HBT

Recent Devlopments & Historical Perspectives

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Outline

- Why I should not give this talk
- Why I will give it anyway
- Historical perspectives
- Recent results, a closer look
- The Partial Coulomb Correction & New Techniques

Answers

- Why I should not give this talk

  - Results the work of A. Enokizono, M. Heffner, J. Burward-Hoy, S. Johnson (I'm just an administrator)

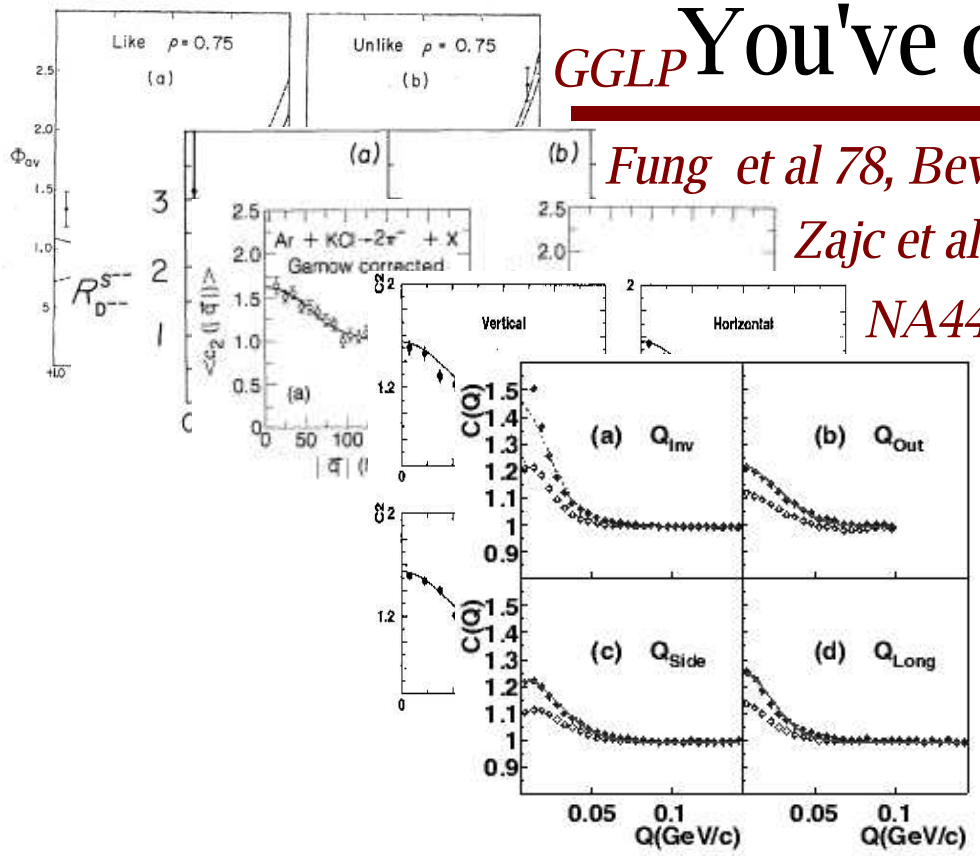
  - Short on new results, long on opinions

  - Introduction unoriginal, see QM95 pre-conference workshop

- Why I will give it anyway

  - That's what administrators do!

GGLP You've come a long way baby!



Fung et al 78, Bevalac

Zajc et al 84, 2D, Gamow

NA44 95, 3D, kT dependence

STAR 01, RHIC

GGLP 60, 1'st Theory

Kopylov 74, Heavy Ions

Gyulassy 79, Gamow , etc

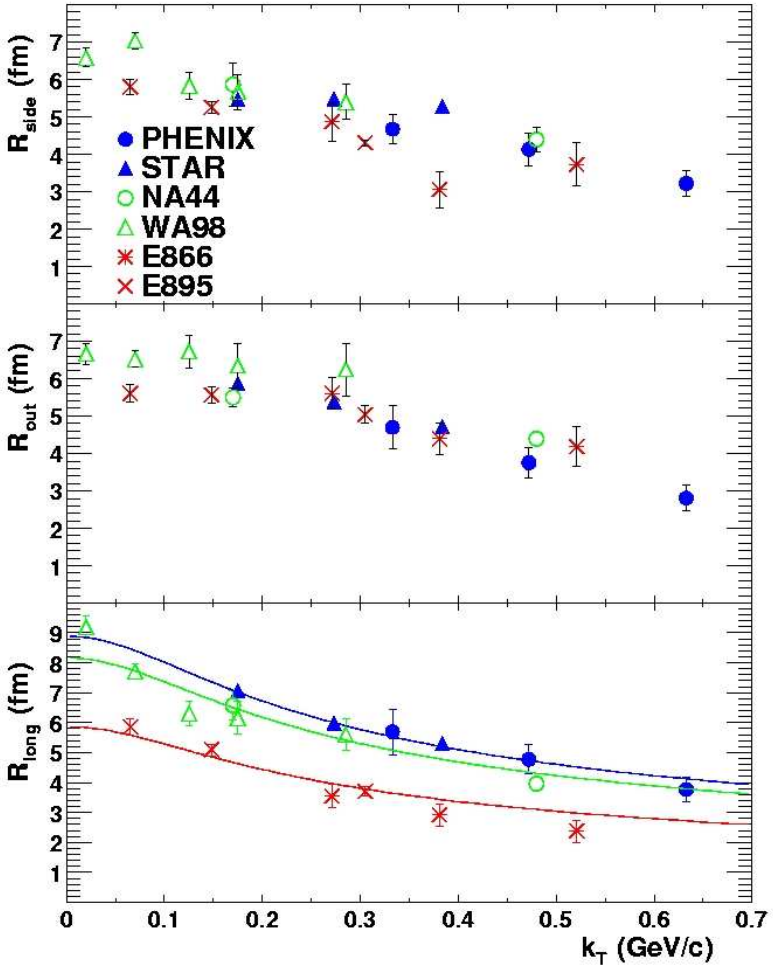
Pratt 84, kT dependence

Csorgo+ 96, core/halo, flow

Analysis advances driven by data quality

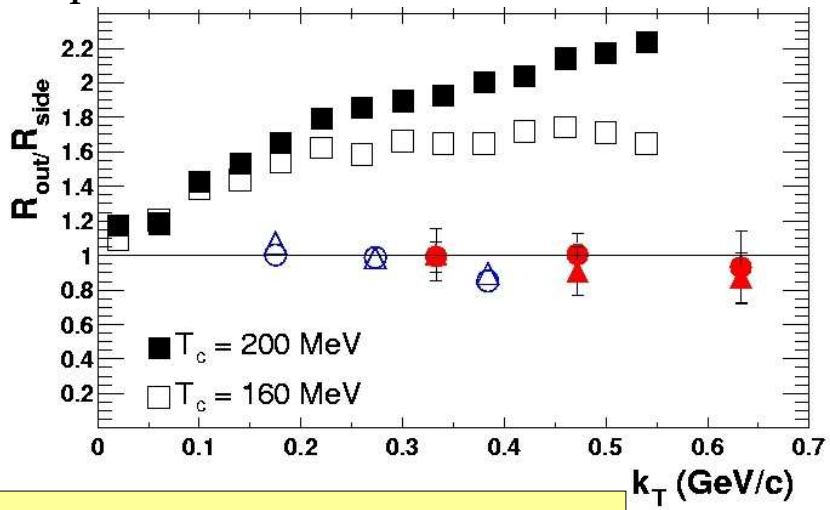
PHENIX Run-1 HBT

Phys. Rev. Lett, 88:192302 (2002)



Everything you need to know about Run-1 HBT

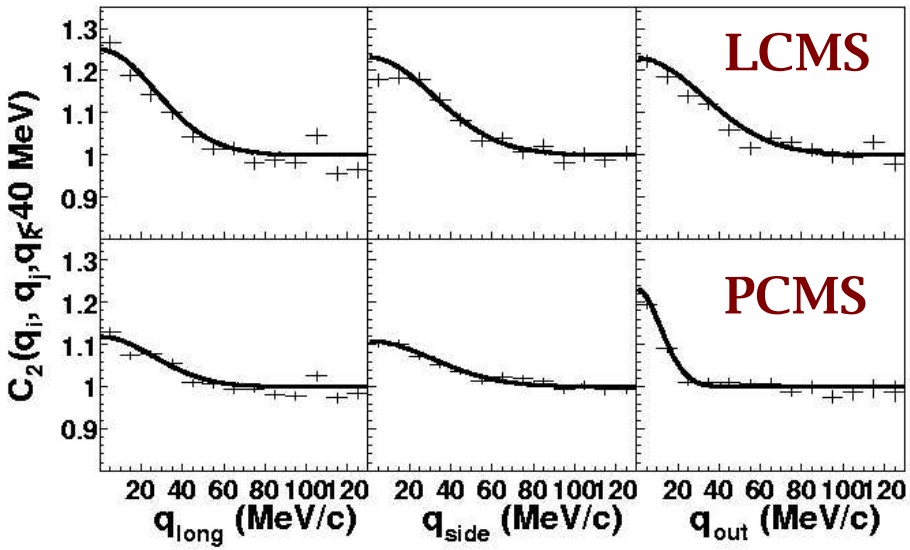
- Sys+Stat errors appear >1/2 fm
- $R_s, R_o(k_T)$ similar to <1 fm
- R_l depends on energy



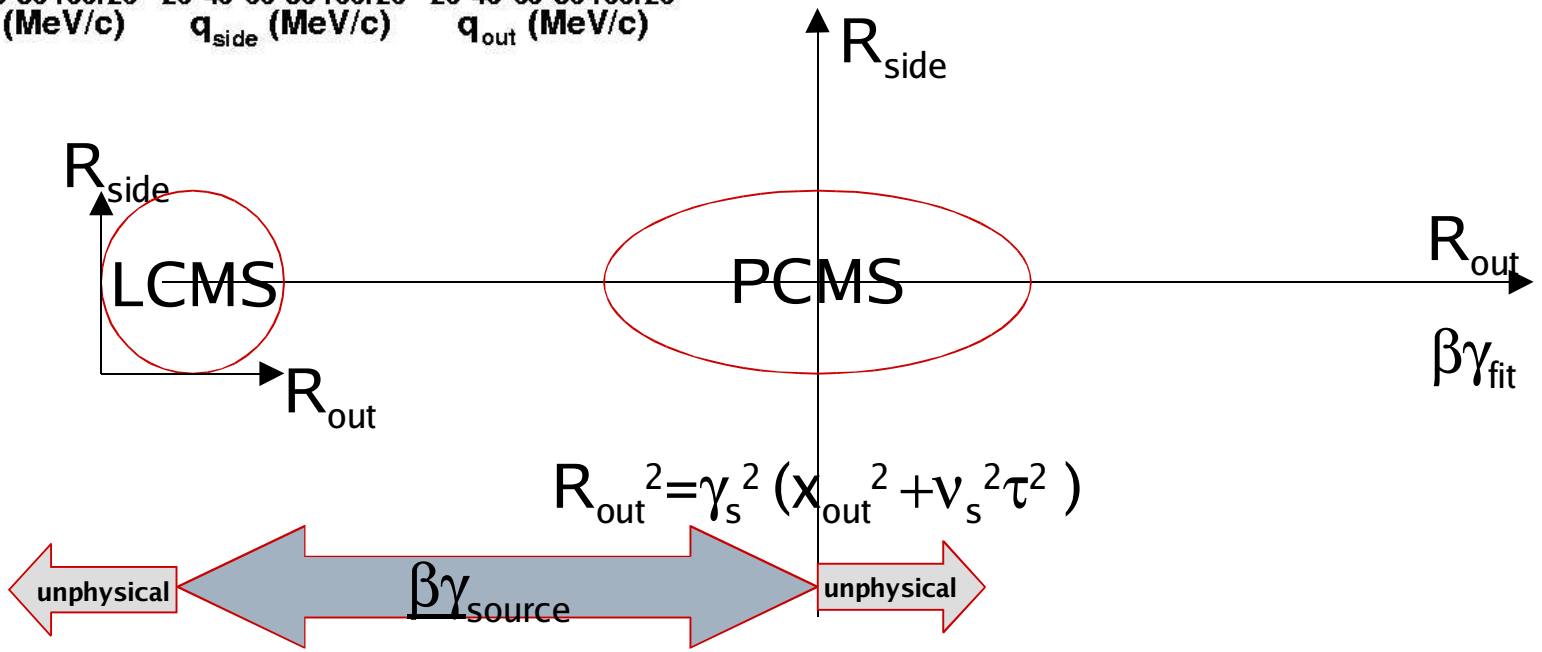
No smoking R_{out}/R_{side} gun

more PHENIX Run-1 HBT

PRL, 88:192302 little known result



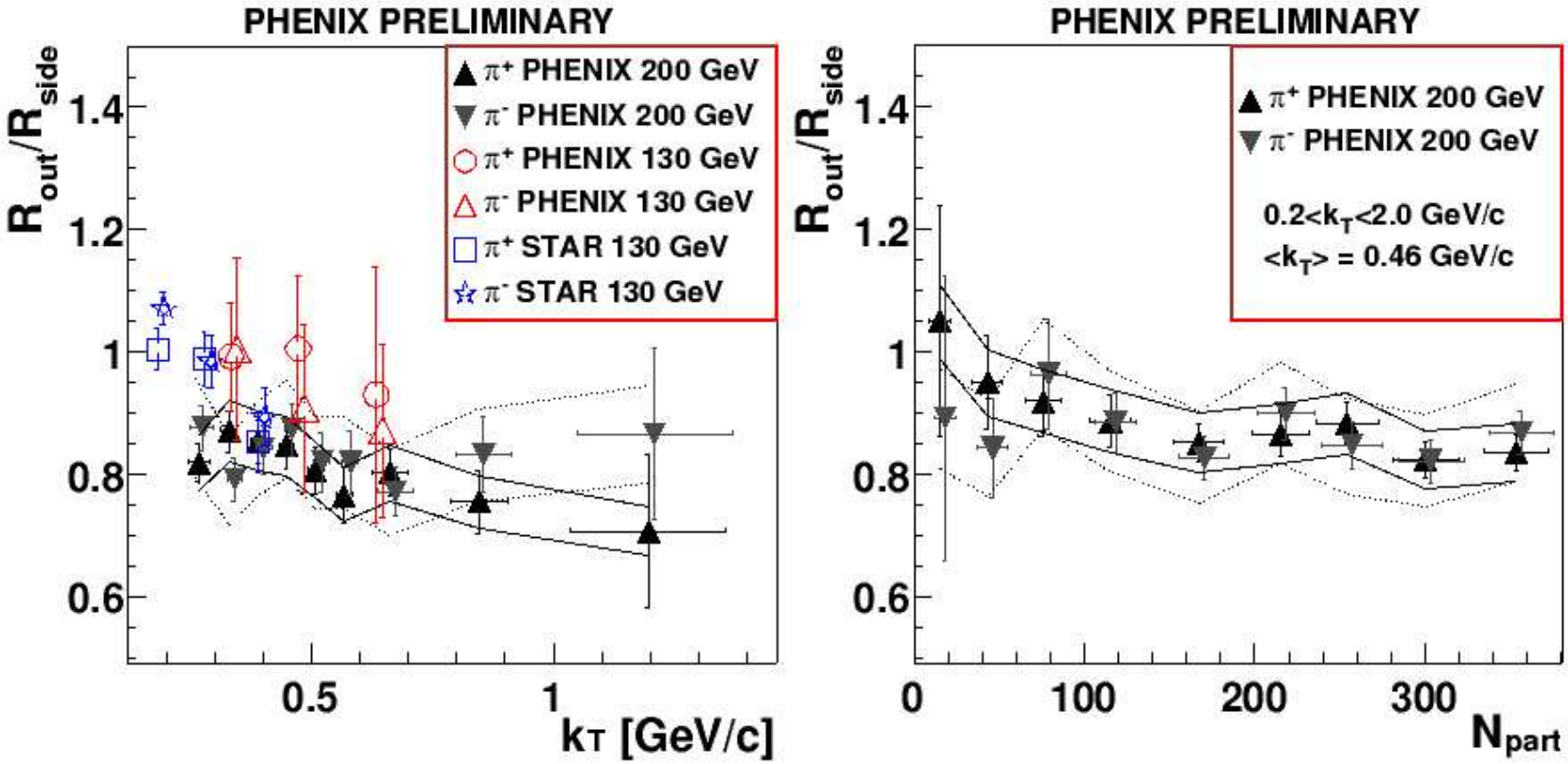
R_{out} increases monotonically as one moves from LCSM to PCMS (Pair Center of Mass System)



Physics same in LCMS, but easier in PCMS

PHENIX Run-2 Preliminiary

- 9 bins in k_T, (0-30%) centrality
- 9 bins in centrality, $\langle k_T \rangle$ = 0.46 GeV/c



The gun has not taken up smoking at 200 GeV

Leave theory to theorists, focus on data (for now)

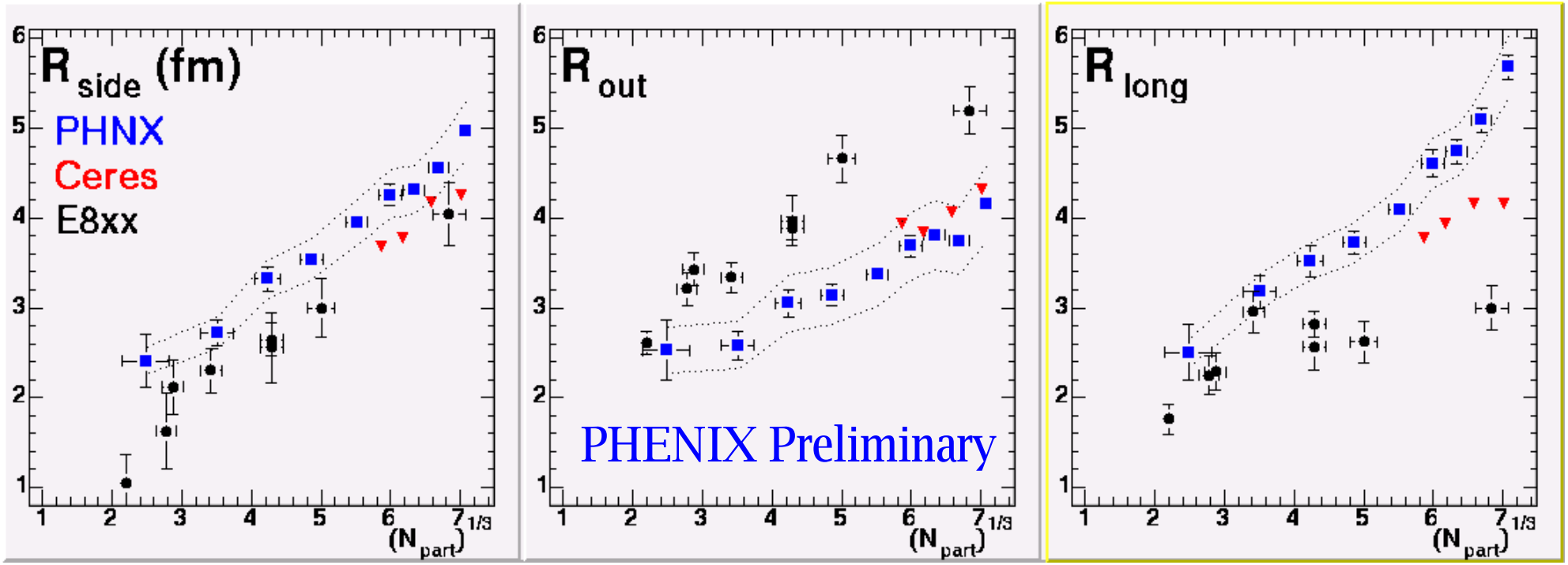
Centrality, a closer look

Phys. Rev. C, 66:054906 (2002) and nucl-ex/ 0207005

k_T caveat

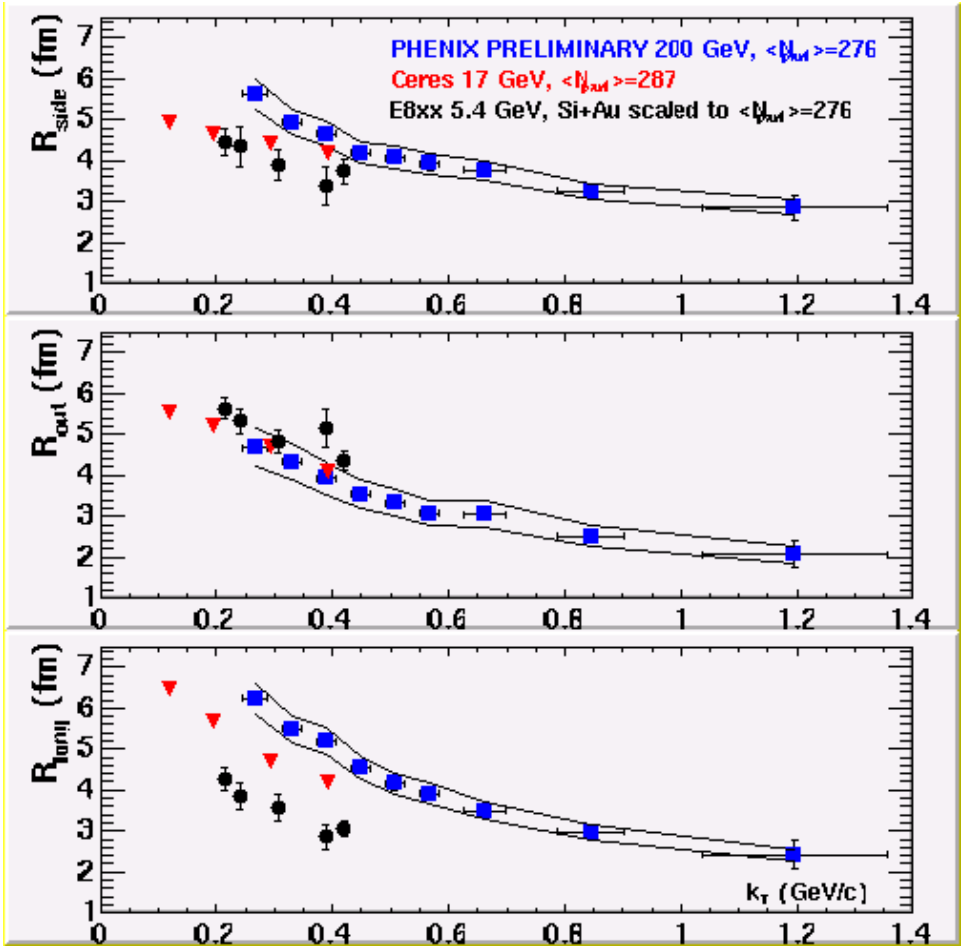
sqrt(s) GeV	kT GeV/c
200	0.46
17	0.39
5	0.32

- All radii exhibit linear $<N_{part}>^{1/3}$ scaling
- *with* energy dependence



How can something so simple be so puzzling?

Run-2 vs k_T, controlling centrality



Energy dependence

- R_{side} slight increase
- R_{long} increasing
- R_{out} not yet significant

Energy differences becoming more apparent

Need better control of systematic errors

Beating down systematic errors

- Statistical errors now approaching 2-3%!
- Sys. errors same range for most Exp.
  - momentum resolution
  - two-track resolution
  - fitting techniques
  - residual correlations
- *Partial Coulomb* correction hovers ~5%

Partial Coulomb needs a closer look

The Partial Coulomb Correction

Ceres – Y.M. Sinyukov et al, Phys. Lett, B432:248 (1998)

A pretty good approximation

Only core contributes to symmetrization and coulomb effects

- F = coulomb correction
- G = gaussian (symmetrization)

$$C_2 = C_{core} + C_{halo}$$

$$C_2 = \lambda F(1+G) + (1-\lambda)$$

Resonances – Weidemann and Heinz, Phys. Rev. C 56:3265 (1998)

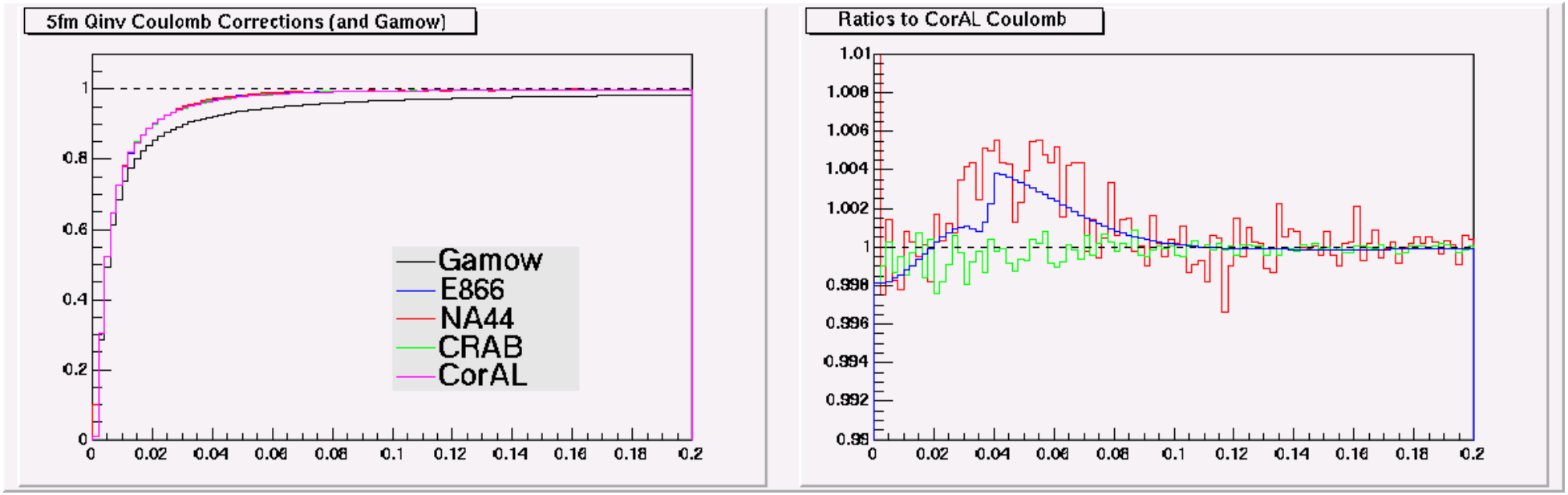
Maybe a better approximation

- core = direct + ρ + K* + Δ + Σ*
- halo = all else except ω-ω, ω-core, and omit $(1+G_\omega)$ term

$$C_2 = \lambda_{core} F_{core}(1+G_{core}) + \lambda_\omega F_\omega + (1-\lambda_{core}-\lambda_\omega)$$

Days of λ as fudge factor are numbered

One thing we do know

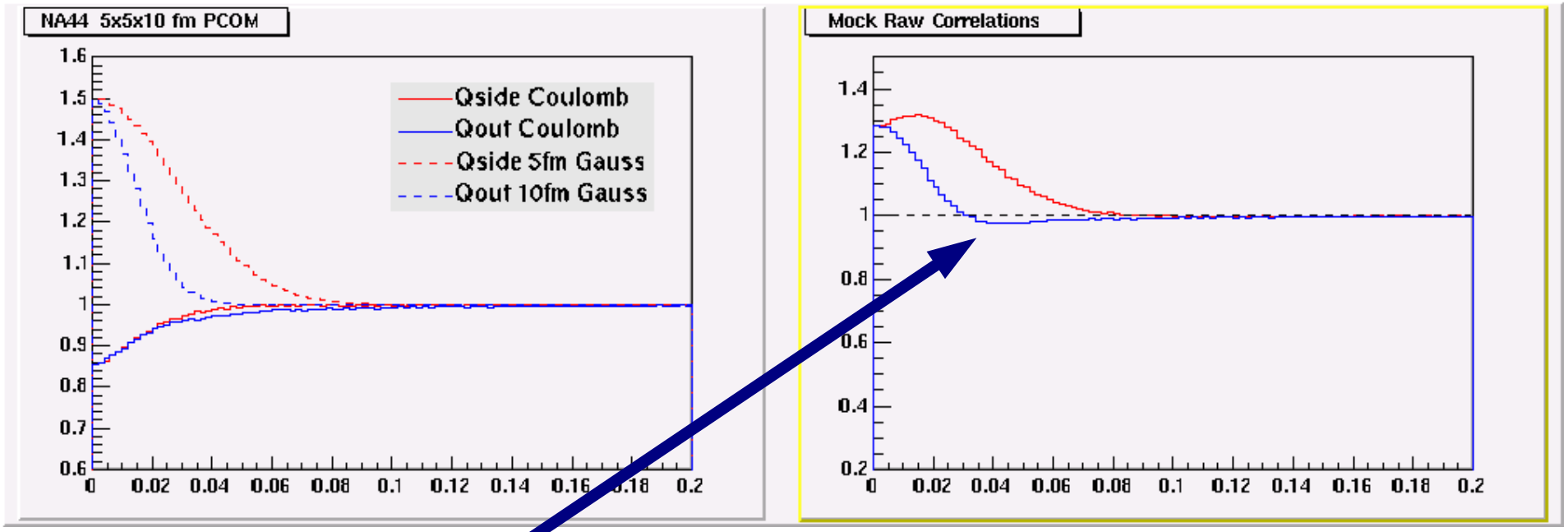


Four different methods to integrate Coulomb Waves

- E866 – M.Baker, MAXIMA integration
- NA44 – S. Pratt & T. Humanic, Fast MC integration
- CRAB – S. Pratt, MC integration
- CorAL – M. Heffner & D.Brown (Correlation Algorithm Library)

Coulomb corrections differ by 0.5% or less

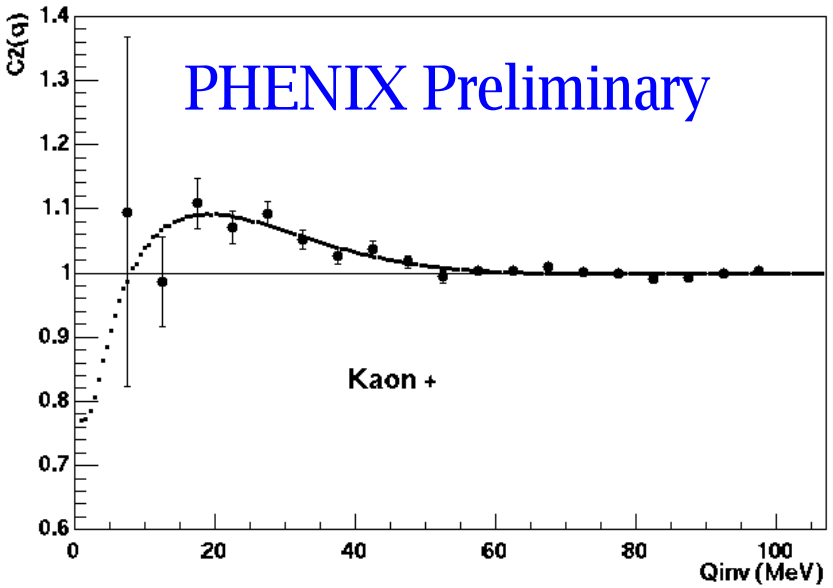
Fit λ_ω where coulomb dominates

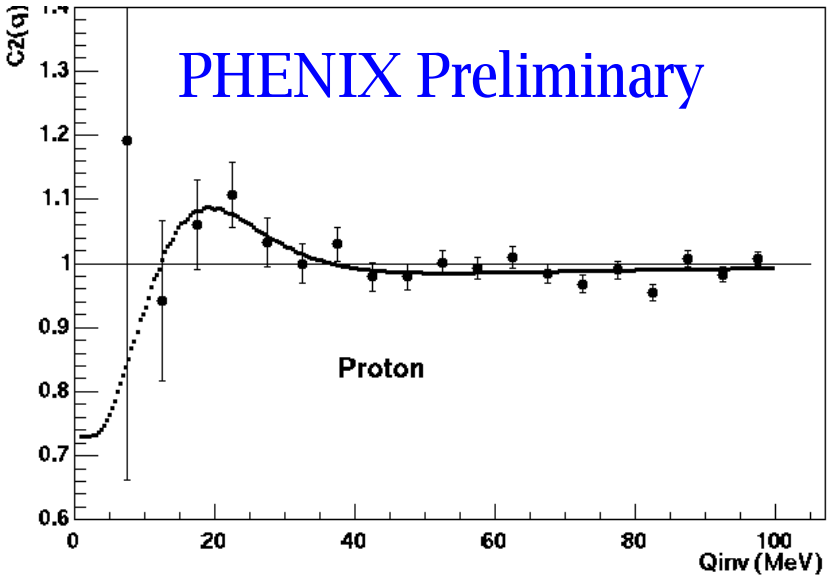


- $0.03 < q_{out} < 0.05$ GeV/c in PCMS is one place
- similar region in LCMS occurs further out in q
- $\pi^+\pi^-$ correlation is another

Can we avoid the correction altogether

Direct fits to Kaons and Protons



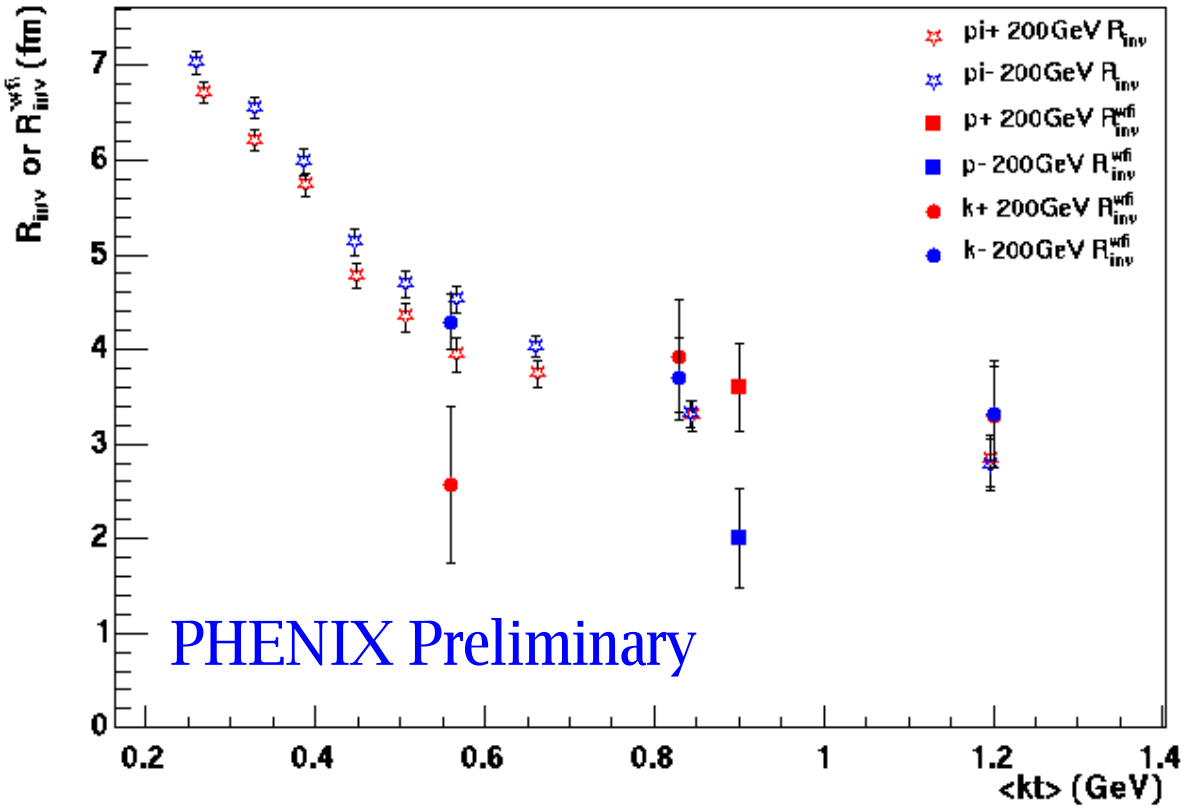


Fits to raw correlation functions

- Corrected only for 2-track
- 1D CorAL fits
- kaons and protons
- Extendable to 3D in principle
- Includes partial coulomb

Brute force source imaging

CorAL results with 2π $R_{inv}(k_T)$



Easily extendable to non-identical particles

Conclusions

- Slow and steady progress in HBT the result of good theoretical input and vastly improved data
- Systematic trends reveal subtle and not so subtle variation with N_{part}, k_T, *and* energy
- Systematic errors from coulomb still loom large, but not for long
- New methods show promise for the future