

Search for Heavy Scalar Bosons decaying in Four Tops at the LHC

Wjj Group Meeting

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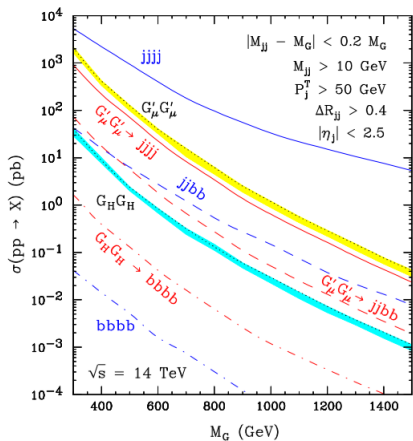
Introduction

- Four Top production small ($\sigma_{t\bar{t}t\bar{t}} < 1 \text{ fb}$)
- Any Four Top signal could be a signal of BSM Physics.
- Many theories: Technicolor, Extra Dimensions, topcolor models of Higgs compositeness, ...
- Par production Heavy Scalar Bosons \Rightarrow Four Tops
- Dobrescu, B. Kong, K. Mahbubani, R. 2008. *Massive color-octet bosons and pairs of resonances at hadron colliders*. Physics Letters B, 670(2), pp. 119-123.



Theoretical Introduction

Dobrescu, et. al.,(2008):

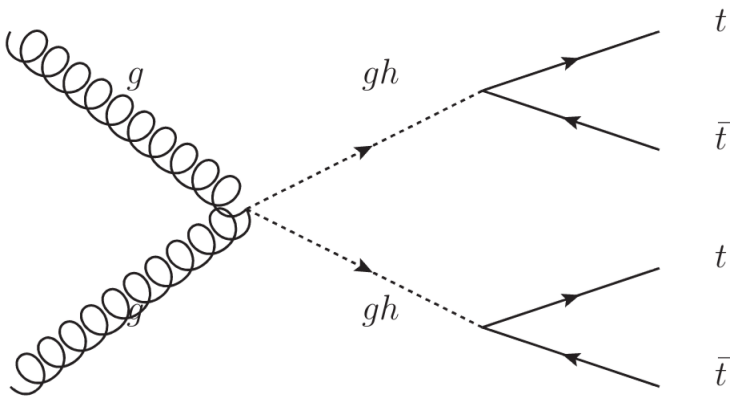


- Production cross sections at the LHC are dominated by gluon initial state.
- Model-independent.
- Dominant decay $b\bar{b}$ or $t\bar{t}$
- G_H mass: 0.75 - 1 TeV.

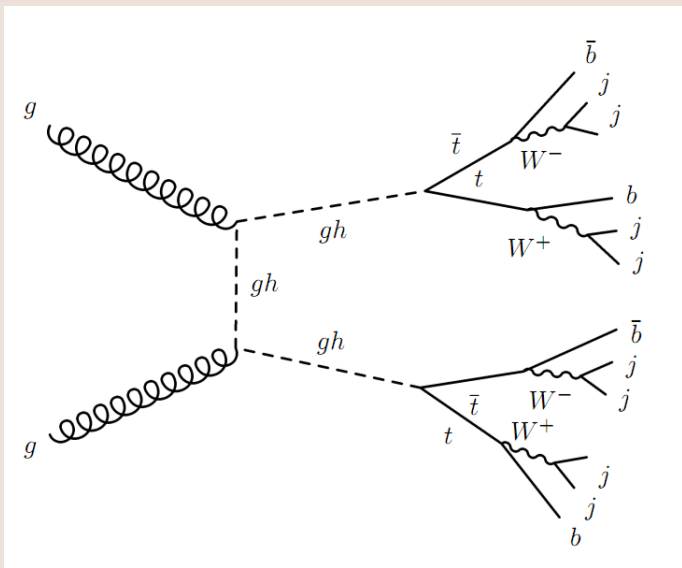


Feynman Diagrams

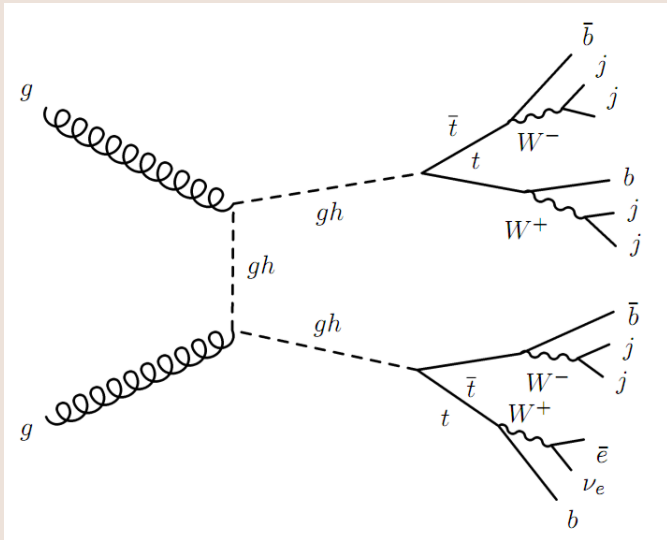
Par Production of Heavy Scalar Bosons



Four Top decay



Four Top decay



Signal MC Sample

Two MC Samples, Gh mass of 0.5 and 1 TeV.

- 1 Private production in MG5.
 - $pp > ghgh, gh > t\bar{t}$
- 2 Hadronization.
 - Pythia8.
 - Pythia6 has problems dealing with multiple fermions.
- 3 CMS Fast Simulation. (CMSSW_4_2_5)

According to MG5:

- 1 Gh mass of 1.0 Tev, 10k events, $\sigma = 0.987 \times 10^{-5}$ pb
- 2 Gh mass of 0.5 Tev, 10k events, $\sigma = 0.254 \times 10^{-3}$ pb

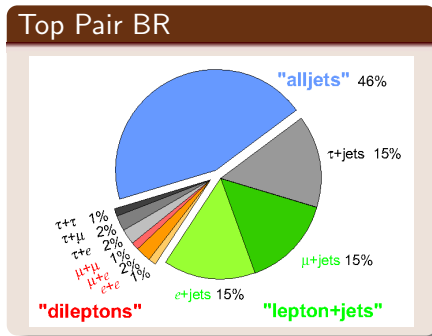


Four Top Branching Ratio

Case		BR (%)
All Jets	12 jets (4 bjets)	20.88
Lepton + Jets	1 lepton + 10 jets (4 bjets)	40.04
Dilepton + Jets	2 lepton + 8 jets (4 bjets)	15.99
Three lepton + Jets	3 lepton + 6 jets (4 bjets)	3.41
Leptonic	4 leptons + 4 bjets	0.04



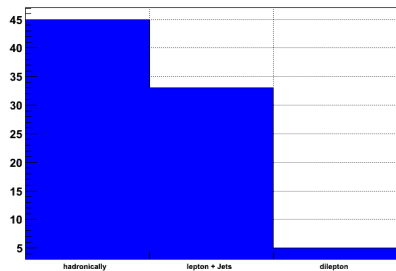
Branching Ratio



Plots at Generator Level

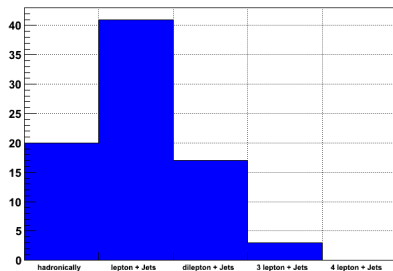
ttbar

Branching Ratio



Four Top

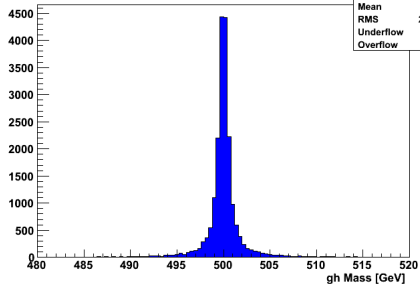
Branching Ratio



Gh mass

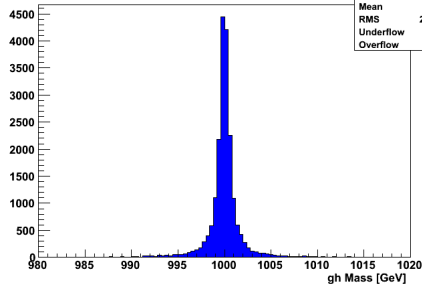
0.5 TeV

gh mass



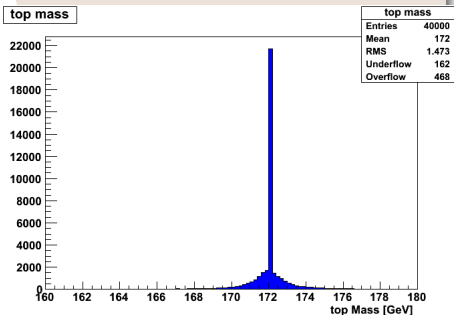
1 TeV

gh mass

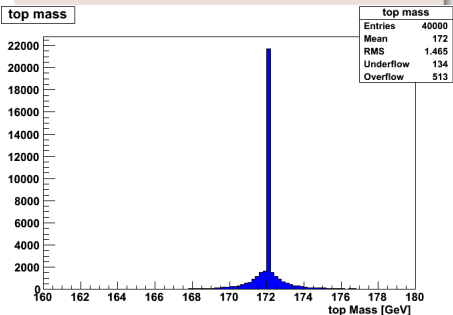


Top mass

0.5 TeV



1 TeV



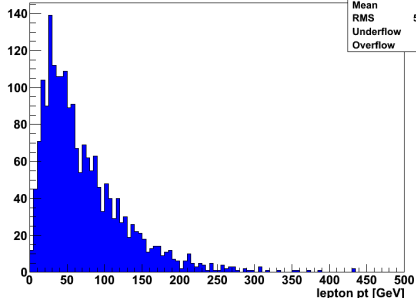
Lepton pt for Lepton + Jets

0.5 TeV

leptons pt for lepton + jets

leptons pt for lepton + jets

Entries	2011
Mean	72.5
RMS	56.41
Underflow	0
Overflow	0

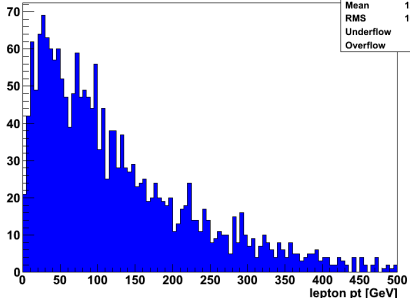


1 TeV

leptons pt for lepton + jets

leptons pt for lepton + jets

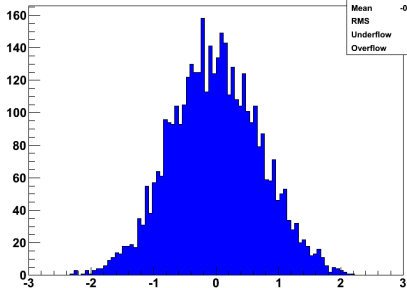
Entries	2008
Mean	126.2
RMS	103.4
Underflow	0
Overflow	19



Parton eta for Lepton + Jets

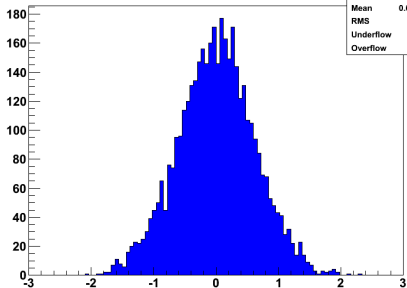
0.5 TeV

partons eta for lepton + jets



1 TeV

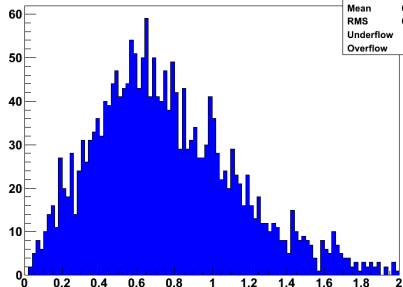
partons eta for lepton + jets



Minimum ΔR Jet-Jet

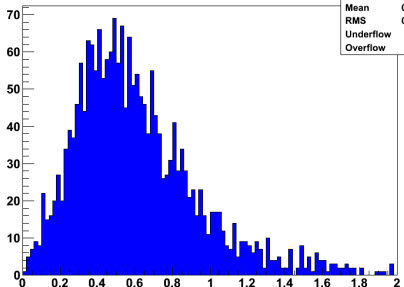
0.5 TeV

deltaR for all jets



1 TeV

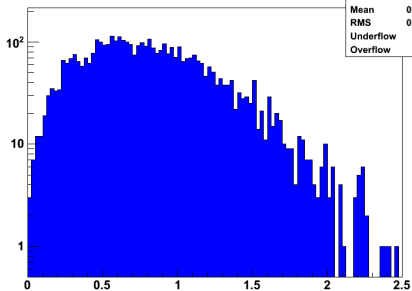
deltaR for all jets



Minimum ΔR Lepton-Jet

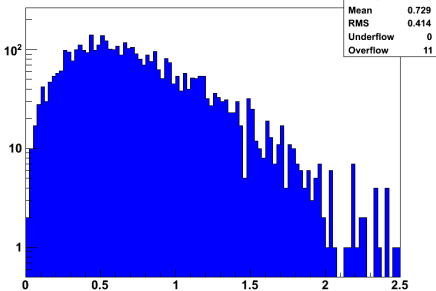
0.5 TeV

deltaR for lepton + jets



1 TeV

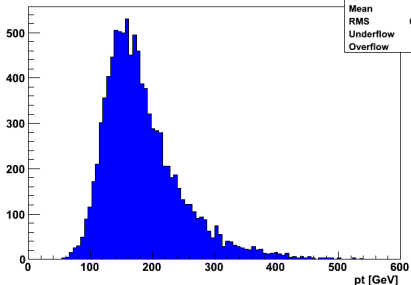
deltaR for lepton + jets



Leading Jet pt

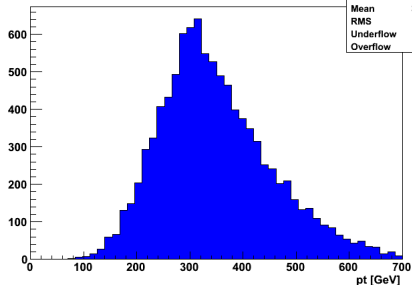
0.5 TeV

leading jet pt



1 TeV

leading jet pt



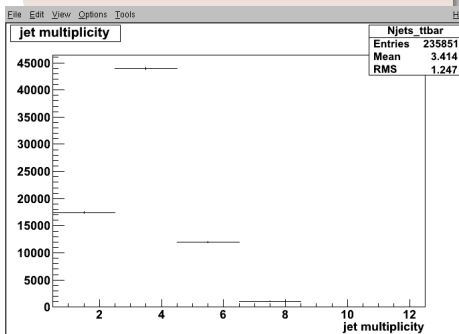
Data/MC Samples

- PATtuples based on TopLikeBSM.
- Similar to $W' \rightarrow tb$
- Cuts:
 - 1 jets: $pt > 40$ GeV, $|\eta| < 2.4$
 - 2 muons: $pt > 40$ GeV, $|\eta| < 2.1$, $reliso < 0.1$

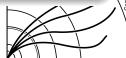
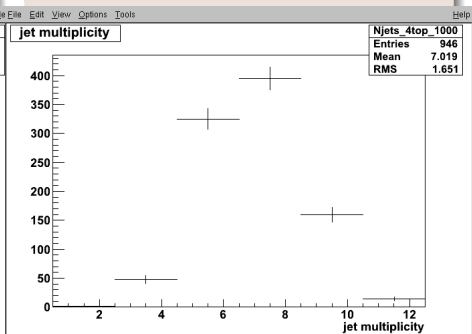


Jet Multiplicity

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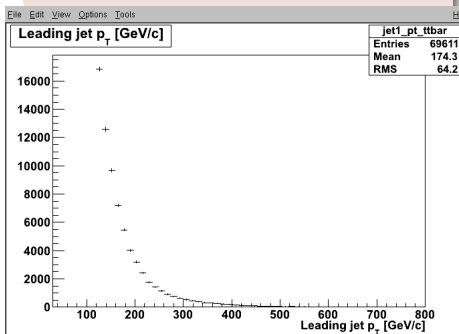


Gh 1 TeV

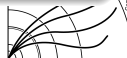
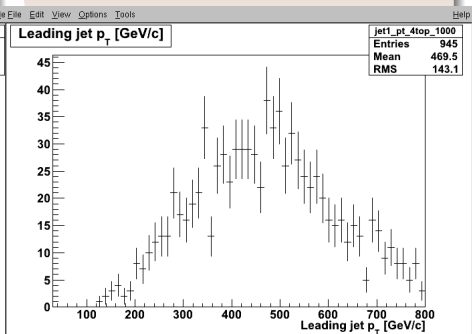


Leading Jet p_T

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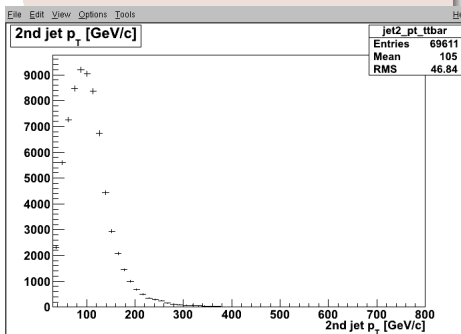


Gh 1 TeV

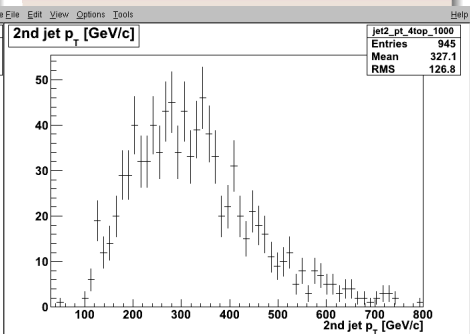


Second Leading Jet p_T

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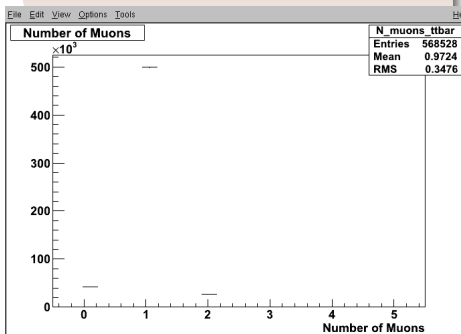


Gh 1 TeV

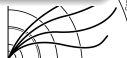
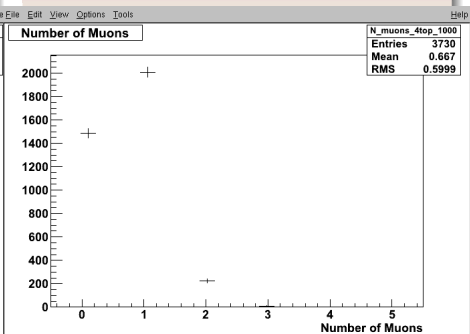


Muon Multiplicity

ttbar

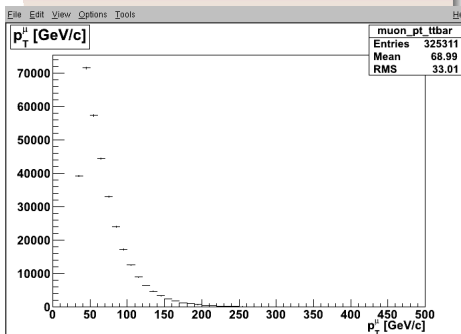


Gh 1 TeV

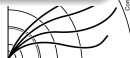
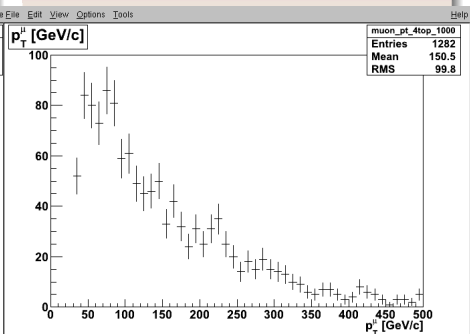


Muon p_T

ttbar

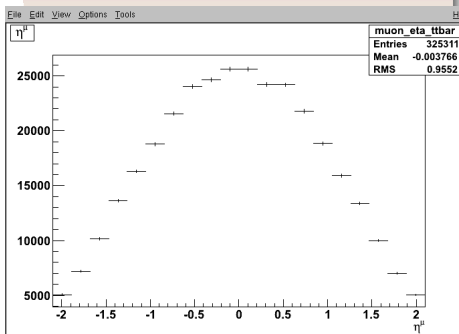


Gh 1 TeV

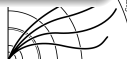
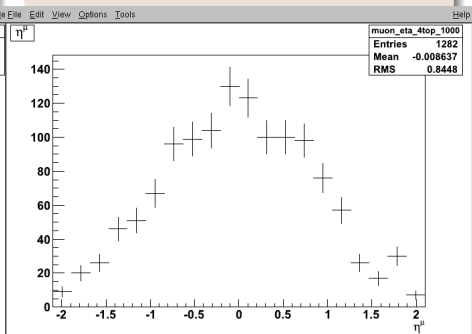


Muon eta

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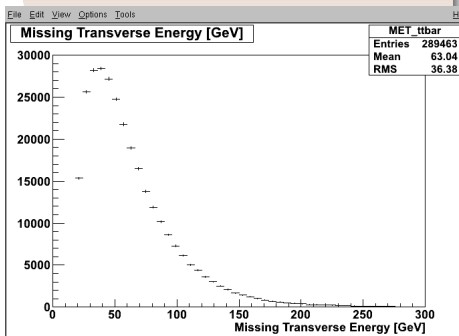


Gh 1 TeV



MET

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Gh 1 TeV

