Precise measurement of the top quark mass and decay width with single top events at CMS

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Introduction

High center of mass energy
Top quark factory LHC

Precision lab for top quark property measurement such as its mass ($m_t$)

Top quark is the heaviest particle of the SM
Largest Yukawa coupling with the higgs boson

Major impact on the stability of EWK vacuum

$t \bar{t}$ is the largest contributor to top quark production at LHC
$t$ channel is the largest contributor to single top quark production

$t t$ is the irreducible bkg & $W + j e s$ is the second domi. bkg. QCD multijet (small selection efficiency)

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Analysis overview

- Two component ML fit $\rightarrow$ QCD contribution

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

- 2 BDTs (per lepton flavour) are trained
- Training variables $\rightarrow$ low correlation with $m_t$

- $\Delta m_t = m_t - m_{\bar{t}}$
Sensitivity to the CPT violation

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Results

- Sub GeV precision is achieved first time in such phase space

$172.13^{+0.57}_{-0.77}$ GeV

$\Delta m_t = 0.83^{+0.77}_{-1.01}$ GeV

Outlook

- Simultaneous ML fit to $m_T$ for QCD shape extraction
- DNN to separate signal from bkg
- Fit the Top quark mass and its width simultaneously
- Add new control region to control syst.
- Improve width precision ?

Signal and backgrounds

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Reference:
1. JHEP 12 (2021) 161
3. CMS Top Quark Physics Group