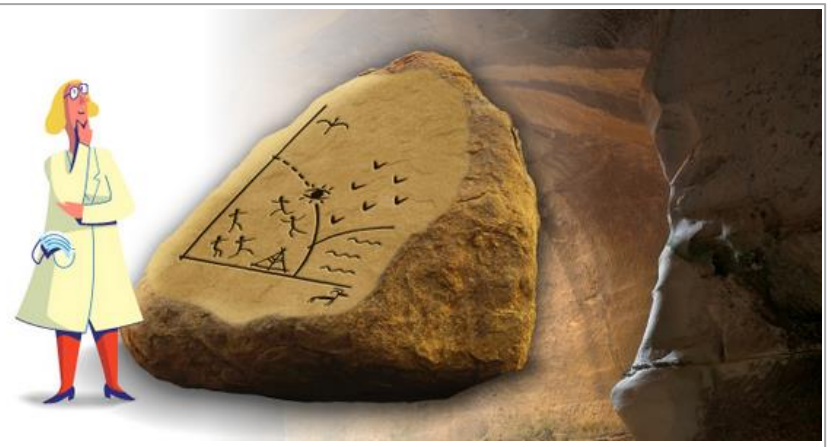
GRANT: 2017/05685-2

IS2021
The VI[th] International Conference on the
INITIAL STAGES
OF HIGH-ENERGY NUCLEAR
COLLISIONS



Using PYTHIA as an initial condition generator for hydrodynamics

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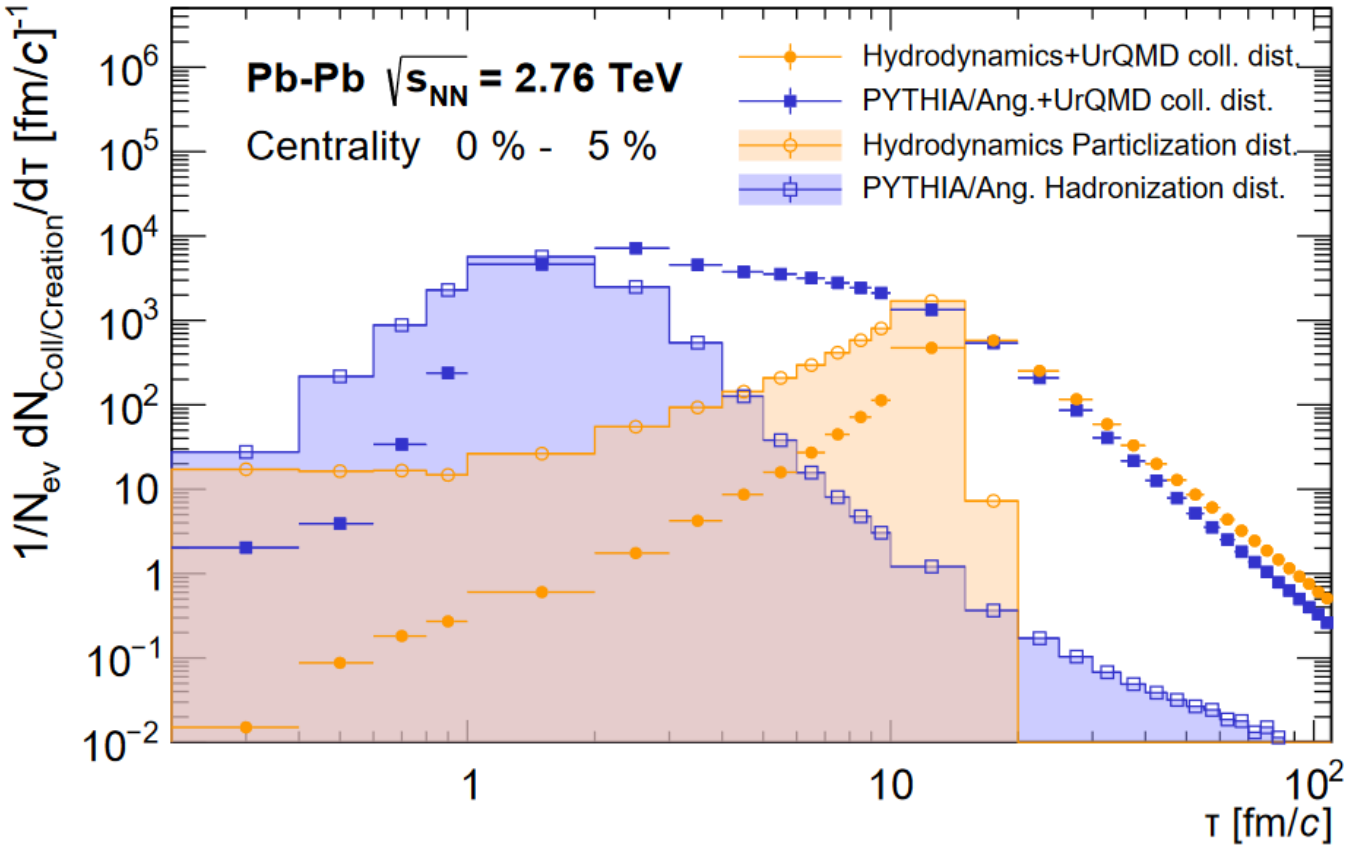
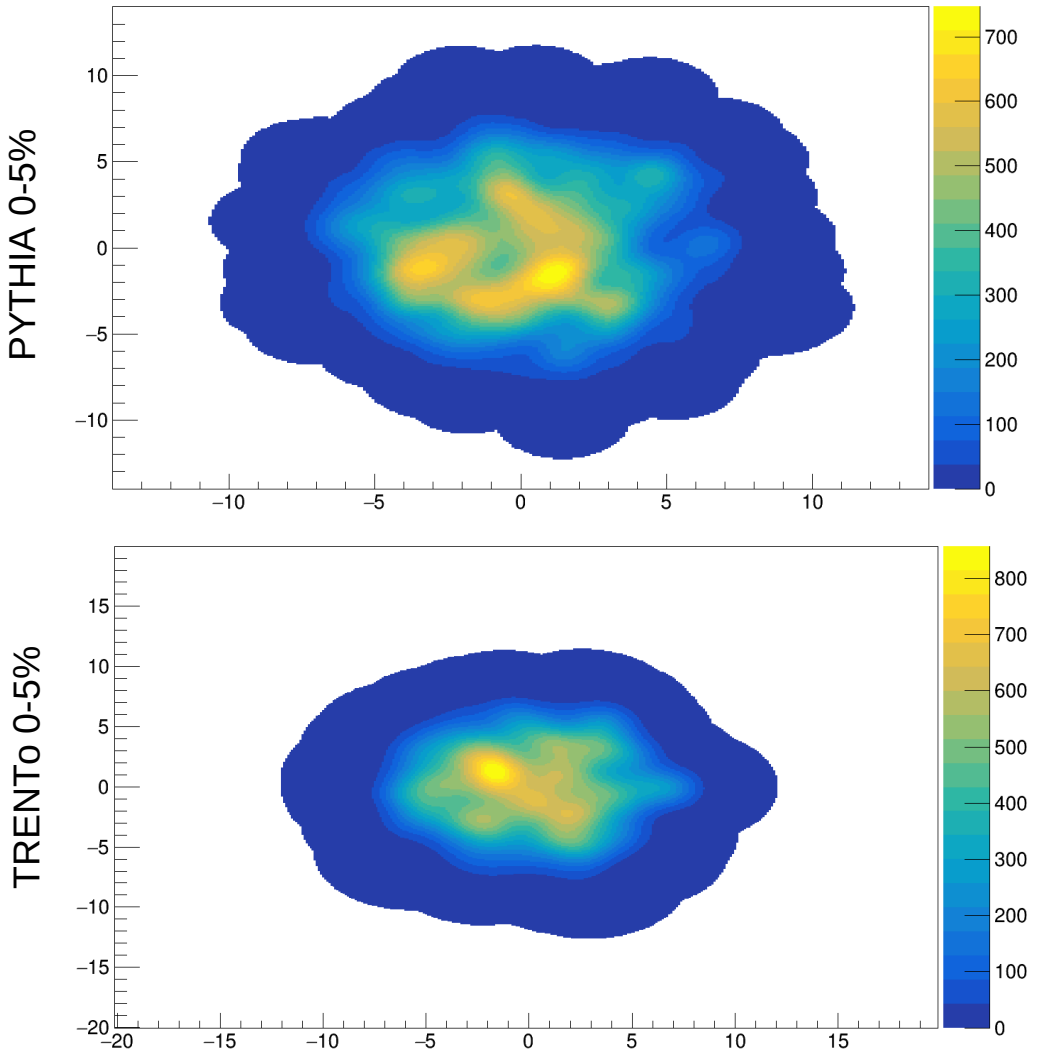
Introduction to the model



- PYTHIA is able to describe hard interactions;
- Hadronization rate is similar to hydrodynamics, up to 2 fm/c.

…Why not use it as an initial condition?

Translating initial conditions



- From PYTHIA generated events, transform point densities into gaussians:

2D Gaussian formula

$$\frac{1}{2\pi\sigma^2}\frac{1}{1+\exp\left(\frac{r-2\sigma}{0.05}\right)}\exp\left(-\frac{\left[(x-x_g)^2+(y-y_g)^2\right]}{2\sigma^2}\right)$$

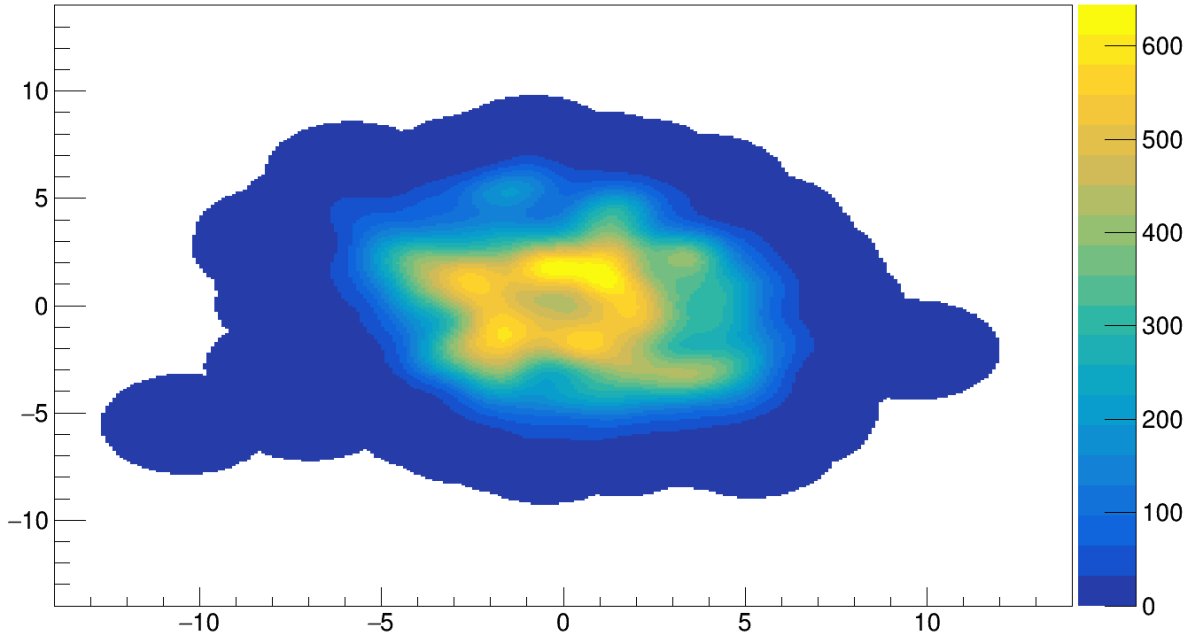
Woods-Saxon potential to suppress gaussian tail

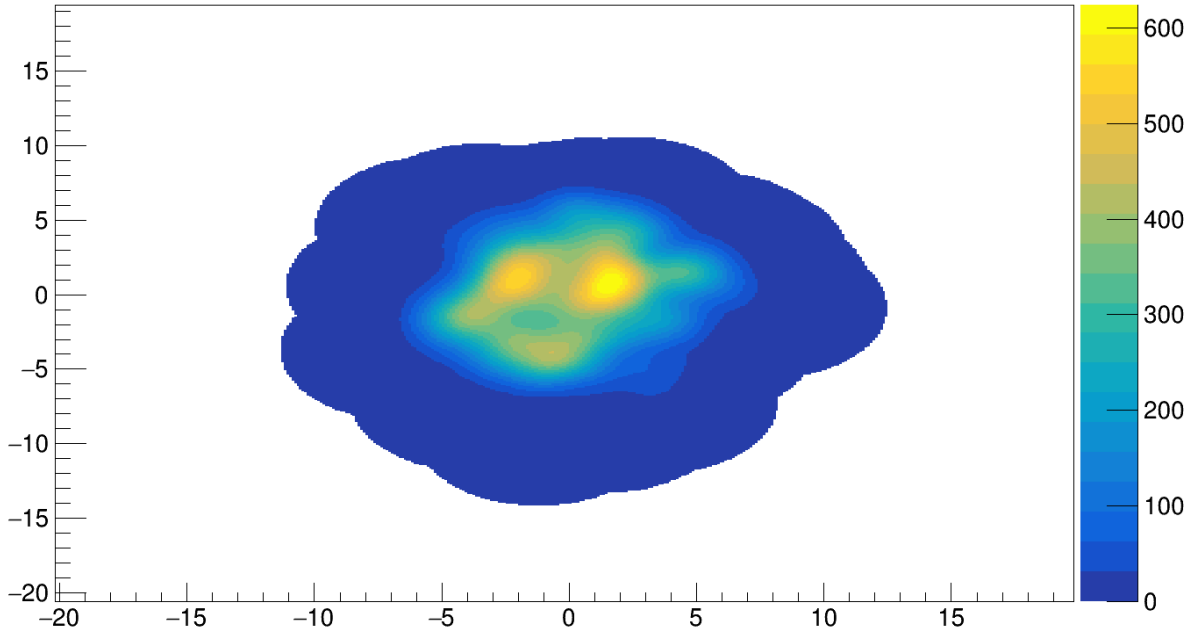
- We apply boundaries on transverse momentum and energy values:

$$p_T < 5\ GeV/c, E < 4\ GeV$$

Translating initial conditions

PYTHIA versus TRENTo initial condition profiles, 10-20%

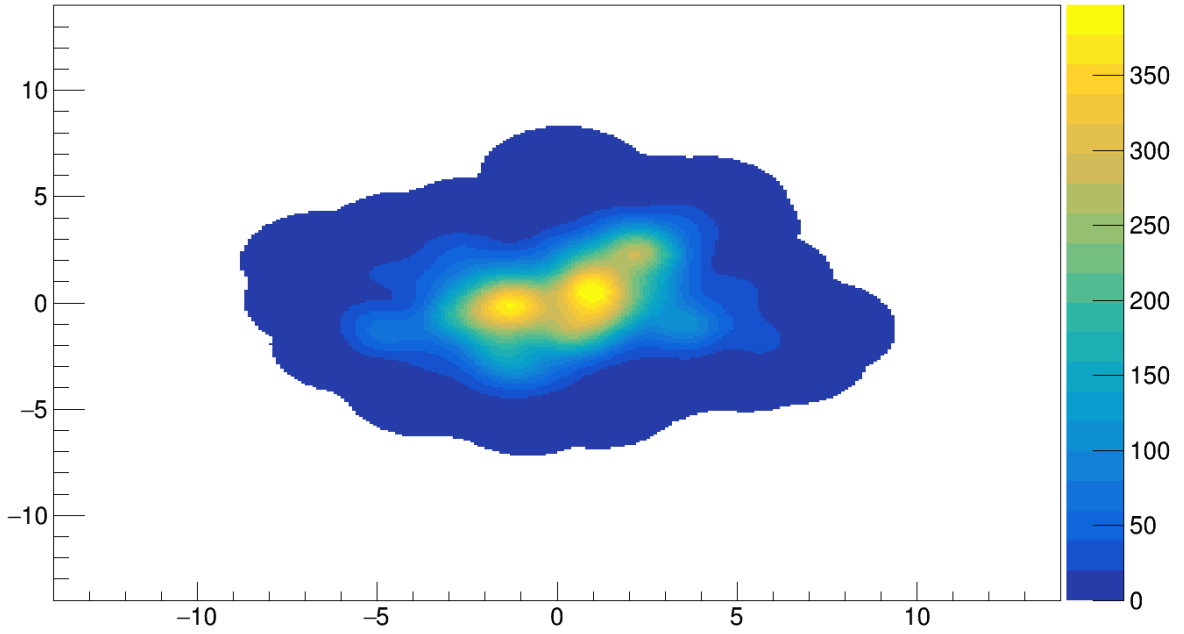


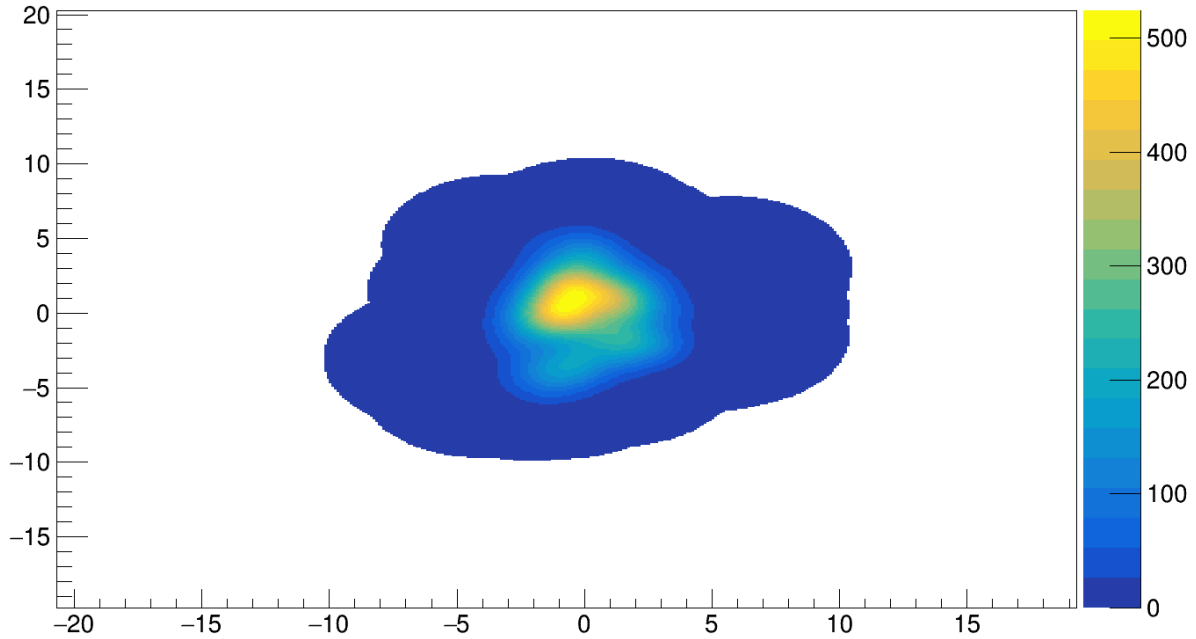


- Gaussian widths: σ_{TRENTo}= 0.956, σ_{PYTHIA} = 0.6

Translating initial conditions

PYTHIA versus TRENTo initial condition profiles, 40-50%

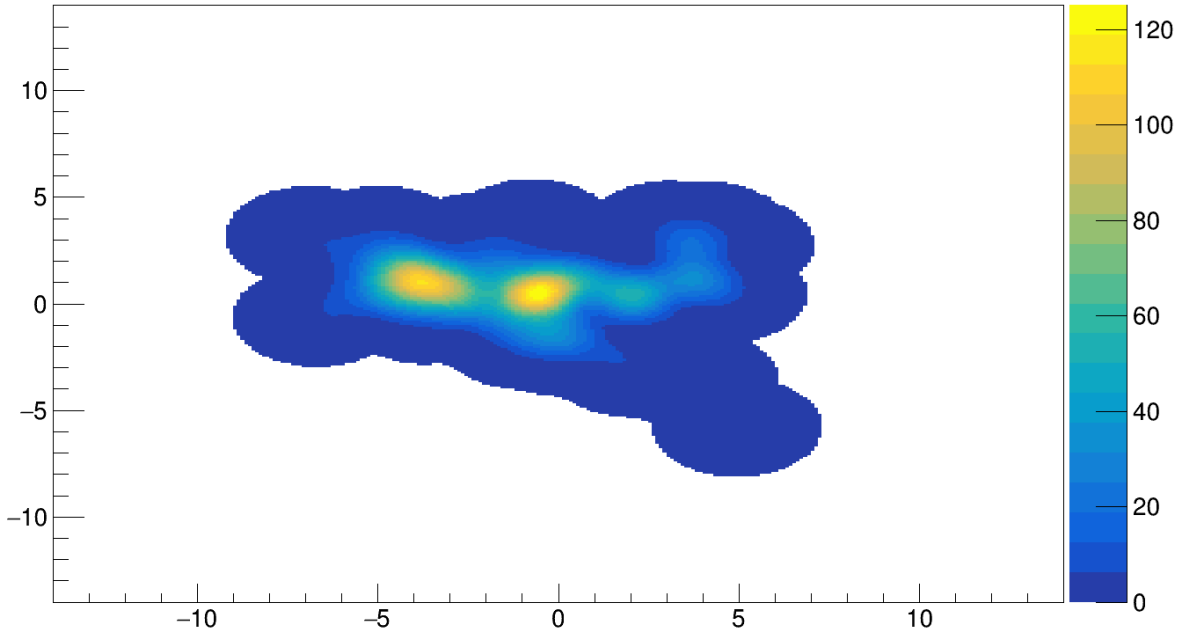


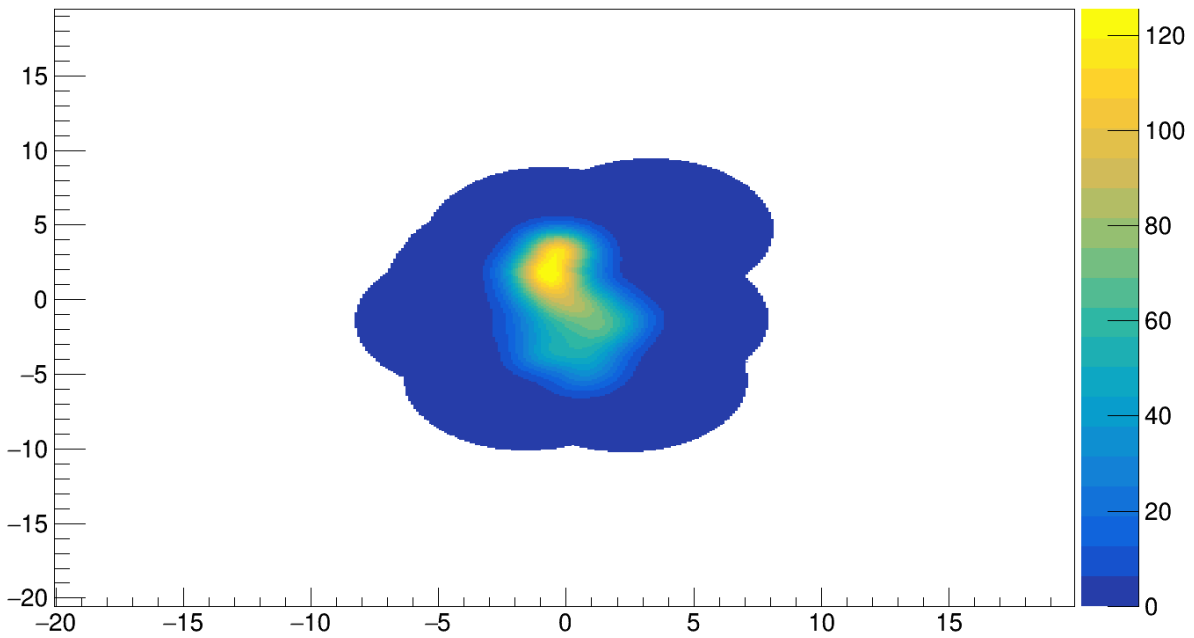


- Gaussian widths: $\sigma_{TRENTo} = 0.956$, $\sigma_{PYTHIA} = 0.6$

Translating initial conditions

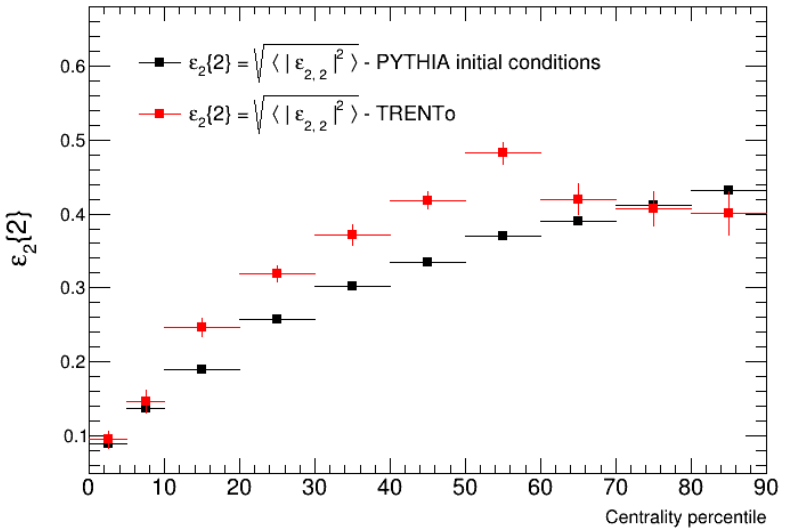
PYTHIA versus TRENTo initial condition profiles, 70-80%

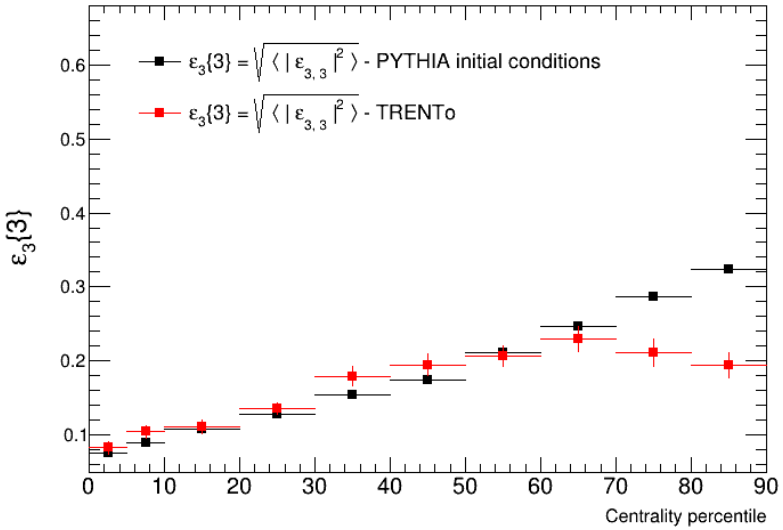


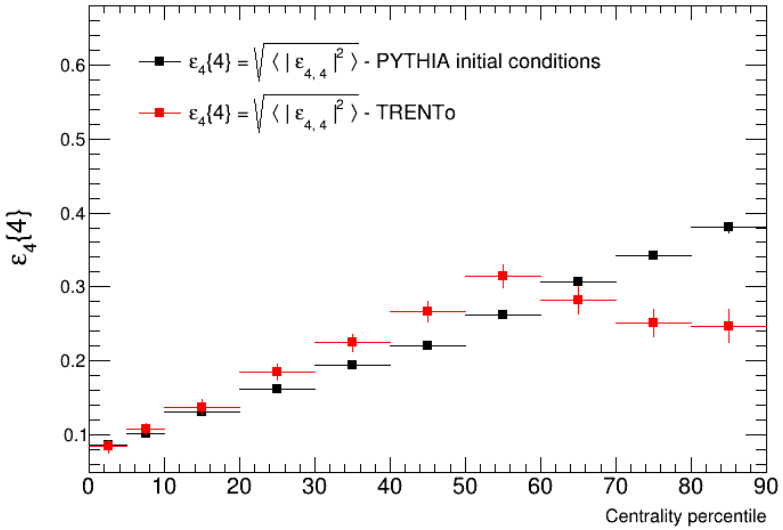


- Gaussian widths: σ_{TRENTo}= 0.956, σ_{PYTHIA} = 0.6;
- Peak values around the same magnitude.

The collision geometry







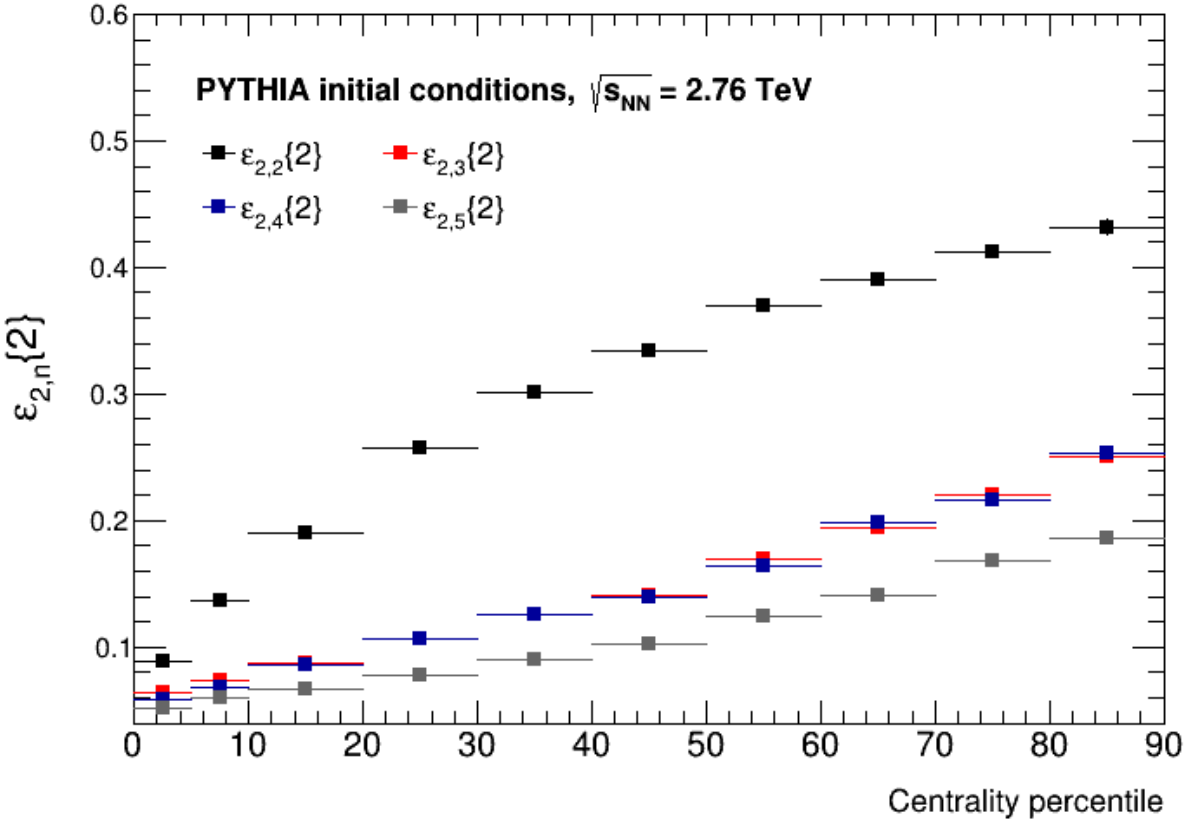
We are using eccentricity vectors [1] to quantify the harmonics above:

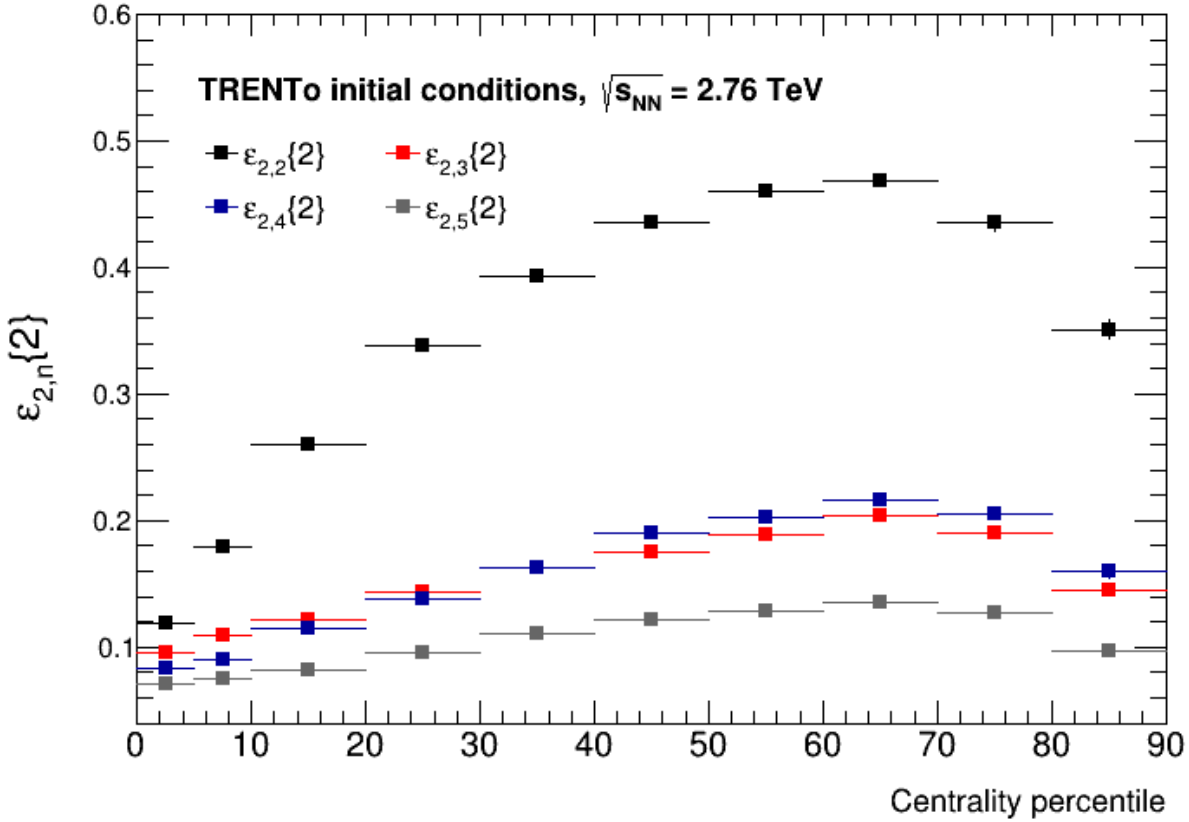
$$\epsilon_{n,m} = \frac{\int r^n e^{im\phi} s(r,\phi) r dr d\phi}{\int r^n s(r,\phi) r dr d\phi}$$

⟹ Clear divergence of eccentricities for peripheral events

[1] *Phys.Rev.C* 100 (2019) 2, 024904

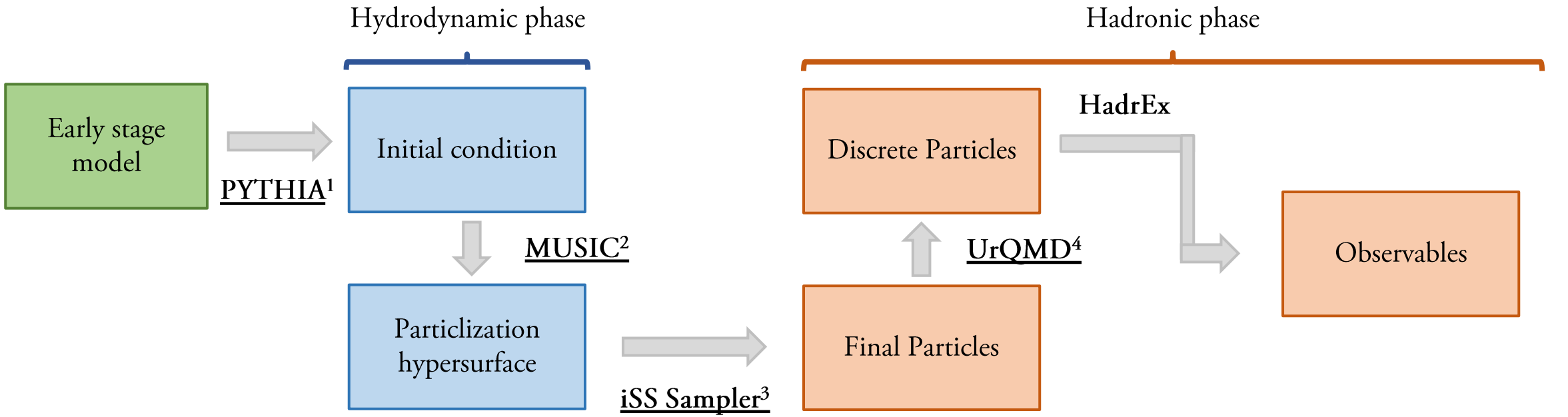
The collision geometry

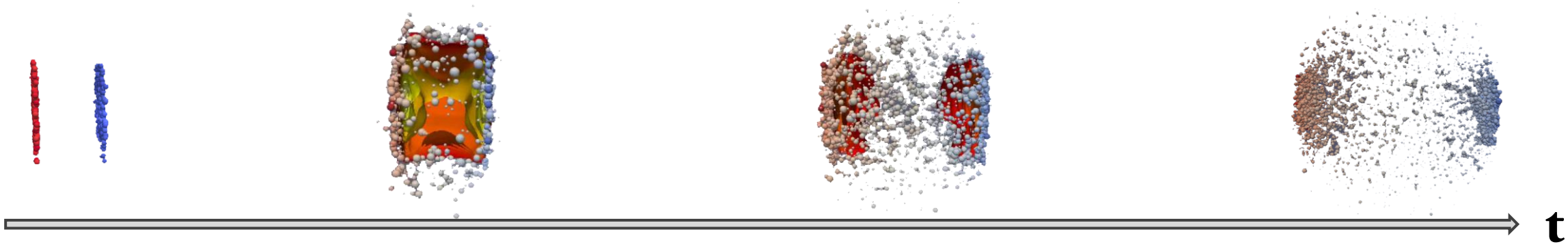




- Similar results only up to 50-60% in centrality
- Differences in higher order eccentricities behavior

Hybrid model

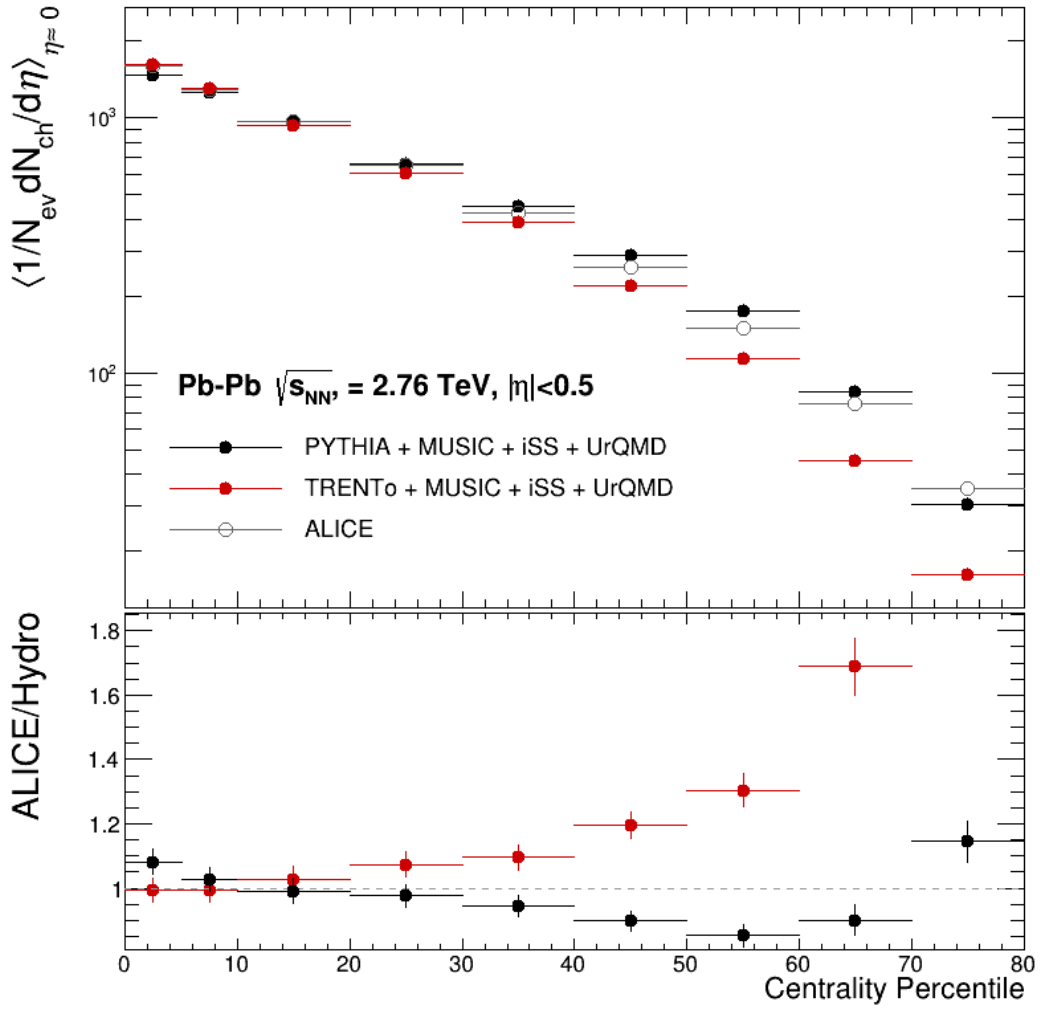




Images from the MADAI collaboration

Work in progress

Applying the hybrid model



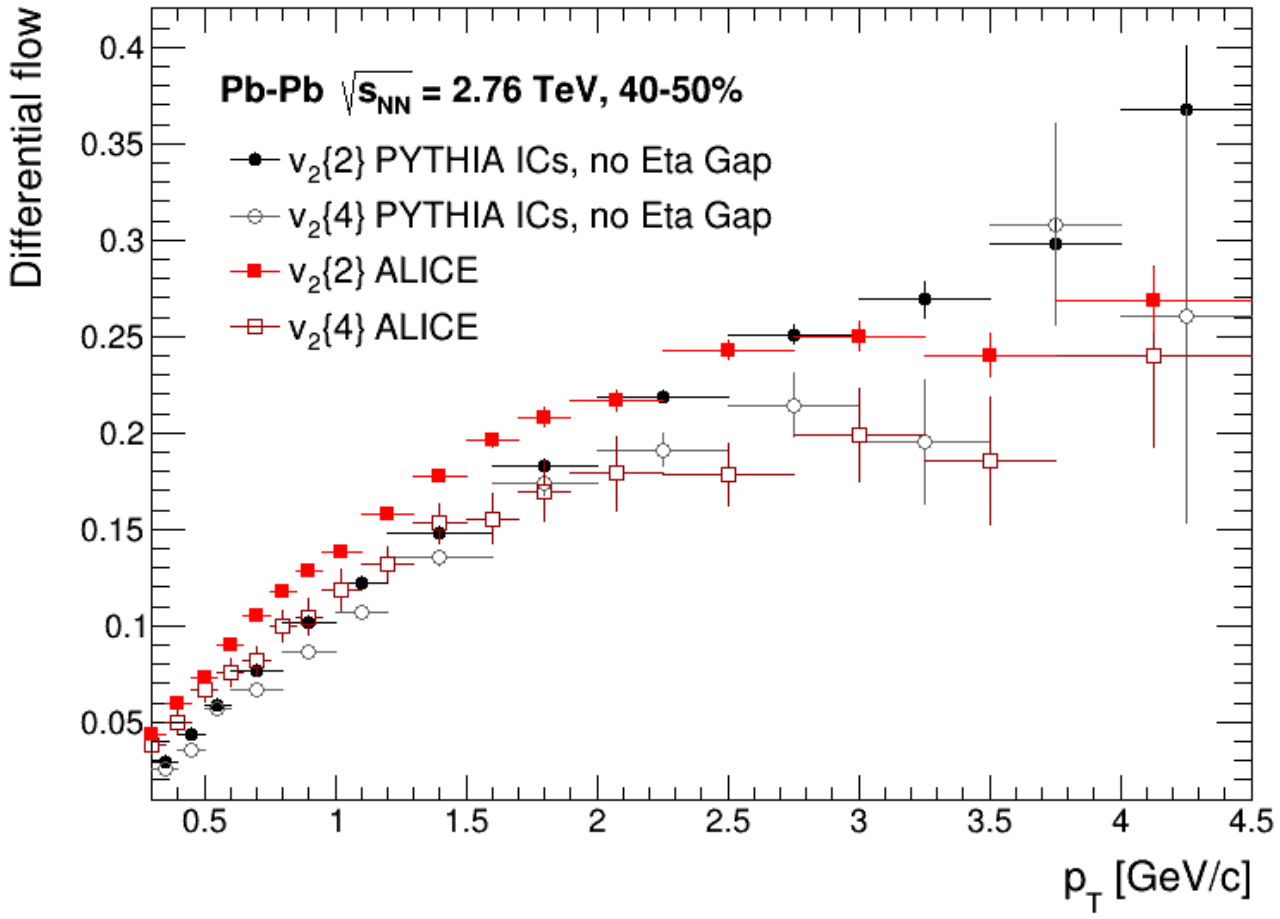
Similar results to TRENTo for central collisions, but smaller divergence from data overall;

⇦ Worse ratio for both approaches on peripheral events.

[1] *Phys. Rev. Lett.* 106, 032301

Work in progress

Applying the hybrid model



- Slightly lower elliptic flow values for $p_T < 2\ GeV/c$;
- Possibly due to starting parameters for hydrodynamics

[1] *Phys. Rev. Lett.* 105, 252302

Conclusions and outlook

- Eccentricity calculations indicates a different substructure of our initial conditions to TRENTo's from higher order harmonic results comparison;
- Our initial condition model describes ALICE data for central events, with similar behavior on peripheral events;
- First steps into combining PYTHIA's ICs with a hydrodynamic chain.

Thank you!

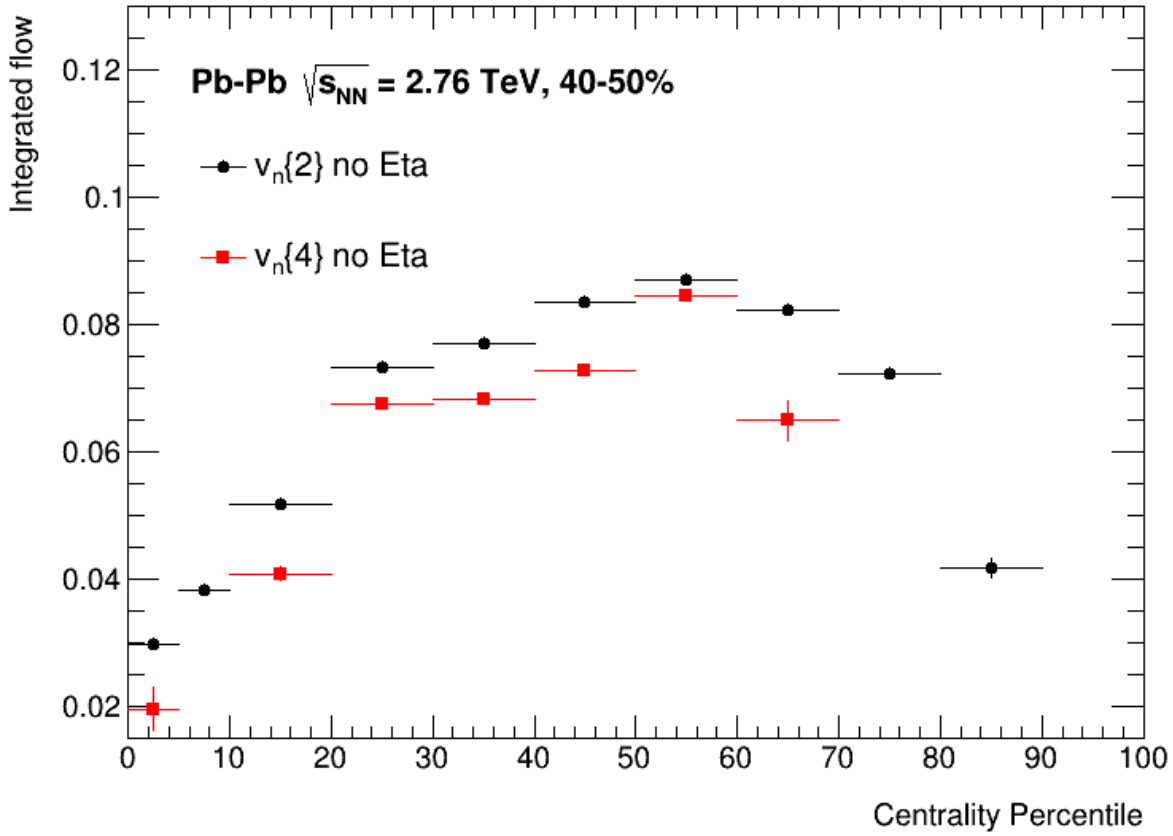
Backup slides

Simulation parameters: Hydro

$$T_{fo} = 151\ MeV$$
$$\tau_0 = 0.2\ fm$$
$$x_{max} = y_{max} = 14\ fm$$
$$N_x = N_y = 280$$

Lattice EOS s95p-v1.2 w/ UrQMD species
(Huovinen and Petrescky, Nucl.Phys.A837:26-53,2010)

Integrated elliptical flow using PYTHIA initial conditions



Integrated gaussian distribution, both IC generation methods