Measurements of generalized jet angularities in pp collisions at $\sqrt{s}$ = 5.02 TeV with ALICE

Ezra Lesser for the ALICE Collaboration

Lawrence Berkeley National Lab / UC Berkeley

References

[1] Z. Kang, K. Lee, F. Ringer, JHEP 1804 (2018) 110

[2] G. D'Agostini, arXiv:1010.0632

ALICE Collaboration:

[3] Int. J. Mod. Phys. A 29 (2014) 14300440

[4] JHEP 10 (2018) 139

[5] Phys. Lett. B776(2018) 249-264

Physics Motivation

- **Jets** are formed from initial hard-scattered q or g in nucleon and are sensitive to higher-order effects after initial scattering
- Provide direct probe of perturbative & non-perturbative QCD
- The generalized angularities λ_α^κ are a class of **jet substructure** observables dependent on p_T and angular distributions of tracks within jets

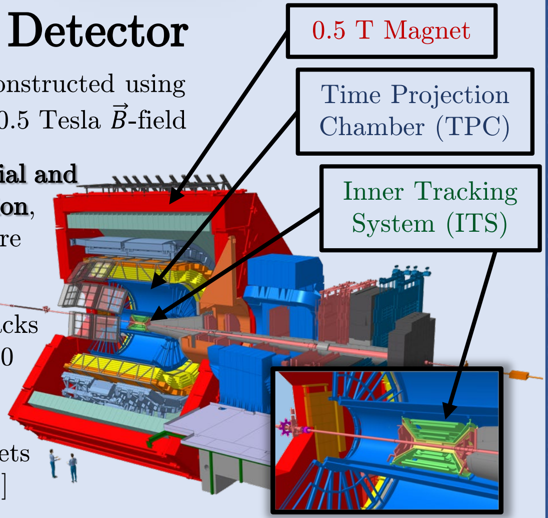
$$\lambda_\alpha^\kappa \equiv \sum_{i\in \text{jet}} \left(\frac{p_{\mathrm{T},i}}{p_{\mathrm{T,jet}}}\right)^{\kappa} \left(\frac{\Delta R_{\mathrm{jet},i}}{R}\right)^{\alpha}$$

Continuous, tunable parameters (κ, α)

- **IRC-safe** observable for $\kappa = 1$, $\alpha > 0$ → can directly compare shapes to theoretical predictions for different jet radius R [1]

The ALICE Detector

- Charged tracks reconstructed using ITS and TPC in a 0.5 Tesla $\vec{B}$-field
- **High-precision spatial and momentum resolution**, ideal for substructure measurements
- Measurement of tracks with p_T down to 150 MeV/c → unique ability to study low-p_T tracks and jets at LHC energies [3]



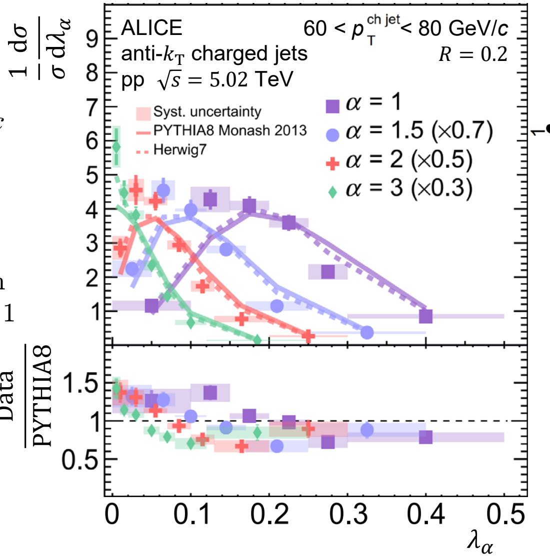
Analysis Method

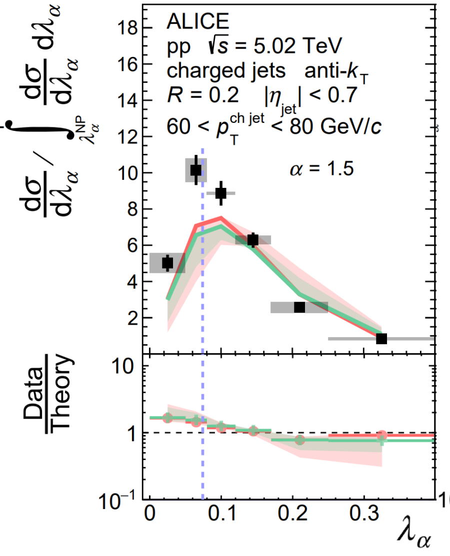
- Reconstruct charged particle jets using the anti-k_T algorithm with radius $\boldsymbol{R = 0.2, 0.4}$ in the E recombination scheme
- Choose observables to be $\boldsymbol{\kappa = 1}$ **and** $\boldsymbol{\alpha \in \{1, 1.5, 2, 3\}}$
  - $\alpha = 1$ → λ_α = jet girth g;
  - $\alpha = 2$ → λ_α = (jet mass)^2 / $(p_{\mathrm{T,jet}}^{\mathrm{ch}})^2$
- Create 4D response matrix ($p_{\mathrm{T,jet,det}}^{\mathrm{ch}}$, $p_{\mathrm{T,jet,tru}}^{\mathrm{ch}}$, $\lambda_{\alpha,\mathrm{det}}$, $\lambda_{\alpha,\mathrm{tru}}$) using PYTHIA 8 Monash 2013 processed by GEANT 3 simulation
- **Unfold measured distributions** with 2D iterative Bayesian procedure [2] to account for finite tracking efficiency, particle-detector interactions, and track p_T resolution

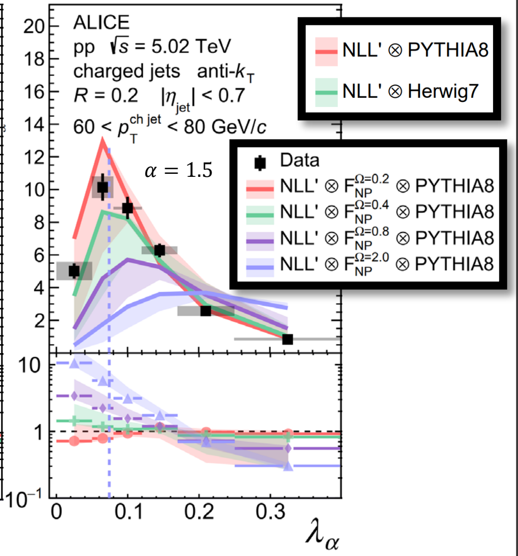
Results

- Results measured in four p_T bins: 20-40, 40-60, 60-80, and 80-100 GeV/c
- Distributions are strongly peaked at lower λ_α for larger values of α and jet radius R
- **Data distributions slightly shifted** with respect to PYTHIA (normalization to 1 demands suppression & enhancement)

  → more/less p_T **collimated/at edges**
- Comparisons to NLL′ predictions
  - Good agreement seen with data
  - **Tests of universality for Ω**







Outlook

- This measurement is a reference for **quenched jet measurements** in heavy-ion collisions
  - Probe QCD medium via induced jet shape modifications
  - Statistically significant modifications were seen in ALICE heavy-ion collisions for $\alpha = 1$ [4] but not for $\alpha = 2$ [5]
  - A wider set of tests will be provided for comparison to existing phenomenological models of the quark-gluon plasma