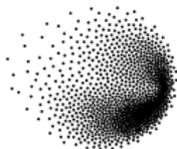


Top Quark Mass Measurement in Single Top Events at $\sqrt{s} = 13$ TeV with CMS

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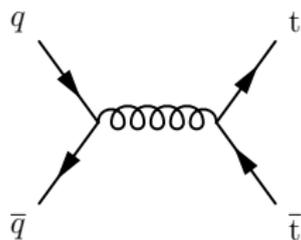
PSI



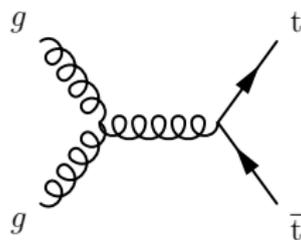
**Universität
Zürich^{UZH}**

Production of Top Quarks

- Top Quark-Antiquark Pair $\longrightarrow \sigma_{t\bar{t}}(pp, \sqrt{s} = 13\text{TeV}) = 832 \text{ pb}$

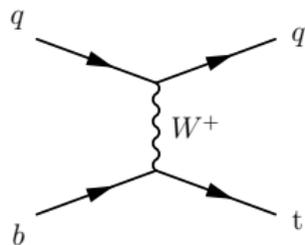


$q\bar{q}$ annihilation

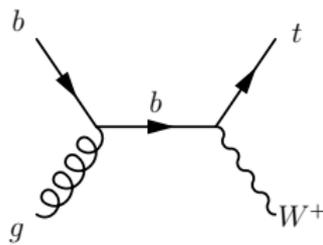


gg fusion

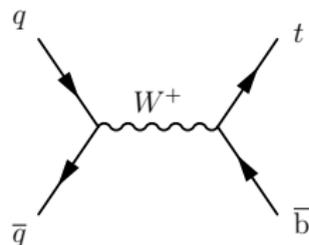
- Single Top quark $\longrightarrow \sigma_t(pp, \sqrt{s} = 13\text{TeV}) = 299 \text{ pb}$



t-channel

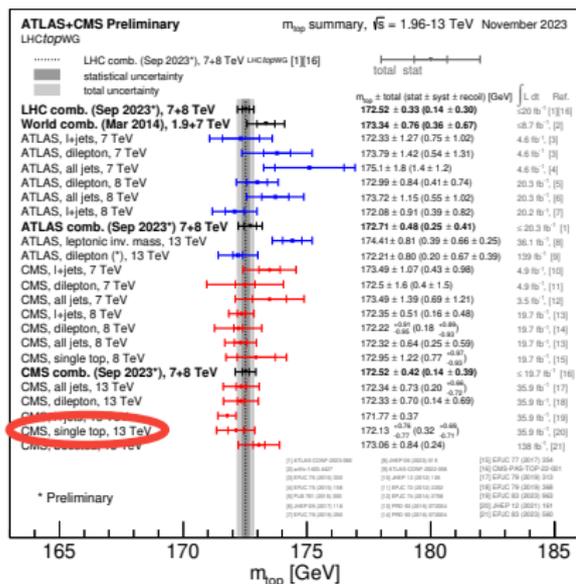


tW-channel



s-channel

Measuring Top Quark Mass



- Most accurate measurements are in semileptonic channels of $t\bar{t}$
- Single-Top measurements in the t-channel



partially uncorrelated systematic sources

Recent CMS Measurement:¹

$$m_{top}^{t-ch} = 172.13 \pm 0.32 \text{ (stat+prof)}^{+0.69}_{-0.71} \text{ (ext)} \text{ GeV} = 172.13^{+0.76}_{-0.77} \text{ GeV}$$

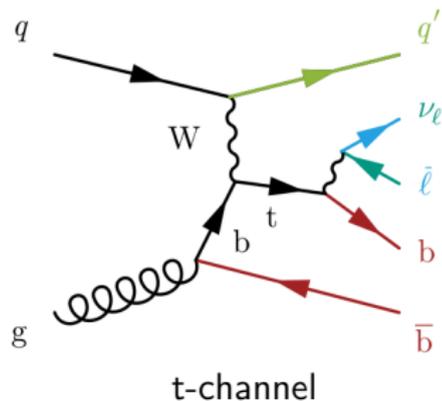
¹CMS Collaboration, JHEP 12 (2021) 161

Traditional Method

The top quark mass is reconstructed from the **momenta of its decay products**

Final state:

- 1 jet from the initial state quark (light jet)
- 1 jet from the b quark (b-jet)
- 1 charged lepton (muon)
- 1 neutrino \rightarrow **missing**



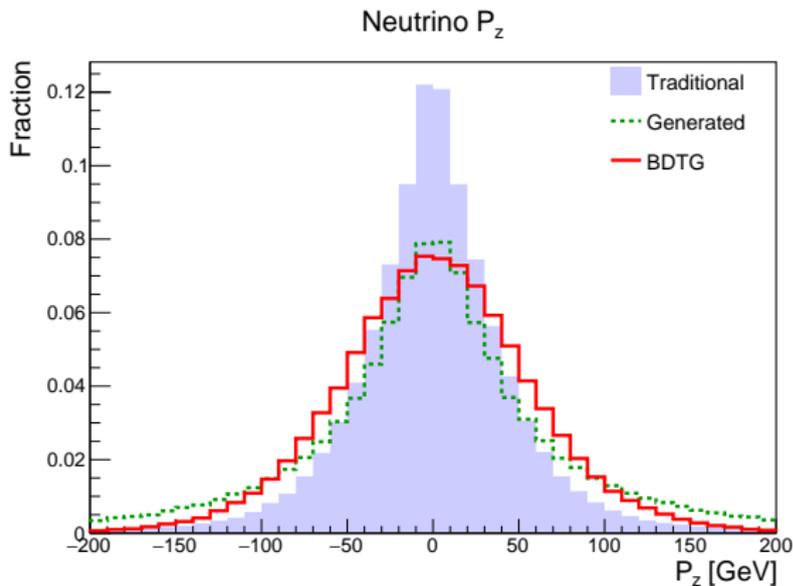
Neutrino Reconstruction:

Neutrino p_x and $p_y \rightarrow$ equal to MET
Neutrino $p_z \rightarrow$ manual constraint at W boson mass } could do better

Kinematic Fit Regression

Innovation #1

Using BDT for regression to estimate the longitudinal component of neutrino momentum (p_z) by utilizing correlations with other kinematic variables



Kinematic Fit Regression

Innovation #2

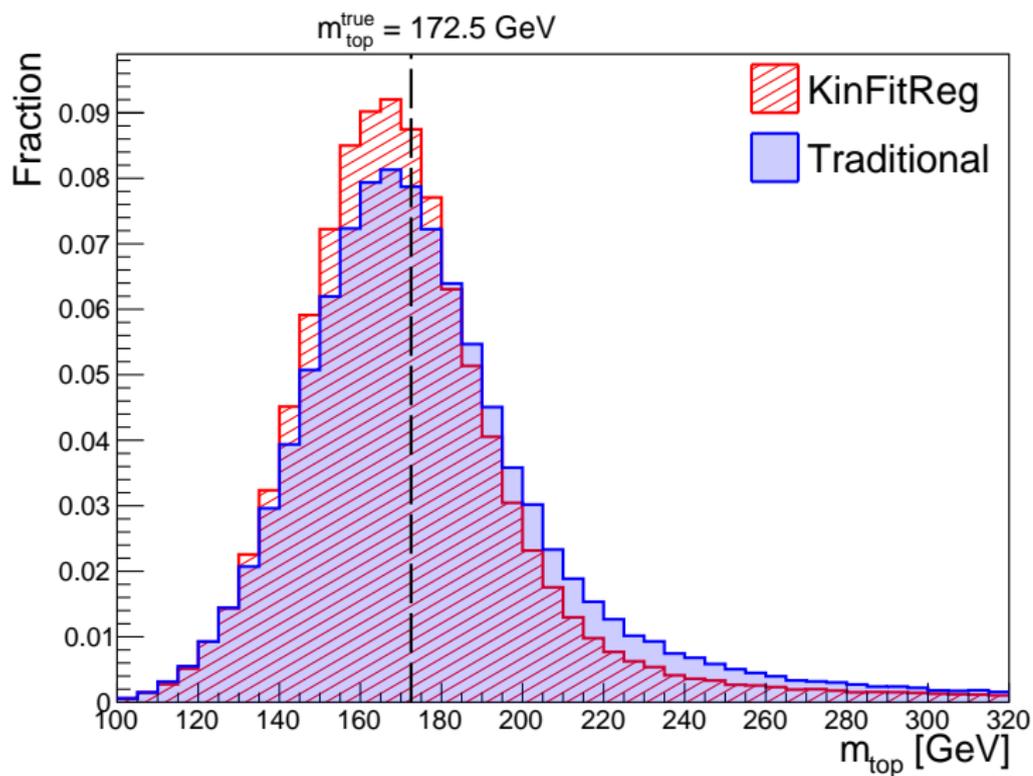
Using kinematic fitting to optimize the simultaneous estimation of all components of the neutrino momentum

- $p_x^{(\nu)}, p_y^{(\nu)}, p_z^{(\nu)}$ already estimated from MET and BDTG
- constraint the mass of W

$$\chi^2(\tilde{p}_x^{(\nu)}, \tilde{p}_y^{(\nu)}, \tilde{p}_z^{(\nu)}) = \left[\frac{m_w^{reco} - m_w^{true}}{\sigma_w} \right]^2 + \left[\frac{\tilde{p}_x^{(\nu)} - p_x^{(\nu)}}{\sigma_x} \right]^2 + \left[\frac{\tilde{p}_y^{(\nu)} - p_y^{(\nu)}}{\sigma_y} \right]^2 + \left[\frac{\tilde{p}_z^{(\nu)} - p_z^{(\nu)}}{\sigma_z} \right]^2$$

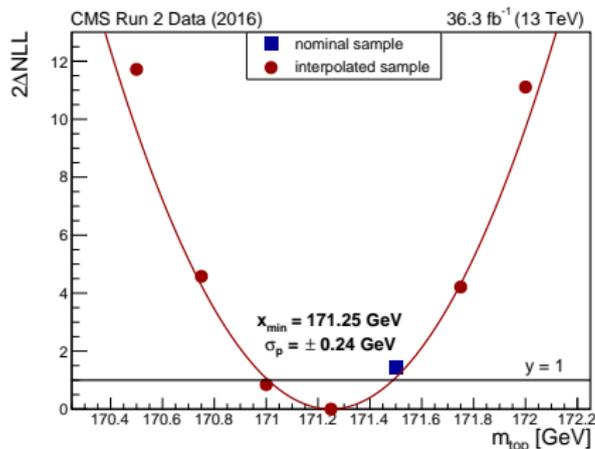
minimize $\chi^2 \rightarrow$ calculate m_{top} with $(\tilde{p}_x^{(\nu)}, \tilde{p}_y^{(\nu)}, \tilde{p}_z^{(\nu)})$

Kinematic Fit Regression



Top Quark's Mass Measurement

- Apply the algorithm to data from CMS (pp collisions, $\sqrt{s} = 13$ TeV)



Result

$$m_{\text{top}}^{t\text{-}ch} = 171.25 \pm 0.24 \text{ (stat) GeV}$$

→ a promising method for reducing uncertainties!

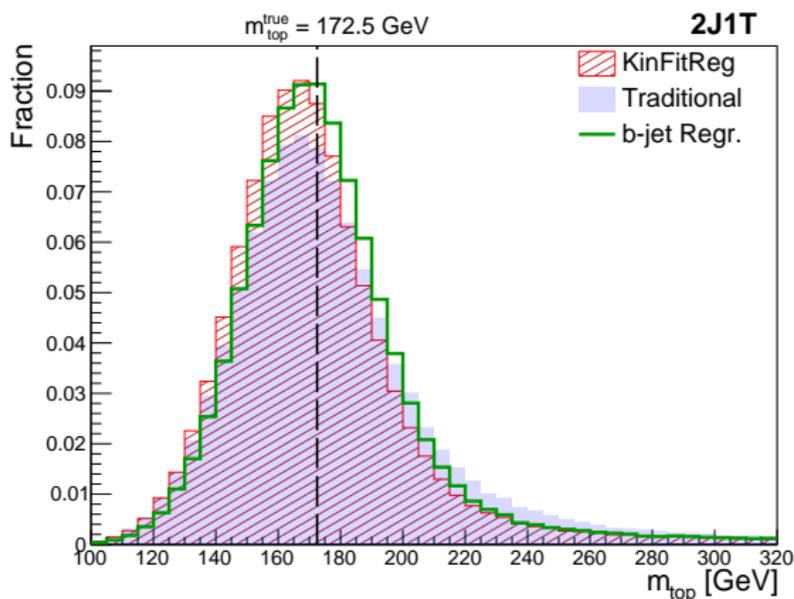
Thank you!

Back-up Slides

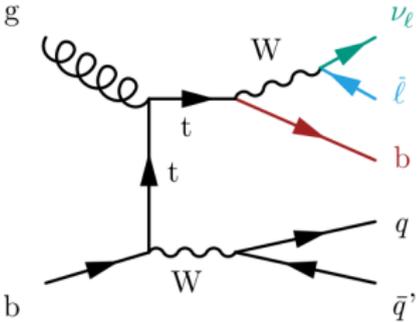
Top Quark's Mass

Reconstruction Algorithm:

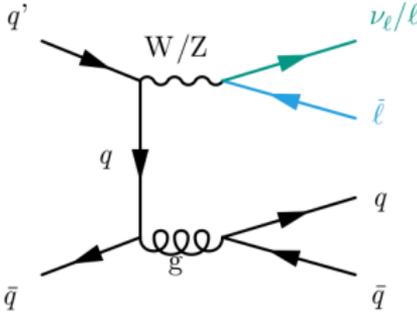
Selection Cuts \rightarrow b-jet Pt Regression \rightarrow Pz-neutrino Regression \rightarrow
 \rightarrow Chi-square \rightarrow Top Mass Reconstruction



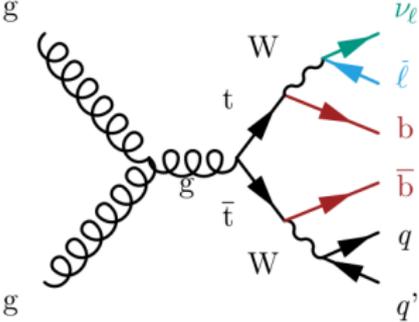
Background Processes



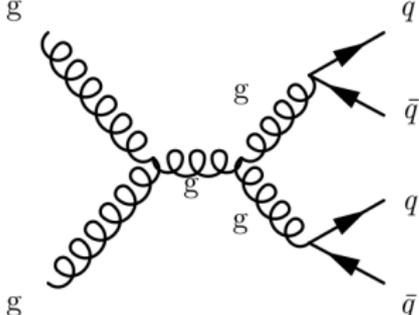
tW -channel



W/Z +jets

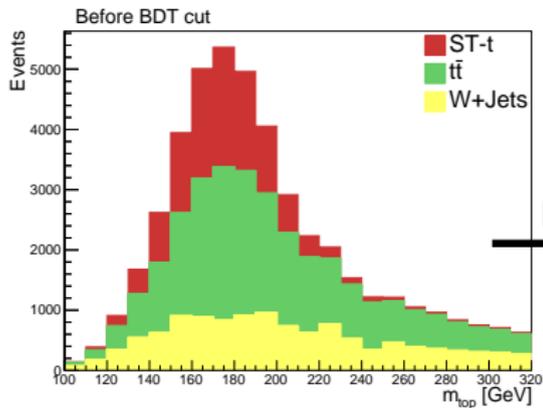
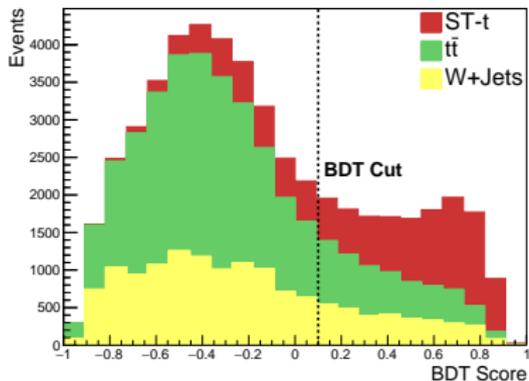


$t\bar{t}$



QCD

Background Suppression



BDT

