WW and multiboson projections and EFT interpretation at the HL-LHC

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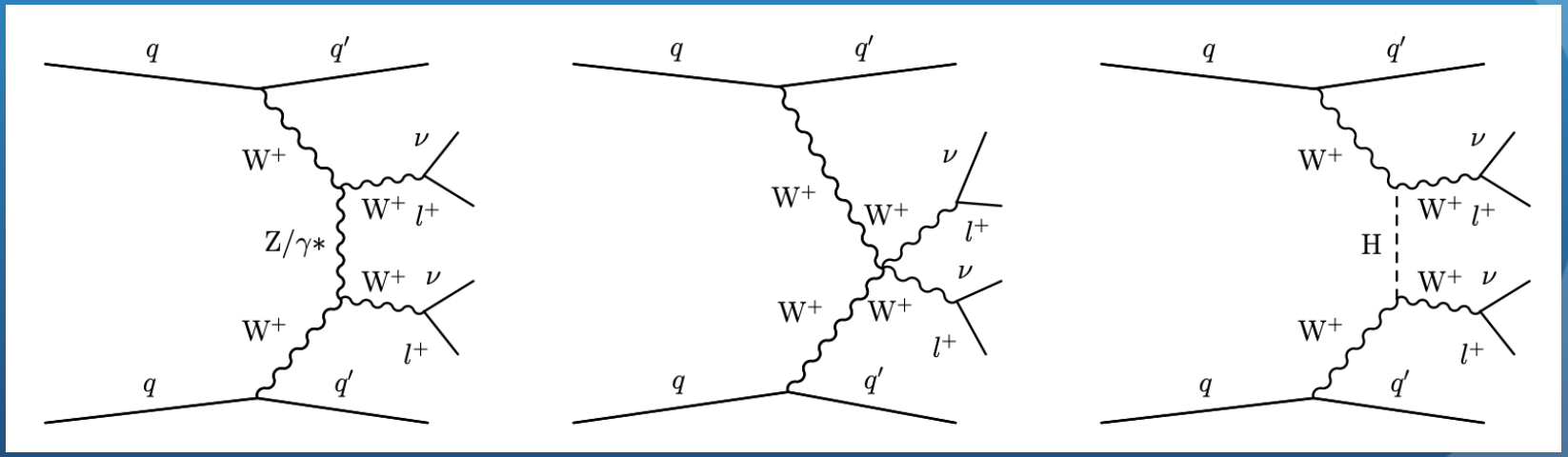
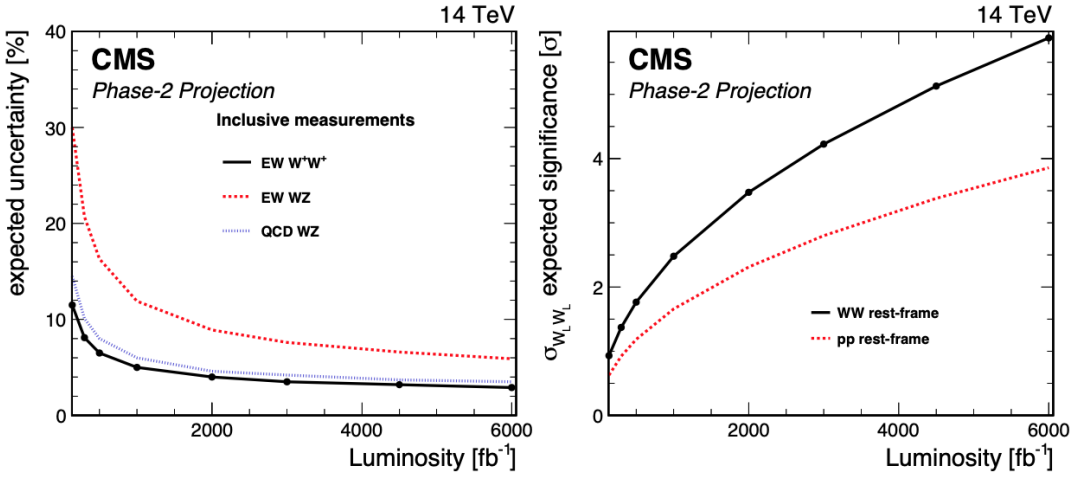
VV Snowmass projections (VBS)

- VV Snowmass projections were mainly done for VBS
- $V_L V_L$ was mainly inspected for WW, WZ, ZZ



VV Snowmass projections (VBS)

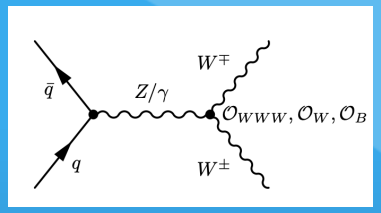
- https://cds.cern.ch/record/2805993



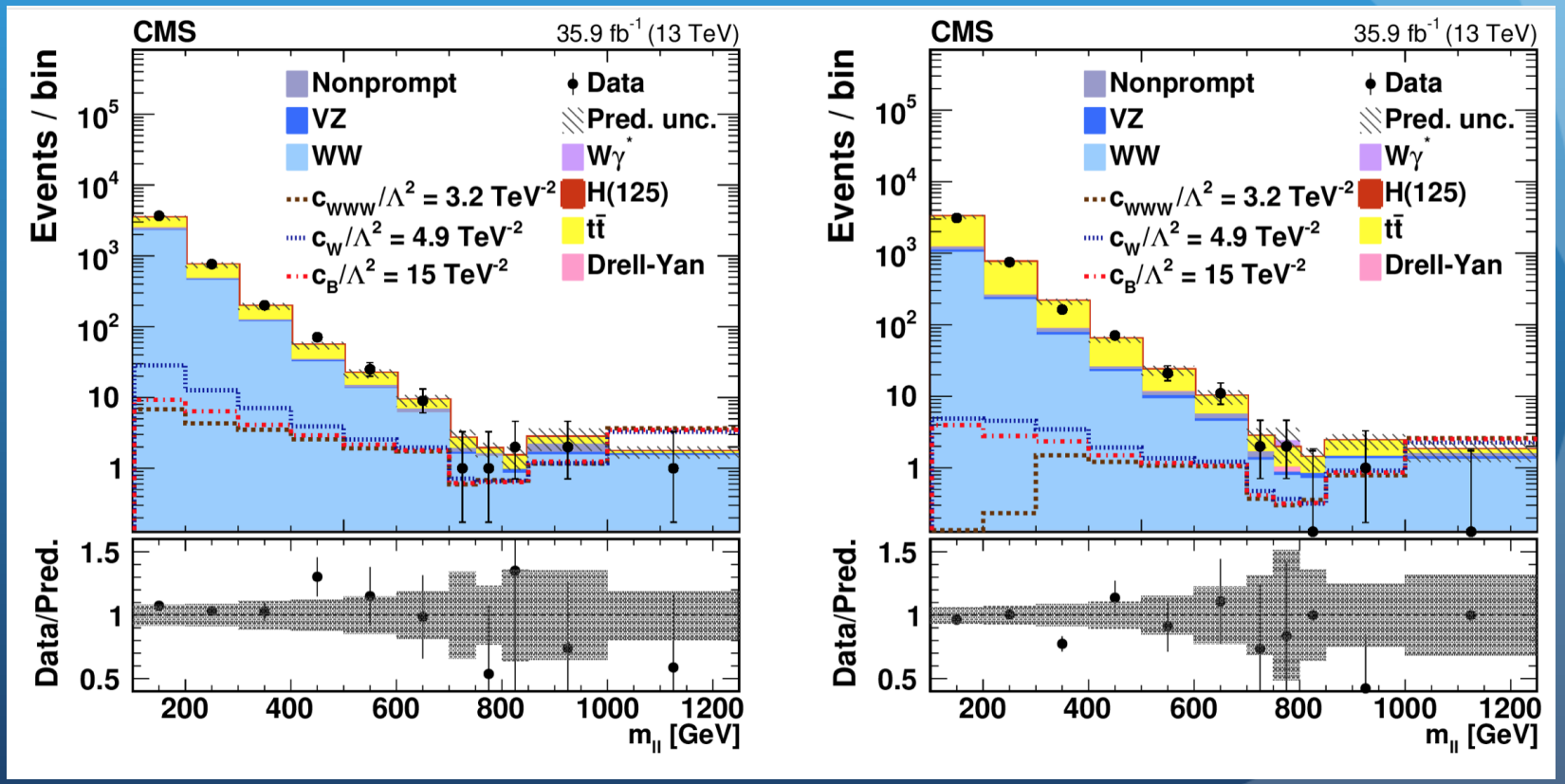
(a) (b)

Figure 33: (a) Projected estimated uncertainty in the EW $W^{\pm}W^{\pm}$, EW $W^{\pm}Z$, and QCD $W^{\pm}Z$ cross-section measurements as a function of the integrated luminosity, and (b) projected estimated significance for the EW $W_L^{\pm}W_L^{\pm}$ process as a function of the integrated luminosity for the $W^{\pm}W^{\pm}$ and parton-parton center-of-mass reference frames. [173]

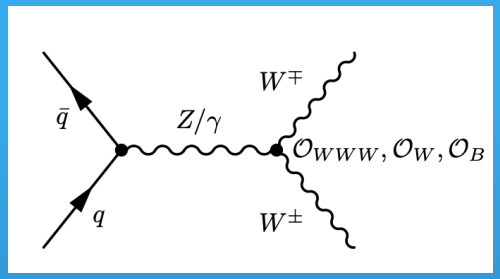
VV EFT projections were not done for Snowmass



- Recent W^+W^+ CMS results: [Phys. Rev. D 102 (2020) 092001]



Phys. Rev. D 102 (2020) 092001



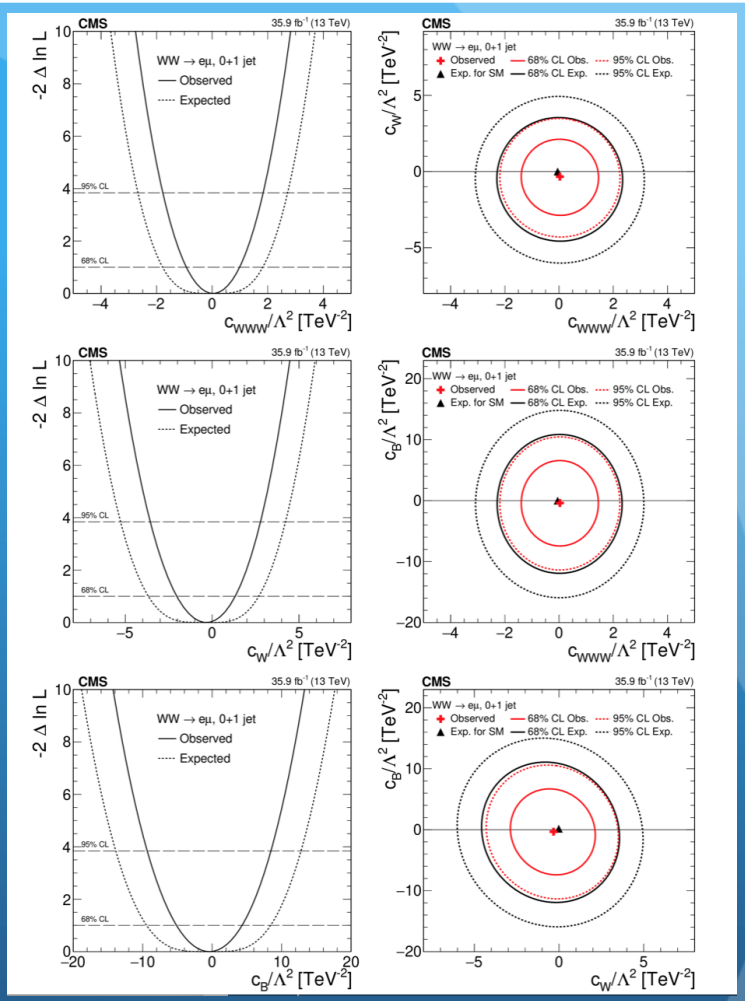
$$\mathcal{O}_{\mathrm{WWW}} = \frac{c_{\mathrm{WWW}}}{\Lambda^2} W_{\mu\nu} W^{\nu\rho} W_{\rho}{}^{\mu}$$

$$\mathcal{O}_{\mathrm{W}} = \frac{c_{\mathrm{W}}}{\Lambda^2} (D^{\mu}\Phi)^{\dagger} W_{\mu\nu} (D^{\nu}\Phi)$$

$$\mathcal{O}_{B} = \frac{c_{B}}{\Lambda^2} (D^{\mu}\Phi)^{\dagger} B_{\mu\nu} (D^{\nu}\Phi)$$

$$\widetilde{\mathcal{O}}_{\mathrm{WWW}} = \frac{\widetilde{c}_{\mathrm{WWW}}}{\Lambda^2} \widetilde{W}_{\mu\nu} W^{\nu\rho} W_{\rho}{}^{\mu}$$

$$\widetilde{\mathcal{O}}_{\mathrm{W}} = \frac{\widetilde{c}_{\mathrm{W}}}{\Lambda^2} (D^{\mu}\Phi)^{\dagger} \widetilde{W}_{\mu\nu} (D^{\nu}\Phi).$$



Coefficients (TeV^{-2})	68% confidence interval expected	68% confidence interval observed	95% confidence interval expected	95% confidence interval observed
$c_{\mathrm{WWW}}/\Lambda^2$	$[-1.8, 1.8]$	$[-0.93, 0.99]$	$[-2.7, 2.7]$	$[-1.8, 1.8]$
c_{W}/Λ^2	$[-3.7, 2.7]$	$[-2.0, 1.3]$	$[-5.3, 4.2]$	$[-3.6, 2.8]$
c_B/Λ^2	$[-9.4, 8.4]$	$[-5.1, 4.3]$	$[-14, 13]$	$[-9.4, 8.5]$

WW+VBS VV EFT projections for HL-LHC

- Thanks to Riccardo Bellan and Giacomo Boldrini for proving the reference and numbers arxiv:2108.03199

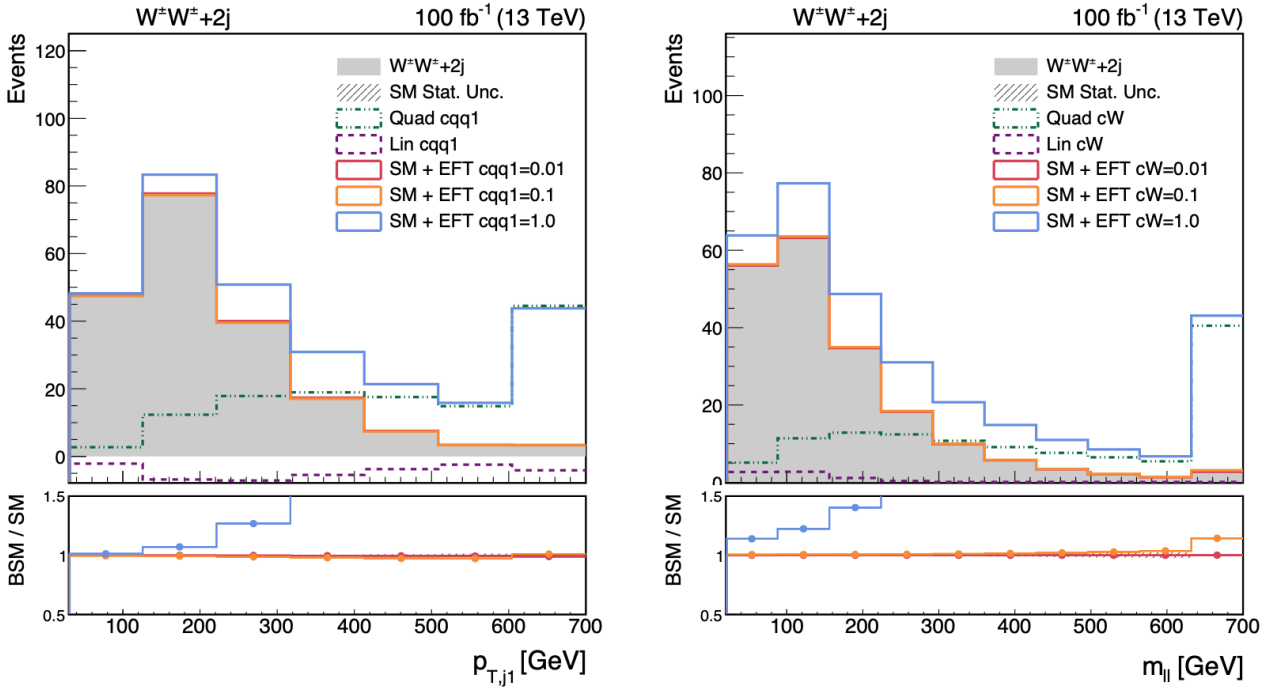
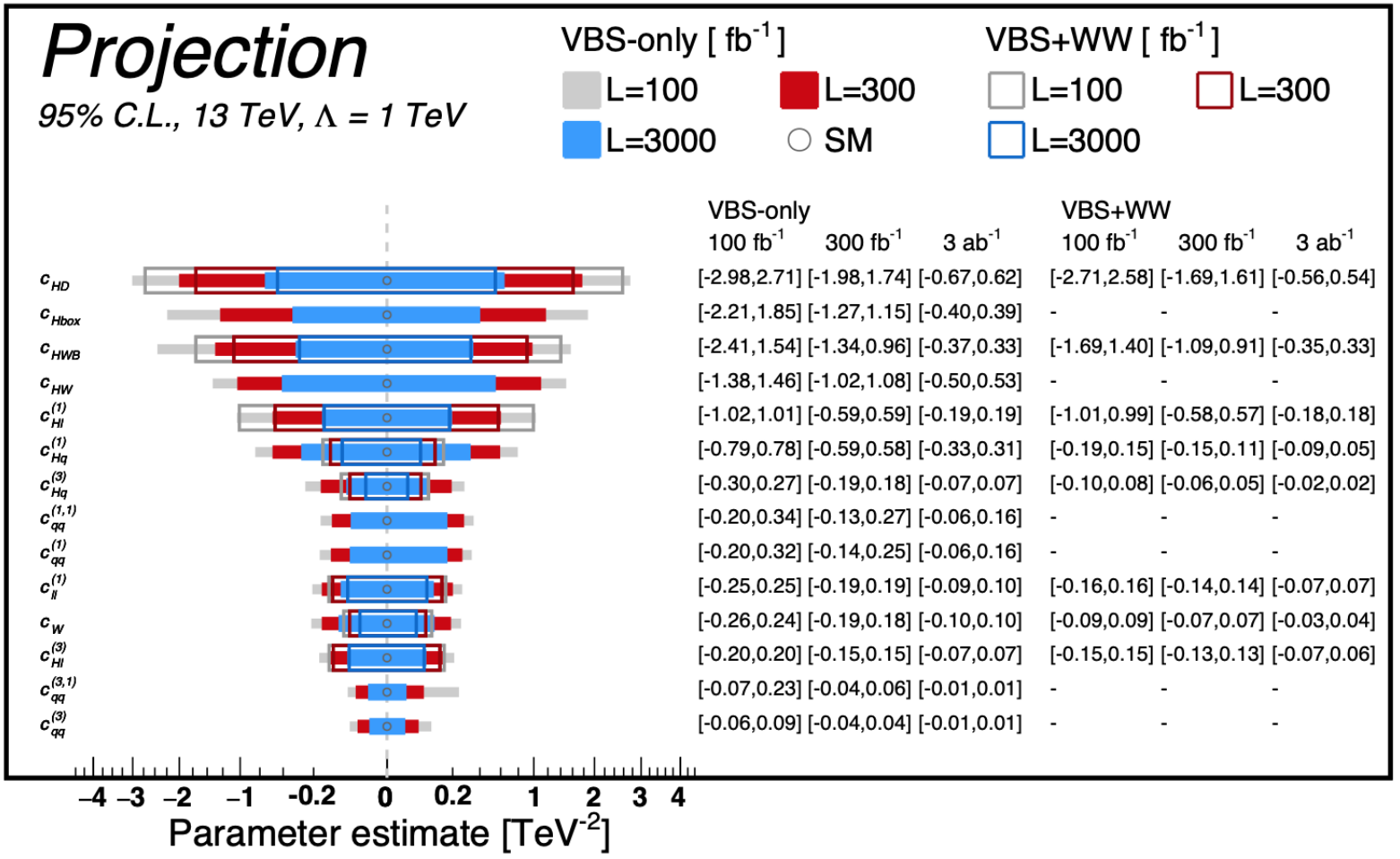


Figure 1. Impact of two Wilson coefficients on representative kinematic distributions in the SSWW+2j process. Solid lines show the total prediction for one Wilson coefficient at a time, with $c_\alpha/\Lambda^2 = 0.01$ (red), 0.1 (orange) or $1\,\text{TeV}^{-2}$ (blue). The pure interference (quadratic) EFT component, normalized to $c_\alpha/\Lambda^2 = 1\,\text{TeV}^{-2}$, is indicated with a purple (green) dashed line. The SM prediction is shown in solid grey. The last bin comprises all the overflow events.

WW+VBS VV



	VBS-only			VBS+WW		
	100 fb^{-1}	300 fb^{-1}	3 ab^{-1}	100 fb^{-1}	300 fb^{-1}	3 ab^{-1}
c_{HD}	[-2.98,2.71]	[-1.98,1.74]	[-0.67,0.62]	[-2.71,2.58]	[-1.69,1.61]	[-0.56,0.54]
c_{Hbox}	[-2.21,1.85]	[-1.27,1.15]	[-0.40,0.39]	-	-	-
c_{HWB}	[-2.41,1.54]	[-1.34,0.96]	[-0.37,0.33]	[-1.69,1.40]	[-1.09,0.91]	[-0.35,0.33]
c_{HW}	[-1.38,1.46]	[-1.02,1.08]	[-0.50,0.53]	-	-	-
$c_{Hl}^{(1)}$	[-1.02,1.01]	[-0.59,0.59]	[-0.19,0.19]	[-1.01,0.99]	[-0.58,0.57]	[-0.18,0.18]
$c_{Hq}^{(1)}$	[-0.79,0.78]	[-0.59,0.58]	[-0.33,0.31]	[-0.19,0.15]	[-0.15,0.11]	[-0.09,0.05]
$c_{Hq}^{(3)}$	[-0.30,0.27]	[-0.19,0.18]	[-0.07,0.07]	[-0.10,0.08]	[-0.06,0.05]	[-0.02,0.02]
$c_{qq}^{(1,1)}$	[-0.20,0.34]	[-0.13,0.27]	[-0.06,0.16]	-	-	-
$c_{qq}^{(1)}$	[-0.20,0.32]	[-0.14,0.25]	[-0.06,0.16]	-	-	-
$c_{ll}^{(1)}$	[-0.25,0.25]	[-0.19,0.19]	[-0.09,0.10]	[-0.16,0.16]	[-0.14,0.14]	[-0.07,0.07]
c_{W}	[-0.26,0.24]	[-0.19,0.18]	[-0.10,0.10]	[-0.09,0.09]	[-0.07,0.07]	[-0.03,0.04]
$c_{Hl}^{(3)}$	[-0.20,0.20]	[-0.15,0.15]	[-0.07,0.07]	[-0.15,0.15]	[-0.13,0.13]	[-0.07,0.06]
$c_{qq}^{(3,1)}$	[-0.07,0.23]	[-0.04,0.06]	[-0.01,0.01]	-	-	-
$c_{qq}^{(3)}$	[-0.06,0.09]	[-0.04,0.04]	[-0.01,0.01]	-	-	-

WW only

Giacomo Boldrini,
private communication

100 fb-1

cHq3 ptl2 [-0.053,0.046] [-0.111,0.086]
cW met [-0.061,0.067] [-0.088,0.094]
cHq1 met [-0.141,0.099] [-0.191,0.149]
cHWB met [-1.474,1.500] [-2.095,2.123]
cHDD ptl2 [-3.073,3.558] [-5.727,7.798]
cHl1 met [-10.471,11.657] [-15.067,16.241]

300 fb-1

cHq3 ptl2 [-0.045,0.039] [-0.096,0.073]
cW met [-0.052,0.058] [-0.076,0.082]
cHq1 met [-0.126,0.084] [-0.168,0.126]
cHWB met [-1.281,1.306] [-1.817,1.843]
cHDD ptl2 [-2.445,2.730] [-4.601,5.759]
cHl1 met [-9.032,10.226] [-12.995,14.181]

3000 fb-1

cHq3 ptl2 [-0.029,0.026] [-0.061,0.048]
cW met [-0.038,0.044] [-0.055,0.061]
cHq1 met [-0.099,0.058] [-0.131,0.089]
cHWB met [-0.952,0.976] [-1.349,1.373]
cHDD ptl2 [-1.452,1.544] [-2.776,3.133]
cHl1 met [-6.604,7.808] [-9.526,10.727]