b-jet cross section measurement using muon p_T^{rel}

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on behalf of the *b*-jet cross section in muon-jets group

(and direct input from Sahar Aoun, Johanna Fleckner, Nancy Tannouri)

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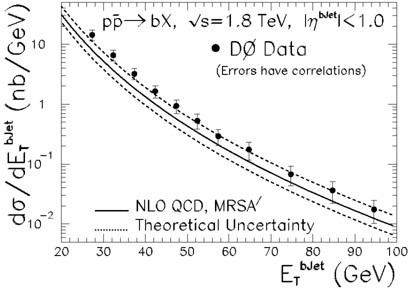
The measurement

$$\frac{d\sigma}{dp_T^{bjet}} = \frac{F_b(p_T^{bjet})N^{jets}}{2\mathcal{L}\epsilon(p_T^{\mu}, p_T^{bjet})} \frac{1}{\Delta p_T^{bjet}}$$

- F_b: b fraction in the sample;
- N^{jets}: total number of jets per p_T bin;
- 2: charge correction to take into account both positive and negative muons;
- $\mathcal{L} = 2.85 \times 10^3\ \text{nb}^{-1}$;
- ϵ: overall efficiency;
- Δp_T^{bjet}: p_T bin width;
- 3 bins considered for this measurement: 25, 40, 60 and 85 GeV.

b-jet cross section measurement by the DØ experiment from semi-leptonic b decays



Fixing the boundary conditions

Aka sample selection

Data and MC selection:

- data: periods from A to F corresponding to $\mathcal{L} \sim 3$ pb^{-1};
- MC: inclusive dijet (JX samples) and dijet muon filtered at the generator level (JX muFIXED samples);

Event selection:

- official GRL from top group;
- reconstructed primary vertex with at least 10 tracks;
- jet cleaning cuts applied;
- muon-jet geometrical matching requiring $\Delta R < 0.4$.

Trigger selection:

- requiring trigger EF_mu4_L1J10_matched to be firing;
- topological HLT algorithm that matches a LVL2 combined muon with a LVL1 jet requiring a geometrical matching $\Delta R < 0.4$ to be satisfied;
- allows to select offline muon-jet candidates with a low p_T jet.

Measuring the b-fraction

Data-driven methods

Two complementary methods to derive the b fraction component of the jet sample.

- both methods select a sample of muon-jet candidates needed for b-tagging calibration studies;
- both determine the b-jet fraction of the selected sample;
- thus the inclusive cross section can be obtained by adding overall efficiency and integrated luminosity.

Measuring the b-fraction

Data-driven methods

Two complementary methods to derive the b fraction component of the jet sample.

p_T^{rel}

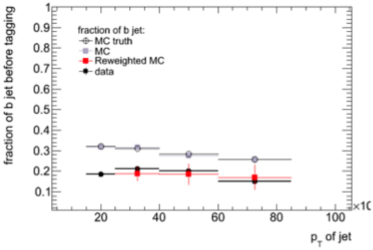
- muon momentum relative to the jet axis $p_T^{rel} = p_\mu \times \sin(\theta)$;
- distribution has different shapes for light, c and b-jets;
- range between 25 and 85 GeV (not for higher p_T values due to the jet angular resolution growth with the muon momentum).

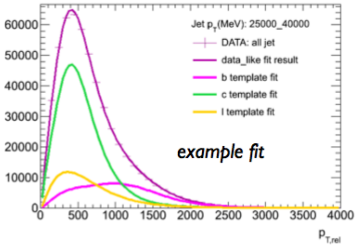
System8

- based on a analytically solvable system of 8 equations;
- uses two low-correalted taggers (soft muon and lifetime) on two samples with different b content to correlate the tagger efficiencies with the numbers of tagged and untagged jets in the sample;
- wider p_T range but more difficult to commission.

Measuring the b-fraction

Using the p_T^{rel} method



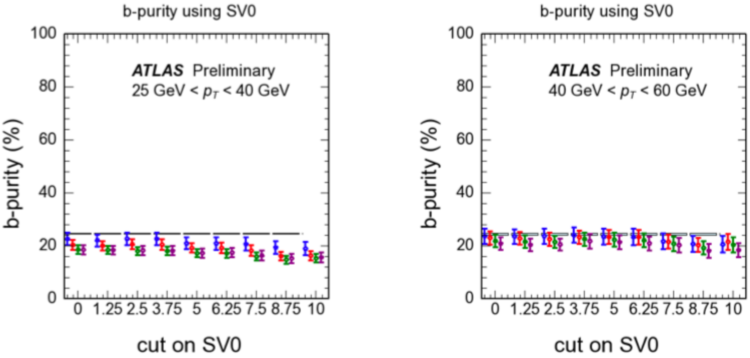


- 3 different methods developed and applied;
- useful for systematic studies.

b fraction before tagging	Method I	Method II	Method III
$25 < p_T < 40$	21.3 ± 0.10	24.7 ± 0.2	22 ± 0.6
$40 < p_T < 60$	20.1 ± 0.08	$24.4. \pm 0.4$	21.6 ± 1.3
$60 < p_T < 85$	15 ± 1	20.4 ± 1.8	20.3 ± 4.0

Measuring the *b*-fraction

Using the System8 method



- method is being validated but results are promising;
- more MC statistics is needed and is coming soon.

Measuring the μ-jet efficiency

Again data-driven method

Basic idea is to compute:

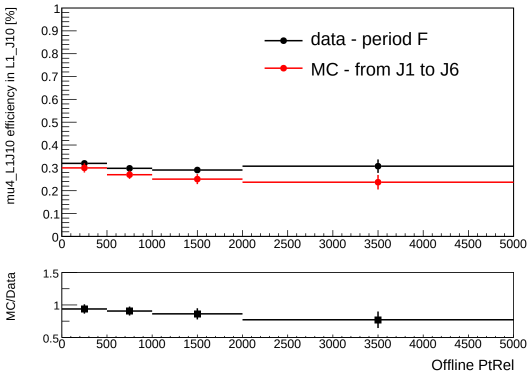
$$\epsilon(mu4\_JXX|JXX) = \frac{N(mujet\ in\ mu4\_JXX\_matched)}{N(mujet\ in\ JXX)}$$
$$\epsilon(mu4\_JXX) = \epsilon(mu4\_JXX|JXX)\epsilon(JXX)$$

Since we are interested in the trigger efficiency for this analysis $JXX = J10$ and since we are interested only in the efficiency for *b*-jets:

- measure the above ratio as a function of p_T^{rel};
  1. the ratio is constant: this means that the efficiency doesn't depend on flavour;
  2. the ratio is not constant: different efficiency for b/c/light jets $\Rightarrow$ need to fit the number of b-jets on mu4_JXX and on JXX samples and then compute the ratio.

Measuring the μ-jet efficiency

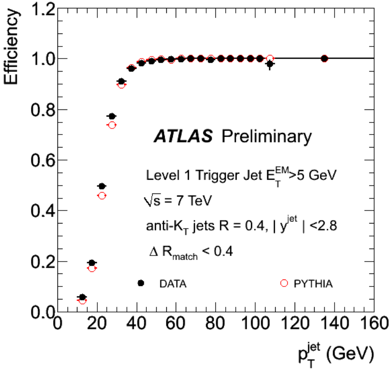
Main results

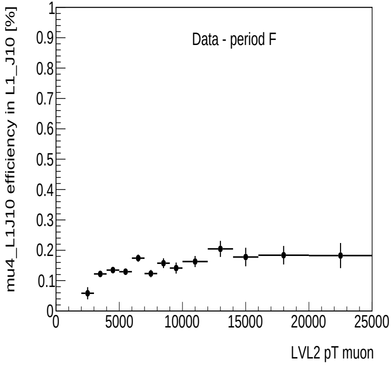


- mu4_L1J10 trigger efficiency in a L1_J10 sample containing offline muon-jet candidates in data and MC;
- the efficiency versus p_T^{rel} indicates no particular dependence on the jet flavor.

Measuring the μ-jet efficiency

Main results





- LVL1 jet item efficiency (left) and mu4_L1J10 trigger efficiency in a L1_J10 sample containing offline muon-jet candidates versus the LVL2 p_T muon (right);
- final trigger efficiency numbers will be released in jet E_t and muon p_T bins.

Systematic uncertainties

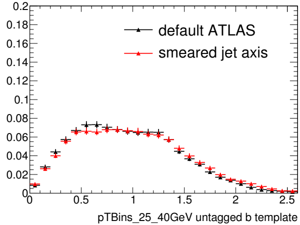
A walkthrough

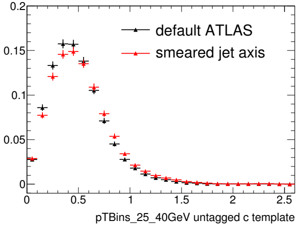
Systematic effects studies started and not yet completed. So far:

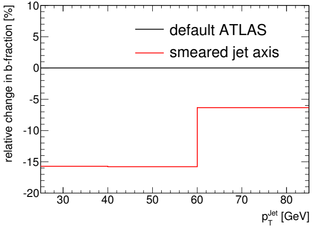
- jet direction modelling;
- correct cross section weighting of templates;
- non-*b* modelling;
- *b*-fragmentation;
- semileptonic *b*-decay modelling;

Systematic uncertainties

A walkthrough - jet direction modelling

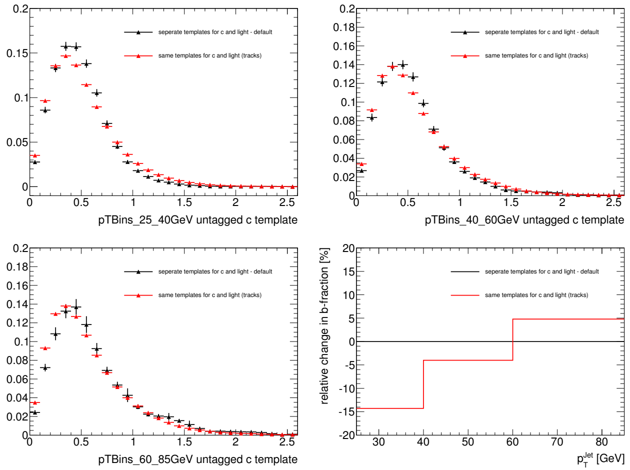






Systematic uncertainties

A walkthrough - fitting light and c samples with same template



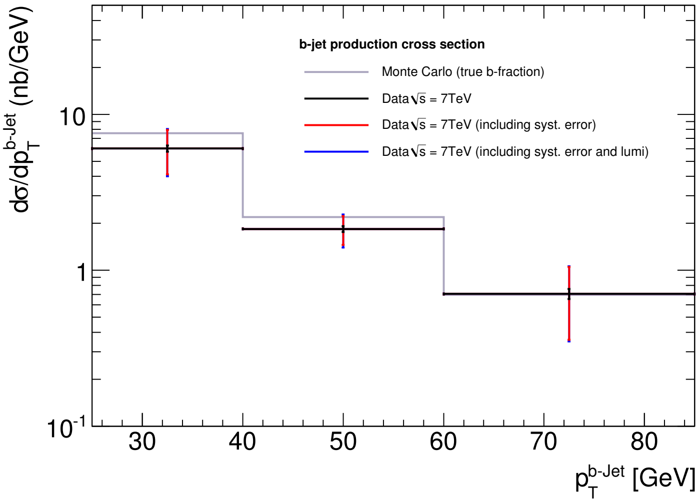
Systematic uncertainties

Summary table

Source	$25 < p_T < 40$	$40 < p_T < 60$	$60 < p_T 85$
Jet direction resolution	15%	14%	11%
Jet energy scale			
Cross section weighting: template for b	12%	13%	14%
Cross section weighting: template for c	14%	18%	14%
Definition of light template	9%	6%	7%
Using the same template for light and c	9%	3%	4%
b-fragmentation	1%	1%	1%
b-decay	1.5%	2%	2.5%
b-decay Babar	4%	5%	4%
Total	27.3%	27.6%	24.5%

Measurement results

Differential b-jet cross section at 7 TeV with p-p collisions



Conclusions

- semi-leptonic *b*-jet cross section measurement is well underway;
- already corrected for most reconstruction and selection efficiencies;
- first systematic error have been estimated and are included in the final measurement;
- final trigger efficiency numbers need to be included;
- comparison with theoretical expectations is ongoing.

- inputs for measurement are being finalized;
- writing of a COM note started;
- workshop planned for mid-December to finalize systematics;
- first draft expected before Christmas.