Measurement of the top quark mass at ATLAS EPS – HEP 2011 Grenoble

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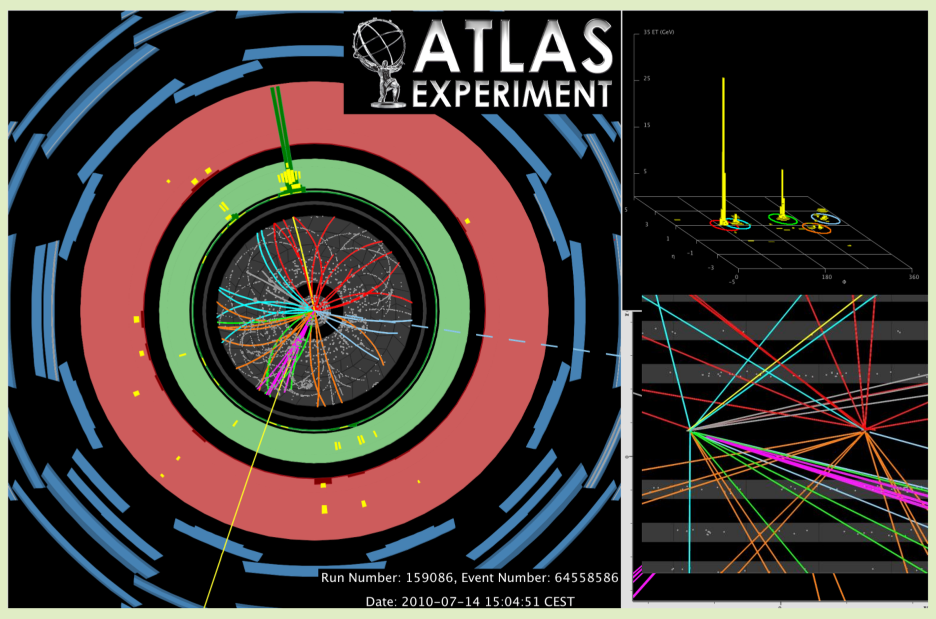
Introduction

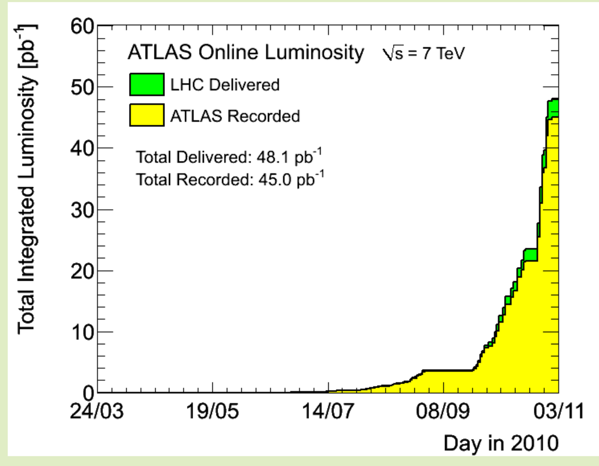


The top quark has been discovered in 1995 at Fermilab. It is the only known fundamental particle with a natural mass, close to electroweak scale.

The top quark large mass makes it strongly interact with the Higgs sector.

→ Its precise measurement can put **constraints on the yet unobserved Higgs boson mass**, last piece of the Standard Model puzzle.

→ The top quark could play a key role in **EWSB** and have preferential connection to **New Physics.**



In 2010, LHC delivered proton-proton collisions at a 7 TeV centre-of-mass energy for an integrated luminosity about 35 pb^{-1}

This amount of data allows for the first mass measurement to be performed.

In the predictions for QCD beyond leading-order predictions, **top quark mass** depends on **the renormalisation scheme**.

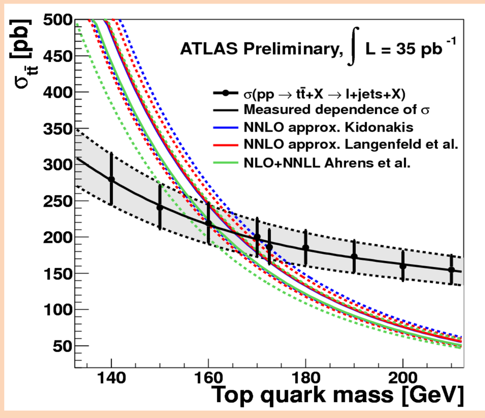
- Extract the top pole mass by comparing **top pair production cross section** to **SM theory → measurement of top pole mass**.

- **Direct measurement depends on the simulation:** top quark mass doesn't correspond to a well defined renormalisation scheme.

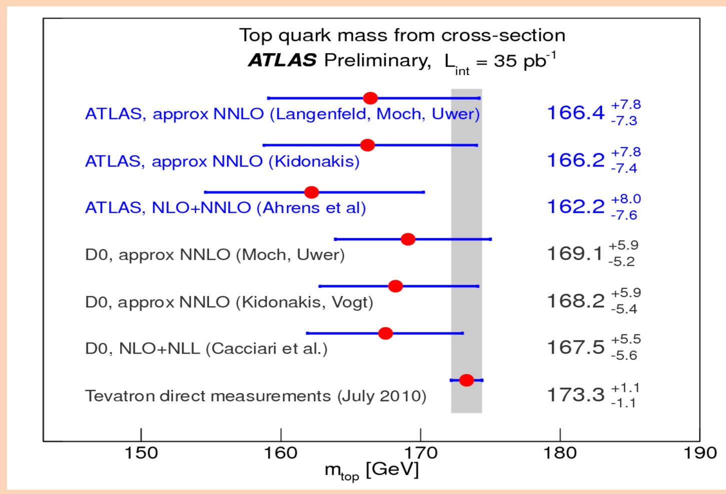
Top mass from cross section measurement

- Theoretical cross section predictions, as a function of m_{top}, are obtained from **NNLO and NLO+NNLL** approximations.

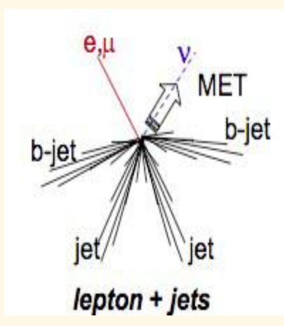
- Use as experimental input the measured cross section obtained by using a topological likelihood discriminant.



- **Top quark mass** is extracted **maximising a likelihood function** composed of theoretical and experimental PDFs.



Semileptonic top event reconstruction

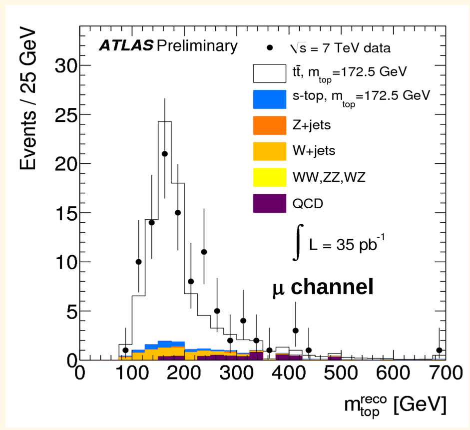


Signature:

- ✓ ≥ 4 jets (at least 1 b-tagged)
- ✓ 1 isolated high p_T lepton
- ✓ Missing energy

direct reconstruction from decay

top reconstruction: highest p_T combination of jets



2 channels studied :

- e channel: lepton = electron
- μ channel: lepton = muon

3 jets product : Need to control the Jet Energy Scale (JES) : 3 methods developed.

Direct top mass measurement

2-D template method

Use reconstructed W and top mass in a simultaneous measurement of m_{top} and a global Jet energy Scale Factor (JSF):

→ Kinematic fit on W to enhance the reconstruction.

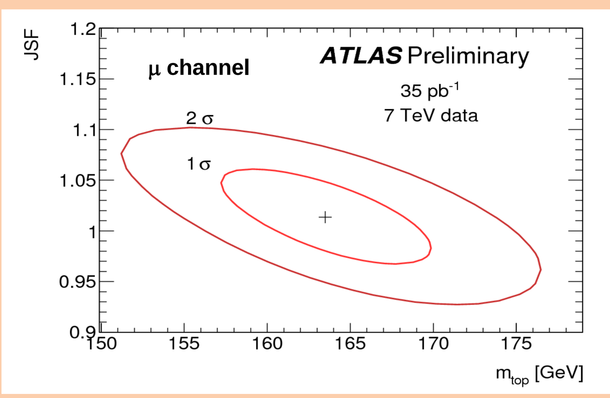
2-D templates:

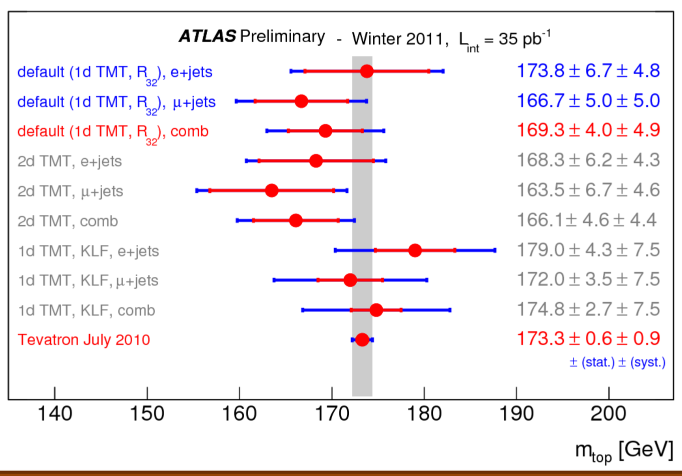
- m_{top} with references on different mass points and different JSF values

- m_W with different JSF references.

Simultaneous likelihood maximisation on data

m_{top} = 166.1 ± 4.6 (stat) ± 4.4 (syst) GeV/c^2 (e/μ + jets)





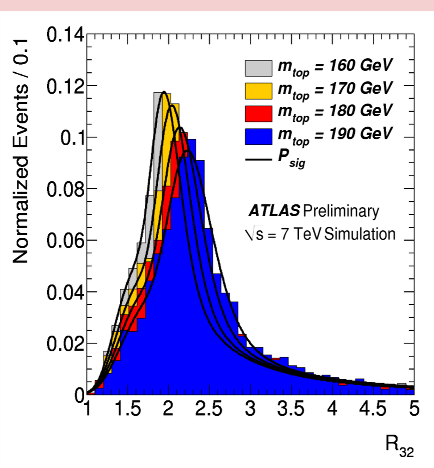
1-D R_{32} template method

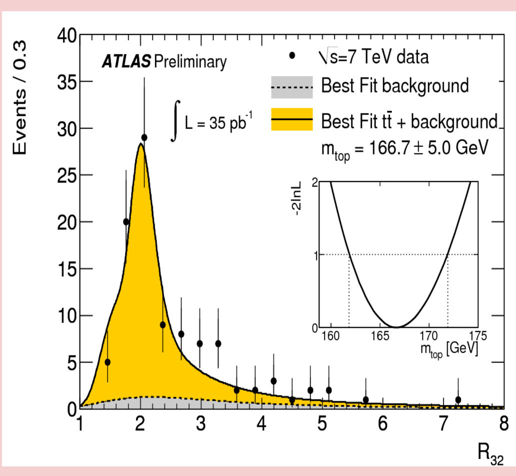
To reduce sensitivity to JES uncertainty:

$$R_{32} = \frac{m_{top}^{reco}}{m_W^{reco}} = \frac{m_{bjj}}{m_{jj}}$$

Template fit:

- R_{32} references for different top masses.
- Likelihood maximisation on the data.





m_{top} = 169.3 ± 4.0 (stat) ± 4.9 (syst) GeV/c^2 (e/μ + jets)

Main systematics		e	μ channels
JES	:	2.3 GeV/c^2	1.9 GeV/c^2
bJES	:	2.5 GeV/c^2	2.5 GeV/c^2
ISR/FSR	:	2.2 GeV/c^2	2.6 GeV/c^2

More than 1 fb^{-1} recorded in July 2011
New measurements ongoing…

1-D kinfit analysis

Full kinematic fit likelihood fit to the decay topology.

- Use transfer function to map reconstructed object to parent partons.
- Use constraints on both hadronic and leptonic W and top masses.
- **Very good top mass resolution, but full sensitivity to JES uncertainty.**
- Template with top mass references for different mass values.

Likelihood maximisation on data.

m_{top} = 174.8 ± 2.7 (stat) ± 7.5 (syst) GeV/c^2 (e/μ + jets)