

ttH: Towards the DBD

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Apologies

Signal and
Backgrounds

g_{tth}
Measurement

Event Recon-
struction
Masses

Event
Selection

Events Passed
Cuts

TMVA and
BDT

Conclusions

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- 2 Signal and Backgrounds
- 3 g_{tth} Measurement
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- 5 Event Selection
Events Passed Cuts
- 6 TMVA and BDT
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Power Outage

On Tuesday 6th November all of the power to Selly Oak and the university campus was cut due to a fire at a substation damaging the HV cables. University still on back up generators but half of batch systems now on. Speed has increased $\sim 3-4$ fold over last week!!

Signal and Backgrounds

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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

$$g_{fHf} \propto m_f \quad (1)$$

$$g_{ttH} = \frac{M_t}{\nu} = 0.711 \quad (2)$$

$$\left(\frac{\Delta g_{ttH}}{g_{ttH}} \right)_{stat} = \frac{1}{S_{stat} (t_{ttH}^2) \sqrt{\epsilon_{sel}^{signal} \rho_{sel}^{sample} L}} \quad (3)$$

assuming radiation off Z is negligible

$$S_{stat} (t_{ttH}^2) = \frac{\sqrt{\sigma_{ttH}}}{g_{ttH}^2} \quad (4)$$

Reconstruction

Using btag information to reduce number of combinations
hadronic W uses 2/3 lowest btags, all others use 4/5 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

Apologies

Signal and Backgrounds

$\bar{g}tth$ Measurement

Event Reconstruction

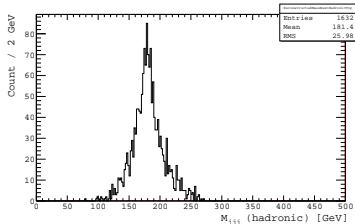
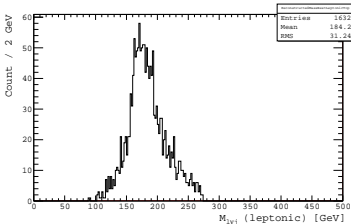
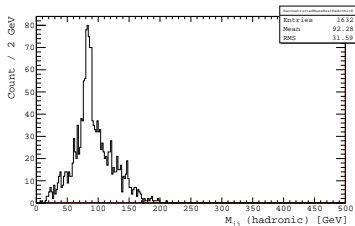
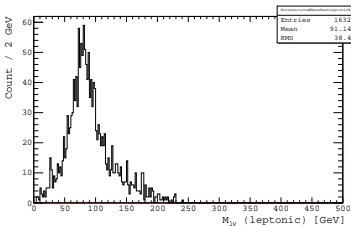
Masses

Event Selection

Events Passed Cuts

TMVA and BDT

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Event Reconstruction

Reconstructed Masses - Higgs

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\mathcal{B}_{ttH}
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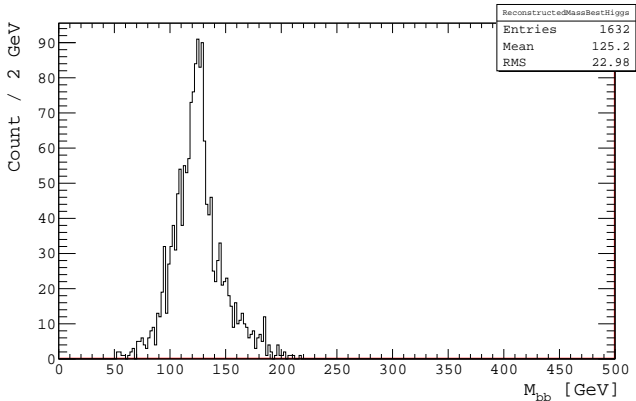
Masses

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Event Selection

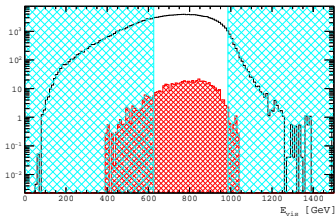
Cuts

- nIsolatedLeptons = 1
- Total Visible Energy
- nPandoraPFOs
- Thrust
- Ycut
- Btag
- χ^2 of reconstruction
- Final masses

Event Selection

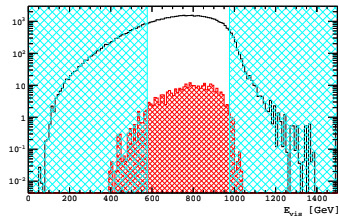
Cuts - Total Visible Energy

Pe-0.8 Pp+0.2



$$626 < E_{vis} < 986$$

Pe+0.8 Pp-0.2

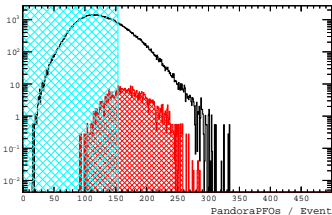


$$577 < E_{vis} < 976$$

Event Selection

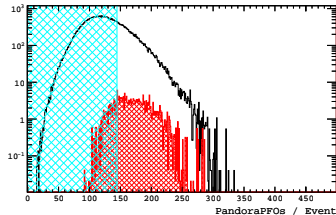
Cuts - No. PandoraPFOs

Pe-0.8 Pp+0.2



152 < PandoraPFOs

Pe+0.8 Pp-0.2

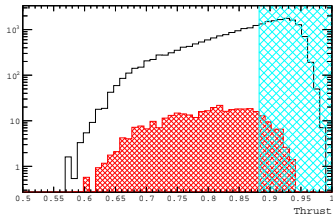


143 < PandoraPFOs

Event Selection

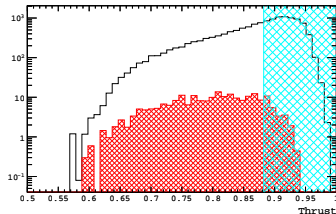
Cuts - Thrust

Pe-0.8 Pp+0.2



Thrust < 0.88

Pe+0.8 Pp-0.2

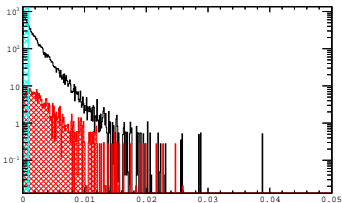


Thrust < 0.88

Event Selection

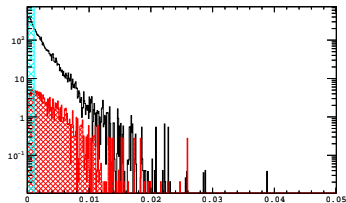
Cuts - Y56

Pe-0.8 Pp+0.2



$0.0008 < Y56$

Pe+0.8 Pp-0.2

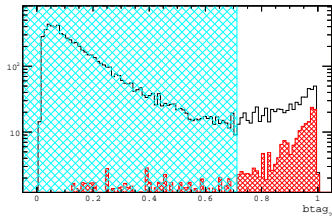


$0.001 < Y56$

Event Selection

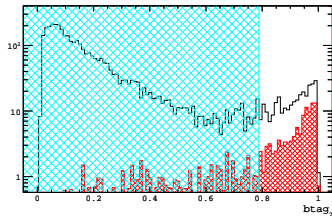
Cuts - Btag3

Pe-0.8 Pp+0.2



$$0.70 < B_{tag3}$$

Pe+0.8 Pp-0.2

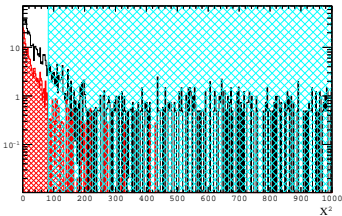


$$0.77 < B_{tag3}$$

Event Selection

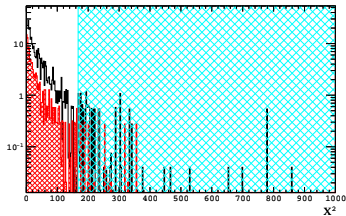
Cuts - χ^2

Pe-0.8 Pp+0.2



$$\chi^2 < 82.5$$

Pe+0.8 Pp-0.2

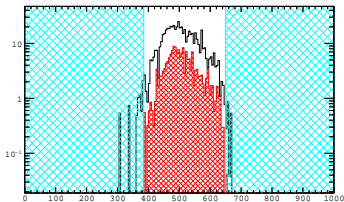


$$\chi^2 < 167$$

Event Selection

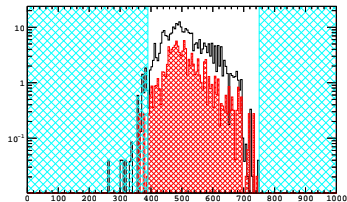
Cuts - Total Mass

Pe-0.8 Pp+0.2



$$385 < M_{tot} < 650$$

Pe+0.8 Pp-0.2

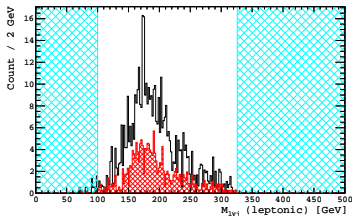


$$390 < M_{tot} < 750$$

Event Selection

Cuts - Leptonic Top Mass

Pe-0.8 Pp+0.2



$$100 < M_t^{lep} < 326$$

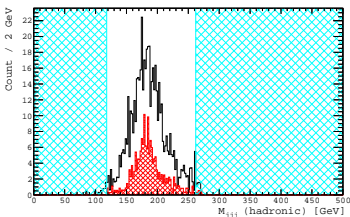
Pe+0.8 Pp-0.2

$$74 < M_t^{lep} < 338$$

Event Selection

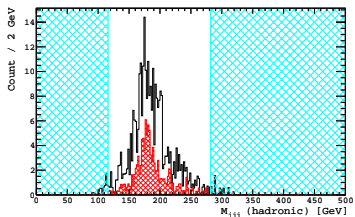
Cuts - Hadronic Top Mass

Pe-0.8 Pp+0.2



$$118 < M_t^{had} < 262$$

Pe+0.8 Pp-0.2

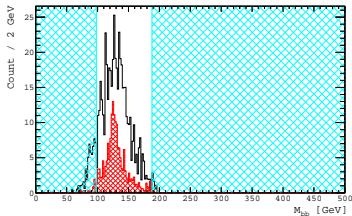


$$116 < M_t^{had} < 282$$

Event Selection

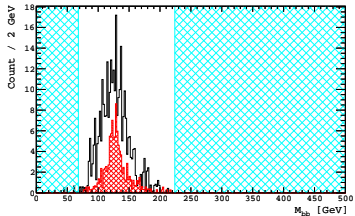
Cuts - Higgs Mass

Pe-0.8 Pp+0.2



$$98 < M_h < 188$$

Pe+0.8 Pp-0.2



$$68 < M_h < 224$$

Event Selection

Events Passed Cuts

Pe-0.8 Pp+0.2, 500 fb⁻¹

Cut	Signal	Background	$\frac{S}{\sqrt{S+B}}$
Total Events	417.2	229593.8	0.87
Isolep=1	261.5	80870.7	0.92
626 < E _{vis} < 986	237.1	57704.0	0.98
nPFOs > 152	175.3	11877.6	1.60
Thrust < 0.88	153.3	5899.4	1.97
Y ₅₆ > 0.0008	128.3	3638.0	2.09
Btag ₃ > 0.7	89.9	322.7	4.43
$\chi^2 < 82.5$	83.6	277.5	4.40
385 < M _{Total} < 650	83.6	273.3	4.42
100 < M _t ^{lep} < 326	83.2	271.0	4.42
118 < M _t ^{had} < 274	83.2	268.3	4.44
98 < M _H < 188	80.5	238.5	4.51

Event Selection

Events Passed Cuts

Pe+0.8 Pp-0.2, 500 fb⁻¹

Cut	Signal	Background	$\frac{S}{\sqrt{S+B}}$
Total Events	211.5	86688.1	0.72
IsoLep=1	137.4	30907.4	0.78
577 < E _{vis} < 976	132.4	24684.0	0.84
nPFOs > 143	110.1	7010.0	1.30
Thrust < 0.88	96.3	3347.8	1.64
Y ₅₆ > 0.001	77.5	1841.7	1.77
Btag ₃ > 0.78	51.5	147.8	3.65
$\chi^2 < 167$	50.6	140.7	3.66
390 < M _{Total} < 750	50.3	138.3	3.66
74 < M _t ^{lep} < 338	49.8	135.3	3.66
116 < M _t ^{had} < 282	49.6	131.5	3.68
68 < M _H < 224	49.6	130.9	3.69

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struction

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Events Passed Cuts

Pe-0.8 Pp+0.2, 500 fb⁻¹

Cut	tth-ln4q-hbb	tth-other	ttz-all-all	ttbb-all-all	6f_ttbar
Total Events	417.2	1054.1	3872.9	956.2	223710.5
IsoLep=1	261.5	278.0	1292.8	331.8	78968.2
626 < E _{vis} < 986	237.1	239.7	981.3	274.9	56208.2
nPFOs > 152	175.3	168.8	544.3	161.5	11003.0
Thrust < 0.88	153.3	147.2	448.2	115.4	5188.7
Y ₅₆ > 0.0008	128.3	134.3	361.3	90.0	3052.4
Btag ₃ > 0.7	89.9	19.3	64.0	57.2	182.3
χ ² < 82.5	83.6	14.7	56.8	50.9	155.1
385 < M _{Total} < 650	83.6	14.4	56.0	50.3	152.6
100 < M _t ^{lep} < 326	83.2	14.0	55.7	49.5	151.8
118 < M _t ^{had} < 274	83.2	13.4	54.8	49.2	150.9
98 < M _H < 188	80.5	12.8	44.2	44.7	136.8

$$\epsilon_{sig} = 0.193$$

$$\rho_{sample} = 0.252$$

$$\left(\frac{\Delta g_{ttH}}{g_{ttH}} \right)_{stat} = 11.2$$

Event Selection

Events Passed Cuts

Pe+0.8 Pp-0.2, 500 fb⁻¹

Cut	tth-ln4q-hbb	tth-other	ttz-all-all	ttbb-all-all	6f_ttbar
Total Events	211.5	534.2	1459.5	478.3	84216.1
IsoLep=1	137.4	136.2	493.4	169.2	30108.6
577 < E _{vis} < 976	132.4	124.7	412.7	152.6	23993.9
nPFOs > 143	110.1	95.8	246.7	106.9	6560.5
Thrust < 0.88	96.3	83.6	206.2	77.5	2980.5
Y ₅₆ > 0.001	77.5	75.1	153.1	58.1	1555.5
Btag ₃ > 0.78	51.5	6.3	27.1	30.5	83.8
χ ² < 167	50.6	5.6	26.4	30.2	78.5
390 < M _{Total} < 750	50.3	5.6	25.7	29.8	77.2
74 < M _t ^{lep} < 338	49.8	5.6	24.7	29.3	75.8
116 < M _t ^{had} < 282	49.6	5.5	24.3	28.0	73.7
68 < M _H < 224	49.6	5.5	24.3	27.6	73.4

$$\epsilon_{sig} = 0.234$$

$$\rho_{sample} = 0.275$$

$$\left(\frac{\Delta g_{ttH}}{g_{ttH}} \right)_{stat} = 13.7$$

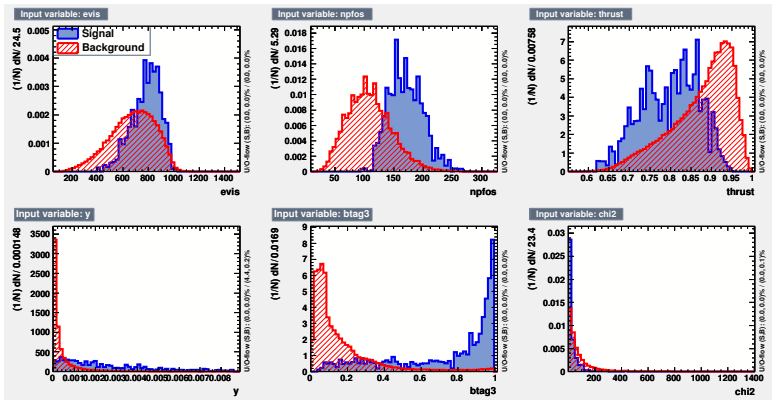
Implemented a TMVA with the following variables

- E_{vis}
- nPandoraPFOs
- Y_{56}
- Thrust
- $Btag_3$
- χ^2 of event reconstruction
- Mass cuts

Thank you to Tomohiko for help setting this up

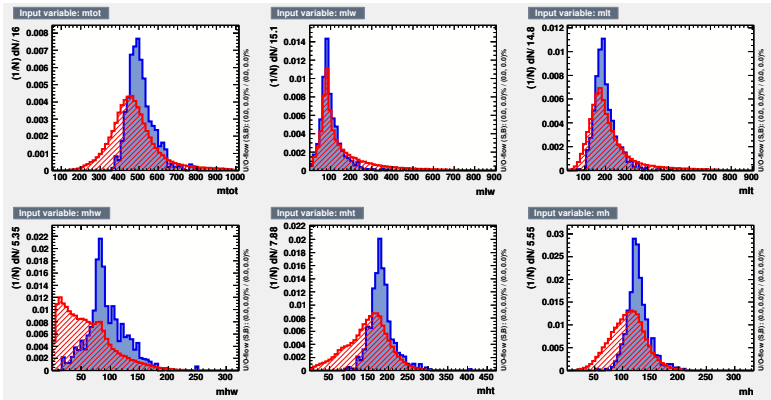
TMVA and BDT

Pe-0.8 Pp+0.2



TMVA and BDT

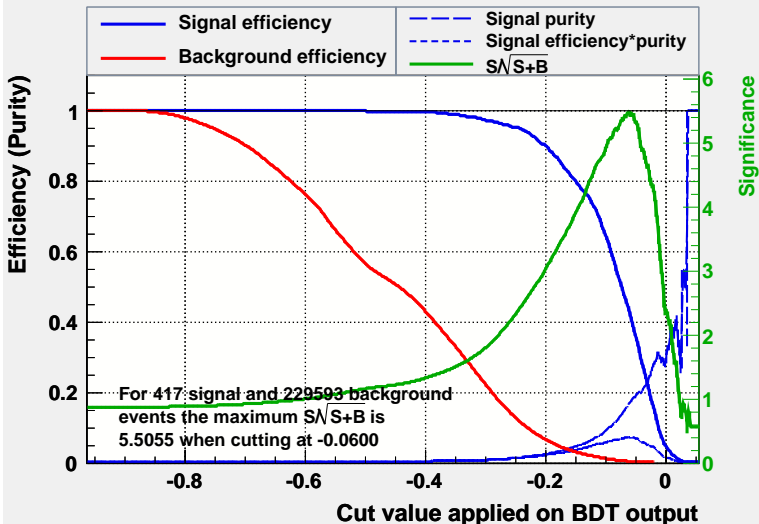
Pe-0.8 Pp+0.2



TMVA and BDT

Pe-0.8 Pp+0.2

Cut efficiencies and optimal cut value



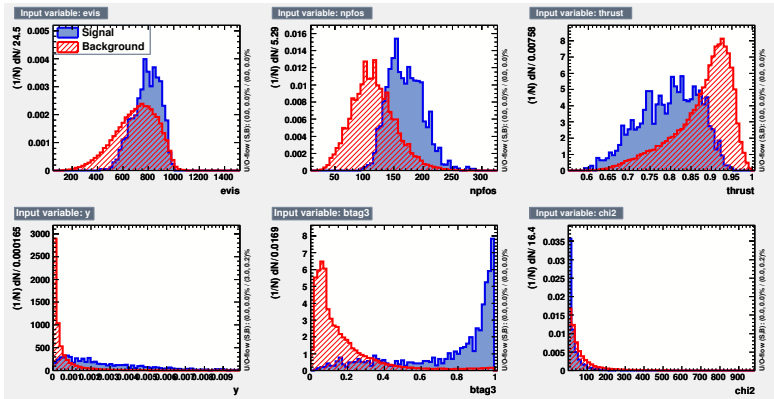
TMVA and BDT

Pe-0.8 Pp+0.2

- $\epsilon_{sig} = 0.4288$
- $\epsilon_{BG} = 0.0038$
- $n_{sig} = 178.8$
- $n_{BG} = 875.6$
- $\rho = 0.1696$
- $\frac{S}{\sqrt{S+B}} = 5.5$
- optimal BDT cut = -0.0600
- $\left(\frac{\Delta g_{ttH}}{g_{ttH}}\right)_{stat} = 9.2$

TMVA and BDT

Pe+0.8 Pp-0.2



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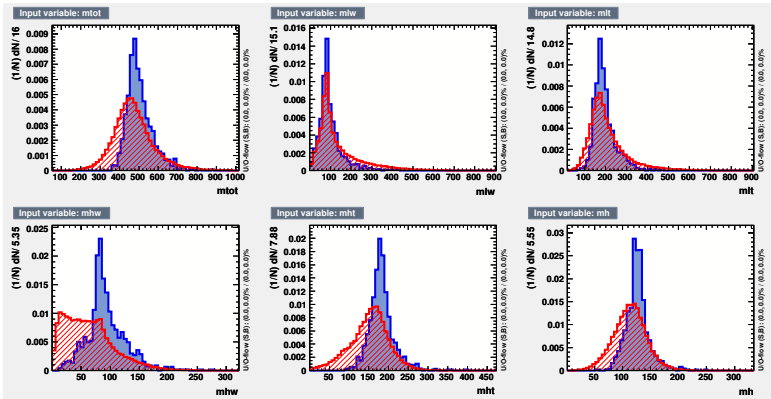
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TMVA and BDT

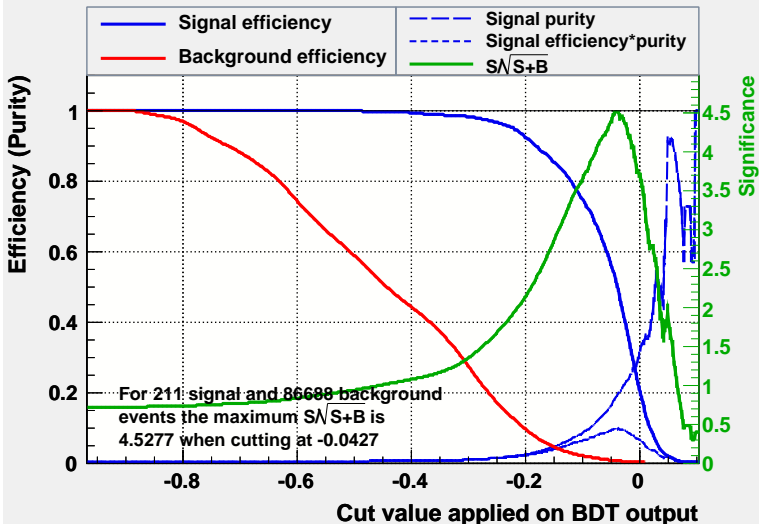
Conclusions



TMVA and BDT

Pe+0.8 Pp-0.2

Cut efficiencies and optimal cut value



TMVA and BDT

Pe+0.8 Pp-0.2

- $\epsilon_{sig} = 0.5265$
- $\epsilon_{BG} = 0.0057$
- $n_{sig} = 111.6$
- $n_{BG} = 491.0$
- $\rho = 0.1852$
- $\frac{S}{\sqrt{S+B}} = 4.54$
- optimal BDT cut = -0.0427
- $\left(\frac{\Delta g_{ttH}}{g_{ttH}}\right)_{stat} = 11.1\%$

Cut Based

- $P_{e-0.8} P_{p+0.2} : \left(\frac{\Delta g_{ttH}}{g_{ttH}} \right)_{stat} = 11.2 \%$
- $P_{e+0.8} P_{p-0.2} : \left(\frac{\Delta g_{ttH}}{g_{ttH}} \right)_{stat} = 13.7 \%$

TMVA

- $P_{e-0.8} P_{p+0.2} : \left(\frac{\Delta g_{ttH}}{g_{ttH}} \right)_{stat} = 9.2 \%$
- $P_{e+0.8} P_{p-0.2} : \left(\frac{\Delta g_{ttH}}{g_{ttH}} \right)_{stat} = 11.1 \%$

To Do

- Add in Kinematic Fit variables to both analyses to reduce ttz background
- Figure out what is wrong with mhw in TMVA
- Improve statistics/ combine polarisations