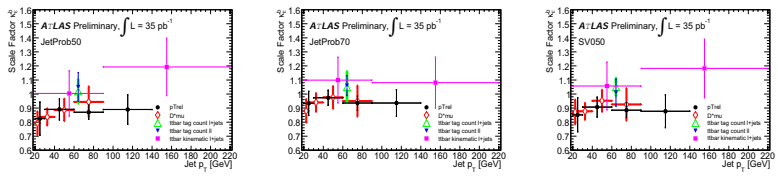
Measuring the b-tagging Performance with ATLAS Data

Nancy Tannoury, for the ATLAS Collaboration
Centre de Physique des Particules de Marseille, FRANCE

The the identification of jets originating from b-quarks, called b-tagging, is an important part of the LHC physics program. Most b-tagging algorithms exploit the relatively long lifetime of the b-hadron, resulting in a second vertex which is significantly displaced from the primary interaction point. For early 2010 data, two simple b-tagging algorithms, reffered as "early taggers algorithms" were easily commissioned: JetProb [1] and SV0 [2]. In order for b-tagging to be used in physics analyses, the efficiency with which a jet originating from a b-quark is tagged by a b-tagging algorithm needs to be measured, as well as the probability to tag a jet originating from a *light*-flavour jet, referred to as the mistag rate. The calibration results are presented as scale factors defined as the ratio of the b-tagging efficiency or the mistag rate in data and simulation. The two early taggers were calibrated using several methods in ATLAS: a 50% and a 70% b-tagging efficiency working points for JetProb (JetProb50 and JetProb70) and a 50% b-tagging efficiency working point for SV0 (SV050).

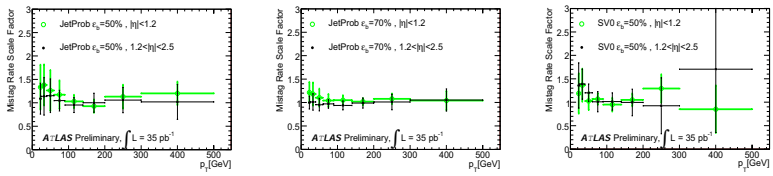
One way to measure the b-tagging efficiency is by using muon-jets. Though muons come from other sources, a major source comes from the semi-leptonic decay of the b or c-quarks resulting from the b-quark decays. The b-tagging efficiency can be measured by using the momentum of the muon transverse to the combined muon+jet axis, the p_T^{rel} [3] method, or by selecting events with a specific finale state of b decays with an exclusevily reconstructed D^{*+} meson with an associated opposite charge muon, the $D^*\mu$ [3] method. The data-to-simulation scale factors for the p_T^{rel} and the $D^*\mu$



(a) (b) (c)

Figure 1: The measured b-tagging efficiency scale factors [3] for the p_T^{rel}, $D^*\mu$ and $t\bar{t}$ methods for the JetProb50 1a, JetProb70 1b and SV050 1c.

methods for the two early tagging algorithms are presented in Fig. 1.
Another way to measure the b-tagging efficiency is to rely on the $t\bar{t}$ events: each $t\bar{t}$ event has two b-jets since the $\mathrm{Br}(t \rightarrow Wb) = 1$. The use of $t\bar{t}$ events allows the measurements of the b-tagging efficiency for a higher range of the jet p_T w.r.t. muon-jets based methods. The b-tagging efficiency can be extracted from $t\bar{t}$ events by two ways: either by counting the number of events with different numbers of b-tagged jets, the *Tag Counting* [3] method, or by reconstructing and selecting the $t\bar{t}$ decay topology in order to identify a pure sample of b-jets, the *Kinematic Selection* [3] method. The data-to-simulation scale factors for both $t\bar{t}$ methods are shown in Fig. 1.
The mistag rate has been measured using two independent methods: the first uses the invariant mass of charged particles associated with the inclusively reconstructed secondary vertex, the *SV0 Mass* [3] method, and the second one uses the negative tag (in impact parameter or in decay length) which describes the effects of a limited resolution on prompt tracks, the *Negative Tag* [3] method. The combined results of the two methods are shown in Fig. 2 for two pseudorapidity regions.



(a) (b) (c)

Figure 2: The data-to-simulation scale factors [3] for the combined results of the SV0 mass and negative tag methods for the JetProb50 2a, JetProb70 2b and SV050 2c.

The early taggers were successfully calibrated in 35 pb^{-1} of Data with the ATLAS Detector using several independent methods, and they were used by many physics analyses. However, the performace of the ATLAS b-tagging can be significantly improved by the use of more sophisticated tagging algorithms that are being prepared.

References

[1] The TrackCounting and JetProb algorithms(ATLAS-CONF-2010-041) https://cdsweb.cern.ch/record/1277681

[2] Secondary Vertex b-tagging Algorithm (ATLAS-CONF-2010-042) https://cdsweb.cern.ch/record/1277682

[3] Calibrating the b-Tag Efficiency and Mistag Rate in 35 pb^{-1} of Data with the ATLAS Detector (ATLAS-CONF-2011-089)https://cdsweb.cern.ch/record/1356198