# Measurement of the single top quark and antiquark production cross sections in the t channel and their ratio at $\sqrt{s}$ = 13 TeV

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on behalf of the CMS collaboration

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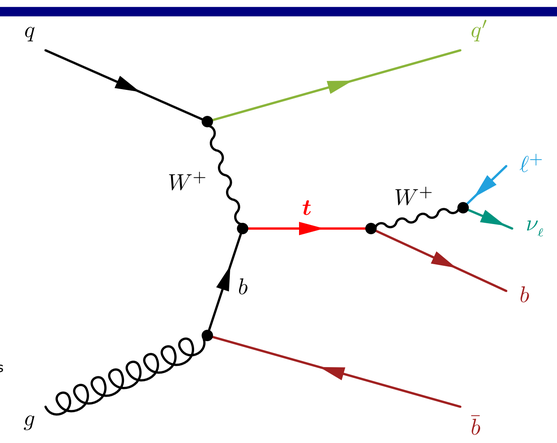
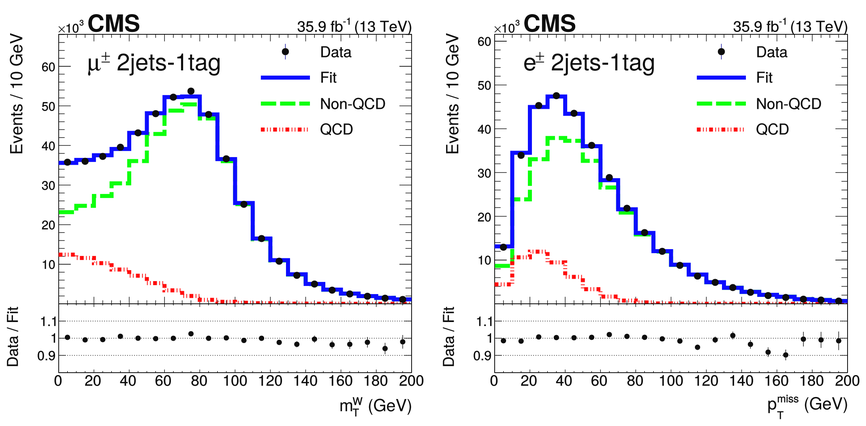
- Production of **single top quarks via electroweak interaction**
- **t** channel dominant production mode for proton-proton collisions at 13 TeV
- Direct measurement of **CKM matrix element** $V_{tb}$
- Cross section ratio $R_{t\text{-ch}} = \sigma_{t\text{-ch,t}}/\sigma_{t\text{-ch,}\bar{t}}$ of t and $\bar{t}$
  - Sensitive to initial quark flavor
  - Probing quark **PDF**

$$\sigma_{t\text{-ch,t}} = 136.0^{+4.1}_{-2.9}(\text{scale}) \pm 3.5(\text{PDF} + \alpha_S)\,\text{pb}$$
$$\sigma_{t\text{-ch,}\bar{t}} = 81.0^{+2.5}_{-1.7}(\text{scale}) \pm 3.2(\text{PDF} + \alpha_S)\,\text{pb}$$
$$\sigma_{t\text{-ch,t+}\bar{t}} = 217^{+6.6}_{-4.6}(\text{scale}) \pm 6.2(\text{PDF} + \alpha_S)\,\text{pb}$$
$$R_{t\text{-ch}} = 1.68 \pm 0.02(\text{scale} + \text{PDF} + \alpha_S)$$

M. Aliev et al., "HATHOR: HAdronic Top and Heavy quarks crOss section calculatoR", Comput. Phys. Commun.182(2011) 1034

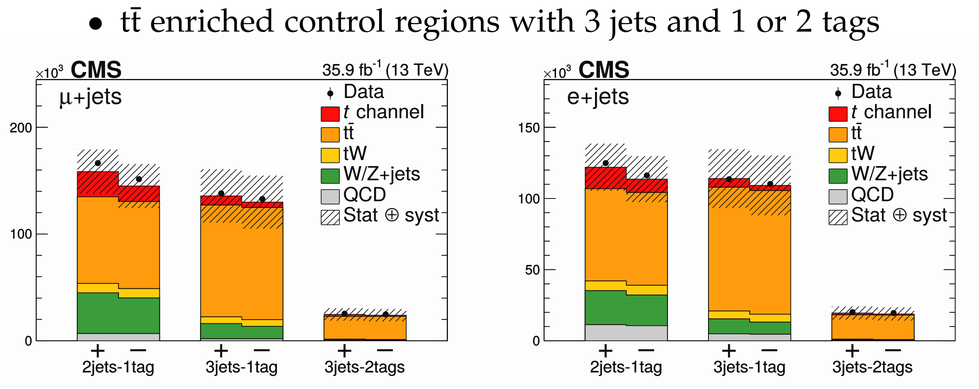
P. Kant et al., "HatHor for single top-quark production: Updated predictions anduncertainty estimates for single top-quark production in hadronic collisions",Comput.Phys.Commun.191(2015) 74

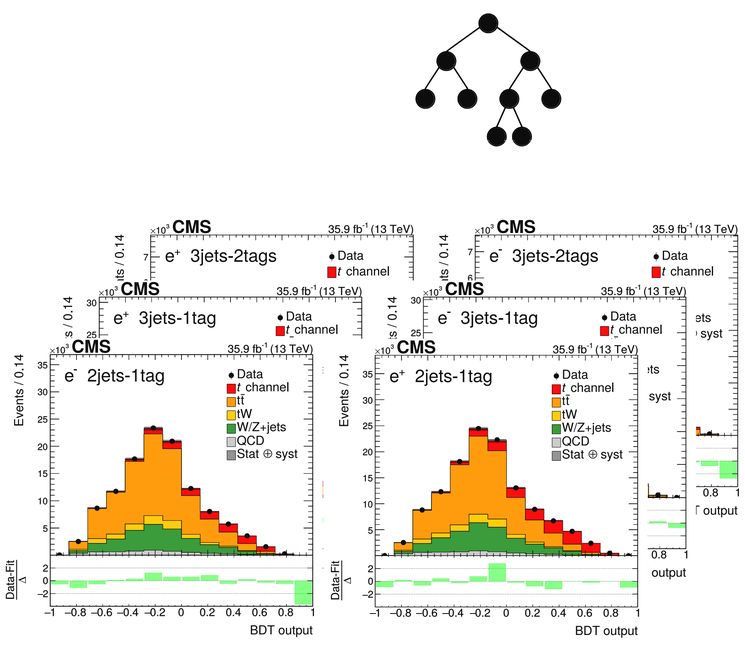


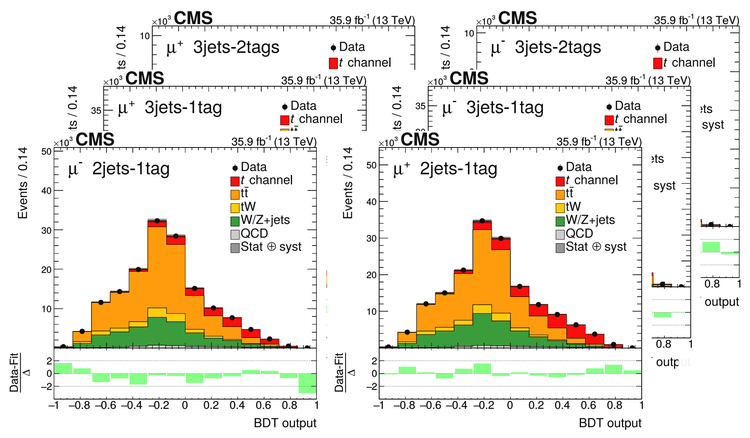




- One isolated muon (electron) with $p_T > 26$ (35) GeV, $|\eta| < 2.4$ (2.1)
- Veto on additional leptons
- 2-3 jets with $p_T > 40$ GeV, $|\eta| < 4.7$
- 1-2 b-tagged jet with $p_T > 40$ GeV, $|\eta| < 2.1$
- $m_T^W > 50$ GeV (muon)
- $p_T^{miss} > 30$ GeV (electron)
- Signal region with 2 jets and 1 tag
- $t\bar{t}$ enriched control regions with 3 jets and 1 or 2 tags

- **Data-driven QCD** estimation
- Enriche data with QCD by inverting lepton isolation
- Fit $m_T^W$ (muon) and $p_T^{miss}$ (electron) distributions to obtain QCD template

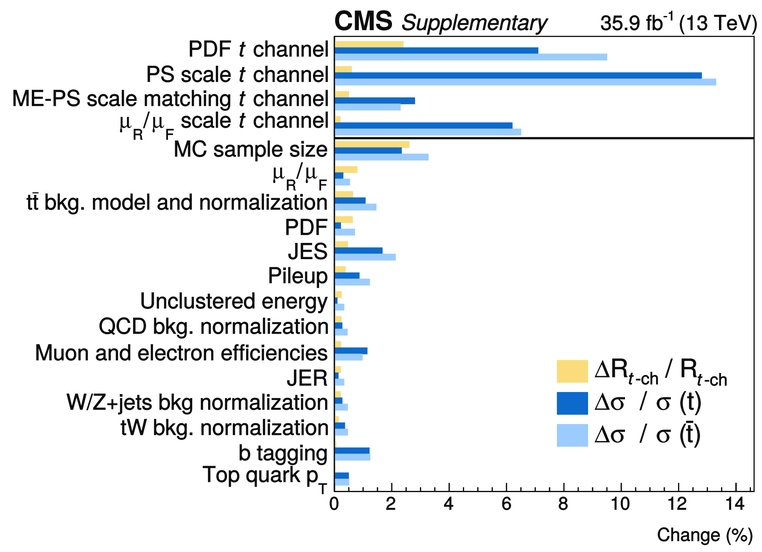


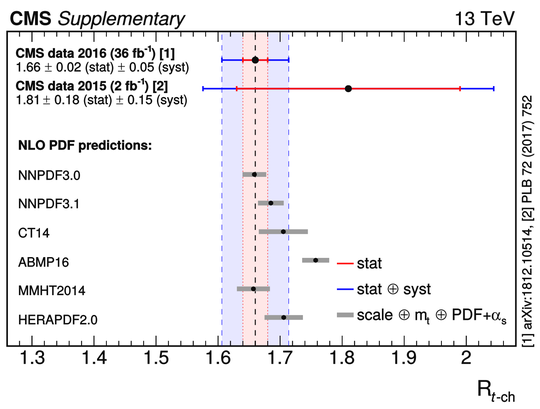

- Signal modeling uncertainties: Repeat fit with varied template.
- Other uncertainties: Treated as nuissance parameters in the fit.
- Dominant uncertainties: Signal modeling, limited size of MC samples.

- BDTs trained in signal region
- Simultaneous maximum likelihood fit on twelve BDT output distributions: three regions, two leptons, two charges




$$\sigma_{t\text{-ch,t}} = 136 \pm 1\,(\text{stat}) \pm 22\,(\text{syst})\,\text{pb}$$
$$\sigma_{t\text{-ch,}\bar{t}} = 82 \pm 1\,(\text{stat}) \pm 14\,(\text{syst})\,\text{pb}$$
$$\sigma_{t\text{-ch,t+}\bar{t}} = 219 \pm 2\,(\text{stat}) \pm 36\,(\text{syst})\,\text{pb}$$
$$R_{t\text{-ch}} = 1.66 \pm 0.02\,(\text{stat}) \pm 0.05\,(\text{syst})$$

$$|f_{LV}V_{tb}| = 1.00 \pm 0.08\,(\text{exp}) \pm 0.02\,(\text{theo})$$




arxiv:1812.10514
Submitted to Physics Letter B



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