LHCb cross-section measurements with heavy flavour jets

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Cross-section measurements of jets originating from the hadronization of beauty (b) and charm (c) quarks at LHCb give the unique opportunity to probe Parton Distribution Functions (PDFs) at low and large momentum fraction and to test the Standard Model in the forward region.
- The measurement of the $Z\rightarrow b\bar{b}$ cross-section validates the tools developed for the study of b-quark jets at LHCb
- The production of t\bar{t} pairs in the forward region can be sensitive to physics beyond the SM
- The measurement of the $W^{+}b\bar{b}$ and $W^{+}c\bar{c}$ cross-sections provides an experimental tests of the perturbative Quantum Chromodynamics (pQCD)

Beauty and charm quark jets identification

Jet reconstruction
- Well contained forward jets $2.2 < \eta < 4.2$
- Particle flow combines tracking and calorimeter information
- Reconstruction performed with anti-kT with $R=0.5$
- Jet energy scale
- Jet energy resolution $\Delta E/E \sim 10\%$

Jet flavor tagging
- Find a secondary vertex (SV) in the jet cone
- Boost Decision Tree (BDT) to separate \texttt{b}c and b	exttt{c}light quark jets
- 65% (25%) efficiency for identifying a b(c) quark jet

Measurement of the $Z\rightarrow b\bar{b}$ cross-section and determination of the b-jet energy scale

The observation for the $Z\rightarrow b\bar{b}$ decay at hadron collider is challenging:
- huge background from QCD dijet production
- lacking of discriminant variables

But it is a unique tool to:
- validate the b-jet reconstruction
- determine the b-jet energy scale
- search for other $b\bar{b}$ resonances

Analysis main steps:
- two b-tagged jets+an additional jet, recoiling against the $Z$, are required
- a multivariate technique (MVA) is employed to define a discriminator variable that is uncorrelated with the dijet invariant mass
- the MVA output is used to define a signal region and a control region
- simultaneous fit to the dijet invariant mass distribution in signal and control regions

Results
- MCFM CT10

The signal yield is determined with a four-dimensional simultaneous fit. Variables to separate $t\bar{t}$, $W^{+}b\bar{b}$ and $W^{+}c\bar{c}$:
- the mass of the dijet system $m_{jj}$
- a multivariate discriminant, $u_{GB}$, constructed such that its response is minimally correlated with $m_{jj}$
- the SV-tagger algorithm response variable $j_{1}$ BDT(b/c) and $j_{2}$ BDT(b/c)

The analysis in a nutshell:
- LHCb Run I sample at a centre-of-mass energy of 8 TeV
- Integrated luminosity of 1.98 fb$^{-1}$
- One high-p$_{T}$, isolated lepton and two heavy flavour tagged jets

The background sources include:
- $Z^{\pm\pm}b\bar{c}$
- $ZZ$W
- Single top
- QCD multi-jet

The templates are taken from MC and the normalizations are obtained from NLO cross-section, except for the QCD multi-jet where a data-driven procedure has been used.

The data sample is split into four subsamples, according to the flavour and charge of the lepton ($\mu^{\pm}$ and $e^{\pm}$)

The production of $W^{+}b\bar{b}$ and $W^{+}c\bar{c}$

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