HBT Measurements "at RHIC"

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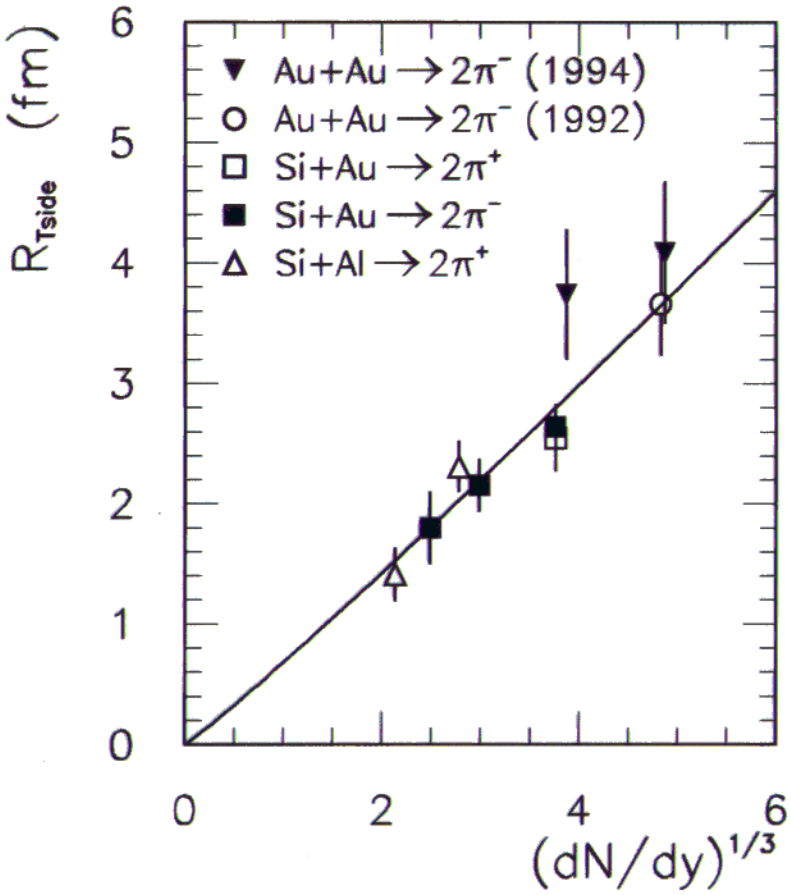
- Current Data (AGS/SPS)
  - System, rapidity dependence
  - Dynamics: k_T dependence
  - A puzzle (beam E dependence)
- Outlook (RHIC)
- Conclusions

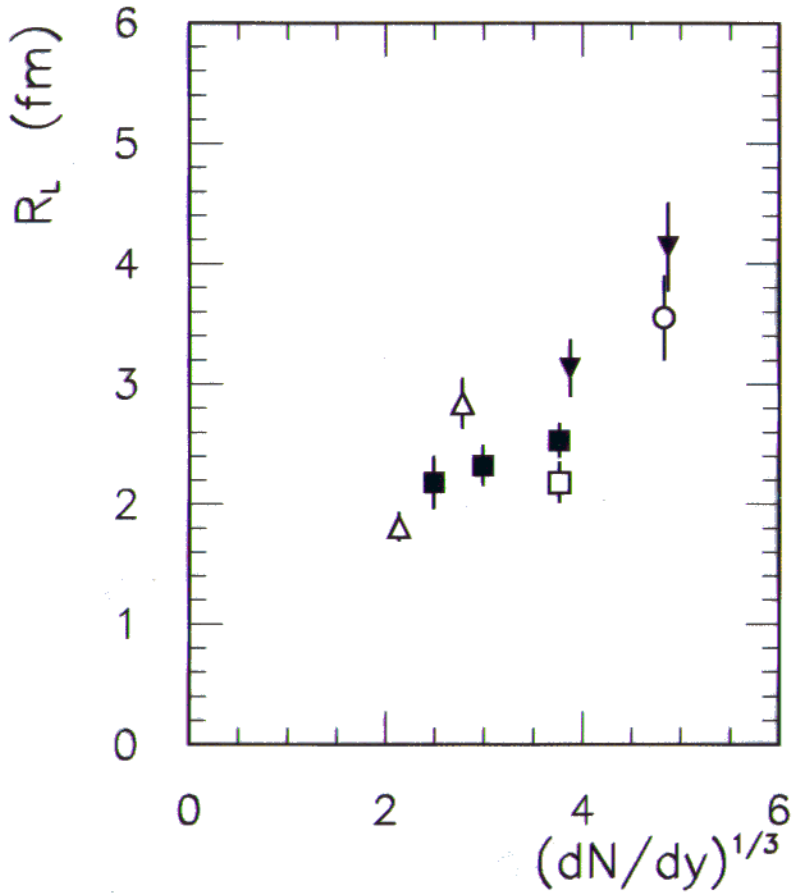
AGS Centrality Dependence (radius)

E866 (Baker, Soltz et al.) Preliminary 11-15 AGeV/c

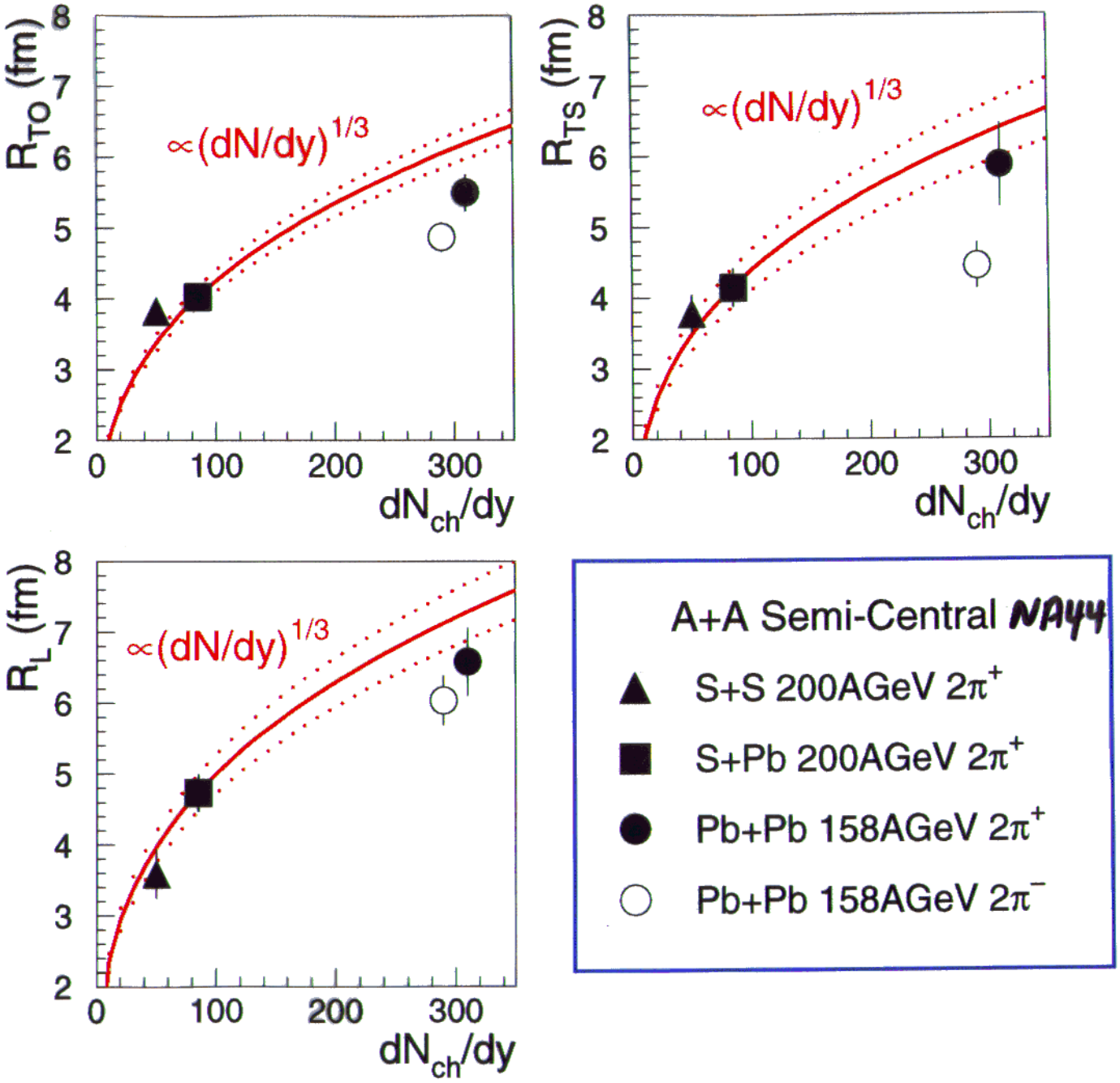
Geometric Radius (transverse)



Longitudinal Length param.

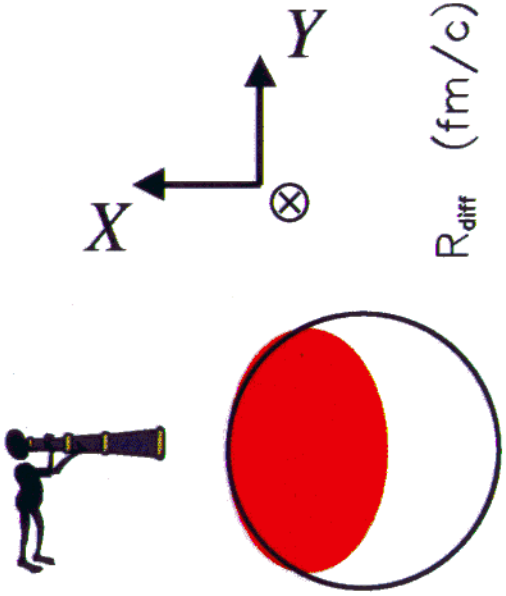


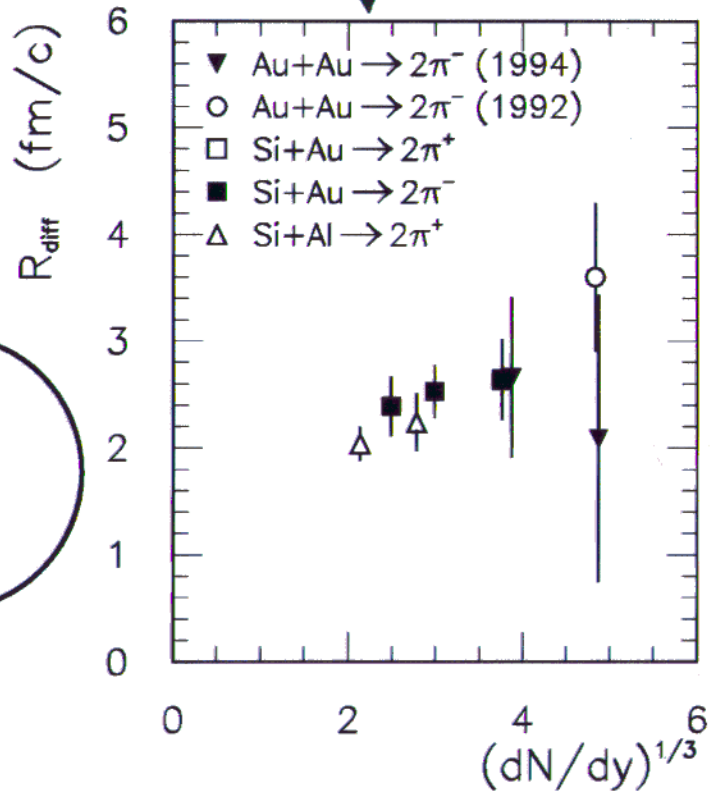
$$R_{Ts} = (0.68 \pm 0.22) \bullet (dN/dy)^{0.355 \pm 0.085}$$

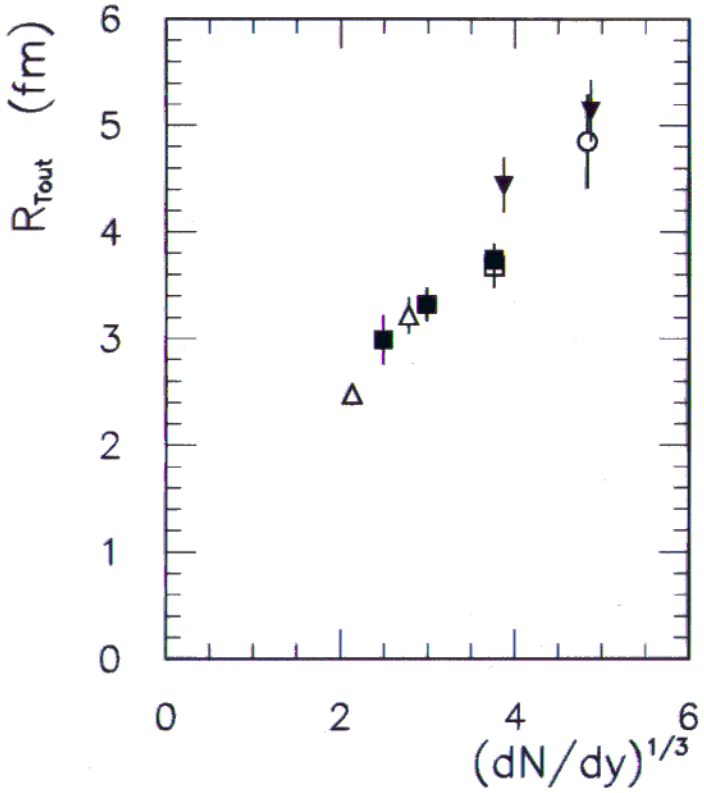

R_{TO} (fm)
$\propto (dN/dy)^{1/3}$
dN_{ch}/dy
R_{TS} (fm)
$\propto (dN/dy)^{1/3}$
dN_{ch}/dy
R_L (fm)
$\propto (dN/dy)^{1/3}$
dN_{ch}/dy
A+A Semi-Central NA44
S+S 200AGeV $2\pi^+$
S+Pb 200AGeV $2\pi^+$
Pb+Pb 158AGeV $2\pi^+$
Pb+Pb 158AGeV $2\pi^-$

Centrality Dependence (lifetime)

$$R_{diff}^2 = \beta_\perp^2 (\Delta\tau)^2 + (X^2 - Y^2) - 2\beta_\perp \sigma_{xt}^2$$

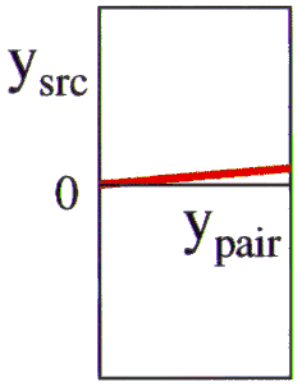


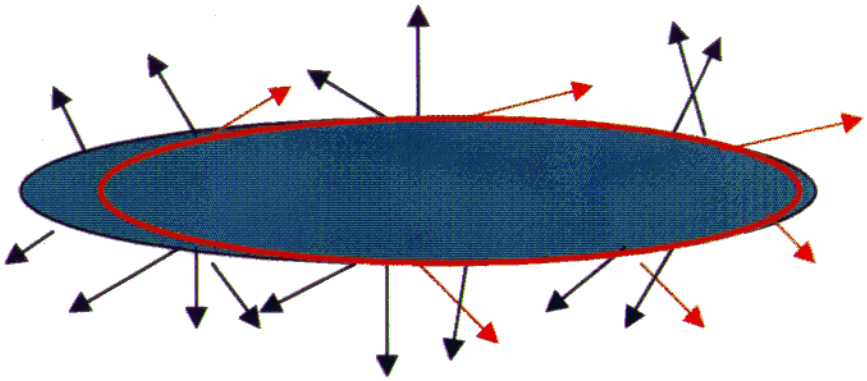




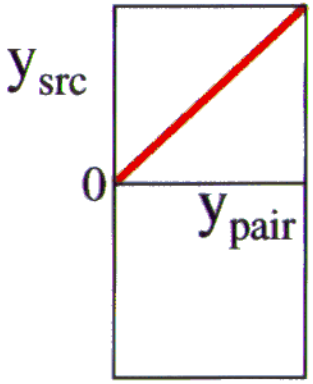
YKP Source Velocity

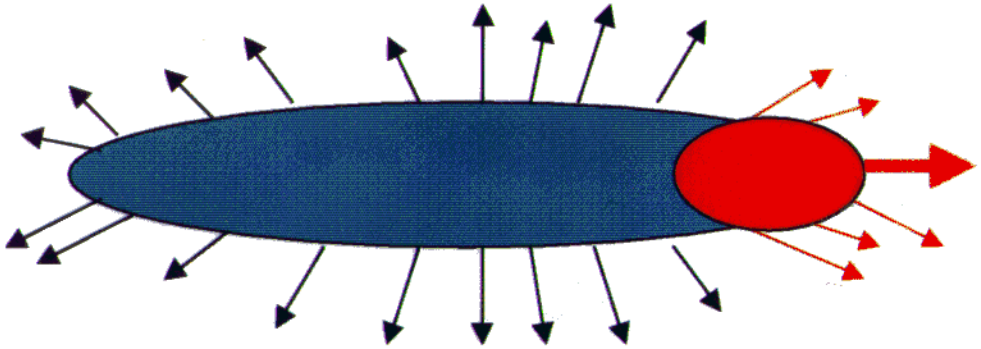
Static Source:
Y_{source}~0 (mid.-rap.)





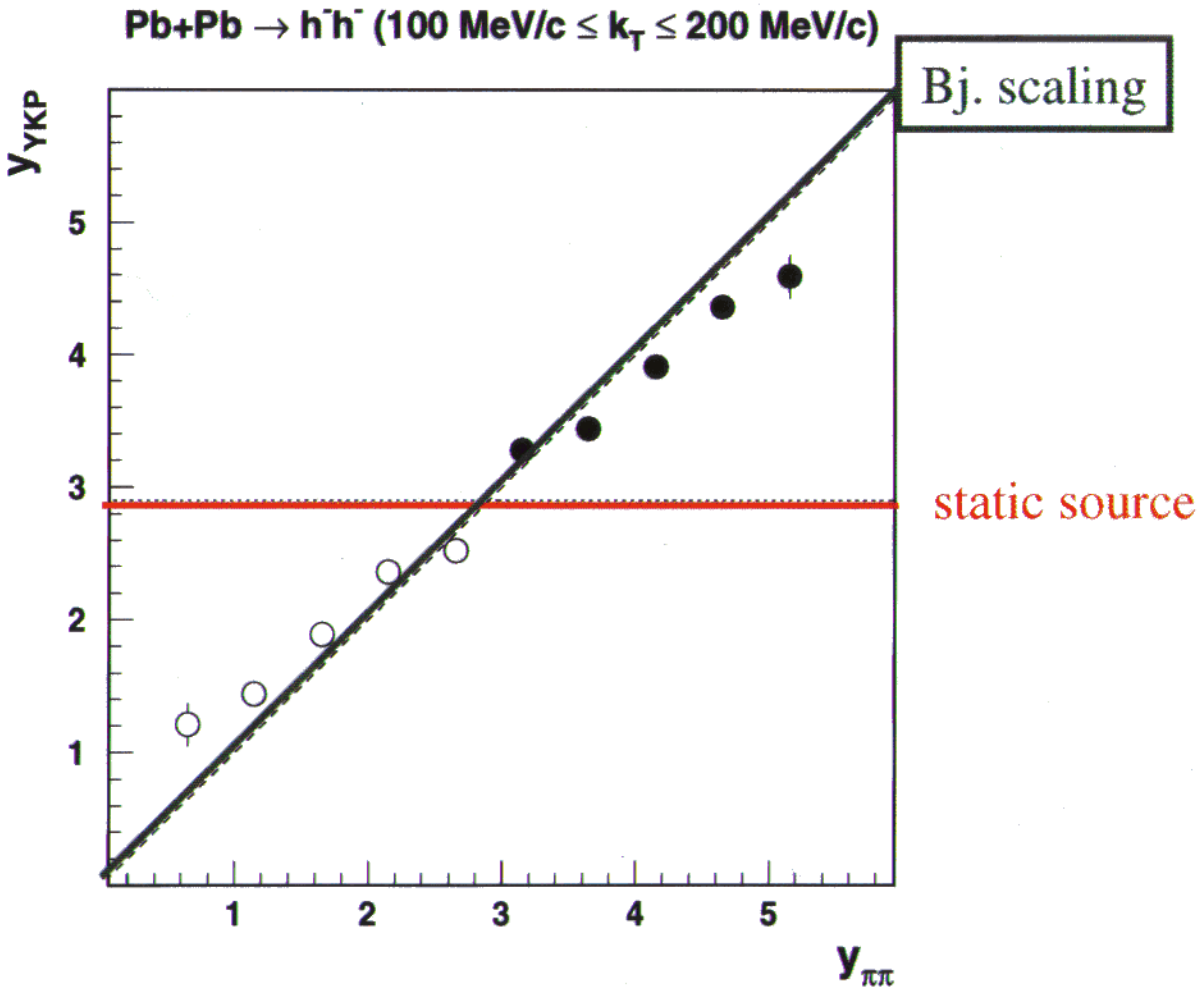
Scaling Source:
$Y_{source}=Y_{pair}$



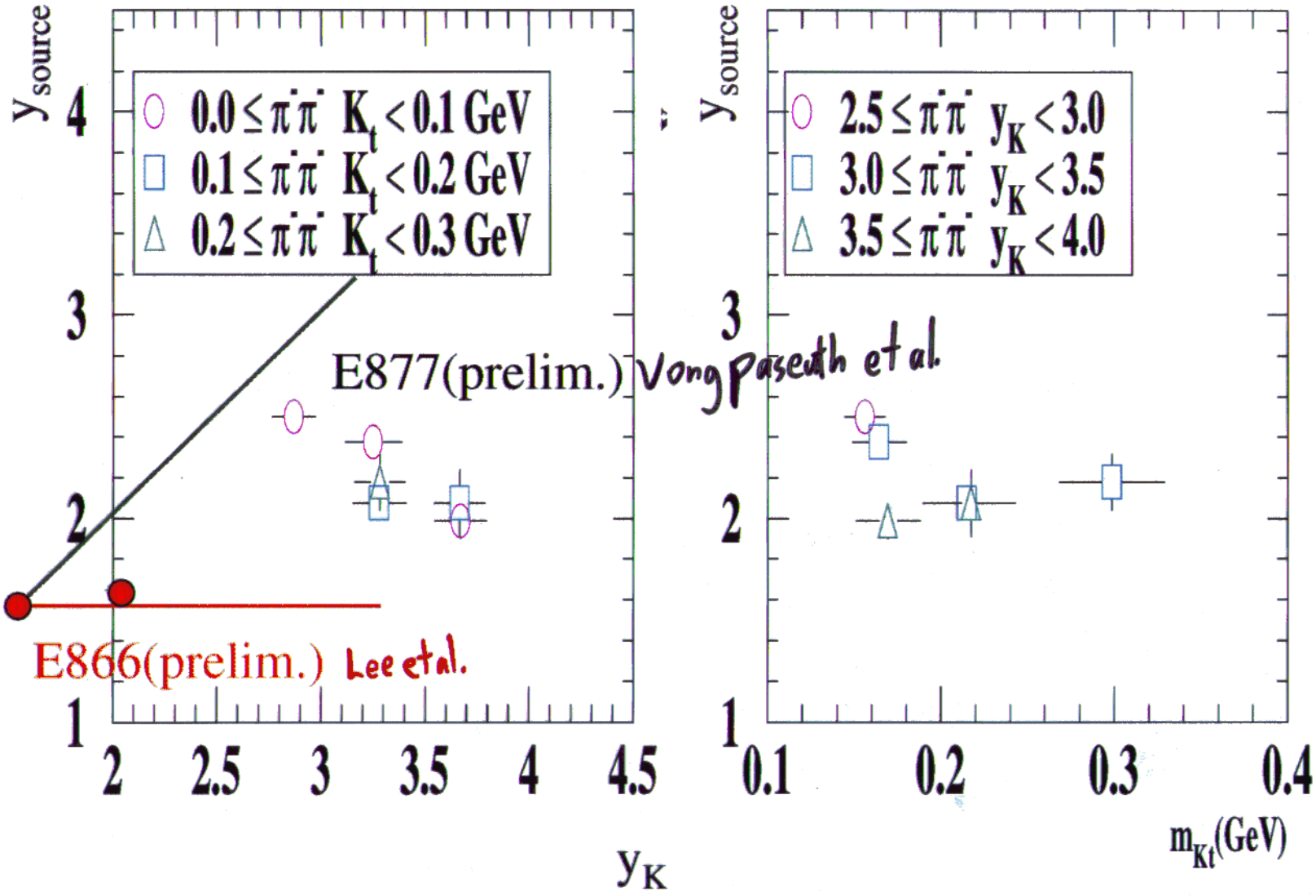


Source Rapidity (SPS)

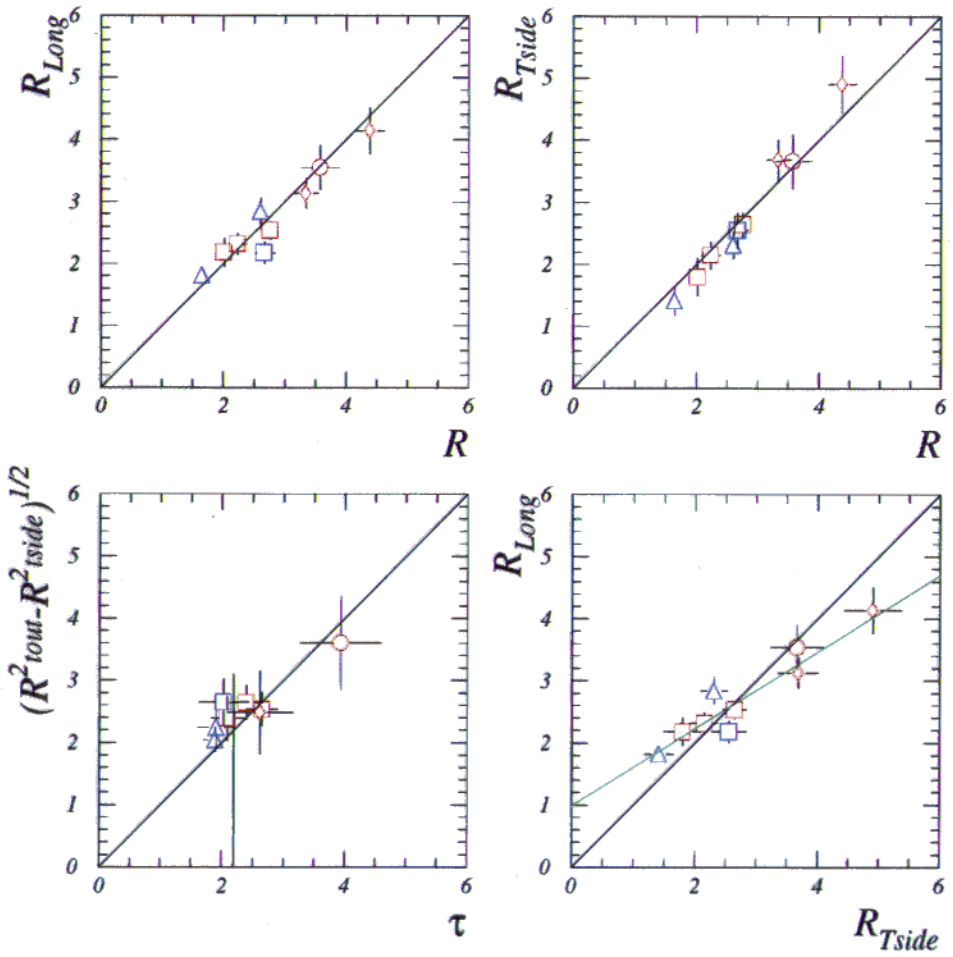
NA49 Preliminary(?)



Source Rapidity (AGS)



The 2D R-τ parameterization "works"!



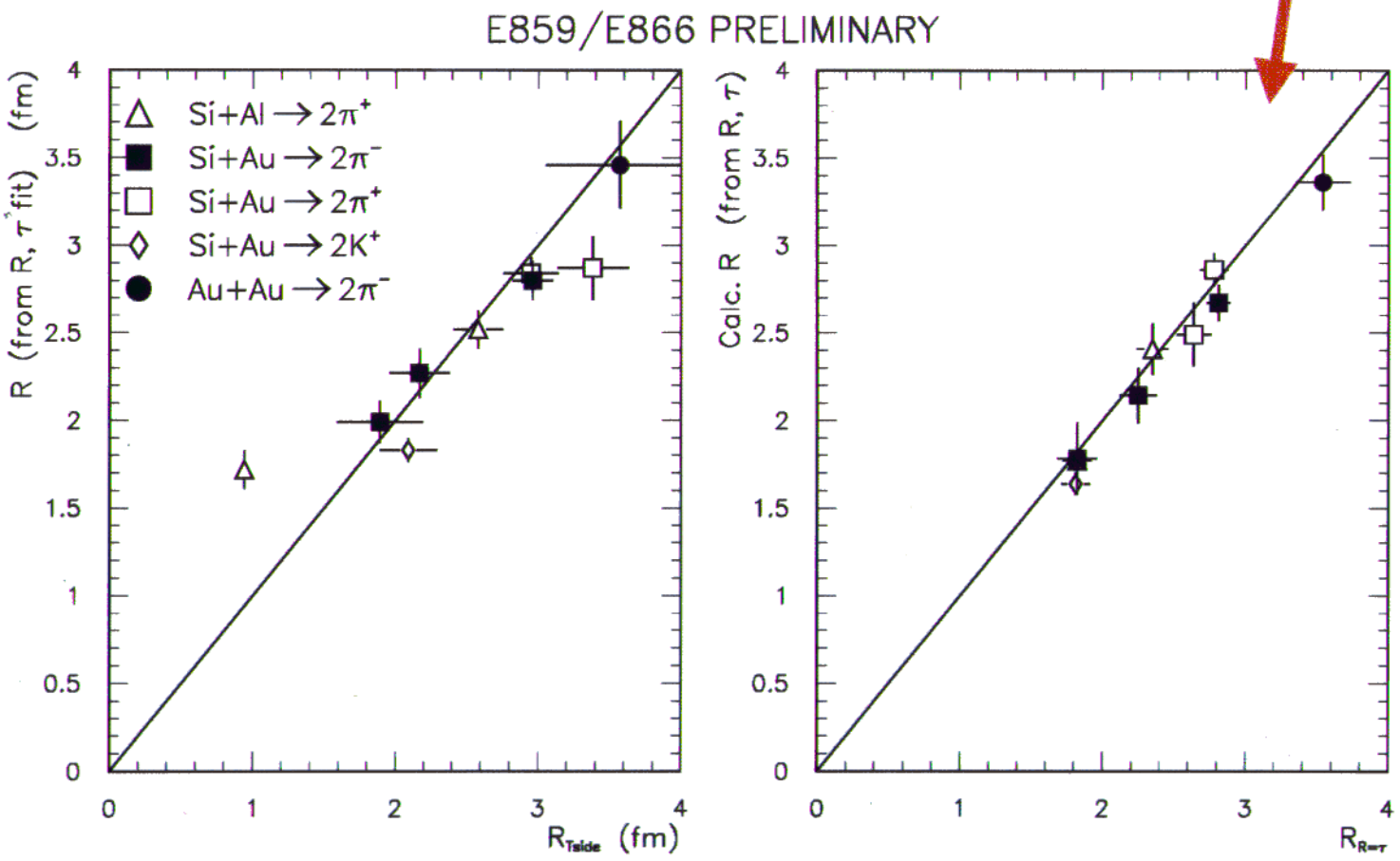
E866 Soltz, Baker etal. Prelim.

R is a mixture of R_{Ts} & R_L

τ is equivalent to R_{diff}

The 1D $R_{eff.}$ parameterization "works"!!

$$Q^2_{eff} = q^2 + q^2_0 \qquad R^2_{eff} = 0.8R^2 + 0.2\tau^2$$

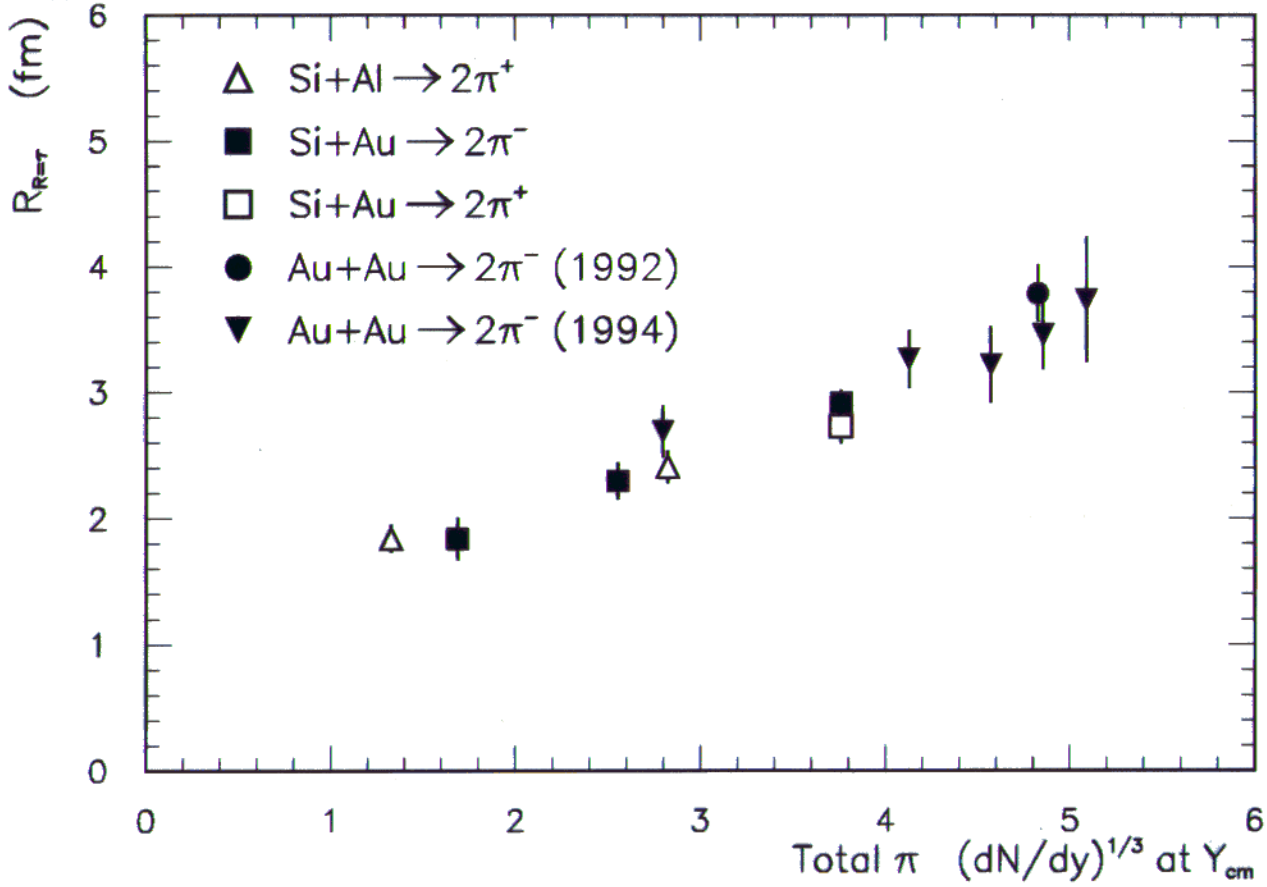


E866
Baker, Soltz et
Preliminary

Centrality Dependence (1D)

No anomalous volume or duration increase

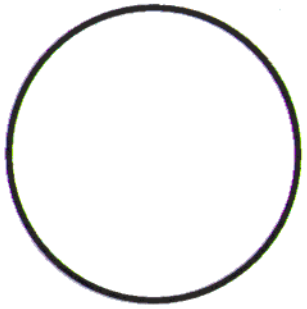
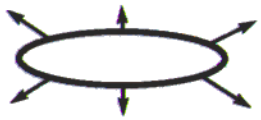
$$R_{1D} = \sqrt{0.8R^2 + 0.2\tau^2}$$



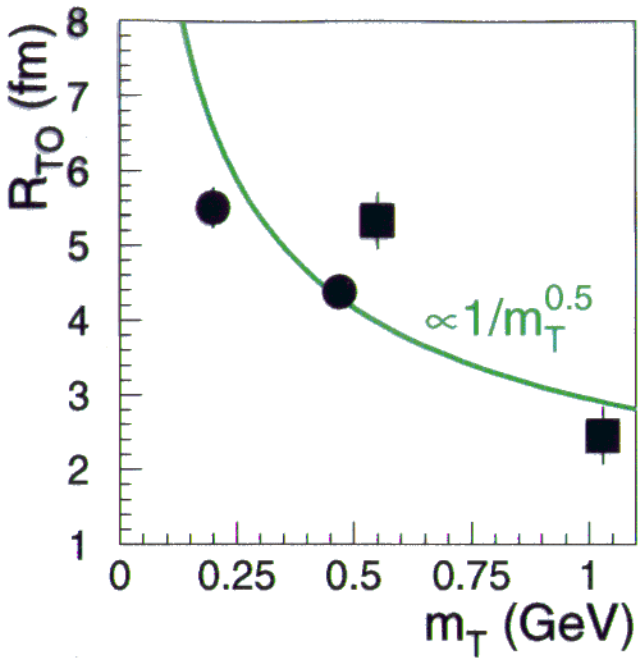
E866 Baker, Soltz etal.

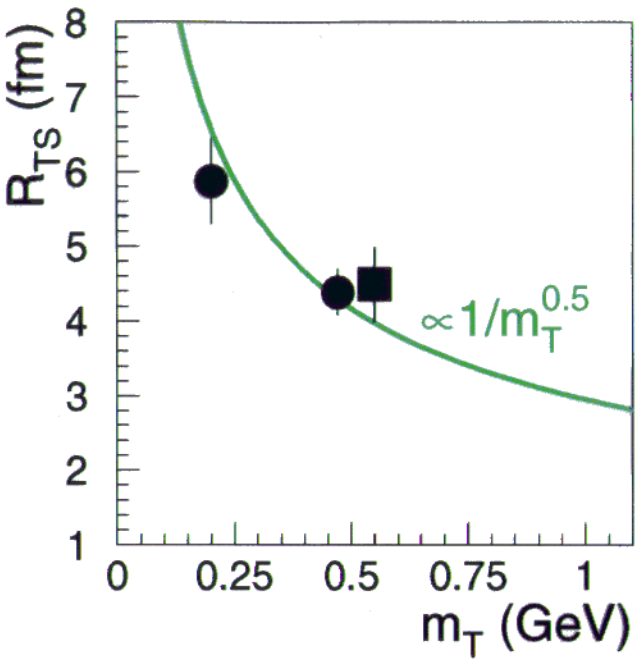
- Universal curve
- Good overlap.

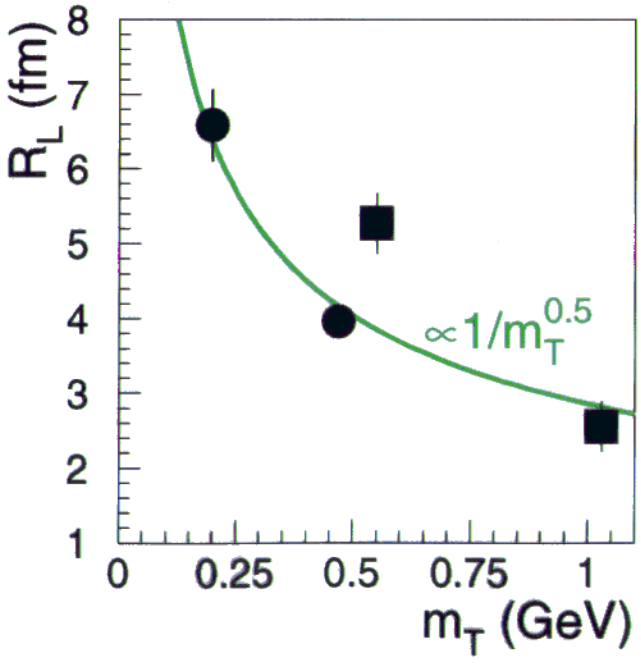
Why HBT theory is non-trivial

A star (in space!)	$\neq$	A heavy ion collision
		
Static (time-independent)		Dynamic (expanding, evolving)
Simple, well-understood geometry		Exact geometry unclear
Simple, well-defined surface		Complicated "freezeout" surface
The source is "large" ($RP \gg \hbar$)		The source is "small" ($RP \gtrsim \hbar$)
γ's are independently produced (incoherent)		π's may be coherent
$\vec{p}$ and $\vec{x}$ are independent		$\vec{p}$ and $\vec{x}$ are correlated
γ's arrive directly from the star		Many π's come from resonances
γ's don't interact after emission		π's interact after emission

Pb+Pb at 158AGeV







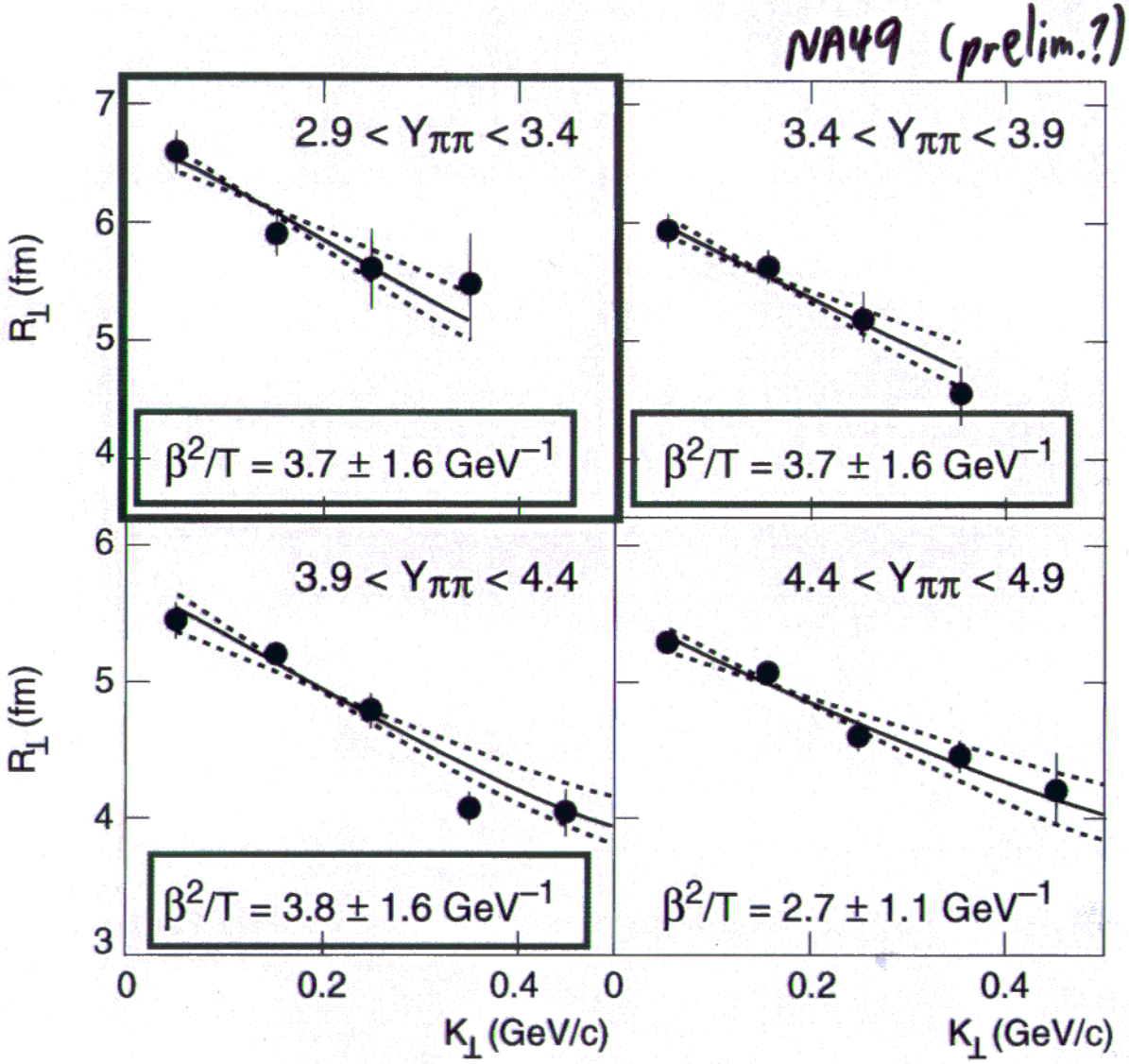
● Pb+Pb → $2\pi^+$ + X

■ Pb+Pb → $2K^+$ + X

(NA44 Preliminary)

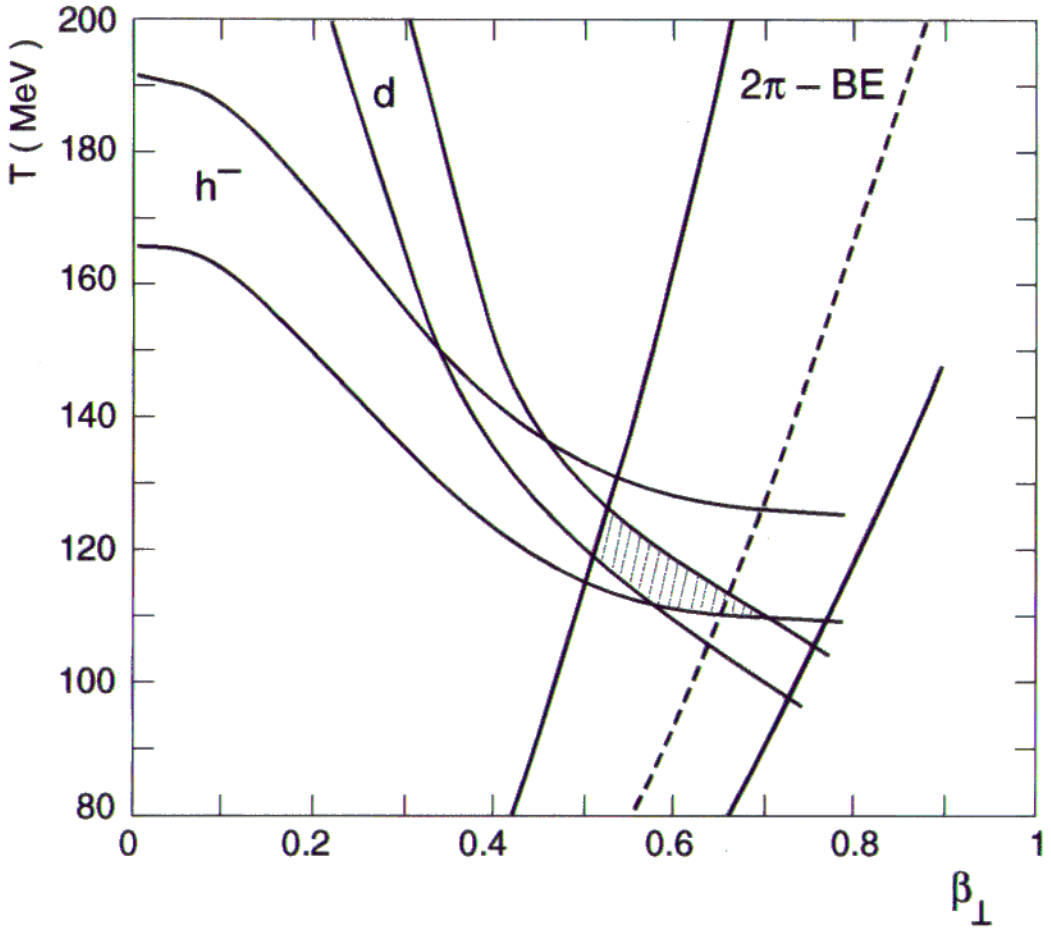
Transverse Expansion (SPS)

NA49 (prelim.?) PbPb



Combining HBT & singles info.

NA49 (Preliminary?)



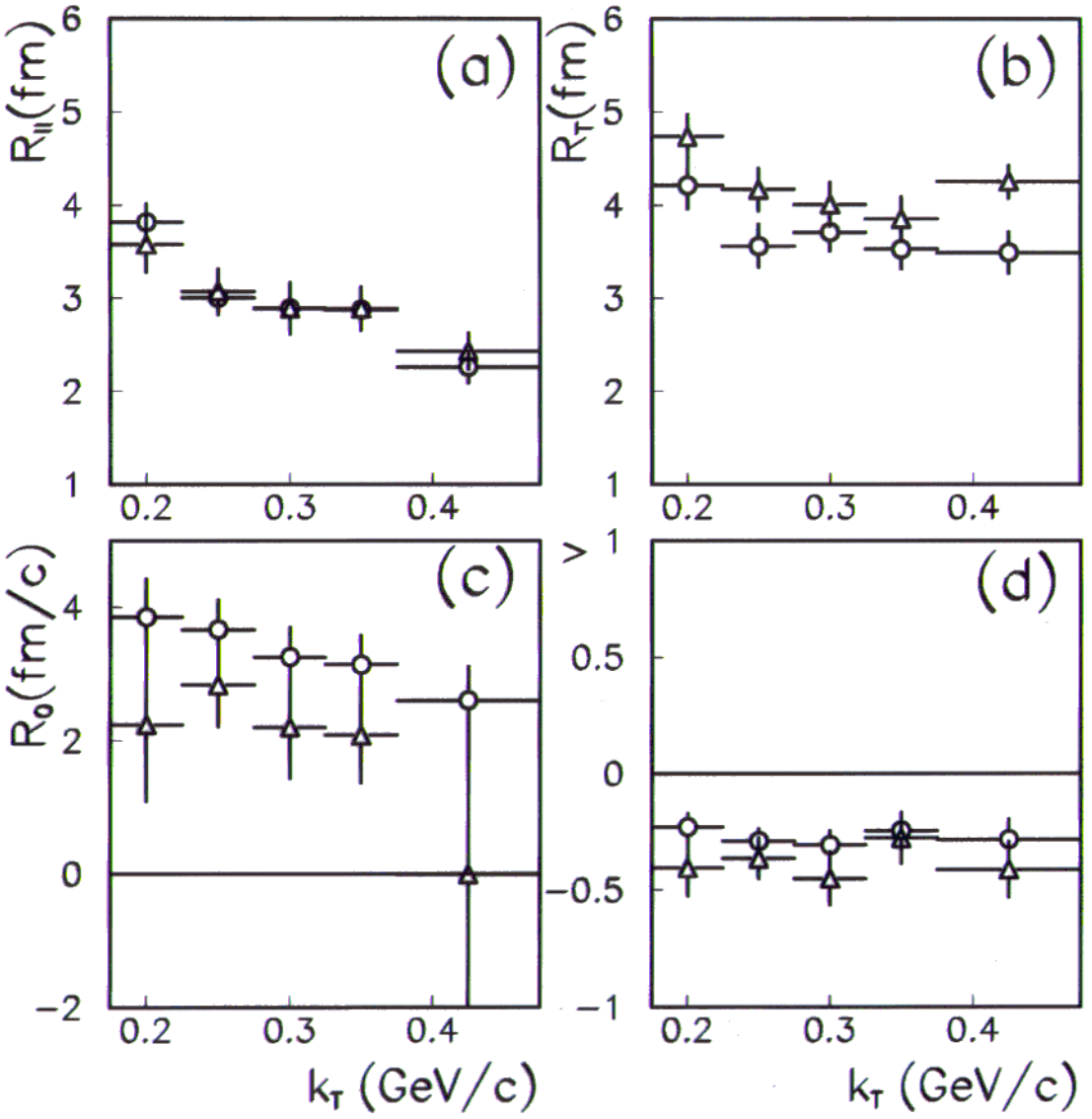
AGS source: Near-mid-rapidity

E866 (Lee et al.)
Preliminary
AuAu

△ $\pi^-\pi^-$

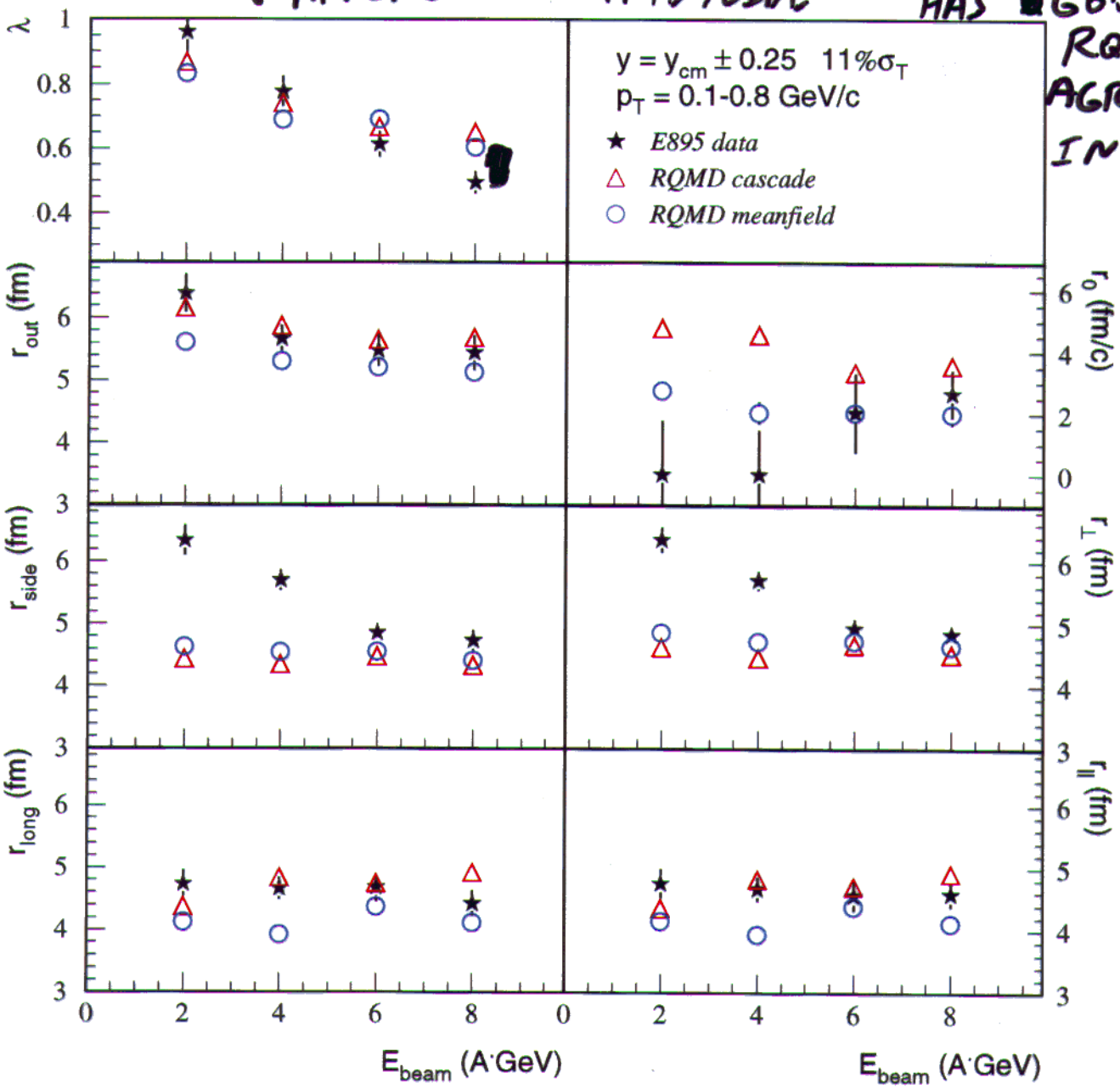
○ $\pi^+\pi^+$

$1.8<y<2.3$



E895 (Lisa et al.) Preliminary

WARNING: OUT OF DATE SLIDE - CORRECT SLIDE HAS GOOD RQMD AGREEMENT IN ↗

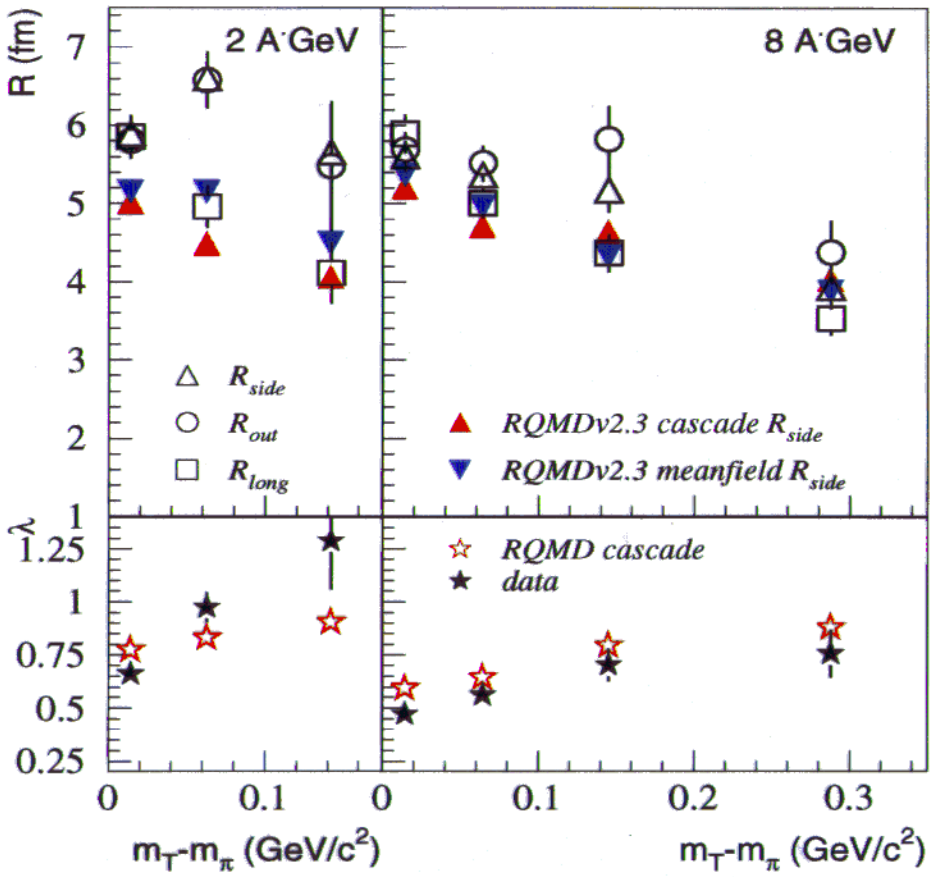


Why the large size (R_{Ts}) at low beam energy?

R_L and R_0 (duration of emission) are not large

E895 Kt dependence

E895 Lisa et al. Preliminary



PHENIX Simulations (CDR)

STAR: Q_s even better
BRAHMS: $Q_s < 50$MeV
PHOBOS: " " for 1arm

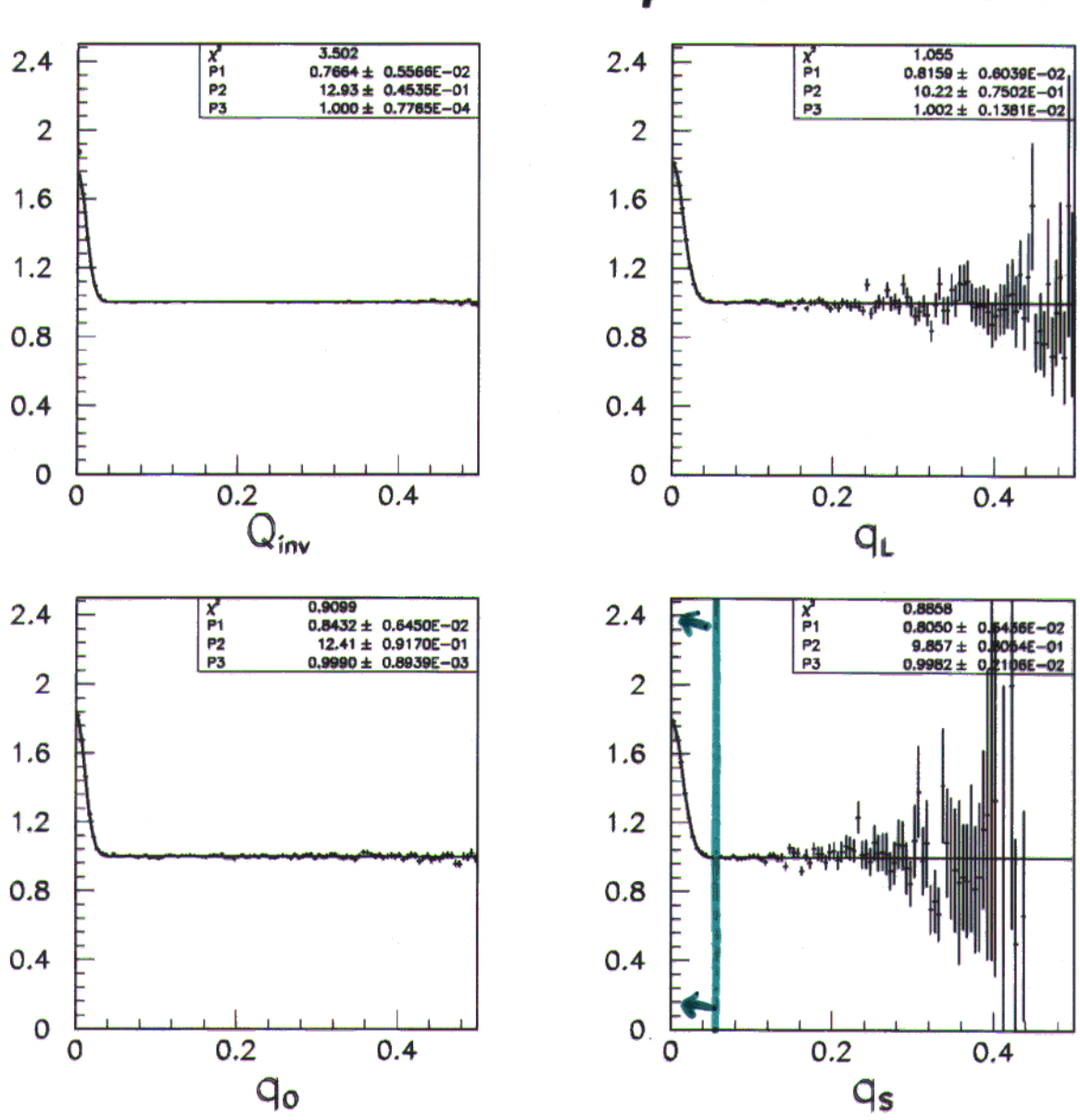
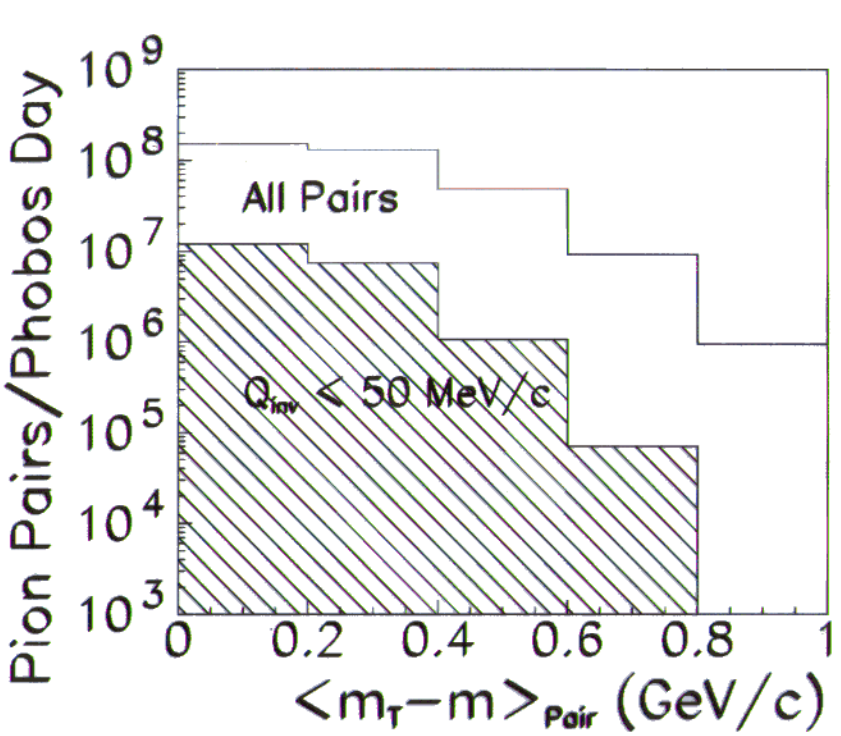
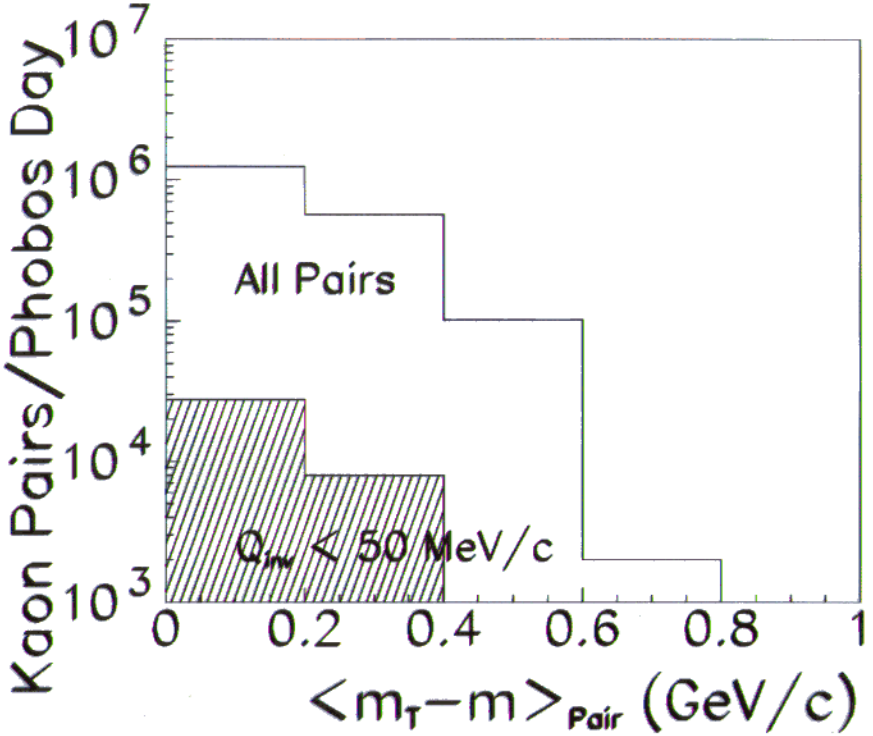


Figure 3.14: The correlation function of pions for a $R = \tau = 10$ fm source as seen in an aperture of $|\eta| < 0.7$, $\Delta\Phi = 30°$ for 1 million Au + Au events.

PHOBOS Rates (1 nominal day)

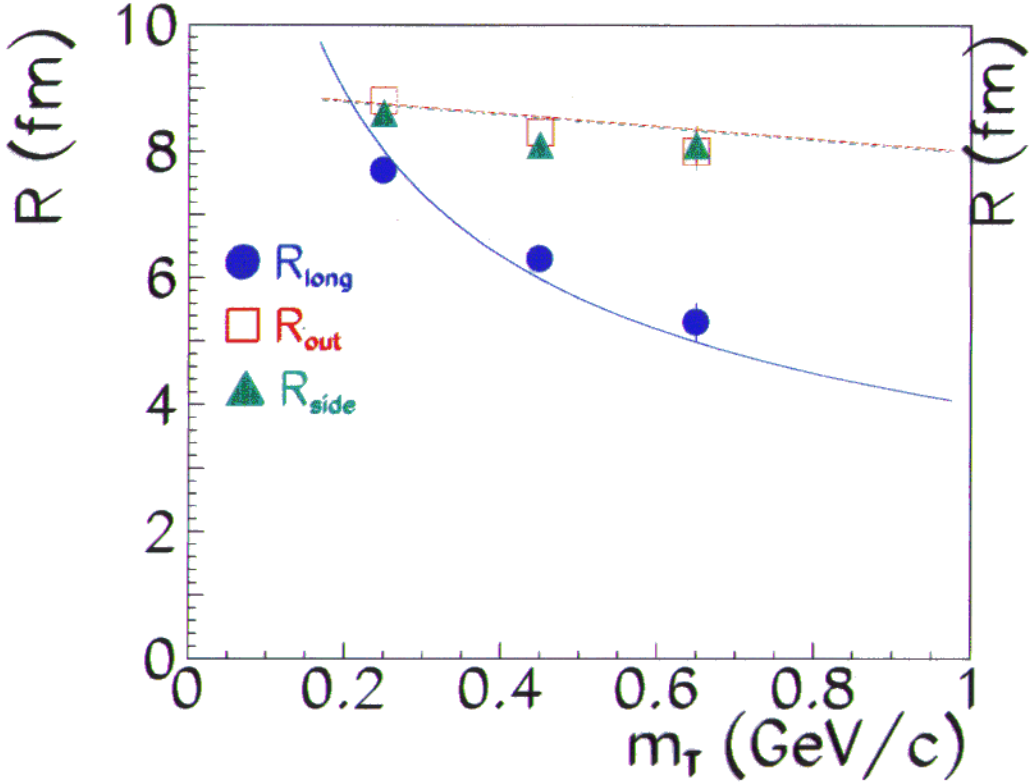


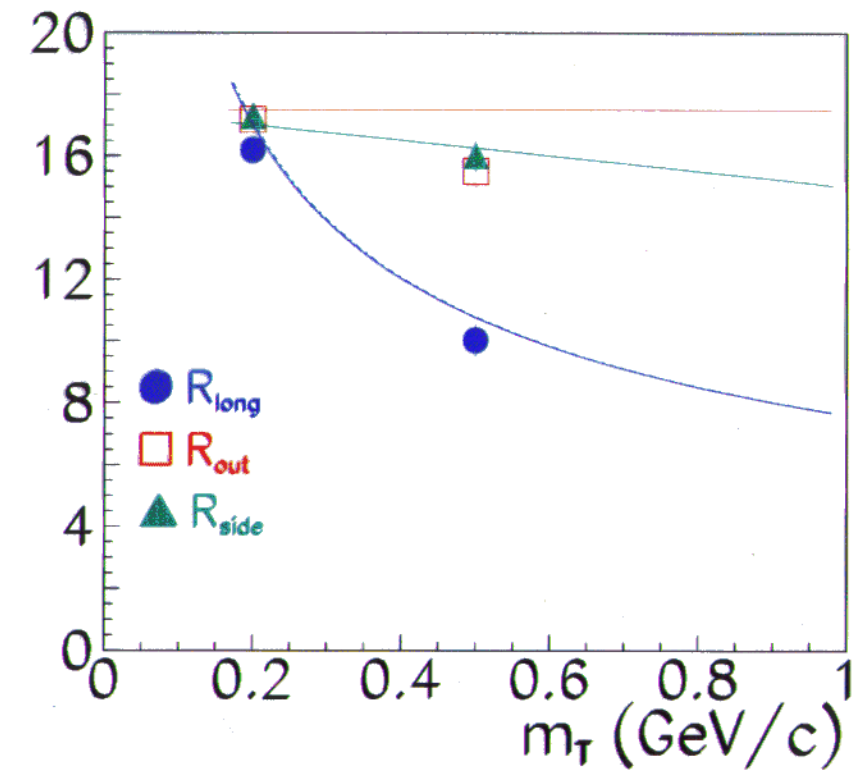


- 1 day nominal = the first 2-3 months in year 1
- Very high pair rates for all RHIC experiments
  - STAR gets ~ a million per event! (thousands at low Q)

PHOBOS HBT Capabilities

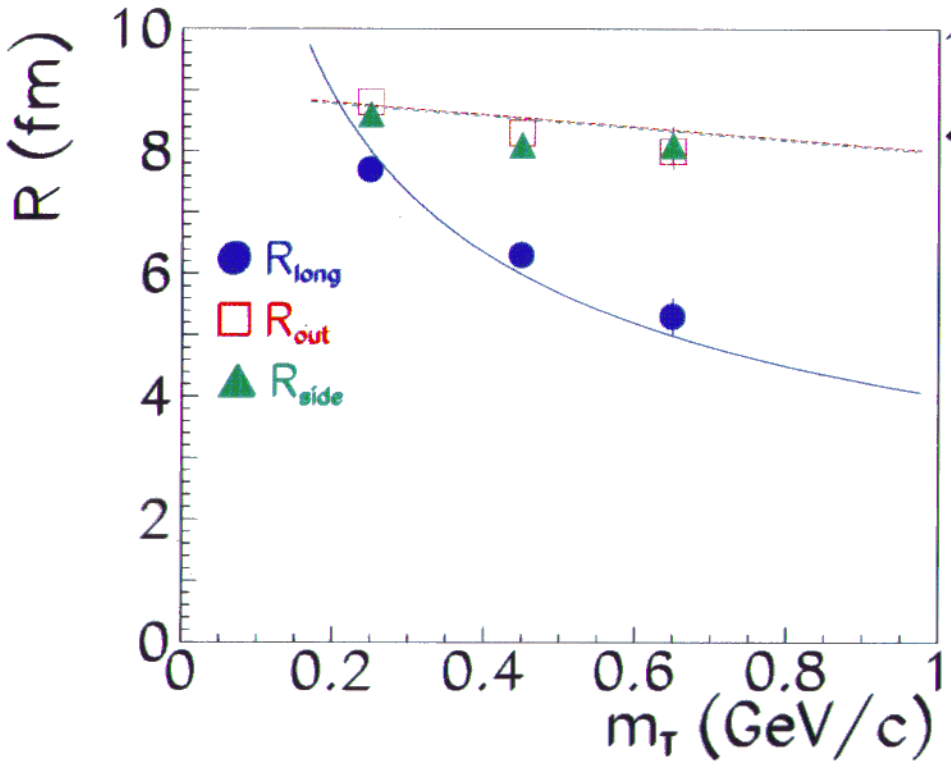
- "Standard" Scenario
  - Extrapolate from low E
- Exotic Scenario I
  - Very large source

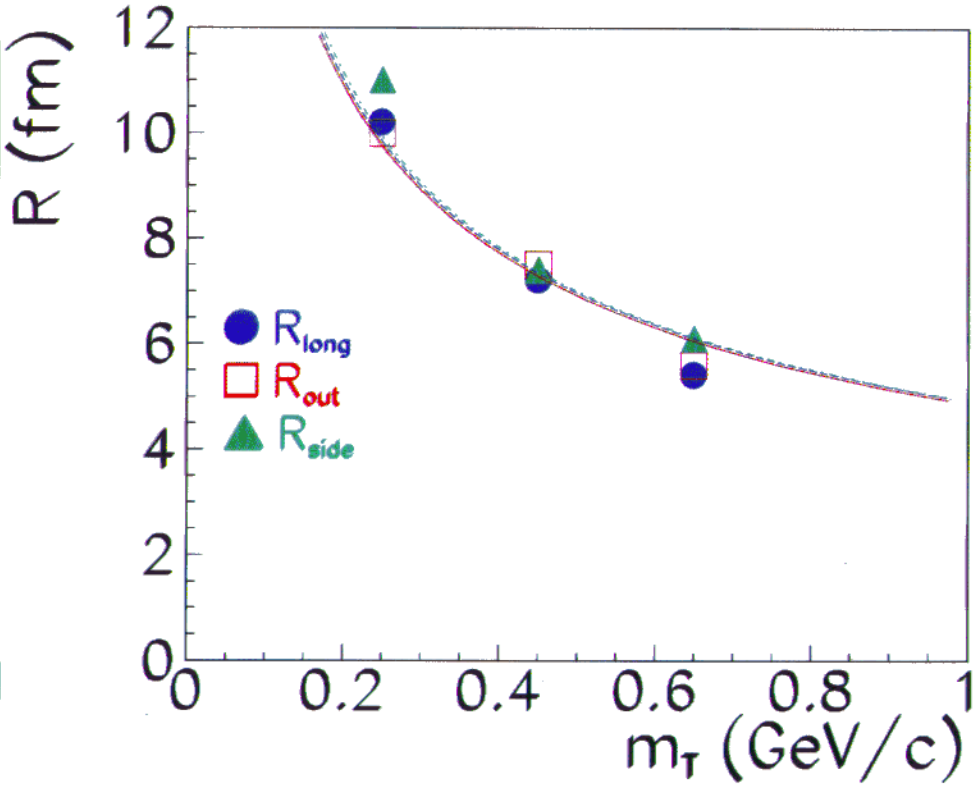




PHOBOS HBT Capabilities

- "Standard" Scenario
  - Extrapolate from low E
- Exotic Scenario II
  - Very rapid expansion





Detectors @ RHIC

- BRAHMS:
  - Pro: Very broad (patchwork) coverage to high y, p_T
  - Con: Acceptance problem for small sources
- PHENIX:
  - Pro: Good acceptance
  - Con: Low p_T particles decay before being PID'd
- PHOBOS:
  - Pro: Good acceptance at low p_T
  - Con: Need 2 arms for small sources
- STAR:
  - Pro: Very large acceptance - full azimuth
  - Con: Annoying high Q combinatoric background
  - NOTE: Event-by-event will be crude

Conclusions

- HBT has matured
  - The theory has improved dramatically!
  - We've learned a lot at the AGS & SPS
  - We stand to learn more at RHIC
- More to do (theory)
  - Understand 1D & 2D parameterizations
    - there will ALWAYS be low statistics data