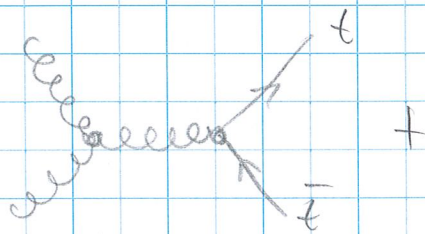


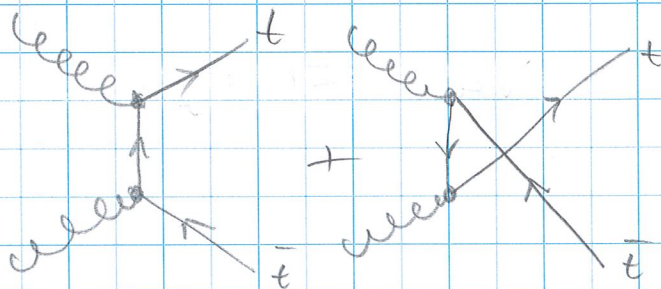
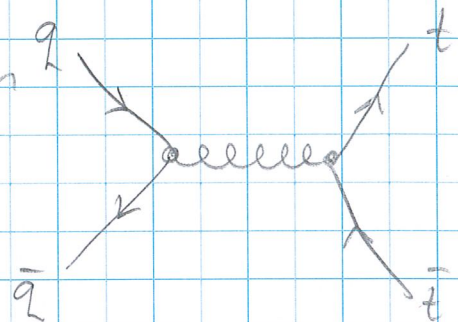
1

Top Quark Production

LHC



Tevatron



Mass: $m_t \approx 173 \text{ GeV}/c^2$

Decays of the top quark:

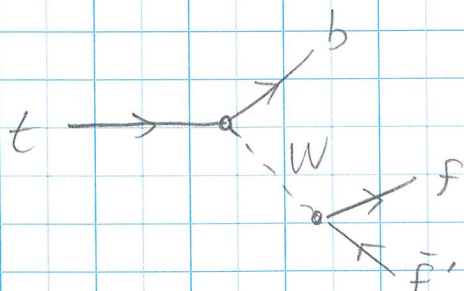
$$B(t \rightarrow e \nu_e b) = 13.3\%$$

$$B(t \rightarrow \mu \nu_\mu b) = 13.4\%$$

$$B(t \rightarrow \tau \nu_\tau b) = 7.1\%$$

$$B(t \rightarrow q \bar{q} b) = 66.5\%$$

τ is more massive than μ or e .



$$Br(W^+ \rightarrow e^+ \nu) = 10.7\%$$

$$Br(W^+ \rightarrow \mu^+ \nu) = 10.6\%$$

$$Br(W^+ \rightarrow \tau^+ \nu) = 11.4\%$$

$$Br(W^+ \rightarrow \text{hadrons}) = 67.4\%$$

Decay Signatures for $t\bar{t}$ production

$e+e$	1%
$\mu+e$	2%
$\mu+\mu$	1%
$\tau+e$	2%
$\tau+\mu$	2%
$\tau+\tau$	1%
$e+\text{jets}$	15%
$\mu+\text{jets}$	15%
$\tau+\text{jets}$	15%
all jets	44%

Cross section measured in dilepton final state at CMS :

$$\sqrt{s} = 13 \text{ TeV}$$

$$\int \mathcal{L} dt = 2.2 \text{ Pb}^{-1}$$

Trigger :

- e with $p_T > 12 \text{ GeV}$
- μ with $p_T > 17 \text{ GeV}$
- or e with $p_T > 17 \text{ GeV}$
- μ with $p_T > 8 \text{ GeV}$
- or e with $p_T > 23 \text{ GeV}$
- or μ with $p_T > 20 \text{ GeV}$

Total trigger efficiency is essentially 100%.

Offline selection:

Opposite sign leptons, one e , one μ .

$$p_T(e) > 20 \text{ GeV}$$

$$p_T(\mu) > 20 \text{ GeV}$$

$$I(e) < 7\%$$

$$I(\mu) < 15\%$$

Selection efficiencies measured using $Z \rightarrow ee$ and $Z \rightarrow \mu\mu$ (tag & probe method)

$$M_{e\mu} > 20 \text{ GeV}$$

Suppresses $\tau^+\tau^-$ production.

Jet reconstruction: anti- k_T with $R = 0.4$

Require at least two jets with $p_T > 30 \text{ GeV}$

b-jets identified using a secondary vertex algorithm

$$\epsilon = 67\%$$

mistag rate is 1% for u, d, s, g jets
15% for c -quark jets.

Backgrounds:

Single-top	(simulation)
Drell-Yan	(data + simulation)
VV	(simulation)
fake leptons	(same-sign samples)

(Figure 1 in CMS-TOP-16-05)

Systematic uncertainties:

Trigger (1.2%) and lepton ID (2.3%)
efficiencies, modelling (2.1%) backgrounds
(1.5%) Luminosity (2.3%).

$$\sigma_{t\bar{t}} = \frac{N - N_B}{A \mathcal{L}}$$

$$= 815 \pm 9 \text{ (stat)} \pm 38 \text{ (syst)} \pm 19 \text{ (lumi)} \text{ pb}$$

Total $t\bar{t}$ signal 2921 events
bkg 646 events.

Acceptance depends on assumed m_t .

Central value: $m_t = 172.5 \text{ GeV}$

$$\frac{d\sigma_{t\bar{t}}}{dm_t} = \frac{3.7 \text{ pb}}{0.5 \text{ GeV}}$$

Cross section using $l + \text{jets}$:

$$\sqrt{s} = 13 \text{ TeV}$$

$$\int \mathcal{L} dt = 2.2 \text{ fb}^{-1}$$

Trigger: $\left. \begin{array}{l} e \text{ with } p_T > 22 \text{ GeV} \\ \text{or } \mu \text{ with } p_T > 20 \text{ GeV} \end{array} \right\} + \text{isolation}$

Offline: $p_T(l) > 30 \text{ GeV}$

Reject event if another lepton is found with $p_T(e) > 15 \text{ GeV}$ or $p_T(\mu) > 10 \text{ GeV}$
(Rejects $Z \rightarrow e^+e^-$ and VV)

Jet reconstruction: anti- k_T , $R = 0.4$
 $p_T(\text{jet}) > 30 \text{ GeV}$

b-tagging: Secondary vertex $\epsilon > 65\%$
Misid $\approx 1\%$ for $udsq$.

Several categories of events:

1-jet	0 - btag	1 - btag	} 11
2-jets	0, 1, 2	b-tags	
3-jets	0, 1, 2	b-tags	
4-jets	0, 1, 2	b-tags	
e^+			} 4
e^-			
μ^+			
μ^-			

⇒ 44 distinct event categories, each with different signal yields and background contributions.

{ figure 1 in CMS-TOP-16-06 } 33

$M(l, b)$ is different for top and bkg.

$$\sigma_{t\bar{t}} = 888 \pm 2 (\text{stat}) \pm 27 (\text{syst}) \pm 20 (\text{lumi})$$

$$\hookrightarrow m_t = 170.6 \pm 2.7 \text{ GeV}$$

Both measurements agree at the 1.5 σ level.