

COLLECTIVE BEHAVIOR IN SMALL SYSTEMS: A FLUID-DYNAMICAL PERSPECTIVE

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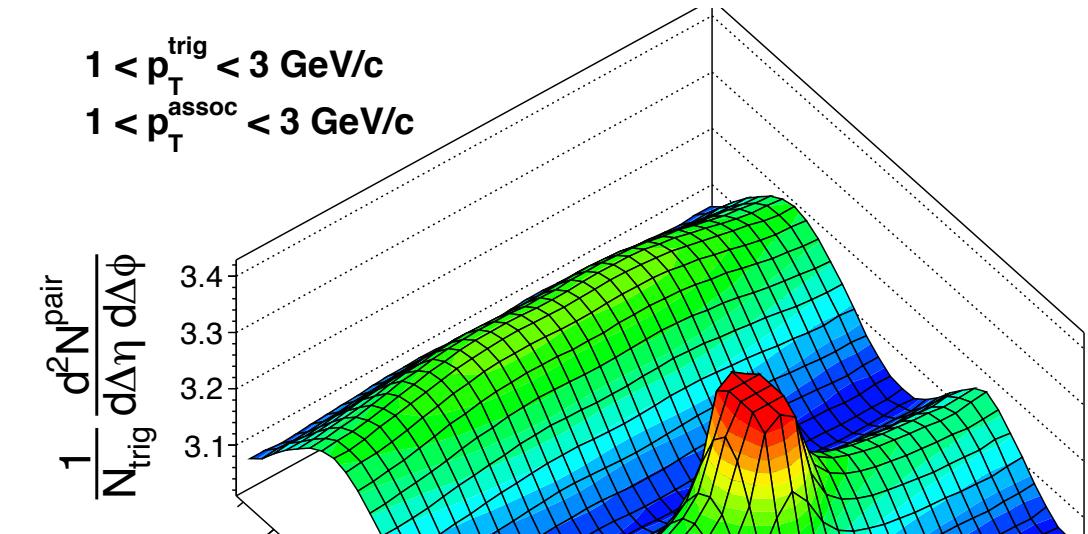
arxiv.org/abs/1405.3976 and [1412.3147](https://arxiv.org/abs/1412.3147)

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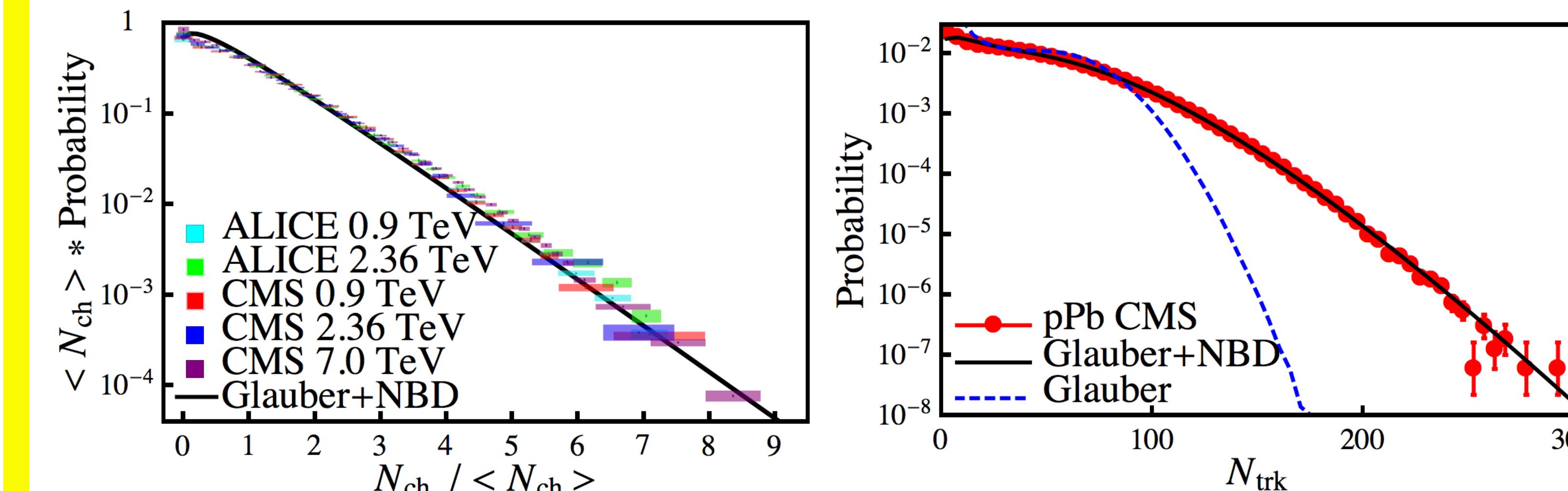
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Model

Why hydrodynamics?
Is it pPb or PbPb?



2 modifications to the conventional wounded nucleon model: **NBD** fluctuations and **rapidity dependence** of initial entropy

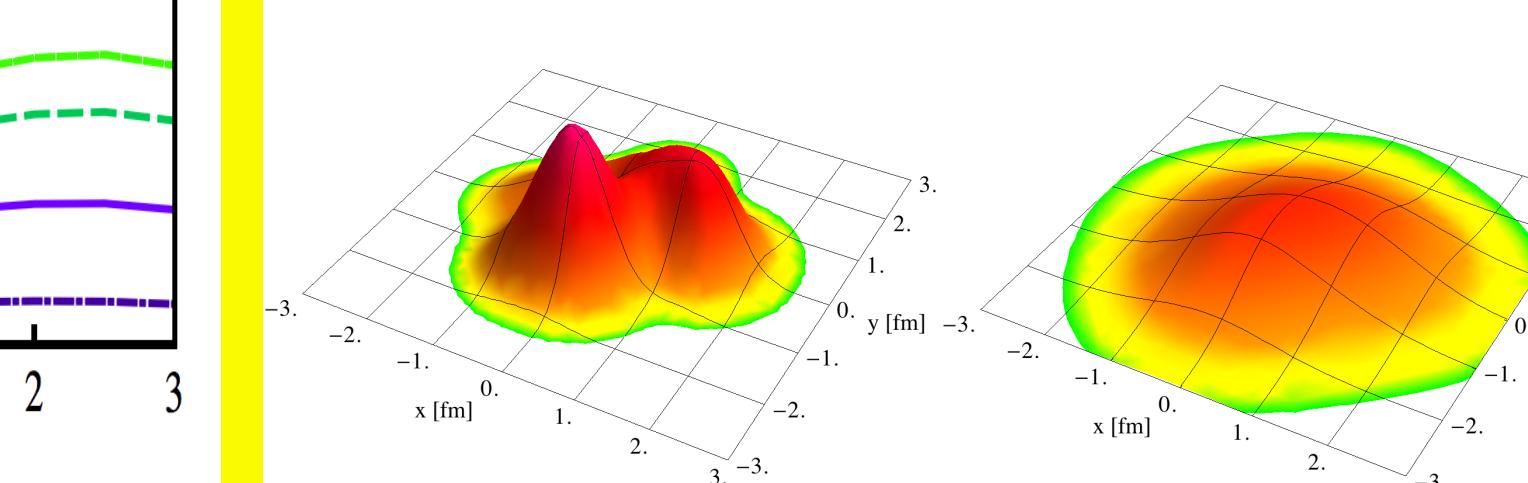


Transverse granularity
is modeled with parameter

σ

width of the Gaussian

$$\sigma = 0.40 \text{ fm} \quad \sigma = 0.80 \text{ fm}$$



Results & Analysis

dashed
thin solid
thick solid

$$\sigma = 0.4 \text{ (fm)}$$

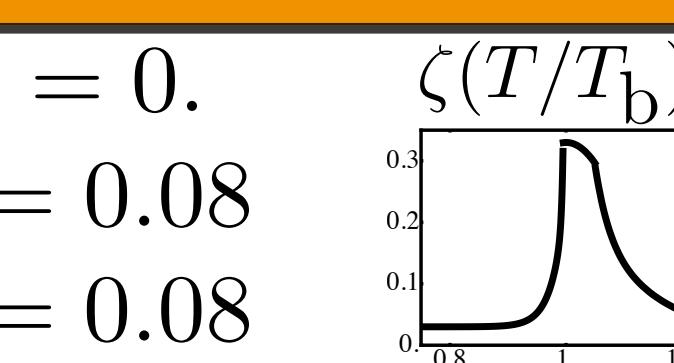
$$\sigma = 0.4 \text{ (fm)}$$

$$\sigma = 0.8 \text{ (fm)}$$

$$\eta/s = 0.$$

$$\eta/s = 0.08$$

$$\eta/s = 0.08$$



$\sigma = 0.4 \text{ fm}, \eta/s = 0.08$
CMS 1305.0609

CMS 1503.01692

$\sigma = 0.4 \text{ fm}, \eta/s = 0.08$

prediction

$\sigma = 0.4 \text{ fm}, \eta/s = 0.08$

CMS 1503.01692

studying parameter space

granularity $\sigma = 0. - 0.4 \text{ fm}$

viscosity $\eta/s = 0. - 0.08$

studying difference in effects

of fluctuations and granularity

on pA and AA

ALICE 1109.2501

$p_T^b [\text{GeV}/c]$

$r_2(p_T^a, p_T^b)$

$p_T^a [\text{GeV}/c]$

$r_2(p_T^a, p_T^b)$

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$p_T^b [\text{GeV}/c]$

$r_2(p_T^a, p_T^b)$

$p_T^a [\text{GeV}/c]$

$r_2(p_T^a, p_T^b)$

Conclusion

pPb system at high multiplicity

differential

$$v_n(p_T)$$

integrated

$$\langle p_T \rangle, \bar{v}_n$$

double-differential

$$r_n(p_T^a, p_T^b) \text{ or } r_n(\eta_T^a, \eta_T^b)$$

$$V_{n\Delta}(x^a, x^b) \equiv \langle v_n(x^a) v_n(x^b) e^{in(\psi_n(x^a) - \psi_n(x^b))} \rangle$$

$$r_n(p_T^a, p_T^b) \equiv V_{n\Delta}(p_T^a, p_T^b) / \sqrt{V_{n\Delta}(p_T^a, p_T^a) V_{n\Delta}(p_T^b, p_T^b)}$$

$$r_n(\eta_T^a, \eta_T^b) \equiv \sqrt{V_{n\Delta}(-\eta_T^a, \eta_T^b) V_{n\Delta}(\eta_T^a, -\eta_T^b)} / \sqrt{V_{n\Delta}(\eta_T^a, \eta_T^b) V_{n\Delta}(-\eta_T^a, -\eta_T^b)}$$

pPb and **PbPb** effects

with one set of parameters

different $\langle \epsilon_3 \rangle$ lead to

remarkably similar $\bar{v}_3\{2\}$

tells us where hydro breaks down

in hydrodynamics $r_n \leq 1$ can **not** be circumvented

a way to probe initial conditions (granularity)

viscosity has small effect
initial conditions - **significant**

a way to study differences between **pA** and **AA**

reveals difficulty to describe both systems

Hydro can reasonably describe available data

r_n predictions provide another handle to explore HIC