Measurement of the Top Quark Mass in the $t\bar{t} \rightarrow$ lepton+jets channel form $\sqrt{s} = 13$TeV ATLAS data

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Why Measuring the Top-Quark mass?

How the Data is taken?

How is the Top-Qark mass measured?

Measurement is based on a 3D-Template method:

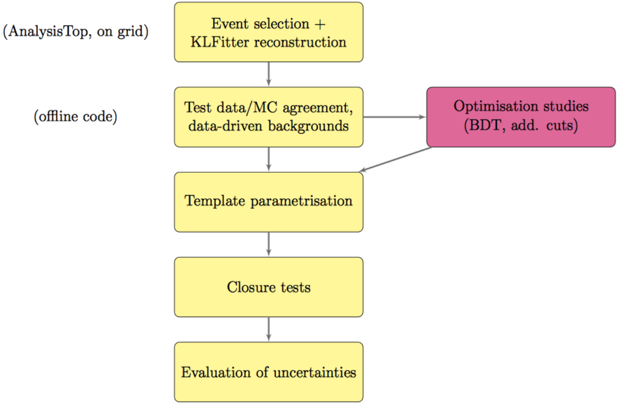
- Variable 1: m_{top}^{reco} from reconstructed Events
- Variable 2: m_{W}^{reco} from chosen jet permutation, sensitive to JSF
- Variable 2: R_{bq}^{reco} from chosen jet permutation, sensitive to bJSF

$$R_{bq}^{reco,1b} = \frac{p_T^{b_{tag}}}{(p_T^{W_{jet1}} + p_T^{W_{jet2}})/2} \qquad R_{bq}^{reco,2b} = \frac{p_T^{b_{had}} + p_T^{b_{lep}}}{p_T^{W_{jet1}} + p_T^{W_{jet2}}}$$

Determination of m_{top} :

- Need fully reconstruction of $t\bar{t}$-finale state
- Template parametrisation of the 3 variables
- Unbinned likelihood fit is performed

Workflow



1.png

Pre-selection

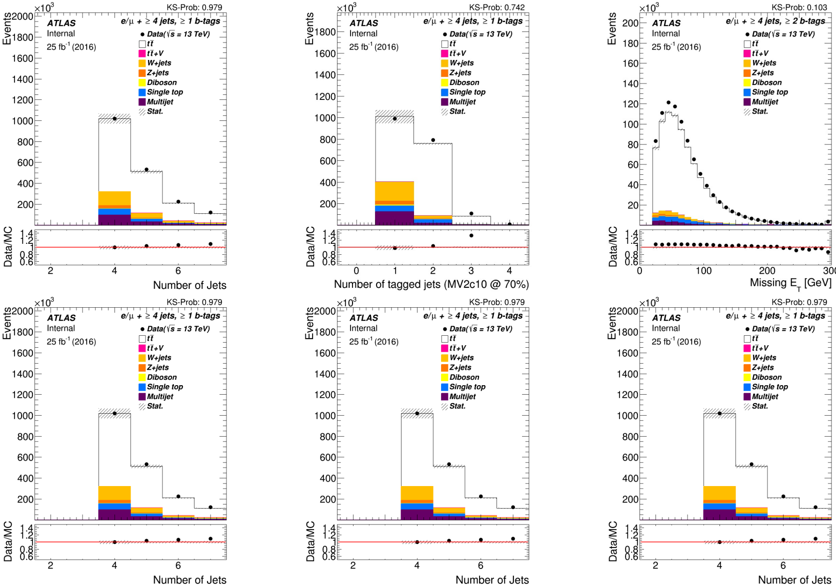
- At least one good primary vertex with five associated tracks
- Exactly one isolated high p_T lepton
- At least 4 central jets with highp_T
- 1 or 2 b-tagged jets
- Cuts on E_T^{miss} , m_T^W or $E_T^{miss} + m_T^W$
- W+jets normalization and HF fraction estimated from data
- Multijet background obtained from data in control region

Event yields after preselection

	One b-tagged jet	Two $b-$tagged jets	1+2 b-tagged jets
Data	168417	96105	264522
$t\bar{t}$ signal	121900 ± 7400	85100 ± 5500	207000 ± 12000
Single-top-quark signal	9300 ± 500	4220 ± 250	13490 ± 730
NP/fake leptons (data)	7400 ± 3700	700 ± 350	8100 ± 4100
W+jets (data)	23600 ± 7200	2780 ± 850	26000 ± 8000
Z+jets	3500 ± 1100	430 ± 130	4000 ± 1200
WW/WZ/ZZ	1033 ± 49	63.0 ± 6.1	1097 ± 53
Signal+background	168000 ± 11000	93300 ± 5500	260000 ± 15000
Expected background fraction	0.21 ± 0.07	0.04 ± 0.06	0.15 ± 0.06
Data/(Signal+background)	1.01 ± 0.07	1.03 ± 0.06	1.02 ± 0.06

- Background contamination dominated by W + Jets
- Mass dependence of single-top ⇒ include in signal
- Reduction of background via cuts on 2 b-tagged jets
- **Good Data/MC agreement**

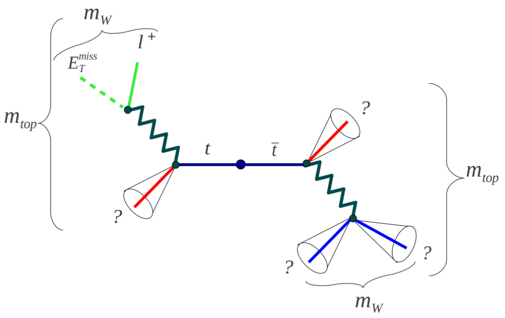
Data/MC agreement



$t\bar{t}$-final state

- 4 jet event $\Rightarrow$ 24 possible jet-parton assignments
- 12 permutations left since light jets from W are indistinguishable
- Kinematic liklihood fit with KLFitter

$\Rightarrow$ **Chose best permutations for calculation**



Reconstruction with KLFitter

- KLFitter input: charged lepton, missing E_T and at least four jets

  $\Rightarrow$ one or two b-tagged jets + untagged jets with highest p_T

- Definition of kinematic Likelihood:
  - W: transfer functions for detector response
  - BW:Breit-Wigner distributions
  - different options to use b-tagging information

Likelihoodfunction

$$
\begin{aligned}
L = {} & BW(m_{q_1 q_2} | m_W, \Gamma_W) \cdot BW(m_{l\nu} | m_W, \Gamma_W) \\
& BW(m_{q_1 q_2 b_{had}} | m_{top}, \Gamma_{top}) \cdot BW(m_{l\nu b_{lep}} | m_{top}, \Gamma_{top}) \\
& W(\tilde{E}_{jet_1} | E_{b_{had}}) W(\tilde{E}_{jet_2} | E_{b_{lep}}) W(\tilde{E}_{jet_3} | q_1) W(\tilde{E}_{jet_4} | q_2) \\
& W(\tilde{E}_x^{miss} | p_{x,\nu}) W(\tilde{E}_y^{miss} | p_{y,\nu}) \left\{ \begin{array}{l} W(\tilde{E}_l | E_l) \\ W(\tilde{p}_{T,l} | p_{T,l}) \end{array} \right\}
\end{aligned}
$$

3D-template technique

determination of m_{top}, JSF and $bJSF$

- absorb data/MC mean deviations into the JEF and $bJSF$
- $JES/bJES$ induced uncertainties, become an additional statical component
- different masses in the range 170?175.5 GeV + independent input for JSF/bJSF 0.96-1.04

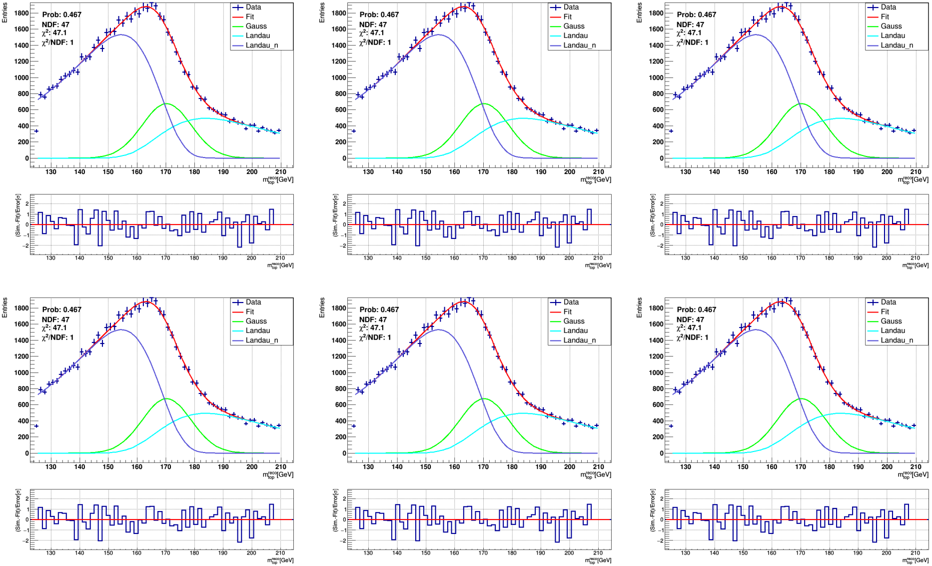
template construction

- templates are derived for $m_{top}^{reco}, m_{top}^{reco}$ and R_{bq}^{reco}
- fit of signal and background with different functions

fit-functions (signal)

- m_{top}^{reco}: gauss+ landau + landau^{-1}
- m_{W}^{reco}: gauss + gauss
- R_{bq}^{reco}: gauss + gauss + landau

signal templates $t\bar{t}$ only for 170 GeV & 171.5 GeV



Next steps

- single top contains additional information $\Rightarrow$ add to signal
- Several fits with variation of *JFS* and *bJSF*
- Repetition of the parametrisation for the different Background processes

$\Rightarrow$ **Dependes of** $m_{top}^{reco}, m_{top}^{reco}$ **and** R_{bq}^{reco} **on** $mtop, JSF\, bJSF$

- Probability density functions for signal and background are used for the unbined Likelihood fit

Summery

Backup

Object definition for 2016 data

Electrons

- E_T >28 GeV, $| \eta |$<2.47
- Gradient isolation, TightLH
- HLT_e26_lhtight_nod0_ivarloos, HLT_e60_lhmedium_nod0, HLT_e140_lhloose_nod0

Muons

- E_T >28 GeV, η <2.47
- Medium, Gradient isolation
- HLT_mu26_ivarmedium, HLT_mu50

Small-R jets

- antiKt R = 0.4, EM-Jets
- JVT >0.59 for $p_T < 60$GeV and $| \eta |$<2.4
- b-tagging: MV2_c10, 77% WP

MET/MTW

- $E_T^{miss} > 20$GeV
- $E_T^{miss} + m_T^W > 60$GeV

AnalysisTop-02-04-27, with 25 fb-1 for 2016 data ▸ Top Mass Ntuple production

Signal templates $t\bar{t}$ only for 173.5 GeV & 175 GeV