Reconstruction of beauty jets in proton-proton collisions at $\sqrt{s} = 13$ TeV with ALICE

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Motivation and Introduction

- b-jet cross section is important ingredient for testing predictions by quantum chromodynamics for production and fragmentation of heavy flavours
- heavy flavours are good probes for investigating properties of the quark-gluon plasma
- ALICE can measure the b-jet production down to low jet momentum due to excellent tracking capabilities

The analysis in short:
- ALICE data for pp collisions at 13 TeV with a luminosity of about $11\text{nb}^{-1}$ are analysed
- b-jet selection (“tagging”) based on impact parameter of tracks within jets
- performance estimation via template fits to jet probability distributions in data
b-Jet Selection

- B hadrons exhibit long lifetimes ($\sim 500 \mu m$)
- secondary vertex of B hadron decays well separated from primary collision vertex (PV)
  $\rightarrow$ b jets tend to contain tracks with large transverse impact parameter significance $S_{d_{xy}}$

In this analysis:
- b jets defined as jets with a b quark within the jet cone
- tracks within jets are ordered such that their $S_{d_{xy}}$ values are decreasing
- threshold selection based on $S_{d_{xy}}$ of tracks with the largest and second largest $S_{d_{xy}}$ within a jet

**Definition of $S_{d_{xy}}$**

$$S_{d_{xy}} = |\vec{d}_0| \text{sign}(\vec{d}_0 \cdot \vec{e}_\text{Jet}) / \sigma(\vec{d}_0)$$

- $\vec{d}_0 =$ transverse impact parameter in $xy$-plane
- $\vec{e}_\text{Jet} =$ vector of the jet axis
- $\sigma(\vec{d}_0) =$ impact parameter resolution
Performance Correction of b-Jet Spectrum

- jet probability $JP$: measure probability that jet originates from PV 
  $\rightarrow -\ln(JP)$ distributions have wider tails than light-flavour or c jets

1. simulated $-\ln(JP)$ distributions for different jet flavours using PYTHIA 8+GEANT 3
2. performed template fits to the data before and after the b-jet selection for every bin of the jet momentum $p_{T,\text{ch jet}}$

Definition of $-\ln(JP)$

$$JP = \prod \times \sum_{k=0}^{N_{\text{tracks}}-1} \frac{(-\ln \prod)^k}{k!}, \quad \prod = \prod_{i=1}^{N_{\text{tracks}}} P_{tr,i}(S_{d_{xy},i})$$

with $P_{tr}(S_{d_{xy},i}) = \int_{-\infty}^{0} R(I) \, dI / \int_{-\infty}^{0} R(I) \, dI$

- only tracks with $S_{dxy} > 0$ are accepted for $-\ln(JP)$ calculation
- resolution function $R(I) = \text{negative side of } S_{d_{xy}} \text{ distribution for inclusive jets}$
Performance Correction of b-Jet Spectrum

3. calculated efficiency $\epsilon_b$ and purity $p_b$ via b-jet fractions obtained from fit results:

$$
\epsilon_b = C_b \frac{f_{b}^{\text{tag}}}{f_{b}^{\text{untag}}} \frac{N_{\text{tag}}}{N_{\text{untag}}}, \quad \text{and} \quad p_b = f_{b}^{\text{tag}}
$$

$f_{b}^{\text{tag}}$, $f_{b}^{\text{untag}}$ and $N_{\text{tag}}$, $N_{\text{untag}}$ = b-jet fractions and number of events in tagged and untagged sample.

$C_b$ = fraction of b-jets with well defined $-\ln(JP)$.

→ tagging purity is about 40\%, efficiency about 50\%.

4. obtained fully corrected spectrum via

$$
\frac{d\sigma_{\text{ch, b jet}}}{dp_{T,\text{ch jet}}} = \frac{\sigma_{V0}}{N_{\text{ev}}} \cdot \text{Unfolded} \left( \frac{dN_{\text{raw \ ch, b-jet}}}{dp_{T,\text{ch jet}}} p_b, \epsilon_b \right)
$$

$\sigma_{V0}$ = reference cross section, $N_{\text{ev}}$ = number of events,

$dN_{\text{raw \ ch, b-jet}}/dp_{T,\text{ch jet}}$ = raw b-tagged spectrum.
• b-jet production measured in pp collisions at $\sqrt{s} = 13$ TeV larger by about a factor of 2-6 from low to large $p_{T,\text{ch jet}}$ with respect to measurements at 5.02 TeV

• fraction of b jets over inclusive jets compatible for 13 TeV and 5.02 TeV data