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$t\bar{t}$ differential cross section in the lepton+jets channels at ATLAS

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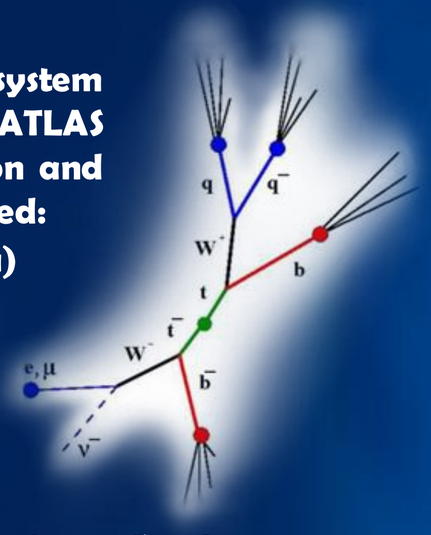
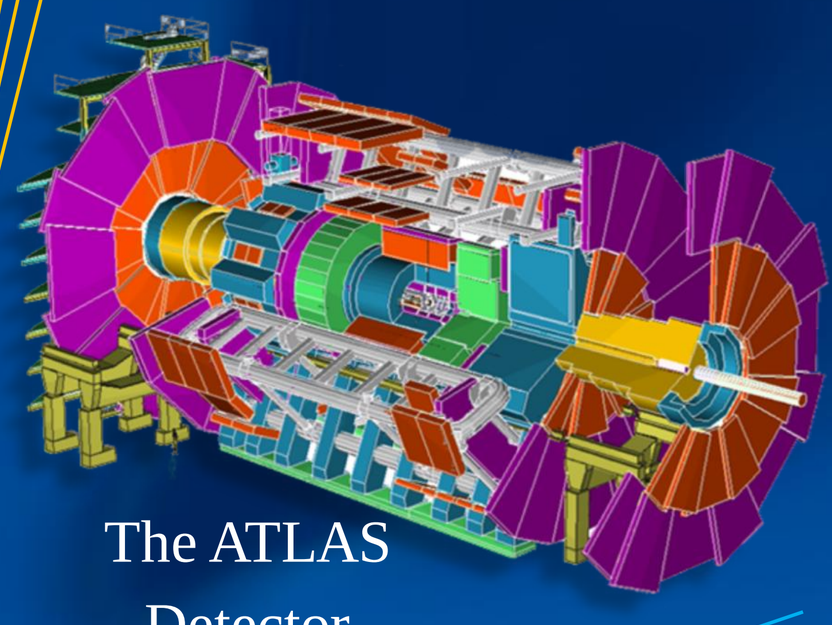
$t\bar{t} \rightarrow bW^+ \bar{b}W^- \rightarrow b\bar{l}\nu\, \bar{b}q\bar{q}$

Event Selection

We're studying the lepton+jets decay channels of the $t\bar{t}$ system produced in pp collision at the LHC recorded with the ATLAS detector. The analysis is performed separately for the electron and muon decay channel. The following selection has been performed:

- **Only 1 isolated lepton of $E_T > 25GeV$ (el) or $p_T > 20GeV$ (mu)**
- **$E_T^{miss} > 30GeV$ (el) or $\left(E_T^{miss} + M_T(W)\right) > 60GeV$ (mu)**
- **At least 4 jets with $p_T > 25GeV$**
- **At least 1 b-jet**



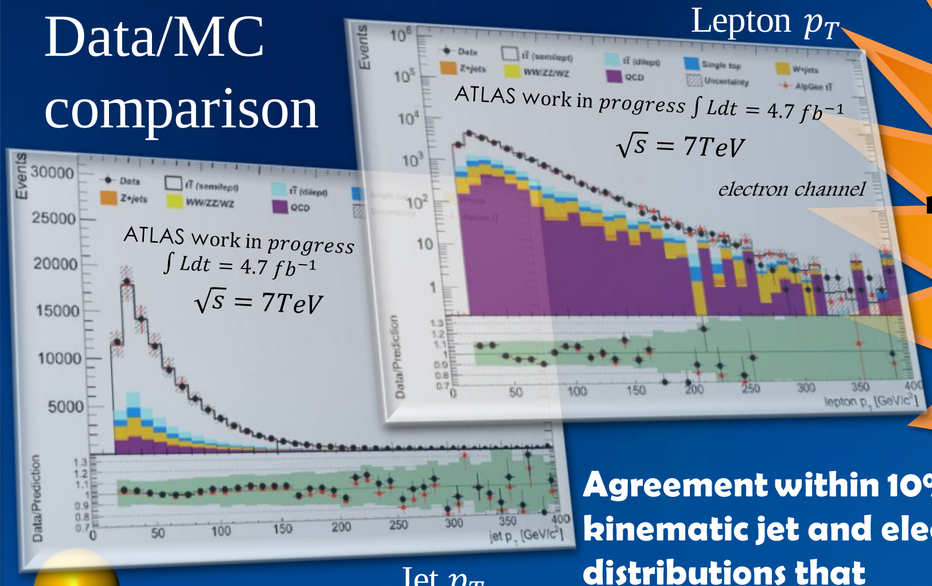


The ATLAS Detector

Background

Fake leptons: from non prompt leptons (both e and μ channel), photon conversion and mis-identified jets (e channel). It is estimated from the data using the so called "matrix method"[3] based on a "loose" and a "tight" lepton selection.
W+jets: shape evaluated from MC simulation while absolute normalization from the data using the asymmetry in the production of W^+ and W^- (charge asymmetry method[4]).
The other main background sources are (*Z*+jets, *WW / WZ / ZZ*, single top) and are evaluated from MC simulation.

Data/MC comparison



Lepton p_T

Agreement within 10% for kinematic jet and electron distributions that guarantee a good jets modeling.

The *top* quark is the heaviest particle in the standard model (173.2 ± 0.9 GeV) so it is strongly connected with the Higgs mechanism and many other possible signs of new physics. The $t\bar{t}$ system is a wonderful candidate to check SM and to search for eventually beyond SM signals. The $t\bar{t}$ integral cross section has been measuring by ATLAS and CMS with increasing precision without significant deviations from the SM.

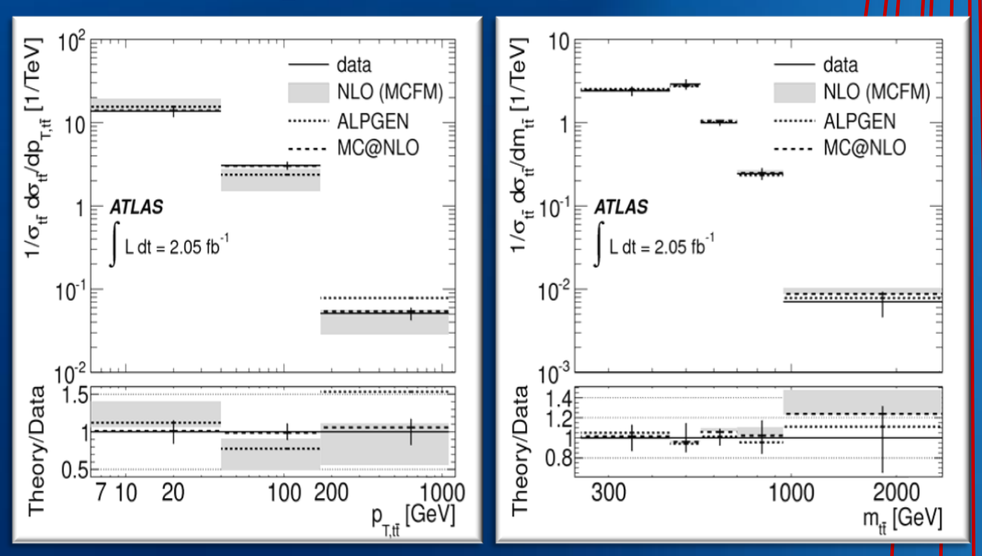
Unfolding

In high-energy physics measurements of physical observables are typically distorted by detector effects.

$$obs = A_{(reco,true)} \cdot phys$$

This makes direct comparison with theoretical predictions and other experiments impossible. A general approach is to unfold the experimental results accounting for resolution and acceptance effects contained in the response matrix A(r,t) evaluated from MC simulation. We are studying some different unfolding methods like bin by bin, SVD, iterative bayesian and simple matrix inversion, used for the results shown below.

Normalized differential Cross Section with respect to $t\bar{t}$ p_T and mass [1]



& boosted object selection

At the LHC center of mass energies heavy particles, including Higgs boson and top quarks, are produced at large enough transverse momentum that their decay products will appear as single heavy, collimated jets, called "fat" jets. These events are perfect candidates for beyond-standard searches but have to contend with large backgrounds from light-parton QCD jets. Over the past few years, in order to separate fat jets from their background, several techniques based on jet substructure have been developed, amongst whitch the Template Overlap method.

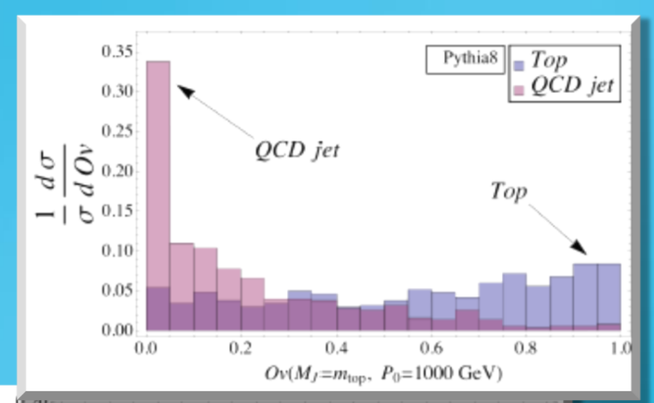
"Fat" jet

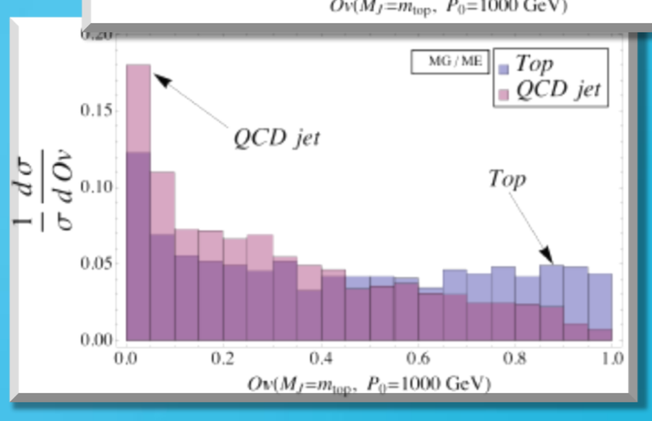
Template Overlap [2]

This method compares the calorimetric clusters (c) that constitute jets in the observed events with a set of simulated particles from boosted decay, called templates (t).
If we introduce a functional F(c,t) that quantifies how well the energy flow of (c) matches (t) *then* the maximum functional overlap of (c) with respect to (t) will be

$$Ov(c,t) = \max[F(c,t)]$$

The results shown beside have been obtained with simulated top and QCD bkg sample from 2 different MC generators, comparing in F(c,t) only the energy of clusters and templates[2].
I'm starting to searches for new physics in ATLAS using samples of $t\bar{t}$ events.





[1] arXiv:1207.5644 submitted to EPJC
[2]arXiv:1006.2035v1 [hep-ph] 10 Jun 2010
[3] Eur.Phys.J.C71:1577,2011, arXiv:1012,1792
[4] Eur.Phys.J. C72 (2012) 2039, arXiv:1203.4211