

ttH: Towards the DBD

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November 14, 2012



Overview

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- 3 $\gamma\gamma$ removal
- 4 Signal and Backgrounds
- 5 Event Reconstruction
neutrino
Masses
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Apologies

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. The university has been running on back up generators with minimal facilities since. Anywhere that this has affected the work I will use the following



Work to be completed

- Finalised $\gamma\gamma \rightarrow hadrons$ background removal
- Update to LCFIPlus with v02 and 1TeV 6q samples
- Add in tth \rightarrow others backgrounds
- Add in additional cuts on Higgs decay helicity
- Add BDT analysis using TMVA
- Process all events and get analysing

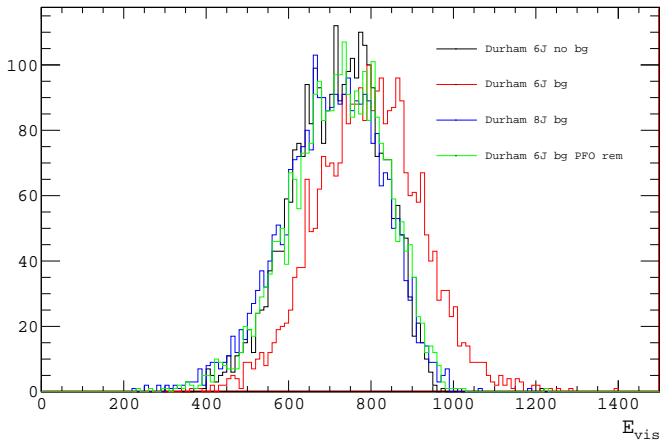
$\gamma\gamma \rightarrow hadrons$

- 4.1 $\gamma\gamma$ evts/bunch overlaid
- ~ 50 GeV extra energy in event
- How does this effect the measurements?

$\gamma\gamma \rightarrow hadrons$ Removal

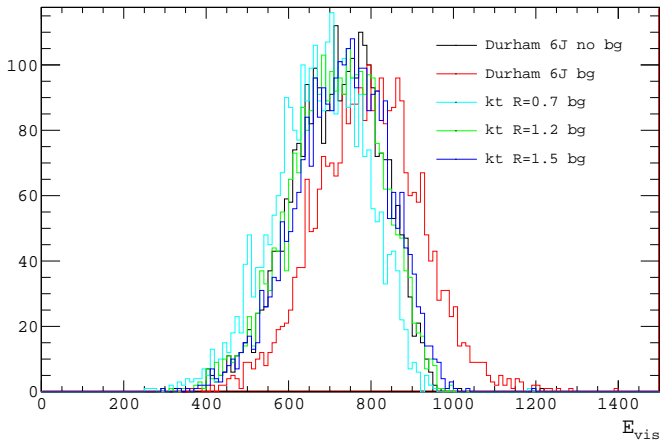
- Ignore and see what happens
- Durham 8 jets remove jets passed certain $\cos(\theta)$
- Remove all PFOs with certain $\cos(\theta)$ then Durham 6 jet
- Use hadronic kt algorithm with optimal value of R
- Also need to evaluate purity of final PFOs

$\gamma\gamma$ removal Durham methods



$\gamma\gamma$ removal

Kt methods



Method	χ^2	Eff	Purity	sqrt(eff*pur)
ee_kt 8j	61.899	0.904	0.922	0.913
kt0.5	252.437	0.729	0.958	0.835
kt0.6	192.129	0.776	0.951	0.859
kt0.7	126.776	0.816	0.944	0.878
kt0.8	88.3815	0.847	0.937	0.891
kt0.9	67.4123	0.873	0.931	0.901
kt1.0	45.6656	0.894	0.925	0.910
kt1.1	38.7979	0.912	0.920	0.916
kt1.2	28.3917	0.927	0.915	0.921
kt1.3	32.9834	0.939	0.911	0.925
kt1.4	37.9565	0.949	0.907	0.928
kt1.5	47.2999	0.957	0.903	0.929

Optimised at kt R=1.2 (Masses also follow same pattern)

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

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 ?? (seem to remember hearing this somewhere)

Event Reconstruction

Neutrino

Apologies

LCWS
Round-up $\gamma\gamma$ removalSignal and
BackgroundsEvent Recon-
struction**neutrino**
MassesEvent
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In signal there is missing energy due to the neutrino. Assume mass = 0 GeV

$$P_x^\nu = - \sum_{pfo=1}^n P_x^{pfo}$$

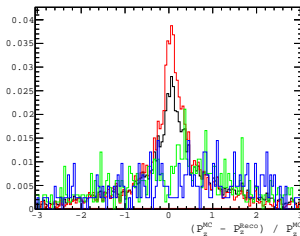
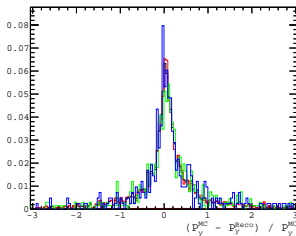
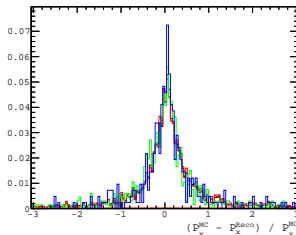
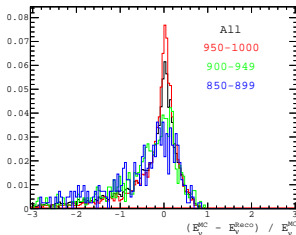
$$P_y^\nu = - \sum_{pfo=1}^n P_y^{pfo}$$

$$P_z^\nu = - \sum_{pfo=1}^n P_z^{pfo}$$

$$E^\nu = \sqrt{(P_x^\nu \times P_x^\nu) + (P_y^\nu \times P_y^\nu) + (P_z^\nu \times P_z^\nu)}$$

Event Reconstruction

Neutrino



Neutrino reconstruction struggles with ISR

Event Reconstruction

Reconstructed Masses

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Signal and Backgrounds

Event Reconstruction

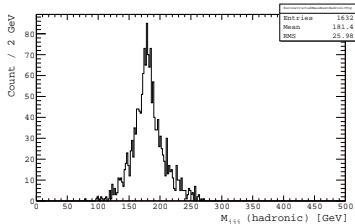
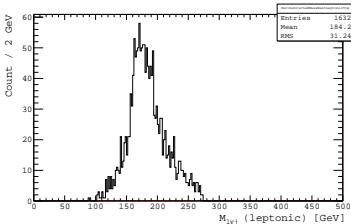
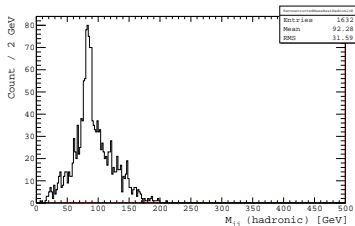
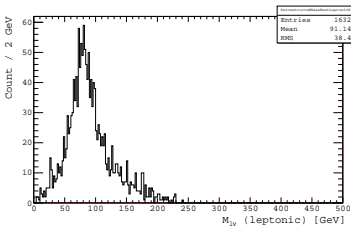
neutrino Masses

Event Selection

Events Passed Cuts

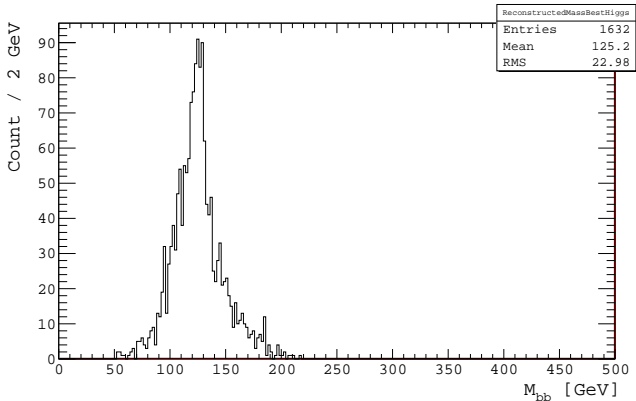
$\tilde{g}t\bar{t}h$ Measurement

Conclusions



Event Reconstruction

Reconstructed Masses - Higgs



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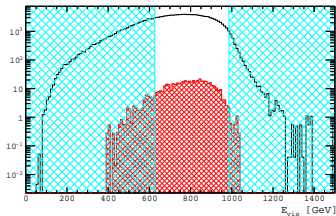
Cuts

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

Event Selection

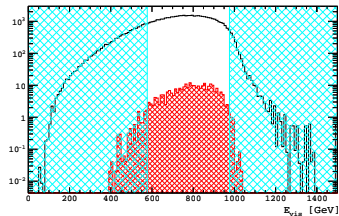
Cuts - Total Visible Energy

Pe-0.8 Pp+0.2



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

Pe+0.8 Pp-0.2

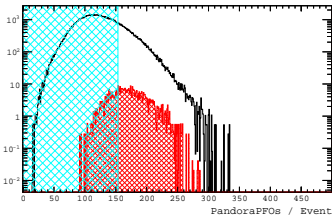


$$577 < E_{vis} < 976$$

Event Selection

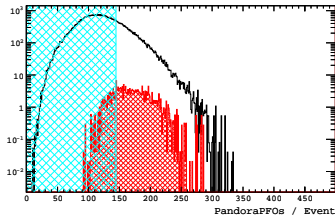
Cuts - No. PandoraPFOs

Pe-0.8 Pp+0.2



152 < PandoraPFOs

Pe+0.8 Pp-0.2

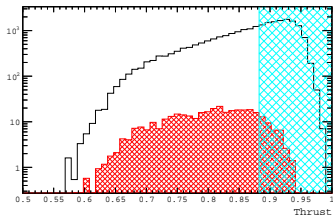


143 < PandoraPFOs

Event Selection

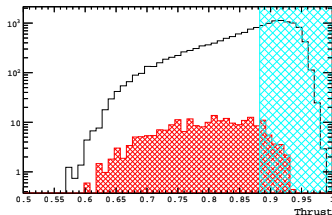
Cuts - Thrust

Pe-0.8 Pp+0.2



Thrust < 0.88

Pe+0.8 Pp-0.2

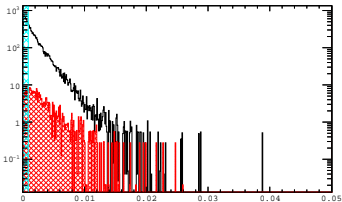


Thrust < 0.88

Event Selection

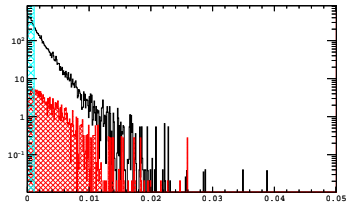
Cuts - Y56

Pe-0.8 Pp+0.2



$$0.0008 < Y56$$

Pe+0.8 Pp-0.2

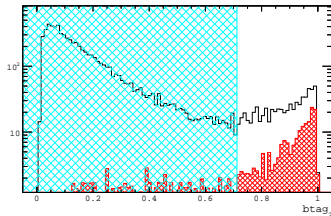


$$0.001 < Y56$$

Event Selection

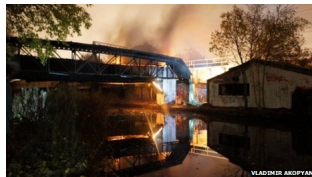
Cuts - Btag3

Pe-0.8 Pp+0.2



$0.70 < B_{\text{tag}3}$

Pe+0.8 Pp-0.2

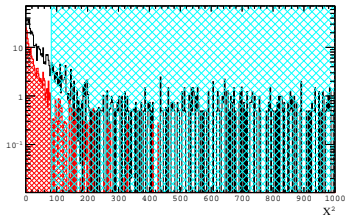


?? < Btag3

Event Selection

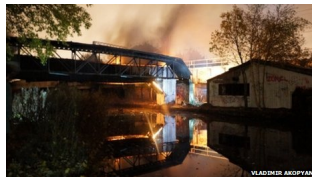
Cuts - χ^2

Pe-0.8 Pp+0.2



$$\chi^2 < 82.5$$

Pe+0.8 Pp-0.2

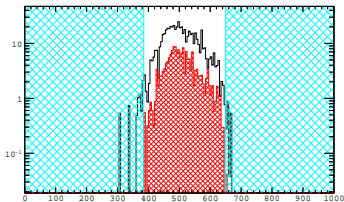


$$\chi^2 < ??$$

Event Selection

Cuts - Total Mass

Pe-0.8 Pp+0.2



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

Pe+0.8 Pp-0.2

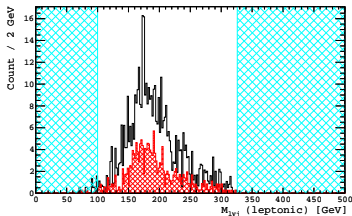


$$0 < M_{\text{tot}} < 1000$$

Event Selection

Cuts - Leptonic Top Mass

Pe-0.8 Pp+0.2



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

Pe+0.8 Pp-0.2

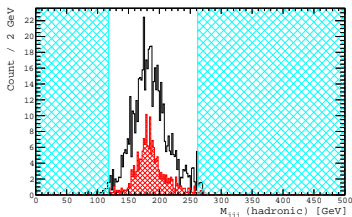


$$0 < M_t^{\text{lep}} < 1000$$

Event Selection

Cuts - Hadronic Top Mass

Pe-0.8 Pp+0.2



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

Pe+0.8 Pp-0.2

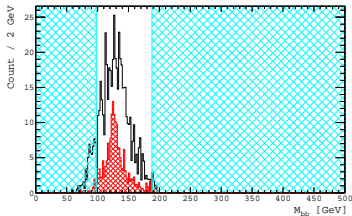


$$0 < M_t^{had} < 1000$$

Event Selection

Cuts - Higgs Mass

Pe-0.8 Pp+0.2



$$98 < M_h < 188$$

Pe+0.8 Pp-0.2



$$0 < M_t^h < 1000$$

Event Selection

Cuts - Higgs Helicity

Not yet implimented. Code written but cut value not optimised

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$P_{e+0.8} P_{p-0.2}$

$P_{e-0.8} P_{p+0.2}$



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T. Price

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Event Selection

Events Passed Cuts $P_{e-0.8}$ $P_{p+0.2}$



Event Selection

Events Passed Cuts $P_{e+0.8}$ $P_{p-0.2}$



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

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

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

$$\left(\frac{\Delta g_{ttH}}{g_{ttH}} \right)_{syst} = \frac{1}{S_{syst} (t_{ttH}^2)} \frac{1 - \rho_{sel}^{sample}}{\rho_{sel}^{sample}} \frac{\Delta \sigma_{BG}^{eff}}{\sigma_{BG}^{eff}} \quad (4)$$

assuming radiation off Z is negligible

$$S_{stat} (t_{ttH}^2) = \frac{\sqrt{\sigma_{ttH}}}{g_{ttH}^2} \quad (5)$$

$$S_{syst} (t_{ttH}^2) = \frac{1}{g_{ttH}^2} \quad (6)$$

Conclusions

- $\gamma\gamma \rightarrow$ hadrons optimally removed using kt R=1.2 for this analysis
- Pe-0.8 Pp+0.2 Final significance is ~ 6.5 leading to a statistical error of $\sim 11\%$ for 500 fb^{-1}
- Pe+0.8 Pp-0.2 Analysis interrupted by power outage again this morning. Will be finished with approx 2 hours of power!
- Need to combine the two results
- Dominant background remaining is $6f_{ttbar}$
- Work to be tested for kinematic fit but really need batch system running for this
- Dummy TMVA tester setup and seems to work. Main focus of work this week

Apologies, work is mainly done for cut based but no access to pre