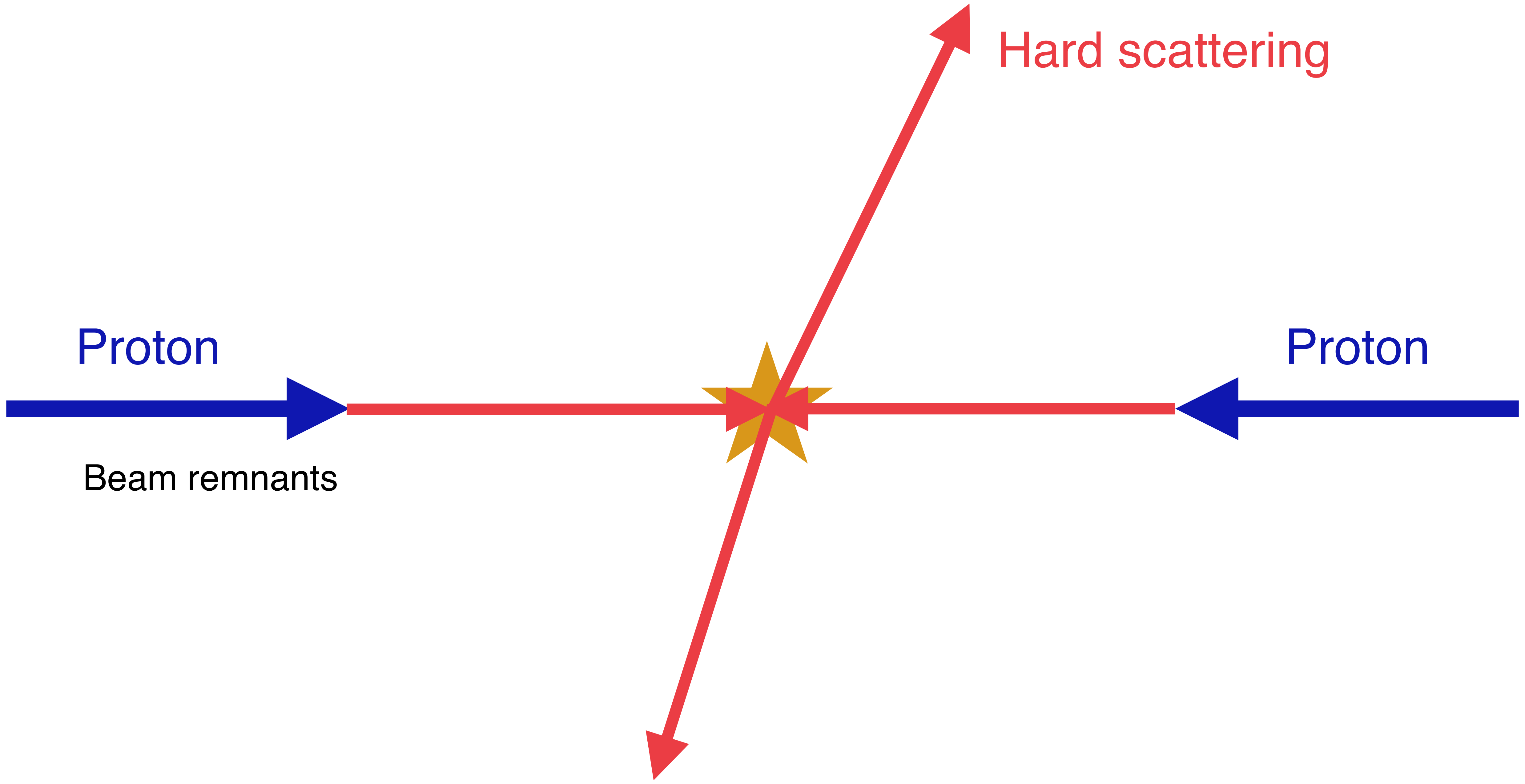
Charged particle production as a function of UE activity and search for jet-like modifications in small systems with ALICE

Sushanta Tripathy for ALICE collaboration
INFN Bologna, Italy

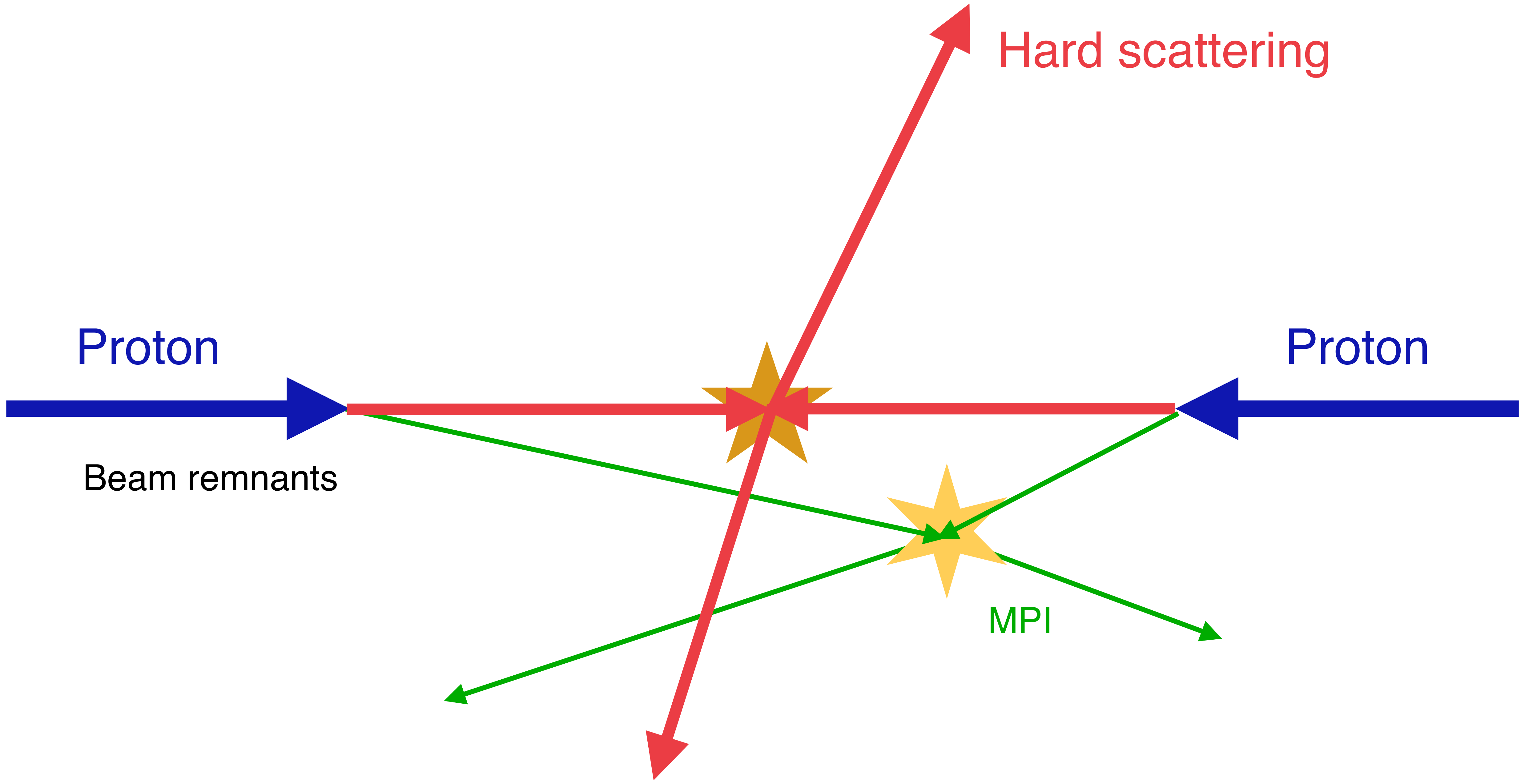
The underlying event

Underlying event (UE): collection of particles which do not originate from the primary hard parton-parton scattering or the related fragmentation (Includes MPI, ISR/FSR, beam remnants)



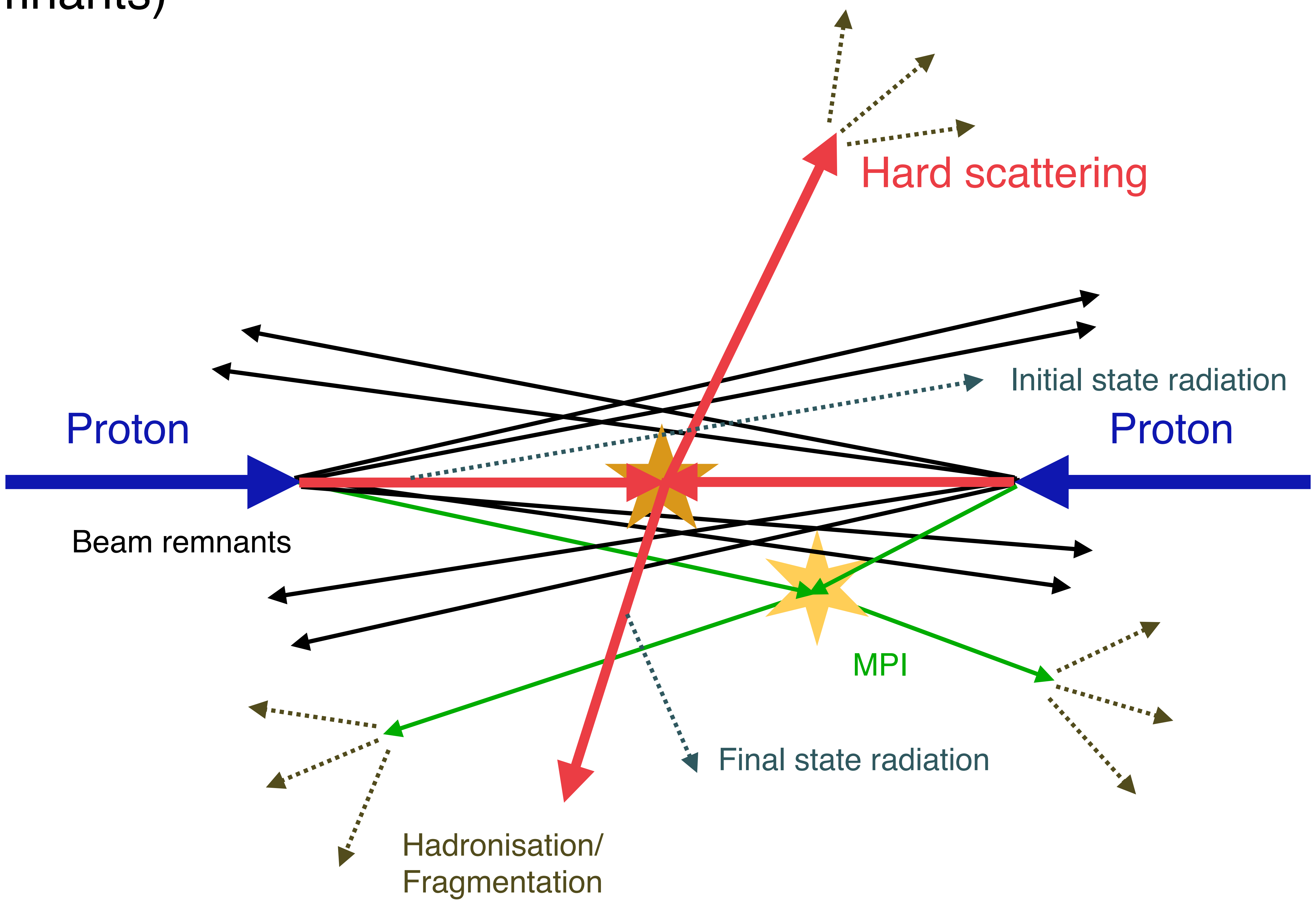
The underlying event

Underlying event (UE): collection of particles which do not originate from the primary hard parton-parton scattering or the related fragmentation (Includes MPI, ISR/FSR, beam remnants)



The underlying event

Underlying event (UE): collection of particles which do not originate from the primary hard parton-parton scattering or the related fragmentation (Includes MPI, ISR/FSR, beam remnants)

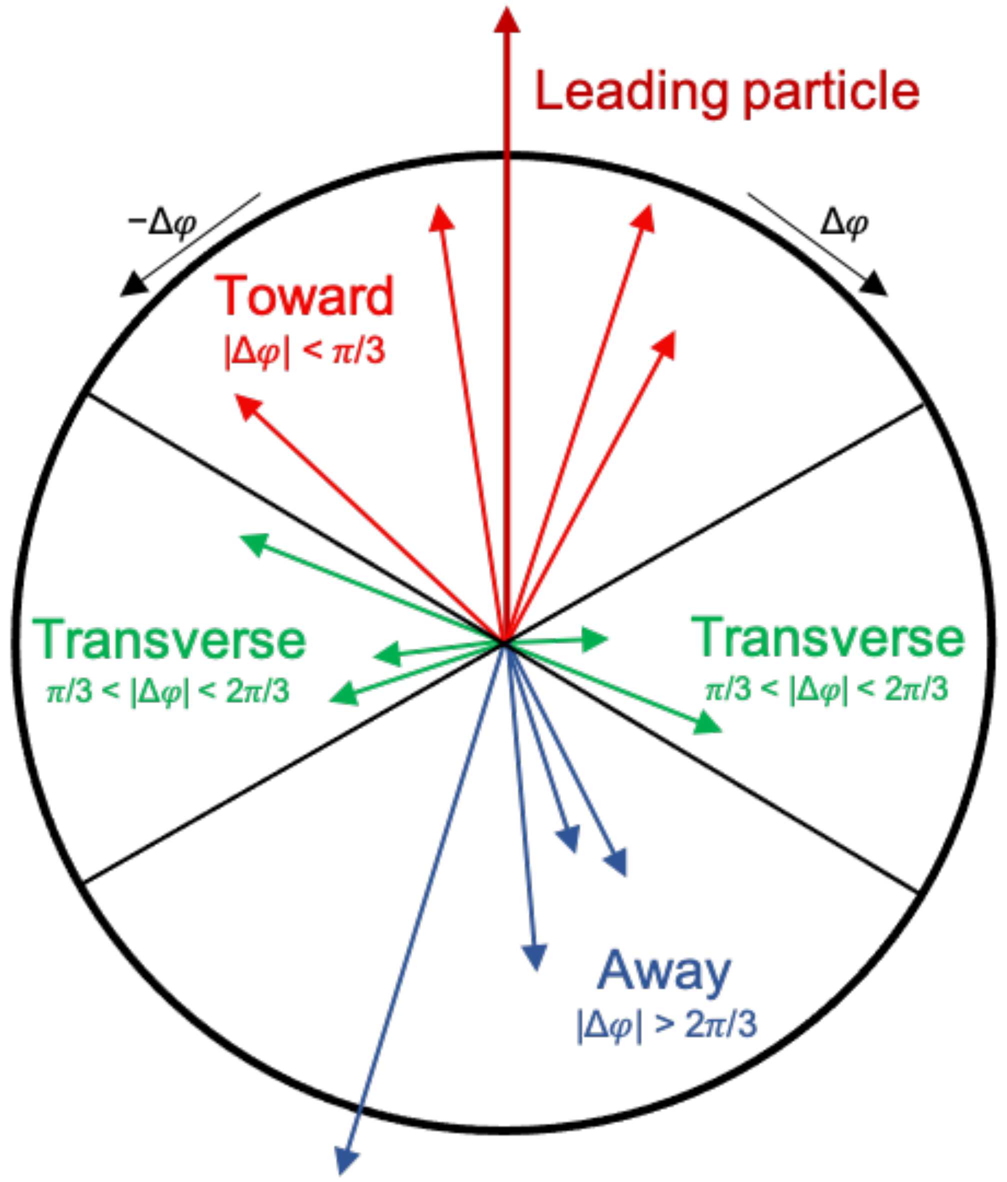


The underlying event

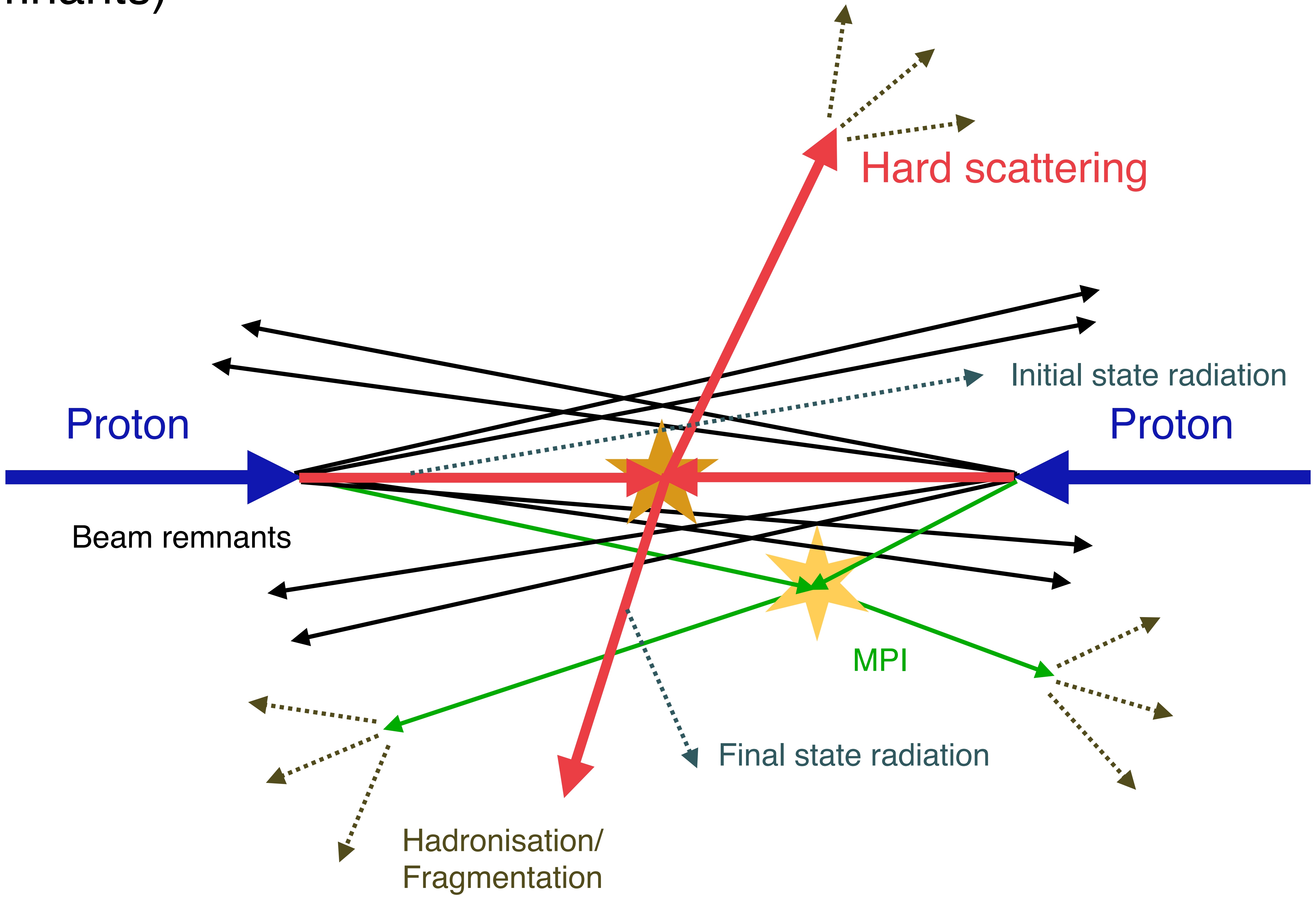
Underlying event (UE): collection of particles which do not originate from the primary hard parton-parton scattering or the related fragmentation (Includes MPI, ISR/FSR, beam remnants)

Conventional UE analyses

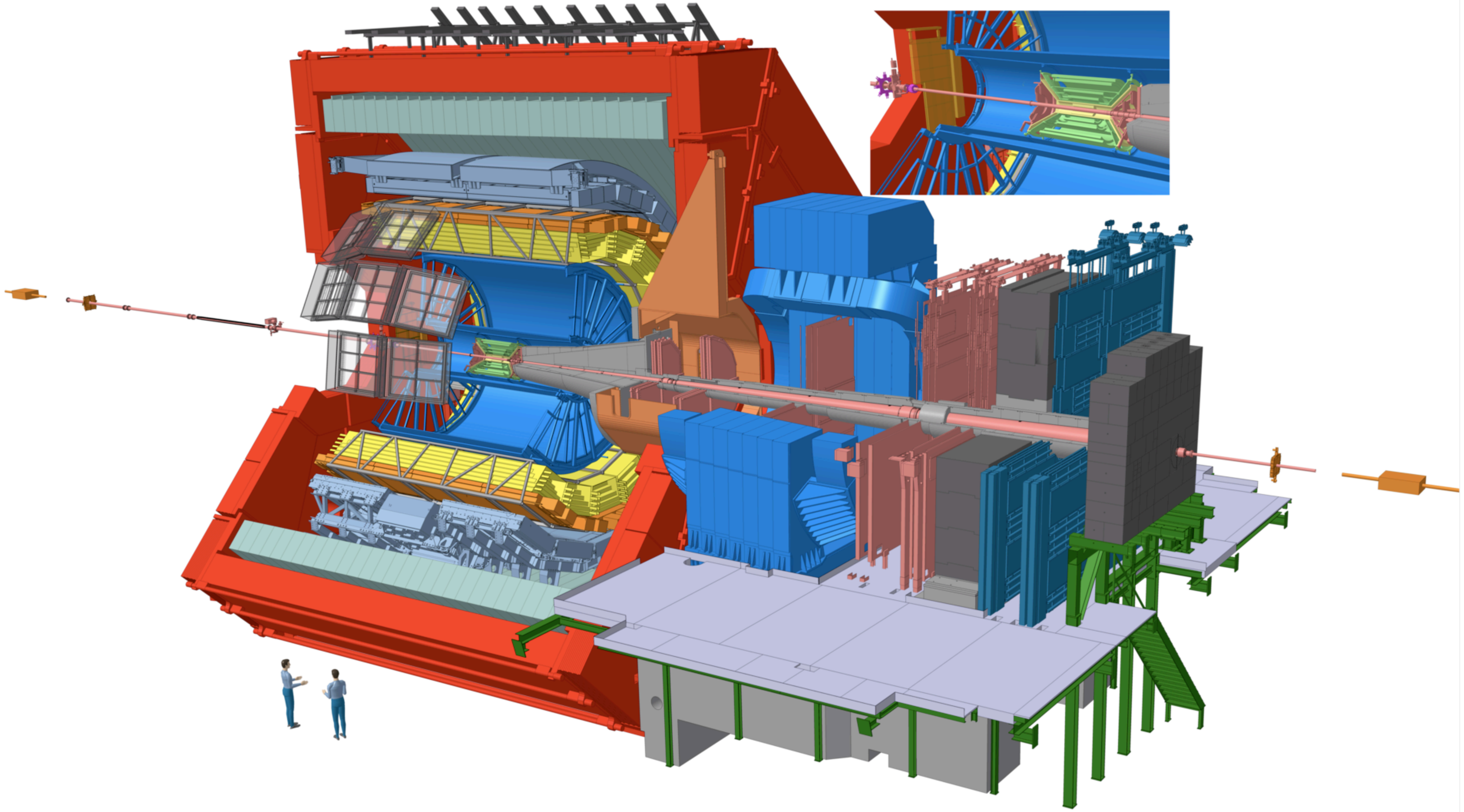
- Particle production in three topological regions w.r.t. leading particle
- Main UE observables: particle density, summed-p_T density



ALICE, arXiv:2204.10157 [nucl-ex]



A Large Ion Collider Experiment



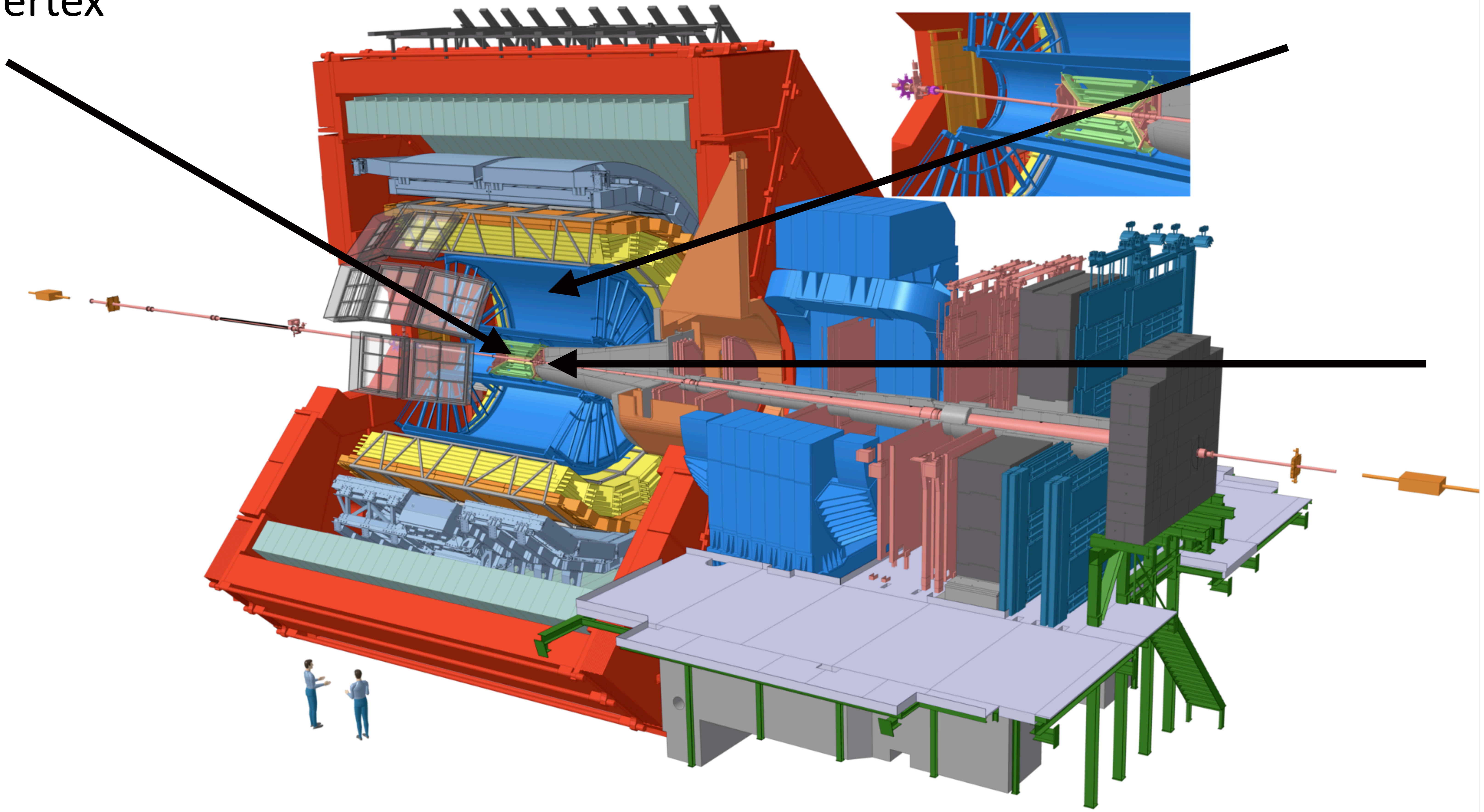
A Large Ion Collider Experiment

Inner Tracking System (ITS)

Tracking, vertex

Time Projection Chamber (TPC)

Tracking



V0

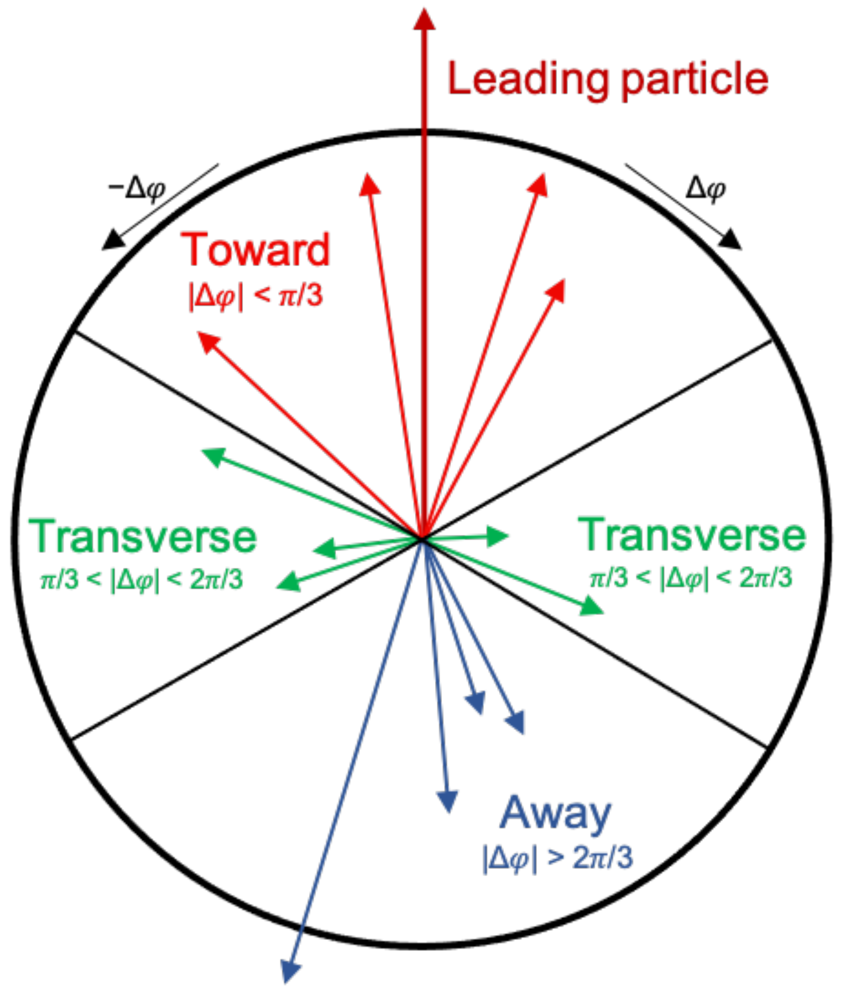
Trigger, multiplicity estimator

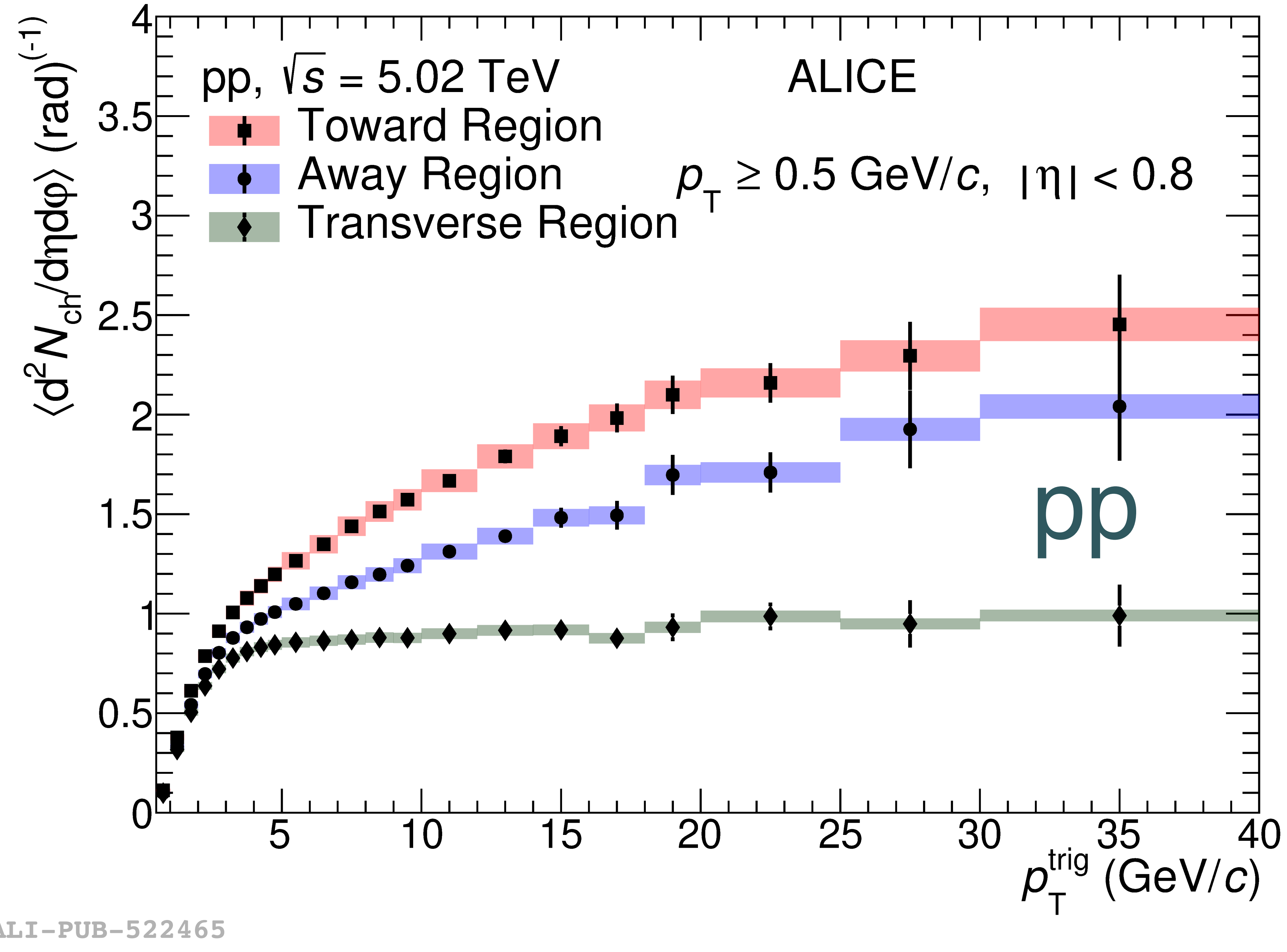
The underlying event

Underlying event (UE): collection of particles which do not originate from the primary hard parton-parton scattering or the related fragmentation (Includes MPI, ISR/FSR, beam remnants)

Conventional UE analyses

- Particle production in three topological regions w.r.t. leading particle
- Main UE observables: particle density, summed-p_T density





- Steep rise in the event activity at low p_T^{trig} for all topological regions
- After $p_T^{trig} > 5$ GeV/c charged particle density in Transverse region is insensitive to hard component
- In Toward/Near and Away regions, charged particle density increases with p_T^{trig}

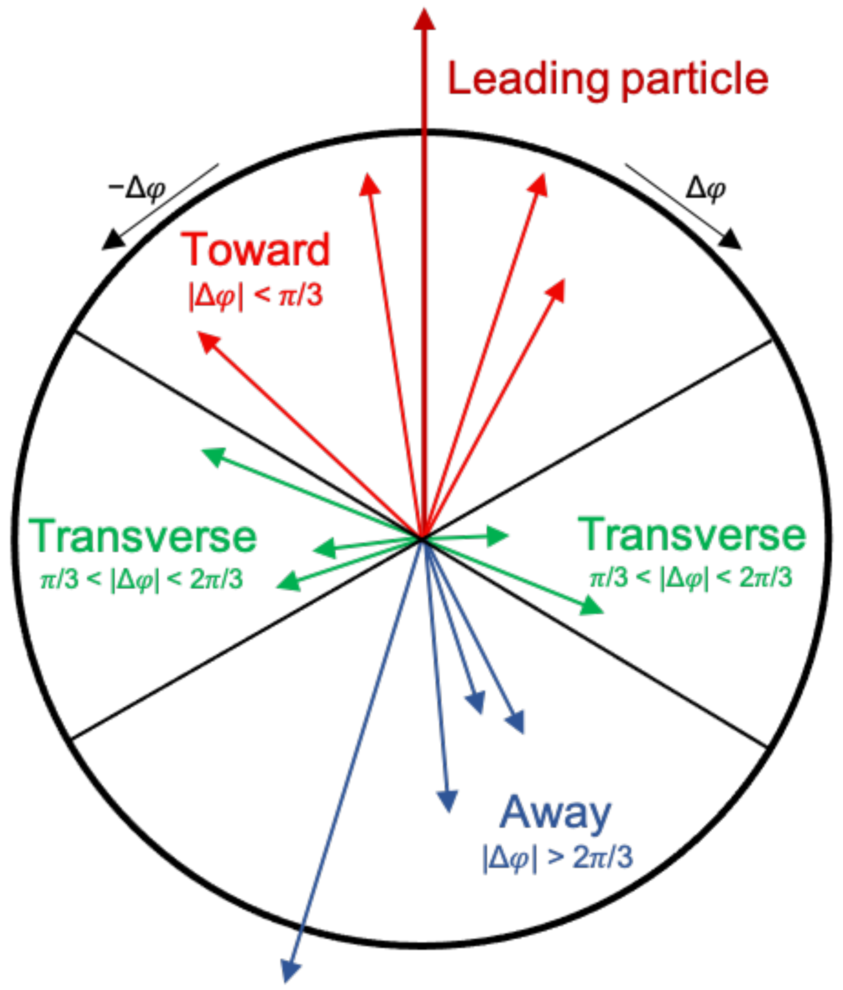
ALICE, arXiv:2204.10389 [nucl-ex]

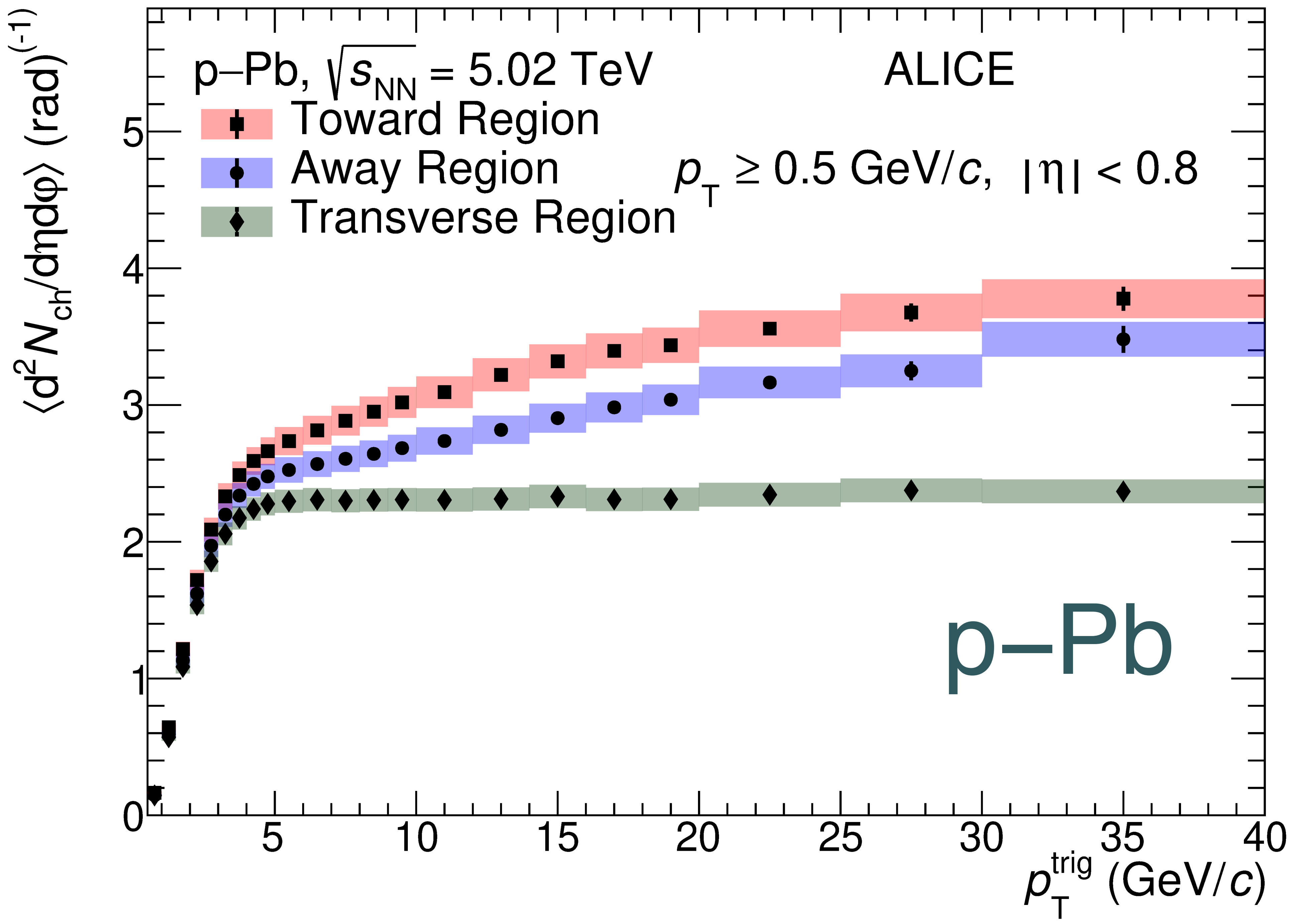
The underlying event

Underlying event (UE): collection of particles which do not originate from the primary hard parton-parton scattering or the related fragmentation (Includes MPI, ISR/FSR, beam remnants)

Conventional UE analyses

- Particle production in three topological regions w.r.t. leading particle
- Main UE observables: particle density, summed-p_T density





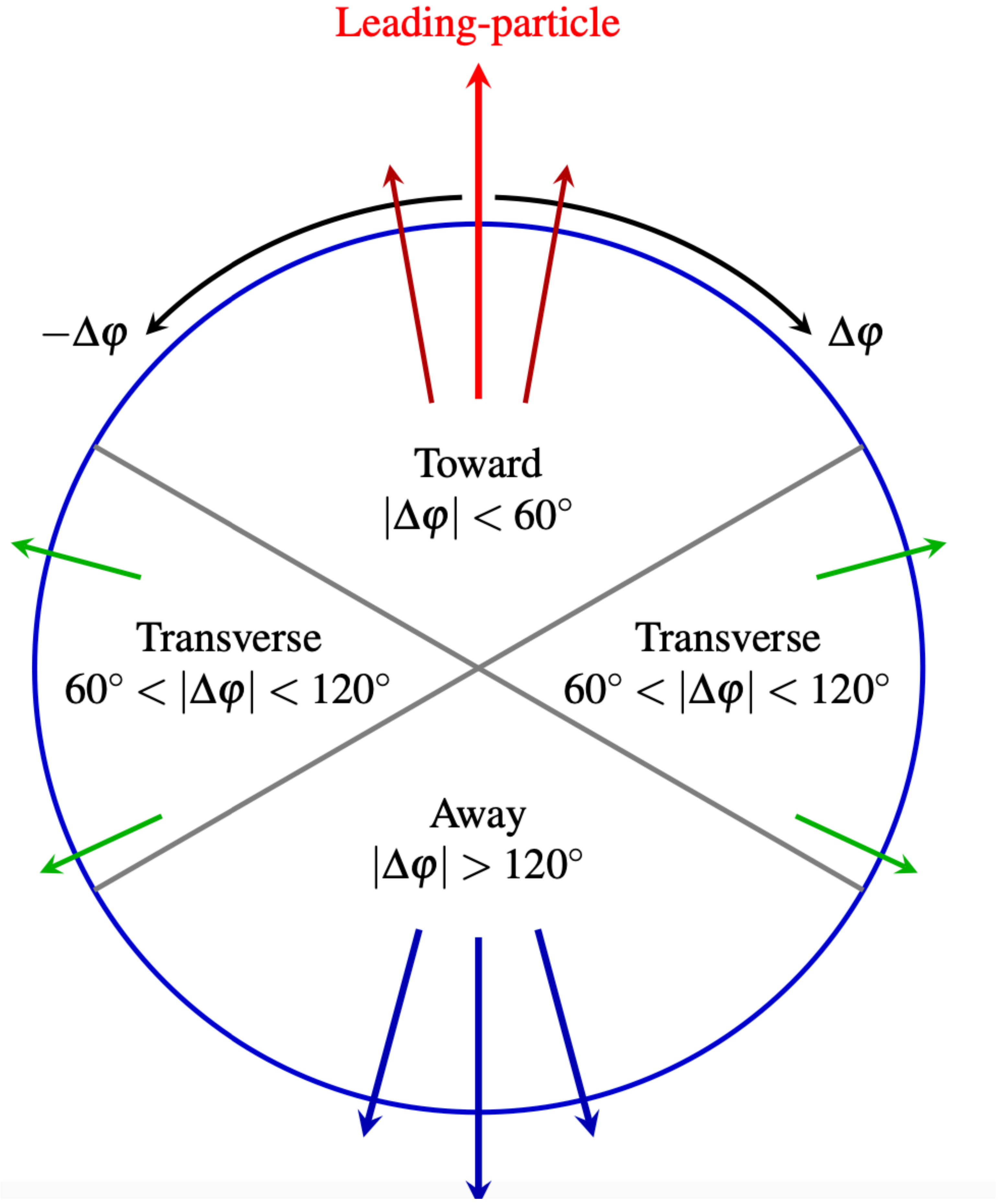
ALI-PUB-522470

- Similar UE structure in p–Pb and pp collisions
- After $p_T^{trig} > 5$ GeV/c charged particle density in Transverse region is insensitive to hard component
- In Toward/Near and Away regions, charged particle density increases with p_T^{trig}

ALICE, arXiv:2204.10389 [nucl-ex]

Relative transverse activity classifier, $R_T = N_{ch}^{T} / \langle N_{ch}^{T} \rangle$

(Introduced in P. Skands et. al., Eur. Phys. J. C **76,** 299 (2016))



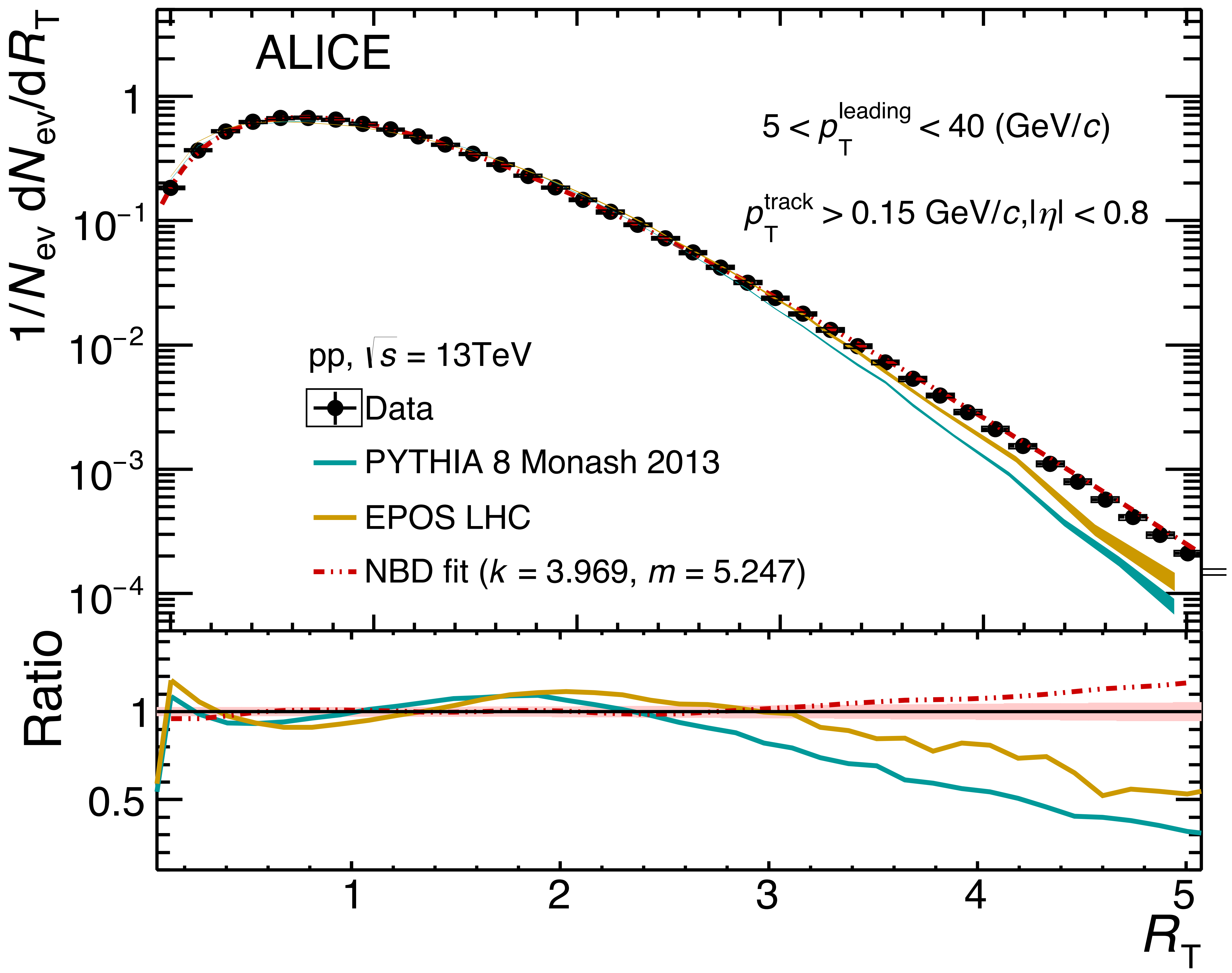
ALICE, JHEP04 (2020) 192

Relative transverse activity classifier, R_T

Relative transverse activity classifier, $R_T = N_{ch}^T / < N_{ch}^T >$

(Introduced in P. Skands et. al., Eur. Phys. J. C **76,** 299 (2016))

- Using R_T, one can vary the magnitude of the underlying event (UE) and study the particle production



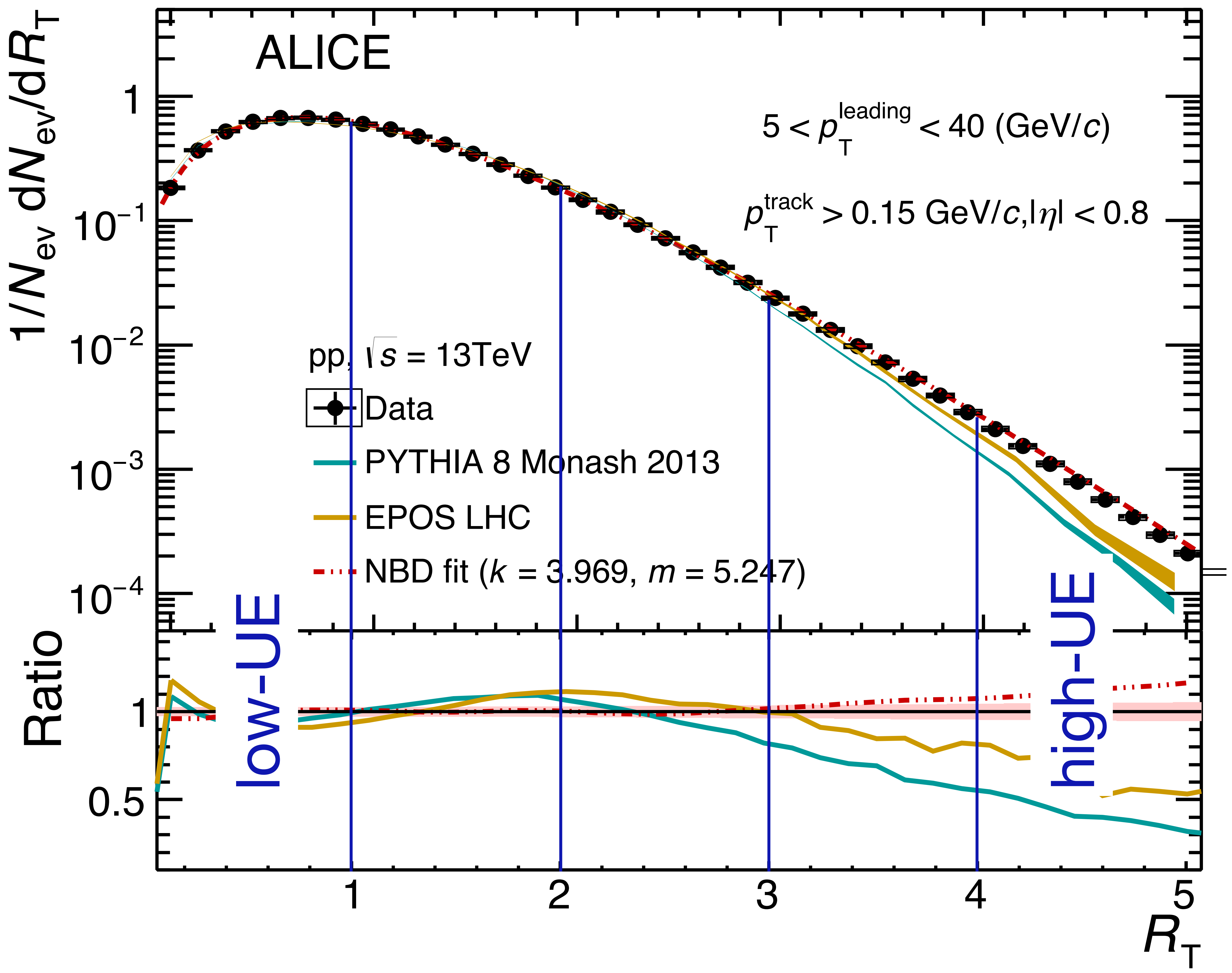
ALICE, JHEP 04 (2020) 192

Relative transverse activity classifier, R_T

Relative transverse activity classifier, $R_T = N_{ch}^T / < N_{ch}^T >$

(Introduced in P. Skands et. al., Eur. Phys. J. C **76,** 299 (2016))

- Using R_T, one can vary the magnitude of the underlying event (UE) and study the particle production
- $R_T \rightarrow 0$: Events with less UE (dominated by jets)
- Higher R_T → Higher UE contribution



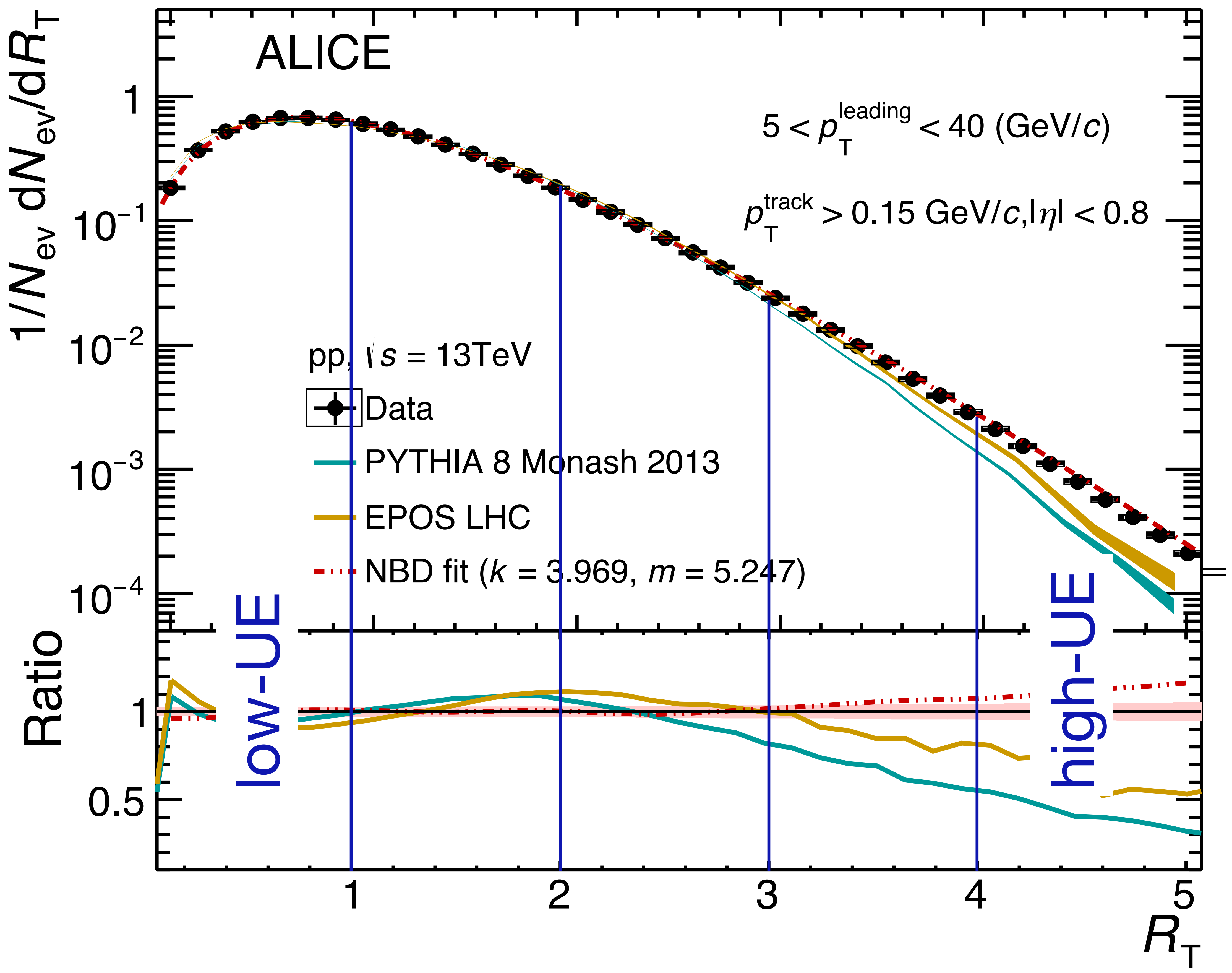
ALICE, JHEP 04 (2020) 192

Relative transverse activity classifier, R_T

Relative transverse activity classifier, $R_T = N_{ch}^T / \langle N_{ch}^T \rangle$

(Introduced in P. Skands et. al., Eur. Phys. J. C **76,** 299 (2016))

- Using R_T, one can vary the magnitude of the underlying event (UE) and study the particle production
- $R_T \rightarrow 0$: Events with less UE (dominated by jets)
- Higher R_T → Higher UE contribution
- A p_T cut for the leading particle is required to ensure a hard process: $p_T^{trig.} > 5$ GeV/c, where the charged particle density in transverse region remains nearly constant

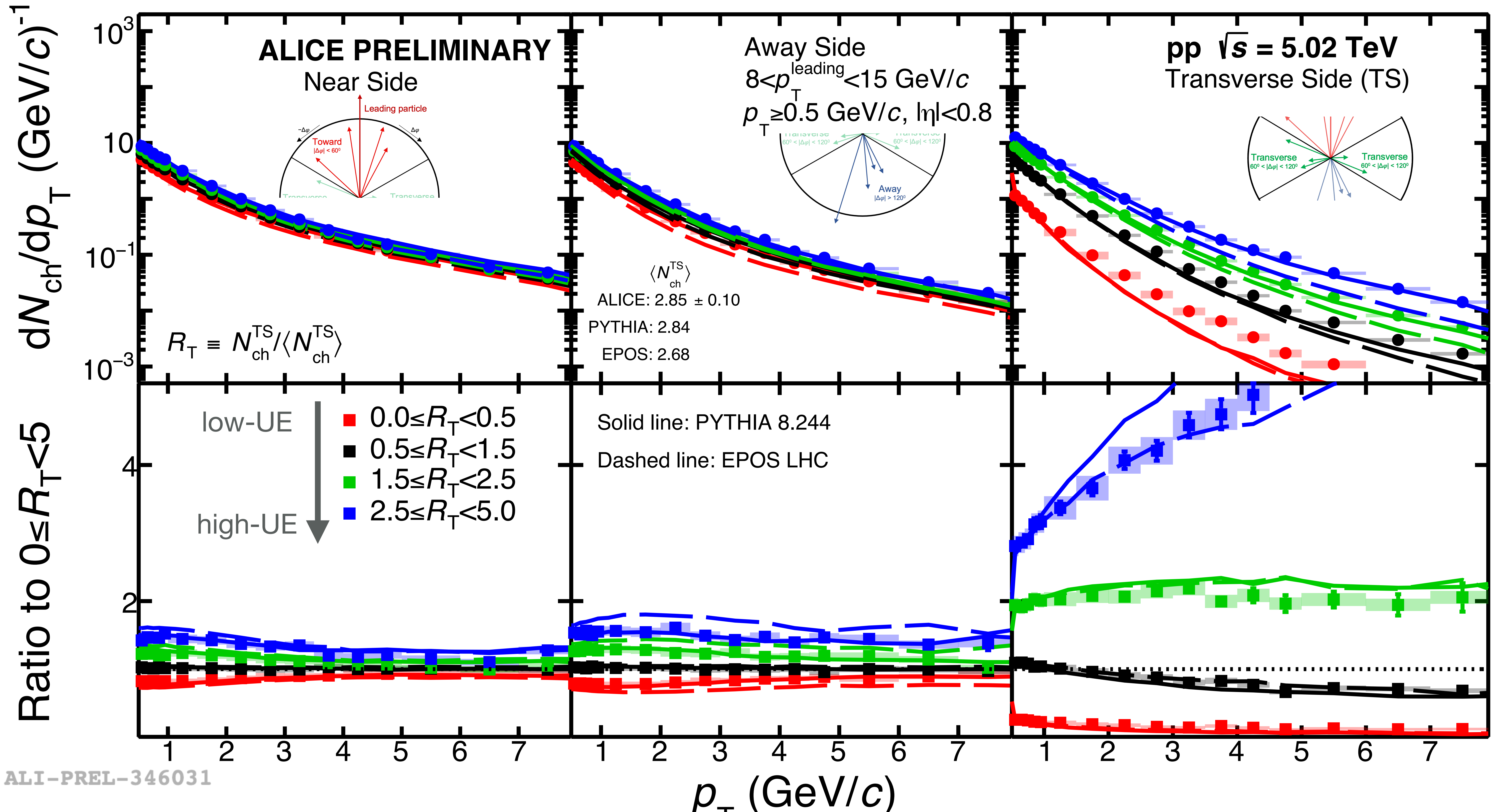


ALICE, JHEP 04 (2020) 192

Charged particle production vs. R_T

pp

Relative transverse activity classifier, $R_T = N_{ch}^{T} / \langle N_{ch}^{T} \rangle$



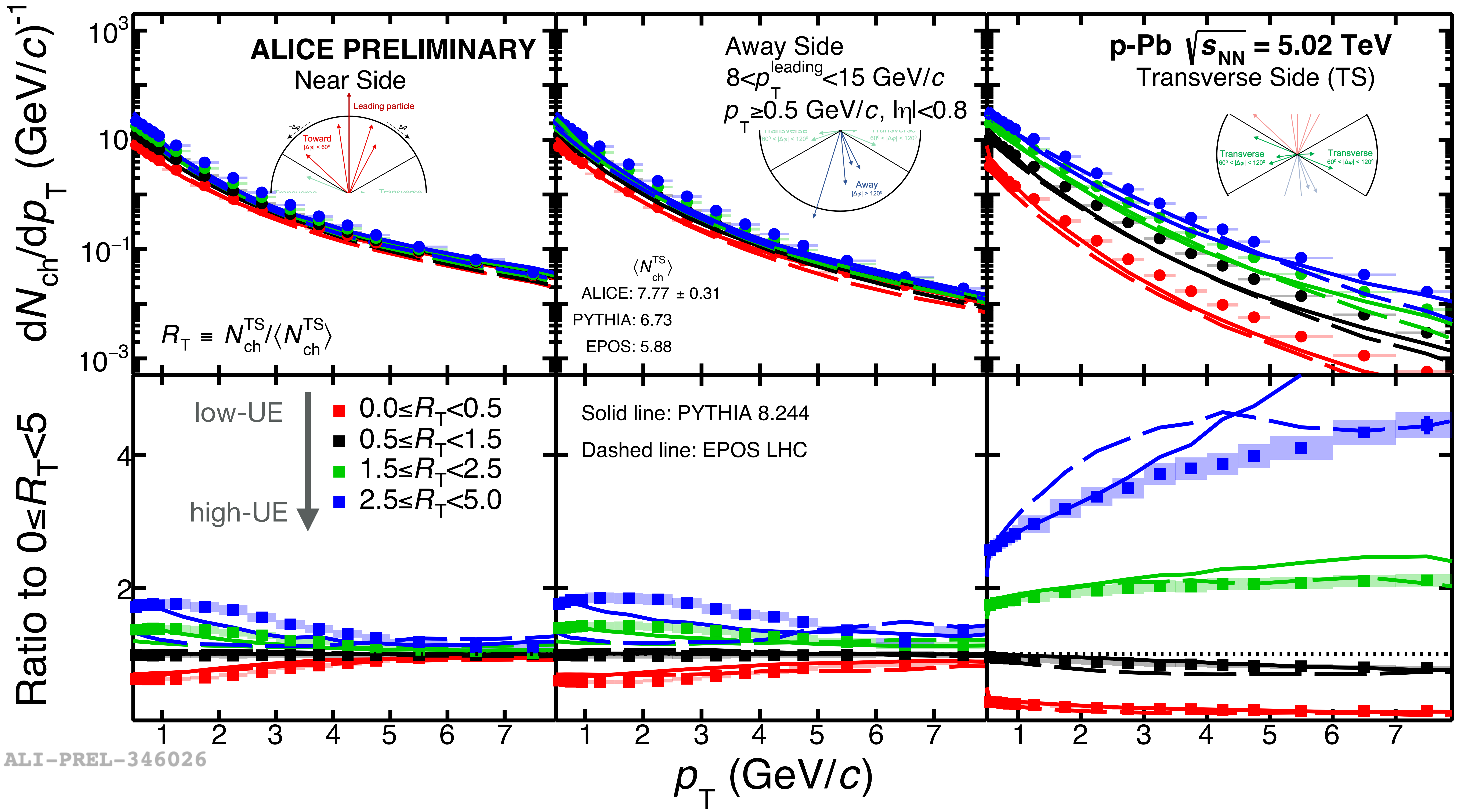
- **Transverse:** hardening of spectra with increase in R_T (Possibly due to initial and/or final state radiation [1])
- **Near and away:** softening of spectra with increase in R_T. High-p_T yields are nearly independent of R_T.
- In general, PYTHIA8 and EPOS-LHC describe data qualitatively

[1] G. Bencédi *et. al.*, J.Phys.G48 (2020) 1, 015007

Charged particle production vs. R_T

p–Pb

Relative transverse activity classifier, $R_T = N_{ch}^T / \langle N_{ch}^T \rangle$

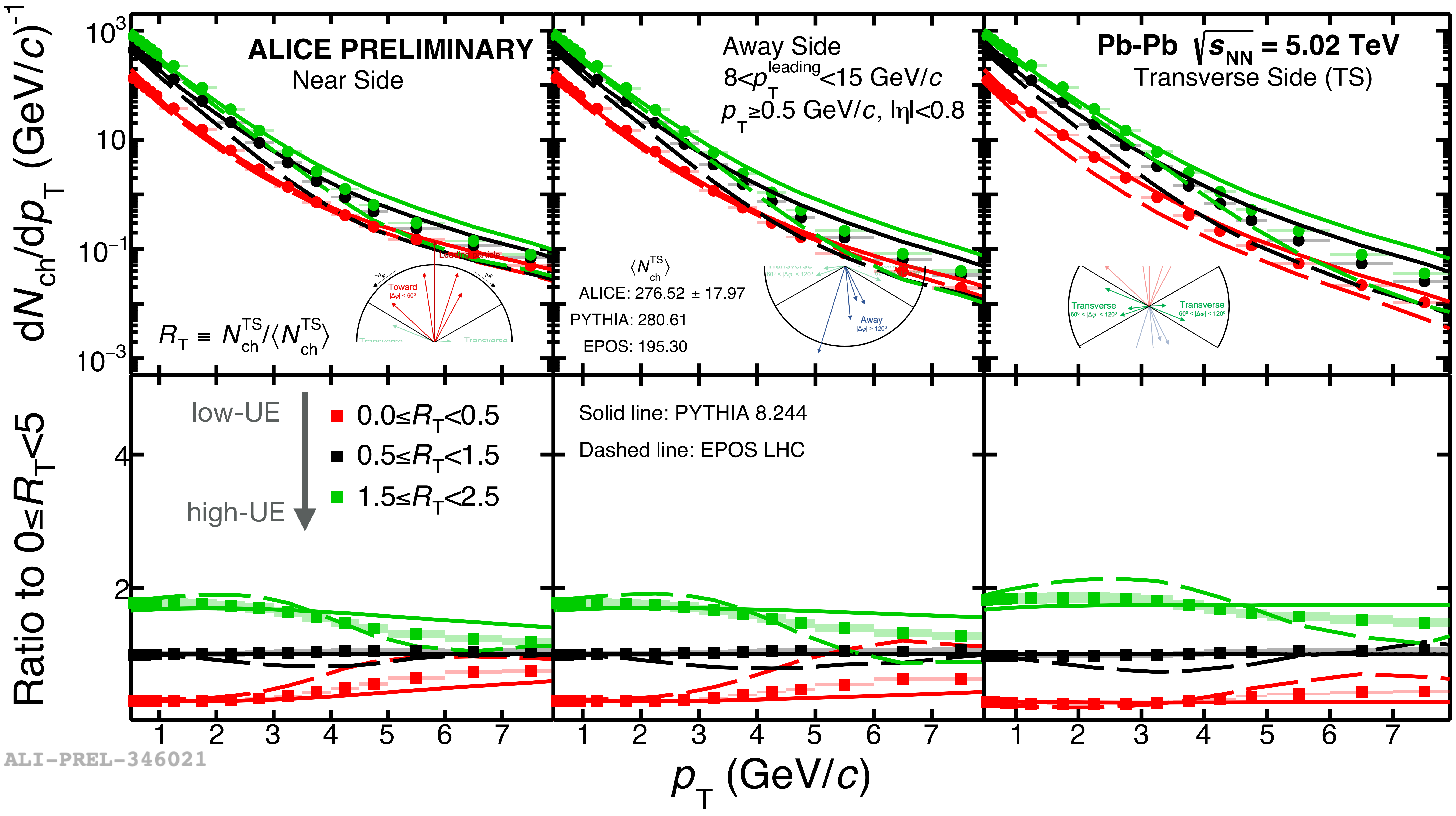


- **Transverse:** hardening of spectra with increase in R_T. Softer compared to pp.
- **Near and away:** softening of spectra with increase in R_T. High-p_T yields are nearly independent of R_T.
- Similar behavior as seen in pp rather than Pb–Pb: possible presence of MPI in pp and p–Pb.

Charged particle production vs. R_T

Pb–Pb

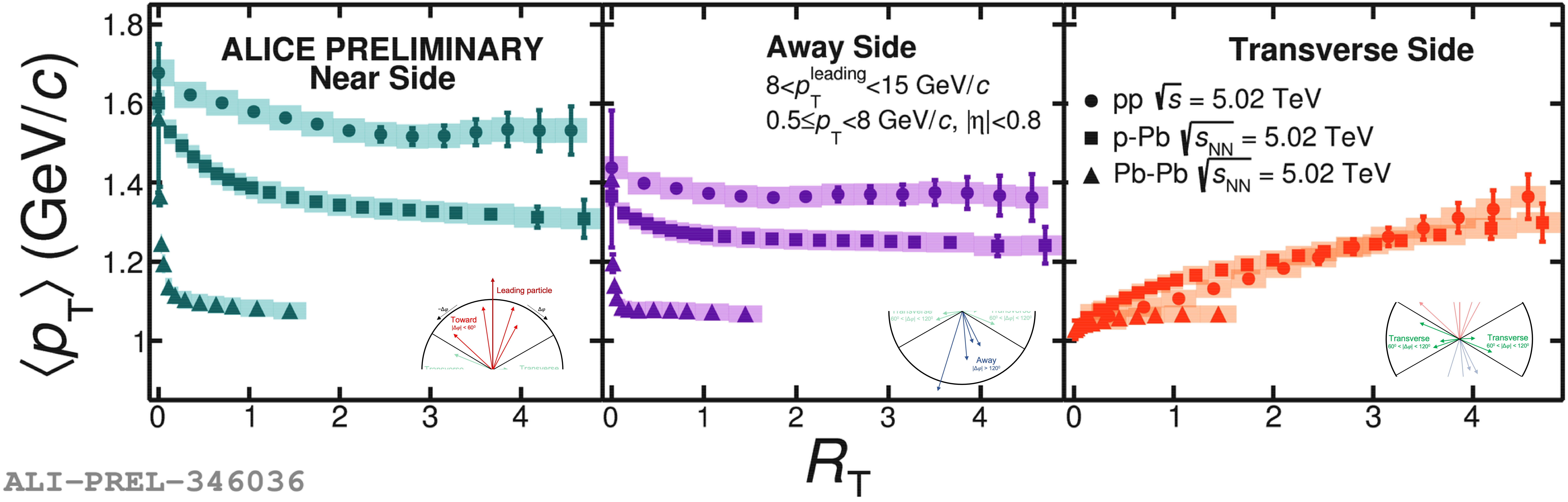
Relative transverse activity classifier, $R_T = N_{ch}^T / \langle N_{ch}^T \rangle$



- Similar behavior seen across all topological regions: dominated by soft particles.
- In general, PYTHIA8 (Angantyr) and EPOS-LHC describe data qualitatively.

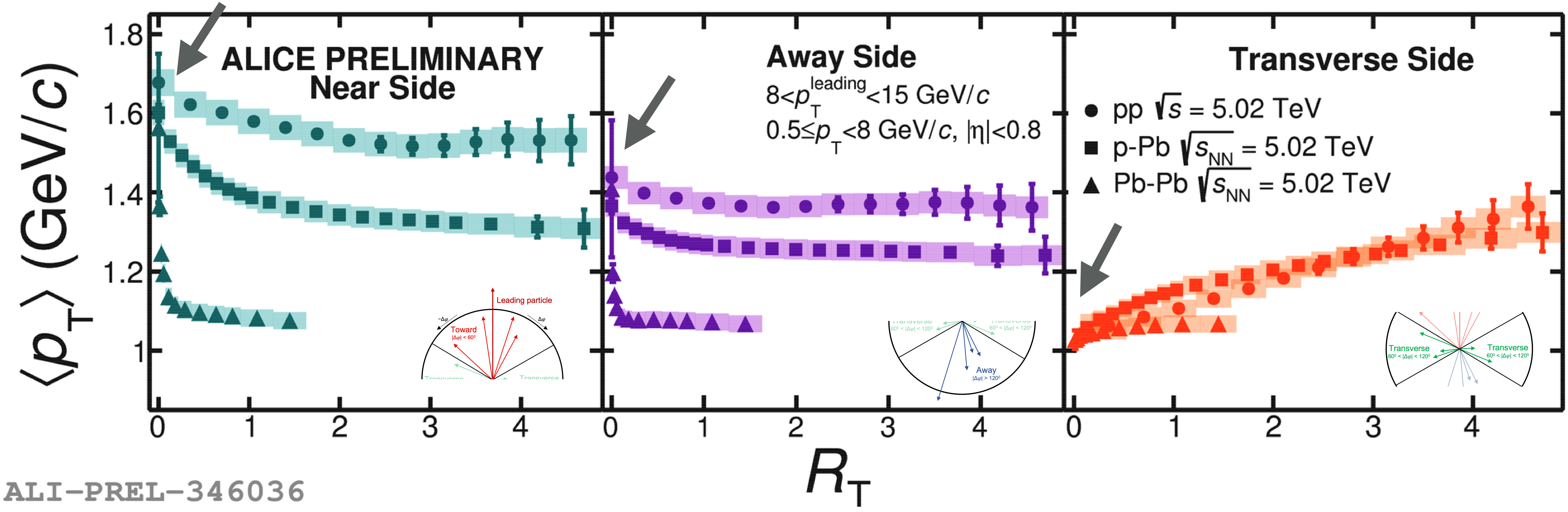
Charged particle production vs. R_T

Relative transverse activity classifier, $R_T = N_{ch}^T / \langle N_{ch}^T \rangle$



Charged particle production vs. R_T

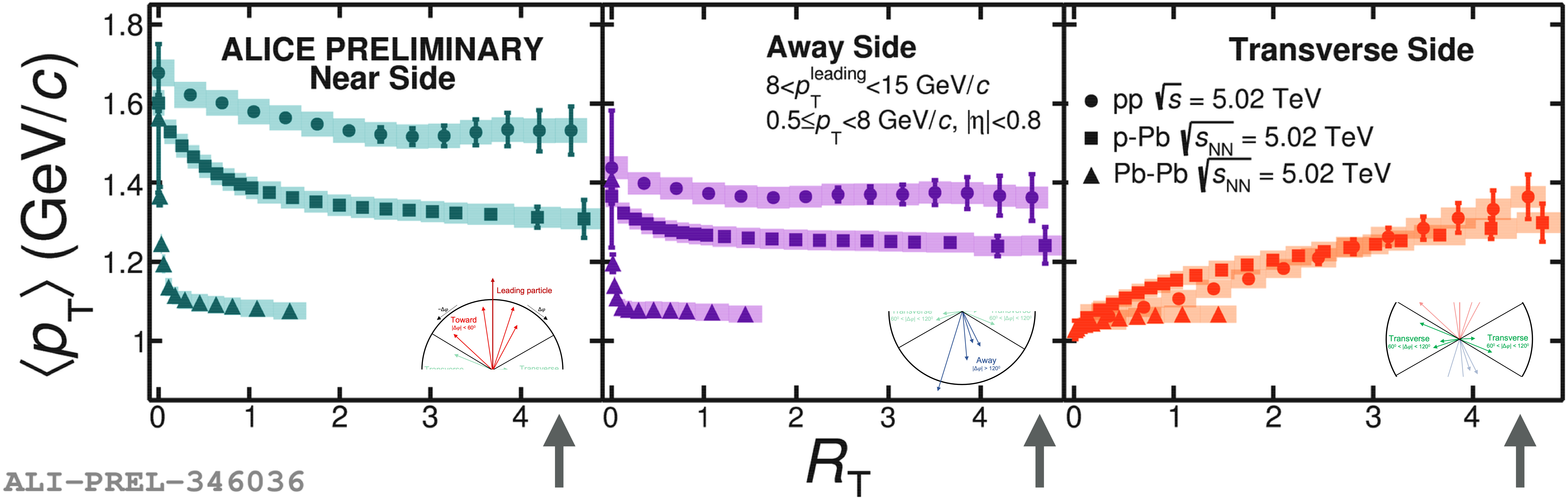
Relative transverse activity classifier, $R_T = N_{ch}^T / \langle N_{ch}^T \rangle$



- The contribution from the jets dominate at low R_T and the values are similar for all systems, as one would naively expect for $R_T \to 0$

Charged particle production vs. R_T

Relative transverse activity classifier, $R_T = N_{ch}^T / \langle N_{ch}^T \rangle$



- For large R_T, the $\langle p_T \rangle$ approaches similar values in all three topological regions for a given system: dominant UE contribution

ALICE

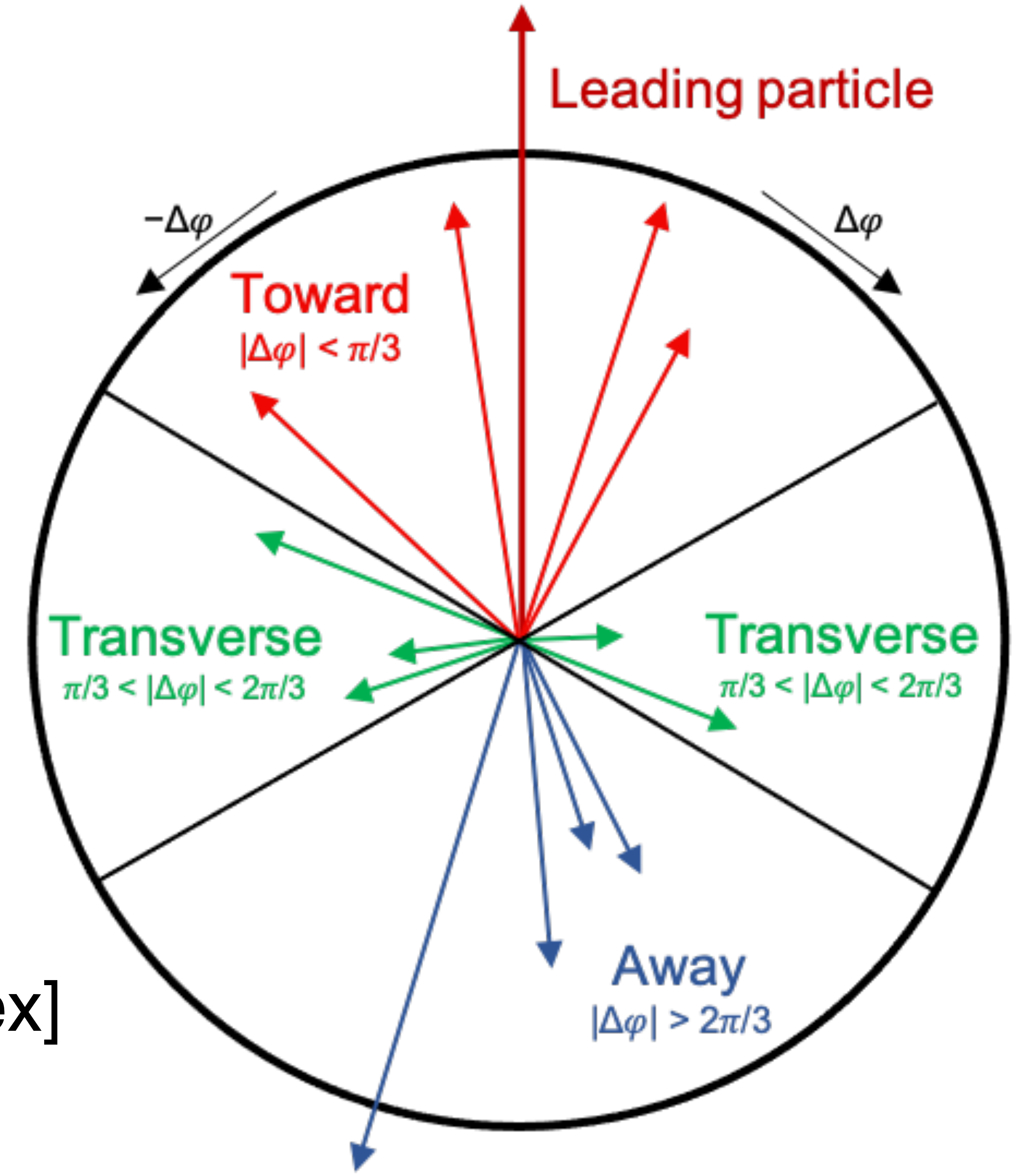
Jet-like region modifications

INFN BOLOGNA

$$I_X = \frac{\left.\frac{dN_{ch}}{dp_T}\right|_{\text{jet−like signal in X collision}}}{\left.\frac{dN_{ch}}{dp_T}\right|_{\text{jet−like signal for MB pp collision}}}$$

X = pp, p-Pb and Pb-Pb collisions

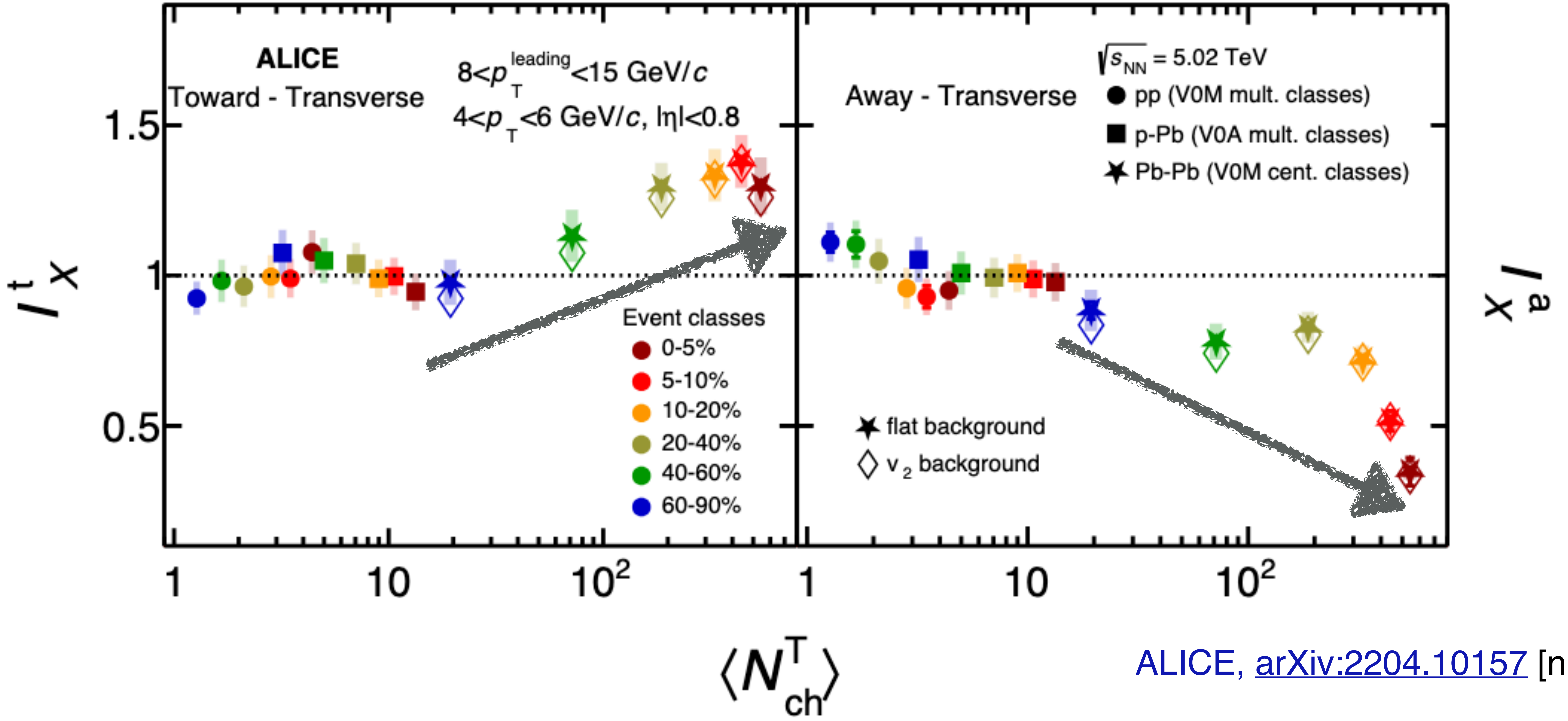
ALICE, arXiv:2204.10157 [nucl-ex]



- I_X is sensitive to medium effects. The suppression in away side for Pb−Pb collisions indicates the presence of jet quenching. ALICE, Phys. Rev. Lett. **108** (2012) 092301

- I_X is obtained as a function of the activity in the V0 detector in pp, p−Pb and Pb−Pb collisions at 5.02 TeV and the results are presented as a function of $\langle N_{ch}^{T} \rangle$.

Jet-like region modifications

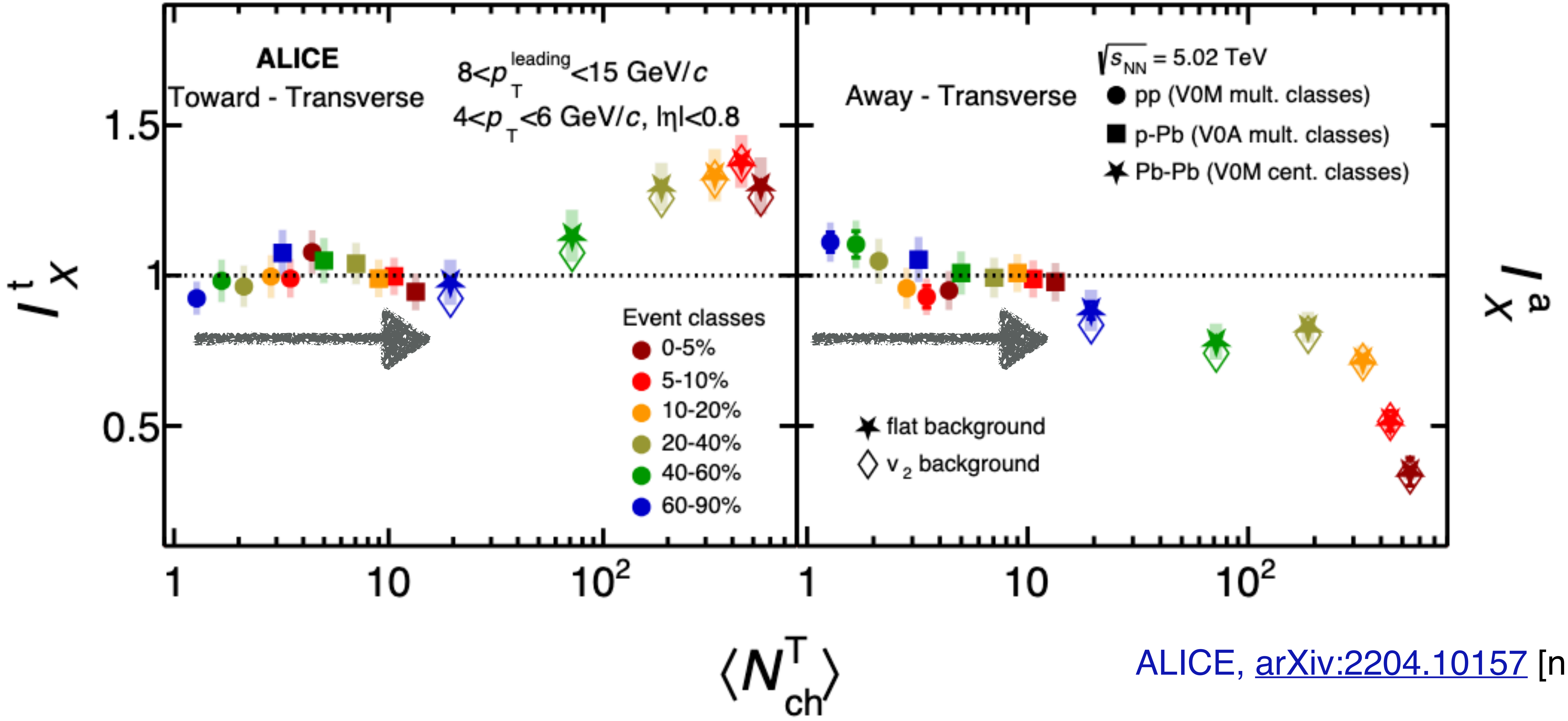


ALICE, arXiv:2204.10157 [nucl-ex]

- Pb–Pb collisions: I_X values in toward (away) region exhibit a enhancement (suppression) relative to MB pp with <N_{ch}^T>, compatible with the I_{AA} results measured by ALICE in Pb–Pb at 2.76 TeV

ALICE, Phys. Rev. Lett. **108** (2012) 092301

Jet-like region modifications



ALICE, arXiv:2204.10157 [nucl-ex]

- pp and p–Pb collisions: Absence of jet-like modifications in pp and p–Pb collisions as a function of the activity in the V0 detector

Summary

- First UE results for p–Pb collisions at the LHC: the charged particle density in the transverse region exhibits the same behaviour in pp and p–Pb collisions

- Using R_T, one can vary the magnitude of the underlying event (UE) and study the particle production in jet-dominated and UE-dominated regions

- Absence of jet-like modifications in pp and p–Pb collisions. In contrast, Pb–Pb data suggest the presence of jet quenching effects

Summary

- First UE results for p–Pb collisions at the LHC: the charged particle density in the transverse region exhibits the same behaviour in pp and p–Pb collisions

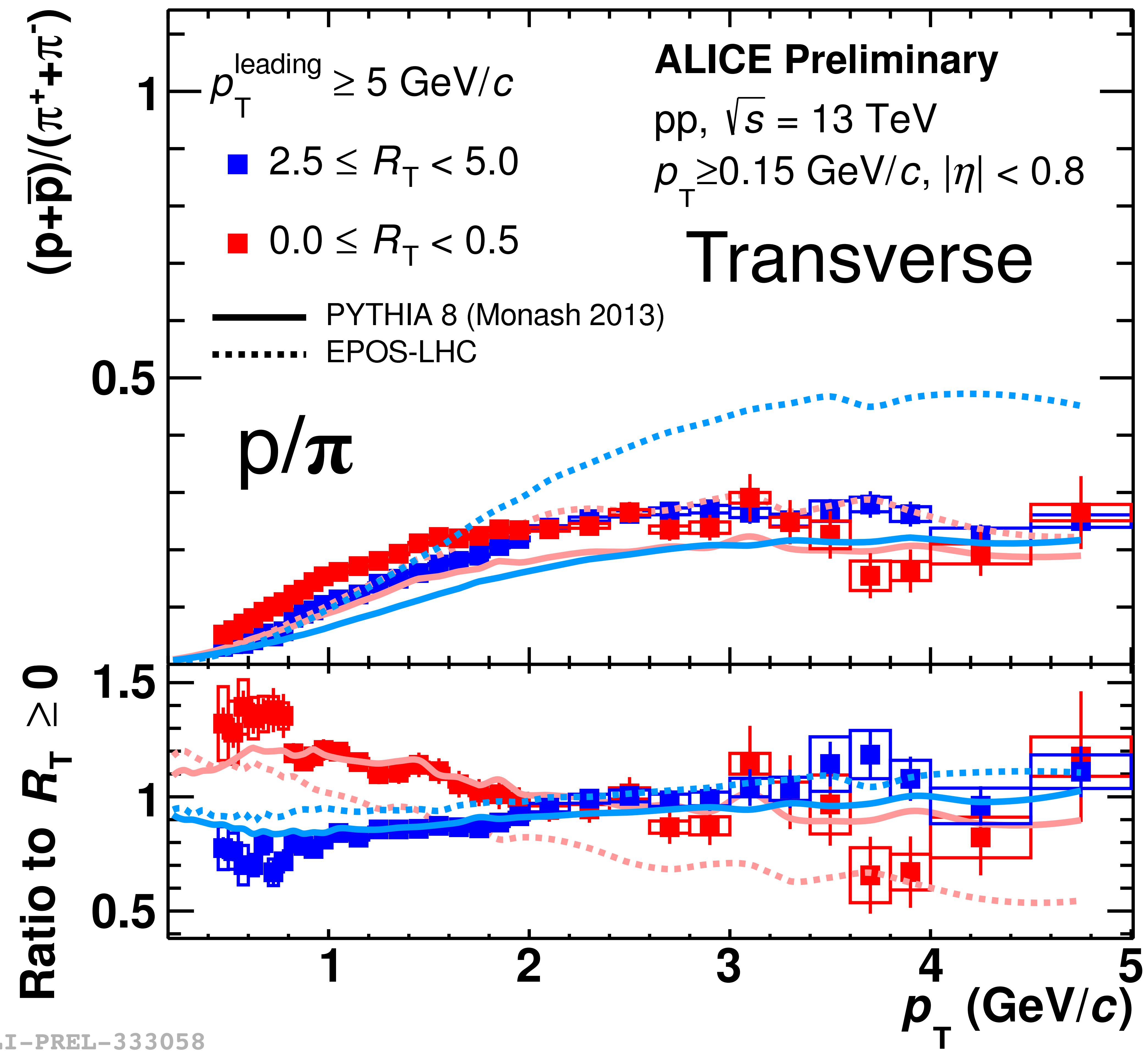
- Using R_T, one can vary the magnitude of the underlying event (UE) and study the particle production in jet-dominated and UE-dominated regions

- Absence of jet-like modifications in pp and p–Pb collisions. In contrast, Pb–Pb data suggest the presence of jet quenching effects

Thank you for your attention!

Back-up

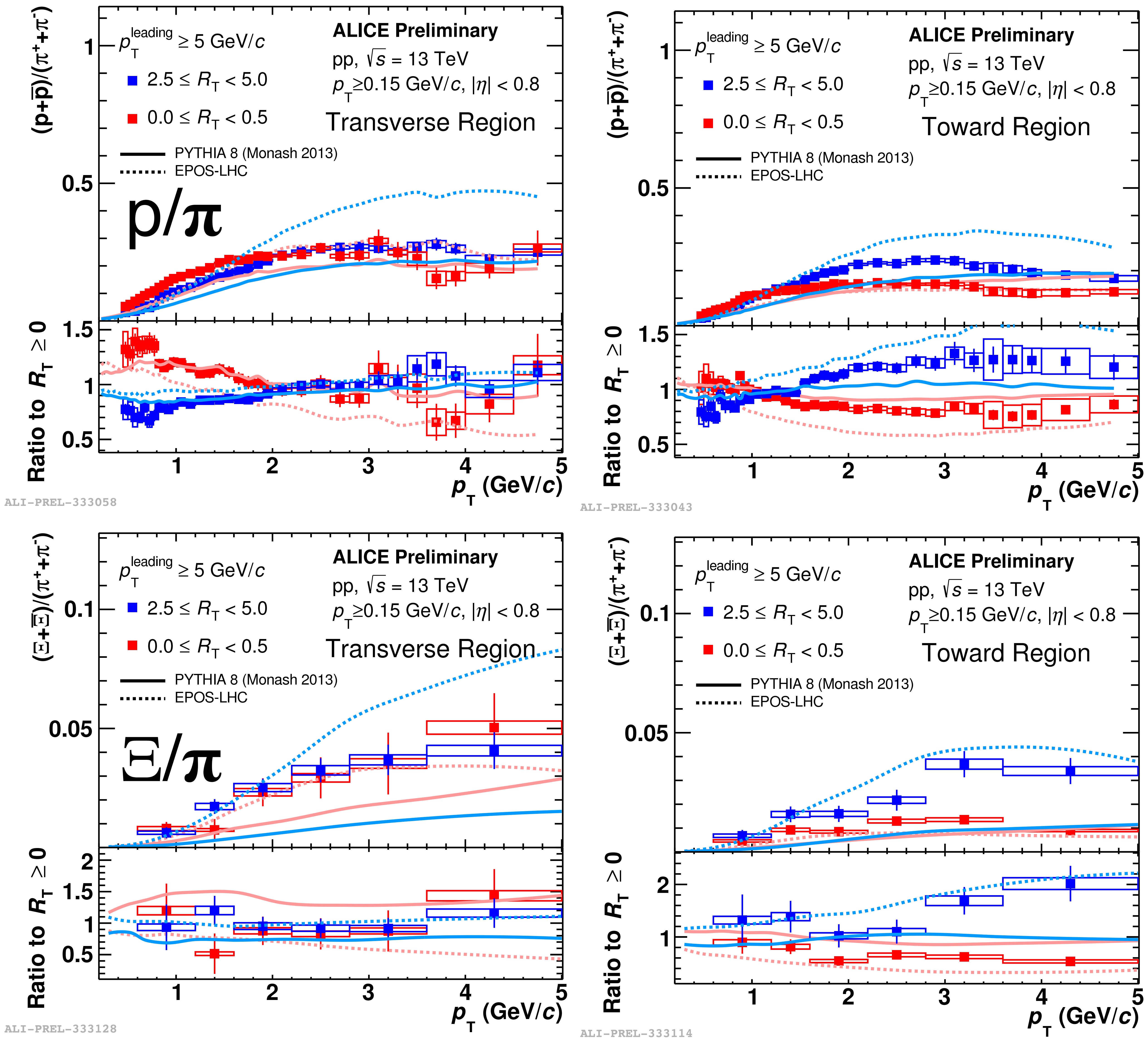
Identified particle production vs. R_T



- p/π ratio:
  - Radial flow-like features
  - Model predictions mostly fail to describe the particle ratios quantitatively

Identified particle production vs. R_T

Transverse | Toward



- p/π ratio:
  - Radial flow-like features in both the regions.
  - Model predictions mostly fail to describe the particle ratios quantitatively
- Ξ/π ratio:
  - show a similar trend to the p/π ratio.
  - high-R_T toward region approaches the results in Transverse region.

The results indicate the interplay between UE and jet-like components