Use, limits of the κ-framework and the need of going beyond

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Overview

Introduction to the chapter

The (eternal) issue

Urgent need of a common language to be used by *experiments* to communicate their results and by *theory* to interpret them

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Chapter II

overview of phenomenological tools and frameworks used for searches at LHC


experiment
new-physics
framework
implementation
theory
unfolding
interpretation
BSM
model-independent
LHC
EFT
tools
Monte-Carlo
Higgs
models
predictions
NLO
analyses
accuracy
discovery
deviations
template
fiducial
interactions
cross-section

1.1 κ-framework: its use and limits $\rightarrow$ this talk

The flow of the chapter

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$\downarrow$

1.2 Fiducial and simplified template cross sections $\rightarrow$ see Davide Melini's talk

alternative fiducial cross sections: tools rising againts issues of phase space definitions (detector vs theory, detector vs detector)

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available tools to parametrise Beyond Standard Model (BSM) effects: phenomenological Lagrangians in generators and precision challenges

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overview of the EFT to describe deviations from Standard Model (SM)

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overview of the EFT to describe deviations from Standard Model (SM)

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1.5 Pseudoobservables (POs) for the LHC $\rightarrow$ see Agnieszka Ilnicka's talk

potential of POs, of which the κ-framework is a subset, and relevance for EFT to show and interpret experimental results

κ-framework

The need

The need of a common language

Higgs boson discovery enhanced need of common language between experiment and theory to communicate and interpret physics results

$\rightsquigarrow$ Higgs boson couplings play a central role

- predicted accurately
- influence its production and decay rates

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κ-framework has been proposed to parametrise them and probe small deviations from the SM

The following is deeply based on CERN-PH-TH-2012-284, LHCHXSWG-2012-001

The assumptions

- Signals observed originate from single narrow resonance with mass ∼125 GeV
- zero-width approximation: signal cross section decomposed as

$$(\sigma \cdot \mathrm{BR})\,(i \rightarrow H \rightarrow f) = \frac{\sigma_i \cdot \Gamma_f}{\Gamma_H} \quad (1)$$

with
$\sigma_i = (ggF, \mathrm{VBF}, WH, ZH, ttH)$
$\Gamma_f = (ZZ, WW, \gamma\gamma, \tau\tau, bb, \mu\mu)$
Γ_H total width of the Higgs boson

The model dependency

Couplings are *pseudoobservables*, i.e. can not be directly measured:
"unfolding procedure" to extract information from measurable observable(s) ($\sigma \times \mathrm{BR}$)

$$+$$

acceptance and specific experimental cuts

$$\downarrow$$

model dependence

Various approacches:

- compare to a specific model
- model-independency, general parametrization of couplings
- use state-of-the-art predictions and insert additional terms in the Lagrangian: change in kinematics $\rightarrow$ difficult to re-interpret results

Additional assumption:

- tensor structure of the couplings same as SM predictions: only modification of coupling strenght

Building the framework

SM Higgs cross section and partial decay widths dressed with scale factors

$$\kappa_j$$

$\rightarrow \sigma_i$ and Γ_f scale with κ_j^2 when compared to SM predictions

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$$(\sigma \cdot \mathrm{BR})\,(i \rightarrow H \rightarrow f) = \sigma_{SM}(i \rightarrow H) \cdot \mathrm{BR}_{\mathrm{SM}}(H \rightarrow f) \cdot \frac{\kappa_i^2 \cdot \kappa_f^2}{\kappa_H^2} \qquad (2)$$

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Corrections

- when $\kappa \neq 1$ higher-order accuracy lost
- NLO QCD corrections factorize

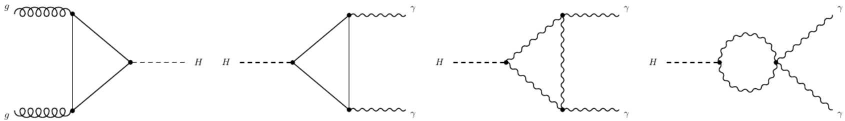
! κ are not the couplings in general, just at tree level

Effective and resolved modifiers

Production	Loops	Interference	Effective scaling factor	Resolved scaling factor
$\sigma(ggF)$	✓	t–b	κ_g^2	$1.06 \cdot \kappa_t^2 + 0.01 \cdot \kappa_b^2 - 0.07 \cdot \kappa_t\kappa_b$
$\sigma(\mathrm{VBF})$	–	–		$0.74 \cdot \kappa_W^2 + 0.26 \cdot \kappa_Z^2$
$\sigma(WH)$	–	–		κ_W^2
$\sigma(qq/qg \to ZH)$	–	–		κ_Z^2
$\sigma(gg \to ZH)$	✓	t–Z		$2.27 \cdot \kappa_Z^2 + 0.37 \cdot \kappa_t^2 - 1.64 \cdot \kappa_Z\kappa_t$
$\sigma(ttH)$	–	–		κ_t^2
$\sigma(gb \to tHW)$	–	t–W		$1.84 \cdot \kappa_t^2 + 1.57 \cdot \kappa_W^2 - 2.41 \cdot \kappa_t\kappa_W$
$\sigma(qq/qb \to tHq)$	–	t–W		$3.40 \cdot \kappa_t^2 + 3.56 \cdot \kappa_W^2 - 5.96 \cdot \kappa_t\kappa_W$
$\sigma(bbH)$	–	–		κ_b^2
Partial decay width				
Γ^{ZZ}	–	–		κ_Z^2
Γ^{WW}	–	–		κ_W^2
$\Gamma^{\gamma\gamma}$	✓	t–W	κ_γ^2	$1.59 \cdot \kappa_W^2 + 0.07 \cdot \kappa_t^2 - 0.66 \cdot \kappa_W\kappa_t$
$\Gamma^{\tau\tau}$	–	–		κ_τ^2
Γ^{bb}	–	–		κ_b^2
$\Gamma^{\mu\mu}$	–	–		κ_μ^2

Loop processes studied through

- *effective* modifiers
  κ_g for ggF
  κ_γ for $H \to \gamma\gamma$
- *resolved* modifiers corresponding to the SM particles



κ-framework in the experiments

Combination: the reasons of the choice

- κ-framework in the experiments has been used from both ATLAS and CMS to interpret results in Run 1
- combination of results useful for improvement in precision (in average 25%-30% improvement)
- big experimental challenge connected to the problem of *unfold* to different regions and phase space (see Davide Melini's talk)

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Important to know the level of precision which will be possible to achieve to know how much deep worth going in calculations

The following is deeply based on CERN-EP-2016-100, ATLAS-HIGG-2015-07, CMS-HIG-15-002

Performing the combination

- profile likelihood method
- simultaneous fits to the data from both experiments
  - systematics correlations within each experiment and between the two experiments taken into account
- input analyses based on event categorisation
  - For each decay mode events classified in different categories based on their kinematics and properties
  - $\sim$ 600 exclusive categories for five production processes for five main decay channels

Parametrization to extract the modifiers from measurements:

production cross-section, partial decay widths $\rightarrow$ coupling modifiers

Changing in the couplings will results in variation of Higgs boson width

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Parametrization

If Higgs boson decays allowed are SM-like

$\kappa_H^2 = \Gamma_H / \Gamma_H^{SM}$ holds

...if couplings are not as expected

variation of the Higgs boson width: new modifier is introduced κ_H^2

$$\kappa_H^2 = \Sigma_j B_{SM}^j \kappa_j^2 \longrightarrow \Gamma = \frac{\kappa_H^2 \cdot \Gamma_H^{SM}}{1 - B_{BSM}}$$

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- The signal yield in a category k

$$\begin{aligned} n_{signal}(k) &= \mathcal{L}(k) \cdot \sum_i \sum_f \left\{ \sigma_i \cdot A_i^{f,SM}(k) \cdot \epsilon_i^f(k) B^f \right\} \\ &= \mathcal{L}(k) \cdot \sum_i \sum_f \mu_i \mu^f \left\{ \sigma_i^{SM} \cdot A_i^{f,SM}(k) \cdot \epsilon_i^f(k) \cdot B_{SM}^f \right\} \end{aligned} \quad (3)$$

$\mathcal{L}$ = integrated luminosity
$A_i^{f,SM}(k)$ = detector acceptance
$\epsilon_i^f(k)$ = selection efficiency for signal category k
$\mu_i \mu^f$ = production and decay signal strenght

Parameters estimation

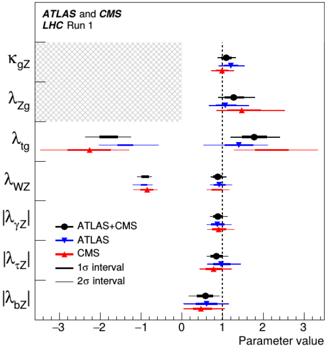
Various parametrizations used: focus on **ratios of couplings modifiers**
Only ratios of κ can be measured in the most generic parameterisation

- Same statistical methodology used by single analyses
- parameters estimated through likelihood test statistics: μ, κ_i, σ, BR, ratios of the above
- likelihood fits to get parameters and uncertainties

Coupling modifier ratio parameterisation
$\kappa_{gZ} = \kappa_g \cdot \kappa_Z / \kappa_H$
$\lambda_{Zg} = \kappa_Z / \kappa_g$
$\lambda_{tg} = \kappa_t / \kappa_g$
$\lambda_{WZ} = \kappa_W / \kappa_Z$
$\lambda_{\gamma Z} = \kappa_\gamma / \kappa_Z$
$\lambda_{\tau Z} = \kappa_\tau / \kappa_Z$
$\lambda_{bZ} = \kappa_b / \kappa_Z$

Results

- $\sigma \cdot BR$ for $gg \rightarrow H \rightarrow ZZ$ parametrised as function of $\kappa_{gZ} = \kappa_g \cdot \kappa_Z / \kappa_H$
- measurement of VBF and ZH probe $\lambda_{Zg} = \kappa_Z / \kappa_g$
- measurements of ttH production processes sensitive to $\lambda_{tg} = \kappa_t / \kappa_g$
- $H \rightarrow WW$, $H \rightarrow \tau\tau$ and $H \rightarrow bb$ through respective ratios to $H \rightarrow ZZ$ branching fraction probe the three ratios $\lambda_{WZ} = \kappa_W / \kappa_Z$, $\lambda_{\tau Z} = \kappa_\tau / \kappa_Z$ and $\lambda_{bZ} = \kappa - b / \kappa_Z$
- $H \rightarrow \gamma\gamma$ sensitive to $\lambda_{\gamma Z} = \kappa_\lambda / \kappa_Z$

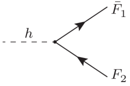


Limits of the framework

Going NLO with the κ-framework - I

- κ-framework not fully consistent
- problems rising when moving to NLO precision

Let's consider a *simplified κ-framework*



$$= ie\,\kappa_{ffS}\left(C_L\frac{1-\gamma_5}{2}+C_R\frac{1+\gamma_5}{2}\right)$$

The Born transition matrix element for the decay process

$$\mathcal{M}_0 = \frac{e\, m_b\, \kappa_{ffS}}{2sM_W}\, \bar{u}(p)v(k) \tag{4}$$

LO SM decay width rescaled by a factor κ_{ffS}^2

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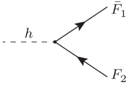

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LO SM decay width rescaled by a factor κ_{ffS}^2

To achieve more accurate theoretical prediction...

Going NLO with the κ-framework - II

Include contributions from higher powers of α

$$\mathcal{M} = \mathcal{M}_0 \left[1 + \frac{\alpha}{4\pi} \left(\delta_{\text{loop}} + \delta_{\text{CT}} \right) \right], \tag{5}$$

Include contributions from higher powers of α

$$\mathcal{M} = \mathcal{M}_0 \left[1 + \frac{\alpha}{4\pi} \left(\delta_{\text{loop}} + \delta_{\text{CT}} \right) \right], \qquad (5)$$

δ_{loop}: contributions due to loops with internal gauge and Higgs bosons
δ_{CT}: counterterm contributions from the renormalization procedure
These are computed and the renormalization procedure is done

$\downarrow$

presence of κ-dependent terms spoils the cancellation of the divergent part: $\mathcal{M}$ gets a UV part

$$\mathcal{M}\big|_{\text{UV}} = \frac{\alpha}{4\pi} \frac{\mathcal{M}_0}{4s^2 M_W^2} \Delta \left(1 - \kappa_{ffS}^2\right) \left(\sum_l m_l^2 + 3 \sum_q m_q^2 \right), \qquad (6)$$

which in general does not vanish for $\kappa_{ffS} \neq 1$

Further issues

Global factors can predict how many times the Higgs decay in a specific channel, but NOT how kinematics of decay products is affected

↓

κ-framework can't describe deviations in differential distributions

New Physics could modify differential distributions, but it wouldn't be captured by overall factors

- κ-framework motivated for deviations from the SM
- deviations would give directions
- no big differences found from ATLAS and CMS in Run 1

↓

Look for small deviations

New framework able to do it needed

Experimental accuracy

The accuracy of experiments

Effective Field Theory (EFT) framework answers this need (see Raquel's talk)
Issue in the past: limited by experiental accuracy

In EFT approach:

- higher dimensional operators ordered by $\frac{g^2 m_h^2}{\Lambda^2}$
    - Λ: scale of momentum cutoff of theory
- only relevant scale for Higgs production is m_h
    - should be well separated from accessible scale Λ

Applicability of EFT limited when scales hierarchy not guaranteed

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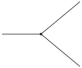
delicate balance between energy scales

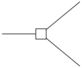
In Run 1 $\rightarrow$ on-shell single Higgs production

How to estimate the physics scale possible to probe?

Considering couplings

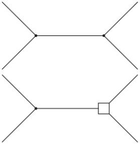


$\sim g_{SM}$



$\sim g_{SM} \frac{g^2 m_h^2}{\Lambda^2}$

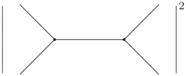
$\rightsquigarrow$



$\sim g_{SM}^2,$

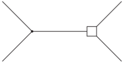
$\sim g_{SM}^2 \frac{g^2 m_h^2}{\Lambda^2}$

For the SM matrix element

$(\sigma \times BR)_{SM} \sim$  $\sim g_{SM}^4$

...for SM + BSM

$(\sigma \times BR) \sim$ 

$+ \quad 2 \times$  $\times$ 

$+ \dots$

$\sim g_{SM}^4 + 2 g_{SM}^4 \frac{g^2 m_h^2}{\Lambda^2} + \dots$

Validity in the tails of distribution

Accuracy on a rate measurement translated into reach of new physics (NP)

$$\left|\frac{\sigma \times \mathrm{BR}}{(\sigma \times \mathrm{BR})_{\mathrm{SM}}} - 1\right| = \frac{g^2 m_h^2}{\Lambda^2} > 10\% \tag{7}$$

This means

$$\Lambda < \frac{g m_h}{\sqrt{10\%}} \tag{8}$$

- $\Lambda \simeq 400$ GeV assuming $g \sim 1$
- $\Lambda \simeq 280$ GeV assuming new weakly interactive theory $g^2 \sim \frac{1}{2}$

LHC Run 2: increased statistics + higher Higgs production cross section

↓

- add new distribtuions
- add off-shell processes to probe higher energy scales

Is the formula still valid if we look at the tails??

Higgs off-shellness

When we sit on the resonance: propagator dominated by Γ_H

$$\frac{1}{(s - M_X^2) + (i\Gamma_X M_X)} \tag{9}$$

$$\sigma^{on}_{i \to X \to f} \sim \frac{g_i^2 g_f^2}{\Gamma_X}. \tag{10}$$

In the off-shell region

$$\sigma^{on}_{i \to X \to f} \sim g_i^2 g_f^2 \tag{11}$$

The previous accuracy equation becomes:

$$\left| \frac{\sigma \times \mathrm{BR}}{(\sigma \times \mathrm{BR})_{\mathrm{SM}}} - 1 \right| = \frac{g^2 Q^2}{\Lambda^2} \tag{12}$$

But uncertainties changes!

- different uncertainties give same Λ testability...

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Open issue How much can go higher in Q^2 and still be reliable **?**

(First set of) conclusion

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(First set of) conclusion

- κ-framework has been used for interpretation of results in Run 1
- good for identifying small deviations but need to move further for various reasons:
  - shown inconsistencies when movinf to NLO
  - cannot detect differential deviations
- choosing a new framework is not trivial: EFT can be a good solution
  - important to take into account experimental accuracy
  - accuracy related to reachable energy scales
  - need to consider now the validity in the tails of distributions

This starting point opened us up many questions...

Which can be a possible alternative framework **?**
Which issues can be solved **?**
How EFT can help and improve the prediction **?**
Which tools are available with the latest implementations**?**
What are pseudo observables and how can them be defined for LHC**?**

...in the attempt of finding a flow and a possible clear picture of the future of phenomenology and interaction between prediction and experimental results...

Stay tuned in the next talks!

Thanks for your attention

κ and actual couplings

The κ have often been confused with the actual couplings in the Lagrangian, which is true at tree level, but not in a NLO formalism, indeed. As an example taking into account the process $gg \to ttH(bb)$, at tree level one can say that the squared matrix elements are proportional to the coupling of the interactions:

$$|\mathcal{M}|^2 \propto (g_{tH} g_{bH})\, 2 \tag{13}$$

and then, assuming the total width of the Higgs boson stays unchanged ($\Gamma^{SM}_{H\to X} = \Gamma_{H\to X}$), one would have: $k_i = g_{tH}$ and $k_f = g_{bH}$.

Scalar fermion couplings

$S\bar{F}_1 F_2$	$h\bar{f}_i f_j$	$\chi\bar{f}_i f_j$	$\phi^+\bar{u}_i d_j$	$\phi^-\bar{d}_j u_i$
C_L	$-\frac{1}{2s}\frac{m_{f,i}}{M_W}\delta_{ij}$	$-\frac{i}{2s}2I^3_{W,f}\frac{m_{f,i}}{M_W}\delta_{ij}$	$\frac{1}{\sqrt{2}s}\frac{m_{u,i}}{M_W}V_{ij}$	$-\frac{1}{\sqrt{2}s}\frac{m_{d,j}}{M_W}V^\dagger_{ji}$
C_R	$-\frac{1}{2s}\frac{m_{f,i}}{M_W}\delta_{ij}$	$\frac{i}{2s}2I^3_{W,f}\frac{m_{f,i}}{M_W}\delta_{ij}$	$-\frac{1}{\sqrt{2}s}\frac{m_{d,j}}{M_W}V_{ij}$	$\frac{1}{\sqrt{2}s}\frac{m_{u,i}}{M_W}V^\dagger_{ji}$

Table 1: Scalar-fermion couplings in the SM.

Combination results for couplings ratios

Table 10: Best fit values of $\kappa_{gZ} = \kappa_g \cdot \kappa_Z / \kappa_H$ and of the ratios of coupling modifiers, as defined in the parameterisation studied in the context of the κ-framework, from the combined analysis of the $\sqrt{s} = 7$ and 8 TeV data. The results are shown for the combination of ATLAS and CMS and also separately for each experiment, together with their total uncertainties and their breakdown into statistical and systematic components. The uncertainties in λ_{tg} and λ_{WZ}, for which a negative solution is allowed, are calculated around the overall best fit value. The combined 1σ CL intervals are $\lambda_{tg} = [-2.00, -1.59] \cup [1.50, 2.07]$ and $\lambda_{WZ} = [-0.96, -0.82] \cup [0.80, 0.98]$. The expected uncertainties in the measurements are displayed in parentheses. For those parameters with no sensitivity to the sign, only the absolute values are shown.

Parameter	Best fit value	Uncertainty Stat	Uncertainty Syst	Best fit value	Uncertainty Stat	Uncertainty Syst	Best fit value	Uncertainty Stat	Uncertainty Syst
	ATLAS+CMS			ATLAS			CMS		
κ_{gZ}	$1.09^{+0.11}_{-0.11}$ $\left(^{+0.11}_{-0.11}\right)$	$^{+0.09}_{-0.09}$ $\left(^{+0.09}_{-0.09}\right)$	$^{+0.06}_{-0.06}$ $\left(^{+0.06}_{-0.05}\right)$	$1.20^{+0.16}_{-0.15}$ $\left(^{+0.15}_{-0.15}\right)$	$^{+0.14}_{-0.14}$ $\left(^{+0.14}_{-0.13}\right)$	$^{+0.08}_{-0.07}$ $\left(^{+0.07}_{-0.06}\right)$	$0.99^{+0.14}_{-0.13}$ $\left(^{+0.14}_{-0.14}\right)$	$^{+0.12}_{-0.12}$ $\left(^{+0.13}_{-0.12}\right)$	$^{+0.07}_{-0.06}$ $\left(^{+0.07}_{-0.06}\right)$
λ_{Zg}	$1.27^{+0.23}_{-0.20}$ $\left(^{+0.20}_{-0.17}\right)$	$^{+0.18}_{-0.16}$ $\left(^{+0.15}_{-0.14}\right)$	$^{+0.15}_{-0.12}$ $\left(^{+0.12}_{-0.10}\right)$	$1.07^{+0.26}_{-0.22}$ $\left(^{+0.28}_{-0.23}\right)$	$^{+0.21}_{-0.18}$ $\left(^{+0.23}_{-0.20}\right)$	$^{+0.15}_{-0.11}$ $\left(^{+0.16}_{-0.11}\right)$	$1.47^{+0.45}_{-0.34}$ $\left(^{+0.27}_{-0.23}\right)$	$^{+0.35}_{-0.28}$ $\left(^{+0.21}_{-0.19}\right)$	$^{+0.28}_{-0.20}$ $\left(^{+0.16}_{-0.13}\right)$
λ_{tg}	$1.78^{+0.30}_{-0.27}$ $\left(^{+0.28}_{-0.38}\right)$	$^{+0.21}_{-0.20}$ $\left(^{+0.20}_{-0.30}\right)$	$^{+0.21}_{-0.18}$ $\left(^{+0.20}_{-0.24}\right)$	$1.40^{+0.34}_{-0.33}$ $\left(^{+0.38}_{-0.54}\right)$	$^{+0.25}_{-0.24}$ $\left(^{+0.28}_{-0.39}\right)$	$^{+0.23}_{-0.23}$ $\left(^{+0.25}_{-0.37}\right)$	$-2.26^{+0.50}_{-0.53}$ $\left(^{+0.42}_{-0.64}\right)$	$^{+0.43}_{-0.39}$ $\left(^{+0.31}_{-0.42}\right)$	$^{+0.26}_{-0.36}$ $\left(^{+0.28}_{-0.49}\right)$
λ_{WZ}	$0.88^{+0.10}_{-0.09}$ $\left(^{+0.12}_{-0.10}\right)$	$^{+0.09}_{-0.08}$ $\left(^{+0.11}_{-0.09}\right)$	$^{+0.04}_{-0.04}$ $\left(^{+0.05}_{-0.04}\right)$	$0.92^{+0.14}_{-0.12}$ $\left(^{+0.18}_{-0.15}\right)$	$^{+0.13}_{-0.11}$ $\left(^{+0.17}_{-0.13}\right)$	$^{+0.05}_{-0.05}$ $\left(^{+0.06}_{-0.06}\right)$	$-0.85^{+0.13}_{-0.15}$ $\left(^{+0.17}_{-0.14}\right)$	$^{+0.11}_{-0.13}$ $\left(^{+0.15}_{-0.13}\right)$	$^{+0.06}_{-0.07}$ $\left(^{+0.07}_{-0.06}\right)$
$\lvert\lambda_{\gamma Z}\rvert$	$0.89^{+0.11}_{-0.10}$ $\left(^{+0.13}_{-0.12}\right)$	$^{+0.10}_{-0.09}$ $\left(^{+0.13}_{-0.11}\right)$	$^{+0.04}_{-0.03}$ $\left(^{+0.04}_{-0.03}\right)$	$0.87^{+0.15}_{-0.13}$ $\left(^{+0.20}_{-0.17}\right)$	$^{+0.15}_{-0.13}$ $\left(^{+0.20}_{-0.17}\right)$	$^{+0.05}_{-0.04}$ $\left(^{+0.06}_{-0.04}\right)$	$0.91^{+0.17}_{-0.14}$ $\left(^{+0.18}_{-0.16}\right)$	$^{+0.16}_{-0.14}$ $\left(^{+0.18}_{-0.15}\right)$	$^{+0.05}_{-0.04}$ $\left(^{+0.05}_{-0.04}\right)$
$\lvert\lambda_{\tau Z}\rvert$	$0.85^{+0.13}_{-0.12}$ $\left(^{+0.17}_{-0.15}\right)$	$^{+0.12}_{-0.10}$ $\left(^{+0.14}_{-0.13}\right)$	$^{+0.07}_{-0.06}$ $\left(^{+0.09}_{-0.08}\right)$	$0.96^{+0.21}_{-0.18}$ $\left(^{+0.27}_{-0.23}\right)$	$^{+0.18}_{-0.15}$ $\left(^{+0.23}_{-0.19}\right)$	$^{+0.11}_{-0.09}$ $\left(^{+0.14}_{-0.12}\right)$	$0.78^{+0.20}_{-0.17}$ $\left(^{+0.23}_{-0.20}\right)$	$^{+0.17}_{-0.15}$ $\left(^{+0.19}_{-0.17}\right)$	$^{+0.10}_{-0.09}$ $\left(^{+0.12}_{-0.11}\right)$
$\lvert\lambda_{bZ}\rvert$	$0.58^{+0.16}_{-0.20}$ $\left(^{+0.25}_{-0.22}\right)$	$^{+0.12}_{-0.17}$ $\left(^{+0.21}_{-0.20}\right)$	$^{+0.10}_{-0.10}$ $\left(^{+0.13}_{-0.10}\right)$	$0.61^{+0.24}_{-0.24}$ $\left(^{+0.36}_{-0.29}\right)$	$^{+0.20}_{-0.19}$ $\left(^{+0.31}_{-0.26}\right)$	$^{+0.14}_{-0.16}$ $\left(^{+0.18}_{-0.13}\right)$	$0.47^{+0.26}_{-0.17}$ $\left(^{+0.38}_{-0.37}\right)$	$^{+0.23}_{-0.13}$ $\left(^{+0.32}_{-0.34}\right)$	$^{+0.13}_{-0.12}$ $\left(^{+0.20}_{-0.16}\right)$