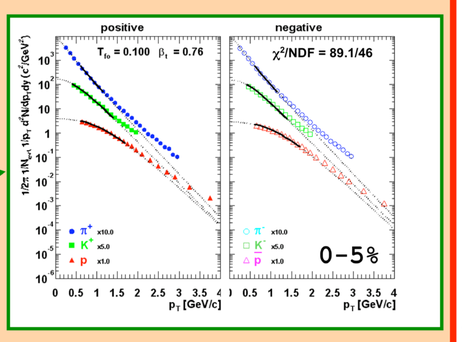
- @central: **saturate**
- @peripheral:
  $N_{part} \rightarrow 0$ :: T_{fo} increase, $<\beta_T> \rightarrow 0$

For the most central:

- *Freeze-out temperature* **T_{fo} = 100MeV**
- *Average flow velocity* **$<\beta_T>$ = 0.5**
  (*Surface flow velocity* β_T = 0.76, $<\beta_T> = 2/3\ \beta_T$)





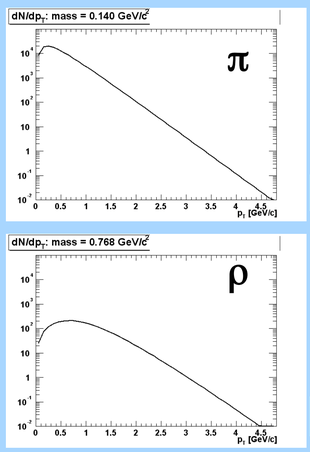


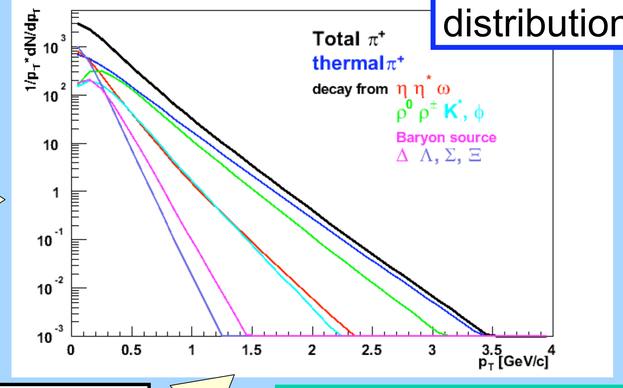
Contour plot of T_{fo} vs. $<\beta_T>$ for each centrality

Fitting region:

- Minimize contribution from hard process.: **$(m_T - m_0) < 1$GeV/c^2**
  → **π : < 1.2GeV/c, K : < 1.4GeV/c, p : < 1.7GeV/c**
- Exclude large resonance for pion at very low p_T . **π: p_T > 0.5GeV/c**

Hydro-dynamical model with resonance



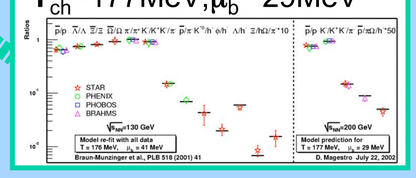


Inclusive π distribution

Decay

Daughter π distribution

Chemical parameter:
T_{ch}~177MeV,μ_b ~29MeV



Create inclusive p_T spectra
for each particles, each (T_{fo} , β_T)

Procedure:

1. Generate resonances with p_T distribution determined by each combinations of T_{fo}, β_T.
2. Decay them and obtain p_T spectra of π,K,p.
3. Particle abundance calculated with chemical parameters : **T_{ch} = 177MeV, μ_B = 29MeV**
   Ref:P.Braun-Munzinger et al,PLB518(2001)41.
4. Merge and create inclusive p_T spectra. → **χ^2 test**

Resonance:

- $\pi^\pm$, $K^\pm$, p, anti-p
- ρ^0, $\rho^\pm$, η, ω
- $K^{*\pm}$, K^{*0}, anti-K^{*0}, ϕ
- Δ^0, $\Delta^\pm$, Δ^{++}, Λ, $\Sigma^\pm$, Σ^0,anti-

Blast-wave model parameterization

$$\frac{1}{m_T}\frac{dN}{dm_T} = A\int_0^R f(r) r dr m_T \mathrm{I}_0\left(\frac{p_T \sinh\rho}{T_{fo}}\right)\mathrm{K}_1\left(\frac{m_T \cosh\rho}{T_{fo}}\right)$$

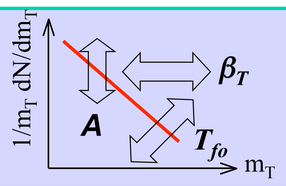
$$\rho(r) = \tanh^{-1}(\beta_T)\cdot r/R$$

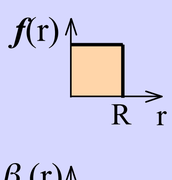
I_0 , K_1: modified Bessel function

Ref:Sollfrank,Schnedermann,Heinz,PRC48(1993)2462.

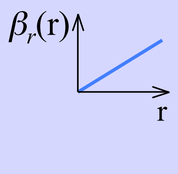
Use **linear flow rapidity profile** and **constant particle density**

Expansion parameters:
normalization ***A***
freeze-out temperature T_{fo}
surface velocity β_T





definite integral from 0 to R
particle density distribution
$f(r) \sim$ const

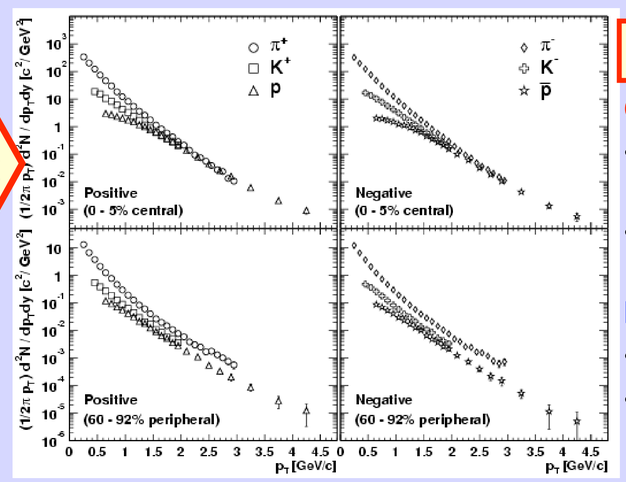


linear profile **n = 1**: $\beta_r = \beta_T \cdot r/R$
average velocity: $<\beta_T> = 2/3\ \beta_T$
S.Esumi,S.Chapman,H.van Hecke,and N.Xu, Phys.Rev.C 55, R2163 (1997)

χ^2 test

Experimental data: Identified charged hadron p_T spectra in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV from PHENIX

PHENIX: PRC accepted,nucl-ex/0307022



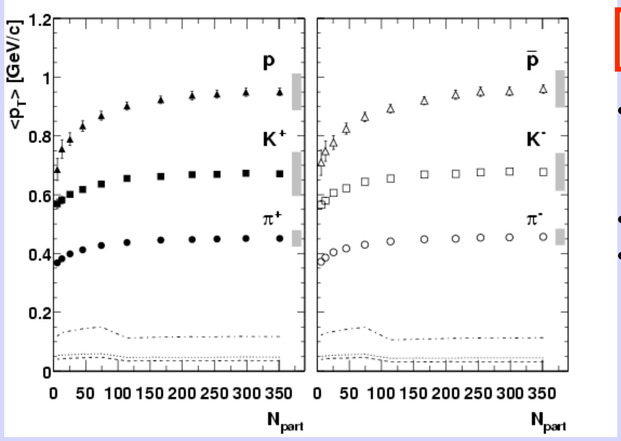
PID p_T Spectra

Central

- Low p_T slopes increase with particle mass.
- Proton and anti-proton yields equal the pion yield at high p_T.

Peripheral

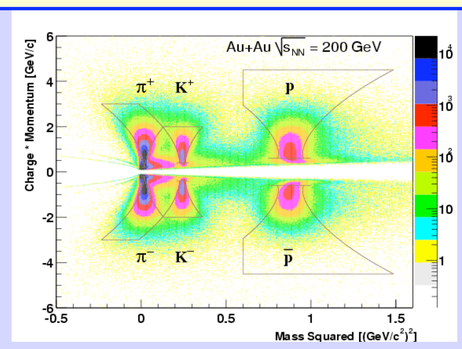
- Mass dependence is less pronounces.
- Similar to pp.

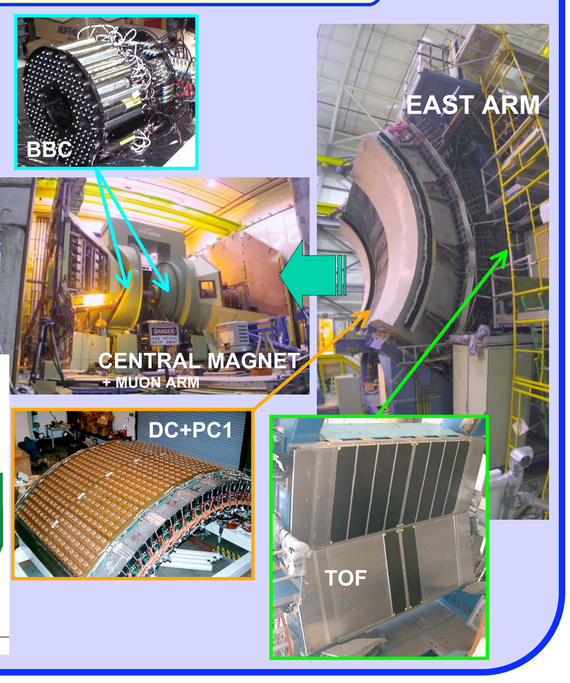


Mean p_T vs. centrality

- Increase from peripheral to mid-central, and then saturate from mid-central to central for all particle species.
- Observed clear mass dependence.
- **Indicative radial expansion.**
  (consistent with hydro picture)

PHENIX Detectors for Charged Hadron PID





Hadron measurement.
• DCH+PC1+TOF+BBC
• $\Delta\phi = \pi/8$, $-0.35 < \eta < 0.35$
Particle ID by TOF
• **π** : $0.2 < p_T < 3.0$ GeV/c
• **K** : $0.4 < p_T < 2.0$ GeV/c
• **p** : $0.6 < p_T < 4.5$ GeV/c