What does the HBT null result at RHIC teach us?

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Why is $R_{out}/R_{side} \simeq 1$?

⇒ see talks by Z. Lin, A. Dumitru, S. Soff, D. Molnar, T. Csörgő, T. Humanic, et al.

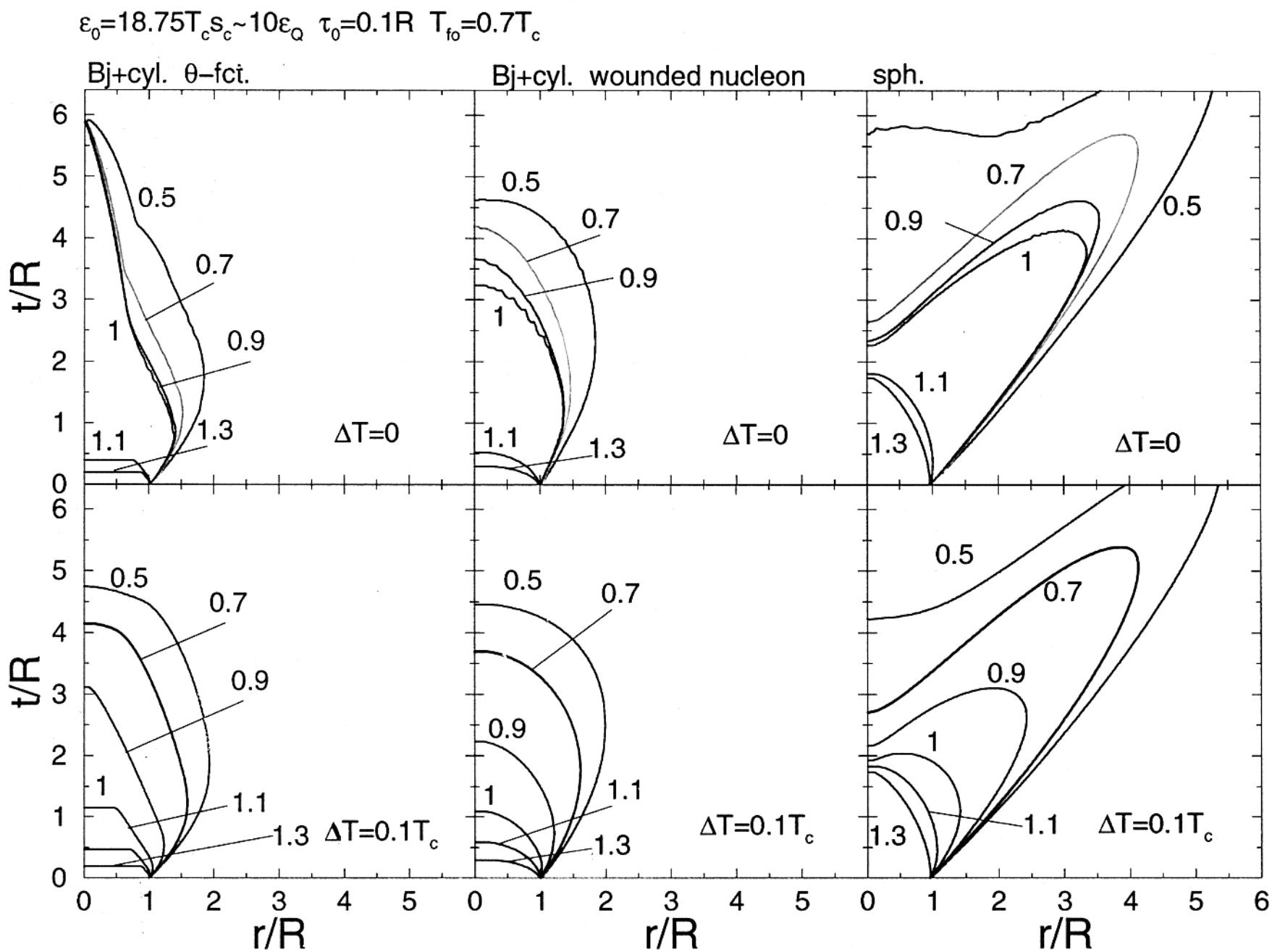
Hydrodynamics describes collective observables exceptionally well:

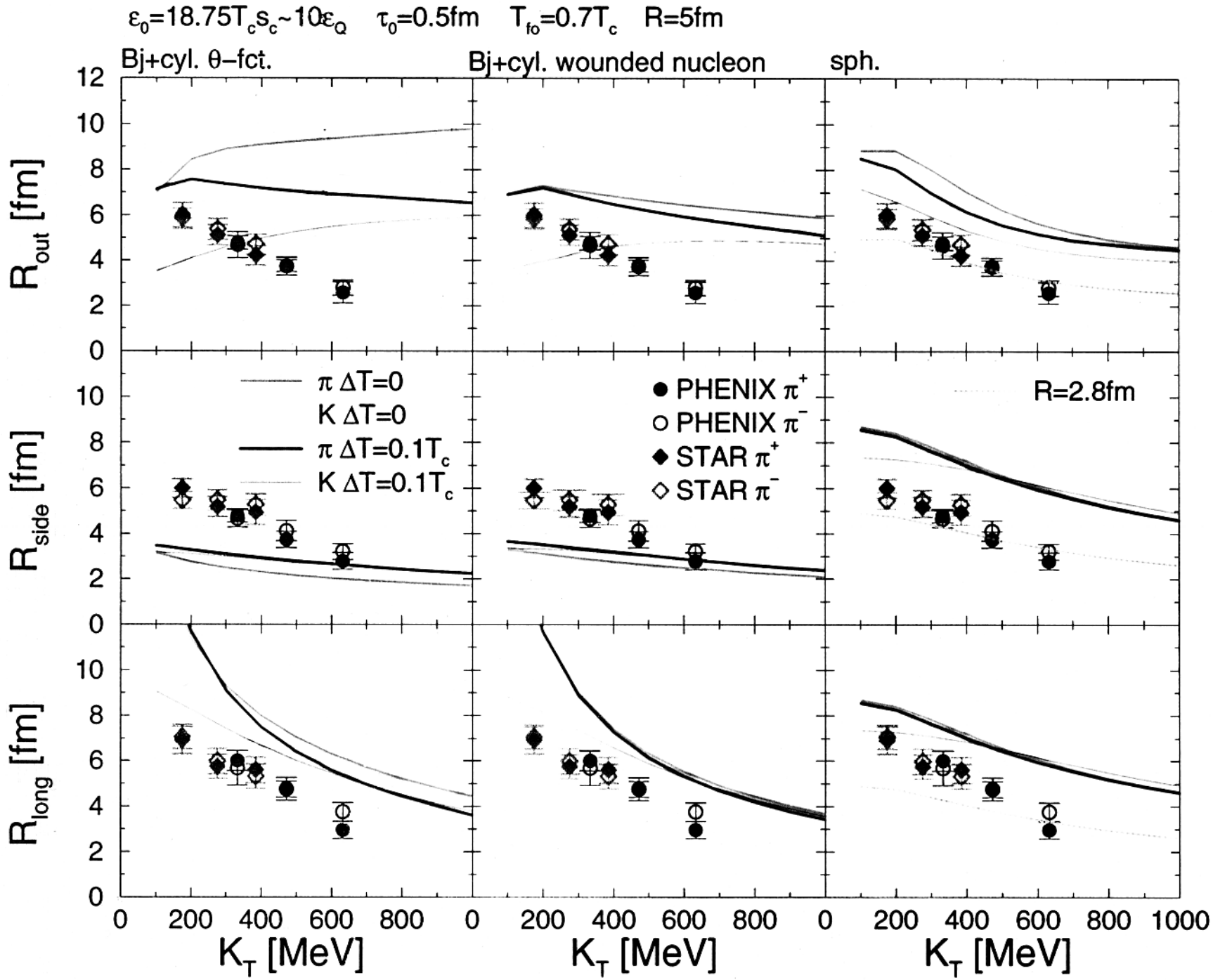
- radial flow
- (directed flow)
- elliptic flow

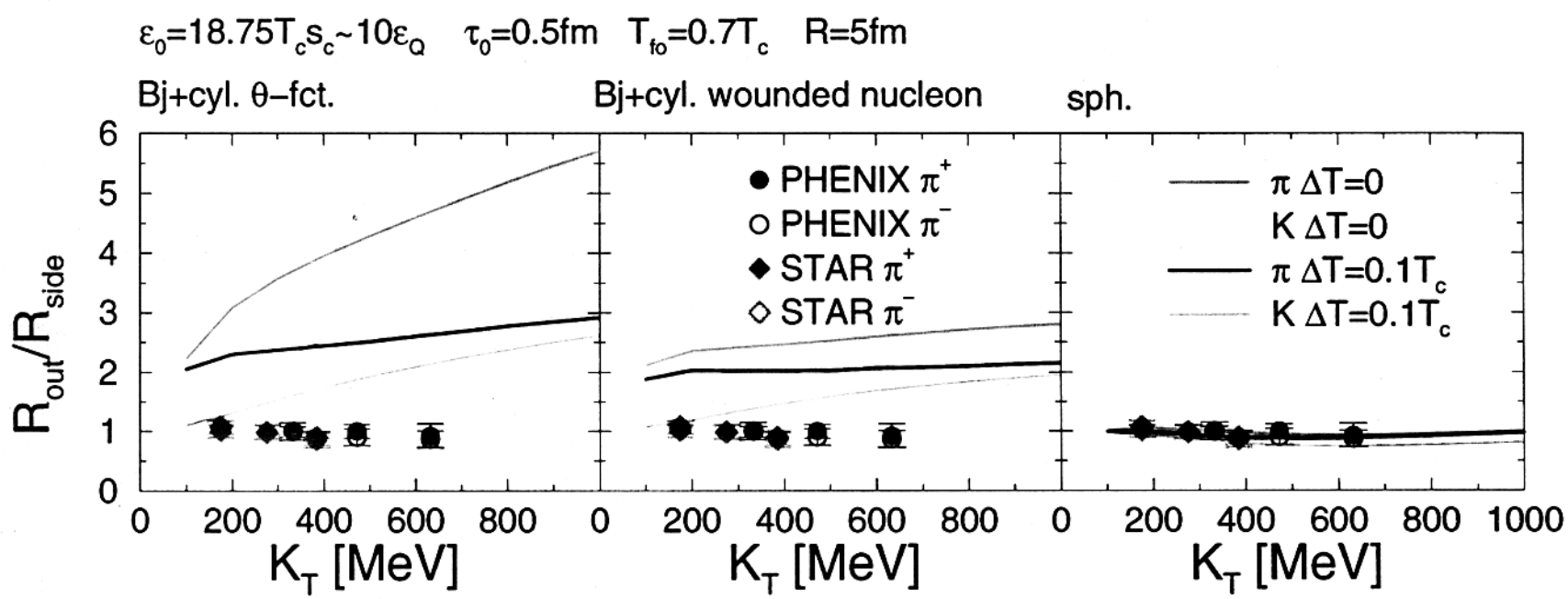
⇒ Why does hydrodynamics fail to describe the HBT radii ?

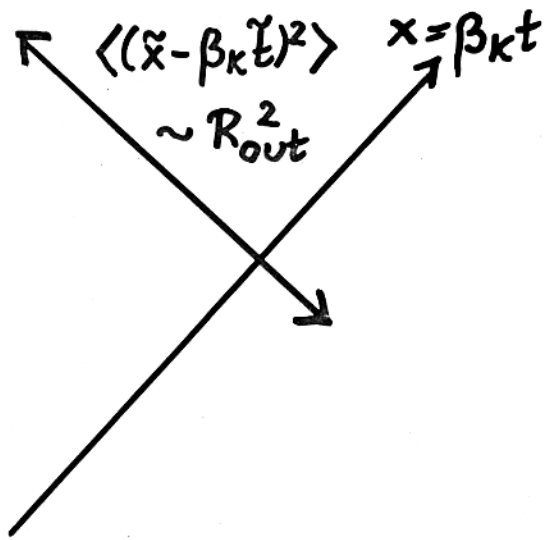
Hydrodynamics propagates initial condition to freeze-out under energy-momentum conservation.

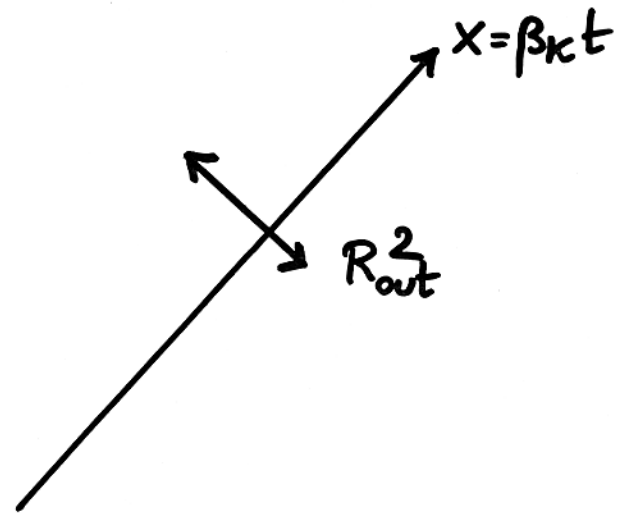
⇒ Is there an initial condition which does reproduce the HBT radii ?


ε0=18.75Tcsc~10εQ τ0=0.1R Tfo=0.7Tc
Bj+cyl. θ−fct.
Bj+cyl. wounded nucleon
sph.
t/R
r/R
ΔT=0
ΔT=0.1Tc
0.5
0.7
0.9
1
1.1
1.3

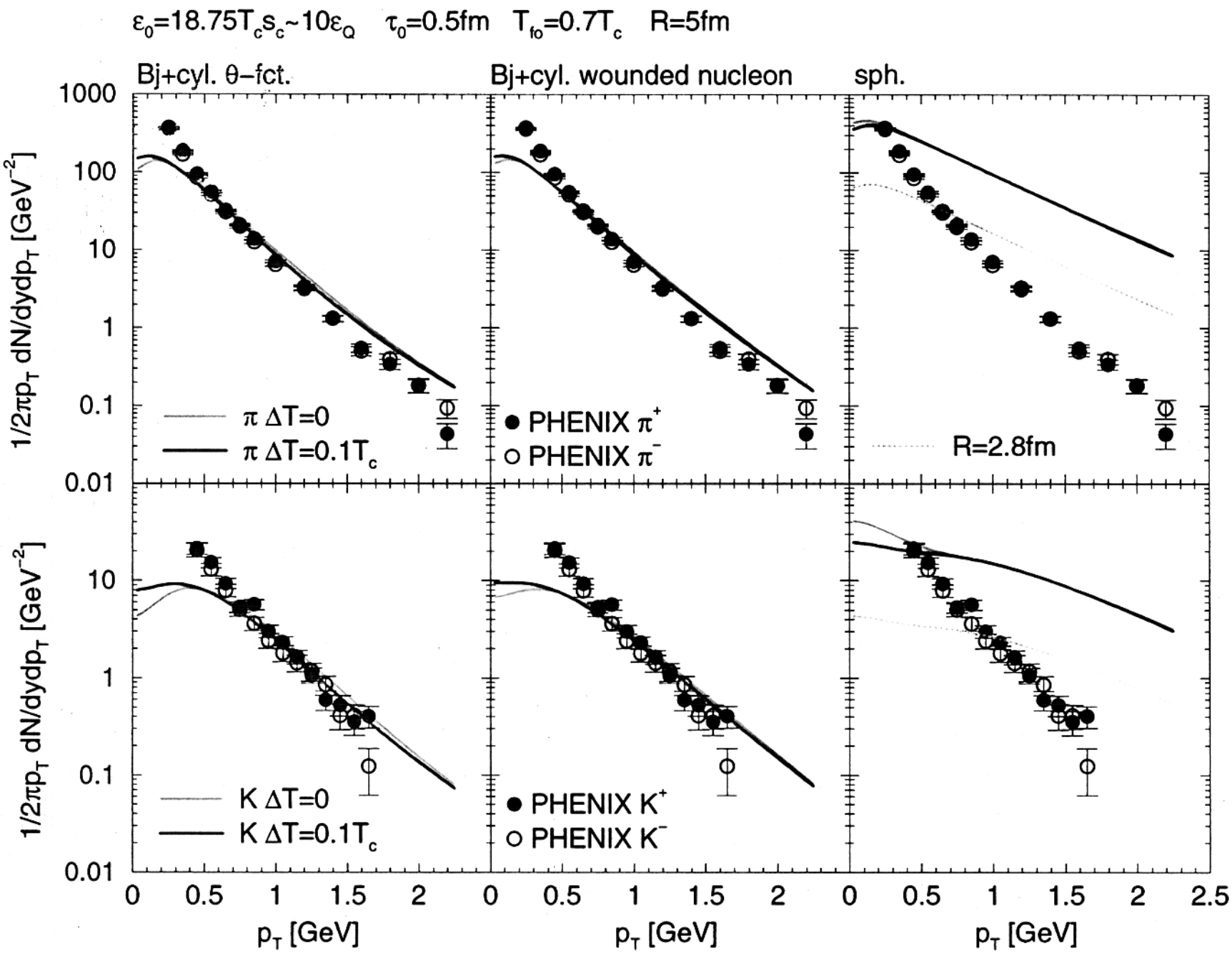

ε0=18.75TcSc~10εQ τ0=0.5fm Tfo=0.7Tc R=5fm
Bj+cyl. θ−fct.
Bj+cyl. wounded nucleon
sph.
Rout [fm]
Rside [fm]
Rlong [fm]
KT [MeV]
π ΔT=0
K ΔT=0
π ΔT=0.1Tc
K ΔT=0.1Tc
PHENIX π+
PHENIX π−
STAR π+
STAR π−
R=2.8fm


ε0=18.75TcSc~10εQ τ0=0.5fm Tfo=0.7Tc R=5fm
Bj+cyl. θ–fct.
Bj+cyl. wounded nucleon
sph.
Rout/Rside
KT [MeV]
PHENIX π+
PHENIX π−
STAR π+
STAR π−
π ΔT=0
K ΔT=0
π ΔT=0.1Tc
K ΔT=0.1Tc


$\langle(\tilde{x}-\beta_K\tilde{t})^2\rangle$
$\sim R_{out}^2$
$x=\beta_K t$


$x=\beta_K t$
R_{out}^2

$\langle\tilde{y}^2\rangle \sim R_{side}^2$


ε0=18.75TcSc~10εQ τ0=0.5fm Tfo=0.7Tc R=5fm
Bj+cyl. θ−fct.
Bj+cyl. wounded nucleon
sph.
1/2πpT dN/dydpT [GeV−2]
π ΔT=0
π ΔT=0.1Tc
PHENIX π+
PHENIX π−
R=2.8fm
K ΔT=0
K ΔT=0.1Tc
PHENIX K+
PHENIX K−
pT [GeV]

⇒ <u>Is there an initial condition which reproduces HBT radii and radial flow?</u>

⇒ Be more explosive in r-direction

⇒ Reduce amount of longitudinal cooling

⇒ <u>Modified longitudinal scaling:</u>

$$\boxed{v_z = \alpha \frac{z}{t}}$$

$\alpha = 1$: Bjorken long. scaling (boost inv.)

$\alpha = 0$: pure cyl. symm. expansion

<u>$\eta = 0$:</u>

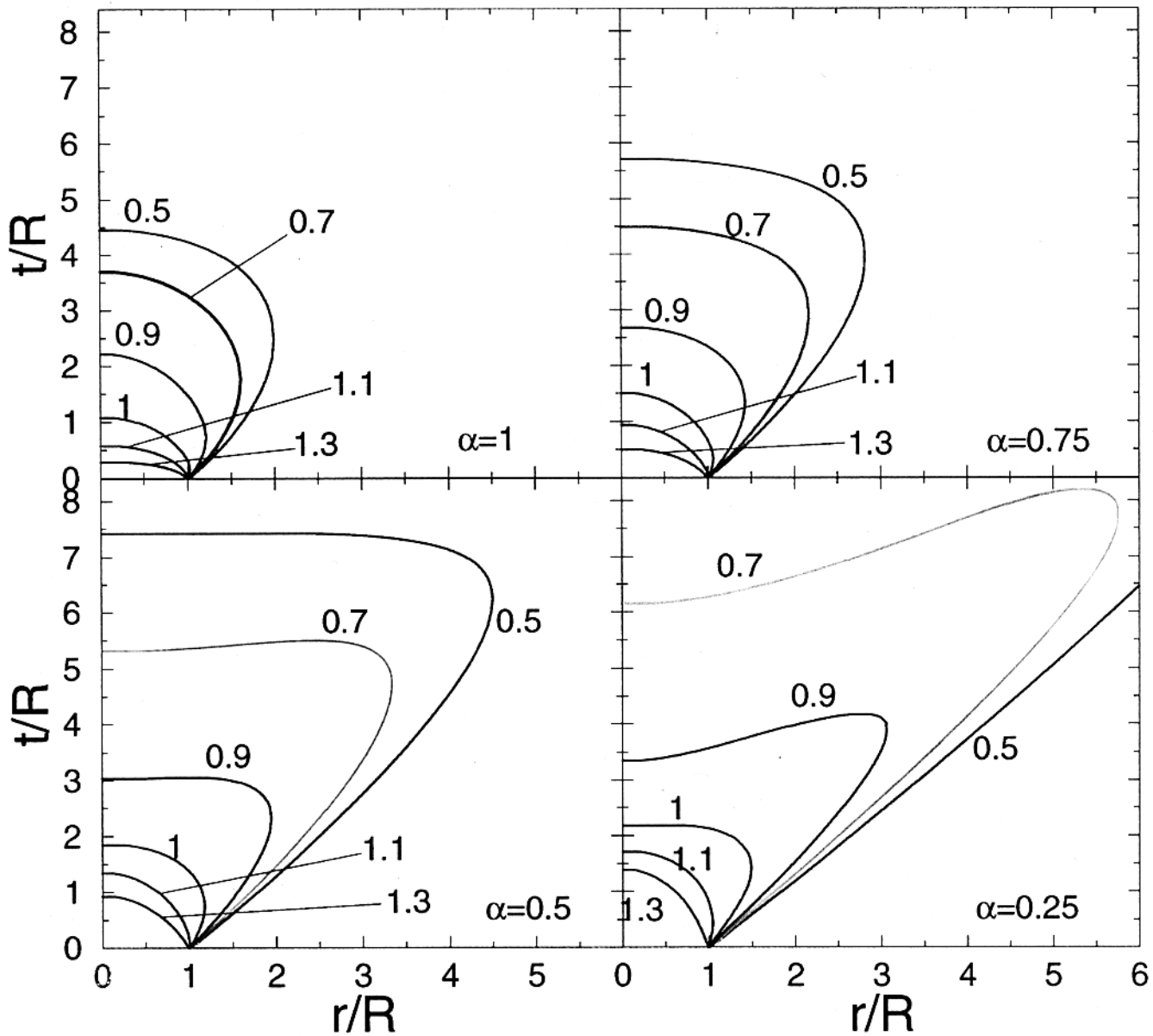
$$\partial_\tau E + \partial_r [(E+p) v_r] = -\left(\frac{\alpha}{\tau} + \frac{v_r}{r}\right)(E+p) ,$$

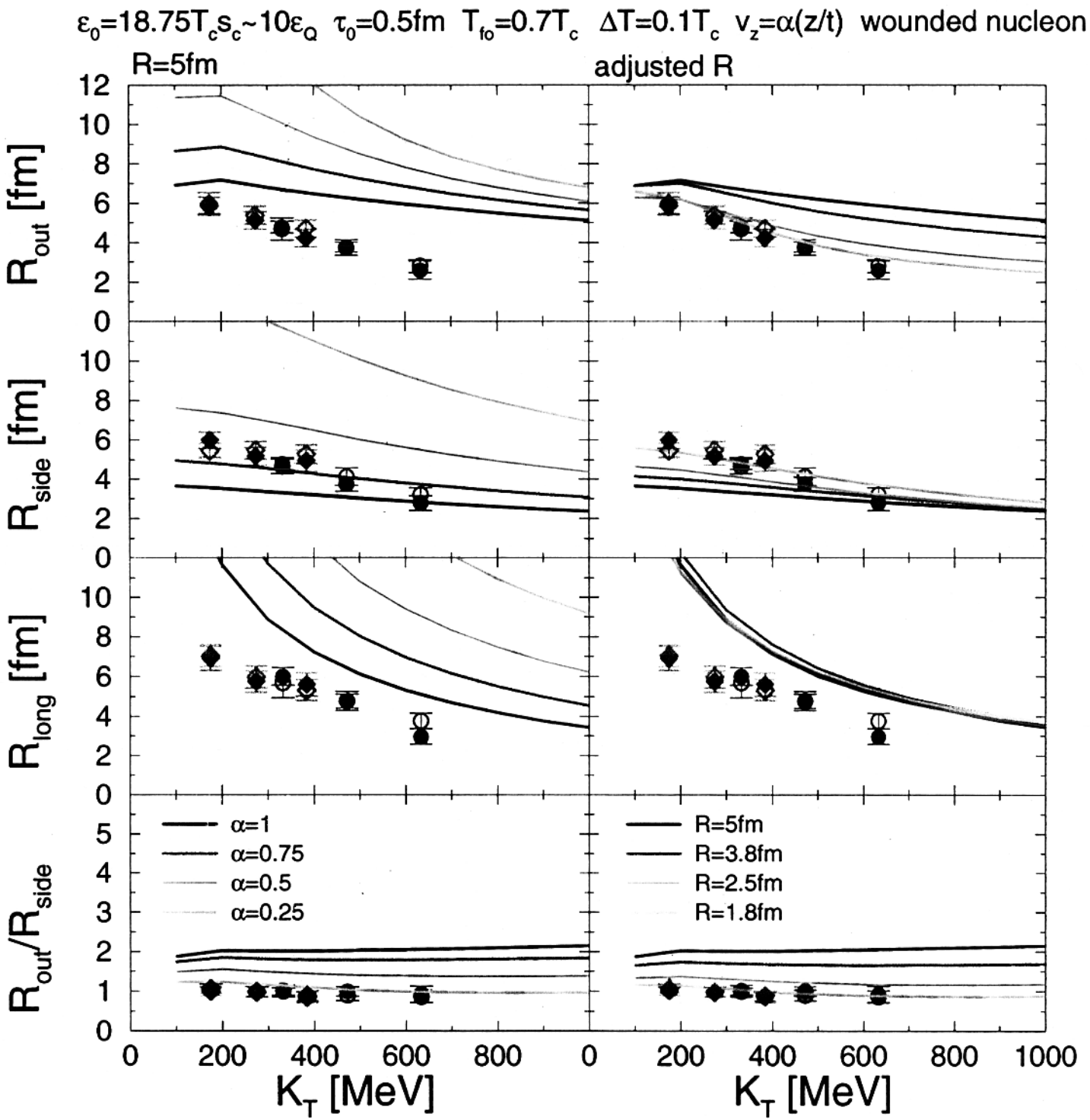
$$\partial_\tau M + \partial_r (M v_r) = -\left(\frac{\alpha}{\tau} + \frac{v_r}{r}\right) M ,$$

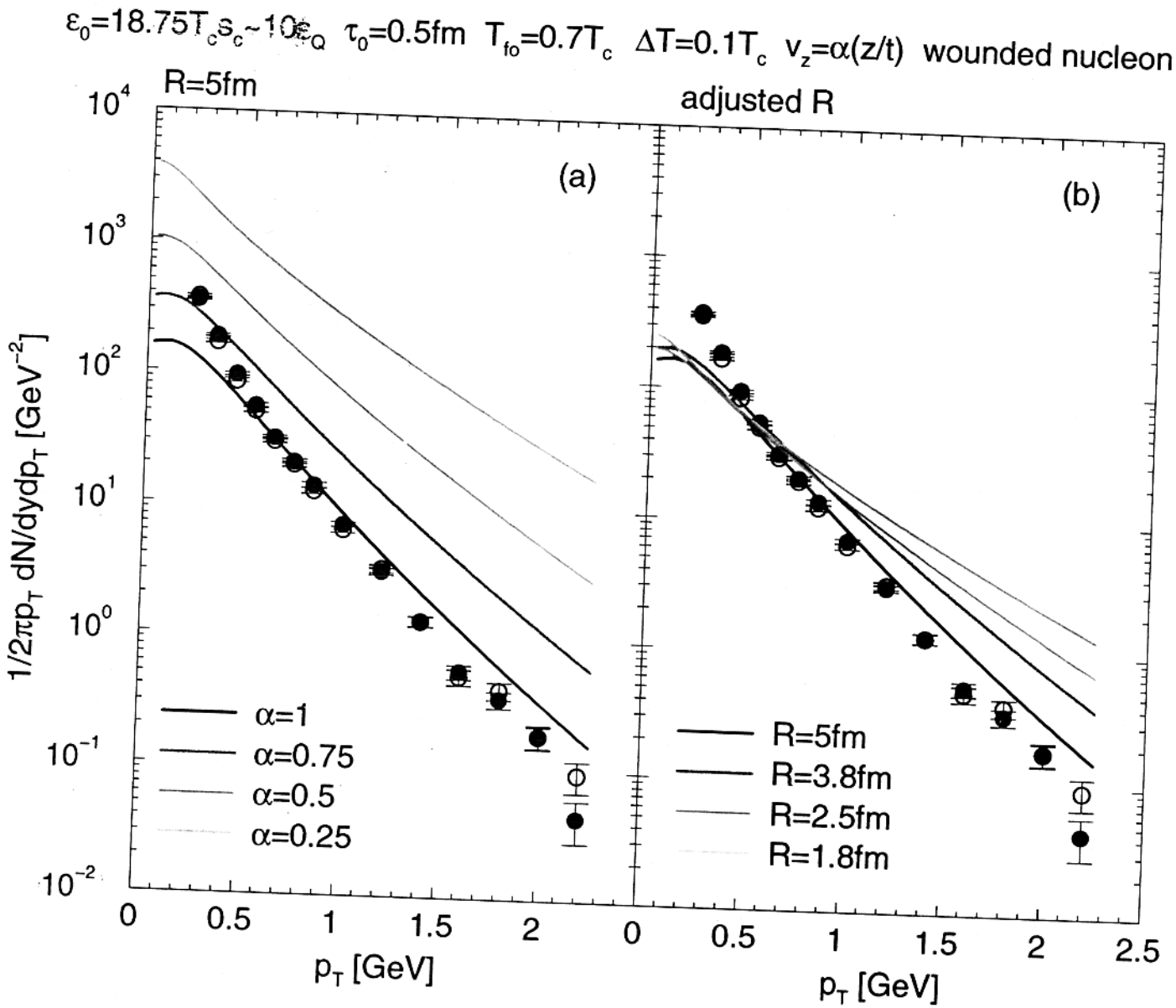
$$\partial_\eta p = 0 ,$$

$$\tau = \sqrt{t^2 - \alpha^2 z^2} , \quad \eta = \mathrm{Arth}\left(\alpha \frac{z}{t}\right) .$$

$\varepsilon_0=18.75T_c s_c \sim 10\varepsilon_Q$ $\tau_0=0.1R$ $T_{fo}=0.7T_c$ $\Delta T=0.1T_c$ $v_z=\alpha(z/t)$ wounded nucleon




ε0=18.75TcSc~10εQ τ0=0.5fm Tfo=0.7Tc ΔT=0.1Tc vz=α(z/t) wounded nucleon
R=5fm
adjusted R
Rout [fm]
Rside [fm]
Rlong [fm]
Rout/Rside
α=1
α=0.75
α=0.5
α=0.25
R=5fm
R=3.8fm
R=2.5fm
R=1.8fm
KT [MeV]
KT [MeV]


ε0=18.75TcSc~10εQ τ0=0.5fm Tfo=0.7Tc ΔT=0.1Tc vz=α(z/t) wounded nucleon
R=5fm
adjusted R
(a)
(b)
1/2πpT dN/dydpT [GeV-2]
pT [GeV]
α=1
α=0.75
α=0.5
α=0.25
R=5fm
R=3.8fm
R=2.5fm
R=1.8fm

Conclusions :

- Explore boost-noninvariant initial conditions to solve RHIC-HBT puzzle.

- Do not trust models which explain few observables, but not all.
  Good models describe all observables.

  ⇒ up-to-day very few (no?) good models on the market...