Exploring the charm content of jets in pp collisions with ALICE

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Quark Matter 2017 February 6-11, 2017, Chicago, IL, USA

Introduction

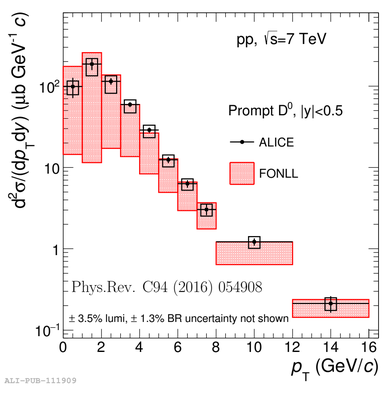

Fig. 1: Prompt D^0 cross section.

D^0 mesons measured down to $p_{T,D} \approx 0$ in pp and p–Pb collisions

- Test **pQCD** at its limits of applicability $Q^2 \approx (m_c c^2)^2 \approx 1\ (\mathrm{GeV})^2$
- Serve as baseline for **QGP** measurements

Jet observables are closer to the parton kinematics than single particles

- Measurement of the c quark **fragmentation**
- Better sensitivity for the **dead-cone effect** in the QGP

ALICE at the LHC

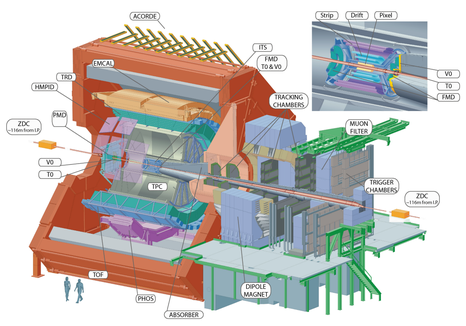

Fig. 2: 3D schematics of the ALICE detector.

- Important features
  - **Particle Identification** (PID) of e, μ, π, K, p, d, ^{3}He
  - **low-momentum tracking** ($p_T > 0.15$ GeV/c)
- **D mesons** via hadronic decays (ITS, TPC, TOF)
  - PID, topological cuts on the decay products
  - invariant mass analysis
- **Jet reconstruction** using anti-k_T algorithm
  - charged constituents (ITS, TPC) $\rightarrow$ *charged jets*
  - add neutral constituents (EMCal, DCal) $\rightarrow$ *full jets*

Results: D^0-Jet p_T-Differential Cross Section

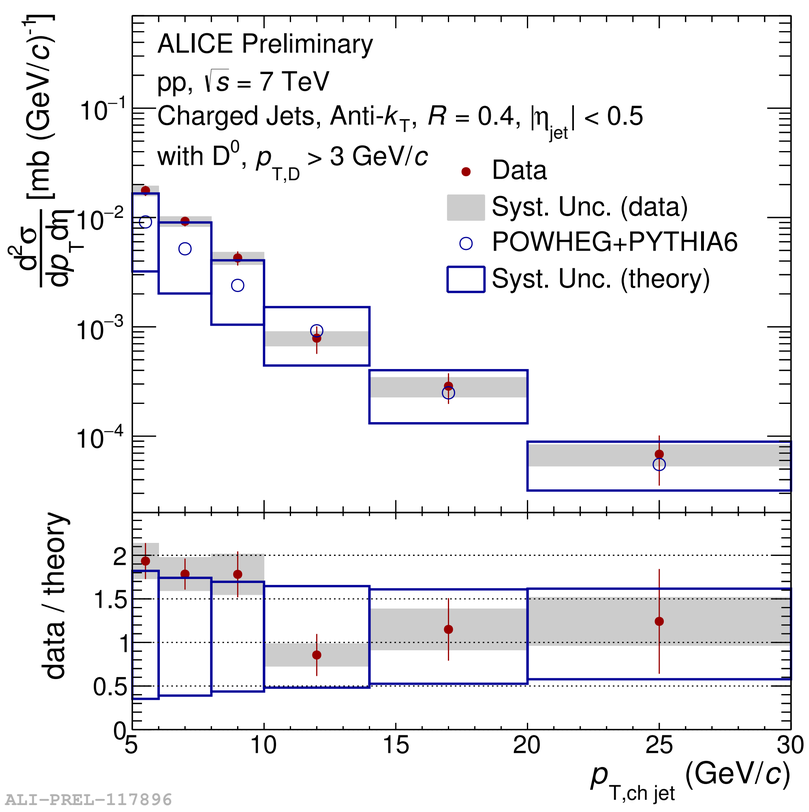

Fig. 3: Prompt charged D^0-jet p_T-differential cross section in pp collisions at $\sqrt{s} = 7$ TeV.

- **pp collisions at $\sqrt{s} = 7$ TeV**
- 355 M minimum-bias events corresponding to $L_{\mathrm{int}} = 5.7\,\mathrm{nb}^{-1}$
- Anti-k_T jet finding algorithm
- Charged constituents, $R = 0.4$
- Charm content tagged with D^0
- B feed-down subtracted using POWHEG+PYTHIA6
- Corrected to particle level

Comparison with predictions from a Monte Carlo generator

- Parton event generator: **POWHEG**
- Shower and hadronization: **PYTHIA6 (Perugia-2011)**

The data is in **good agreement** with predictions from the MC simulation.

Raw Signal Extraction

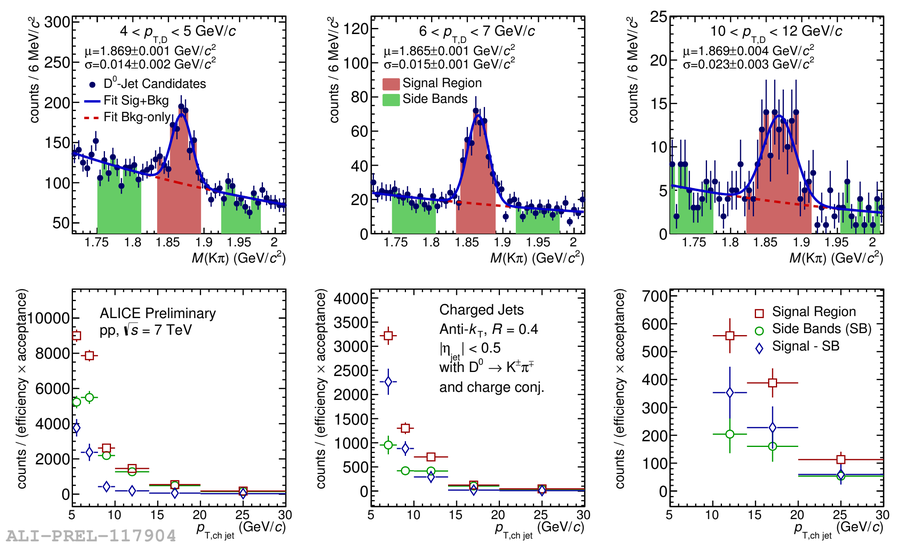

Fig. 4: Top: invariant mass distributions; bottom: jet p_T distributions from signal region and side bands.

- D^0-candidate + all other charged tracks $\xrightarrow{Anti-k_T}$ D^0-jet candidate
- The **invariant mass distributions** of identified D^0-jet candidates are **fit** in bins of $p_{T,D}$ to extract the peak position and width and the background normalization B'
- The $p_{T,\mathrm{ch\,jet}}$ distributions of the **side bands** are subtracted from those of the **signal region** and weighted by the efficiency $\epsilon_{D^0}(p_{T,D})$

$$N(p_{T,\mathrm{ch\,jet}}) = \sum_{p_{T,D}} \frac{1}{\epsilon_{D^0}(p_{T,D})} \cdot [N_{\mathrm{Sign}}(p_{T,D}, p_{T,\mathrm{ch\,jet}}) - B' N_{\mathrm{SB}}(p_{T,D}, p_{T,\mathrm{ch\,jet}})]$$

Detector Performance

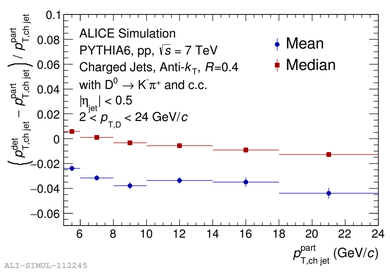

Fig. 5: Mean and median of the JES shift.

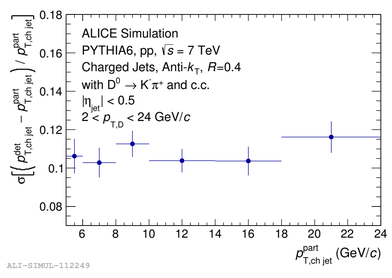

Fig. 8: Jet momentum resolution.

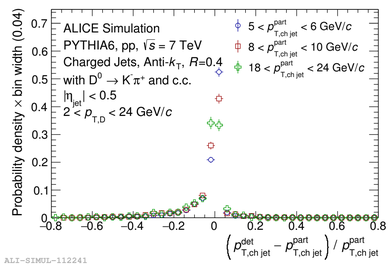

Fig. 6: Momentum shift distribution.

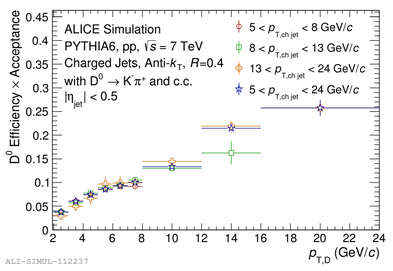

Fig. 7: Efficiency vs. $p_{T,\mathrm{ch\,jet}}$.

- PYTHIA6+GEANT3
- Mean jet energy scale (JES) shift ≈ -3 %
- Jet p_T resolution ≈ 11 %, independent of $p_{T,\mathrm{ch\,jet}}$
- The distribution of the momentum shift features a sharp peak at 0 with a longer tail at negative values (as expected due to tracking inefficiency)
- The D^0 reconstruction efficiency has weak or no dependence on the jet p_T $\rightarrow$ simplifies corrections and reduces systematic uncertainties

B Feed-Down Subtraction

Prompt: fragmentation of a c quark

Non-Prompt: decay of a B hadron

Due to the longer decay length of the B hadrons, the topological cuts are more efficient for non-prompt D^0, thus biasing the relative contributions. We subtract the B feed-down fraction using POWHEG+PYTHIA6.

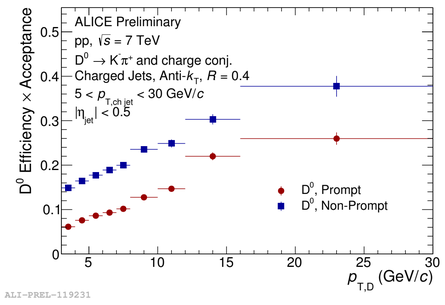

Fig. 9: Reconstruction efficiency.

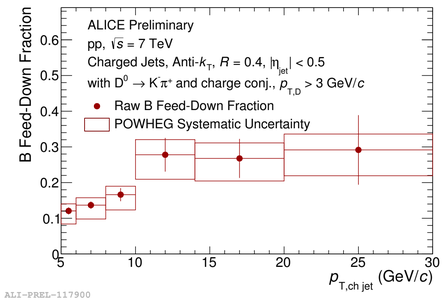

Fig. 10: B feed-down fraction.

Conclusions and Outlook

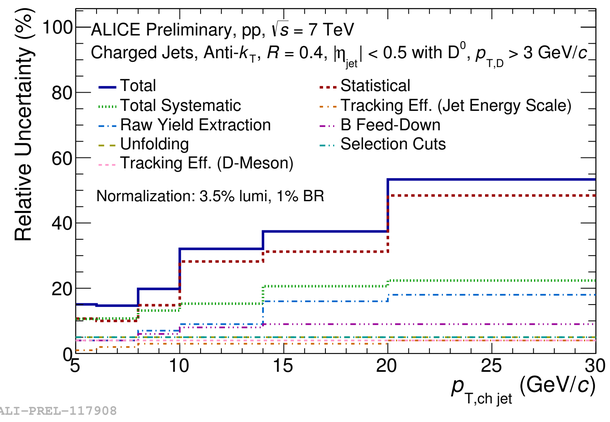

Fig. 11: Relative uncertainties.

- ALICE has measured the cross section of charm (charged) jets tagged with D^0 mesons in pp collisions at $\sqrt{s} = 7$ TeV in the range $5 < p_{T,\mathrm{ch\,jet}} < 30$ GeV/c
- POWHEG+PYTHIA6 is in **agreement with the data**
- Raw yield extraction is the largest systematic uncertainty, but the precision of the measurement is limited by **statistics**
- In the near future we will extend this measurement to the larger datasets at $\sqrt{s} = 8$ and 13 TeV using electromagnetic calorimeters for triggering and full jet reconstruction
- The goal is the measurement of the **fragmentation of charm jets** in an extended kinematic region