Bose-Einstein correlations of charged pion pair in Au-Au collisions at sqrt(s_{NN}) = 200 GeV.

Outline:
- Motivation
- Partial Coulomb correction based on a core-halo model
- Results (k_T and centrality dependences)
- Prospect
- Summary

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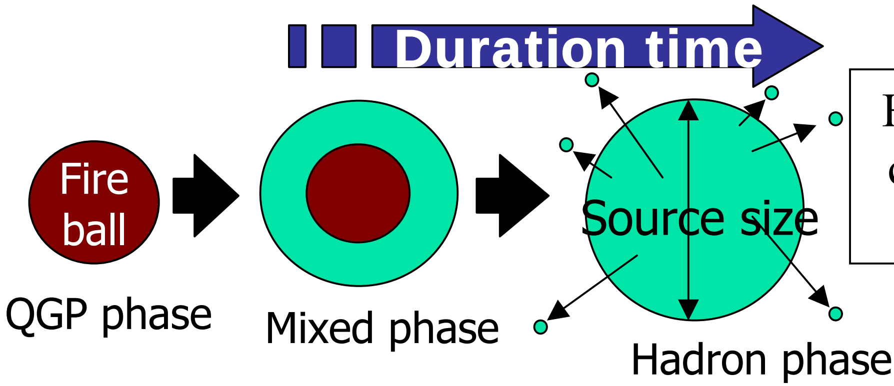
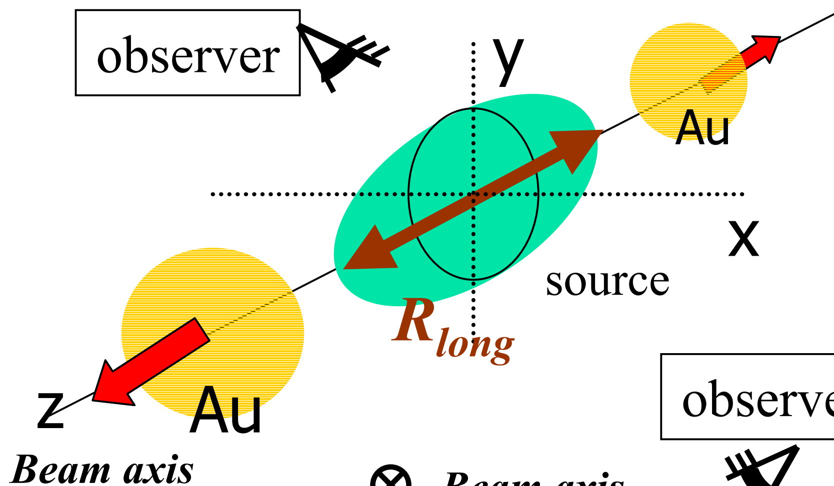
Akitomo Enokizono (Hiroshima University)

Motivation of HBT analysis



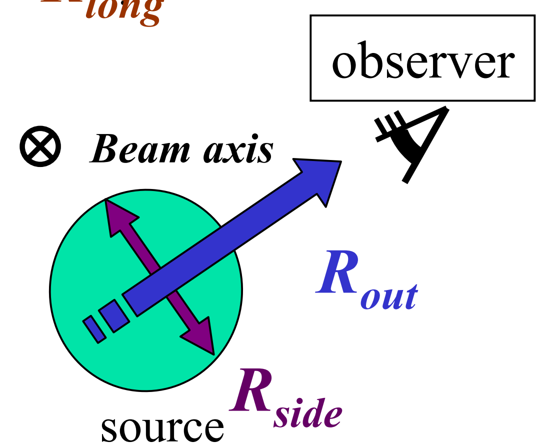
HBT sees source dynamics of the final state of collision. The state (HBT radii, duration time) is being predicted by some hydro-models.



Bertsch-Pratt parameterization

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

- Longitudinal Co-Moving System
- Cylindrically symmetric



The duration time

$$\Delta\tau = \sqrt{R_{out}^2 - R_{side}^2} / \beta$$

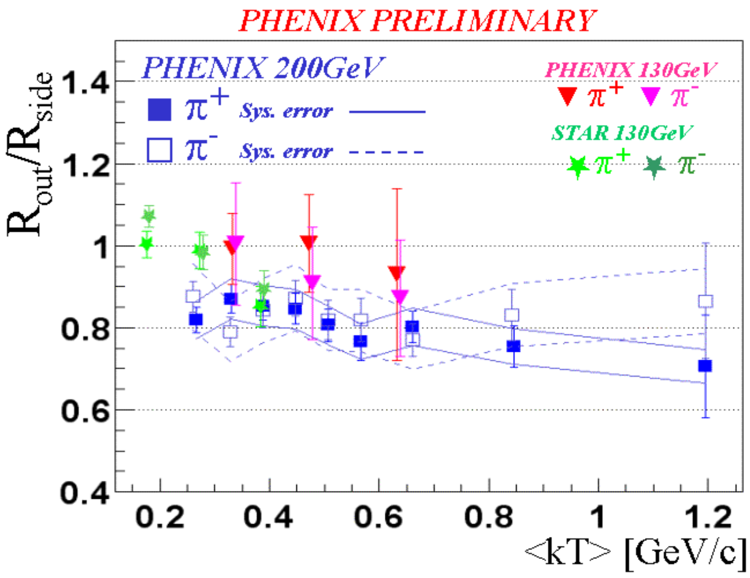
Static, transparent source

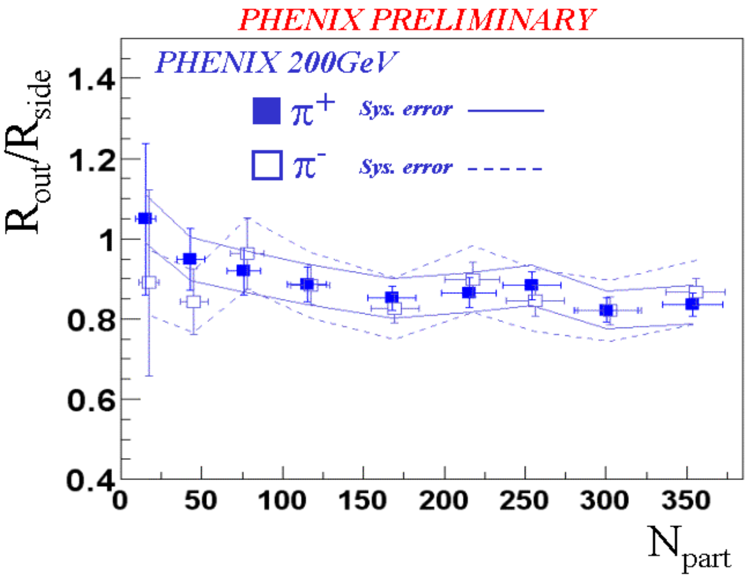
$$R_{out} / R_{side}$$

Rout/Rside <= 1
"HBT puzzle"

Motivation of this talk

- At QM02, we have shown the preliminary result of Bose-Einstein correlation of charged pion at sqrt(s_{NN}) = 200 GeV by PHENIX.





  - Coulomb effect was corrected by using the traditional “full” Coulomb correction.

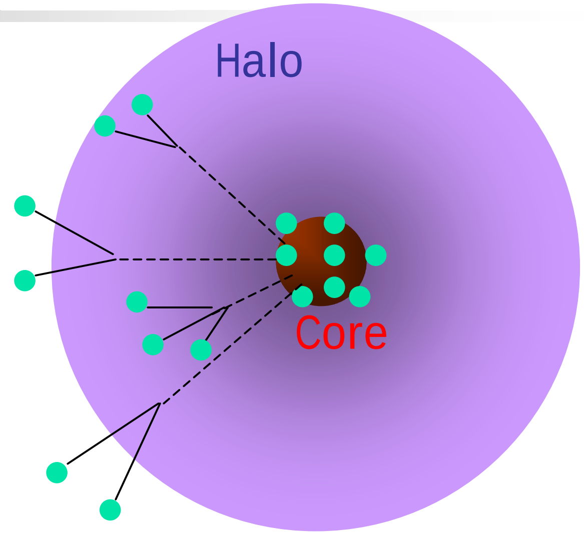
- Coulomb effect is corrected by using “partial” Coulomb correction based upon a picture of Core-Halo structure.

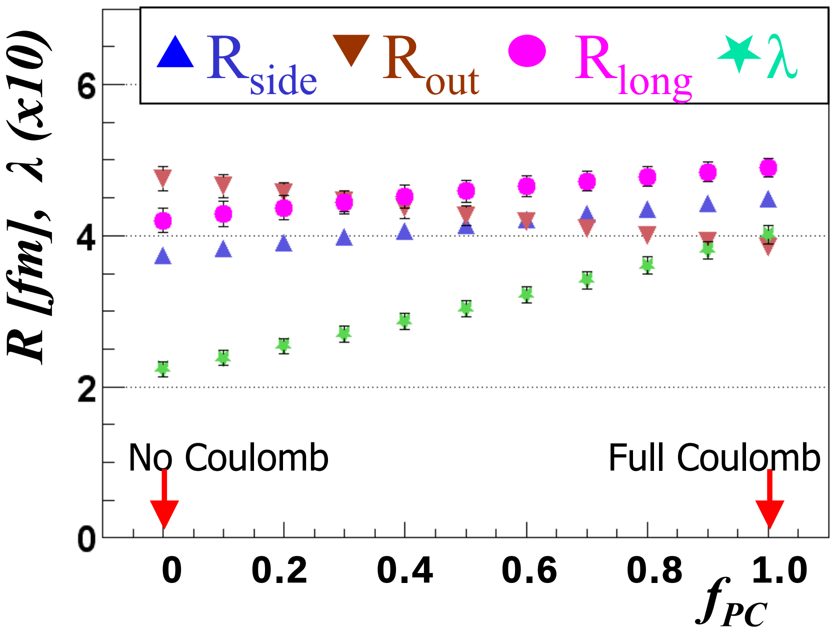
Why partial Coulomb correction?

Long-lived resonance contribution

• In the full Coulomb correction, all pion pairs are corrected by Coulomb wave function assuming a well localized (core) source ~5fm.

• In fact, pions from long-lived particles (resonance decays) come from a larger "halo" source, and these pairs have weaker (negligible) Coulomb effect.





f_{PC} dependence of Bertsch-Pratt radii

• Vary the fraction (f_{PC}) of Coulomb corrected pairs from 0 (no Coulomb) to 1 (full Coulomb).

• Rside and Rlong decrease as f_{PC} is reduced.

• In contrast, Rout increase as f_{PC} is reduced.

• The ratio Rout/Rside is very sensitive to f_{PC}.

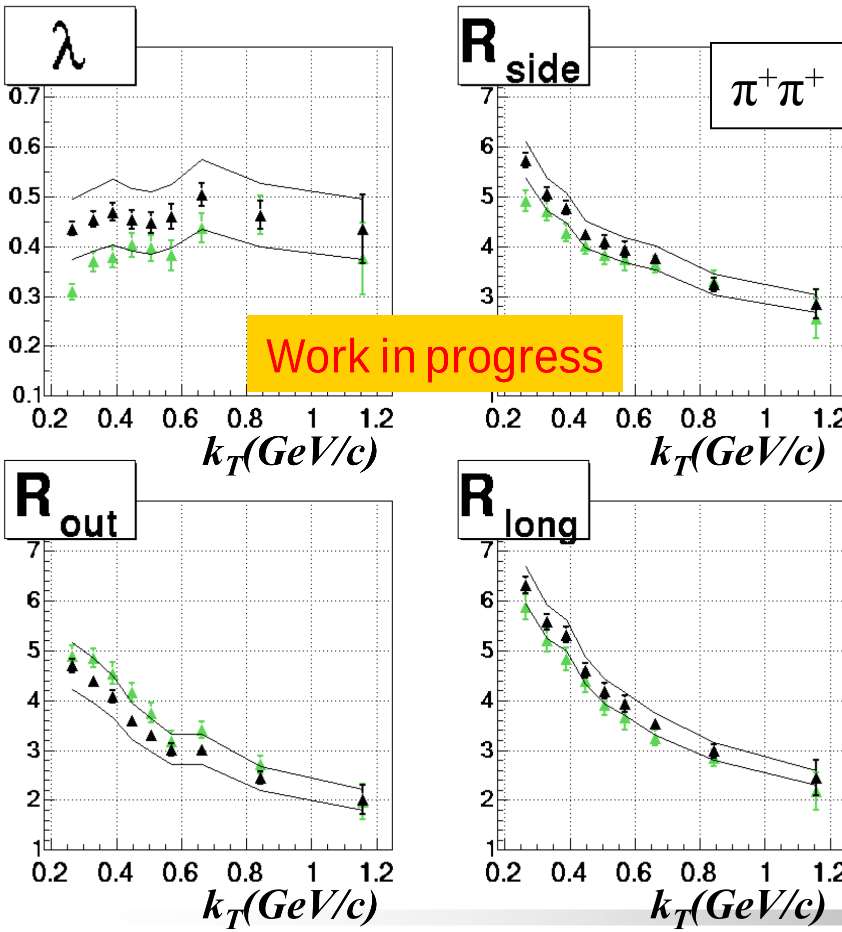
PHENIX

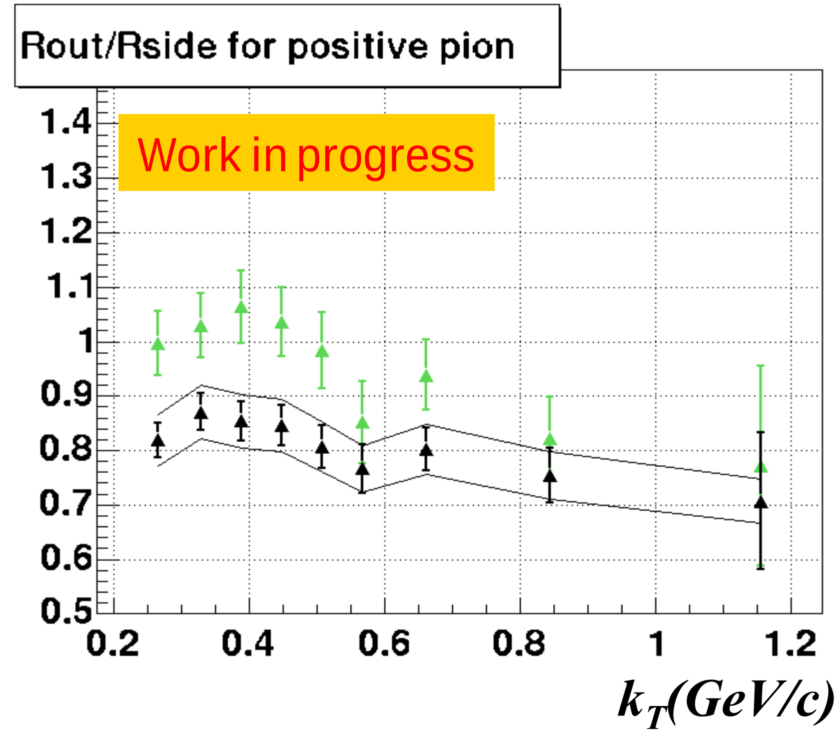
Scaled partial Coulomb. (Work in progress)

A simple inspection of partial Coulomb correction with the usual fit function.

▼ *"Full" Coulomb (preliminary@QM02)*

▼ *50% scaled partial Coulomb*





$$C_2(q) = \frac{A_{\text{Coulomb corrected}}(q)}{B_{\text{Normalized}}(q)}$$

$$= 1 + \lambda G \quad \text{(usual fit function)}$$

Fit to Core-Halo structure (Sinyukov's fit)

We fit the correlation function with a core-halo parameterization.

(Yu.M. Sinyukov et al, Phys. Lett. B 432 (1998) 248)

$$C_2^{raw}(q) = \frac{A(q)}{B_{Normalized}(q)} = C_2(Core) + C_2(Halo)$$

$$= \left[\lambda'(1+G)\cdot F^*\right] + \left[1-\lambda'\right]$$

$$\text{where } F^* = (\lambda/\lambda')\left(F_{coul}(q_{inv})-1\right)+1,$$

Momentum resolution effect on the lambda (λ/λ') is estimated by using MC.

(Systematic error estimate)

Many of relatively long-lived particles (e.g. eta, eta'), which have a Bose-Einstein interference too narrow to be resolved by experiment, also have a Coulomb interaction.

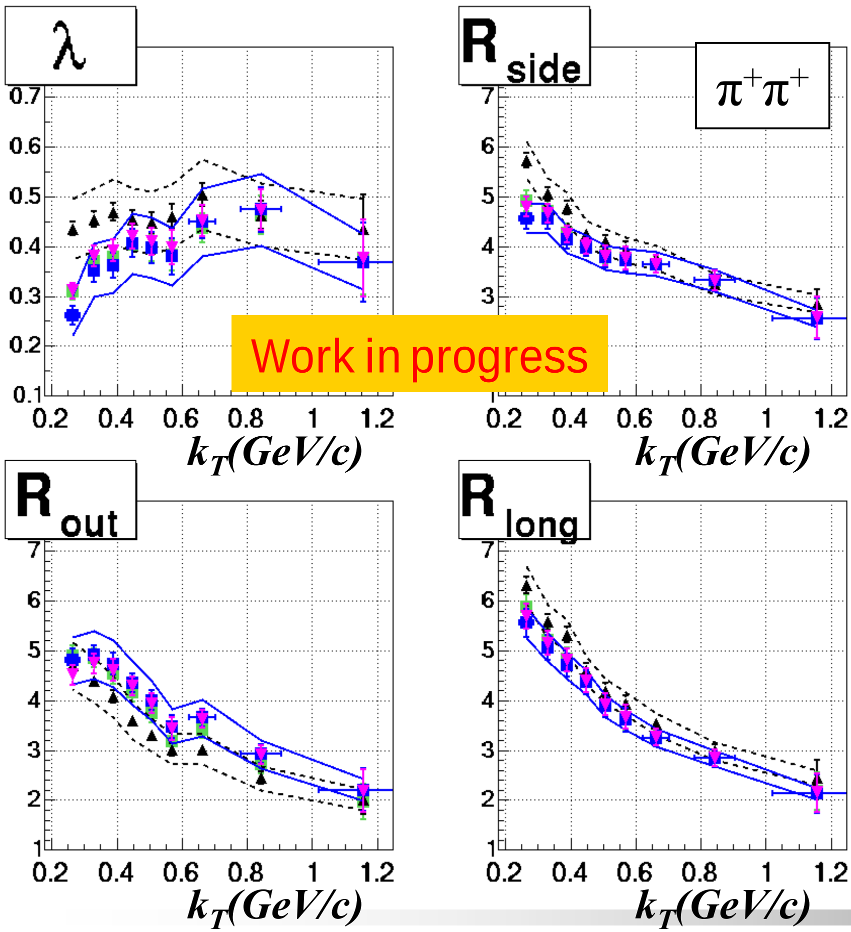
$$C_2^{raw}(q) = C_2(Core) + \underline{C_2(Coulomb\,only)} + C_2(Halo)$$

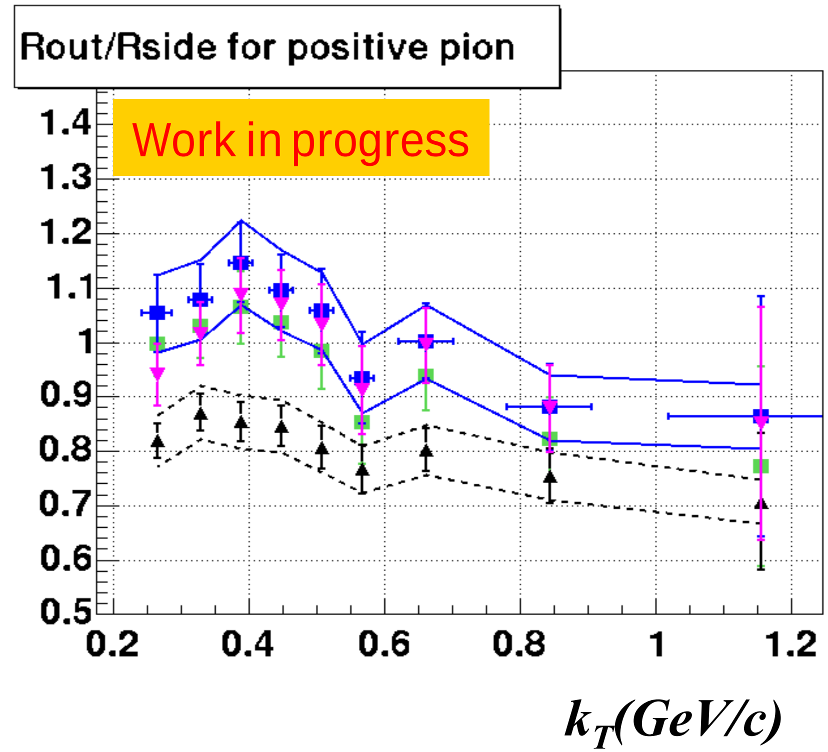
$$= \left[\lambda'(1+G)\cdot F^*\right] + \left[F^*(0.5-\lambda')\right] + \left[0.5\right]$$

Coulomb fraction "0.5" is the value estimated by chi² test using C(pi+pi-).

k_T dependence (work in progress)

- ■ *Fit to Core-Halo structure (Sinykov's fit)*
- ▼ *Modified fit to Core-Halo with 50% Coulomb*
- ■ *Scaled 50% partial Coulomb*
- ▲ *"Full" Coulomb (preliminary@QM02)*

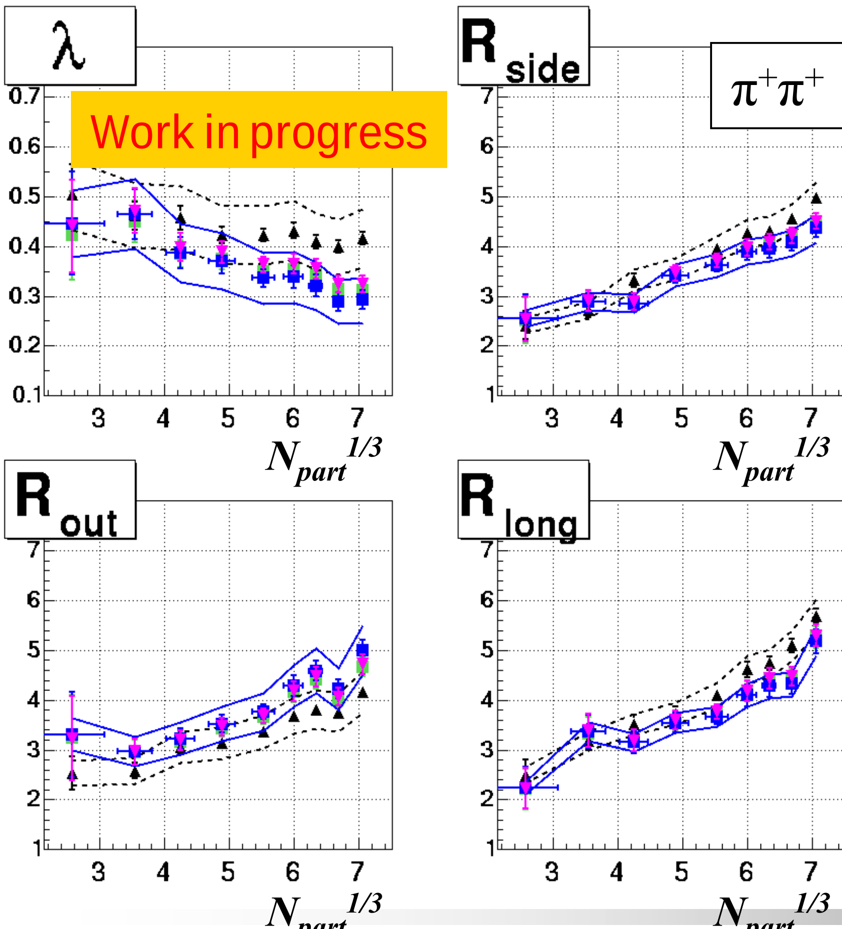


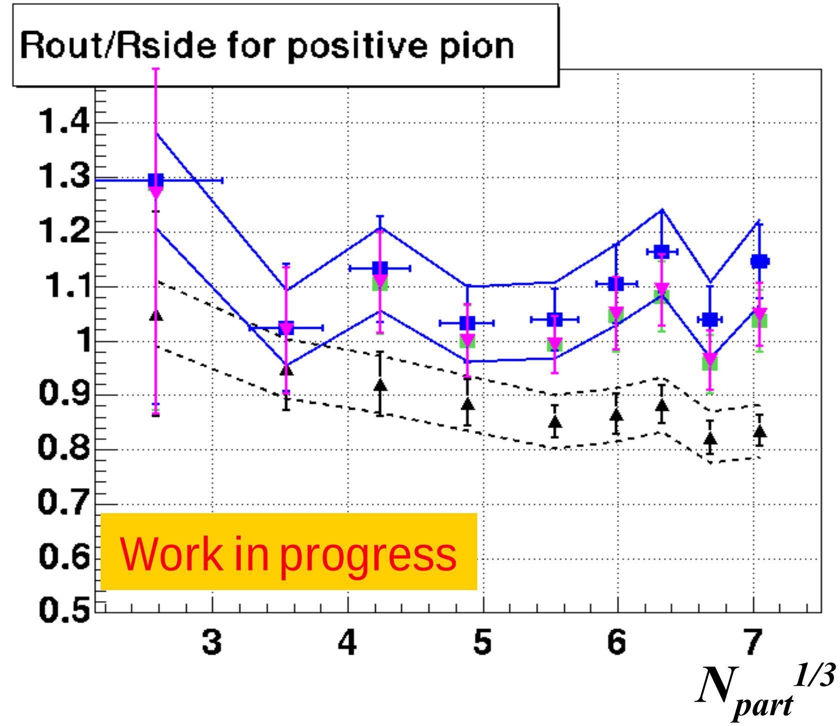


R_{out}/R_{side} ratio for the core source is larger than that of with "full" Coulomb correction and slight over unity at low-k_T region

Centrality dependence (work in progress)

- *Fit to Core-Halo structure (Sinykov's fit)*
- *Modified fit to Core-Halo with 50% Coulomb*
- *Scaled 50% partial Coulomb*
- *"Full" Coulomb (preliminary@QM02)*



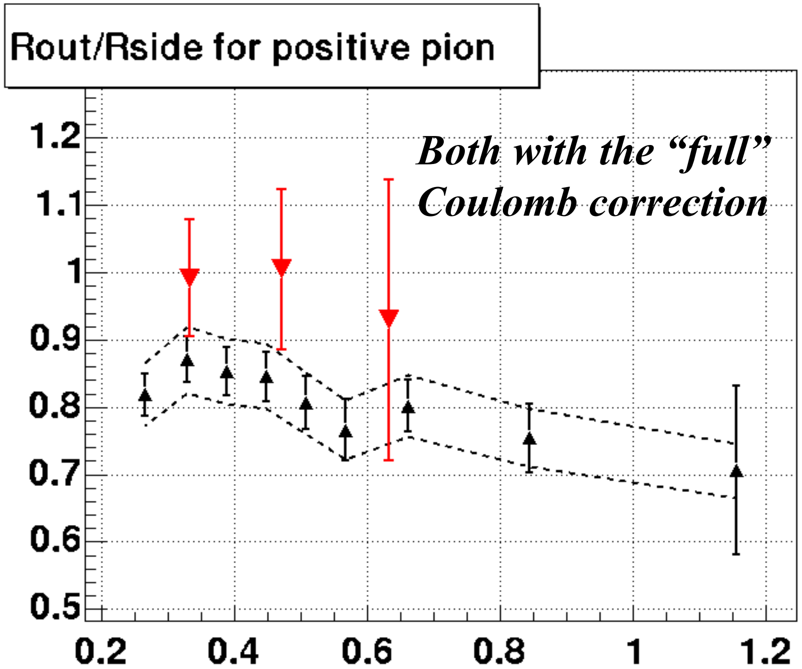


R_{out}/R_{side} ratio for the core source is larger than that of with "full" Coulomb correction, especially at high N_{part} region

Prospect

Why is the R_{out}/R_{side} ratio still around unity?

We are working on pair efficiency correction by MC for looser pair separation cuts.



▼ ***PHENIX 130 GeV***

Pair inefficiency correction by MC
\+ Loose pair separation cuts

▲ ***PHENIX 200 GeV preliminary***

Tight pair separation cuts

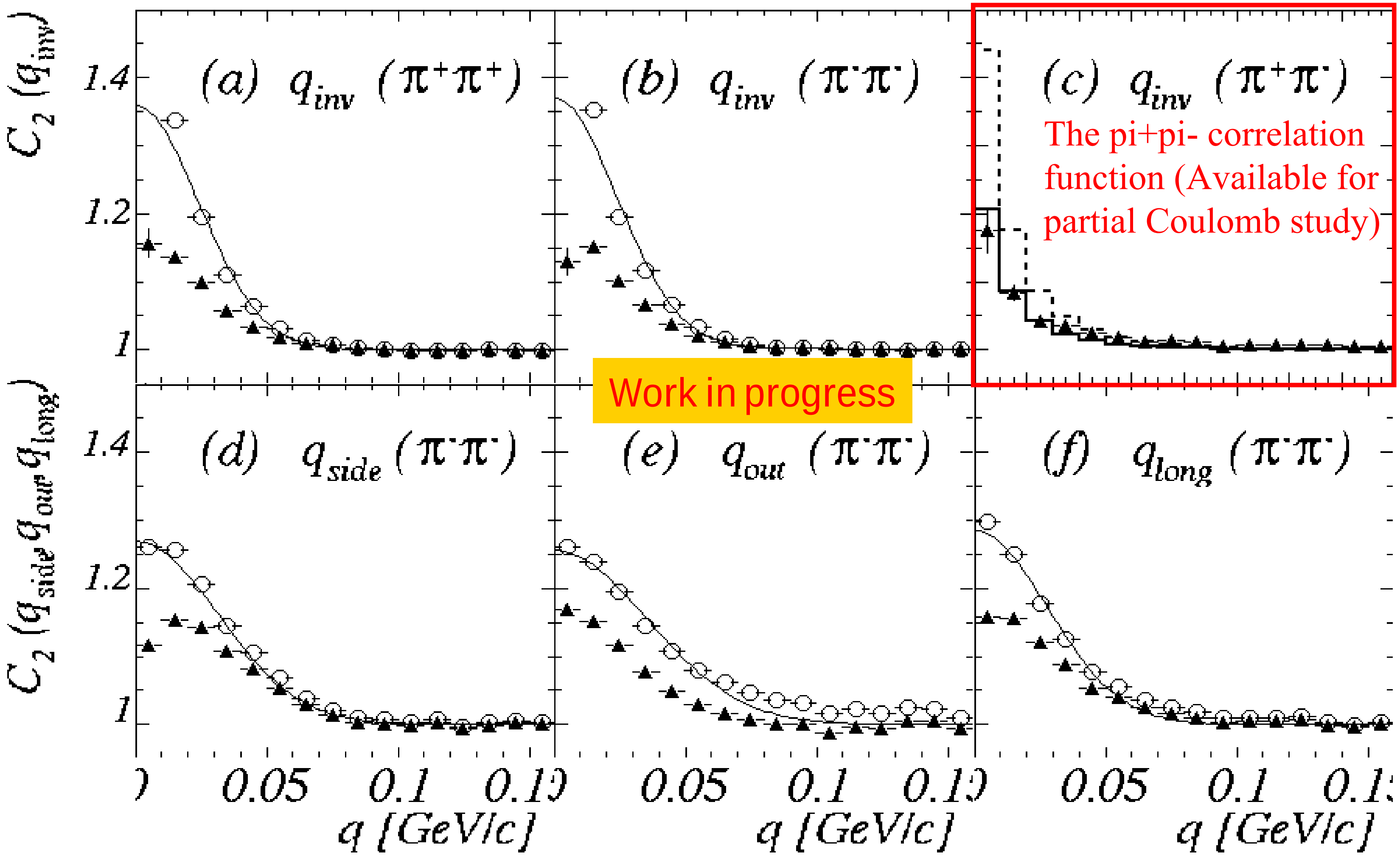
Summary

- We have presented HBT results in the Bertsch-Pratt frame for identified charged pions measured by PHENIX in Au+Au collisions at $\mathrm{sqrt}(s_{NN}) = 200$ GeV.
  - The pion radius parameters fall by a factor of ~2 as k_T is increased from 0.2 to 1.2 GeV/c and are in agreement with the results at $\mathrm{sqrt}(s_{NN}) = 130$ GeV.
  - R_{out}/R_{side} ratio is equal to or slightly smaller than unity within the errors when we apply the traditional "full" Coulomb correction.
- More realistic HBT radius parameters are obtained with a new fit technique based upon a core-halo source structure.
  - R_{out} is decrease while R_{side} and R_{long} slightly increase.
  - R_{out}/R_{side} of the core source is significantly increase from the result with the full Coulomb correction, especially low-k_T and high N_{part} regions.
  - The excessive "full" Coulomb correction seems to be part of the cause for "HBT puzzle" ($R_{out}/R_{side} < 1$).

Back-up slide

The correlation functions. (work in progress)

▲ Raw correlation function ○ "full" Coulomb corrected



0.2<kT<2.0 GeV/c, Top 30% central collision

PHENIX