Update on EFT prediction note

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on behalf of the LHC EFT prediction note team

17 November 2023

Introduction

This note aims to provide a **guide** to obtain SMEFT predictions, highlighting **best practices** and documenting **common pitfalls**.

Main topic

Identify the subtleties and provide solution to common problems of the available simulation methods:

Direct simulation

Simulation of a desired configuration of the Wilson coefficients.

- CPU demanding to get high statistical precision.
- Conceptually clean.

Separate simulation

Different samples for SM, linear and quadratic EFT predictions.

- CPU demanding to get high statistical precision.
- Independent from any reference point.

Reweighted simulation

Single sample with a per-event weight to get different values of Wilson coefficients.

- Least demanding in CPU.
- Predictions far from reference point can lead to large weights.

Not covered in the note:

- Model comparison, truncation uncertainty, choice of observables.

Introduction

Different physics processes that cover most of the LHC physics program have been chosen as benchmark for the main EFT prediction generation methods.

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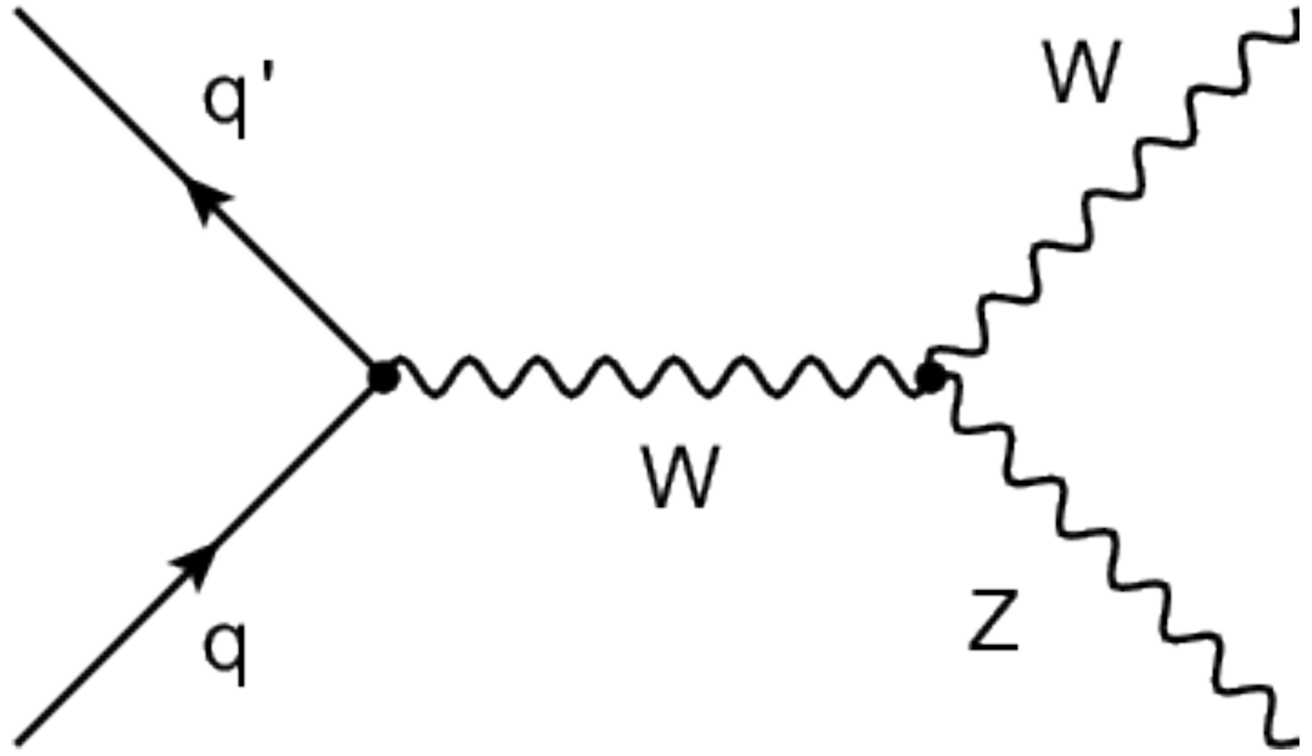
Reweighting in WZ

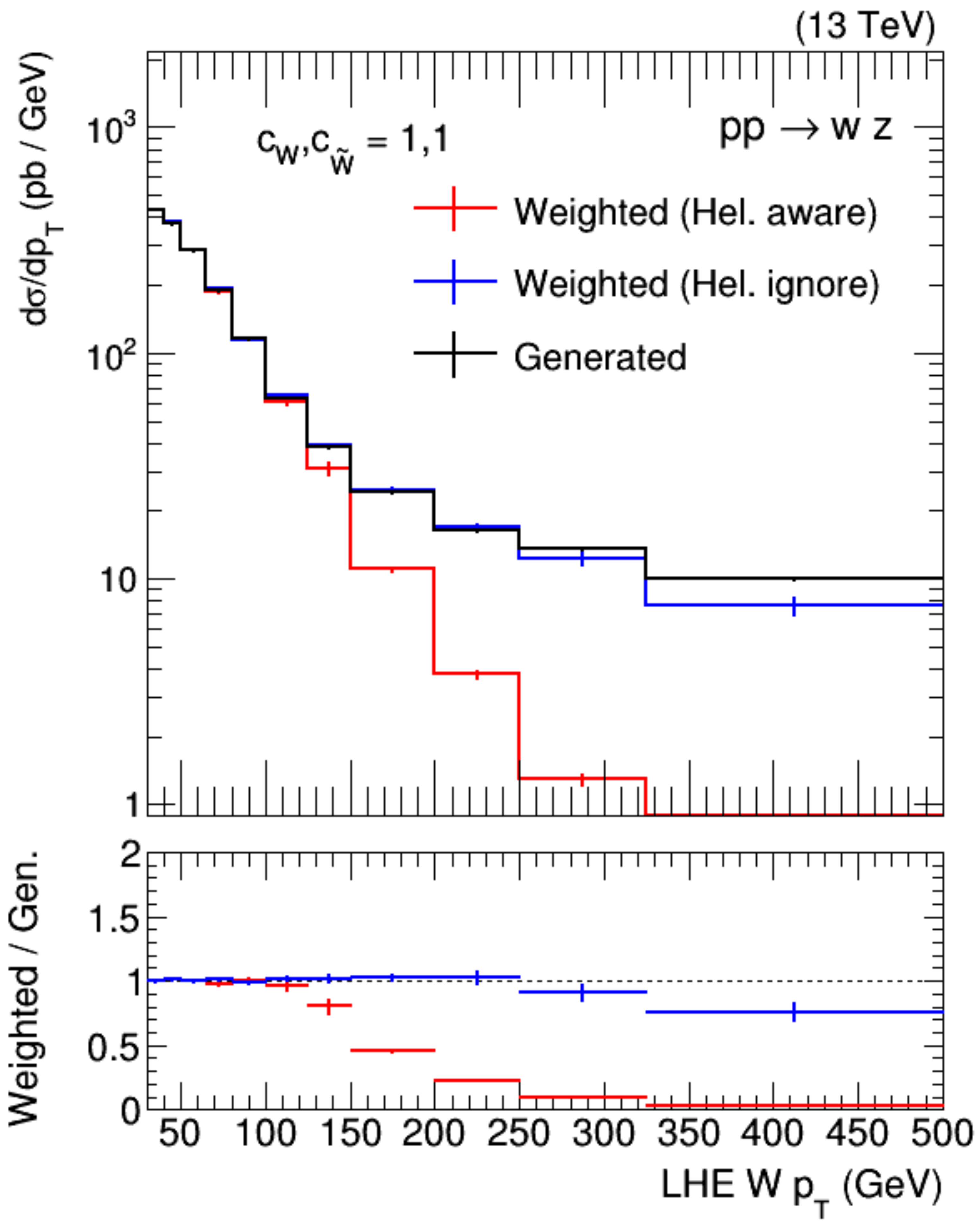
S. Banerjee, A. Calandri, S. Chatterjee, F. Glessgen, N. Smith, V. Perovic

- Process: WZ

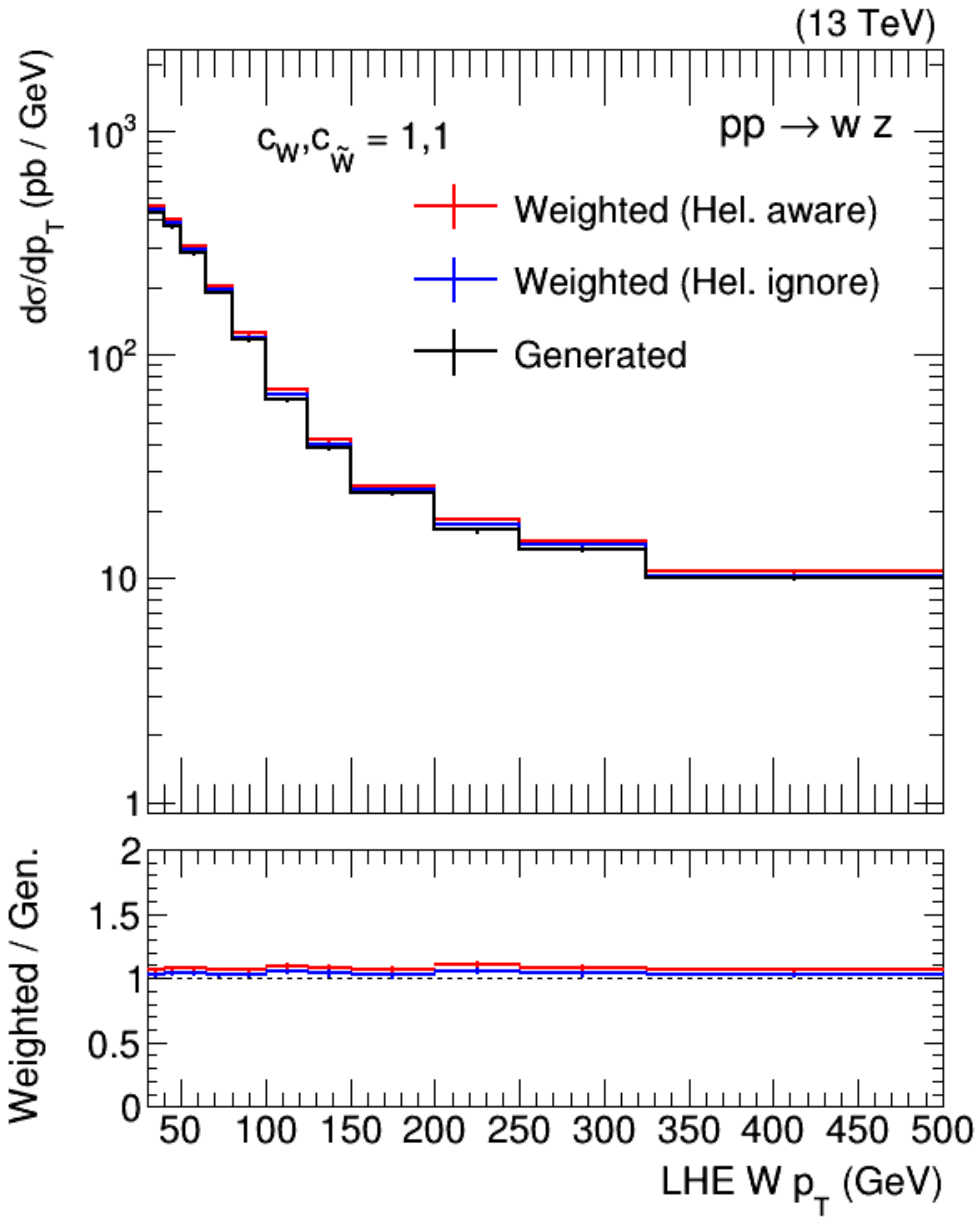


- Model: SMEFTsim
- Operator: $\mathcal{O}_W, \mathcal{O}_{\widetilde{W}}$
- Final state: summed on all helicity configurations.

SM reference point



$c_W = 0.5$ and $c_{\tilde{W}} = 0.5$ ref. point

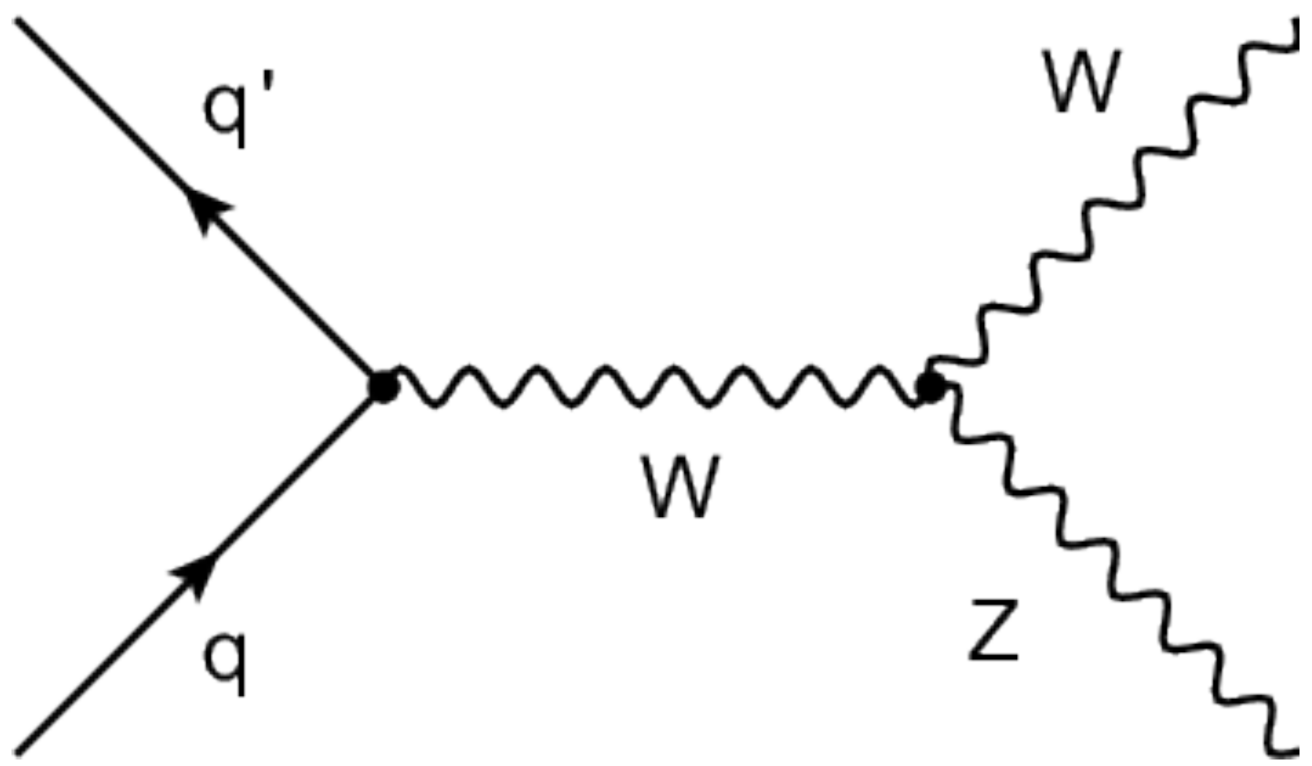


Helicity ignorant reweighting works better when summing on all the helicity configurations.

Reweighting in WZ

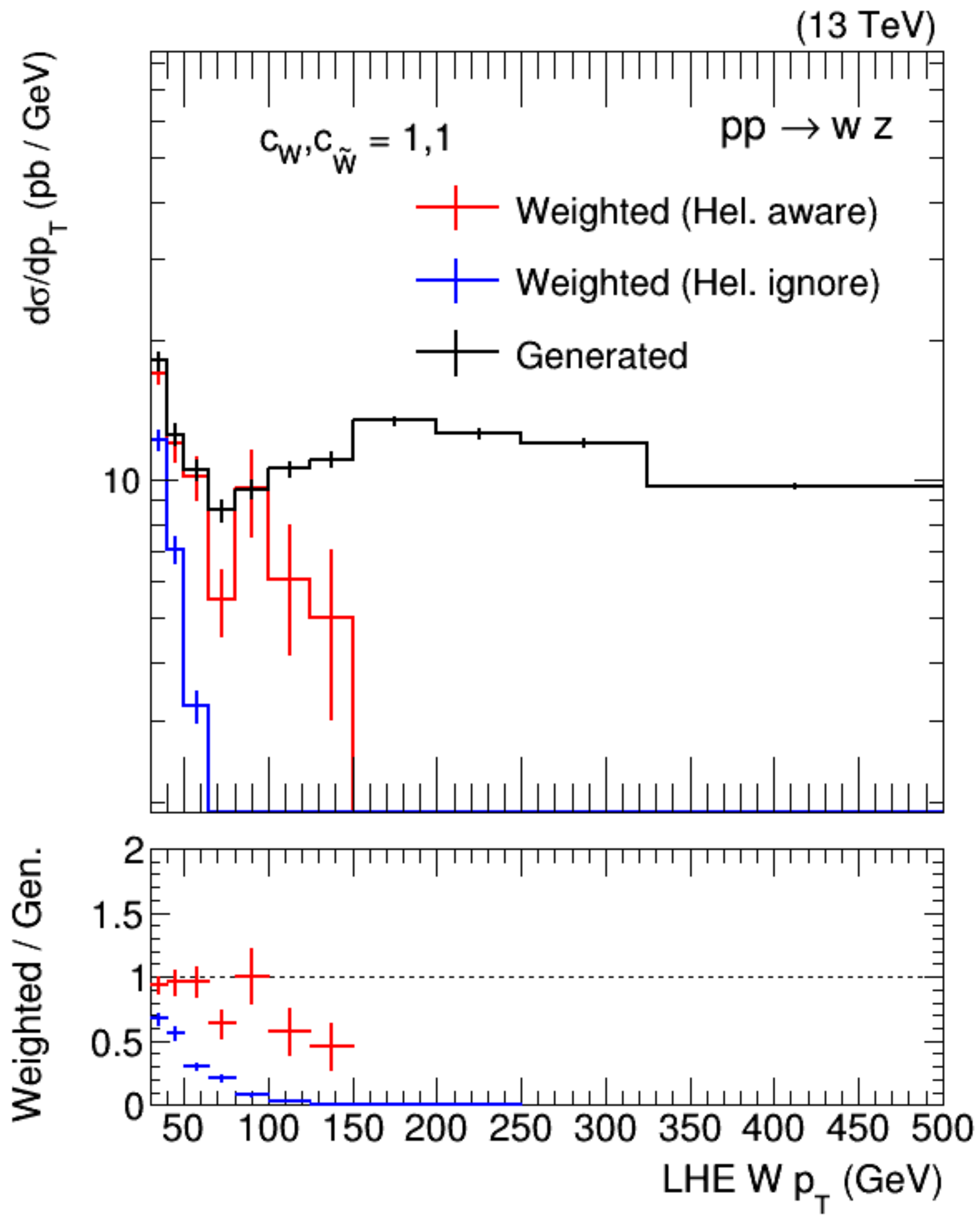
S. Banerjee, A. Calandri, S. Chatterjee, F. Glessgen, N. Smith, V. Perovic

- Process: WZ

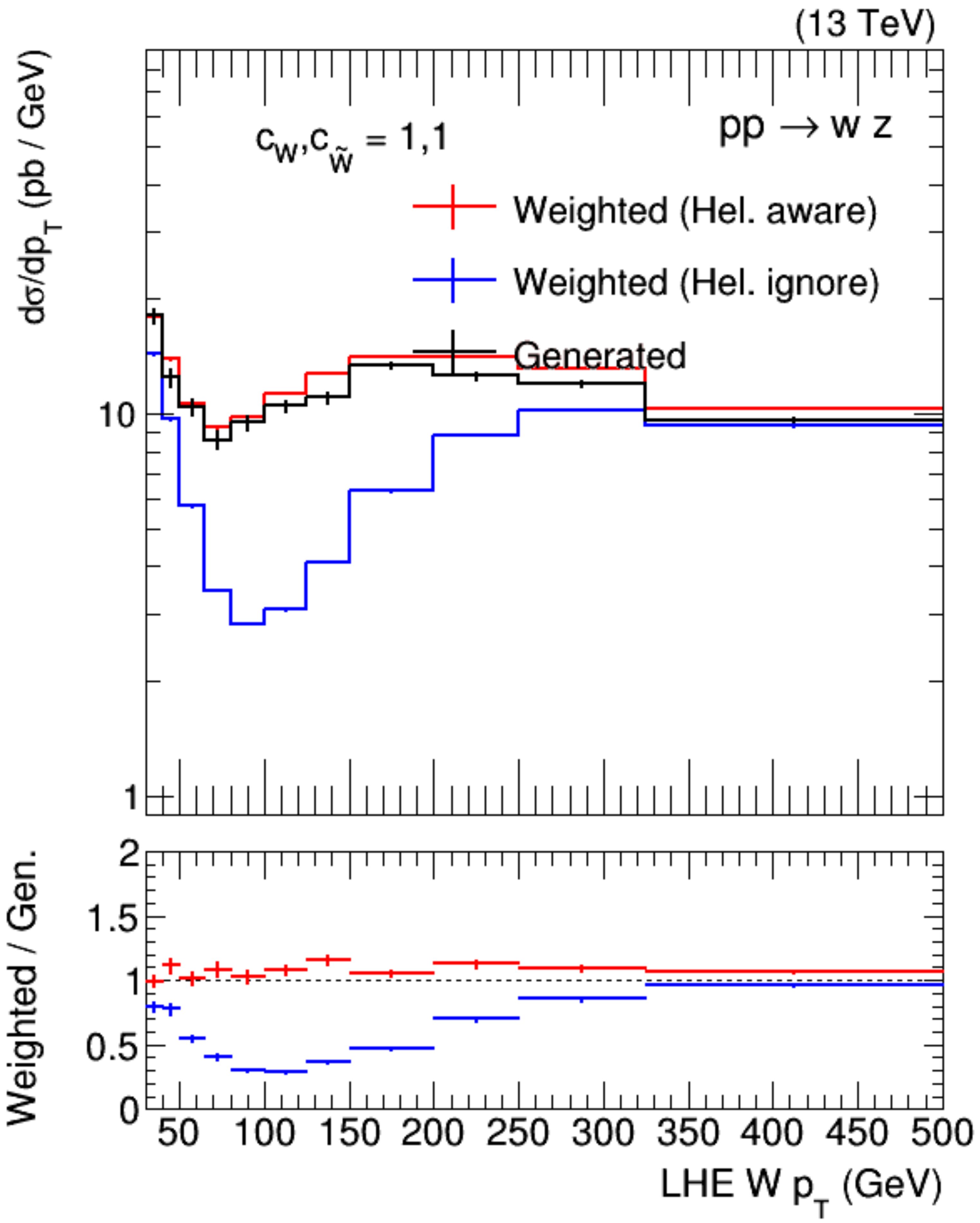


- Model: SMEFTsim
- Operator: $\mathcal{O}_W, \mathcal{O}_{\widetilde{W}}$
- Final state: same-sign transverse polarization

SM reference point



$c_W = 0.5$ and $c_{\tilde{W}} = 0.5$ ref. point

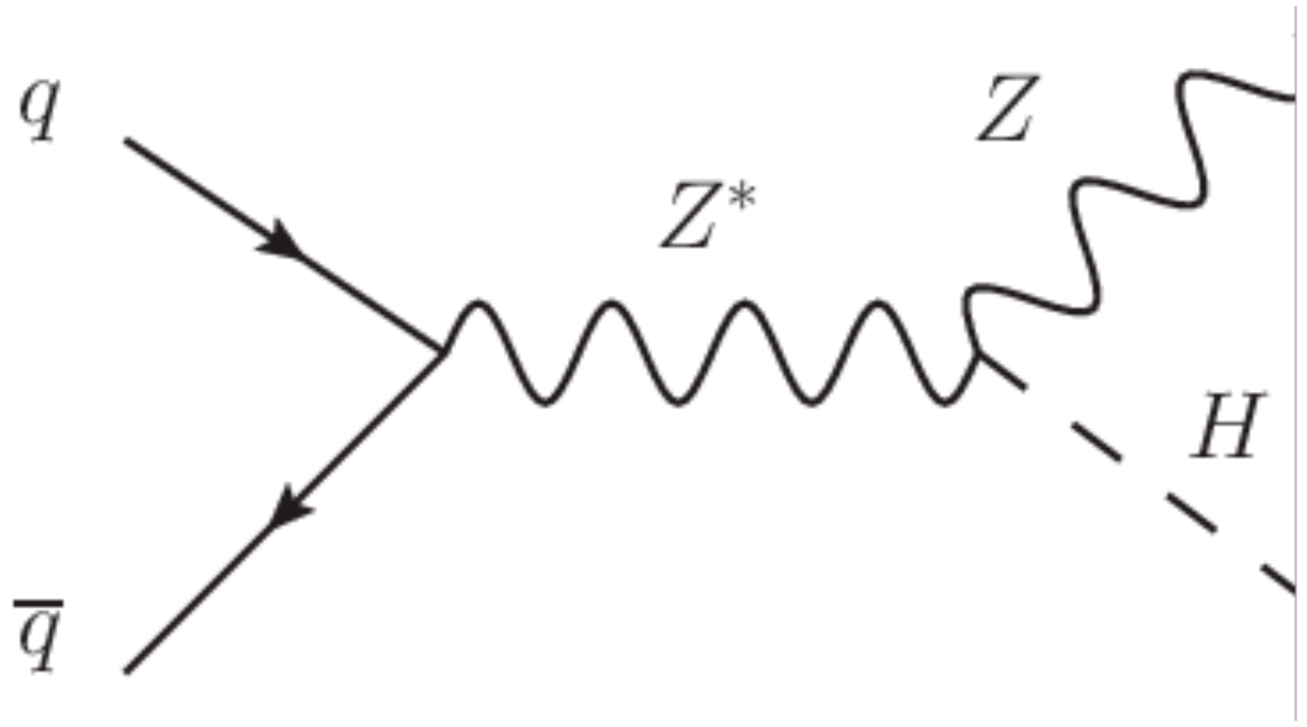


Only helicity aware reweighting works when considering a specific helicity configuration.

Reweighting in ZH

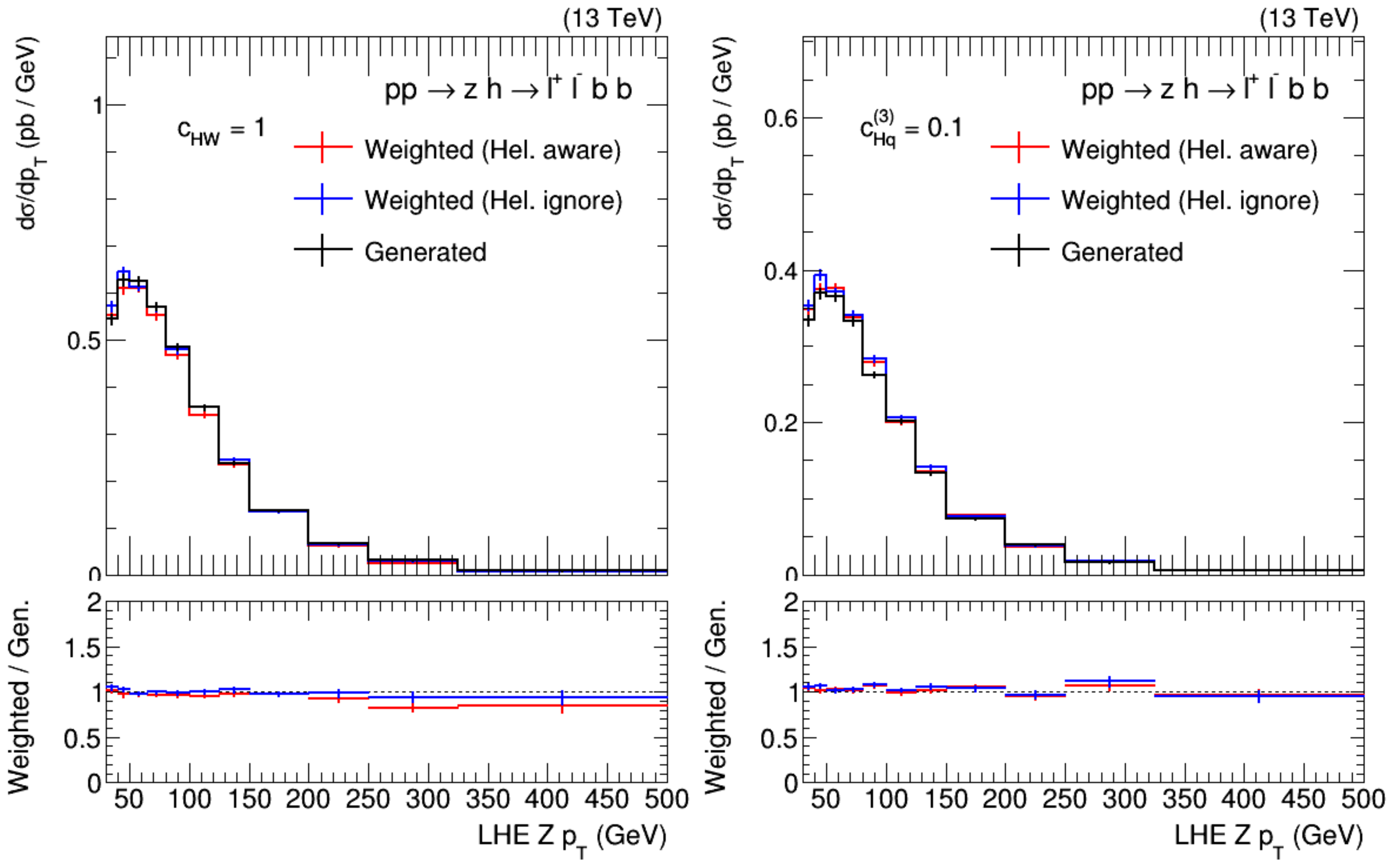
S. Banerjee, A. Calandri, S. Chatterjee, F. Glessgen, N. Smith, V. Perovic

- Process: ZH



- Model: SMEFTsim
- Operator: $\mathcal{O}_{HW}$, $\mathcal{O}_{Hq}^{(3)}$

Both helicity aware and ignorant reweighting are in good agreement with the generated distribution.



Reweighting for $t\bar{t}$

R. Goldouzian

Simulation of the 4-fermion EFT operators for the $t\bar{t}$ process with SMEFT@NLO using the reweighting.

- Process: $t\bar{t}$
- Model: SMEFT@NLO
- Operators:

$$O_{qq}^{1(ijkl)} = (\bar{q}_i\gamma^\mu q_j)(\bar{q}_k\gamma_\mu q_l),$$
$$O_{qq}^{3(ijkl)} = (\bar{q}_i\gamma^\mu\tau^I q_j)(\bar{q}_k\gamma_\mu\tau^I q_l),$$
$$O_{qu}^{1(ijkl)} = (\bar{q}_i\gamma^\mu q_j)(\bar{u}_k\gamma_\mu u_l),$$
$$O_{qu}^{8(ijkl)} = (\bar{q}_i\gamma^\mu T^A q_j)(\bar{u}_k\gamma_\mu T^A u_l),$$
$$O_{qd}^{1(ijkl)} = (\bar{q}_i\gamma^\mu q_j)(\bar{d}_k\gamma_\mu d_l),$$
$$O_{qd}^{8(ijkl)} = (\bar{q}_i\gamma^\mu T^A q_j)(\bar{d}_k\gamma_\mu T^A d_l),$$
$$O_{uu}^{(ijkl)} = (\bar{u}_i\gamma^\mu u_j)(\bar{u}_k\gamma_\mu u_l),$$
$$O_{ud}^{1(ijkl)} = (\bar{u}_i\gamma^\mu u_j)(\bar{d}_k\gamma_\mu d_l),$$
$$O_{ud}^{8(ijkl)} = (\bar{u}_i\gamma^\mu T^A u_j)(\bar{d}_k\gamma_\mu T^A d_l),$$
$$^{\ddagger}O_{quqd}^{1(ijkl)} = (\bar{q}_i u_j)\,\varepsilon\,(\bar{q}_k d_l),$$
$$^{\ddagger}O_{quqd}^{8(ijkl)} = (\bar{q}_i T^A u_j)\,\varepsilon\,(\bar{q}_k T^A d_l),$$

LO simulation

	sm	ctu1	cqd1	cqq13	ctu8	cqu1	cqq11	cqq83	ctd1	ctd8	ctg	ctq1	cqq81	cqu8	cqd8	ctq8
sm	455.58	-0.00	0.00	0.00	4.19	-0.00	0.00	1.66	-0.00	2.98	146.04	0.00	6.57	4.13	2.99	7.02
ctu1	-0.00	4.04	-0.00	0.00	-0.00	1.09	0.00	-0.00	0.00	0.00	-0.00	0.00	-0.00	0.00	0.00	0.00
cqd1	0.00	-0.00	2.57	-0.00	-0.00	0.00	0.00	-0.00	0.78	0.00	-0.00	0.00	0.00	0.00	0.00	0.00
cqq13	0.00	0.00	-0.00	5.86	-0.00	0.00	4.25	-0.00	0.00	-0.00	0.00	0.39	-0.00	-0.00	-0.00	0.00
ctu8	4.19	-0.00	-0.00	-0.00	0.90	-0.00	0.00	0.00	-0.00	-0.00	0.63	-0.00	-0.00	0.24	-0.00	-0.00
cqu1	-0.00	1.09	0.00	0.00	-0.00	3.98	0.00	0.00	-0.00	0.00	-0.00	0.00	-0.00	-0.00	0.00	0.00
cqq11	0.00	0.00	0.00	4.25	0.00	0.00	5.86	-0.00	-0.00	-0.00	0.00	1.79	-0.00	-0.00	-0.00	-0.00
cqq83	1.66	-0.00	-0.00	-0.00	0.00	0.00	-0.00	1.30	-0.00	0.00	0.24	-0.00	0.95	-0.00	-0.00	0.09
ctd1	-0.00	0.00	0.78	0.00	-0.00	-0.00	-0.00	-0.00	2.56	0.00	0.00	0.00	0.00	-0.00	-0.00	0.00
ctd8	2.98	0.00	0.00	-0.00	-0.00	0.00	-0.00	0.00	0.00	0.57	0.45	0.00	-0.00	-0.00	0.17	-0.00
ctg	146.04	-0.00	-0.00	0.00	0.63	-0.00	0.00	0.24	0.00	0.45	25.84	0.00	0.99	0.62	0.45	1.05
ctq1	0.00	0.00	0.00	0.39	-0.00	0.00	1.79	-0.00	0.00	0.00	0.00	6.56	-0.00	0.00	-0.00	-0.00
cqq81	6.57	-0.00	0.00	-0.00	-0.00	-0.00	-0.00	0.95	0.00	-0.00	0.99	-0.00	1.30	-0.00	-0.00	0.40
cqu8	4.13	0.00	0.00	-0.00	0.24	-0.00	-0.00	-0.00	-0.00	-0.00	0.62	0.00	-0.00	0.89	0.00	-0.00
cqd8	2.99	0.00	0.00	-0.00	-0.00	0.00	-0.00	-0.00	-0.00	0.17	0.45	-0.00	-0.00	0.00	0.57	0.00
ctq8	7.02	0.00	0.00	0.00	-0.00	0.00	-0.00	0.09	0.00	-0.00	1.05	-0.00	0.40	-0.00	0.00	1.46

SMEFT@NLO documentation

c_i	$\mathcal{O}(\Lambda^{-2})$ LO	$\mathcal{O}(\Lambda^{-2})$ NLO		$\mathcal{O}(\Lambda^{-4})$ LO	$\mathcal{O}(\Lambda^{-4})$ NLO
c_{tu}^{8}	$4.27^{+11\%}_{-9\%}$	$4.06^{+1\%}_{-3\%}$		$1.04^{+6\%}_{-5\%}$	$1.03^{+2\%}_{-2\%}$
c_{td}^{8}	$2.79^{+11\%}_{-9\%}$	$2.77^{+1\%}_{-3\%}$		$0.577^{+6\%}_{-5\%}$	$0.611^{+3\%}_{-2\%}$
c_{tq}^{8}	$6.99^{+11\%}_{-9\%}$	$6.67^{+1\%}_{-3\%}$		$1.61^{+6\%}_{-5\%}$	$1.29^{+3\%}_{-2\%}$
c_{Qu}^{8}	$4.26^{+11\%}_{-9\%}$	$3.93^{+1\%}_{-4\%}$		$1.04^{+6\%}_{-5\%}$	$0.798^{+3\%}_{-3\%}$
c_{Qd}^{8}	$2.79^{+11\%}_{-9\%}$	$2.93^{+0\%}_{-1\%}$		$0.58^{+6\%}_{-5\%}$	$0.485^{+2\%}_{-2\%}$
$c_{Qq}^{8,1}$	$6.99^{+11\%}_{-9\%}$	$6.82^{+1\%}_{-3\%}$		$1.61^{+6\%}_{-5\%}$	$1.69^{+3\%}_{-3\%}$
$c_{Qq}^{8,3}$	$1.50^{+10\%}_{-9\%}$	$1.32^{+1\%}_{-3\%}$		$1.61^{+6\%}_{-5\%}$	$1.57^{+2\%}_{-2\%}$
c_{tu}^{1}	$[0.67^{+1\%}_{-1\%}]$	$-0.078(7)^{+31\%}_{-23\%}$	$[0.41^{+13\%}_{-17\%}]$	$4.66^{+6\%}_{-5\%}$	$5.92^{+6\%}_{-5\%}$
c_{td}^{1}	$[-0.21^{+1\%}_{-2\%}]$	$-0.306^{+30\%}_{-22\%}$	$[-0.15^{+10\%}_{-13\%}]$	$2.62^{+6\%}_{-5\%}$	$3.46^{+5\%}_{-5\%}$
c_{tq}^{1}	$[0.39^{+0\%}_{-1\%}]$	$-0.47^{+24\%}_{-18\%}$	$[0.50^{+3\%}_{-2\%}]$	$7.25^{+6\%}_{-5\%}$	$9.36^{+6\%}_{-5\%}$
c_{Qu}^{1}	$[0.33^{+0\%}_{-0\%}]$	$-0.359^{+23\%}_{-17\%}$	$[0.57^{+6\%}_{-5\%}]$	$4.68^{+6\%}_{-5\%}$	$5.96^{+6\%}_{-5\%}$
c_{Qd}^{1}	$[-0.11^{+0\%}_{-1\%}]$	$0.023(6)^{+114\%}_{-75\%}$	$[-0.19^{+6\%}_{-5\%}]$	$2.61^{+6\%}_{-5\%}$	$3.46^{+5\%}_{-5\%}$
$c_{Qq}^{1,1}$	$[0.57^{+0\%}_{-1\%}]$	$-0.24^{+30\%}_{-22\%}$	$[0.39^{+9\%}_{-12\%}]$	$7.25^{+6\%}_{-5\%}$	$9.34^{+5\%}_{-5\%}$
$c_{Qq}^{1,3}$	$[1.92^{+1\%}_{-1\%}]$	$0.088(7)^{+28\%}_{-20\%}$	$[1.05^{+17\%}_{-22\%}]$	$7.25^{+6\%}_{-5\%}$	$9.32^{+5\%}_{-5\%}$
c_{QQ}^{8}	$0.0586^{+27\%}_{-25\%}$	$0.125^{+10\%}_{-11\%}$		$0.00628^{+13\%}_{-16\%}$	$0.0133^{+7\%}_{-5\%}$
c_{Qt}^{8}	$0.0583^{+27\%}_{-25\%}$	$-0.107(6)^{+40\%}_{-33\%}$		$0.00619^{+13\%}_{-16\%}$	$0.0118^{+8\%}_{-5\%}$
c_{QQ}^{1}	$[-0.11^{+15\%}_{-18\%}]$	$-0.039(4)^{+51\%}_{-33\%}$	$[-0.12^{+7\%}_{-5\%}]$	$0.0282^{+13\%}_{-16\%}$	$0.0651^{+5\%}_{-6\%}$
c_{Qt}^{1}	$[-0.068^{+16\%}_{-18\%}]$	$-2.51^{+29\%}_{-21\%}$	$[-0.12^{+3\%}_{-6\%}]$	$0.0283^{+13\%}_{-16\%}$	$0.066^{+5\%}_{-6\%}$
c_{tt}^{1}	×	$0.215^{+23\%}_{-18\%}$		×	×

At LO good agreement between the cross-sections obtained trough reweighting and the expected ones.

Reweighting for $t\bar{t}$

R. Goldouzian

Simulation of the 4-fermion EFT operators for the $t\bar{t}$ process with SMEFT@NLO using the reweighting.

- Process: $t\bar{t}$
- Model: SMEFT@NLO
- Operators:

$$O_{qq}^{1(ijkl)} = (\bar{q}_i\gamma^\mu q_j)(\bar{q}_k\gamma_\mu q_l),$$
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$$O_{qu}^{1(ijkl)} = (\bar{q}_i\gamma^\mu q_j)(\bar{u}_k\gamma_\mu u_l),$$
$$O_{qu}^{8(ijkl)} = (\bar{q}_i\gamma^\mu T^A q_j)(\bar{u}_k\gamma_\mu T^A u_l),$$
$$O_{qd}^{1(ijkl)} = (\bar{q}_i\gamma^\mu q_j)(\bar{d}_k\gamma_\mu d_l),$$
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$$O_{ud}^{1(ijkl)} = (\bar{u}_i\gamma^\mu u_j)(\bar{d}_k\gamma_\mu d_l),$$
$$O_{ud}^{8(ijkl)} = (\bar{u}_i\gamma^\mu T^A u_j)(\bar{d}_k\gamma_\mu T^A d_l),$$
$$^\ddagger O_{quqd}^{1(ijkl)} = (\bar{q}_i u_j)\,\varepsilon\,(\bar{q}_k d_l),$$
$$^\ddagger O_{quqd}^{8(ijkl)} = (\bar{q}_i T^A u_j)\,\varepsilon\,(\bar{q}_k T^A d_l),$$

NLO simulation

	sm	ctu1	cqd1	cqq13	ctu8	cqu1	cqq11	cqq83	ctd1	ctd8	ctg	ctq1	cqq81	cqu8	cqd8	ctq8
sm	714.43	-1.97	0.92	-0.83	4.06	1.46	-3.11	1.28	-1.15	2.83	167.68	2.38	6.84	2.30	1.77	4.03
ctu1	-1.97	10.87	-0.00	-0.00	-1.67	1.62	-0.00	-0.00	-0.00	0.00	-0.24	0.00	-0.00	-0.01	-0.00	0.00
cqd1	0.92	-0.00	2.67	0.00	0.00	-0.00	0.00	0.00	1.07	-0.01	0.11	0.00	-0.00	-0.00	0.90	-0.00
cqq13	-0.83	-0.00	0.00	17.28	-0.00	0.00	8.92	-2.50	0.00	0.00	-0.10	0.56	-0.83	0.00	-0.00	-0.01
ctu8	4.06	-1.67	0.00	-0.00	0.97	-0.01	-0.00	-0.00	0.00	0.00	0.58	0.00	-0.00	0.21	-0.00	-0.00
cqu1	1.46	1.62	-0.00	0.00	-0.01	4.34	-0.00	-0.00	0.00	-0.00	0.17	0.00	-0.00	1.49	0.00	0.00
cqq11	-3.11	-0.00	0.00	8.92	-0.00	-0.00	17.28	-0.83	-0.00	-0.00	-0.38	2.68	-2.50	0.00	-0.00	-0.02
cqq83	1.28	-0.00	0.00	-2.50	-0.00	-0.00	-0.83	1.53	-0.00	0.00	0.18	-0.01	0.81	0.00	0.00	0.06
ctd1	-1.15	-0.00	1.07	0.00	0.00	0.00	-0.00	-0.00	6.48	-0.84	-0.14	0.00	-0.00	0.00	-0.01	-0.00
ctd8	2.83	0.00	-0.01	0.00	0.00	-0.00	-0.00	0.00	-0.84	0.58	0.40	-0.00	0.00	0.00	0.15	0.00
ctg	167.68	-0.24	0.11	-0.10	0.58	0.17	-0.38	0.18	-0.14	0.40	36.54	0.28	0.98	0.37	0.28	0.64
ctq1	2.38	0.00	0.00	0.56	0.00	0.00	2.68	-0.01	0.00	-0.00	0.28	6.97	-0.02	-0.00	0.00	2.39
cqq81	6.84	-0.00	-0.00	-0.83	-0.00	-0.00	-2.50	0.81	-0.00	0.00	0.98	-0.02	1.53	-0.00	-0.00	0.35
cqu8	2.30	-0.01	-0.00	0.00	0.21	1.49	0.00	0.00	0.00	0.00	0.37	-0.00	-0.00	0.14	0.00	-0.00
cqd8	1.77	-0.00	0.90	-0.00	-0.00	0.00	-0.00	0.00	-0.01	0.15	0.28	0.00	-0.00	0.00	0.12	-0.00
ctq8	4.03	0.00	-0.00	-0.01	-0.00	0.00	-0.02	0.06	-0.00	0.00	0.64	2.39	0.35	-0.00	-0.00	0.25

SMEFT@NLO documentation

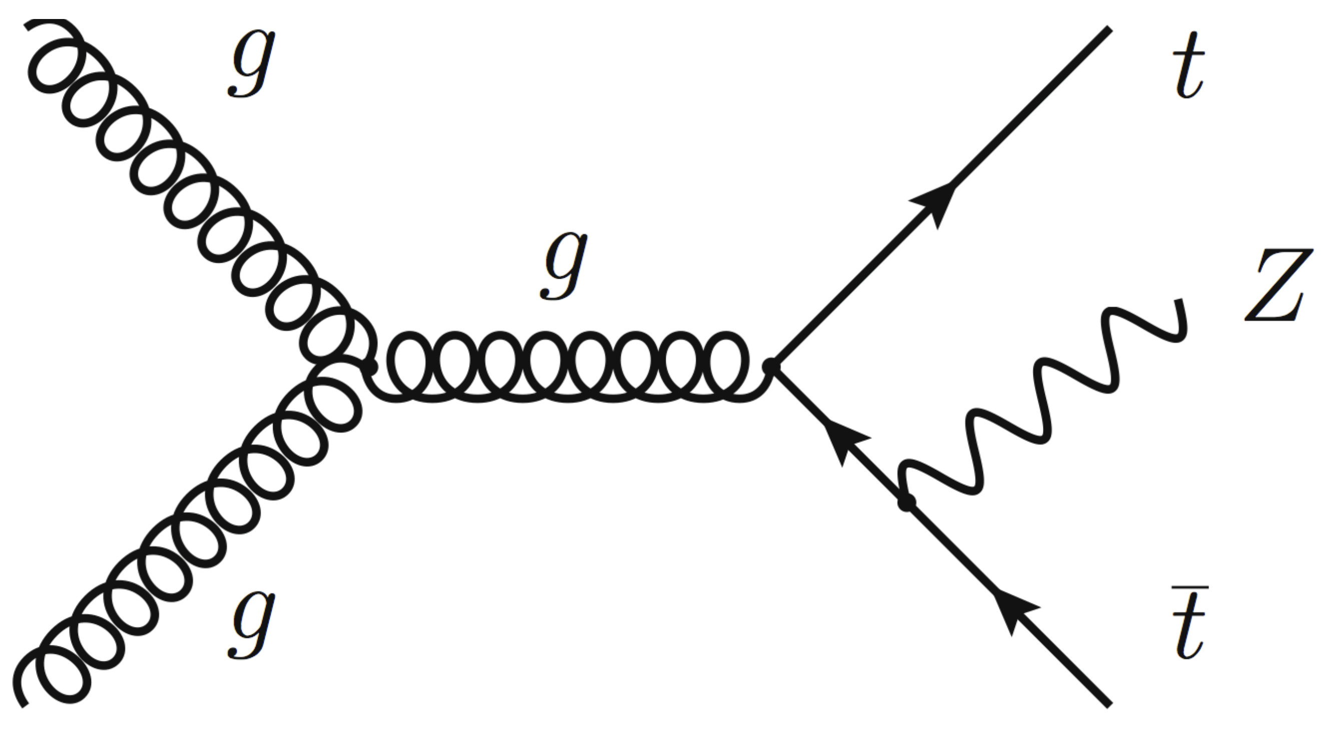
c_i	$\mathcal{O}(\Lambda^{-2})$ LO	$\mathcal{O}(\Lambda^{-2})$ NLO		$\mathcal{O}(\Lambda^{-4})$ LO	$\mathcal{O}(\Lambda^{-4})$ NLO
c_{tu}^8	$4.27^{+11\%}_{-9\%}$	$4.06^{+1\%}_{-3\%}$		$1.04^{+6\%}_{-5\%}$	$1.03^{+2\%}_{-2\%}$
c_{td}^8	$2.79^{+11\%}_{-9\%}$	$2.77^{+1\%}_{-3\%}$		$0.577^{+6\%}_{-5\%}$	$0.611^{+3\%}_{-2\%}$
c_{tq}^8	$6.99^{+11\%}_{-9\%}$	$6.67^{+1\%}_{-3\%}$		$1.61^{+6\%}_{-5\%}$	$1.29^{+3\%}_{-2\%}$
c_{Qu}^8	$4.26^{+11\%}_{-9\%}$	$3.93^{+1\%}_{-4\%}$		$1.04^{+6\%}_{-5\%}$	$0.798^{+3\%}_{-3\%}$
c_{Qd}^8	$2.79^{+11\%}_{-9\%}$	$2.93^{+0\%}_{-1\%}$		$0.58^{+6\%}_{-5\%}$	$0.485^{+2\%}_{-2\%}$
$c_{Qq}^{8,1}$	$6.99^{+11\%}_{-9\%}$	$6.82^{+1\%}_{-3\%}$		$1.61^{+6\%}_{-5\%}$	$1.69^{+3\%}_{-3\%}$
$c_{Qq}^{8,3}$	$1.50^{+10\%}_{-9\%}$	$1.32^{+1\%}_{-3\%}$		$1.61^{+6\%}_{-5\%}$	$1.57^{+2\%}_{-2\%}$
c_{tu}^1	$[0.67^{+1\%}_{-1\%}]$	$-0.078(7)^{+31\%}_{-23\%}$	$[0.41^{+13\%}_{-17\%}]$	$4.66^{+6\%}_{-5\%}$	$5.92^{+6\%}_{-5\%}$
c_{td}^1	$[-0.21^{+1\%}_{-2\%}]$	$-0.306^{+30\%}_{-22\%}$	$[-0.15^{+10\%}_{-13\%}]$	$2.62^{+6\%}_{-5\%}$	$3.46^{+5\%}_{-5\%}$
c_{tq}^1	$[0.39^{+0\%}_{-1\%}]$	$-0.47^{+24\%}_{-18\%}$	$[0.50^{+3\%}_{-2\%}]$	$7.25^{+6\%}_{-5\%}$	$9.36^{+6\%}_{-5\%}$
c_{Qu}^1	$[0.33^{+0\%}_{-0\%}]$	$-0.359^{+23\%}_{-17\%}$	$[0.57^{+6\%}_{-5\%}]$	$4.68^{+6\%}_{-5\%}$	$5.96^{+6\%}_{-5\%}$
c_{Qd}^1	$[-0.11^{+0\%}_{-1\%}]$	$0.023(6)^{+114\%}_{-75\%}$	$[-0.19^{+6\%}_{-5\%}]$	$2.61^{+6\%}_{-5\%}$	$3.46^{+5\%}_{-5\%}$
$c_{Qq}^{1,1}$	$[0.57^{+0\%}_{-1\%}]$	$-0.24^{+30\%}_{-22\%}$	$[0.39^{+9\%}_{-12\%}]$	$7.25^{+6\%}_{-5\%}$	$9.34^{+5\%}_{-5\%}$
$c_{Qq}^{1,3}$	$[1.92^{+1\%}_{-1\%}]$	$0.088(7)^{+28\%}_{-20\%}$	$[1.05^{+17\%}_{-22\%}]$	$7.25^{+6\%}_{-5\%}$	$9.32^{+5\%}_{-5\%}$
c_{QQ}^8	$0.0586^{+27\%}_{-25\%}$	$0.125^{+10\%}_{-11\%}$		$0.00628^{+13\%}_{-16\%}$	$0.0133^{+7\%}_{-5\%}$
c_{Qt}^8	$0.0583^{+27\%}_{-25\%}$	$-0.107(6)^{+40\%}_{-33\%}$		$0.00619^{+13\%}_{-16\%}$	$0.0118^{+8\%}_{-5\%}$
c_{QQ}^1	$[-0.11^{+15\%}_{-18\%}]$	$-0.039(4)^{+51\%}_{-33\%}$	$[-0.12^{+7\%}_{-5\%}]$	$0.0282^{+13\%}_{-16\%}$	$0.0651^{+5\%}_{-6\%}$
c_{Qt}^1	$[-0.068^{+16\%}_{-18\%}]$	$-2.51^{+29\%}_{-21\%}$	$[-0.12^{+3\%}_{-6\%}]$	$0.0283^{+13\%}_{-16\%}$	$0.066^{+5\%}_{-6\%}$
c_{tt}^1	×	$0.215^{+23\%}_{-18\%}$		×	×

Disagreement reported to MadGraph authors. Bug in the reweighting in MGv3.x, it should have been solved in MGv3.5.1.

Reweighting for $t\bar{t}Z$

A. Belvedere

- Process: $t\bar{t}Z$

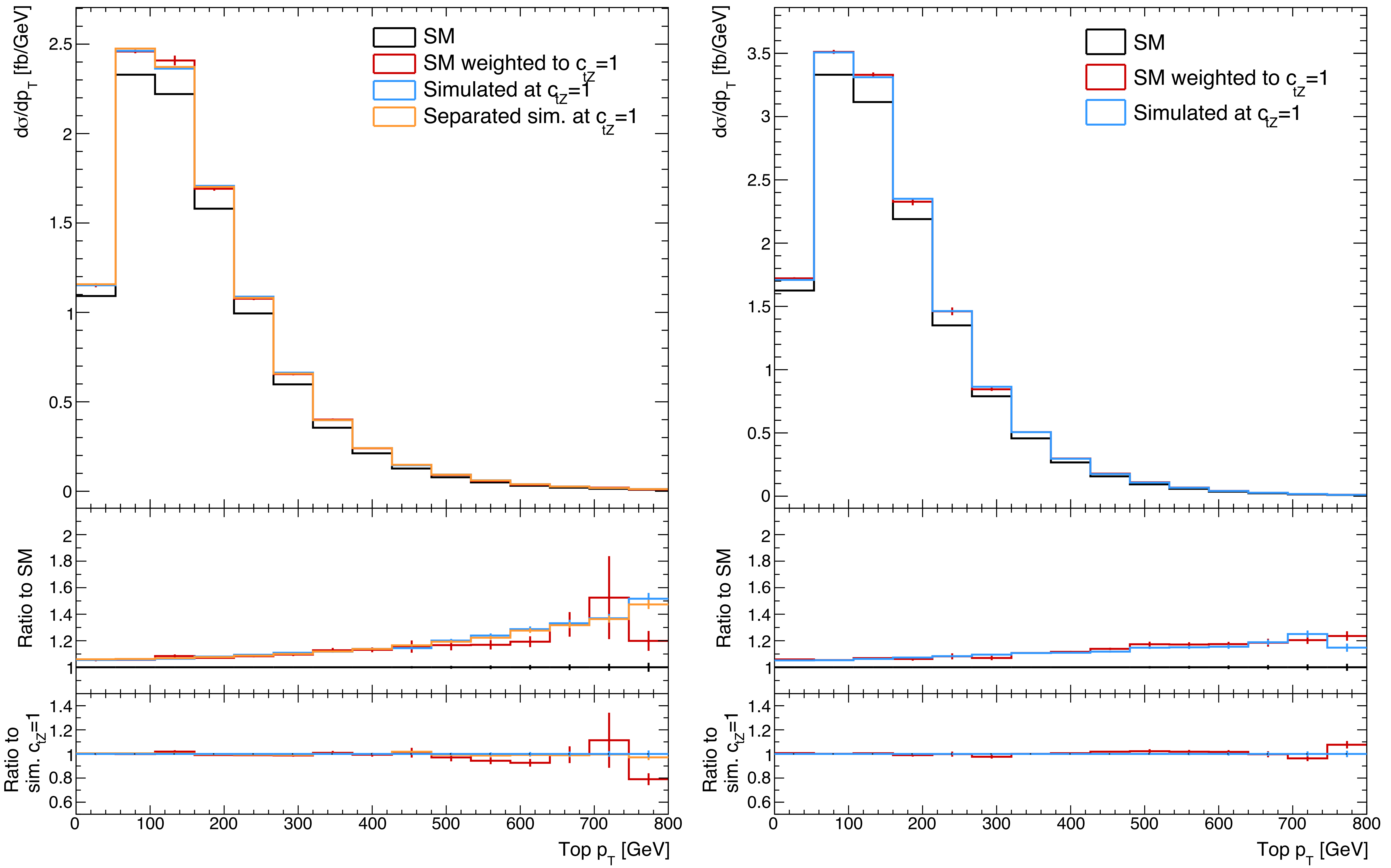


- Model: SMEFT@NLO & SMEFTsim
- Operator: $\mathcal{O}_{tZ}$

Good agreement among the different distributions.
Slightly larger EFT effect for LO+1jet.

LO+1jet

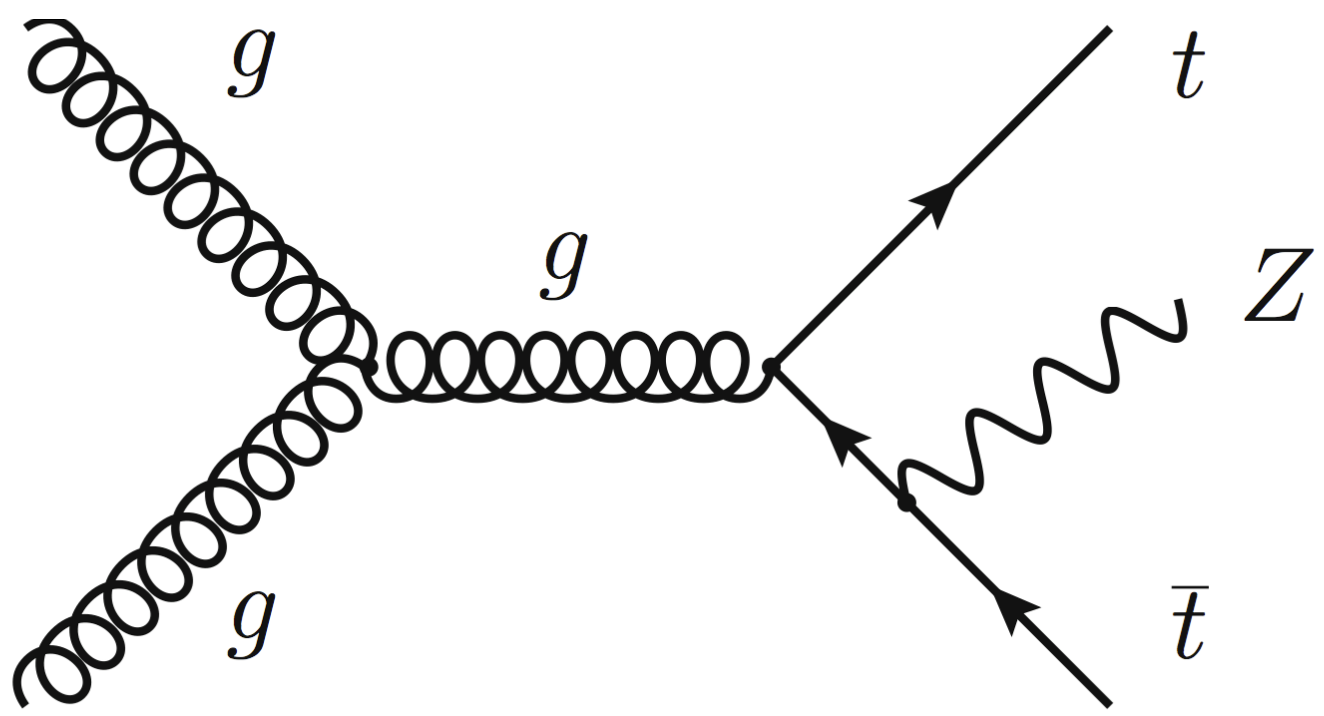
NLO



Reweighting for $t\bar{t}Z$

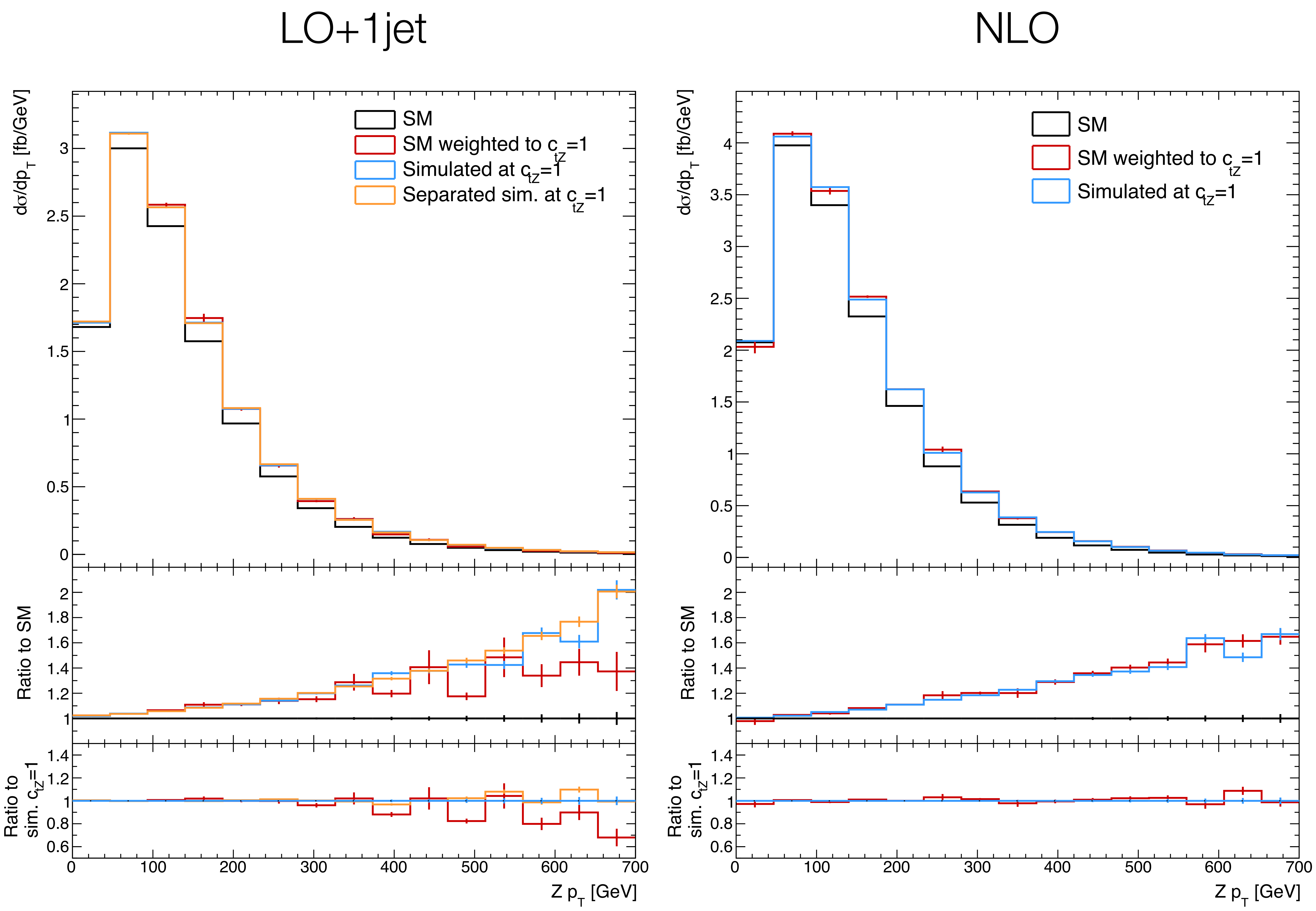
A. Belvedere

- Process: $t\bar{t}Z$



- Model: SMEFT@NLO & SMEFTsim
- Operator: $\mathcal{O}_{tZ}$

Reweighting seems to work better in the NLO simulation.
Slightly larger EFT effect for LO+1jet.



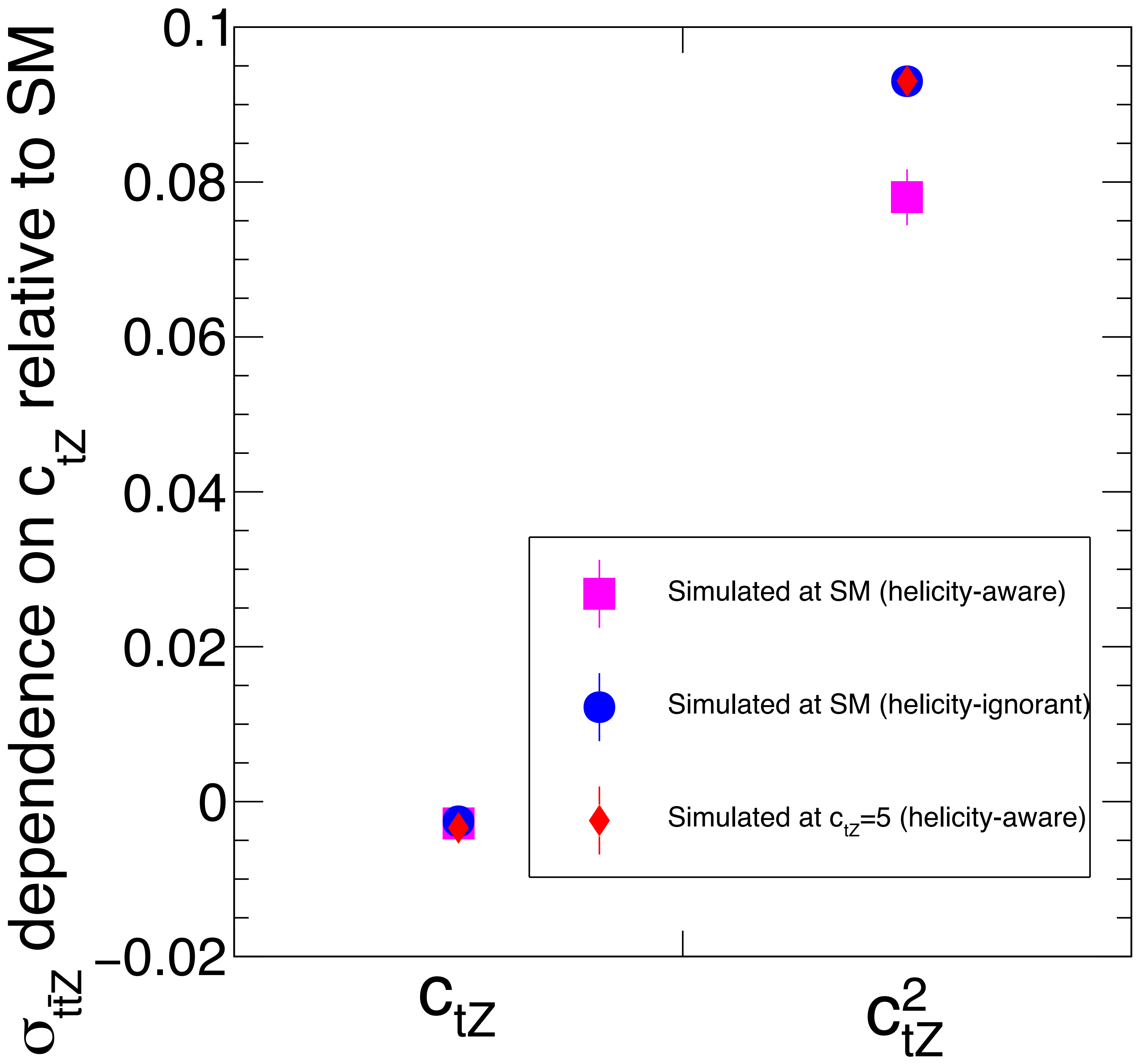
Helicity reweighting in $t\bar{t}Z$

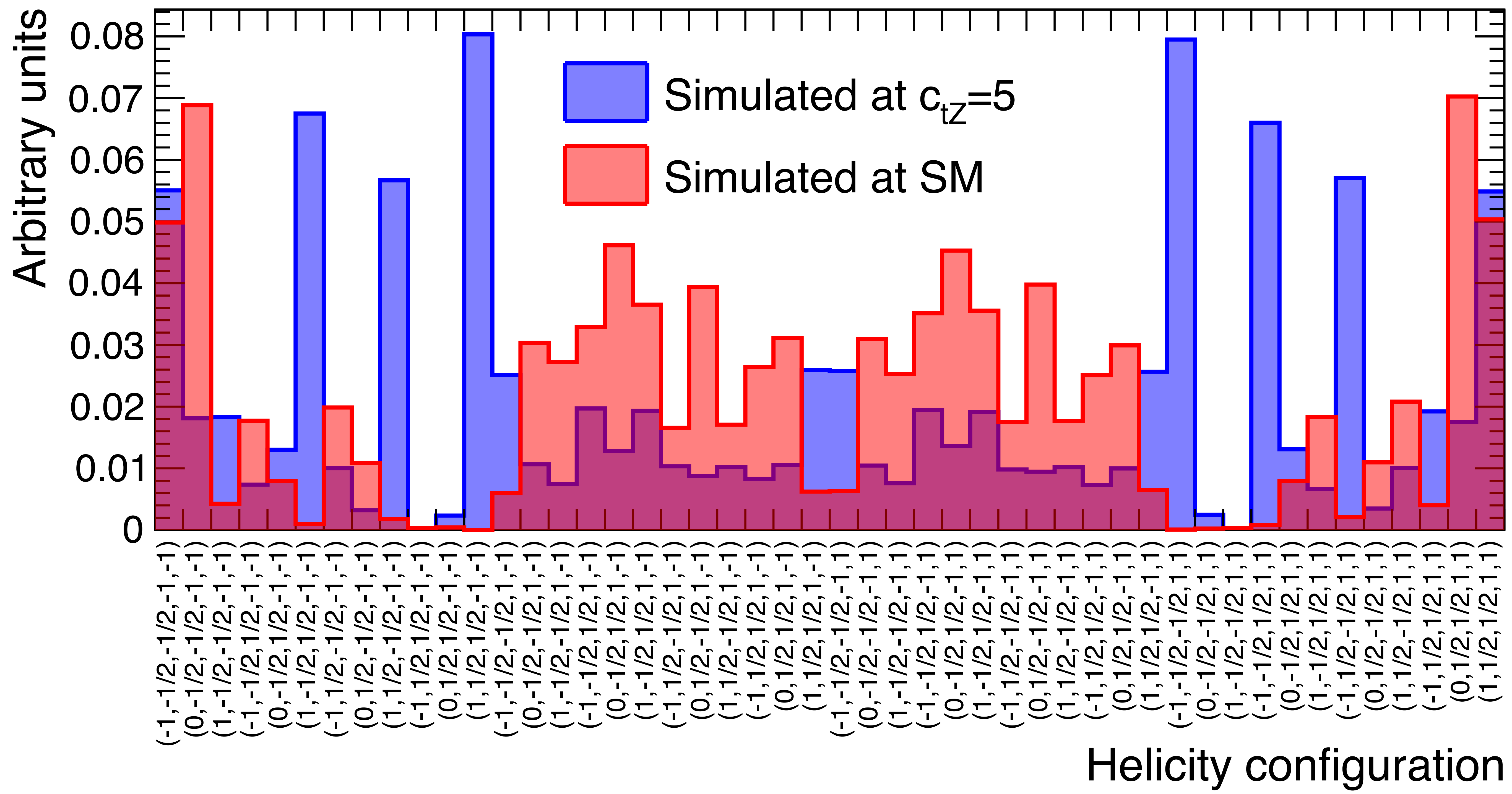
S. S. Cruz

- Process: $t\bar{t}Z$
- Model: Dim6top
- Operator: $\mathcal{O}_{tZ}$

Helicity-aware reweighting: $W_{new} = |\mathcal{M}_h^{new}|^2 / \mathcal{M}_h^{old}|^2 \cdot w_{old}$

Helicity-ignorant reweighting: $W_{new} = |\sum_h \mathcal{M}_h^{new}|^2 / \sum_h \mathcal{M}_h^{old}|^2 \cdot w_{old}$



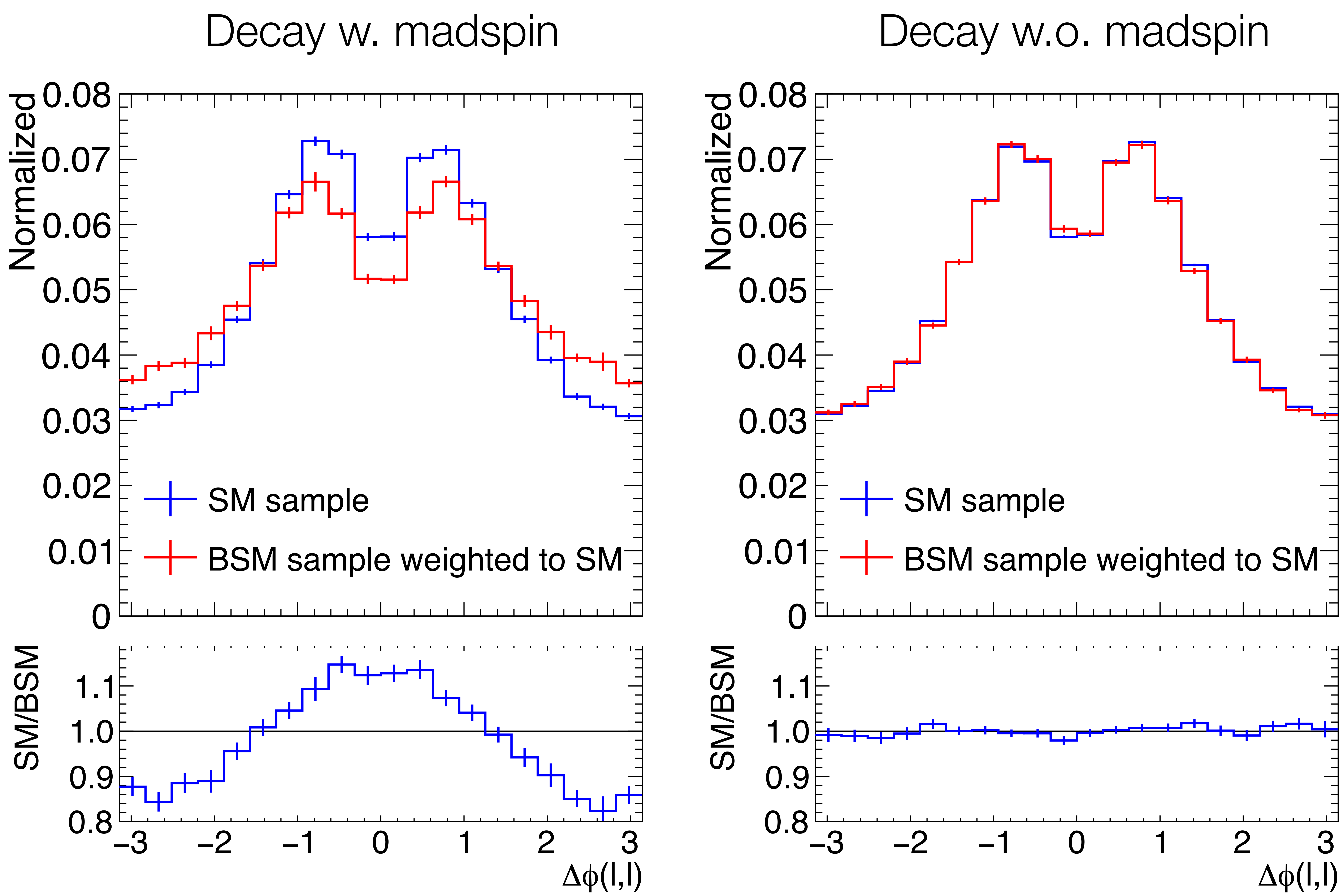


Helicity reweighting in $t\bar{t}Z$

S. S. Cruz

- MadSpin computes the matrix element at the reference point.
- It can't infer spin correlation of the decay products at another point.

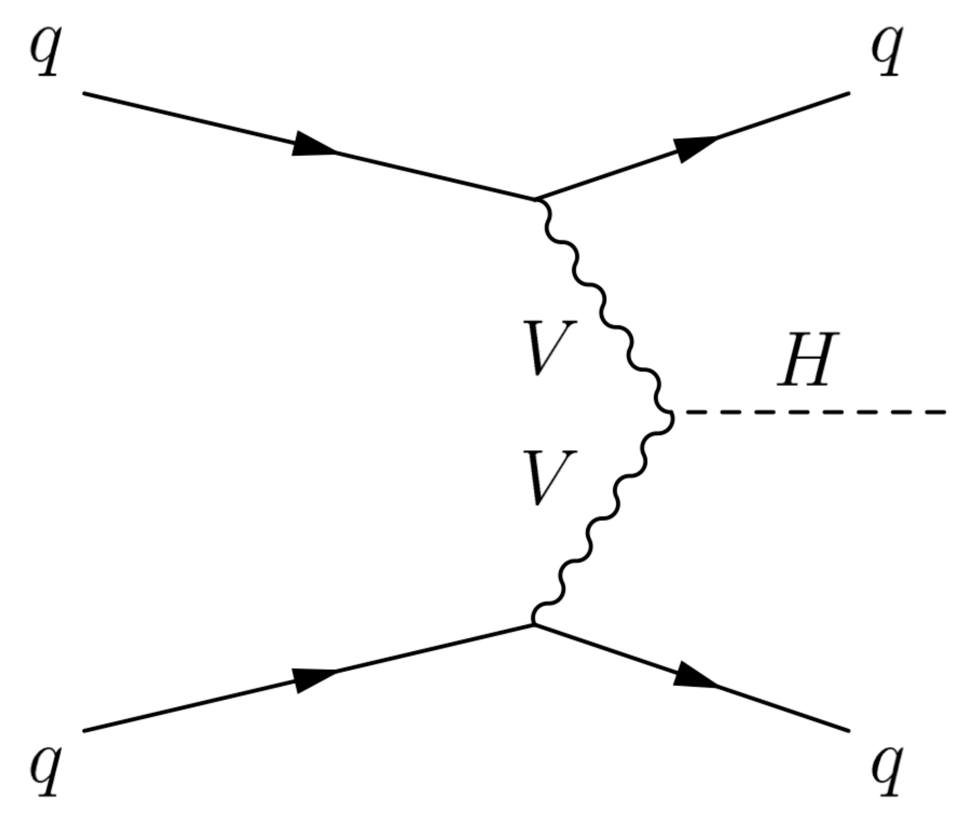
Good agreement when reweighting is performed after top and Z decay.



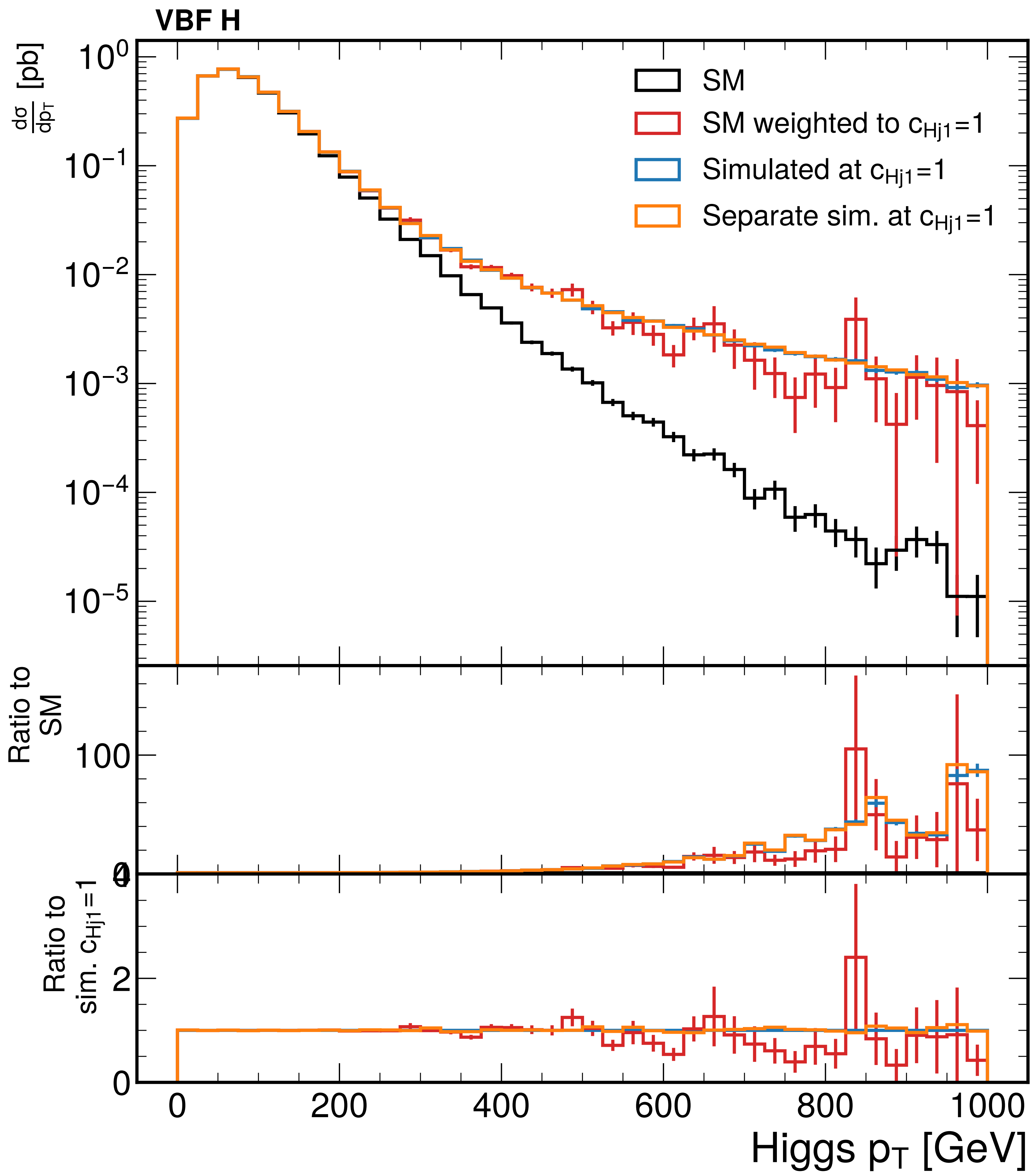
Reweighting in VBF Higgs production

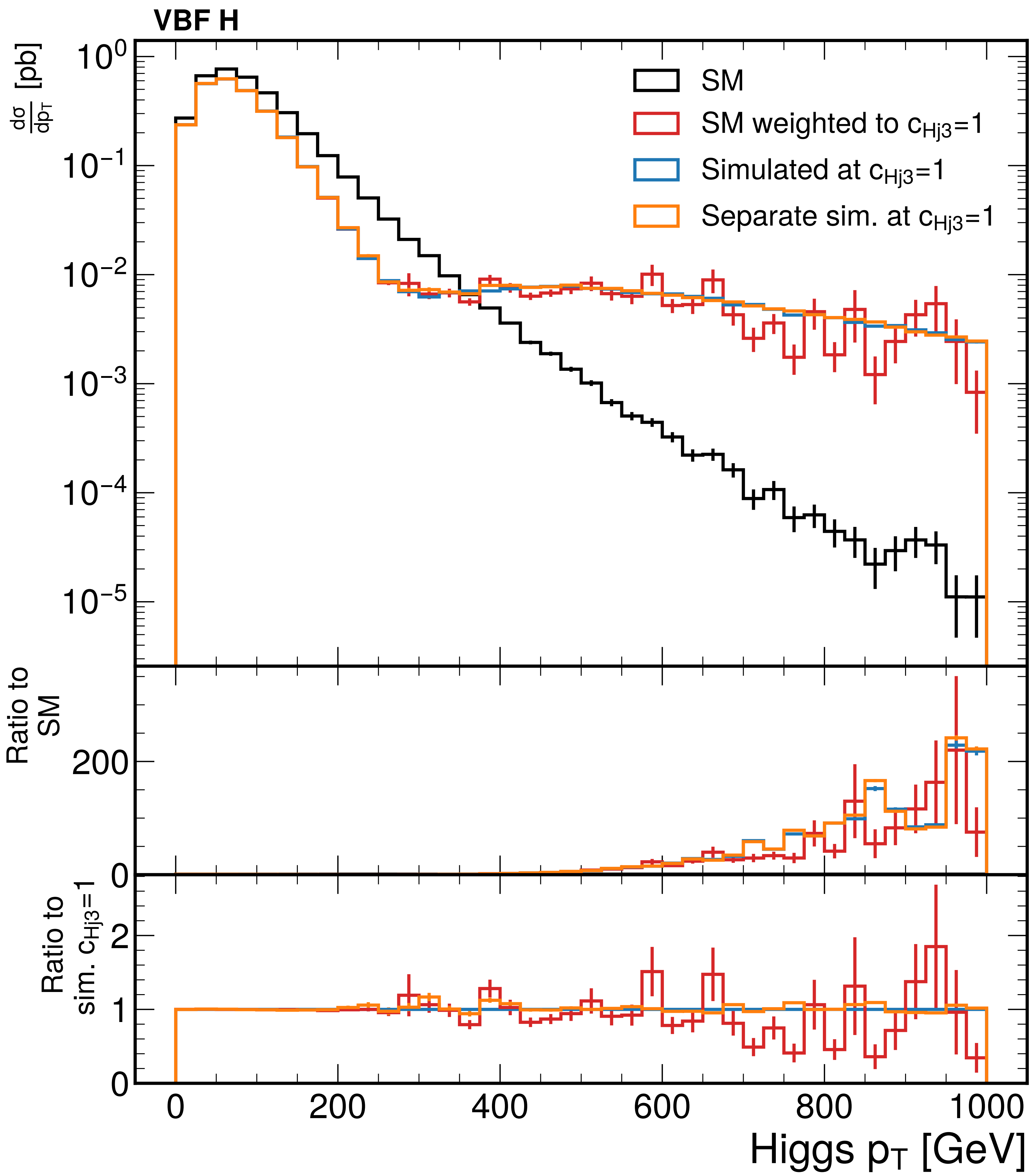
S. Chatterjee & J.Dickinson

- Process: VBF Higgs production



- Model: SMEFTsim using NPall
- Operators: $\mathcal{O}_{Hq}^{(1)}, \mathcal{O}_{Hq}^{(3)}, \mathcal{O}_{HW}, \mathcal{O}_{H\widetilde{W}}$



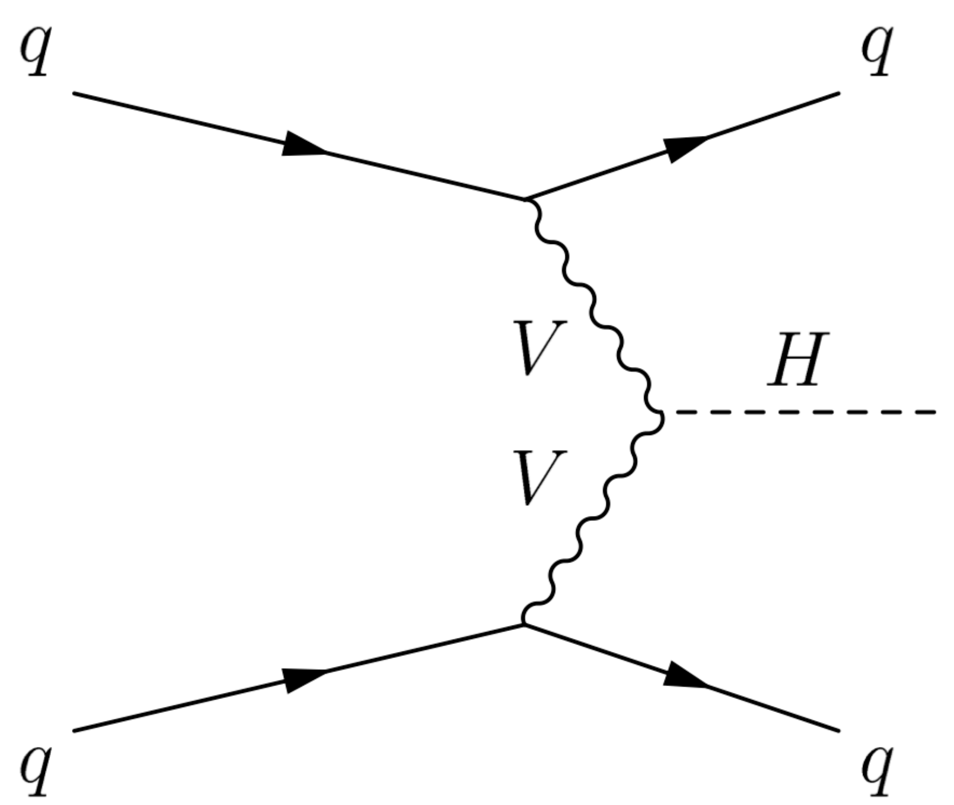


Good agreement among direct, separate and reweighted distributions.

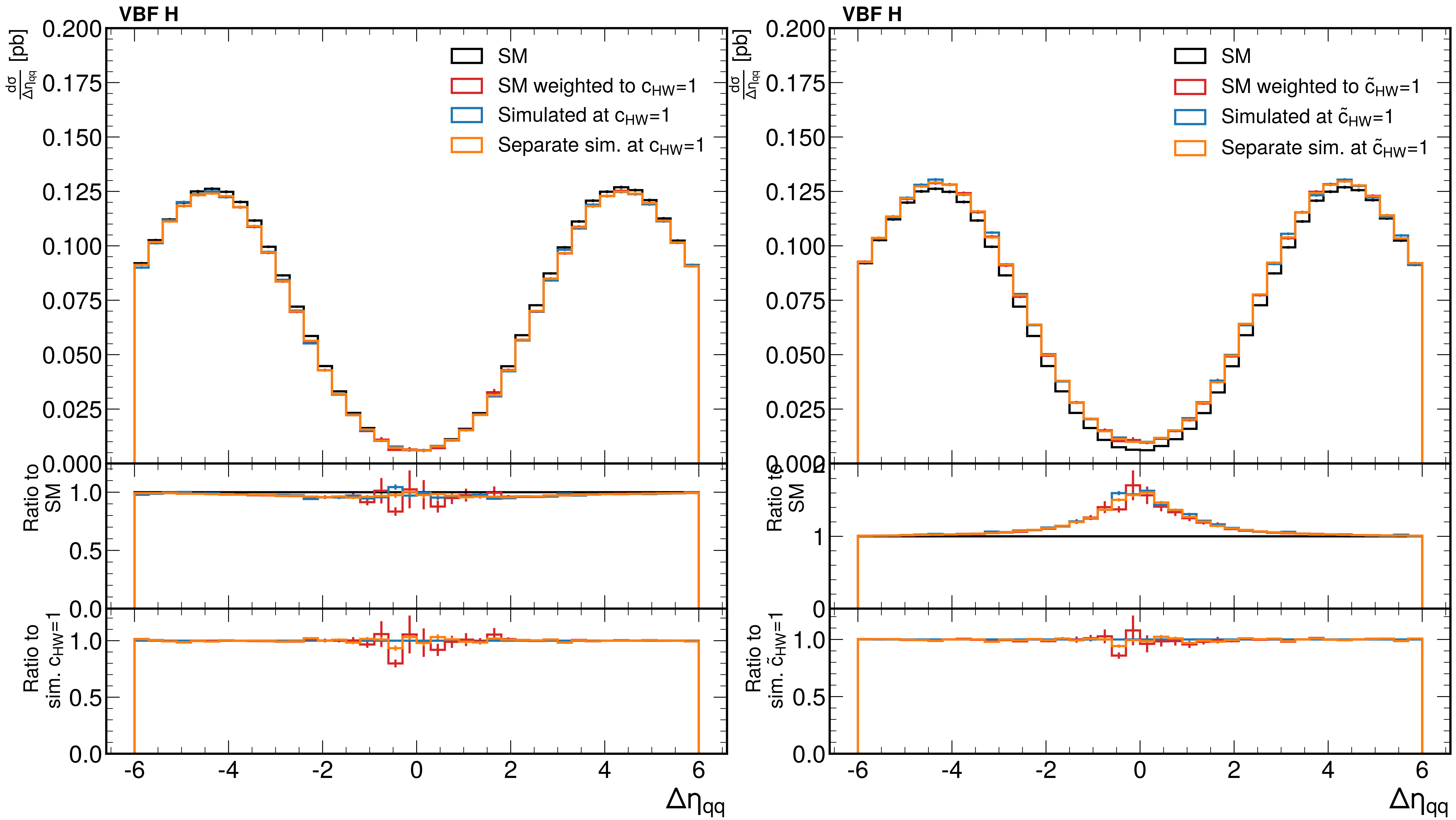
Reweighting in VBF Higgs production

S. Chatterjee & J.Dickinson

- Process: VBF Higgs production



- Model: SMEFTsim using NPall
- Operators: $\mathcal{O}_{Hq}^{(1)}, \mathcal{O}_{Hq}^{(3)}, \mathcal{O}_{HW}, \mathcal{O}_{H\widetilde{W}}$

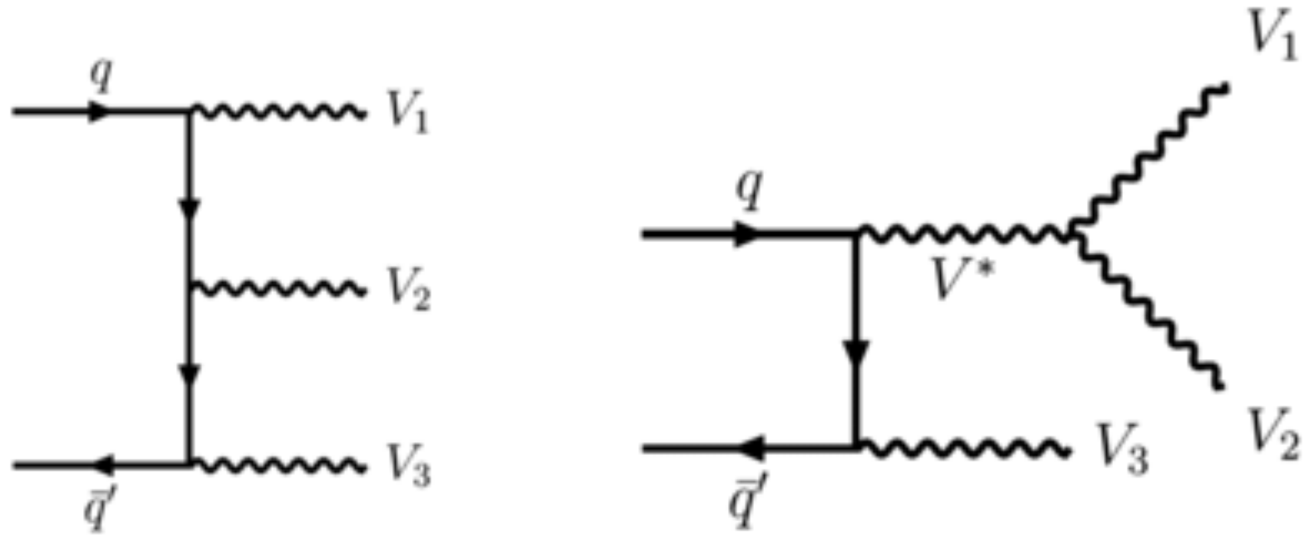


Good agreement among direct, separate and reweighted distributions.

Triboson processes

S. Bhattacharya & Triboson team

- Process: triboson production

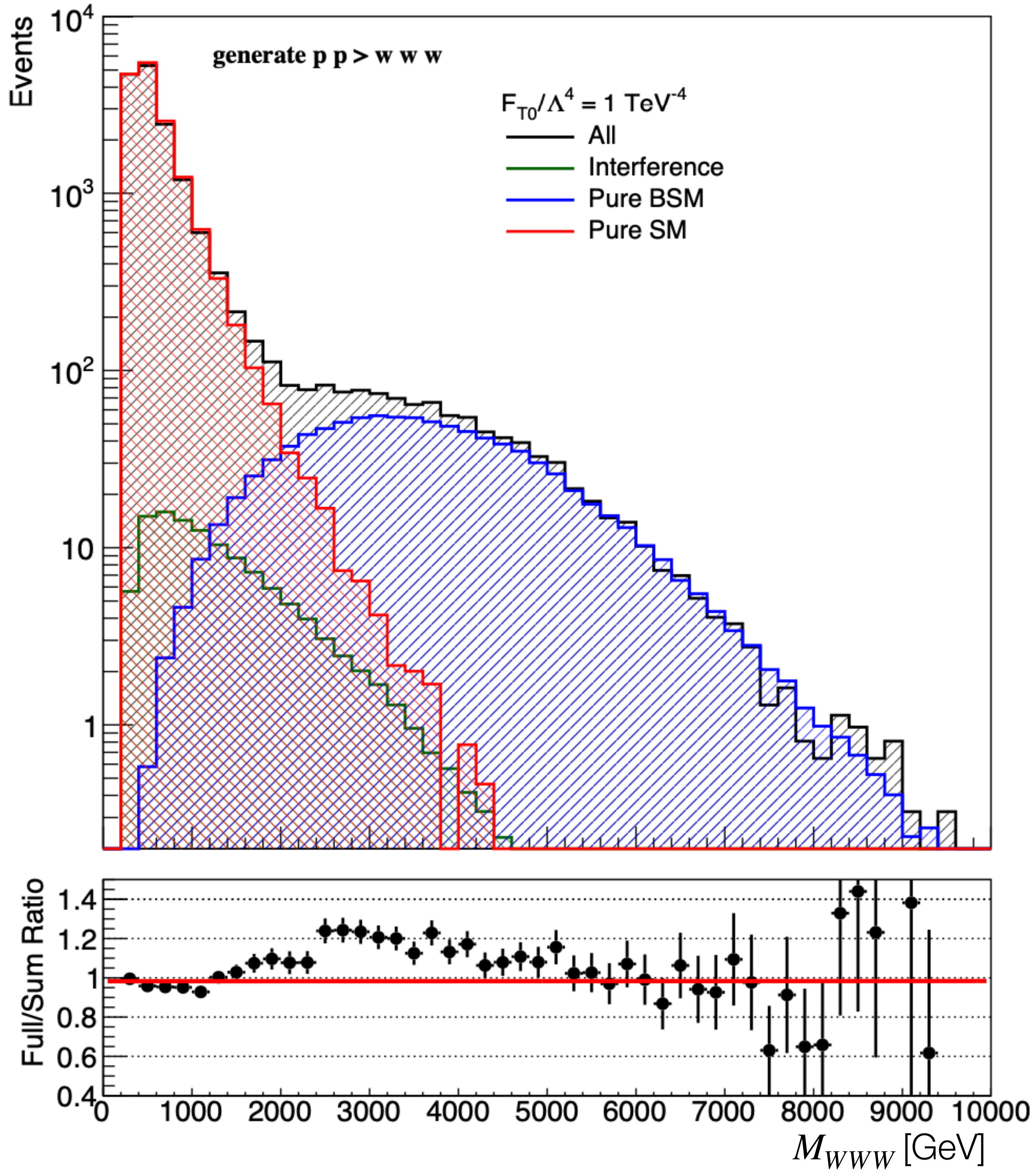


- Model: SMEFTsim
- Operator: $\mathcal{O}_W$

A careful choice of the scale is needed to correctly simulate the EFT contribution separately.

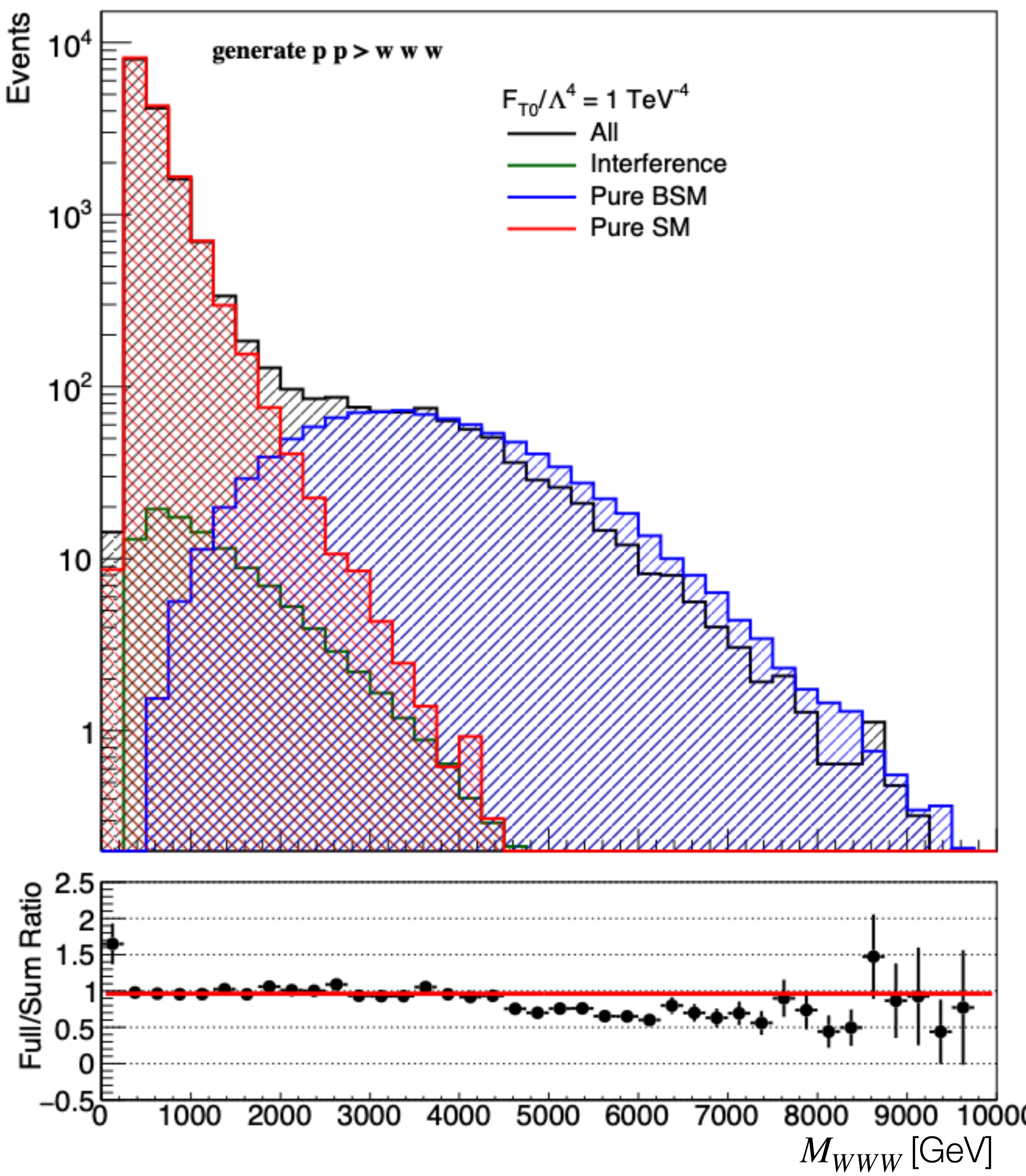
Dynamical scale = - 1

Transverse mass of 2→2 system from kT clustering



Dynamical scale = 1

Total transverse energy



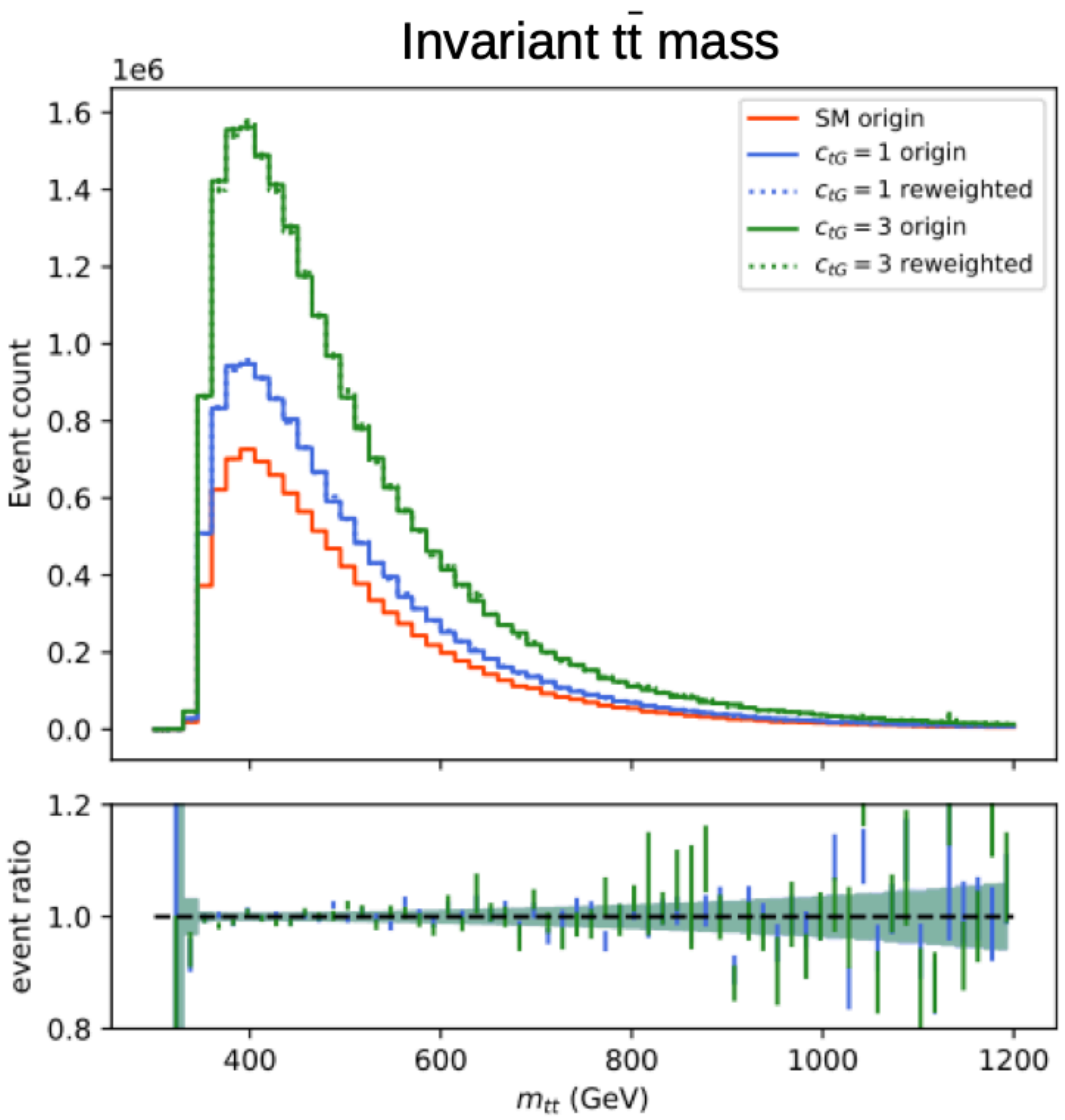
Post-mortem reweighting

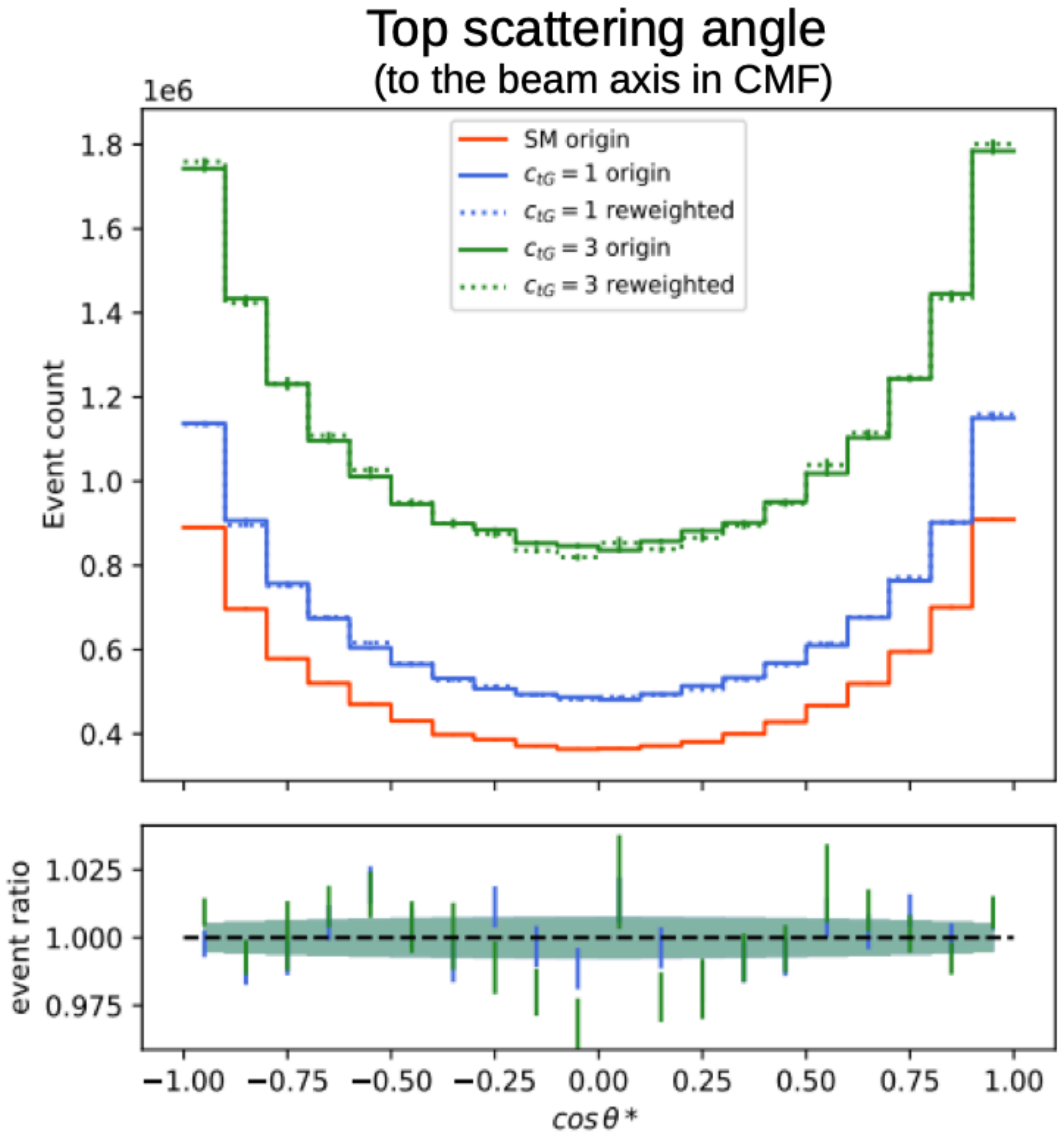
L. Jeppe & A. Grohsjean

Possibility to reuse existing simulated SM samples with large statistics for EFT analyses calculating event weights for specific EFT points.

$$w = \frac{|M_{EFT}(p_i, s_i)|^2}{|M_{SM}(p_i, s_i)|^2}$$

- **Inputs**: momenta and spin of initial and final state particles.
- **Restrictions**:
  - Baseline and EFT sample must have same initial and final state.
  - Phase space well covered by the SM sample.
- Implemented in MG5 at **LO**.
- Tested on $t\bar{t}$ process and $\mathcal{O}_{tG}$ operator using dim6top.





Summary

An overview of the **LHC EFT prediction note** content has been presented.

What did we learn?

- **Helicity-ignorant reweighting** does a great job in sampling the (B)SM phase space but it's not able to reproduce specific helicity configurations.
- **MadSpin** computes the matrix element at the reference point but can't infer **spin correlation** of the decay products at another point.
- The choice of the **scale** is crucial when producing separate simulations predictions.
- It is possible to **add EFT effects to simulated samples** at LO.

Residual discrepancies that need further investigations:

- **Discrepancy** at high energy in the M_{WWW} distribution.
- Significant **fluctuations** in the tail of few reweighting distributions.

Conclusions

A big thanks to all the contributors.

The most important aspects of **EFT prediction simulation** are covered in the note.

Helicity ignorant and aware reweighting, NLO reweighting, separated sample method, scale choice and post-mortem reweighting.

The selected **benchmark processes** cover most of the LHC physics program.

Top physics, Higgs physics, vector boson fusion and multi boson processes.

Next steps:

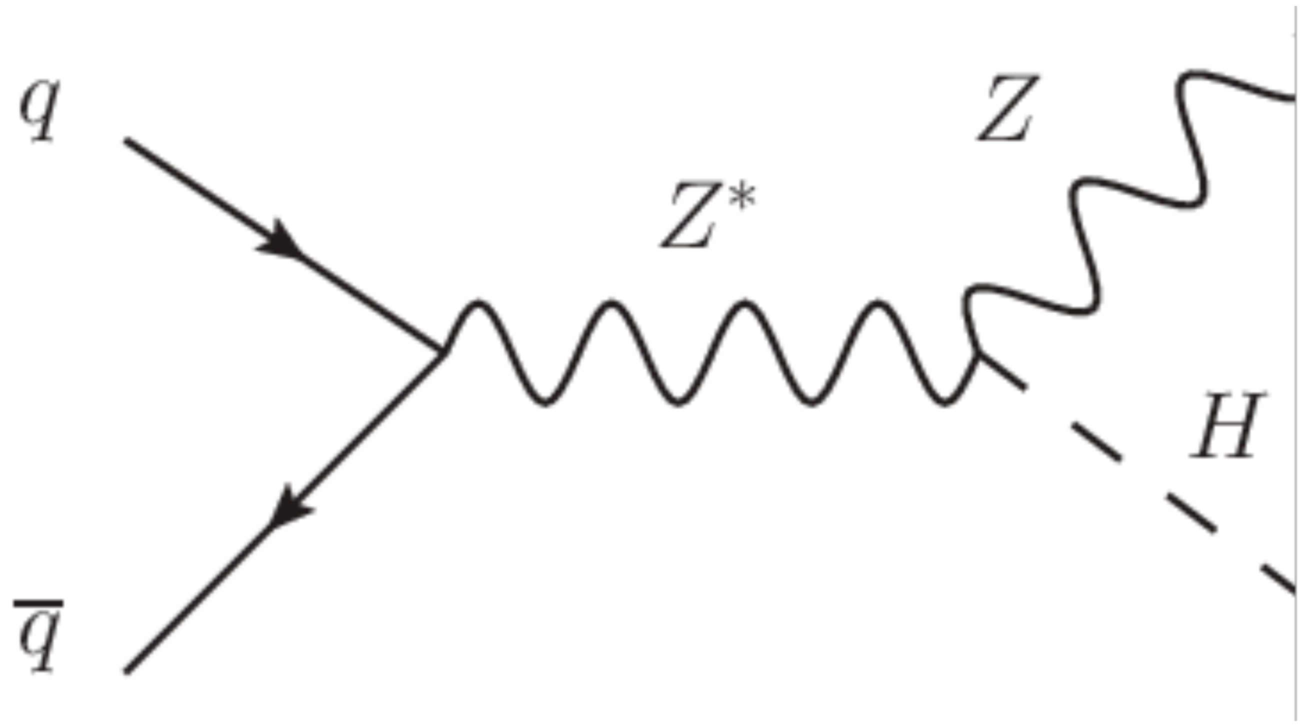
1) Authors + editors meeting to finalize draft text.
2) Invite theory colleagues for contributions & scrutiny of the draft.

Backup

Reweighting in ZH

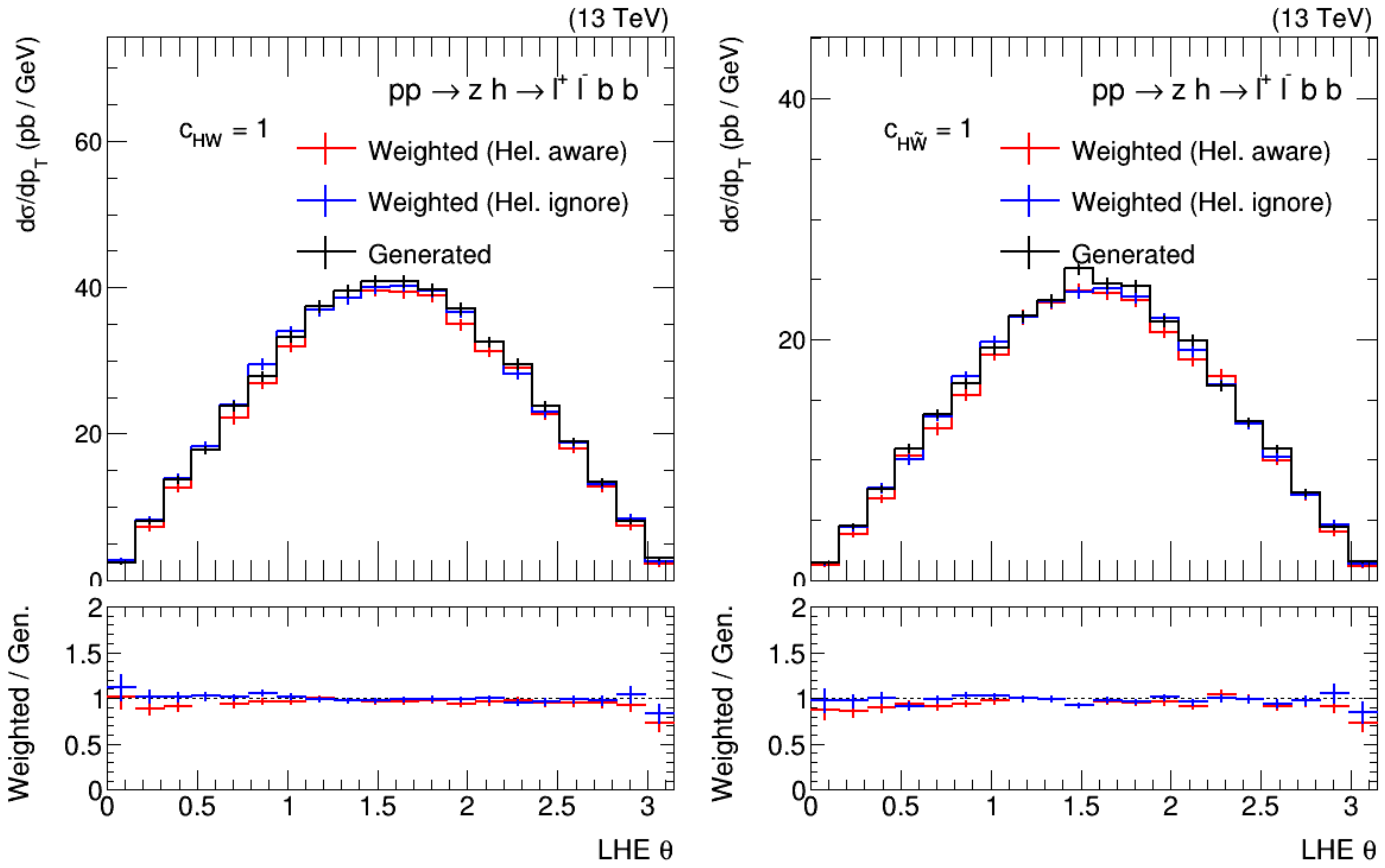
S. Banerjee, A. Calandri, S. Chatterjee, F. Glessgen, N. Smith, V. Perovic

- Process: ZH



- Model: SMEFTsim
- Operator: $\mathcal{O}_{HW}, \mathcal{O}_{H\widetilde{W}}$

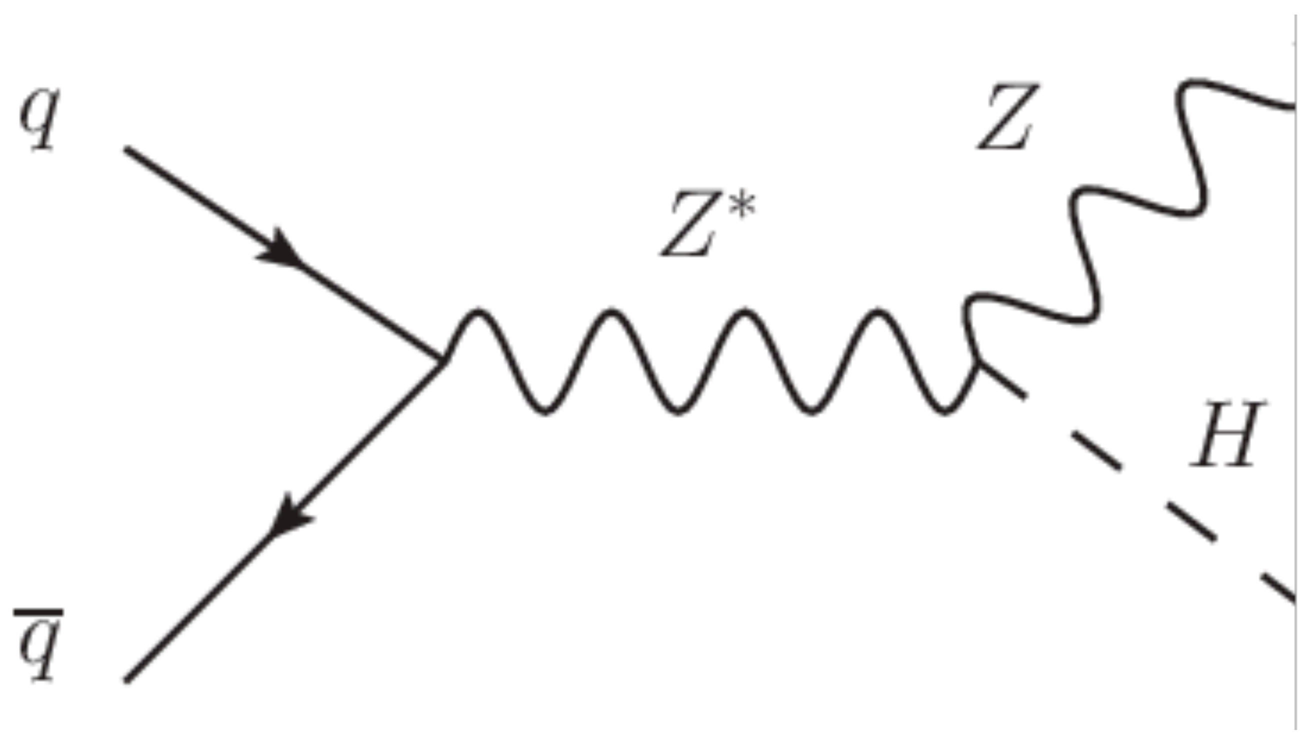
Both helicity aware and ignorant reweighting are in good agreement with the generated distribution.



Reweighting in ZH

S. Banerjee, A. Calandri, S. Chatterjee, F. Glessgen, N. Smith, V. Perovic

- Process: ZH



- Model: SMEFTsim
- Operator: $\mathcal{O}_{HW}, \mathcal{O}_{H\widetilde{W}}$

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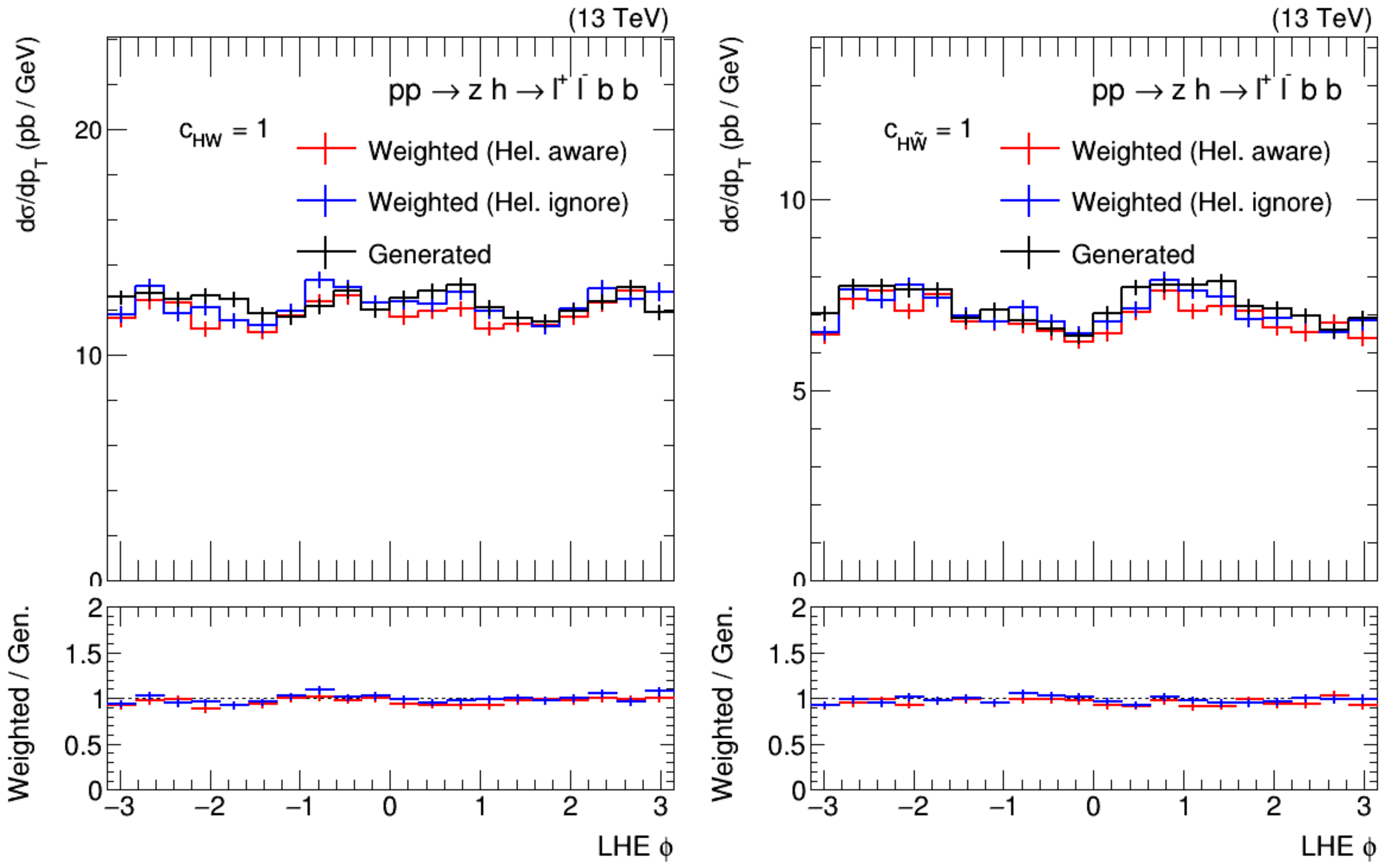
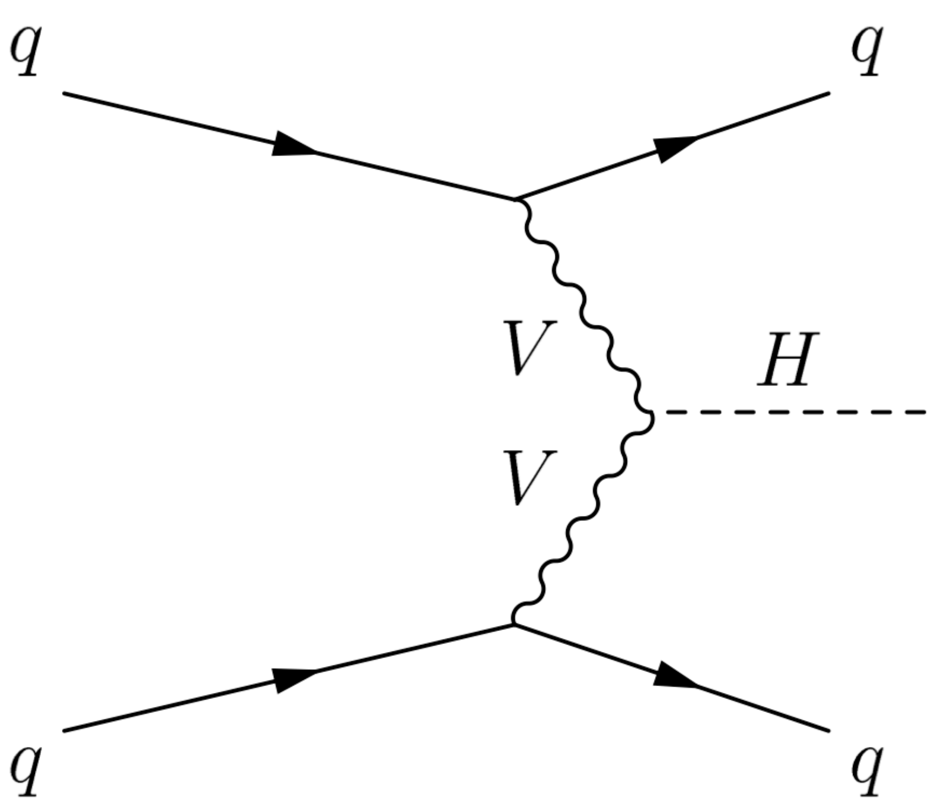


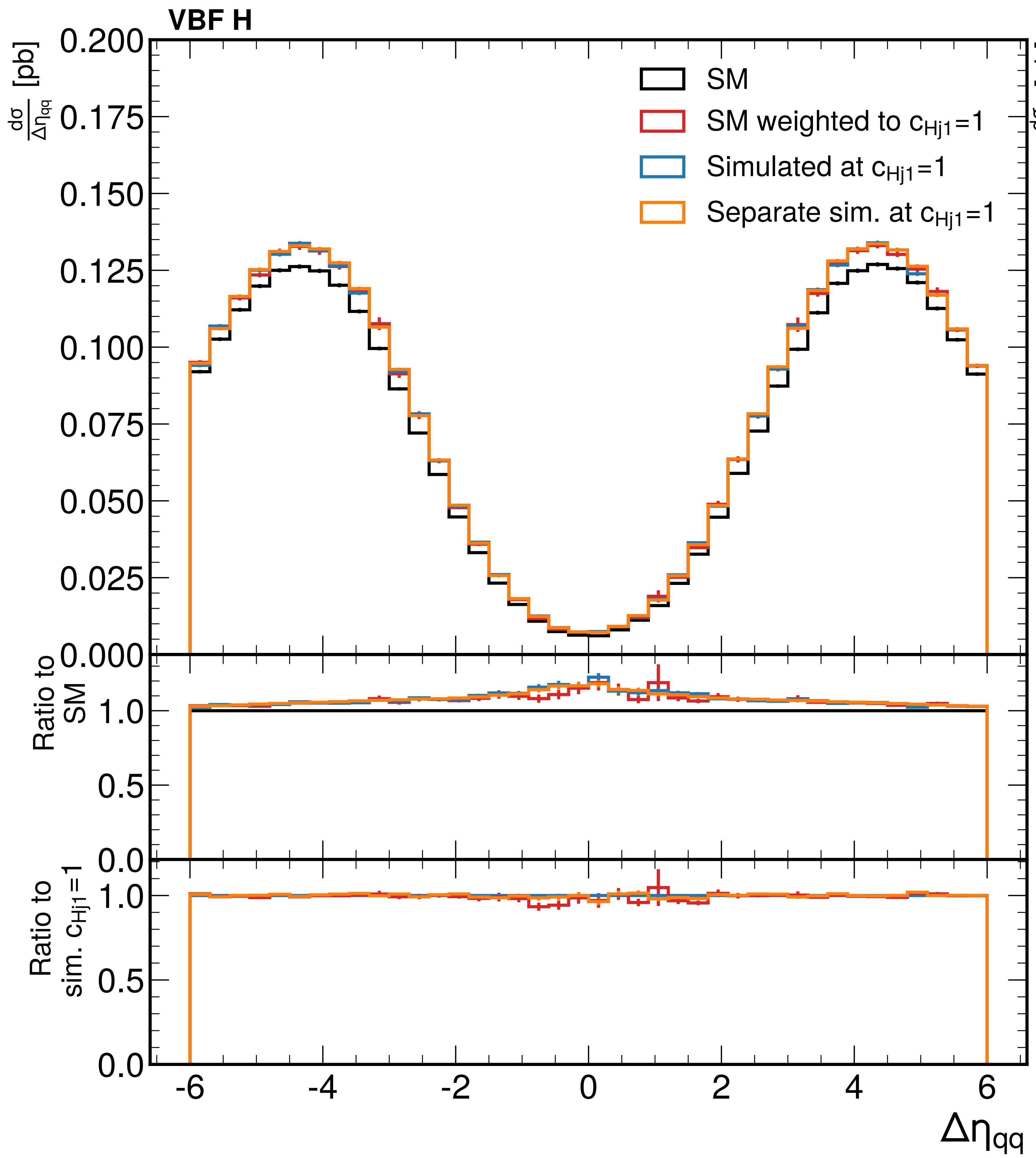
Reweighting in VBF Higgs production

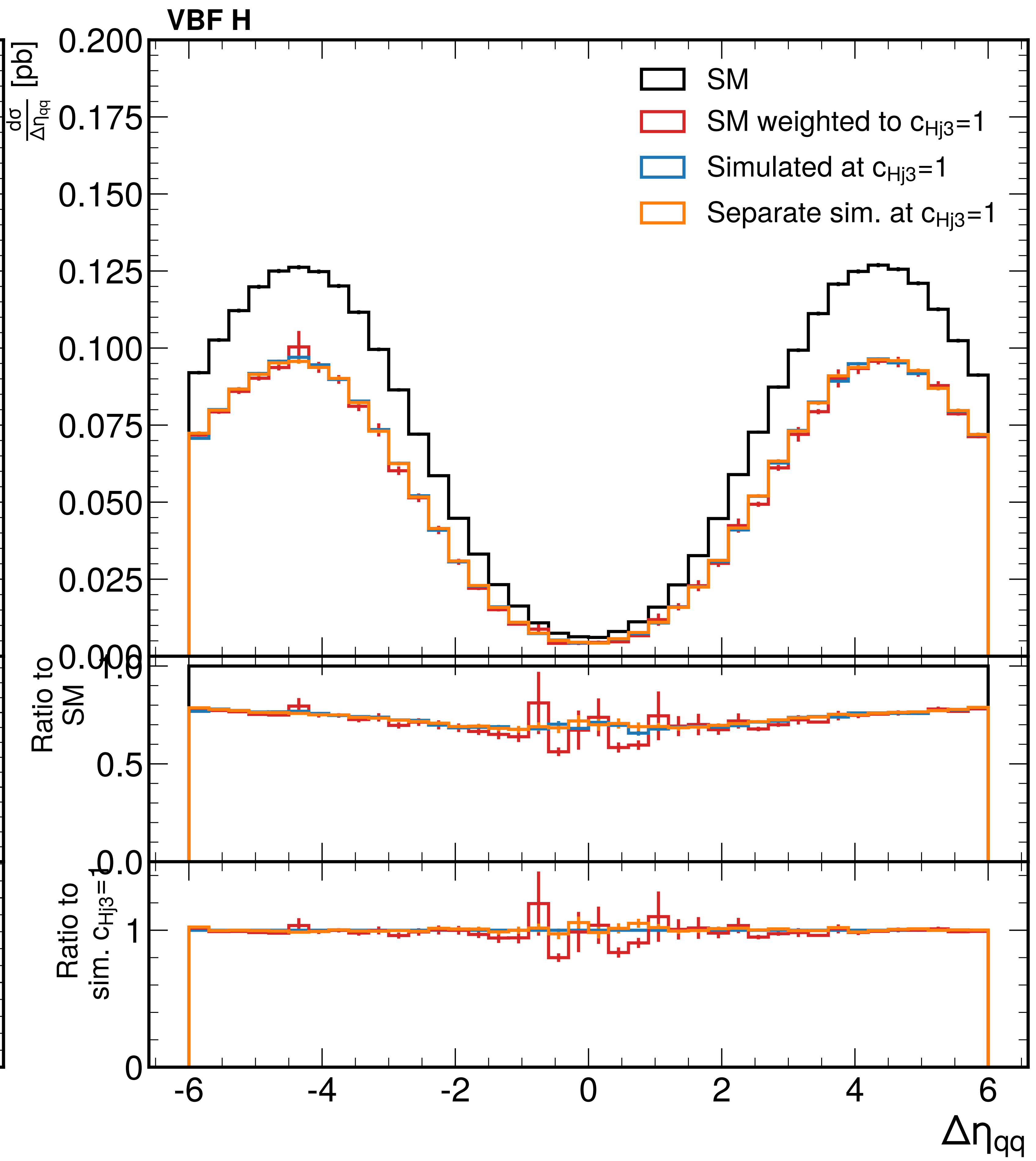
S. Chatterjee & J.Dickinson

- Process: VBF Higgs production



- Model: SMEFTsim using NPall
- Operators: $\mathcal{O}^{(1)}_{Hq}, \mathcal{O}^{(3)}_{Hq}, \mathcal{O}_{HW}, \mathcal{O}_{H\widetilde{W}}$



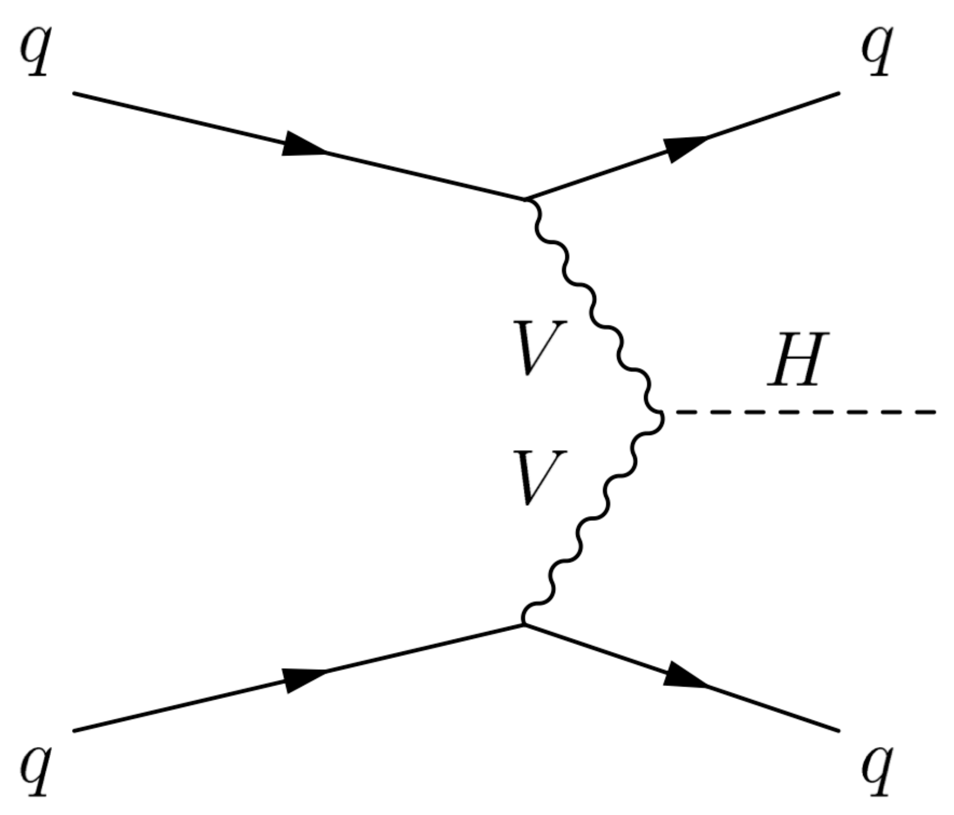


Good agreement among direct, separate and reweighted distributions.

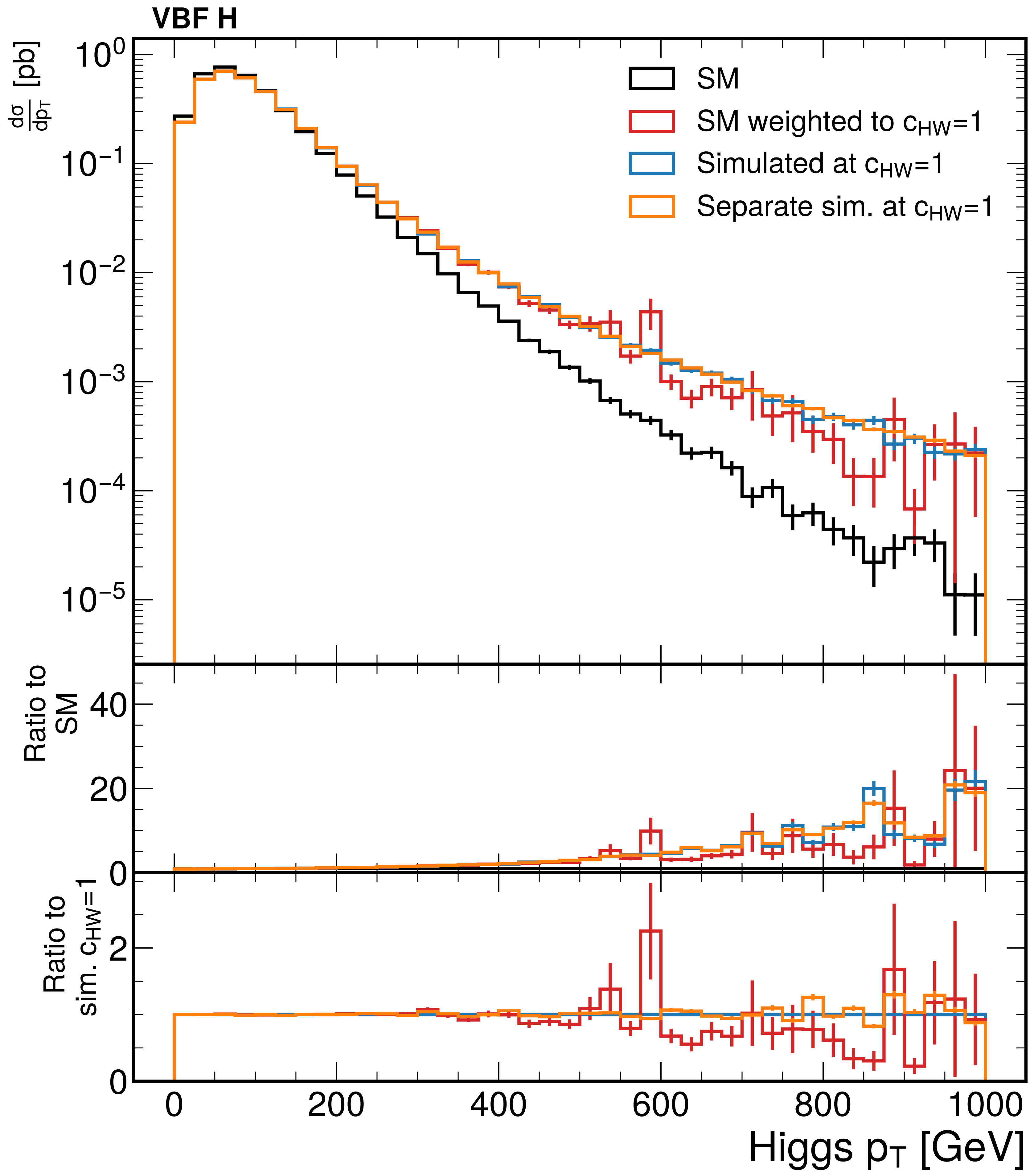
Reweighting in VBF Higgs production

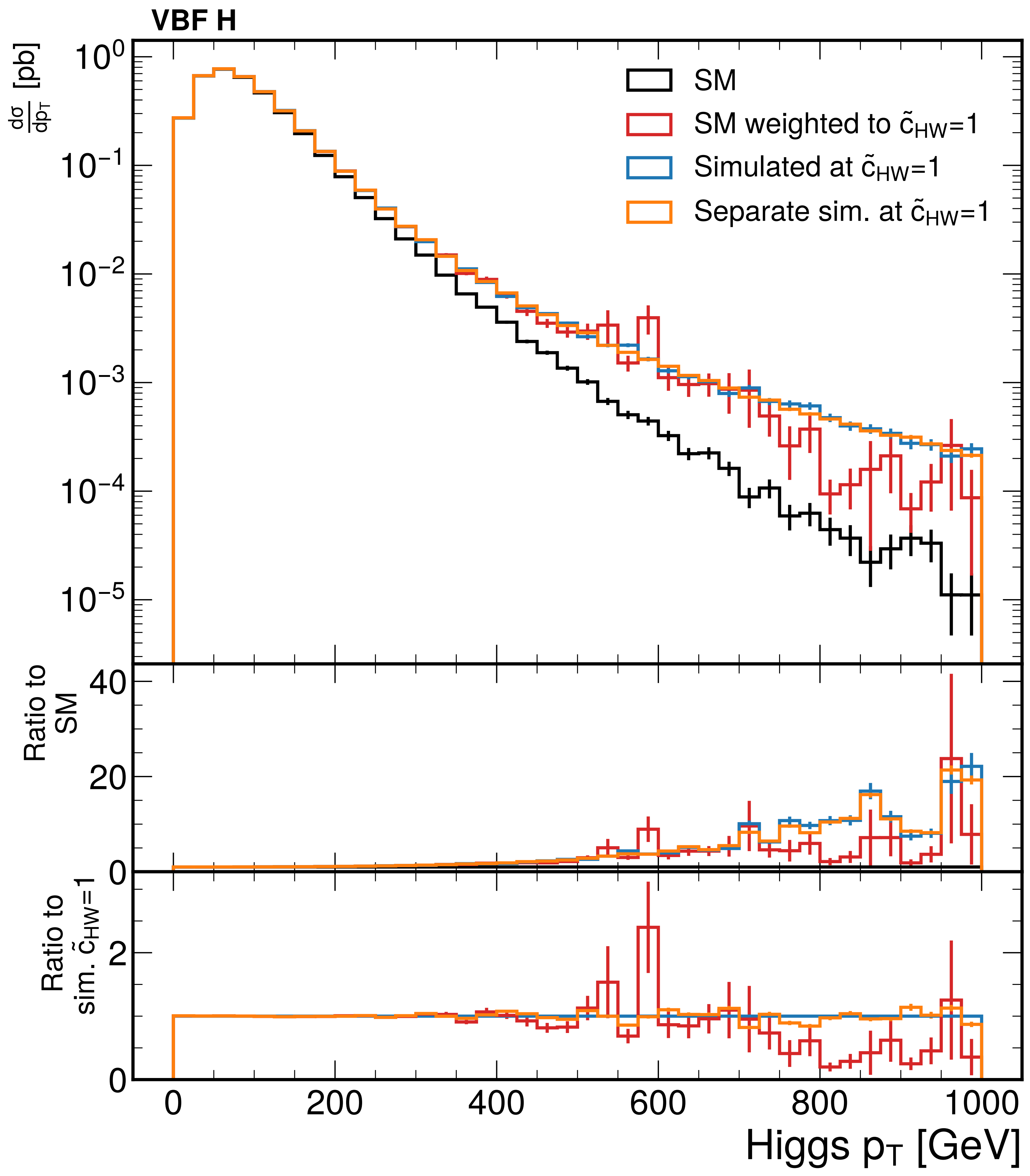
S. Chatterjee & J.Dickinson

- Process: VBF Higgs production



- Model: SMEFTsim using NPall
- Operators: $\mathcal{O}_{Hq}^{(1)}, \mathcal{O}_{Hq}^{(3)}, \mathcal{O}_{HW}, \mathcal{O}_{H\widetilde{W}}$





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