The LaTeX report

Generated by elijahsheridan on 21 March 2020, 16:02:08

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Please cite:

> **E. Conte, B. Fuks and G. Serret**,
> *MadAnalysis 5, A User-Friendly Framework for Collider Phenomenology*,
> Comput. Phys. Commun. **184** (2013) 222-256,
> arXiv:1206.1599 [hep-ph].

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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]) > 3.6 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 tight_analysis_sdeta_3.6_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_c 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_c 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]) > 3.6 and M (jets[1] jets[2]) > 1250.0**

Dataset	Events kept: K	Rejected events: R	Efficiency: K / (K + R)	Cumul. efficiency: K / Initial
signal	405.3 +/- 19.1	3688.8 +/- 19.1	0.09899 +/- 0.00467	0.09899 +/- 0.00467
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_	136.8 +/- 10.9	850.1 +/- 10.9	0.139 +/- 0.011	0.139 +/- 0.011
bg_vbf_600_	23.84 +/- 4.65	228.24 +/- 4.65	0.0946 +/- 0.0184	0.0946 +/- 0.0184
bg_vbf_800_	6.03 +/- 2.39	108.7 +/- 2.4	0.0526 +/- 0.0208	0.0526 +/- 0.0208
bg_vbf_1200_	0.336 +/- 0.575	20.260 +/- 0.576	0.0163 +/- 0.0279	0.0163 +/- 0.0279
bg_vbf_1600_	0.0247 +/- 0.1569	7.634 +/- 0.157	0.00323 +/- 0.02049	0.00323 +/- 0.02049
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_	293.0 +/- 17.0	28505.7 +/- 54.4	0.010174 +/- 0.000591	0.010174 +/- 0.000591
bg_dip_600_	44.57 +/- 6.66	6629.8 +/- 28.2	0.006677 +/- 0.000997	0.006677 +/- 0.000997
bg_dip_800_	10.89 +/- 3.29	2931.45 +/- 6.02	0.00370 +/- 0.00112	0.00370 +/- 0.00112
bg_dip_1200_	0.675 +/- 0.821	512.83 +/- 2.75	0.00131 +/- 0.00160	0.00131 +/- 0.00160
bg_dip_1600_	0.0437 +/- 0.2090	187.740 +/- 0.348	0.000233 +/- 0.001113	0.000233 +/- 0.001113

3.2 Histogram 1

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	405	1.0	388.548	279.5	0.0	3.884
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	136	1.0	275.099	52.46	0.0	0.0
bg_vbf_600_80	23.8	1.0	393.959	73.83	0.0	0.0
bg_vbf_800_12	6.04	1.0	532.576	113.4	0.0	0.4932
bg_vbf_1200_1	0.337	1.0	768.132	172.3	0.0	11.36
bg_vbf_1600_i	0.0252	1.0	1041.52	293.6	0.0	32.64
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	292	1.0	271.564	55.81	0.0	0.0
bg_dip_600_80	44.6	1.0	392.465	82.52	0.0	0.0
bg_dip_800_12	10.9	1.0	542.214	141.1	0.0	1.481
bg_dip_1200_1	0.675	1.0	774.93	209.4	0.0	14.9
bg_dip_1600_i	0.0437	1.0	1062.59	357.2	0.0	29.34

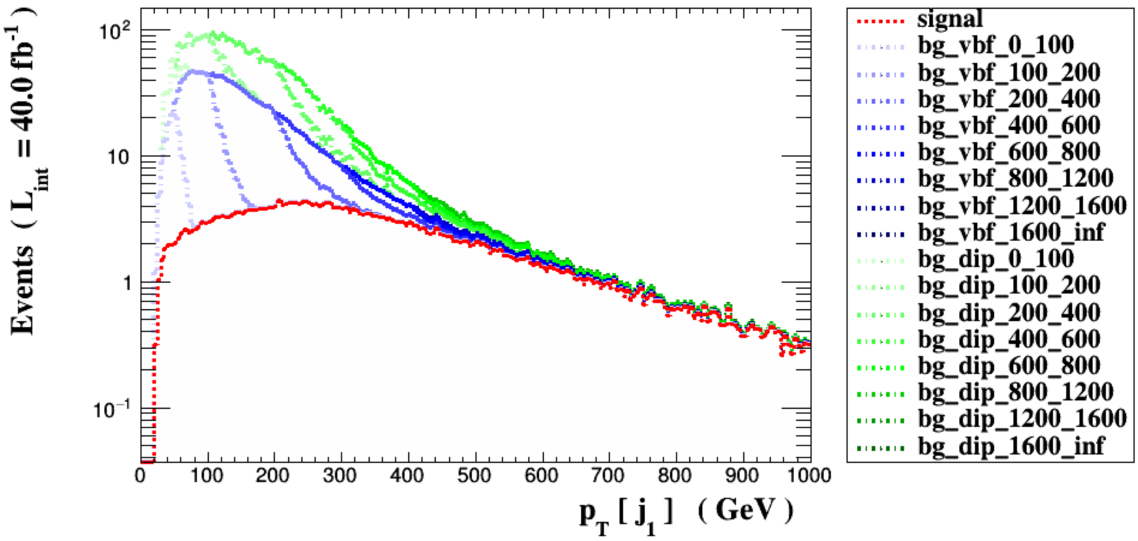

Figure 1.

3.3 Histogram 2

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	405	1.0	1.93288	0.8878	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	136	1.0	2.07025	0.6598	0.0	0.0
bg_vbf_600_80	23.8	1.0	1.96155	0.5638	0.0	0.0
bg_vbf_800_12	6.04	1.0	1.88259	0.4906	0.0	0.0
bg_vbf_1200_1	0.337	1.0	1.79038	0.437	0.0	0.0
bg_vbf_1600_i	0.0252	1.0	1.69945	0.4477	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	292	1.0	2.02025	0.7074	0.0	0.0
bg_dip_600_80	44.6	1.0	1.92378	0.6381	0.0	0.0
bg_dip_800_12	10.9	1.0	1.80999	0.6146	0.0	0.0
bg_dip_1200_1	0.675	1.0	1.73565	0.5501	0.0	0.0
bg_dip_1600_i	0.0437	1.0	1.61899	0.6004	0.0	0.0

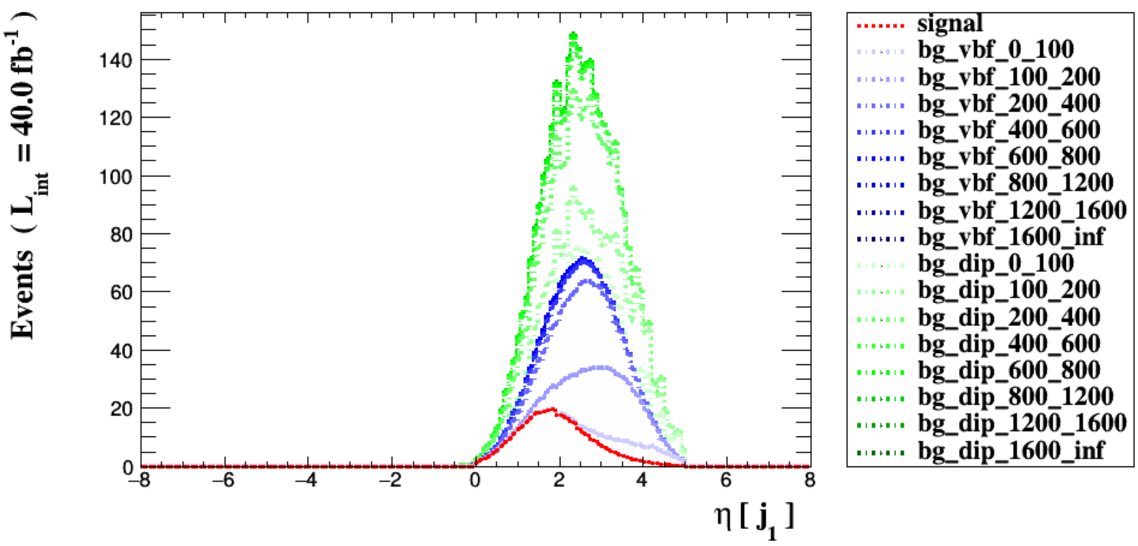

Figure 2.

3.4 Histogram 3

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	405	1.0	- 0.000461567	1.813	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	136	1.0	-0.00076842	1.812	0.0	0.0
bg_vbf_600_80	23.8	1.0	0.00932615	1.812	0.0	0.0
bg_vbf_800_12	6.04	1.0	-0.00383047	1.813	0.0	0.0
bg_vbf_1200_1	0.337	1.0	0.0192996	1.809	0.0	0.0
bg_vbf_1600_i	0.0252	1.0	-0.0612997	1.785	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	292	1.0	-0.0169474	1.802	0.0	0.0
bg_dip_600_80	44.6	1.0	-0.0041996	1.819	0.0	0.0
bg_dip_800_12	10.9	1.0	0.0287461	1.813	0.0	0.0
bg_dip_1200_1	0.675	1.0	-0.111858	1.79	0.0	0.0
bg_dip_1600_i	0.0437	1.0	-0.0242244	1.737	0.0	0.0

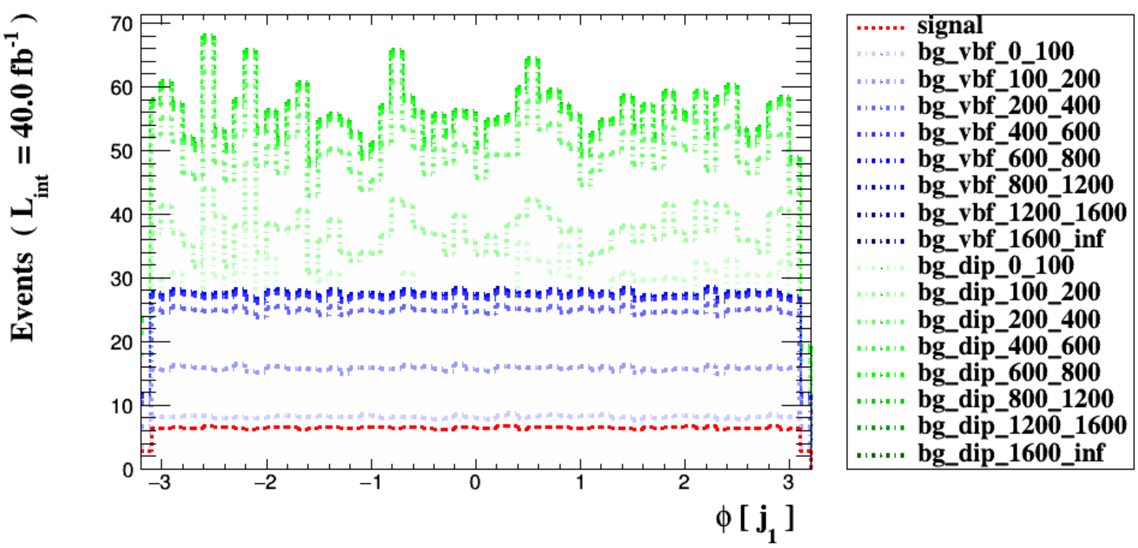

Figure 3.

3.5 Histogram 4

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	405	1.0	118.962	84.1	0.0	0.2323
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	136	1.0	195.78	46.92	0.0	0.0
bg_vbf_600_80	23.8	1.0	279.817	70.52	0.0	0.0
bg_vbf_800_12	6.04	1.0	381.023	107.6	0.0	8.421
bg_vbf_1200_1	0.337	1.0	548.791	166.3	0.0	78.99
bg_vbf_1600_i	0.0252	1.0	704.575	256.7	0.0	83.13
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	292	1.0	196.391	49.4	0.0	0.0
bg_dip_600_80	44.6	1.0	279.332	79.47	0.0	0.0
bg_dip_800_12	10.9	1.0	370.05	134.1	0.0	8.548
bg_dip_1200_1	0.675	1.0	537.054	199.7	0.0	81.48
bg_dip_1600_i	0.0437	1.0	699.472	304.3	0.0	82.64

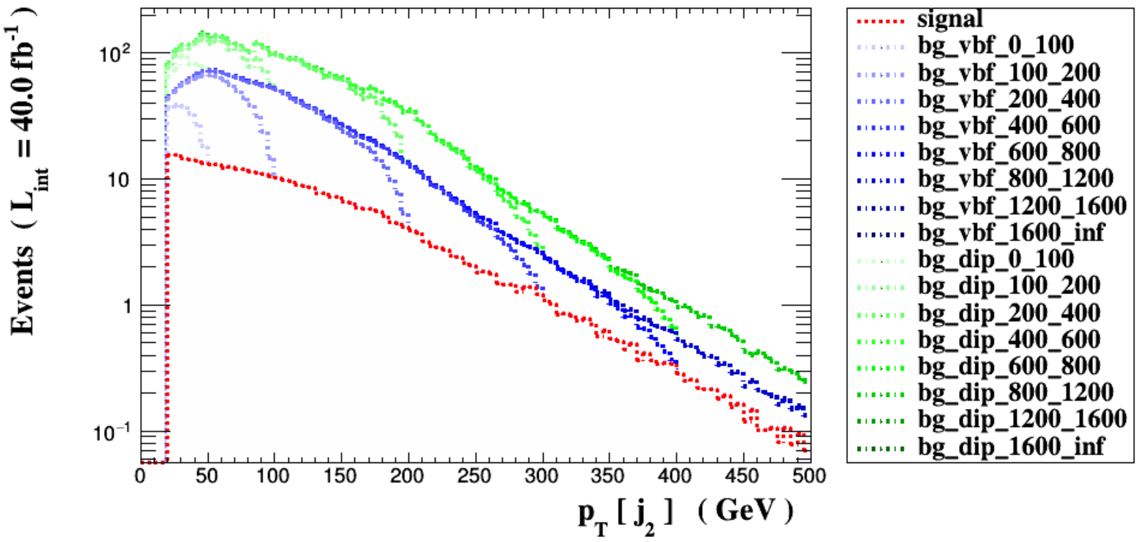

Figure 4.

3.6 Histogram 5

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	405	1.0	-3.00573	0.8372	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	136	1.0	-2.34591	0.6955	0.0	0.0
bg_vbf_600_80	23.8	1.0	-2.26091	0.5995	0.0	0.0
bg_vbf_800_12	6.04	1.0	-2.19432	0.5325	0.0	0.0
bg_vbf_1200_1	0.337	1.0	-2.14009	0.4985	0.0	0.0
bg_vbf_1600_i	0.0252	1.0	-2.14792	0.5185	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	292	1.0	-2.06643	0.7781	0.0	0.0
bg_dip_600_80	44.6	1.0	-2.09025	0.708	0.0	0.0
bg_dip_800_12	10.9	1.0	-2.14791	0.7068	0.0	0.0
bg_dip_1200_1	0.675	1.0	-2.13001	0.6727	0.0	0.0
bg_dip_1600_i	0.0437	1.0	-2.20017	0.7261	0.0	0.0

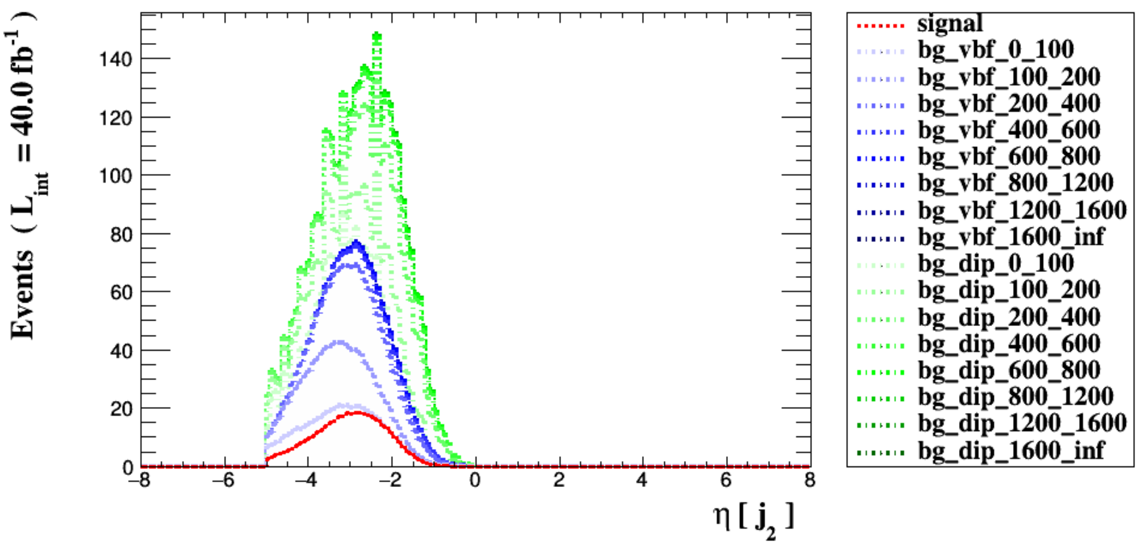

Figure 5.

3.7 Histogram 6

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	405	1.0	-0.00526342	1.814	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	136	1.0	-0.00184318	1.815	0.0	0.0
bg_vbf_600_80	23.8	1.0	-0.00298582	1.817	0.0	0.0
bg_vbf_800_12	6.04	1.0	-0.0150365	1.818	0.0	0.0
bg_vbf_1200_1	0.337	1.0	-0.00539569	1.822	0.0	0.0
bg_vbf_1600_i	0.0252	1.0	0.0399503	1.79	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	292	1.0	-0.0161945	1.826	0.0	0.0
bg_dip_600_80	44.6	1.0	-0.0181903	1.811	0.0	0.0
bg_dip_800_12	10.9	1.0	-0.0153119	1.817	0.0	0.0
bg_dip_1200_1	0.675	1.0	0.0739514	1.823	0.0	0.0
bg_dip_1600_i	0.0437	1.0	-0.174818	1.849	0.0	0.0

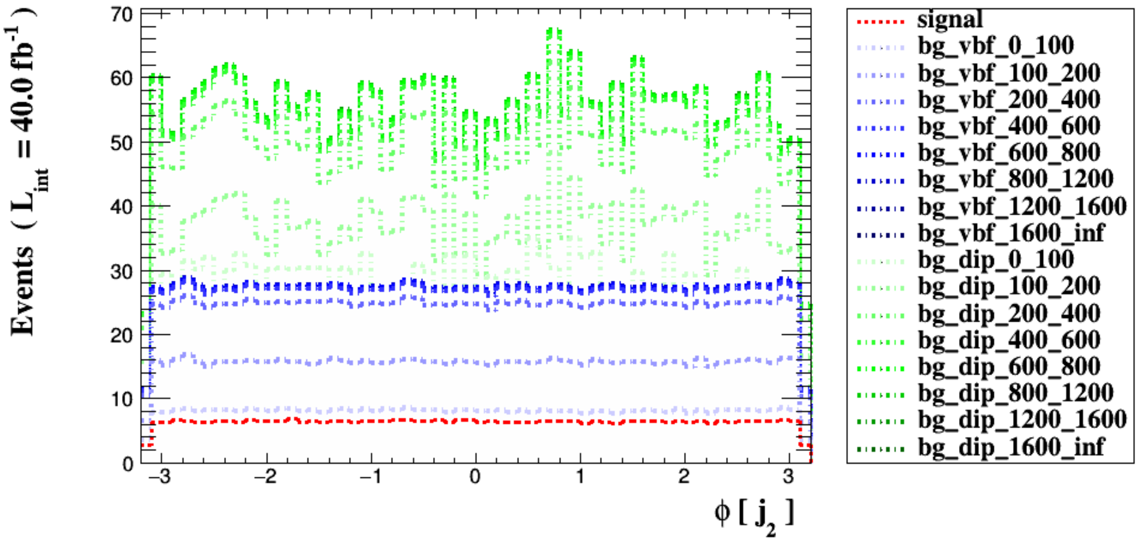

Figure 6.

3.8 Histogram 7

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	405	1.0	5.27638	1.111	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	136	1.0	5.24308	0.5412	0.0	0.0
bg_vbf_600_80	23.8	1.0	5.09234	0.4485	0.0	0.0
bg_vbf_800_12	6.04	1.0	4.98571	0.3741	0.0	0.0
bg_vbf_1200_1	0.337	1.0	4.88302	0.3	0.0	0.0
bg_vbf_1600_i	0.0252	1.0	4.82191	0.2795	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	292	1.0	5.01265	0.3721	0.0	0.0
bg_dip_600_80	44.6	1.0	4.9591	0.329	0.0	0.0
bg_dip_800_12	10.9	1.0	4.90662	0.3104	0.0	0.0
bg_dip_1200_1	0.675	1.0	4.82935	0.2943	0.0	0.0
bg_dip_1600_i	0.0437	1.0	4.78152	0.2814	0.0	0.0

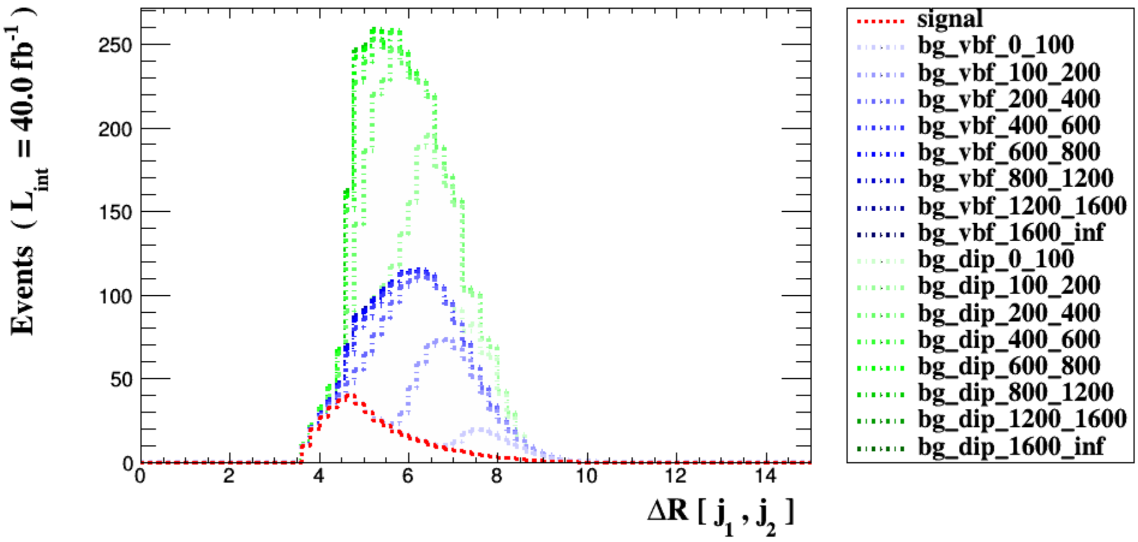

Figure 7.

3.9 Histogram 8

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	405	1.0	2092.76	733.8	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	136	1.0	2182.58	739.7	0.0	0.001443
bg_vbf_600_80	23.8	1.0	2781.69	757.5	0.0	0.007403
bg_vbf_800_12	6.04	1.0	3450.11	796.3	0.0	0.02375
bg_vbf_1200_1	0.337	1.0	4535.16	874.5	0.0	0.1026
bg_vbf_1600_i	0.0252	1.0	5588.19	1179	0.0	1.462
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	292	1.0	1792.15	421.1	0.0	0.0
bg_dip_600_80	44.6	1.0	2435.56	527.9	0.0	0.0
bg_dip_800_12	10.9	1.0	3104.76	731.5	0.0	0.0
bg_dip_1200_1	0.675	1.0	4189.44	984.4	0.0	0.0
bg_dip_1600_i	0.0437	1.0	5239.8	1493	0.0	0.414

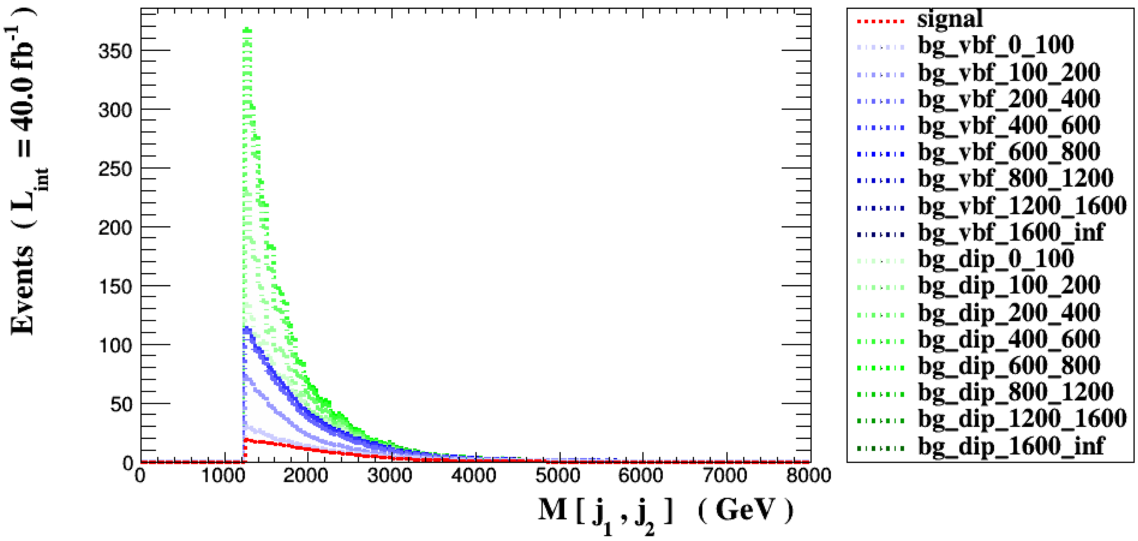

Figure 8.

3.10 Histogram 9

*** Plot: MET**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	405	1.0	8.08519e-09	1.046e-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	136	1.0	4.57136e-09	2.627e-09	0.0	0.0
bg_vbf_600_80	23.8	1.0	4.96532e-09	2.759e-09	0.0	0.0
bg_vbf_800_12	6.04	1.0	5.29507e-09	3.266e-09	0.0	0.0
bg_vbf_1200_1	0.337	1.0	7.57578e-09	9.664e-09	0.0	0.0
bg_vbf_1600_i	0.0252	1.0	1.17343e-08	1.543e-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	292	1.0	4.46119e-09	2.584e-09	0.0	0.0
bg_dip_600_80	44.6	1.0	4.86013e-09	2.677e-09	0.0	0.0
bg_dip_800_12	10.9	1.0	5.19487e-09	4.117e-09	0.0	0.0
bg_dip_1200_1	0.675	1.0	8.45939e-09	1.179e-08	0.0	0.0
bg_dip_1600_i	0.0437	1.0	1.08698e-08	1.476e-08	0.0	0.0

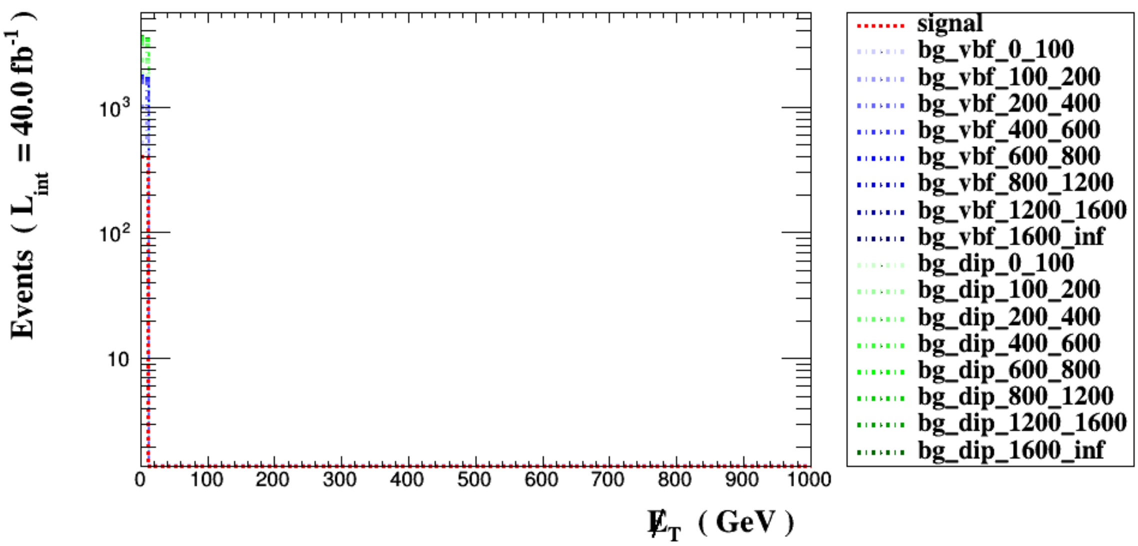

Figure 9.

3.11 Histogram 10

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	405	1.0	4.93861	1.162	0.0	2.039
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	136	1.0	4.41616	0.6066	0.0	0.0
bg_vbf_600_80	23.8	1.0	4.22247	0.4867	0.0	0.0
bg_vbf_800_12	6.04	1.0	4.07691	0.392	0.0	0.0
bg_vbf_1200_1	0.337	1.0	3.93047	0.2943	0.0	0.0
bg_vbf_1600_i	0.0252	1.0	3.84737	0.2443	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	292	1.0	4.08668	0.4285	0.0	0.0
bg_dip_600_80	44.6	1.0	4.01403	0.3681	0.0	0.0
bg_dip_800_12	10.9	1.0	3.95789	0.3287	0.0	0.0
bg_dip_1200_1	0.675	1.0	3.86566	0.2738	0.0	0.0
bg_dip_1600_i	0.0437	1.0	3.81916	0.2447	0.0	0.0

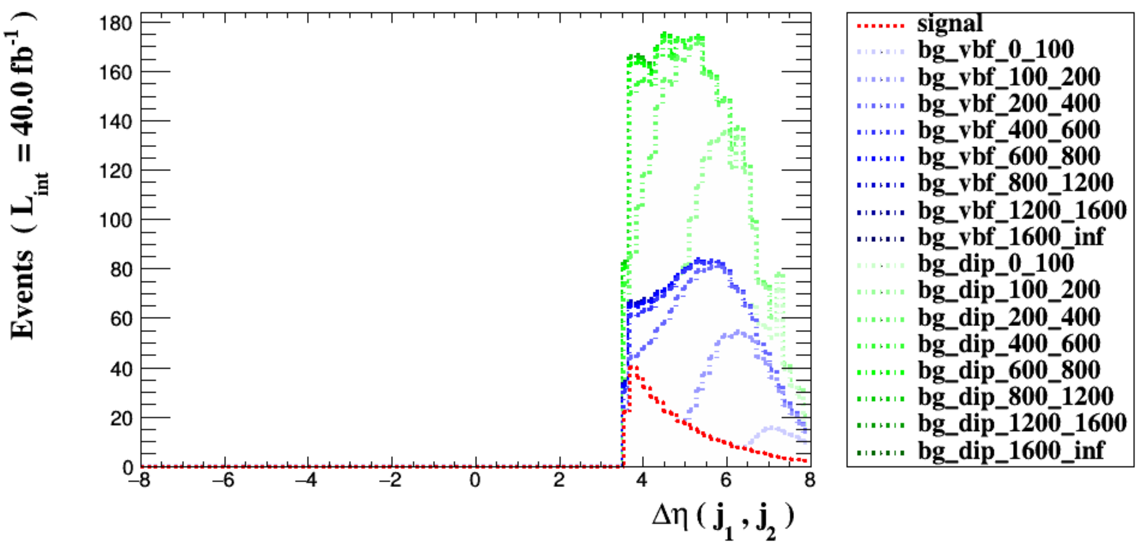

Figure 10.

3.12 Histogram 11

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	405	1.0	1033.19	770.9	0.0	41.25
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	136	1.0	139.497	143.5	0.0	0.2771
bg_vbf_600_80	23.8	1.0	165.376	176.9	0.0	0.6767
bg_vbf_800_12	6.04	1.0	184.367	198.5	0.0	0.9958
bg_vbf_1200_1	0.337	1.0	211.673	240.5	0.0	1.847
bg_vbf_1600_i	0.0252	1.0	258.692	305.6	0.0	3.602
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	292	1.0	128.284	156.9	0.0	0.4064
bg_dip_600_80	44.6	1.0	159.226	192.7	0.0	0.882
bg_dip_800_12	10.9	1.0	192.169	228.1	0.0	1.247
bg_dip_1200_1	0.675	1.0	219.108	274.9	0.0	2.71
bg_dip_1600_i	0.0437	1.0	276.432	301.7	0.0	2.477

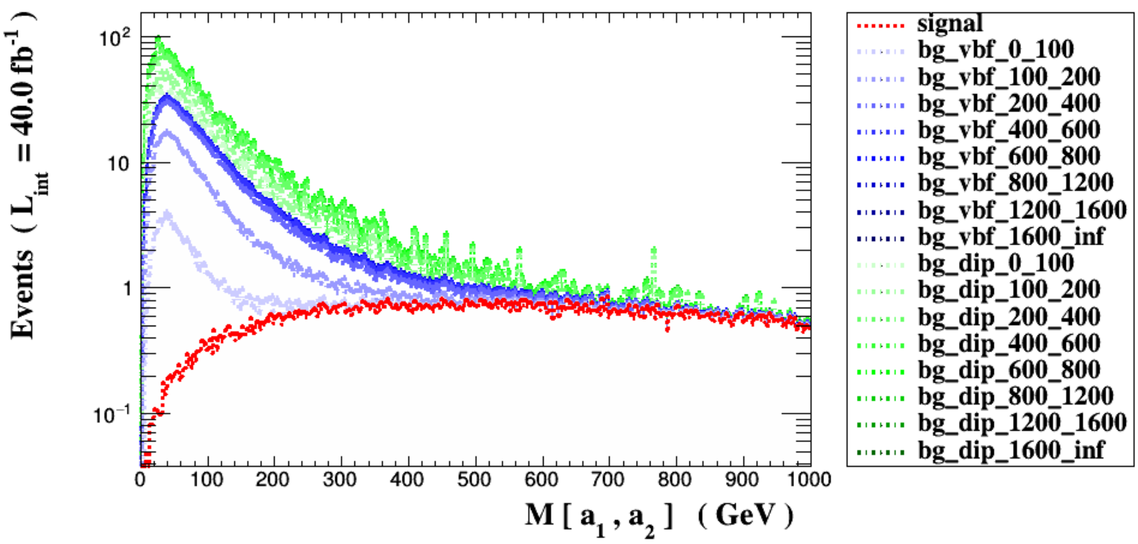

Figure 11.

3.13 Histogram 12

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	405	1.0	592.21	364.8	0.0	12.6
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	136	1.0	120.13	110.2	0.0	0.002886
bg_vbf_600_80	23.8	1.0	162.739	163.7	0.0	0.0148
bg_vbf_800_12	6.04	1.0	205.495	231.0	0.0	0.7822
bg_vbf_1200_1	0.337	1.0	277.542	353.0	0.0	8.228
bg_vbf_1600_i	0.0252	1.0	395.601	548.9	0.0	15.97
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	292	1.0	101.734	112.2	0.0	0.0
bg_dip_600_80	44.6	1.0	143.507	174.0	0.0	0.02262
bg_dip_800_12	10.9	1.0	205.072	276.7	0.0	1.974
bg_dip_1200_1	0.675	1.0	274.485	426.3	0.0	13.32
bg_dip_1600_i	0.0437	1.0	399.282	651.2	0.0	17.36

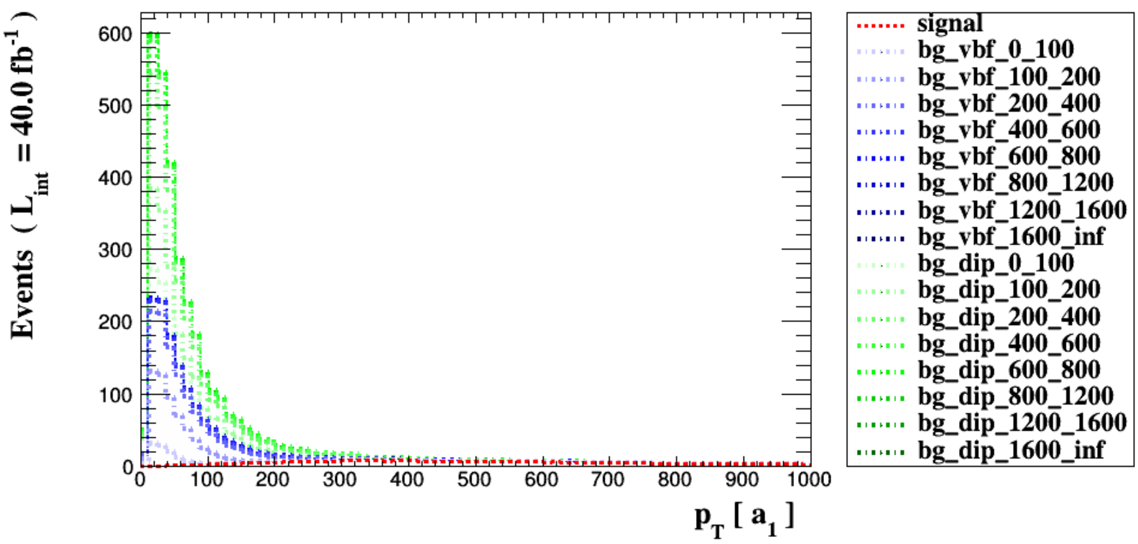

Figure 12.

3.14 Histogram 13

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	405	1.0	362.444	311.6	0.0	4.721
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	136	1.0	33.8376	35.49	0.0	0.0
bg_vbf_600_80	23.8	1.0	38.9053	45.07	0.0	0.001058
bg_vbf_800_12	6.04	1.0	42.0948	52.87	0.0	0.0
bg_vbf_1200_1	0.337	1.0	47.3593	66.98	0.0	0.01921
bg_vbf_1600_i	0.0252	1.0	56.8733	90.0	0.0	0.1126
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	292	1.0	27.9732	28.27	0.0	0.0
bg_dip_600_80	44.6	1.0	31.8662	36.74	0.0	0.0
bg_dip_800_12	10.9	1.0	34.9499	43.35	0.0	0.0
bg_dip_1200_1	0.675	1.0	41.3463	66.97	0.0	0.0
bg_dip_1600_i	0.0437	1.0	37.3756	50.21	0.0	0.0

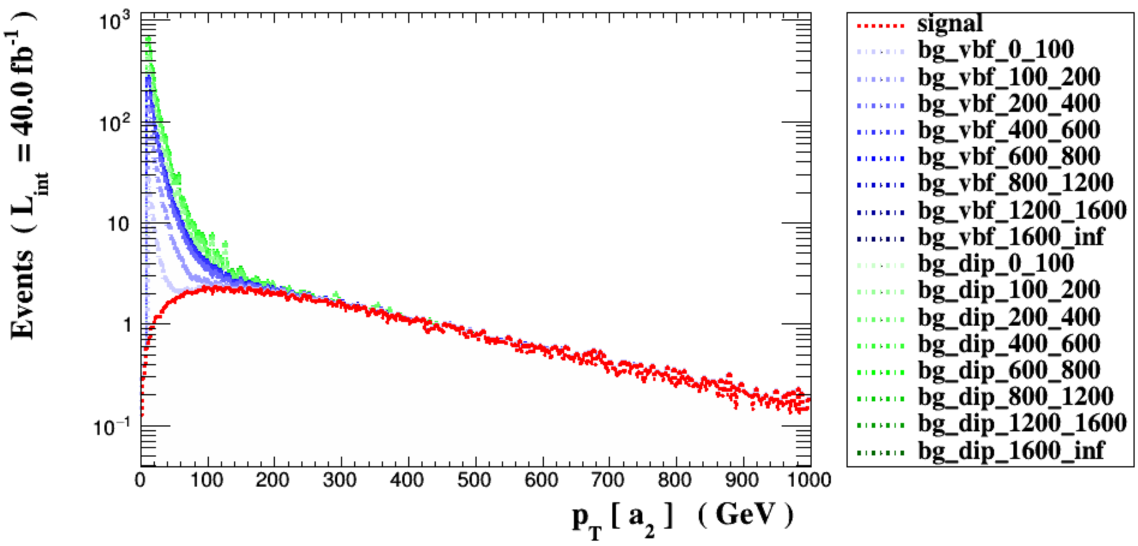

Figure 13.

3.15 Histogram 14

*** Plot: THT**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	405	1.0	507.51	301.7	0.0	6.672
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	136	1.0	470.879	53.35	0.0	0.0
bg_vbf_600_80	23.8	1.0	673.777	54.21	0.0	0.0
bg_vbf_800_12	6.04	1.0	913.6	95.92	0.0	19.0
bg_vbf_1200_1	0.337	1.0	1316.92	95.9	0.0	100.0
bg_vbf_1600_i	0.0252	1.0	1746.1	152.6	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	292	1.0	467.955	52.63	0.0	0.0
bg_dip_600_80	44.6	1.0	671.796	53.38	0.0	0.0
bg_dip_800_12	10.9	1.0	912.263	93.82	0.0	17.93
bg_dip_1200_1	0.675	1.0	1311.98	94.87	0.0	100.0
bg_dip_1600_i	0.0437	1.0	1762.06	166.2	0.0	100.0

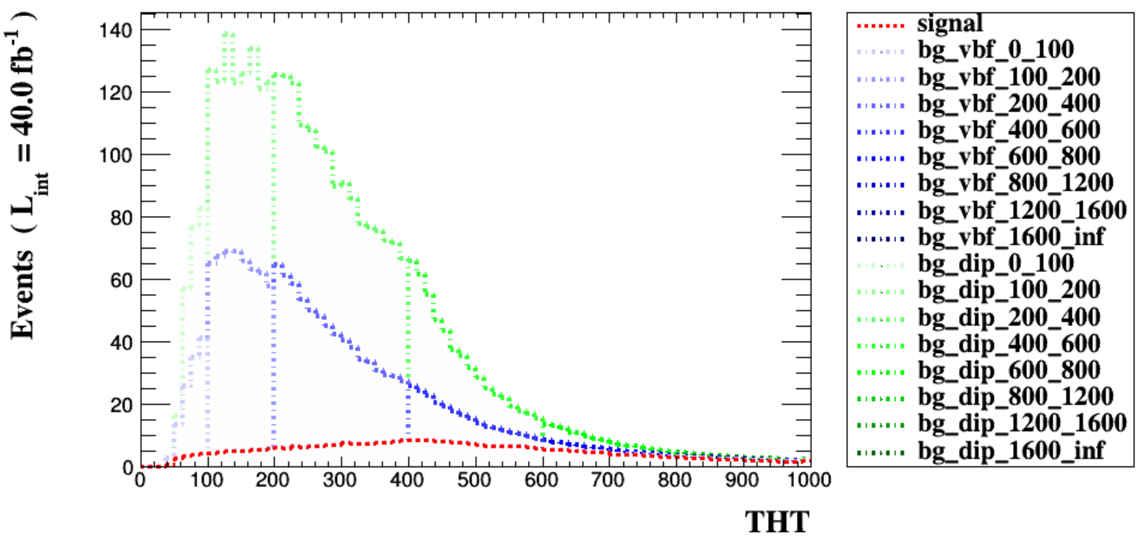

Figure 14.

3.16 Histogram 15

*** Plot: MET**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	405	1.0	8.08519e-09	1.046e-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	136	1.0	4.57136e-09	2.627e-09	0.0	0.0
bg_vbf_600_80	23.8	1.0	4.96532e-09	2.759e-09	0.0	0.0
bg_vbf_800_12	6.04	1.0	5.29507e-09	3.266e-09	0.0	0.0
bg_vbf_1200_1	0.337	1.0	7.57578e-09	9.664e-09	0.0	0.0
bg_vbf_1600_i	0.0252	1.0	1.17343e-08	1.543e-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	292	1.0	4.46119e-09	2.584e-09	0.0	0.0
bg_dip_600_80	44.6	1.0	4.86013e-09	2.677e-09	0.0	0.0
bg_dip_800_12	10.9	1.0	5.19487e-09	4.117e-09	0.0	0.0
bg_dip_1200_1	0.675	1.0	8.45939e-09	1.179e-08	0.0	0.0
bg_dip_1600_i	0.0437	1.0	1.08698e-08	1.476e-08	0.0	0.0

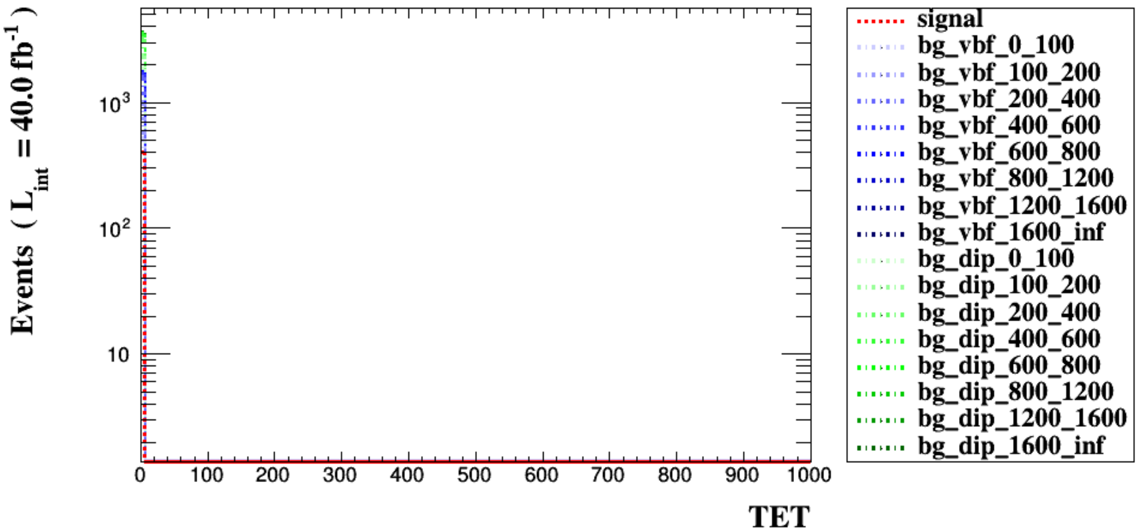

Figure 15.

3.17 Histogram 16

*** Plot: TET**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	405	1.0	1462.16	772.4	0.0	69.3
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	136	1.0	624.846	145.1	0.0	2.447
bg_vbf_600_80	23.8	1.0	875.421	196.4	0.0	20.92
bg_vbf_800_12	6.04	1.0	1161.19	277.5	0.0	66.39
bg_vbf_1200_1	0.337	1.0	1641.82	397.8	0.0	100.0
bg_vbf_1600_i	0.0252	1.0	2198.57	636.7	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	292	1.0	597.663	143.1	0.0	2.599
bg_dip_600_80	44.6	1.0	847.17	201.6	0.0	15.68
bg_dip_800_12	10.9	1.0	1152.29	315.5	0.0	58.66
bg_dip_1200_1	0.675	1.0	1627.82	477.4	0.0	100.0
bg_dip_1600_i	0.0437	1.0	2198.72	744.6	0.0	100.0

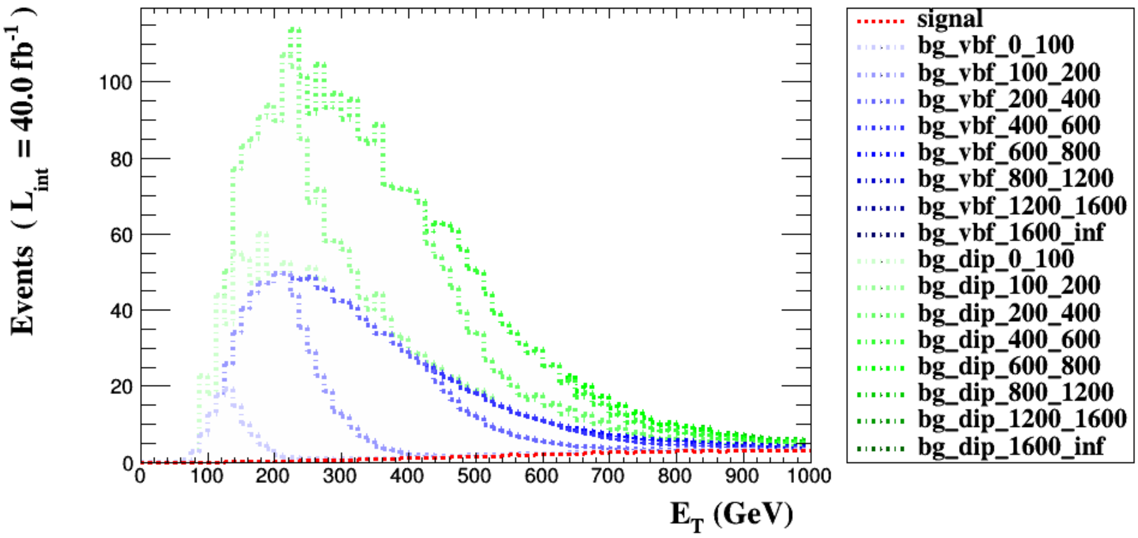

Figure 16.

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]) > 3.6 and M (jets[	405.3 +/- 19.1	3098.1 +/- 54.7	6.847 +/- 0.309