

Three-dimensional source function from a hydro + cascade model

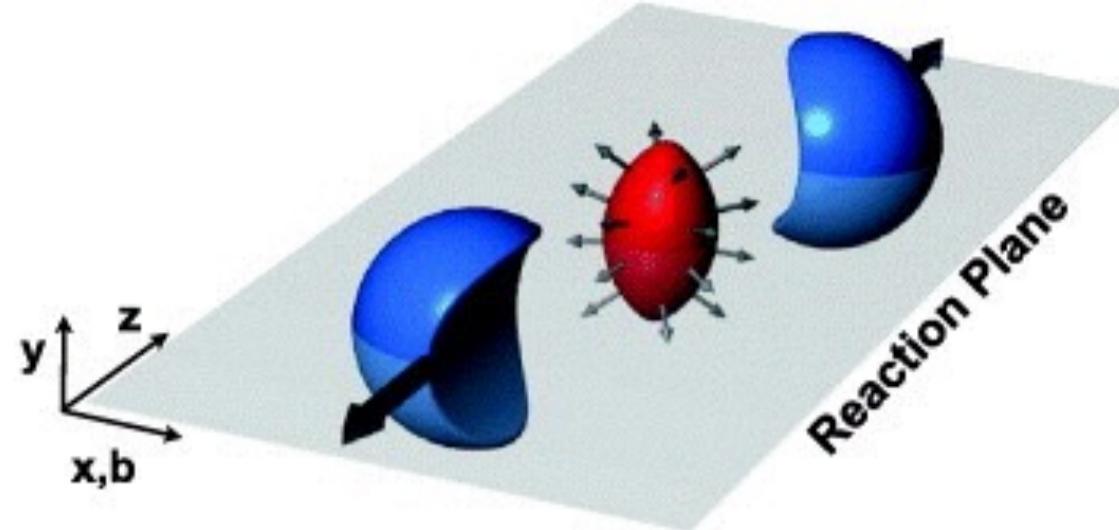
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Introduction

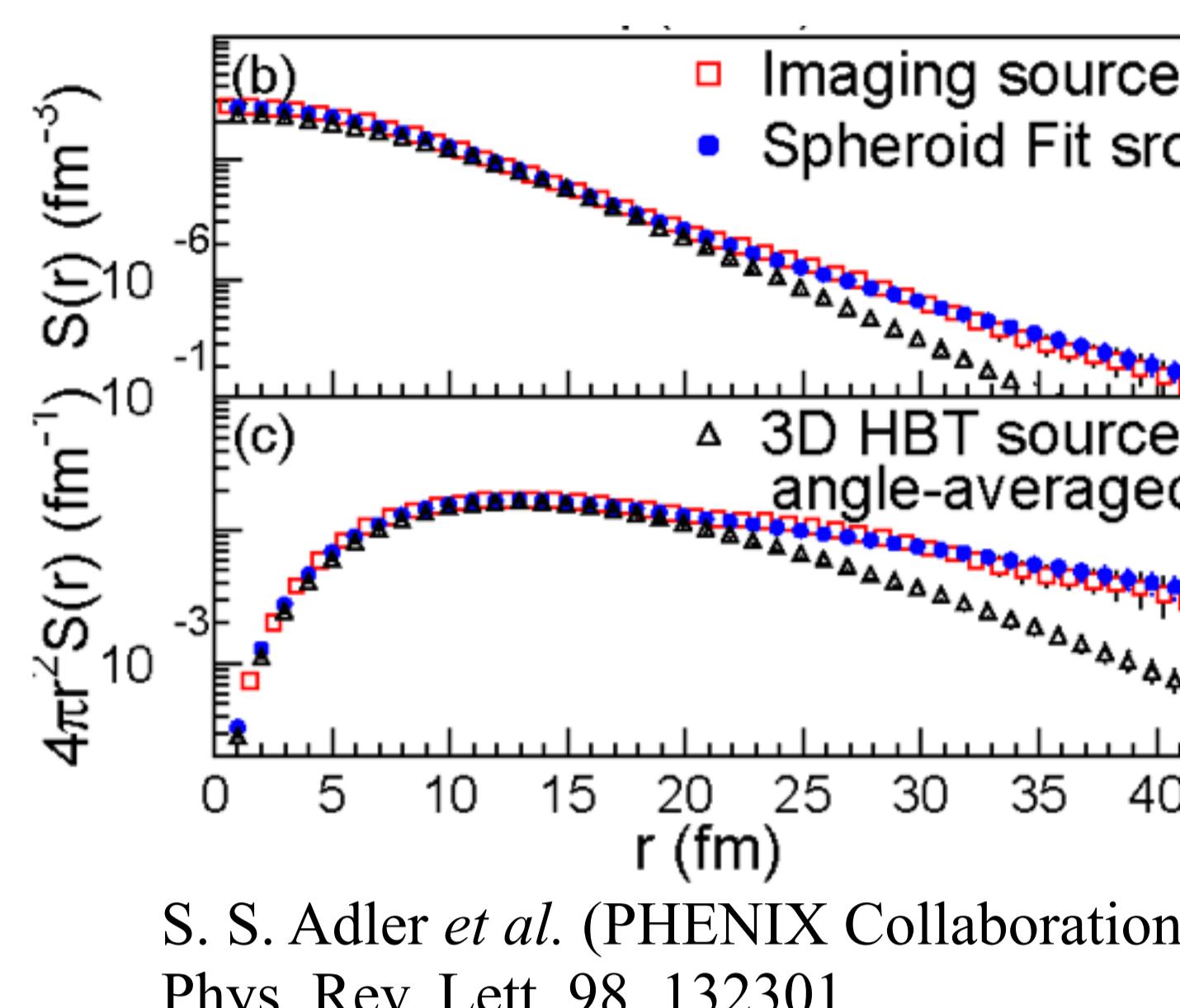
- Spatial information of the system in high energy nuclear collisions

<http://iopscience.iop.org/article/10.1088/1367-2630/13/5/055008/pdf>



Two major observables

- HBT radii: based on Gaussian assumption
- Source function: all information about emission source



Source function is NOT a Gaussian

Purpose

Study of geometry through source functions from a hydro + cascade model

Model and source function

• Model

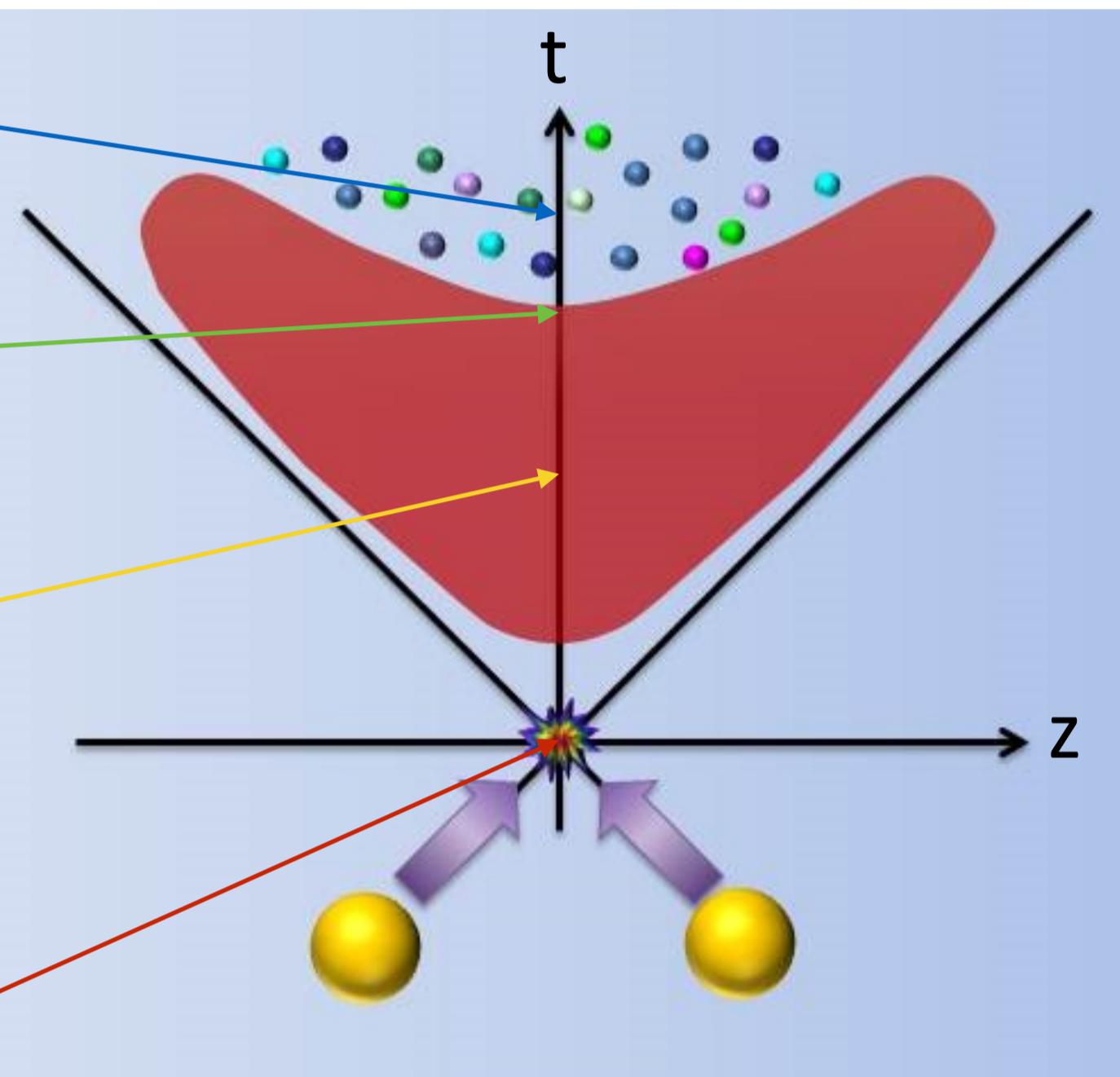
Hadron gas
• Hadron cascade model (JAM)

Switching from fluid to cascade
• Cooper-Frye formula

QGP fluid
• (3+1)D perfect fluid
• EoS: lattice-QCD (s95p-v1.1)

Initial condition
• Monte-Carlo Glauber model
• Au+Au ($\sqrt{s_{NN}} = 200 \text{ GeV}$)

or Pb+Pb ($\sqrt{s_{NN}} = 2.76 \text{ TeV}$)



T.Hirano, P.Huovinen, K.Murase and Y.Nara,
Prog. Part. Nucl. Phys. 70, 108 (2013)

• Source function

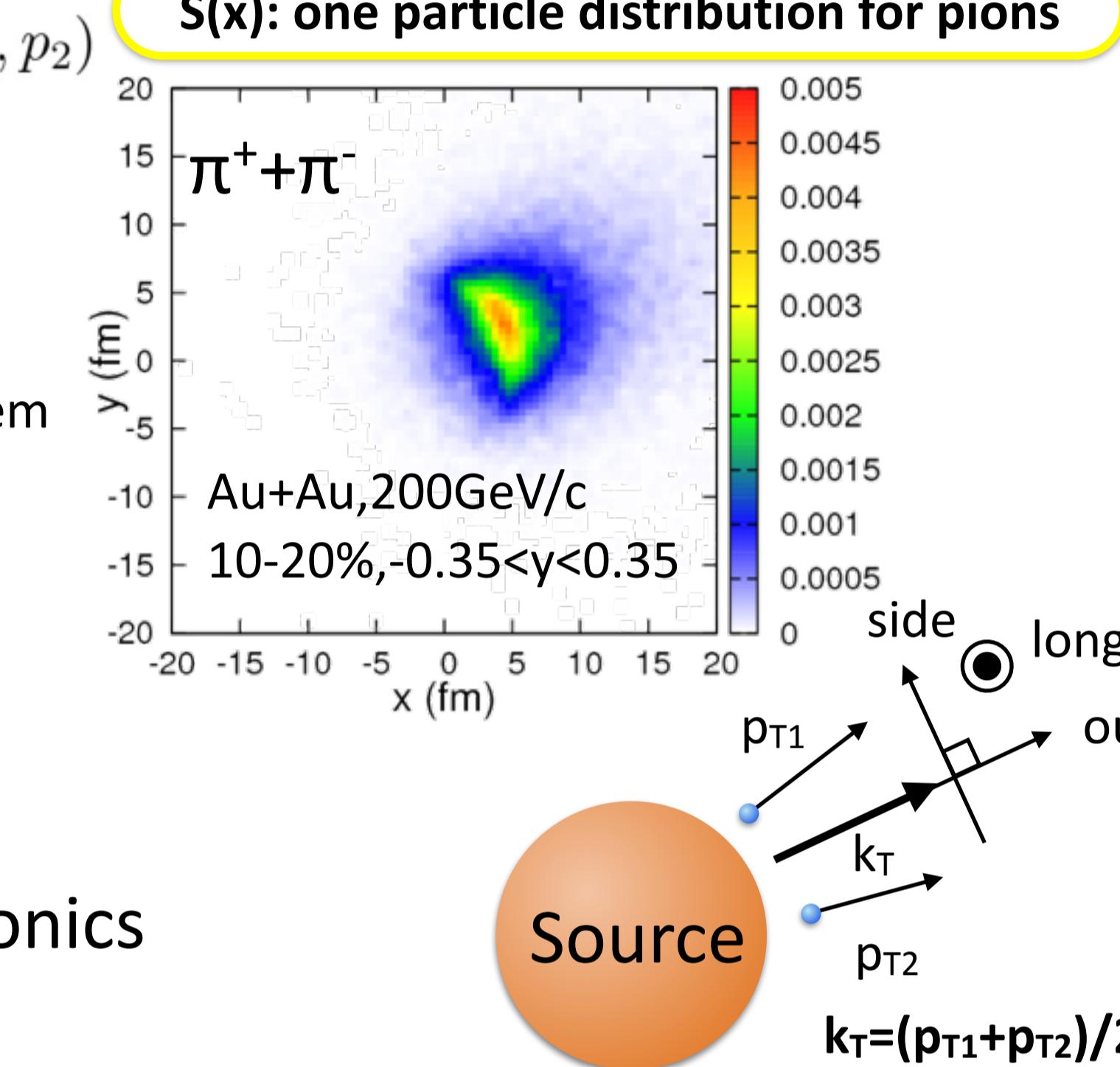
(distribution of relative distance of two identical particles)

$$\begin{aligned} D_p(\mathbf{r}') &= \int dt' \int d^4R S_1(x_1, p_1) S_2(x_2, p_2) \\ \text{Source function} \quad x_1 &= R + r/2, x_2 = R - r/2 \\ S(x, p) &= \frac{Ed^7N}{d^4xd^3p} / \frac{Ed^3N}{d^3p} \end{aligned}$$

primed ('') variables in the pair co-moving system

1D: Spherical polar coordinates
⇒ Angular integration

3D: out-side-long coordinates
⇒ Expansion in Cartesian harmonics



Reproduction of one particle distribution from a hydro + cascade model
→ Two particle distribution (source function) ?

Results

1D and 3D source functions for pions

Centrality 0-20%, Rapidity $-0.35 < y < 0.35$

Mean Momentum $0.20 < k_T < 0.36 \text{ GeV}/c$, $\lambda_\pi = 0.45$

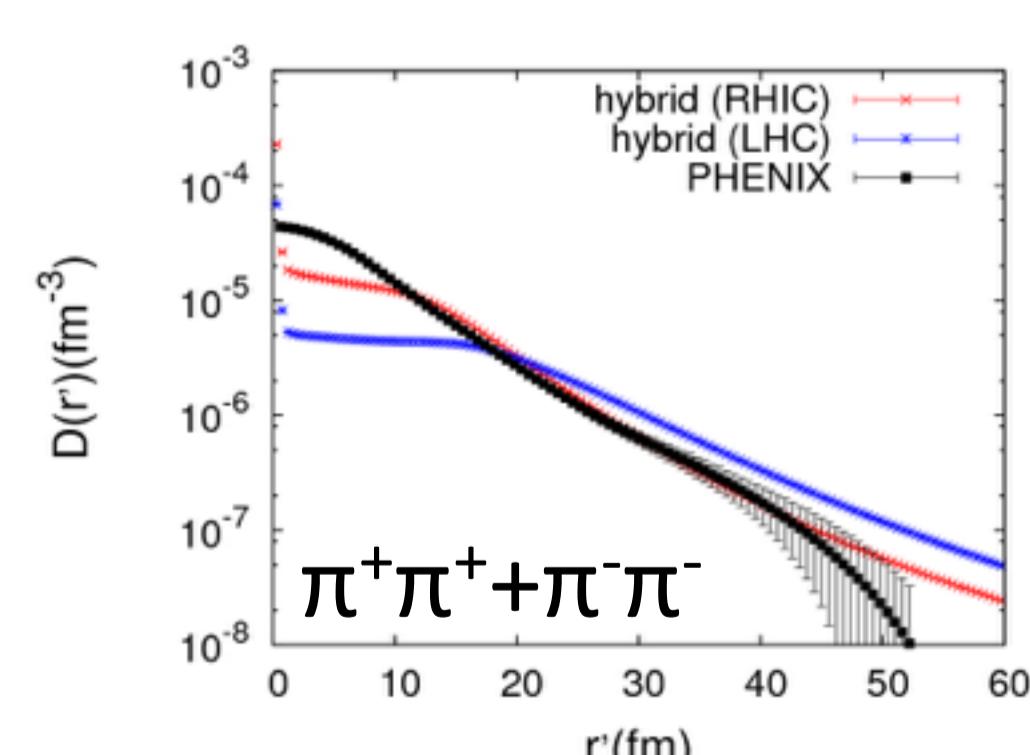
1D source function for kaons

Centrality 0-30%, Rapidity $-0.35 < y < 0.35$

Mean Momentum $0.30 < k_T < 0.90 \text{ GeV}/c$, $\lambda_K = 1.00$

1D source function for pions and kaons

• Comparison between RHIC and LHC

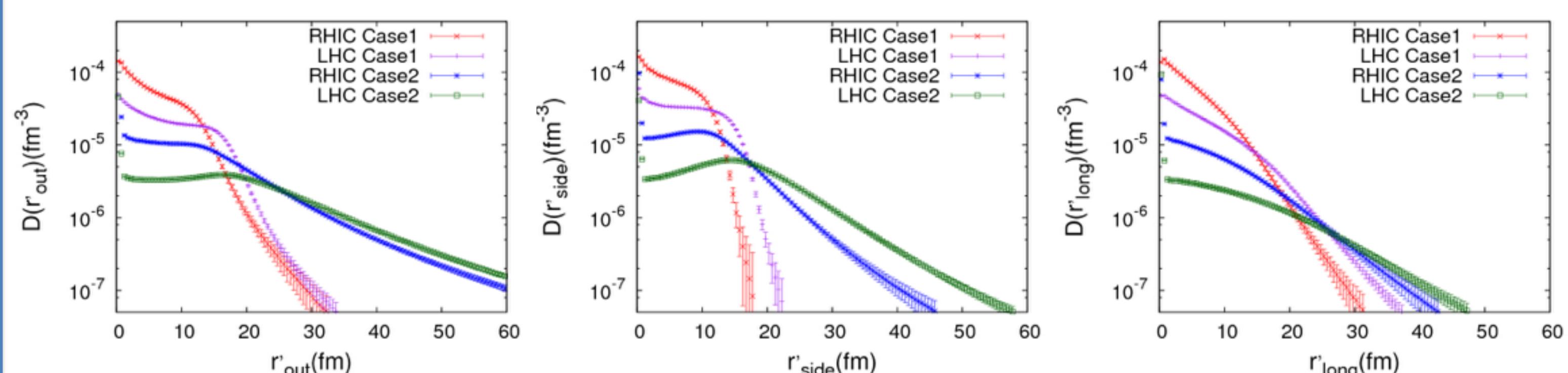


- Good reproduction of the PHENIX data
- Longer tail at the LHC energy

3D source function for pions

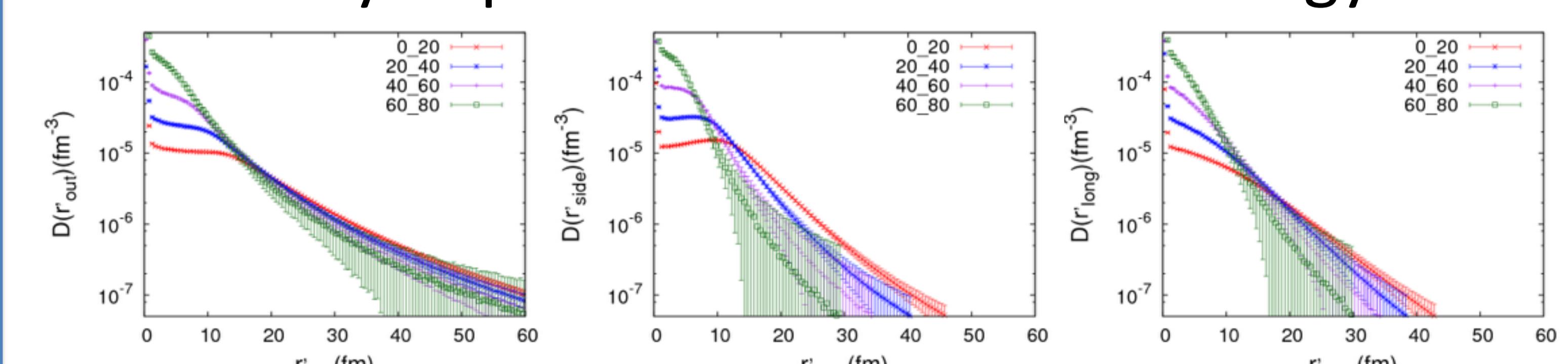
• Comparison between RHIC and LHC

Case1: w/o hadronic rescatterings or decays
Case2: w/ hadronic rescatterings and decays



- Longer tail at the LHC energy
- Small r' ($r' < 20 \text{ fm}$) → Remnant of size of switching hypersurface
- Large r' ($r' > 20 \text{ fm}$) → hadronic rescatterings and decays

• Centrality dependence at the RHIC energy



- Central → larger system size → longer tail
- Peripheral → smaller system size → shorter tail

Summary

- Analysis of 1D and 3D source functions for pions and kaons from a hydro+cascade model at the RHIC and LHC energies

1D source function for pions and kaons

- Consistency between model results and PHENIX data
- Longer tail at the LHC energy than at the RHIC energy

3D source function for pions

- Two component (short and long distance) behavior
- Sensitive to centrality