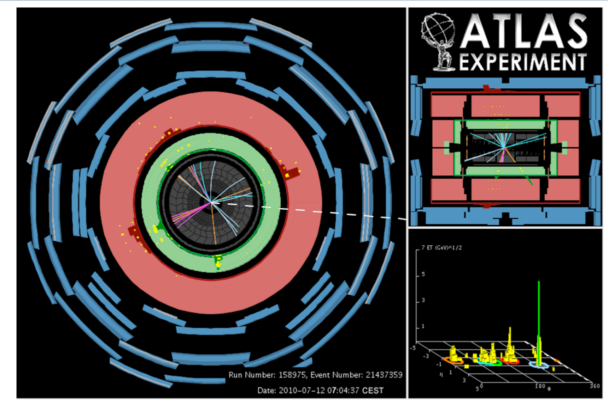
LHCC Poster Session - CERN, 23 March 2011

Measurement of Top Quark Properties at ATLAS

ttbar→e + jets candidate



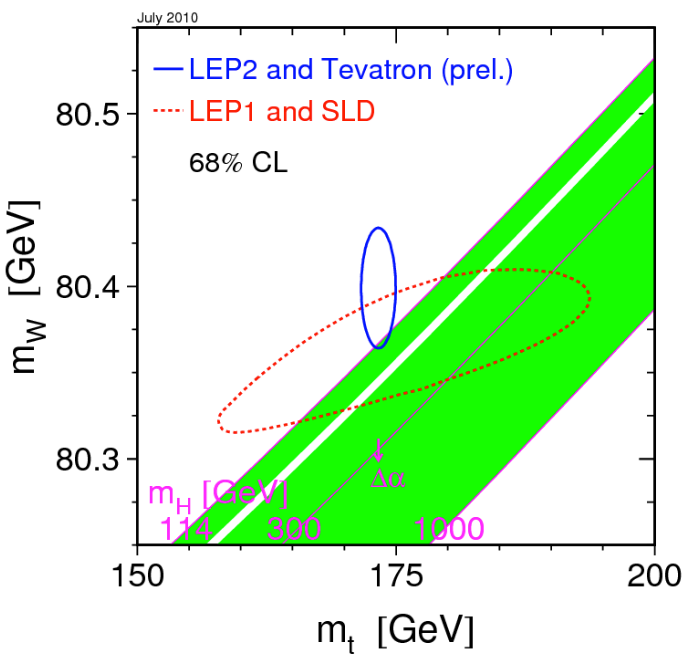
Introduction

The top quark was discovered at Fermilab in 1995. It is to date, the heaviest known elementary particle of the Standard Model. Being approximately as heavy as a gold atom, it is thought to play a special role in the SM and as such its properties are of interest. During ATLAS run in 2010 at 7 TeV centre-of-mass energies for pp collisions, some of the properties of the top quark were analyzed.

Top Mass

The top mass is a very important parameter of the SM not only because of its uniquely large mass, but the contribution of this large mass to limits on the search for the Higgs boson and new physics.

The World Average from the Tevatron has a combined relative precision of about 0.6 %.



Three separate direct measurements were performed in the semi-leptonic decay channel. All three compare data to templates from MC simulation at different mass points. The methods are:

- 1-d Stabilized Method (default): Uses the R_{32} variable (three jet mass over two jet mass),
- 1-d Kinematic Fit: Reconstructs the full event decay topology using the KLFitter,
- 2-d Template Method: Fits both the top mass and JSF (Jet Energy Scale Factor) simultaneously,

The R_{32} variable is defined as:

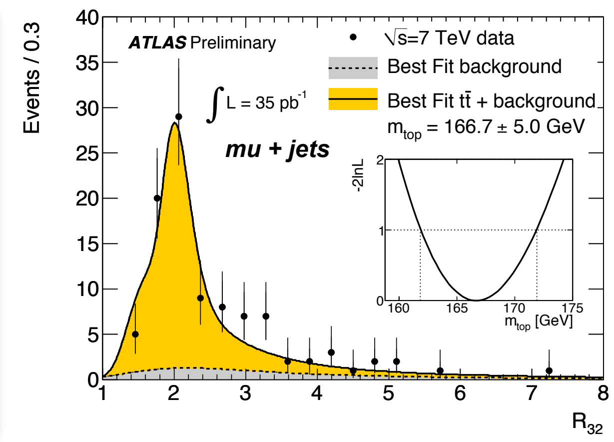
$$R_{32} = \frac{m_{\mathrm{top}}^{\mathrm{reco}}}{m_{\mathrm{W}}^{\mathrm{reco}}}$$

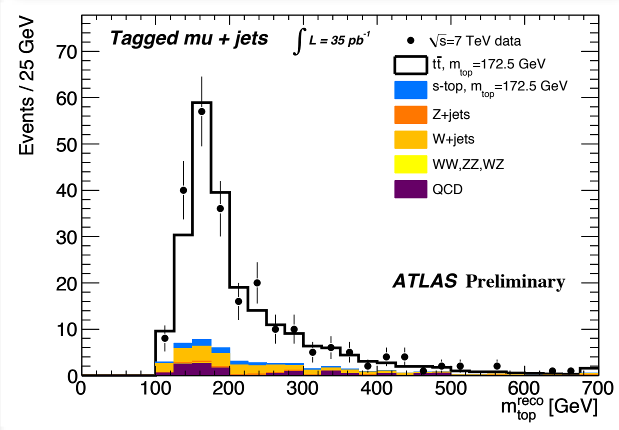
It also uses a tight W mass window of 40 GeV to assign the two light jets from the decaying W boson.

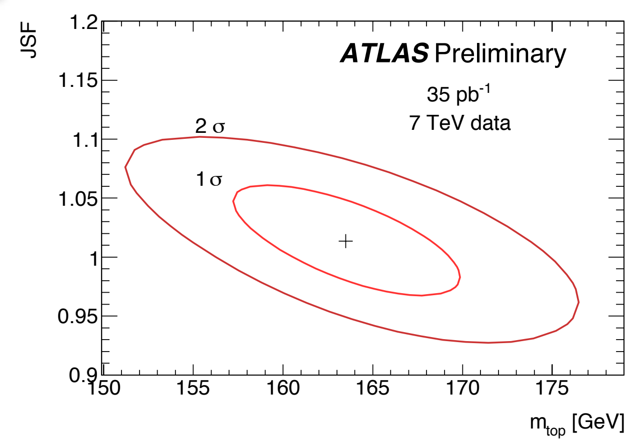
The fit of data uses a likelihood based on the shape of the distribution, signal and background numbers and a Gaussian for the background.

$$\mathscr{L} = \mathscr{L}_{\mathrm{shape}} \times \mathscr{L}_{\mathrm{ns+nb}} \times \mathscr{L}_{\mathrm{bkg}}$$

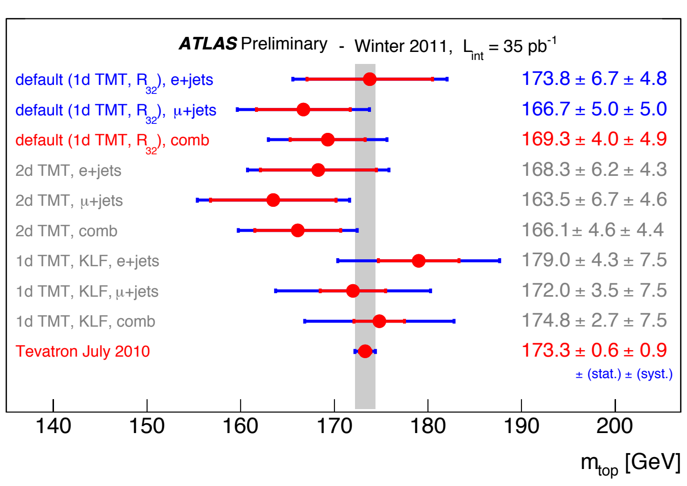
The highest systematics in all three measurements are the JES, bJES and ISR / FSR variations.





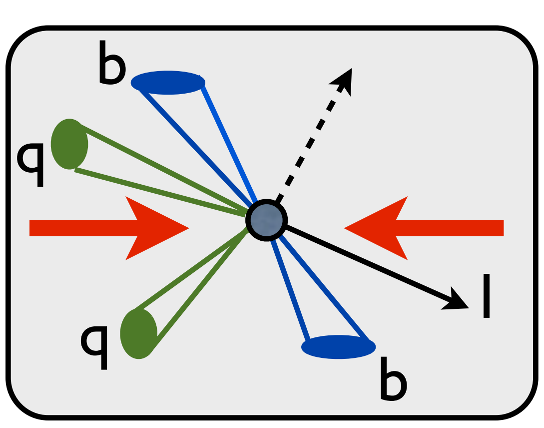


ATLAS Top Mass Results

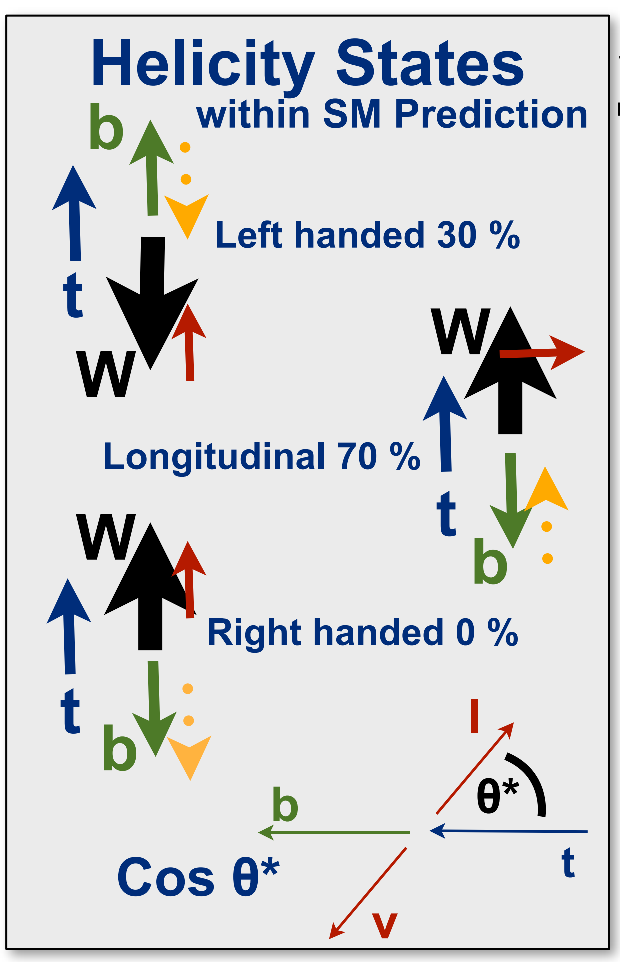


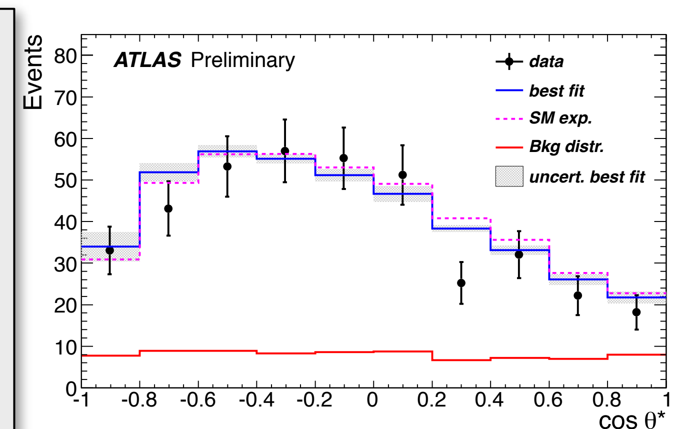
Semi-leptonic decay channel

Analyses are performed in the semi-leptonic channel, which is one of three ttbar decay channels. It is optimal because of its relatively high branching fraction and good balance between efficiency and purity. The final state contains one lepton and neutrino and 4 jets, two of which are b jets.



W Helicity





Results

Forward-Backward Asymmetry (Correction Function):

A_{FB} = -0.29 ± 0.08

A_{+} = 0.50 ± 0.07

A_{-} = -0.86 ± 0.08

W Helicity (Kinematic Fit Template):

F_0 = 0.59 ± 0.12

F_L = 0.41 ± 0.12

F_R = 0 (Assumed)

Two separate measurements in the semi-leptonic channel measure the polarization of the W boson from top decays. It is an important measurement to constrain anomalous couplings.

- Kinematic Fit Template: Reconstruct the entire event using a kinematic fit and compare to templates
- Correction Function: corrects reconstructed cosθ* distribution to recover the corresponding parton level distribution

For the kinematic fit template method, the boosted angle between lepton and decaying reconstructed b jet is measured.

For the correction function, first the data is subtracted, second a correction is applied for the detector and reconstruction efficiencies. Finally a correction function is applied which assumes the SM hypothesis.

ttbar + E_T^{miss}

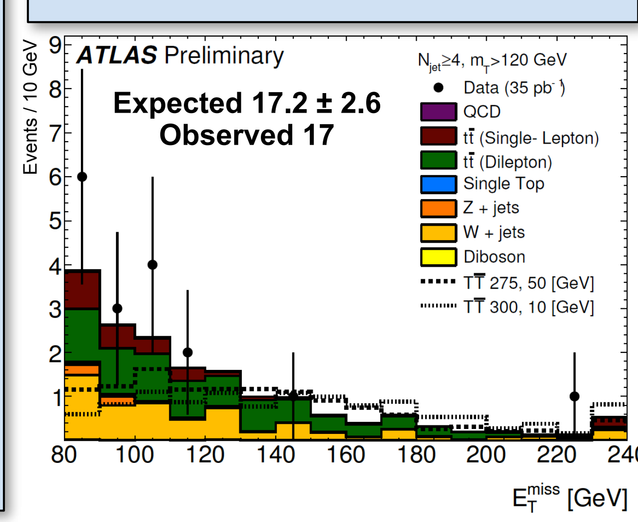
The uniquely large mass of the top quark distinguishes it from the other fermions of the SM. Because of this, searches for new physics are made using the top quark. Event searches are performed for a heavy 4th generation "quark-like" object (**T**) decaying directly to dark matter candidates (**A**), leaving only a ttbar + E_T^{miss} signal. This would be direct evidence of dark matter candidates.

The search involves a very high missing energy cut, hence limiting statistics. The suppression of di-leptonic decays is important as it has high E_T^{miss} from the two neutrinos. There is no excess of events found so far in these events which would show sign of new physics.

Results with 95 % CL:

m(T) = 300 GeV exclude m(A) < 10 GeV

m(T) = 275 GeV exclude m(A) < 50 GeV



Common Systematics

Some common systematics that have been studied include:

- ***JES*: Uncertainty on jets energy response of detector in different regions**
- ***bJES*: Additional 2.5 % uncertainty on b-tagged jets (Secondary Vertex Tagger)**
- ***Initial and final State Radiation***

The physics results require a great deal of understanding not only from the underlying physics, but also detector response and performance.

The results are due to a lot of hard work from many contributors, not just ones directly stated on this poster!

Stefan Guindon, for the ATLAS Collaboration

References: [1] "**Measurement of the Top-Quark Mass using the Template Method in pp Collisions at √s = 7 TeV with the ATLAS detector**", ATL-CONF-2011-033
[2] "**Measurement of the *W*-boson polarization in top quark decays in *pp* collision data at √s = 7 TeV using the ATLAS detector**", ATL-CONF-2011-037
[3] "**Search for Anomalous Missing E_T in *tt* Events**", ATL-CONF-2011-036

ATLAS EXPERIMENT