

Top Yukawa Coupling: Semileptonic “Final” Results

T. Price

University of Birmingham

txp@hep.ph.bham.ac.uk

December 19, 2012



Overview

- 1 Signal and Backgrounds
- 2 Analysis
- 3 Event Reconstruction
- 4 Improved Statistics
- 5 Lepton Isolation
- 6 $\gamma\gamma \rightarrow$ hadron Removal
- 7 Cuts Used
- 8 Cut Based Results
- 9 TMVA
- 10 Conclusions

Signal and Backgrounds

Signal and
Backgrounds

Analysis

Event Recon-
struction

Improved
Statistics

Lepton
Isolation

$\gamma\gamma \rightarrow$ hadron
Removal

Cuts Used

Cut Based
Results

TMVA

Conclusions

Signal

$e^+e^- \rightarrow bl\nu \bar{b}q\bar{q} b\bar{b}$ (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

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

8 fermion

PID	Name	Pol	σ	N_evts	Lumi
I106427	Pttbb-all-all	eL.pR	3.42925	21000	6123.79
I106428	Pttbb-all-all	eR.pL	1.51742	10600	6985.54
I106429	Pttz-all-all	eL.pR	14.0206	13777	982.626
I106430	Pttz-all-all	eR.pL	4.36711	13200	3022.59
I106451	Ptth-6q-hbb	eL.pR	1.55275	14561	9377.56
I106452	Ptth-6q-hbb	eR.pL	0.698004	4561	6534.35
I106453	Ptth-6q-hnonbb	eL.pR	1.13367	6149	5423.98
I106454	Ptth-6q-hnonbb	eR.pL	0.509616	3787	7431.09
I106455	Ptth-ln4q-hbb	eL.pR	1.49556	17603	11770.2
I106456	Ptth-ln4q-hbb	eR.pL	0.672428	7311	10872.5
I106457	Ptth-ln4q-hnonbb	eL.pR	1.09192	6684	6121.33
I106458	Ptth-ln4q-hnonbb	eR.pL	0.490942	3358	6839.91
I106459	Ptth-2l2nbb-hbb	eL.pR	0.360104	800	2221.58
I106460	Ptth-2l2nbb-hbb	eR.pL	0.161938	400	2470.08
I106461	Ptth-2l2nbb-hnonbb	eL.pR	0.262914	600	2282.12
I106462	Ptth-2l2nbb-hnonbb	eR.pL	0.118232	400	3383.18

Thank You!

Huge thank you to Jan for sorting the samples quickly.

6 fermions

Samples Used

PID	Name	Pol	σ	N_evts	Lumi
135786	P6f_yyveev	eL.pL	0.753694	10000	13268
135787	P6f_yyveev	eL.pR	14.2626	14263	1000.03
135788	P6f_yyveev	eR.pL	3.19105	10000	3133.76
135789	P6f_yyveev	eR.pR	0.759213	9999	13170.2
135790	P6f_yyvelv	eL.pL	1.43439	10000	6971.6
135791	P6f_yyvelv	eL.pR	22.8764	22873	999.851
135792	P6f_yyvelv	eR.pL	6.27219	10000	1594.34
135794	P6f_yyveyx	eL.pL	4.12162	9999	2425.99
135795	P6f_yyveyx	eL.pR	67.5343	87971	1302.61
135796	P6f_yyveyx	eR.pL	18.6453	22206	1190.97
135799	P6f_yyvlev	eL.pR	22.8751	22871	999.821
135800	P6f_yyvlev	eR.pL	6.26441	9998	1596
135801	P6f_yyvlev	eR.pR	1.42761	10000	7004.71
135803	P6f_yyvllv	eL.pR	41.2755	41270	999.867
135804	P6f_yyvllv	eR.pL	12.5982	12597	999.905
135807	P6f_yyvlyx	eL.pR	115.979	114832	990.11
135808	P6f_yyvlyx	eR.pL	37.3065	40263	1079.25
135811	P6f_yyxyev	eL.pR	68.5022	112610	1643.89
135812	P6f_yyxyev	eR.pL	18.6593	28170	1509.7
135813	P6f_yyxyev	eR.pR	4.16307	10000	2402.07
135815	P6f_yyxylv	eL.pR	116.427	114986	987.623
135816	P6f_yyxylv	eR.pL	37.3211	42758	1145.68
135819	P6f_yyuyyu	eL.pR	84.596	84588	999.905
135820	P6f_yyuyyu	eR.pL	27.5005	28100	1021.8
135823	P6f_yyuyyc	eL.pR	84.5818	81782	966.898
135824	P6f_yyuyyc	eR.pL	27.5085	27949	1016.01
135827	P6f_yycyyu	eL.pR	84.4265	84412	999.828
135828	P6f_yycyyu	eR.pL	27.484	28484	1036.38
135831	P6f_yycyyc	eL.pR	84.9759	87364	1028.1
135832	P6f_yycyyc	eR.pL	27.5846	27785	1007.26

Signal and
Backgrounds

Analysis

Event Recon-
structionImproved
StatisticsLepton
Isolation $\gamma\gamma \rightarrow$ hadron
Removal

Cuts Used

Cut Based
Results

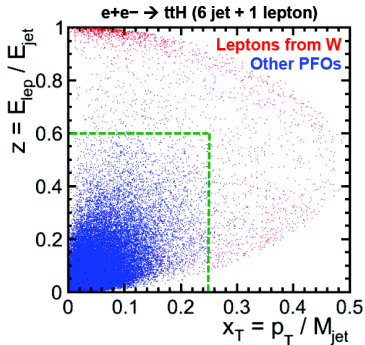
TMVA

Conclusions

Lepton Isolation

Updated my isolator to the LAL method to be consistent with Tomohiko

LAL Isolator

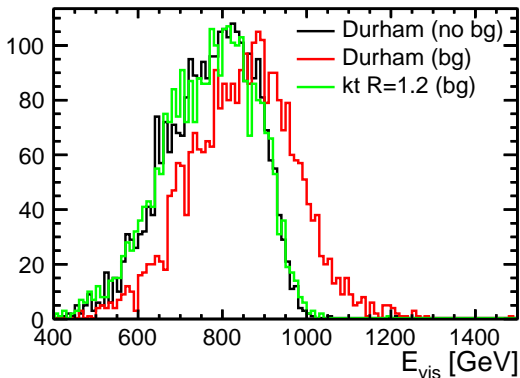


	leptonic	semilep	hadronic	tth-other	ttZ	ttbb	6f_ttbar	$\frac{S}{\sqrt{S+B}}$
Total	151.4	628.7	652.7	1046.1	5332.4	1434.5	308800.9	1.11
Mine	-	399.0	-	-	1785.1	501.0	109076.1	-
LAL	74.6	363.5	5.0	371.8	1581.5	439.9	101295.2	1.13

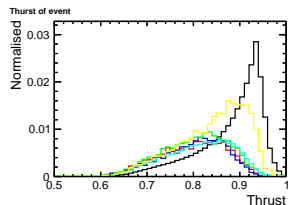
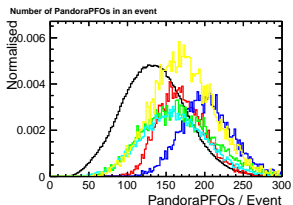
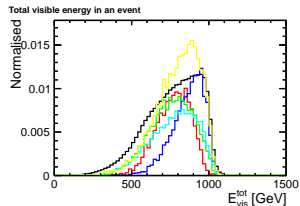
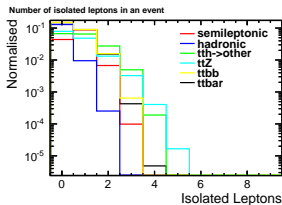
$\gamma\gamma \rightarrow \text{hadron}$ Removal

Removed using the kt algorithm in exclusive mode to form 6 jets with $R=1.2$

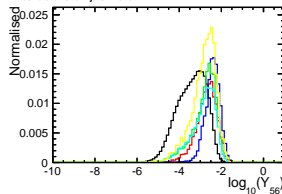
Total Visible Energy in the event



Cuts Used

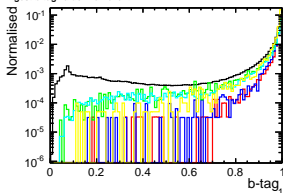


Threshold of 6 to 7 jets in event

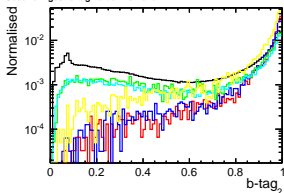


Cuts Used II

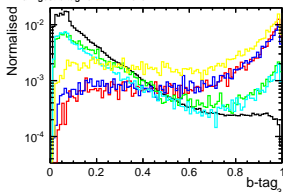
Higest b-tag value in an event



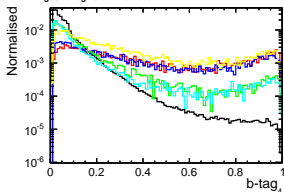
Second higest b-tag value in an event



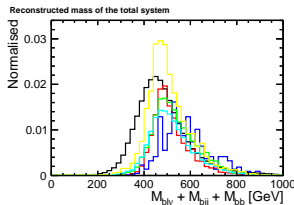
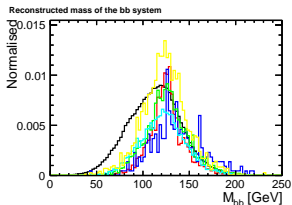
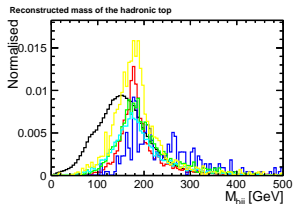
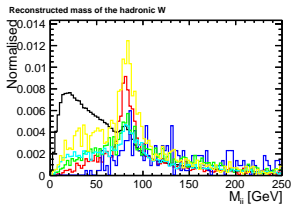
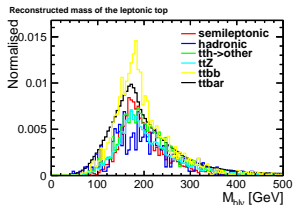
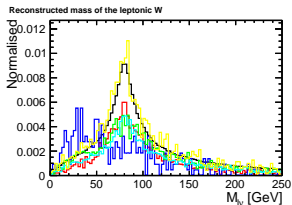
Third highest b-tag value in an event



Fourth highest b-tag value in an event



Cuts Used III



Cut Based - Results

Signal and
Backgrounds

Analysis

Event Recon-
structionImproved
StatisticsLepton
Isolation $\gamma \rightarrow$ hadron
Removal

Cuts Used

Cut Based
Results

TMVA

Conclusions

	leptonic	semilep	hadronic	tth-other	ttZ	ttbb	6f_ttbar	$\frac{S}{\sqrt{S+B}}$
Total	151.4	628.7	652.7	1046.1	5332.4	1434.5	308800.9	1.11
Isol _{lep} =1	74.6	363.5	5.0	371.8	1581.5	439.9	101295.2	1.13
E_{vis}	49.6	338.5	4.7	312.7	1228.9	373.8	75507.1	1.21
nPFOs	15.0	235.0	4.1	195.0	589.0	194.5	12605.9	2.00
Thrust	12.5	205.6	3.7	168.9	492.6	140.0	6092.3	2.44
$\log_{10}(Y_{45})$	7.7	151.3	3.2	108.5	295.2	91.0	2067.2	2.90
$\log_{10}(Y_{56})$	6.9	145.1	3.2	106.2	277.6	86.0	1836.1	2.92
b-tag ₁	6.7	135.1	2.8	79.8	216.9	78.3	1367.8	3.11
b-tag ₂	6.1	118.2	2.3	41.2	135.1	66.9	715.2	3.59
b-tag ₃	5.5	102.1	1.6	5.7	59.4	56.0	137.2	5.33
b-tag ₄	5.5	100.5	1.5	5.4	58.3	54.8	128.7	5.34
χ^2	5.3	100.0	1.4	5.2	56.8	53.7	126.0	5.36
M_{Total}	5.2	99.7	1.4	5.2	56.5	53.5	124.7	5.36
M_W^{lep}	5.1	99.5	1.4	5.2	56.5	53.3	122.5	5.37
M_t^{lep}	5.1	99.5	1.4	5.2	56.5	53.2	121.9	5.37
M_W^{had}	5.1	99.4	1.4	5.1	56.5	53.1	121.3	5.38
M_t^{had}	5.1	99.4	1.4	5.1	56.5	53.0	121.0	5.38
M_H	4.4	94.8	1.2	4.6	46.1	48.2	106.7	5.42
helicity	4.4	94.8	1.2	4.6	46.1	48.2	106.7	5.42

$$\frac{S}{\sqrt{S+B}} = 5.42 \quad \left(\frac{\Delta g_{ttH}}{g_{ttH}} \right)_{stat} = 9.6\%$$

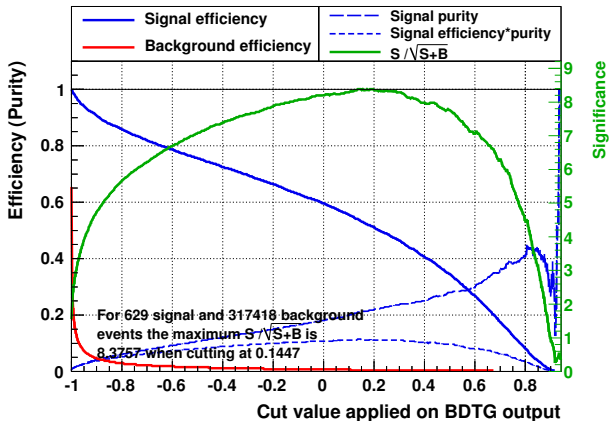
Input Variables

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

Cuts

IsolatedLeptons == 1

Cut efficiencies and optimal cut value



$$\frac{S}{\sqrt{S+B}} = 8.38 \quad \left(\frac{\Delta g_{ttH}}{g_{ttH}} \right)_{stat} = 6.2\%$$

Conclusions

- Analysis using the semileptonic mode has been carried out using a cut based and TMVA method.
- Leptons isolated using LAL method
- $\gamma\gamma \rightarrow$ hadrons removed using kt Njet = 6 R=1.2
- LC note writing well under way

Cut Based

$$\frac{S}{\sqrt{S+B}} = 5.42 \quad \left(\frac{\Delta g_{ttH}}{g_{ttH}} \right)_{stat} = 9.6\%$$

TMVA

$$\frac{S}{\sqrt{S+B}} = 8.38 \quad \left(\frac{\Delta g_{ttH}}{g_{ttH}} \right)_{stat} = 6.2\%$$

Any questions/comments?