Measurement of the Top Quark Mass With 2012 CMS Data- #36

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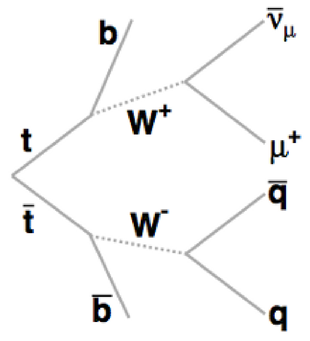
1) INTRODUCTION

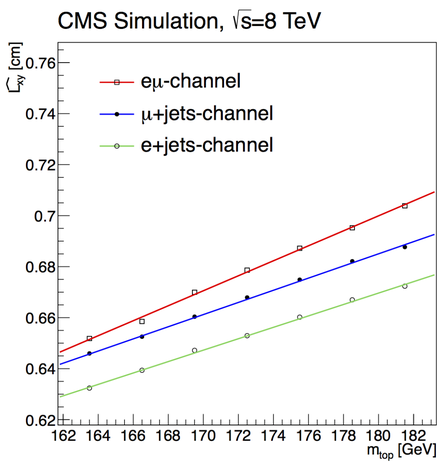
- Top physics is a topic of active research at CMS
- State of the art in 2011: combined mass: m_t = 173.36 $\pm$ 0.38 (stat.) $\pm$ 0.91 (syst.) GeV [2]
- Several measurements of the top mass with 2012 CMS data



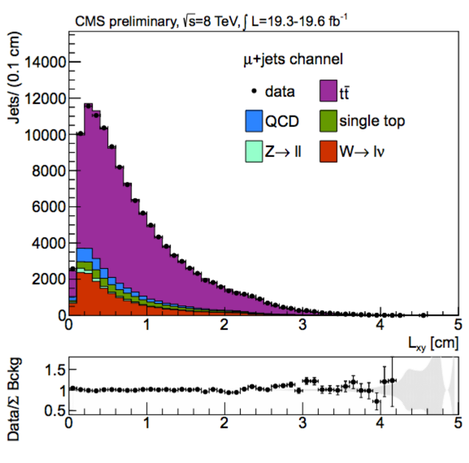
(a) A semileptonic $t\bar{t}$ decay [1].

2) B-HADRON DECAY LENGTH [3]

- Extract m_t from transverse decay length L_{xy} of B-hadron formed by b quark in $t \to Wb$ decay
  - Uses tracker, not calorimeter to avoid systematics from jet energy scale
- $\widehat{L_{xy}}$ has a linear dependency on m_t of order 25 - 30 μm/GeV
  - This dependency needs to be calibrated on a channel-by-channel basis
- Analysis looks at two channels
  - 1 charged lepton, 4+ jets or 1 electron, 1 muon, 2+ jets
- Select secondary vertex with maximal L_{xy} in each accepted event
- m_t = 173.5 $\pm$ 1.5 (stat) $\pm$ 1.3 (sys) $\pm$ 2.6 (p_t^T) GeV



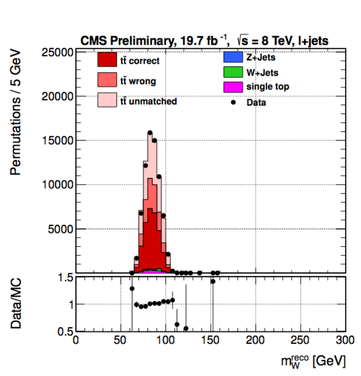
(b) Simulated calibration curves for all three channels.



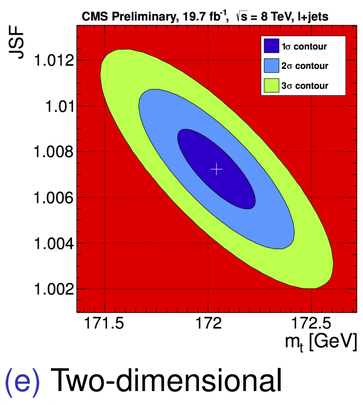
(c) Distribution of L_{xy} in the μ+jets channel.

3) SEMILEPTONIC $t\bar{t}$ DECAYS: THE IDEOGRAM METHOD [4]

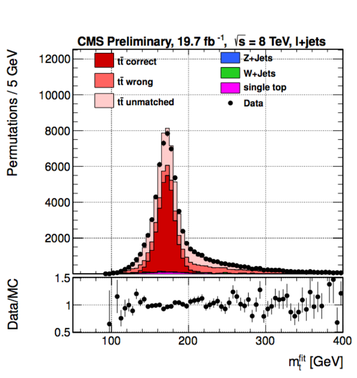
- Semileptonic decays $t\bar{t} \to bWbW \to b\ell\nu bq\bar{q}$
- From jets, can reconstruct W mass m_W^{reco}
- Kinematic fits performed on each event to find fitted top mass m_t^{fit}
- Ideogram method: simultaneous fit of m_t and jet scale factor (JSF)
- Template distributions of m_t^{fit} and m_W^{reco} are generated and fitted to data with two-dimensional likelihood $\mathcal{L}$
- m_t and JSF are found by minimizing $-2\ln\mathcal{L}$
- m_t = 172.04 $\pm$ 0.19 (stat + JSF) $\pm$ 0.75 (sys) GeV
  - JSF = 1.007 $\pm$ 0.002 (stat) $\pm$ 0.012 (sys)
  - First top mass result with sub-GeV uncertainty!



(d) Distribution of M_W^{reco}.



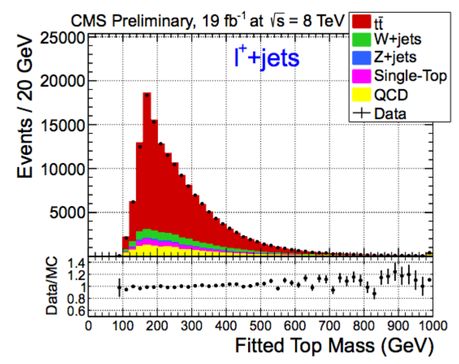
(e) Two-dimensional likelihood contours.



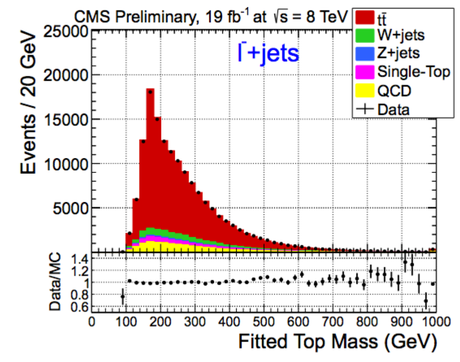
(f) Distribution of M_t^{fit}.

4) $t\bar{t}$ MASS DIFFERENCE [5]

- A test of CPT invariance of SM
- Semileptonic $t\bar{t}$ decays: uses methods described in Section 3
- Δm_t is measured by separating events by lepton sign, measuring ideogram mass from each category, and subtratcting them
- Δm_t = -272 $\pm$ 196 (stat) $\pm$ 122 (sys) MeV



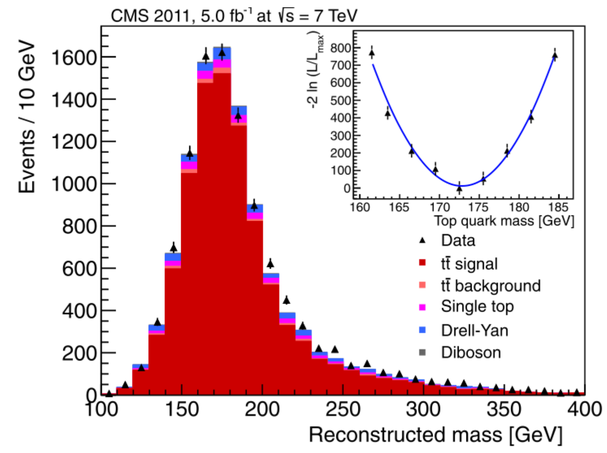
(g) Reconstructed top masses in events with a positive lepton.



(h) Reconstructed top masses in events with a negative lepton.

5) FULLY LEPTONIC $t\bar{t}$ DECAYS: THE AMWT METHOD [6]

- Dilepton decays: two neutrinos so cannot reconstruct mass directly
- Use analytical matrix weighting technique (AMWT) to reconstruct top mass
  - For each event, loop a hypothesis mass between 100 and 700 GeV in 1 GeV steps and assign weight to each value. Mass with highest weight is reconstructed value.
- Likelihood of MC templates generated with different top masses
- m_t = 172.5 $\pm$ 0.4 (stat) $\pm$ 1.5 (sys) GeV
- Currently being performed on 2012 data



(i) AMWT distributions from data and a simulated sample with m_t = 172.5 GeV, with a plot of fitted likelihoods inset.

6) REFERENCES

[1] CMS Public Data
[2] CMS-PAS-TOP-11-018
[3] CMS-PAS-TOP-12-030
[4] CMS-PAS-TOP-14-001
[5] CMS-PAS-TOP-12-031
[6] Eur. Phys. J. C72 (2012) 2202