Measurement of the Underlying Event in pp collisions at $\sqrt{s}$ = 13 TeV with the ALICE experiment at the LHC

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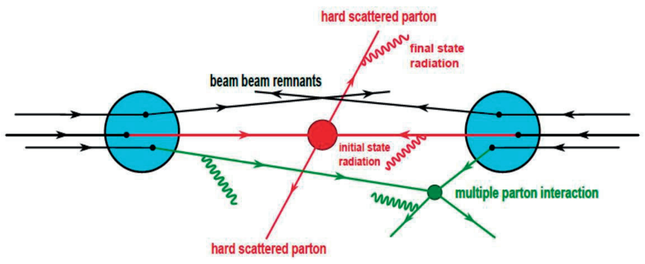
Motivation

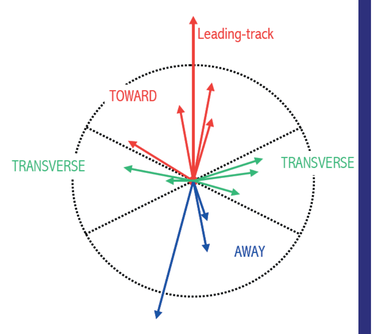
- **Underlying Event (UE):** everything in a single particle collision except the hard process.
  - MPI, initial and final state radiations, beam remnants etc.



- **Why it is important to study UE.**
  - Allows us to access detailed information of the hadronic structure, and also impacts on isolation criteria, jet pedestals, etc.
  - Providing a good description of the ambient activity in the event, a basic step of the event characterization process.

Analysis Strategy

- **Data sample**: pp collisions data at 13 TeV taken by ALICE detector in 2016.
- **Monte-Carlo simulation:** Pythia 8 (Monash 2013) and EPOS-LHC.
- **Definition of the topological regions**: according to the azimuthal direction of leading particle, we define three distinct topological regions,
  - Toward $|\Delta\varphi| < \pi/3$.
  - Away $|\Delta\varphi| < 2\pi/3$.
  - Transverse $\pi/3 < |\Delta\varphi| < 2\pi/3$.



- **Main observables.**
  - Average charged particles density vs. leading track p_T.

$$\frac{1}{\Delta\eta.\Delta\varphi}\frac{1}{N_{ev}\left(p_{T,lead}\right)}N_{ch}\left(p_{T,lead}\right)$$

  - Average sum (p_T) density vs. leading track p_T.

$$\frac{1}{\Delta\eta.\Delta\varphi}\frac{1}{N_{ev}\left(p_{T,lead}\right)}\Sigma p_T\left(p_{T,lead}\right)$$

- **Three track transverse momentum thresholds**: all the observables were measured with three track p_T thresholds 0.15 GeV/c, 0.5 GeV/c, 1 GeV/c.
- **Four corrections**: leading track misidentification, tracking efficiency, track contamination, vertex reconstruction.

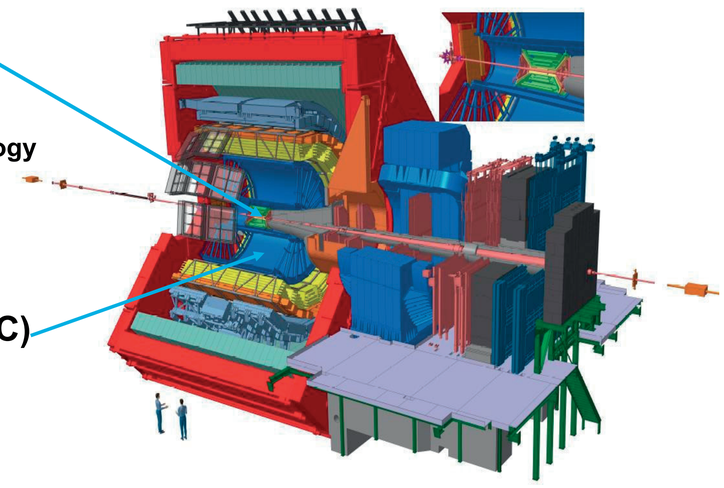
ALICE detector

Inner Tracking system(ITS)

- |η| < 0.9
- Based on 3 types of silicon technology
- Vertex reconstruction
- event trigger decision

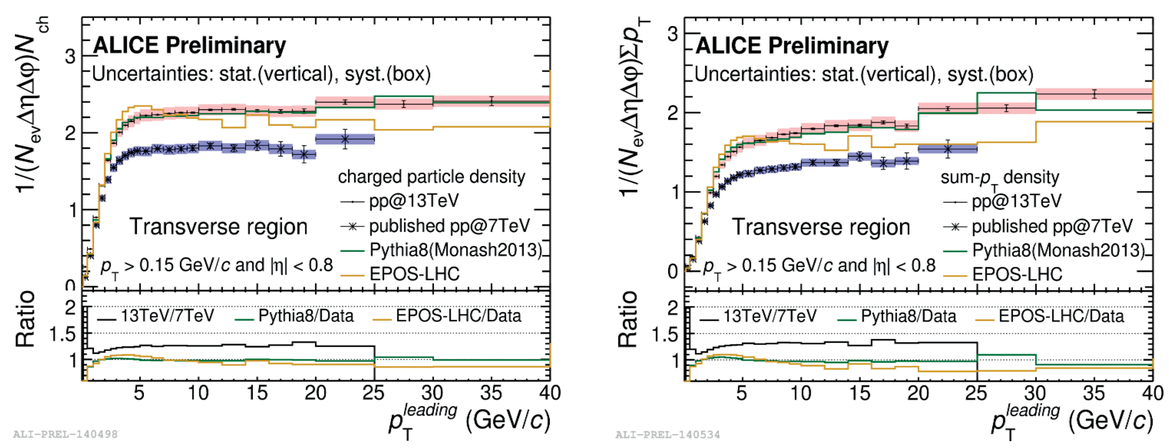
Time projection chamber(TPC)

- |η| < 0.9
- Charged particle tracking
- Particle identification

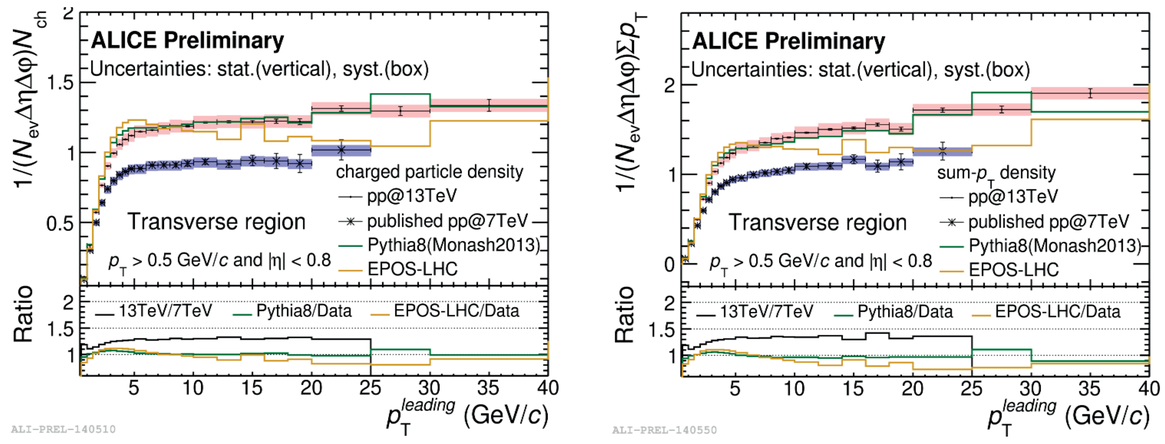


Results

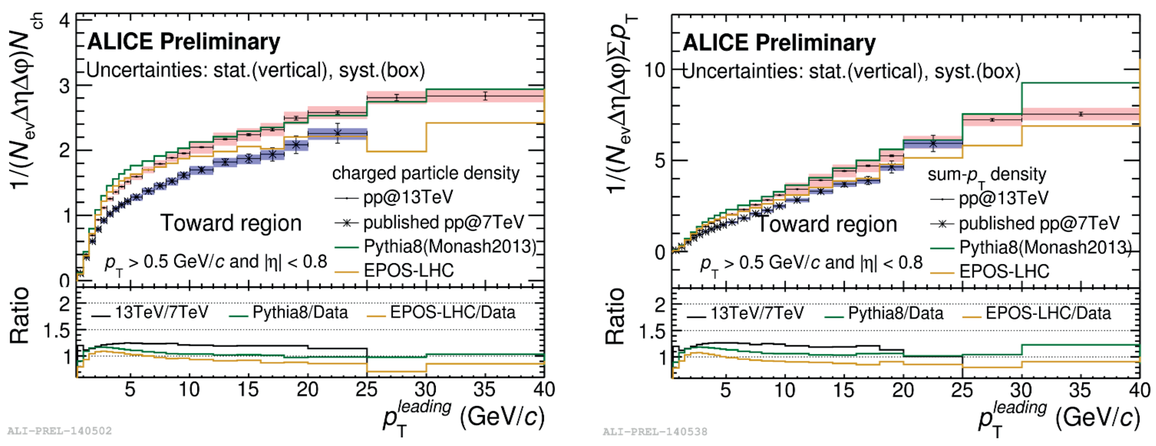
UE measurements in Transverse region for track p_T > 0.15 GeV/c



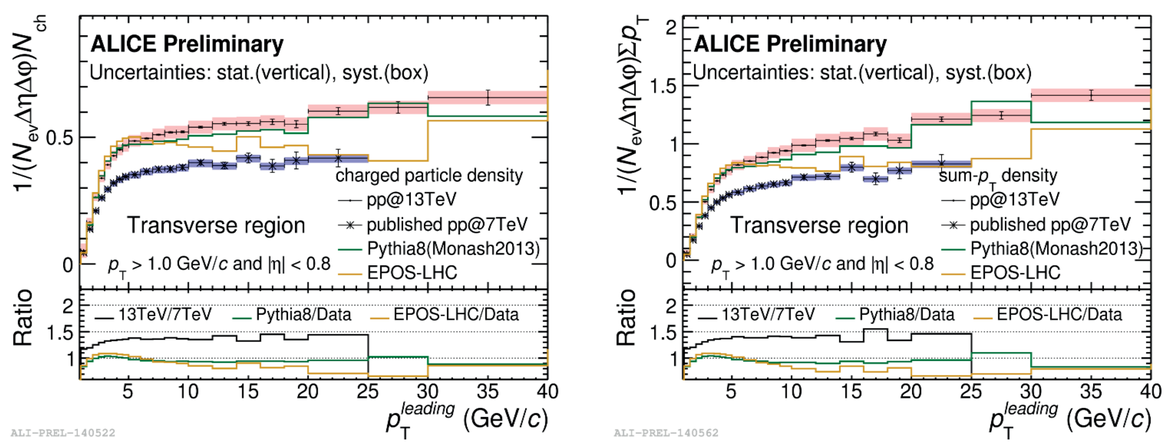
UE measurements in Transverse region for track p_T > 0.5 GeV/c



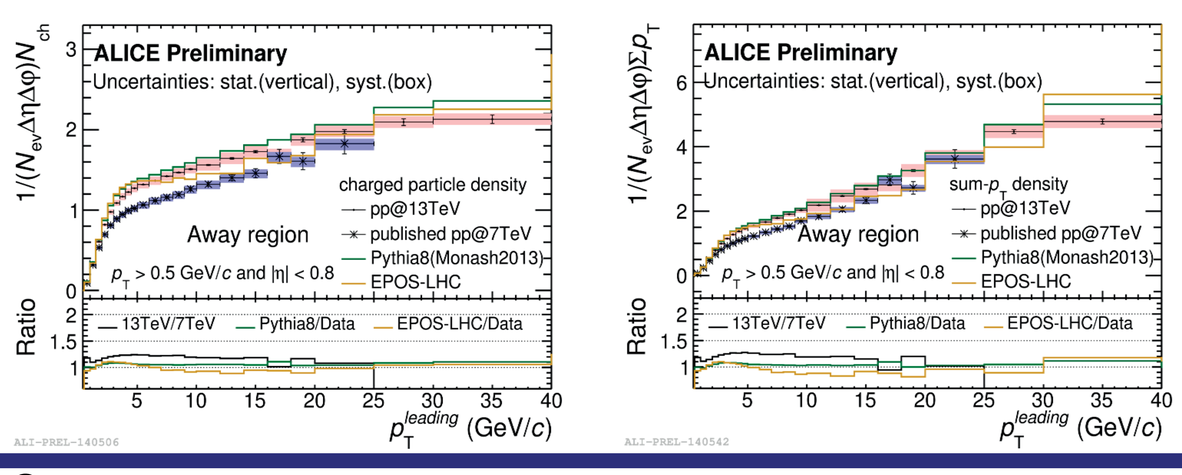
Jet activity + UE in Toward region for track p_T > 0.5 GeV/c



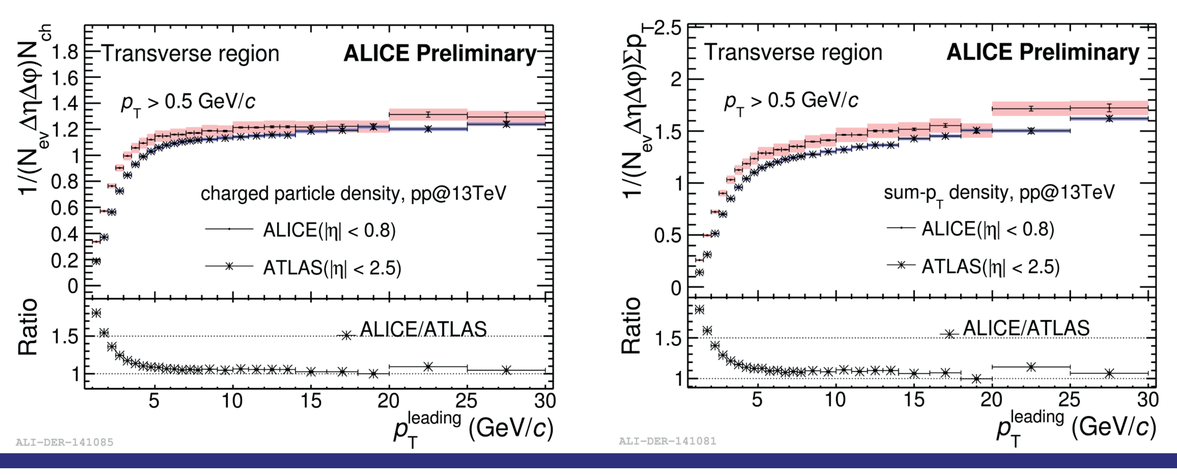
UE measurements in Transverse region for track p_T > 1 GeV/c



Jet activity + UE in Away region for track p_T > 0.5 GeV/c



Compare to ATLAS UE results in Transverse region for track p_T > 0.5 GeV/c



Summary

- First Underlying Event measurements of the charged particle density and sum p_T density in pp collisions at 13 TeV with ALICE detector have been presented.
  - A plateau range was observed in the results of charged particle density in Transverse region, the same as at 0.9 TeV and 7 TeV.
  - The shapes are similar for different track p_T thresholds.
  - Observed the same trends for different collision energies(7 TeV and 13 TeV).
- In general, PYTHIA8 describes the observed trends better than EPOS-LHC, in particular for high leading p_T.
- ALICE results (narrower η range) are in general higher than ATLAS results. This is most likely due to the larger influence of the leading interaction in a restricted η range.

References

[1] The ALICE Collaboration, "Underlying Event measurement in pp collisions at $\sqrt{s}$ = 0.9 and 7 TeV with the ALICE experiment at the LHC", JHEP 1207 (2012) 116.

[2] The ATLAS Collaboration, "Measurement of charged-particle distributions sensitive to the underlying event in $\sqrt{s}$ = 13 TeV proton-proton collisions with the ATLAS detector at the LHC", JHEP 1703 (2017) 157.