The LaTeX report

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Contents

1 Setup

1.1 Command history

```
ma5># set directory where running "./bin/ma5"; set lumi; define the signal significance
ma5>set main.currentdir = /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data # need to
change this directory path -> exit and type "pwd" to get the path
ma5>set main.lumi = 40.0
ma5>set main.SBratio = 'S/sqrt(S+B)'
ma5># import samples -> change the path to the LHE file
ma5>import /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/axion_signal/axion_signal_gurrola_cuts_
as signal
ma5>import /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/vbf_diphoton_background_data/-
merged_lhe/vbf_diphoton_background_ht_0_100_merged.lhe.gz as bg_vbf_0_100
ma5>import /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/vbf_diphoton_background_data/-
merged_lhe/vbf_diphoton_background_ht_100_200_merged.lhe.gz as bg_vbf_100_200
ma5>import /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/vbf_diphoton_background_data/-
merged_lhe/vbf_diphoton_background_ht_200_400_merged.lhe.gz as bg_vbf_200_400
ma5>import /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/vbf_diphoton_background_data/-
merged_lhe/vbf_diphoton_background_ht_400_600_merged.lhe.gz as bg_vbf_400_600
ma5>import /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/vbf_diphoton_background_data/-
merged_lhe/vbf_diphoton_background_ht_600_800_merged.lhe.gz as bg_vbf_600_800
ma5>import /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/vbf_diphoton_background_data/-
merged_lhe/vbf_diphoton_background_ht_800_1200_merged.lhe.gz as bg_vbf_800_1200
ma5>import /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/vbf_diphoton_background_data/-
merged_lhe/vbf_diphoton_background_ht_1200_1600_merged.lhe.gz as bg_vbf_1200_1600
ma5>import /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/vbf_diphoton_background_data/-
merged_lhe/vbf_diphoton_background_ht_1600_inf_merged.lhe.gz as bg_vbf_1600_inf
ma5>import /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/diphoton_double_isr_background_data/-
merged_lhe/diphoton_double_isr_background_ht_0_100_merged.lhe.gz as bg_dip_0_100
ma5>import /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/diphoton_double_isr_background_data/-
merged_lhe/diphoton_double_isr_background_ht_100_200_merged.lhe.gz as bg_dip_100_200
ma5>import /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/diphoton_double_isr_background_data/-
merged_lhe/diphoton_double_isr_background_ht_200_400_merged.lhe.gz as bg_dip_200_400
ma5>import /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/diphoton_double_isr_background_data/-
merged_lhe/diphoton_double_isr_background_ht_400_600_merged.lhe.gz as bg_dip_400_600
ma5>import /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/diphoton_double_isr_background_data/-
merged_lhe/diphoton_double_isr_background_ht_600_800_merged.lhe.gz as bg_dip_600_800
ma5>import /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/diphoton_double_isr_background_data/-
merged_lhe/diphoton_double_isr_background_ht_800_1200_merged.lhe.gz as bg_dip_800_1200
ma5>import /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/diphoton_double_isr_background_data/-
merged_lhe/diphoton_double_isr_background_ht_1200_1600_merged.lhe.gz as bg_dip_1200_1600
ma5>import /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/diphoton_double_isr_background_data/-
merged_lhe/diphoton_double_isr_background_ht_1600_inf_merged.lhe.gz as bg_dip_1600_inf
ma5># define bg and signal samples
ma5>set signal.type = signal
ma5>set bg_vbf_0_100.type = background
ma5>set bg_vbf_100_200.type = background
ma5>set bg_vbf_200_400.type = background
ma5>set bg_vbf_400_600.type = background
```

```
ma5>set bg_vbf_600_800.type = background
ma5>set bg_vbf_800_1200.type = background
ma5>set bg_vbf_1200_1600.type = background
ma5>set bg_vbf_1600_inf.type = background
ma5>set bg_dip_0_100.type = background
ma5>set bg_dip_100_200.type = background
ma5>set bg_dip_200_400.type = background
ma5>set bg_dip_400_600.type = background
ma5>set bg_dip_600_800.type = background
ma5>set bg_dip_800_1200.type = background
ma5>set bg_dip_1200_1600.type = background
ma5>set bg_dip_1600_inf.type = background
ma5># define weights for the samples
ma5>#set sample_1.weight = 1
ma5>#set sample_2.weight = 1
ma5># line styles and colors
ma5>set signal.linecolor = red
ma5>set signal.linestyle = dashed
ma5>set signal.linewidth = 3
ma5>set bg_vbf_0_100.linecolor = blue-4
ma5>set bg_vbf_0_100.linestyle = dash-dotted
ma5>set bg_vbf_0_100.linewidth = 4
ma5>set bg_vbf_100_200.linecolor = blue-3
ma5>set bg_vbf_100_200.linestyle = dash-dotted
ma5>set bg_vbf_100_200.linewidth = 4
ma5>set bg_vbf_200_400.linecolor = blue-2
ma5>set bg_vbf_200_400.linestyle = dash-dotted
ma5>set bg_vbf_200_400.linewidth = 4
ma5>set bg_vbf_400_600.linecolor = blue-1
ma5>set bg_vbf_400_600.linestyle = dash-dotted
ma5>set bg_vbf_400_600.linewidth = 4
ma5>set bg_vbf_600_800.linecolor = blue
ma5>set bg_vbf_600_800.linestyle = dash-dotted
ma5>set bg_vbf_600_800.linewidth = 4
ma5>set bg_vbf_800_1200.linecolor = blue+1
ma5>set bg_vbf_800_1200.linestyle = dash-dotted
ma5>set bg_vbf_800_1200.linewidth = 4
ma5>set bg_vbf_1200_1600.linecolor = blue+2
ma5>set bg_vbf_1200_1600.linestyle = dash-dotted
ma5>set bg_vbf_1200_1600.linewidth = 4
ma5>set bg_vbf_1600_inf.linecolor = blue+3
ma5>set bg_vbf_1600_inf.linestyle = dash-dotted
ma5>set bg_vbf_1600_inf.linewidth = 4
ma5>set bg_dip_0_100.linecolor = green-4
ma5>set bg_dip_0_100.linestyle = dash-dotted
ma5>set bg_dip_0_100.linewidth = 4
ma5>set bg_dip_100_200.linecolor = green-3
ma5>set bg_dip_100_200.linestyle = dash-dotted
ma5>set bg_dip_100_200.linewidth = 4
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```
ma5>set bg_dip_200_400.linecolor = green-2
ma5>set bg_dip_200_400.linestyle = dash-dotted
ma5>set bg_dip_200_400.linewidth = 4
ma5>set bg_dip_400_600.linecolor = green-1
ma5>set bg_dip_400_600.linestyle = dash-dotted
ma5>set bg_dip_400_600.linewidth = 4
ma5>set bg_dip_600_800.linecolor = green
ma5>set bg_dip_600_800.linestyle = dash-dotted
ma5>set bg_dip_600_800.linewidth = 4
ma5>set bg_dip_800_1200.linecolor = green+1
ma5>set bg_dip_800_1200.linestyle = dash-dotted
ma5>set bg_dip_800_1200.linewidth = 4
ma5>set bg_dip_1200_1600.linecolor = green+2
ma5>set bg_dip_1200_1600.linestyle = dash-dotted
ma5>set bg_dip_1200_1600.linewidth = 4
ma5>set bg_dip_1600_inf.linecolor = green+3
ma5>set bg_dip_1600_inf.linestyle = dash-dotted
ma5>set bg_dip_1600_inf.linewidth = 4
ma5># a jet can be from a light quark or b quark
ma5>define jets = j
ma5>define e = e+ e-
ma5>define mu = mu+ mu-
ma5>define ta = ta+ ta-
ma5>define lept = e mu ta
ma5># reduce contribution from V+Zp ==> jj+Zp
ma5>select sdETA(jets[1] jets[2]) > 2.6 and M(jets[1] jets[2]) > 1250
ma5># define which plots to make
ma5>plot PT(jets[1])
ma5>plot ETA(jets[1])
ma5>plot PHI(jets[1])
ma5>plot PT(jets[2])
ma5>plot ETA(jets[2])
ma5>plot PHI(jets[2])
ma5>plot DELTAR(jets[1], jets[2])
ma5>plot M(jets[1] jets[2])
ma5>plot MET
ma5>plot sdETA(jets[1] jets[2])
ma5>plot M(a[1] a[2])
ma5>plot PT(a[1])
ma5>plot PT(a[2])
ma5>plot THT
ma5>plot MET
ma5>plot TET
ma5>#set the plot/graph parameters
ma5>set selection[2].xmax = 1000
ma5>set selection[2].xmin = 0
ma5>set selection[2].nbins = 200
ma5>set selection[2].logY = true
ma5>set selection[2].logX = false
```

```
ma5>set selection[2].rank = PTordering
ma5>#set selection[2].stacking_method = normalize2one
ma5>set selection[2].titleX = "p_{T}[j_{1}] (GeV)"
ma5>set selection[3].xmax = 8
ma5>set selection[3].xmin = -8
ma5>set selection[3].nbins = 160
ma5>set selection[3].logY = false
ma5>set selection[3].logX = false
ma5>set selection[3].rank = PTordering
ma5>#set selection[3].stacking_method = normalize2one
ma5>set selection[3].titleX = "#eta[j_{1}]"
ma5>set selection[4].xmax = 3.2
ma5>set selection[4].xmin = -3.2
ma5>set selection[4].nbins = 64
ma5>set selection[4].logY = false
ma5>set selection[4].logX = false
ma5>set selection[4].rank = PTordering
ma5>#set selection[4].stacking_method = normalize2one
ma5>set selection[4].titleX = "#phi[j_{1}]"
ma5>set selection[5].xmax = 500
ma5>set selection[5].xmin = 0
ma5>set selection[5].nbins = 100
ma5>set selection[5].logY = true
ma5>set selection[5].logX = false
ma5>set selection[5].rank = PTordering
ma5>#set selection[5].stacking_method = normalize2one
ma5>set selection[5].titleX = "p_{T}[j_{2}] (GeV)"
ma5>set selection[6].xmax = 8
ma5>set selection[6].xmin = -8
ma5>set selection[6].nbins = 160
ma5>set selection[6].logY = false
ma5>set selection[6].logX = false
ma5>set selection[6].rank = PTordering
ma5>#set selection[6].stacking_method = normalize2one
ma5>set selection[6].titleX = "#eta[j_{2}]"
ma5>set selection[7].xmax = 3.2
ma5>set selection[7].xmin = -3.2
ma5>set selection[7].nbins = 64
ma5>set selection[7].logY = false
ma5>set selection[7].logX = false
ma5>set selection[7].rank = PTordering
ma5>#set selection[7].stacking_method = normalize2one
ma5>set selection[7].titleX = "#phi[j_{2}]"
ma5>set selection[8].xmax = 15
ma5>set selection[8].xmin = 0
ma5>set selection[8].nbins = 75
ma5>set selection[8].logY = false
ma5>set selection[8].logX = false
ma5>set selection[8].rank = PTordering
```

```
ma5>#set selection[8].stacking_method = normalize2one
ma5>set selection[8].titleX = "#DeltaR[j_{1},j_{2}]"
ma5>set selection[9].xmax = 8000
ma5>set selection[9].xmin = 0
ma5>set selection[9].nbins = 160
ma5>set selection[9].logY = false
ma5>set selection[9].logX = false
ma5>set selection[9].rank = PTordering
ma5>#set selection[9].stacking_method = normalize2one
ma5>set selection[9].titleX = "M[j_{1},j_{2}] (GeV)"
ma5>set selection[10].xmax = 1000
ma5>set selection[10].xmin = 0
ma5>set selection[10].nbins = 100
ma5>set selection[10].logY = true
ma5>set selection[10].logX = false
ma5>set selection[10].rank = PTordering
ma5>#set selection[10].stacking_method = normalize2one
ma5>set selection[10].titleX = "#slash{E}_{T} (GeV)"
ma5>#set selection[11].stacking_method = normalize2one
ma5>set selection[11].titleX = "#Delta#eta(j_{1},j_{2})"
ma5>#set selection[12].xmax = 2000
ma5>#set selection[12].xmin = 0
ma5>set selection[12].nbins = 400
ma5>set selection[12].logY = true
ma5>set selection[12].logX = false
ma5>set selection[12].rank = PTordering
ma5>#set selection[12].stacking_method = normalize2one
ma5>set selection[12].titleX = "M[a_{1},a_{2}] (GeV)"
ma5>#set selection[13].xmax = 4
ma5>#set selection[13].xmin = -4
ma5>set selection[13].nbins = 80
ma5>set selection[13].logY = false
ma5>set selection[13].logX = false
ma5>set selection[13].rank = PTordering
ma5>#set selection[13].stacking_method = normalize2one
ma5>set selection[13].titleX = "p_{T}[a_{1}]"
ma5>#set selection[14].xmax = 2000
ma5>#set selection[14].xmin = 0
ma5>set selection[14].nbins = 400
ma5>set selection[14].logY = true
ma5>set selection[14].logX = false
ma5>set selection[14].rank = PTordering
ma5>#set selection[14].stacking_method = normalize2one
ma5>set selection[14].titleX = "p_{T}[a_{2}] (GeV)"
ma5>#set selection[15].xmax = 4
ma5>#set selection[15].xmin = -4
ma5>set selection[15].nbins = 80
ma5>set selection[15].logY = false
ma5>set selection[15].logX = false
```

```
ma5>set selection[15].rank = PTordering
ma5>#set selection[15].stacking_method = normalize2one
ma5>set selection[15].titleX = "THT"
ma5>#set selection[16].xmax = 1000
ma5>#set selection[16].xmin = 0
ma5>set selection[16].nbins = 200
ma5>set selection[16].logY = true
ma5>set selection[16].logX = false
ma5>set selection[16].rank = PTordering
ma5>#set selection[16].stacking_method = normalize2one
ma5>set selection[16].titleX = "MET"
ma5>#set selection[17].xmax = 4
ma5>#set selection[17].xmin = -4
ma5>set selection[17].nbins = 80
ma5>set selection[17].logY = false
ma5>set selection[17].logX = false
ma5>set selection[17].rank = PTordering
ma5>#set selection[17].stacking_method = normalize2one
ma5>set selection[16].titleX = "TET"
ma5># apply selections
ma5>submit loose_analysis_sdeta_2.6_mmjj_1250
```

1.2 Configuration

- MadAnalysis version 1.6.33 (2017/11/20).
- Histograms given for an integrated luminosity of 40.0fb^{-1}.

2 Datasets

2.1 signal

- Samples stored in the directory: /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/-optimization/dEta_mmjj_cuts_plots .
- Sample consisting of: signal events.
- Generated events: 1000000 events.
- Normalization to the luminosity: 4094+/- 2 events.
- Ratio (event weight): 0.0041 .

Path to the event file	Nr. of events	Cross section (pb)	Negative wgts (%)
/Users/elijahsheridan/-MG5_aMC_v2_6_5/-axion_data/axion_signal/-axion_signal_gurrola_cuts_1MeV.lh	1000000	0.102 @ 0.028%	0.0

2.2 bg_vbf_0_100

- Samples stored in the directory: /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/-optimization/dEta_mmjj_cuts_plots .
- Sample consisting of: background events.
- Generated events: 1000000 events.
- Normalization to the luminosity: 12150+/- 24 events.
- Ratio (event weight): 0.012 .

Path to the event file	Nr. of events	Cross section (pb)	Negative wgts (%)
/Users/elijahsheridan/-MG5_aMC_v2_6_5/-axion_data/-vbf_diphoton_background_data/-merged_lhe/-vbf_diphoton_background_ht_0_1(	1000000	0.304 @ 0.19%	0.0

2.3 bg_vbf_100_200

- Samples stored in the directory: /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/-optimization/dEta_mmjj_cuts_plots .
- Sample consisting of: background events.
- Generated events: 965662 events.
- Normalization to the luminosity: 9695+/- 17 events.

- Ratio (event weight): 0.01 .

Path to the event file	Nr. of events	Cross section (pb)	Negative wgts (%)
/Users/elijahsheridan/-MG5_aMC_v2_6_5/-axion_data/-vbf_diphoton_background_data/-merged_lhe/-vbf_diphoton_background_ht_100_	965662	0.242 @ 0.17%	0.0

2.4 bg_vbf_200_400

- Samples stored in the directory: /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/-optimization/dEta_mmjj_cuts_plots .
- Sample consisting of: background events.
- Generated events: 984165 events.
- Normalization to the luminosity: 5413+/- 11 events.
- Ratio (event weight): 0.0055 .

Path to the event file	Nr. of events	Cross section (pb)	Negative wgts (%)
/Users/elijahsheridan/-MG5_aMC_v2_6_5/-axion_data/-vbf_diphoton_background_data/-merged_lhe/-vbf_diphoton_background_ht_200_	984165	0.135 @ 0.2%	0.0

2.5 bg_vbf_400_600

- Samples stored in the directory: /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/-optimization/dEta_mmjj_cuts_plots .
- Sample consisting of: background events.
- Generated events: 1000000 events.
- Normalization to the luminosity: 986+/- 2 events.
- Ratio (event weight): 0.00099 .

Path to the event file	Nr. of events	Cross section (pb)	Negative wgts (%)
/Users/elijahsheridan/-MG5_aMC_v2_6_5/-axion_data/-vbf_diphoton_background_data/-merged_lhe/-vbf_diphoton_background_ht_400_	1000000	0.0247 @ 0.14%	0.0

2.6 bg_vbf_600_800

- Samples stored in the directory: /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/-optimization/dEta_mmjj_cuts_plots .
- Sample consisting of: background events.
- Generated events: 1000000 events.
- Normalization to the luminosity: 252+/- 1 events.
- Ratio (event weight): 0.00025 .

Path to the event file	Nr. of events	Cross section (pb)	Negative wgts (%)
/Users/elijahsheridan/-MG5_aMC_v2_6_5/-axion_data/-vbf_diphoton_background_data/-merged_lhe/-vbf_diphoton_background_ht_600_	1000000	0.0063 @ 0.13%	0.0

2.7 bg_vbf_800_1200

- Samples stored in the directory: /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/-optimization/dEta_mmjj_cuts_plots .
- Sample consisting of: background events.
- Generated events: 400839 events.
- Normalization to the luminosity: 114+/- 1 events.
- Ratio (event weight): 0.00028 .

Path to the event file	Nr. of events	Cross section (pb)	Negative wgts (%)
/Users/elijahsheridan/-MG5_aMC_v2_6_5/-axion_data/-vbf_diphoton_background_data/-merged_lhe/-vbf_diphoton_background_ht_800_	400839	0.00287 @ 0.16%	0.0

2.8 bg_vbf_1200_1600

- Samples stored in the directory: /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/-optimization/dEta_mmjj_cuts_plots .
- Sample consisting of: background events.
- Generated events: 953803 events.
- Normalization to the luminosity: 20+/- 1 events.

- Ratio (event weight): 2.1e-05 .

Path to the event file	Nr. of events	Cross section (pb)	Negative wgts (%)
/Users/elijahsheridan/-MG5_aMC_v2_6_5/-axion_data/-vbf_diphoton_background_data/-merged_lhe/-vbf_diphoton_background_ht_1200	953803	0.000515 @ 0.16%	0.0

2.9 bg_vbf_1600_inf

- Samples stored in the directory: /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/-optimization/dEta_mmjj_cuts_plots .
- Sample consisting of: background events.
- Generated events: 270148 events.
- Normalization to the luminosity: 7+/- 1 events.
- Ratio (event weight): 2.6e-05 .

Path to the event file	Nr. of events	Cross section (pb)	Negative wgts (%)
/Users/elijahsheridan/-MG5_aMC_v2_6_5/-axion_data/-vbf_diphoton_background_data/-merged_lhe/-vbf_diphoton_background_ht_1600	270148	0.000191 @ 0.11%	0.0

2.10 bg_dip_0_100

- Samples stored in the directory: /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/-optimization/dEta_mmjj_cuts_plots .
- Sample consisting of: background events.
- Generated events: 1040000 events.
- Normalization to the luminosity: 2710847+/- 4614 events.
- Ratio (event weight): 2.6 - warning: please generate more events (weight larger than 1)!

Path to the event file	Nr. of events	Cross section (pb)	Negative wgts (%)
/Users/elijahsheridan/-MG5_aMC_v2_6_5/-axion_data/-diphoton_double_isr_background_d-merged_lhe/-diphoton_double_isr_background_l	1040000	67.8 @ 0.17%	0.0

2.11 bg_dip_100_200

- Samples stored in the directory: /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/-optimization/dEta_mmjj_cuts_plots .
- Sample consisting of: background events.
- Generated events: 1040000 events.
- Normalization to the luminosity: 1095362+/- 1528 events.
- Ratio (event weight): 1.1 - warning: please generate more events (weight larger than 1)!

Path to the event file	Nr. of events	Cross section (pb)	Negative wgts (%)
/Users/elijahsheridan/- MG5_aMC_v2_6_5/- axion_data/- diphoton_double_isr_background_d merged_lhe/- diphoton_double_isr_background_l	1040000	27.4 @ 0.14%	0.0

2.12 bg_dip_200_400

- Samples stored in the directory: /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/-optimization/dEta_mmjj_cuts_plots .
- Sample consisting of: background events.
- Generated events: 1040000 events.
- Normalization to the luminosity: 239548+/- 414 events.
- Ratio (event weight): 0.23 .

Path to the event file	Nr. of events	Cross section (pb)	Negative wgts (%)
/Users/elijahsheridan/- MG5_aMC_v2_6_5/- axion_data/- diphoton_double_isr_background_d merged_lhe/- diphoton_double_isr_background_l	1040000	5.99 @ 0.17%	0.0

2.13 bg_dip_400_600

- Samples stored in the directory: /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/-optimization/dEta_mmjj_cuts_plots .
- Sample consisting of: background events.
- Generated events: 1040000 events.
- Normalization to the luminosity: 28798+/- 53 events.

- Ratio (event weight): 0.028 .

Path to the event file	Nr. of events	Cross section (pb)	Negative wgts (%)
/Users/elijahsheridan/-MG5_aMC_v2_6_5/-axion_data/-diphoton_double_isr_background_c merged_lhe/-diphoton_double_isr_background_l	1040000	0.72 @ 0.18%	0.0

2.14 bg_dip_600_800

- Samples stored in the directory: /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/-optimization/dEta_mmjj_cuts_plots .
- Sample consisting of: background events.
- Generated events: 662009 events.
- Normalization to the luminosity: 6674+/- 28 events.
- Ratio (event weight): 0.01 .

Path to the event file	Nr. of events	Cross section (pb)	Negative wgts (%)
/Users/elijahsheridan/-MG5_aMC_v2_6_5/-axion_data/-diphoton_double_isr_background_c merged_lhe/-diphoton_double_isr_background_l	662009	0.167 @ 0.41%	0.0

2.15 bg_dip_800_1200

- Samples stored in the directory: /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/-optimization/dEta_mmjj_cuts_plots .
- Sample consisting of: background events.
- Generated events: 1040000 events.
- Normalization to the luminosity: 2942+/- 6 events.
- Ratio (event weight): 0.0028 .

Path to the event file	Nr. of events	Cross section (pb)	Negative wgts (%)
/Users/elijahsheridan/-MG5_aMC_v2_6_5/-axion_data/-diphoton_double_isr_background_c merged_lhe/-diphoton_double_isr_background_l	1040000	0.0736 @ 0.17%	0.0

2.16 bg_dip_1200_1600

- Samples stored in the directory: /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/-optimization/dEta_mmjj_cuts_plots .
- Sample consisting of: background events.
- Generated events: 337115 events.
- Normalization to the luminosity: 513+/- 3 events.
- Ratio (event weight): 0.0015 .

Path to the event file	Nr. of events	Cross section (pb)	Negative wgts (%)
/Users/elijahsheridan/-MG5_aMC_v2_6_5/-axion_data/-diphoton_double_isr_background_c merged_lhe/-diphoton_double_isr_background_l	337115	0.0128 @ 0.51%	0.0

2.17 bg_dip_1600_inf

- Samples stored in the directory: /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_data/-optimization/dEta_mmjj_cuts_plots .
- Sample consisting of: background events.
- Generated events: 1040000 events.
- Normalization to the luminosity: 187+/- 1 events.
- Ratio (event weight): 0.00018 .

Path to the event file	Nr. of events	Cross section (pb)	Negative wgts (%)
/Users/elijahsheridan/-MG5_aMC_v2_6_5/-axion_data/-diphoton_double_isr_background_c merged_lhe/-diphoton_double_isr_background_l	1040000	0.00469 @ 0.15%	0.0

3 Histos and cuts

3.1 Cut 1

*** Cut: select sdETA (jets[1] jets[2]) > 2.6 and M (jets[1] jets[2]) > 1250.0**

Dataset	Events kept: K	Rejected events: R	Efficiency: K / (K + R)	Cumul. efficiency: K / Initial
signal	853.4 +/- 26.0	3240.7 +/- 26.0	0.20845 +/- 0.00635	0.20845 +/- 0.00635
bg_vbf_0_10	102.9 +/- 10.1	12047.5 +/- 25.0	0.008467 +/- 0.000831	0.008467 +/- 0.000831
bg_vbf_100_	477.8 +/- 21.3	9217.5 +/- 26.5	0.0493 +/- 0.0022	0.0493 +/- 0.0022
bg_vbf_200_	573.7 +/- 22.7	4839.6 +/- 24.7	0.10598 +/- 0.00418	0.10598 +/- 0.00418
bg_vbf_400_	174.5 +/- 12.0	812.4 +/- 12.0	0.1768 +/- 0.0121	0.1768 +/- 0.0121
bg_vbf_600_	55.66 +/- 6.59	196.41 +/- 6.59	0.2208 +/- 0.0261	0.2208 +/- 0.0261
bg_vbf_800_	20.15 +/- 4.08	94.61 +/- 4.08	0.1756 +/- 0.0355	0.1756 +/- 0.0355
bg_vbf_1200_	2.24 +/- 1.41	18.35 +/- 1.41	0.1088 +/- 0.0686	0.1088 +/- 0.0686
bg_vbf_1600_	0.395 +/- 0.612	7.264 +/- 0.612	0.0516 +/- 0.0799	0.0516 +/- 0.0799
bg_dip_0_10	117.3 +/- 10.8	2710729 +/- 4613	4.33e-05 +/- 3.99e-06	4.33e-05 +/- 3.99e-06
bg_dip_100_	496.1 +/- 22.3	1094866 +/- 1526	4.53e-04 +/- 2.03e-05	4.53e-04 +/- 2.03e-05
bg_dip_200_	814.2 +/- 28.5	238734 +/- 413	0.003399 +/- 0.000119	0.003399 +/- 0.000119
bg_dip_400_	531.5 +/- 22.9	28267.2 +/- 56.1	0.018455 +/- 0.000793	0.018455 +/- 0.000793
bg_dip_600_	263.8 +/- 16.0	6410.5 +/- 30.9	0.03953 +/- 0.00239	0.03953 +/- 0.00239
bg_dip_800_	96.62 +/- 9.67	2845.7 +/- 10.8	0.03284 +/- 0.00329	0.03284 +/- 0.00329
bg_dip_1200_	10.79 +/- 3.25	502.72 +/- 4.15	0.02101 +/- 0.00633	0.02101 +/- 0.00633
bg_dip_1600_	2.03 +/- 1.42	185.76 +/- 1.44	0.01080 +/- 0.00754	0.01080 +/- 0.00754

3.2 Histogram 1

*** Plot: PT (jets[1])**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	853	1.0	546.753	330.3	0.0	9.285
bg_vbf_0_100	102	1.0	47.9902	10.41	0.0	0.0
bg_vbf_100_20	477	1.0	89.1639	20.3	0.0	0.0
bg_vbf_200_40	573	1.0	164.708	39.2	0.0	0.0
bg_vbf_400_60	174	1.0	277.982	50.49	0.0	0.0
bg_vbf_600_80	55.7	1.0	387.324	64.69	0.0	0.0
bg_vbf_800_12	20.2	1.0	526.407	99.77	0.0	0.247
bg_vbf_1200_1	2.25	1.0	745.066	129.2	0.0	5.612
bg_vbf_1600_i	0.403	1.0	993.632	186.2	0.0	33.44
bg_dip_0_100	117	1.0	49.7115	9.454	0.0	0.0
bg_dip_100_20	496	1.0	91.8635	23.0	0.0	0.0
bg_dip_200_40	814	1.0	172.144	42.31	0.0	0.0
bg_dip_400_60	531	1.0	278.285	49.18	0.0	0.0
bg_dip_600_80	263	1.0	377.328	56.29	0.0	0.0
bg_dip_800_12	96.6	1.0	514.057	91.51	0.0	0.2489
bg_dip_1200_1	10.8	1.0	726.305	113.8	0.0	3.273
bg_dip_1600_i	2.03	1.0	971.998	157.6	0.0	29.65

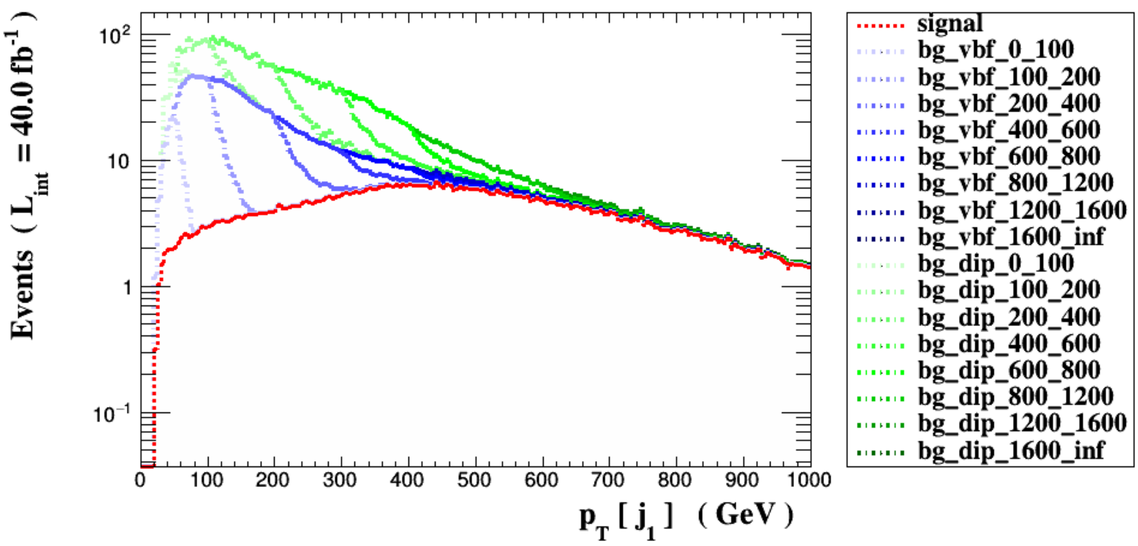


Figure 1.

3.3 Histogram 2

*** Plot: ETA (jets[1])**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	853	1.0	1.51865	0.8256	0.0	0.0
bg_vbf_0_100	102	1.0	3.69767	0.6913	0.0	0.0
bg_vbf_100_20	477	1.0	3.05831	0.7484	0.0	0.0
bg_vbf_200_40	573	1.0	2.48868	0.7253	0.0	0.0
bg_vbf_400_60	174	1.0	1.9668	0.7042	0.0	0.0
bg_vbf_600_80	55.7	1.0	1.67633	0.6784	0.0	0.0
bg_vbf_800_12	20.2	1.0	1.56562	0.5919	0.0	0.0
bg_vbf_1200_1	2.25	1.0	1.47431	0.4874	0.0	0.0
bg_vbf_1600_i	0.403	1.0	1.42179	0.4013	0.0	0.0
bg_dip_0_100	117	1.0	3.61672	0.8533	0.0	0.0
bg_dip_100_20	496	1.0	3.05543	0.9267	0.0	0.0
bg_dip_200_40	814	1.0	2.39716	0.8274	0.0	0.0
bg_dip_400_60	531	1.0	1.88454	0.7296	0.0	0.0
bg_dip_600_80	263	1.0	1.58738	0.6804	0.0	0.0
bg_dip_800_12	96.6	1.0	1.51534	0.5903	0.0	0.0
bg_dip_1200_1	10.8	1.0	1.46872	0.4816	0.0	0.0
bg_dip_1600_i	2.03	1.0	1.4296	0.3873	0.0	0.0

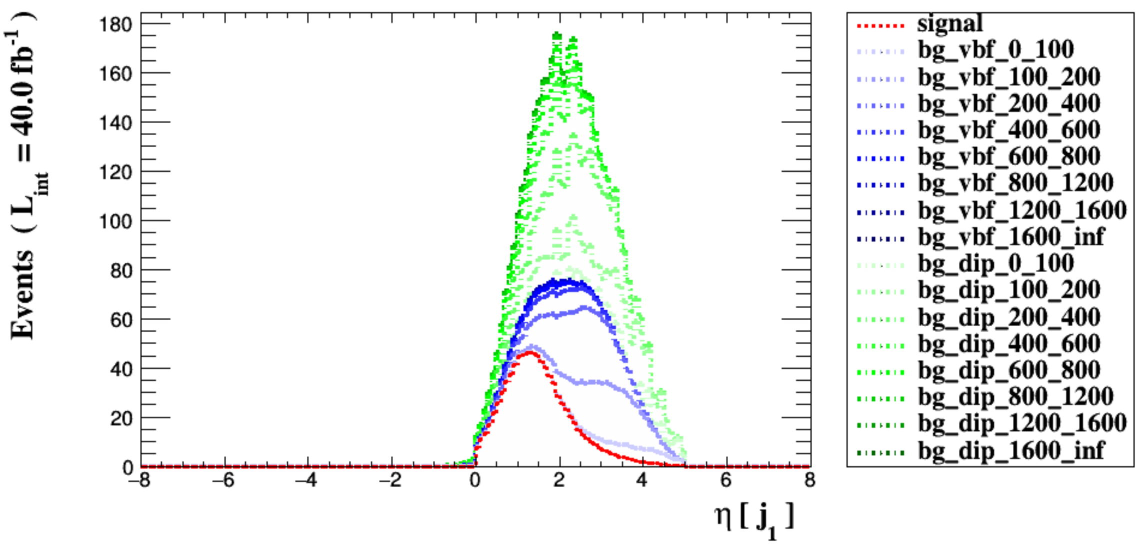


Figure 2.

3.4 Histogram 3

*** Plot: PHI (jets[1])**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	853	1.0	0.00262009	1.814	0.0	0.0
bg_vbf_0_100	102	1.0	-0.00381425	1.809	0.0	0.0
bg_vbf_100_20	477	1.0	-0.00399372	1.815	0.0	0.0
bg_vbf_200_40	573	1.0	-0.000180864	1.812	0.0	0.0
bg_vbf_400_60	174	1.0	-0.0007668	1.812	0.0	0.0
bg_vbf_600_80	55.7	1.0	0.000310622	1.814	0.0	0.0
bg_vbf_800_12	20.2	1.0	-0.00826697	1.815	0.0	0.0
bg_vbf_1200_1	2.25	1.0	0.000685286	1.809	0.0	0.0
bg_vbf_1600_i	0.403	1.0	-0.00505461	1.814	0.0	0.0
bg_dip_0_100	117	1.0	0.131552	1.932	0.0	0.0
bg_dip_100_20	496	1.0	-0.0494161	1.808	0.0	0.0
bg_dip_200_40	814	1.0	-0.0325304	1.8	0.0	0.0
bg_dip_400_60	531	1.0	-0.0180546	1.805	0.0	0.0
bg_dip_600_80	263	1.0	-0.00294976	1.824	0.0	0.0
bg_dip_800_12	96.6	1.0	0.00642014	1.813	0.0	0.0
bg_dip_1200_1	10.8	1.0	0.00301387	1.825	0.0	0.0
bg_dip_1600_i	2.03	1.0	-0.0114902	1.816	0.0	0.0

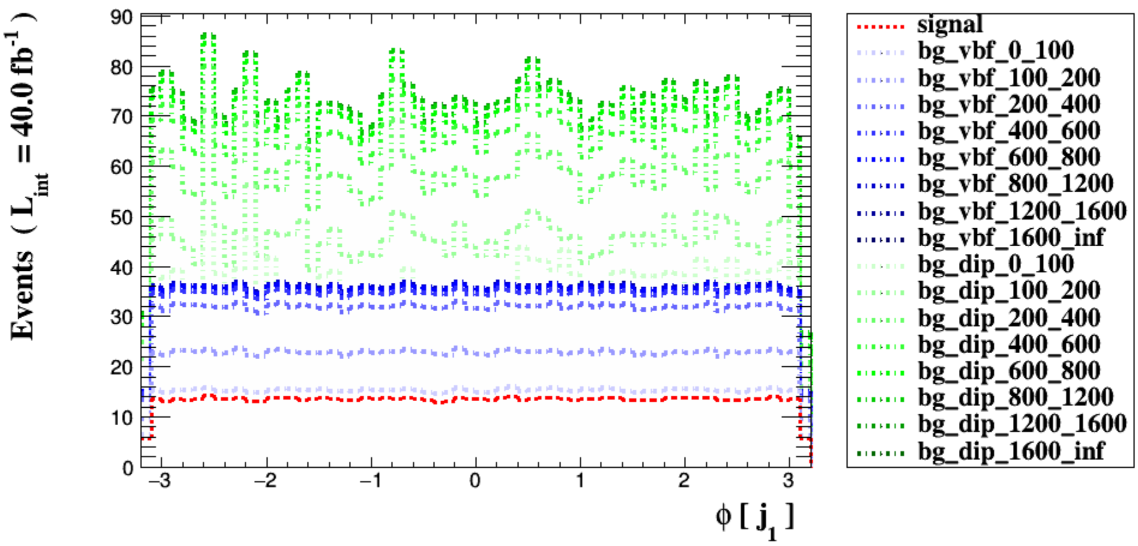


Figure 3.

3.5 Histogram 4

*** Plot: PT (jets[2])**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	853	1.0	205.725	143.1	0.0	4.097
bg_vbf_0_100	102	1.0	32.1093	7.26	0.0	0.0
bg_vbf_100_20	477	1.0	59.3482	16.86	0.0	0.0
bg_vbf_200_40	573	1.0	115.402	33.11	0.0	0.0
bg_vbf_400_60	174	1.0	203.446	46.93	0.0	0.0
bg_vbf_600_80	55.7	1.0	291.584	61.32	0.0	0.0
bg_vbf_800_12	20.2	1.0	401.508	94.51	0.0	11.67
bg_vbf_1200_1	2.25	1.0	591.301	126.8	0.0	86.39
bg_vbf_1600_i	0.403	1.0	825.305	181.1	0.0	95.2
bg_dip_0_100	117	1.0	32.1082	6.852	0.0	0.0
bg_dip_100_20	496	1.0	58.8617	17.59	0.0	0.0
bg_dip_200_40	814	1.0	119.32	37.13	0.0	0.0
bg_dip_400_60	531	1.0	214.002	47.08	0.0	0.0
bg_dip_600_80	263	1.0	302.138	53.94	0.0	0.0
bg_dip_800_12	96.6	1.0	414.316	87.72	0.0	13.24
bg_dip_1200_1	10.8	1.0	610.588	111.8	0.0	91.98
bg_dip_1600_i	2.03	1.0	856.028	157.0	0.0	98.0

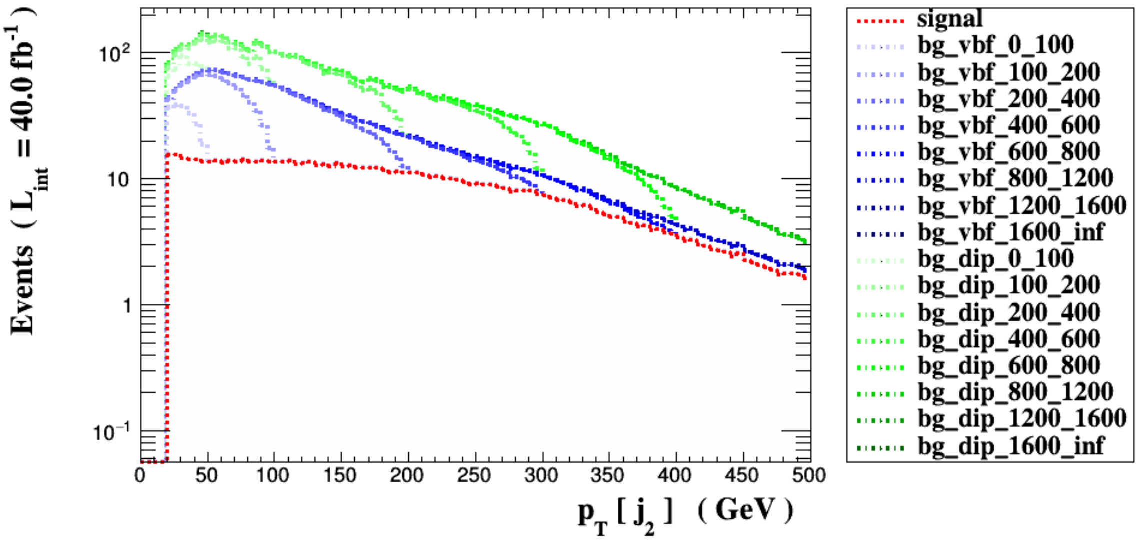


Figure 4.

3.6 Histogram 5

*** Plot: ETA (jets[2])**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	853	1.0	-2.41853	0.9021	0.0	0.0
bg_vbf_0_100	102	1.0	-3.87669	0.6852	0.0	0.0
bg_vbf_100_20	477	1.0	-3.34195	0.7753	0.0	0.0
bg_vbf_200_40	573	1.0	-2.76309	0.7681	0.0	0.0
bg_vbf_400_60	174	1.0	-2.21601	0.7459	0.0	0.0
bg_vbf_600_80	55.7	1.0	-1.90089	0.7218	0.0	0.0
bg_vbf_800_12	20.2	1.0	-1.79372	0.6283	0.0	0.0
bg_vbf_1200_1	2.25	1.0	-1.67073	0.5231	0.0	0.0
bg_vbf_1600_i	0.403	1.0	-1.58018	0.4338	0.0	0.0
bg_dip_0_100	117	1.0	-3.69603	0.8703	0.0	0.0
bg_dip_100_20	496	1.0	-3.05582	0.9476	0.0	0.0
bg_dip_200_40	814	1.0	-2.42149	0.9066	0.0	0.0
bg_dip_400_60	531	1.0	-1.84889	0.7917	0.0	0.0
bg_dip_600_80	263	1.0	-1.58425	0.7171	0.0	0.0
bg_dip_800_12	96.6	1.0	-1.56186	0.6304	0.0	0.0
bg_dip_1200_1	10.8	1.0	-1.51945	0.5189	0.0	0.0
bg_dip_1600_i	2.03	1.0	-1.47137	0.4096	0.0	0.0

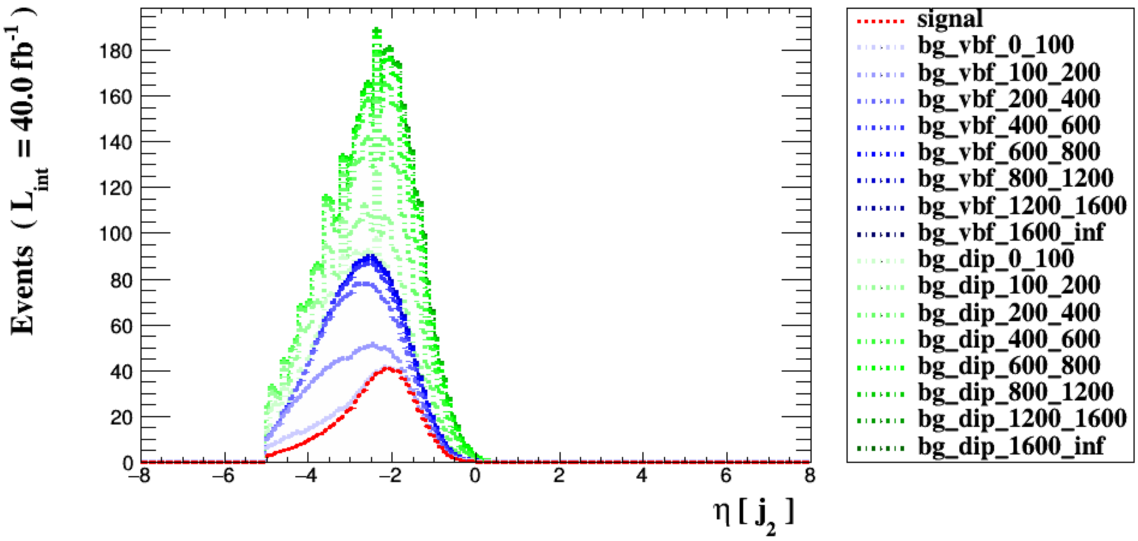
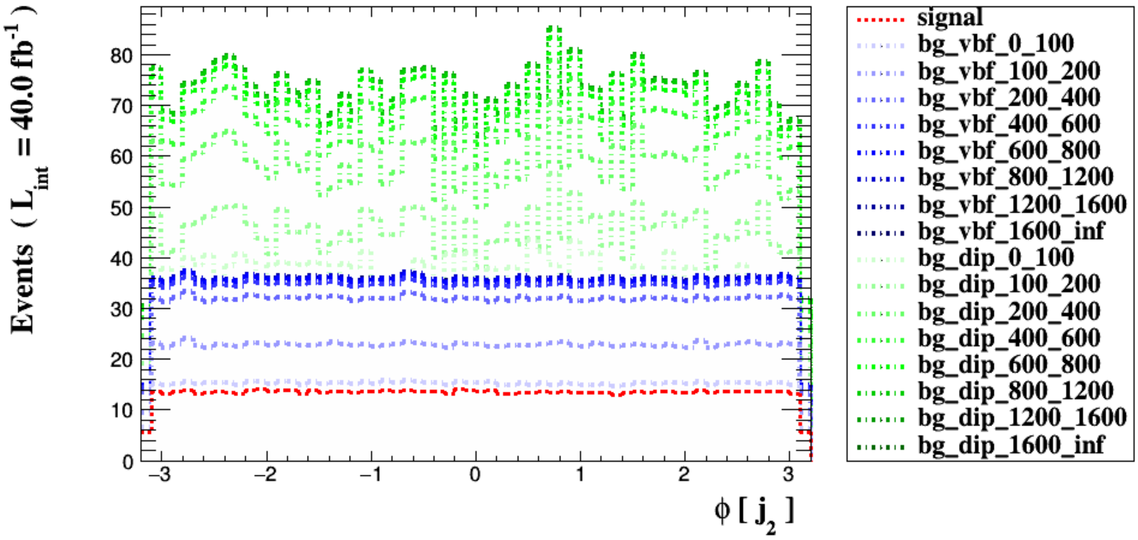


Figure 5.

3.7 Histogram 6

*** Plot: PHI (jets[2])**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	853	1.0	-0.00548129	1.812	0.0	0.0
bg_vbf_0_100	102	1.0	-0.0109881	1.822	0.0	0.0
bg_vbf_100_20	477	1.0	0.00648616	1.818	0.0	0.0
bg_vbf_200_40	573	1.0	-0.000152277	1.815	0.0	0.0
bg_vbf_400_60	174	1.0	-0.000896361	1.816	0.0	0.0
bg_vbf_600_80	55.7	1.0	0.00247374	1.814	0.0	0.0
bg_vbf_800_12	20.2	1.0	-0.000887017	1.81	0.0	0.0
bg_vbf_1200_1	2.25	1.0	-0.0022585	1.82	0.0	0.0
bg_vbf_1600_i	0.403	1.0	0.0107912	1.808	0.0	0.0
bg_dip_0_100	117	1.0	-0.382442	1.517	0.0	0.0
bg_dip_100_20	496	1.0	0.0518113	1.834	0.0	0.0
bg_dip_200_40	814	1.0	-0.013668	1.825	0.0	0.0
bg_dip_400_60	531	1.0	-0.0091491	1.822	0.0	0.0
bg_dip_600_80	263	1.0	-0.0115319	1.804	0.0	0.0
bg_dip_800_12	96.6	1.0	-0.00818692	1.814	0.0	0.0
bg_dip_1200_1	10.8	1.0	0.0189346	1.8	0.0	0.0
bg_dip_1600_i	2.03	1.0	-0.000887935	1.813	0.0	0.0



Events (L_{int} = 40.0 fb^{-1})
80
70
60
50
40
30
20
10
0
−3
−2
−1
0
1
2
3
ϕ [j_2]
signal
bg_vbf_0_100
bg_vbf_100_200
bg_vbf_200_400
bg_vbf_400_600
bg_vbf_600_800
bg_vbf_800_1200
bg_vbf_1200_1600
bg_vbf_1600_inf
bg_dip_0_100
bg_dip_100_200
bg_dip_200_400
bg_dip_400_600
bg_dip_600_800
bg_dip_800_1200
bg_dip_1200_1600
bg_dip_1600_inf

Figure 6.

3.8 Histogram 7

*** Plot: DELTAR (jets[1] , jets[2])**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	853	1.0	4.42115	1.166	0.0	0.0
bg_vbf_0_100	102	1.0	7.95218	0.591	0.0	0.0
bg_vbf_100_20	477	1.0	6.93039	0.6173	0.0	0.0
bg_vbf_200_40	573	1.0	5.94197	0.6418	0.0	0.0
bg_vbf_400_60	174	1.0	5.06636	0.595	0.0	0.0
bg_vbf_600_80	55.7	1.0	4.61037	0.5519	0.0	0.0
bg_vbf_800_12	20.2	1.0	4.45532	0.4696	0.0	0.0
bg_vbf_1200_1	2.25	1.0	4.32176	0.3646	0.0	0.0
bg_vbf_1600_i	0.403	1.0	4.24682	0.289	0.0	0.0
bg_dip_0_100	117	1.0	7.74752	0.3267	0.0	0.0
bg_dip_100_20	496	1.0	6.66929	0.4759	0.0	0.0
bg_dip_200_40	814	1.0	5.59206	0.4871	0.0	0.0
bg_dip_400_60	531	1.0	4.75718	0.4185	0.0	0.0
bg_dip_600_80	263	1.0	4.35595	0.3723	0.0	0.0
bg_dip_800_12	96.6	1.0	4.29607	0.3328	0.0	0.0
bg_dip_1200_1	10.8	1.0	4.2533	0.2769	0.0	0.0
bg_dip_1600_i	2.03	1.0	4.21455	0.215	0.0	0.0

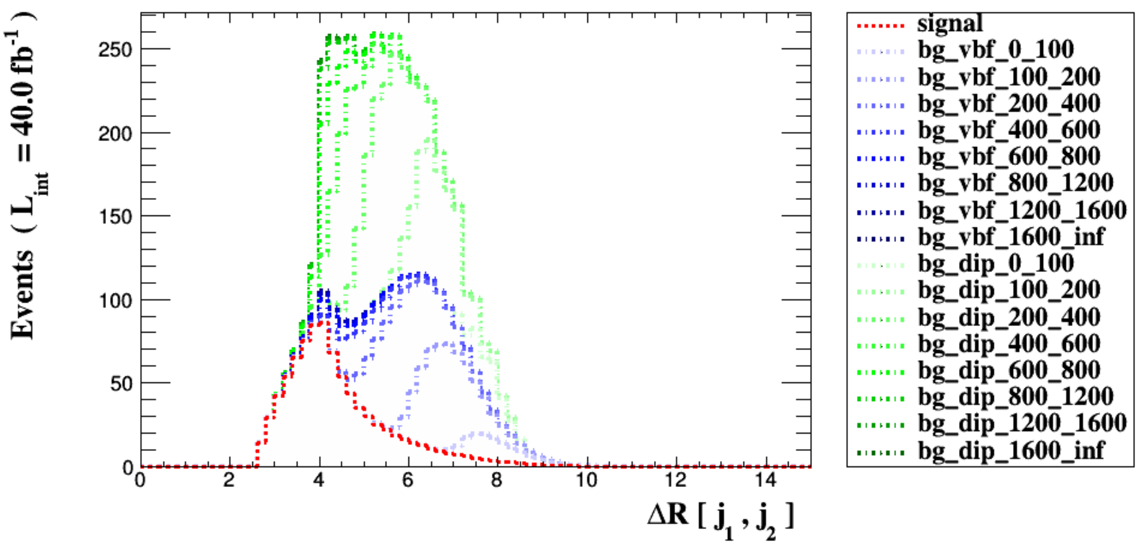


Figure 7.

3.9 Histogram 8

*** Plot: M (jets[1] jets[2])**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	853	1.0	1998.75	664.8	0.0	0.0
bg_vbf_0_100	102	1.0	1754.92	545.8	0.0	0.0
bg_vbf_100_20	477	1.0	1797.03	586.5	0.0	0.0
bg_vbf_200_40	573	1.0	1935.01	656.1	0.0	0.0
bg_vbf_400_60	174	1.0	2014.63	731.2	0.0	0.001131
bg_vbf_600_80	55.7	1.0	2138.11	768.7	0.0	0.00317
bg_vbf_800_12	20.2	1.0	2585.16	786.6	0.0	0.007109
bg_vbf_1200_1	2.25	1.0	3328.08	768.0	0.0	0.01539
bg_vbf_1600_i	0.403	1.0	4223.33	831.2	0.0	0.09855
bg_dip_0_100	117	1.0	1536.49	260.9	0.0	0.0
bg_dip_100_20	496	1.0	1527.46	316.0	0.0	0.0
bg_dip_200_40	814	1.0	1563.67	323.6	0.0	0.0
bg_dip_400_60	531	1.0	1613.17	379.0	0.0	0.0
bg_dip_600_80	263	1.0	1735.66	437.1	0.0	0.0
bg_dip_800_12	96.6	1.0	2245.96	521.5	0.0	0.0
bg_dip_1200_1	10.8	1.0	3099.28	583.3	0.0	0.0
bg_dip_1600_i	2.03	1.0	4083.27	710.6	0.0	0.00892

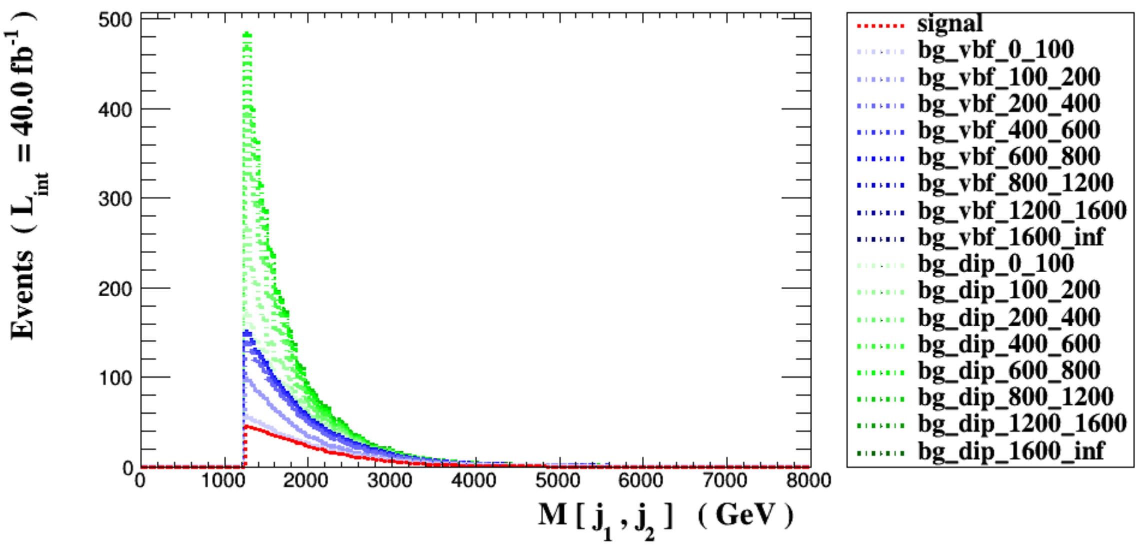


Figure 8.

3.10 Histogram 9

*** Plot: MET**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	853	1.0	9.37816e-09	1.182e-08	0.0	0.0
bg_vbf_0_100	102	1.0	6.19944e-10	4.643e-10	0.0	0.0
bg_vbf_100_20	477	1.0	1.03193e-09	1.184e-09	0.0	0.0
bg_vbf_200_40	573	1.0	3.36658e-09	2.26e-09	0.0	0.0
bg_vbf_400_60	174	1.0	4.57571e-09	2.628e-09	0.0	0.0
bg_vbf_600_80	55.7	1.0	4.94087e-09	2.743e-09	0.0	0.0
bg_vbf_800_12	20.2	1.0	5.22726e-09	3.088e-09	0.0	0.0
bg_vbf_1200_1	2.25	1.0	6.30339e-09	6.791e-09	0.0	0.0
bg_vbf_1600_i	0.403	1.0	1.03516e-08	1.322e-08	0.0	0.0
bg_dip_0_100	117	1.0	7.65424e-10	5.853e-10	0.0	0.0
bg_dip_100_20	496	1.0	1.18704e-09	1.387e-09	0.0	0.0
bg_dip_200_40	814	1.0	3.50088e-09	2.275e-09	0.0	0.0
bg_dip_400_60	531	1.0	4.48695e-09	2.593e-09	0.0	0.0
bg_dip_600_80	263	1.0	4.80027e-09	2.685e-09	0.0	0.0
bg_dip_800_12	96.6	1.0	5.05807e-09	2.996e-09	0.0	0.0
bg_dip_1200_1	10.8	1.0	5.73972e-09	5.438e-09	0.0	0.0
bg_dip_1600_i	2.03	1.0	9.32802e-09	1.244e-08	0.0	0.0

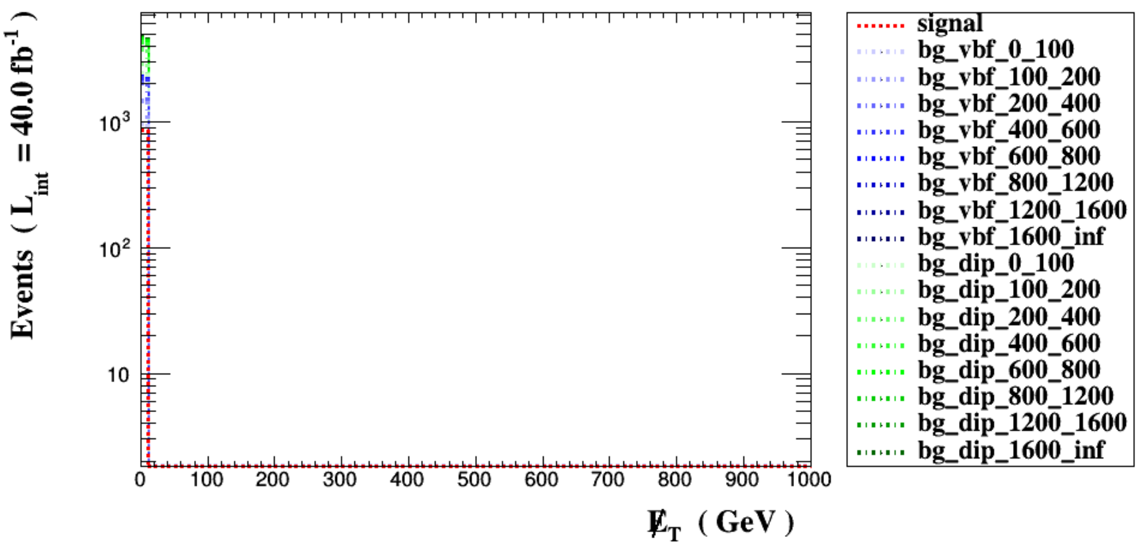


Figure 9.

3.11 Histogram 10

*** Plot: sdETA (jets[1] jets[2])**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	853	1.0	3.93718	1.261	0.0	0.9681
bg_vbf_0_100	102	1.0	7.57435	0.6115	0.0	23.21
bg_vbf_100_20	477	1.0	6.40026	0.6673	0.0	2.156
bg_vbf_200_40	573	1.0	5.25178	0.7177	0.0	0.03453
bg_vbf_400_60	174	1.0	4.1828	0.7028	0.0	0.0
bg_vbf_600_80	55.7	1.0	3.57723	0.6768	0.0	0.0
bg_vbf_800_12	20.2	1.0	3.35934	0.5677	0.0	0.0
bg_vbf_1200_1	2.25	1.0	3.14504	0.4308	0.0	0.0
bg_vbf_1600_i	0.403	1.0	3.00196	0.3367	0.0	0.0
bg_dip_0_100	117	1.0	7.31275	0.3459	0.0	4.448
bg_dip_100_20	496	1.0	6.11125	0.5289	0.0	0.0
bg_dip_200_40	814	1.0	4.81866	0.5746	0.0	0.0
bg_dip_400_60	531	1.0	3.73343	0.5229	0.0	0.0
bg_dip_600_80	263	1.0	3.17164	0.476	0.0	0.0
bg_dip_800_12	96.6	1.0	3.0772	0.4164	0.0	0.0
bg_dip_1200_1	10.8	1.0	2.98817	0.3412	0.0	0.0
bg_dip_1600_i	2.03	1.0	2.90097	0.2648	0.0	0.0

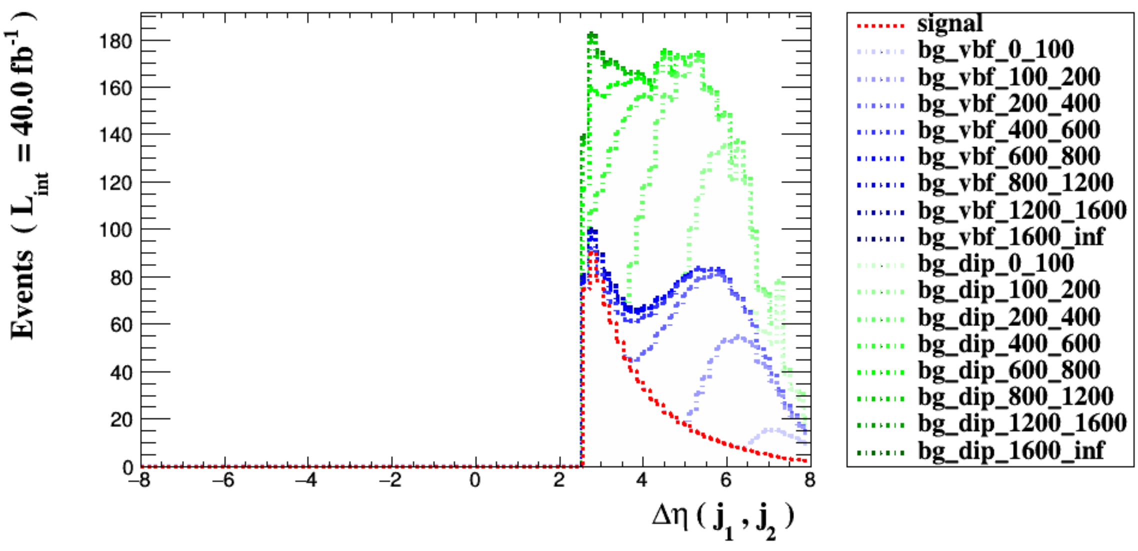


Figure 10.

3.12 Histogram 11

*** Plot: M (a[1] a[2])**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	853	1.0	996.626	716.7	0.0	39.92
bg_vbf_0_100	102	1.0	74.8671	64.42	0.0	0.01176
bg_vbf_100_20	477	1.0	89.3839	83.48	0.0	0.0399
bg_vbf_200_40	573	1.0	113.725	113.1	0.0	0.1218
bg_vbf_400_60	174	1.0	133.277	137.6	0.0	0.2421
bg_vbf_600_80	55.7	1.0	145.549	156.9	0.0	0.4347
bg_vbf_800_12	20.2	1.0	163.011	179.6	0.0	0.7012
bg_vbf_1200_1	2.25	1.0	176.229	203.3	0.0	1.067
bg_vbf_1600_i	0.403	1.0	180.895	212.8	0.0	1.247
bg_dip_0_100	117	1.0	67.9791	48.97	0.0	0.0
bg_dip_100_20	496	1.0	81.4606	86.76	0.0	0.0
bg_dip_200_40	814	1.0	101.829	117.4	0.0	0.08477
bg_dip_400_60	531	1.0	116.247	141.0	0.0	0.2657
bg_dip_600_80	263	1.0	127.197	151.3	0.0	0.3668
bg_dip_800_12	96.6	1.0	148.707	182.6	0.0	0.6794
bg_dip_1200_1	10.8	1.0	165.538	206.2	0.0	1.101
bg_dip_1600_i	2.03	1.0	178.029	215.3	0.0	1.193

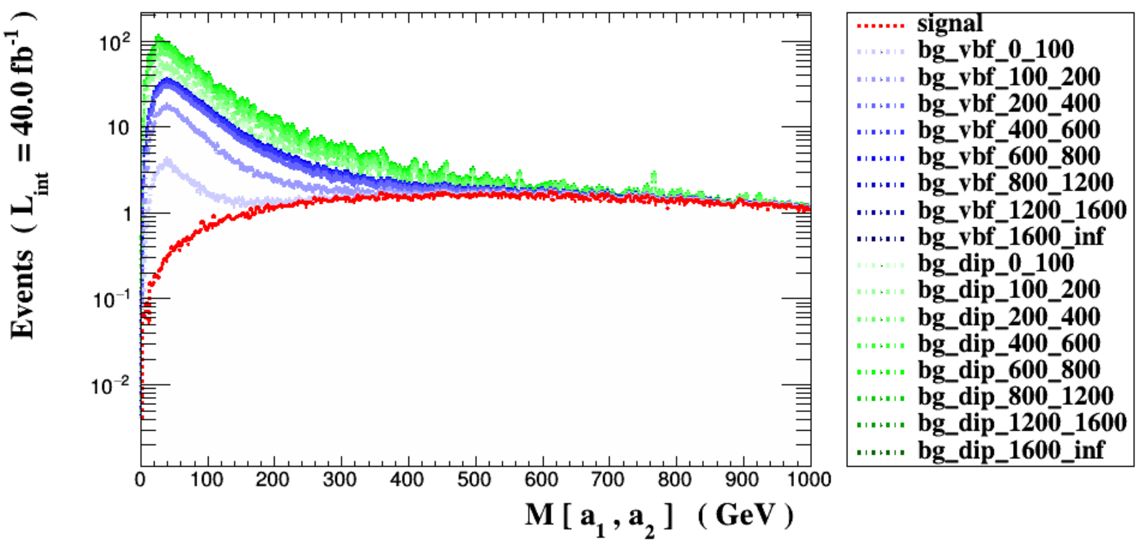


Figure 11.

3.13 Histogram 12

*** Plot: PT (a[1])**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	853	1.0	656.187	372.1	0.0	16.29
bg_vbf_0_100	102	1.0	37.6561	21.46	0.0	0.0
bg_vbf_100_20	477	1.0	51.7205	34.53	0.0	0.0
bg_vbf_200_40	573	1.0	79.4071	64.6	0.0	0.0
bg_vbf_400_60	174	1.0	114.223	106.2	0.0	0.002262
bg_vbf_600_80	55.7	1.0	140.703	144.4	0.0	0.009507
bg_vbf_800_12	20.2	1.0	176.007	200.4	0.0	0.4498
bg_vbf_1200_1	2.25	1.0	209.34	270.7	0.0	3.606
bg_vbf_1600_i	0.403	1.0	224.24	328.6	0.0	4.472
bg_dip_0_100	117	1.0	39.6474	25.66	0.0	0.0
bg_dip_100_20	496	1.0	55.7039	43.6	0.0	0.0
bg_dip_200_40	814	1.0	77.1175	73.41	0.0	0.0
bg_dip_400_60	531	1.0	89.1572	97.37	0.0	0.0
bg_dip_600_80	263	1.0	102.356	117.0	0.0	0.007647
bg_dip_800_12	96.6	1.0	129.437	168.5	0.0	0.3952
bg_dip_1200_1	10.8	1.0	147.694	223.8	0.0	2.441
bg_dip_1600_i	2.03	1.0	147.279	239.6	0.0	1.798

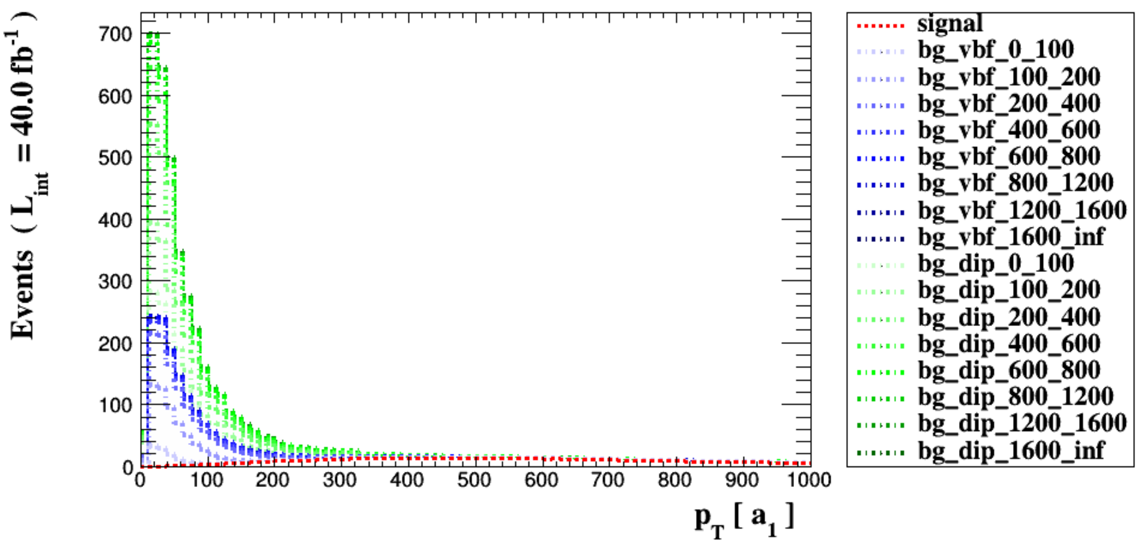


Figure 12.

3.14 Histogram 13

*** Plot: PT (a[2])**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	853	1.0	352.1	284.5	0.0	3.577
bg_vbf_0_100	102	1.0	19.9879	13.16	0.0	0.0
bg_vbf_100_20	477	1.0	23.3502	18.44	0.0	0.0
bg_vbf_200_40	573	1.0	28.1052	26.02	0.0	0.0
bg_vbf_400_60	174	1.0	33.0218	34.3	0.0	0.0
bg_vbf_600_80	55.7	1.0	36.2955	40.84	0.0	0.0004532
bg_vbf_800_12	20.2	1.0	39.6378	47.89	0.0	0.0
bg_vbf_1200_1	2.25	1.0	42.8767	56.71	0.0	0.005763
bg_vbf_1600_i	0.403	1.0	43.8682	60.26	0.0	0.01411
bg_dip_0_100	117	1.0	21.3156	12.28	0.0	0.0
bg_dip_100_20	496	1.0	21.5768	16.61	0.0	0.0
bg_dip_200_40	814	1.0	24.8054	22.89	0.0	0.0
bg_dip_400_60	531	1.0	26.8814	26.02	0.0	0.0
bg_dip_600_80	263	1.0	28.87	29.88	0.0	0.0
bg_dip_800_12	96.6	1.0	31.6547	35.19	0.0	0.0
bg_dip_1200_1	10.8	1.0	33.502	38.62	0.0	0.0
bg_dip_1600_i	2.03	1.0	34.6417	42.68	0.0	0.00892

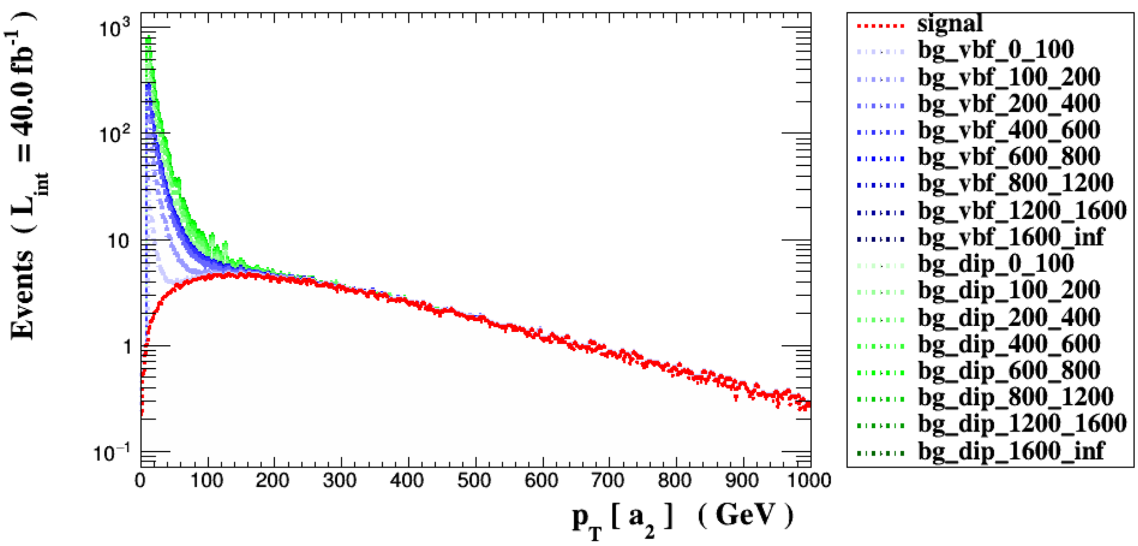


Figure 13.

3.15 Histogram 14

*** Plot: THT**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	853	1.0	752.478	393.0	0.0	23.55
bg_vbf_0_100	102	1.0	80.0995	13.51	0.0	0.0
bg_vbf_100_20	477	1.0	148.512	28.32	0.0	0.0
bg_vbf_200_40	573	1.0	280.111	55.42	0.0	0.0
bg_vbf_400_60	174	1.0	481.428	56.16	0.0	0.0
bg_vbf_600_80	55.7	1.0	678.908	55.16	0.0	0.0
bg_vbf_800_12	20.2	1.0	927.914	102.4	0.0	23.73
bg_vbf_1200_1	2.25	1.0	1336.37	104.5	0.0	100.0
bg_vbf_1600_i	0.403	1.0	1818.94	218.8	0.0	100.0
bg_dip_0_100	117	1.0	81.8197	10.1	0.0	0.0
bg_dip_100_20	496	1.0	150.725	28.95	0.0	0.0
bg_dip_200_40	814	1.0	291.464	57.47	0.0	0.0
bg_dip_400_60	531	1.0	492.287	57.74	0.0	0.0
bg_dip_600_80	263	1.0	679.466	54.63	0.0	0.0
bg_dip_800_12	96.6	1.0	928.373	102.3	0.0	23.83
bg_dip_1200_1	10.8	1.0	1336.89	103.8	0.0	100.0
bg_dip_1600_i	2.03	1.0	1828.03	226.7	0.0	100.0

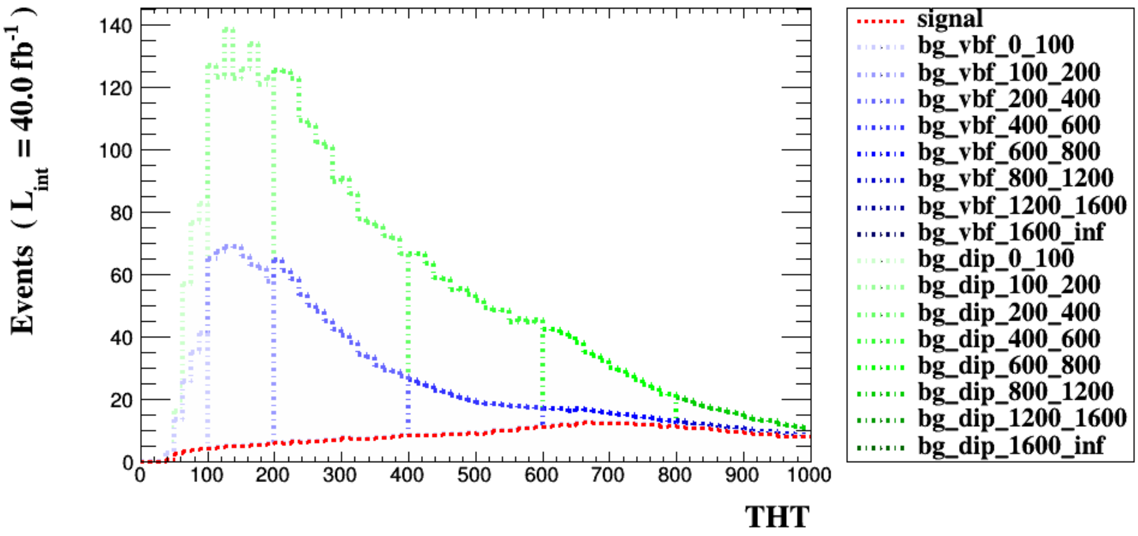


Figure 14.

3.16 Histogram 15

*** Plot: MET**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	853	1.0	9.37816e-09	1.182e-08	0.0	0.0
bg_vbf_0_100	102	1.0	6.19944e-10	4.643e-10	0.0	0.0
bg_vbf_100_20	477	1.0	1.03193e-09	1.184e-09	0.0	0.0
bg_vbf_200_40	573	1.0	3.36658e-09	2.26e-09	0.0	0.0
bg_vbf_400_60	174	1.0	4.57571e-09	2.628e-09	0.0	0.0
bg_vbf_600_80	55.7	1.0	4.94087e-09	2.743e-09	0.0	0.0
bg_vbf_800_12	20.2	1.0	5.22726e-09	3.088e-09	0.0	0.0
bg_vbf_1200_1	2.25	1.0	6.30339e-09	6.791e-09	0.0	0.0
bg_vbf_1600_i	0.403	1.0	1.03516e-08	1.322e-08	0.0	0.0
bg_dip_0_100	117	1.0	7.65424e-10	5.853e-10	0.0	0.0
bg_dip_100_20	496	1.0	1.18704e-09	1.387e-09	0.0	0.0
bg_dip_200_40	814	1.0	3.50088e-09	2.275e-09	0.0	0.0
bg_dip_400_60	531	1.0	4.48695e-09	2.593e-09	0.0	0.0
bg_dip_600_80	263	1.0	4.80027e-09	2.685e-09	0.0	0.0
bg_dip_800_12	96.6	1.0	5.05807e-09	2.996e-09	0.0	0.0
bg_dip_1200_1	10.8	1.0	5.73972e-09	5.438e-09	0.0	0.0
bg_dip_1600_i	2.03	1.0	9.32802e-09	1.244e-08	0.0	0.0

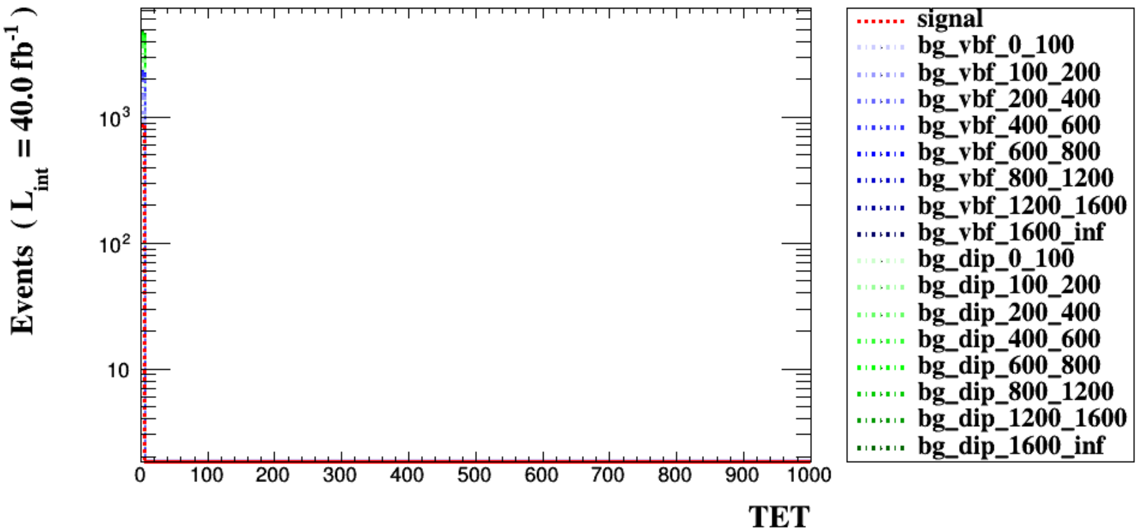


Figure 15.

3.17 Histogram 16

*** Plot: TET**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	853	1.0	1760.77	810.5	0.0	83.4
bg_vbf_0_100	102	1.0	137.744	35.69	0.0	0.0
bg_vbf_100_20	477	1.0	223.583	59.29	0.0	0.01051
bg_vbf_200_40	573	1.0	387.623	105.1	0.0	0.08151
bg_vbf_400_60	174	1.0	628.672	140.2	0.0	2.28
bg_vbf_600_80	55.7	1.0	855.907	177.2	0.0	16.73
bg_vbf_800_12	20.2	1.0	1143.56	250.2	0.0	66.96
bg_vbf_1200_1	2.25	1.0	1588.58	315.6	0.0	100.0
bg_vbf_1600_i	0.403	1.0	2087.04	419.9	0.0	100.0
bg_dip_0_100	117	1.0	142.783	39.01	0.0	0.0
bg_dip_100_20	496	1.0	228.006	64.22	0.0	0.0
bg_dip_200_40	814	1.0	393.387	108.5	0.0	0.05657
bg_dip_400_60	531	1.0	608.326	127.5	0.0	1.844
bg_dip_600_80	263	1.0	810.693	145.6	0.0	8.579
bg_dip_800_12	96.6	1.0	1089.47	214.1	0.0	59.21
bg_dip_1200_1	10.8	1.0	1518.09	264.2	0.0	100.0
bg_dip_1600_i	2.03	1.0	2009.95	344.4	0.0	100.0

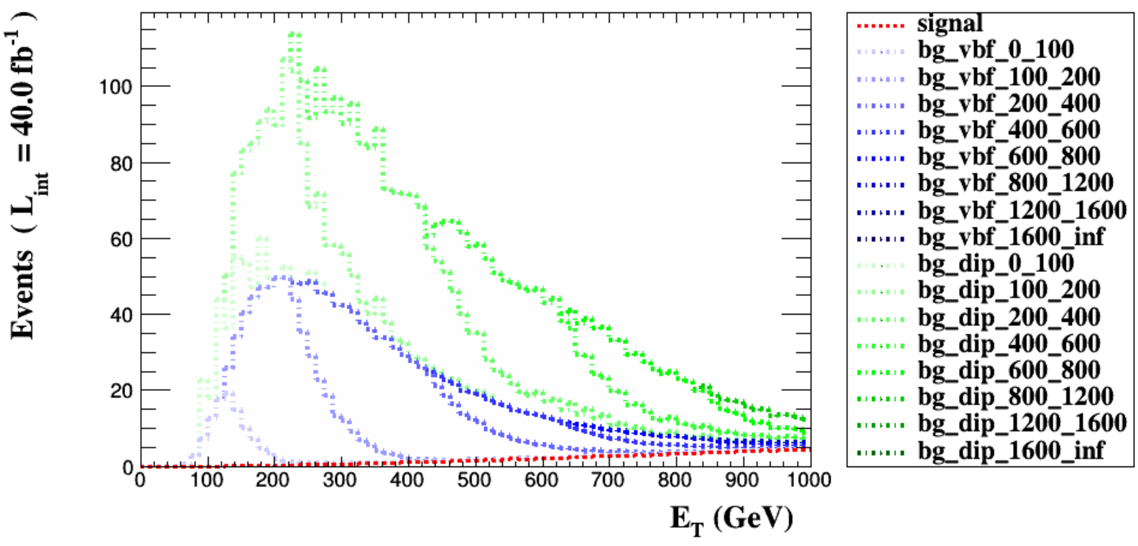


Figure 16.

4 Summary

4.1 Cut-flow charts

- How to compare signal (S) and background (B): S/sqrt(S+B) .
- Object definition selections are indicated in cyan.
- Reject and select are indicated by 'REJ' and 'SEL' respectively

Cuts	Signal (S)	Background (B)	S vs B
Initial (no cut)	4094.08 +/- 1.13	4113516 +/- 4877	2.01760 +/- 0.00132
SEL: sdETA (jets[1] jets[2]) > 2.6 and M (jets[	853.4 +/- 26.0	3739.6 +/- 59.9	12.592 +/- 0.357