Measuring the b-jet tagging efficiency on c-jets containing D^{*+} mesons with ATLAS data

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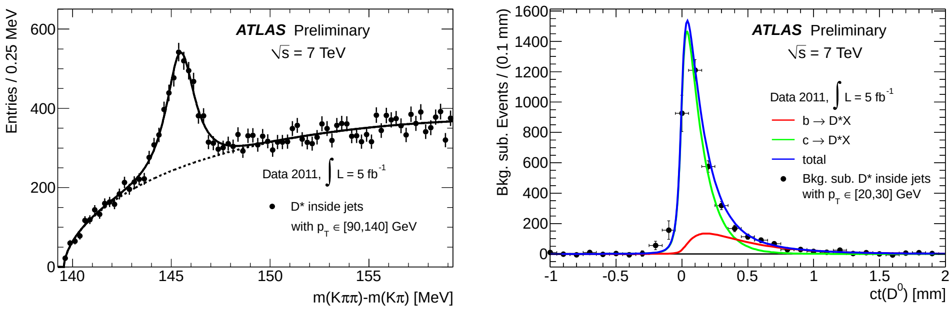
1 Introduction

The identification of jets originating from b-quarks (b-tagging) is a crucial tool for the ATLAS [1] physics program at the LHC, both for precision measurements and in searches for new particles. One important ingredient when using b-tagging in physics analyses is the determination of the probability to mistakenly b-tag a jet originating from a c-quark (c-tag efficiency). The optimal sample for measurements of the c-tag efficiency would be a clean sample of jets originating from c-quarks. The sample of jets associated to reconstructed D^{*+} mesons (through the decay chain $D^{*+} \to D^0\pi^+ \to K^-\pi^+\pi^+$) is quite close to this ideal case since most D^{*+} mesons originate from c-quark hadronization. The c-tag efficiency has been measured by comparing the reduction in the yield of D^{*+} mesons before and after the b-tagging requirement of the associated jet. The contamination from D^{*+} mesons that originate from b-hadron decays has been taken into account using a fit to the D^0 pseudo-proper time distribution.

2 Flavour composition and c-tag efficiency

The data sample has been collected by ATLAS during 2011, using events selected by single jet triggers, and corresponds to a total integrated luminosity $\mathcal{L} \simeq 5$ fb^{-1}. Signal and background regions are defined as the region within 3σ of the Δm peak center and the region above 150 MeV respectively (Fig. 1a).

The discriminating variable to identify beauty and charm components is the D^0 pseudo-proper time: $t(D^0) = \mathrm{sign}(\mathbf{L_{xy}} \cdot \mathbf{p_T}(\mathbf{D^0})) \cdot m_{D^0} \cdot \frac{L_{xy}(D^0)}{p_\mathrm{T}(D^0)}$. The beauty component $F_b(t)$ is modelled as the convolution of two exponential functions with the resolution function, while the charm component $F_c(t)$ is modelled as a single exponential function convolved with the resolution. The beauty component f_b is fitted as: $F(t) = f_b \cdot F_b(t) + (1 - f_b) \cdot F_c(t)$. The fit is done on background subtracted data (Fig. 1b), obtained by subtracting the background $t(D^0)$ distribution, normalized to the fitted background fraction in the Δm signal region, from the signal $t(D^0)$ distribution.



(a) (b)

Figure 1: (a) Δm distribution of the D^{*+} candidates associated with a jet of transverse momentum between 90 and 140 GeV. (b) Fitted D^0 pseudo-proper time distribution on background subtracted D^{*+} samples in jet p_{T} bin 20–30 GeV [3].

The c-tag efficiency can be obtained as: $\epsilon_c = \frac{\epsilon_{D^*} - f_b \epsilon_b}{1 - f_b}$, where f_b is the fitted beauty fraction, ϵ_{D^*} accounts for the D^* mesons yield reduction when applying the b-tagging selection, and ϵ_b is the b-tagging efficiency measured by independent analyses [2]. Results are presented for the MV1 tagging algorithm at 70% efficiency (Fig. 2). A complete list of results and systematic uncertainties is available in [3]. Scale factors ($SF = \epsilon_c^{\mathrm{data}} / \epsilon_c^{\mathrm{sim}}$) are consistent with unity for all the taggers and operating points with uncertainties varying, depending on the jet p_{T}, from 10% to 40%.

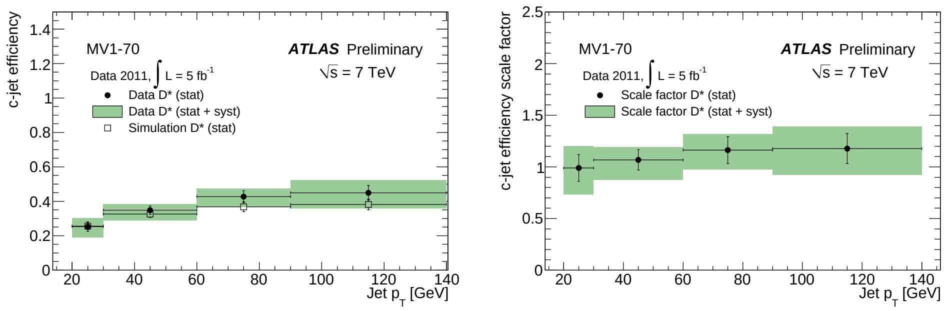


Figure 2: The c-tag efficiency in data and simulation (left) and the data-to-simulation scale factor (right) [3].

References

[1] ATLAS Collaboration, JINST **3** S08003 (2008).

[2] ATLAS Collaboration, ATLAS-CONF-2012-043, http://cdsweb.cern.ch/record/1435197.

[3] ATLAS Collaboration, ATLAS-CONF-2012-039, http://cdsweb.cern.ch/record/1435193.