Liverpool seminar, 17<sup>th</sup> February 2021



# Searching for EFT Deformations of the SM

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Based on 2012.02779 J. Ellis, M. Madigan, K. Mimasu, V. Sanz, TY

Allanach, Gripaios, TY [1710.06363]

University of Liverpool seminar, 13<sup>th</sup> February 2019

## **SMEXIT** Implications of decoupling new physics



### Contents

- Motivation
- Measurements
- Map to operators
- Global SMEFT fit
- B anomalies
- Conclusion

## We've always been doing EFT

• QED EFT = QED + Euler-Heisenberg + Fermi theory

$$2\frac{\xi}{\alpha\xi\rho} = \Psi; \forall PD_{\mu}\Psi - m\Psi\Psi - \frac{i}{4}F_{\mu\nu}F^{\mu\nu}$$
Fermi theory
$$+ \sum_{j} \frac{\zeta_{0}^{(j)}}{\Lambda^{2}} (\Psi P\Psi) (\Psi P\Psi)$$

$$P = \{1, \forall s, \forall_{\mu}, \forall_{\mu}\forall_{s}, \delta_{\mu\nu}\}$$
Euler-
$$\frac{F}{Heisenberg} + \frac{\zeta_{0}^{(j)}}{\Lambda^{4}} (F_{\mu\nu}F^{\mu\nu})^{2} + \frac{\zeta_{0}^{(2)}}{\Lambda^{4}} F_{\mu\nu}F^{\nu\rho}F_{\rho\lambda}F^{\lambda\mu} + \dots$$
(1936)

- EFT fits to experimental data established V-A structure
- (Light-by-light scattering observed 80 years later)

D'Enterria, Silveira 1305.7142 ATLAS 1702.01625 CMS 1810.04602

## EFT including weak gauge bosons

- **1980s-2012**: Discovery of weak bosons. Non-linear effective Lagrangian for spontaneously-broken global symmetry (*breaking mechanism unknown!*)
- Global symmetry-breaking pattern gives low-energy effective theory regardless of UV mechanism responsible for it

$$SU(2) \times SU(2) \rightarrow SU(2)_V$$
  $(\rho \equiv M_W/M_Z \cos \theta_w \sim 1)$ 

$$\mathcal{L} = \frac{v^2}{4} \mathrm{Tr} D_{\mu} \Sigma^{\dagger} D^{\mu} \Sigma - m_i \bar{\psi}_L^i \Sigma \psi_R^i + \mathrm{h.c.}$$

$$\Sigma = \exp\left(i\frac{\sigma^a\pi^a}{v}\right)$$

## [EWSB mechanism?]

A priori many ways to break electroweak symmetry!



#### New scalars could also be something other than a Higgs

## EFT including weak gauge bosons

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$$\Sigma = \exp\left(i\frac{\sigma^a\pi^a}{v}\right)$$

• 2012: Non-linear electroweak Lagrangian + general couplings to singlet scalar

$$\begin{split} \mathcal{L} &= \frac{v^2}{4} \mathrm{Tr} D_{\mu} \Sigma^{\dagger} D^{\mu} \Sigma \left( 1 + 2 \frac{a}{v} \frac{h}{v} + \frac{b}{v^2} \frac{h^2}{v^2} + \ldots \right) - m_i \bar{\psi}_L^i \Sigma \left( 1 + \frac{c}{v} \frac{h}{v} + \ldots \right) \psi_R^i + \mathrm{h.c.} \\ &+ \frac{1}{2} (\partial_{\mu} h)^2 + \frac{1}{2} m_h^2 h^2 + \frac{d_3}{6} \left( \frac{3m_h^2}{v} \right) h^3 + \frac{d_4}{24} \frac{1}{24} \left( \frac{3m_h^2}{v^2} \right) h^4 + \ldots \quad , \end{split}$$

$$\Sigma &= \exp\left( i \frac{\sigma^a \pi^a}{v} \right)$$

• (c.f. HEFT)





• Could have had very different coupling patterns to SM!



July 2012 post-discovery J. Ellis and T.Y. [arXiv:1207.1693]







### The Standard Model

$$\mathcal{L}_{SM} = \mathcal{L}_m + \mathcal{L}_g + \mathcal{L}_h + \mathcal{L}_y$$
,

$$\begin{split} \mathcal{L}_m &= \bar{Q}_L i \gamma^\mu D^L_\mu Q_L + \bar{q}_R i \gamma^\mu D^R_\mu q_R + \bar{L}_L i \gamma^\mu D^L_\mu L_L + \bar{l}_R i \gamma^\mu D^R_\mu l_R \\ \mathcal{L}_G &= -\frac{1}{4} B_{\mu\nu} B^{\mu\nu} - \frac{1}{4} W^a_{\mu\nu} W^{a\mu\nu} \\ \mathcal{L}_H &= (D^L_\mu \phi)^\dagger (D^{L\mu} \phi) - V(\phi) \\ \mathcal{L}_Y &= y_d \bar{Q}_L \phi q^d_R + y_u \bar{Q}_L \phi^c q^u_R + y_L \bar{L}_L \phi l_R + \text{h.c.} \quad , \end{split}$$

## SM to SMEFT framework

- New physics appear to be decoupled at higher energies
- Given particle content, write down *all* terms allowed by symmetries...

	$SU(3)_c$	$SU(2)_L$	$U(1)_Y$
$Q_L$	3	2	$\frac{1}{6}$
$q^u_R$	3	1	$\frac{2}{3}$
$q_R^d$	3	1	$-\frac{1}{3}$
$L_L$	1	2	$-\frac{1}{2}$
$l_R$	1	1	-1
$\phi$	1	2	$\frac{1}{2}$

$$\begin{split} \mathcal{L}_{SM} &= \mathcal{L}_m + \mathcal{L}_g + \mathcal{L}_h + \mathcal{L}_y \qquad, \\ \mathcal{L}_m &= \bar{Q}_L i \gamma^\mu D^L_\mu Q_L + \bar{q}_R i \gamma^\mu D^R_\mu q_R + \bar{L}_L i \gamma^\mu D^L_\mu L_L + \bar{l}_R i \gamma^\mu D^R_\mu l_R \\ \mathcal{L}_G &= -\frac{1}{4} B_{\mu\nu} B^{\mu\nu} - \frac{1}{4} W^a_{\mu\nu} W^{a\mu\nu} \\ \mathcal{L}_H &= (D^L_\mu \phi)^\dagger (D^{L\mu} \phi) - V(\phi) \\ \mathcal{L}_Y &= y_d \bar{Q}_L \phi q^d_R + y_u \bar{Q}_L \phi^c q^u_R + y_L \bar{L}_L \phi l_R + \text{h.c.} \quad, \end{split}$$

• ...Including **higher-dimensional** operators!

$$\mathcal{L}_{ ext{SM}}^{ ext{dim-6}} = \sum_i rac{c_i}{\Lambda^2} \mathcal{O}_i$$

• Generated by new physics at scale  $\Lambda \gg v$ 

• Lagrangian dim-6 operator coefficient normalization:  $\mathcal{L}_{SMEFT} = \mathcal{L}_{SM} + \sum_{i=1}^{2499} \frac{C_i}{\Lambda^2} \mathcal{O}_i$ 

#### • Warsaw basis

[1008.4884 Grzadkowski et al]

		$X^3$		$H^6$ and $H^4D^2$		$\psi^2 H^3$
	$\mathcal{O}_{G}$	$f^{ABC}G^{A\nu}_{\mu}G^{B\rho}_{\nu}G^{C\mu}_{\rho}$	$\mathcal{O}_{H}$	$(H^{\dagger}H)^3$	$\mathcal{O}_{eH}$	$(H^{\dagger}H)(\bar{l}_{p}e_{r}H)$
	$\mathcal{O}_{\widetilde{G}}$	$f^{ABC}\widetilde{G}^{A\nu}_{\mu}G^{B ho}_{\nu}G^{C\mu}_{ ho}$	$\mathcal{O}_{H\square}$	$(H^{\dagger}H)\square(H^{\dagger}H)$	${\cal O}_{uH}$	$(H^{\dagger}H)(\bar{q}_{p}u_{r}\widetilde{H})$
	$\mathcal{O}_W$	$\varepsilon^{IJK}W^{I\nu}_{\mu}W^{J\rho}_{\nu}W^{K\mu}_{\rho}$	$\mathcal{O}_{HD}$	$\left  \left( H^{\dagger}D^{\mu}H ight) ^{\star}\left( H^{\dagger}D_{\mu}H ight)  ight $	${\cal O}_{_{dH}}$	$(H^{\dagger}H)(\bar{q}_{p}d_{r}H)$
	${\mathcal O}_{\widetilde{W}}$	$\varepsilon^{IJK}\widetilde{W}^{I\nu}_{\mu}W^{J\rho}_{\nu}W^{K\mu}_{\rho}$				
		$X^2H^2$		$\psi^2 X H$		$\psi^2 H^2 D$
	$\mathcal{O}_{{}_{HG}}$	$H^{\dagger}HG^{A}_{\mu\nu}G^{A\mu\nu}$	${\cal O}_{eW}$	$(\bar{l}_p \sigma^{\mu\nu} e_r) \tau^I H W^I_{\mu\nu}$	$\mathcal{O}_{Hl}^{(1)}$	$(H^{\dagger}i \stackrel{\leftrightarrow}{D}_{\mu} H)(\bar{l}_p \gamma^{\mu} l_r)$
	$\mathcal{O}_{H\widetilde{G}}$	$H^{\dagger}H\widetilde{G}^{A}_{\mu u}G^{A\mu u}$	${\cal O}_{eB}$	$(\bar{l}_p \sigma^{\mu\nu} e_r) H B_{\mu\nu}$	$\mathcal{O}_{Hl}^{(3)}$	$(H^{\dagger}i D_{\underline{\mu}}^{I} H)(\bar{l}_{p} \tau^{I} \gamma^{\mu} l_{r})$
	${\cal O}_{HW}$	$H^{\dagger}HW^{I}_{\mu\nu}W^{I\mu\nu}$	$\mathcal{O}_{uG}$	$(\bar{q}_p \sigma^{\mu\nu} T^A u_r) \widetilde{H} G^A_{\mu\nu}$	${\cal O}_{_{He}}$	$(H^{\dagger}i D_{\mu} H)(\bar{e}_p \gamma^{\mu} e_r)$
	${\cal O}_{{}_{H\widetilde{W}}}$	$H^{\dagger}H\widetilde{W}^{I}_{\mu\nu}W^{I\mu\nu}$	$\mathcal{O}_{uW}$	$(\bar{q}_p \sigma^{\mu\nu} u_r) \tau^I \tilde{H} W^I_{\mu\nu}$	$\mathcal{O}_{Hq}^{(1)}$	$(H^{\dagger}i \overset{\leftrightarrow}{D}_{\mu} H)(\bar{q}_p \gamma^{\mu} q_r)$
	$\mathcal{O}_{{}_{HB}}$	$H^{\dagger}HB_{\mu u}B^{\mu u}$	${\cal O}_{uB}$	$(\bar{q}_p \sigma^{\mu u} u_r) \widetilde{H} B_{\mu u}$	$\mathcal{O}_{Hq}^{(3)}$	$(H^{\dagger}i D_{\underline{\mu}}^{I} H)(\bar{q}_{p} \tau^{I} \gamma^{\mu} q_{r})$
	$\mathcal{O}_{H\widetilde{B}}$	$H^{\dagger}H\widetilde{B}_{\mu u}B^{\mu u}$	${\cal O}_{dG}$	$(\bar{q}_p \sigma^{\mu\nu} T^A d_r) H G^A_{\mu\nu}$	$\mathcal{O}_{Hu}$	$(H^{\dagger}i \overset{\sim}{D_{\mu}} H)(\bar{u}_p \gamma^{\mu} u_r)$
	$\mathcal{O}_{HWB}$	$H^{\dagger} \tau^{I} H W^{I}_{\mu u} B^{\mu u}$	${\cal O}_{dW}$	$(\bar{q}_p \sigma^{\mu\nu} d_r) \tau^I H W^I_{\mu\nu}$	${\cal O}_{Hd}$	$(H^{\dagger}i D_{\mu} H)(\bar{d}_p \gamma^{\mu} d_r)$
	$\mathcal{O}_{H\widetilde{W}B}$	$H^{\dagger} \tau^{I} H  \widetilde{W}^{I}_{\mu u} B^{\mu u}$	$\mathcal{O}_{dB}$	$(\bar{q}_p \sigma^{\mu u} d_r) H B_{\mu u}$	${\cal O}_{_{Hud}}$	$i(\widetilde{H}^{\dagger}D_{\mu}H)(\bar{u}_{p}\gamma^{\mu}d_{r})$
_						
$\square$		$(\bar{L}L)(\bar{L}L)$		$(\bar{R}R)(\bar{R}R)$		$(\bar{L}L)(\bar{R}R)$
	$\mathcal{O}_{ll}$	$\frac{(\bar{L}L)(\bar{L}L)}{(\bar{l}_p\gamma_\mu l_r)(\bar{l}_s\gamma^\mu l_t)}$	$\mathcal{O}_{ee}$	$\begin{array}{c c} (\bar{R}R)(\bar{R}R) \\ (\bar{e}_p \gamma_\mu e_r)(\bar{e}_s \gamma^\mu e_t) \end{array}$	$\mathcal{O}_{le}$	$\frac{(\bar{L}L)(\bar{R}R)}{(\bar{l}_p\gamma_\mu l_r)(\bar{e}_s\gamma^\mu e_t)}$
	$\mathcal{O}_{ll} \ \mathcal{O}_{qq}^{(1)}$	$ \begin{array}{c} (\bar{L}L)(\bar{L}L) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{l}_s \gamma^\mu l_t) \\ (\bar{q}_p \gamma_\mu q_r)(\bar{q}_s \gamma^\mu q_t) \end{array} $	$\mathcal{O}_{ee}$ $\mathcal{O}_{uu}$	$\begin{array}{c} (\bar{R}R)(\bar{R}R) \\ (\bar{e}_p \gamma_\mu e_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{u}_p \gamma_\mu u_r)(\bar{u}_s \gamma^\mu u_t) \end{array}$	$egin{array}{c} \mathcal{O}_{le} \ \mathcal{O}_{lu} \end{array}$	$\begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{u}_s \gamma^\mu u_t) \end{array}$
	$\mathcal{O}_{ll} \ \mathcal{O}_{qq}^{(1)} \ \mathcal{O}_{qq}^{(3)} \ \mathcal{O}_{qq}^{(3)}$	$ \begin{array}{c} (\bar{L}L)(\bar{L}L) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{l}_s \gamma^\mu l_t) \\ (\bar{q}_p \gamma_\mu q_r)(\bar{q}_s \gamma^\mu q_t) \\ (\bar{q}_p \gamma_\mu \tau^I q_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \end{array} $	$egin{array}{c} \mathcal{O}_{ee} \ \mathcal{O}_{uu} \ \mathcal{O}_{dd} \end{array}$	$ \begin{array}{c} (\bar{R}R)(\bar{R}R) \\ (\bar{e}_p \gamma_\mu e_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{u}_p \gamma_\mu u_r)(\bar{u}_s \gamma^\mu u_t) \\ (\bar{d}_p \gamma_\mu d_r)(\bar{d}_s \gamma^\mu d_t) \end{array} $	$egin{array}{c} \mathcal{O}_{le} \ \mathcal{O}_{lu} \ \mathcal{O}_{ld} \end{array}$	$\begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{u}_s \gamma^\mu u_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{d}_s \gamma^\mu d_t) \end{array}$
	$\mathcal{O}_{ll} \ \mathcal{O}_{qq}^{(1)} \ \mathcal{O}_{qq}^{(3)} \ \mathcal{O}_{lq}^{(3)} \ \mathcal{O}_{lq}^{(1)} \ \mathcal{O}_{lq}^{(2)}$	$ \begin{array}{c} (\bar{L}L)(\bar{L}L) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{l}_s \gamma^\mu l_t) \\ (\bar{q}_p \gamma_\mu q_r)(\bar{q}_s \gamma^\mu q_t) \\ (\bar{q}_p \gamma_\mu \tau^I q_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{q}_s \gamma^\mu q_t) \end{array} $	$egin{array}{c} \mathcal{O}_{ee} \ \mathcal{O}_{uu} \ \mathcal{O}_{dd} \ \mathcal{O}_{eu} \end{array}$	$ \begin{array}{c} (\bar{R}R)(\bar{R}R) \\ (\bar{e}_p \gamma_\mu e_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{u}_p \gamma_\mu u_r)(\bar{u}_s \gamma^\mu u_t) \\ (\bar{d}_p \gamma_\mu d_r)(\bar{d}_s \gamma^\mu d_t) \\ (\bar{e}_p \gamma_\mu e_r)(\bar{u}_s \gamma^\mu u_t) \end{array} $	$egin{array}{c} \mathcal{O}_{le} \ \mathcal{O}_{lu} \ \mathcal{O}_{ld} \ \mathcal{O}_{qe} \end{array}$	$\begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_p\gamma_\mu l_r)(\bar{e}_s\gamma^\mu e_t) \\ (\bar{l}_p\gamma_\mu l_r)(\bar{u}_s\gamma^\mu u_t) \\ (\bar{l}_p\gamma_\mu l_r)(\bar{d}_s\gamma^\mu d_t) \\ (\bar{q}_p\gamma_\mu q_r)(\bar{e}_s\gamma^\mu e_t) \end{array}$
	$\mathcal{O}_{ll} \ \mathcal{O}_{qq} \ \mathcal{O}_{qq} \ \mathcal{O}_{qq} \ \mathcal{O}_{ll} \ \mathcal{O}_{qq}^{(3)} \ \mathcal{O}_{lq}^{(3)} \ \mathcal{O}_{lq}^{(3)}$	$ \begin{array}{c} (\bar{L}L)(\bar{L}L) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{l}_s \gamma^\mu l_t) \\ (\bar{q}_p \gamma_\mu q_r)(\bar{q}_s \gamma^\mu q_t) \\ (\bar{q}_p \gamma_\mu \tau^I q_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{q}_s \gamma^\mu q_t) \\ (\bar{l}_p \gamma_\mu \tau^I l_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \end{array} $	$\mathcal{O}_{ee}$ $\mathcal{O}_{uu}$ $\mathcal{O}_{dd}$ $\mathcal{O}_{eu}$ $\mathcal{O}_{ed}$	$ \begin{array}{c} (\bar{R}R)(\bar{R}R) \\ \hline (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{d}_{p}\gamma_{\mu}d_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \end{array} $	$egin{array}{c} \mathcal{O}_{le} & & \ \mathcal{O}_{lu} & & \ \mathcal{O}_{ld} & & \ \mathcal{O}_{qe} & & \ \mathcal{O}_{qu} & $	$\begin{array}{c} (\bar{L}L)(\bar{R}R) \\ \hline (\bar{l}_p \gamma_\mu l_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{u}_s \gamma^\mu u_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{d}_s \gamma^\mu d_t) \\ (\bar{q}_p \gamma_\mu q_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{q}_p \gamma_\mu q_r)(\bar{u}_s \gamma^\mu u_t) \end{array}$
	$egin{aligned} &\mathcal{O}_{ll} \ &\mathcal{O}_{qq}^{(1)} \ &\mathcal{O}_{qq}^{(3)} \ &\mathcal{O}_{lq}^{(1)} \ &\mathcal{O}_{lq}^{(1)} \ &\mathcal{O}_{lq}^{(3)} \end{aligned}$	$ \begin{array}{c} (\bar{L}L)(\bar{L}L) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{l}_s \gamma^\mu l_t) \\ (\bar{q}_p \gamma_\mu q_r)(\bar{q}_s \gamma^\mu q_t) \\ (\bar{q}_p \gamma_\mu \tau^I q_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{q}_s \gamma^\mu q_t) \\ (\bar{l}_p \gamma_\mu \tau^I l_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \end{array} $	$\mathcal{O}_{ee}$ $\mathcal{O}_{uu}$ $\mathcal{O}_{dd}$ $\mathcal{O}_{eu}$ $\mathcal{O}_{ed}$ $\mathcal{O}_{ud}^{(1)}$	$ \begin{array}{c} (\bar{R}R)(\bar{R}R) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{d}_{p}\gamma_{\mu}d_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \end{array} $	$\mathcal{O}_{le}$ $\mathcal{O}_{lu}$ $\mathcal{O}_{ld}$ $\mathcal{O}_{qe}$ $\mathcal{O}_{qu}^{(1)}$ $\mathcal{O}_{qu}^{(8)}$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ \hline (\bar{l}_p \gamma_\mu l_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{u}_s \gamma^\mu u_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{d}_s \gamma^\mu d_t) \\ (\bar{q}_p \gamma_\mu q_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{q}_p \gamma_\mu q_r)(\bar{u}_s \gamma^\mu u_t) \\ (\bar{q}_p \gamma_\mu T^A q_r)(\bar{u}_s \gamma^\mu T^A u_t) \end{array} $
	$egin{aligned} &\mathcal{O}_{ll} \ &\mathcal{O}_{qq}^{(1)} \ &\mathcal{O}_{qq}^{(3)} \ &\mathcal{O}_{lq}^{(3)} \ &\mathcal{O}_{lq}^{(3)} \ &\mathcal{O}_{lq}^{(3)} \end{aligned}$	$ \begin{array}{c} (\bar{L}L)(\bar{L}L) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{l}_s \gamma^\mu l_t) \\ (\bar{q}_p \gamma_\mu q_r)(\bar{q}_s \gamma^\mu q_t) \\ (\bar{q}_p \gamma_\mu \tau^I q_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{q}_s \gamma^\mu q_t) \\ (\bar{l}_p \gamma_\mu \tau^I l_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \end{array} $	$\begin{array}{c c} & \mathcal{O}_{ee} \\ \mathcal{O}_{uu} \\ \mathcal{O}_{dd} \\ \mathcal{O}_{eu} \\ \mathcal{O}_{ed} \\ \mathcal{O}_{ud}^{(1)} \\ \mathcal{O}_{ud}^{(8)} \end{array}$	$\begin{array}{c} (\bar{R}R)(\bar{R}R) \\ \hline (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{d}_{p}\gamma_{\mu}d_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{u}_{p}\gamma_{\mu}T^{A}u_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array}$	$\mathcal{O}_{le}$ $\mathcal{O}_{lu}$ $\mathcal{O}_{ld}$ $\mathcal{O}_{qe}$ $\mathcal{O}_{qu}^{(1)}$ $\mathcal{O}_{qu}^{(1)}$ $\mathcal{O}_{qd}^{(2)}$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ \hline (\bar{l}_p\gamma_\mu l_r)(\bar{e}_s\gamma^\mu e_t) \\ (\bar{l}_p\gamma_\mu l_r)(\bar{u}_s\gamma^\mu u_t) \\ (\bar{l}_p\gamma_\mu l_r)(\bar{d}_s\gamma^\mu d_t) \\ (\bar{q}_p\gamma_\mu q_r)(\bar{e}_s\gamma^\mu e_t) \\ (\bar{q}_p\gamma_\mu q_r)(\bar{u}_s\gamma^\mu u_t) \\ (\bar{q}_p\gamma_\mu T^A q_r)(\bar{u}_s\gamma^\mu T^A u_t) \\ (\bar{q}_p\gamma_\mu q_r)(\bar{d}_s\gamma^\mu d_t) \\ (\bar{q}_p\gamma_\mu q_r)(\bar{d}_s\gamma^\mu d_r) \\ (\bar{q}_p\gamma_\mu q_r)(\bar{d}_s\gamma^\mu d_r) \\ (\bar{q}_p\gamma_\mu q_r)(\bar{d}_s\gamma^\mu d_r) \\ (\bar{q}_p\gamma_\mu q_r)(\bar{d}_s\gamma^\mu d_r) \\ (\bar{d}_p\gamma_\mu q_r)(\bar{d}_s\gamma^\mu d_r) \\ (\bar{d}_p\gamma_\mu q_r)(\bar{d}_s\gamma^\mu d_r) \\ (\bar{d}_p\gamma_\mu q_r) \\ ($
	$egin{aligned} &\mathcal{O}_{ll} \ &\mathcal{O}_{qq}^{(1)} \ &\mathcal{O}_{qq}^{(3)} \ &\mathcal{O}_{lq}^{(1)} \ &\mathcal{O}_{lq}^{(3)} \ &\mathcal{O}_{lq}^{(3)} \end{aligned}$	$ \begin{array}{c} (\bar{L}L)(\bar{L}L) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{l}_s \gamma^\mu l_t) \\ (\bar{q}_p \gamma_\mu q_r)(\bar{q}_s \gamma^\mu q_t) \\ (\bar{q}_p \gamma_\mu \tau^I q_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{q}_s \gamma^\mu q_t) \\ (\bar{l}_p \gamma_\mu \tau^I l_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \end{array} $	$\mathcal{O}_{ee}$ $\mathcal{O}_{uu}$ $\mathcal{O}_{dd}$ $\mathcal{O}_{eu}$ $\mathcal{O}_{ed}$ $\mathcal{O}_{ud}^{(1)}$ $\mathcal{O}_{ud}^{(8)}$	$\begin{array}{c} (\bar{R}R)(\bar{R}R) \\ (\bar{e}_p \gamma_\mu e_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{u}_p \gamma_\mu u_r)(\bar{u}_s \gamma^\mu u_t) \\ (\bar{d}_p \gamma_\mu d_r)(\bar{d}_s \gamma^\mu d_t) \\ (\bar{e}_p \gamma_\mu e_r)(\bar{u}_s \gamma^\mu u_t) \\ (\bar{e}_p \gamma_\mu e_r)(\bar{d}_s \gamma^\mu d_t) \\ (\bar{u}_p \gamma_\mu u_r)(\bar{d}_s \gamma^\mu d_t) \\ (\bar{u}_p \gamma_\mu u_r)(\bar{d}_s \gamma^\mu T^A d_t) \end{array}$	$\mathcal{O}_{le}$ $\mathcal{O}_{lu}$ $\mathcal{O}_{ld}$ $\mathcal{O}_{qe}$ $\mathcal{O}_{qu}^{(1)}$ $\mathcal{O}_{qd}^{(8)}$ $\mathcal{O}_{qd}^{(8)}$ $\mathcal{O}_{qd}^{(8)}$	$\begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array}$
	$\mathcal{O}_{ll} \ \mathcal{O}_{qq}^{(1)} \ \mathcal{O}_{lq}^{(1)} \ \mathcal{O}_{lq}^{(3)} \ \mathcal{O}_{lq}^{(3)} \ \mathcal{O}_{lq}^{(3)}$	$ \begin{array}{c} (\bar{L}L)(\bar{L}L) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t}) \\ (\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}q_{t}) \\ (\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t}) \\ \end{array} \\ ) (\bar{R}L) \text{ and } (\bar{L}R)(\bar{L}R) $	$\mathcal{O}_{ee}$ $\mathcal{O}_{uu}$ $\mathcal{O}_{dd}$ $\mathcal{O}_{eu}$ $\mathcal{O}_{ed}$ $\mathcal{O}_{ud}^{(1)}$	$\begin{array}{c} (\bar{R}R)(\bar{R}R) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{d}_{p}\gamma_{\mu}d_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{u}_{p}\gamma_{\mu}T^{A}u_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array}$	$\begin{matrix} \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qu}^{(8)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(8)} \\ \end{matrix}$	$\begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_p\gamma_\mu l_r)(\bar{e}_s\gamma^\mu e_t) \\ (\bar{l}_p\gamma_\mu l_r)(\bar{u}_s\gamma^\mu u_t) \\ (\bar{l}_p\gamma_\mu l_r)(\bar{d}_s\gamma^\mu d_t) \\ (\bar{q}_p\gamma_\mu q_r)(\bar{e}_s\gamma^\mu e_t) \\ (\bar{q}_p\gamma_\mu q_r)(\bar{u}_s\gamma^\mu u_t) \\ (\bar{q}_p\gamma_\mu T^A q_r)(\bar{u}_s\gamma^\mu T^A u_t) \\ (\bar{q}_p\gamma_\mu T^A q_r)(\bar{d}_s\gamma^\mu d_t) \\ (\bar{q}_p\gamma_\mu T^A q_r)(\bar{d}_s\gamma^\mu T^A d_t) \end{array}$
	$\mathcal{O}_{ll} \ \mathcal{O}_{qq} \ \mathcal{O}_{qq} \ \mathcal{O}_{qq} \ \mathcal{O}_{lq} \ \mathcal{O}$	$ \begin{array}{c} (\bar{L}L)(\bar{L}L) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{l}_s \gamma^\mu l_t) \\ (\bar{q}_p \gamma_\mu q_r)(\bar{q}_s \gamma^\mu q_t) \\ (\bar{q}_p \gamma_\mu \tau^I q_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{q}_s \gamma^\mu q_t) \\ (\bar{l}_p \gamma_\mu \tau^I l_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \\ \end{array} $	$\begin{array}{c c} & \mathcal{O}_{ee} \\ \mathcal{O}_{uu} \\ \mathcal{O}_{dd} \\ \mathcal{O}_{eu} \\ \mathcal{O}_{ed} \\ \mathcal{O}_{ud}^{(1)} \\ \mathcal{O}_{ud}^{(8)} \\ \end{array}$	$ \begin{array}{c} (\bar{R}R)(\bar{R}R) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{d}_{p}\gamma_{\mu}d_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{u}_{p}\gamma_{\mu}T^{A}u_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array} $ $ \begin{array}{c} B\text{-vio} \\ \hline & \varepsilon^{\alpha\beta\gamma}\varepsilon_{jk} \left[ (d_{p}\gamma_{\mu}) \\ (d_{p}\gamma_{\mu}) \\ \varepsilon^{\alpha\beta\gamma}\varepsilon_{jk} \right] \\ \end{array}$	$\begin{matrix} \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qd}^{(1)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(8)$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_p\gamma_\mu l_r)(\bar{e}_s\gamma^\mu e_t) \\ (\bar{l}_p\gamma_\mu l_r)(\bar{u}_s\gamma^\mu u_t) \\ (\bar{l}_p\gamma_\mu l_r)(\bar{d}_s\gamma^\mu d_t) \\ (\bar{q}_p\gamma_\mu q_r)(\bar{e}_s\gamma^\mu e_t) \\ (\bar{q}_p\gamma_\mu q_r)(\bar{u}_s\gamma^\mu u_t) \\ (\bar{q}_p\gamma_\mu T^A q_r)(\bar{u}_s\gamma^\mu T^A u_t) \\ (\bar{q}_p\gamma_\mu T^A q_r)(\bar{d}_s\gamma^\mu d_t) \\ (\bar{q}_p\gamma_\mu T^A q_r)(\bar{d}_s\gamma^\mu T^A d_t) \\ \end{array} $
	$\mathcal{O}_{ll} \\ \mathcal{O}_{qq}^{(1)} \\ q^{qq} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(2)} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{ledq} \\ \mathcal{O}_{quqd}^{(1)} \end{pmatrix}$	$ \begin{array}{c} (\bar{L}L)(\bar{L}L) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{l}_s \gamma^\mu l_t) \\ (\bar{q}_p \gamma_\mu q_r)(\bar{q}_s \gamma^\mu q_t) \\ (\bar{q}_p \gamma_\mu \tau^I q_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{q}_s \gamma^\mu q_t) \\ (\bar{l}_p \gamma_\mu \tau^I l_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \\ (\bar{l}_p q_\mu \tau^I l_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \\ \end{array} $	$\begin{array}{c c} & \mathcal{O}_{ee} \\ \mathcal{O}_{uu} \\ \mathcal{O}_{dd} \\ \mathcal{O}_{eu} \\ \mathcal{O}_{ed} \\ \mathcal{O}_{ud}^{(1)} \\ \mathcal{O}_{ud}^{(8)} \\ \mathcal{O}_{ud}^{(8)} \end{array}$	$ \begin{array}{c} (\bar{R}R)(\bar{R}R) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{d}_{p}\gamma_{\mu}d_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{u}_{p}\gamma_{\mu}T^{A}u_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array} $ $ \begin{array}{c} B\text{-vio} \\ \varepsilon^{\alpha\beta\gamma}\varepsilon_{jk} \left[ (d_{p}^{\alpha}) \\ \varepsilon^{\alpha\beta\gamma}\varepsilon_{jk} \right] \\ \left[ (d_{p}^{\alpha}) \\ \varepsilon^{\alpha\beta\gamma}\varepsilon_{jk} \right] \\ \end{array}$	$\begin{matrix} \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qu}^{(8)} \\ \mathcal{O}_{qd}^{(g)} \\ \mathcal{O}_{qd}^{(g)} \\ \begin{matrix} \mathcal{O}_{qd}^{(g)} \\ \mathcal{O}_{qd}^{(g)} \\ \end{matrix} \end{matrix}$	$\begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array}$
	$\mathcal{O}_{ll} \\ \mathcal{O}_{qq}^{(1)} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{ledq} \\ \mathcal{O}_{quqd}^{(1)} \\ \mathcal{O}_{quqd}^{(8)} \\ \mathcal{O}_{quqd}^{(8)} \end{pmatrix}$	$ \begin{array}{c} (\bar{L}L)(\bar{L}L) \\ (\bar{l}_p\gamma_\mu l_r)(\bar{l}_s\gamma^\mu l_t) \\ (\bar{q}_p\gamma_\mu q_r)(\bar{q}_s\gamma^\mu q_t) \\ (\bar{q}_p\gamma_\mu \tau^I q_r)(\bar{q}_s\gamma^\mu \tau^I q_t) \\ (\bar{l}_p\gamma_\mu l_r)(\bar{q}_s\gamma^\mu q_t) \\ (\bar{l}_p\gamma_\mu \tau^I l_r)(\bar{q}_s\gamma^\mu \tau^I q_t) \\ \end{array} \\ \hline )(\bar{R}L) \text{ and } (\bar{L}R)(\bar{L}R) \\ \hline (\bar{l}_p^j p_r)(\bar{d}_s q_t^j) \\ (\bar{q}_p^j u_r) \varepsilon_{jk}(\bar{q}_s^k d_t) \\ (\bar{q}_p^j T_{-u}^A u_r) \varepsilon_{jk}(\bar{q}_s^k T^A d_t) \end{array} $	$\begin{array}{c} & \mathcal{O}_{ee} \\ \mathcal{O}_{uu} \\ \mathcal{O}_{dd} \\ \mathcal{O}_{eu} \\ \mathcal{O}_{ed} \\ \mathcal{O}_{ud}^{(1)} \\ \mathcal{O}_{ud}^{(8)} \\ \mathcal{O}_{ud}^{(8)} \end{array}$	$ \begin{array}{c} (\bar{R}R)(\bar{R}R) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{d}_{p}\gamma_{\mu}d_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{u}_{p}\gamma_{\mu}T^{A}u_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array} $ $ \begin{array}{c} B\text{-vio} \\ \varepsilon^{\alpha\beta\gamma}\varepsilon_{jk} \left[ (d_{p}^{\alpha}\varepsilon^{\alpha\beta\gamma}\varepsilon_{jk} \left[ (d_{p}^{\alpha}\varepsilon^{\alpha\beta\gamma}\varepsilon_{jn}\varepsilon_{km} \left[ (q_{p}^{\alpha}\varepsilon^{\alpha\beta\gamma}\varepsilon_{jn}\varepsilon_{km} \left[ (q_{p}^{\alpha}\varepsilon^{\alpha}\varepsilon_{jn}\varepsilon_{km} \left[ (q_{p}^{\alpha}\varepsilon^{\alpha}\varepsilon_{jn}\varepsilon_{km} \left[ (q_{p}^{\alpha}\varepsilon_{jn}\varepsilon_{km} \left[ (q_{p}^{\alpha}\varepsilon_{jn}\varepsilon_{km} \left[ (q_{p}^{\alpha}\varepsilon_{jn}\varepsilon_{jn}\varepsilon_{km} \left[ (q_{p}^{\alpha}\varepsilon_{jn}\varepsilon_{jn}\varepsilon_{jm} \left[ (q_{p}^{\alpha}\varepsilon_{jn}\varepsilon_{jm} c_{jm} c_{jm} c_{jm} c_{jm} c_{jm} c_{jm} c_{jm} c_{jm} c_{$	$\begin{matrix} \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(2)} \\ \mathcal{O}_{qd}^{(3)} \\ \mathcal{O}_{qd}^{(3)$	$\begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}C^{A}d_{t}) \\ [(q_{s}^{\gamma j})^{T}Cl_{t}^{k}] \\ ] \\ [(u_{s}^{\gamma})^{T}Ce_{t}] \\ \\ k \end{bmatrix} \underbrace{[(q_{s}^{\gamma m})^{T}Cl_{t}^{n}] \\ \end{array}$
	$ \begin{array}{c} \mathcal{O}_{ll} \\ \mathcal{O}_{qq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \\ \end{array} \\ \hline \left( \bar{L}R \right) \\ \begin{array}{c} \mathcal{O}_{ledq} \\ \mathcal{O}_{quqd}^{(1)} \\ \mathcal{O}_{lequd}^{(3)} \\ \mathcal{O}_{lequd}^{(1)} \\ \mathcal{O}_{lequ}^{(1)} \\ \mathcal{O}_{lequ}^{(1)} \\ \end{array} \\ \end{array} $	$ \begin{array}{c} (\bar{L}L)(\bar{L}L) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t}) \\ (\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}q_{t}) \\ (\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t}) \\ \end{array} \\ (\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t}) \\ \hline (\bar{l}_{p}^{j}q_{\mu}\tau)\varepsilon_{jk}(\bar{q}_{s}k^{j}d_{t}) \\ (\bar{q}_{p}^{j}T^{A}u_{r})\varepsilon_{jk}(\bar{q}_{s}^{k}T^{A}d_{t}) \\ (\bar{l}_{p}^{j}e_{r})\varepsilon_{jk}(\bar{q}_{s}^{k}u_{t}) \\ \end{array} $	$\begin{array}{c} & \mathcal{O}_{ee} \\ \mathcal{O}_{uu} \\ \mathcal{O}_{dd} \\ \mathcal{O}_{eu} \\ \mathcal{O}_{ed} \\ \mathcal{O}_{ud}^{(1)} \\ \mathcal{O}_{ud}^{(8)} \\ \mathcal{O}_{ud}^{(8)} \end{array}$	$\begin{array}{c} (\bar{R}R)(\bar{R}R) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{d}_{p}\gamma_{\mu}d_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{u}_{s}\gamma^{\mu}d_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{u}_{p}\gamma_{\mu}T^{A}u_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array}$ $\begin{array}{c} B\text{-vio} \\ & \mathcal{E}^{\alpha\beta\gamma}\varepsilon_{jk} \left[ (d_{p}^{\alpha}) \\ & \varepsilon^{\alpha\beta\gamma}\varepsilon_{jn}\varepsilon_{km} \left[ (q_{p}^{\alpha}) \\ & \varepsilon^{\alpha\beta\gamma}\varepsilon_{jn}\varepsilon_{km} \right] \right] \end{array}$	$\begin{matrix} & \mathcal{O}_{le} \\ & \mathcal{O}_{lu} \\ & \mathcal{O}_{ld} \\ & \mathcal{O}_{qe} \\ & \mathcal{O}_{qu}^{(1)} \\ & \mathcal{O}_{qd}^{(1)} \\ & \mathcal{O}_{qd}^{(2)} \\ & \mathcal{O}_{qd}^{(3)} \\ & \mathcal{O}$	$\begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{s}\gamma^{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \\ \end{array}$

Input scheme:

Tevong You

$$\begin{split} &\alpha_{\scriptscriptstyle EW}^{-1} = 127.95, \quad G_{\scriptscriptstyle F} = 1.16638 \times 10^{-5}\,{\rm GeV}^{-2}\,, \\ &m_{\scriptscriptstyle Z} = 91.1876\,{\rm GeV}, \quad m_{\scriptscriptstyle H} = 125.09\,{\rm GeV}, \quad m_t = 173.2\,{\rm GeV} \end{split}$$



• 20 operators relevant for Higgs, diboson, and EWPO:

	$X^3$		$H^6$ and $H^4D^2$		$\psi^2 H^3$
$\mathcal{O}_{G}$	$\int f^{ABC} G^{A\nu}_{\mu} G^{B\rho}_{\nu} G^{C\mu}_{\rho}$	$\mathcal{O}_{H}$	$(H^{\dagger}H)^3$	$\mathcal{O}_{eH}$	$(H^{\dagger}H)(\bar{l}_{p}e_{r}H)$
$\mathcal{O}_{\widetilde{G}}$	$f^{ABC} \widetilde{G}^{A\nu}_{\mu} G^{B\rho}_{\nu} G^{C\mu}_{\rho}$	$\mathcal{O}_{H\square}$	$(H^{\dagger}H)\square(H^{\dagger}H)$	${\cal O}_{uH}$	$(H^{\dagger}H)(\bar{q}_{p}u_{r}\widetilde{H})$
$\mathcal{O}_{W}$	$\varepsilon^{IJK} W^{I\nu}_{\mu} W^{J\rho}_{\nu} W^{K\mu}_{\rho}$	$\mathcal{O}_{_{HD}}$	$\left(H^{\dagger}D^{\mu}H ight)^{\star}\left(H^{\dagger}D_{\mu}H ight)$	$\mathcal{O}_{_{dH}}$	$(H^{\dagger}H)(\bar{q}_p d_r H)$
$\mathcal{O}_{\widetilde{W}}$	$\varepsilon^{IJK} W^{I\nu}_{\mu} W^{J\rho}_{\nu} W^{K\mu}_{\rho}$				
	$X^2H^2$		$\psi^2 X H$		$\psi^2 H^2 D$
$\mathcal{O}_{HG}$	$H^{\dagger}HG^{A}_{\mu\nu}G^{A\mu\nu}$	${\cal O}_{eW}$	$(\bar{l}_p \sigma^{\mu\nu} e_r) \tau^I H W^I_{\mu\nu}$	$\mathcal{O}_{Hl}^{(1)}$	$(H^{\dagger}i \overset{\leftrightarrow}{D}_{\mu} H)(\bar{l}_{p} \gamma^{\mu} l_{r})$
$\mathcal{O}_{H\widetilde{G}}$	$H^{\dagger}H\widetilde{G}^{A}_{\mu u}G^{A\mu u}$	${\cal O}_{eB}$	$(\bar{l}_p \sigma^{\mu\nu} e_r) H B_{\mu\nu}$	${\cal O}_{_{Hl}}^{_{(3)}}$	$(H^{\dagger}i D^{I}_{\underline{\mu}} H)(\bar{l}_{p} \tau^{I} \gamma^{\mu} l_{r})$
${\cal O}_{HW}$	$H^{\dagger}H W^{I}_{\mu\nu}W^{I\mu\nu}$	${\cal O}_{uG}$	$(\bar{q}_p \sigma^{\mu\nu} T^A u_r) \widetilde{H} G^A_{\mu\nu}$	${\cal O}_{_{He}}$	$(H^{\dagger}i D_{\mu} H) (\bar{e}_p \gamma^{\mu} e_r)$
$\mathcal{O}_{H\widetilde{W}}$	$H^{\dagger}H \widetilde{W}^{I}_{\mu\nu}W^{I\mu\nu}$	${\cal O}_{uW}$	$(\bar{q}_p \sigma^{\mu\nu} u_r) \tau^I \tilde{H} W^I_{\mu\nu}$	$\mathcal{O}_{Hq}^{(1)}$	$(H^{\dagger}i D_{\mu} H)(\bar{q}_p \gamma^{\mu} q_r)$
$\mathcal{O}_{HB}$	$H^{\dagger}H B_{\mu\nu}B^{\mu\nu}$	${\cal O}_{uB}$	$(\bar{q}_p \sigma^{\mu\nu} u_r) \widetilde{H} B_{\mu\nu}$	${\cal O}_{{\scriptscriptstyle H}q}^{(3)}$	$(H^{\dagger}i D^{I}_{\underline{\mu}} H)(\bar{q}_{p}\tau^{I}\gamma^{\mu}q_{r})$
$\mathcal{O}_{H\widetilde{B}}$	$H^{\dagger}H\widetilde{B}_{\mu u}B^{\mu u}$	${\cal O}_{dG}$	$(\bar{q}_p \sigma^{\mu\nu} T^A d_r) H G^A_{\mu\nu}$	${\cal O}_{Hu}$	$(H^{\dagger}i \overset{\sim}{D_{\mu}} H)(\bar{u}_p \gamma^{\mu} u_r)$
$\mathcal{O}_{HWB}$	$H^{\dagger}\tau^{I}H W^{I}_{\mu\nu}B^{\mu\nu}$	${\cal O}_{dW}$	$(\bar{q}_p \sigma^{\mu\nu} d_r) \tau^I H W^I_{\mu\nu}$	${\cal O}_{Hd}$	$(H^{\dagger}i D_{\mu} H) (\bar{d}_p \gamma^{\mu} d_r)$
Oump	$H^{\dagger} \tau^{I} H W^{I}_{} B^{\mu  u}$	$\mathcal{O}_{dB}$	$(\bar{q}_{p}\sigma^{\mu\nu}d_{r})HB_{\mu\nu}$	$\mathcal{O}_{Hud}$	$i(\hat{H}^{\dagger}D_{\mu}H)(\bar{u}_{p}\gamma^{\mu}d_{r})$
U HWB	$\mu \nu$	uD	$(1p)$ $(1)$ $\mu\nu$	11.000	
	$(\bar{L}L)(\bar{L}L)$		$(\bar{R}R)(\bar{R}R)$		$(\bar{L}L)(\bar{R}R)$
$\mathcal{O}_{ll}$	$(\bar{L}L)(\bar{L}L)$ $(\bar{l}_p\gamma_{\mu}l_r)(\bar{l}_s\gamma^{\mu}l_t)$	$\mathcal{O}_{ee}$	$(\bar{R}R)(\bar{R}R)$ $(\bar{e}_p\gamma_\mu e_r)(\bar{e}_s\gamma^\mu e_t)$	$\mathcal{O}_{le}$	$ \frac{(\bar{L}L)(\bar{R}R)}{(\bar{l}_p\gamma_\mu l_r)(\bar{e}_s\gamma^\mu e_t)} $
$\begin{array}{ c } \mathcal{O}_{ll} \\ \mathcal{O}_{ll} \\ \mathcal{O}_{qq}^{(1)} \end{array}$	$ \begin{array}{c c} (\bar{L}L)(\bar{L}L) \\ \hline (\bar{l}_p \gamma_\mu l_r)(\bar{l}_s \gamma^\mu l_t) \\ \hline (\bar{q}_p \gamma_\mu q_r)(\bar{q}_s \gamma^\mu q_t) \end{array} $	$\mathcal{O}_{ee}$ $\mathcal{O}_{uu}$	$ \begin{array}{c} (\overline{R}R)(\overline{R}R) \\ (\overline{e}_p \gamma_\mu e_r)(\overline{e}_s \gamma^\mu e_t) \\ (\overline{u}_p \gamma_\mu u_r)(\overline{u}_s \gamma^\mu u_t) \end{array} $	$\mathcal{O}_{le}$ $\mathcal{O}_{lu}$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{u}_s \gamma^\mu u_t) \end{array} $
$\begin{array}{ c } \hline \mathcal{O}_{ll} \\ \hline \mathcal{O}_{ll} \\ \hline \mathcal{O}_{qq}^{(1)} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{qq}^{(3)} \end{array}$	$\begin{array}{c} (\bar{L}L)(\bar{L}L) \\ \hline (\bar{l}_p \gamma_\mu l_r)(\bar{l}_s \gamma^\mu l_t) \\ \hline (\bar{q}_p \gamma_\mu q_r)(\bar{q}_s \gamma^\mu q_t) \\ (\bar{q}_p \gamma_\mu \tau^I q_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \end{array}$	$\mathcal{O}_{ee}$ $\mathcal{O}_{uu}$ $\mathcal{O}_{dd}$	$ \begin{array}{c} (\overline{R}R)(\overline{R}R) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t}) \\ (\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t}) \\ (\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \end{array} $	$\begin{array}{c c} & & \\ & &$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ \hline (\bar{l}_p\gamma_{\mu}l_r)(\bar{e}_s\gamma^{\mu}e_t) \\ (\bar{l}_p\gamma_{\mu}l_r)(\bar{u}_s\gamma^{\mu}u_t) \\ (\bar{l}_p\gamma_{\mu}l_r)(\bar{d}_s\gamma^{\mu}d_t) \end{array} $
$\begin{array}{ c c } \hline \mathcal{O}_{ll} \\ \hline \mathcal{O}_{qq}^{(1)} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(1)} \\ \end{array}$	$(\bar{L}L)(\bar{L}L)$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t})$ $(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$	$\mathcal{O}_{ee}$ $\mathcal{O}_{uu}$ $\mathcal{O}_{dd}$ $\mathcal{O}_{eu}$	$(\overline{RR})(\overline{RR})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$ $(\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$	$\begin{array}{c c} & \mathcal{O}_{le} \\ & \mathcal{O}_{lu} \\ & \mathcal{O}_{ld} \\ & \mathcal{O}_{qe} \end{array}$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ \hline (\bar{l}_p \gamma_\mu l_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{u}_s \gamma^\mu u_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{d}_s \gamma^\mu d_t) \\ (\bar{q}_p \gamma_\mu q_r)(\bar{e}_s \gamma^\mu e_t) \end{array} $
$\begin{matrix} \mathcal{O}_{ll} \\ \mathcal{O}_{qq}^{(1)} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \end{matrix}$	$ \begin{array}{c} (\bar{L}L)(\bar{L}L) \\ \hline (\bar{l}_p \gamma_\mu l_r)(\bar{l}_s \gamma^\mu l_t) \\ \hline (\bar{q}_p \gamma_\mu q_r)(\bar{q}_s \gamma^\mu q_t) \\ (\bar{q}_p \gamma_\mu \tau^I q_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{q}_s \gamma^\mu q_t) \\ \hline (\bar{l}_p \gamma_\mu \tau^I l_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \end{array} $	$\begin{array}{c c} & & \\ & &$	$(\overline{RR})(\overline{RR})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$ $(\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{u}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$	$\begin{matrix} \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \end{matrix}$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{u}_s \gamma^\mu u_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{d}_s \gamma^\mu d_t) \\ (\bar{q}_p \gamma_\mu q_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{q}_p \gamma_\mu q_r)(\bar{u}_s \gamma^\mu u_t) \end{array} $
$ \begin{bmatrix} \mathcal{O}_{ll} \\ \mathcal{O}_{qq}^{(1)} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \end{bmatrix} $	$\begin{array}{c} (\bar{L}L)(\bar{L}L) \\ \hline (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t}) \\ \hline (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t}) \\ (\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}q_{t}) \\ (\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t}) \end{array}$	$\begin{array}{c c} & & \\ & &$	$\begin{array}{c c} (\bar{R}R)(\bar{R}R) \\ \hline (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{d}_{p}\gamma_{\mu}d_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \end{array}$	$\begin{array}{ c c c c c }\hline & & & & \\ & & & & \\ & & & & \\ & & & & $	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \end{array} $
$\begin{bmatrix} \mathcal{O}_{ll} \\ \mathcal{O}_{qq}^{(1)} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{lq}^{(2)} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \end{bmatrix}$	$\begin{array}{c} (\bar{L}L)(\bar{L}L) \\ \hline (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t}) \\ \hline (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t}) \\ (\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}q_{t}) \\ (\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t}) \end{array}$	$\begin{array}{c c} & & \\ & &$	$\begin{array}{c c} (\bar{R}R)(\bar{R}R) \\ \hline (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{d}_{p}\gamma_{\mu}d_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{u}_{p}\gamma_{\mu}T^{A}u_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array}$	$\begin{array}{ c c c c }\hline & & & & \\ & & & & \\ & & & & \\ & & & & $	$\begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \end{array}$
$\begin{array}{ c c }\hline \mathcal{O}_{ll} \\ \hline \mathcal{O}_{ll} \\ \mathcal{O}_{qq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \\ \end{array}$	$ \begin{array}{c} \mu\nu \\ \hline (\bar{L}L)(\bar{L}L) \\ \hline (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}l_{t}) \\ \hline (\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t}) \\ \hline (\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t}) \\ \hline (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}q_{t}) \\ \hline (\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t}) \end{array} $	$\begin{array}{c c} & & \\ & &$	$ \begin{array}{c} (\overline{R}R)(\overline{R}R) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t}) \\ (\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t}) \\ (\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{u}_{s}\gamma^{\mu}u_{t}) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{u}_{p}\gamma_{\mu}T^{A}u_{r})(\overline{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array} $	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array} $
$ \begin{bmatrix} \mathcal{O}_{ll} \\ \mathcal{O}_{qq}^{(1)} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \\ \end{bmatrix} $	$(\bar{L}L)(\bar{L}L)$ $(\bar{q}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}l_{t})$ $(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\chi_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$	$\begin{array}{ c c c }\hline & & & \\ $	$\frac{(\bar{R}p)(\bar{R}R)}{(\bar{e}_p\gamma_\mu e_r)(\bar{e}_s\gamma^\mu e_t)}$ $\frac{(\bar{u}_p\gamma_\mu u_r)(\bar{u}_s\gamma^\mu u_t)}{(\bar{d}_p\gamma_\mu d_r)(\bar{d}_s\gamma^\mu d_t)}$ $\frac{(\bar{e}_p\gamma_\mu e_r)(\bar{u}_s\gamma^\mu u_t)}{(\bar{e}_p\gamma_\mu e_r)(\bar{d}_s\gamma^\mu d_t)}$ $\frac{(\bar{u}_p\gamma_\mu u_r)(\bar{d}_s\gamma^\mu d_t)}{(\bar{u}_p\gamma_\mu T^A u_r)(\bar{d}_s\gamma^\mu T^A d_t)}$ $B\text{-vio}$	$\begin{matrix} \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qd}^{(3)} \\ \mathcal{O}_{qd}^{(3)} \\ \mathcal{O}_{qd}^{(3)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(8)} \\ \end{matrix}$	$\begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array}$
$ \begin{bmatrix} \mathcal{O}_{ll} \\ \mathcal{O}_{qq}^{(1)} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \\ \end{bmatrix} $	$(\bar{L}L)(\bar{L}L)$ $(\bar{q}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}l_{t})$ $(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\rho_{\mu}\tau^{I}l_{r})(\bar{q}_{s}q^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\rho_{\mu}\tau^{I}l_{r})(\bar{q}_{s}q^{\mu}q_{t})$	$\begin{array}{c c} & & \\ & &$	$\frac{(\bar{R}R)(\bar{R}R)}{(\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{e}_{s}\gamma^{\mu}e_{t})}$ $\frac{(\bar{e}_{p}\gamma_{\mu}u_{r})(\bar{u}_{s}\gamma^{\mu}u_{t})}{(\bar{d}_{p}\gamma_{\mu}d_{r})(\bar{d}_{s}\gamma^{\mu}d_{t})}$ $\frac{(\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{u}_{s}\gamma^{\mu}u_{t})}{(\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{d}_{s}\gamma^{\mu}d_{t})}$ $\frac{(\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{d}_{s}\gamma^{\mu}d_{t})}{(\bar{u}_{p}\gamma_{\mu}T^{A}u_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t})}$ $B\text{-vio}$ $\frac{\varepsilon^{\alpha\beta\gamma}\varepsilon_{jk}\left[(d_{s}\gamma^{\mu})$	$\begin{matrix} \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qd}^{(3)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(8)} \\ \partial_{qd}^{(8)} \\ \partial_{qd}^{(8)} \\ \partial_{qd}^{(7)} \\ \partial_$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_p\gamma_{\mu}l_r)(\bar{e}_s\gamma^{\mu}e_t) \\ (\bar{l}_p\gamma_{\mu}l_r)(\bar{u}_s\gamma^{\mu}u_t) \\ (\bar{l}_p\gamma_{\mu}l_r)(\bar{d}_s\gamma^{\mu}d_t) \\ (\bar{q}_p\gamma_{\mu}q_r)(\bar{e}_s\gamma^{\mu}e_t) \\ (\bar{q}_p\gamma_{\mu}q_r)(\bar{u}_s\gamma^{\mu}u_t) \\ (\bar{q}_p\gamma_{\mu}T^Aq_r)(\bar{u}_s\gamma^{\mu}T^Au_t) \\ (\bar{q}_p\gamma_{\mu}T^Aq_r)(\bar{d}_s\gamma^{\mu}d_t) \\ (\bar{q}_p\gamma_{\mu}T^Aq_r)(\bar{d}_s\gamma^{\mu}T^Ad_t) \\ (\bar{q}_s\gamma^{\mu}T^Aq_r)(\bar{d}_s\gamma^{\mu}T^Ad_t) \end{array} $
$ \begin{bmatrix} \mathcal{O}_{ll} \\ \mathcal{O}_{qq}^{(1)} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{lq}^{(2)} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{lq}^{(2)} \\ \end{bmatrix} $	$\begin{array}{c} (\bar{L}L)(\bar{L}L) \\ \hline (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t}) \\ (\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}q_{t}) \\ (\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t}) \\ \hline (\bar{l}_{p}\gamma_{\mu}\sigma^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t}) \\ \hline (\bar{l}_{p}\rho_{\mu}\sigma^{I}l_{r})(\bar{q}_{s}q_{t}^{\mu}d_{t}) \\ \hline (\bar{l}_{p}\rho_{\mu}\rho_{r})(\bar{d}_{s}q_{t}^{I}) \\ \hline (\bar{q}_{p}^{j}u_{r})\varepsilon_{jk}(\bar{q}_{s}^{k}d_{t}) \end{array}$	$\begin{array}{c c} & & \\ & &$	$ \begin{array}{c} (\overline{R}R)(\overline{R}R) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t}) \\ (\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t}) \\ (\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{u}_{s}\gamma^{\mu}u_{t}) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{u}_{p}\gamma_{\mu}T^{A}u_{r})(\overline{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array} $ $ \begin{array}{c} B\text{-vio} \\ \end{array} $	$\begin{matrix} \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(g)} \\ \begin{matrix} \mathcal{O}_{qd}^{(g)} \\ \mathcal{O}_{qd}^{(g)} \\ \end{matrix} \end{matrix}$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \\ \hline \\ [(q_{s}^{\gamma j})^{T}Cl_{t}^{k}] \\ [(u_{s}^{\gamma})^{T}Ce_{t}] \end{array} $
$ \begin{bmatrix} \mathcal{O}_{ll} \\ \mathcal{O}_{ll} \\ \mathcal{O}_{qq} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \\ \end{bmatrix} \\ \begin{bmatrix} (\bar{L}R \\ \mathcal{O}_{ledq} \\ \mathcal{O}_{quqd}^{(1)} \\ \mathcal{O}_{quqd}^{(8)} \\ \mathcal{O}_{quqd}^{(8)} \end{bmatrix} \\ \end{bmatrix} $	$ \begin{array}{c} (\bar{L}L)(\bar{L}L) \\ \hline (\bar{l}_p\gamma_\mu l_r)(\bar{l}_s\gamma^\mu l_t) \\ (\bar{q}_p\gamma_\mu q_r)(\bar{q}_s\gamma^\mu q_t) \\ (\bar{q}_p\gamma_\mu \tau^I q_r)(\bar{q}_s\gamma^\mu \tau^I q_t) \\ (\bar{l}_p\gamma_\mu l_r)(\bar{q}_s\gamma^\mu q_t) \\ (\bar{l}_p\gamma_\mu \tau^I l_r)(\bar{q}_s\gamma^\mu \tau^I q_t) \\ \hline (\bar{l}_p\gamma_\mu \tau^I l_r)(\bar{q}_s\gamma^\mu \tau^I q_t) \\ \hline (\bar{q}_p^j q_r) \varepsilon_{jk}(\bar{q}_s^k d_t) \\ (\bar{q}_p^j T^A u_r) \varepsilon_{jk}(\bar{q}_s^k T^A d_t) \end{array} $	$\begin{array}{c c} & & \\ & &$	$\begin{array}{c} (\overline{R}R)(\overline{R}R) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t}) \\ (\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t}) \\ (\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{u}_{s}\gamma^{\mu}u_{t}) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{u}_{p}\gamma_{\mu}T^{A}u_{r})(\overline{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array}$ $\begin{array}{c} B\text{-vio} \\ \end{array}$	$\begin{matrix} \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(1)} \\ \mathcal{O}_{qd}^{(s)} \\ \mathcal{O}_{qd}^{(s)$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array} $
$ \begin{bmatrix} \mathcal{O}_{ll} \\ \mathcal{O}_{qq} \\ \mathcal{O}_{qq} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(q)} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \\ \end{bmatrix} \\ \begin{bmatrix} (\bar{L}R \\ \mathcal{O}_{ledq} \\ \mathcal{O}_{qud}^{(1)} \\ \mathcal{O}_{qudd}^{(0)} \\ \mathcal{O}_{lequ}^{(1)} \\ \mathcal{O}_{lequ}^{(1)} \\ \end{bmatrix} $	$(\bar{L}L)(\bar{L}L)$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t})$ $(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}p_{\mu}\tau^{I}l_{r})(\bar{q}_{s}q^{\mu}\tau^{I}q_{t})$ $(\bar{q}_{p}^{j}u_{r})\varepsilon_{jk}(\bar{q}_{s}^{k}d_{t})$ $(\bar{q}_{p}^{j}T^{A}u_{r})\varepsilon_{jk}(\bar{q}_{s}^{k}T^{A}d_{t})$ $(\bar{l}_{p}^{j}e_{r})\varepsilon_{jk}(\bar{q}_{s}^{k}u_{t})$	$\begin{array}{c c} & & \\ & &$	$\begin{array}{c} (\overline{R}p)(\overline{R}R) \\ (\overline{R}R)(\overline{R}R) \\ (\overline{e}_p\gamma_\mu e_r)(\overline{e}_s\gamma^\mu e_t) \\ (\overline{u}_p\gamma_\mu u_r)(\overline{u}_s\gamma^\mu u_t) \\ (\overline{d}_p\gamma_\mu d_r)(\overline{d}_s\gamma^\mu d_t) \\ (\overline{e}_p\gamma_\mu e_r)(\overline{u}_s\gamma^\mu u_t) \\ (\overline{e}_p\gamma_\mu e_r)(\overline{d}_s\gamma^\mu d_t) \\ (\overline{u}_p\gamma_\mu u_r)(\overline{d}_s\gamma^\mu d_t) \\ (\overline{u}_p\gamma_\mu T^A u_r)(\overline{d}_s\gamma^\mu T^A d_t) \end{array}$ $\begin{array}{c} B\text{-viol} \\ \varepsilon^{\alpha\beta\gamma}\varepsilon_{jk} \left[ (d_p^{\alpha} \\ \varepsilon^{\alpha\beta\gamma}\varepsilon_{jk} \\ [q_p^{\alpha} \\ \varepsilon^{\alpha\beta\gamma}\varepsilon_{jk} \\ \varepsilon^{\alpha\beta\gamma}\varepsilon_{jk} \\ [q_p^{\alpha} \\ \varepsilon^{\alpha\beta\gamma}\varepsilon_{jk} \\ \varepsilon^{\alpha\beta\gamma}\varepsilon_{jk} \\ \varepsilon^{\alpha\beta\gamma}\varepsilon_{jk} \\ [q_p^{\alpha} \\ \varepsilon^{\alpha\beta\gamma}\varepsilon_{jk} \\ \varepsilon^{\alpha\beta\gamma$	$\begin{matrix} \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qd}^{(2)} \\ \mathcal{O}_{qd}^{(2)} \\ \mathcal{O}_{qd}^{(3)} \\ \mathcal{O}_{qd}^{(3)$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{a}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}C_{t}) \\ [(q_{s}^{\gamma})^{T}Cl_{t}^{k}] \\ [(q_{s}^{\gamma})^{T}Ce_{t}] \\ k] [(q_{s}^{\gamma})^{T}Ce_{t}] \\ (u_{s}^{\gamma})^{T}Ce_{t}] \end{array} $

EWPO: 
$$\mathcal{O}_{HWB}, \mathcal{O}_{HD}, \mathcal{O}_{ll}, \mathcal{O}_{Hl}^{(3)}, \mathcal{O}_{Hl}^{(1)}, \mathcal{O}_{He}, \mathcal{O}_{Hq}^{(3)}, \mathcal{O}_{Hq}^{(1)}, \mathcal{O}_{Hd}, \mathcal{O}_{Hu},$$
  
Bosonic:  $\mathcal{O}_{H\Box}, \mathcal{O}_{HG}, \mathcal{O}_{HW}, \mathcal{O}_{HB}, \mathcal{O}_{W}, \mathcal{O}_{G},$   
Yukawa:  $\mathcal{O}_{\tau H}, \mathcal{O}_{\mu H}, \mathcal{O}_{bH}, \mathcal{O}_{tH}.$ 



• 20 operators relevant for Higgs, diboson, and EWPO:

	$X^3$		$H^6$ and $H^4D^2$		$\psi^2 H^3$
$\mathcal{O}_{G}$	$f^{ABC}G^{A u}_{\mu}G^{B ho}_{\nu}G^{C\mu}_{ ho}$	$\mathcal{O}_{H}$	$(H^{\dagger}H)^3$	$\mathcal{O}_{eH}$	$(H^{\dagger}H)(\bar{l}_{p}e_{r}H)$
$\mathcal{O}_{\widetilde{G}}$	$f^{ABC} \tilde{G}^{A\nu}_{\mu} G^{B\rho}_{\nu} G^{C\mu}_{\rho}$	$\mathcal{O}_{H\square}$	$(H^{\dagger}H)\square(H^{\dagger}H)$	${\cal O}_{uH}$	$(H^{\dagger}H)(\bar{q}_{p}u_{r}\widetilde{H})$
$\mathcal{O}_{W}$	$\varepsilon^{IJK}W^{I\nu}_{\mu}W^{J\rho}_{\nu}W^{K\mu}_{\rho}$	${\cal O}_{{}_{HD}}$	$\left(H^{\dagger}D^{\mu}H\right)^{\star}\left(H^{\dagger}D_{\mu}H ight)$	$\mathcal{O}_{_{dH}}$	$(H^{\dagger}H)(\bar{q}_p d_r H)$
$\mathcal{O}_{\widetilde{W}}$	$\varepsilon^{IJK} W^{I\nu}_{\mu} W^{J\rho}_{\nu} W^{K\mu}_{\rho}$				
	$X^2H^2$		$\psi^2 X H$		$\psi^2 H^2 D$
$\mathcal{O}_{HG}$	$H^{\dagger}HG^{A}_{\mu\nu}G^{A\mu\nu}$	${\cal O}_{eW}$	$(\bar{l}_p \sigma^{\mu\nu} e_r) \tau^I H W^I_{\mu\nu}$	$\mathcal{O}_{Hl}^{(1)}$	$(H^{\dagger}i \overset{\leftrightarrow}{D}_{\mu} H)(\bar{l}_p \gamma^{\mu} l_r)$
$\mathcal{O}_{H\widetilde{G}}$	$H^{\dagger}H\widetilde{G}^{A}_{\mu\nu}G^{A\mu\nu}$	${\cal O}_{eB}$	$(\bar{l}_p \sigma^{\mu u} e_r) H B_{\mu u}$	${\cal O}_{Hl}^{(3)}$	$(H^{\dagger}i D^{I}_{\underline{\mu}} H)(\bar{l}_{p} \tau^{I} \gamma^{\mu} l_{r})$
$\mathcal{O}_{HW}$	$H^{\dagger}H W^{I}_{\mu\nu}W^{I\mu\nu}$	${\cal O}_{uG}$	$(\bar{q}_p \sigma^{\mu\nu} T^A u_r) \widetilde{H} G^A_{\mu\nu}$	${\cal O}_{_{He}}$	$(H^{\dagger}i \overset{\frown}{D}_{\mu} H) (\bar{e}_p \gamma^{\mu} e_r)$
$\mathcal{O}_{H\widetilde{W}}$	$H^{\dagger}H\widetilde{W}^{I}_{\mu\nu}W^{I\mu\nu}$	$\mathcal{O}_{uW}$	$(\bar{q}_p \sigma^{\mu\nu} u_r) \tau^I \widetilde{H} W^I_{\mu\nu}$	$\mathcal{O}_{Hq}^{(1)}$	$(H^{\dagger}i \overset{\frown}{D}_{\mu} H)(\bar{q}_p \gamma^{\mu} q_r)$
$\mathcal{O}_{HB}$	$H^{\dagger}H B_{\mu u}B^{\mu u}$	${\cal O}_{uB}$	$(\bar{q}_p \sigma^{\mu\nu} u_r) \widetilde{H} B_{\mu\nu}$	${\cal O}_{Hq}^{(3)}$	$(H^{\dagger}i D^{I}_{\mu} H)(\bar{q}_{p}\tau^{I}\gamma^{\mu}q_{r})$
$\mathcal{O}_{H\widetilde{B}}$	$H^{\dagger}H\widetilde{B}_{\mu u}B^{\mu u}$	${\cal O}_{dG}$	$(\bar{q}_p \sigma^{\mu\nu} T^A d_r) H G^A_{\mu\nu}$	${\cal O}_{Hu}$	$(H^{\dagger}i D_{\mu} H)(\bar{u}_p \gamma^{\mu} u_r)$
$\mathcal{O}_{HWB}$	$H^{\dagger}\tau^{I}HW^{I}_{\mu\nu}B^{\mu\nu}$	${\cal O}_{dW}$	$(\bar{q}_p \sigma^{\mu\nu} d_r) \tau^I H W^I_{\mu\nu}$	${\cal O}_{Hd}$	$(H^{\dagger}i D_{\mu} H)(\bar{d}_p \gamma^{\mu} d_r)$
$\mathcal{O}_{H\widetilde{W}B}$	$H^{\dagger}\tau^{I}HW^{I}_{\mu\nu}B^{\mu\nu}$	$\mathcal{O}_{dB}$	$(\bar{q}_p \sigma^{\mu\nu} d_r) H B_{\mu\nu}$	${\cal O}_{{}_{Hud}}$	$i(H^{\dagger}D_{\mu}H)(\bar{u}_{p}\gamma^{\mu}d_{r})$
	μν				
	$(\bar{L}L)(\bar{L}L)$		$(\bar{R}R)(\bar{R}R)$		$(\bar{L}L)(\bar{R}R)$
$\mathcal{O}_{ll}$	$\frac{(\bar{L}L)(\bar{L}L)}{(\bar{l}_p\gamma_\mu l_r)(\bar{l}_s\gamma^\mu l_t)}$	$\mathcal{O}_{ee}$	$(\bar{R}R)(\bar{R}R)$ $(\bar{e}_p\gamma_\mu e_r)(\bar{e}_s\gamma^\mu e_t)$	$\mathcal{O}_{le}$	$(\bar{L}L)(\bar{R}R)$ $(\bar{l}_p\gamma_\mu l_r)(\bar{e}_s\gamma^\mu e_t)$
$\mathcal{O}_{ll}$ $\mathcal{O}_{qq}^{(1)}$	$ \begin{array}{c} \mu^{\mu} \\ \hline (\bar{L}L)(\bar{L}L) \\ \hline (\bar{l}_p \gamma_\mu l_r)(\bar{l}_s \gamma^\mu l_t) \\ \hline (\bar{q}_p \gamma_\mu q_r)(\bar{q}_s \gamma^\mu q_t) \end{array} $	$\mathcal{O}_{ee}$ $\mathcal{O}_{uu}$	$ \begin{array}{c} (\bar{R}R)(\bar{R}R) \\ (\bar{e}_p \gamma_\mu e_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{u}_p \gamma_\mu u_r)(\bar{u}_s \gamma^\mu u_t) \end{array} $	$\mathcal{O}_{le} \ \mathcal{O}_{lu}$	$ \begin{array}{c c} (\bar{L}L)(\bar{R}R) \\ \hline (\bar{l}_p \gamma_\mu l_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{u}_s \gamma^\mu u_t) \end{array} $
$\mathcal{O}_{ll}$ $\mathcal{O}_{qq}^{(1)}$ $\mathcal{O}_{qq}^{(3)}$	$ \begin{array}{c} \mu \mu \\ \hline (\bar{L}L)(\bar{L}L) \\ \hline (\bar{l}_p \gamma_\mu l_r)(\bar{l}_s \gamma^\mu l_t) \\ \hline (\bar{q}_p \gamma_\mu q_r)(\bar{q}_s \gamma^\mu q_t) \\ \hline (\bar{q}_p \gamma_\mu \tau^I q_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \end{array} $	$\mathcal{O}_{ee}$ $\mathcal{O}_{uu}$ $\mathcal{O}_{dd}$	$ \begin{array}{c} (\bar{R}R)(\bar{R}R) \\ (\bar{e}_p \gamma_\mu e_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{u}_p \gamma_\mu u_r)(\bar{u}_s \gamma^\mu u_t) \\ (\bar{d}_p \gamma_\mu d_r)(\bar{d}_s \gamma^\mu d_t) \end{array} $	$egin{array}{c} \mathcal{O}_{le} \ \mathcal{O}_{lu} \ \mathcal{O}_{ld} \end{array}$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{u}_s \gamma^\mu u_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{d}_s \gamma^\mu d_t) \end{array} $
$\begin{array}{ c c }\hline \mathcal{O}_{ll} \\ \hline \mathcal{O}_{qq}^{(1)} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(1)} \\ \end{array}$	$ \begin{array}{c} \mu \mu \\ \hline (\bar{L}L)(\bar{L}L) \\ \hline (\bar{l}_p \gamma_\mu l_r)(\bar{l}_s \gamma^\mu l_t) \\ \hline (\bar{q}_p \gamma_\mu q_r)(\bar{q}_s \gamma^\mu q_t) \\ \hline (\bar{q}_p \gamma_\mu \tau^I q_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \\ \hline (\bar{l}_p \gamma_\mu l_r)(\bar{q}_s \gamma^\mu q_t) \\ \hline \end{array} $	$\mathcal{O}_{ee}$ $\mathcal{O}_{uu}$ $\mathcal{O}_{dd}$ $\mathcal{O}_{eu}$	$(\overline{RR})(\overline{RR})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$ $(\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$	$egin{array}{c} \mathcal{O}_{le} \ \mathcal{O}_{lu} \ \mathcal{O}_{ld} \ \mathcal{O}_{qe} \end{array}$	$\begin{array}{c c} (\bar{L}L)(\bar{R}R) \\ \hline (\bar{l}_p \gamma_\mu l_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{u}_s \gamma^\mu u_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{d}_s \gamma^\mu d_t) \\ (\bar{q}_p \gamma_\mu q_r)(\bar{e}_s \gamma^\mu e_t) \end{array}$
$\begin{matrix} \mathcal{O}_{ll} \\ \mathcal{O}_{qq}^{(1)} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \end{matrix}$	$ \begin{array}{c} \mu \mu \\ \hline (\bar{L}L)(\bar{L}L) \\ \hline (\bar{l}_p \gamma_\mu l_r)(\bar{l}_s \gamma^\mu l_t) \\ \hline (\bar{q}_p \gamma_\mu q_r)(\bar{q}_s \gamma^\mu q_t) \\ \hline (\bar{q}_p \gamma_\mu \tau^I q_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \\ \hline (\bar{l}_p \gamma_\mu l_r)(\bar{q}_s \gamma^\mu q_t) \\ \hline (\bar{l}_p \gamma_\mu \tau^I l_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \end{array} $	$\begin{array}{c c} & & \\ & &$	$ \begin{array}{c} (\overline{R}R)(\overline{R}R) \\ \hline (\overline{e}_p \gamma_\mu e_r)(\overline{e}_s \gamma^\mu e_t) \\ (\overline{u}_p \gamma_\mu u_r)(\overline{u}_s \gamma^\mu u_t) \\ (\overline{d}_p \gamma_\mu d_r)(\overline{d}_s \gamma^\mu d_t) \\ (\overline{e}_p \gamma_\mu e_r)(\overline{u}_s \gamma^\mu u_t) \\ (\overline{e}_p \gamma_\mu e_r)(\overline{d}_s \gamma^\mu d_t) \end{array} $	$egin{array}{c c} \mathcal{O}_{le} & & \\ \mathcal{O}_{lu} & & \\ \mathcal{O}_{ld} & & \\ \mathcal{O}_{qe} & & \\ \mathcal{O}_{qu}^{(1)} & & \\ \end{array}$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{u}_s \gamma^\mu u_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{d}_s \gamma^\mu d_t) \\ (\bar{q}_p \gamma_\mu q_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{q}_p \gamma_\mu q_r)(\bar{u}_s \gamma^\mu u_t) \end{array} $
$\begin{array}{ c c c }\hline \mathcal{O}_{ll} \\ \mathcal{O}_{qq}^{(1)} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \end{array}$	$ \begin{array}{c} \mu \mu \\ \hline (\bar{L}L)(\bar{L}L) \\ \hline (\bar{l}_p \gamma_\mu l_r)(\bar{l}_s \gamma^\mu l_t) \\ \hline (\bar{q}_p \gamma_\mu q_r)(\bar{q}_s \gamma^\mu q_t) \\ \hline (\bar{q}_p \gamma_\mu \tau^I q_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \\ \hline (\bar{l}_p \gamma_\mu l_r)(\bar{q}_s \gamma^\mu q_t) \\ \hline (\bar{l}_p \gamma_\mu \tau^I l_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \end{array} $	$\begin{array}{c c} & & \\ & &$	$\begin{array}{c c} (\bar{R}R)(\bar{R}R) \\ \hline (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{d}_{p}\gamma_{\mu}d_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \end{array}$	$\mathcal{O}_{le}$ $\mathcal{O}_{lu}$ $\mathcal{O}_{ld}$ $\mathcal{O}_{qe}$ $\mathcal{O}_{qu}^{(1)}$ $\mathcal{O}_{qu}^{(8)}$	$\begin{array}{c c} \hline (\bar{L}L)(\bar{R}R) \\ \hline (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \end{array}$
$\begin{array}{ c c c }\hline & & & \\ & & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & $	$(\overline{L}L)(\overline{L}L)$ $(\overline{l}_{p}\gamma_{\mu}l_{r})(\overline{l}_{s}\gamma^{\mu}l_{t})$ $(\overline{q}_{p}\gamma_{\mu}q_{r})(\overline{q}_{s}\gamma^{\mu}q_{t})$ $(\overline{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\overline{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\overline{l}_{p}\gamma_{\mu}l_{r})(\overline{q}_{s}\gamma^{\mu}q_{t})$ $(\overline{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\overline{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$	$\begin{array}{c c} & & \\ & &$	$\begin{array}{c c} (\bar{R}R)(\bar{R}R) \\ \hline (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{d}_{p}\gamma_{\mu}d_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{u}_{p}\gamma_{\mu}T^{A}u_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array}$	$\mathcal{O}_{le}$ $\mathcal{O}_{lu}$ $\mathcal{O}_{ld}$ $\mathcal{O}_{qe}$ $\mathcal{O}_{qu}^{(1)}$ $\mathcal{O}_{qd}^{(1)}$	$\begin{array}{c c} (\bar{L}L)(\bar{R}R) \\ \hline (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \end{array}$
$ \begin{bmatrix} \mathcal{O}_{ll} \\ \mathcal{O}_{qq}^{(1)} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \end{bmatrix} $	$(\overline{L}L)(\overline{L}L)$ $(\overline{l}_{p}\gamma_{\mu}l_{r})(\overline{l}_{s}\gamma^{\mu}l_{t})$ $(\overline{q}_{p}\gamma_{\mu}q_{r})(\overline{q}_{s}\gamma^{\mu}q_{t})$ $(\overline{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\overline{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\overline{l}_{p}\gamma_{\mu}l_{r})(\overline{q}_{s}\gamma^{\mu}q_{t})$ $(\overline{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\overline{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$	$\mathcal{O}_{ee}$ $\mathcal{O}_{uu}$ $\mathcal{O}_{dd}$ $\mathcal{O}_{eu}$ $\mathcal{O}_{ed}$ $\mathcal{O}_{ud}^{(1)}$ $\mathcal{O}_{ud}^{(8)}$	$\begin{array}{c} (\overline{R}R)(\overline{R}R) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t}) \\ (\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t}) \\ (\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}u_{t}) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{u}_{p}\gamma_{\mu}T^{A}u_{r})(\overline{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array}$	$\mathcal{O}_{le}$ $\mathcal{O}_{lu}$ $\mathcal{O}_{ld}$ $\mathcal{O}_{qe}$ $\mathcal{O}_{qu}^{(1)}$ $\mathcal{O}_{qd}^{(8)}$ $\mathcal{O}_{qd}^{(8)}$	$\begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array}$
$\begin{array}{  c  }\hline \mathcal{O}_{ll} \\ \mathcal{O}_{qq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \\ \end{array}$	$(\bar{L}L)(\bar{L}L)$ $(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\lambda_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$	$\begin{array}{c c} & & \\ & &$	$ \begin{array}{c} (\overline{R}R)(\overline{R}R) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t}) \\ (\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t}) \\ (\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{u}_{s}\gamma^{\mu}u_{t}) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{u}_{p}\gamma_{\mu}T^{A}u_{r})(\overline{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array} $ $ B\text{-vio} $	$egin{aligned} & \mathcal{O}_{le} \ & \mathcal{O}_{lu} \ & \mathcal{O}_{ld} \ & \mathcal{O}_{qe} \ & \mathcal{O}_{qu}^{(1)} \ & \mathcal{O}_{qd}^{(1)} \ & \mathcal{O}_{qd}^{(2)} \ & \mathcal{O}_{qd}^{(3)} \ & \mathcal{O}_{qd}^{$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array} $
$\begin{array}{ c c c c c }\hline & \mathcal{O}_{ll} \\ & \mathcal{O}_{qq}^{(1)} \\ & \mathcal{O}_{lq}^{(3)} \\ & \mathcal{O}_{lq}^{(1)} \\ & \mathcal{O}_{lq}^{(3)} \\ & \mathcal{O}_{lq}^{(3)} \\ \hline & & \\ \hline & & \\ \hline & & \\ & & \\ \hline & & \\ & \mathcal{O}_{ledq} \end{array}$	$(\bar{L}L)(\bar{L}L)$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t})$ $(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{k}L) \text{ and } (\bar{L}R)(\bar{L}R)$ $(\bar{l}_{p}^{j}e_{r})(\bar{d}_{s}q_{j}^{j})$	$\begin{array}{c c} & & \\ & &$	$ \begin{array}{c} (\overline{R}R)(\overline{R}R) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t}) \\ (\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t}) \\ (\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{u}_{s}\gamma^{\mu}u_{t}) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{u}_{p}\gamma_{\mu}T^{A}u_{r})(\overline{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array} $ $ \begin{array}{c} B\text{-vio} \\ \end{array} $	$\begin{matrix} \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(8)} \\ \end{matrix}$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \\ (\bar{q}_{s}\gamma^{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array} $
$ \begin{array}{ c c c } \hline \mathcal{O}_{ll} \\ \hline \mathcal{O}_{qq} \\ \mathcal{O}_{qq} \\ \mathcal{O}_{qq} \\ \mathcal{O}_{lq} \\ \mathcal{O}_{lq} \\ \mathcal{O}_{lq} \\ \mathcal{O}_{lq} \\ \hline \end{array} \\ \hline \hline \hline \hline \\ \hline \hline \\ \hline \\ \hline \\ \hline \\ \hline \\$	$\frac{\mu\nu}{(\bar{L}L)(\bar{L}L)}$ $\frac{(\bar{L}L)(\bar{L}L)}{(\bar{q}_p\gamma_\mu q_r)(\bar{q}_s\gamma^\mu q_t)}$ $(\bar{q}_p\gamma_\mu \tau^I q_r)(\bar{q}_s\gamma^\mu \tau^I q_t)$ $(\bar{q}_p\gamma_\mu \tau^I q_r)(\bar{q}_s\gamma^\mu q_t)$ $(\bar{l}_p\gamma_\mu \tau^I l_r)(\bar{q}_s\gamma^\mu \tau^I q_t)$ $\frac{(\bar{l}_p\gamma_\mu \tau^I l_r)(\bar{q}_s\gamma^\mu \tau^I q_t)}{(\bar{q}_p^j \mu_r)^2(\bar{d}_s q_t^j)}$ $(\bar{q}_p^j u_r)\varepsilon_{jk}(\bar{q}_s^k d_t)$	$\begin{array}{c c} & & \\ & &$	$ \begin{array}{c} (\overline{R}R)(\overline{R}R) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t}) \\ (\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t}) \\ (\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{u}_{s}\gamma^{\mu}u_{t}) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{u}_{p}\gamma_{\mu}T^{A}u_{r})(\overline{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array} $ $ \begin{array}{c} B\text{-vio} \\ \end{array} $	$\begin{matrix} \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(3)} \\ \\ lating \\ \overset{(x)}{j}^T C u_r^\beta ] \\ j^J ^T C q_r^{\beta k} \end{matrix}$	$ \begin{array}{c c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array} $
$ \begin{array}{ c c c } \hline \mathcal{O}_{ll} \\ \hline \mathcal{O}_{qq}^{(1)} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \\ \hline \mathcal{O}_{lq}^{(3)} \\ \hline \end{array} \\ \hline \hline \hline \hline \begin{array}{ c c } \hline (\bar{L}R \\ \hline \mathcal{O}_{ledq} \\ \mathcal{O}_{quqd}^{(1)} \\ \mathcal{O}_{quqd}^{(8)} \\ \mathcal{O}_{quqd}^{(8)} \\ \hline \end{array} \\ \hline \end{array} \\ \end{array} $	$(\bar{L}L)(\bar{L}L)$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t})$ $(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}t_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}p_{\mu}\tau^{I}l_{r})(\bar{q}_{s}q^{\mu}\tau^{I}q_{t})$ $(\bar{q}_{p}^{j}q_{r})(\bar{d}_{s}q_{t}^{j})$ $(\bar{q}_{p}^{j}q_{r})\varepsilon_{jk}(\bar{q}_{s}^{k}d_{t})$ $(\bar{q}_{p}^{j}T^{A}u_{r})\varepsilon_{jk}(\bar{q}_{s}^{k}T^{A}d_{t})$	$\begin{array}{c c} & & \\ & \mathcal{O}_{ee} \\ & \mathcal{O}_{uu} \\ & \mathcal{O}_{dd} \\ & \mathcal{O}_{eu} \\ & \mathcal{O}_{ed} \\ & \mathcal{O}_{ud}^{(1)} \\ & \mathcal{O}_{ud}^{(8)} \\ & \\ & \\ & \\ & \\ & \\ & \\ & \\ & \\ & \\ $	$\begin{array}{c} (\overline{R}R)(\overline{R}R) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t}) \\ (\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t}) \\ (\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{u}_{p}\gamma_{\mu}T^{A}u_{r})(\overline{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array}$ $\begin{array}{c} B\text{-vio} \\ \end{array}$ $\begin{array}{c} B\text{-vio} \\ \varepsilon^{\alpha\beta\gamma}\varepsilon_{jk} \left[ (d_{p}^{\alpha}\\ \varepsilon^{\alpha\beta\gamma}\varepsilon_{jn}\varepsilon_{km} \right] \right] \end{array}$	$\begin{matrix} \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qd}^{(3)} \\ \mathcal{O}_{qd}^{(3)$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array} $
$ \begin{array}{ c c c c c } \hline \mathcal{O}_{ll} & & \\ \hline \mathcal{O}_{qq} & \mathcal{O}_{qq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} & & \\ \mathcal{O}_{lq}^{(1)} & & \\ \mathcal{O}_{lq}^{(3)} & & \\ \hline \hline & & \\ \hline & & \\ \hline & & \\ \hline \hline \\ \hline & & \\ \hline \hline \\ \hline & & \\ \hline \hline \\ \hline \\$	$ \frac{\mu^{\mu}}{(\bar{L}L)(\bar{L}L)} \\ \frac{(\bar{L}p\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t})}{(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})} \\ (\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t}) \\ (\bar{l}_{p}\gamma_{\mu}\tau^{I})(\bar{q}_{s}\gamma^{\mu}q_{t}) \\ (\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t}) \\ (\bar{l}_{p}p_{\mu}\tau^{I}l_{r})(\bar{q}_{s}q^{\mu}\tau^{I}q_{t}) \\ (\bar{q}_{p}j_{\mu}\tau^{I})(\bar{q}_{s}q^{\mu}\tau^{I}q_{t}) \\ (\bar{q}_{p}j^{I}q_{r})\varepsilon_{jk}(\bar{q}_{s}^{k}d_{t}) \\ (\bar{q}_{p}j^{T}A_{u})\varepsilon_{jk}(\bar{q}_{s}^{k}T^{A}d_{t}) \\ (\bar{l}_{p}j^{I}e_{r})\varepsilon_{jk}(\bar{q}_{s}^{k}u_{t}) $	$\begin{array}{c c} & & \\ & &$	$\begin{array}{c} (\overline{R}R)(\overline{R}R) \\ (\overline{R}R)(\overline{R}R) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t}) \\ (\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t}) \\ (\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{a}_{s}\gamma^{\mu}u_{t}) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{u}_{p}\gamma_{\mu}T^{A}u_{r})(\overline{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array}$ $\begin{array}{c} B\text{-vio} \\ \end{array}$	$\begin{bmatrix} \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qd}^{(2)} \\ \mathcal{O}_{qd}^{(3)} \\ \mathcal{O}_{qd}^{(3)} \\ \mathcal{O}_{qd}^{(3)} \\ \end{bmatrix}_{p}^{(3)} Cu_r^{\beta} \end{bmatrix}$	$\begin{array}{c c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array}$

EWPO:  $\mathcal{O}_{HWB}, \mathcal{O}_{HD}, \mathcal{O}_{ll}, \mathcal{O}_{Hl}^{(3)}, \mathcal{O}_{Hl}^{(1)}, \mathcal{O}_{He}, \mathcal{O}_{Hq}^{(3)}, \mathcal{O}_{Hq}^{(1)}, \mathcal{O}_{Hd}, \mathcal{O}_{Hu}$ , Can be constrained setting  $|H|^2 \rightarrow v^2$ Bosonic:  $\mathcal{O}_{H\Box}, \mathcal{O}_{HG}, \mathcal{O}_{HW}, \mathcal{O}_{HB}, \mathcal{O}_{W}, \mathcal{O}_{G}$ , Triple-gauge field strength operators Yukawa:  $\mathcal{O}_{\tau H}, \mathcal{O}_{\mu H}, \mathcal{O}_{bH}, \mathcal{O}_{tH}$ . Can only be constrained by Higgs physics

• Top-specific flavour symmetry:

 $SU(3)^5 \to SU(2)^2 \times SU(3)^3$ =  $SU(2)_q \times SU(2)_u \times SU(3)_d \times SU(3)_l \times SU(3)_e$ 

• + 14 Top operators See 1802.07237 Top 2F:  $\mathcal{O}_{HQ}^{(3)}, \mathcal{O}_{HQ}^{(1)}, \mathcal{O}_{Ht}, \mathcal{O}_{tG}, \mathcal{O}_{tW}, \mathcal{O}_{tB}$ Top 4F:  $\mathcal{O}_{Qq}^{3,1}, \mathcal{O}_{Qq}^{3,8}, \mathcal{O}_{Qq}^{1,8}, \mathcal{O}_{Qu}^{8}, \mathcal{O}_{Qd}^{8}, \mathcal{O}_{tQ}^{8}, \mathcal{O}_{tu}^{8}, \mathcal{O}_{td}^{8}$ 

• 20 operators relevant for Higgs, diboson, and EWPO:

	$X^3$		$H^6$ and $H^4D^2$		$\psi^2 H^3$
$\mathcal{O}_{G}$	$f^{ABC}G^{A u}_{\mu}G^{B ho}_{ u}G^{C\mu}_{ ho}$	$\mathcal{O}_{H}$	$(H^{\dagger}H)^3$	$\mathcal{O}_{eH}$	$(H^{\dagger}H)(\bar{l}_{p}e_{r}H)$
$\mathcal{O}_{\tilde{G}}$	$f^{ABC} \widetilde{G}^{A\nu}_{\mu} G^{B\rho}_{\nu} G^{C\mu}_{\rho}$	$\mathcal{O}_{H\square}$	$(H^{\dagger}H)\square(H^{\dagger}H)$	${\cal O}_{uH}$	$(H^{\dagger}H)(\bar{q}_{p}u_{r}\widetilde{H})$
$\mathcal{O}_{W}$	$\varepsilon^{IJK}W^{I\nu}_{\mu}W^{J\rho}_{\nu}W^{K\mu}_{\rho}$	$\mathcal{O}_{HD}$	$\left(H^{\dagger}D^{\mu}H ight)^{\star}\left(H^{\dagger}D_{\mu}H ight)$	$\mathcal{O}_{_{dH}}$	$(H^{\dagger}H)(\bar{q}_p d_r H)$
$\mathcal{O}_{\widetilde{W}}$	$\varepsilon^{IJK} W^{I\nu}_{\mu} W^{J\rho}_{\nu} W^{K\mu}_{\rho}$				
	$X^2H^2$		$\psi^2 X H$		$\psi^2 H^2 D$
$\mathcal{O}_{HG}$	$H^{\dagger}HG^{A}_{\mu\nu}G^{A\mu\nu}$	${\cal O}_{eW}$	$(\bar{l}_p \sigma^{\mu\nu} e_r) \tau^I H W^I_{\mu\nu}$	$\mathcal{O}_{Hl}^{(1)}$	$(H^{\dagger}i \overset{\leftrightarrow}{D}_{\mu} H)(\bar{l}_{p} \gamma^{\mu} l_{r})$
$\mathcal{O}_{H\widetilde{G}}$	$H^{\dagger}H\widetilde{G}^{A}_{\mu u}G^{A\mu u}$	${\cal O}_{eB}$	$(\bar{l}_p \sigma^{\mu\nu} e_r) H B_{\mu\nu}$	$\mathcal{O}_{_{Hl}}^{_{(3)}}$	$(H^{\dagger}i D_{\underline{\mu}}^{I} H)(\bar{l}_{p} \tau^{I} \gamma^{\mu} l_{r})$
$\mathcal{O}_{HW}$	$H^{\dagger}H W^{I}_{\mu\nu}W^{I\mu\nu}$	$\mathcal{O}_{uG}$	$(\bar{q}_p \sigma^{\mu\nu} T^A u_r) \widetilde{H} G^A_{\mu\nu}$	${\cal O}_{He}$	$(H^{\dagger}i D_{\mu} H)(\bar{e}_p \gamma^{\mu} e_r)$
$\mathcal{O}_{H\widetilde{W}}$	$H^{\dagger}H\widetilde{W}^{I}_{\mu u}W^{I\mu u}$	$\mathcal{O}_{uW}$	$(\bar{q}_p \sigma^{\mu\nu} u_r) \tau^I \tilde{H} W^I_{\mu\nu}$	$\mathcal{O}_{Hq}^{(1)}$	$(H^{\dagger}i \overset{\frown}{D}_{\mu} H)(\bar{q}_p \gamma^{\mu} q_r)$
$\mathcal{O}_{HB}$	$H^{\dagger}H B_{\mu u}B^{\mu u}$	$\mathcal{O}_{uB}$	$(\bar{q}_p \sigma^{\mu\nu} u_r) \widetilde{H} B_{\mu\nu}$	${\cal O}_{Hq}^{(3)}$	$(H^{\dagger}i \widetilde{D}^{I}_{\mu} H)(\bar{q}_{p} \tau^{I} \gamma^{\mu} q_{r})$
$\mathcal{O}_{H\widetilde{B}}$	$H^{\dagger}H\widetilde{B}_{\mu u}B^{\mu u}$	${\cal O}_{{}_{dG}}$	$(\bar{q}_p \sigma^{\mu\nu} T^A d_r) H G^A_{\mu\nu}$	${\cal O}_{Hu}$	$(H^{\dagger}i D_{\mu} H)(\bar{u}_p \gamma^{\mu} u_r)$
$\mathcal{O}_{HWB}$	$H^{\dagger}\tau^{I}HW^{I}_{\mu\nu}B^{\mu\nu}$	${\cal O}_{dW}$	$(\bar{q}_p \sigma^{\mu\nu} d_r) \tau^I H W^I_{\mu\nu}$	${\cal O}_{Hd}$	$(H^{\dagger}i\overline{D}_{\mu}H)(\overline{d}_{p}\gamma^{\mu}d_{r})$
$\mathcal{O}_{H\widetilde{W}B}$	$H^{\dagger}\tau^{I}HW^{I}_{\mu\nu}B^{\mu\nu}$	$\mathcal{O}_{dB}$	$(\bar{q}_n \sigma^{\mu\nu} d_r) H B_{\mu\nu}$	${\cal O}_{_{Hud}}$	$i(\tilde{H}^{\dagger}D_{\mu}H)(\bar{u}_{p}\gamma^{\mu}d_{r})$
11110	μν	42	$\langle 1p \rangle \rangle \mu \nu$		
	$(\bar{L}L)(\bar{L}L)$		$(\bar{R}R)(\bar{R}R)$		$(\bar{L}L)(\bar{R}R)$
	$\frac{(\bar{L}L)(\bar{L}L)}{(\bar{l}_p\gamma_\mu l_r)(\bar{l}_s\gamma^\mu l_t)}$	$\mathcal{O}_{ee}$	$(\bar{R}R)(\bar{R}R)$ $(\bar{e}_p\gamma_\mu e_r)(\bar{e}_s\gamma^\mu e_t)$	$\mathcal{O}_{le}$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{e}_s \gamma^\mu e_t) \end{array} $
$\mathcal{O}_{ll}$ $\mathcal{O}_{qq}^{(1)}$	$ \begin{array}{c} & \mu\nu \\ \hline (\bar{L}L)(\bar{L}L) \\ \hline (\bar{l}_p\gamma_\mu l_r)(\bar{l}_s\gamma^\mu l_t) \\ \hline (\bar{q}_p\gamma_\mu q_r)(\bar{q}_s\gamma^\mu q_t) \end{array} $	$\mathcal{O}_{ee}$ $\mathcal{O}_{uu}$	$(\overline{R}R)(\overline{R}R)$ $(\overline{e}_p\gamma_\mu e_r)(\overline{e}_s\gamma^\mu e_t)$ $(\overline{u}_p\gamma_\mu u_r)(\overline{u}_s\gamma^\mu u_t)$	$\mathcal{O}_{le} \ \mathcal{O}_{lu}$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{u}_s \gamma^\mu u_t) \end{array} $
$\begin{bmatrix} \mathcal{O}_{ll} \\ \mathcal{O}_{qq} \\ \mathcal{O}_{qq}^{(1)} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{qq}^{(3)} \end{bmatrix}$	$ \begin{array}{c} \mu \nu \\ \hline (\bar{L}L)(\bar{L}L) \\ \hline (\bar{l}_p \gamma_\mu l_r)(\bar{l}_s \gamma^\mu l_t) \\ \hline (\bar{q}_p \gamma_\mu q_r)(\bar{q}_s \gamma^\mu q_t) \\ \hline (\bar{q}_p \gamma_\mu \tau^I q_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \end{array} $	$\mathcal{O}_{ee}$ $\mathcal{O}_{uu}$ $\mathcal{O}_{dd}$	$(\overline{R}R)(\overline{R}R)$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$ $(\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$	$\mathcal{O}_{le}$ $\mathcal{O}_{lu}$ $\mathcal{O}_{ld}$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{u}_s \gamma^\mu u_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{d}_s \gamma^\mu d_t) \end{array} $
$\begin{array}{ c c }\hline & & & \\ & & & \\ \hline & & & \\ & & & & \\ & & & \\ & & & & \\ & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & \\ & & & & \\ & & & & \\ & & & $	$\frac{\overline{(\bar{L}L)(\bar{L}L)}}{(\bar{l}_p\gamma_\mu l_r)(\bar{l}_s\gamma^\mu l_t)}$ $\frac{(\bar{q}_p\gamma_\mu q_r)(\bar{q}_s\gamma^\mu q_t)}{(\bar{q}_p\gamma_\mu \tau^I q_r)(\bar{q}_s\gamma^\mu \tau^I q_t)}$ $\frac{(\bar{l}_p\gamma_\mu l_r)(\bar{q}_s\gamma^\mu q_t)}{(\bar{l}_p\gamma_\mu l_r)(\bar{q}_s\gamma^\mu q_t)}$	$\begin{array}{c} \mathcal{O}_{ee} \\ \mathcal{O}_{uu} \\ \mathcal{O}_{dd} \\ \mathcal{O}_{eu} \end{array}$	$(\overline{RR})(\overline{RR})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$ $(\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$	$egin{array}{c} \mathcal{O}_{le} & & \ \mathcal{O}_{lu} & & \ \mathcal{O}_{ld} & & \ \mathcal{O}_{qe} & & \ \end{array}$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ \hline (\bar{l}_p \gamma_\mu l_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{u}_s \gamma^\mu u_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{d}_s \gamma^\mu d_t) \\ (\bar{q}_p \gamma_\mu q_r)(\bar{e}_s \gamma^\mu e_t) \end{array} $
$\begin{array}{  c  }\hline \mathcal{O}_{ll}\\ \hline \mathcal{O}_{qq}\\ \mathcal{O}_{qq}^{(3)}\\ \mathcal{O}_{lq}^{(3)}\\ \mathcal{O}_{lq}^{(1)}\\ \mathcal{O}_{lq}^{(3)} \end{array}$	$ \begin{array}{c} \mu \nu \\ \hline (\bar{L}L)(\bar{L}L) \\ \hline (\bar{q}_p \gamma_\mu l_r)(\bar{l}_s \gamma^\mu l_t) \\ \hline (\bar{q}_p \gamma_\mu q_r)(\bar{q}_s \gamma^\mu q_t) \\ \hline (\bar{q}_p \gamma_\mu \tau^I q_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \\ \hline (\bar{l}_p \gamma_\mu l_r)(\bar{q}_s \gamma^\mu q_t) \\ \hline (\bar{l}_p \gamma_\mu \tau^I l_r)(\bar{q}_s \gamma^\mu \tau^I q_t) \end{array} $	$\begin{array}{c c} & & \\ & &$	$(\overline{RR})(\overline{RR})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$ $(\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{u}_{s}\gamma^{\mu}d_{t})$	$\mathcal{O}_{le}$ $\mathcal{O}_{lu}$ $\mathcal{O}_{ld}$ $\mathcal{O}_{qe}$ $\mathcal{O}_{qu}^{(1)}$	$(\overline{L}L)(\overline{R}R)$ $(\overline{l}_{p}\gamma_{\mu}l_{r})(\overline{e}_{s}\gamma^{\mu}e_{t})$ $(\overline{l}_{p}\gamma_{\mu}l_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$ $(\overline{l}_{p}\gamma_{\mu}l_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{q}_{p}\gamma_{\mu}q_{r})(\overline{e}_{s}\gamma^{\mu}e_{t})$ $(\overline{q}_{p}\gamma_{\mu}q_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$
$\begin{bmatrix} \mathcal{O}_{ll} \\ \mathcal{O}_{qq} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \end{bmatrix}$	$(\overline{L}L)(\overline{L}L)$ $(\overline{l}_{p}\gamma_{\mu}l_{r})(\overline{l}_{s}\gamma^{\mu}l_{t})$ $(\overline{q}_{p}\gamma_{\mu}q_{r})(\overline{q}_{s}\gamma^{\mu}q_{t})$ $(\overline{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\overline{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\overline{l}_{p}\gamma_{\mu}l_{r})(\overline{q}_{s}\gamma^{\mu}q_{t})$ $(\overline{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\overline{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$	$\begin{array}{c} \mathcal{O}_{ee} \\ \mathcal{O}_{uu} \\ \mathcal{O}_{dd} \\ \mathcal{O}_{eu} \\ \mathcal{O}_{ed} \\ \mathcal{O}_{ud}^{(1)} \\ \mathcal{O}_{ud}^{(8)} \end{array}$	$(\overline{R}R)(\overline{R}R)$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$ $(\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$	$\mathcal{O}_{le}$ $\mathcal{O}_{lu}$ $\mathcal{O}_{ld}$ $\mathcal{O}_{qe}$ $\mathcal{O}_{qu}^{(1)}$ $\mathcal{O}_{qu}^{(8)}$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_p\gamma_{\mu}l_r)(\bar{e}_s\gamma^{\mu}e_t) \\ (\bar{l}_p\gamma_{\mu}l_r)(\bar{u}_s\gamma^{\mu}u_t) \\ (\bar{l}_p\gamma_{\mu}l_r)(\bar{d}_s\gamma^{\mu}d_t) \\ (\bar{q}_p\gamma_{\mu}q_r)(\bar{e}_s\gamma^{\mu}e_t) \\ (\bar{q}_p\gamma_{\mu}q_r)(\bar{u}_s\gamma^{\mu}u_t) \\ \hline (\bar{q}_p\gamma_{\mu}T^Aq_r)(\bar{u}_s\gamma^{\mu}T^Au_t) \end{array} $
$\begin{array}{ c c }\hline \mathcal{O}_{ll}\\ \hline \mathcal{O}_{qq}\\ \mathcal{O}_{qq}^{(1)}\\ \mathcal{O}_{lq}^{(3)}\\ \mathcal{O}_{lq}^{(3)}\\ \mathcal{O}_{lq}^{(3)} \end{array}$	$(\overline{L}L)(\overline{L}L)$ $(\overline{l}_{p}\gamma_{\mu}l_{r})(\overline{l}_{s}\gamma^{\mu}l_{t})$ $(\overline{q}_{p}\gamma_{\mu}q_{r})(\overline{q}_{s}\gamma^{\mu}q_{t})$ $(\overline{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\overline{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\overline{l}_{p}\gamma_{\mu}l_{r})(\overline{q}_{s}\gamma^{\mu}q_{t})$ $(\overline{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\overline{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$	$\begin{array}{c c} & & \\ & &$	$\begin{array}{c} (\overline{R}R)(\overline{R}R) \\ \hline (\overline{e}_p \gamma_\mu e_r)(\overline{e}_s \gamma^\mu e_t) \\ \hline (\overline{u}_p \gamma_\mu u_r)(\overline{u}_s \gamma^\mu u_t) \\ \hline (\overline{d}_p \gamma_\mu d_r)(\overline{d}_s \gamma^\mu d_t) \\ \hline (\overline{e}_p \gamma_\mu e_r)(\overline{u}_s \gamma^\mu u_t) \\ \hline (\overline{e}_p \gamma_\mu e_r)(\overline{d}_s \gamma^\mu d_t) \\ \hline (\overline{u}_p \gamma_\mu u_r)(\overline{d}_s \gamma^\mu d_t) \\ \hline (\overline{u}_p \gamma_\mu T^A u_r)(\overline{d}_s \gamma^\mu T^A d_t) \end{array}$	$ \begin{array}{c} \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qu}^{(8)} \\ \mathcal{O}_{qd}^{(7)} \\ \mathcal{O}_{qd}^{(8)} \end{array} $	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_p\gamma_\mu l_r)(\bar{e}_s\gamma^\mu e_t) \\ (\bar{l}_p\gamma_\mu l_r)(\bar{u}_s\gamma^\mu u_t) \\ (\bar{l}_p\gamma_\mu l_r)(\bar{d}_s\gamma^\mu d_t) \\ (\bar{q}_p\gamma_\mu q_r)(\bar{e}_s\gamma^\mu e_t) \\ (\bar{q}_p\gamma_\mu q_r)(\bar{u}_s\gamma^\mu u_t) \\ (\bar{q}_p\gamma_\mu T^A q_r)(\bar{u}_s\gamma^\mu T^A u_t) \\ (\bar{q}_p\gamma_\mu q_r)(\bar{d}_s\gamma^\mu d_t) \\ (\bar{q}_p\gamma_\mu q_r) \\ (\bar{q}_p\gamma_\mu q$
$\begin{bmatrix} \mathcal{O}_{ll} \\ \mathcal{O}_{qq}^{(1)} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \\ \end{bmatrix}$	$(\overline{L}L)(\overline{L}L)$ $(\overline{l}_{p}\gamma_{\mu}l_{r})(\overline{l}_{s}\gamma^{\mu}l_{t})$ $(\overline{q}_{p}\gamma_{\mu}q_{r})(\overline{q}_{s}\gamma^{\mu}q_{t})$ $(\overline{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\overline{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\overline{l}_{p}\gamma_{\mu}l_{r})(\overline{q}_{s}\gamma^{\mu}q_{t})$ $(\overline{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\overline{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$	$\begin{array}{c c} & & \\ & &$	$(\overline{R}R)(\overline{R}R)$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$ $(\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{u}_{p}\gamma_{\mu}T^{A}u_{r})(\overline{d}_{s}\gamma^{\mu}T^{A}d_{t})$	$egin{aligned} & \mathcal{O}_{le} \ & \mathcal{O}_{lu} \ & \mathcal{O}_{ld} \ & \mathcal{O}_{qe} \ & \mathcal{O}_{qu}^{(1)} \ & \mathcal{O}_{qd}^{(8)} \ & \mathcal{O}_{qd}^{(4)} \ & \mathcal{O}_{qd}^{(8)} \ & \mathcal{O}_{qd}^{$	$\begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array}$
$ \begin{bmatrix} \mathcal{O}_{ll} \\ \mathcal{O}_{qq} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \\ \end{bmatrix} $	$(\bar{L}L)(\bar{L}L)$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t})$ $(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{k}L) \text{ and } (\bar{L}R)(\bar{L}R)$	$\begin{array}{c c} & & \\ & &$	$(\overline{R}R)(\overline{R}R)$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$ $(\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{u}_{p}\gamma_{\mu}T^{A}u_{r})(\overline{d}_{s}\gamma^{\mu}T^{A}d_{t})$ $B-\text{viores}$	$\begin{matrix} \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qd}^{(1)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(8)} \\ \end{matrix}$	$\begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array}$
$ \begin{bmatrix} \mathcal{O}_{ll} \\ \mathcal{O}_{qq} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \\ \end{bmatrix} $	$\frac{\overline{(\bar{L}L)(\bar{L}L)}}{(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t})}$ $\frac{(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})}{(\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})}$ $\frac{(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})}{(\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})}$ $\frac{(\bar{k}L) \text{ and } (\bar{L}R)(\bar{L}R)}{(\bar{l}_{p}^{j}e_{r})(\bar{d}_{s}q_{t}^{j})}$	$\begin{array}{c c} & & \\ & &$	$(\overline{R}R)(\overline{R}R)$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$ $(\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{u}_{p}\gamma_{\mu}T^{A}u_{r})(\overline{d}_{s}\gamma^{\mu}T^{A}d_{t})$ $B-\text{vio}$ $\varepsilon^{\alpha\beta\gamma}\varepsilon_{jk}\left[(d_{p}\gamma_{\mu})$	$\begin{bmatrix} \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(8)} \\ \end{bmatrix}$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \\ \hline \\ [(q_{s}^{\gamma j})^{T}Cl_{t}^{k}] \\ \end{array} $
$ \begin{bmatrix} \mathcal{O}_{ll} \\ \mathcal{O}_{qq} \\ \mathcal{O}_{qq} \\ \mathcal{O}_{qq} \\ \mathcal{O}_{lq} \\ \mathcal{O}_{lq} \\ \mathcal{O}_{lq} \\ \mathcal{O}_{lq} \\ \end{bmatrix} $	$(\bar{L}L)(\bar{L}L)$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t})$ $(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}t_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}p_{\mu}\tau^{I}l_{r})(\bar{q}_{s}q^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}p_{\mu}\tau^{I}l_{r})(\bar{q}_{s}q^{\mu}d_{t})$ $(\bar{l}_{p}p_{\mu}r)(\bar{l}_{s}q_{t})$ $(\bar{q}_{p}^{j}u_{r})\varepsilon_{jk}(\bar{q}_{s}^{k}d_{t})$	$\begin{array}{c c} & & \\ & &$	$\begin{array}{c} (\overline{R}R)(\overline{R}R) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t}) \\ (\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t}) \\ (\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{u}_{s}\gamma^{\mu}u_{t}) \\ (\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{d}_{s}\gamma^{\mu}d_{t}) \\ (\overline{u}_{p}\gamma_{\mu}T^{A}u_{r})(\overline{d}_{s}\gamma^{\mu}T^{A}d_{t}) \\ \end{array}$ $\begin{array}{c} B\text{-vio} \\ \end{array}$	$\begin{matrix} \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qd}^{(1)} \\ \mathcal{O}_{qd}^{(2)} \\ \mathcal{O}_{qd}^{(3)} \\ \mathcal{O}_{qd}^{(3)} \\ \end{bmatrix} \\ \begin{matrix} 1 \\ \mathbf$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \\ \hline \\ [(q_{s}^{\gamma})^{T}Cl_{t}^{k}] \\ [(u_{s}^{\gamma})^{T}Ce_{t}] \\ \end{array} \right] $
$ \begin{bmatrix} \mathcal{O}_{ll} \\ \mathcal{O}_{qq} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \\ \end{bmatrix} \\ \begin{bmatrix} (\bar{L}R) \\ \mathcal{O}_{ledq} \\ \mathcal{O}_{quqd}^{(1)} \\ \mathcal{O}_{quqd}^{(8)} \\ \mathcal{O}_{quqd}^{(8)} \end{bmatrix} $	$(\bar{L}L)(\bar{L}L)$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t})$ $(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}p_{\mu}\tau^{I}l_{r})(\bar{q}_{s}q^{\mu}\tau^{I}q_{t})$ $(\bar{q}_{p}^{j}u_{r})\varepsilon_{jk}(\bar{q}_{s}^{k}d_{t})$ $(\bar{q}_{p}^{j}T^{A}u_{r})\varepsilon_{jk}(\bar{q}_{s}^{k}T^{A}d_{t})$	$\begin{array}{c c} & & \\ & &$	$(\overline{R}R)(\overline{R}R)$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t})$ $(\overline{a}_{p}\gamma_{\mu}u_{r})(\overline{a}_{s}\gamma^{\mu}u_{t})$ $(\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{a}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{u}_{p}\gamma_{\mu}T^{A}u_{r})(\overline{d}_{s}\gamma^{\mu}T^{A}d_{t})$ $B-\text{vio}$ $\mathcal{B}-\text{vio}$	$\begin{matrix} \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qd}^{(1)} \\ \mathcal{O}_{qd}^{(2)} \\ \mathcal{O}_{qd}^{(1)} \\ \mathcal{O}_{qd}^{(2)} \\ \mathcal{O}_{qd}^{(2)$	$\begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \\ \hline \\ [(q_{s}^{\gamma j})^{T}Cl_{t}^{k}] \\ [[(q_{s}^{\gamma m})^{T}Cl_{t}^{n}] \\ \end{array}$
$ \begin{bmatrix} \mathcal{O}_{ll} \\ \mathcal{O}_{qq} \\ \mathcal{O}_{qq} \\ \mathcal{O}_{qq} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \\ \end{bmatrix} \\ \begin{bmatrix} (\bar{L}R \\ \mathcal{O}_{ledq} \\ \mathcal{O}_{quqd}^{(3)} \\ \mathcal{O}_{quqd}^{(8)} \\ \mathcal{O}_{lequ}^{(1)} \\ \mathcal{O}_{lequ}^{(1)} \\ \end{bmatrix} $	$(\bar{L}L)(\bar{L}L)$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t})$ $(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}p_{\mu}\tau^{I}l_{r})(\bar{d}_{s}q_{t})$ $(\bar{q}_{p}^{j}u_{r})\varepsilon_{jk}(\bar{q}_{s}^{k}d_{t})$ $(\bar{q}_{p}^{j}T^{A}u_{r})\varepsilon_{jk}(\bar{q}_{s}^{k}T^{A}d_{t})$ $(\bar{l}_{p}^{j}e_{r})\varepsilon_{jk}(\bar{q}_{s}^{k}u_{t})$	$\begin{array}{c c} & & \\ & &$	$\begin{array}{c} (\overline{n}p) & \overline{\rho} \\ (\overline{R}R)(\overline{R}R) \\ (\overline{e}_p \gamma_\mu e_r)(\overline{e}_s \gamma^\mu e_t) \\ (\overline{u}_p \gamma_\mu u_r)(\overline{u}_s \gamma^\mu u_t) \\ (\overline{d}_p \gamma_\mu d_r)(\overline{d}_s \gamma^\mu d_t) \\ (\overline{e}_p \gamma_\mu e_r)(\overline{d}_s \gamma^\mu d_t) \\ (\overline{e}_p \gamma_\mu e_r)(\overline{d}_s \gamma^\mu d_t) \\ (\overline{u}_p \gamma_\mu u_r)(\overline{d}_s \gamma^\mu d_t) \\ (\overline{u}_p \gamma_\mu T^A u_r)(\overline{d}_s \gamma^\mu T^A d_t) \\ \end{array}$ $\begin{array}{c} B\text{-vio} \\ B\text{-vio} \\ \end{array}$	$\begin{bmatrix} \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qd}^{(s)} \\ \mathcal{O}_{qd}^{(s)} \\ \mathcal{O}_{qd}^{(s)} \\ \end{bmatrix}_{qd} \begin{bmatrix} \mathcal{O}_{qd}^{(s)} \\ \mathcal{O}_{qd}^{(s)} \\ \mathcal{O}_{qd}^{(s)} \end{bmatrix}_{p}^{(s)} T C u_r^{\beta} \end{bmatrix}$	$\begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \\ \hline \\ [(q_{s}^{\gamma j})^{T}Cl_{t}^{k}] \\ [(q_{s}^{\gamma m})^{T}Cl_{t}^{n}] \\ (u_{s}^{\gamma})^{T}Ce_{t}] \end{array}$

EWPO:  $\mathcal{O}_{HWB}, \mathcal{O}_{HD}, \mathcal{O}_{ll}, \mathcal{O}_{Hl}^{(3)}, \mathcal{O}_{Hl}^{(1)}, \mathcal{O}_{He}, \mathcal{O}_{Hq}^{(3)}, \mathcal{O}_{Hq}^{(1)}, \mathcal{O}_{Hd}, \mathcal{O}_{Hu}$ , Can be constrained setting  $|H|^2 \rightarrow v^2$ Bosonic: Yukawa:  $\mathcal{O}_{H\Box}, \mathcal{O}_{HG}, \mathcal{O}_{HW}, \mathcal{O}_{HB}, \mathcal{O}_{W}, \mathcal{O}_{G}$ , Triple-gauge field strength operators Can only be constrained by Higgs physics

• Top-specific flavour symmetry:

 $SU(3)^5 \rightarrow SU(2)^2 \times SU(3)^3$ 

 $= SU(2)_q \times SU(2)_u \times SU(3)_d \times SU(3)_l \times SU(3)_e$ 

*Linear* fit

• +14 Top operators

See 1802.07237

Top 2F:  $\mathcal{O}_{HQ}^{(3)}, \mathcal{O}_{HQ}^{(1)}, \mathcal{O}_{Ht}, \mathcal{O}_{tG}, \mathcal{O}_{tW}, \mathcal{O}_{tB}$ Top 4F:  $\mathcal{O}_{Qq}^{3,1}, \mathcal{O}_{Qq}^{3,8}, \mathcal{O}_{Qq}^{1,8}, \mathcal{O}_{Qu}^{8}, \mathcal{O}_{Qd}^{8}, \mathcal{O}_{tQ}^{8}, \mathcal{O}_{tu}^{8}, \mathcal{O}_{td}^{8}$ 

• 20 operators relevant for Higgs, diboson, and EWPO:

	$X^3$		$H^6$ and $H^4D^2$		$\psi^2 H^3$
$\mathcal{O}_{G}$	$f^{ABC}G^{A u}_{\mu}G^{B ho}_{ u}G^{C\mu}_{ ho}$	$\mathcal{O}_{H}$	$(H^{\dagger}H)^3$	$\mathcal{O}_{eH}$	$(H^{\dagger}H)(\bar{l}_{p}e_{r}H)$
$\mathcal{O}_{\tilde{G}}$	$f^{ABC} \widetilde{G}^{A\nu}_{\mu} G^{B\rho}_{\nu} G^{C\mu}_{\rho}$	$\mathcal{O}_{H\square}$	$(H^{\dagger}H)\square(H^{\dagger}H)$	${\cal O}_{uH}$	$(H^{\dagger}H)(\bar{q}_{p}u_{r}\widetilde{H})$
$\mathcal{O}_{W}$	$\varepsilon^{IJK}W^{I\nu}_{\mu}W^{J\rho}_{\nu}W^{K\mu}_{\rho}$	$\mathcal{O}_{HD}$	$\left(H^{\dagger}D^{\mu}H ight)^{\star}\left(H^{\dagger}D_{\mu}H ight)$	$\mathcal{O}_{_{dH}}$	$(H^{\dagger}H)(\bar{q}_{p}d_{r}H)$
$\mathcal{O}_{\widetilde{W}}$	$\varepsilon^{IJK} \widetilde{W}^{I\nu}_{\mu} W^{J\rho}_{\nu} W^{K\mu}_{\rho}$				
	$X^2H^2$		$\psi^2 X H$		$\psi^2 H^2 D$
$\mathcal{O}_{HG}$	$H^{\dagger}HG^{A}_{\mu\nu}G^{A\mu\nu}$	${\cal O}_{eW}$	$(\bar{l}_p \sigma^{\mu\nu} e_r) \tau^I H W^I_{\mu\nu}$	$\mathcal{O}_{Hl}^{(1)}$	$(H^{\dagger}i \overset{\leftrightarrow}{D}_{\mu} H)(\bar{l}_{p} \gamma^{\mu} l_{r})$
$\mathcal{O}_{H\widetilde{G}}$	$H^{\dagger}H\widetilde{G}^{A}_{\mu u}G^{A\mu u}$	${\cal O}_{eB}$	$(\bar{l}_p \sigma^{\mu\nu} e_r) H B_{\mu\nu}$	$\mathcal{O}_{Hl}^{(3)}$	$(H^{\dagger}i D_{\underline{\mu}}^{I} H)(\bar{l}_{p} \tau^{I} \gamma^{\mu} l_{r})$
$\mathcal{O}_{HW}$	$H^{\dagger}H W^{I}_{\mu\nu}W^{I\mu\nu}$	$\mathcal{O}_{uG}$	$(\bar{q}_p \sigma^{\mu\nu} T^A u_r) \widetilde{H} G^A_{\mu\nu}$	${\cal O}_{He}$	$(H^{\dagger}i D_{\mu} H)(\bar{e}_p \gamma^{\mu} e_r)$
$\mathcal{O}_{H\widetilde{W}}$	$H^{\dagger}H\widetilde{W}^{I}_{\mu u}W^{I\mu u}$	$\mathcal{O}_{uW}$	$(\bar{q}_p \sigma^{\mu\nu} u_r) \tau^I \tilde{H} W^I_{\mu\nu}$	$\mathcal{O}_{Hq}^{(1)}$	$(H^{\dagger}i \overset{\overleftarrow{D}}{D}_{\mu} H)(\bar{q}_p \gamma^{\mu} q_r)$
$\mathcal{O}_{_{HB}}$	$H^{\dagger}H B_{\mu u}B^{\mu u}$	$\mathcal{O}_{uB}$	$(\bar{q}_p \sigma^{\mu\nu} u_r) \widetilde{H} B_{\mu\nu}$	${\cal O}_{Hq}^{(3)}$	$(H^{\dagger}i D^{I}_{\mu} H)(\bar{q}_{p}\tau^{I}\gamma^{\mu}q_{r})$
$\mathcal{O}_{H\widetilde{B}}$	$H^{\dagger}H\widetilde{B}_{\mu u}B^{\mu u}$	${\cal O}_{_{dG}}$	$(\bar{q}_p \sigma^{\mu\nu} T^A d_r) H G^A_{\mu\nu}$	${\cal O}_{Hu}$	$(H^{\dagger}i D_{\mu} H)(\bar{u}_p \gamma^{\mu} u_r)$
$\mathcal{O}_{HWB}$	$H^{\dagger}\tau^{I}HW^{I}_{\mu\nu}B^{\mu\nu}$	${\cal O}_{dW}$	$(\bar{q}_p \sigma^{\mu\nu} d_r) \tau^I H W^I_{\mu\nu}$	${\cal O}_{Hd}$	$(H^{\dagger}iD_{\mu}H)(\bar{d}_{p}\gamma^{\mu}d_{r})$
$\mathcal{O} \sim$	$H^{\dagger}\tau^{I}HW^{I}B^{\mu\nu}$	0	$(\bar{a} \sigma^{\mu\nu} d) H B$	<i>O</i>	$i(\tilde{H}^{\dagger}D_{-}H)(\bar{u}_{-}\gamma^{\mu}d_{-})$
$O_{HWB}$	$\Pi \eta \Pi W_{\mu\nu}B$	$\mathcal{U}_{dB}$	$(q_p o^{\mu} a_r) \Pi D_{\mu\nu}$	U Hud	$\int v(\mathbf{II} \ \mathcal{D}_{\mu}\mathbf{II})(u_p \ , \ u_r)$
	$\frac{(\bar{L}L)(\bar{L}L)}{(\bar{L}L)}$		$(\bar{R}R)(\bar{R}R)$		$\frac{(\bar{L}L)(\bar{R}R)}{(\bar{L}L)(\bar{R}R)}$
$\mathcal{O}_{HWB}$	$ \begin{array}{c} (\bar{L}L)(\bar{L}L) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t}) \end{array} $	$\mathcal{O}_{dB}$	$(\bar{R}R)(\bar{R}R)$ $(\bar{e}_{r}\gamma_{\mu}e_{r})(\bar{e}_{s}\gamma^{\mu}e_{t})$	$\mathcal{O}_{le}$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{e}_s \gamma^\mu e_t) \end{array} $
$\mathcal{O}_{ll}$ $\mathcal{O}_{ll}$	$ \begin{array}{c} (\bar{L}L)(\bar{L}L) \\ \hline (\bar{l}_p \gamma_\mu l_r)(\bar{l}_s \gamma^\mu l_t) \\ \hline (\bar{q}_p \gamma_\mu q_r)(\bar{q}_s \gamma^\mu q_t) \end{array} $	$\mathcal{O}_{dB}$ $\mathcal{O}_{ee}$ $\mathcal{O}_{uu}$	$(\overline{RR})(\overline{RR})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$	$\mathcal{O}_{le}$ $\mathcal{O}_{lu}$	$\frac{(\bar{L}L)(\bar{R}R)}{(\bar{l}_p\gamma_\mu l_r)(\bar{e}_s\gamma^\mu e_t)}$ $\frac{(\bar{l}_p\gamma_\mu l_r)(\bar{e}_s\gamma^\mu e_t)}{(\bar{l}_p\gamma_\mu l_r)(\bar{u}_s\gamma^\mu u_t)}$
$\begin{array}{ c c } \mathcal{O}_{HWB} \\ \hline \\ \mathcal{O}_{ll} \\ \mathcal{O}_{qq} \\ $	$(\bar{L}L)(\bar{L}L)$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t})$ $(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$	$\mathcal{O}_{dB}$ $\mathcal{O}_{ee}$ $\mathcal{O}_{uu}$ $\mathcal{O}_{dd}$	$(\overline{R}R)(\overline{R}R)$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$ $(\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$	$\begin{array}{c c} \mathcal{O}_{Hud} \\ \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \end{array}$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ \hline (\bar{l}_p \gamma_\mu l_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{u}_s \gamma^\mu u_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{d}_s \gamma^\mu d_t) \end{array} $
$\begin{array}{ c c } \hline \mathcal{O}_{HWB} \\ \hline \\ \hline \\ \mathcal{O}_{ll} \\ \hline \\ \mathcal{O}_{lq} \end{array}$	$(\bar{L}L)(\bar{L}L)$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t})$ $(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$	$\mathcal{O}_{ee}$ $\mathcal{O}_{uu}$ $\mathcal{O}_{dd}$ $\mathcal{O}_{eu}$	$(\overline{R}R)(\overline{R}R)$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$ $(\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$	$\begin{array}{ c c } \hline & & \\$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ \hline (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \end{array} $
$\begin{matrix} & \mathcal{O}_{ll} \\ & \mathcal{O}_{ll} \\ & \mathcal{O}_{qq}^{(1)} \\ & \mathcal{O}_{lq}^{(3)} \\ & \mathcal{O}_{lq}^{(3)} \\ & \mathcal{O}_{lq}^{(3)} \end{matrix}$	$ \begin{array}{c} (\bar{L}L)(\bar{L}L) \\ \hline (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t}) \\ \hline (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t}) \\ \hline (\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t}) \\ \hline (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}q_{t}) \\ \hline (\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t}) \end{array} $	$\begin{array}{c} \mathcal{O}_{dB} \\ \mathcal{O}_{ee} \\ \mathcal{O}_{uu} \\ \mathcal{O}_{dd} \\ \mathcal{O}_{eu} \\ \mathcal{O}_{ed} \\ \mathcal{O}_{ed} \\ \mathcal{O}_{ed} \end{array}$	$(\overline{R}R)(\overline{R}R)$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$ $(\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{u}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$	$\begin{array}{ c c }\hline & & & \\ & & & & \\ & & & \\ & & & \\ & & & & \\ & & & & \\ & & & \\ & & & & \\ & & & \\ & & & & \\ & & & \\ & & & & \\ & & & $	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{u}_s \gamma^\mu u_t) \\ (\bar{l}_p \gamma_\mu l_r)(\bar{d}_s \gamma^\mu d_t) \\ (\bar{q}_p \gamma_\mu q_r)(\bar{e}_s \gamma^\mu e_t) \\ (\bar{q}_p \gamma_\mu q_r)(\bar{u}_s \gamma^\mu u_t) \end{array} $
$\begin{bmatrix} \mathcal{O}_{ll} \\ \mathcal{O}_{ll} \\ \mathcal{O}_{qq} \\ \mathcal{O}_{qq}^{(3)} \\ \mathcal{O}_{lq}^{qq} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \end{bmatrix}$	$(\bar{L}L)(\bar{L}L)$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t})$ $(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$	$\begin{array}{c c} \mathcal{O}_{dB} \\ \hline \mathcal{O}_{ee} \\ \mathcal{O}_{uu} \\ \mathcal{O}_{dd} \\ \mathcal{O}_{eu} \\ \mathcal{O}_{ed} \\ \mathcal{O}_{ud} \\ \mathcal{O}_{u$	$(\overline{R}R)(\overline{R}R)$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$ $(\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$	$\begin{matrix} \mathcal{O}_{le} \\ \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qu}^{(8)} \end{matrix}$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \end{array} $
$\begin{array}{ c c }\hline \mathcal{O}_{ll}\\ \hline \mathcal{O}_{ll}\\ \mathcal{O}_{qq}\\ \mathcal{O}_{qq}\\ \mathcal{O}_{lq}\\ \mathcal{O}_{lq}\\ \mathcal{O}_{lq}\\ \mathcal{O}_{lq}\\ \mathcal{O}_{lq} \end{array}$	$(\overline{L}L)(\overline{L}L)$ $(\overline{l}_{p}\gamma_{\mu}l_{r})(\overline{l}_{s}\gamma^{\mu}l_{t})$ $(\overline{q}_{p}\gamma_{\mu}q_{r})(\overline{q}_{s}\gamma^{\mu}q_{t})$ $(\overline{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\overline{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\overline{l}_{p}\gamma_{\mu}l_{r})(\overline{q}_{s}\gamma^{\mu}q_{t})$ $(\overline{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\overline{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$	$\begin{array}{c} \mathcal{O}_{dB} \\ \mathcal{O}_{ee} \\ \mathcal{O}_{uu} \\ \mathcal{O}_{dd} \\ \mathcal{O}_{eu} \\ \mathcal{O}_{ed} \\ \mathcal{O}_{ud}^{(1)} \\ \mathcal{O}_{ud}^{(8)} \end{array}$	$ \begin{array}{c} (\bar{q}_{p} \beta^{\mu}  \bar{u}_{r}) \Pi  \bar{D}_{\mu\nu} \\ \hline \\ (\bar{R}R)(\bar{R}R) \\ (\bar{e}_{p} \gamma_{\mu} e_{r})(\bar{e}_{s} \gamma^{\mu} e_{t}) \\ (\bar{u}_{p} \gamma_{\mu} u_{r})(\bar{u}_{s} \gamma^{\mu} u_{t}) \\ (\bar{d}_{p} \gamma_{\mu} d_{r})(\bar{d}_{s} \gamma^{\mu} d_{t}) \\ (\bar{e}_{p} \gamma_{\mu} e_{r})(\bar{d}_{s} \gamma^{\mu} u_{t}) \\ (\bar{e}_{p} \gamma_{\mu} e_{r})(\bar{d}_{s} \gamma^{\mu} d_{t}) \\ (\bar{u}_{p} \gamma_{\mu} u_{r})(\bar{d}_{s} \gamma^{\mu} d_{t}) \\ (\bar{u}_{p} \gamma_{\mu} T^{A} u_{r})(\bar{d}_{s} \gamma^{\mu} T^{A} d_{t}) \end{array} $	$\begin{array}{c c} \mathcal{O}_{Hud} \\ \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(2)} \end{array}$	$(\bar{L}L)(\bar{R}R)$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t})$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}u_{t})$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t})$ $(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t})$ $(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t})$ $(\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t})$ $(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t})$
$\begin{array}{ c c }\hline \mathcal{O}_{ll}\\ \hline \mathcal{O}_{ll}\\ \mathcal{O}_{lq}^{(1)}\\ \mathcal{O}_{lq}^{(3)}\\ \mathcal{O}_{lq}^{(1)}\\ \mathcal{O}_{lq}^{(3)}\\ \end{array}$	$(\bar{L}L)(\bar{L}L)$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t})$ $(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$	$\begin{array}{c} \mathcal{O}_{dB} \\ \mathcal{O}_{ee} \\ \mathcal{O}_{uu} \\ \mathcal{O}_{dd} \\ \mathcal{O}_{eu} \\ \mathcal{O}_{ed} \\ \mathcal{O}_{ud}^{(1)} \\ \mathcal{O}_{ud}^{(8)} \end{array}$	$(\overline{R}R)(\overline{R}R)$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t})$ $(\overline{a}_{p}\gamma_{\mu}u_{r})(\overline{a}_{s}\gamma^{\mu}u_{t})$ $(\overline{a}_{p}\gamma_{\mu}d_{r})(\overline{a}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{a}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{a}_{p}\gamma_{\mu}u_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{u}_{p}\gamma_{\mu}T^{A}u_{r})(\overline{d}_{s}\gamma^{\mu}T^{A}d_{t})$	$\begin{array}{c} \mathcal{O}_{Hud} \\ \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(g)} \end{array}$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{a}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array} $
$ \begin{bmatrix} \mathcal{O}_{ll} \\ \mathcal{O}_{ll} \\ \mathcal{O}_{qq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(3)} \\ \end{bmatrix} $	$(\bar{L}L)(\bar{L}L)$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t})$ $(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\lambda_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{k}L) \text{ and } (\bar{L}R)(\bar{L}R)$	$\begin{array}{c} \mathcal{O}_{dB} \\ \mathcal{O}_{ee} \\ \mathcal{O}_{uu} \\ \mathcal{O}_{dd} \\ \mathcal{O}_{eu} \\ \mathcal{O}_{ed} \\ \mathcal{O}_{ud}^{(1)} \\ \mathcal{O}_{ud}^{(8)} \end{array}$	$\frac{(\bar{q}_{p} \delta^{-} u_{r}) \Pi B_{\mu\nu}}{(\bar{R}R)(\bar{R}R)}$ $\frac{(\bar{e}_{p} \gamma_{\mu} e_{r})(\bar{e}_{s} \gamma^{\mu} e_{t})}{(\bar{d}_{p} \gamma_{\mu} u_{r})(\bar{u}_{s} \gamma^{\mu} u_{t})}$ $\frac{(\bar{d}_{p} \gamma_{\mu} d_{r})(\bar{d}_{s} \gamma^{\mu} d_{t})}{(\bar{e}_{p} \gamma_{\mu} e_{r})(\bar{d}_{s} \gamma^{\mu} d_{t})}$ $\frac{(\bar{e}_{p} \gamma_{\mu} e_{r})(\bar{d}_{s} \gamma^{\mu} d_{t})}{(\bar{u}_{p} \gamma_{\mu} u_{r})(\bar{d}_{s} \gamma^{\mu} d_{t})}$ $\frac{(\bar{u}_{p} \gamma_{\mu} T^{A} u_{r})(\bar{d}_{s} \gamma^{\mu} T^{A} d_{t})}{B\text{-vio}}$	$\begin{matrix} \mathcal{O}_{Hud} \\ \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(2)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(1)} \\ \mathcal{O}_{qd}^{(2)} \\ \mathcal$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{a}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \end{array} $
$ \begin{bmatrix} \mathcal{O}_{HWB} \\ \mathcal{O}_{ll} \\ \mathcal{O}_{qq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \\ \end{bmatrix} $	$(\bar{L}L)(\bar{L}L)$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t})$ $(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\rho_{\mu}\tau^{I}l_{r})(\bar{q}_{s}q^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\rho_{\mu}r^{I}l_{r})(\bar{d}_{s}q^{\mu}t^{I}q_{t})$	$\begin{array}{c} \mathcal{O}_{dB} \\ \mathcal{O}_{ee} \\ \mathcal{O}_{uu} \\ \mathcal{O}_{dd} \\ \mathcal{O}_{eu} \\ \mathcal{O}_{ed} \\ \mathcal{O}_{ud}^{(1)} \\ \mathcal{O}_{ud}^{(8)} \\ \end{array}$	$(\overline{q}_{p}\delta^{\mu}d_{r})\Pi B_{\mu\nu}$ $(\overline{R}R)(\overline{R}R)$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{u}_{s}\gamma^{\mu}u_{t})$ $(\overline{d}_{p}\gamma_{\mu}d_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{u}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{u}_{p}\gamma_{\mu}T^{A}u_{r})(\overline{d}_{s}\gamma^{\mu}T^{A}d_{t})$ $B\text{-vio}$ $\mathcal{E}^{\alpha\beta\gamma}\varepsilon_{jk}\left[(d_{p}\gamma_{\mu})^{\mu}d_{\mu}\partial_{\mu}\partial_{\mu}\partial_{\mu}\partial_{\mu}\partial_{\mu}\partial_{\mu}\partial_{\mu}\partial$	$\begin{matrix} \mathcal{O}_{le} \\ \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qd}^{(2)} \\ \mathcal{O}_{qd}^{(3)} \\ $	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \\ \hline (\bar{q}_{s}\gamma^{j})^{T}Cl_{t}^{k} \end{bmatrix} $
$ \begin{bmatrix} \mathcal{O}_{HWB} \\ \mathcal{O}_{ll} \\ \mathcal{O}_{qq} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq}^{(1)} \\ \mathcal{O}_{lq}^{(3)} \\ \mathcal{O}_{lq} \\ \end{bmatrix} $	$(\bar{L}L)(\bar{L}L)$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t})$ $(\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}q_{t})$ $(\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t})$ $(\bar{l}_{p}p_{\mu}\tau^{I}l_{r})(\bar{q}_{s}q_{t})$ $(\bar{l}_{p}p_{\mu}r)(\bar{d}_{s}q_{t})$ $(\bar{q}_{p}^{j}u_{r})\varepsilon_{jk}(\bar{q}_{s}^{k}d_{t})$	$\begin{array}{c} \mathcal{O}_{dB} \\ \mathcal{O}_{ee} \\ \mathcal{O}_{uu} \\ \mathcal{O}_{dd} \\ \mathcal{O}_{eu} \\ \mathcal{O}_{ed} \\ \mathcal{O}_{ud}^{(1)} \\ \mathcal{O}_{ud}^{(8)} \\ \mathcal{O}_{duq} \\ \mathcal{O}_{qqu} \end{array}$	$\frac{(\bar{q}_{p}\delta^{-}\bar{u}_{r})\Pi D_{\mu\nu}}{(\bar{R}R)(\bar{R}R)}$ $\frac{(\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{e}_{s}\gamma^{\mu}e_{t})}{(\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{u}_{s}\gamma^{\mu}u_{t})}$ $\frac{(\bar{d}_{p}\gamma_{\mu}d_{r})(\bar{d}_{s}\gamma^{\mu}d_{t})}{(\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{u}_{s}\gamma^{\mu}d_{t})}$ $\frac{(\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{d}_{s}\gamma^{\mu}d_{t})}{(\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{d}_{s}\gamma^{\mu}d_{t})}$ $\frac{(\bar{u}_{p}\gamma_{\mu}T^{A}u_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t})}{\bar{u}_{s}\gamma^{\mu}\gamma^{\mu}\delta_{s}\gamma^{\mu}\delta_{s}\gamma_{s}k}\left[(d_{p}^{\alpha})$	$\begin{matrix} \mathcal{O}_{le} \\ \mathcal{O}_{le} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qu} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(8)} \\ \mathcal{O}_{qd}^{(9)} \\ \mathcal{O}_{qd}^{(9)} \\ \mathcal{O}_{qd}^{(9)} \\ \mathcal{O}_{qd}^{(7)} \\ $	$\begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{u}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \\ \end{array}$
$ \begin{bmatrix} \mathcal{O}_{ll} \\ \mathcal{O}_{ll} \\ \mathcal{O}_{lq} \\ \mathcal{O}_{lq} \\ \mathcal{O}_{lq} \\ \mathcal{O}_{lq} \\ \mathcal{O}_{lq} \\ \mathcal{O}_{lq} \\ \end{bmatrix} \\ \begin{bmatrix} (\bar{L}R) \\ \mathcal{O}_{ledq} \\ \mathcal{O}_{quqd} \\ \mathcal{O}_{quqd} \\ \mathcal{O}_{quqd} \\ \end{bmatrix} $	$\begin{array}{c} (\bar{L}L)(\bar{L}L) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t}) \\ (\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}q_{t}) \\ (\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t}) \\ (\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t}) \\ \end{array}$	$\begin{array}{c} \mathcal{O}_{dB} \\ \mathcal{O}_{ee} \\ \mathcal{O}_{uu} \\ \mathcal{O}_{dd} \\ \mathcal{O}_{eu} \\ \mathcal{O}_{ed} \\ \mathcal{O}_{ud} \\ \mathcal{O}_{ud} \\ \mathcal{O}_{qqu} \\ \mathcal{O}_{qqq} \\ \mathcal{O}_{qqq} \\ \mathcal{O}_{qqq} \end{array}$	$\frac{(\bar{q}_{p}\delta^{-}\bar{u}_{r})\Pi D_{\mu\nu}}{(\bar{R}R)(\bar{R}R)}$ $\frac{(\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{e}_{s}\gamma^{\mu}e_{t})}{(\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{u}_{s}\gamma^{\mu}u_{t})}$ $\frac{(\bar{d}_{p}\gamma_{\mu}d_{r})(\bar{d}_{s}\gamma^{\mu}d_{t})}{(\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{u}_{s}\gamma^{\mu}d_{t})}$ $\frac{(\bar{e}_{p}\gamma_{\mu}e_{r})(\bar{d}_{s}\gamma^{\mu}d_{t})}{(\bar{u}_{p}\gamma_{\mu}u_{r})(\bar{d}_{s}\gamma^{\mu}d_{t})}$ $\frac{(\bar{u}_{p}\gamma_{\mu}T^{A}u_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t})}{\bar{u}_{s}\gamma^{\mu}\gamma^{\mu}d_{t}}$ $B-\text{vio}$ $B-\text{vio}$ $\frac{\varepsilon^{\alpha\beta\gamma}\varepsilon_{jk}\left[(d_{p}^{\alpha}\varepsilon^{\alpha\beta\gamma}\varepsilon_{jk}\left[(d_{p}^{\alpha}\varepsilon^{\alpha\beta\gamma}\varepsilon_{jk}\varepsilon_{jk}\right]\right]}{\varepsilon^{\alpha\beta\gamma}\varepsilon_{jn}\varepsilon_{km}}\left[(d_{p}^{\alpha}\varepsilon^{\alpha\beta\gamma}\varepsilon_{jk}\varepsilon_{jk}\varepsilon_{jk}\right]$	$\begin{matrix} \mathcal{O}_{lu} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{ld} \\ \mathcal{O}_{qe} \\ \mathcal{O}_{qd}^{(1)} \\ \mathcal{O}_{qd}^{(3)} \\ \mathcal{O}_{qd}^{(3)} \\ \mathcal{O}_{qd}^{(3)} \\ \begin{matrix} \mathcal{O}_{qd}^{(3)} \\ \mathcal{O}_{qd}^{(3)} \\ \begin{matrix} \mathcal{O}_{qd} \\ \mathcal{O}_{qd} \\ \end{matrix} \end{matrix}$	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}d_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \\ \end{array} \right] \\ \begin{bmatrix} (q_{s}^{\gamma j})^{T}Cl_{t}^{k} \\ ] \\ [(q_{s}^{\gamma m})^{T}Cl_{t}^{n} \end{bmatrix} \\ \end{array} $
$ \begin{bmatrix} \mathcal{O}_{HWB} \\ \mathcal{O}_{ll} \\ \mathcal{O}_{qq} \\ \mathcal{O}_{lq} \\ \mathcal{O}_{lq} \\ \mathcal{O}_{lq} \\ \mathcal{O}_{lq} \\ \mathcal{O}_{lq} \\ \mathcal{O}_{lq} \\ \end{bmatrix} $	$\begin{array}{c} (\bar{L}L)(\bar{L}L) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{l}_{s}\gamma^{\mu}l_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t}) \\ (\bar{q}_{p}\gamma_{\mu}\tau^{I}q_{r})(\bar{q}_{s}\gamma^{\mu}q_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{q}_{s}\gamma^{\mu}q_{t}) \\ (\bar{l}_{p}\gamma_{\mu}t^{I})(\bar{q}_{s}\gamma^{\mu}q_{t}) \\ (\bar{l}_{p}\gamma_{\mu}\tau^{I}l_{r})(\bar{q}_{s}\gamma^{\mu}\tau^{I}q_{t}) \\ \end{array}$	$\begin{array}{c} \mathcal{O}_{dB} \\ \mathcal{O}_{ee} \\ \mathcal{O}_{uu} \\ \mathcal{O}_{dd} \\ \mathcal{O}_{eu} \\ \mathcal{O}_{ed} \\ \mathcal{O}_{ud} \\ \mathcal{O}_{ud} \\ \mathcal{O}_{ud} \\ \mathcal{O}_{qqu} \\ \mathcal{O}_{qqu} \\ \mathcal{O}_{qqu} \\ \mathcal{O}_{qqu} \\ \mathcal{O}_{qqu} \\ \mathcal{O}_{duu} \end{array}$	$(\overline{R}R)(\overline{R}R)$ $(\overline{e}_{P}\gamma_{\mu}e_{r})(\overline{e}_{s}\gamma^{\mu}e_{t})$ $(\overline{a}_{p}\gamma_{\mu}u_{r})(\overline{a}_{s}\gamma^{\mu}u_{t})$ $(\overline{a}_{p}\gamma_{\mu}d_{r})(\overline{a}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{a}_{s}\gamma^{\mu}d_{t})$ $(\overline{e}_{p}\gamma_{\mu}e_{r})(\overline{a}_{s}\gamma^{\mu}d_{t})$ $(\overline{u}_{p}\gamma_{\mu}u_{r})(\overline{d}_{s}\gamma^{\mu}d_{t})$ $(\overline{u}_{p}\gamma_{\mu}T^{A}u_{r})(\overline{d}_{s}\gamma^{\mu}T^{A}d_{t})$ $B-\text{vio}$ $B-\text{vio}$ $\varepsilon^{\alpha\beta\gamma}\varepsilon_{jk}\left[(d_{p}^{\alpha}\varepsilon^{\alpha\beta\gamma}\varepsilon_{jk}\varepsilon_{jk}^{\alpha\beta\gamma}\varepsilon_{jk}\right](d_{p}^{\alpha}\varepsilon^{\alpha\beta\gamma}\varepsilon_{jk}\varepsilon_{jk}^{\alpha\beta\gamma}\varepsilon_{jk}^{\beta}\varepsilon_{jk}^{\alpha\beta\gamma}\varepsilon_{jk}^{\beta$	$\begin{matrix} \mathcal{O}_{lu} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{lu} \\ \mathcal{O}_{qu} \\ \mathcal{O}_{qu} \\ \mathcal{O}_{qu}^{(1)} \\ \mathcal{O}_{qd}^{(2)} \\ \mathcal{O}_{qd}^{(2)} \\ \mathcal{O}_{qd}^{(3)} \\ $	$ \begin{array}{c} (\bar{L}L)(\bar{R}R) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{e}_{s}\gamma^{\mu}u_{t}) \\ (\bar{l}_{p}\gamma_{\mu}l_{r})(\bar{d}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{e}_{s}\gamma^{\mu}e_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{u}_{s}\gamma^{\mu}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}u_{t}) \\ (\bar{q}_{p}\gamma_{\mu}T^{A}q_{r})(\bar{d}_{s}\gamma^{\mu}T^{A}d_{t}) \\ \hline (\bar{q}_{s}\gamma^{j})^{T}Cl_{t}^{k} \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\$

EWPO:  $\mathcal{O}_{HWB}, \mathcal{O}_{HD}, \mathcal{O}_{ll}, \mathcal{O}_{Hl}^{(3)}, \mathcal{O}_{Hl}^{(1)}, \mathcal{O}_{He}, \mathcal{O}_{Hq}^{(3)}, \mathcal{O}_{Hq}^{(1)}, \mathcal{O}_{Hd}, \mathcal{O}_{Hu}$ , Can be constrained setting  $|H|^2 \rightarrow v^2$ Bosonic: Yukawa:  $\mathcal{O}_{H\Box}, \mathcal{O}_{HG}, \mathcal{O}_{HW}, \mathcal{O}_{HB}, \mathcal{O}_{W}, \mathcal{O}_{G}$ , Triple-gauge field strength operators Can only be constrained by Higgs physics

#### • Higgs, diboson, EWPO:

EW precision observables	$n_{\mathbf{obs}}$	Ref.
Precision electroweak measurements on the $Z$ resonance.	12	[1]
$\Gamma_Z,  \sigma_{\text{had}}^0,  R_\ell^0,  A_{FB}^\ell,  A_\ell(\text{SLD}),  A_\ell(\text{Pt}),  R_b^0,  R_c^0,  A_{FB}^b,  A_{FB}^c,  A_b  \&  A_c$		
Combination of CDF and D0 W-Boson Mass Measurements	1	[6]
LHC run 1 W boson mass measurement by ATLAS	1	[57]

Diboson LEP & LHC	$n_{\mathbf{obs}}$	Ref.
$W^+W^-$ angular distribution measurements at LEP II.	8	[5]
$W^+ W^-$ total cross section measurements at L3 in the $\ell \nu \ell \nu$ , $\ell \nu qq \& qqqq$	24	[3]
final states for 8 energies		
$W^+ W^-$ total cross section measurements at OPAL in the $\ell \nu \ell \nu$ , $\ell \nu qq$ &	21	[4]
qqqq final states for 7 energies		
$W^+ W^-$ total cross section measurements at ALEPH in the $\ell \nu \ell \nu$ , $\ell \nu q q$	21	[2]
& $qqqq$ final states for 8 energies		
ATLAS $W^+ W^-$ differential cross section in the $e\nu\mu\nu$ channel, $\frac{d\sigma}{dp_1^T}$ ,	1	
$p_T > 120 \text{ GeV}$ overflow bin		[225]
ATLAS $W^+ W^-$ fiducial differential cross section in the $e\nu\mu\nu$ channel,	14	[58]
$rac{d\sigma}{dp_{\ell_1}^T}$		
ATLAS $Zjj$ fiducial differential cross section in the $\ell^+\ell^-$ channel, $\frac{d\sigma}{d\Delta\varphi_{jj}}$	12	[60]

LHC Run 1 Higgs	$n_{\mathbf{obs}}$	Ref.
ATLAS and CMS LHC Run 1 combination of Higgs signal strengths.	21	[8]
Production: $ggF$ , $VBF$ , $ZH$ , $WH$ & $ttH$		
Decay: $\gamma\gamma$ , $ZZ$ , $W^+W^-$ , $\tau^+\tau^-$ & $b\bar{b}$		
ATLAS inclusive $Z\gamma$ signal strength measurement	1	[9]
LHC Bun 2 Higgs (new)	noha	Bef.
	1.010.05	
ATLAS combination of signal strengths and stage 1.0 STXS in $H \rightarrow 4\ell$	16 19 25	[10]
including ratios of branching fractions to $\gamma\gamma$ , $WW^*$ , $\tau^+\tau^-$ & bb		
Signal strengths coarse STXS bins fine STXS bins		
CMS LHC combination of Higgs signal strengths.	23	[11]
Production: $ggF$ , $VBF$ , $ZH$ , $WH$ & $ttH$		
Decay: $\gamma\gamma$ , $ZZ$ , $W^+W^-$ , $\tau^+\tau^-$ , $b\bar{b}$ & $\mu^+\mu^-$		
CMS stage 1.0 STXS measurements for $H \to \gamma \gamma$ .	13 7	[12]
13 parameter fit   7 parameter fit		
CMS stage 1.0 STXS measurements for $H \to \tau^+ \tau^-$	9	[13]
CMS stage 1.1 STXS measurements for $H \to 4\ell$	19	[14]
CMS differential cross section measurements of inclusive Higgs produc-	5 6	[15]
tion in the $WW^* \to \ell \nu \ell \nu$ final state.		
$\frac{d\sigma}{dn_{\rm jet}} \mid \frac{d\sigma}{dp_H^T}$		
ATLAS $H \to Z\gamma$ signal strength.	1	[16]
ATLAS $H \to \mu^+ \mu^-$ signal strength.	1	[17]

• + Top

Tevatron & Run 1 top	$n_{\mathbf{obs}}$	Ref.
Tevatron combination of differential $t\bar{t}$ forward-backward asymmetry,	4	[7]
$A_{FB}(m_{t\bar{t}}).$		
ATLAS $t\bar{t}$ differential distributions in the dilepton channel.	6	[18]
$\frac{d\sigma}{dm_{\star}r}$		
ATLAS $t\bar{t}$ differential distributions in the $\ell$ +jets channel.	7 5 8 5	[19]
$\frac{d\sigma}{dm_{z\bar{z}}}$ $\frac{d\sigma}{d u_{z\bar{z}} }$ $\frac{d\sigma}{dn^T}$ $\frac{d\sigma}{d u_{z} }$ .		
CMS $t\bar{t}$ differential distributions in the $\ell$ +jets channel.	7 10 8  10	[20,
$\frac{d\sigma}{dm} = \frac{d\sigma}{dm} = \frac{d\sigma}{dm} = \frac{d\sigma}{dm}$		226
$\frac{am_{tt} + ay_{tt} + ay_{t}}{CMS}$ measurement of differential t $\bar{t}$ charge asymmetry $A_{C}(m_{t\bar{t}})$ in the	3	· ·
dilepton channel.		[227]
ATLAS inclusive measurement $t\bar{t}$ charge asymmetry. $A_C(m_{t\bar{t}})$ in the	1	[]
dilepton channel.	-	[228]
ATLAS & CMS combination of differential tt charge asymmetry.	6	[21]
$A_C(m_{t\bar{t}})$ , in the $\ell$ +jets channel.	_	[ []
CMS $t\bar{t}$ double differential distributions in the dilepton channel.	16 16	[22,
$\frac{d\sigma}{dm} \frac{d\sigma}{dm} \frac{d\sigma}{dm} \frac{d\sigma}{dm} \frac{d\sigma}{dm} \frac{d\sigma}{dm} \frac{d\sigma}{dm} \frac{d\sigma}{dm}$	16 16	229
$am_{tt}ay_{tt} = am_{tt}ay_{tt} = am_{tt}ay_{tt} = am_{tt}ay_{tt} = ay_{t}ay_{t}$ ATLAS & CMS Bun 1 combination of W-boson helicity fractions in top	3	[23]
decay, $f_0$ , $f_1$ & $f_P$	0	[ [20]
ATLAS measurement of W-boson helicity fractions in top decay.	3	[24]
$f_0, f_L \& f_R$		()
CMS measurement of W-boson helicity fractions in top decay.	3	[25]
$f_0, f_L \& f_R$		
ATLAS $t\bar{t}W$ & $t\bar{t}Z$ cross section measurements. $\sigma_{t\bar{t}W} \sigma_{t\bar{t}Z}$	2	[26]
CMS $t\bar{t}W \& t\bar{t}Z$ cross section measurements. $\sigma_{t\bar{t}W} \sigma_{t\bar{t}Z}$	2	[27]
ATLAS <i>t</i> -channel single-top differential distributions.	4 4 4 5	[28]
$\left  \frac{d\sigma}{dn^T} \right  \left  \frac{d\sigma}{dn^T} \right  \left  \frac{d\sigma}{d u_t } \right  \left  \frac{d\sigma}{d u_t } \right $		
CMS s-channel single-top cross section measurement.	1	[29]
CMS <i>t</i> -channel single-top differential distributions.	6 6	[30]
$\frac{d\sigma}{dr_{\perp}^{T}} = \frac{d\sigma}{dl_{l+1}z}$		
CMS measurement of the <i>t</i> -channel single-top and anti-top cross sections.	11111	[31]
$\sigma_t   \sigma_{\bar{t}}   \sigma_{t+\bar{t}}   R_t.$	-1-1-1-	[]
ATLAS s-channel single-top cross section measurement.	1	[32]
CMS $tW$ cross section measurement.	1	[33]
ATLAS $tW$ cross section measurement in the single lepton channel.	1	[34]
ATLAS $tW$ cross section measurement in the dilepton channel.	1	[35]

Run 2 top	$n_{\mathbf{obs}}$	Ref.
CMS $t\bar{t}$ differential distributions in the dilepton channel.	6	[36,
$\frac{d\sigma}{dm_{\star T}}$		230]
CMS $t\bar{t}$ differential distributions in the $\ell$ +jets channel.	10	[37]
$\frac{d\sigma}{dm_{\star\tau}}$		
ATLAS measurement of differential $t\bar{t}$ charge asymmetry, $A_C(m_{t\bar{t}})$ .	5	[38]
ATLAS $t\bar{t}W$ & $t\bar{t}Z$ cross section measurements. $\sigma_{t\bar{t}W} \sigma_{t\bar{t}Z}$	2	[39]
CMS $t\bar{t}W$ & $t\bar{t}Z$ cross section measurements. $\sigma_{t\bar{t}W}   \sigma_{t\bar{t}Z}$	1 1	[40]
CMS $t\bar{t}Z$ differential distributions.	4 4	[41]
$\frac{d\sigma}{dp_T^T} \qquad \frac{d\sigma}{d\cos\theta^*}$		
$\overline{\text{CMS}}$ measurement of differential cross sections and charge ratios for $t$ -	5 5	[42]
channel single-top quark production.		
$rac{d\sigma}{dp_{t+ar{t}}^T} \hspace{0.2cm} igert \hspace{0.2cm} R_t \left( p_{t+ar{t}}^T  ight)$		
CMS measurement of <i>t</i> -channel single-top and anti-top cross sections.	4	[43]
$\sigma_t,  \sigma_{\bar{t}},  \sigma_{t+\bar{t}} \&  R_t.$		
CMS measurement of the $t\mbox{-}{\rm channel}$ single-top and anti-top cross sections.	1 1 1 1	[44]
$\sigma_t     \sigma_{ar{t}}     \sigma_{t+ar{t}}     R_t.$		
CMS $t$ -channel single-top differential distributions.	4 4	[45]
$\left  rac{d\sigma}{dp_{t+ar{t}}^{T}}  ight  = \left  rac{d\sigma}{d y_{t+ar{t}} }  ight $		
ATLAS $tW$ cross section measurement.	1	[46]
CMS $tZ$ cross section measurement.	1	[47]
CMS $tW$ cross section measurement.	1	[48]
ATLAS $tZ$ cross section measurement.	1	[49]
CMS $tZ (Z \to \ell^+ \ell^-)$ cross section measurement	1	[50]
ATLAS four-top search in the multi-lepton and same-sign dilepton chan-	1	[51]
nels.		
ATLAS four-top search in the single-lepton and opposite-sign dilepton	1	[52]
channels.		
CMS four-top search in the multi-lepton and same-sign dilepton chan-	1	[53]
nels.		
CMS four-top search in the single-lepton and opposite-sign dilepton	1	[54]
channels.		
CMS $t\bar{t}b\bar{b}$ cross section measurement in the all-jet channel.	1	[55]
CMS $t\bar{t}b\bar{b}$ cross section measurement in the dilepton channel.	1	[56]

• EWPO:

EW precision observables	$n_{\mathbf{obs}}$	Ref.
Precision electroweak measurements on the $Z$ resonance.	12	[1]
$\Gamma_Z,  \sigma^0_{\text{had.}},  R^0_\ell,  A^\ell_{FB},  A_\ell(\text{SLD}),  A_\ell(\text{Pt}),  R^0_b,  R^0_c  A^b_{FB},  A^c_{FB},  A_b  \&  A_c$		
Combination of CDF and D0 $W$ -Boson Mass Measurements	1	[6]
LHC run 1 W boson mass measurement by ATLAS	1	[57]

Revised QCD uncertainties on  $A^b_{FB}$  not included: [2011.00530 d'Enterria & Yan]

$$T_{t}^{\nu} = T_{had}^{\nu} + 3T_{t}^{2} + 3T_{t}^{2} \quad R_{t} = \frac{T_{t}^{\nu}}{T_{t}} \quad \mathcal{B}_{had} = 12\pi \frac{T_{t}^{\nu}}{\Omega_{t}^{\nu}} \quad \mathcal{A}_{f}^{f} = \frac{3}{4} \mathcal{A}_{e} \mathcal{A}_{f} \quad M_{w} = c_{w} M_{t}^{2}$$

$$R_{q} = \frac{T_{q}}{T_{had}}$$

$$T_{t}^{\nu} = \frac{52G_{F}}{G_{T}} \frac{M_{t}^{2} \hat{M}_{t}}{G_{T}} \left[ \left(g_{L}^{f}\right)^{2} + \left(g_{R}^{f}\right)^{2} \right] \qquad \mathcal{A}_{f} = \frac{\left(g_{L}^{f}\right)^{2} - \left(g_{R}^{f}\right)^{2}}{\left(g_{L}^{f}\right)^{2} + \left(g_{R}^{f}\right)^{2}}$$

$$g^{f} = T_{f}^{2} - Q_{f} S_{w}^{2} \qquad S_{w}^{2} = \frac{1}{2} - \frac{1}{2} \sqrt{1 - \frac{4\pi}{52}G_{F}} M_{t}^{2}$$

 $m_{t}^{2} = (m_{t}^{2})^{\circ} (1 + \pi_{t}^{2}) \quad G_{f} = G_{f}^{\circ} (1 - \pi_{uw}^{\circ}) \quad \propto (m_{t}) = \alpha^{\circ}(m_{t}) (1 + \pi_{s}^{\circ})$ 

• Diboson:

Diboson LEP & LHC	$n_{\mathbf{obs}}$	Ref.
$W^+ W^-$ angular distribution measurements at LEP II.	8	[5]
$W^+W^-$ total cross section measurements at L3 in the $\ell\nu\ell\nu$ , $\ell\nu qq$ & $qqqq$	24	[3]
final states for 8 energies		
$W^+W^-$ total cross section measurements at OPAL in the $\ell\nu\ell\nu$ , $\ell\nu qq$ &	21	[4]
qqqq final states for 7 energies		
$W^+ W^-$ total cross section measurements at ALEPH in the $\ell \nu \ell \nu$ , $\ell \nu q q$	21	[2]
& $qqqq$ final states for 8 energies		
ATLAS $W^+ W^-$ differential cross section in the $e\nu\mu\nu$ channel, $\frac{d\sigma}{dp_e^T}$ ,	1	
$p_T > 120 \text{ GeV}$ overflow bin		[225]
ATLAS $W^+ W^-$ fiducial differential cross section in the $e\nu\mu\nu$ channel,	14	[58]
$rac{d\sigma}{dp_{\ell_1}^T}$		
ATLAS $Zjj$ fiducial differential cross section in the $\ell^+\ell^-$ channel, $\frac{d\sigma}{d\Delta\varphi_{ij}}$	12	[60]

(+ WZ)

 Conservative approach to unknown bin correlations at LEP: fit to subset of angular distribution bins
 1606.06693 Berthier, Bjorn, Trott

 $B_1 = [-1, -0.8], B_2 = [-0.4, -0.2], B_3 = [0.4, 0.6], B_4 = [0.8, 1] \text{ for } \sqrt{s} = \{182.66, 205.92\} \text{ GeV}$ 

- LHC WW suppressed linear term
- Zjj recovers interference:



#### • Higgs:

LHC Run 1 Higgs	$n_{\mathbf{obs}}$	Ref.
ATLAS and CMS LHC Run 1 combination of Higgs signal strengths.	21	[8]
Production: $ggF$ , $VBF$ , $ZH$ , $WH$ & $ttH$		
Decay: $\gamma\gamma$ , $ZZ$ , $W^+W^-$ , $\tau^+\tau^-$ & $b\bar{b}$		
ATLAS inclusive $Z\gamma$ signal strength measurement	1	[9]
LHC Run 2 Higgs (new)	$n_{\mathbf{obs}}$	Ref.
ATLAS combination of signal strengths and stage 1.0 STXS in $H \to 4\ell$	16 19 25	[10]
including ratios of branching fractions to $\gamma\gamma$ , $WW^*$ , $\tau^+\tau^- \& b\bar{b}$		
Signal strengths coarse STXS bins fine STXS bins		
CMS LHC combination of Higgs signal strengths.	23	[11]
Production: $ggF$ , $VBF$ , $ZH$ , $WH$ & $ttH$		
Decay: $\gamma\gamma$ , $ZZ$ , $W^+W^-$ , $\tau^+\tau^-$ , $b\bar{b} \& \mu^+\mu^-$		
CMS stage 1.0 STXS measurements for $H \to \gamma \gamma$ .	13 7	[12]
13 parameter fit   7 parameter fit		
CMS stage 1.0 STXS measurements for $H \to \tau^+ \tau^-$	9	[13]
CMS stage 1.1 STXS measurements for $H \to 4\ell$	19	[14]
CMS differential cross section measurements of inclusive Higgs produc-	5 6	[15]
tion in the $WW^* \to \ell \nu \ell \nu$ final state.		
$\frac{d\sigma}{dn_{\rm jet}} \mid \frac{d\sigma}{dp_H^T}$		
ATLAS $H \to Z\gamma$ signal strength.	1	[16]
ATLAS $H \to \mu^+ \mu^-$ signal strength.	1	[17]

To be added: 2009.04363 CMS 3 $\sigma$  evidence for  $H \rightarrow \mu \mu^-$ 



#### • Top:

Run 2 top	$n_{\mathbf{obs}}$	Ref.
CMS $t\bar{t}$ differential distributions in the dilepton channel.	6	[36,
$\frac{d\sigma}{dm_{\star\bar{\tau}}}$		230]
CMS $t\bar{t}$ differential distributions in the $\ell$ +jets channel.	10	[37]
$\frac{d\sigma}{dm_{+\bar{i}}}$		
ATLAS measurement of differential $t\bar{t}$ charge asymmetry, $A_C(m_{t\bar{t}})$ .	5	[38]
ATLAS $t\bar{t}W$ & $t\bar{t}Z$ cross section measurements. $\sigma_{t\bar{t}W} \sigma_{t\bar{t}Z}$	2	[39]
CMS $t\bar{t}W$ & $t\bar{t}Z$ cross section measurements. $\sigma_{t\bar{t}W}   \sigma_{t\bar{t}Z}$	11	[40]
CMS $t\bar{t}Z$ differential distributions.	4 4	[41]
$\frac{d\sigma}{dp_{T}^{T}}$ $\frac{d\sigma}{d\cos\theta^{*}}$		
CMS measurement of differential cross sections and charge ratios for $t$ -	5 5	[42]
channel single-top quark production.		
$rac{d\sigma}{dp_{t+ ilde{t}}^T} \mid R_t\left(p_{t+ ilde{t}}^T ight)$		
CMS measurement of <i>t</i> -channel single-top and anti-top cross sections.	4	[43]
$\sigma_t,  \sigma_{\bar{t}},  \sigma_{t+\bar{t}} \& R_t.$		
CMS measurement of the $t$ -channel single-top and anti-top cross sections.	1 1 1 1	[44]
$\sigma_t   \sigma_{\bar{t}}   \sigma_{t+\bar{t}}   R_t.$		
CMS $t$ -channel single-top differential distributions.	4 4	[45]
$\left  \frac{d\sigma}{dp_{1+\bar{x}}^T} \right  \left  \frac{d\sigma}{d y_{t+\bar{t}} } \right $		
ATLAS $tW$ cross section measurement.	1	[46]
CMS $tZ$ cross section measurement.	1	[47]
CMS $tW$ cross section measurement.	1	[48]
ATLAS $tZ$ cross section measurement.	1	[49]
CMS $tZ(Z \to \ell^+ \ell^-)$ cross section measurement	1	[50]
ATLAS four-top search in the multi-lepton and same-sign dilepton chan-	1	[51]
nels.		
ATLAS four-top search in the single-lepton and opposite-sign dilepton	1	[52]
channels.		
CMS four-top search in the multi-lepton and same-sign dilepton chan-	1	[53]
nels.		
CMS four-top search in the single-lepton and opposite-sign dilepton	1	[54]
channels.		
CMS $t\bar{t}b\bar{b}$ cross section measurement in the all-jet channel.	1	[55]
CMS $t\bar{t}b\bar{b}$ cross section measurement in the dilepton channel.	1	[56]



## SMEFT fit

- Combine Top, Higgs, diboson, and electroweak data
- Simultaneous linear fit at leading order to **34** operators
- Matched to simplified models at tree-level and one-loop stop example
- Analytical Hessian method and numerical MCMC algorithm
- Easily extendable database and modular capabilities
- Fitmaker public python code to be released

## SMEFT fit

Ellis, Madigan, Mimasu, Sanz, TY [2012.02779]

#### • Fitmaker: modular library of observables and theories

```
"observable group name": "W mass",
"description": "W mass measurements from Tevatron & ATLAS found in 1701.07240 (Fig. 29).",
"observables": [
   "observable_name": "W_mass",
   "measurement name": "W mass Tevatron",
   "arxiv": "1307.7627",
   "CDS": "",
   "reportnumber": "FERMILAB-PUB-13-289-E",
   "DOI": "10.1103/PhysRevD.88.052018",
   "date": "2013/07/29",
   "experiment": " CDF, D0 collaboration(s).",
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     "syst": 0.006
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   "arXiv": "1701.07240"
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    "measurement name": "W mass ATLAS",
   "arxiv": "1701.07240",
   "CDS": "http://cds.cern.ch/record/2242923"
   "reportnumber": "CERN-EP-2016-305",
   "DOI":
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     "10.1140/epjc/s10052-018-6354-3"
   ],
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   "experiment": "CERN LHC experiment. ATLAS collaboration.",
   "description": "Measurement of the $W$-boson mass in pp collisions at $\\sqrt{s}=7$ TeV
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    "uncertainty": {
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     "syst": 0.006
   },
   "experiment": "LHC",
   "arXiv": "1701.07240"
1
"correlation matrix": [
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 [0.0, 1.0]
```

```
"observable_name": "mu_dsig_dptZ_ttZ_13TeV_CMS",
"measurement_name": "mu_dsig_dptZ_ttZ_13TeV_CMS",
"arxiv": "1907.11270",
"CDS": "http://cds.cern.ch/record/2684052",
"reportnumber": "CMS-TOP-18-009",
"DOI": "10.1007/JHEP03(2020)056",
"date": "2019/07/26",
"experiment": "CERN LHC experiment. CMS collaboration.",
"description": "Measurement of top quark pair production in
"value": [1.063, 1.153, 1.11, 0.943],
"uncertainty": {
    "tot": [0.198, 0.171, 0.173, 0.206]
    },
    "uncertainty_sigma": 1,
    "th_flat": true
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"observable": "ggF0j",
"params": [ "CHG", "CuH", "CuG", "CHbox" ],
"constant": 1.0,
"linear": [ 35.8, -0.122, 0.959, -0.121 ],
"quadratic": [
[ 321.0, -1.095, 8.45, -1.085 ],
[ -1.095, 0.00371, -0.02925, 0.003695 ],
[ 8.45, -0.02925, 0.23, -0.0291 ],
[ -1.085, 0.003695, -0.0291, 0.00367 ]
```

```
],
"lambda_gen": 1000.0
```

## SMEFT fit

Ellis, Madigan, Mimasu, Sanz, TY [2012.02779]

• Fitmaker: modular library of observables and theories

```
1 #import fitmaker
 2 from fitmaker.fitlib.fitter import FitterChiSquare
 3 from fitmaker.theories.SMEFT fit full import SMEFT as SMEFT full
 4
 5 #Load observables
 6 odir = '../fitmaker/observables/'
 7
 8 EWPO data = ObsGroup({'observable group name':"EWPO data", 'description':"Z pole & W mass data"})
 9 EWPO data.add obs(
10
    ObsGroup.init_from_json(odir+'EWPO/Zpole.json'),
11
     ObsGroup.init_from_json(odir+'EWPO/Wmass.json')
12)
13
14 Diboson_data = ObsGroup({'observable_group_name': "Diboson_data", 'description': "LEP & LHC Diboson data"})
15 Diboson data.add obs(
16
       ObsGroup.init_from_json(odir+'Diboson/LEP2_Diboson.json'),
       Obs.init from json(odir+'Diboson/fidmu WW enumunu ptl ATLAS13.json')
17
18 )
19
20 |Higgs_data = ObsGroup({'observable_group_name':"Higgs_data", 'description':"Updated Higgs signal strength and STXS data'
21 Higgs data.add obs(
       ObsGroup.init_from_json(odir + 'Higgs/Run_1/LHC_Run1_Higgs_SignalStrengths.json'),
22
23
       ObsGroup.init from json(odir + 'Higgs/new/CMS Run2 Higgs SignalStrengths.json'),
24
       ObsGroup.init from json(odir+'Higgs/new ATLAS/ATLAS STXS fine/ATLAS Run2 STXS1p0 H ZZ 41 comb.json')
25)
26
27 EWPO Diboson Higgs data = ObsGroup({'observable group name': "EWPO Diboson Higgs data", 'description': "EWPO, Diboson & Hi
28 EWPO Diboson Higgs data.add obs(
     EWPO data,
29
30
     Diboson data,
31
     Higgs data
32 )
33
34 #Load fit
35 fitter U3 5 = FitterAnalyticalChiSquare(
36
       arg obsgroup = EWPO Diboson Higgs data,
37
       arg theory = SMEFT U3 5,
38
        arg theorykwargs = { 'Lambda':1000. }
39)
40
41 #Get fit results
42 marg_bestfitc_list_U3_5 = [fitter_U3_5.get_bestfit(c,marginalise=True)[0] for c in coeffs_U3_5]
43 marg_sd_list_U3_5 = [fitter_U3_5.standard_deviation(c, marginalise=True) for c in coeffs_U3_5]
44
45
```

• Keep only linear coefficient dependence

$$\mu_X \equiv \frac{\Lambda}{X_{SM}} = 1 + \sum_i \frac{a_i^X C_i}{\Lambda^2} + \mathcal{O}\left(\frac{V}{\Lambda^4}\right)$$

C

11

- (For each observable X, normalised such that largest  $a_i^X = 1$ )
- EWPO:



 $\mathbf{v}$ 



• Diboson



Tevong You

• Higgs signal strengths



**Tevong You** 





• Higgs STXS



$$u_X \equiv \frac{X}{X_{SM}} = 1 + \sum_i \frac{a_i^X}{\Lambda^2} + \mathcal{O}\left(\frac{1}{\Lambda^4}\right)$$



• Higgs STXS







## Impact of measurements

• Individual 95% CL bounds switching on one operator at a time



• Which observables constrain which operators the most?
• Individual 95% CL bounds switching on one operator at a time



• Individual 95% CL bounds switching on one operator at a time



#### • Individual 95% CL bounds switching on one operator at a time





#### Tevong You

# Impact of measurements



• Individual 95% CL bounds switching on one operator at a time



- Individual bounds hardly affected by STXS
- Impact on marginalised constraints

#### Tevong You

# Impact of measurements

• Marginalised 95% CL bounds allowing all **20** operators to vary



#### Tevong You

# Impact of measurements

• Marginalised 95% CL bounds allowing all 34 operators to vary



• Which observables constrain which directions in marginalised fit?

- Which observables constrain which directions in marginalised fit?
- Principal component analysis: eigenvectors of covariance matrix



**Tevong You** 

Relative constraining power (%)

- Which observables constrain which directions in marginalised fit?
- Principal component analysis: eigenvectors of covariance matrix





**Tevong You** 

- Which observables constrain which directions in marginalised fit?
- Principal component analysis: eigenvectors of covariance matrix





**Tevong You** 

- Higgs and Top complementarity:
- Fit to  $\{C_{H\Box}, C_{HG}, C_{HW}, C_{HB}, C_{tH}, C_{bH}, C_{\tau H}, C_{\mu H} C_G \text{ and } C_{tG}\}$



• 2-D fits and marginalised over full fit



#### • Simplified models: renormalisable SM extensions

Name	Spin	SU(3)	SU(2)	U(1)	Name	Spin	SU(3)	SU(2)	U(1)
S	0	1	1	0	$\Delta_1$	$\frac{1}{2}$	1	2	$-\frac{1}{2}$
$S_1$	0	1	1	1	$\Delta_3$	$\frac{1}{2}$	1	2	$-\frac{1}{2}$
$\varphi$	0	1	2	$\frac{1}{2}$	Σ	$\frac{1}{2}$	1	3	0
[I]	0	1	3	0	$\Sigma_1$	$\frac{1}{2}$	1	3	-1
$\Xi_1$	0	1	3	1	U	$\frac{1}{2}$	3	1	$\frac{2}{3}$
B	1	1	1	0	D	$\frac{1}{2}$	3	1	$-\frac{1}{3}$
$B_1$	1	1	1	1	$Q_1$	$\frac{1}{2}$	3	2	$\frac{1}{6}$
W	1	1	3	0	$Q_5$	$\frac{1}{2}$	3	2	$-\frac{5}{6}$
$W_1$	1	1	3	1	$Q_7$	$\frac{1}{2}$	3	2	$\frac{7}{6}$
N	$\frac{1}{2}$	1	1	0	$T_1$	$\frac{1}{2}$	3	3	$-\frac{1}{3}$
E	$\frac{1}{2}$	1	1	-1	$T_2$	$\frac{1}{2}$	3	3	$\frac{2}{3}$
T	$\frac{1}{2}$	3	1	$\frac{2}{3}$	TB	$\frac{1}{2}$	3	2	$\frac{1}{6}$

Model	$C_{HD}$	$C_{ll}$	$C_{Hl}^3$	$C_{Hl}^1$	$C_{He}$	$C_{H\square}$	$C_{\tau H}$	$C_{tH}$	$C_{bH}$
S						-1			
$S_1$		1							
Σ			$\frac{5}{8}$	$\frac{3}{16}$			$\frac{y_{\tau}}{4}$		
$\Sigma_1$			$-\frac{5}{8}$	$-\frac{3}{16}$			$\frac{y_{\tau}}{8}$		
N			$-\frac{1}{4}$	$\frac{1}{4}$					
E			$-\frac{1}{4}$	$-\frac{1}{4}$			$\frac{y_{\tau}}{2}$		
$\Delta_1$					$\frac{1}{2}$		$\frac{y_{\tau}}{2}$		
$\Delta_3$					$-\frac{1}{2}$		$\frac{y_{\tau}}{2}$		
$B_1$	1					$-\frac{1}{2}$	$-\frac{y_{\tau}}{2}$	$-\frac{y_t}{2}$	$-\frac{y_b}{2}$
Ξ	-2					$\frac{1}{2}$	$y_{\tau}$	$y_t$	$y_b$
$W_1$	$-\frac{1}{4}$					$-\frac{1}{8}$	$-\frac{y_{\tau}}{8}$	$-\frac{y_t}{8}$	$-\frac{y_b}{8}$
$\varphi$							$-y_{\tau}$	$-y_t$	$-y_b$
$\{B, B_1\}$						1	$y_{\tau}$	$y_t$	$y_b$
$\{Q_1, Q_7\}$								$y_t$	
Model	$C_{HG}$	$C^3_{Hq}$	$C^1_{Hq}$	$(C^3_{Hq})_{33}$	$(C^{1}_{Hq})_{33}$	$C_{Hu}$	$C_{Hd}$	$C_{tH}$	$C_{bH}$
U		$-\frac{1}{4}$	$\frac{1}{4}$	$-\frac{1}{4}$	$\frac{1}{4}$			$\frac{y_t}{2}$	
D		$-\frac{1}{4}$	$-\frac{1}{4}$	$-\frac{1}{4}$	$-\frac{1}{4}$				$\frac{y_b}{2}$
$Q_5$							$-\frac{1}{2}$		$\frac{y_b}{2}$
$Q_7$						$\frac{1}{2}$		$\frac{y_t}{2}$	
$T_1$		$-\frac{5}{8}$	$-\frac{3}{16}$	$-\frac{5}{8}$	$-\frac{3}{16}$			$\frac{y_t}{4}$	$\frac{y_b}{8}$
$T_2$		$-\frac{5}{8}$	$\frac{3}{16}$	$-\frac{5}{8}$	$\frac{3}{16}$			$\frac{y_t}{8}$	$\frac{y_b}{4}$
T	$-\frac{M_T^2}{v^2}\frac{\alpha_s(0.02)}{8\pi}$			$-\frac{1}{2}\frac{M_T^2}{v^2}$	$\frac{1}{2} \frac{M_T^2}{v^2}$			$y_t \frac{M_T^2}{v^2}$	

• Classification and tree-level matching dictionary

De Blas, Criado, Perez-Victoria, Santiago [1711.10391]

• Streamlines process of interpreting limits on BSM parameter space



#### • Streamlines process of interpreting limits on BSM parameter space





• Systematic search for pulls in all N parameter combinations of operators



• Are we seeing the appearance of non-zero Wilson coefficients in SMEFT four-fermion operators?

• Anomalies in charged ( $B \rightarrow D^{(*)} \mu \nu$ ) and neutral ( $B \rightarrow K^{(*)} \mu^+ \mu^-$ ) current B decays



• Focus on **neutral current** B decays

• Anomalies in charged ( $B \rightarrow D^{(*)}\mu\nu$ ) and neutral ( $B \rightarrow K^{(*)}\mu^+\mu^-$ ) current B decays



• Focus on neutral current B decays

- Anomalies in processes involving  $b \rightarrow s \mu^+ \mu^-$  transitions:
- LHCb **3.4**  $\sigma$  in **P5' angular distribution** of  $B \rightarrow K^* \mu^+ \mu^-$  (**2**  $\sigma$  for Belle)
- Various other kinematic observables in  $b \rightarrow s \ \mu^+\mu^-$
- **3.2**  $\sigma$  in  $B_s \rightarrow \varphi \ \mu^+ \mu^-$
- ⇒~4 σ non-zero Wilson coefficient in global fit to these "messy" observables
- **2.5**  $\sigma$  in *"clean"* observable  $R_K$
- **2.5**  $\sigma$  in *"clean"* observable  $R_K^*$
- $\Rightarrow$  ~4  $\sigma$  non-zero Wilson coefficient in combined fit to just these two clean observables
- Consistency of all these various anomalies is non-trivial

 Points towards new physics parametrised by a fourfermion effective operator



## Historical Aside

• Fermi theory of radioactive beta decay:



• Underlying new physics ⇒ **electroweak gauge bosons** 



# New physics behind B anomalies?

• Z' or leptoquarks (at tree-level)



# Motivation for future colliders

• Can we *definitely* discover directly the source of the anomalies at higher energies?

80 TeV unitarity limit = no general no-lose theorem at FCC-hh (Di Luzio, Nardecchia [1706.01868])

• Consider sensitivity to most **pessimistic** scenario: only include **minimal couplings** required to explain  $b \rightarrow s\mu^+\mu^-$  anomalies



• More realistic models will typically be *easier* to discover

 $u^+$ 

# Z' Sensitivity

• Extrapolate current 13 TeV di-muon search:



 $u^+$ 

# Z' Sensitivity

• Extrapolate current 13 TeV di-muon search:



 $\cdot \mu^+$ 

# Z' Sensitivity

• Extrapolate current 13 TeV di-muon search:



 $\mu^+$ 

# Z' Sensitivity

• Extrapolate current 13 TeV di-muon search:



# Z' Sensitivity

• Extrapolate current 13 TeV di-muon search:



• Actual limits depend on Z' couplings in signal x-section

 $\mu^+$ 

# Z' Sensitivity

• Extrapolate current 13 TeV di-muon search:



• 100 TeV can cover almost **all** (narrow width) parameter space of most *pessimistic* scenario

 $\mu^+$ 

# Z' Sensitivity

#### • Extrapolate current 13 TeV di-muon search:



• 100 TeV can cover almost **all** (narrow width) parameter space of most *pessimistic* scenario

# Z' Sensitivity

• Improved MC study including **large widths** and **two benchmark flavour scenarios**:



9000

# Leptoquark Sensitivity

• Extrapolate current 8 TeV LQ di-muon+di-jet search: grow JQ



- Pair production for scalar LQ depends only on QCD coupling
- Upper limit from Bs mixing constraint

9000

d'alla

# Leptoquark Sensitivity

• Extrapolate current 8 TeV LQ di-muon+di-jet search: g and g



- Pair production for scalar LQ depends only on QCD coupling
- Upper limit from Bs mixing constraint

# Leptoquark single production







# Take-home message

- **First studies** of **direct search** potential for source of B anomalies at future colliders
- Points to **accessible scale** of new physics
- Await LHCb Run 2 update and Belle II...
- Even if anomalies vanish, motivates interplay between **direct** discovery potential of future hadron colliders and **indirect** sensitivity from precision physics

#### Conclusion

- QED+Fermi theory  $\rightarrow$  chiral electroweak+pion EFT
- Chiral electroweak EFT+Higgs  $\rightarrow$  SM
- SM  $\rightarrow$  SMEFT
- SMEFT  $\rightarrow$  ?
- More data needed
## Conclusion

• "What would be the use of such extreme refinement in the science of measurement? [...] The more important fundamental laws and facts of physical science have all been discovered, and these are so firmly established that the possibility of their ever being supplanted in consequence of new discoveries is exceedingly remote. [...]"

–A. Michelson 1903

## Conclusion

 "What would be the use of such extreme refinement in the science of measurement? Very briefly and in general terms the answer would be that in this direction the greater part of all future discovery must lie. The more important fundamental laws and facts of physical science have all been discovered, and these are so firmly established that the possibility of their ever being supplanted in consequence of new discoveries is exceedingly remote. Nevertheless, it has been found that there are apparent exceptions to most of these laws, and this is particularly true when the observations are pushed to a limit, i.e., whenever the circumstances of experiment are such that extreme cases can be examined."

–A. Michelson 1903

• Keep pushing to examine extreme cases across *all frontiers* of fundamental physics