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_pheno/madgraph_data
# need to change this directory path -> exit and type "pwd" to get the path
ma5>set main.lumi = 40
ma5>set main.fom.formula = 5
ma5>set main.fom.x = 0.0
ma5>
# import samples -> change the path to the LHE file
ma5>import /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_pheno/madgraph_data/axion_signal/-
axion_signal_gurrola_cuts_1MeV.lhe.gz as signal
ma5>import /Users/elijahsheridan/MG5_aMC_v2_6_5/axion_pheno/madgraph_data/vbf_diphoton_background_
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_pheno/madgraph_data/vbf_diphoton_background_
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_pheno/madgraph_data/vbf_diphoton_background_
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_pheno/madgraph_data/vbf_diphoton_background_
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_pheno/madgraph_data/vbf_diphoton_background_
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_pheno/madgraph_data/vbf_diphoton_background_
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_pheno/madgraph_data/vbf_diphoton_background_
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_pheno/madgraph_data/vbf_diphoton_background_
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_pheno/madgraph_data/diphoton_double_isr_back
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_pheno/madgraph_data/diphoton_double_isr_back
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_pheno/madgraph_data/diphoton_double_isr_back
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_pheno/madgraph_data/diphoton_double_isr_back
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_pheno/madgraph_data/diphoton_double_isr_back
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_pheno/madgraph_data/diphoton_double_isr_back
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_pheno/madgraph_data/diphoton_double_isr_back
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_pheno/madgraph_data/diphoton_double_isr_back
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># 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>define ax = 9000005
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 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[1].xmin = 0
ma5>set selection[1].xmax = 2000
ma5>set selection[1].nbins = 200
ma5>set selection[1].rank = PTordering
ma5>set selection[1].titleX = "p_{T}[j_{1}] (GeV)"
ma5>set selection[2].xmin = -8
ma5>set selection[2].xmax = 8
ma5>set selection[2].nbins = 160
ma5>set selection[2].rank = PTordering
ma5>set selection[2].titleX = "#eta[j_{1}]"
ma5>set selection[3].xmin = -3.2
ma5>set selection[3].xmax = 3.2
```

```
ma5>set selection[3].nbins = 64
ma5>set selection[3].rank = PTordering
ma5>set selection[3].titleX = "#phi[j_{1}]"
ma5>set selection[4].xmin = 0
ma5>set selection[4].xmax = 1000
ma5>set selection[4].nbins = 100
ma5>set selection[4].rank = PTordering
ma5>set selection[4].titleX = "p_{T}[j_{2}] (GeV)"
ma5>set selection[5].xmin = -8
ma5>set selection[5].xmax = 8
ma5>set selection[5].nbins = 160
ma5>set selection[5].rank = PTordering
ma5>set selection[5].titleX = "#eta[j_{2}]"
ma5>set selection[6].xmin = -3.2
ma5>set selection[6].xmax = 3.2
ma5>set selection[6].nbins = 64
ma5>set selection[6].rank = PTordering
ma5>set selection[6].titleX = "#phi[j_{2}]"
ma5>set selection[7].xmin = 0
ma5>set selection[7].xmax = 15
ma5>set selection[7].nbins = 75
ma5>set selection[7].rank = PTordering
ma5>set selection[7].titleX = "#DeltaR[j_{1},j_{2}]"
ma5>set selection[8].xmin = 0
ma5>set selection[8].xmax = 8000
ma5>set selection[8].nbins = 160
ma5>set selection[8].rank = PTordering
ma5>set selection[8].titleX = "M[j_{1},j_{2}] (GeV)"
ma5>set selection[9].xmin = -15
ma5>set selection[9].xmax = 15
ma5>set selection[9].titleX = "#Delta#eta(j_{1},j_{2})"
ma5>set selection[10].xmin = 0
ma5>set selection[10].xmax = 4000
ma5>set selection[10].nbins = 400
ma5>set selection[10].rank = PTordering
ma5>set selection[10].titleX = "M[a_{1},a_{2}] (GeV)"
ma5>set selection[11].xmin = 0
ma5>set selection[11].xmax = 2000
ma5>set selection[11].nbins = 80
ma5>set selection[11].rank = PTordering
ma5>set selection[11].titleX = "p_{T}[a_{1}]"
ma5>set selection[12].xmin = 0
ma5>set selection[12].xmax = 2000
ma5>set selection[12].nbins = 400
ma5>set selection[12].rank = PTordering
ma5>set selection[12].titleX = "p_{T}[a_{2}] (GeV)"
ma5>set selection[13].xmin = 0
ma5>set selection[13].xmax = 4000
ma5>set selection[13].nbins = 80
```

```
ma5>set selection[13].rank = PTordering
ma5>set selection[13].titleX = "THT"
ma5>set selection[14].xmin = 0
ma5>set selection[14].xmax = 1000
ma5>set selection[14].nbins = 200
ma5>set selection[14].rank = PTordering
ma5>set selection[14].titleX = "MET"
ma5>set selection[15].xmin = 0
ma5>set selection[15].xmax = 8000
ma5>set selection[15].nbins = 80
ma5>set selection[15].rank = PTordering
ma5>set selection[15].titleX = "TET"
ma5>submit no_cuts
```

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_pheno/-optimization/ma_scripts .
- 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_pheno/-madgraph_data/axion_signal/-axion_signal_gurrola_cuts_1MeV.ll	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_pheno/-optimization/ma_scripts .
- 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_pheno/madgraph_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_pheno/-optimization/ma_scripts .
- 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_pheno/madgraph_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_pheno/-optimization/ma_scripts .
- 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_pheno/madgraph_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_pheno/-optimization/ma_scripts .
- 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_pheno/madgraph_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_pheno/-optimization/ma_scripts .
- 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_pheno/madgraph_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_pheno/-optimization/ma_scripts .
- 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_pheno/madgraph_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_pheno/-optimization/ma_scripts .
- 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_pheno/madgraph_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_pheno/-optimization/ma_scripts .
- 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_pheno/madgraph_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_pheno/-optimization/ma_scripts .
- 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_pheno/madgraph_data/-diphoton_double_isr_background_ 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_pheno/-optimization/ma_scripts .
- 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_pheno/madgraph_data/-diphoton_double_isr_background_ 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_pheno/-optimization/ma_scripts .
- 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_pheno/madgraph_data/-diphoton_double_isr_background_ 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_pheno/-optimization/ma_scripts .
- 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_pheno/madgraph_data/-diphoton_double_isr_background_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_pheno/-optimization/ma_scripts .
- 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_pheno/madgraph_data/-diphoton_double_isr_background_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_pheno/-optimization/ma_scripts .
- 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_pheno/madgraph_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_pheno/-optimization/ma_scripts .
- 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_pheno/madgraph_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_pheno/-optimization/ma_scripts .
- 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_pheno/madgraph_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 Histogram 1

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	4094	1.0	445.82	317.0	0.0	0.1235
bg_vbf_0_100	12150	1.0	43.2985	11.12	0.0	0.0
bg_vbf_100_20	9695	1.0	86.3826	20.39	0.0	0.0
bg_vbf_200_40	5413	1.0	159.529	38.29	0.0	0.0
bg_vbf_400_60	986	1.0	274.713	51.11	0.0	0.0
bg_vbf_600_80	252	1.0	386.5	64.86	0.0	0.0
bg_vbf_800_12	114	1.0	524.651	93.71	0.0	0.0
bg_vbf_1200_1	20.6	1.0	738.359	109.6	0.0	0.0
bg_vbf_1600_i	7.66	1.0	1048.57	221.9	0.0	0.4884
bg_dip_0_100	2710844	1.0	40.686	11.76	0.0	0.0
bg_dip_100_20	1095361	1.0	82.4526	20.05	0.0	0.0
bg_dip_200_40	239548	1.0	156.478	38.77	0.0	0.0
bg_dip_400_60	28798	1.0	273.736	54.14	0.0	0.0
bg_dip_600_80	6674	1.0	383.447	66.67	0.0	0.0
bg_dip_800_12	2942	1.0	518.277	91.07	0.0	0.0
bg_dip_1200_1	513	1.0	728.693	100.2	0.0	0.0
bg_dip_1600_i	187	1.0	1036.3	211.6	0.0	0.4069

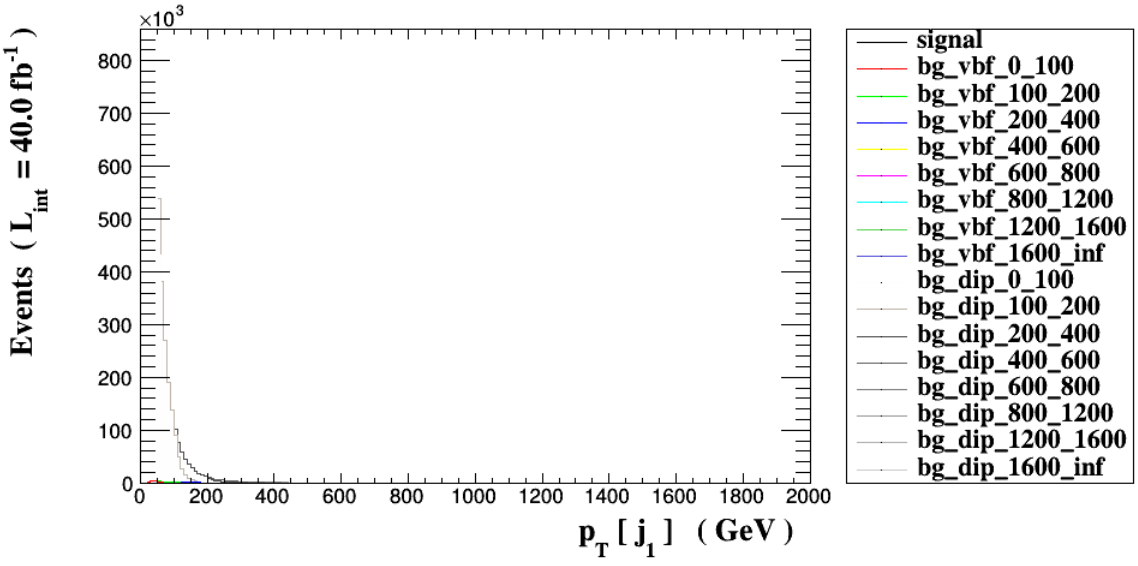

Figure 1.

3.2 Histogram 2

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	4094	1.0	-0.0023996	1.616	0.0	0.0
bg_vbf_0_100	12150	1.0	0.000371015	2.059	0.0	0.0
bg_vbf_100_20	9695	1.0	0.00372318	2.194	0.0	0.0
bg_vbf_200_40	5413	1.0	0.00194759	1.96	0.0	0.0
bg_vbf_400_60	986	1.0	-0.00101336	1.681	0.0	0.0
bg_vbf_600_80	252	1.0	0.000528588	1.498	0.0	0.0
bg_vbf_800_12	114	1.0	-0.00311756	1.329	0.0	0.0
bg_vbf_1200_1	20.6	1.0	-0.000172131	1.134	0.0	0.0
bg_vbf_1600_i	7.66	1.0	0.00127081	0.9541	0.0	0.0
bg_dip_0_100	2710844	1.0	-0.000628973	1.791	0.0	0.0
bg_dip_100_20	1095361	1.0	0.00112025	1.645	0.0	0.0
bg_dip_200_40	239548	1.0	-0.000638999	1.463	0.0	0.0
bg_dip_400_60	28798	1.0	-0.0017681	1.278	0.0	0.0
bg_dip_600_80	6674	1.0	-0.00486777	1.156	0.0	0.0
bg_dip_800_12	2942	1.0	0.00137964	1.052	0.0	0.0
bg_dip_1200_1	513	1.0	-0.00486293	0.9226	0.0	0.0
bg_dip_1600_i	187	1.0	-0.0010731	0.8	0.0	0.0

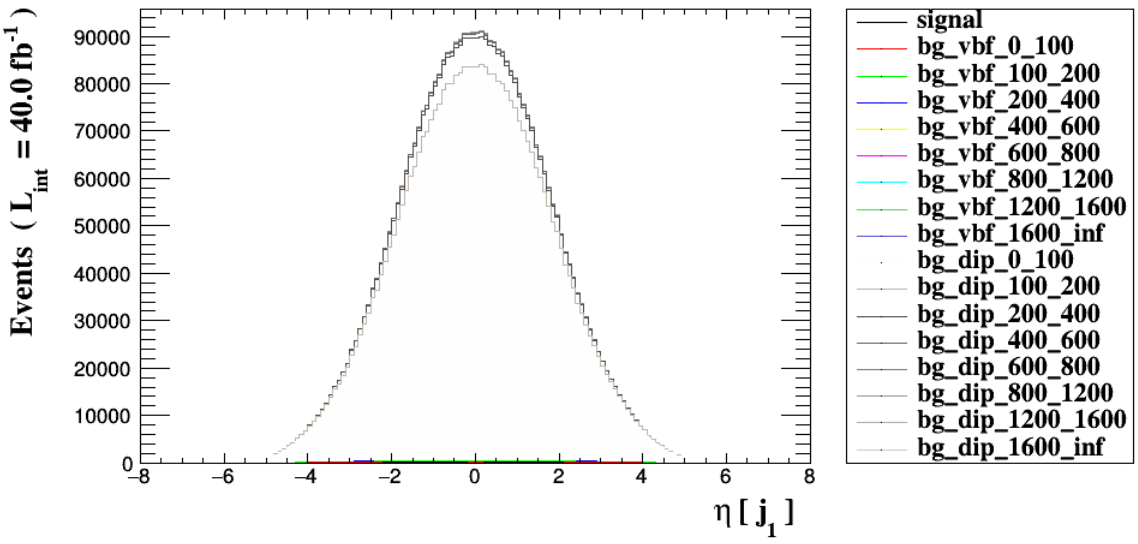

Figure 2.

3.3 Histogram 3

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	4094	1.0	0.00102738	1.813	0.0	0.0
bg_vbf_0_100	12150	1.0	0.00412621	1.813	0.0	0.0
bg_vbf_100_20	9695	1.0	-0.00114327	1.814	0.0	0.0
bg_vbf_200_40	5413	1.0	0.00195755	1.814	0.0	0.0
bg_vbf_400_60	986	1.0	-0.00347712	1.813	0.0	0.0
bg_vbf_600_80	252	1.0	-0.000970243	1.813	0.0	0.0
bg_vbf_800_12	114	1.0	-0.00348235	1.813	0.0	0.0
bg_vbf_1200_1	20.6	1.0	0.00205456	1.813	0.0	0.0
bg_vbf_1600_i	7.66	1.0	0.00218185	1.813	0.0	0.0
bg_dip_0_100	2710844	1.0	0.000565782	1.815	0.0	0.0
bg_dip_100_20	1095361	1.0	0.000302315	1.815	0.0	0.0
bg_dip_200_40	239548	1.0	-0.00160784	1.813	0.0	0.0
bg_dip_400_60	28798	1.0	-0.0021849	1.813	0.0	0.0
bg_dip_600_80	6674	1.0	0.00111123	1.814	0.0	0.0
bg_dip_800_12	2942	1.0	0.000382954	1.814	0.0	0.0
bg_dip_1200_1	513	1.0	9.82053e-05	1.814	0.0	0.0
bg_dip_1600_i	187	1.0	0.00144174	1.814	0.0	0.0

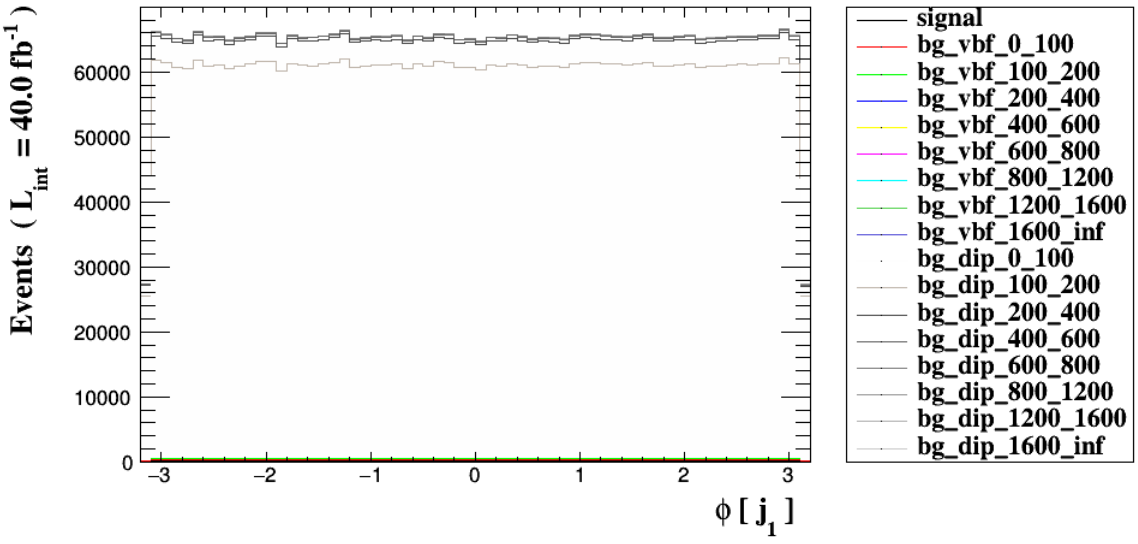

Figure 3.

3.4 Histogram 4

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	4094	1.0	161.87	136.0	0.0	0.0446
bg_vbf_0_100	12150	1.0	29.7897	6.782	0.0	0.0
bg_vbf_100_20	9695	1.0	55.7792	17.23	0.0	0.0
bg_vbf_200_40	5413	1.0	111.095	32.99	0.0	0.0
bg_vbf_400_60	986	1.0	201.201	47.92	0.0	0.0
bg_vbf_600_80	252	1.0	293.807	62.95	0.0	0.0
bg_vbf_800_12	114	1.0	415.011	90.61	0.0	0.0
bg_vbf_1200_1	20.6	1.0	613.828	108.5	0.0	0.0
bg_vbf_1600_i	7.66	1.0	917.972	221.8	0.0	25.12
bg_dip_0_100	2710844	1.0	27.8531	6.44	0.0	0.0
bg_dip_100_20	1095361	1.0	51.3191	16.24	0.0	0.0
bg_dip_200_40	239548	1.0	105.003	34.49	0.0	0.0
bg_dip_400_60	28798	1.0	200.18	52.16	0.0	0.0
bg_dip_600_80	6674	1.0	296.396	65.67	0.0	0.0
bg_dip_800_12	2942	1.0	421.324	89.31	0.0	0.0
bg_dip_1200_1	513	1.0	623.411	99.84	0.0	0.0
bg_dip_1600_i	187	1.0	926.288	210.5	0.0	25.44

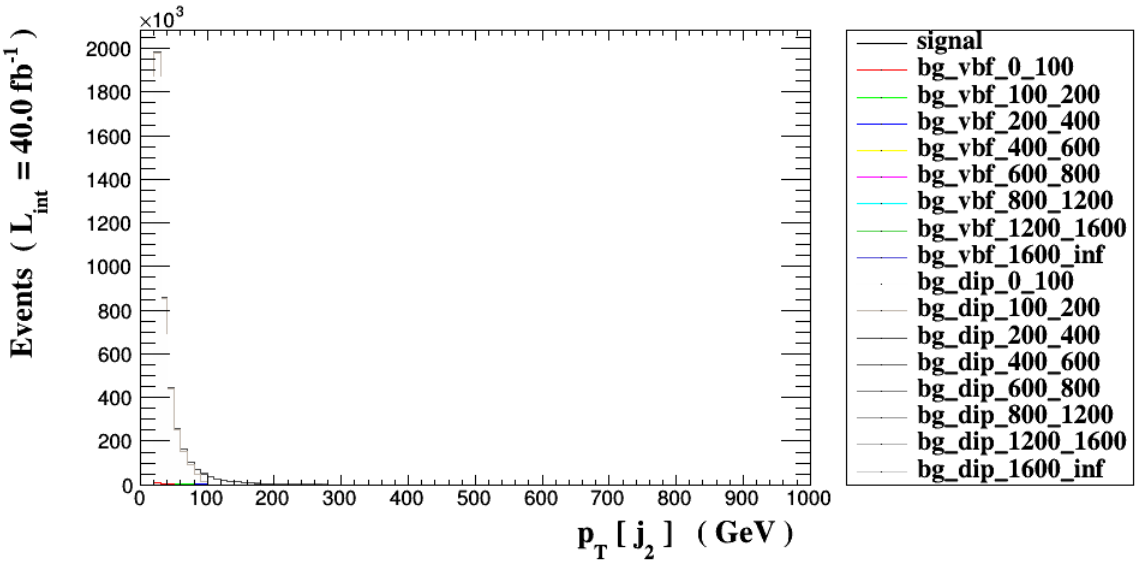

Figure 4.

3.5 Histogram 5

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	4094	1.0	0.00500696	2.329	0.0	0.0
bg_vbf_0_100	12150	1.0	-0.0012127	2.073	0.0	0.0
bg_vbf_100_20	9695	1.0	-0.00624445	2.309	0.0	0.0
bg_vbf_200_40	5413	1.0	0.00023751	2.126	0.0	0.0
bg_vbf_400_60	986	1.0	-0.000763309	1.861	0.0	0.0
bg_vbf_600_80	252	1.0	-0.00167246	1.666	0.0	0.0
bg_vbf_800_12	114	1.0	-0.000468537	1.473	0.0	0.0
bg_vbf_1200_1	20.6	1.0	0.000592645	1.238	0.0	0.0
bg_vbf_1600_i	7.66	1.0	-0.00207042	1.017	0.0	0.0
bg_dip_0_100	2710844	1.0	0.00019908	1.748	0.0	0.0
bg_dip_100_20	1095361	1.0	-0.00179844	1.594	0.0	0.0
bg_dip_200_40	239548	1.0	-0.00217858	1.442	0.0	0.0
bg_dip_400_60	28798	1.0	-0.000407628	1.289	0.0	0.0
bg_dip_600_80	6674	1.0	-0.000290936	1.181	0.0	0.0
bg_dip_800_12	2942	1.0	0.00123653	1.078	0.0	0.0
bg_dip_1200_1	513	1.0	-0.000424243	0.9457	0.0	0.0
bg_dip_1600_i	187	1.0	0.000907795	0.8179	0.0	0.0

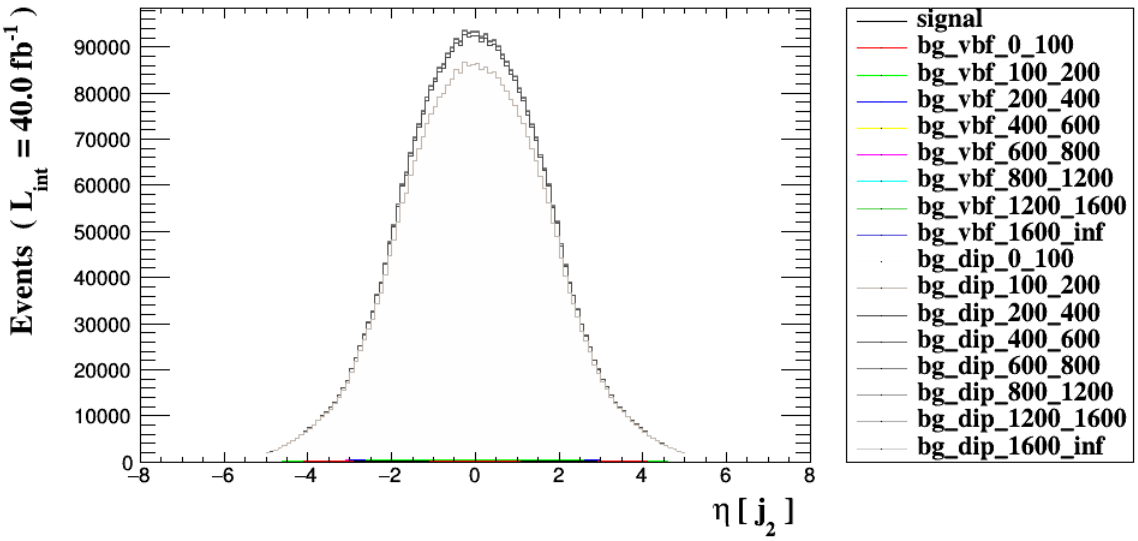
Events (L_{int} = 40.0 fb^{-1})
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
−8
−6
−4
−2
0
2
4
6
8
η [j_2]
signal
bg_vbf_0_100
bg_vbf_100_200
bg_vbf_200_400
bg_vbf_400_600
bg_vbf_600_800
bg_vbf_800_1200
bg_vbf_1200_1600
bg_vbf_1600_inf
bg_dip_0_100
bg_dip_100_200
bg_dip_200_400
bg_dip_400_600
bg_dip_600_800
bg_dip_800_1200
bg_dip_1200_1600
bg_dip_1600_inf

Figure 5.

3.6 Histogram 6

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	4094	1.0	-0.00274458	1.814	0.0	0.0
bg_vbf_0_100	12150	1.0	-0.000390721	1.815	0.0	0.0
bg_vbf_100_20	9695	1.0	-0.000748165	1.814	0.0	0.0
bg_vbf_200_40	5413	1.0	-0.00148399	1.814	0.0	0.0
bg_vbf_400_60	986	1.0	0.00309107	1.814	0.0	0.0
bg_vbf_600_80	252	1.0	0.000470979	1.815	0.0	0.0
bg_vbf_800_12	114	1.0	0.000124126	1.813	0.0	0.0
bg_vbf_1200_1	20.6	1.0	-0.00342189	1.815	0.0	0.0
bg_vbf_1600_i	7.66	1.0	-0.00282812	1.814	0.0	0.0
bg_dip_0_100	2710844	1.0	0.000242632	1.812	0.0	0.0
bg_dip_100_20	1095361	1.0	0.000855811	1.814	0.0	0.0
bg_dip_200_40	239548	1.0	0.000682802	1.815	0.0	0.0
bg_dip_400_60	28798	1.0	9.86323e-05	1.814	0.0	0.0
bg_dip_600_80	6674	1.0	-0.00254972	1.815	0.0	0.0
bg_dip_800_12	2942	1.0	-0.000758074	1.813	0.0	0.0
bg_dip_1200_1	513	1.0	-0.00202378	1.813	0.0	0.0
bg_dip_1600_i	187	1.0	0.00235585	1.814	0.0	0.0

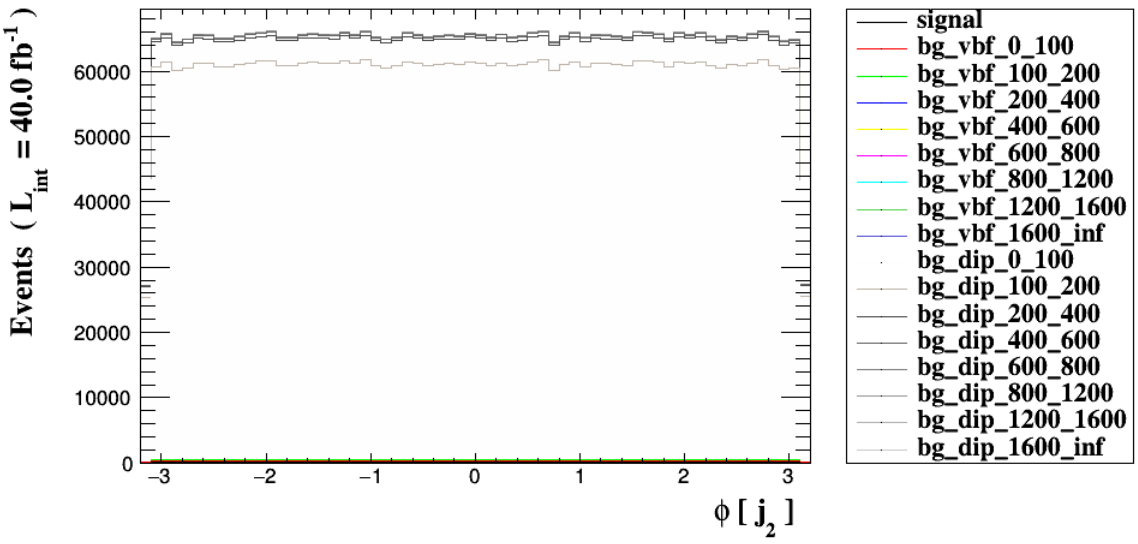

Figure 6.

3.7 Histogram 7

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	4094	1.0	4.02835	1.056	0.0	0.0
bg_vbf_0_100	12150	1.0	3.6437	1.351	0.0	0.0
bg_vbf_100_20	9695	1.0	4.43942	1.431	0.0	0.0
bg_vbf_200_40	5413	1.0	4.36935	1.146	0.0	0.0
bg_vbf_400_60	986	1.0	4.1046	0.9149	0.0	0.0
bg_vbf_600_80	252	1.0	3.92394	0.7774	0.0	0.0
bg_vbf_800_12	114	1.0	3.75769	0.6598	0.0	0.0
bg_vbf_1200_1	20.6	1.0	3.58471	0.5261	0.0	0.0
bg_vbf_1600_i	7.66	1.0	3.44779	0.4108	0.0	0.0
bg_dip_0_100	2710844	1.0	3.17806	0.938	0.0	0.0
bg_dip_100_20	1095361	1.0	3.22987	0.8214	0.0	0.0
bg_dip_200_40	239548	1.0	3.25054	0.7204	0.0	0.0
bg_dip_400_60	28798	1.0	3.27012	0.6166	0.0	0.0
bg_dip_600_80	6674	1.0	3.27863	0.5424	0.0	0.0
bg_dip_800_12	2942	1.0	3.28404	0.4723	0.0	0.0
bg_dip_1200_1	513	1.0	3.2807	0.3852	0.0	0.0
bg_dip_1600_i	187	1.0	3.26767	0.3024	0.0	0.0

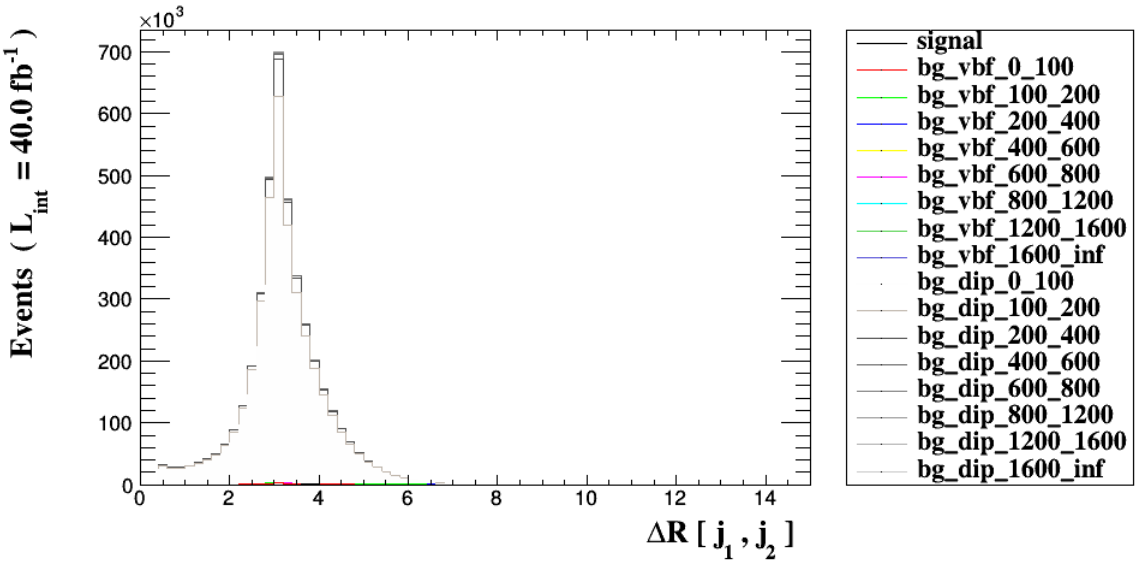

Figure 7.

3.8 Histogram 8

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	4094	1.0	1376.2	772.9	0.0	0.0
bg_vbf_0_100	12150	1.0	204.768	298.2	0.0	0.0
bg_vbf_100_20	9695	1.0	559.274	525.7	0.0	0.0
bg_vbf_200_40	5413	1.0	880.56	672.7	0.0	0.0003051
bg_vbf_400_60	986	1.0	1208.33	762.5	0.0	0.0006
bg_vbf_600_80	252	1.0	1464.21	805.7	0.0	0.0014
bg_vbf_800_12	114	1.0	1732.18	822.2	0.0	0.002495
bg_vbf_1200_1	20.6	1.0	2125.24	815.9	0.0	0.002831
bg_vbf_1600_i	7.66	1.0	2691.74	857.1	0.0	0.01037
bg_dip_0_100	2710844	1.0	108.441	80.26	0.0	0.0
bg_dip_100_20	1095361	1.0	194.945	125.9	0.0	0.0
bg_dip_200_40	239548	1.0	358.574	197.8	0.0	0.0
bg_dip_400_60	28798	1.0	622.657	280.2	0.0	0.0
bg_dip_600_80	6674	1.0	871.188	339.5	0.0	0.0
bg_dip_800_12	2942	1.0	1177.62	409.7	0.0	0.0
bg_dip_1200_1	513	1.0	1647.72	468.6	0.0	0.0
bg_dip_1600_i	187	1.0	2311.53	635.5	0.0	0.0001923

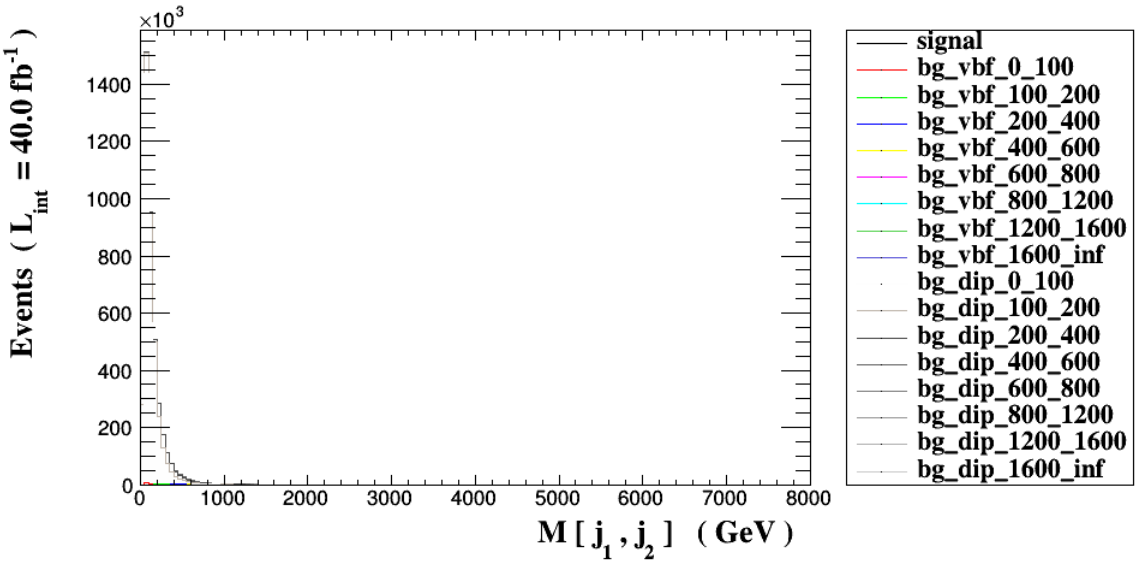

Figure 8.

3.9 Histogram 9

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	4094	1.0	-0.00740656	3.704	0.0	0.0
bg_vbf_0_100	12150	1.0	0.00158372	2.865	0.0	0.0
bg_vbf_100_20	9695	1.0	0.00996763	3.823	0.0	0.0
bg_vbf_200_40	5413	1.0	0.00171008	3.551	0.0	0.0
bg_vbf_400_60	986	1.0	-0.000250051	3.085	0.0	0.0
bg_vbf_600_80	252	1.0	0.00220104	2.753	0.0	0.0
bg_vbf_800_12	114	1.0	-0.00264902	2.428	0.0	0.0
bg_vbf_1200_1	20.6	1.0	-0.000764776	2.046	0.0	0.0
bg_vbf_1600_i	7.66	1.0	0.00334122	1.694	0.0	0.0
bg_dip_0_100	2710844	1.0	-0.000828053	2.094	0.0	0.0
bg_dip_100_20	1095361	1.0	0.00291869	1.936	0.0	0.0
bg_dip_200_40	239548	1.0	0.00153958	1.779	0.0	0.0
bg_dip_400_60	28798	1.0	-0.00136047	1.634	0.0	0.0
bg_dip_600_80	6674	1.0	-0.00457683	1.538	0.0	0.0
bg_dip_800_12	2942	1.0	0.000143111	1.448	0.0	0.0
bg_dip_1200_1	513	1.0	-0.00443869	1.327	0.0	0.0
bg_dip_1600_i	187	1.0	-0.0019809	1.196	0.0	0.0

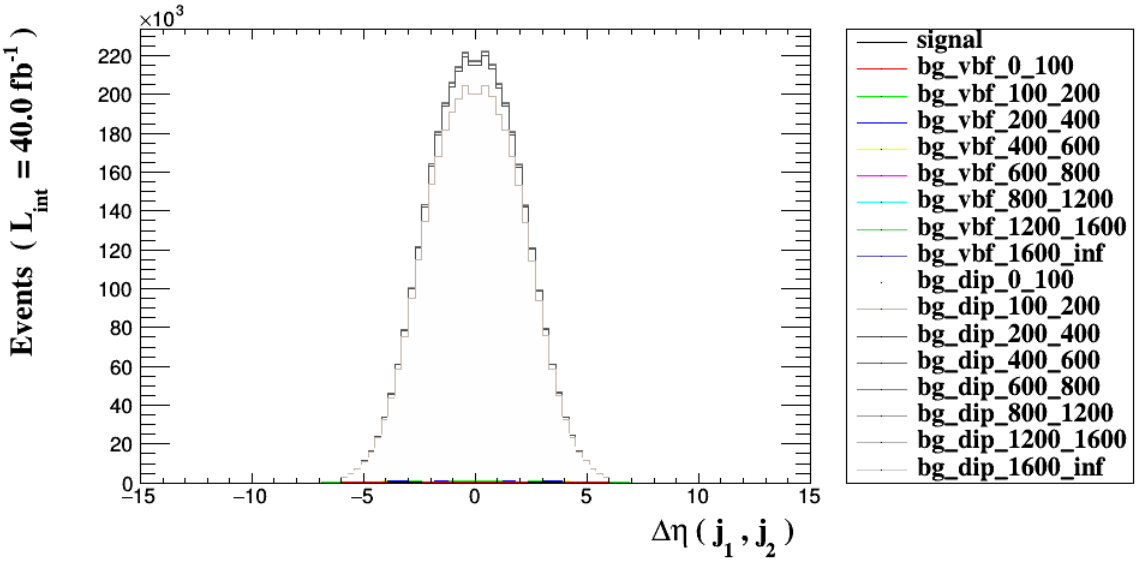

Figure 9.

3.10 Histogram 10

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	4094	1.0	950.206	725.5	0.0	0.3972
bg_vbf_0_100	12150	1.0	49.9447	41.51	0.0	0.0
bg_vbf_100_20	9695	1.0	72.2084	67.24	0.0	0.0
bg_vbf_200_40	5413	1.0	93.4511	94.54	0.0	0.0
bg_vbf_400_60	986	1.0	117.645	125.2	0.0	0.0
bg_vbf_600_80	252	1.0	132.708	146.3	0.0	0.0
bg_vbf_800_12	114	1.0	143.854	162.7	0.0	0.0
bg_vbf_1200_1	20.6	1.0	153.532	177.9	0.0	0.000629
bg_vbf_1600_i	7.66	1.0	159.525	184.7	0.0	0.0007418
bg_dip_0_100	2710844	1.0	46.4963	35.46	0.0	0.0
bg_dip_100_20	1095361	1.0	58.0352	53.53	0.0	0.0
bg_dip_200_40	239548	1.0	76.6639	79.81	0.0	0.0
bg_dip_400_60	28798	1.0	96.3455	109.6	0.0	9.609e-05
bg_dip_600_80	6674	1.0	109.413	128.8	0.0	0.0
bg_dip_800_12	2942	1.0	120.0	144.2	0.0	0.0
bg_dip_1200_1	513	1.0	131.581	157.3	0.0	0.0
bg_dip_1600_i	187	1.0	143.683	167.2	0.0	9.641e-05

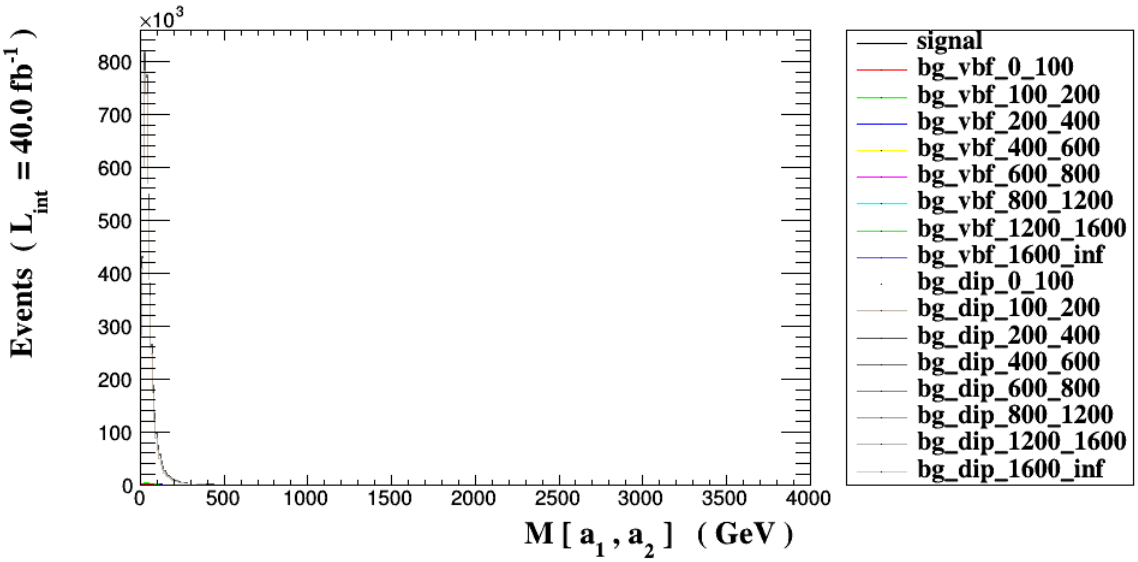

Figure 10.

3.11 Histogram 11

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	4094	1.0	588.092	368.7	0.0	0.4184
bg_vbf_0_100	12150	1.0	29.2182	18.35	0.0	0.0
bg_vbf_100_20	9695	1.0	49.5585	34.8	0.0	0.0
bg_vbf_200_40	5413	1.0	73.7805	63.02	0.0	0.0
bg_vbf_400_60	986	1.0	107.933	105.3	0.0	0.0
bg_vbf_600_80	252	1.0	132.767	142.4	0.0	0.0
bg_vbf_800_12	114	1.0	154.271	182.2	0.0	0.0
bg_vbf_1200_1	20.6	1.0	172.927	223.8	0.0	0.0008386
bg_vbf_1600_i	7.66	1.0	181.168	246.2	0.0	0.07471
bg_dip_0_100	2710844	1.0	29.8081	19.13	0.0	0.0
bg_dip_100_20	1095361	1.0	46.2821	35.82	0.0	0.0
bg_dip_200_40	239548	1.0	70.6716	67.58	0.0	0.0
bg_dip_400_60	28798	1.0	97.6941	110.3	0.0	0.0
bg_dip_600_80	6674	1.0	114.634	141.7	0.0	0.0
bg_dip_800_12	2942	1.0	127.334	169.6	0.0	9.616e-05
bg_dip_1200_1	513	1.0	138.818	193.7	0.0	0.0002954
bg_dip_1600_i	187	1.0	146.263	199.0	0.0	0.04173

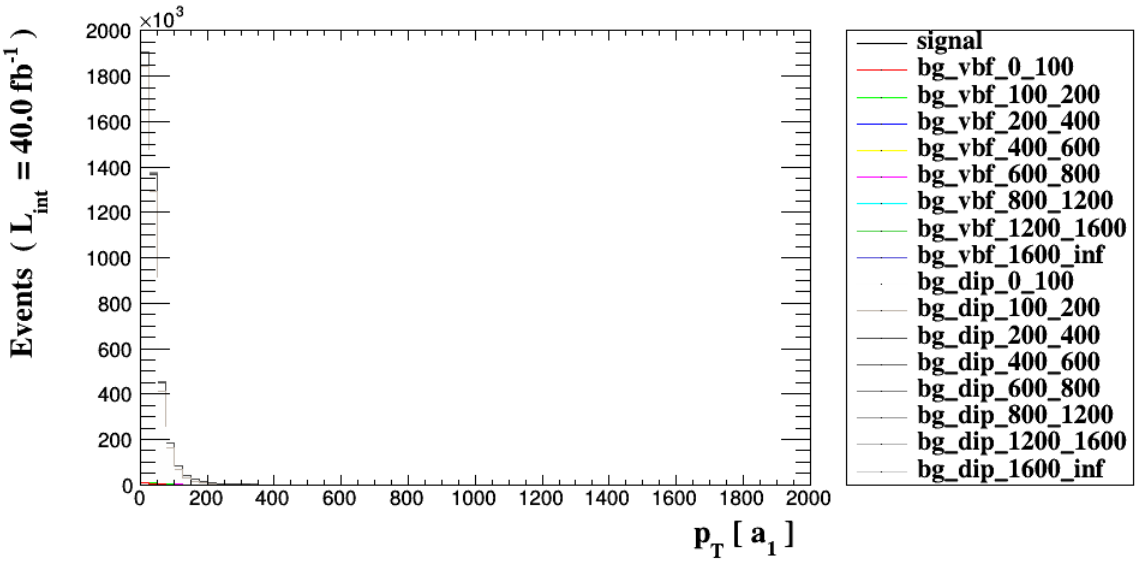

Figure 11.

3.12 Histogram 12

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

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	4094	1.0	334.941	290.0	0.0	0.1287
bg_vbf_0_100	12150	1.0	16.7975	10.54	0.0	0.0
bg_vbf_100_20	9695	1.0	21.7009	16.69	0.0	0.0
bg_vbf_200_40	5413	1.0	26.1576	23.66	0.0	0.0
bg_vbf_400_60	986	1.0	31.3191	32.61	0.0	0.0
bg_vbf_600_80	252	1.0	34.6235	38.99	0.0	0.0
bg_vbf_800_12	114	1.0	37.1184	44.65	0.0	0.0
bg_vbf_1200_1	20.6	1.0	39.4376	49.92	0.0	0.0
bg_vbf_1600_i	7.66	1.0	40.8098	52.8	0.0	0.0
bg_dip_0_100	2710844	1.0	16.4095	9.466	0.0	0.0
bg_dip_100_20	1095361	1.0	19.392	13.88	0.0	0.0
bg_dip_200_40	239548	1.0	23.2538	20.42	0.0	0.0
bg_dip_400_60	28798	1.0	27.0718	27.59	0.0	0.0
bg_dip_600_80	6674	1.0	29.4856	32.31	0.0	0.0
bg_dip_800_12	2942	1.0	31.4354	36.1	0.0	0.0
bg_dip_1200_1	513	1.0	33.6499	39.8	0.0	0.0
bg_dip_1600_i	187	1.0	35.6026	42.32	0.0	0.0

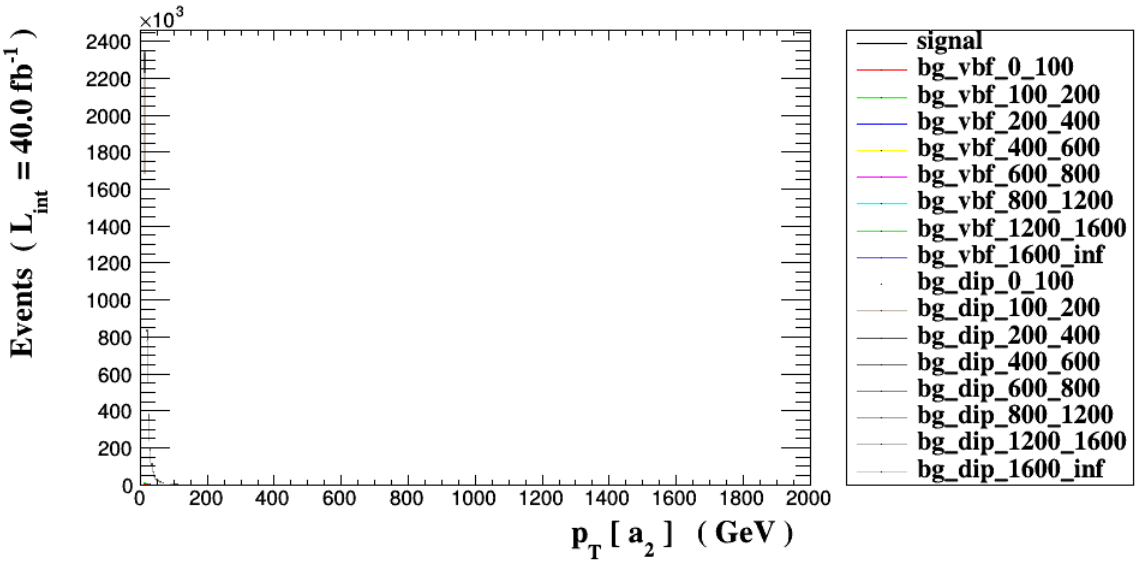

Figure 12.

3.13 Histogram 13

*** Plot: THT**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	4094	1.0	607.684	391.1	0.0	0.0
bg_vbf_0_100	12150	1.0	73.0879	14.72	0.0	0.0
bg_vbf_100_20	9695	1.0	142.161	28.33	0.0	0.0
bg_vbf_200_40	5413	1.0	270.622	53.34	0.0	0.0
bg_vbf_400_60	986	1.0	475.894	55.07	0.0	0.0
bg_vbf_600_80	252	1.0	680.199	56.48	0.0	0.0
bg_vbf_800_12	114	1.0	938.845	110.2	0.0	0.0
bg_vbf_1200_1	20.6	1.0	1349.44	125.4	0.0	0.0
bg_vbf_1600_i	7.66	1.0	1929.14	471.8	0.0	0.273
bg_dip_0_100	2710847	1.0	68.539	15.42	0.0	0.0
bg_dip_100_20	1095362	1.0	133.772	26.41	0.0	0.0
bg_dip_200_40	239548	1.0	261.481	50.79	0.0	0.0
bg_dip_400_60	28798	1.0	473.915	54.57	0.0	0.0
bg_dip_600_80	6674	1.0	679.837	55.82	0.0	0.0
bg_dip_800_12	2942	1.0	939.589	106.7	0.0	0.0
bg_dip_1200_1	513	1.0	1351.79	111.6	0.0	0.0
bg_dip_1600_i	187	1.0	1962.18	387.0	0.0	0.2515

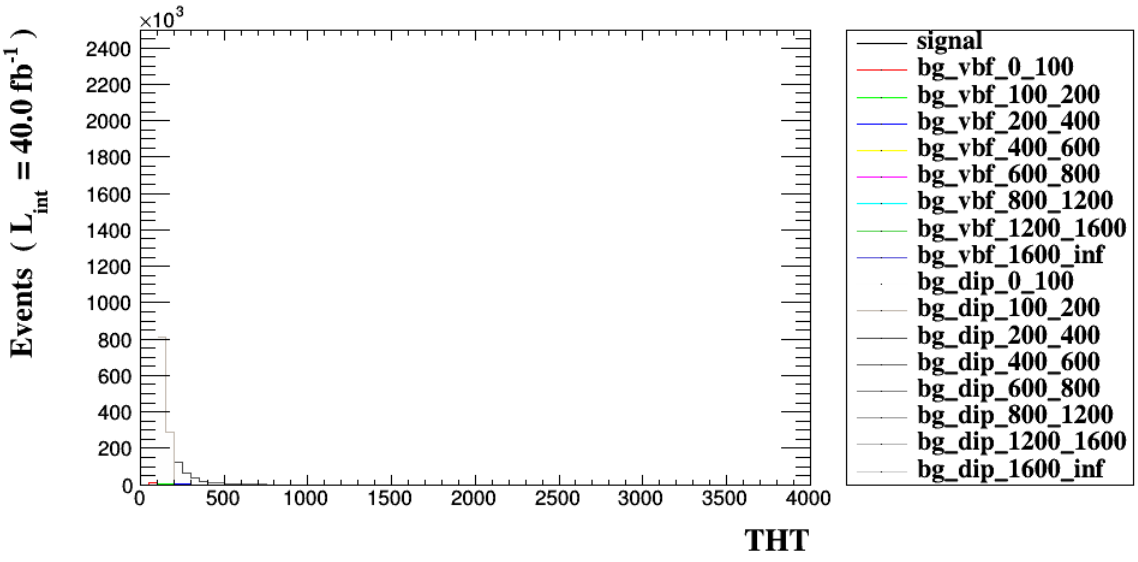

Figure 13.

3.14 Histogram 14

*** Plot: MET**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	4094	1.0	8.33075e-09	1.078e-08	0.0	0.0
bg_vbf_0_100	12150	1.0	5.87589e-10	4.167e-10	0.0	0.0
bg_vbf_100_20	9695	1.0	9.77311e-10	1.133e-09	0.0	0.0
bg_vbf_200_40	5413	1.0	3.24025e-09	2.224e-09	0.0	0.0
bg_vbf_400_60	986	1.0	4.5261e-09	2.611e-09	0.0	0.0
bg_vbf_600_80	252	1.0	4.90173e-09	2.72e-09	0.0	0.0
bg_vbf_800_12	114	1.0	5.15201e-09	2.983e-09	0.0	0.0
bg_vbf_1200_1	20.6	1.0	5.8088e-09	5.344e-09	0.0	0.0
bg_vbf_1600_i	7.66	1.0	1.2815e-08	1.633e-08	0.0	0.0
bg_dip_0_100	2710847	1.0	5.83304e-10	4.119e-10	0.0	0.0
bg_dip_100_20	1095362	1.0	9.17249e-10	1.079e-09	0.0	0.0
bg_dip_200_40	239548	1.0	3.1345e-09	2.199e-09	0.0	0.0
bg_dip_400_60	28798	1.0	4.43742e-09	2.58e-09	0.0	0.0
bg_dip_600_80	6674	1.0	4.80256e-09	2.678e-09	0.0	0.0
bg_dip_800_12	2942	1.0	5.06408e-09	3.037e-09	0.0	0.0
bg_dip_1200_1	513	1.0	5.59027e-09	4.834e-09	0.0	0.0
bg_dip_1600_i	187	1.0	1.25054e-08	1.605e-08	0.0	0.0

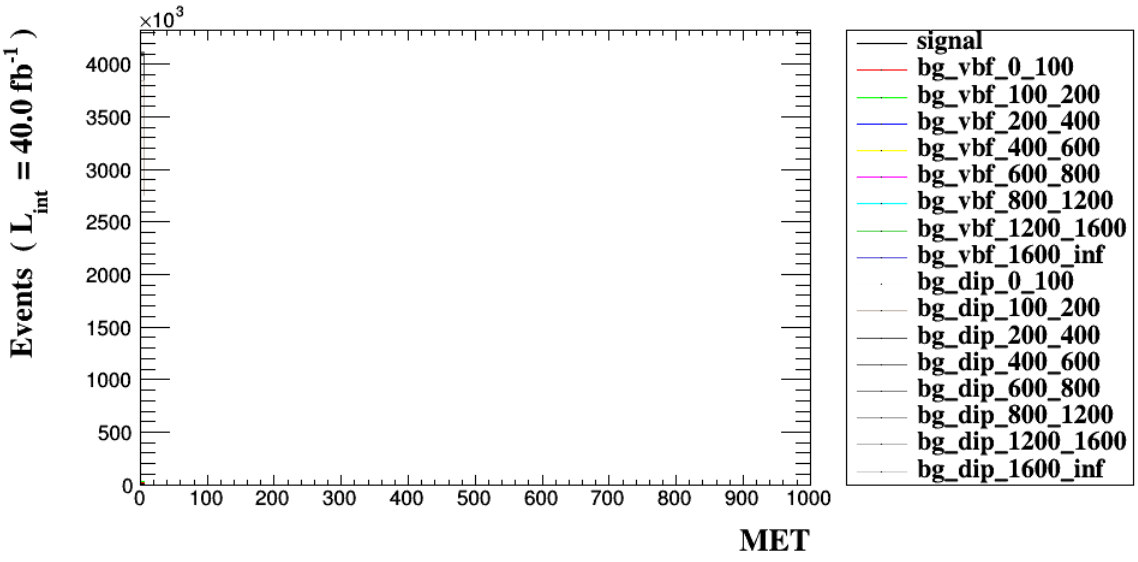

Figure 14.

3.15 Histogram 15

*** Plot: TET**

Dataset	Integral	Entries per event	Mean	RMS	% underflow	% overflow
signal	4094	1.0	1530.71	825.4	0.0	0.0001
bg_vbf_0_100	12150	1.0	119.104	33.34	0.0	0.0
bg_vbf_100_20	9695	1.0	213.42	57.37	0.0	0.0
bg_vbf_200_40	5413	1.0	370.559	100.3	0.0	0.0
bg_vbf_400_60	986	1.0	615.141	138.1	0.0	0.0
bg_vbf_600_80	252	1.0	847.563	173.8	0.0	0.0
bg_vbf_800_12	114	1.0	1130.07	235.9	0.0	0.0
bg_vbf_1200_1	20.6	1.0	1561.37	280.1	0.0	0.0
bg_vbf_1600_i	7.66	1.0	2146.89	558.2	0.0	0.0
bg_dip_0_100	2710847	1.0	114.757	32.41	0.0	0.0
bg_dip_100_20	1095362	1.0	199.446	55.32	0.0	0.0
bg_dip_200_40	239548	1.0	355.406	98.44	0.0	0.0
bg_dip_400_60	28798	1.0	598.681	138.0	0.0	0.0
bg_dip_600_80	6674	1.0	823.955	168.1	0.0	0.0
bg_dip_800_12	2942	1.0	1098.36	217.0	0.0	0.0
bg_dip_1200_1	513	1.0	1524.22	240.1	0.0	0.0
bg_dip_1600_i	187	1.0	2144.01	446.2	0.0	0.0

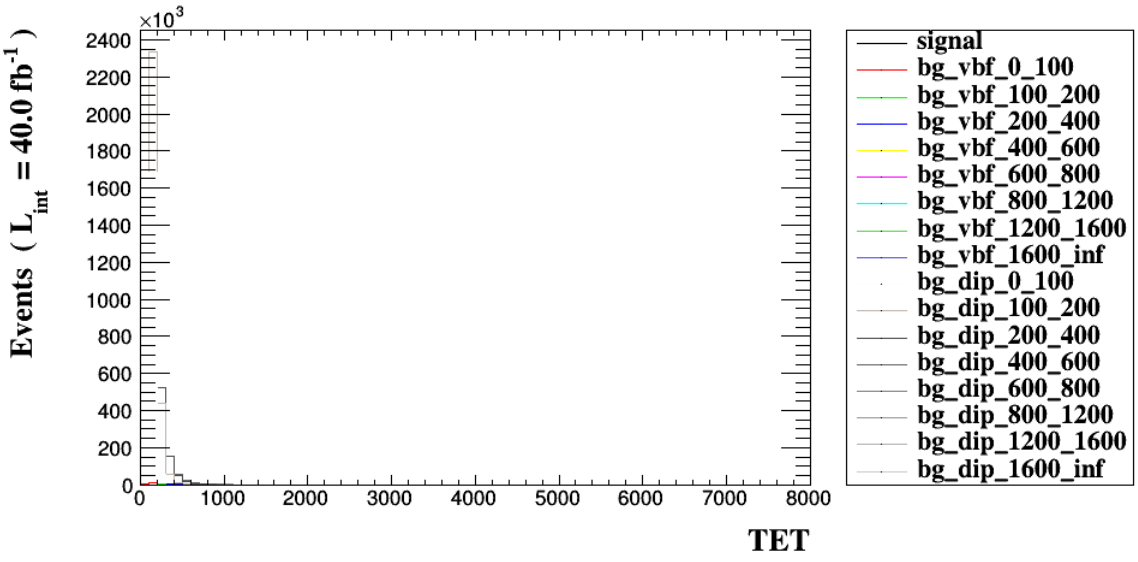

Figure 15.