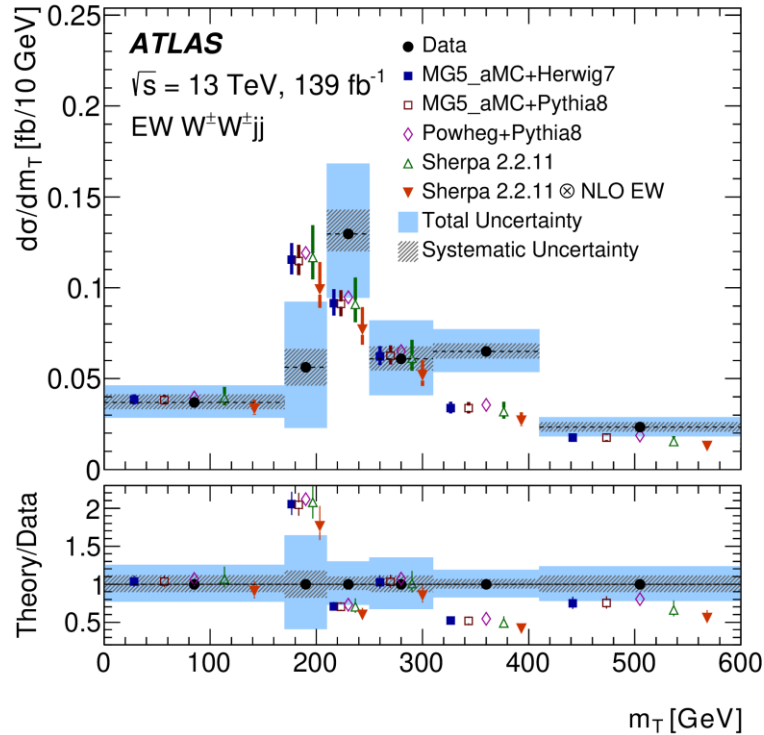


Cross section results

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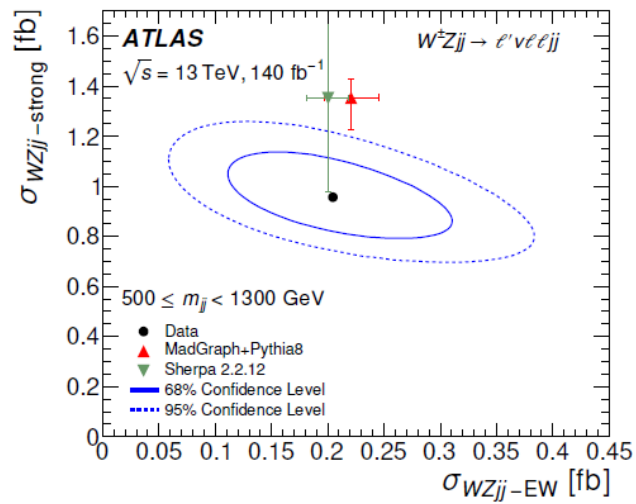


...plus $m_{\ell\ell}, N_{\text{gap jets}}, \xi_{3j}$
 ...plus inclusive $W^\pm W^\pm jj$ cross sections

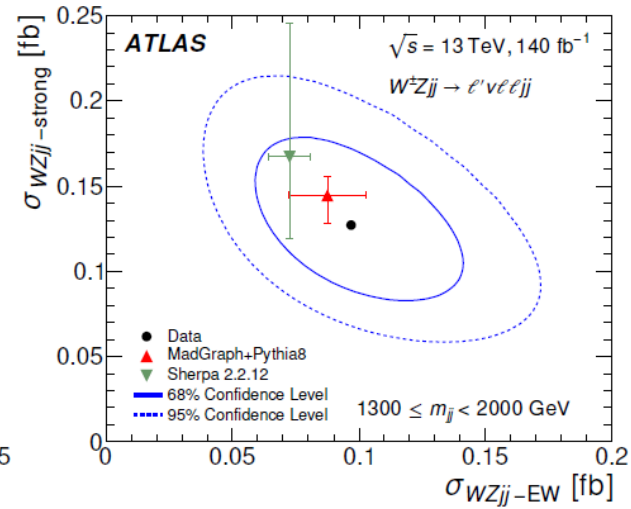
Variable	EW $W^\pm W^\pm jj$		Inclusive $W^\pm W^\pm jj$		Max. value in data
	χ^2/N_{dof}	p -value	χ^2/N_{dof}	p -value	
$m_{\ell\ell}$	4.5/6	0.605	7.34/6	0.291	1081 GeV
m_T	13.0/6	0.043	16.33/6	0.012	1270 GeV
m_{jj}	7.6/6	0.266	8.67/6	0.193	6328 GeV
$N_{\text{gap jets}}$	2.5/2	0.282	2.53/2	0.282	5
ξ_{3j}	4.2/5	0.517	4.93/5	0.424	1.74

Description	$\sigma_{\text{fid}}^{\text{EW}}$ [fb]	$\sigma_{\text{fid}}^{\text{EW+Int+QCD}}$ [fb]
Measured cross section	2.92 ± 0.22 (stat.) ± 0.19 (syst.)	3.38 ± 0.22 (stat.) ± 0.19 (syst.)
MG5_AMC+HERWIG7	2.53 ± 0.04 (PDF) $^{+0.22}_{-0.19}$ (scale)	2.92 ± 0.05 (PDF) $^{+0.34}_{-0.27}$ (scale)
MG5_AMC+PYTHIA8	2.53 ± 0.04 (PDF) $^{+0.22}_{-0.19}$ (scale)	2.90 ± 0.05 (PDF) $^{+0.33}_{-0.26}$ (scale)
SHERPA	2.48 ± 0.04 (PDF) $^{+0.40}_{-0.27}$ (scale)	2.92 ± 0.03 (PDF) $^{+0.60}_{-0.40}$ (scale)
SHERPA ⊗ NLO EW	2.10 ± 0.03 (PDF) $^{+0.34}_{-0.23}$ (scale)	2.54 ± 0.03 (PDF) $^{+0.50}_{-0.33}$ (scale)
POWHEG BOX+PYTHIA	2.64	–

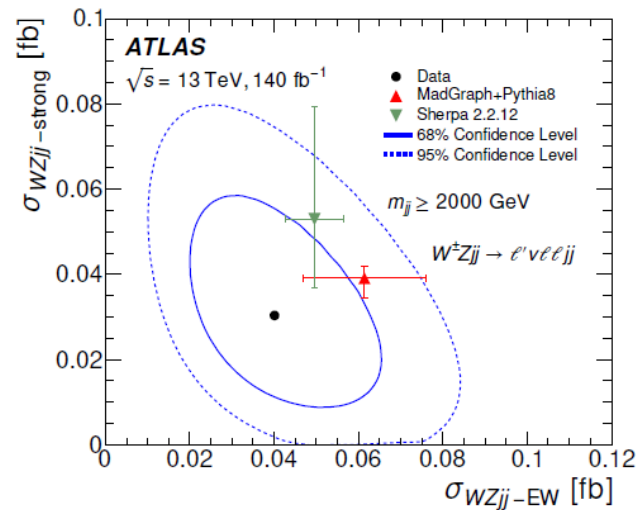
WZ VBS differential cross sections



(a)



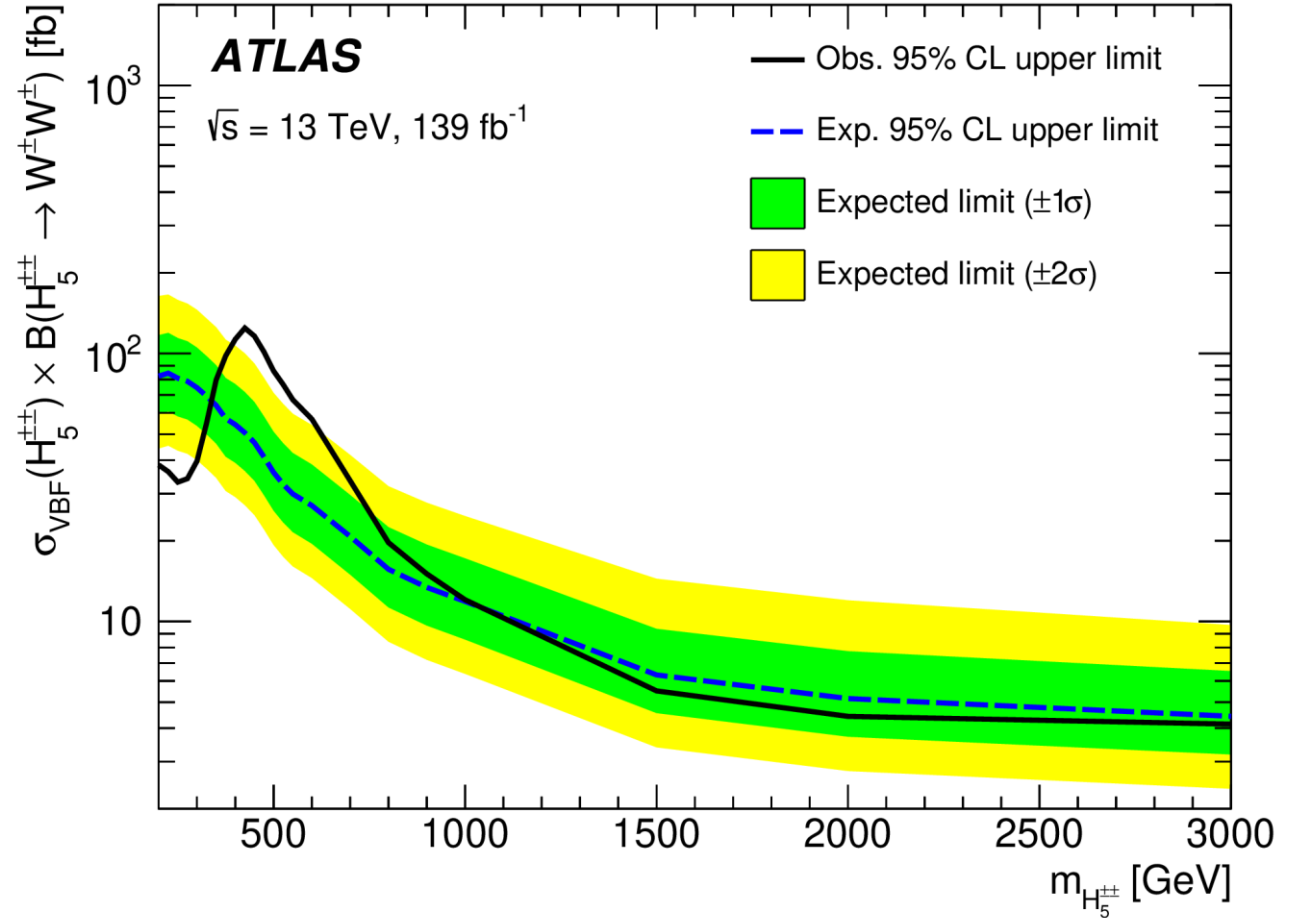
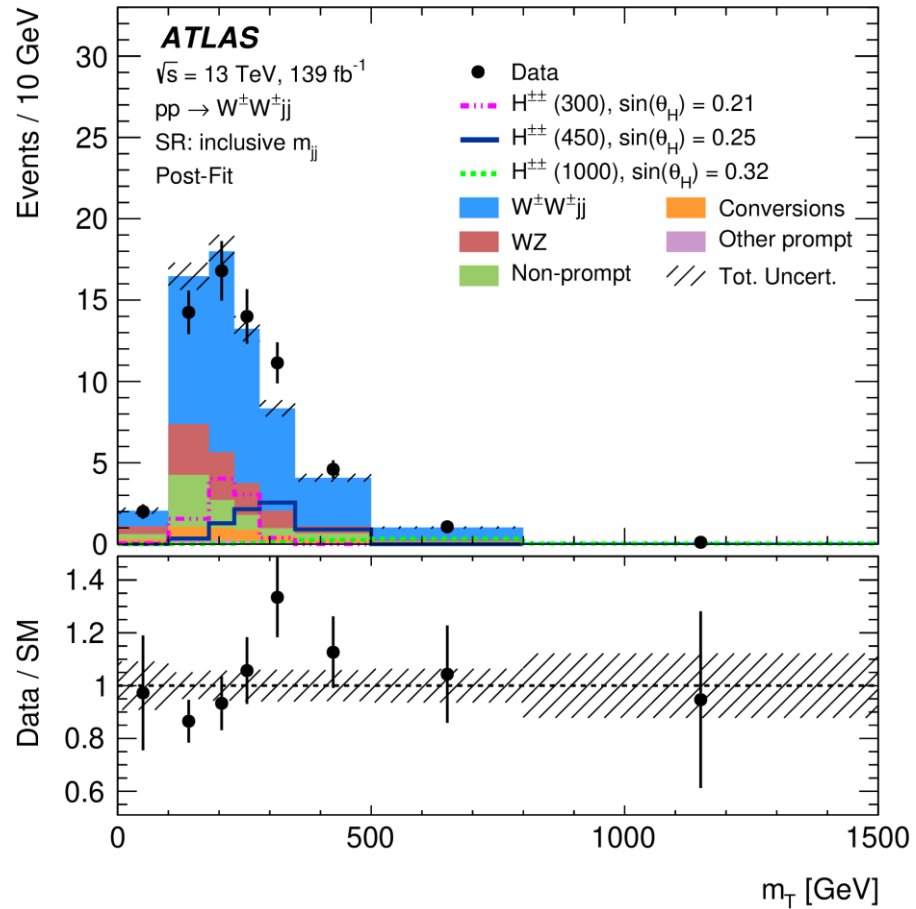
(b)



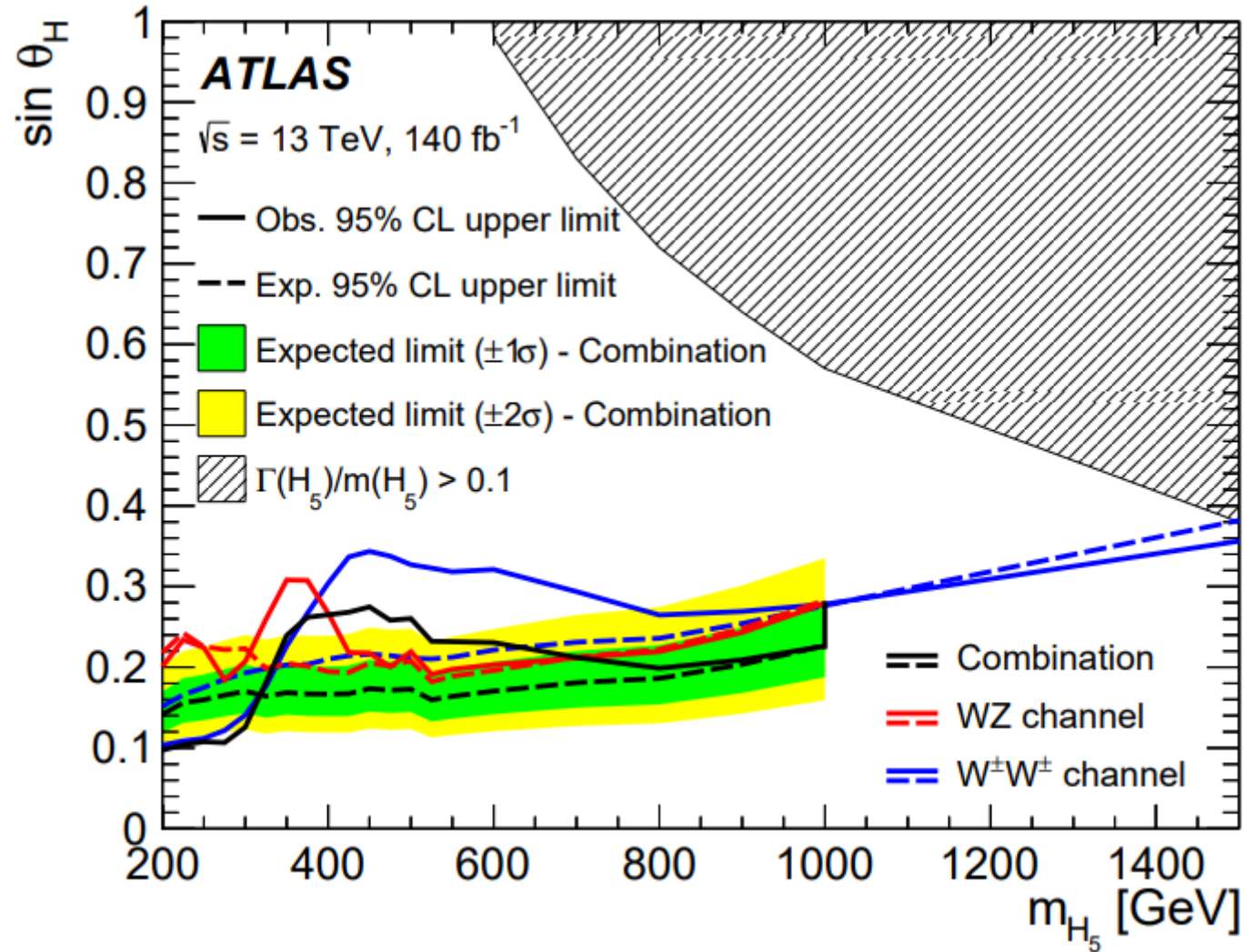
(c)

H^{±±} limits

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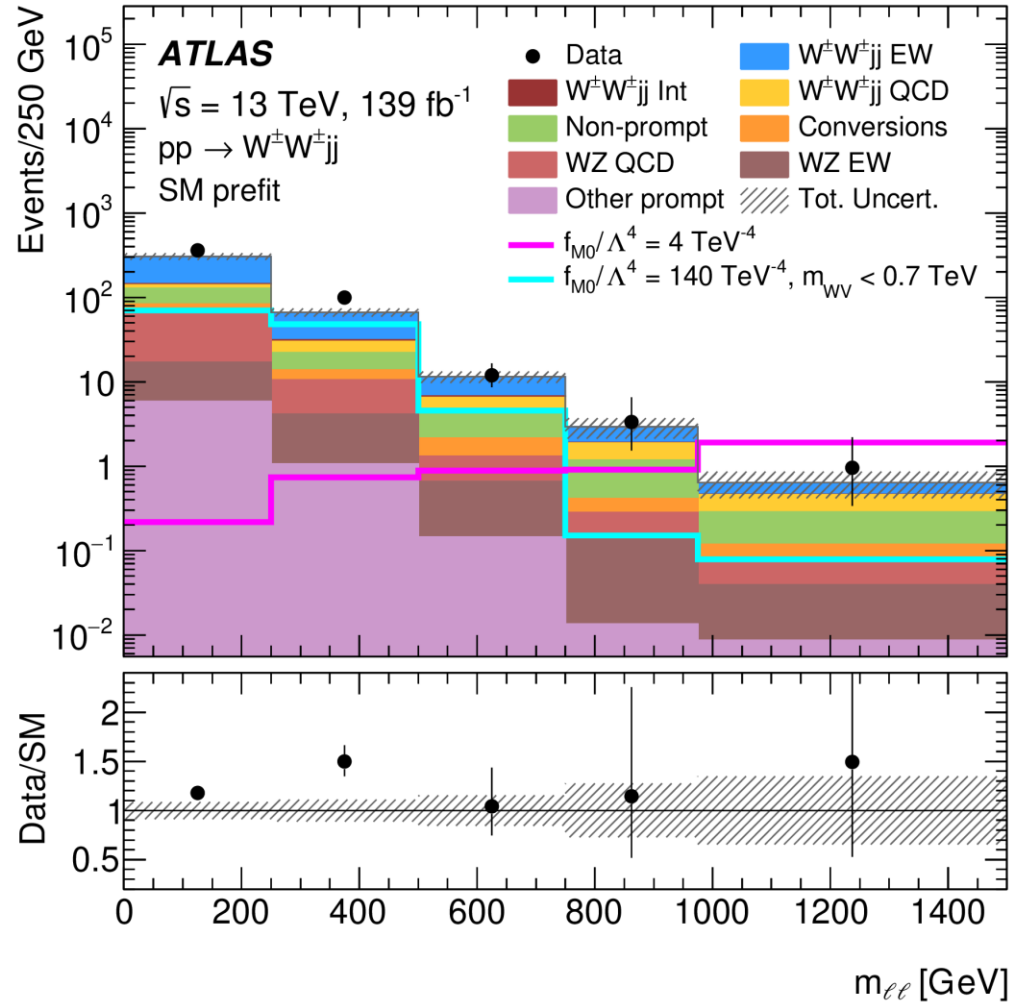
H₅ limits: combination of $W^\pm W^\pm jj$ and $WZjj$



[arXiv:2407.10798](https://arxiv.org/abs/2407.10798)

Dim-8 EFT limits

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Dim-8 EFT limits

Operators of [Phys. Rev. D 93, 093013 \(2016\)](#)

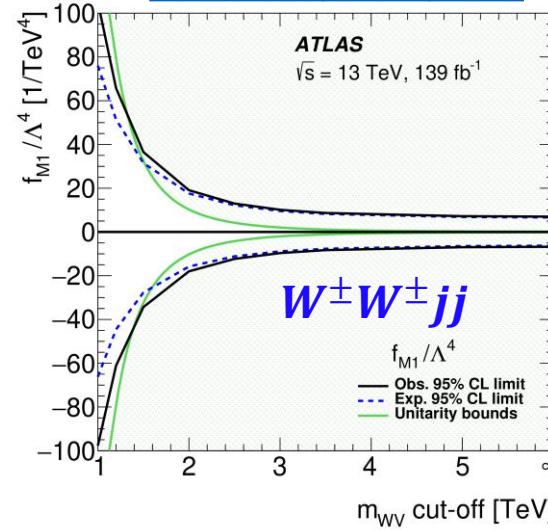
[S. Todt](#) Set of 18 dim-8 operators affecting quartic boson vertices:

Quartic vertex	Dim-8 operator	\mathcal{O}_{S0}	\mathcal{O}_{M0}	\mathcal{O}_{M2}	\mathcal{O}_{M3}	\mathcal{O}_{M4}	\mathcal{O}_{M5}	\mathcal{O}_{T0}	\mathcal{O}_{T1}	\mathcal{O}_{T2}	\mathcal{O}_{T5}	\mathcal{O}_{T6}	\mathcal{O}_{T7}	\mathcal{O}_{T8}	\mathcal{O}_{T9}
	WWWW		✓	✓					✓						
W^+W^-ZZ		✓	✓	✓	✓	✓		✓	✓	✓					
$W^+W^-Z\gamma$			✓	✓	✓	✓		✓	✓	✓					
$W^+W^-\gamma\gamma$			✓	✓	✓	✓		✓	✓	✓					
ZZZZ		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
ZZZ γ			✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
ZZ $\gamma\gamma$			✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Z $\gamma\gamma\gamma$								✓	✓	✓	✓	✓	✓	✓	✓
$\gamma\gamma\gamma\gamma$								✓	✓	✓	✓	✓	✓	✓	✓

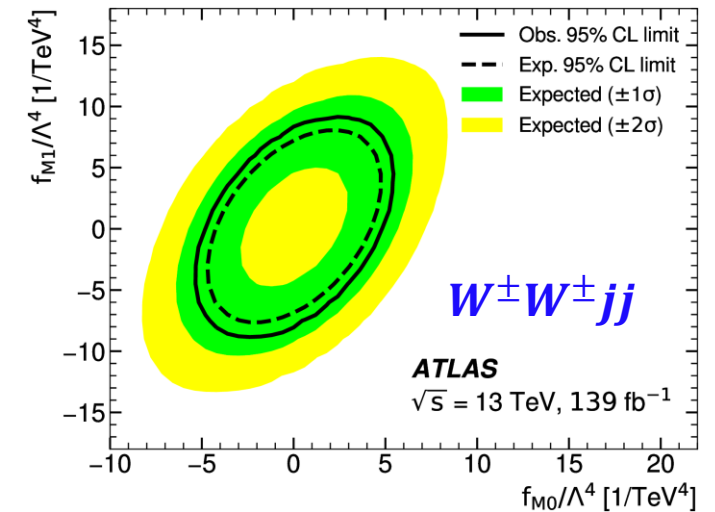
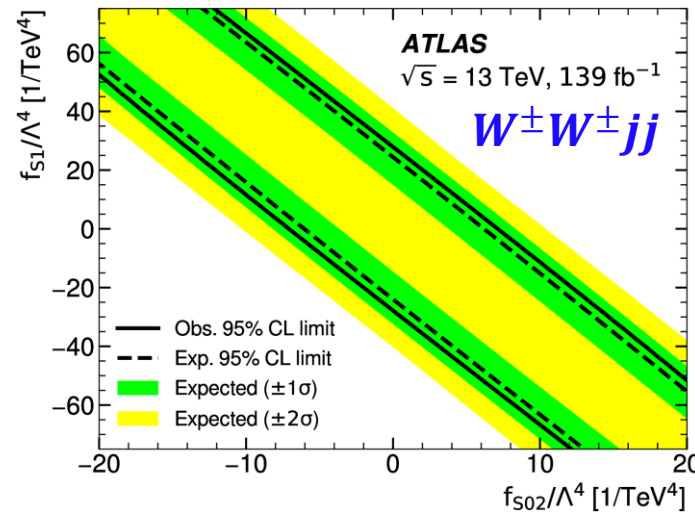
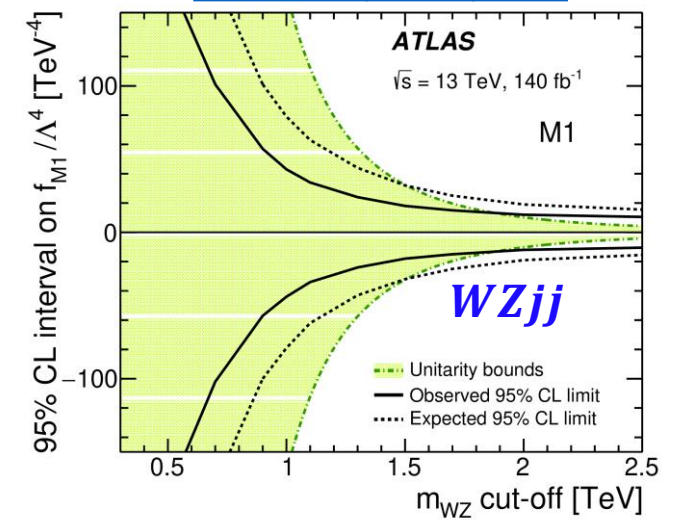
Various sets of limits:

- With and without EFT clipping
- 1D and 2D limits

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[JHEP 06 \(2024\) 192](#)



Prospects

Lumi @ \sqrt{s}	140 fb ⁻¹ @ 13 TeV		3000 fb ⁻¹ @ 14 TeV	
	ATLAS	CMS	ATLAS	CMS
$\sigma_{stat}, \%$	7.4	8.9	2	1.8
$\sigma_{syst}, \%$	6.4	5.7	5.6	4.1
$\sigma_{tot}, \%$	9.8	11	6.0	4.5
$W_L W_L$?	< 1 σ	1.86	2.7 σ
$W_L W_X$?	2.3 (3.1) σ BDT	$\sim \Delta\phi_{jj}$	
Published	2024-?	2020-21	2018	2018 4 σ using ANN

References

Theory

[M. Schwartz, Quantum Field Theory and the Standard Model](#)
[International Journal of Modern Physics A, 36 \(2021\) 2130009](#)
[JHEP 1710 \(2017\) 124](#)
[JHEP 10 \(2021\) 228](#)
[Nucl. Phys. B 262 \(1985\) 463-477](#)
[Phys. Rev. D 93, 093013 \(2016\)](#)
[arXiv:2411.02483](#)

Experiment

[JHEP 04 \(2024\) 026](#)
[JHEP 06 \(2024\) 192](#)
[Phys. Lett. B 809 \(2020\) 135710](#)
[Phys. Lett. B 812 \(2020\) 136018](#)
[ATL-PHYS-PUB-2018-052](#)
[FTR-18-005](#)

Backup

dim-8 limits comparison

Operator	ssWW	ssWW	WZ	WZ	Wy	Wy	Z(vv)y	Z(lly)	ZZ4l	ZZ4l
	ATLAS	CMS	ATLAS	CMS	ATLAS	CMS	ATLAS	CMS	ATLAS	CMS
	STDM-2018-32	SMP-19-012	STDM-2018-35	SMP-19-012	STDM-2018-31	SMP-21-011	STDM-2018-59	SMP-20-016	STDM-2020-02	SMP-20-001
FS02	[-5.5, 5.7]	[-6.0, 6.2]	[-14, 14]	[-5.7, 6.1]	-	-	-	-	-	-
FS1	[-22, 23]	[-18, 19]	[-42, 41]	[-16, 17]	-	-	-	-	-	-
FM0	[-3.9, 3.8]	[-3.7, 3.8]	[-8.3, 8.3]	[-7.6, 7.6]	[-28, 28]	[-5.1, 5.1]	[-6.2, 6.2]	[-13, 13]	-	-
FM1	[-6.3, 6.6]	[-5.4, 5.8]	[-12.3, 12.2]	[-11, 11]	[-43, 44]	[-7.1, 7.4]	[-10, 10]	[-28, 27]	-	-
FM2	-	-	-	-	[-10, 10]	[-1.8, 1.8]	[-2.6, 2.6]	[5.2, 5.1]	-	-
FM3	-	-	-	-	[-16, 16]	[-2.5, 2.5]	-	[-10, 10]	-	-
FM4	-	-	-	-	[-18, 18]	[-3.3, 3.3]	-	[-10, 10]	-	-
FM5	-	-	-	-	[-17, 14]	[-3.4, 3.6]	-	[-18, 17]	-	-
FM6	-	[-6.0, 6.5]	-	[-5.4, 5.8]	-	-	-	-	-	-
FM7	[-9.3, 8.8]	[-8.3, 8.1]	[-16, 16]	[-14, 14]	[-78, 77]	[-13, 13]	-	[-45, 45]	-	-
FT0	[-0.34, 0.34]	[-0.36, 0.39]	[-0.80, 0.80]	[-0.82, 0.85]	[-2.4, 2.4]	[-0.43, 0.51]	[-0.13, 0.12]	[-0.52, 0.44]	[-0.98, 0.93]	[-0.37, 0.35]
FT1	[-0.16, 0.17]	[-0.16, 0.19]	[-0.52, 0.49]	[-0.49, 0.55]	[-1.5, 1.6]	[-0.27, 0.31]	-	[-0.65, 0.63]	[-1.2, 1.2]	[-0.49, 0.49]
FT2	[-0.56, 0.70]	[-0.50, 0.63]	[-1.6, 1.4]	[-1.4, 1.7]	[-4.4, 4.7]	[-0.72, 0.92]	-	[-1.4, 1.2]	[-2.5, 2.4]	[-0.98, 0.95]
FT3	-	-	-	-	[-3.3, 3.5]	-	-	-	-	-
FT4	-	-	-	-	[-3.0, 3.0]	-	-	-	-	-
FT5	-	-	-	-	[-1.7, 1.7]	[-0.29, 0.31]	[-0.12, 0.13]	[-0.45, 0.52]	[-2.5, 2.4]	-
FT6	-	-	-	-	[-1.5, 1.5]	[-0.23, 0.25]	-	[-1.0, 1.1]	[-3.9, 3.9]	-
FT7	-	-	-	-	[-3.8, 3.9]	[-0.6, 0.68]	-	[-1.7, 2.0]	[-8.5, 8.1]	-
FT8	-	-	-	-	-	-	[-0.081, 0.080]	[-0.36, 0.36]	[-2.1, 2.1]	[-0.68, 0.68]
FT9	-	-	-	-	-	-	[-0.17, 0.17]	[-0.72, 0.72]	[-4.5, 4.5]	[-1.5, 1.5]

Expected limits from Run-2 VBS papers