Do we understand the HBT results at RHIC ?

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Correlationsfest

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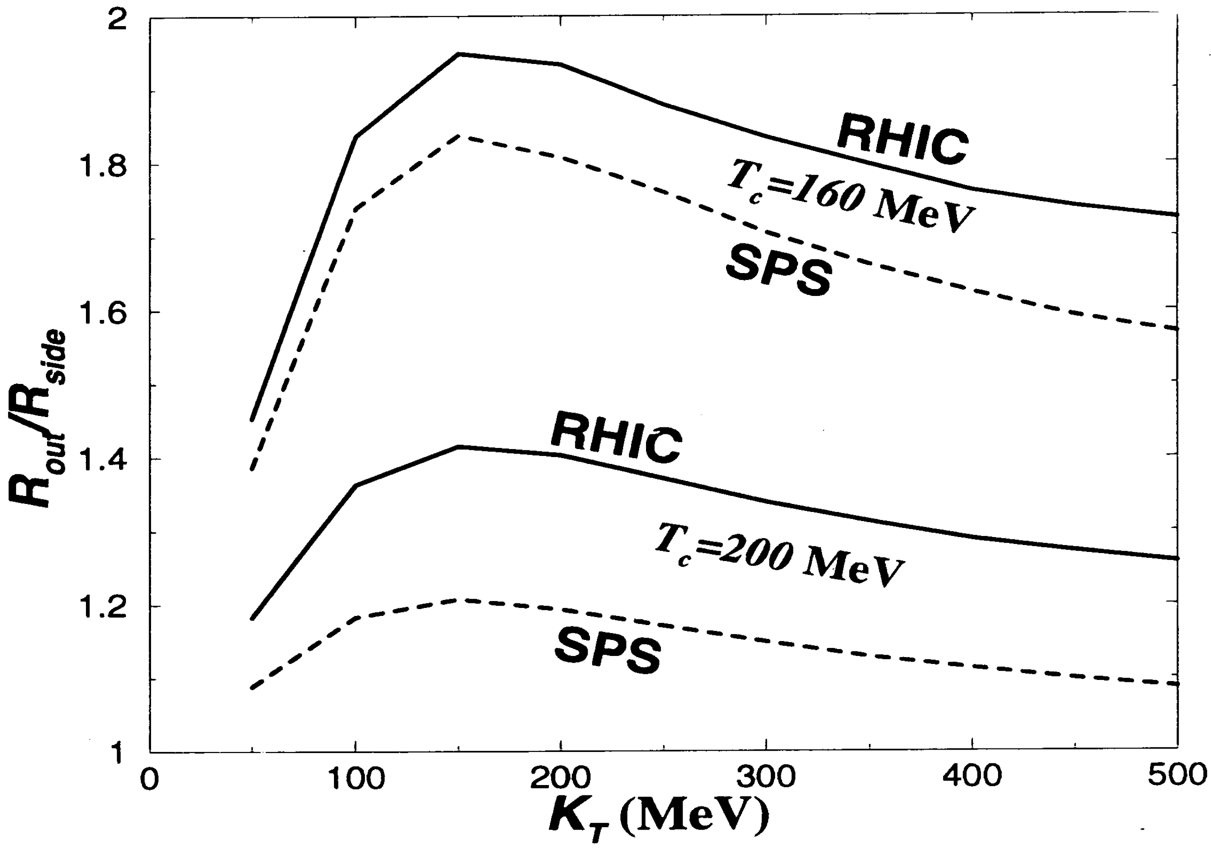
$R_{\text{out}}/R_{\text{side}}$ at Phase Boundary



- Strong QGP-lifetime effect for the *low* critical temperature !
- Higher T_c means phase boundary is reached earlier from above (initial temperature $\approx$ 300 MeV), i.e. shorter plasma lifetime.
- $R_{\text{out}}/R_{\text{side}}$ decreases with K_T stronger for the lower T_c $\rightarrow$ collective flow build up in prolonged plasma phase.
- hadronization time is given by $\tau_H/\tau_i = s_i/s_H(T_c)$ (for isentropic expansion) $\rightarrow$ as s_H increases with T_c $\rightarrow$ τ_H decreases

HBT-Radius-Parameters characterizing the Gaussian ansatz

Determination from **freeze-out coordinates** $\tilde{x}, \tilde{y}, \tilde{z}, \tilde{t}$ via 'model-independent' expressions

$$R^2_{\text{side}}(\vec{K}_T) = \langle \tilde{y}^2 \rangle (\vec{K}_T)$$

$$R^2_{\text{out}}(\vec{K}_T) = \langle (\tilde{x} - \beta_t \tilde{t})^2 \rangle (\vec{K}_T)$$

$$R^2_{\text{long}}(\vec{K}_T) = \langle (\tilde{z} - \beta_l \tilde{t})^2 \rangle (\vec{K}_T)$$

$$R^2_{\text{lo}}(\vec{K}_T) = \langle (\tilde{x} - \beta_t \tilde{t})(\tilde{z} - \beta_l \tilde{t}) \rangle (\vec{K}_T)$$

with space-time coordinates

$$\tilde{x}^\mu(\vec{K}_T) = x^\mu - \bar{x}^\mu(\vec{K}_T)$$

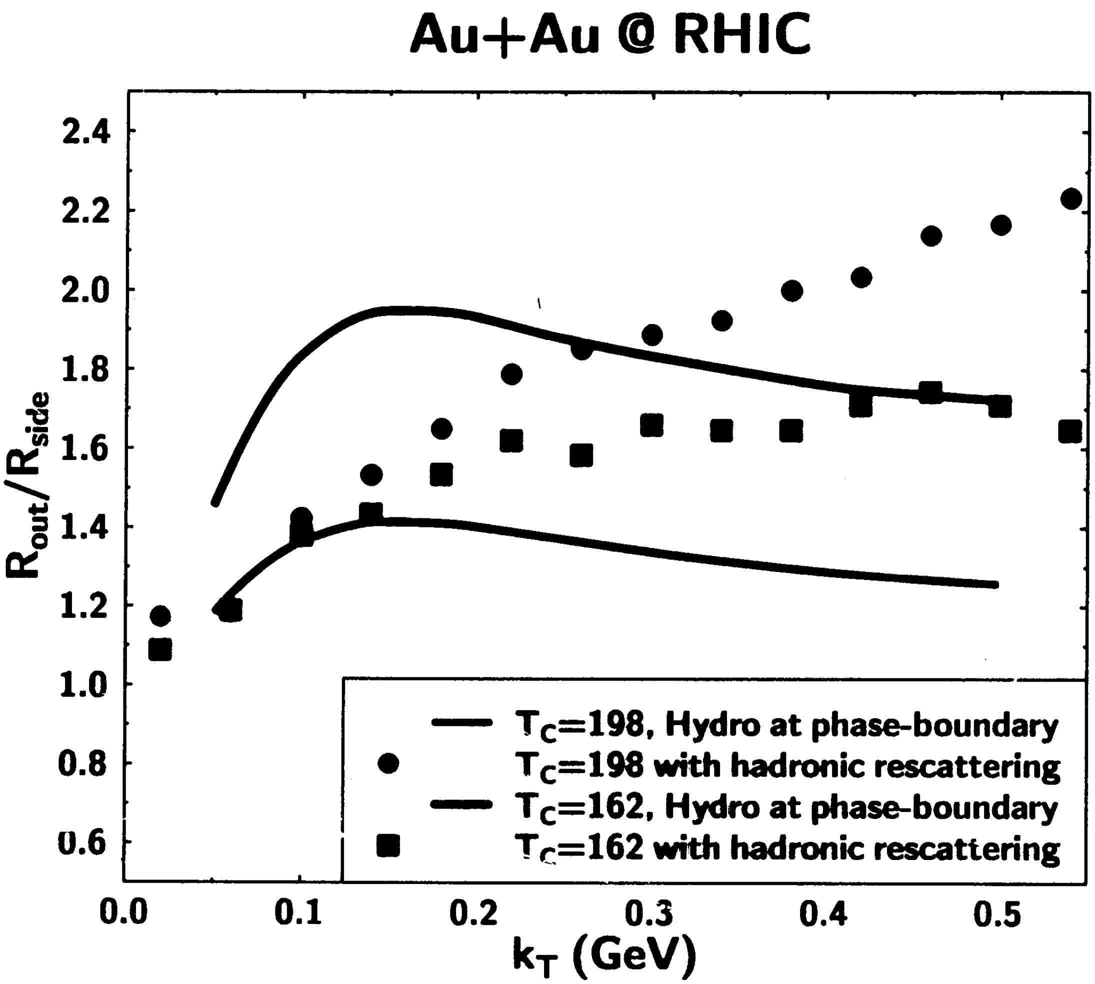
relative to *effective source centers*

$$\bar{x}^\mu(\vec{K}_T) = \langle x^\mu \rangle (\vec{K}_T)$$

$$\beta_i = K_i / E_K \qquad E_K = \sqrt{m^2 + \vec{K}^{\,2}}$$

$$\langle \xi \rangle = \langle \xi \rangle (K) = \frac{\int \xi \, S(x,K) \, d^4x}{\int S(x,K) \, d^4x}$$

$R_{\text{out}}/R_{\text{side}}$ at Freeze-out



- Dependence on T_c is reversed with hadronic rescattering
- Higher T_c speeds up hadronization but prolongs dissipative hadronic phase (dominating the HBT-radii)

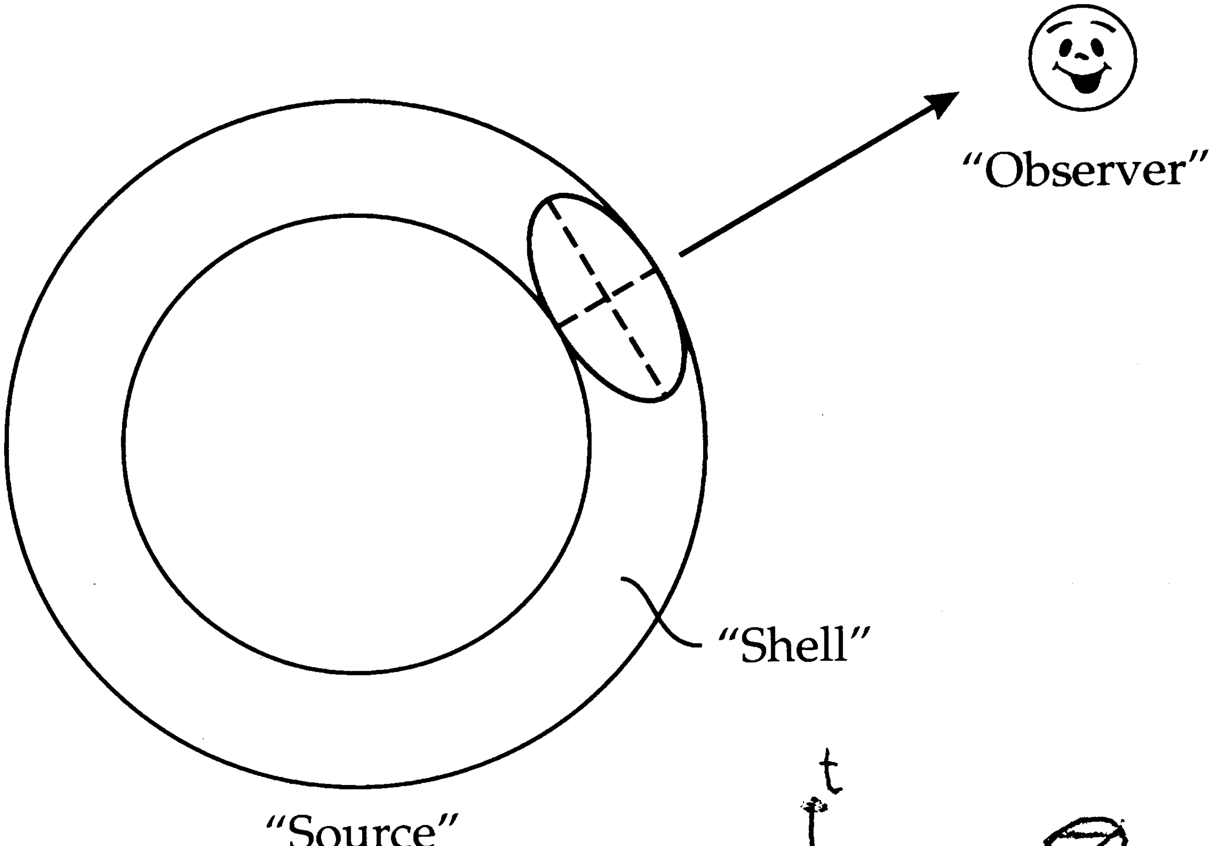
Interpretation/Approximation of Relation between R_{out} and R_{side}

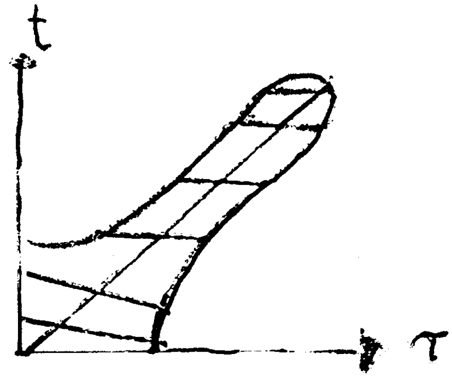
$$R_{\text{out}}{}^2(\vec{K}_T) = \langle \tilde{x}^2 + \beta_T{}^2 \tilde{t}^2 - 2\beta_T \tilde{x}\tilde{t} \rangle$$

$$R_{\text{side}}{}^2(\vec{K}_T) = \langle \tilde{y}^2 \rangle$$

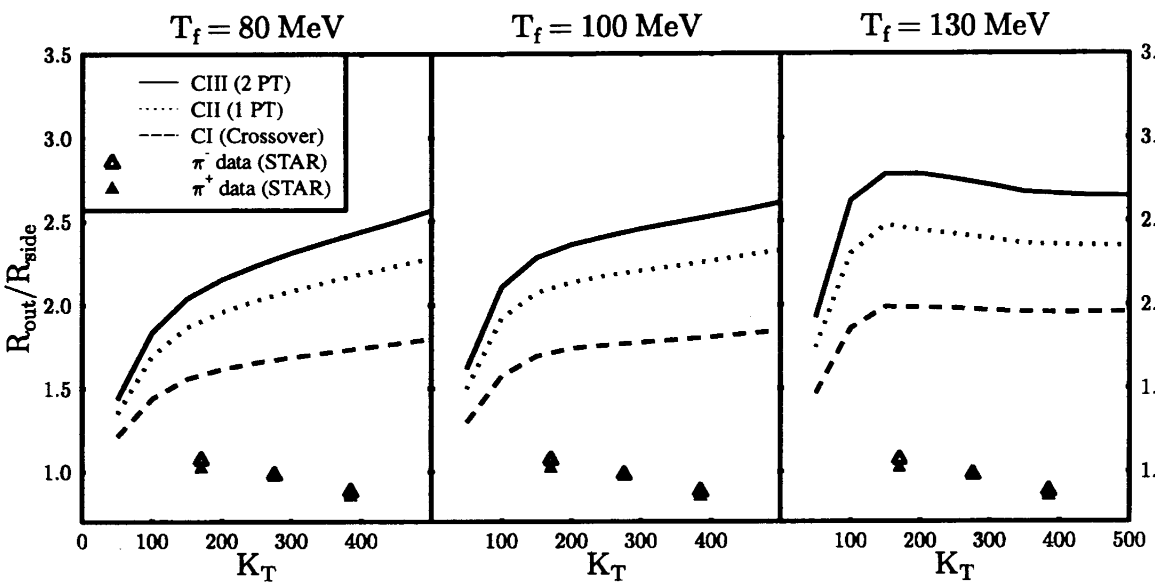
- Only if $\tilde{x}\tilde{t}$-correlations are small and $\langle \tilde{x}^2 \rangle \approx \langle \tilde{y}^2 \rangle$ we get

$$R_{\text{out}}{}^2 \approx R_{\text{side}}{}^2 + \beta_T{}^2 \langle \tilde{t} \rangle^2$$





Pure Ideal Hydrodynamics $R_{\text{out}}/R_{\text{side}}$ Ratio vs K_T



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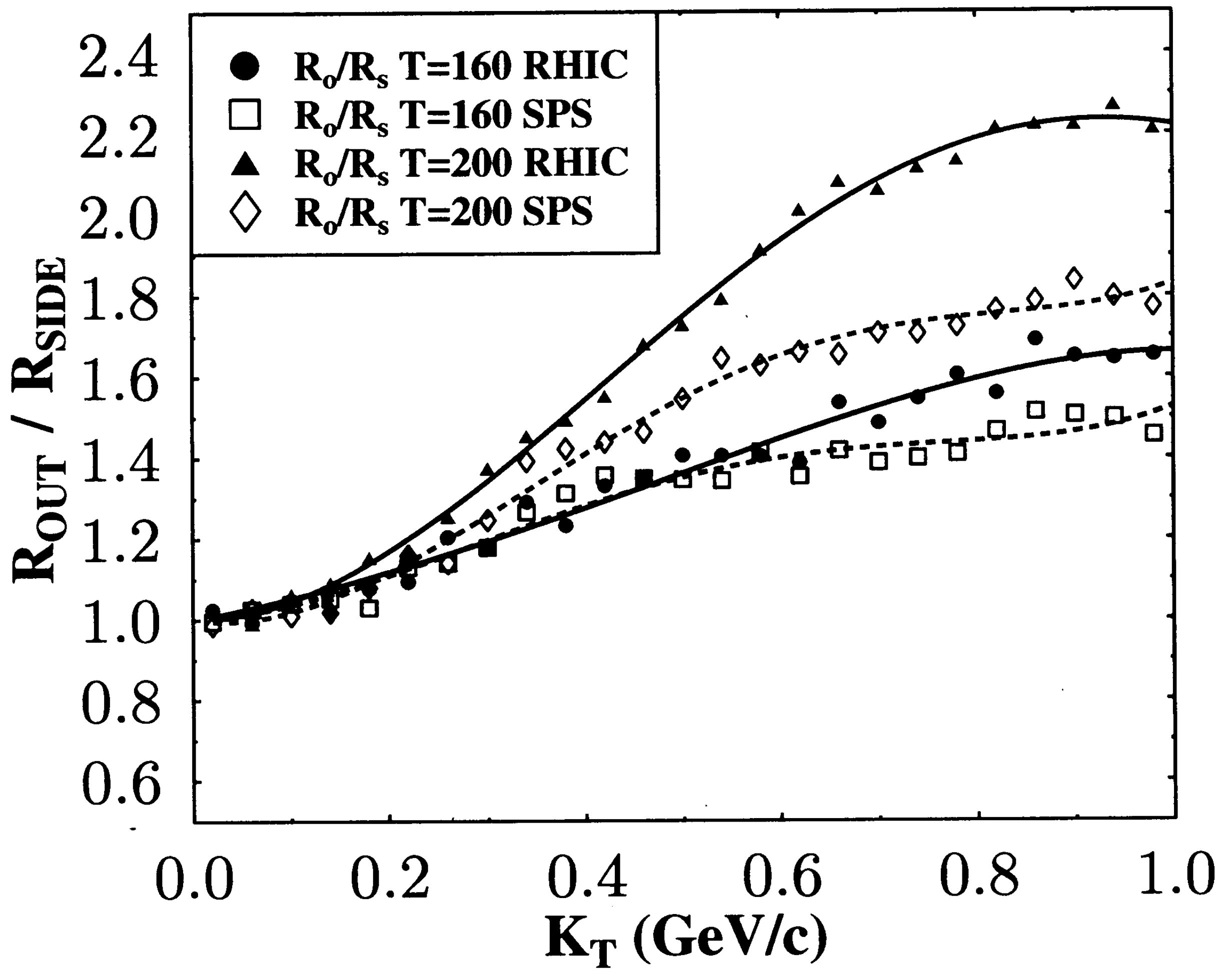
Why Kaons ?

- Coulomb correction for charged kaons presumedly under better control
- For neutral kaons, 2-particle Coulomb interactions do not distort BE correlations.

- Less contamination by (long-lived) resonances
- higher multiparticle correlation effects for pions - kaon density smaller
  ($\approx$ 70% increase of pion multiplicity while HBT radii are constant from SPS to RHIC)

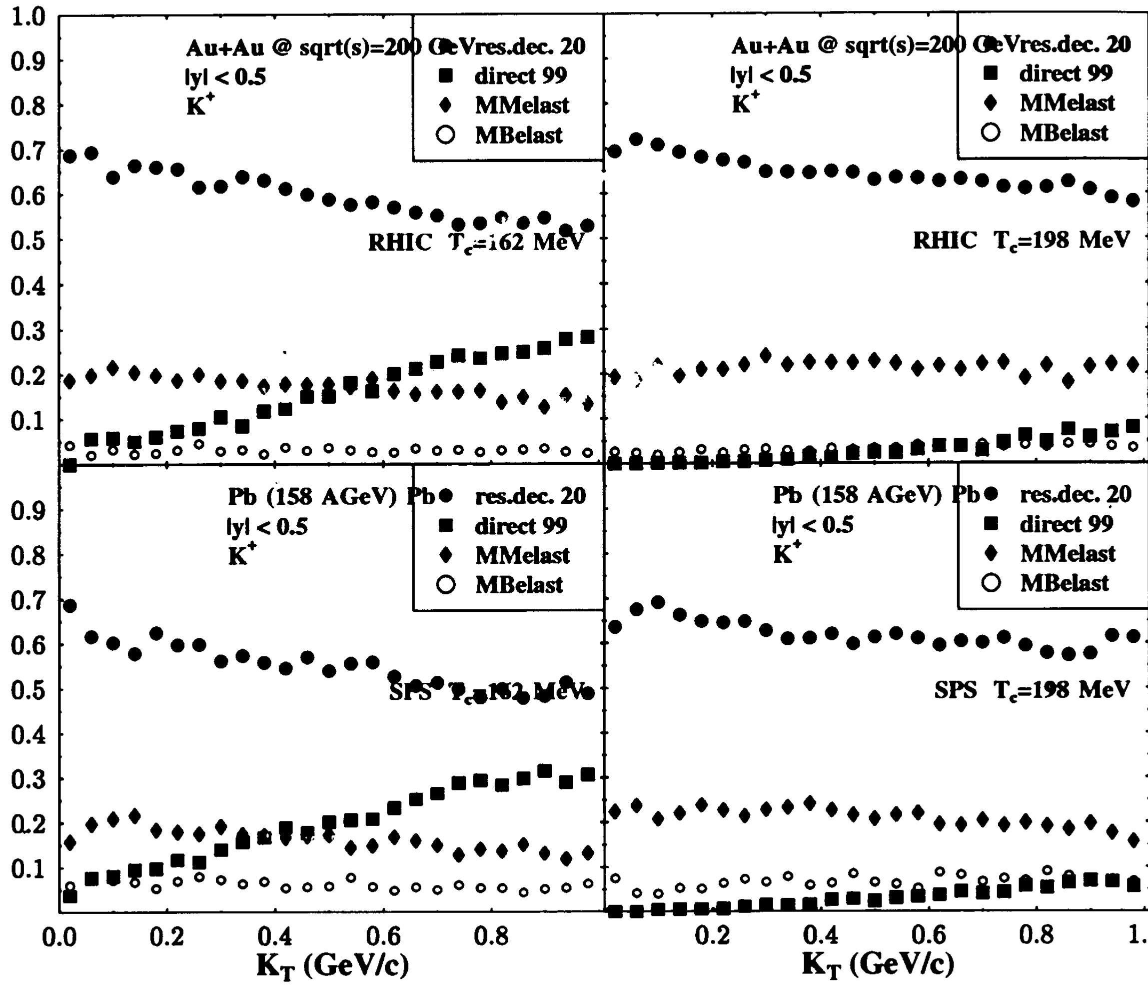
- comparison between pions and kaons will provide test of presently applied correlation formalism
- additional effects through strangeness distillation ?

Kaons at RHIC, $R_{\text{out}}/R_{\text{side}}$



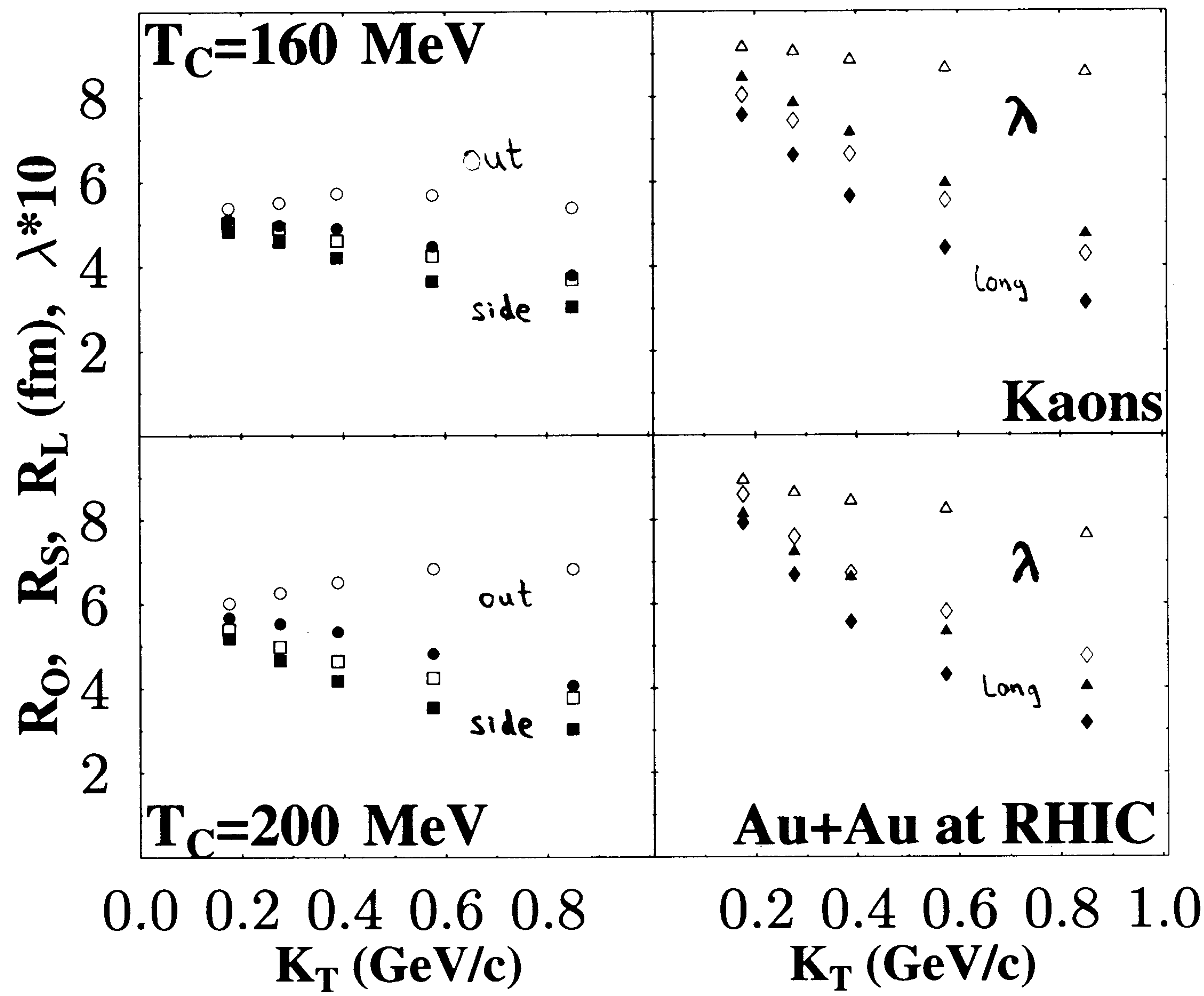
- ➪ Gradual increase with K_T
- ➪ Enlarged sensitivity to QGP properties at high K_T

Kaons and their "Sources"



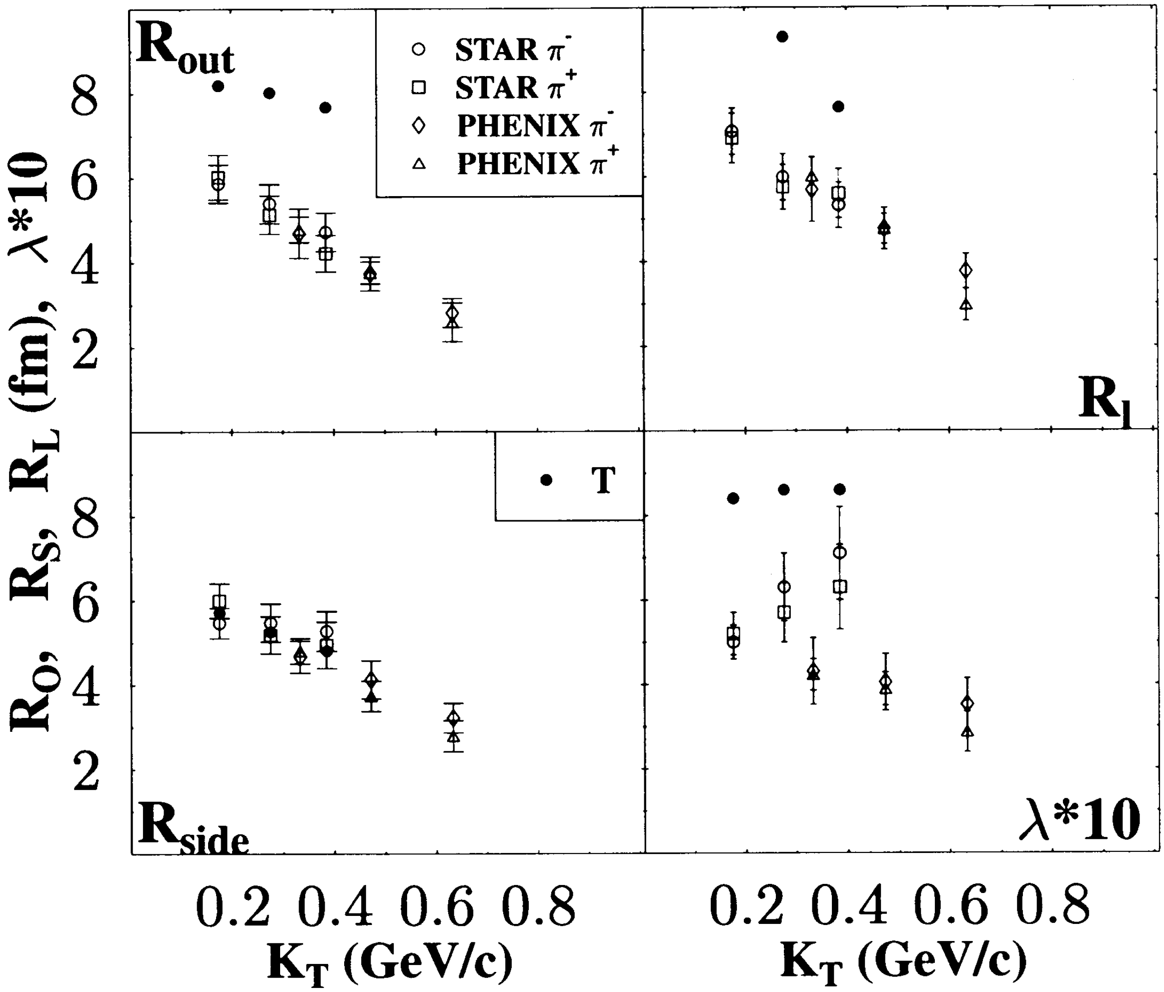
- Resonance contribution still ≈ 70–50% (K^*)
- Direct emission increasing with K_T
- Are kaons at high K_T the way to look for the *lifetime signal* ?

HBT parameter from 3d-fits



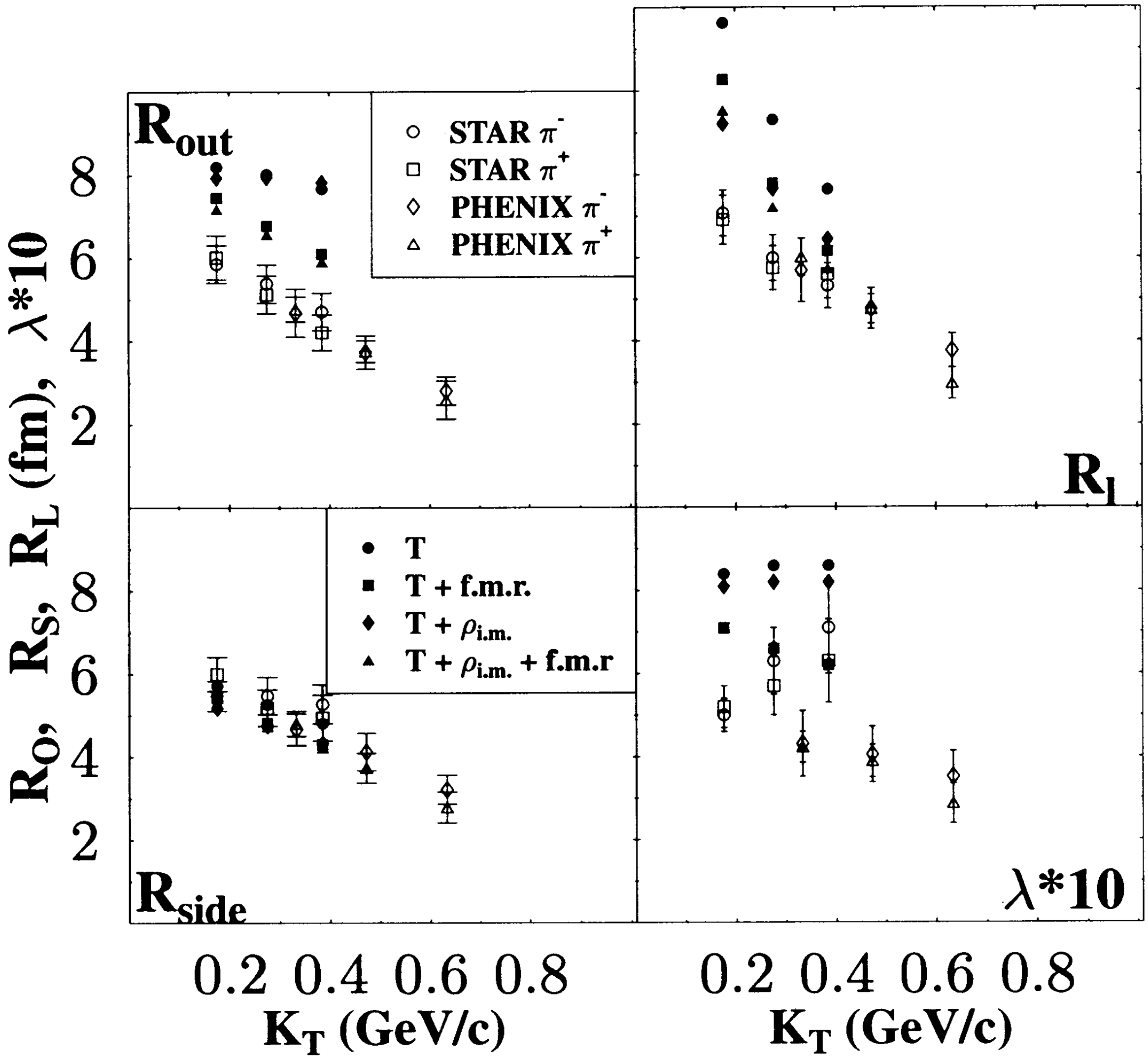
- No unusually large kaon HBT radii
- R_{out}, λ, and R_{out}/Rside strongly decreased by finite momentum resolution

Theory versus Data



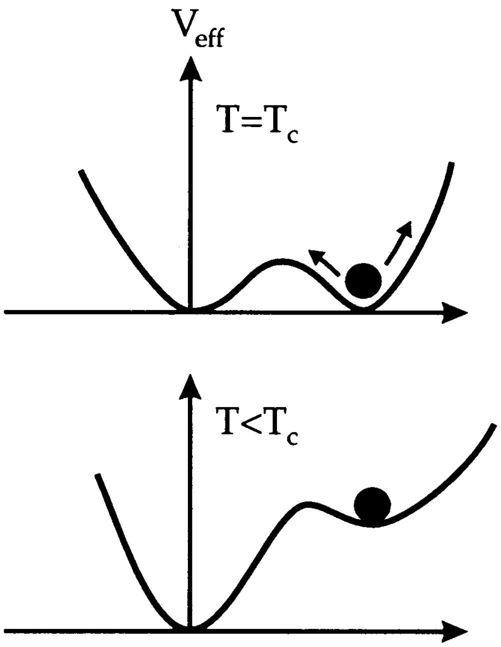
- Results of the 3d-fits to complete C_2's
- All radii have the correct order of magnitude
- R_{out} to large by 1.5-2 fm
- R_{side} agrees well with data

In-medium ρ + mom. resol.

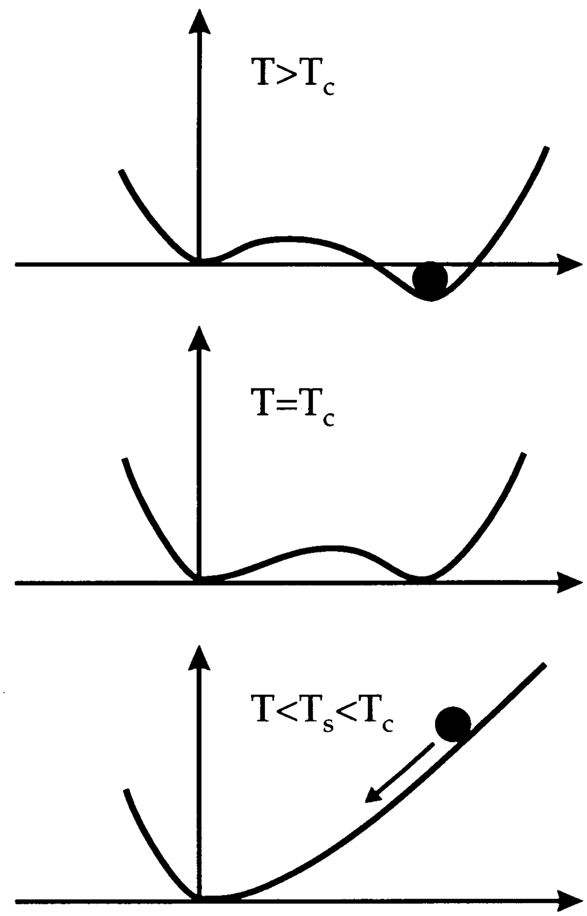


- "ρ + f.m.r" yields *best* agreement, but
- $R_{\mathrm{out}}/R_{\mathrm{side}} > 1$ still holds

Cooking versus Explosion



soft response to cooling
bubble nucleation
tunneling



strong response to cooling
explosive evolution
spinodal decomposition