# $D^0$-meson tagged jets in pp collisions at $\sqrt{s} = 7$ TeV with ALICE


Salvatore Aiola, on behalf of the ALICE Collaboration

Yale University

salvatore.aiola@yale.edu



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## Introduction

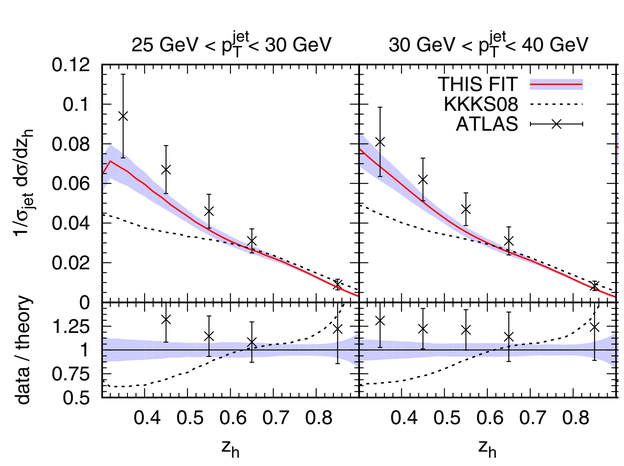


Figure 1: Momentum fraction $z_h$ carried by $D^{*\pm}$ mesons in jets measured by ATLAS compared with a global QCD fit and an older calculation using only single-hadron data [1].

Critical experimental input to:

- gluon PDFs at **small $x$**
- **transport properties** of the Quark-Gluon Plasma
- **parton-to-hadron** fragmentation functions, particularly g→D

## ALICE at the LHC

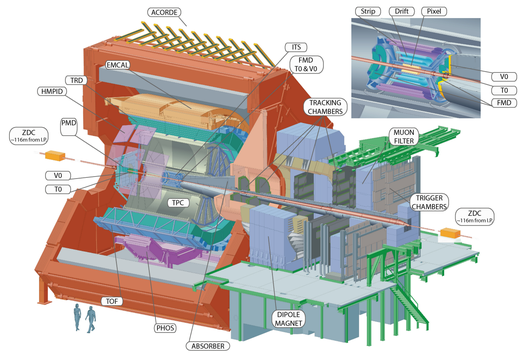


Figure 2: 3D schematics of the ALICE detector.

- **$D^0$ mesons** reconstructed via hadronic decays: $D^0 \to K^-\pi^+$ [2]
  - Particle Identification (K/$\pi$)
  - Displaced decay topology
  - Invariant mass analysis
- **Tracking down to low momentum**: $p_T \gtrsim 0.1$ GeV/$c$
- **Track-based jets** reconstruction with the anti-$k_T$ algorithm [3]

## $p_T$-Differential Cross Section and Momentum Fraction Distributions

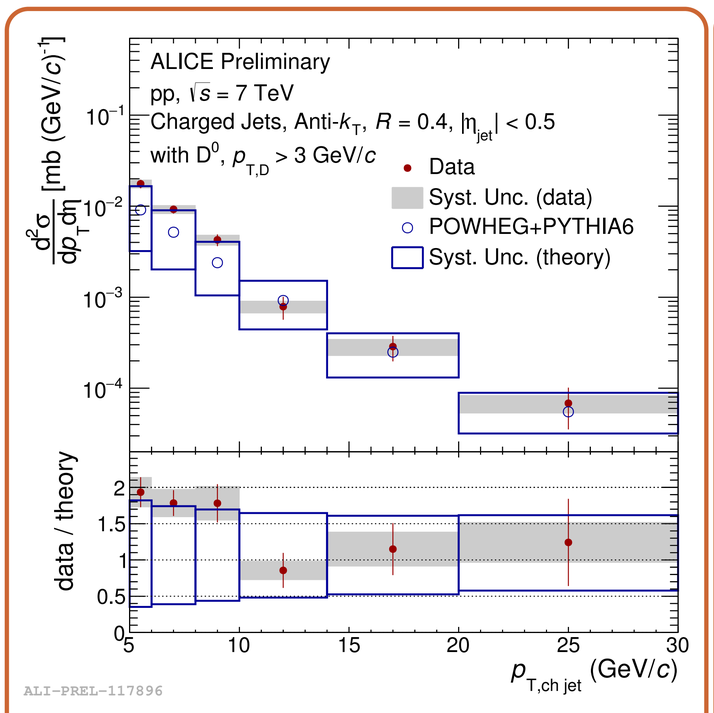


Figure 3: $D^0$-jet $p_T$-differential cross section.

$$z_{||,D}^{ch\ jet} = \frac{\vec{p}_{ch\ jet} \cdot \vec{p}_D}{\vec{p}_{ch\ jet} \cdot \vec{p}_{ch\ jet}} \to$$

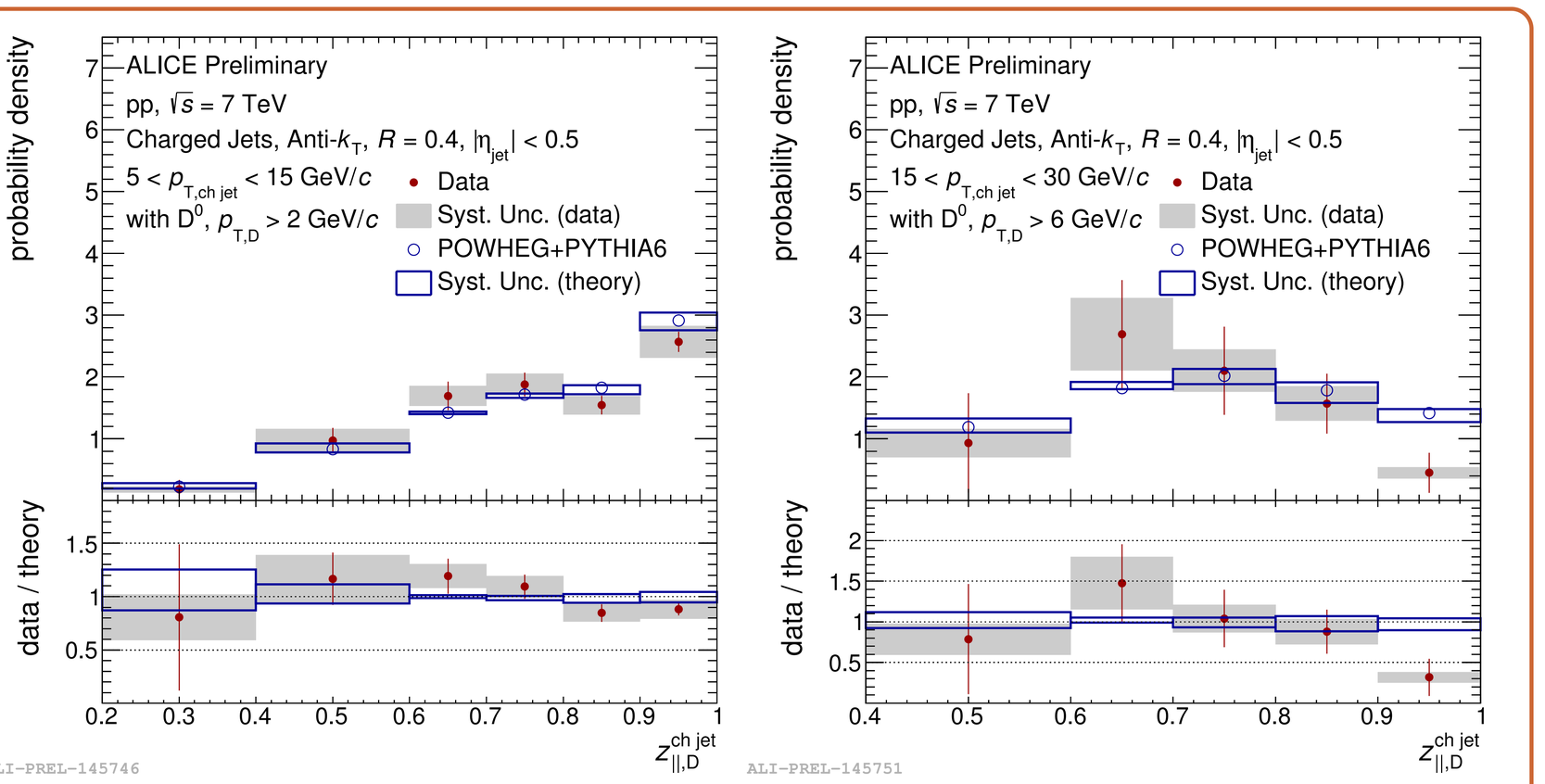


Figure 4: Distribution of the momentum fraction $z_{||,D}^{ch\ jet}$ carried by the $D^0$ in jets with $5 < p_{T,ch\ jet} < 15$ GeV/$c$ (left) and $15 < p_{T,ch\ jet} < 30$ GeV/$c$ (right).

- Data systematic uncertainty dominated by extraction of raw yield (invariant mass fit) and non-prompt subtraction
- Theory systematic uncertainty: renormalization and factorization scales, charm mass, PDFs

**Overall the data is in good agreement with POWHEG (NLO parton event) + PYTHIA6 (parton shower and hadronization), with possibly a hint of a softer fragmentation in the $15 < p_{T,ch\ jet} < 30$ GeV/$c$ kinematic range**

## Raw Signal Extraction

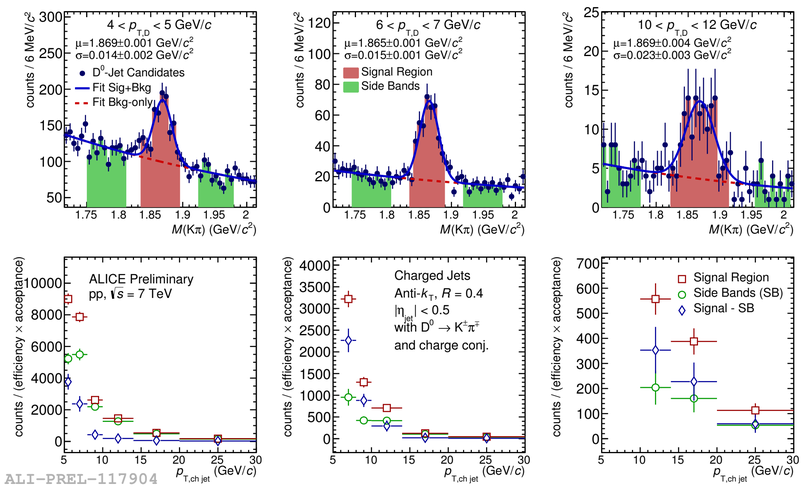


Figure 5: Invariant mass distributions (top) and $p_{T,ch\ jet}$ distributions (bottom) from the peak region and the side bands (SBs).

- The normalized **side-band** distributions in $p_{T,ch\ jet}$ and $z_{||,D}^{ch\ jet}$ are subtracted from **peak-region** ones
- The subtracted distributions are weighted by the inverse of the reconstruction efficiency $\epsilon_{p_{T,D}}$ and summed over $p_{T,D}$

$$N(p_{T,ch\ jet}) = \sum_{p_{T,D}} \frac{1}{\epsilon_{p_{T,D}}} \cdot [N_P(p_{T,D}, p_{T,ch\ jet}) - B' N_{SB}(p_{T,D}, p_{T,ch\ jet})]$$

## Corrections

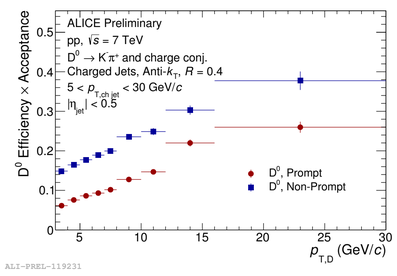


Figure 6: Reconstruction efficiency.

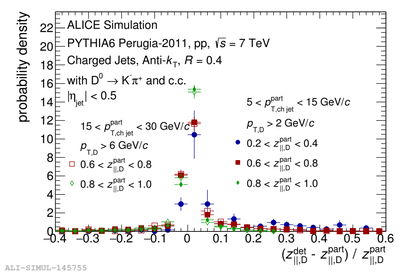


Figure 7: $z_{||,D}^{ch\ jet}$ resolution.

Strong dependence of the **reconstruction efficiency** on the $D^0$ momentum $p_{T,D}$:

- Affected by **tracking efficiency** and displaced **decay topology cuts**
- Weak or no dependence on $p_{T,ch\ jet}$ or $z_{||,D}^{ch\ jet}$
- Higher efficiency for non-prompt (b → $D^0$) vs. prompt (c, g → $D^0$)
- **Non-prompt** ≈ 15%, **subtracted** based on POWHEG expectations folded with detector effects

**Unfolding** with the regularized SVD method:

- Resolution: $\sigma(z_{||,D}^{ch\ jet}) \approx 15\%$, $\sigma(p_{T,ch\ jet}) \approx 11\%$
- Detector response simulated with PYTHIA6+GEANT3

## Outlook

- ALICE has measured the **cross section** and the **fragmentation function** of $D^0$ mesons in jets with $5 < p_{T,ch\ jet} < 30$ GeV/$c$ in pp collisions at $\sqrt{s} = 7$ TeV
- POWHEG+PYTHIA6 is in **agreement with the data**
- Comparisons with other models and calculations are under way
- Plans to extend this measurement to the larger data samples at $\sqrt{s} = 8$ and 13 TeV, possibly using electromagnetic calorimeters for triggering and full jet reconstruction
- Similar measurements are being pursued in p–Pb and Pb–Pb collisions to explore **QGP effects** on the charm production


[1] D. P. Anderle et al., PRD 96 (2017) 034028.
[2] S. Acharya et al. (ALICE), EPJC 77 (2017) 550.
[3] B. Abelev et al. (ALICE), PRD 91 (2015) 112012.