HLT Optimization for a Heavy B Quark

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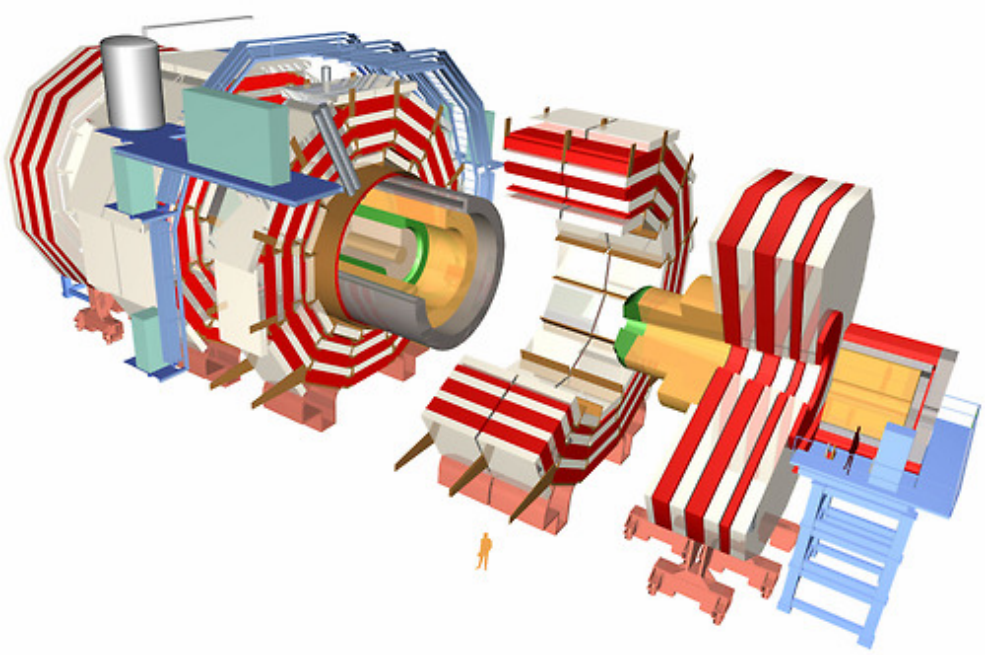
CMS: A "general purpose" detector

Looking for:

- The Higgs
- Supersymmetry
- Technicolor
- etc.



Any confirmation of old physics; any evidence of new physics!

The HLT

Too much to store!

~40 TB of data per second

L1 (level 1) trigger

Keeps "interesting" events,

i.e. those with high-energy particles or

unexpected combinations of particles

~50 GB of data per second

HLT (high level trigger)

Performs quick reconstruction of events,

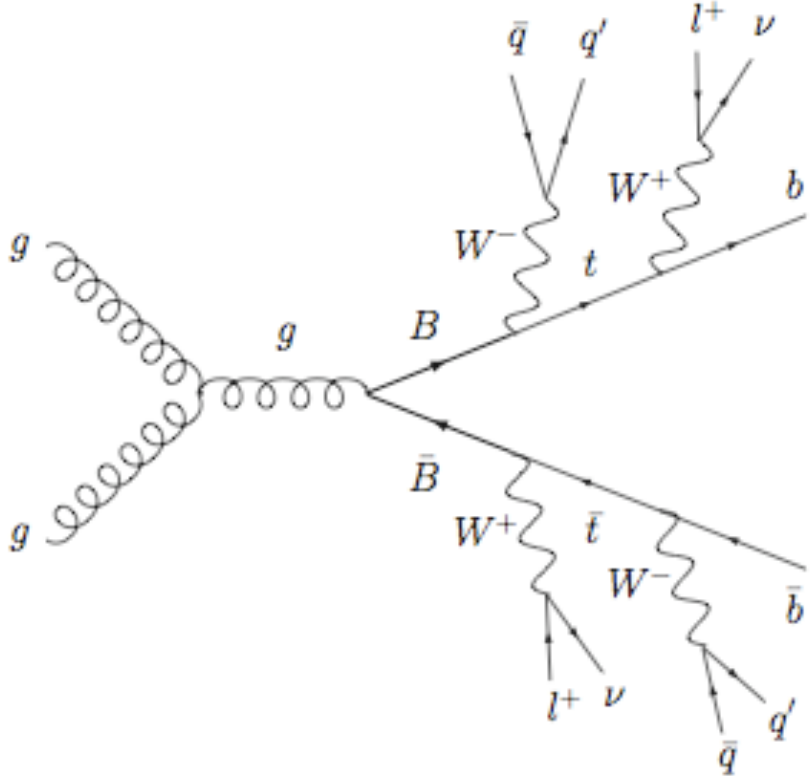
does not keep well-understood events

Optimized using Monte Carlo simulations

~100 MB of data per second

The Heavy B

- Partner of the $T_{5/3}$
- Charge: -1/3
- Mass: 400 GeV – 1 TeV
  (testing 400 GeV, 500 GeV)



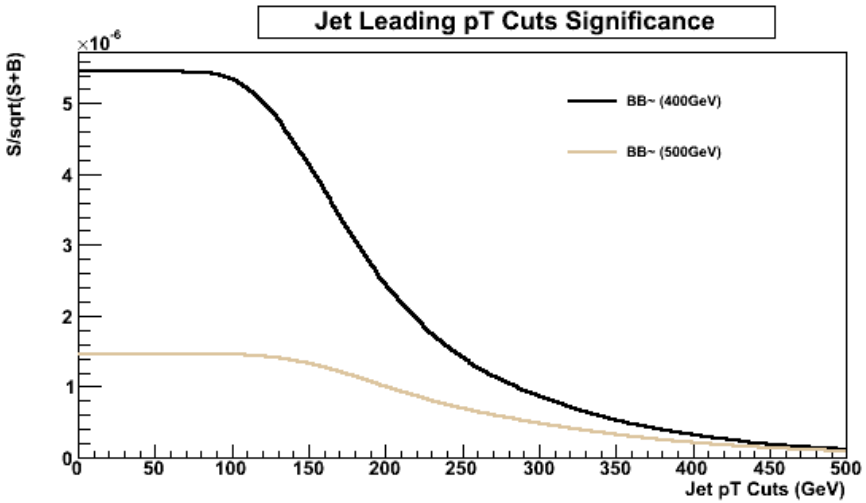
Tasks completed

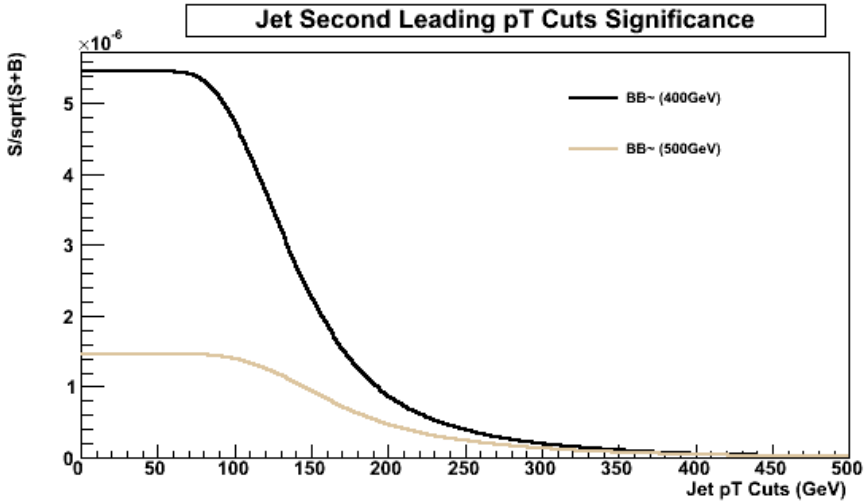
- Signal and background generation
- Analysis:
  - Efficiency plots for cuts on transverse momentum
    - Jet leading p_T
    - Jet second leading p_T
    - Lepton leading p_T
    - Lepton second leading p_T

    (E = S/sqrt[S+B])
- Partial revision of PAT analysis code

Efficiency plots: jet pT

(requiring 5 jets of pT >= 50 GeV before creating significance plots)





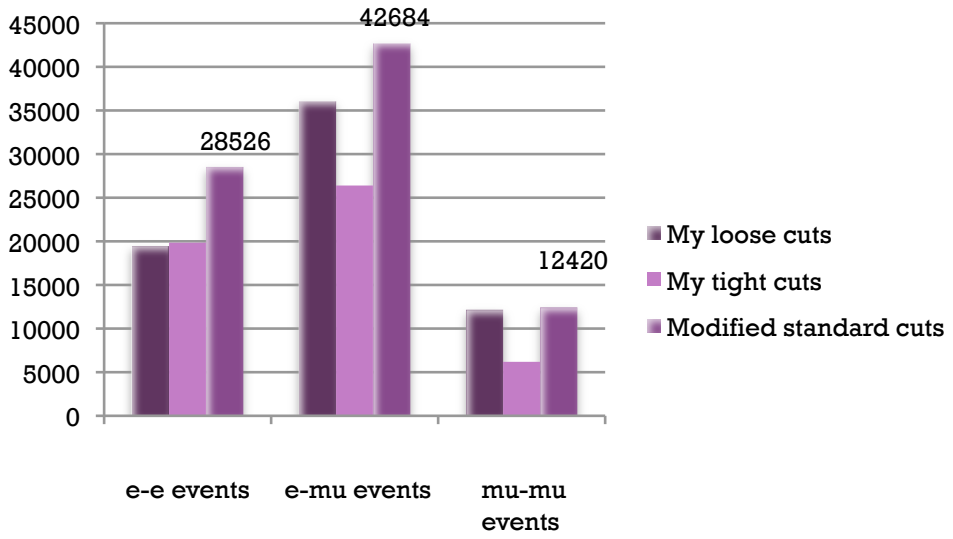
+ Sources of background:

- $t\bar{t}W^{\pm}+-$
- $t\bar{t}W^{+}W^{-}$
- $W^{\pm}W^{+}W^{-}$
- $W^{\pm}W^{\pm}$
- $t\bar{t}$ + jets
- W + jets
- Z + jets
- QCD multijets

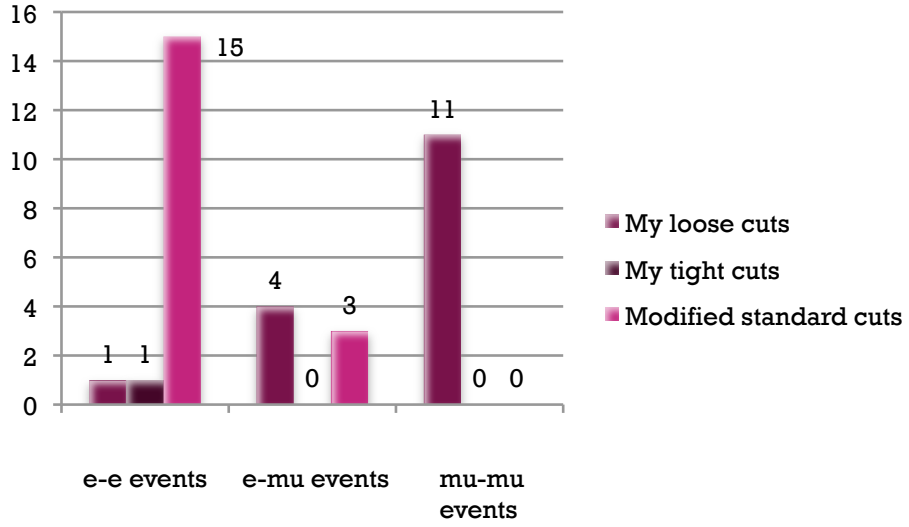
Samples	σ (fb)	$\sigma \times BR(l^{\pm}l^{\pm})$ (fb)	# of Events	Integrated £(fb^{-1})
$T_{5/3}$ (M=400 GeV)	1715	36.0	100000	2.77×10^{3}
$T_{5/3}$ (M=500 GeV)	399	8.40	99998	1.19×10^{4}
$t\bar{t}W^{\pm}$	98	3.34	92407	2.77×10^{4}
$t\bar{t}W^{+}W^{-}$	22.1	0.47	100000	2.13×10^{5}
$W^{\pm}W^{+}W^{-}$	80	1.50	96691	6.45×10^{4}
$W^{\pm}W^{\pm}$	252	11.6	60486	5.21×10^{3}
$t\bar{t} + jets$	9.4×10^{4}	- [1]	1460228	15.5
$Z + jets$	-	2.2×10^{6}	2524654	1.15
$W^{\pm} + jets$	-	2.4×10^{7}	14789801	0.62
QCD multijets	2.2×10^{13}	-	1550753	1.45×10^{-8}

Effects of lepton quality cuts

Signal



QCD background



Work for the future

- Monte Carlo simulations:
  - Finish editing PAT analysis code
  - Remake significance plots to optimize kinematic cuts
  - Optimize for lepton isolation
  - Apply all optimized cuts
  - Determine expected # of particles from signal, background at current luminosity
  - Determine luminosity required to either discover or exclude heavy B at these masses
- Data:
  - Apply cuts on # jets, p_T, isolation
  - Search for events matching heavy B signature
  - Attempt to either discover or exclude heavy B with mass of 400/500 GeV

Sources

- CERN. (2011). *CMS – Detector (Triggering).* Retrieved from http://cms.web.cern.ch/cms/Detector/DataAcquisition/Triggering.html
- Cheung, E. (May 17, 2011). *Searching for Heavy Top Quark Partners Using the CMS Detector.*
- The CMS Collaboration. (July 21, 2009). *Search for Exotic Partners of the Top Quark with the CMS Experiment.*
- Florida State University. (2006). *A 3D View of the CMS Detector*. [Web]. Retrieved from http://www.hep.fsu.edu/cms.html

Munich!