Precise measurement of the top quark mass with single top events at CMS at √s = 13 TeV

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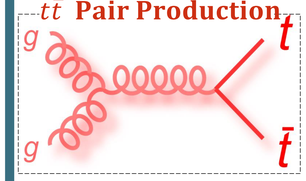
Introduction

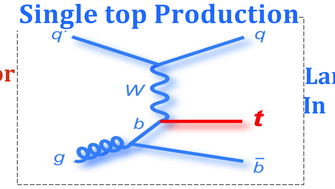
High center of mass energy → Top quark factory LHC
A major goal for the LHC → Precision measurement of top quark mass

$t\bar{t}$ Pair Production



Largest contributor in top Pair Production

Single top Production



Largest contributor In Single top quark Production

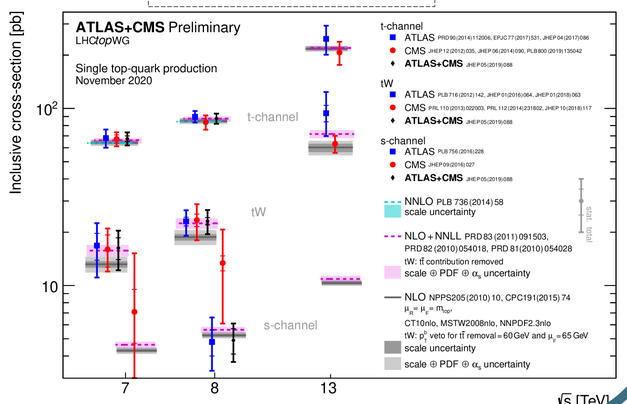
top

Anti-top

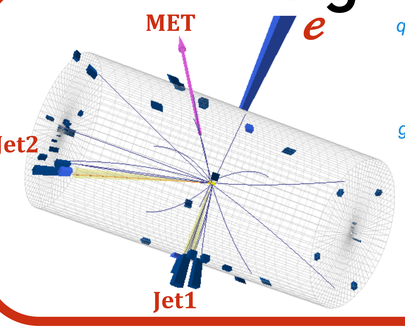
Heaviest particle of the SM

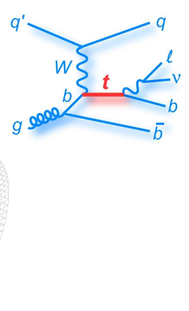
↓

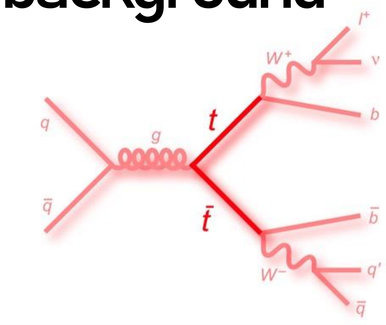
Largest Yukawa coupling with Higgs Boson

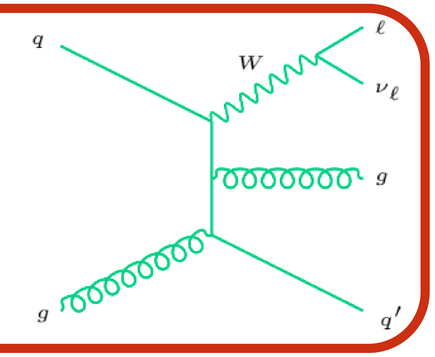


Signal and background







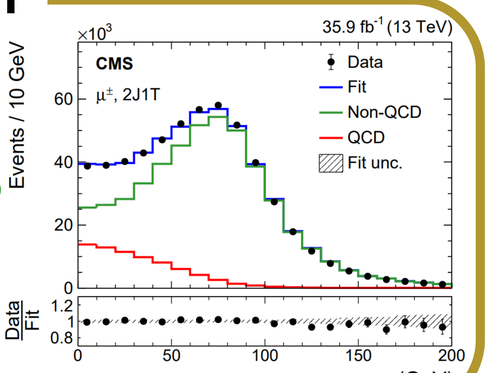


QCD template extraction

- derive QCD template using sideband data
- Two component Maximum Likelihood fit → QCD contribution

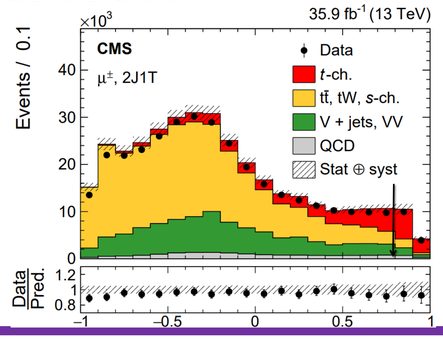
$$F(m_T) = N_{QCD} \times Q(m_T) + N_{non-QCD} \times W(m_T)$$

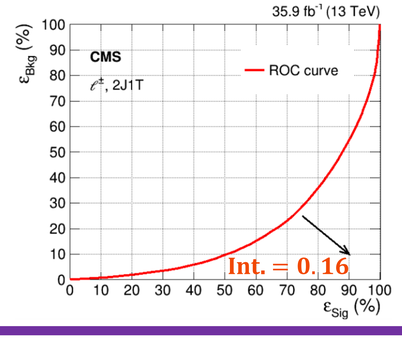
- m_T^W > 50 GeV considered
- 50% uncertainty (shape+rate) on the estimated QCD bkg. propagated as systematic



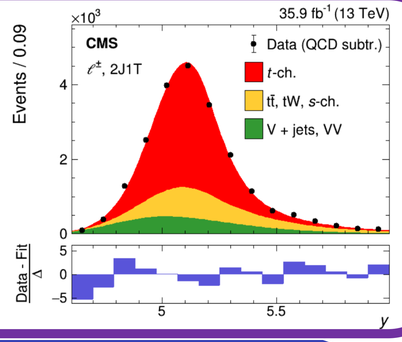
Analysis overview

- 2 lepton flavours → 2 BDTs are trained
- Training variables → low correlation with m_t (reconstructed)
- BDT response > 0.8 selected → ≈ 60% signal purity





- $y = ln(m_t)$ is used for the final fit
- Simultaneous Maximum Likelihood fit performed
- 3 Parametric shapes:
  - Asym. Gaussian core + Landau tail
  - Crystal ball function
  - Novosibirsk function
- Fit is validated in a control region -0.2<BDT<0.8



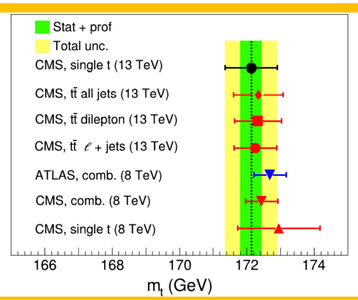
Results

- Inclusive of the lepton charge:

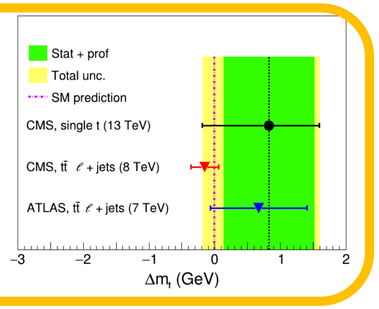
$$m_t = 172.13 \pm 0.32\,(\text{stat+prof})^{+0.69}_{-0.70}\ \text{GeV} = 172.13^{+0.76}_{-0.77}\ \text{GeV}$$

Sub GeV precision is achieved in such phase space

- ℓ^+ → top quark mass $m_t = 172.62^{+1.04}_{-0.75}$
- ℓ^- → antitop quark mass $m_{\bar{t}} = 171.79^{+1.44}_{-1.51}$.



- Top to anti top quark mass difference:
  $\Delta m_t = 0.83^{+0.77}_{-1.01}$ GeV
- Anti top to top quark mass ratio:
  $R_{m_t} = 0.995^{+0.005}_{-0.006}$



Reference:

1. PAS-TOP-19-009
2. LHC Top WG Summary Plots
3. CMS Top Quark Physics Group