Leptons-only Top quark mass measurement

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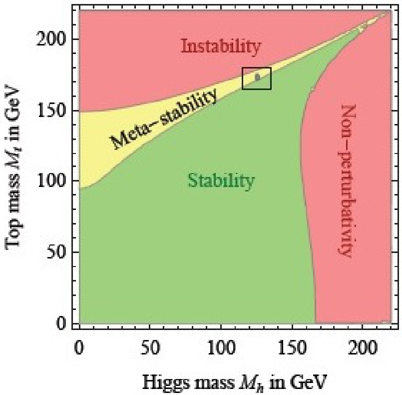
Top quark mass: How fundamental is this parameter?

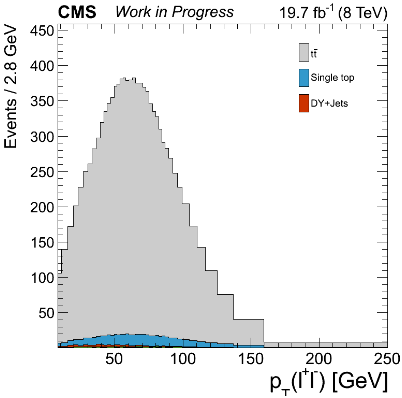
- m_t provides cross check of the internal consistency of the SM.
- Crucial role in the calculation of radiative corrections for SM observables. m_t provides together with m_W and m_H over-constraints to SM fits
- Can place strong constraints on BSM scenarios.
- m_t and m_H determine the SM vacuum stability.



Simple idea: Use only lepton kinematic distributions

It is important to compare the results obtained from different methods with different sensitivities to the modelling of the kinematics of observed final states.

- No full reconstruction of the top quark takes place, only final state particles are used.
- Expected to have minimal sensitivity to the modelling of both perturbative and non-perturbative QCD effects: May affect jets more than leptons.
- Leptons are easier to identify and their momentum/energy can be measured with greater precision.

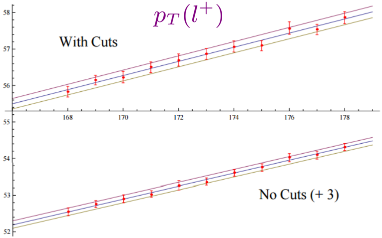


[1] Frixione, Stefano and Mitov, Alexander, "Determination of the top quark mass from leptonic observables" JHEP **1409**, 012 (2014) [arXiv:1407.2763 [hep-ph]].

How is m_t related to the kinematics of the leptons in the final state?

- The Mellin moments of the shapes of kinematic distributions are sensitive to m_t, and also to modelling details.
  $\mu_O^{(1)} =< O >$ (Mean)
  $\mu_O^{(2)} =< O^2 >= \sigma^2 + < O >^2$
- Measure the shapes in data and as expected from simulation. (**Blinded analysis**)
- Correct data for experimental effects (Unfolding).
- Compare to different predictions.

Kinematic Distributions
$p_T(l^+)$
$p_T(l^+l^-)$
$M_T(l^+l^-)$
$E(l^+) + E(l^-)$
$p_T(l^+) + p_T(l^-)$

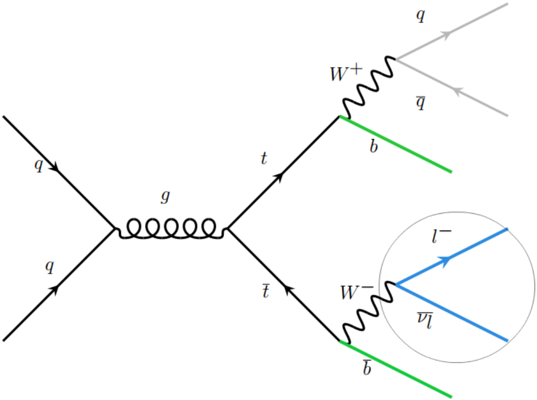


Scale choice	$\mu^{(1)}_{p_T(l^+)}$
1	$174{,}73^{+0{,}8}_{-0{,}79}[0{,}2]$
2	$174{,}78^{+0{,}9}_{-0{,}9}[0{,}6]$
3	$172{,}73^{+2{,}0}_{-1{,}2}[0{,}5]$
Scenario	$\mu^{(1)}_{p_T(l^+)}$
LO+PS+MS	$173{,}61^{+1{,}1}_{-1{,}34}[1{,}0]$
NLO+PS	$174{,}4^{+0{,}75}_{-0{,}81}[3{,}5]$
LO+PS	$173{,}68^{+1{,}08}_{-1{,}31}[0{,}8]$

Top mass values extracted from $p_T(l^+)$. [1]

[1] Frixione, Stefano and Mitov, Alexander, "Determination of the top quark mass from leptonic observables" JHEP **1409**, 012 (2014) [arXiv:1407.2763 [hep-ph]].

Event Selection

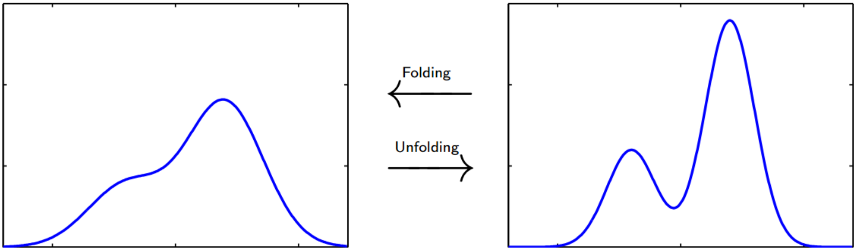


- 1 electron or muon
- At least 2 jets, $p_T > 30$ GeV, $|\eta| < 2{,}5$
- At least one jet with reconstructed secondary vertex
- Lepton $p_T > 20$ GeV, $|\eta| < 2{,}5$
- $m_{ll} > 12$ GeV

$\sigma_{t\bar{t}} = 241{,}5 \pm 8{,}5$ pb
8 TeV, 19.6 fb^{-1}

Unfolding Procedure

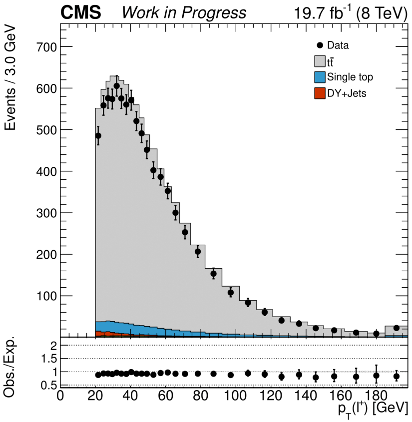
- What would the distribution look like when measured with a device having a perfect experimental resolution?
- Estimate particle-level distribution of some physical quantity of interest on the basis of observations smeared by an imperfect detector.



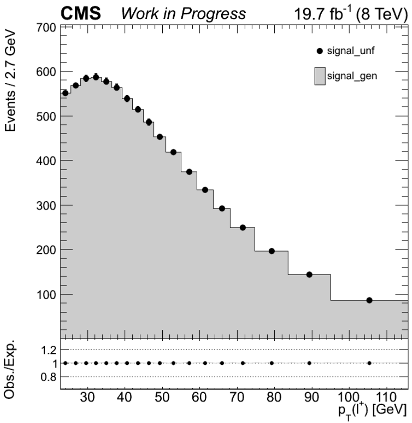
Smeared density

True Density

Unfolding Procedure

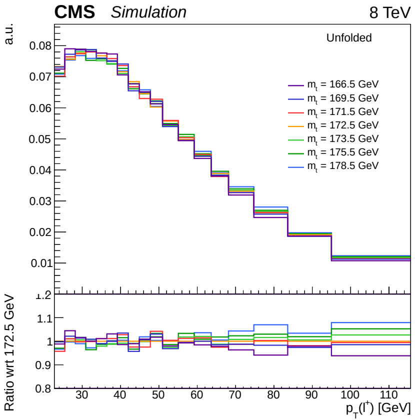


$p_T(l^+)$ distribution at reconstructed level

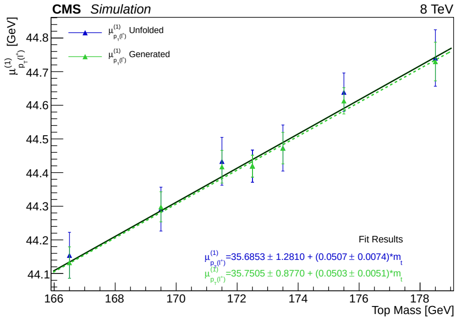


$p_T(l^+)$ unfolded distribution

Calibration procedure



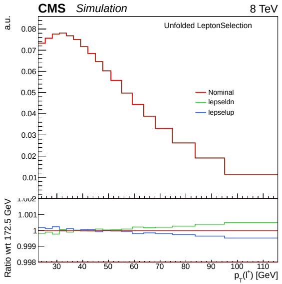
$p_T(l^+)$ unfolded distribution for different MC mass samples.

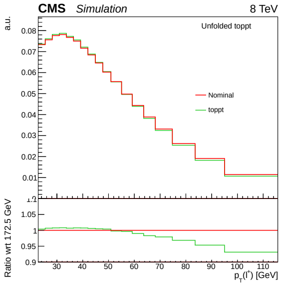


$\mu^{(1)}_{p_T(l^+)}$ calibration curve using different MC mass samples.

First results on Systematic Uncertainties

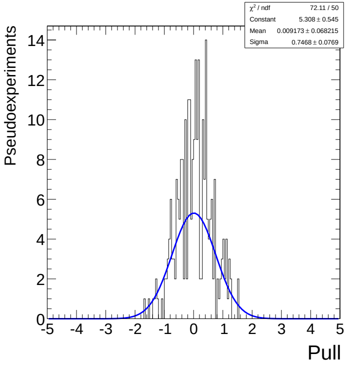
	$p_T(l^+)$	
	$\delta\mu^{(1)}_{p_T(l^+)}$ [GeV]	δm_t [GeV] [GeV]
QCD scales Up	-0.067	-1.329
QCD scales Down	0.115	2.264
Matrix element/Parton shower matching Scale Up	0.077	1.511
Matrix element/Parton shower matching Scale Down	0.102	2.018
Pile Up	0.020	0.402
Pile Down	-0.016	-0.308
Lepton Selection Up	-0.002	-0.043
Lepton Selection Down	0.002	0.044
Top Pt	-0.200	-3.946
Lepton Energy Scale Up	0.003	0.069
Lepton Energy Scale Down	-0.014	-0.282





Next Steps

- Optimize the unfolding procedure with crosschecks.
- Calculate systematic uncertainties of this analysis.
- Compare the calculated moments with the theoretical predictions.
- Perform the measurement of m_t using pseudo data, comparing with the results obtained from the calibration curve.



Pull distribution for $\mu^{(1)}_{p_T(l+)}$. Pull$=\frac{(M_{true}-M_{unfolded})}{\sigma(M_{unfolded})}$.