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

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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 $v_n$ \cite{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
The ALICE Detector

**ElectroMagnetic Calorimeter**
sampling scintillator calorimeter
full jet reconstruction
$|\eta| < 0.7$, $1.4 < \varphi < \pi$

**Inner Tracking System**
silicon detectors
charged-particle tracking, secondary vertex

**Time Projection Chamber:**
gas detector
charged-particle tracking and identification

**Time of Flight detector:**
precise identification

**Muon spectrometer:**
forward: $-4 < \eta < -2.5$
muon trigger and tracking

**V0:** event characterization

central barrel: $|\eta| < 0.9$
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

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.

Fragmentation function: $z_{ch} = \frac{p_T^{\text{particle}}}{p_T^{\text{jet}}}$
Jet Fragmentation Function for MB and HM events

1\textsuperscript{st} 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.

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

Average multiplicity: $\langle N_{ch} \rangle = \frac{1}{N_{jets}} \sum_{i=1}^{N_{jets}} N_{ch,i}$
Average multiplicity distributions in p-Pb

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).
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:
  \( \rightarrow \) Scaling of the fragmentation of leading jets with \( p_T^{\text{jet, ch}} \) in the middle of the measured \( z^{\text{ch}} \) 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 \( z^{\text{ch}} \) values.

These measurements provide important constraints to pQCD-based Monte Carlo models.
Thank you for your attention!