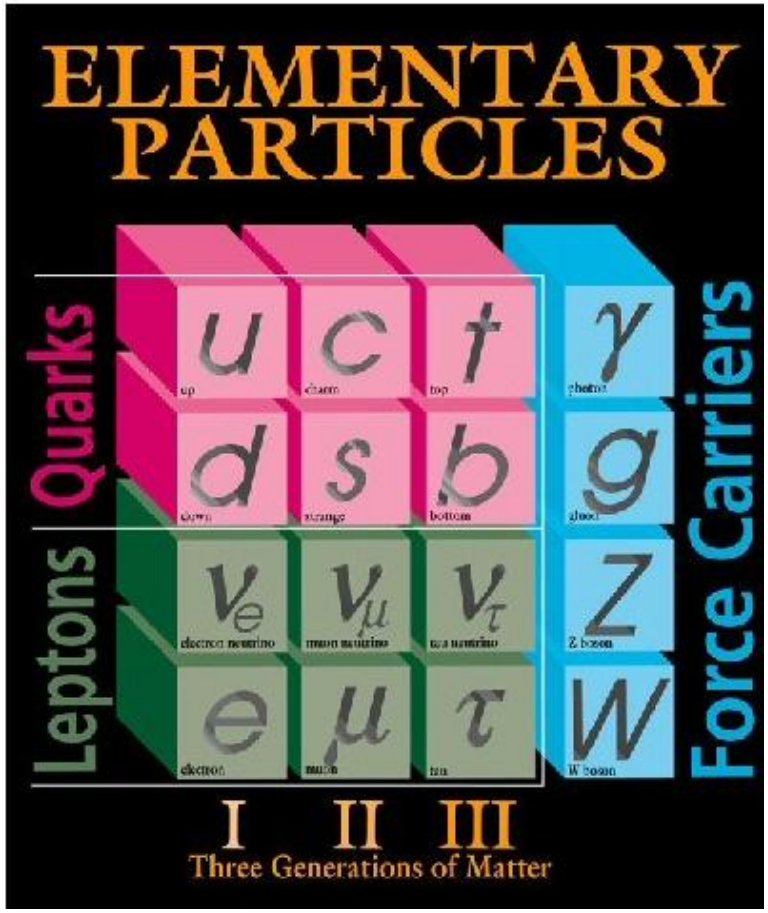
Like sign top pair

Seungkyu Ha

index

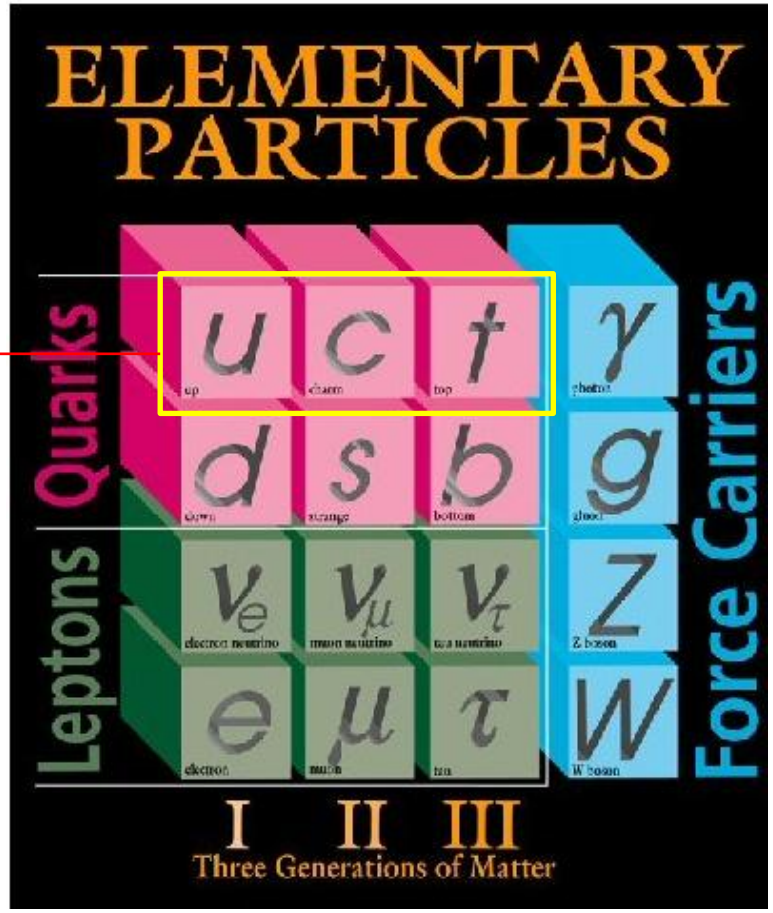
- Standard model
- Problems with the Standard Model
- Top quark asymmetry
- zprime ? (beyond standard model)
- FCNC Z prime (like sign top pair)

Elementary particle



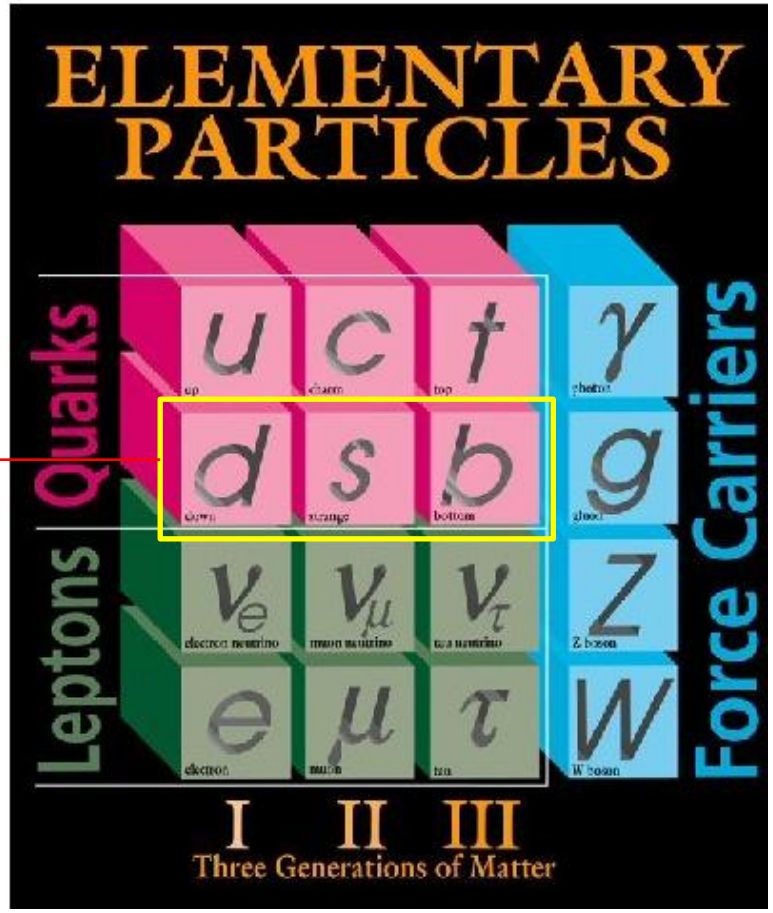
Elementary particle

Spin: ½
Charge: +2/3

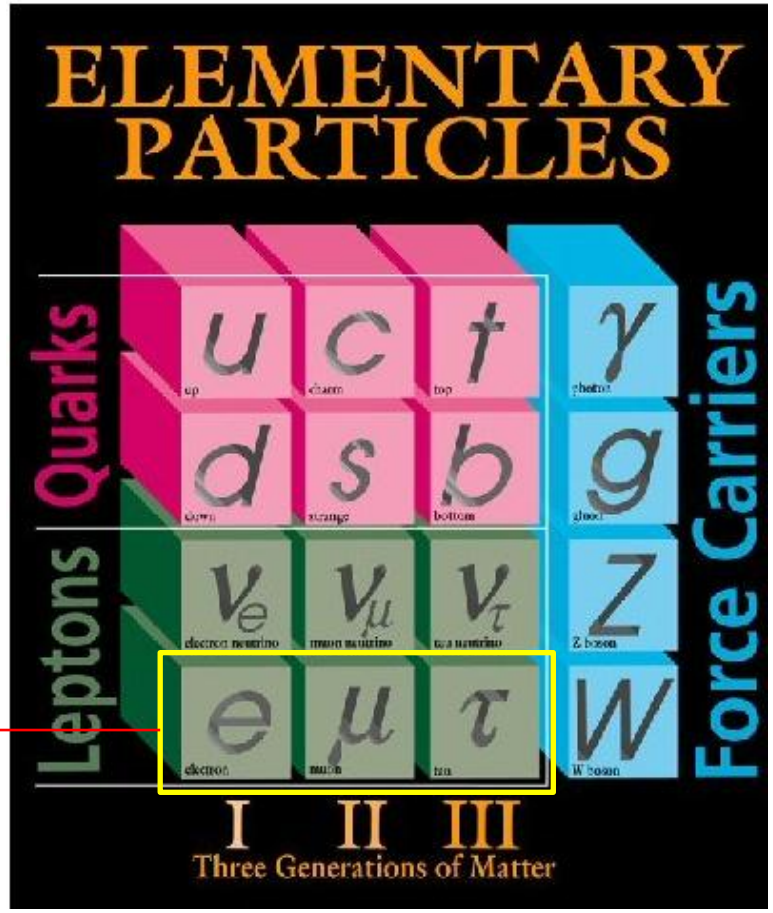


Elementary particle

Spin: ½
Charge: -1/3

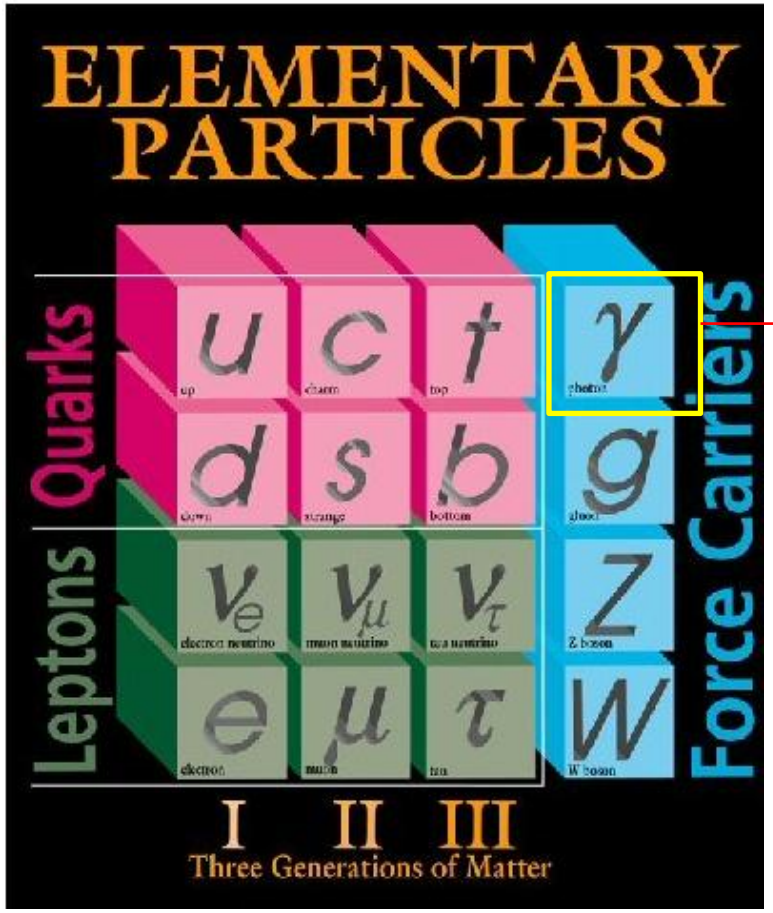


Elementary particle



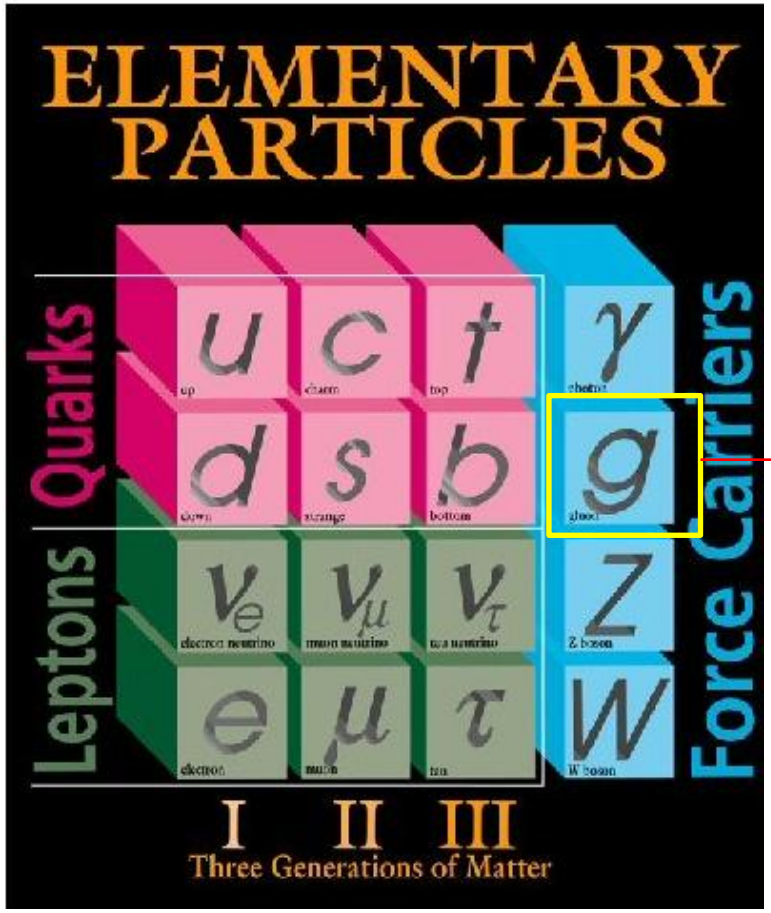
Spin: ½
Charge: -1

Elementary particle



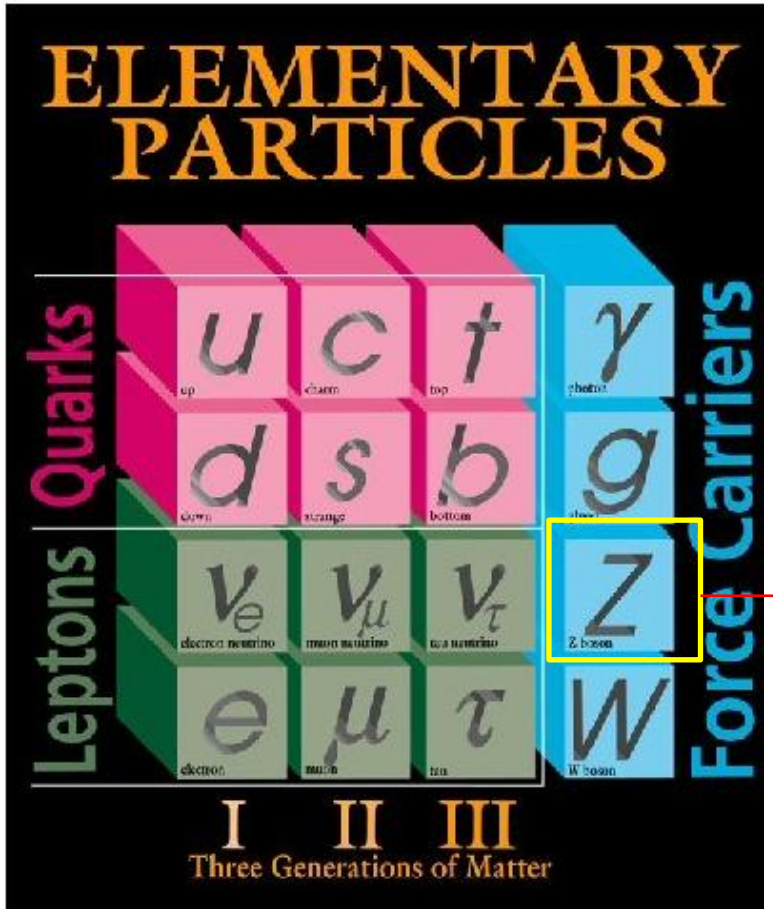
e.m. force
Spin: 1

Elementary particle



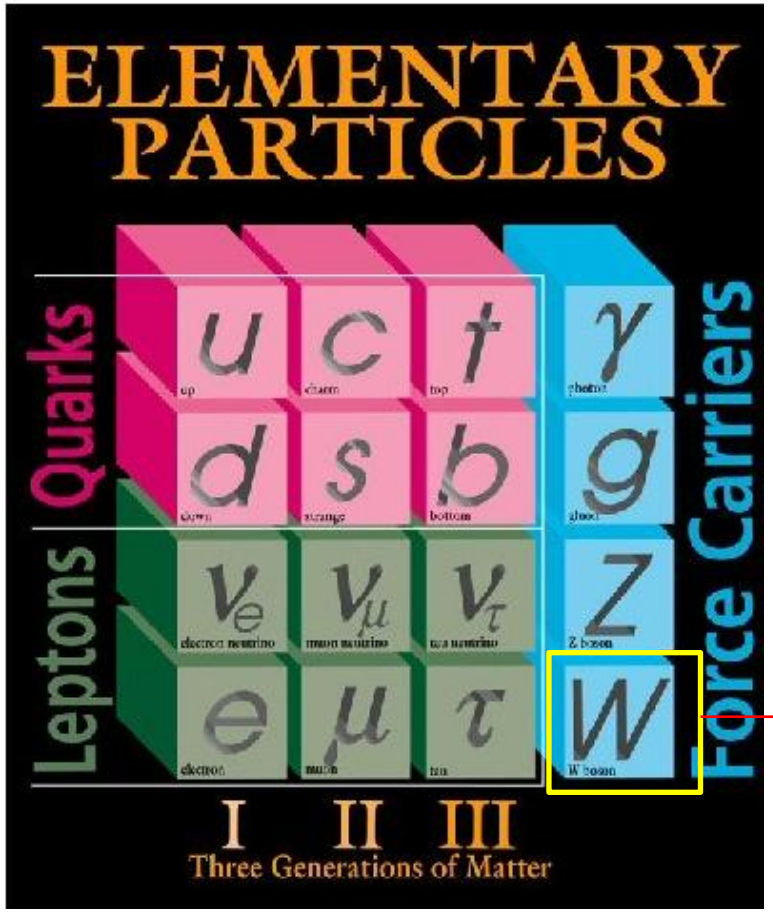
strongforce
Spin: 1

Elementary particle



weak force
Spin: 1

Elementary particle



weak interaction
Spin: 1

Standard model

What force exist in nature

1. gravity
2. electromagnetic force
3. weak force
4. strong force

Standard model

What force exist in nature

1. gravity
2. electromagnetic force
3. weak force
4. strong force

Standard model
->U(1) × SU(2) × SU(3)

Problems with S.M.

- The gravity doesn't explain it.
- The Hierarchy problem
- Dark matter

Beyond Standard model

explain the deficiencies of the Standard Model

->the origin of mass

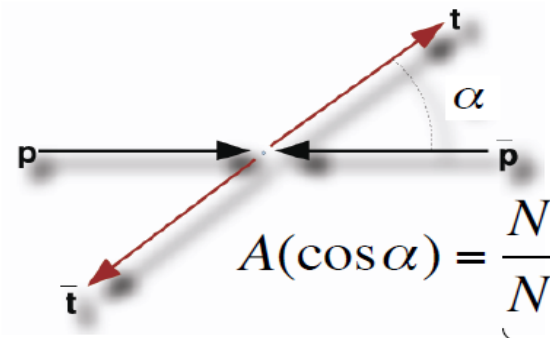
the strong CP problem

neutrino oscillations

matter–antimatter asymmetry

the nature of dark matter and dark energy.

Top quark asymmetry



CP symmetry, not at LHC

$$A(\cos\alpha) = \underbrace{\frac{N_t(\cos\alpha) - N_{\bar{t}}(\cos\alpha)}{N_t(\cos\alpha) + N_{\bar{t}}(\cos\alpha)}}_{\text{Charge asymmetry}} \overset{\downarrow}{=} \underbrace{\frac{N_t(\cos\alpha) - N_t(-\cos\alpha)}{N_t(\cos\alpha) + N_t(-\cos\alpha)}}_{\text{Forward-backward asymmetry}} \neq 0$$

- Not enough statistics for differential measurement
  => measure total forward-backward asymmetry A_{fb}:

$$A_{fb} = \frac{N_f - N_b}{N_f + N_b}$$

N_f = # "forward" events (cos α>0 ~> Δy>0)
N_b = # "backward" events (cos α<0 ~> Δy<0)

$$\Delta y = y_t - y_{\bar{t}} = 2 \cdot \text{atanh}\left(\frac{\cos\alpha}{\sqrt{1 + 4m_t^2/(\hat{s} - 4m_t^2)}}\right)$$

(LO; invariant to boosts)

Top quark asymmetry (SM)

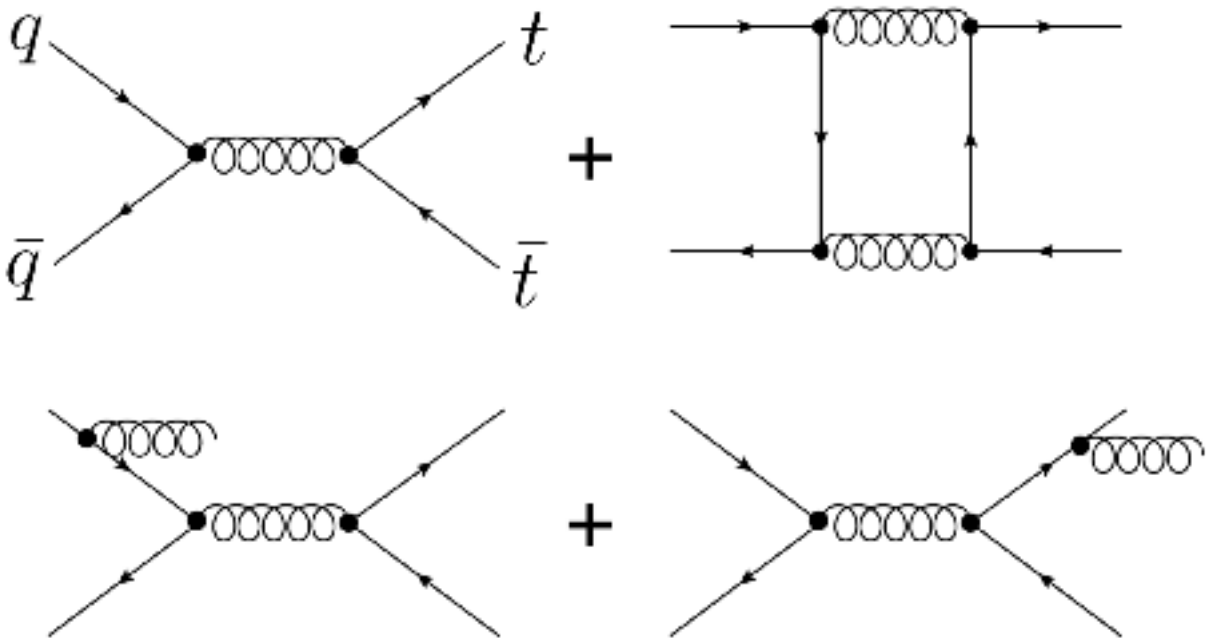


FIG. 1: Interfering $q\bar{q} \to t\bar{t}$ (above) and $q\bar{q} \to t\bar{t}j$ (below) amplitudes.

Z prime types

Models with a new U(1) gauge symmetry
E6 models
Topcolor and Top Seesaw Models
Little Higgs models
Kaluza-Klein models
Stueckelberg Extensions

Etc….

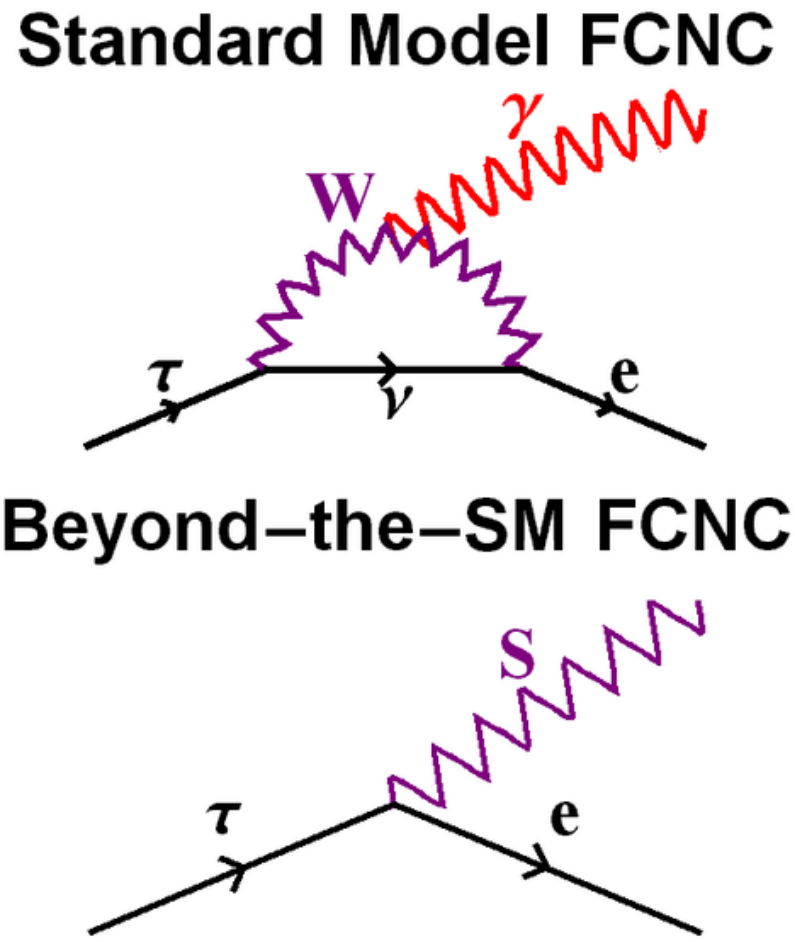
FCNC ?

flavor-changing neutral currents

->change the flavor of

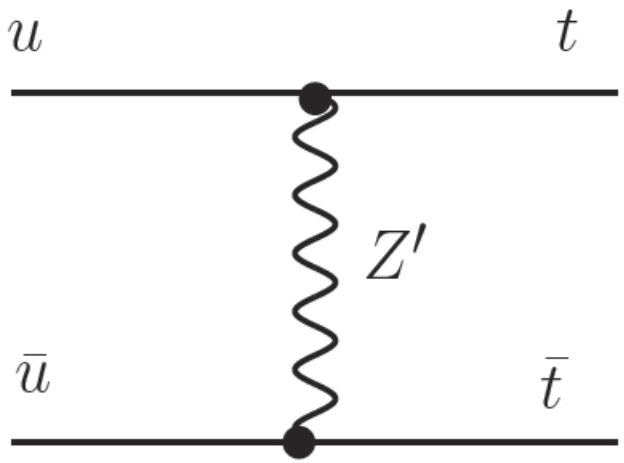
a fermion current without

altering its electric charge

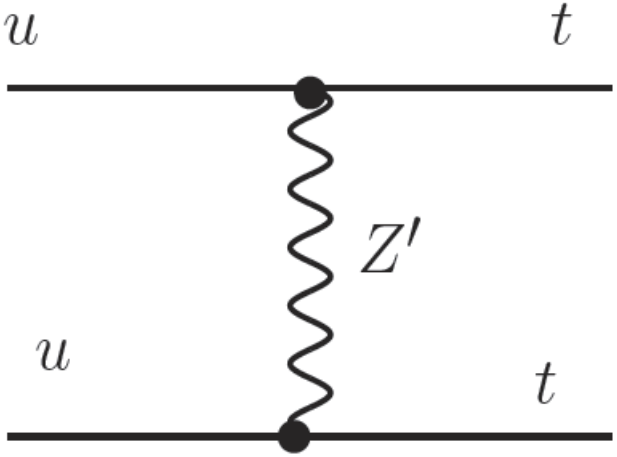


FCNC Zprime

Tevatron
(proton-antiproton)



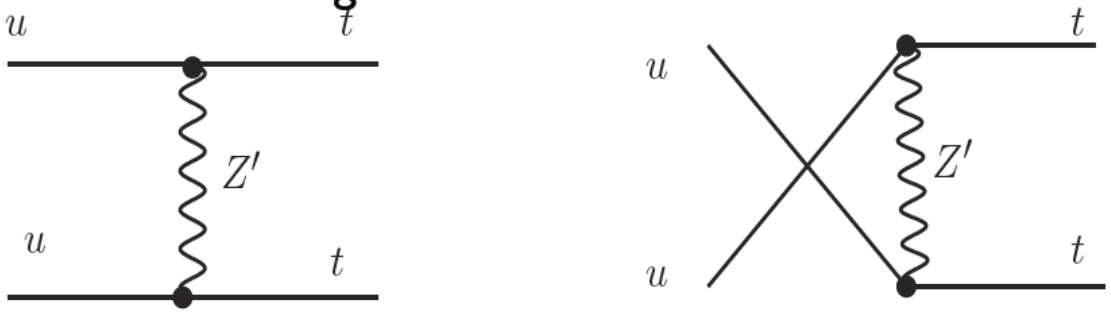
LHC
(proton-proton)



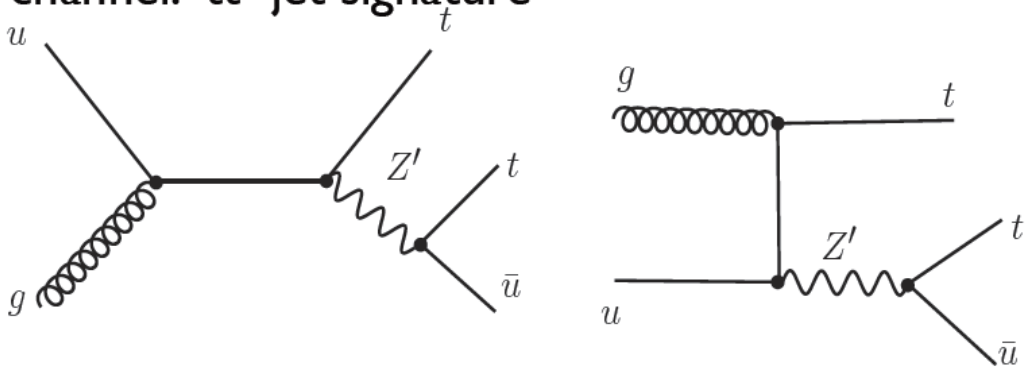
Such a Z' exchange would create a high inv. mass asymmetry at the Tevatron

FCNC Zprime

Production in t-channel: tt signature



Production in s-channel: tt+jet signature



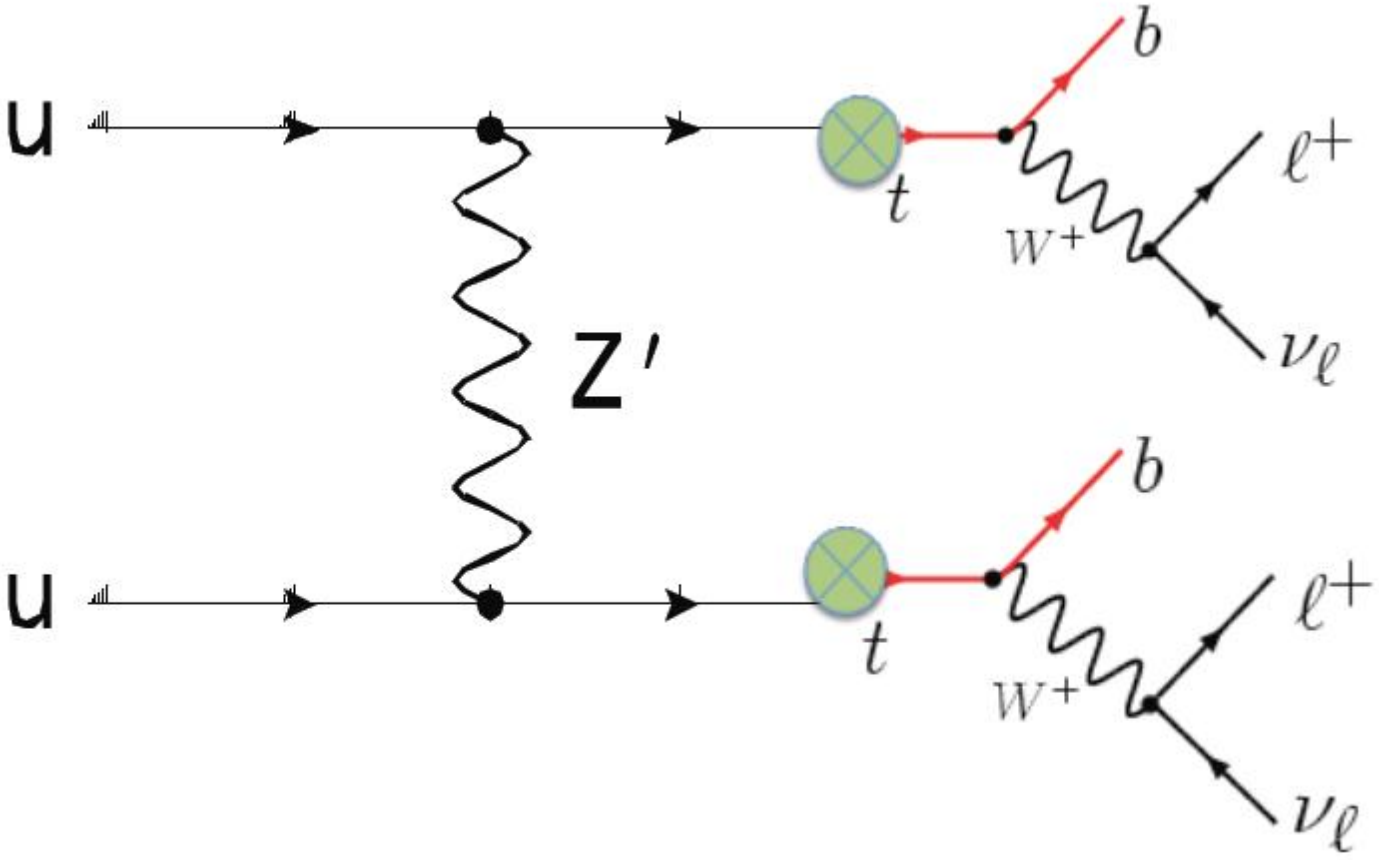
FCNC Zprime

$$\mathcal{L} = g_W \bar{u} \gamma^\mu (f_L P_L + f_R P_R) t Z'_\mu + h.c$$

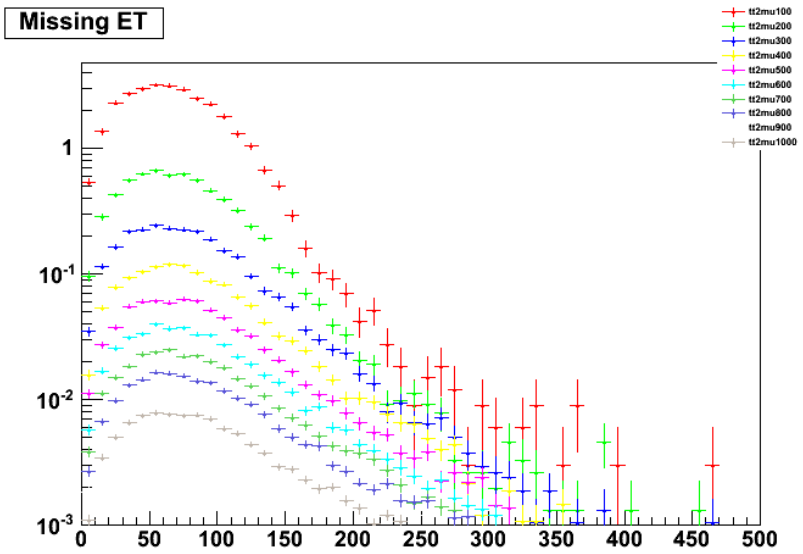
- Consider the effective Lagrangean of the utZ' interaction
  - u quarks from proton to t quarks only
  - consists of a left- and right-handed coupling to the boson
  - with g_W the weak coupling strength, f_L and f_R the coupling strengths and Z' the mass of the hypothetical boson
- The left-handed coupling is experimentally constrained to ≈0 by measurements of B_d-B_d mixing, leaving only the right-handed fermion coupling

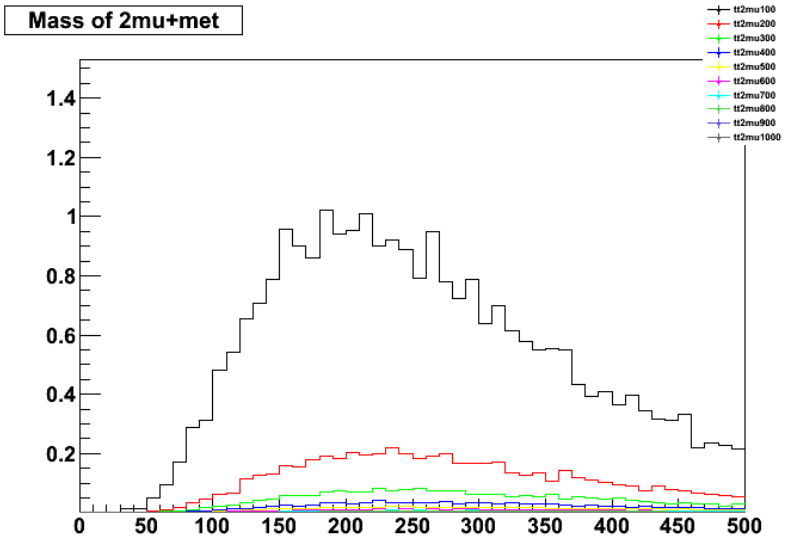
Experimental signature: two top (not antitop!) in final state

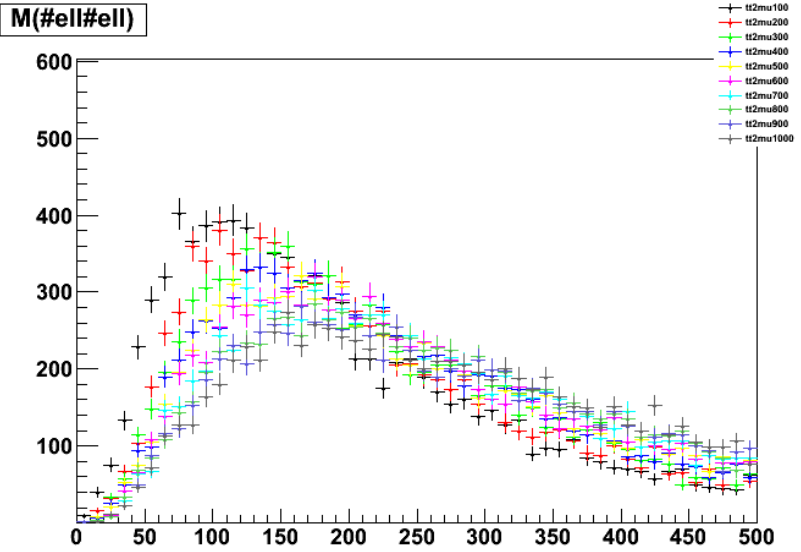
Like sign top pair

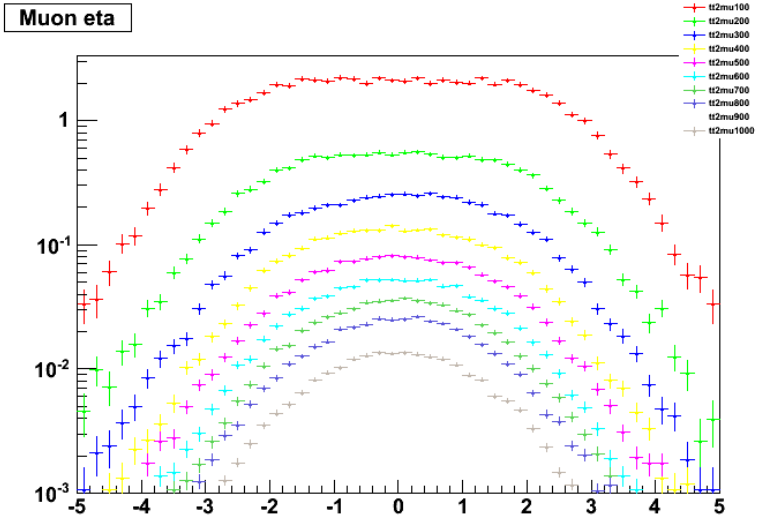


Analysis (using the pythia)

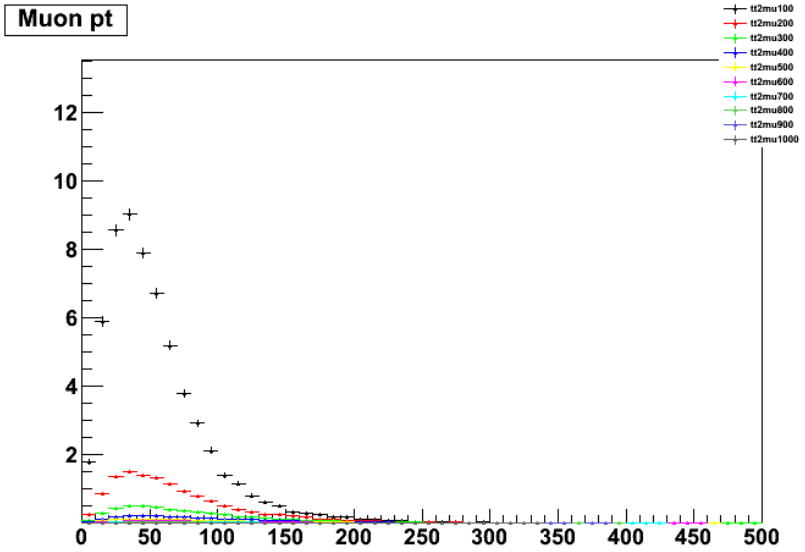


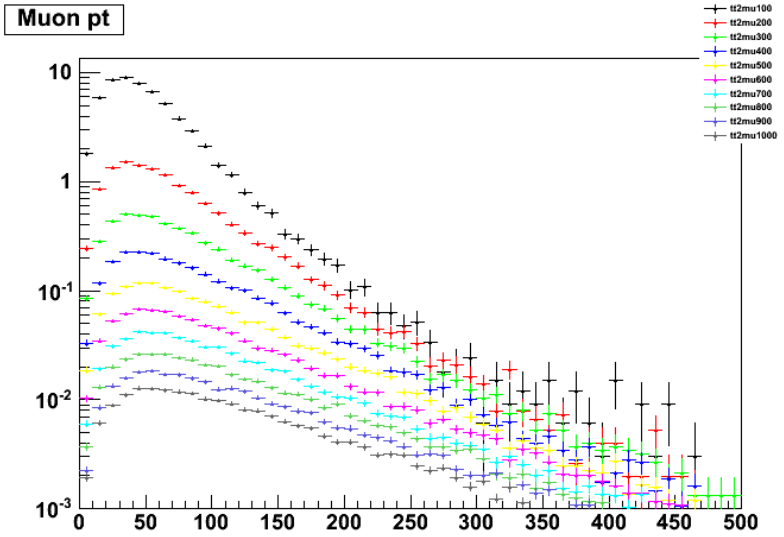






Analysis


Muon pt
tt2mu100
tt2mu200
tt2mu300
tt2mu400
tt2mu500
tt2mu600
tt2mu700
tt2mu800
tt2mu900
tt2mu1000


Muon pt
tt2mu100
tt2mu200
tt2mu300
tt2mu400
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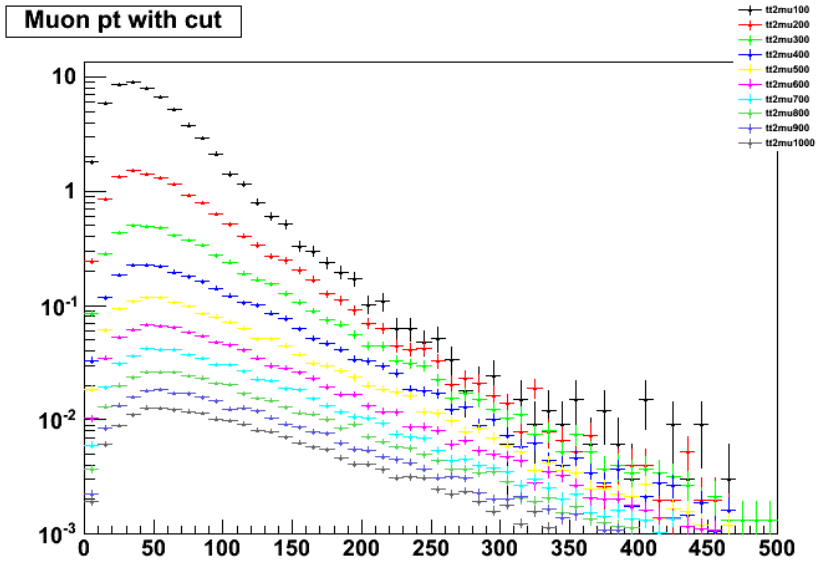
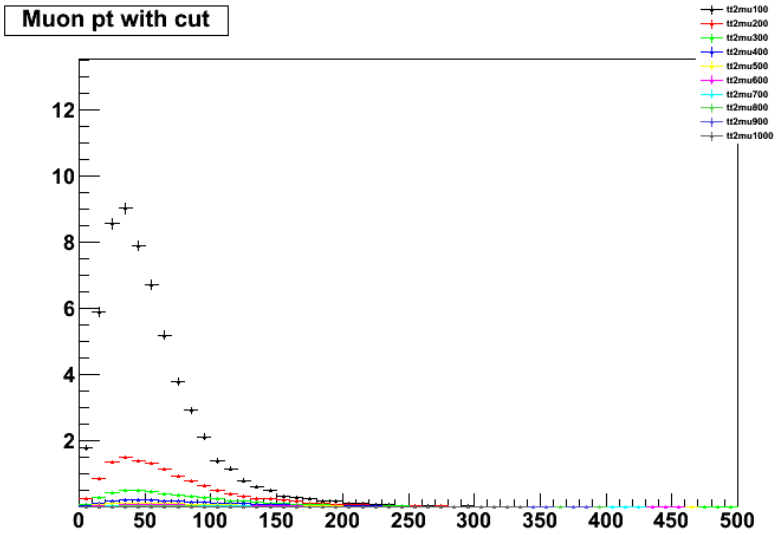
tt2mu600
tt2mu700
tt2mu800
tt2mu900
tt2mu1000


Muon pt with cut
tt2mu100
tt2mu200
tt2mu300
tt2mu400
tt2mu500
tt2mu600
tt2mu700
tt2mu800
tt2mu900
tt2mu1000


Muon pt with cut
tt2mu100
tt2mu200
tt2mu300
tt2mu400
tt2mu500
tt2mu600
tt2mu700
tt2mu800
tt2mu900
tt2mu1000

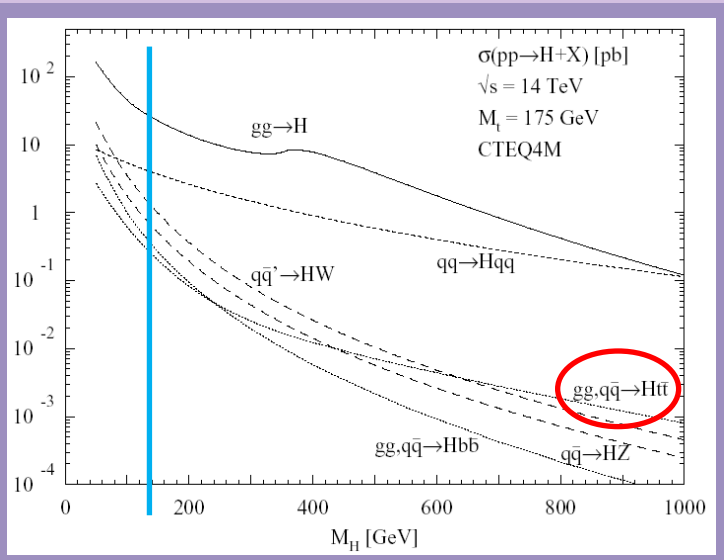
Analysis

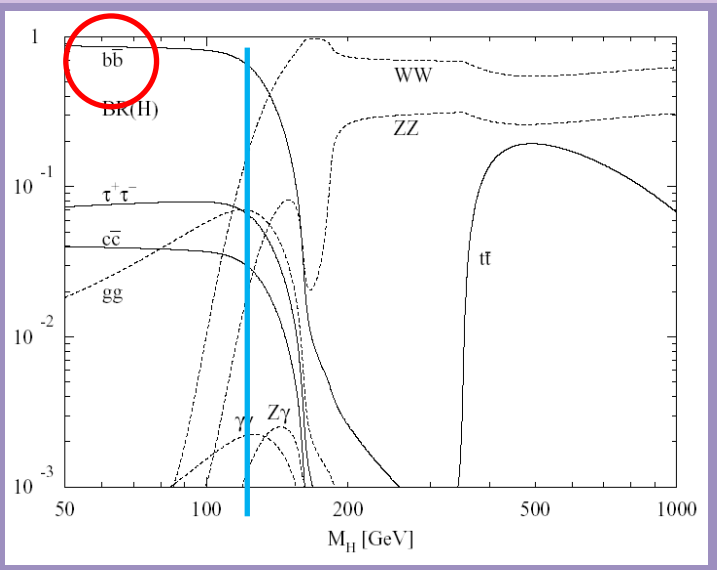
- I can't reconstructed top mass

ttH^0, $H^0 \rightarrow bb$ Channel With Pythia8

Seungkyu Ha

Overview of Channel

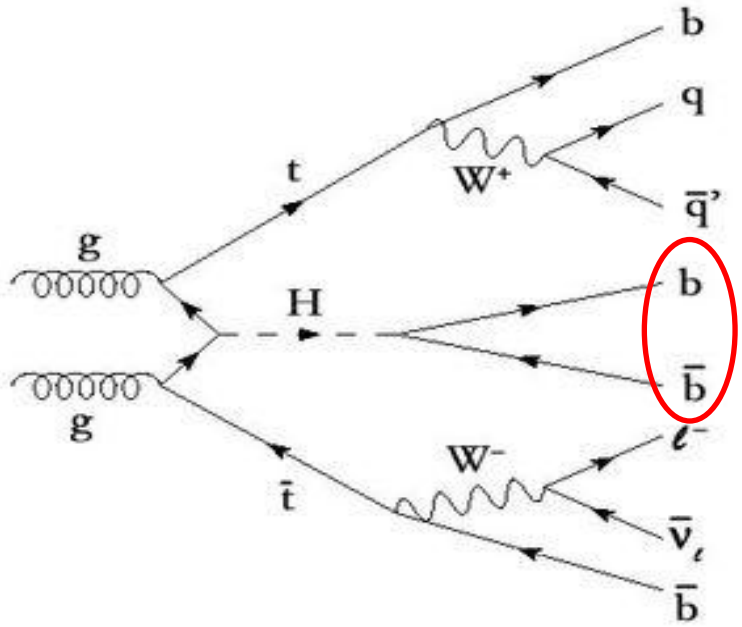




H → bb main decay mode for m_H<135 GeV

Higgs mass 125GeV

Event Topology

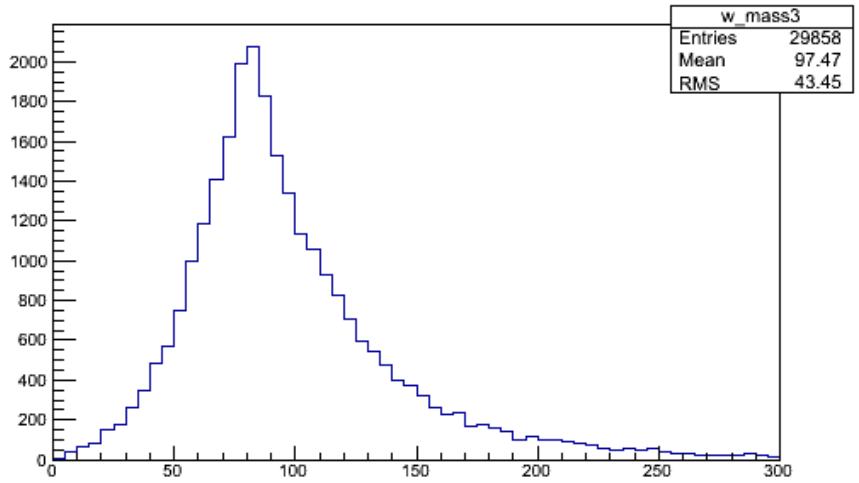


final state:
- 4 b-jets
- 2 light jets
- 1 isolated lepton
- Missing E_T

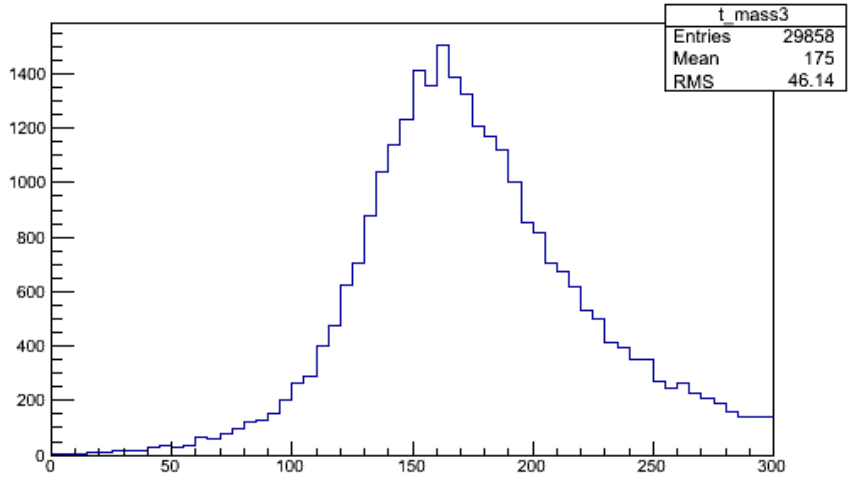
Reconstruction is very difficult.
So I reconstructed higgs mass,
I didn't reconstruct top.

GEN

MAOS method

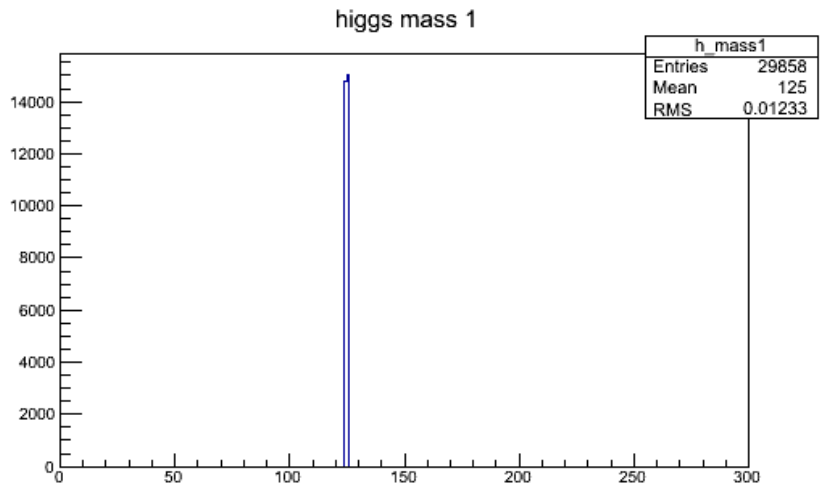


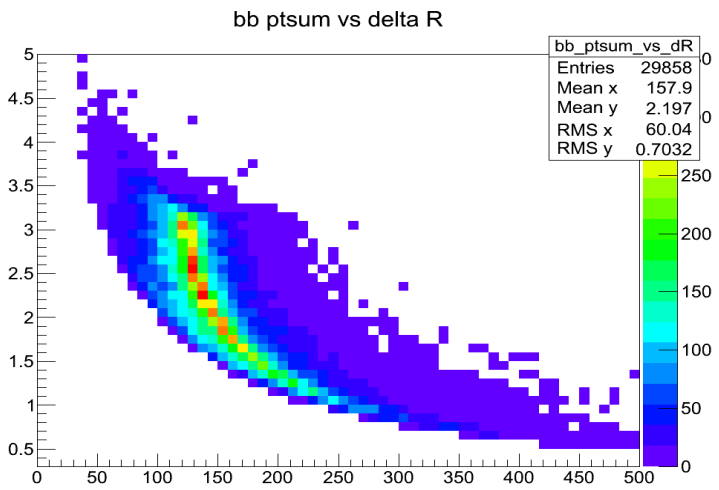
W boson



Top quark

GEN

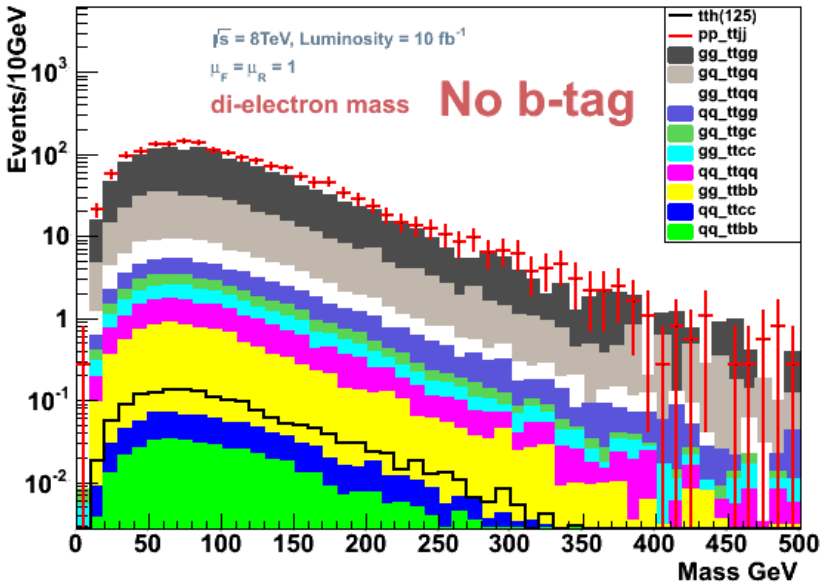


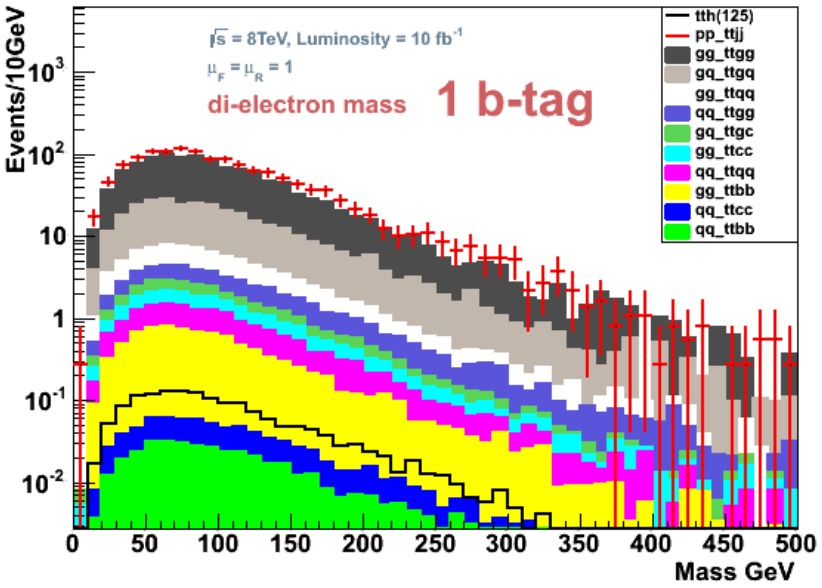


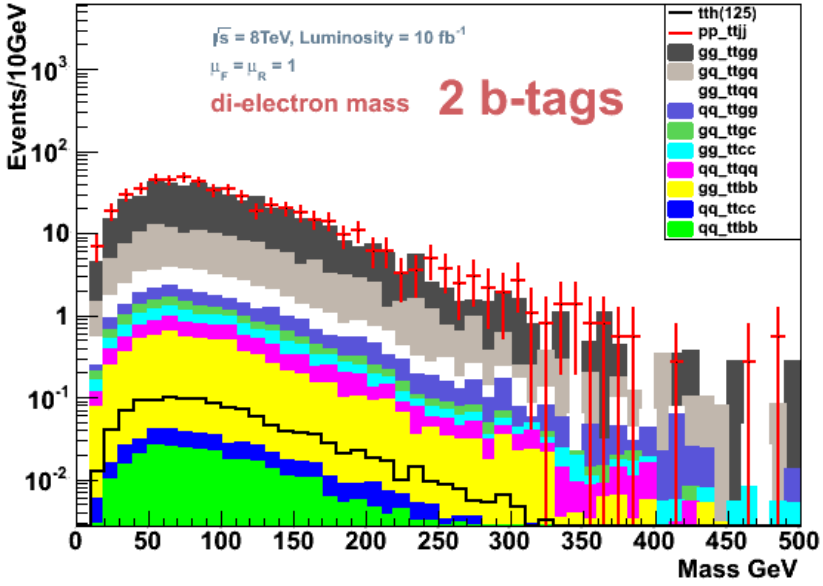
Higgs boson(125GeV)

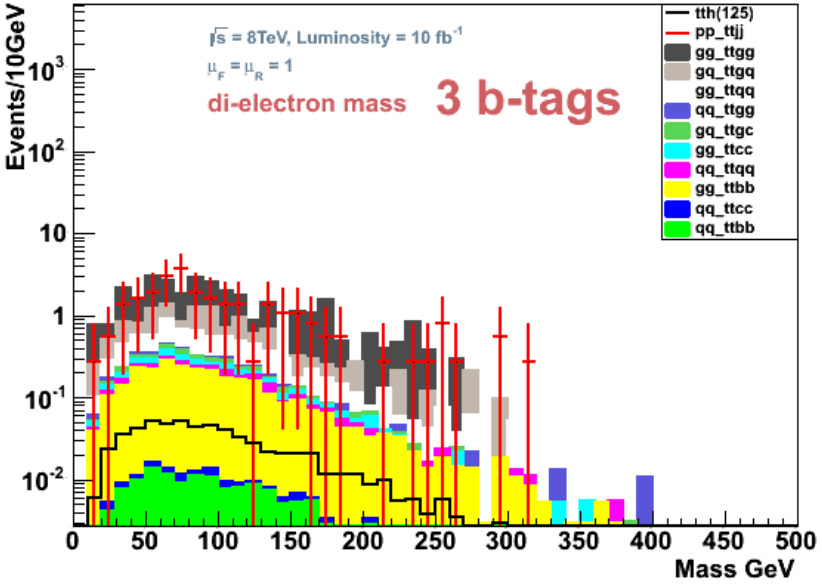
ANALYSIS

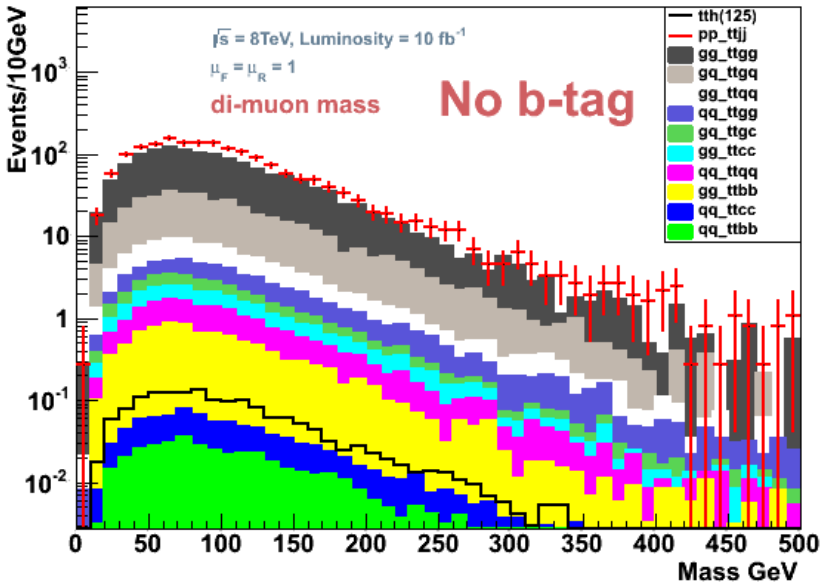
Electron_PT > 15 GeV,
Electron_IsolFlag == true
Muon_PT > 15 GeV,
Muon_IsoFlag == true
Jet PT > 20 GeV, Jet_EhoverEE > 0.1
Lepton number=>2
Jet number=>4
Luminosity = 10 fb^-1

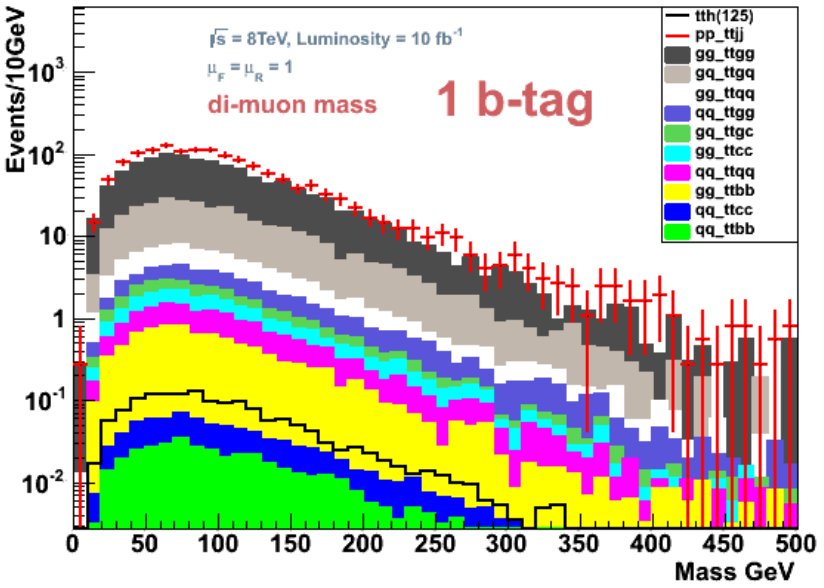

√s = 8TeV, Luminosity = 10 fb-1
μF = μR = 1
di-electron mass
No b-tag
tth(125)
pp_ttjj
gg_ttgg
gq_ttgq
gg_ttqq
qq_ttgg
gq_ttgc
gg_ttcc
qq_ttqq
gg_ttbb
qq_ttcc
qq_ttbb
Events/10GeV
Mass GeV

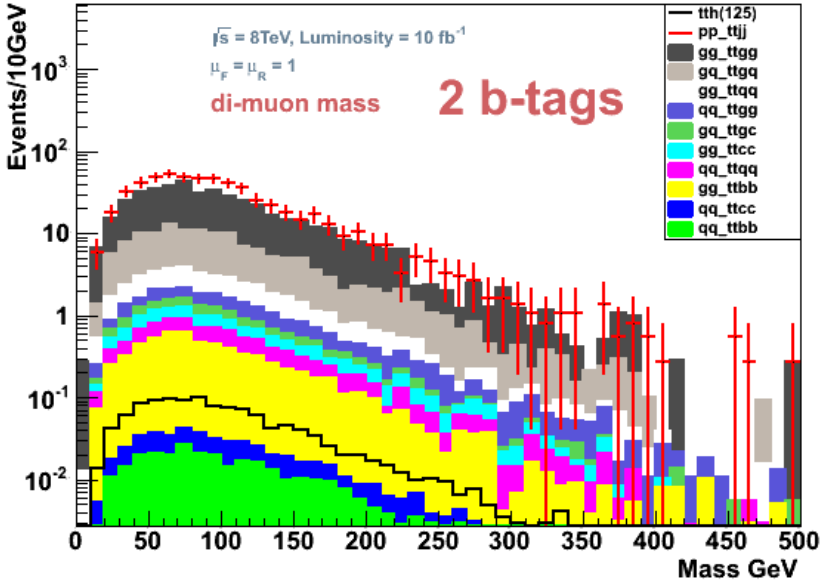

√s = 8TeV, Luminosity = 10 fb-1
μF = μR = 1
di-electron mass
1 b-tag
tth(125)
pp_ttjj
gg_ttgg
gq_ttgq
gg_ttqq
qq_ttgg
gq_ttgc
gg_ttcc
qq_ttqq
gg_ttbb
qq_ttcc
qq_ttbb
Events/10GeV
Mass GeV

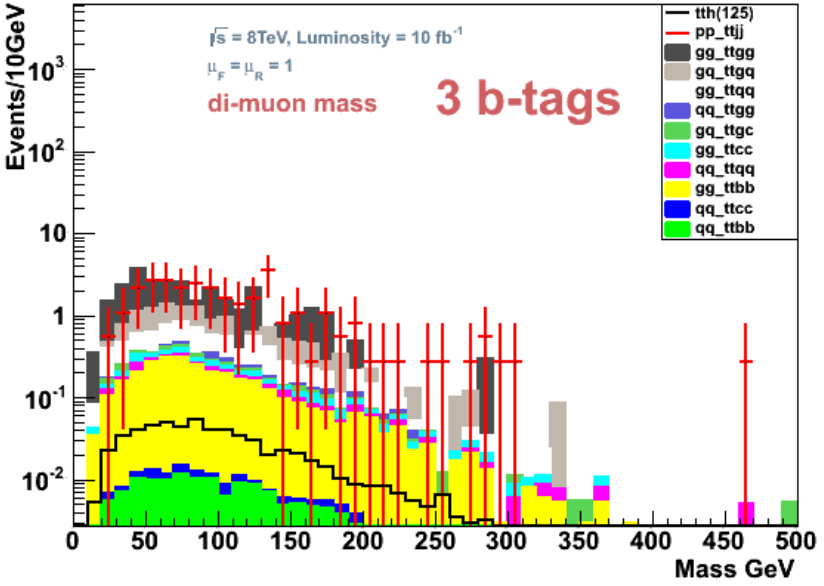

√s = 8TeV, Luminosity = 10 fb-1
μF = μR = 1
di-electron mass
2 b-tags
tth(125)
pp_ttjj
gg_ttgg
gq_ttgq
gg_ttqq
qq_ttgg
gq_ttgc
gg_ttcc
qq_ttqq
gg_ttbb
qq_ttcc
qq_ttbb
Events/10GeV
Mass GeV

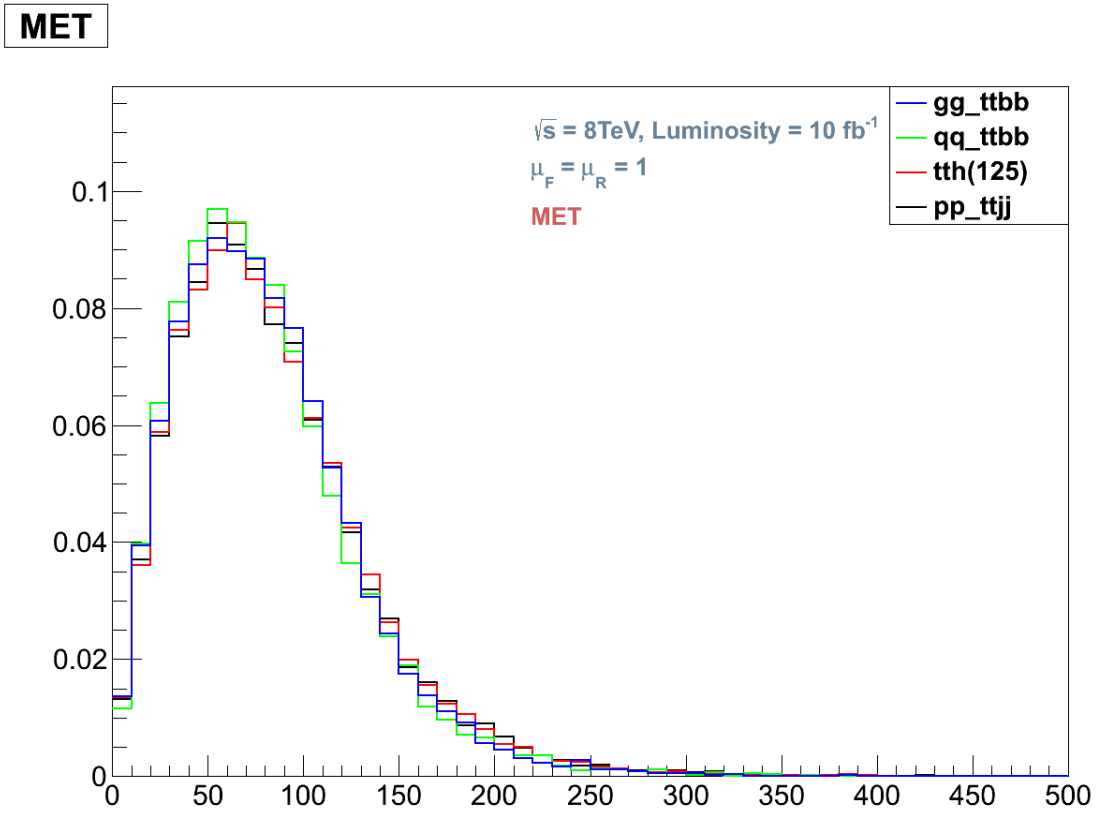

√s = 8TeV, Luminosity = 10 fb-1
μF = μR = 1
di-electron mass
3 b-tags
tth(125)
pp_ttjj
gg_ttgg
gq_ttgq
gg_ttqq
qq_ttgg
gq_ttgc
gg_ttcc
qq_ttqq
gg_ttbb
qq_ttcc
qq_ttbb
Events/10GeV
Mass GeV


√s = 8TeV, Luminosity = 10 fb-1
μF = μR = 1
di-muon mass
No b-tag
tth(125)
pp_ttjj
gg_ttgg
gq_ttgq
gg_ttqq
qq_ttgg
gq_ttgc
gg_ttcc
qq_ttqq
gg_ttbb
qq_ttcc
qq_ttbb
Events/10GeV
Mass GeV


√s = 8TeV, Luminosity = 10 fb-1
μF = μR = 1
di-muon mass
1 b-tag
tth(125)
pp_ttjj
gg_ttgg
gq_ttgq
gg_ttqq
qq_ttgg
gq_ttgc
gg_ttcc
qq_ttqq
gg_ttbb
qq_ttcc
qq_ttbb
Events/10GeV
Mass GeV

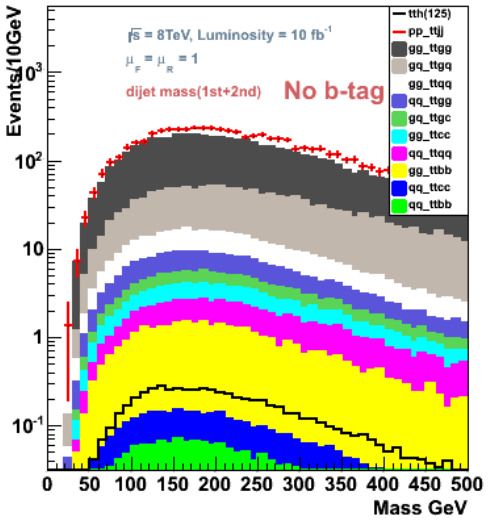

√s = 8TeV, Luminosity = 10 fb-1
μF = μR = 1
di-muon mass
2 b-tags
tth(125)
pp_ttjj
gg_ttgg
gq_ttgq
gg_ttqq
qq_ttgg
gq_ttgc
gg_ttcc
qq_ttqq
gg_ttbb
qq_ttcc
qq_ttbb
Events/10GeV
Mass GeV

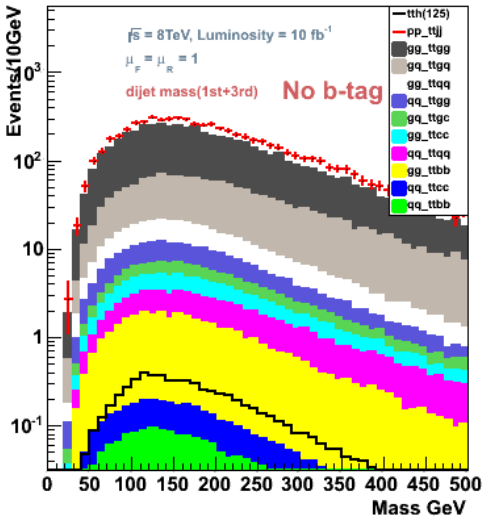

√s = 8TeV, Luminosity = 10 fb-1
μF = μR = 1
di-muon mass
3 b-tags
tth(125)
pp_ttjj
gg_ttgg
gq_ttgq
gg_ttqq
qq_ttgg
gq_ttgc
gg_ttcc
qq_ttqq
gg_ttbb
qq_ttcc
qq_ttbb
Events/10GeV
Mass GeV

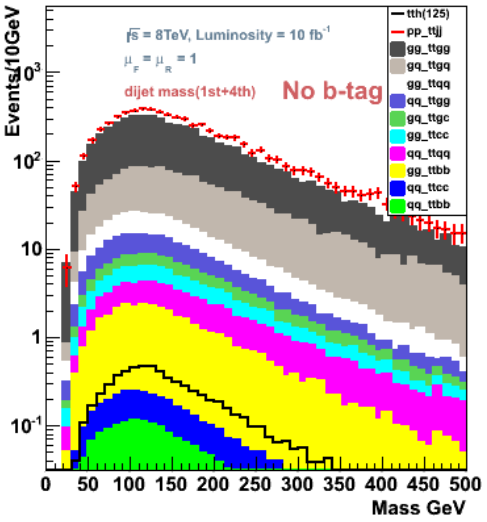


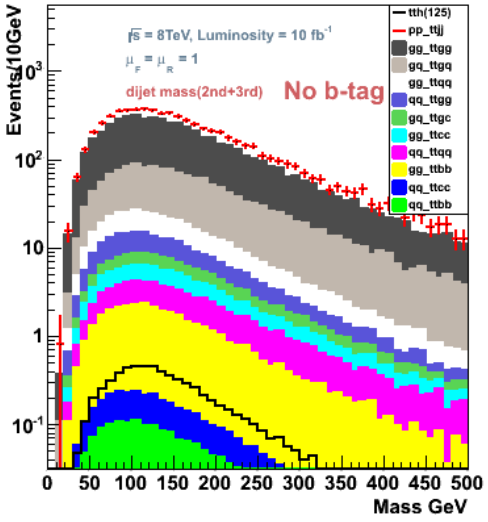
Missing transverse energy

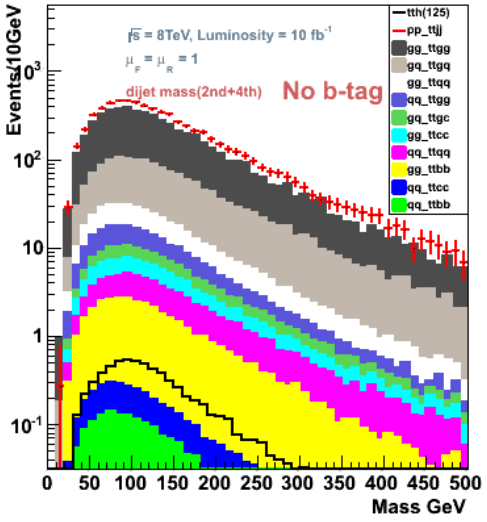
Di-jet mass (No b-tag)

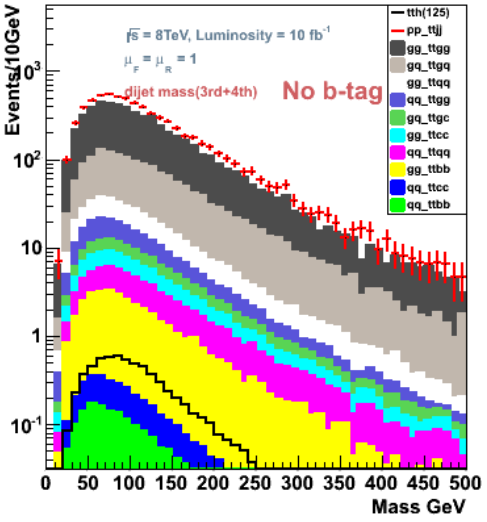




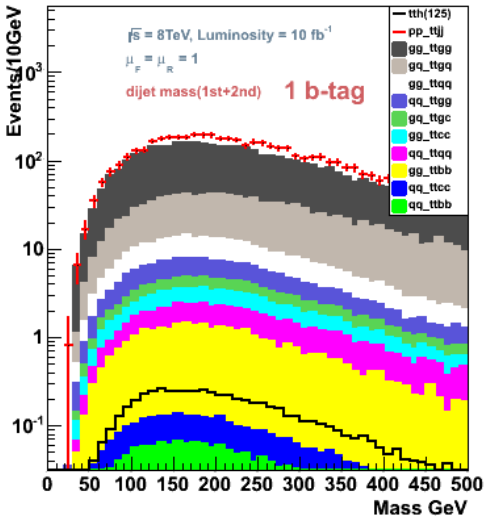


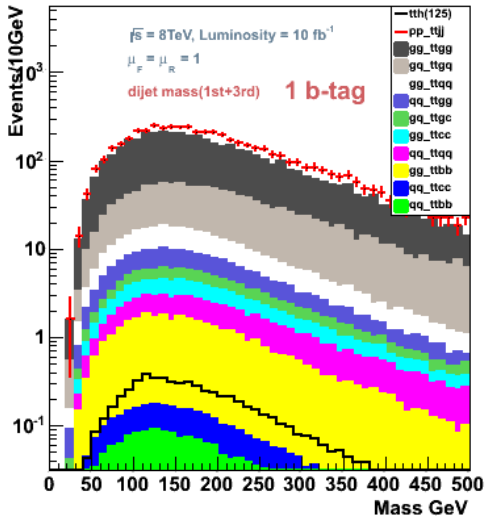


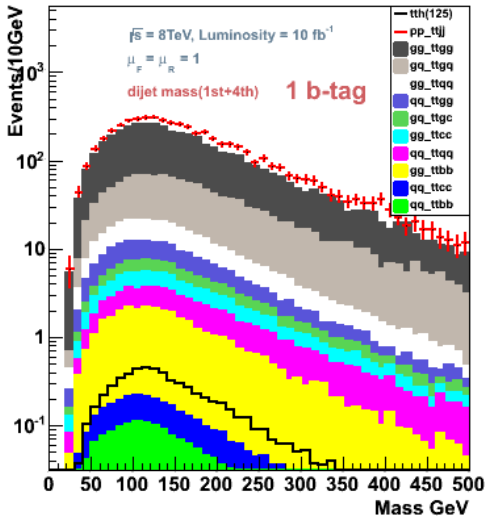


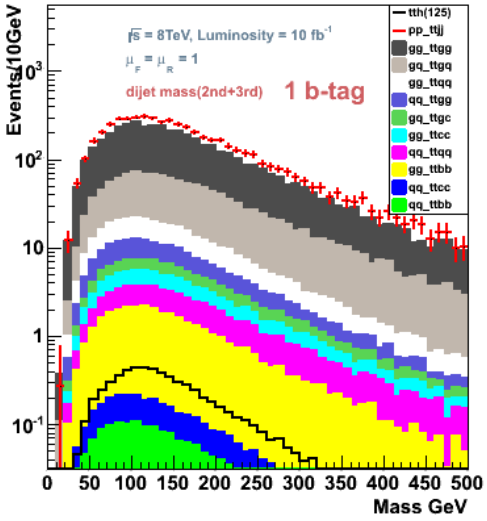


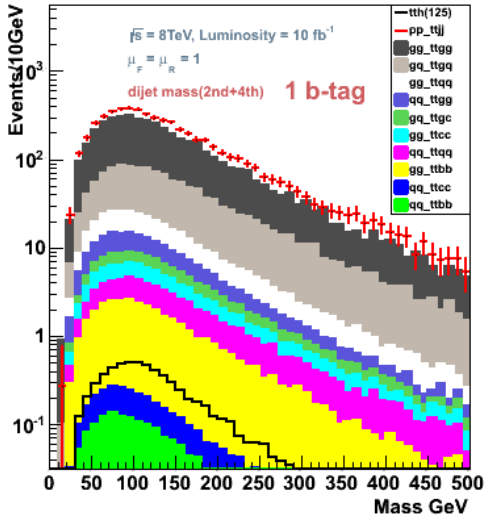
Di-jet mass (1 b-tag)

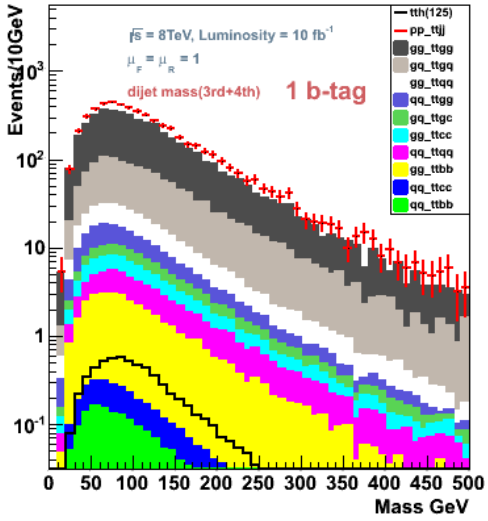




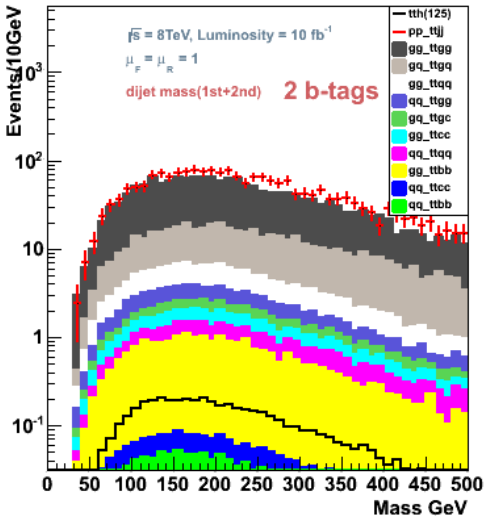


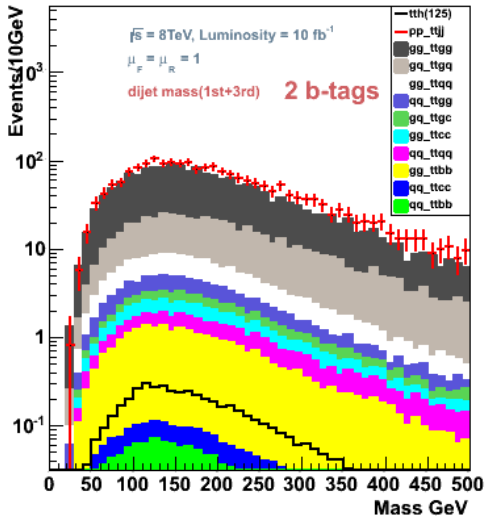


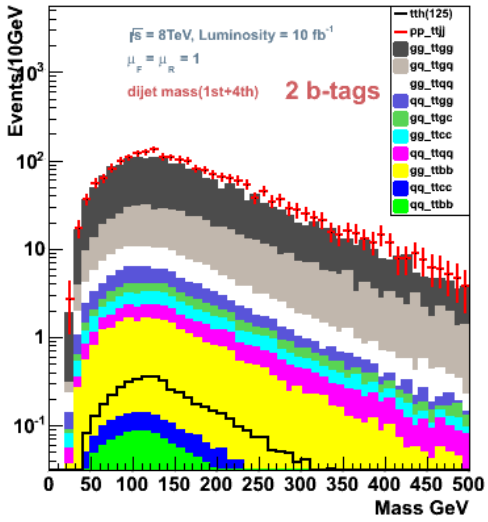


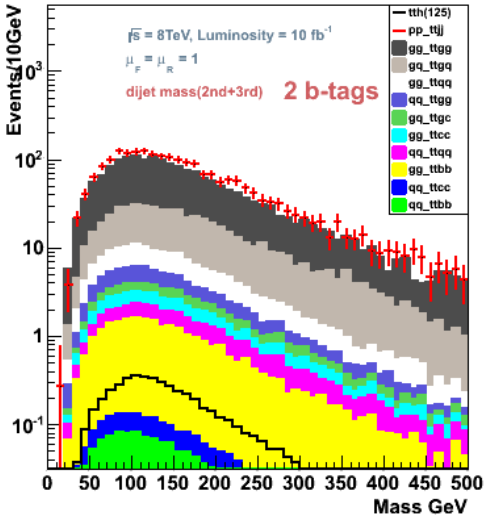


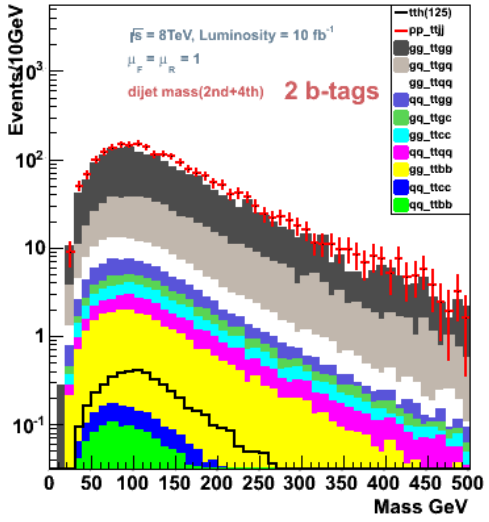
Di-jet mass (2 b-tag)

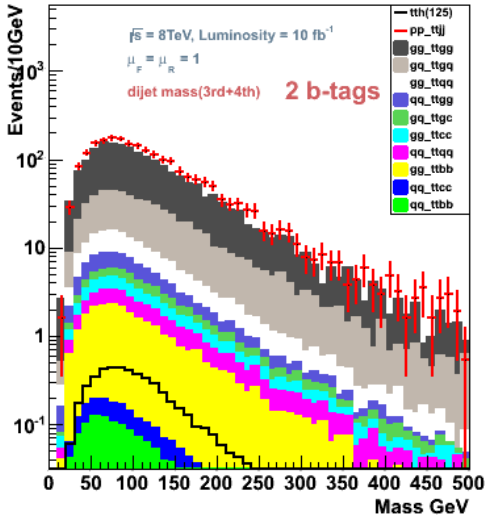




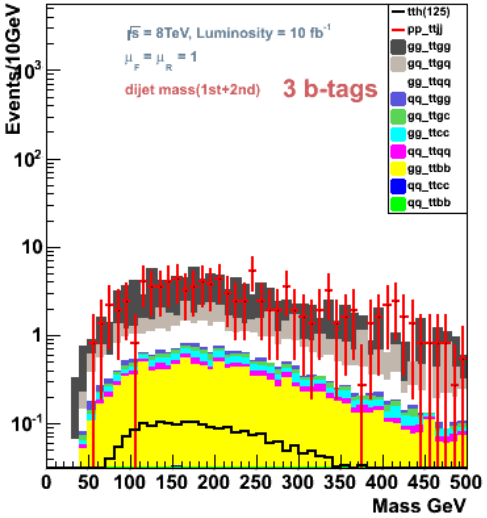


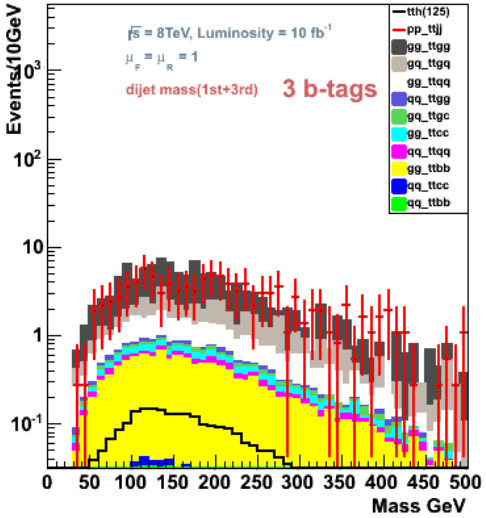


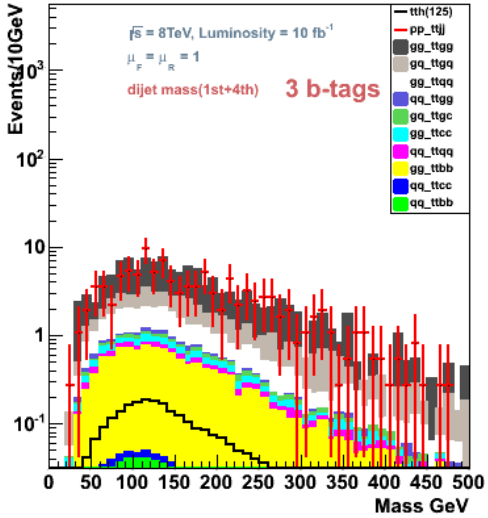


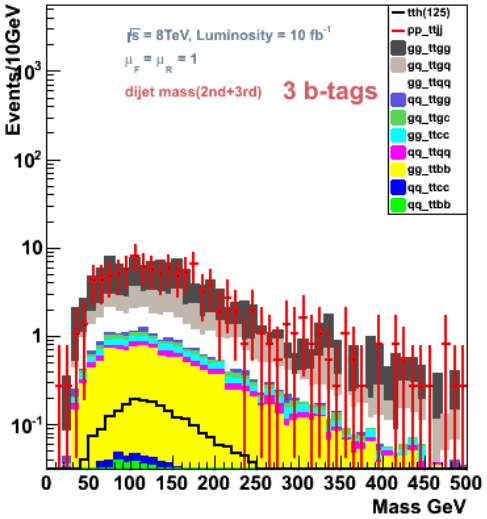


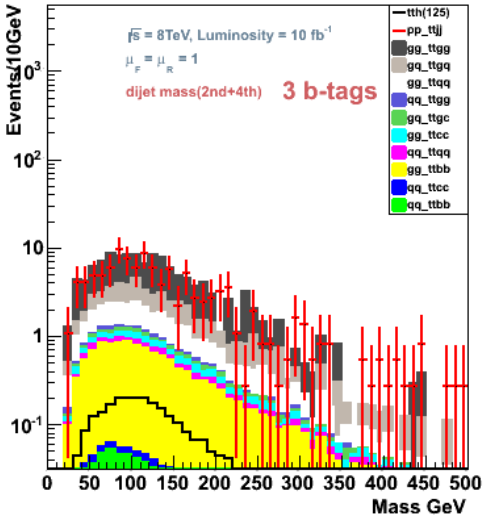
Di-jet mass (3 b-tag)

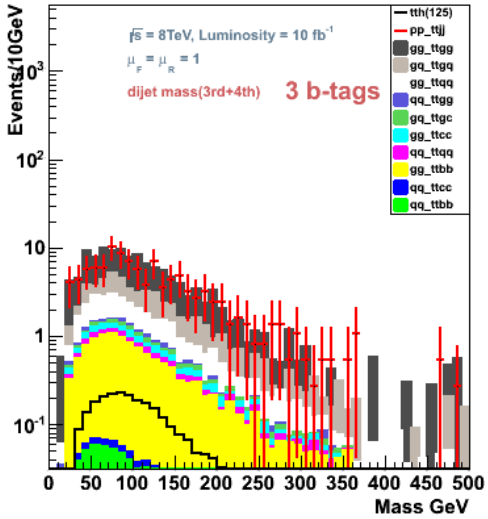




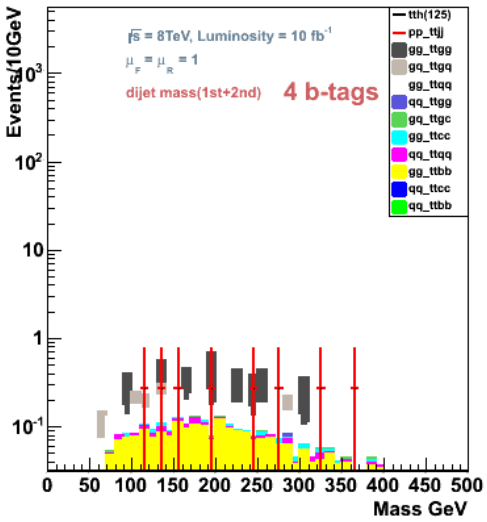


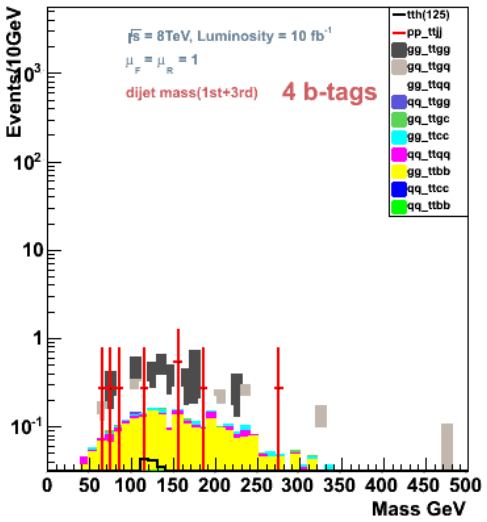


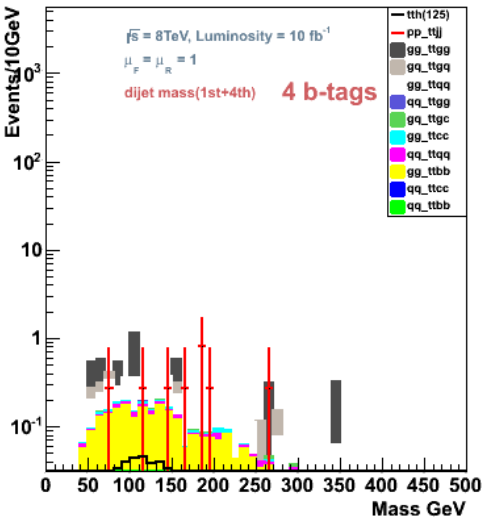


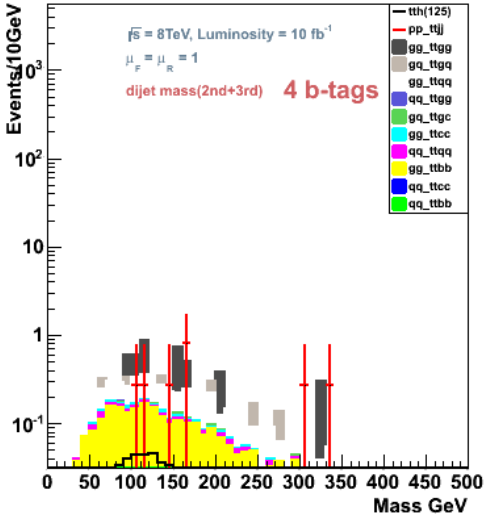


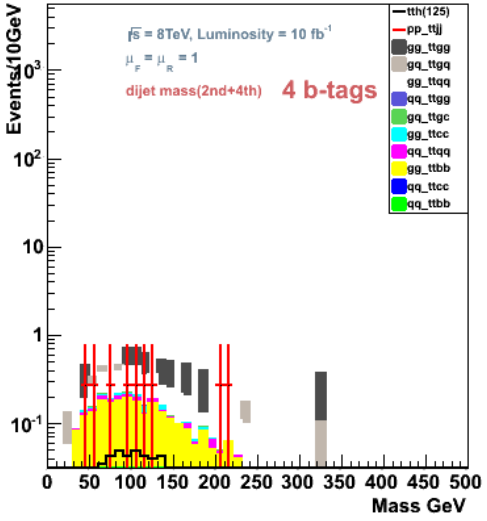
Di-jet mass (4 b-tag)

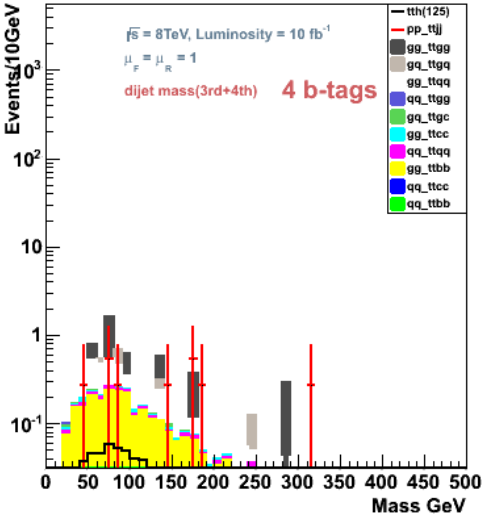


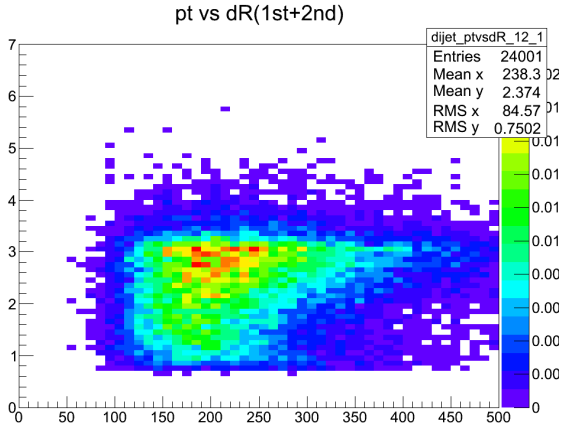


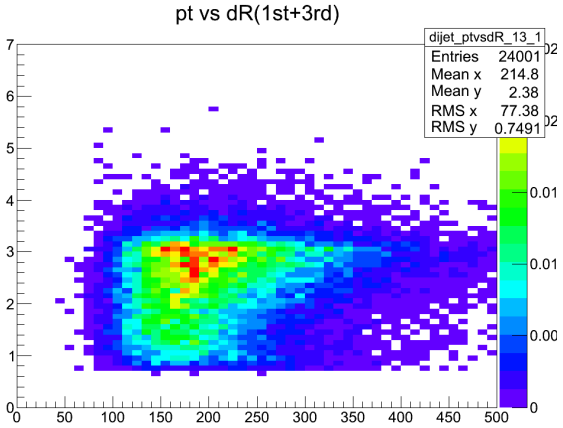









pt vs dR(1st+2nd)
dijet_ptvsdR_12_1
Entries 24001
Mean x 238.3
Mean y 2.374
RMS x 84.57
RMS y 0.7502


pt vs dR(1st+3rd)
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Entries 24001
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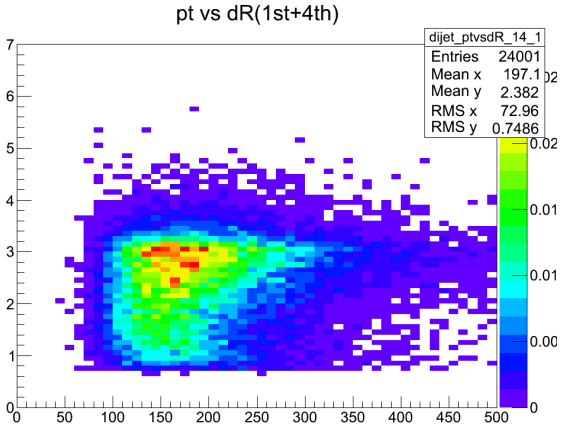
Mean y 2.38
RMS x 77.38
RMS y 0.7491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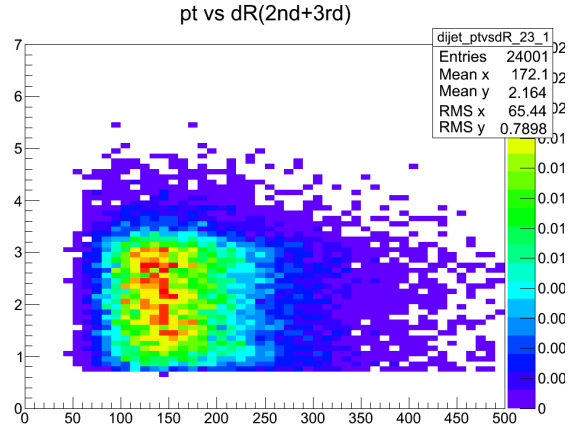
RMS y 0.7486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Entries 24001
Mean x 172.1
Mean y 2.164
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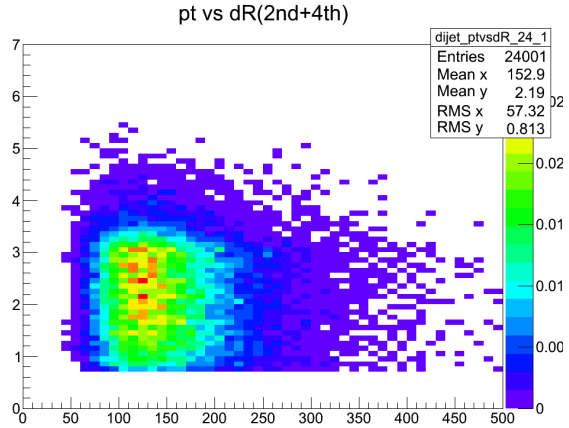
pt vs dR(2nd+4th)
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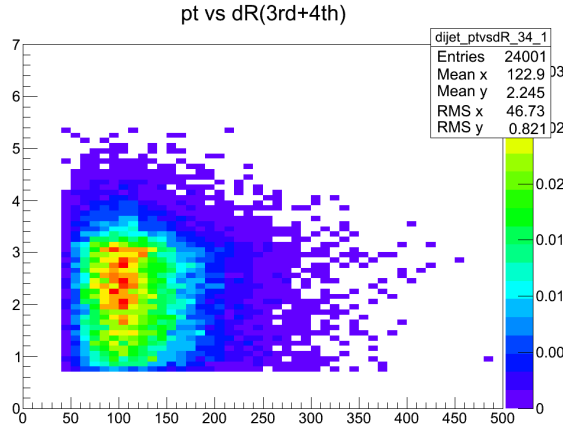
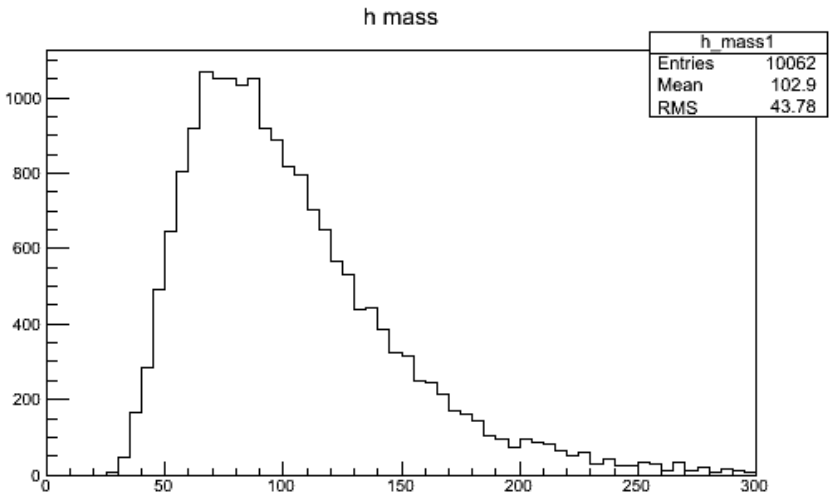
Entries 24001
Mean x 152.9
Mean y 2.19
RMS x 57.32
RMS y 0.813

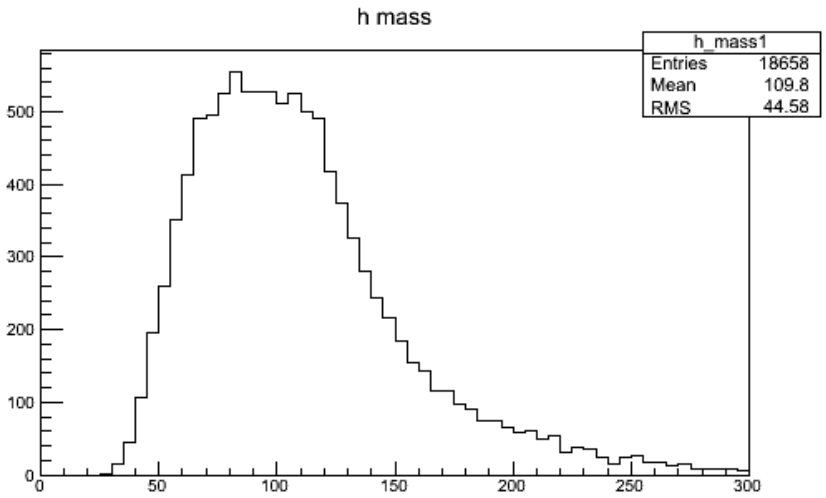

pt vs dR(3rd+4th)
dijet_ptvsdR_34_1
Entries 24001
Mean x 122.9
Mean y 2.245
RMS x 46.73
RMS y 0.821

ANALYSIS

Delta R< min && Delta R < 1.5

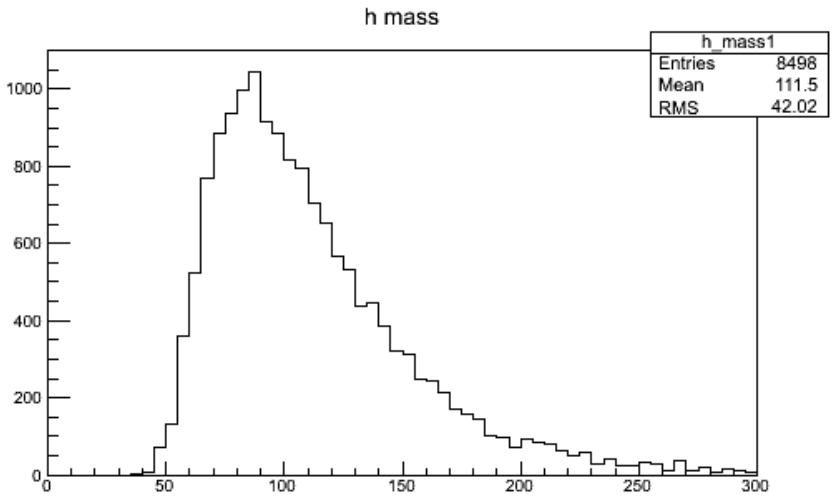


gg_ttbb

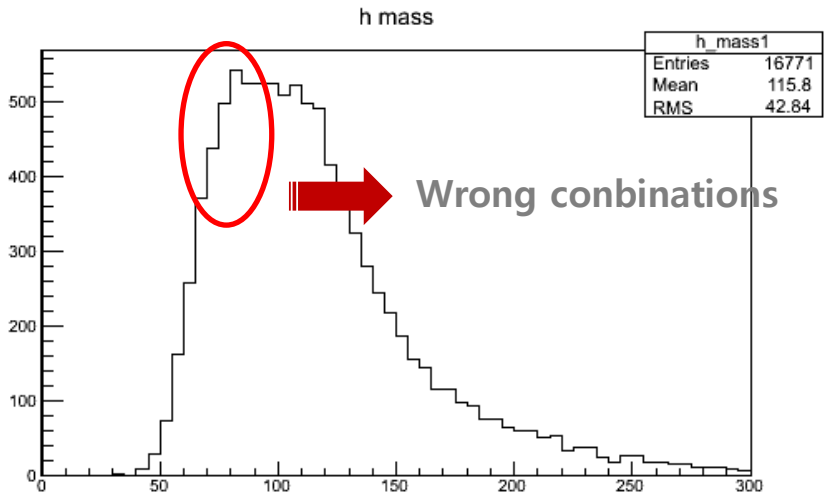


tth(125GeV)

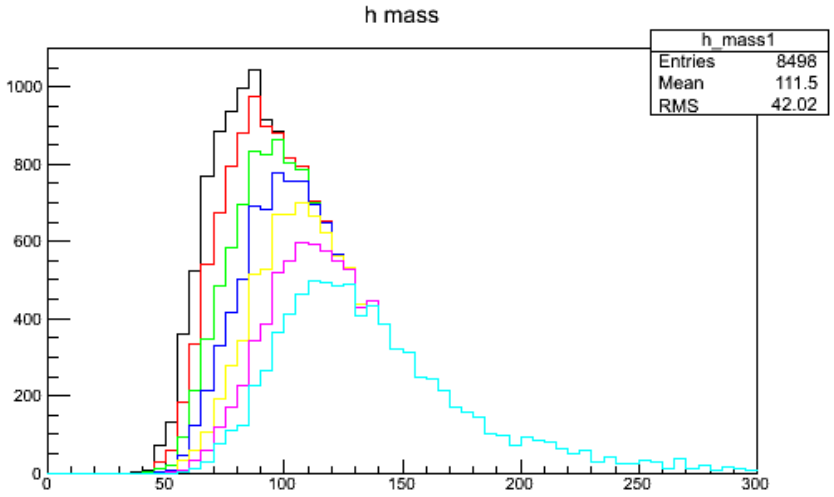
Delta R< min && Delta R < 1.5 && Ptsum > 100



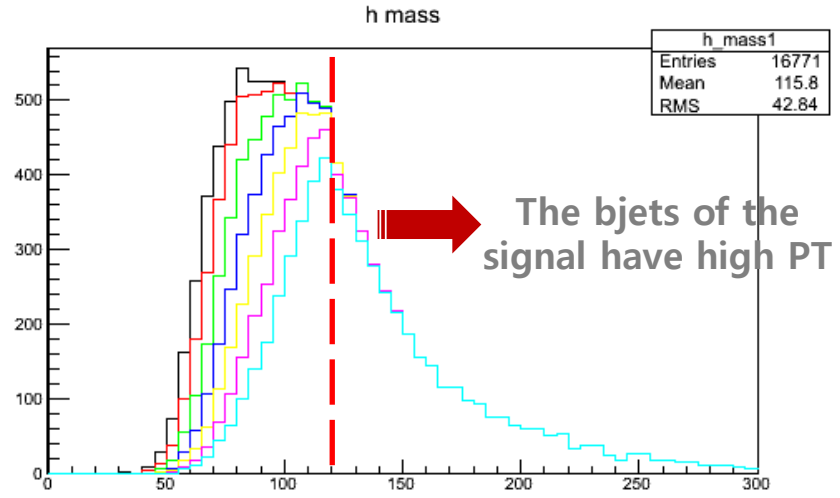
gg_ttbb



tth(125GeV)

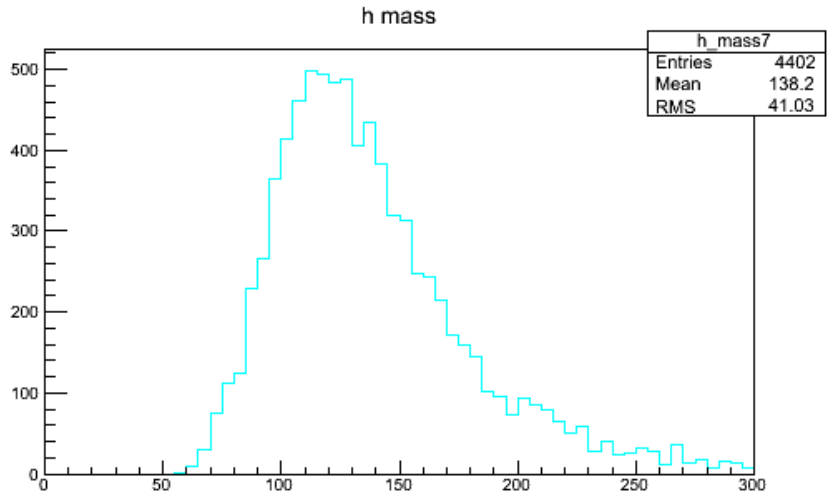


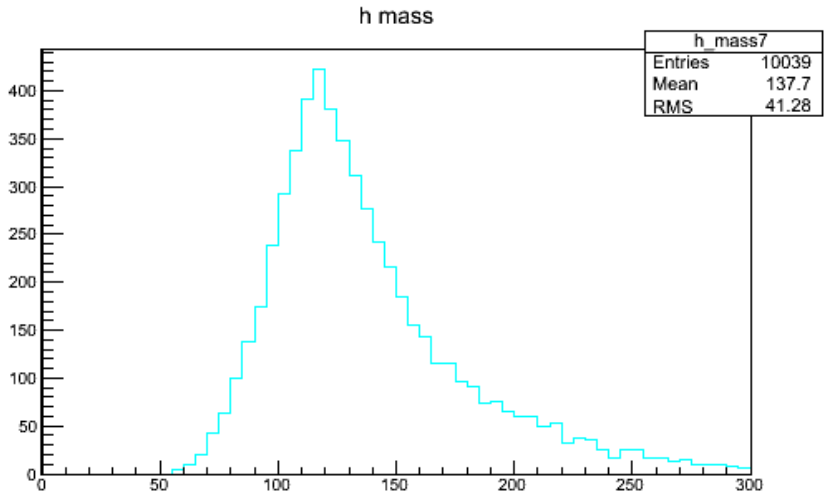
gg_ttbb

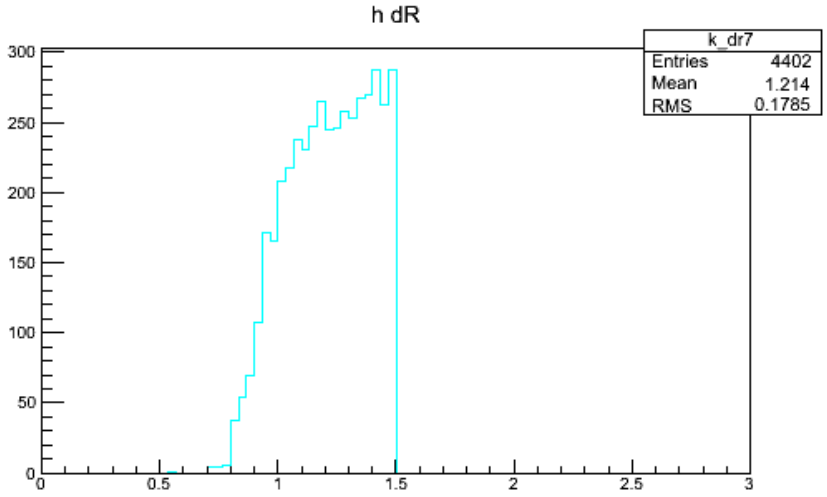


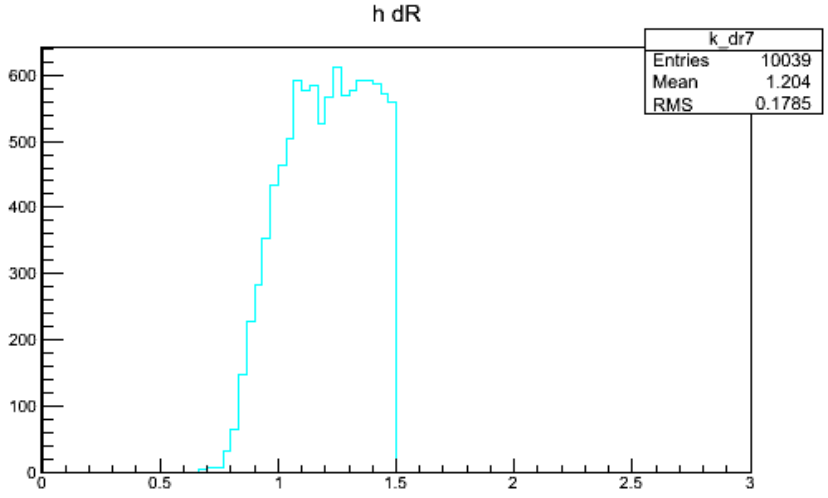
tth(125GeV)

Delta R< min && Delta R < 1.5 && Ptsum > 170









- NLO QCD corrections to **ttH**

  W. Beenakker, S. Dittmaier, M. Krämer, B. Plümper, M. Spira, P.M. Zerwas '01
  L. Reina, S. Dawson '01, S. Dawson, L.H. Orr, L. Reina, D. Wackeroth '03

- NLO QCD corrections to **ttH → ttbb**

  G. Bevilacqua, M. Czakon, M.V. Garzelli, A. van Hameren, C.G. Papadopoulos, R. Pittau, M. Worek '10 (Les Houches 2009)

- NLO QCD corrections to **ttbb**

  A. Bredenstein, A. Denner , S. Dittmaier , S. Pozzorini '08, '09, '10
  G. Bevilacqua, M. Czakon, C. G. Papadopoulos, R. Pittau, M.Worek '09

- NLO QCD corrections to **ttjj**

  G. Bevilacqua, M. Czakon, C.G. Papadopoulos, M.Worek '10