

Measuring λ_{WZ} through tree-level interference

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Higgs Coupling Measurements

- Electroweak Symmetry Breaking

- g_{hWW}, g_{hZZ}

- $\lambda_{WZ} = \frac{\kappa_W}{\kappa_Z}$

$$\mathcal{L} = gm_W h \left(\kappa_W W^+ W^- + \frac{\kappa_Z}{2c_W^2} Z^2 \right)$$

- Interference Effects are needed to resolve **the sign**

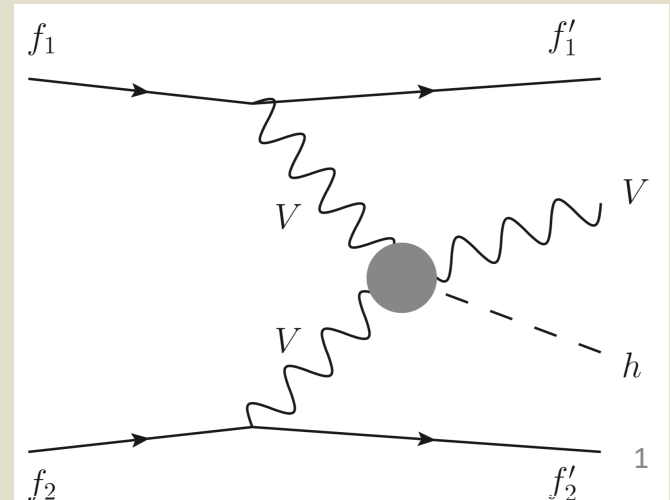
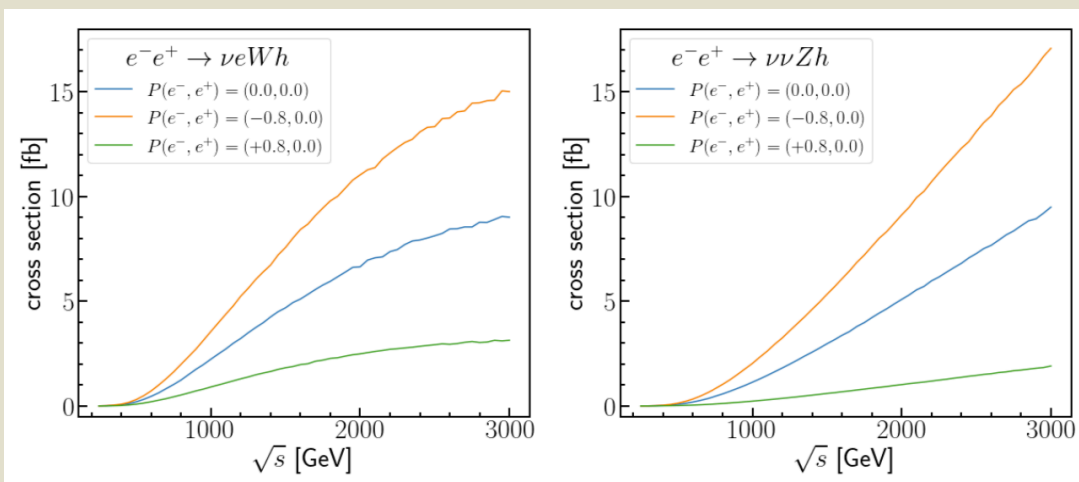
- VBF induced Vector boson + Higgs production

- Tree level interference

- $\ell^+ \ell^- \rightarrow \ell^\pm \nu_\ell W^\mp h$ ($W^\pm Z \rightarrow W^\pm h$)

- Large Cross Section

- $\ell^+ \ell^- \rightarrow \nu_\ell \nu_\ell Z h$ ($W^+ W^- \rightarrow Z h$)



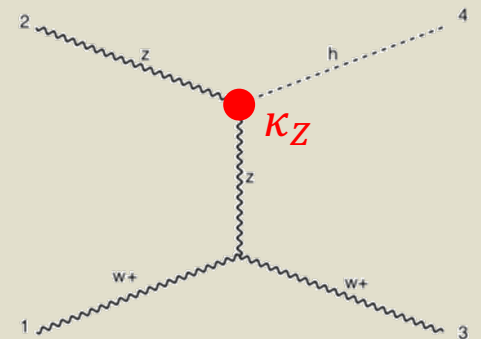
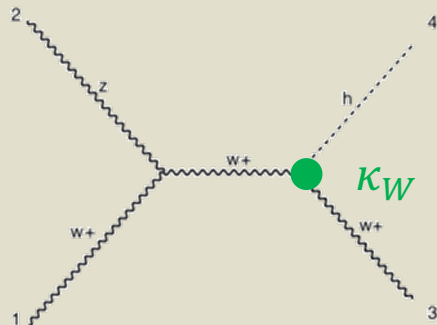
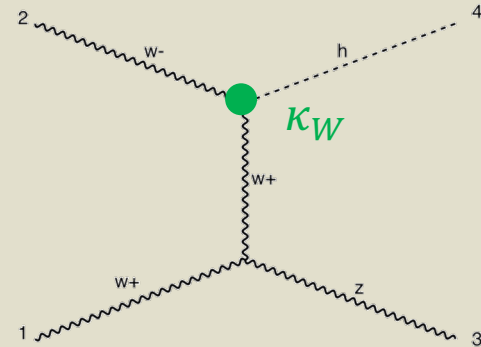
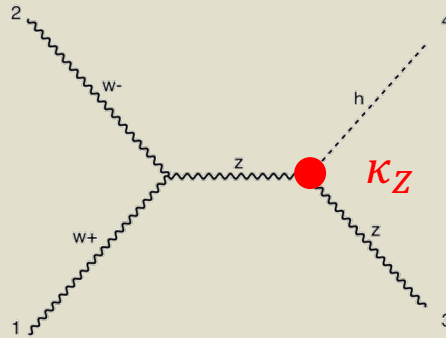
2 → 2 Processes

- $VV \rightarrow Vh$ Processes:

- $W^+W^- \rightarrow Zh$
- $W^\pm Z \rightarrow W^\pm h$

- Parameterization:

- $\mathcal{L} = gm_W h \left(\kappa_W W^+W^- + \frac{\kappa_Z}{2c_W^2} Z^2 \right)$
- $\lambda_{WZ} = \frac{\kappa_W}{\kappa_Z}$



	$\mathcal{M}_{s/t}$	$\mathcal{M}_s + \mathcal{M}_t$	$d\sigma_{s/t}$	$d\sigma_{\text{tot}}$
TTT	$\frac{1}{\sqrt{s}}$	$\frac{1}{\sqrt{s}}$	$\frac{1}{s^2}$	$\frac{1}{s^2}$
LTT	s^0	s^0	$\frac{1}{s}$	$\frac{1}{s}$
LLT	\sqrt{s}	$\frac{1}{\sqrt{s}}$	s^0	$\frac{1}{s^2}$
LLL	s	s^0	s	$\frac{1}{s}$

- For $W_L W_L \rightarrow Z_L h$:

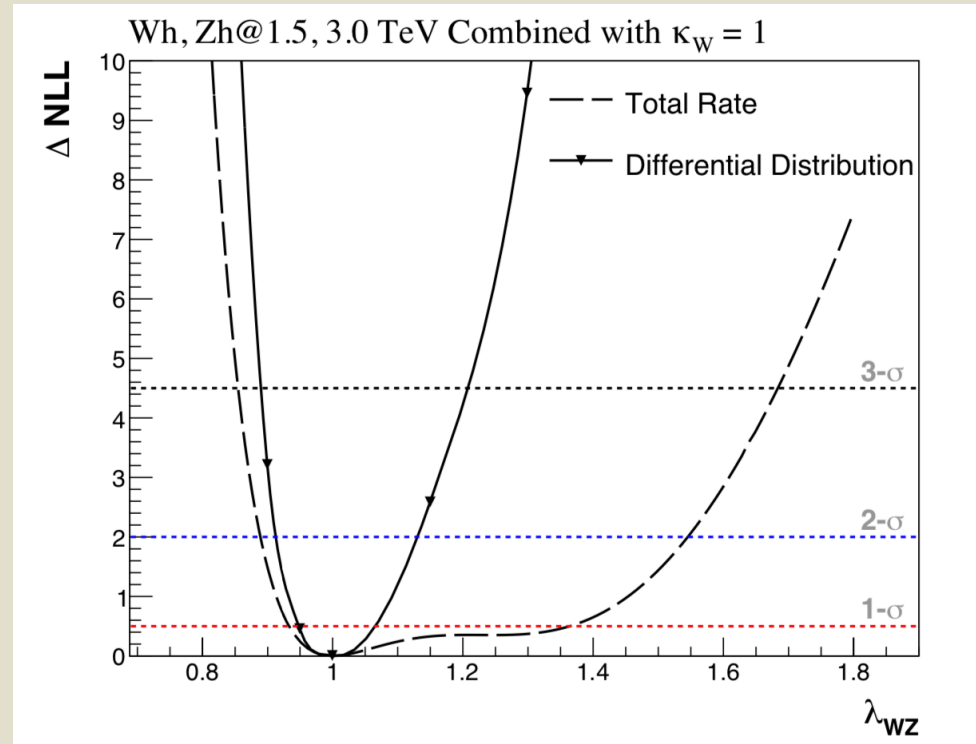
- $\mathcal{M}(W_L^+ W_L^- \rightarrow Z_L h) = \kappa_Z \frac{g^2 c_\theta}{4m_W^2} (1 - \lambda_{WZ}) s + \mathcal{O}(s^0)$

Sensitivity of the Measurement

Rate Measurement

Benchmark	$\sqrt{s} = 3.0 \text{ TeV}$	$\sqrt{s} = 1.5 \text{ TeV}$
$\kappa_W = \pm 1, \kappa_Z = \mp 1$	3.4 fb^{-1}	14.1 fb^{-1}
$\kappa_W = 1, \kappa_Z = 0$	29.3 fb^{-1}	243.3 fb^{-1}
$\kappa_W = 0, \kappa_Z = 1$	62.1 fb^{-1}	1772.4 fb^{-1}

Rate + Distribution



Summary

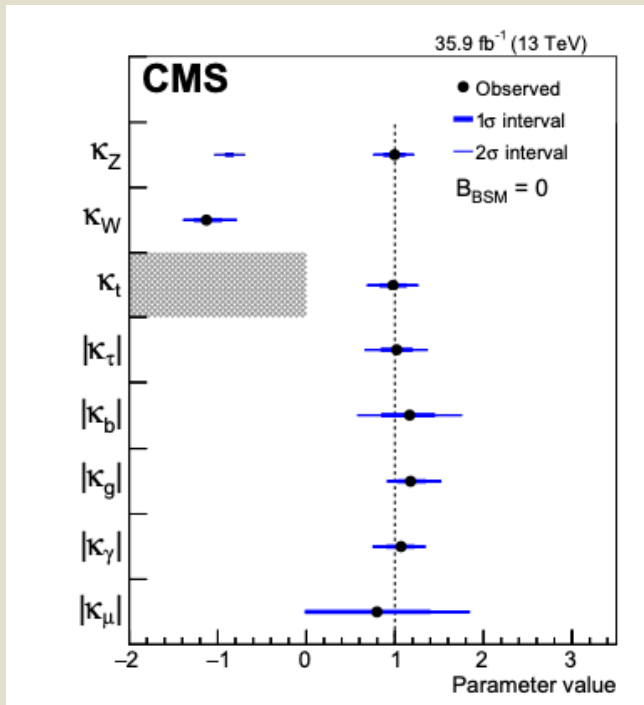
- VBF process:
 - $W^+W^- \rightarrow Zh$
 - $W^\pm Z \rightarrow W^\pm h$
- Tree level interferences, sensitive to the relation between κ_W and κ_Z
- Can be well probed at high energy lepton collider
- Plan:
 - Operators in SMEFT
 - Muon Collider/LHC

Backups

Higgs Coupling Measurements

- Current Measurement:
 - LHC Run I: **ATLAS+CMS, 1606.02266**
 - $\lambda_{WZ} \in [-1.10, -0.73] \cup [0.72, 1.10]$
 - CMS Run II 35.9 fb⁻¹:

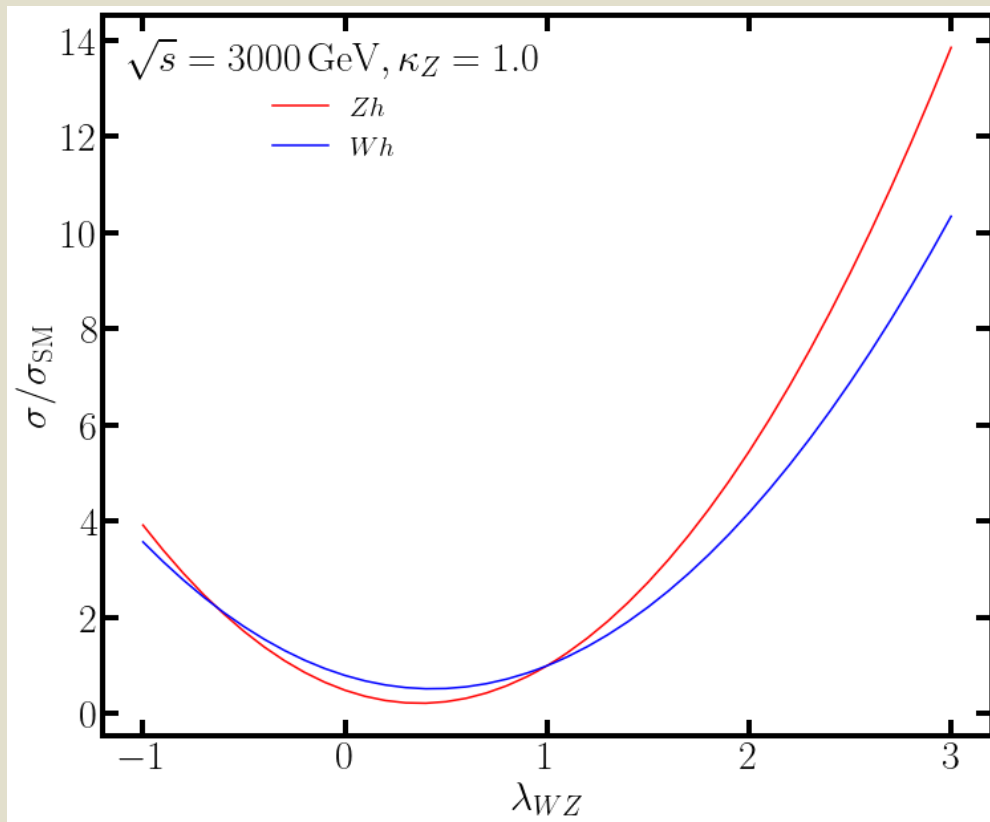
CMS: 1809.10733

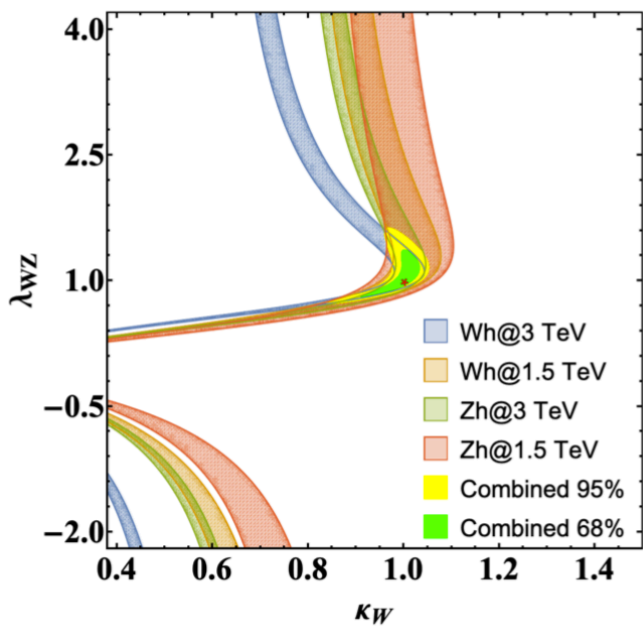
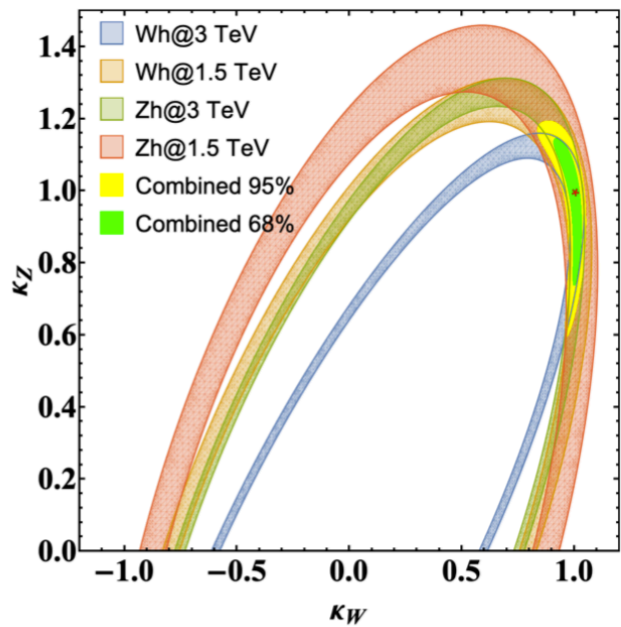


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- Future Prospects at HL-LHC

POI	Scenario	Precision
κ_W	HL-LHC S1	+0.028 -0.027
	HL-LHC S2	+0.019 -0.019
κ_Z	HL-LHC S1	+0.026 -0.025
	HL-LHC S2	+0.017 -0.017
κ_t	HL-LHC S1	+0.043 -0.041
	HL-LHC S2	+0.030 -0.029
κ_b	HL-LHC S1	+0.064 -0.060
	HL-LHC S2	+0.044 -0.043
κ_τ	HL-LHC S1	+0.038 -0.036
	HL-LHC S2	+0.028 -0.027
κ_μ	HL-LHC S1	+0.079 -0.076
	HL-LHC S2	+0.070 -0.071





Rate Measurement Combined

