New measurements of charged jet fragmentation properties in pp and p–Pb collisions with ALICE

Zoltán Varga
for the **ALICE** collaboration
varga.zoltan@wigner.hu

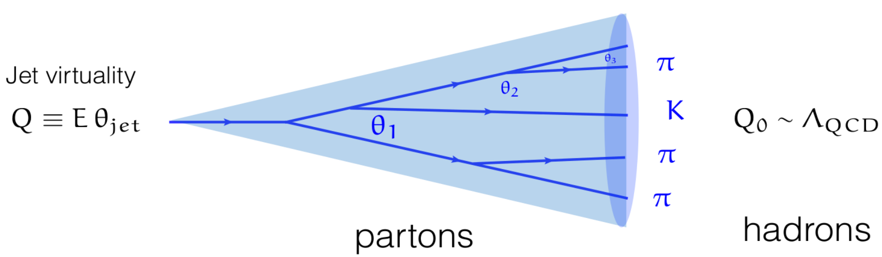
This work has been supported by the Hungarian NKFIH OTKA FK131979 and K135515, as well as the NKFIH grant 2021-4.1.2-NEMZ_KI-2022-00007.

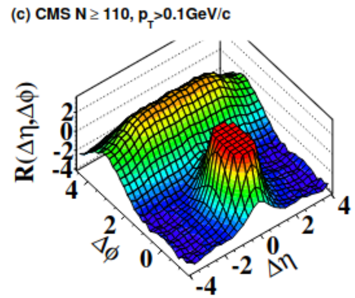
Background

- **Jets are collimated showers of particles which are produced by fragmentation and hadronization of hard-scattered partons**

- **Collectivity in high-multiplicity p-p collisions**
  - Substantial v_n Yan-Ollitrault, PRL 112, 082301 (2014)
  - Enhancement of strange hadrons
  - Ridge-like structure
  - Intra-jet properties (such as z^{ch}) are promising observables, since they are sensitive to the parton shower and hadronization processes

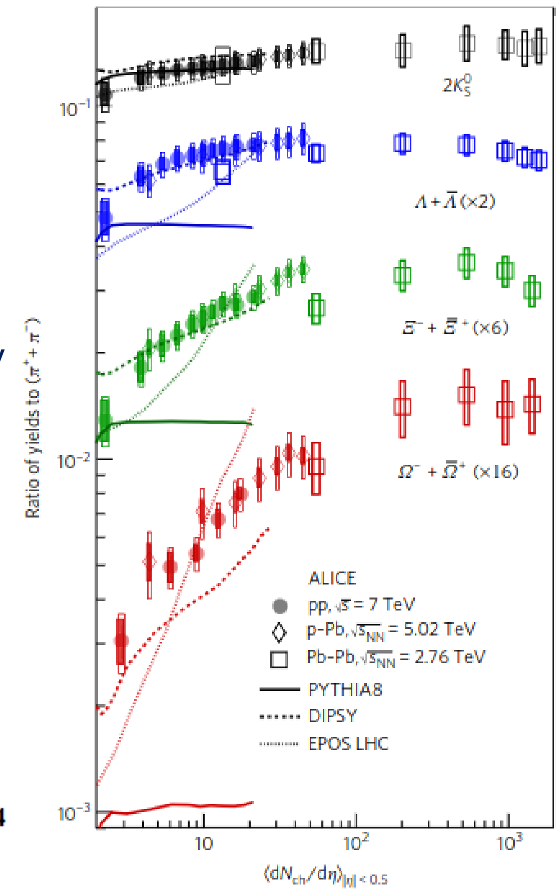
- **Jets in p-Pb collisions:**
  - Help testing the impact of cold nuclear matter effects
  - Valuable tools to understand the possible medium formation in small collision systems



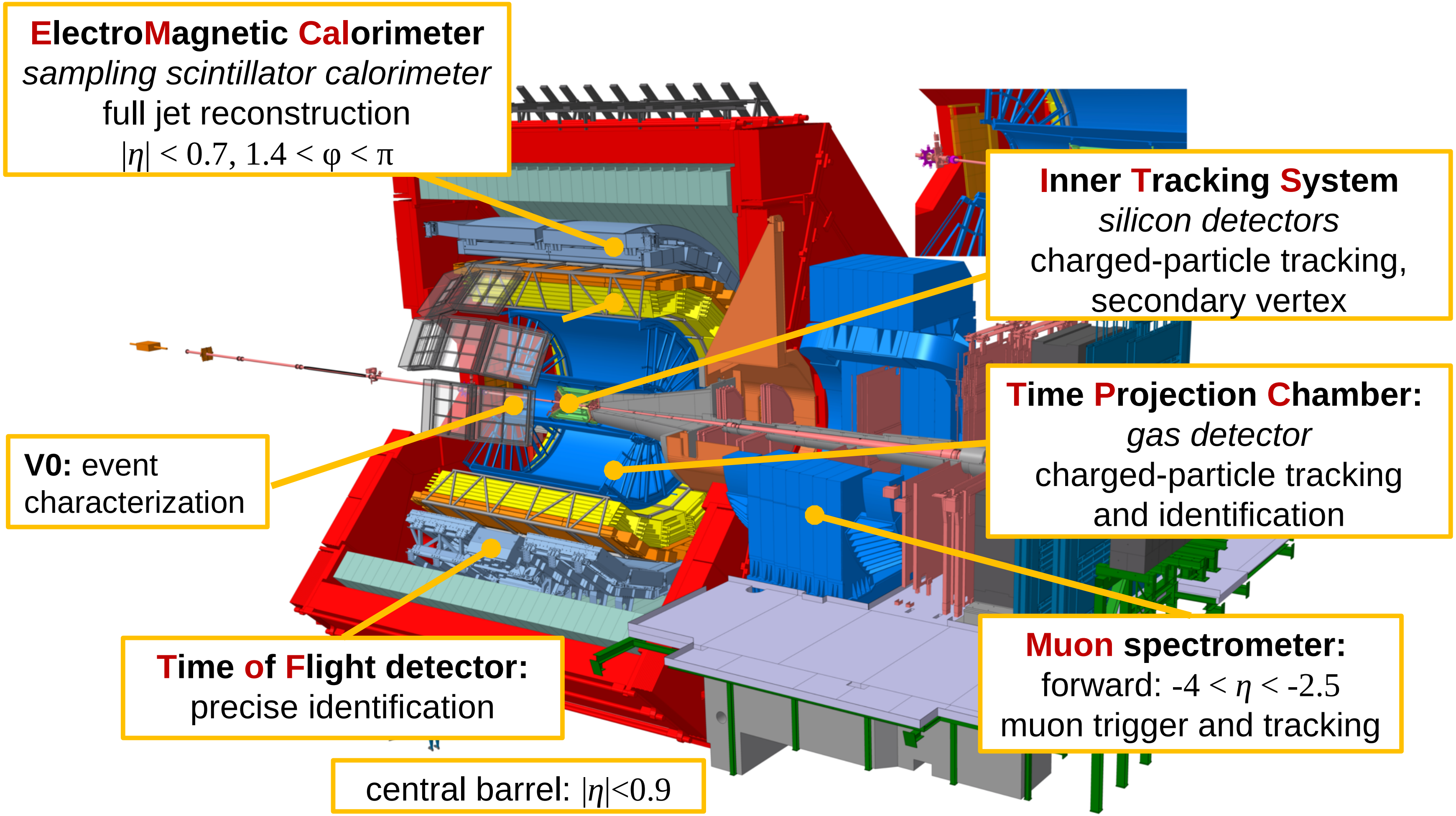


CMS, JHEP 09 (2010)

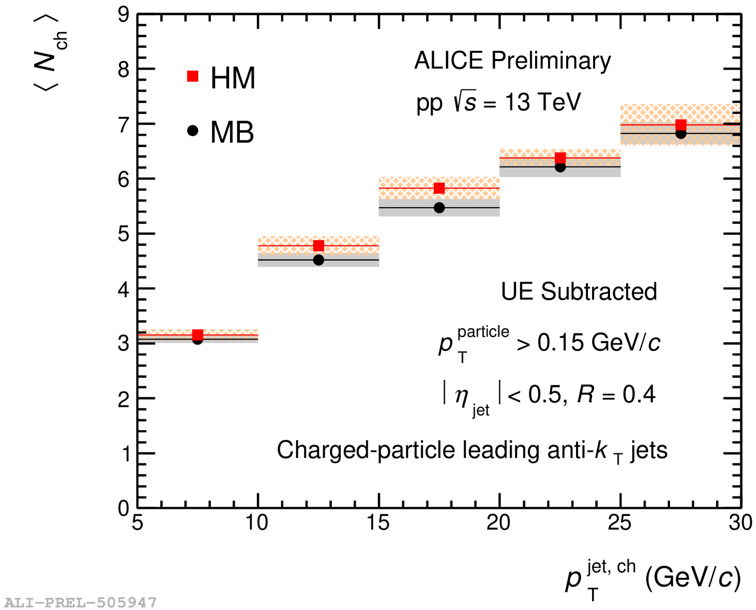
Nature Physics 13 (2017) 535-539



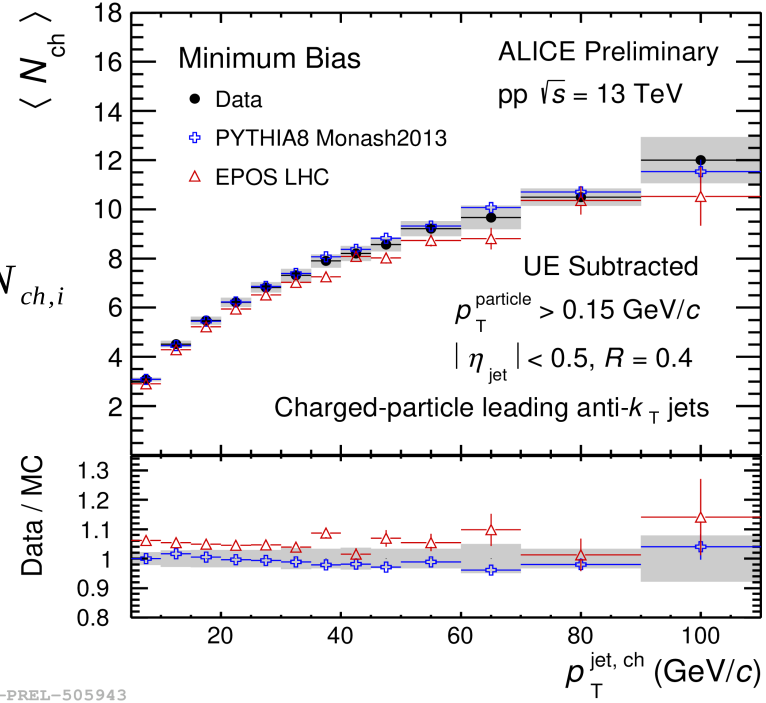
The ALICE Detector



Average multiplicity as a function of p_T^{jet}



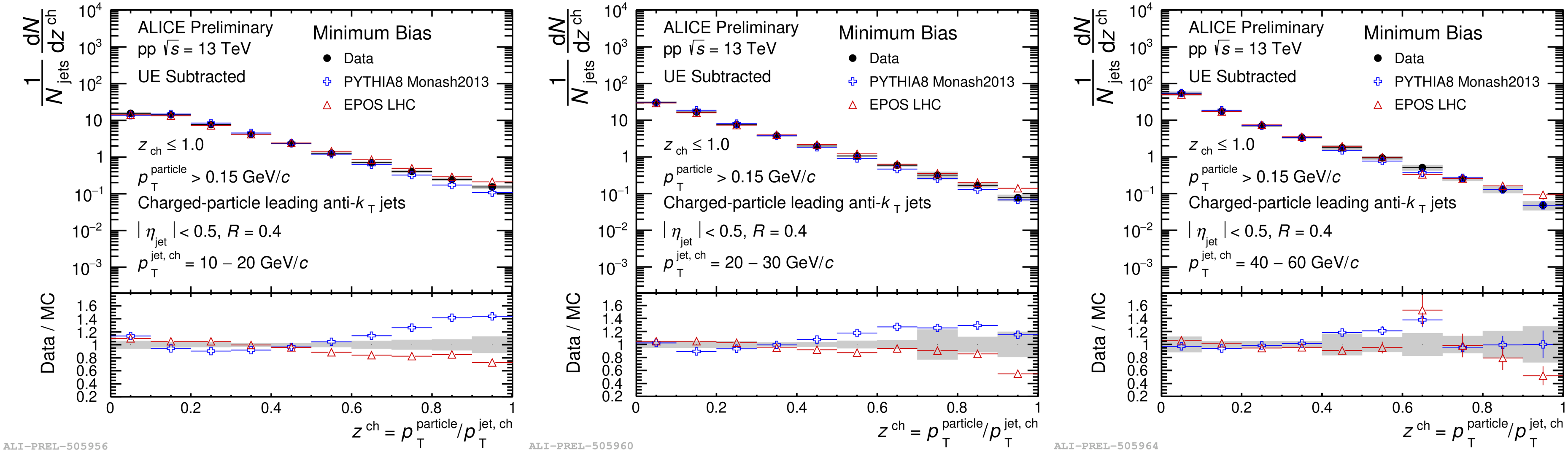
$$\langle N_{ch} \rangle = \frac{1}{N_{jets}} \sum_{i=1}^{N_{jets}} N_{ch,i}$$



Measuring the average jet multiplicity as a function of leading jet p_T :

- For both MB and HM events: **average jet multiplicity is monotonically increasing**,
- **EPOS LHC simulations underestimate the data, but PYTHIA 8 describes it well within systematic uncertainties.**
- **$\langle N_{ch} \rangle$ is larger for HM events**, especially in the (10 GeV/c) < p_T < (25 GeV/c) region.

Jet fragmentation functions compared to PYTHIA 8 and EPOS LHC

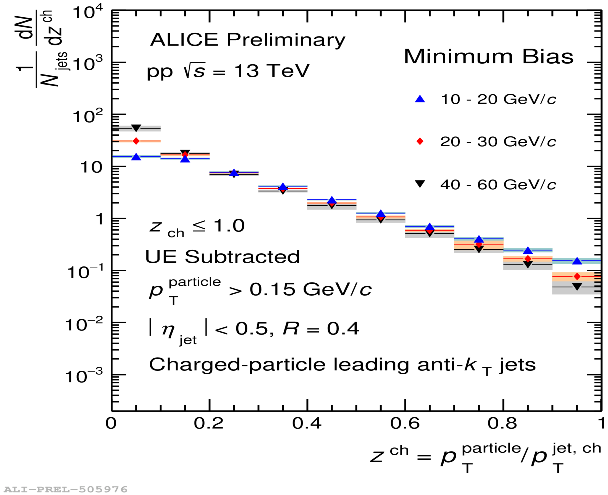


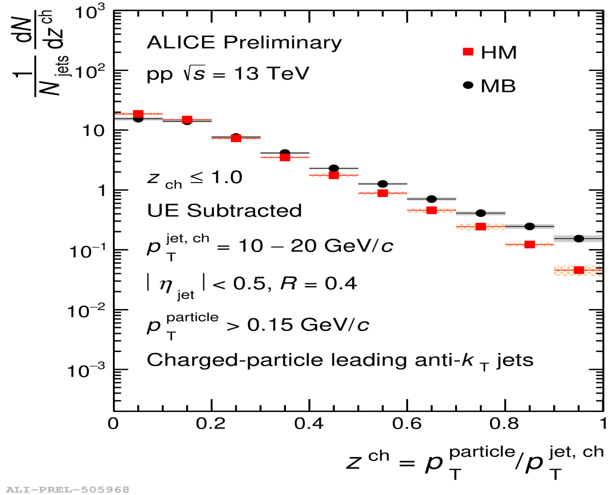
Fragmentation function: $z^{ch} = \frac{p_T^{particle}}{p_T^{jet}}$

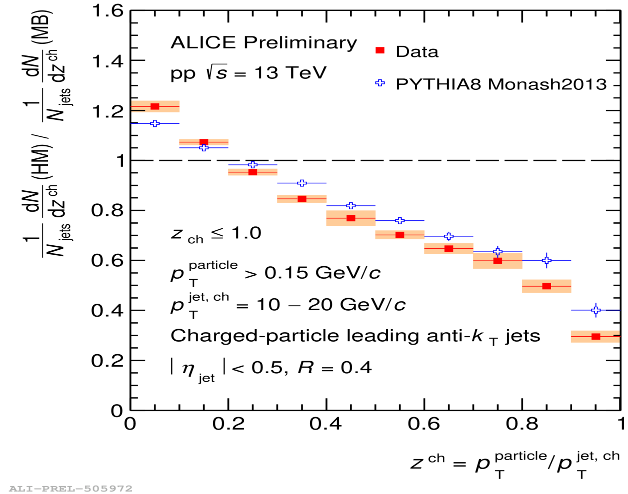
DATA is compared to PYTHIA 8 (Monash 2013 tune) and EPOS LHC simulations:

- For low z^{ch} (< 0.5): **both models predict the data** within systematic uncertainties,
- For high z^{ch} (> 0.5): **EPOS LHC explains data better than PYTHIA 8 for lower jet p_T** ranges, while **both models predict the data well for high jet p_T ranges**.

Jet Fragmentation Function for MB and HM events







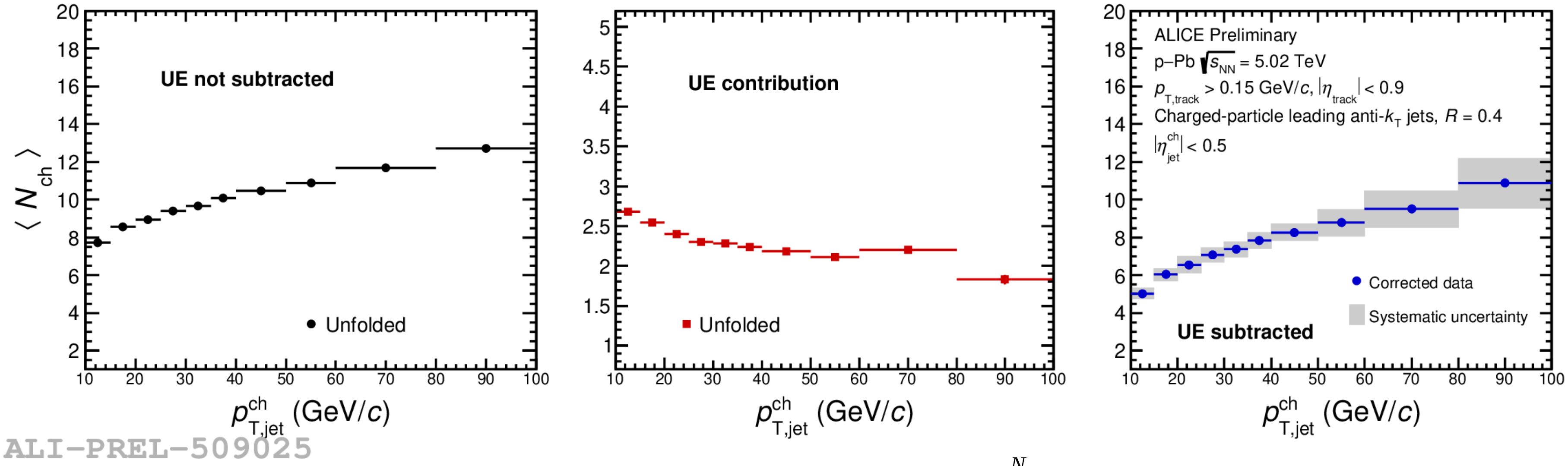
Fragmentation function: $z^{ch} = \frac{p_T^{particle}}{p_T^{jet}}$

Average multiplicity: $\langle N_{ch} \rangle = \frac{1}{N_{jets}} \sum_{i=1}^{N_{jets}} N_{ch,i}$

1st measurement of the jet multiplicity dependence of the jet fragmentation function:

- Indicates a **scaling** of the charged-particle jet **fragmentation function** with jet p_T except at highest and lowest z^{ch} ,
- Jet **fragmentation is softer in HM events** and this effect is **not explained by the change in shape of jet p_T spectra** between HM and MB.

Average multiplicity distributions in p-Pb

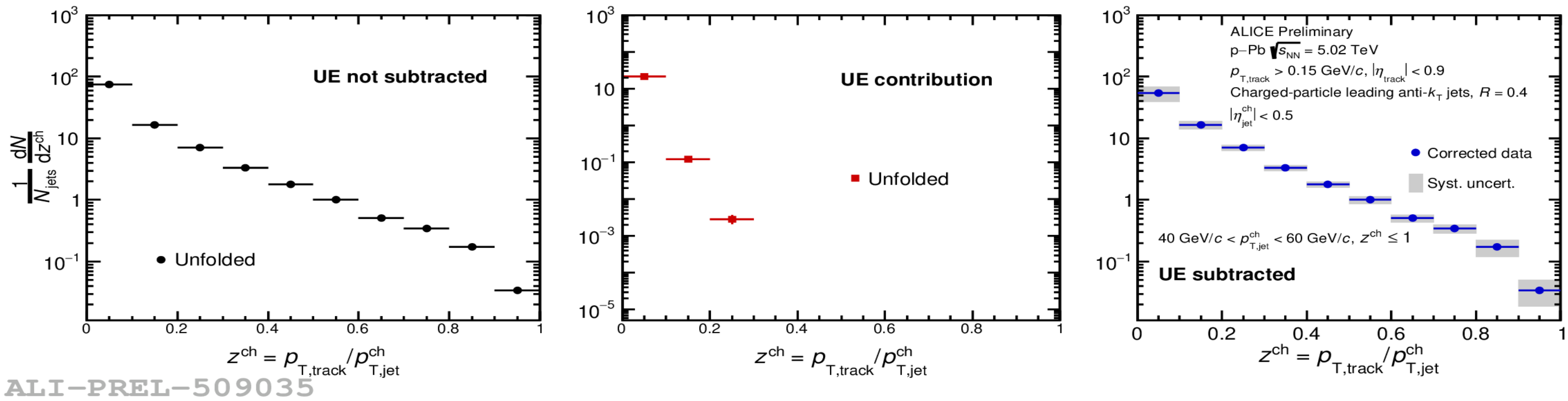


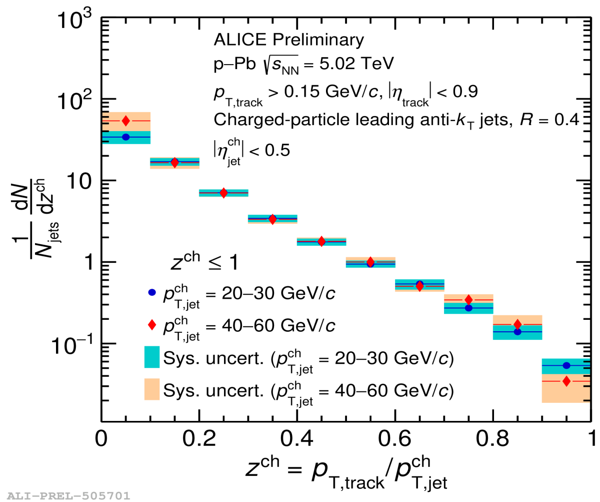
Average multiplicity: $$\langle N_{ch} \rangle = \frac{1}{N_{jets}} \sum_{i=1}^{N_{jets}} N_{ch,i}$$

Average multiplicity measured as a function of $p_T^{jet,ch}$:

- **<N_{ch}>** monotonically **increases** with $p_T^{jet,ch}$,
- while the **UE** contribution **decreases** with $p_T^{jet,ch}$.
- **UE contribution is significant** (~15-30% in the measured range).

Fragmentation functions in p-Pb





- The **UE contribution is significant** in the low z^{ch} range,
- but it **falls off exponentially** with increasing z^{ch} values.
- In the final corrected result a **scaling of the charged-jet fragmentation function is observed**, for both 20-30 GeV/c and 40-60 GeV/c ranges.

Summary

1st measurements of the multiplicity dependence of intra-jet properties of leading charged-particle jets in pp collisions at $\sqrt{s}$ = 13 TeV

- The mean charged-particle multiplicity is measured in both minimum-bias and high-multiplicity pp collisions.
- The mean charged-particle multiplicity inside the leading jet rises monotonically, in qualitative agreement with previous measurements.
- Measurements of jet fragmentation functions:

→ Scaling of the fragmentation of leading jets with $p_{T}^{jet,ch}$ in the middle of the measured z^{ch} range.

Measurements of mean charged-particle multiplicity and fragmentation functions in p-Pb collisions at $\sqrt{s}$=5.02 TeV

→ Scaling of charged-jet fragmentation function is observed for the middle ranges of z^{ch} values.

These measurements provide important constraints to pQCD-based Monte Carlo models.

Thank you for your attention!