Study of angular correlations in Monte Carlo Simulations

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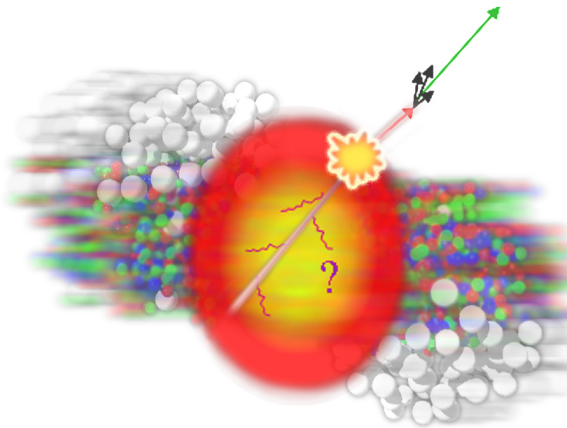
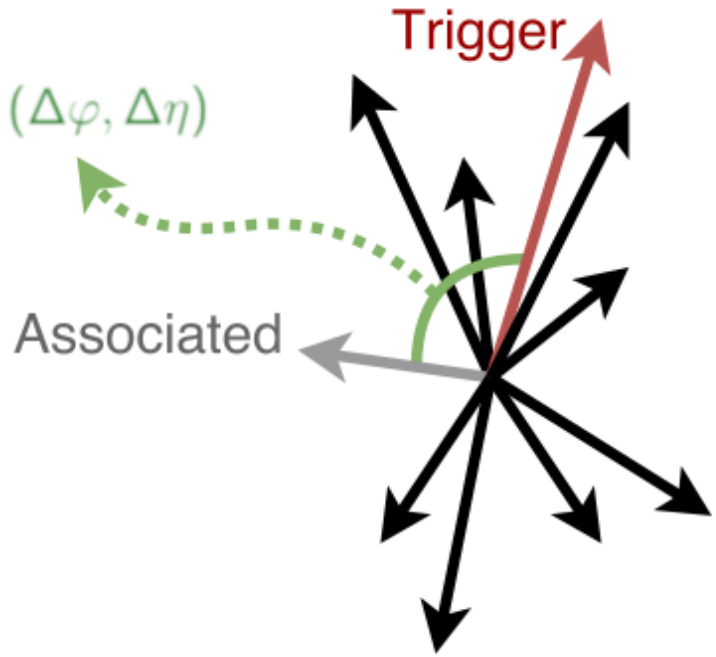
Physics Motivation

- Heavy-Ion Collision
- Goal: study interaction of jets with medium
- Angular Correlations represent a powerful tool to study jets
  - where jet quenching effects expected to be large
  - in an energy region where jets cannot be identified event-by-event
- ALICE results: jet broadening, depletion
- MC Simulations with different Physical background



Analysis

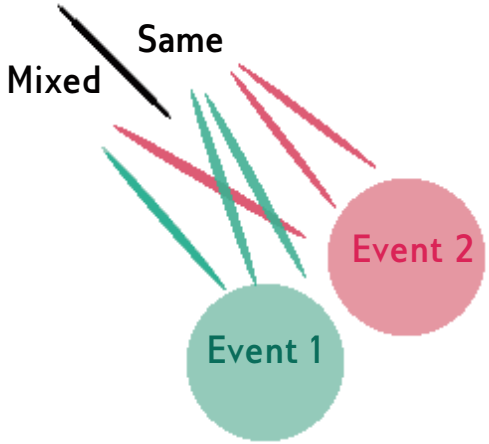
- The direction of the produced particles are correlated
- Trigger and associated particles
- Particle momenta represented by
  - Pseudorapidity (η)
  - Azimuth angle (φ)
- ($\Delta\varphi$) and ($\Delta\eta$) differences
- Associated yield per trigger:
- $$\frac{1}{N_{trigger}} \frac{d^2 N_{assoc}}{d\Delta\varphi d\Delta\eta}$$

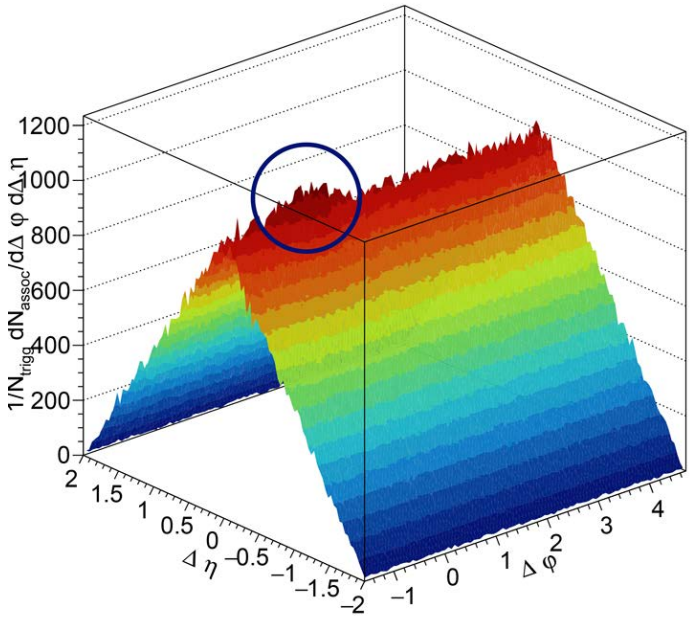


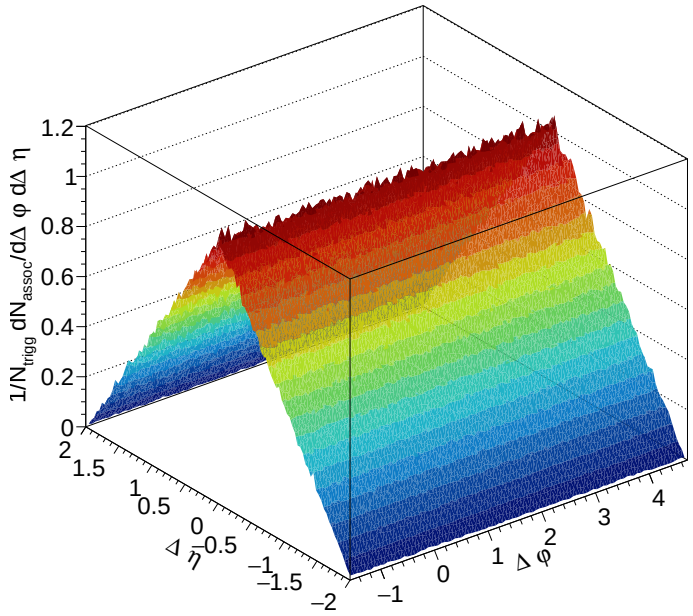
  - (identified)hadron-(identified)hadron, jet-hadron, hadron-jet, lepton-hadron, etc.

Same and Mixed event

- The associated yield per trigger is expressed in terms of the ratio of the same and mixed event
- In the ratio the detector acceptance effects disappear

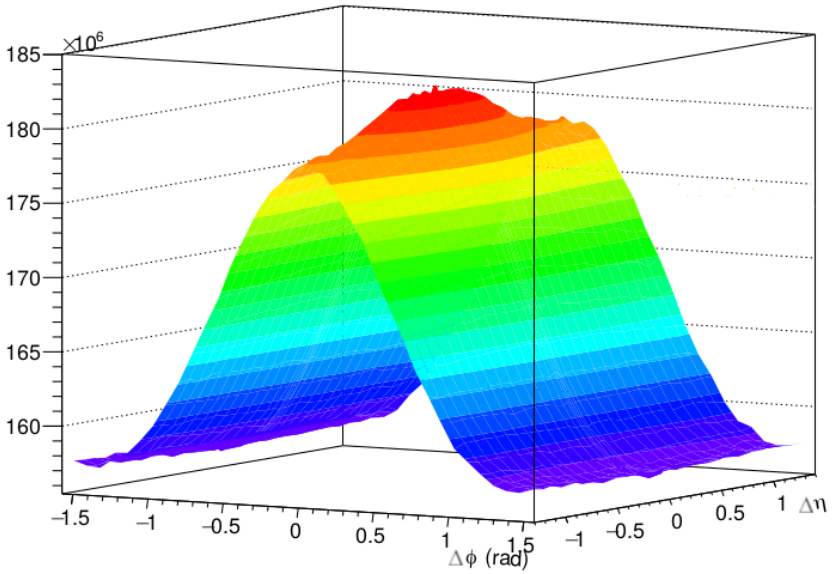






Associated yield per trigger

- Associated yield per trigger:
- $$\frac{1}{N_{trigger}} \frac{d^2 N_{assoc}}{d\Delta\varphi d\Delta\eta} = \frac{S(\Delta\varphi;\Delta\eta)}{M(\Delta\varphi;\Delta\eta)}$$



- Useful tool
  - to study flow and jets
  - to study soft and hard process

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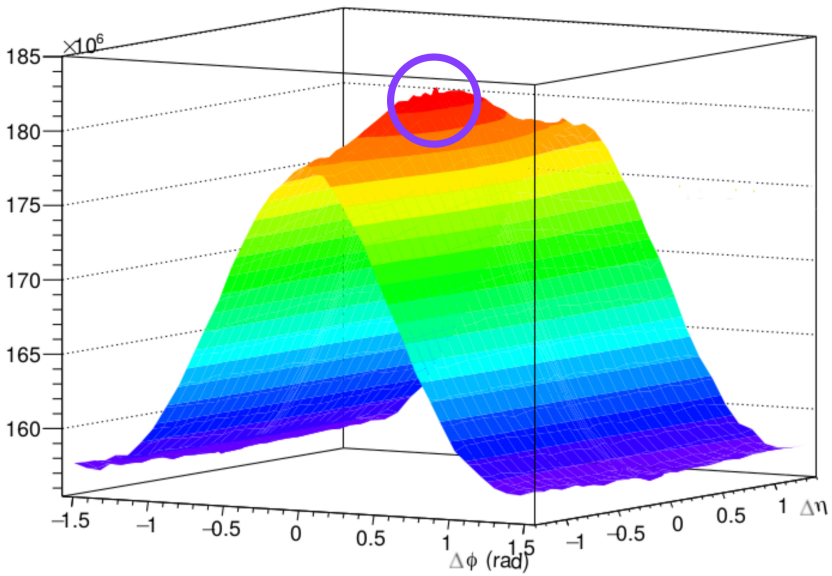

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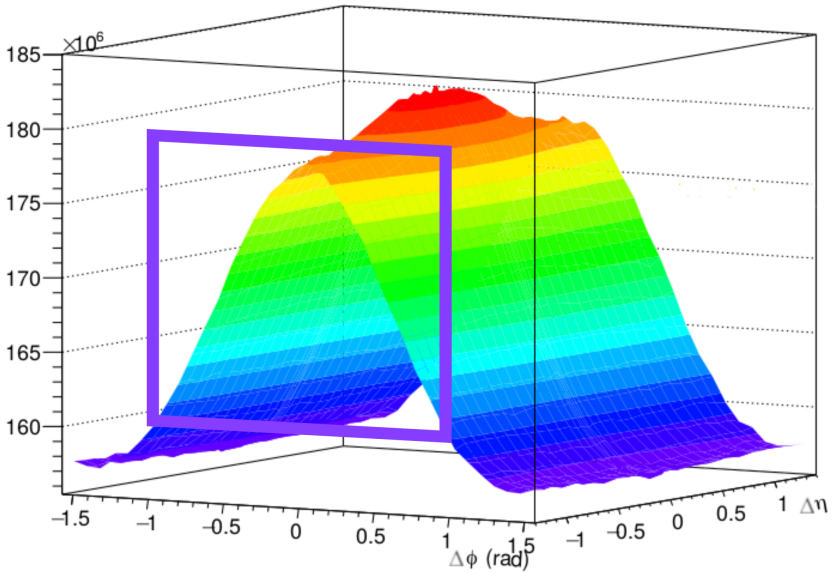

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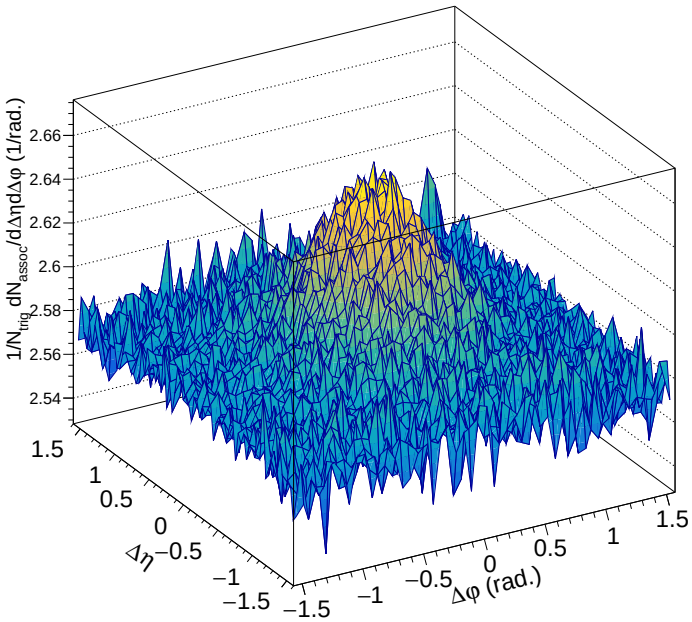
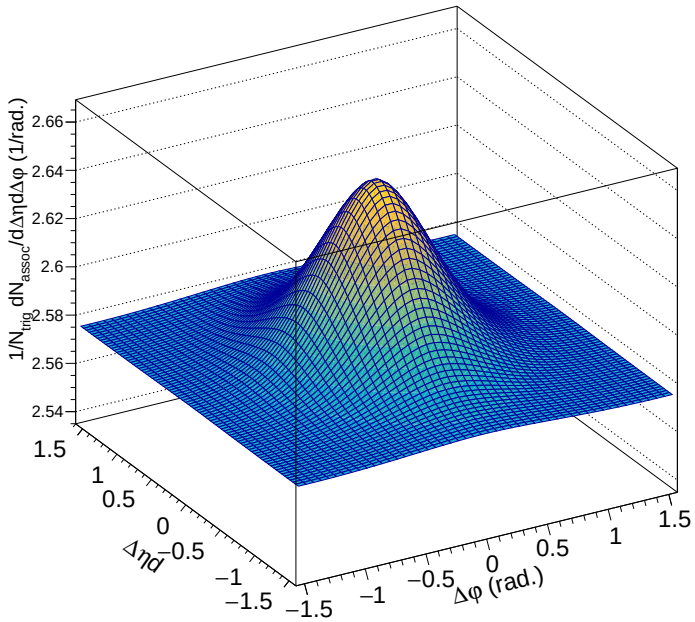
Fitting methods

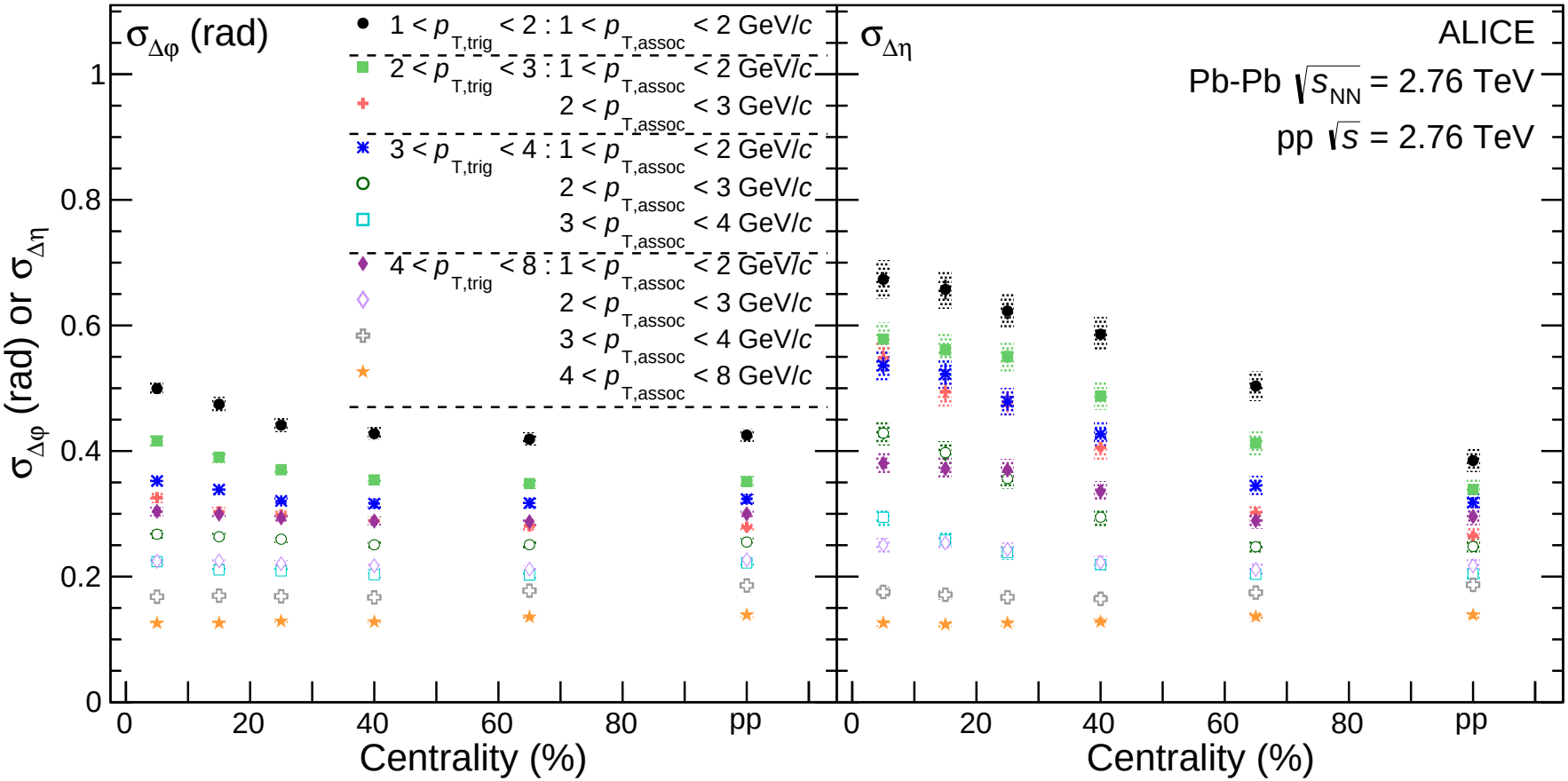
Fit the jet shape with a **Generalised Gaussian:**





- $G_{\gamma_x,\omega_x}(x) = \frac{\gamma_x}{2\omega_x\Gamma(1/\gamma_x)} exp\left[- \left(\frac{|x|}{\omega_x} \right)^{\gamma_x} \right]$
- The $\sigma_{\Delta\varphi}$ and $\sigma_{\Delta\eta}$ variance values characterise the jet shape

ALICE Results[1]



[1] [The ALICE Collaboration; Phys.Rev.Lett. 119. (2017)]

Monte Carlo Simulation

Pythia 8.235

- Developed for pp,$p\bar{p}$ collision
- Multi-Parton Interactions, Colour Reconnections
- Heavy-Ion Mode: Angantyr
- Lund-string fragmentations

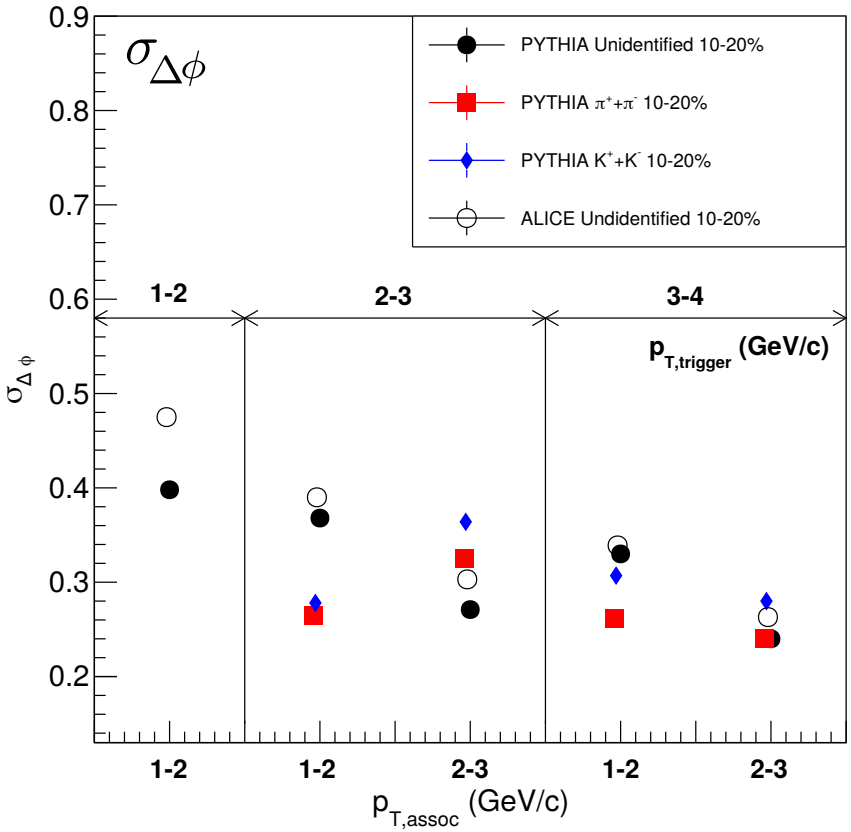
AMPT

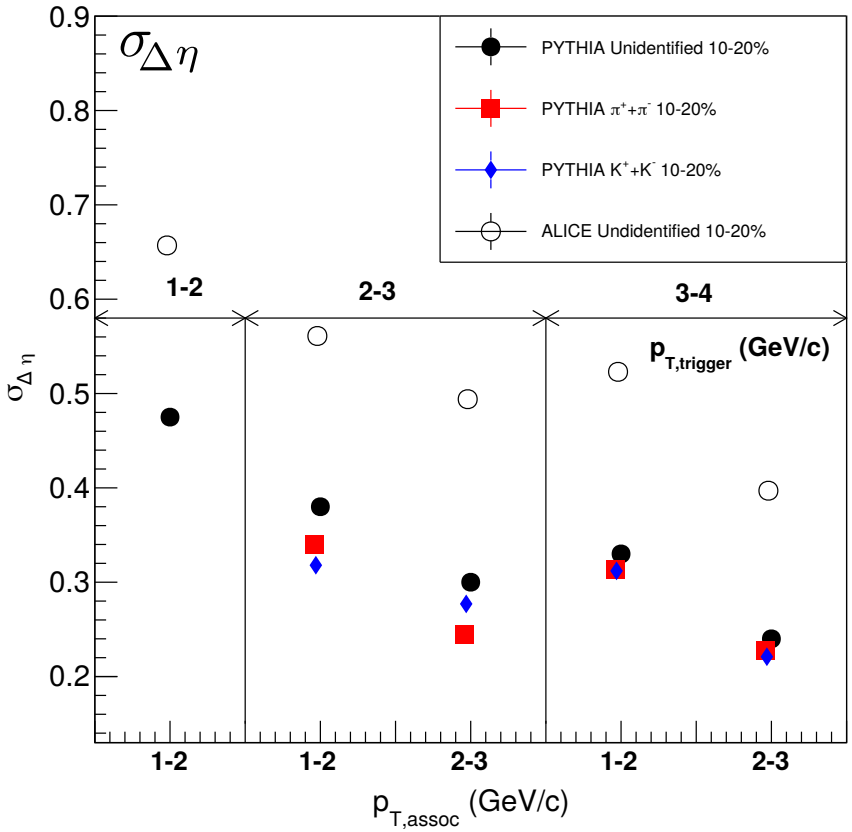
- Developed for heavy-ion collisions
- Based on Hijing
- Collective effects, ZPC
- String Melting and Default mode
- Cluster-, and string hadronization

JetScape

- Modular Structure
- Pythia 8.235, Matter, Martini, LBT, AdS/CFT
- Viscosus hydro models: ViSHNew, MUSIC
- Hadronic scatterings: SMASH

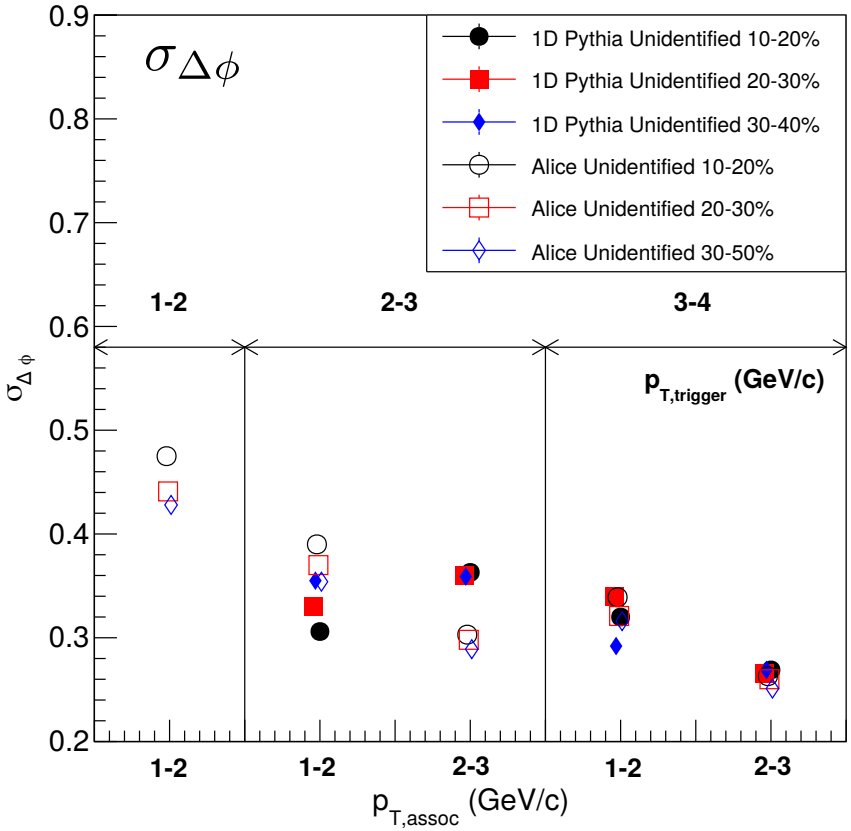
Results from Pythia

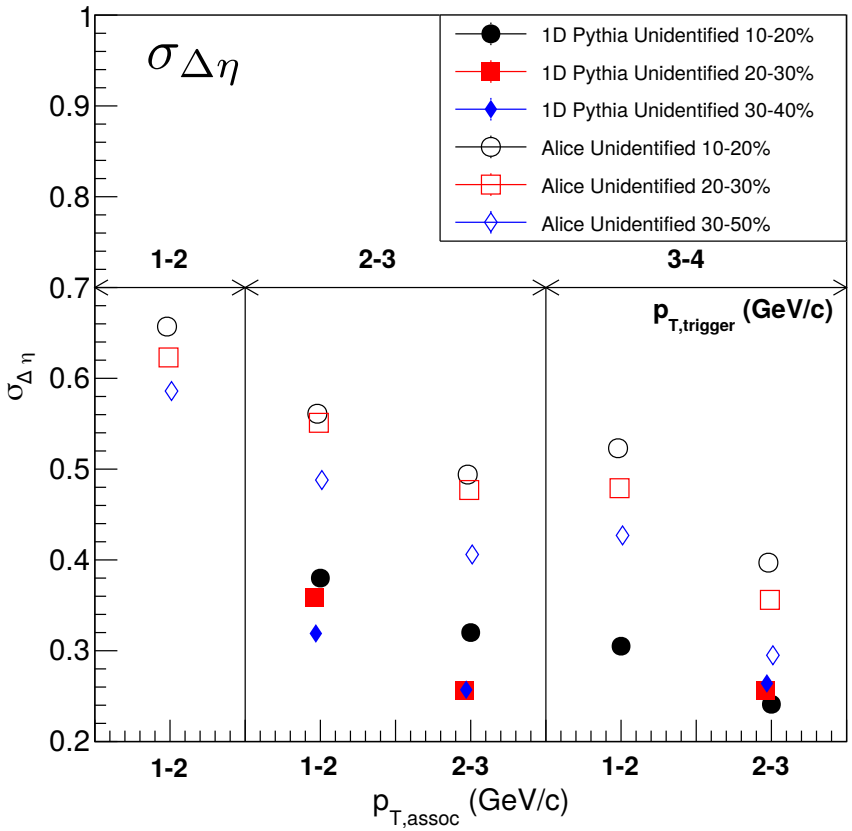




Hint of particle species dependence in Pythia 8.235

Results (Pythia-ALICE[2])

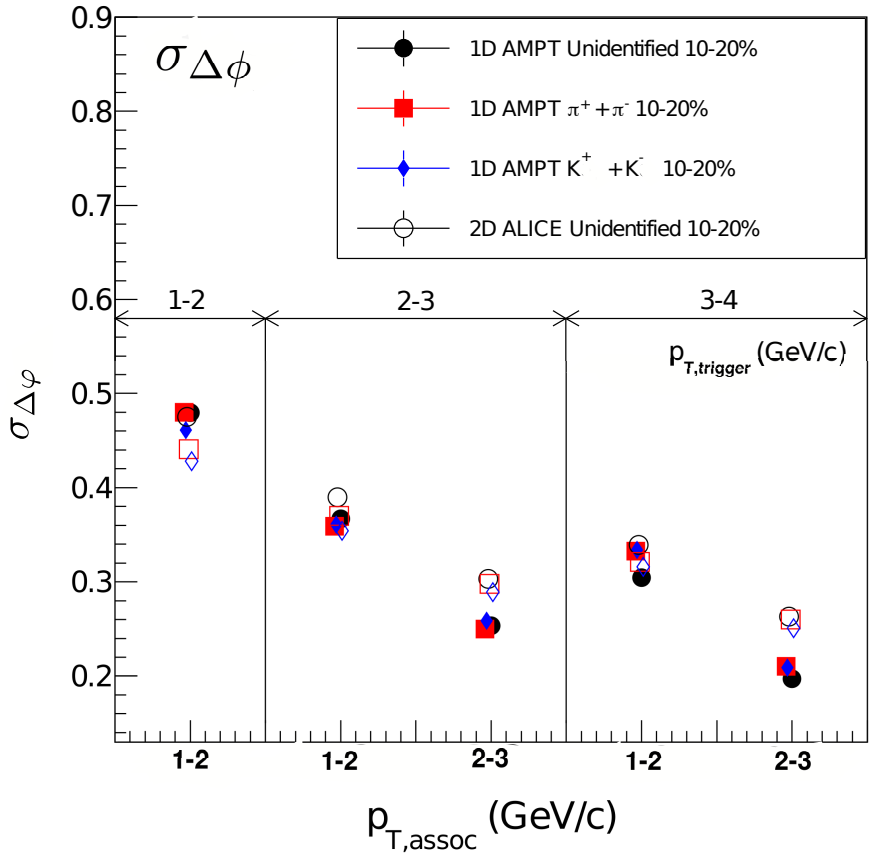


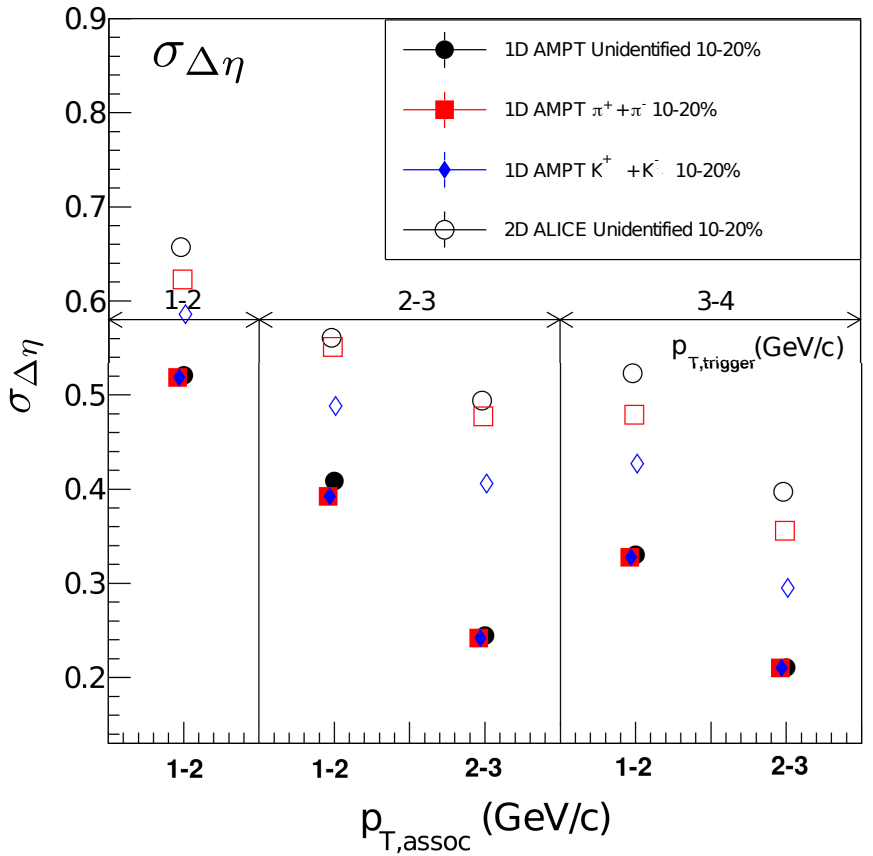


Better description in $\Delta\varphi$, and huge differences in $\Delta\eta$

[2][The ALICE Collaboration; Phys.Rev.Lett. 119. (2017)]

Results (AMPT-ALICE[3])

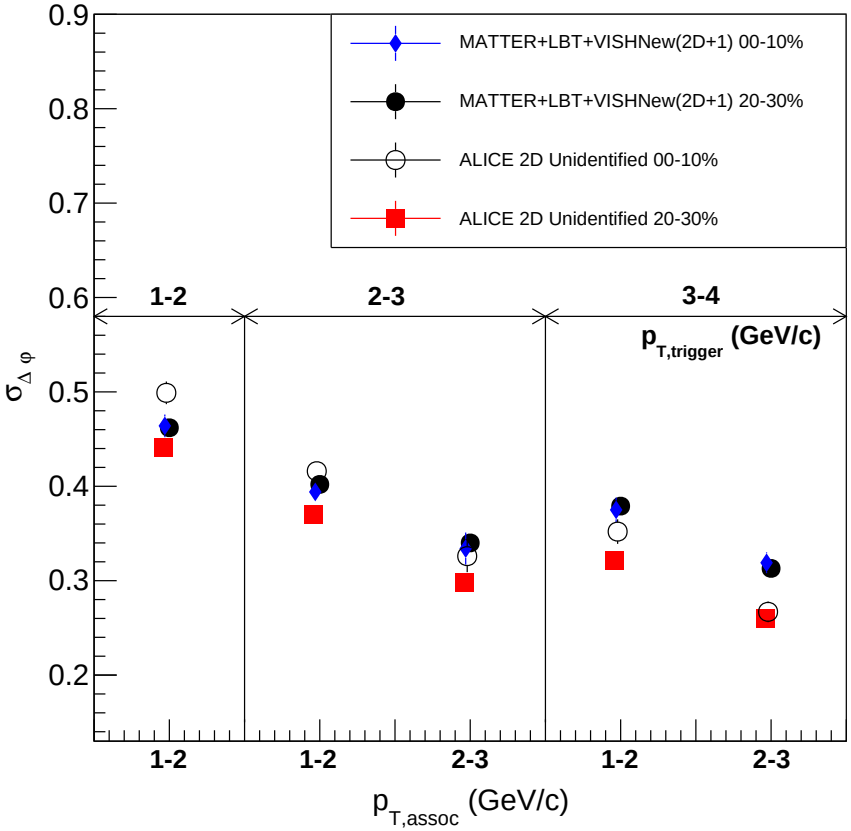


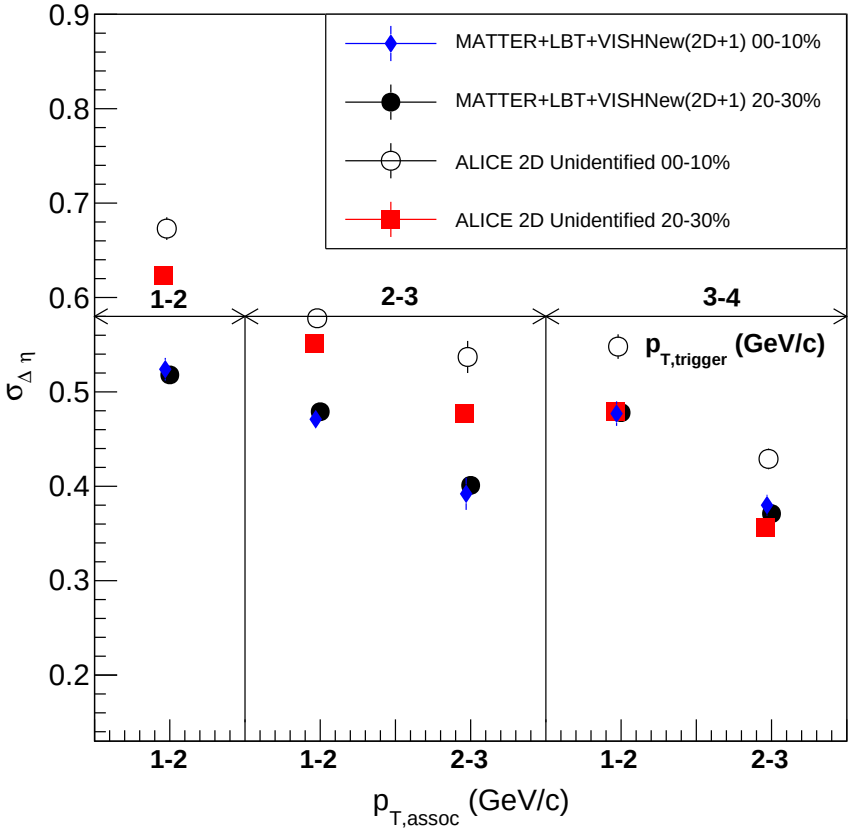


Better trends from AMPT then in Pythia 8.235

[3][The ALICE Collaboration; Phys.Rev.Lett. 119. (2017)]

JETSCAPE Results





Quite good description in $\Delta\varphi$, significant difference in $\Delta\eta$ No centrality dependence

Summary

To summarise:

- Angular correlations are useful tools to study jets and flow.
- Fit the jet shape with a Generalised Gaussian
- Different MC simulators with different physical background
- Better trends from AMPT then in Pythia 8.235
- Hint of particle dependence in Pythia 8.235

Future plans:

- Different MC simulations: Hijing++,
- Different centralities in AMPT.
- Different models in JetScape

Thank you for the Attention!