Production of heavy quark jets in association with weak gauge bosons

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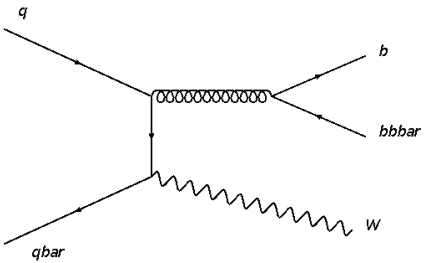
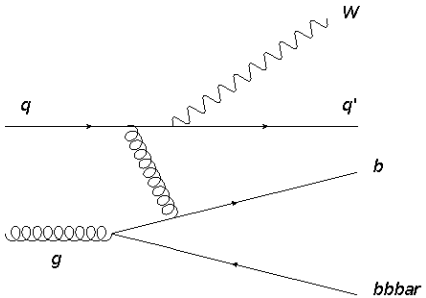
Motivation for $W + bjets$ study





Important for SM and beyond

- Verification of proton parton density function
- Important BG for Higgs and Top physics
- BG for rare processes

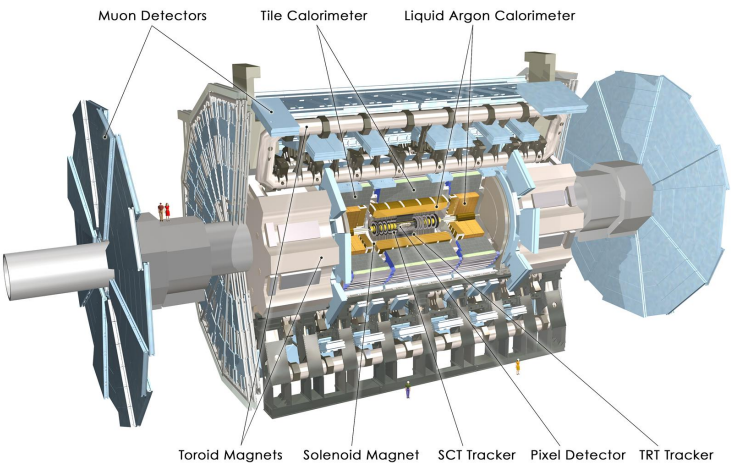
CDF results

Big discrepancy between CDF results and NLO theoretical calculation
$\sigma^{th}_{NLO} = 1.22 \pm 0.14$
$\sigma_{CDF} \times BR = 2.74 \pm 0.27 \pm 0.42$
See arXiv:0909.1505

Topics of this talk

- Baseline analysis for $W + bjets$ analysis uses secondary vertex based tagging of b jets
- The selection for this analysis and the impact of background will be shown
- Alternative to cross check the baseline analysis: b tagging using soft muons
- Main topic of the talk: preparation of the muon p_T^{rel} method for the alternative analysis

The ATLAS detector



Subdetectors

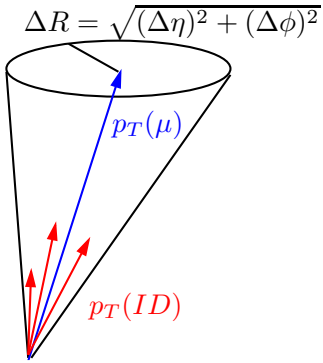
- Inner Detector (solenoidal field)
  - Silicon tracker up to $|\eta| < 2.5$
- Calorimeters
  - EM up to $|\eta| < 3.2$
    - Liquid Argon sampling calorimeter
  - Hadronic up to $|\eta| < 4.9$
    - Tile sampling calorimeter
    - Liquid Argon Calorimeter (forward)
- Muon Spectrometer (toroidal field)
  - Tracking up to $|\eta| < 2.7$
  - Trigger up to $|\eta| < 2.4$

W + b jets selection

Final state: $W + bjet(s) \longrightarrow \mu\nu + bjet(s)$

W selection

- Vertex with 3+ tracks (avoid cosmic background)
- Muon trigger requested
- MUON CUTS:
  - Combined muon (ID+MS track)
  - Exactly one isolated muon with $p_T > 20\ GeV$, $|\eta| < 2.4$
  - Isolation: $\frac{\sum p_T^{\Delta R<0.2}}{p_T^{\mu}} < 0.1$
- Jets at EM scale are used
- Jet Cleaning: remove events with poorly reconstructed jets (needed for E_T^{miss} calculation)
- $E_T^{miss} > 25\ GeV$
- $m_T > 40\ GeV$

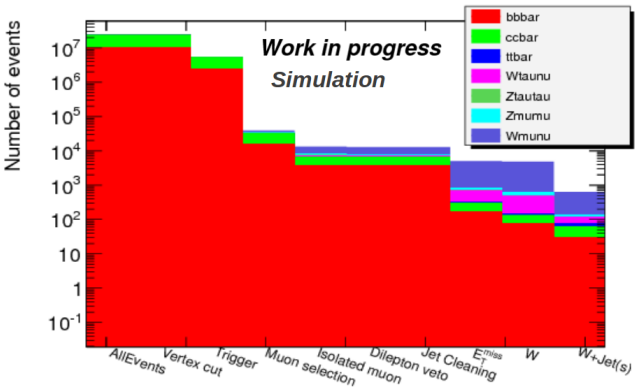


W + jets selection

- $\geq 1 jet$: well reconstructed, $p_T > 30\ GeV$, $|y| < 4.5$, boson decay lepton overlap removal

W + b jets selection

- Baseline analysis: ≥ 1 b jet, identified by secondary vertex b tagging.
- Alternative analysis with muons: 1 muon with $p_T > 4\ GeV$ inside a jet



All samples normalized to 1 pb^{-1}

In W+jets events

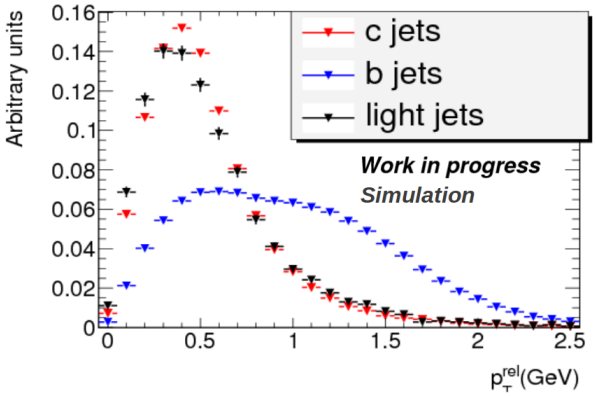
- Fraction of b jets = 0.46%
- Fraction of jets tagged as b jets = 1.4%
- Fraction of jets with a muon inside = 0.82%
- Fraction of b jets events with a muon inside = 7.5%

Conclusions

- 15 times more statistics needed for alternative analysis than for baseline analysis
- Alternative analysis only for 2011 data ($O(1\ fb^{-1})$ expcted)

The p_T^{rel} templates technique

p_T^{rel} is defind for muons inside jets as $p_T^{rel} = \overrightarrow{p_\mu} \perp \overrightarrow{p_{jet}}$
p_T^{rel} spectrum is different for muons from b-decay and muons from c-decay or inside light jets



Distinction between b and non-b jets possible on statistical basis fitting a linear combination of the b and non-b p_T^{rel} templates to the p_T^{rel} distribution

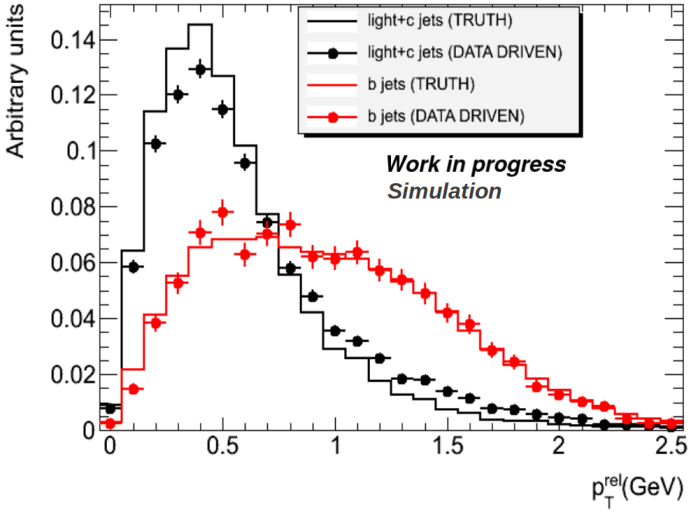
p_T^{rel} templates from MC not necessarily reliable enough, preference for an experimental determination of p_T^{rel} templates

See ATLAS-CONF-2010-099

Data driven determination of p_T^{rel} templates

- Use dijet events for the determination of the p_T^{rel} templates
- Dijet event selection:
  - Muon trigger for the event
  - 2 well reconstructed highest p_T jets with $p_T > 25\ GeV$
  - Reconstructed muon with $p_T > 4\ GeV$ inside one jet
- Selection to get a b enhanced jet sample:
  - The jet without the muon is b tagged using secondary vertex information
  - Muon impact parameter significance $\frac{d_0}{\sigma(d_0)} > 5$
- Selection to get a b depleted jet sample:
  - The jet without the muon is not b tagged by the secondary vertex b tagger
  - Muon impact parameter significance $\frac{d_0}{\sigma(d_0)} < 1.3$

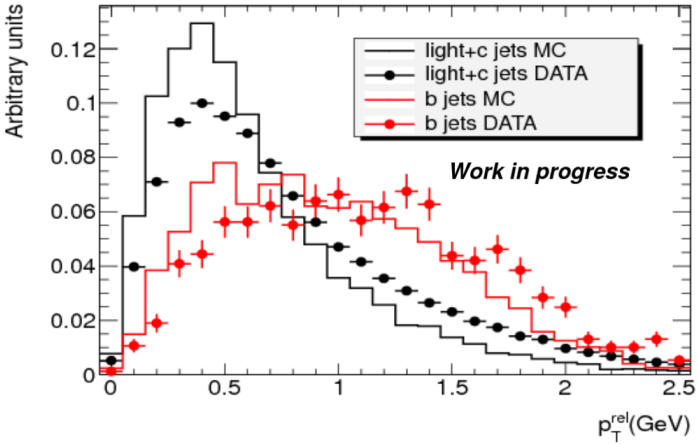
Validation of the data driven template determination on MC



Test of data driven method on MC

- Common template used for light and c jets
- Very good agreement for b jets
- Systematic effect in the light+c template
- Contamination can be reduced with the ongoing improvement in the selection
- Any residual effect will be accounted as systematic error

A first look at p_T^{rel} templates from data



First results with data driven method

- Agreement is reasonable for b jets
- For light+c jets, there is a systematic effect
- It is a known effect on MC simulations
- Work ongoing on the selection
- Still, there is a good separation between b and non b jets

Application of data driven method on Data and on MC simulation

Conclusions

- W+b jet(s) is an a important and challenging channel; 2010 data collected by ATLAS are enough to perform a first measurement of the cross section
- Baseline analysis uses secondary vertex information for b tagging.
- Cross check using soft muon tagging with p_T^{rel} requires 10 times higher statistics which will be available in 2011.
- Key point for cross check: data driven determination of p_T^{rel} templates.
- First results of data driven templates using dijet events look promising.
- Other possible techniques which use muons inside jets are under investigation: above all, the usage of charge correlation between the W decay muon and muon from c decay in W+c events