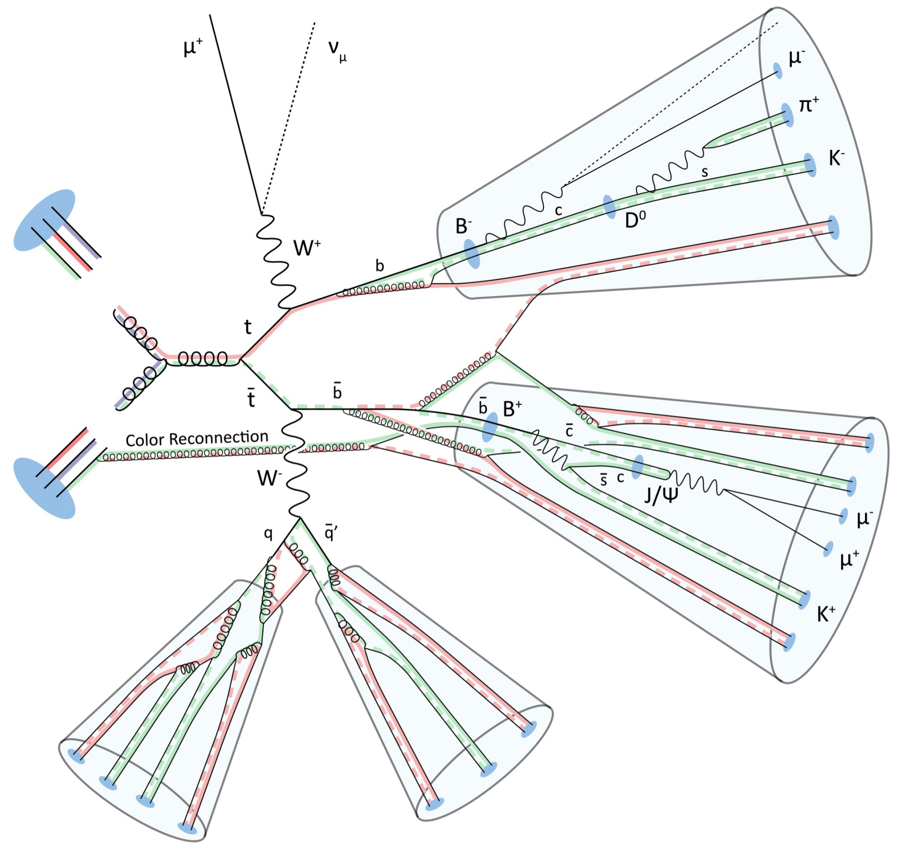
Introduction to the Terascale

1st day

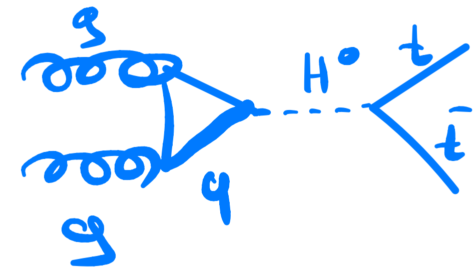


$m_t \simeq 172\,GeV$

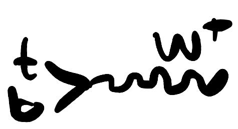
$m_p \simeq 1\,GeV$

$\tau \sim 10^{-25}\,s$

$BR(t \to W^+ b) \simeq 99.9\%$



1/2				1	0
u	c	t ~ 172		$W^\pm$	
d	s	b		Z	h^0
e	μ	τ		γ	
ν	ν	ν		g	



Exercise 1

$x = BR(t\bar{t} \to \mu^\pm + \text{jets}) = \begin{cases} t\bar{t}\ \text{MC truth} \\ \text{theory} \to p \pm \delta p \end{cases}$

$BR(W^\pm \to \mu^\pm \nu) = 0.1$

$BR(W^+ \to q\bar{q}) = 0.7$

$t\bar{t} \to W^+ b\ W^- \bar{b} \to \begin{cases} \mu^+ \nu b\ q\bar{q}\bar{b} \\ q\bar{q} b\ \mu^- \bar{\nu} \bar{b} \end{cases}$

$N(t\text{tbar}) = 36941$ events

$BR(t\bar{t} \to \mu^\pm + \text{jets}) = 0.1\ 0.7 \cdot 2 = 0.14$

$p = 0.14$ $\qquad q \equiv 1 - p$

$\square\ \square\ \cancel{\square}\ \square\ \square\ \square\ \cancel{\square}\ \square\ \square\ \square\ \ldots = \frac{N}{(N-n)!\,n!}\, p^n q^{N-n}$

q q p q q q p q q q

$$P(n) = \binom{N}{n} p^n (1-p)^{N-n}$$

$$\delta p = \sqrt{\langle p^2 \rangle - \langle p \rangle^2} = \frac{\sqrt{Np(1-p)}}{N} = \sqrt{\frac{p(1-p)}{N}} = 0.18\%$$

theory	$0.1400 + 0.0018$
MC truth	0.1450

$3\sigma \sim 1\%$

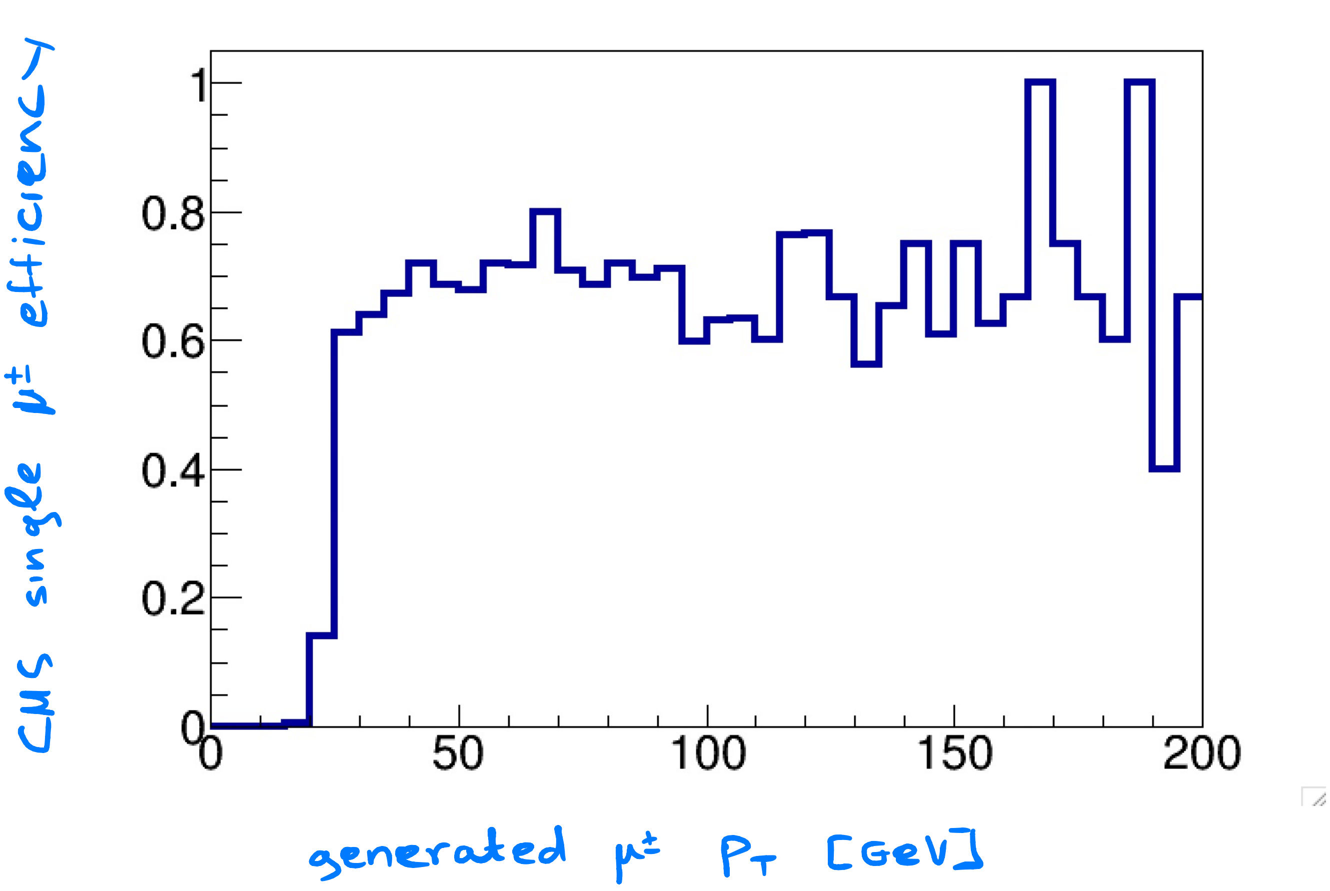
MC analysis

- we selected semi-leptonic $t\bar{t}$ events with a $\mu^\pm$ at MC truth level = GEN level

abs(MCleptonPDGid) == 13

and check how often those fire the CMS single $\mu^\pm$ trigger

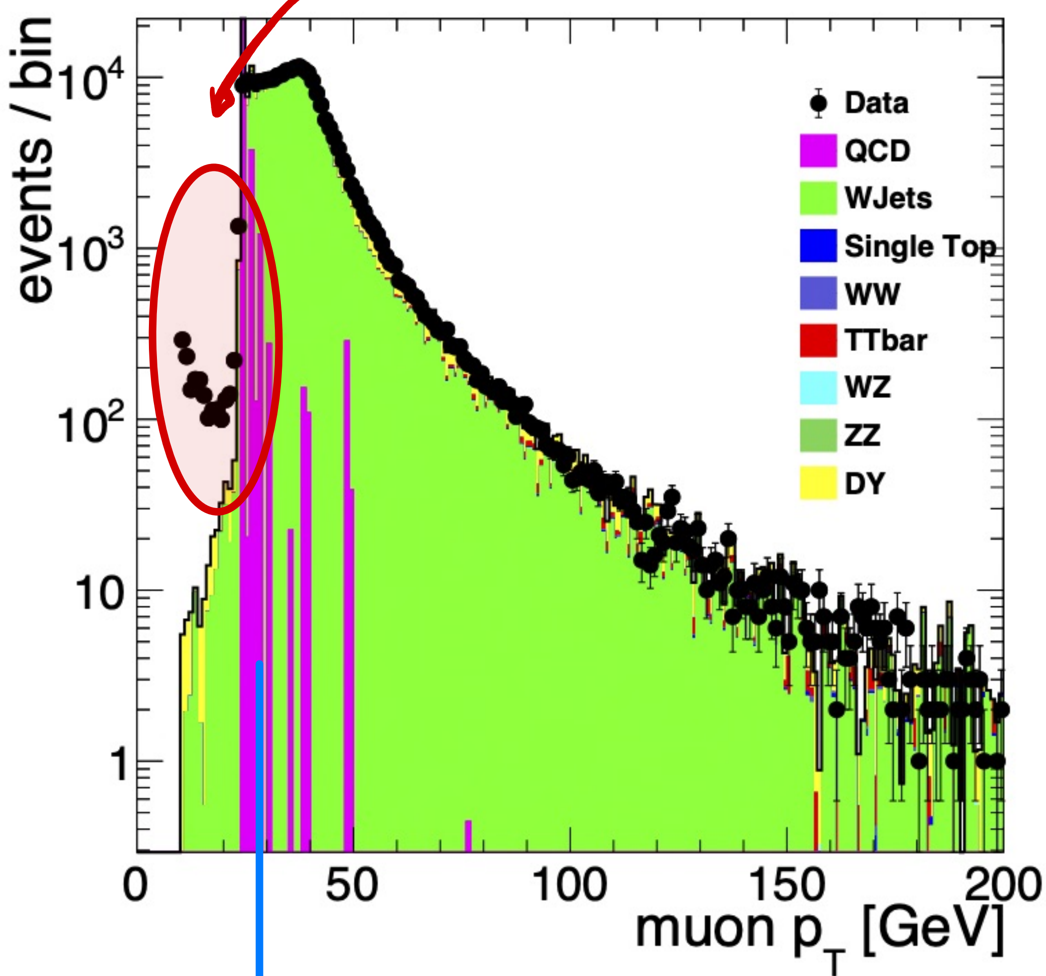
triggerIsoMu24 == 1



Introduction to the Terascale

2nd day

events that the reco $\mu^\pm$ p_T != $\mu^\pm$ p_T that the CMS trigger has estimated



~24 GeV trigger threshold

QCD = pp → multi jets

huge cross section

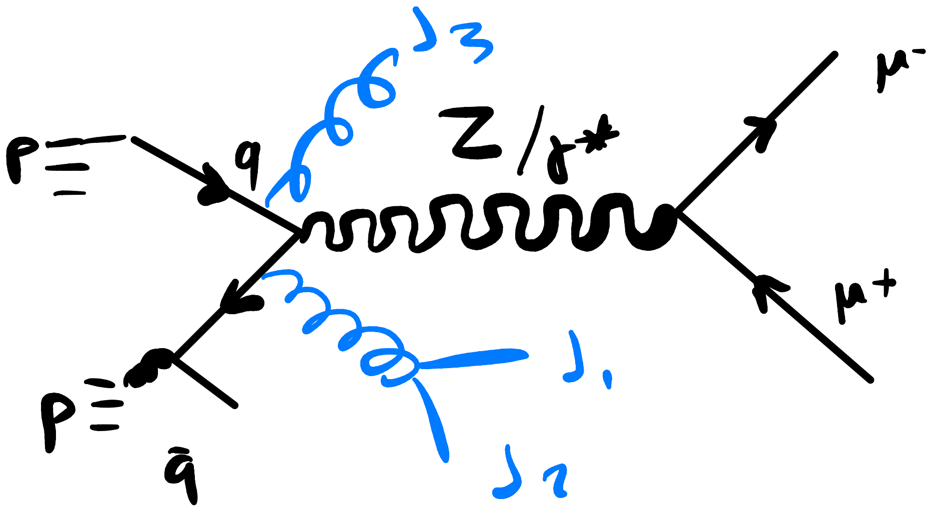
↓

huge event weight

↓

large uncertainty

- Looking into Data (unbeinded)
- $\sigma(t\bar{t})$ = ?
- students presentations Thursday 16:00–18:00
  ~10'
- ROOT without ROOT aka uproot
  awkward
  numpy
  matplotlib

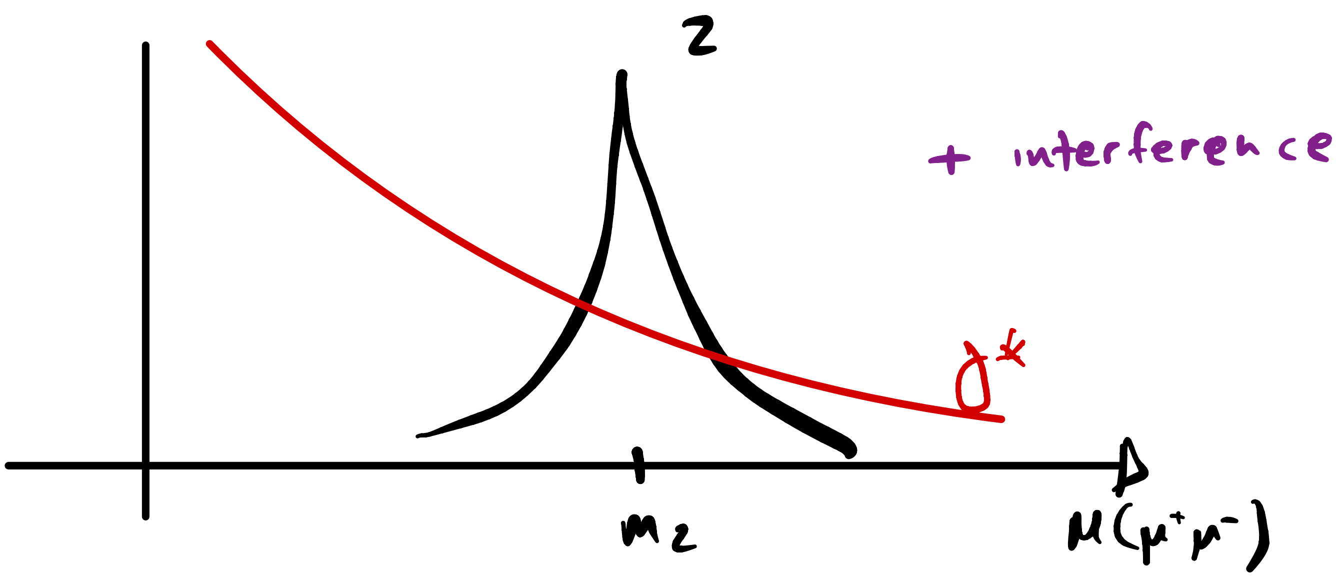


$\mu^- \rightarrow p_1^\mu = (E_1, p_{x1}, p_{y1}, p_{z1})$

$\mu^+ \rightarrow p_2^\mu = (E_2, p_{x2}, p_{y2}, p_{z2})$

$$(p_1+p_2)^\mu (p_1+p_2)_\mu = (E_1+E_2)^2 - (p_{1x}+p_{2x})^2 - (p_{1y}+p_{2y})^2 - (p_{1z}+p_{2z})^2 = M^2$$

$n^{\mu\nu} = (+1, -1, -1, -1)$



integrated lumi.
(area)$^{-1}$

$$N_{tot}^{DY} = \sigma_{DY} \cdot L$$

area

30% uncert

integrated lumi. $= 50\ pb^{-1}$
(area)$^{-1}$
$+ 2\text{-}3\%$

$$N_{sel}^{DY} = \varepsilon_{DY}\, \sigma_{DY} \cdot L$$

area

$$B = N_{sel}^{DY} + N_{sel}^{w+j} + \dots \qquad \delta B$$

estimation

$N - B$ = signal candidates in Data !

$$\sigma_{t\bar{t}}^{Data} \cdot \varepsilon_{t\bar{t}} \cdot L = N - B$$

$$\sigma_{t\bar{t}} = \frac{N-B}{\varepsilon_{t\bar{t}} \cdot L} \qquad \varepsilon_{t\bar{t}} = \frac{\text{selected } t\bar{t} \text{ events}}{\text{total number of } t\bar{t}} \qquad \delta\varepsilon_{t\bar{t}} = 30\%$$