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# **Outline**

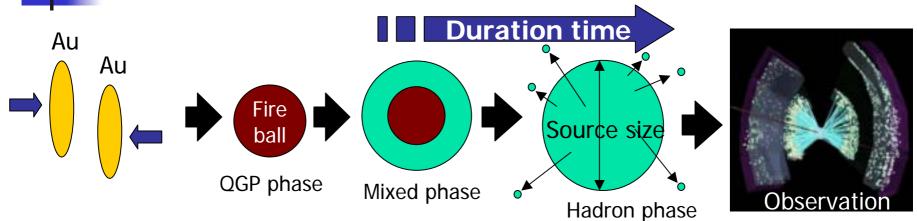
- Physics motivation.
- Data statistics.
- Corrections, Systematic errors.
- HBT results for charged pion pairs.
  - > kT dependence of HBT radius parameters.
  - > Centrality dependence of HBT radius parameters.
  - $> k_T$  and Centrality dependencies of the  $R_{out}/R_{side}$  ratio.
- HBT results for charged kaon pairs.
- •Summary





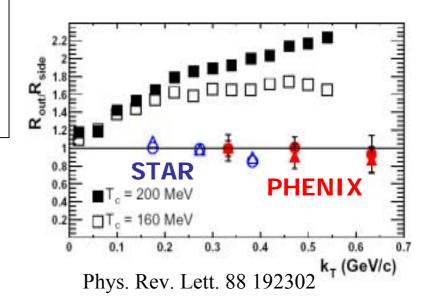


### Physics motivation



Some models predict that a large source size and a long duration time would be observed due to softening of the EOS in a first order phase transition from a QGP state.

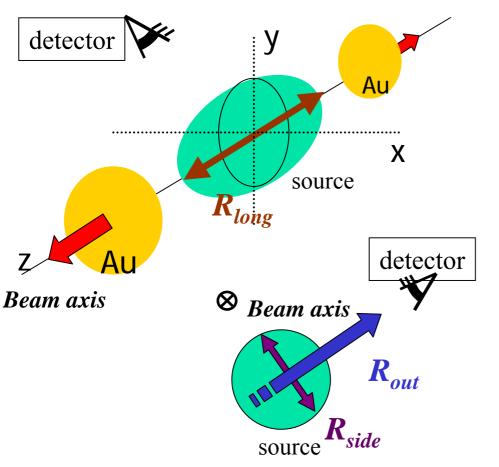
PHENIX and STAR results show that source radii don't increase and no duration time at  $sqrt(s_{NN})=130GeV$ 





## Bertsch-Pratt radius parameters (R<sub>side</sub>, R<sub>out</sub>, R<sub>long</sub>)

$$C_2 \equiv 1 + \lambda \exp\left(-R_{\text{side}}^2 q_{\text{side}}^2 - R_{\text{out}}^2 q_{\text{out}}^2 - R_{\text{long}}^2 q_{\text{long}}^2\right) \leftarrow$$



- LCMS (Longitudinal Co-Moving System)  $p_{z1} = p_{z2}$
- Cylindrically symmetric

If a source is assumed to be

- Static source.
- Transparent source.

The duration time

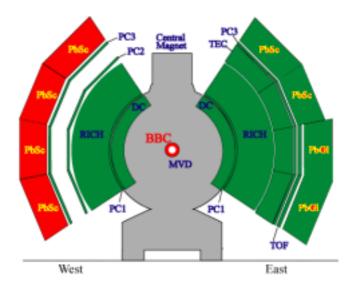
$$\Delta \tau = \sqrt{R_{\rm TO}^2 - R_{\rm TS}^2} \, / \, \beta$$

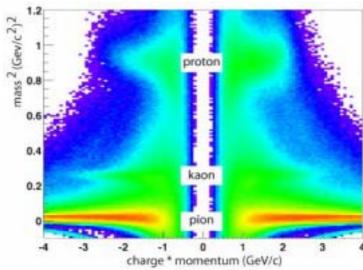




- About 50M minimum bias event.
  - > Z-vertex < 30 cm
  - $p_T > 0.2 \text{GeV/c}$
- Charged pi, K PID by EMCal
  - > 1.5σ within pi mass, (and 2.0σ away from K mass)
  - > 1.5σ within K mass, (and 2.5σ away from p, pi mass)

	200GeV data	130GeV data
pi+ pair	164M	4.2M
pi- pair	157M	4.6M
K+ pair	1.2M	0.023M
K- pair	1.1M	0.029M









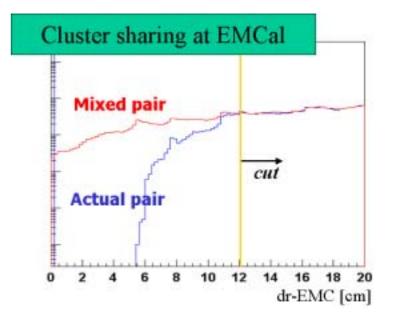
### Corrections and systematic errors

#### • Two-track quality cut

- > Tracking inefficiency
- > Ghost track
- > Cluster sharing

#### Coulomb correction

 The Coulomb effect is corrected by full coulomb correction assuming a Gaussian source without pairs coming from resonance decays.



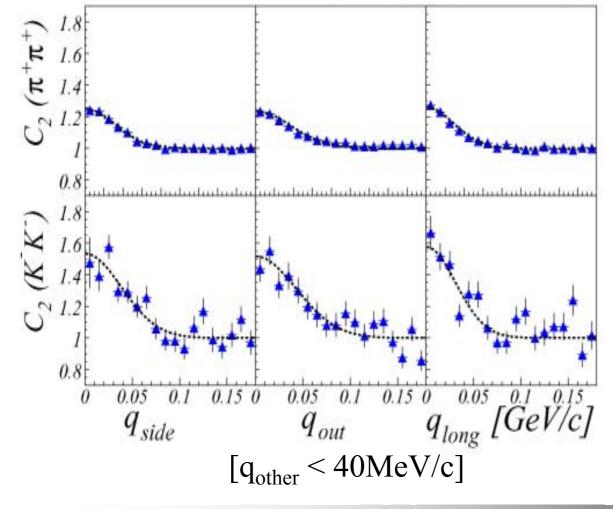
Sytematic errors (%)	lambda	Rside	Rout	Rlong	Rout/Rside
Cluster share cut	11.7	4.9	5.7	4.4	1.1
Tracking inefficiency cut	5.9	2.6	6.4	2.5	2.4
Ghost track cut	2.8	0.8	3.4	1.3	4.2
Coulomb	3.1	2.4	3.7	2.2	2.9
Total (%)	13.9	6.4	10.1	6	5.7





### Correlation functions





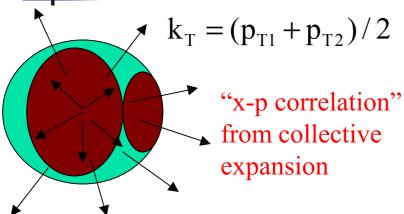
#### $0.2 < k_T < 2.0 \text{ GeV/c}$

$$\langle k_T \rangle = 0.46 \text{ GeV/c}$$
  
 $\lambda = 0.397 \pm 0.015$   
 $R_{\text{side}} = 4.40 \pm 0.12$   
 $R_{\text{out}} = 3.73 \pm 0.12$  [fm]  
 $R_{\text{long}} = 4.82 \pm 0.15$ 

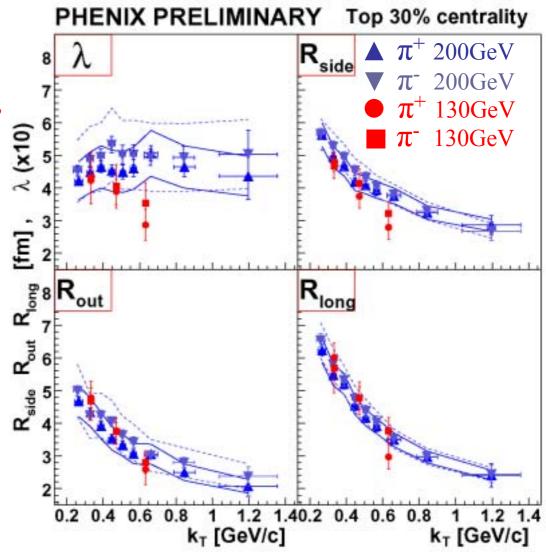
$$<$$
k<sub>T</sub> $> = 0.78 \text{ GeV/c}$   
 $\lambda = 0.785 \pm 0.181$   
 $R_{\text{side}} = 3.65 \pm 0.43$   
 $R_{\text{out}} = 3.23 \pm 0.47$  [fm]  
 $R_{\text{long}} = 4.48 \pm 0.68$ 



### k<sub>T</sub> dependence



- $\lambda$  (chaoticity) is constant with kT.
- Bertsch-Pratt radius parameters at 200GeV are equal to the corresponding results at 130 GeV within errors.



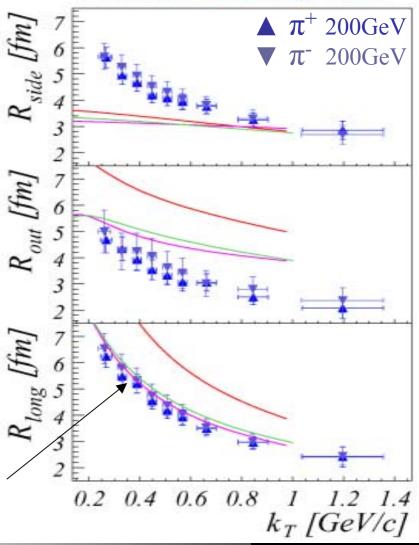


### Comparison to Hydrodynamic models

- U. Heinz and P. F. Kolb (hep-ph/0204061)
  - Hydro w/o FS
  - Standard initialization and freeze out which reproduce single particle spectra.
  - Hydro at e<sub>crit</sub>
  - Assuming freeze out directly at the hadronization point.  $(e_{dec} = e_{crit})$
- T. Hirano and K. Tsuda (hep-th/0205043)
  - Hydro w PCE
  - Assuming partial chemical freeze-out.

Experimental longitudinal radius parameter is well reproduced by hydro models.





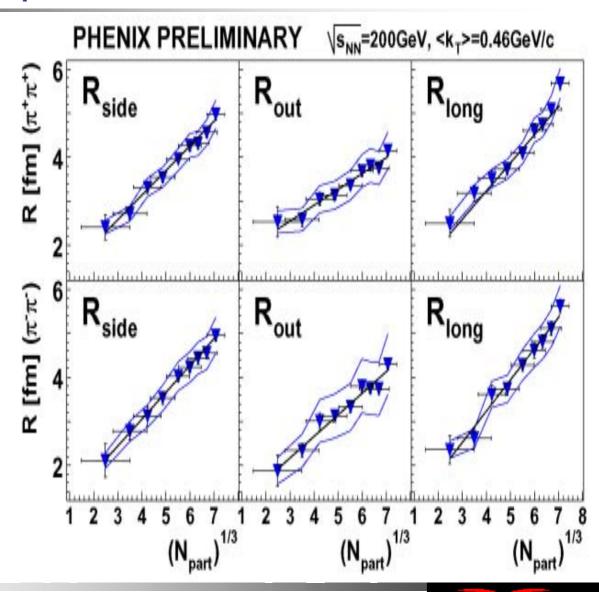


### Centrality dependence

Centrality is defined by the coincidence between BBC and ZDC.

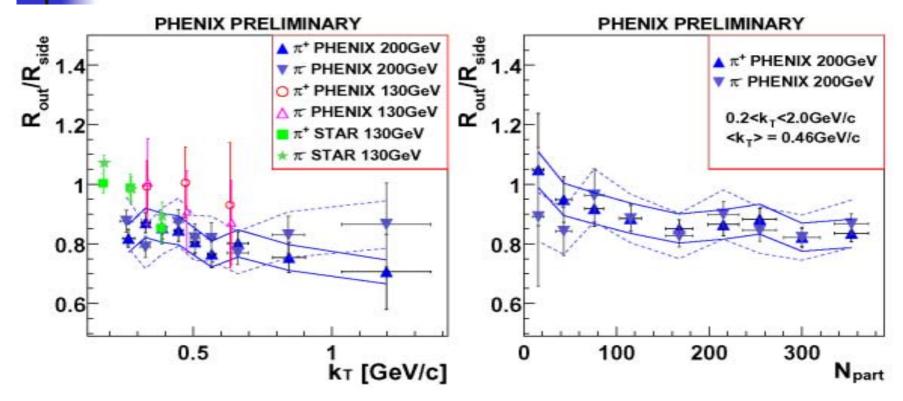
The number of participant  $(N_{part})$  is calculated by a Glauber model.

• Bertsch-Pratt radius parameters depend on N<sub>part</sub>^1/3 linearly.





# k<sub>T</sub> and centrality dependence of R<sub>out</sub>/R<sub>side</sub>



- The ratio is similar to those results from PHENIX and STAR at 130 GeV
- $R_{out}/R_{side}$  is independent of centrality and is constant for  $k_T$  up to ~1.2 GeV.
- R<sub>out</sub>/R<sub>side</sub> is systematically smaller then 1.

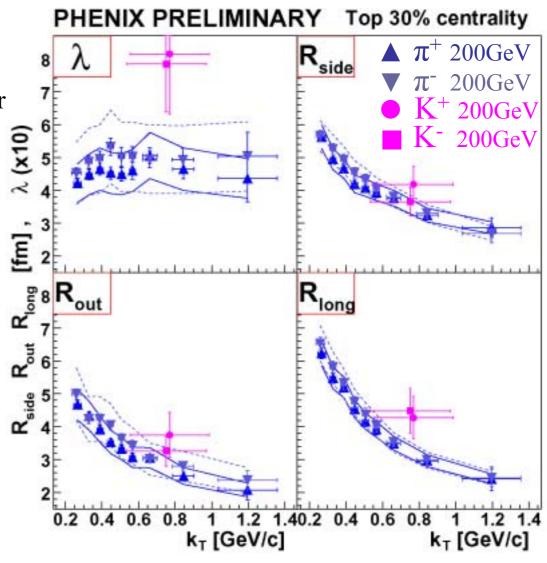




### HBT results for charged kaon pairs

- The kaon  $\lambda$  (chaoticity) is larger than that of pion.
- --> due to a small amount of resonance decays.

The kaon radius parameters are slightly larger than that of pion at the same <k<sub>T</sub>>.





### Summary

- Using a first data sample from PHENIX in Au+Au collisions at sqrt(s\_NN) = 200 GeV, we have analyzed 164M pi+(157M pi-) pairs, and 1.2M K+(1.1M K-) kaon pairs.
  - > HBT source radii are consistent between 130 and 200 GeV within errors.
  - > All Bertsch-Pratt radius parameters decrease with  $k_T$ , and depend on  $N_{part}^{1/3}$  linearly.
  - > The ratio  $R_{out}/R_{side}$  is independent of  $k_T$  ( ~ 1GeV) and centrality, and is systematically below one.
  - > The kaon radius parameters are slightly larger that those of pions at the same <kT>.