Heavy flavor hadrons produced in jets with the ALICE experiment

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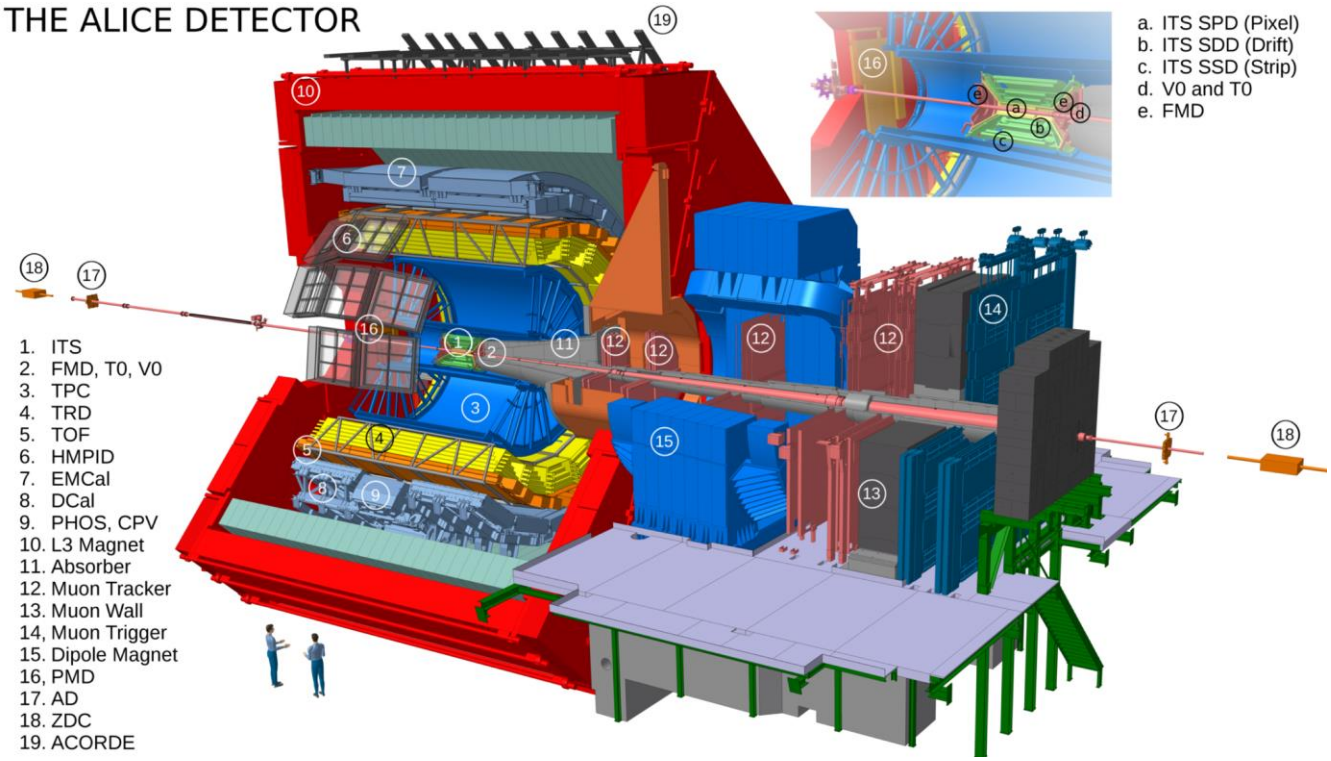
Motivation

- **Heavy flavor hadrons**
  - Heavy quarks (b,c) are mostly produced in hard scatterings at the **initial stage** of the collision
  - measurement down to $p_{\mathrm{D}} \approx 0$
  - Production cross section can be calculated within pQCD
- **HF-tagged jets**
  - Measurement of jets from hard scattering down to very low $p_{\mathrm{T,jet}}$
    - which helps in constraining the **jet background** (even in large systems)
  - Experimental input for gluon-to-hadron Fragmentation Function ($g \rightarrow D^0$) and gluon PDF at low x
  - Quark-enhanced jet sample (w.r.t inclusive jets ⇐ gluon-induced showers)
- **pp**: pQCD test
- **pA**: Cold-Nuclear-Matter effect
- **AA**: Probe of Quark-Gluon Plasma

ALICE Detector

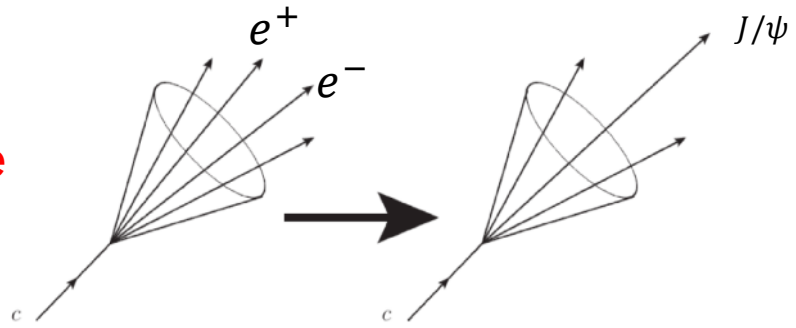


- ITS $|\eta| < 0.9$
  - Vertexing and tracking
- TPC $|\eta| < 0.9$
  - Tracking and PID
- TOF $|\eta| < 0.9$
  - PID
- EMCAL $|\eta| < 0.7$
  - ePID and trigger
- V0 $-3.7 < \eta < -1.7$
  $2.8 < \eta < 5.1$
  - Trigger and background rejection

Analysis Methods

HF-tagged jet reconstruction

- HF hadrons (D, Λ_c, J/ψ) reconstruction with selected channels
- **Replace daughters with hadron candidate**
- Jet clustering with all charged tracks
  - Anti-k_T algorithm, R=0.4

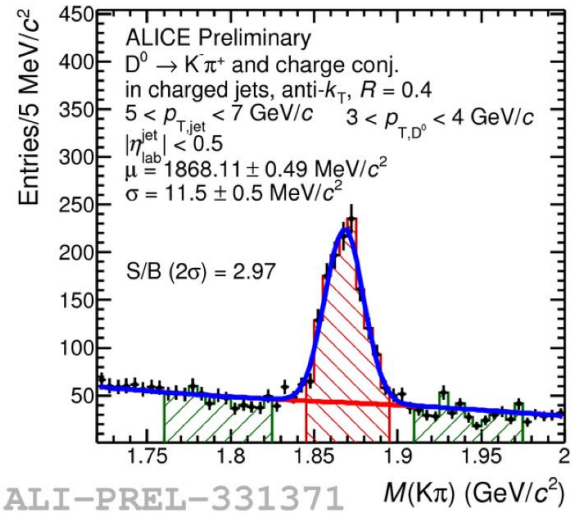


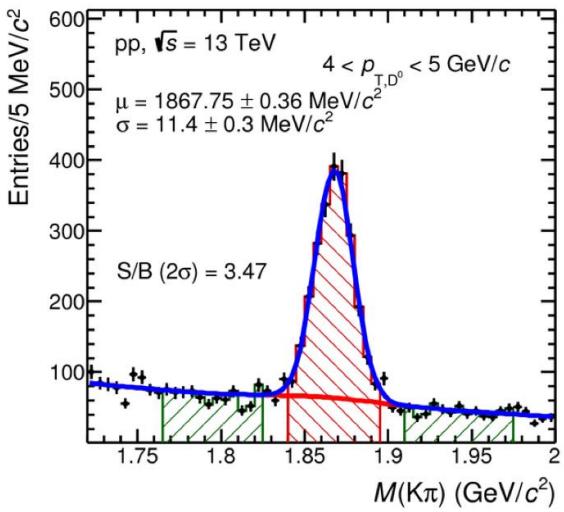
Signal extraction by invariant mass

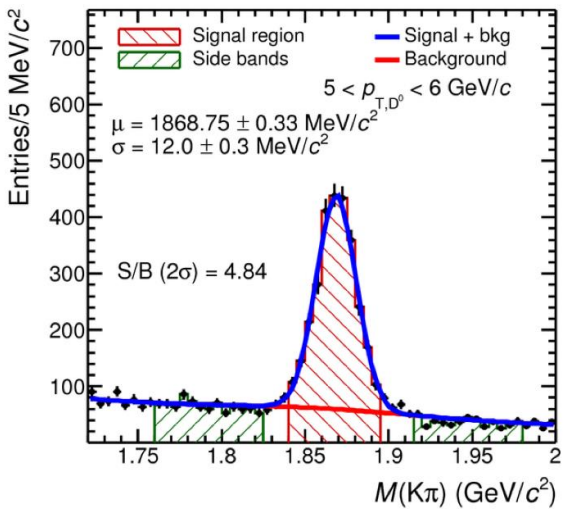
- Fitting raw spectrum
- Side-band method for background subtraction
- Correction on efficiency and beauty feed-down (prompt and non-prompt)
- 2D unfolding $(z, p_{T,jet})$ for detector effect

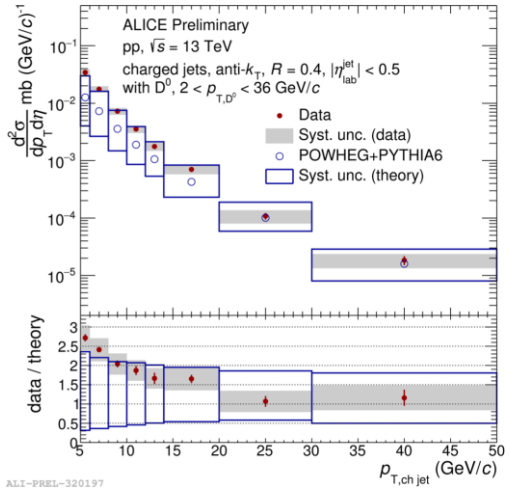
$D^0 \to K^-\pi^+ + conj$ (B.R. 3.89%)
$\Lambda_C^+ \to pK_S^0 + conj.$ (B.R. 1.59%)
$J/\psi \to e^+e^-$ (B.R. 5.97%)

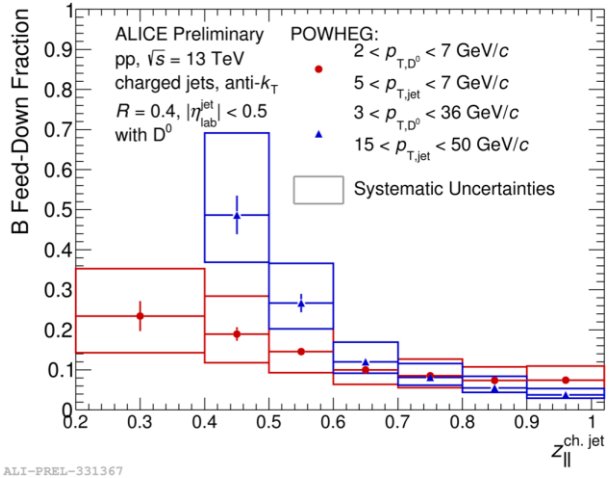
D^0-tagged jet

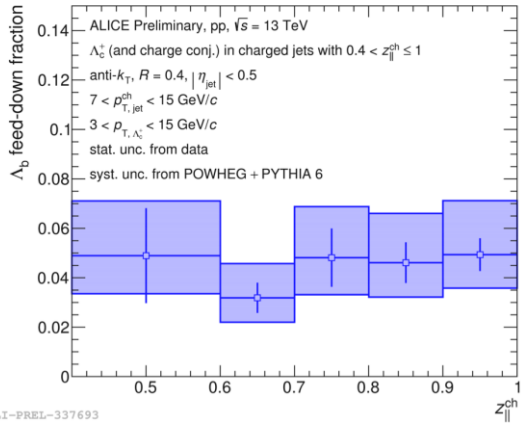






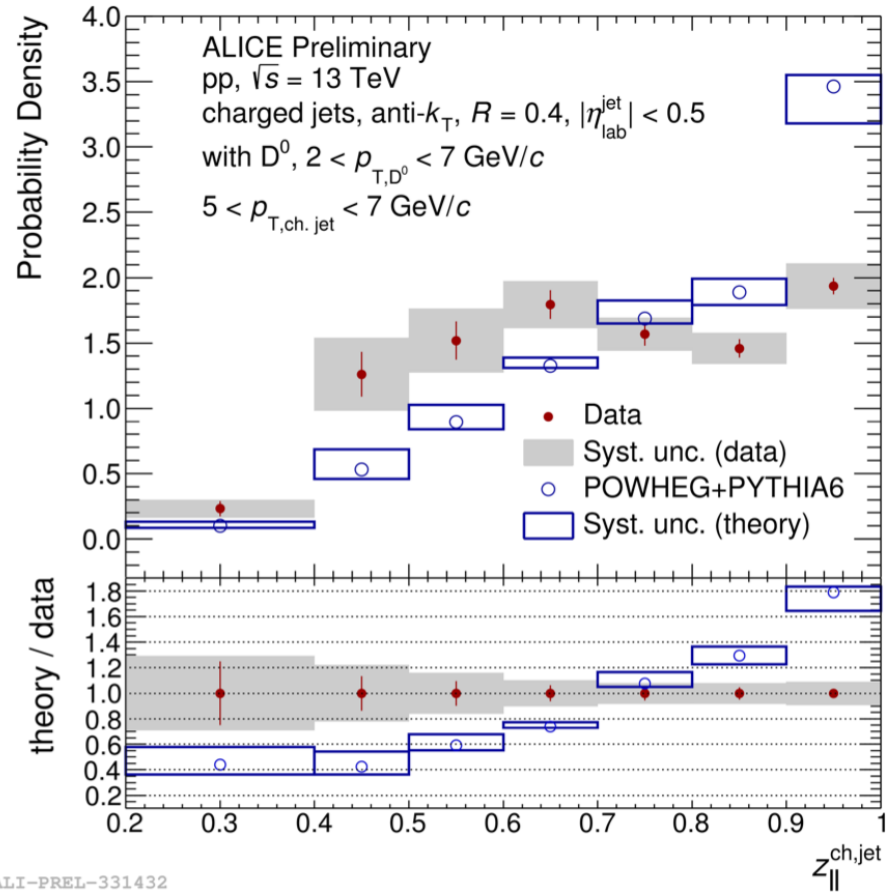


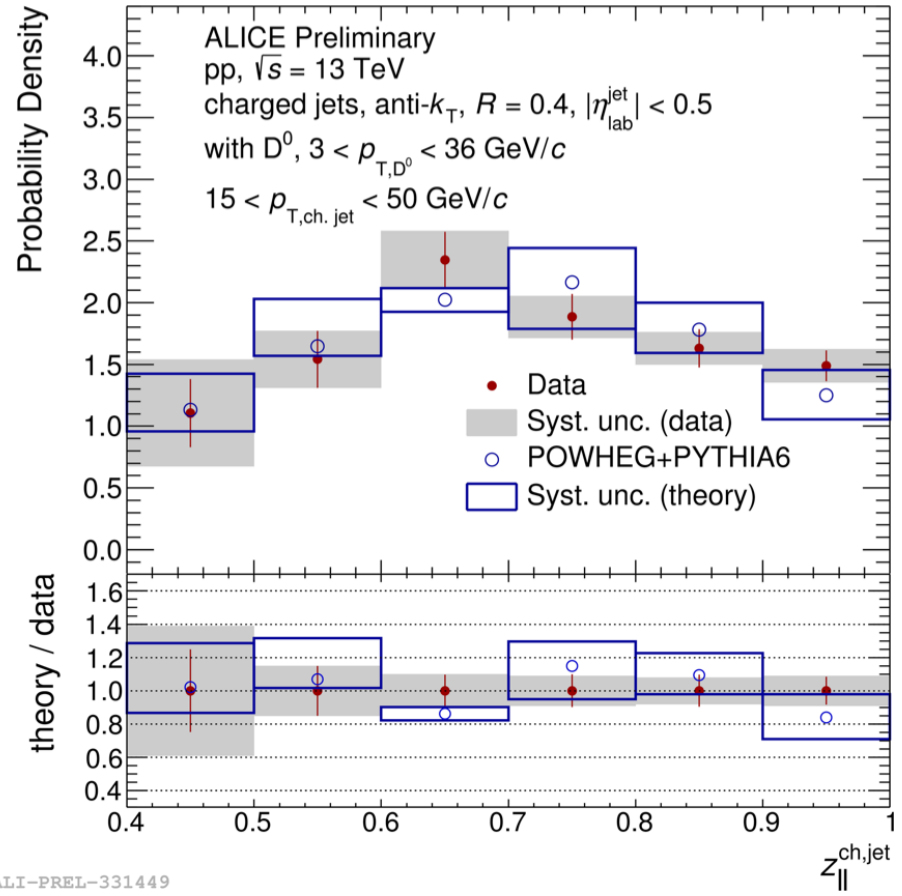




D^0-tagged jet

$z = p_{T,D^0}/p_{T,jet}$





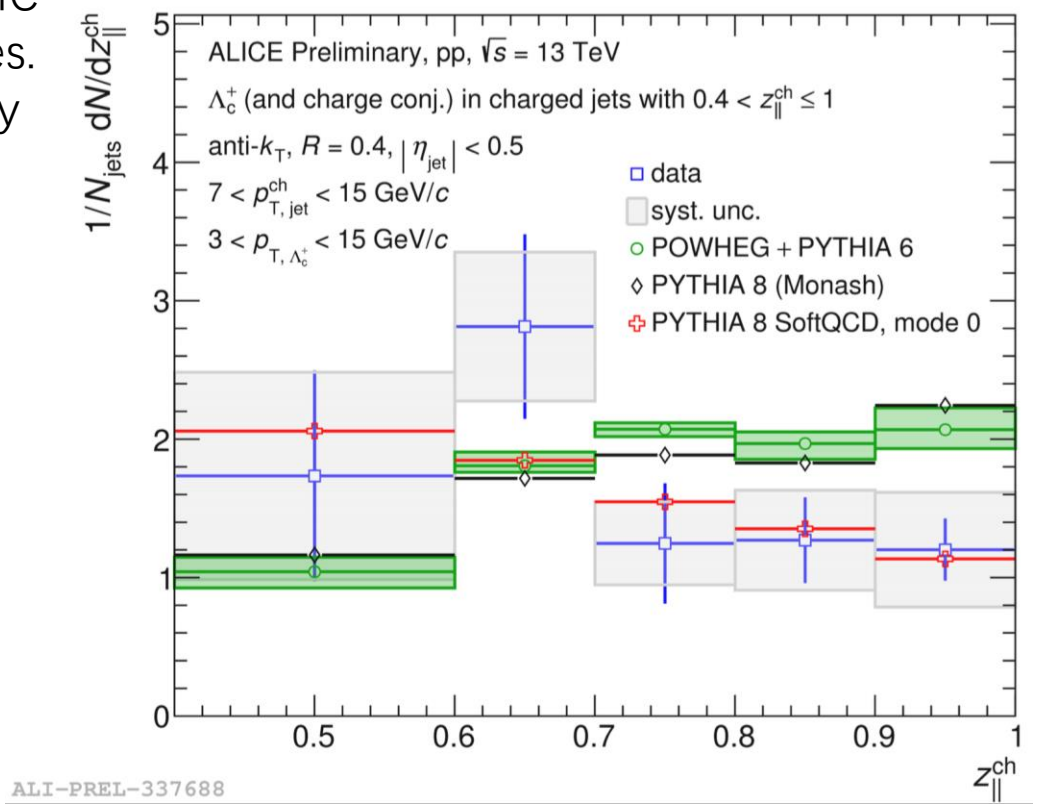
Λ_c^+-tagged jet

$$z = p_{T,\Lambda_c^+} / p_{T,jet}$$

- First measurement of Λ_c^+ in jets at LHC
- Measurement with large uncertainties.
- Exciting prospects for high luminosity LHC run!

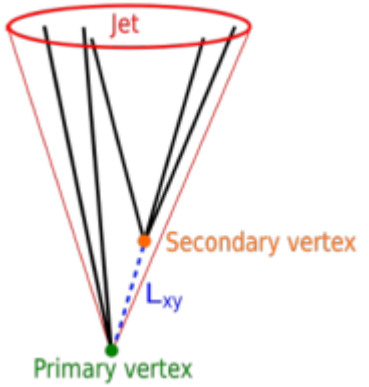
Comparison to model

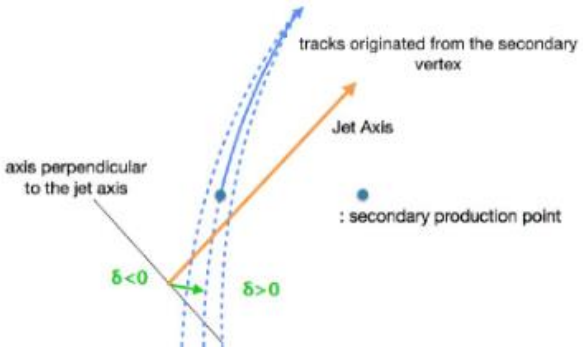
- POWHEG hvq CT10NLO + PYTHIA6
- Softer fragmentation in data
- Seems to favor PYTHIA with softer settings
- Allow to put constrains on models



b-tagged jets

- **Selection**
- Most displaced Secondary Vertex (SV)
  - 3 prongs, p-Pb 2016 data at 5.02 TeV
  - Displacement significance: $SL_{xy} = L_{xy}/\sigma_{L_{xy}}$
  - Dispersion of SV: $\sigma_{SV} = \sqrt{\Sigma_i (d_{0,i})^2}$
- Track counting algorithm
  - Using impact parameter of b-hadrons
  - Evaluate a discriminator $sd_{xy} = sign\left(\overrightarrow{d_{xy}} \cdot \overrightarrow{p_{jet}}\right) d_{xy}$
  - Sort the d_{xy} of the tracks inside the jet in descending order
  - A jet is tagged as a b-jet if the Nth most displaced track with IP larger than a threshold parameter
- Correction
  - Data-driven method for efficiency and purity

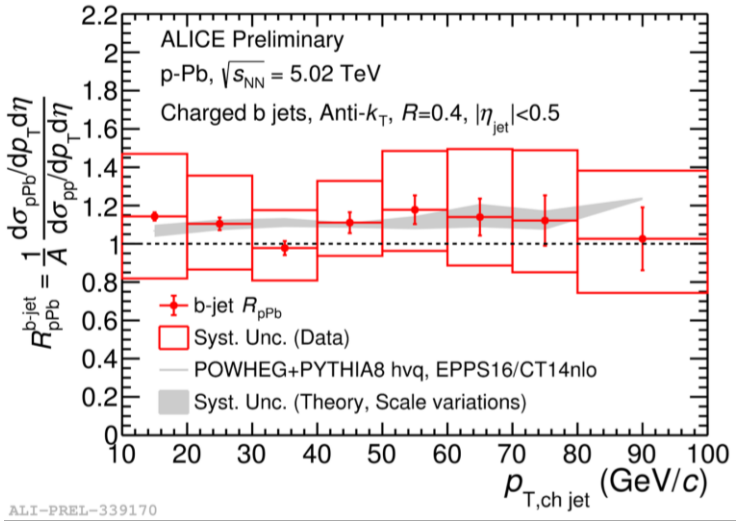


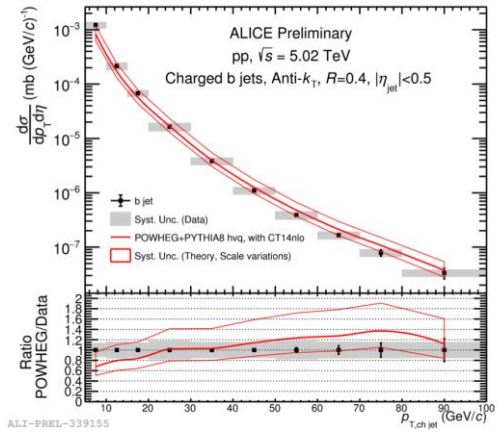


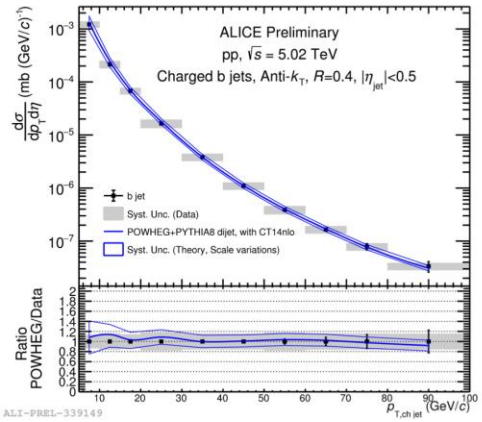
b-tagged jets

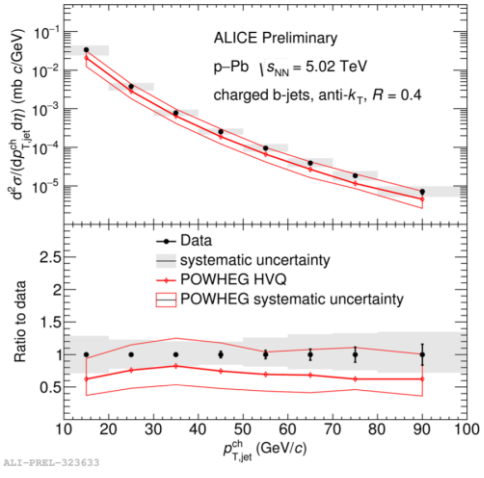
- Cross sections
  - Top: pp 5.02 TeV
  - Bottom: pPb 5.02 TeV
- Model comparison
  - **Red: POWHEG HVQ**
  - **Blue: POWHEG Dijet**

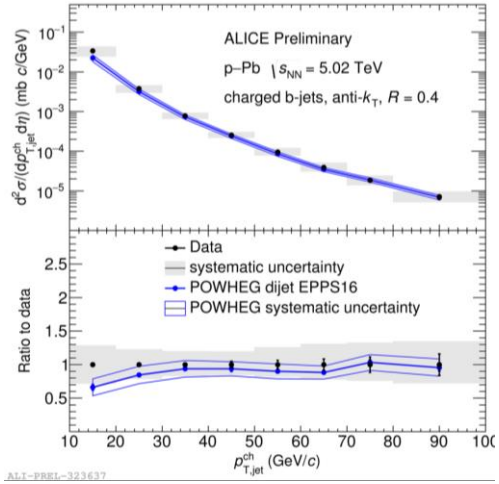
b-jet production is not affected by cold-nuclear-matter effect within the current uncertainties











Summary

- D-tagged jets
  - p_T differential cross-section consistent with theory
  - D-meson jet momentum fraction in pp shows softer fragmentation in data for low $p_{T,jet}$
  - Pb-Pb: analysis ongoing
- Λ_c-tagged jets
  - First measurement at LHC
  - Allow to put constrains on models
- b-jets
  - Good agreement with POWHEG+PYTHIA
  - R_{pPb} indicating no cold nuclear matter effects
- J/ψ-tagged jets
  - Analysis ongoing