Top Yukawa Coupling: Semileptonic Update

T. Price

University of Birmingham

txp@hep.ph.bham.ac.uk

December 5, 2012

Overview

Signal and Backgrounds

Signal

$e^+e^- \to bl\nu\, \bar{b}q\bar{q}\, b\bar{b}$ (semi leptonic)

- 6 Jet final state
- 4 b-jets
- Isolated lepton
- Missing energy and momentum (neutrino)
- Reconstructed masses $M_{l\nu}=M_W=M_{jj}$, $M_{l\nu j}=M_t=M_{jjj}$, $M_{jj}=M_H$

Backgrounds

- tth other
- ttz-all-all
- ttbb-all-all
- 6f_ttbar

Analysis Method

Method

- Search for isolated leptons and remove
- Remove $\gamma\gamma \rightarrow$hadrons background
- Force remaining PFOs into 6 jets
- Flavour tag jets
- Find optimal jet configuration for event
- Reconstruct event - 2 lowest btags = hadronic W, other 4 are b jets for ts and H

Polarisation Weights

- eL.pR = 0.58
- eR.pL = 0.58
- eL.pL = 0.42
- eR.pR = 0.42

Reconstruction

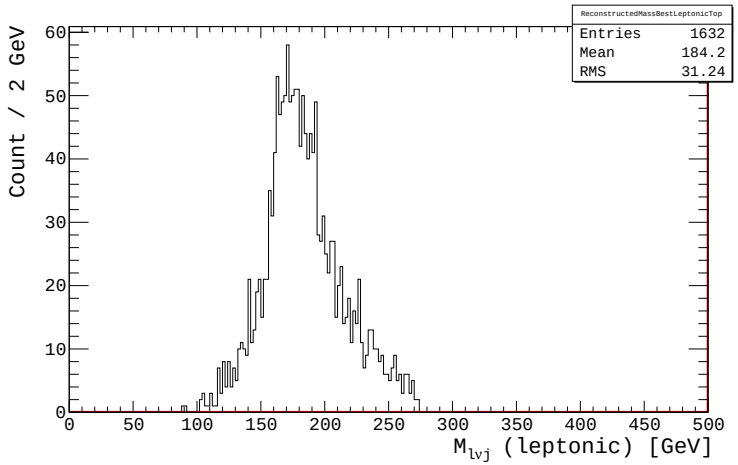
Using btag information to reduce number of combinations
hadronic W uses 2 lowest btags, all others use 4 of highest tags

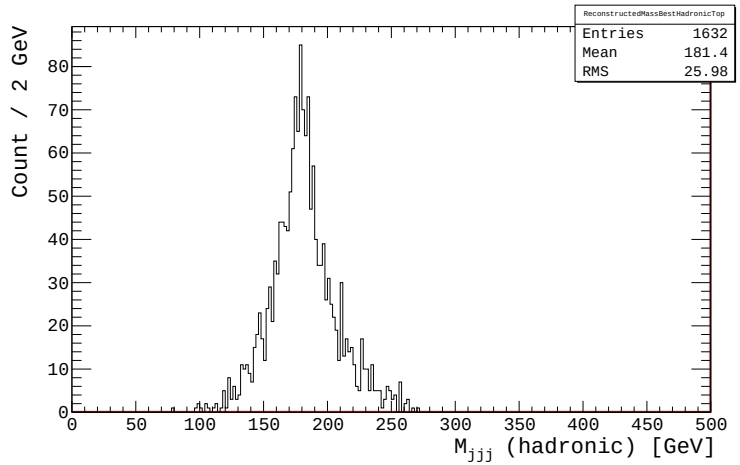
$$\chi^2 = \frac{(M_{bb} - M_H)^2}{\sigma_{bb}^2} + \frac{(M_{bjj} - M_t)^2}{\sigma_{bjj}^2} + \frac{(M_{bl\nu} - M_t)^2}{\sigma_{bl\nu}^2}$$

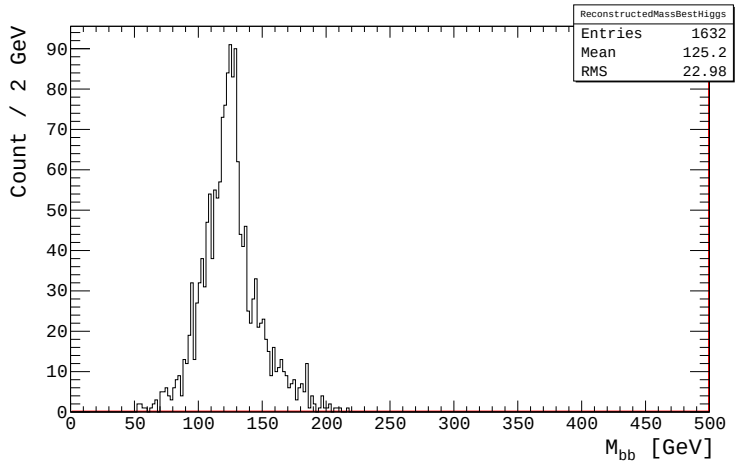
- $M_H = 125$ GeV
- $M_t = 173$ GeV

Event Reconstruction

Reconstructed Masses







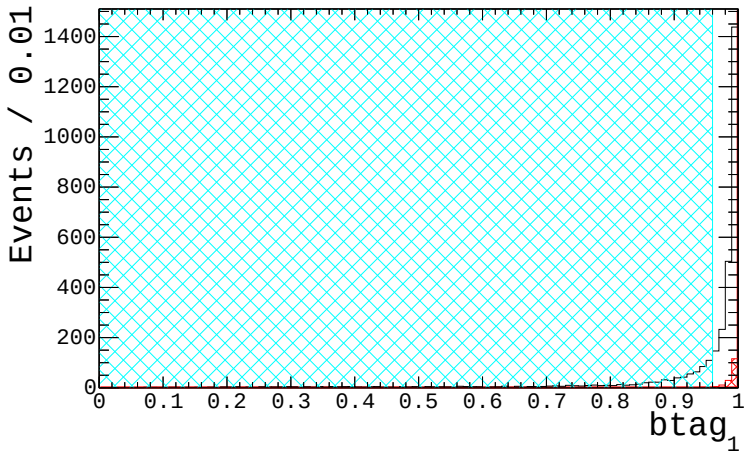
Event Selection

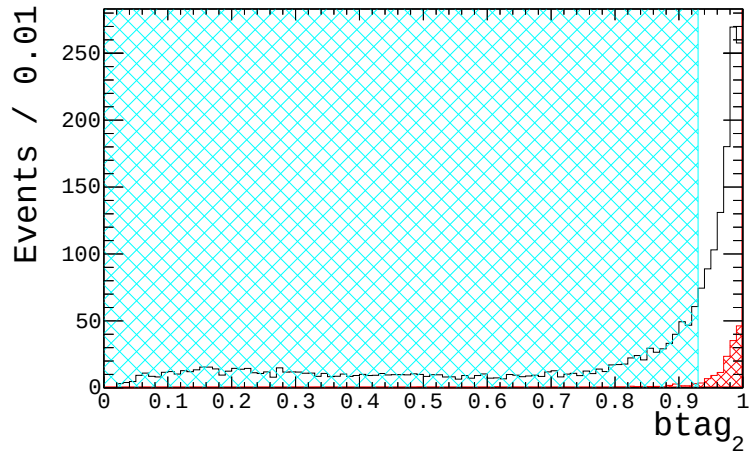
Cuts

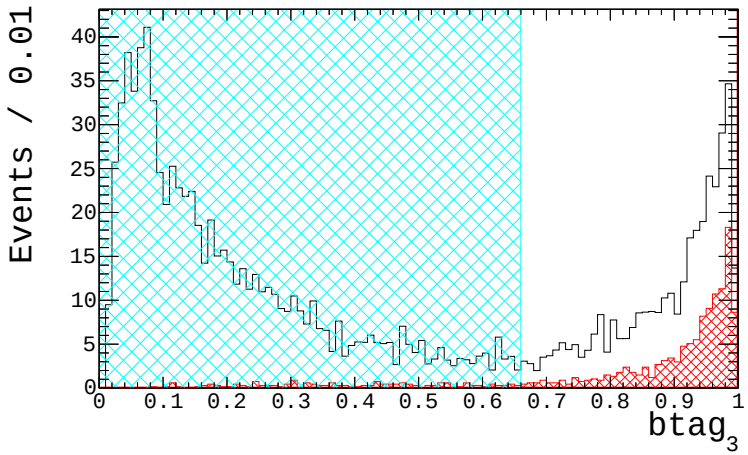
- nIsolatedLeptons $= 1$
- Total Visible Energy
- nPandoraPFOs
- Thrust
- Ycuts - Now cut on Y45 and Y56
- Btags - Now cut on btag1–4 not just 3
- χ^2 of reconstruction
- Final masses
- Helicity of Higgs Decay

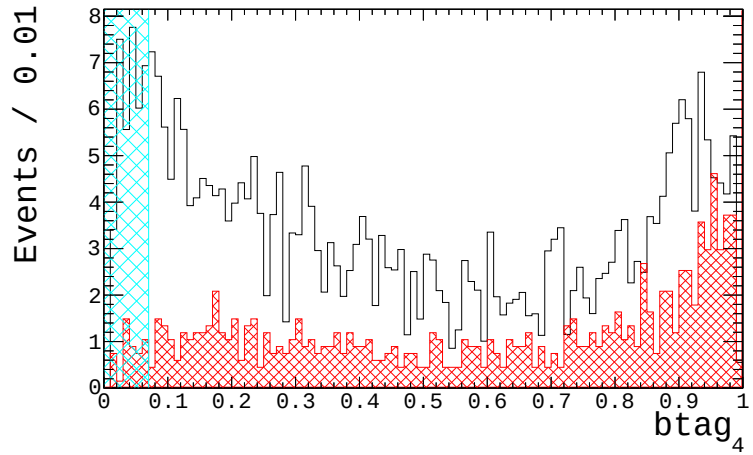
Event Selection

Btag Cuts



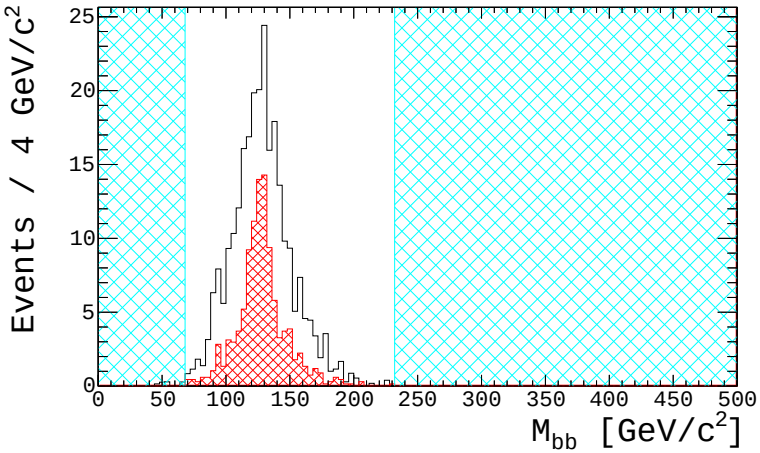


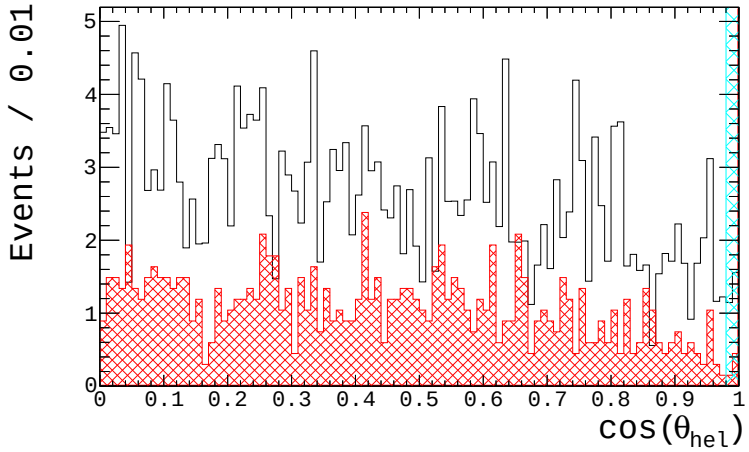




Event Selection

Higgs Cuts





Event Selection

Cut Flow

Cut	tth-ln4q-hbb	tth-other	ttz-all-all	ttbb-all-all	6f_ttbar
Total Events	628.7	1850.2	5332.4	1434.5	307926.6
IsoLep=1	399.0	518.9	1785.1	501.0	109076.1
$580 < E_{vis} < 1000$	382.1	457.2	1486.6	452.4	87204.5
nPFOs>152	277.5	288.1	778.3	263.2	16684.6
Thrust<0.89	255.2	263.0	677.7	201.6	8999.6
Ycuts	186.3	174.2	393.6	130.2	2984.8
btags	120.5	21.8	70.7	70.6	173.8
χ^2 <347	119.5	19.6	68.9	69.0	167.1
Masses	114.6	17.4	63.3	60.7	145.6
helicity<0.98	114.4	17.2	63.0	60.4	145.4

$$\epsilon_{sig} = 18.2\% \qquad \rho_{sample} = 28.6\%$$

$$\frac{S}{\sqrt{S+B}} = 5.7 \qquad \left(\frac{\Delta g_{ttH}}{g_{ttH}}\right)_{stat} = 8.8\%$$

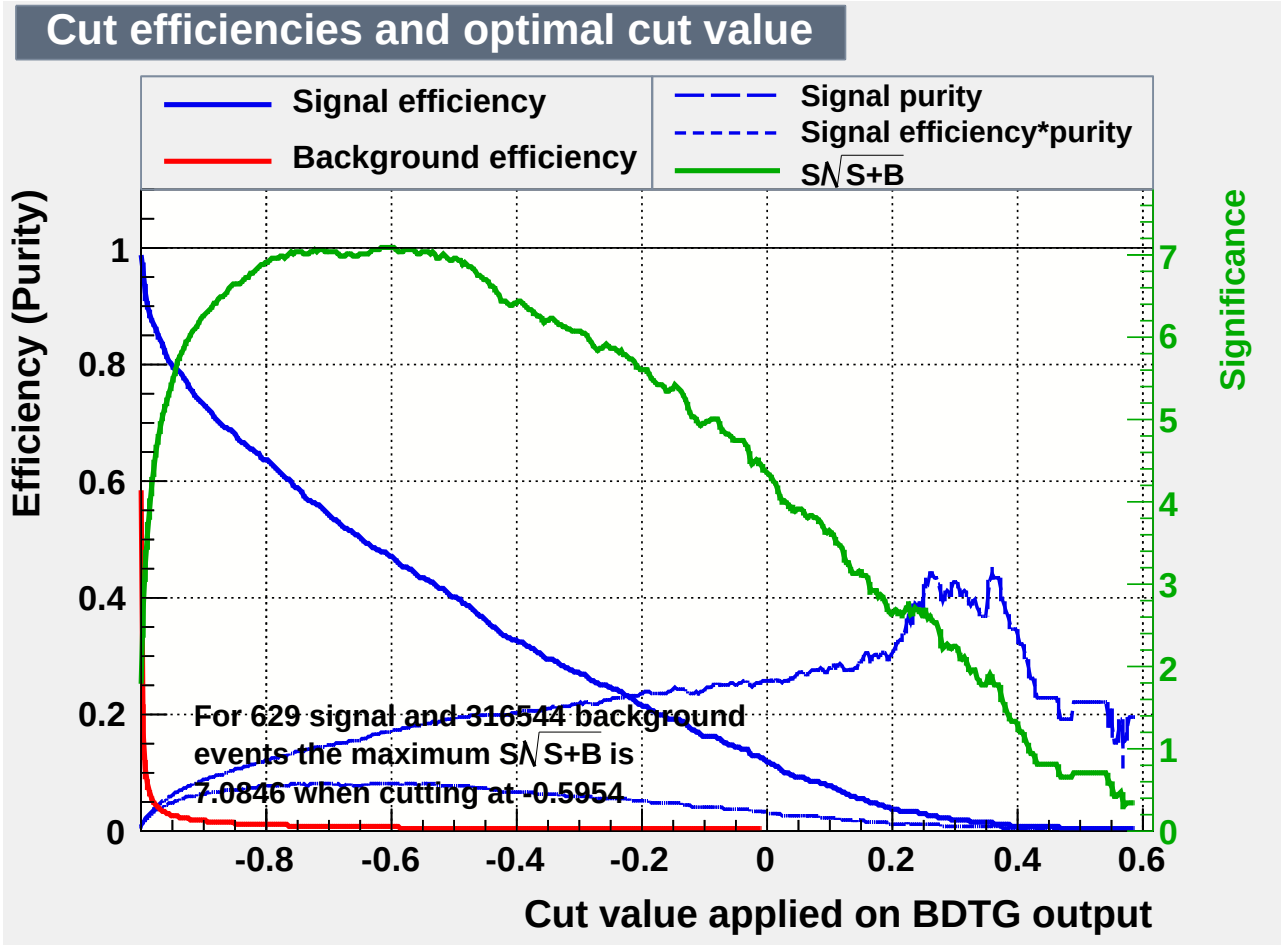
TMVA

Input Variables

- E_{vis}
- nPandoraPFOs
- Y_{45}, Y_{56}
- Thrust
- $Btag_{1--4}$
- χ^2 of event reconstruction
- Mass cuts
- Higgs Helicity

TMVA

BDTG



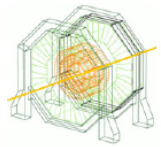
$$\epsilon_{sig} = 46.6\% \qquad \rho_{sample} = 17.1\%$$

$$\frac{S}{\sqrt{S+B}} = 7.1 \qquad \left(\frac{\Delta g_{ttH}}{g_{ttH}}\right)_{stat} = 7.1\%$$

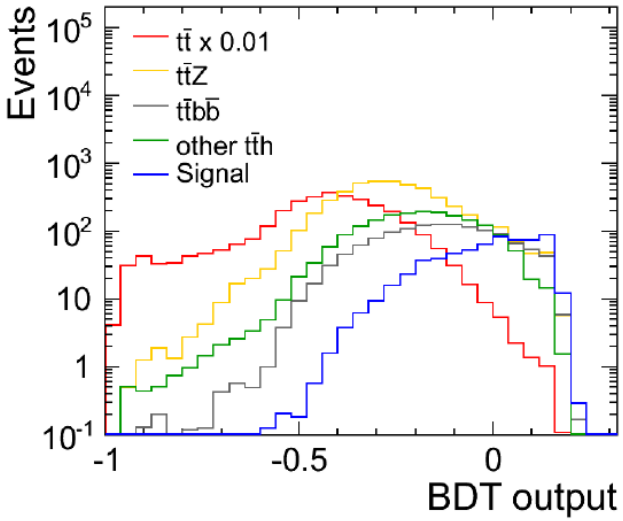
SiD Results

How are the "competition" getting on?

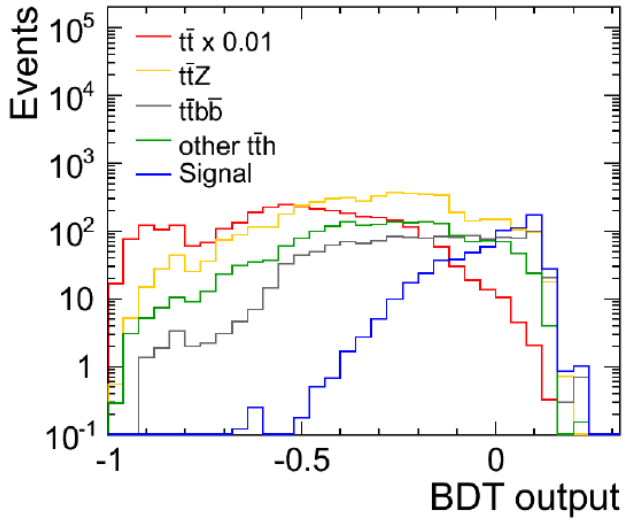
BDT outputs and results



6 jets:



8 jets:



Using cut on BDT output with best $S / (S + B)^{½}$

$\Delta\sigma / \sigma = 13.6\% \rightarrow \Delta y_t / y \approx 6.8\%$

$\Delta\sigma / \sigma = 12.3\% \rightarrow \Delta y_t / y \approx 6.2\%$

Combined: $\Delta y_t / y \approx 4.6\%$

$L_{int} = 1\ ab^{-1}$

Future Work

Lepton Isolation

Method	Eff iso electrons	Eff other electrons	Eff iso muons	Eff other muons
Mine	0.793 (0.874)	0.110 (0.029)	0.848 (0.929)	0.117(0.086)
Tomohiko	0.748 (0.762)	0.017 (0.003)	0.847 (0.860)	0.016 (0.003)
Isolator2 6J	0.717 (0.737)	0.019 (0.000)	0.805 (0.818)	0.017 (0.004)
Isolator2 8J	0.794 (0.819)	0.027 (0.002)	0.878 (0.894)	0.020 (0.004)

Update to LAL isolator as purer sample

Requests

Reprocessing

- Reprocessing of all events with LAL isolator will take lots of cpu power so need a supercluster.
- Bluebear at bham down until Monday - could just wait.
- lxbatch: dst's not on castor can somebody replicate the files there?
- grid: could someone help me run on the grid with my own processors aswell as iLCSoft? DIRAC install but don't know how to use

Extra Statistics

From meeting with SiD folks earlier they use 20k events for each sample. I used 2-5k on average. Possible to get extra samples? Will prepare list this afternoon if so

Conclusions

- TMVA BDTG yields $\left(\frac{\Delta g_{ttH}}{g_{ttH}}\right)_{stat} = 7.3\%$
- Cut based method yields $\left(\frac{\Delta g_{ttH}}{g_{ttH}}\right)_{stat} = 8.8\%$
- Cut based method results worse when treat both polarisations as one sample compared to splitting the analysis and combining later
- LAL Lepton Isolator shows improved results to update to this to match 8J channel
- $\gamma\gamma$ removal optimised to be kt R=1.2–1.3
- Need to optimise variables in TMVA analysis
- Extra statistics would improve the analysis
- Results are consistent with SiD results