

# The LaTeX report

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## Contents

<b>1</b>	<b>Setup</b>	<b>2</b>
1.1	Command history	2
1.2	Configuration	4
<b>2</b>	<b>Datasets</b>	<b>5</b>
2.1	signal	5
2.2	bg_vbf_0_100	5
2.3	bg_vbf_100_200	5
2.4	bg_vbf_200_400	6
2.5	bg_vbf_400_600	6
2.6	bg_vbf_600_800	7
2.7	bg_vbf_800_1200	7
2.8	bg_vbf_1200_1600	8
2.9	bg_vbf_1600_inf	8
2.10	bg_dip_0_100	8
2.11	bg_dip_100_200	9
2.12	bg_dip_200_400	9
2.13	bg_dip_400_600	10
2.14	bg_dip_600_800	10
2.15	bg_dip_800_1200	10
2.16	bg_dip_1200_1600	11
2.17	bg_dip_1600_inf	11
<b>3</b>	<b>Histos and cuts</b>	<b>12</b>
3.1	Cut 1	12
3.2	Cut 2	13
<b>4</b>	<b>Summary</b>	<b>14</b>
4.1	Cut-flow charts	14

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# 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 # 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_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
```

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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

```

```

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>define ax = 9000005
ma5># apply selections
ma5>select PT(a[1]) > 350 and M(a[1] a[2]) > 400
ma5>select (sdETA(jets[1] jets[2]) > 3.6 or sdETA(jets[1] jets[2]) < -3.6) and M(jets[1]
jets[2]) > 1500
ma5>submit second_analysis_sdEta3.6_mjj1500

```

## 1.2 Configuration

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

## 2 Datasets

### 2.1 signal

- Samples stored in the directory: [/Users/elijahsheridan/MG5\\_aMC\\_v2\\_6\\_5/axion\\_pheno/-optimization](#) .
- 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.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\\_pheno/-optimization](#) .
- 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_100	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](#) .
- Sample consisting of: [background](#) events.
- Generated events: [965662](#) events.

- Normalization to the luminosity: 9695 $\pm$ 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 .
- Sample consisting of: background events.
- Generated events: 984165 events.
- Normalization to the luminosity: 5413 $\pm$ 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 .
- Sample consisting of: background events.
- Generated events: 1000000 events.
- Normalization to the luminosity: 986 $\pm$ 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](#) .
- 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](#) .
- 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](#) .
- 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](#) .
- 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](#) .
- 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_c 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](#) .
- 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_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\\_pheno/-optimization](#) .
- 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_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\\_pheno/-optimization](#) .
- 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 (%)
<a href="#">/Users/elijahsheridan/-MG5_aMC_v2_6_5/-axion_pheno/madgraph_data/-diphoton_double_isr_background_cmerged_lhe/-diphoton_double_isr_background_l</a>	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](#) .
- 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 (%)
<a href="#">/Users/elijahsheridan/-MG5_aMC_v2_6_5/-axion_pheno/madgraph_data/-diphoton_double_isr_background_cmerged_lhe/-diphoton_double_isr_background_l</a>	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](#) .
- 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 .
- 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 .
- 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 Cut 1

\* **Cut:** select  $P_T ( a[1] ) > 350.0$  and  $M ( a[1] a[2] ) > 400.0$

Dataset	Events kept: K	Rejected events: R	Efficiency: K / (K + R)	Cumul. efficiency: K / Initial
signal	2606.2 +/- 30.8	1487.9 +/- 30.8	0.63657 +/- 0.00752	0.63657 +/- 0.00752
bg_vbf_0_10	0.377 +/- 0.614	12149.9 +/- 23.1	3.10e-05 +/- 5.05e-05	3.10e-05 +/- 5.05e-05
bg_vbf_100_	2.39 +/- 1.55	9692.9 +/- 16.7	0.000247 +/- 0.000159	0.000247 +/- 0.000159
bg_vbf_200_	10.50 +/- 3.24	5402.8 +/- 11.4	0.001939 +/- 0.000598	0.001939 +/- 0.000598
bg_vbf_400_	12.18 +/- 3.47	974.67 +/- 3.72	0.01234 +/- 0.00351	0.01234 +/- 0.00351
bg_vbf_600_	6.45 +/- 2.51	245.62 +/- 2.53	0.02560 +/- 0.00995	0.02560 +/- 0.00995
bg_vbf_800_	4.21 +/- 2.01	110.56 +/- 2.02	0.0366 +/- 0.0175	0.0366 +/- 0.0175
bg_vbf_1200_	0.925 +/- 0.940	19.670 +/- 0.941	0.0449 +/- 0.0456	0.0449 +/- 0.0456
bg_vbf_1600_	0.359 +/- 0.585	7.300 +/- 0.585	0.0469 +/- 0.0764	0.0469 +/- 0.0764
bg_dip_0_10	20.85 +/- 4.57	2710826 +/- 4613	7.69e-06 +/- 1.68e-06	7.69e-06 +/- 1.68e-06
bg_dip_100_	105.3 +/- 10.3	1095257 +/- 1526	9.62e-05 +/- 9.37e-06	9.62e-05 +/- 9.37e-06
bg_dip_200_	420.4 +/- 20.5	239128 +/- 413	1.75e-03 +/- 8.55e-05	1.75e-03 +/- 8.55e-05
bg_dip_400_	334.8 +/- 18.2	28463.9 +/- 54.7	0.011624 +/- 0.000632	0.011624 +/- 0.000632
bg_dip_600_	129.4 +/- 11.3	6545.0 +/- 29.3	0.01939 +/- 0.00169	0.01939 +/- 0.00169
bg_dip_800_	71.50 +/- 8.35	2870.8 +/- 9.7	0.02430 +/- 0.00284	0.02430 +/- 0.00284
bg_dip_1200_	14.45 +/- 3.75	499.05 +/- 4.54	0.0281 +/- 0.0073	0.0281 +/- 0.0073
bg_dip_1600_	5.74 +/- 2.36	182.04 +/- 2.37	0.0306 +/- 0.0126	0.0306 +/- 0.0126

### 3.2 Cut 2

\* Cut: select ( sdETA ( jets[1] jets[2] ) > 3.6 or sdETA ( jets[1] jets[2] ) < -3.6 ) and  
M ( jets[1] jets[2] ) > 1500.0

Dataset	Events kept: K	Rejected events: R	Efficiency: K / (K + R)	Cumul. efficiency: K / Initial
signal	430.5 +/- 19.6	2175.7 +/- 31.9	0.16517 +/- 0.00727	0.10514 +/- 0.00479
bg_vbf_0_10	0.0 +/- 0.0	0.377 +/- 0.614	0.0 +/- 0.0	0.0 +/- 0.0
bg_vbf_100_	0.161 +/- 0.401	2.23 +/- 1.49	0.0672 +/- 0.1620	1.66e-05 +/- 4.13e-05
bg_vbf_200_	2.08 +/- 1.44	8.4 +/- 2.9	0.198 +/- 0.123	0.000384 +/- 0.000266
bg_vbf_400_	3.66 +/- 1.91	8.52 +/- 2.91	0.300 +/- 0.131	0.00370 +/- 0.00193
bg_vbf_600_	1.91 +/- 1.38	4.54 +/- 2.11	0.30 +/- 0.18	0.00759 +/- 0.00547
bg_vbf_800_	0.829 +/- 0.907	3.38 +/- 1.81	0.197 +/- 0.194	0.00723 +/- 0.00791
bg_vbf_1200_	0.0695 +/- 0.2631	0.856 +/- 0.906	0.0751 +/- 0.2739	0.00337 +/- 0.01278
bg_vbf_1600_	0.00709 +/- 0.08417	0.352 +/- 0.579	0.0198 +/- 0.2324	0.000926 +/- 0.010991
bg_dip_0_10	0.0 +/- 0.0	20.85 +/- 4.57	0.0 +/- 0.0	0.0 +/- 0.0
bg_dip_100_	0.0 +/- 0.0	105.3 +/- 10.3	0.0 +/- 0.0	0.0 +/- 0.0
bg_dip_200_	1.84 +/- 1.36	418.5 +/- 20.5	0.00438 +/- 0.00322	7.69e-06 +/- 5.67e-06
bg_dip_400_	5.04 +/- 2.24	329.7 +/- 18.1	0.01505 +/- 0.00666	1.75e-04 +/- 7.79e-05
bg_dip_600_	2.60 +/- 1.61	126.8 +/- 11.2	0.0201 +/- 0.0123	0.000390 +/- 0.000242
bg_dip_800_	1.23 +/- 1.11	70.28 +/- 8.28	0.0172 +/- 0.0154	0.000417 +/- 0.000377
bg_dip_1200_	0.102 +/- 0.319	14.35 +/- 3.74	0.00706 +/- 0.02203	0.000199 +/- 0.000622
bg_dip_1600_	0.011 +/- 0.105	5.73 +/- 2.36	0.00192 +/- 0.01826	5.87e-05 +/- 5.59e-04

## 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: PT ( a[1] ) > 350.0 and M ( a[1] a[2] ) > 400	2606.2 +/- 30.8	1139.8 +/- 33.6	42.58 +/- 0.38
SEL: ( sdETA ( jets[1] jets[2] ) > 3.6 or sdETA (	430.5 +/- 19.6	19.54 +/- 4.42	20.292 +/- 0.493