Constraints on longitudinal-dependent initial conditions from $dN_{\mathrm{ch}}/d\eta$ and two-particle η-correlation @ LHC

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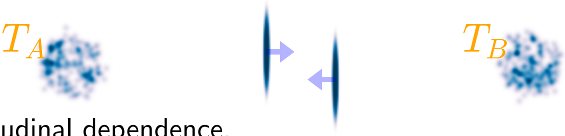
Motivation: a simple 3d-initial condition model

Boost-invariant hydrodynamic-based modelling is successful at mid-rapidity. But,

- model asymmetric collisions like pA;
- EbE longitudinal fluctuations in AA collisions;
- impact on medium evolution, probes propagation and observables.

Extend existing 2d-IC model (TRENTo) to 3d

- A parametric IC model at $\eta \sim 0$: $T_A(x_\perp), T_B(x_\perp) \to s_0(x_\perp)|_{\tau=\tau_0}$.



Add longitudinal dependence,

$$s(x_\perp, \eta_s) = s_0(x_\perp) g(x_\perp, y) \frac{dy}{d\eta}.$$

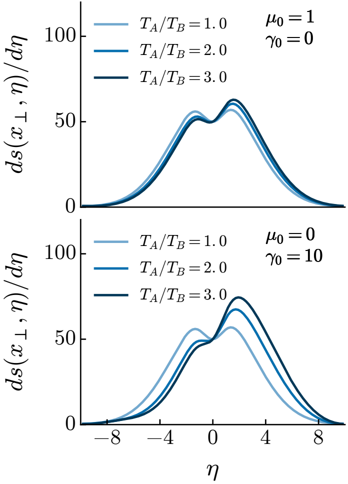
- Difference in $T_A(x_\perp), T_B(x_\perp)$ induces asymmetry in longitudinal profile function $g(x_\perp, y)$.
- Normalize $g(x_\perp, 0) = 1$ to preserve 2d-model calculation.
- $g(x_\perp, y)$ characterized by its first 3 y-cumulants:

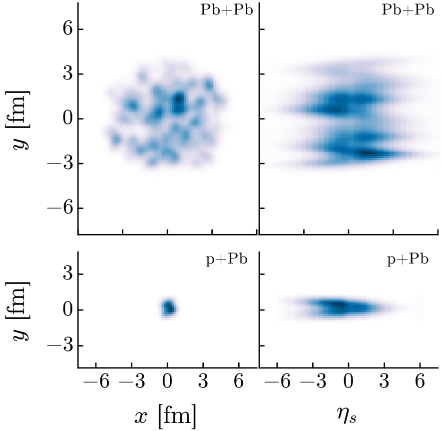
Cumulants	mean	width	skewness
Param-1 (relative)	$\mu_0 \frac{1}{2} \ln \frac{T_A}{T_B}$	σ_0	$\gamma_0 (T_A - T_B)/(T_A + T_B)$
Param-2 (absolute)			$\gamma_0 (T_A - T_B)$

$g(x_\perp, y)$ reconstructed from cumulant-generating function.

Example events

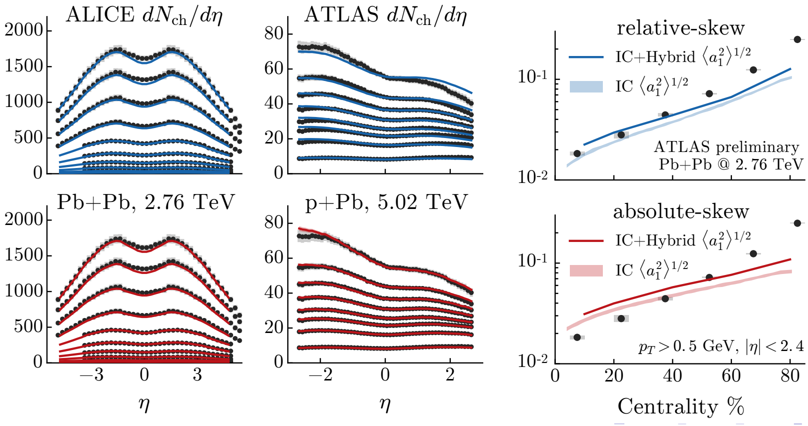
Cumulants	mean	width	skewness
Param-1 (relative)	$\mu_0 \frac{1}{2} \ln \frac{T_A}{T_B}$	σ_0	$\gamma_0(T_A - T_B)/(T_A + T_B)$





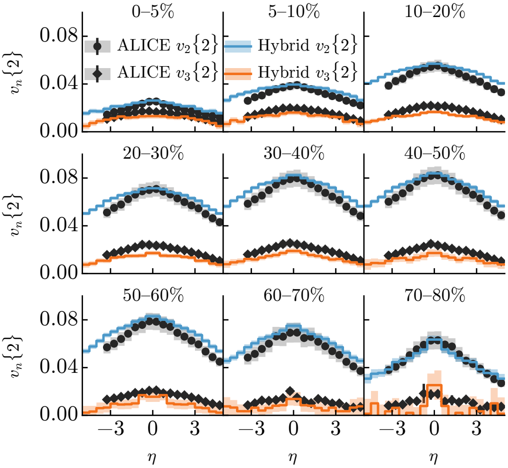
Model Calibration and Selection

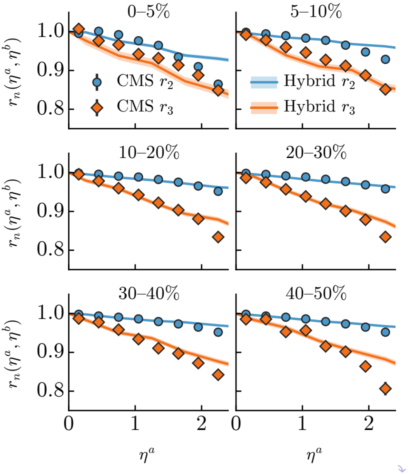
- Using Bayesian methodology, globally fit IC to $dN_{\text{ch}}/d\eta$
  $\rightarrow$ data constrained IC parameters distribution.
- Optimal parameters $\rightarrow$ 3+1D hydro (Iurii Karpenko) + UrQMD. Calculate $C_N(\eta_1, \eta_2)$ observable $\langle a_1^2 \rangle$.
- Relative-skew model is better. $\mu_0 \sim 0$, $\gamma_0 \sim 7.2$.



Predictions

- IC model tuned on multiplicity observables ($\perp$-integrated).
- Predict η-diff flows and event-plane decorrelations (η evolution of $\perp$ structure).





Conclusion

This work:

- A 3d extension of TRENTo initial condition model.
- Model tuned on $dN_{\text{ch}}/d\eta$ with Bayesian technique.
- Achieve a reasonable η-dependence of transverse structure.

Things to do and limitations:

- Use full model calculation to compare with $dN_{\text{ch}}/d\eta$.
- Study more longitudinal observables.
- Inclusion of proton geometry fluctuation in pA (3 quarks?).
- Lack of early stage dynamical fluctuations.