Title

Subtitle

# Abstract

TOC

# Introduction

## Reweighting

## Applications

### Sherpa

### FeynRules

# SherpaWeight

## Developing SherpaWeight

## Using SherpaME

## Using SherpaWeight

# Effective Field Theory

## Implementing a UFO model for EFT in FeynRules

## Validating EFT model using WZ production

# Reweighting

## Comparison of reweighted EFT to SM for WZ-production

## Notes on reweighting using ROOT

### Scaling luminosity

### Reweighting histograms

# Optimal Observables

# Chosen observables for parton-level WZ-production

Table of selected observables. Description of range definition.

# Fitting EFT to SM for parton-level WZ-production

Confident that we have the reweighting tools to construct the observable plots for any defined set of EFT model parameters, we will now measure the fit characteristics of reweighting EFT to SM data at the parton-level. Specifically, we measure how well reweighted EFT data fits the SM data for each selected observable, using a fit algorithm to determine the EFT model parameters that fit best. This is done using the same parton-level WZ-production pseudo-data generated by Sherpa used previously.

The SM and EFT data samples both have 1M events. Their total cross-sections are 18.554 ± 0.016 pb for SM and 42.805 ± 0.038 pb for EFT. The data samples are scaled to a luminosity of 10 fb–1, and Asimov bin errors are used as discussed in 4.2.1.

Log-likelihood minimization is used to fit to event counted observables, and -minimization is used to fit to mean-observables. The results are shown in Table XXX.

Observables

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Observable** | **Type** | **Bin Range** | **Bins** | **Fit Bins a** | **Underflow**  **Count b** | **Overflow**  **Count b** |
| **PT(Z)** | count | 0 to 750 GeV/c | 150 | 150 | 0 | 8.2 |
| **M(WZ) =** | count | 0 to 3000 GeV/c2 | 150 | 142 | 0 | 6.3 |
| **y(Z)** | count | −5 to +5 | 100 | 98 | 0 | 0 |
| **O1(cWWW)** | count | −60000 to 7000 | 1000 | 1000 | 6.7 | 3.4 |
| **O2(cWWW)** | count | 0 to 2×1012 | 1000 | 1000 | 0 | 5.9 |
| **O1(cW)** | count | (−200 to 2)×104 | 1000 | 997 | 2.7 | 0 |
| **O2(cW)** | count | 0 to 6×1011 | 1000 | 1000 | 0 | 7.6 |
| **O1(cB)** | count | −800 to 5000 | 1000 | 996 | 1.5 | 8.2 |
| **O2(cB)** | count | 0 to 2×108 | 1000 | 1000 | 0 | 3.7 |
| **O1(cWWW) vs** | mean | 0 to 3000 GeV | 100 | 76 | 0 | 6.3 |
| **O2(cWWW) vs** | mean | 0 to 3000 GeV | 100 | 76 | 0 | 6.3 |
| **O1(cW) vs** | mean | 0 to 3000 GeV | 100 | 76 | 0 | 6.3 |
| **O2(cW) vs** | mean | 0 to 3000 GeV | 100 | 76 | 0 | 6.3 |
| **O1(cB) vs** | mean | 0 to 3000 GeV | 100 | 76 | 0 | 6.3 |
| **O2(cB) vs** | mean | 0 to 3000 GeV | 100 | 76 | 0 | 6.3 |

1. Fit skips bins with a zero error value. For mean observables, fit also skips bins with less than 10 effective events in either the SM or EFT sample prior to any luminosity scaling.
2. SM sample at 10 fb−1.

Fit Results

| Observable | EFT Parameter | Fit Single | | | Fit All | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Value  [10−6] | Error  [10−6] |  | Value  [10−6] | Error  [10−6] |  |
| PT(Z) | cWWW | −0.25 | 0.33 | 0.27 | 0.053 | 0.58 | 0.27 |
| cW | −0.11 | 0.13 | 0.27 | −0.16 | 0.20 |
| cB | 2.4 | 5.3 | 0.26 | −2.3 | 10 |
| M(WZ) | cWWW | −1.2 | 0.19 | 0.52 | 0.23 | 2.4 | 0.50 |
| cW | −1.1 | 0.25 | 0.48 | −1.42 | 0.71 |
| cB | 23.0 | 12.0 | 0.49 | −27 | 41 |
| y(Z) | cWWW | −0.98 | 0.73 | 0.61 | 0.60 | 3.2 | 0.62 |
| cW | −0.41 | 0.37 | 0.61 | −1.6 | 3.2 |
| cB | 12 | 11 | 0.61 | −39 | 140 |
| O1(cWWW) | cWWW | −0.29 | 0.28 | 0.36 | 0.37 | 0.89 | 0.36 |
| cW | −0.10 | 0.11 | 0.36 | 0.020 | 0.39 |
| cB | 3.8 | 3.8 | 0.36 | 7.3 | 17 |
| O2(cWWW) | cWWW | −0.30 | 0.25 | 0.058 | 0.42 | 0.48 | 0.057 |
| cW | −0.10 | 0.12 | 0.059 | 0.18 | 0.50 |
| cB | 7.0 | 6.4 | 0.058 | 17 | 22 |
| O1(cW) | cWWW | −0.21 | 0.23 | 0.099 | 0.16 | 0.69 | 0.099 |
| cW | −0.069 | 0.095 | 0.099 | 0.0081 | 0.24 |
| cB | 3.4 | 3.9 | 0.099 | 5.0 | 13 |
| O2(cW) | cWWW | −0.35 | 0.23 | 0.076 | 0.51 | 0.44 | 0.074 |
| cW | −0.12 | 0.11 | 0.077 | 0.23 | 0.50 |
| cB | 7.3 | 5.5 | 0.075 | 19 | 20 |
| O1(cB) | cWWW | −0.28 | 0.28 | 0.40 | 0.32 | 0.98 | 0.40 |
| cW | −0.095 | 0.11 | 0.40 | −0.0091 | 0.36 |
| cB | 3.4 | 3.8 | 0.40 | 5.7 | 17 |
| O2(cB) | cWWW | −0.24 | 0.24 | 0.086 | 0.17 | 0.67 | 0.087 |
| cW | −0.086 | 0.10 | 0.087 | −0.012 | 0.25 |
| cB | 4.1 | 4.4 | 0.086 | 5.1 | 13 |
| O1(cWWW) vs | cWWW | 0.0028 | 0.077 | 0.19 | −0.00027 | 0.11 | 0.065 |
| cW | 0.44 | 0.17 | 0.063 | 0.44 | 0.17 |
| cB | −6.2 | 12 | 0.19 | −0.97 | 17 |
| O2(cWWW) vs | cWWW | 0.0029 | 0.018 | 3.3 | −0.00024 | 0.026 | 0.87 |
| cW | 0.46 | 0.041 | 0.85 | 0.46 | 0.041 |
| cB | −6.3 | 2.9 | 3.2 | −0.94 | 4 |
| O1(cW) vs | cWWW | 0.0028 | 0.021 | 2.5 | −0.00024 | 0.029 | 0.69 |
| cW | 0.46 | 0.046 | 0.67 | 0.45 | 0.047 |
| cB | −6.3 | 3.3 | 2.5 | −0.94 | 4.5 |
| O2(cW) vs | cWWW | 0.0028 | 0.020 | 2.7 | −0.00024 | 0.028 | 0.74 |
| cW | 0.46 | 0.045 | 0.72 | 0.46 | 0.045 |
| cB | −6.3 | 3.1 | 2.7 | −0.94 | 4.3 |
| O1(cB) vs | cWWW | 0.0029 | 0.13 | 0.080 | −0.00032 | 0.17 | 0.035 |
| cW | 0.43 | 0.27 | 0.034 | 0.43 | 0.28 |
| cB | −6.2 | 20 | 0.035 | −0.91 | 27 |
| O2(cB) vs | cWWW | 0.0028 | 0.12 | 0.091 | −0.00030 | 0.16 | 0.037 |
| cW | 0.43 | 0.25 | 0.036 | 0.43 | 0.25 |
| cB | −6.2 | 18 | 0.090 | −0.92 | 25 |

cWWW

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Observable** | **Fit cWWW** | | | **Fit All** | | |
| **Value**  **[10−6]** | **Error**  **[10−6]** |  | **Value**  **[10−6]** | **Error**  **[10−6]** |  |
| **PT(Z)** | −0.25 | 0.33 | 0.27 | 0.053 | 0.58 | 0.27 |
| **M(WZ)** | −1.18 | 0.18 | 0.50 | 0.10 | 2.1 | 0.47 |
| **y(Z)** | −0.98 | 0.73 | 0.61 | 0.60 | 3.2 | 0.62 |
| **O1(cWWW)** | −0.29 | 0.28 | 0.36 | 0.37 | 0.89 | 0.36 |
| **O2(cWWW)** | −0.30 | 0.25 | 0.058 | 0.42 | 0.48 | 0.057 |
| **O1(cW)** | −0.21 | 0.23 | 0.099 | 0.16 | 0.69 | 0.099 |
| **O2(cW)** | −0.35 | 0.23 | 0.076 | 0.51 | 0.44 | 0.074 |
| **O1(cB)** | −0.28 | 0.28 | 0.40 | 0.32 | 0.98 | 0.40 |
| **O2(cB)** | −0.24 | 0.24 | 0.086 | 0.17 | 0.67 | 0.087 |
| **O1(cWWW) vs** | 0.0028 | 0.077 | 0.19 | −0.00027 | 0.11 | 0.065 |
| **O2(cWWW) vs** | 0.0029 | 0.018 | 3.3 | −0.00024 | 0.026 | 0.87 |
| **O1(cW) vs** | 0.0028 | 0.021 | 2.5 | −0.00024 | 0.029 | 0.69 |
| **O2(cW) vs** | 0.0028 | 0.020 | 2.7 | −0.00024 | 0.028 | 0.74 |
| **O1(cB) vs** | 0.0029 | 0.13 | 0.080 | −0.00032 | 0.17 | 0.035 |
| **O2(cB) vs** | 0.0028 | 0.12 | 0.091 | −0.00030 | 0.16 | 0.037 |

cW

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Observable** | **Fit cW** | | | **Fit All** | | |
| **Value**  **[10−6]** | **Error**  **[10−6]** |  | **Value**  **[10−6]** | **Error**  **[10−6]** |  |
| **PT(Z)** | −0.11 | 0.13 | 0.27 | −0.16 | 0.20 | 0.27 |
| **M(WZ)** | −1.1 | 0.24 | 0.46 | −1.42 | 0.37 | 0.47 |
| **y(Z)** | −0.41 | 0.37 | 0.61 | −1.6 | 3.2 | 0.62 |
| **O1(cWWW)** | −0.10 | 0.11 | 0.36 | 0.020 | 0.39 | 0.36 |
| **O2(cWWW)** | −0.10 | 0.12 | 0.059 | 0.18 | 0.50 | 0.057 |
| **O1(cW)** | −0.069 | 0.095 | 0.099 | 0.0081 | 0.24 | 0.099 |
| **O2(cW)** | −0.12 | 0.11 | 0.077 | 0.23 | 0.50 | 0.074 |
| **O1(cB)** | −0.095 | 0.11 | 0.40 | −0.0091 | 0.36 | 0.40 |
| **O2(cB)** | −0.086 | 0.10 | 0.087 | −0.012 | 0.25 | 0.087 |
| **O1(cWWW) vs** | 0.44 | 0.17 | 0.063 | 0.44 | 0.17 | 0.065 |
| **O2(cWWW) vs** | 0.457 | 0.041 | 0.85 | 0.456 | 0.041 | 0.87 |
| **O1(cW) vs** | 0.456 | 0.046 | 0.67 | 0.455 | 0.047 | 0.69 |
| **O2(cW) vs** | 0.456 | 0.045 | 0.72 | 0.455 | 0.045 | 0.74 |
| **O1(cB) vs** | 0.43 | 0.27 | 0.034 | 0.43 | 0.28 | 0.035 |
| **O2(cB) vs** | 0.43 | 0.25 | 0.036 | 0.43 | 0.25 | 0.037 |

cB

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Observable** | **Fit cB** | | | **Fit All** | | |
| **Value**  **[10−6]** | **Error**  **[10−6]** |  | **Value**  **[10−6]** | **Error**  **[10−6]** |  |
| **PT(Z)** | 2.4 | 5.3 | 0.26 | −2.3 | 10 | 0.27 |
| **M(WZ)** | 23 | 12 | 0.47 | −27 | 29 | 0.47 |
| **y(Z)** | 12 | 11 | 0.61 | −39 | 140 | 0.62 |
| **O1(cWWW)** | 3.8 | 3.8 | 0.36 | 7.3 | 17 | 0.36 |
| **O2(cWWW)** | 7.0 | 6.4 | 0.058 | 17 | 22 | 0.057 |
| **O1(cW)** | 3.4 | 3.9 | 0.099 | 5.0 | 13 | 0.099 |
| **O2(cW)** | 7.3 | 5.5 | 0.075 | 19 | 20 | 0.074 |
| **O1(cB)** | 3.4 | 3.8 | 0.40 | 5.7 | 17 | 0.40 |
| **O2(cB)** | 4.1 | 4.4 | 0.086 | 5.1 | 13 | 0.087 |
| **O1(cWWW) vs** | −6.2 | 12 | 0.19 | −0.97 | 17 | 0.065 |
| **O2(cWWW) vs** | −6.3 | 2.9 | 3.2 | −0.94 | 4 | 0.87 |
| **O1(cW) vs** | −6.3 | 3.3 | 2.5 | −0.94 | 4.5 | 0.69 |
| **O2(cW) vs** | −6.3 | 3.1 | 2.7 | −0.94 | 4.3 | 0.74 |
| **O1(cB) vs** | −6.2 | 20 | 0.079 | −0.91 | 27 | 0.035 |
| **O2(cB) vs** | −6.2 | 18 | 0.090 | −0.92 | 25 | 0.037 |

# Fitting EFT to SM for simulated measurement of WZ-production

# Conclusion

# Bibliography