BSM Higgs Flavoured Correlations

by **Arturo de Giorgi (Madrid, IFT)**

based on **2109.07490** - *JHEP* 05 (2022)

in collaboration with J. Alonso-Gonzalez (Madrid, IFT), L. Merlo (Madrid, IFT), S. Pokorski (Warsaw U.)

Contribution to: *LHC Higgs Working Group - Common WG2 and WG3 - CP violation and Higgs Sector*

June 23, 2022

UAM

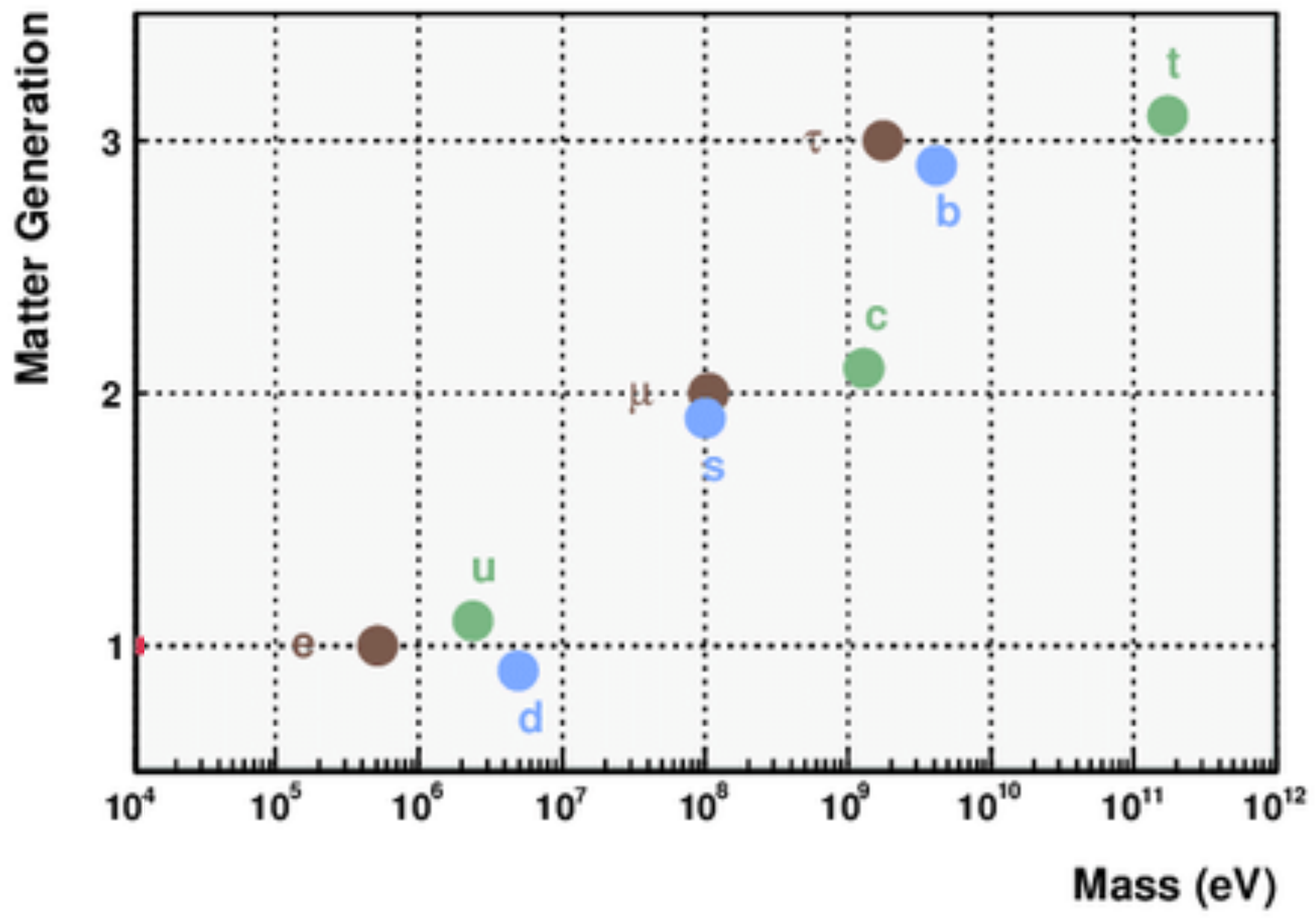
ift Instituto de Física Teórica UAM-CSIC

HIDDeν
Hunting Invisibles: Dark sectors, Dark matter and Neutrinos

Motivation

1. **SM Flavour-puzzle**: lack of explanation for masses **hierarchy** in the SM

$\Longrightarrow$ is there a deeper **underlying theory**? What would its **consequences** imply?



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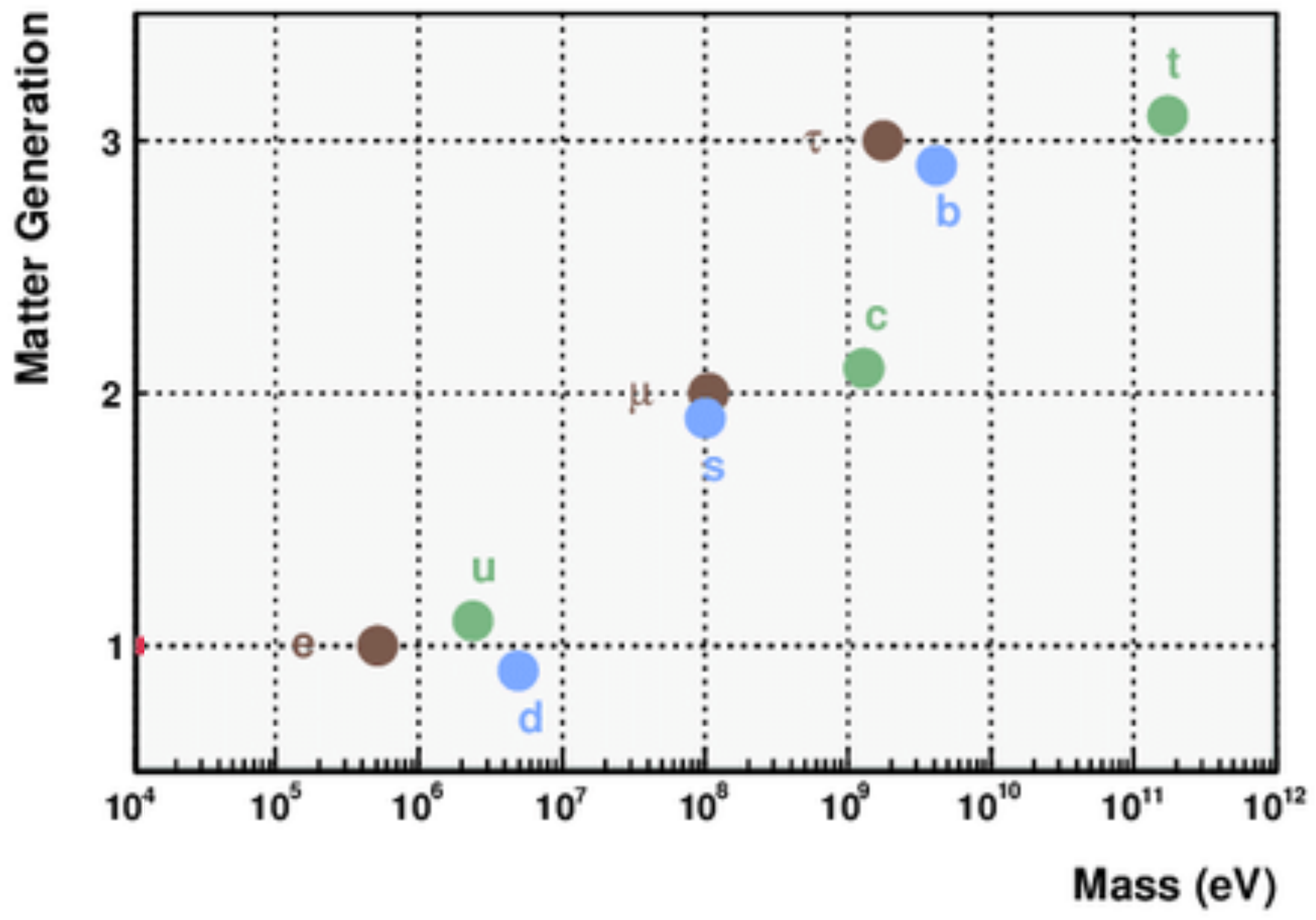
No ν in this talk!



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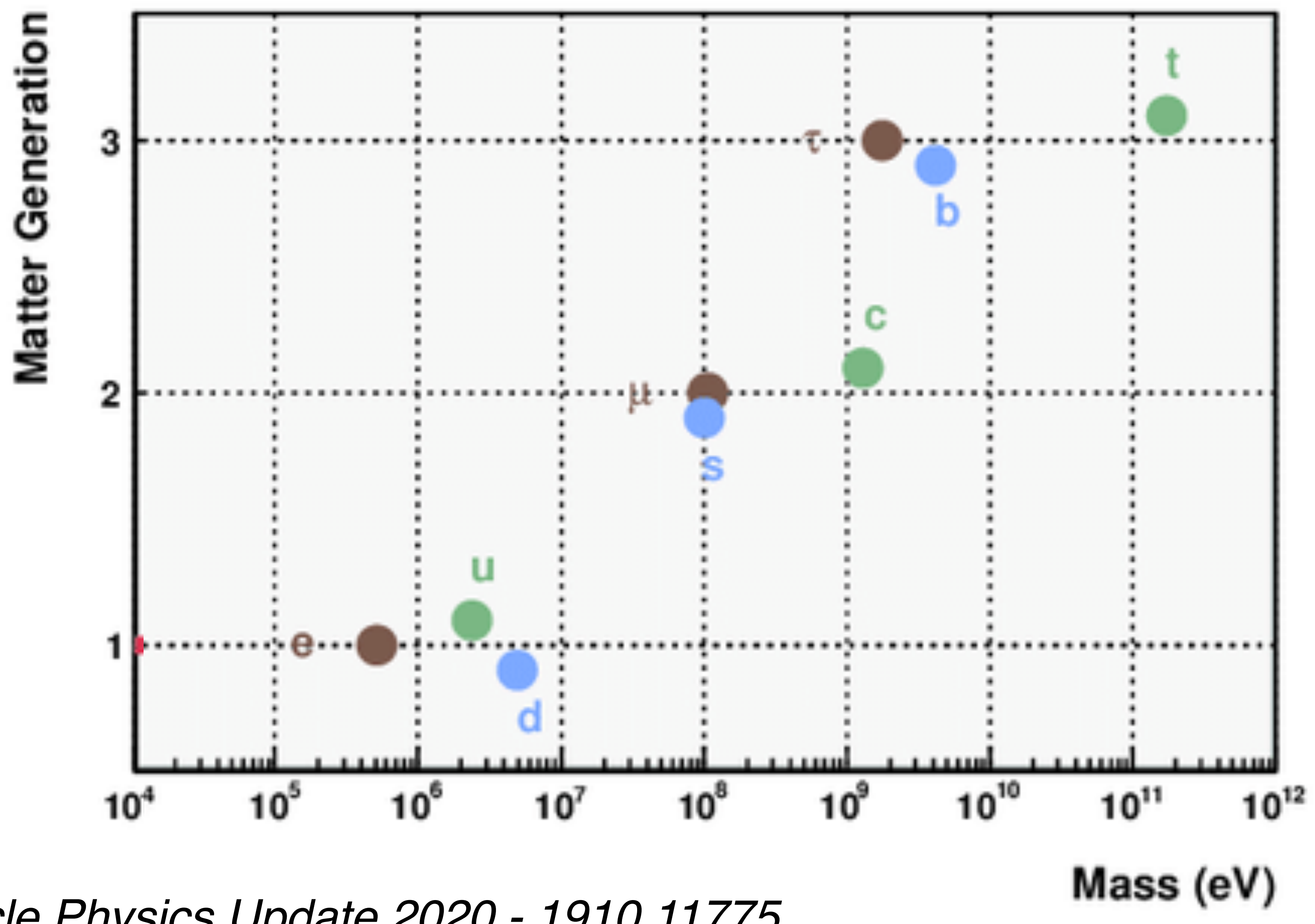

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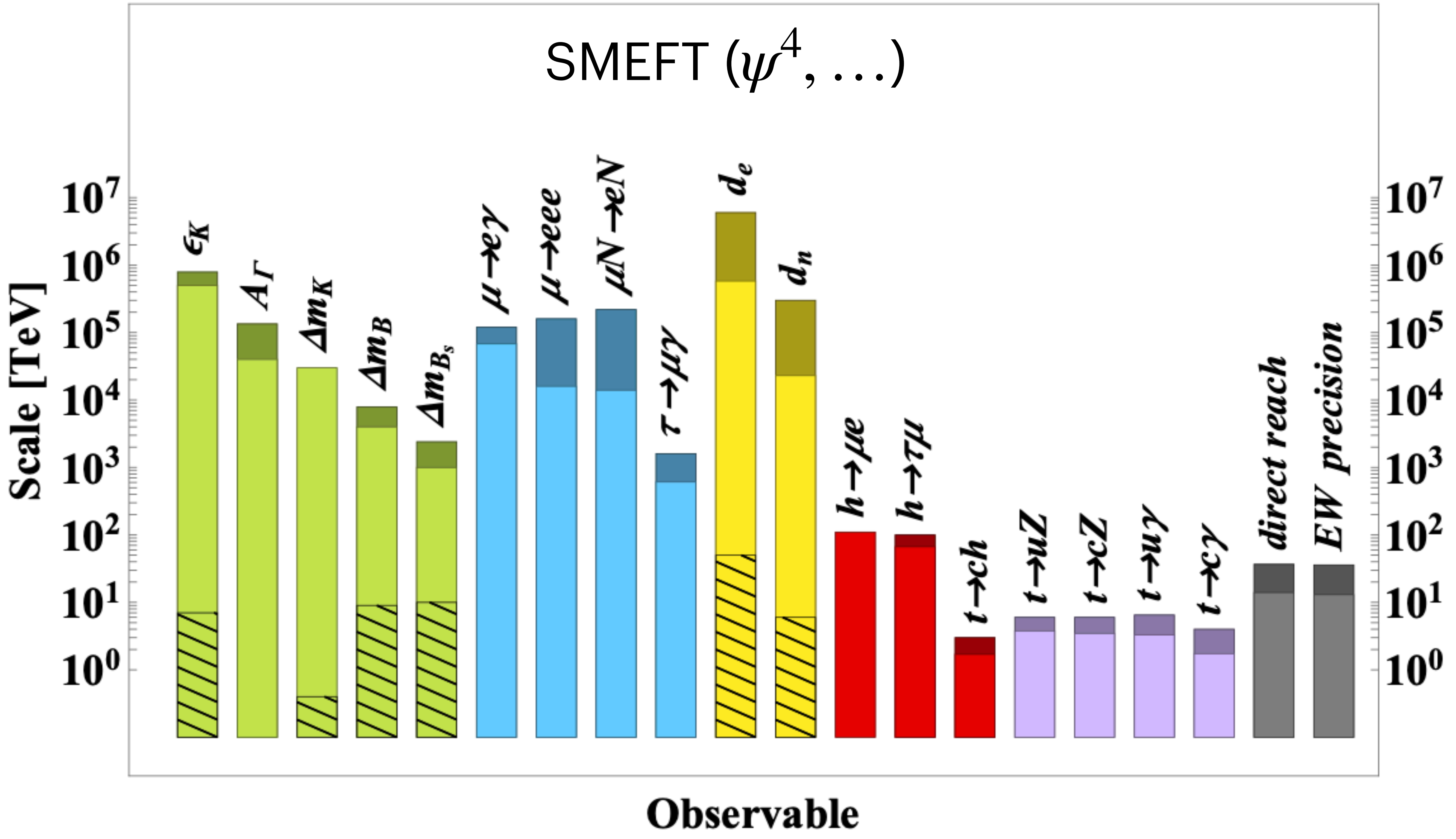
Input for the European Strategy for Particle Physics Update 2020 - 1910.11775



2. Many different experimental **searches** probing different types of physics at different energy scales

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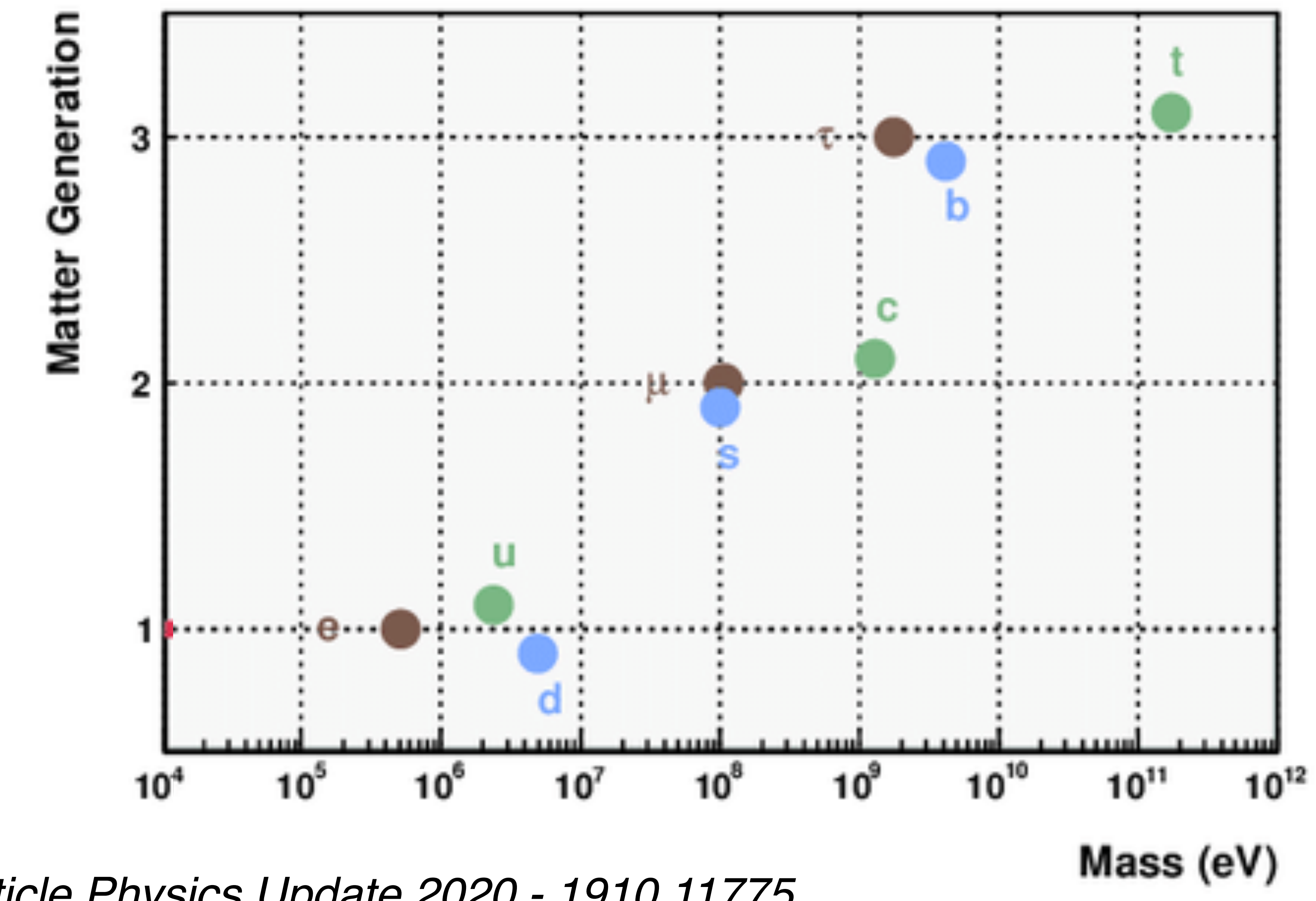

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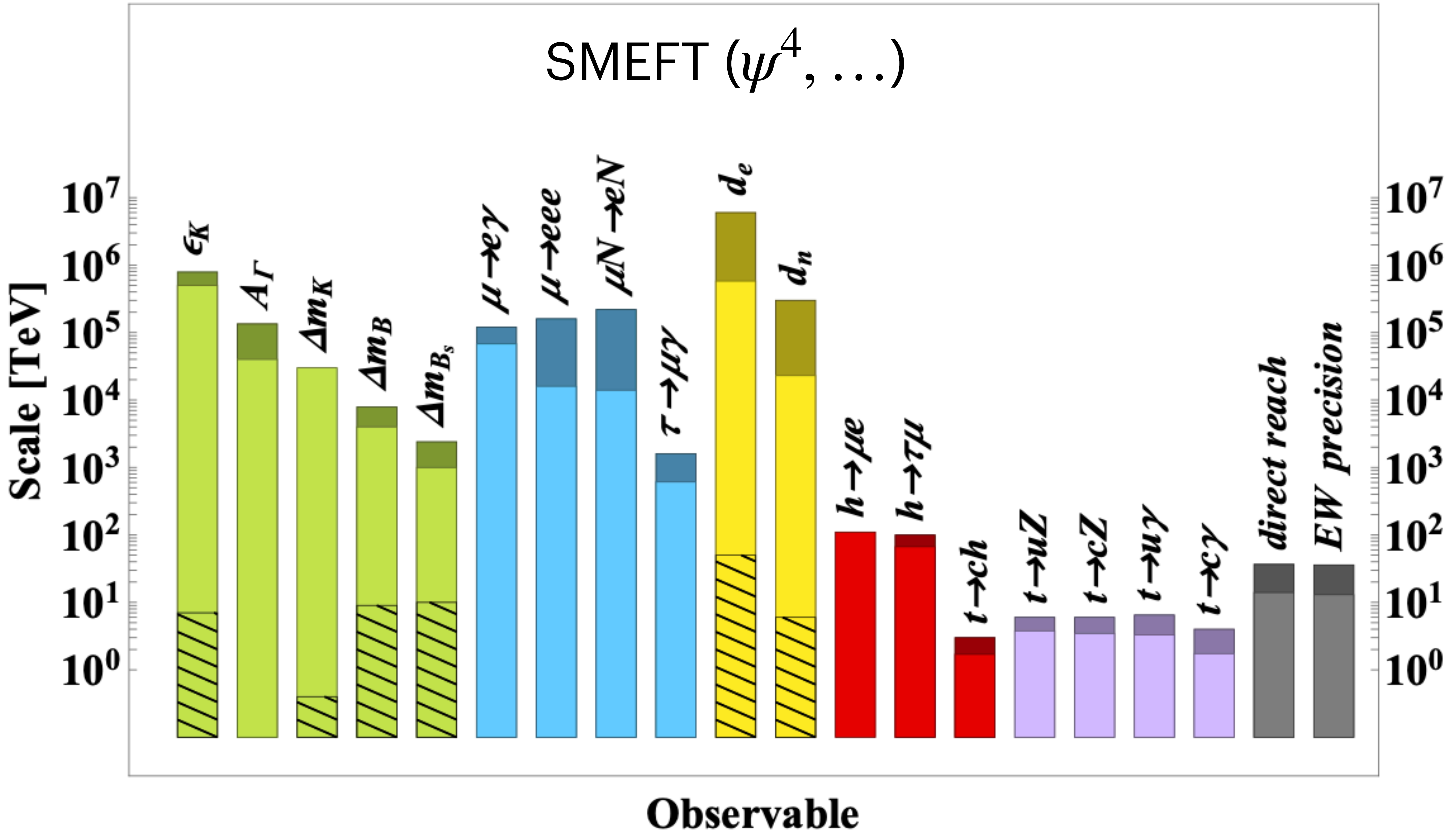

Let's be transparent!

Focus on Higgs (FV) couplings:
"**Proof of Principle**"

<u>Conclusions can be generalised!</u>

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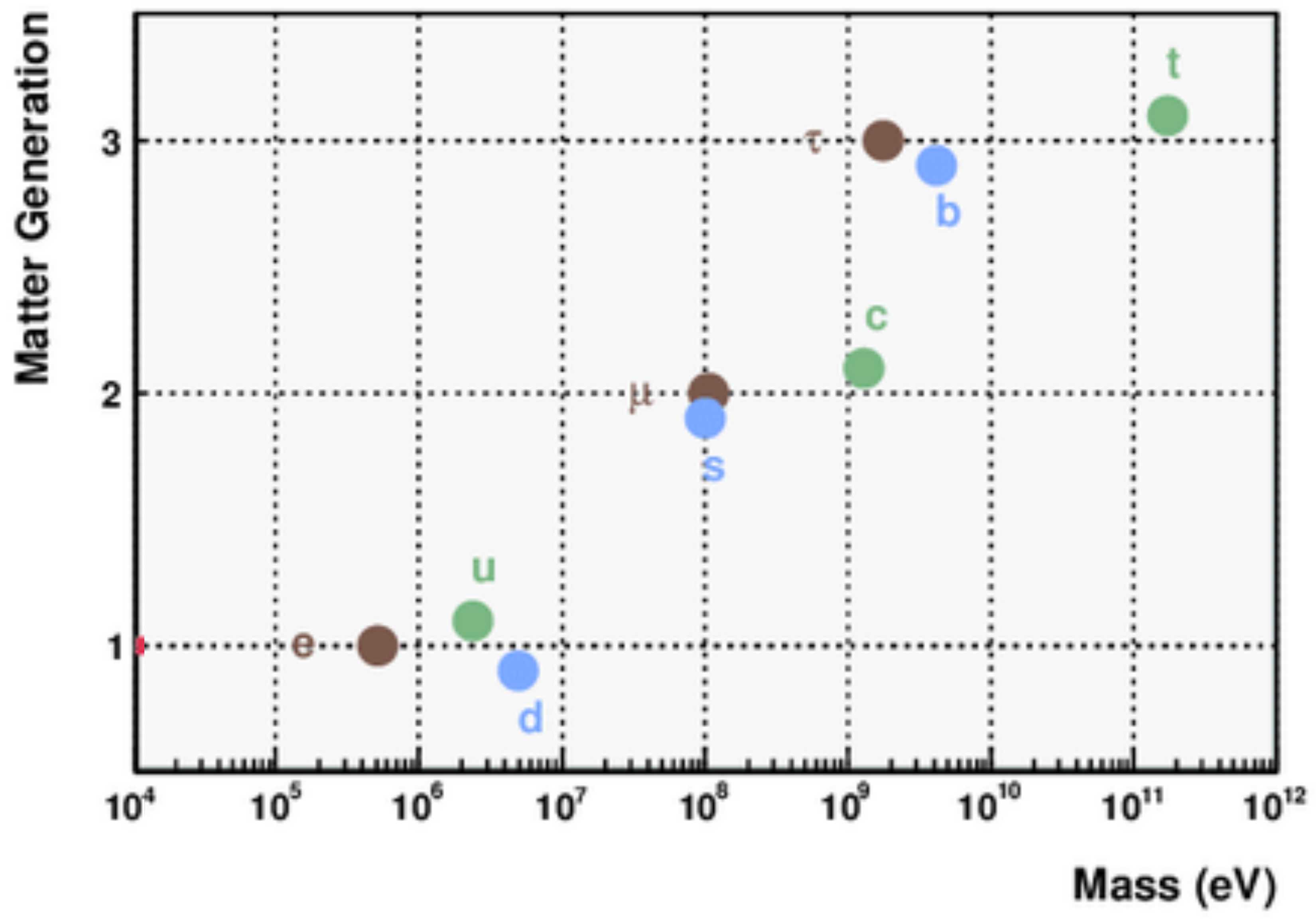

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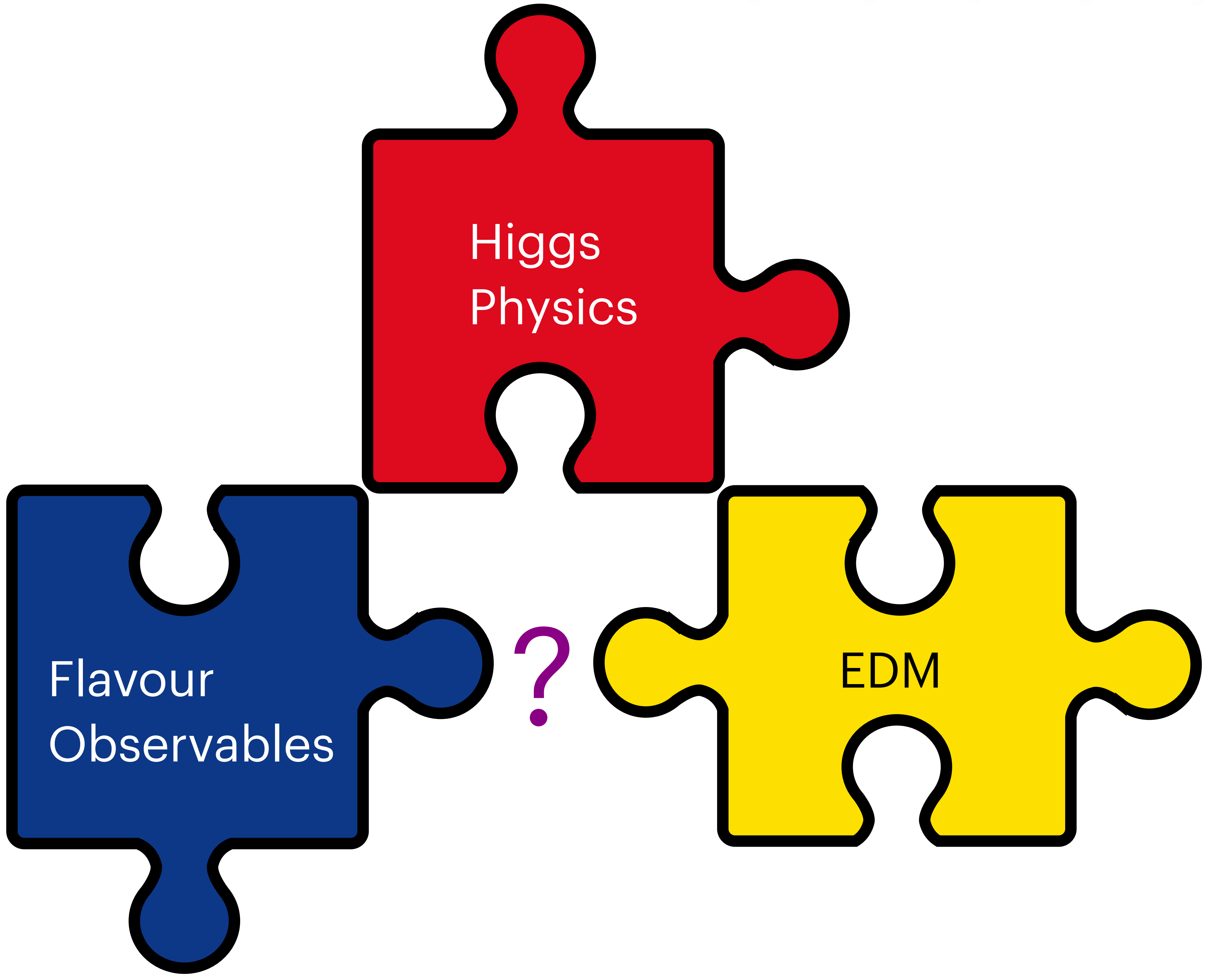

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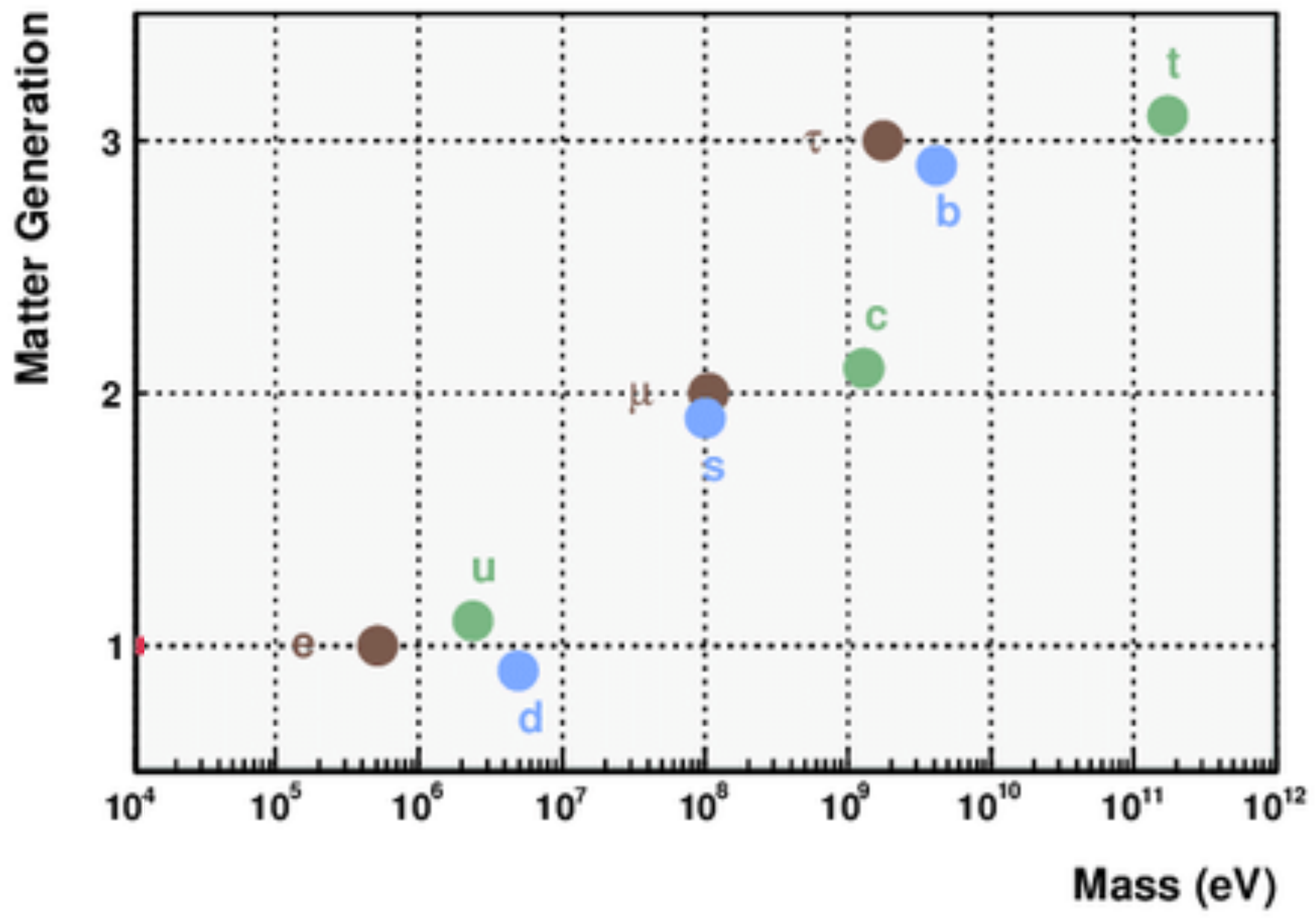

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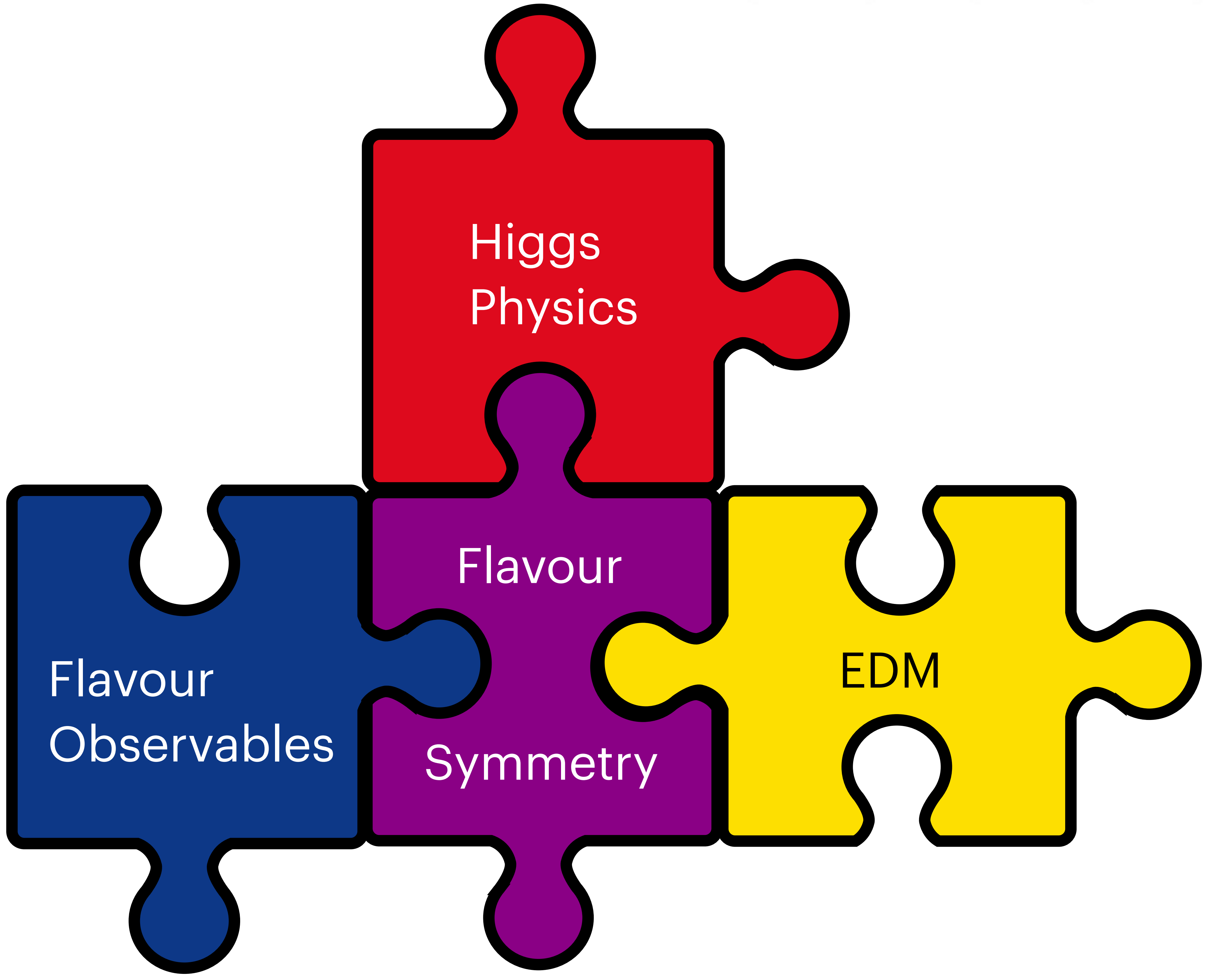
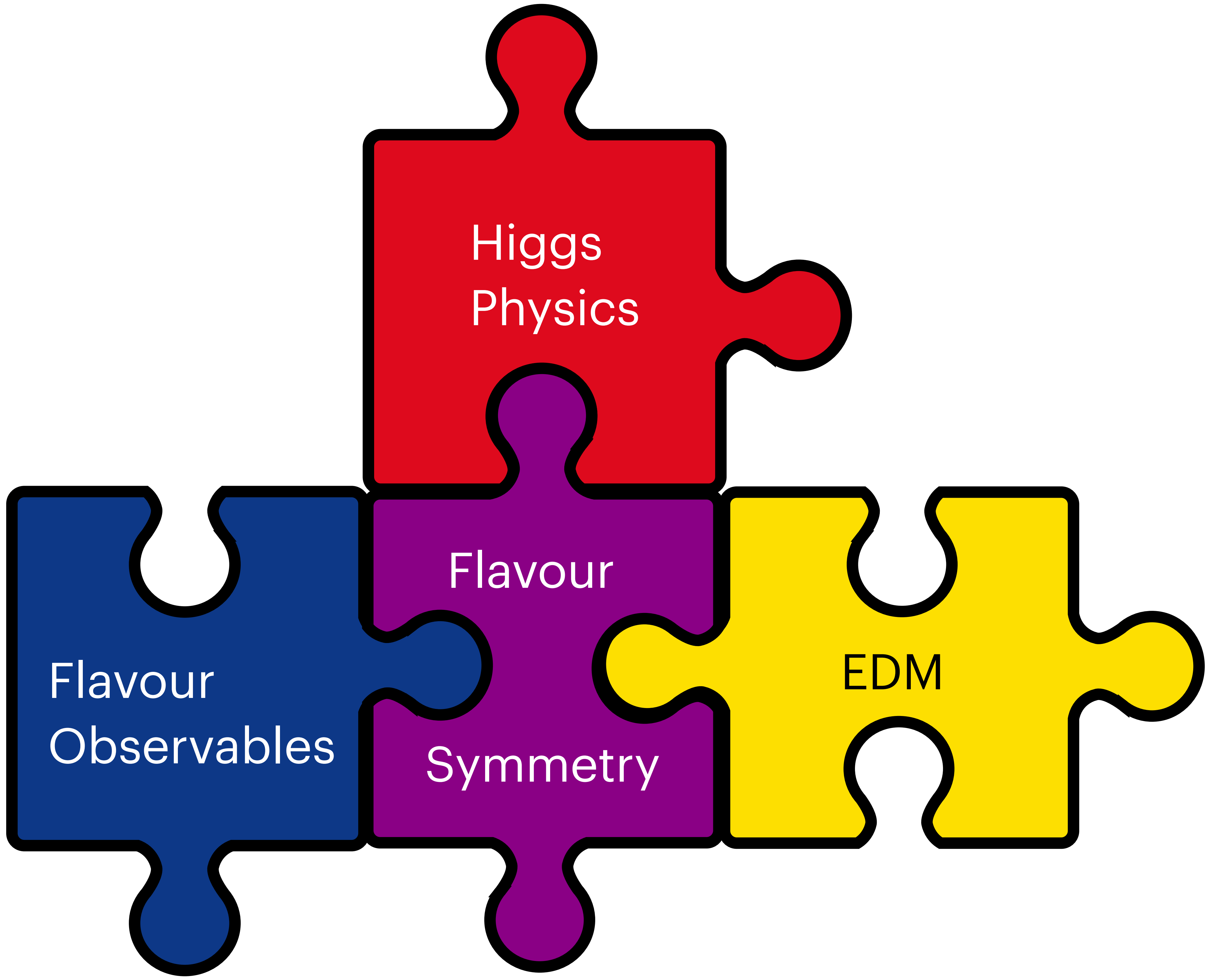


Outlook

A. **Theoretical Framework**
B. **Flavour-Symmetries**
   1. Minimal Flavour Violation
   2. Froggatt-Nielsen
C. **Searches & Consequences**
   1. Higgs Physics
   2. EDM
   3. Flavour Observables
D. **Synergy & Prospects**



Theoretical Framework

- Assuming NP can be described within the **SMEFT**, there is just one type of **dimension-6 operator** contributing to the modification of the **Yukawa interactions**:

$$\mathcal{L} \supset -\bar{F}'_L Y'_f \overset{(\sim)}{H} f'_R - \bar{F}'_L C'_f \overset{(\sim)}{H} f'_R \frac{H^\dagger H}{\Lambda_f^2} + \text{h.c.} \xrightarrow[\text{+ Mass Basis}]{\text{EWSB}} \mathcal{L} \supset -\bar{f}_L Y_f f_R \frac{v}{\sqrt{2}} - \bar{f}_L \left(Y_f + \frac{v^2}{\Lambda_f^2} C_f \right) f_R \frac{h}{\sqrt{2}} + \text{h.c.}$$

Notice that in principle the **NP scale** Λ can be **different** in the quark and lepton sector!

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EWSB → **+ Mass Basis**

$$\mathcal{L} \subset -\bar{f}_L Y_f f_R \frac{v}{\sqrt{2}} - \bar{f}_L \left(Y_f + \frac{v^2}{\Lambda_f^2} C_f \right) f_R \frac{h}{\sqrt{2}} + \text{h.c.}$$

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- Parametrize **deviations**:

Effective Yukawa:

$$\hat{Y}_f \equiv Y_f + \frac{v^2}{\Lambda^2} C_f$$

Phenomenological Lagrangian:

$$\mathcal{L}_{\text{eff.}} = \frac{y_{ffh}^{\text{SM}}}{\sqrt{2}} \left(\kappa_f \bar{f} f + \tilde{\kappa} \bar{f} i \gamma_5 f \right) h \qquad \text{SM: } \kappa_f = 1 \ , \ \tilde{\kappa}_f = 0$$

Deviation Parameter:

$$r_f^2 \equiv \frac{|\hat{y}_{ffh}|^2}{|y_{ffh}^{\text{SM}}|^2} = \frac{v^2 |\hat{y}_{ffh}|^2}{2 m_f^2} = \kappa_f^2 + \tilde{\kappa}_f^2$$

M. E. Peskin (1312.4974)

Handbook of LHC Higgs Cross Sections: 3. Higgs Properties (1307.1347)

G. D'Ambrosio, G.F. Giudice, G. Isidori, A. Strumia (0207036)

A Flavour Model (1/2)

Minimal Flavour Violation

The Model

- **SM**: accidental symmetry $U(3)^5 = U(3)^3_q$ x $U(3)^2_l$ broken solely by Yukawas
- **MFV**: the only source of flavour and CP-violation in the SM comes from the Yukawas

- The Yukawas are promoted to **spurion fields** transforming as bi-triplets of the flavour symmetry

$\Longrightarrow$ **all** higher dimensional flavour-violating operators must be **controlled by Yukawas**!

Consequences

$$\mathcal{L} \subset - \bar{F}'_L C'_f \overset{(\sim)}{H} f'_R \frac{H^\dagger H}{\Lambda_f^2} + \text{h.c.}$$

$$C'_f = c'_f Y'_f$$

No flavour-violating terms!
Only one c'_f for each fermion sector!

C.D.Froggatt, H.B.Nielsen (1979)

A Flavour Model (2/2)

Froggatt-Nielsen

The Model

- New $U(1)$ **symmetry** and **SM-*singlet* scalar field** ϕ (conventionally, with charge $n_\phi = -1$)
- **Fermions** and ϕ **transform** under the new symmetry and the Yukawa terms are made invariant adding powers of ϕ/Λ_F

$$\mathcal{L} \subset -\left[y'_{f,ij} \bar{F}'_{i,L} \overset{(\sim)}{H} f'_{j,R} + c'_{f,ij} \bar{F}'_L \overset{(\sim)}{H} f'_R \frac{H^\dagger H}{\Lambda_f^2} \right] \left(\frac{\phi}{\Lambda_F} \right)^{n_{F_i}+n_{f_j}} + \text{h.c.}$$

Consequences

- Once the ϕ takes **VEV**, each term is **suppressed** by powers of $\epsilon \equiv \langle \phi \rangle / \Lambda_F$

$$Y_f = \text{diag}\left(y_{f_1} \epsilon^{n_{F_1}+n_{f_1}}, y_{f_2} \epsilon^{n_{F_2}+n_{f_2}}, y_{f_3} \epsilon^{n_{F_3}+n_{f_3}} \right) \qquad C_{f,ij} \approx \mathcal{O}(1) \epsilon^{n_{F_i}+n_{f_j}} e^{i\theta_{f,ij}}$$

Incomplete list of authors: G. Altarelli, F. Feruglio, N. Haba, I. Masina, D. Meloni, L. Merlo, H. Murayama, …

FN: Benchmarks

- **Free parameters**: singlet **vev**, the fermion **charges** and the **phases**

$\Longrightarrow$ we can **trade** the **right-field charges** to the **masses** but we are still left with quite some **freedom**!

- The conclusions are **fairly independent** of the **charges** assignation, while **phases** can play a **mayor role**!
- We consider a specific scenario for quarks and three possibilities for leptons

$$\epsilon \equiv \langle \phi \rangle / \Lambda_F = 0.23$$

Quarks	Q'_L	u'_R	d'_R
	$(2,1,0)$	$(5,2,0)$	$(5,4,2)$

Leptons	L'_L	e'_R
Anarchy (A)	$(0,0,0)$	$(10,5,3)$
$\mu\tau$-Anarchy $(A_{\mu\tau})$	$(1,0,0)$	$(9,5,3)$
Hierarchy (H)	$(2,1,0)$	$(8,4,3)$

ATTENTION!

The **phases** are **not fixed** at all and can have **major impact** on the constraints!

Flavour Symmetry at Work

- **Deviations** in each sector are **related**!

$$Y_f K_f = Y_f + \frac{v^2}{\Lambda^2}\texttt{diag}(\texttt{Re}C_f)\,, \qquad Y_f \tilde{K}_f = \frac{v^2}{\Lambda^2}\texttt{diag}(\texttt{Im}C_f)$$

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$$C'_f = c'_f Y'_f$$

$$\kappa_{f_1} = \kappa_{f_2} = \kappa_{f_3} = 1 + \frac{v^2}{\Lambda_f^2}\,\mathrm{Re}\, c'_f$$

$$\tilde{\kappa}_{f_1} = \tilde{\kappa}_{f_2} = \tilde{\kappa}_{f_3} = \frac{v^2}{\Lambda_f^2}\,\mathrm{Im}\, c'_f$$

$$r_f^2 = 1 + \frac{v^4}{\Lambda_f^4}|c'_f|^2 + 2\frac{v^2}{\Lambda_f^2}\,\mathrm{Re}\, c'_f$$

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Froggatt-Nielsen

$$C_{f,ij} \approx \mathcal{O}(1)\epsilon^{n_{F_i}+n_{f_j}}e^{i\theta_{f,ij}}$$

$$K_f = 1 + \frac{v^2}{\Lambda^2}\mathtt{diag}\left(\mathcal{O}(1)\cos\theta_{f,11},\, \mathcal{O}(1)\cos\theta_{f,22},\, \mathcal{O}(1)\cos\theta_{f,33}\right)\,,$$

$$\tilde{K}_f = \frac{v^2}{\Lambda^2}\mathtt{diag}\left(\mathcal{O}(1)\sin\theta_{f,11},\, \mathcal{O}(1)\sin\theta_{f,22},\, \mathcal{O}(1)\sin\theta_{f,33}\right)\,,$$

$$r_f^2 \simeq 1 + \mathcal{O}(1)^2\frac{v^4}{\Lambda^4} + 2\mathcal{O}(1)\frac{v^2}{\Lambda^2}\cos\theta_f$$

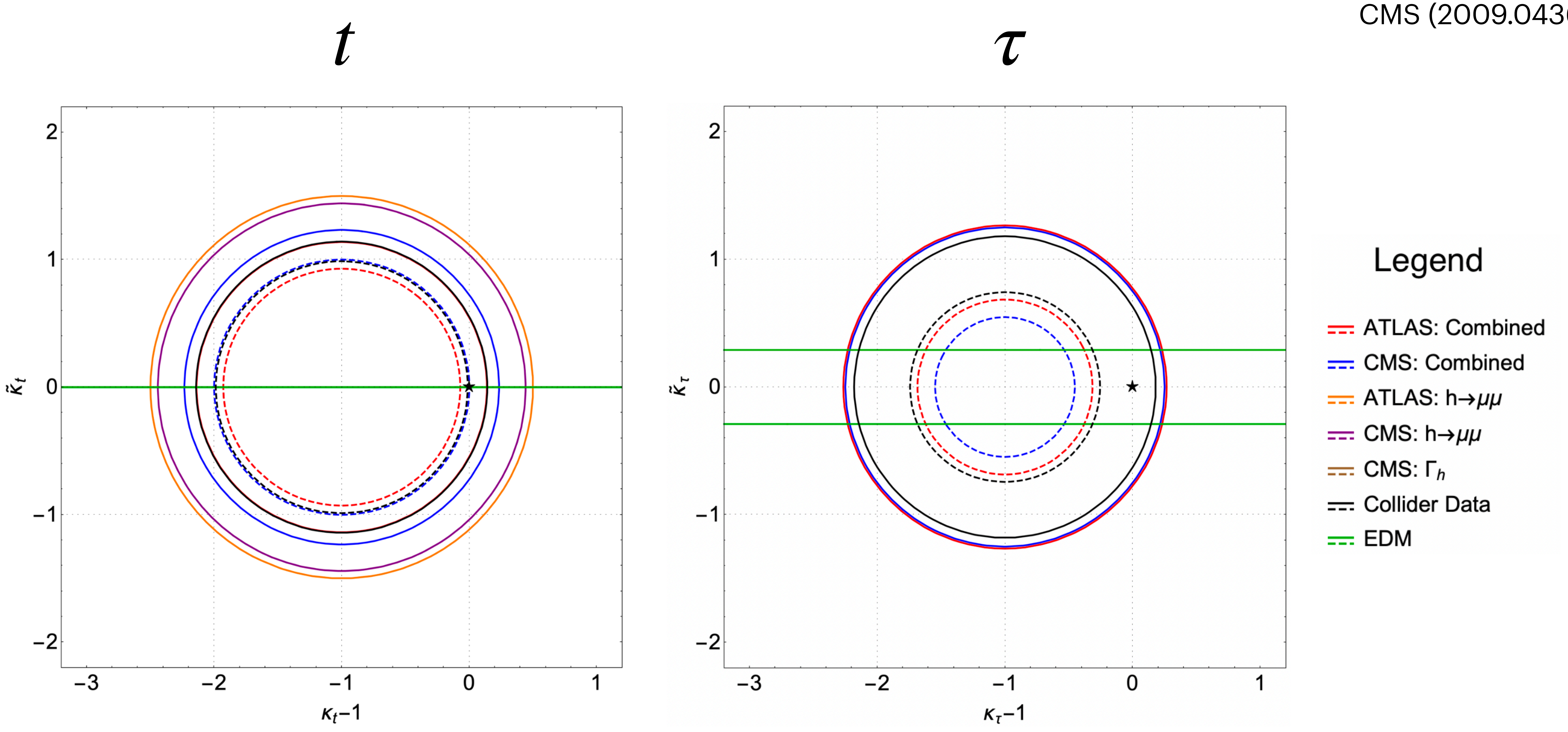
Higgs Physics (1/2)

Data from:
ATLAS (1909.02845)
ATLAS (2007.07830)
CMS (1809.10733)
CMS (2009.04363)

- Global χ^2 fit:

95% C.L.:

$0.98 \lesssim r_t^2 \lesssim 1.31$
$r_c^2 \lesssim 2.36$
$0.73 \lesssim r_b^2 \lesssim 1.08$
$0.56 \lesssim r_\tau^2 \lesssim 1.40$
$0.36 \lesssim r_\mu^2 \lesssim 1.85$



- **Strong** bounds only for **third** generations
- Relatively **weak** bounds for **second** generations
- **Null** bounds for the **first** generations!

Higgs Physics (2/2)

Deviations:

$0.82 \lesssim r^2_{t,c,u} \lesssim 1.61$	$0.49 \lesssim r^2_{\tau,\mu,e} \lesssim 1.51$
$0.67 \lesssim r^2_{b,s,d} \lesssim 1.52$	

NP Scale:

$\sin\theta_{u,33} = 0$	$\Lambda_q \gtrsim 0.8$ TeV
$\sin\theta_{e,11} = 0 = \sin\theta_{e,33}$	$\Lambda_\ell \gtrsim 0.5$ TeV

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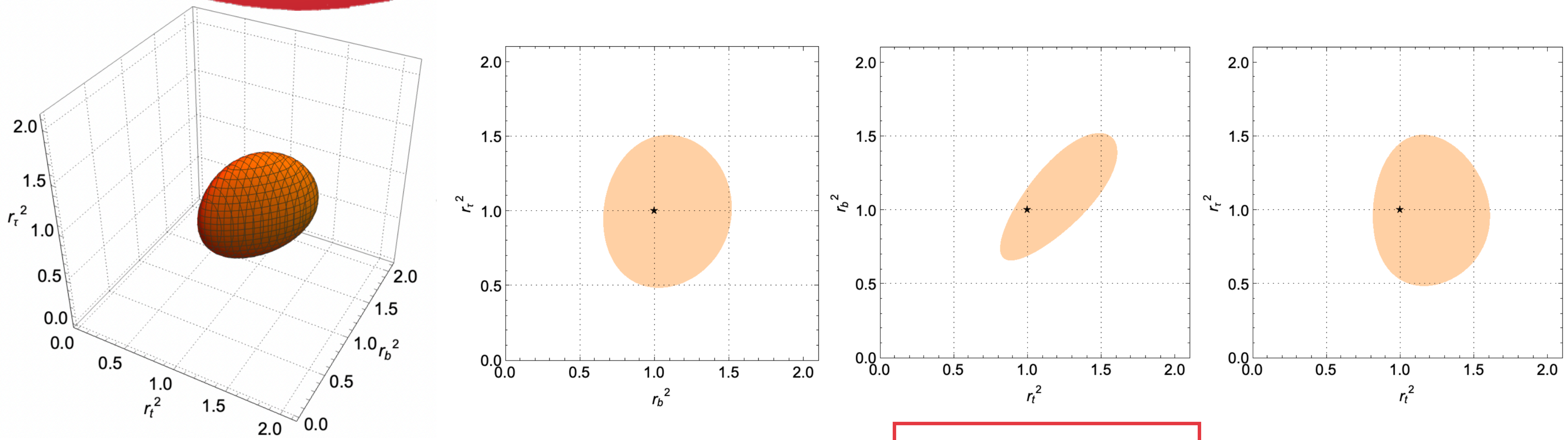

CORRELATIONS!

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Scale of NP~TeV

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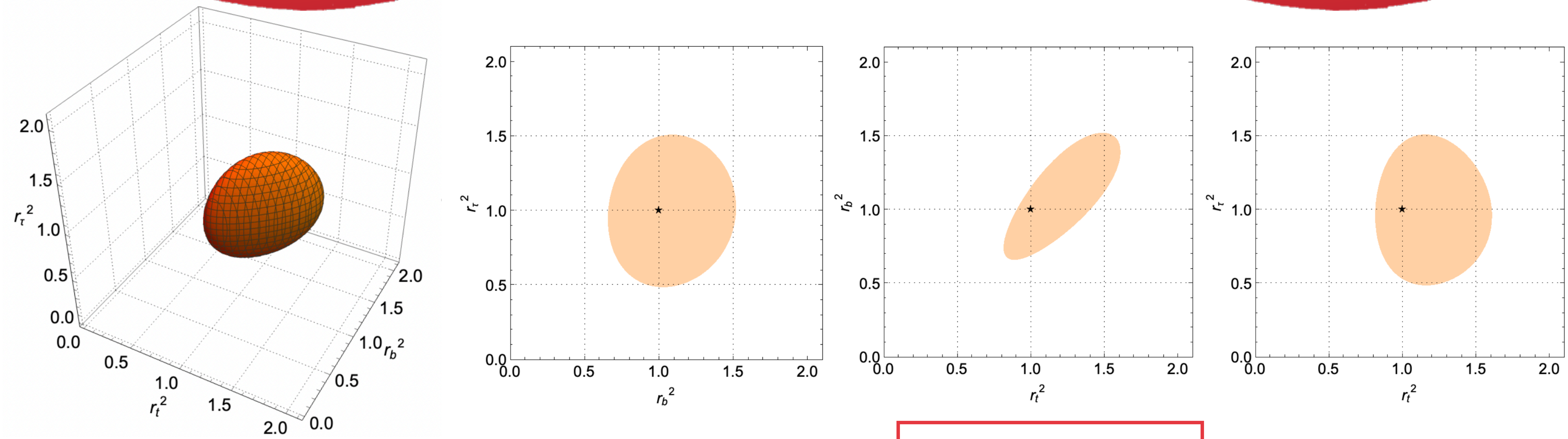


CORRELATIONS!

Electron Dipole Moment (EDM) (1/2)

- **CP-odd** process

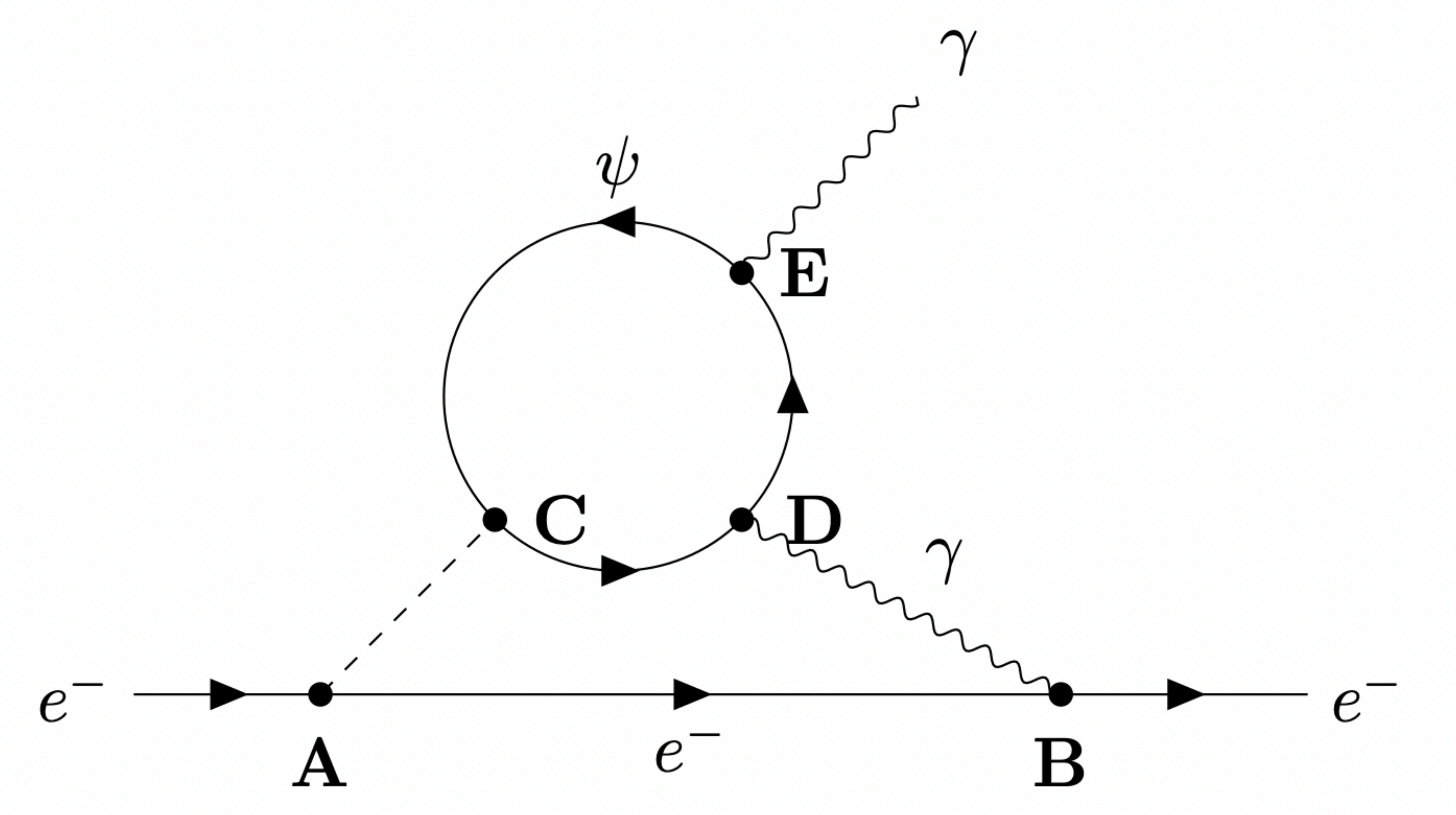
SM: $d_e^{\text{CKM}} \leq 10^{-44} e$ cm	**Experimentally:** $|d_e| < 1.1 \times 10^{-29}$ e cm, at 90% C.L.

M. Pospelov, and A. Ritz (1311.5537)

- FV-NP through **Bar-Zee** diagram:

$$\frac{d_e}{e} = 4\, N_C\, Q_\psi^2\, \frac{\alpha_{\text{em}}}{(4\pi)^3}\, \sqrt{2}\, G_F\, m_e \left[\kappa_e \tilde{\kappa}_\psi f_1(x_{\psi/h}) + \tilde{\kappa}_e \kappa_\psi f_2(x_{\psi/h})\right]$$

J. Brod, U. Haisch, and J. Zupan (1310.1385)



90% C.L.

$$|\tilde{\kappa}_t| \lesssim 0.0012\,, \quad |\tilde{\kappa}_b| \lesssim 0.24\,, \quad |\tilde{\kappa}_\tau| \lesssim 0.29$$

$$|\tilde{\kappa}_c| \lesssim 0.37\,, \quad |\tilde{\kappa}_\mu| \lesssim 31 \quad |\tilde{\kappa}_e| \lesssim 0.0017$$

J. Alonso-Gonzalez, L. Merlo, and S. Pokorski (2103.16569)

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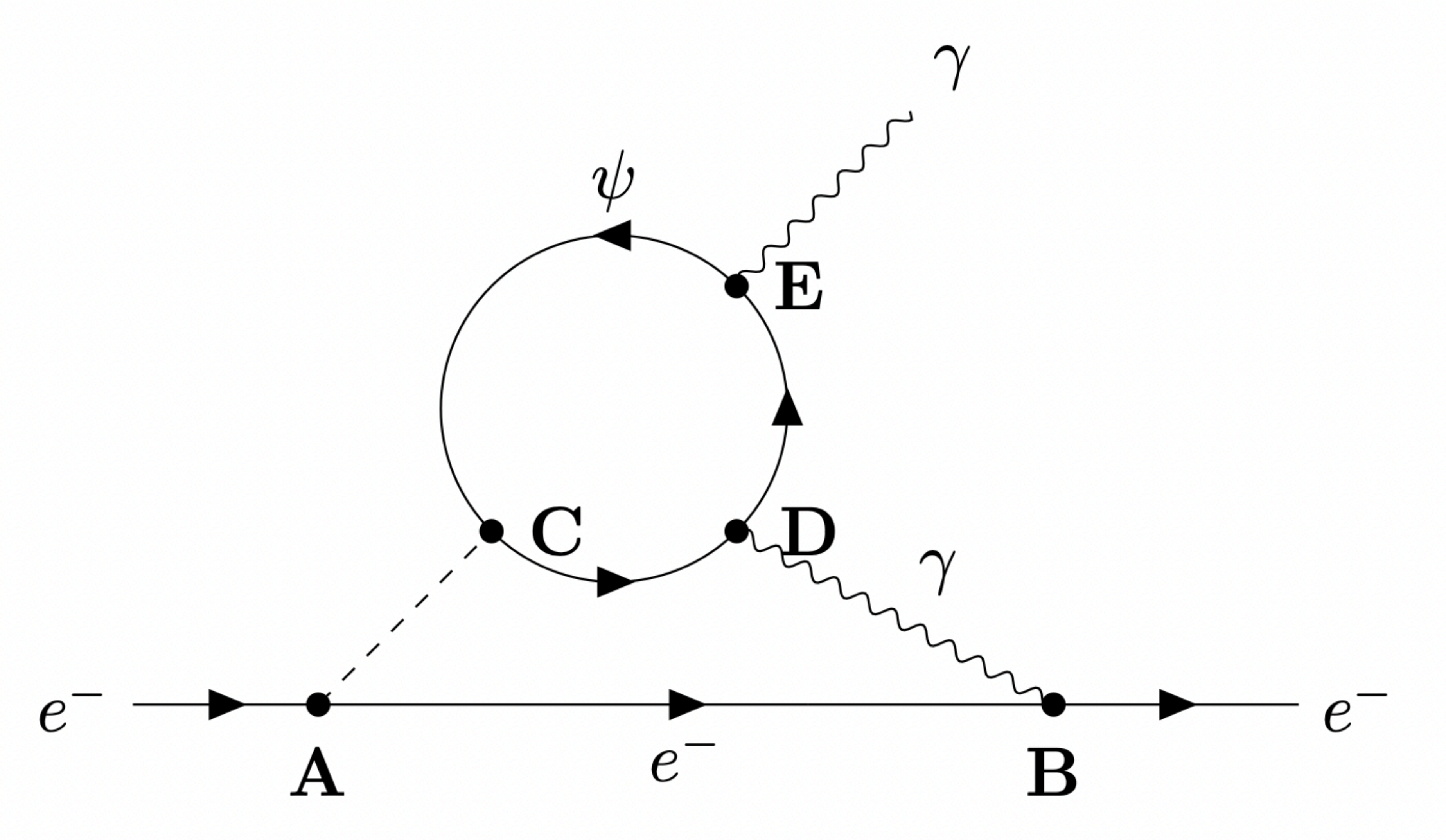

STRONG! 90% C.L.

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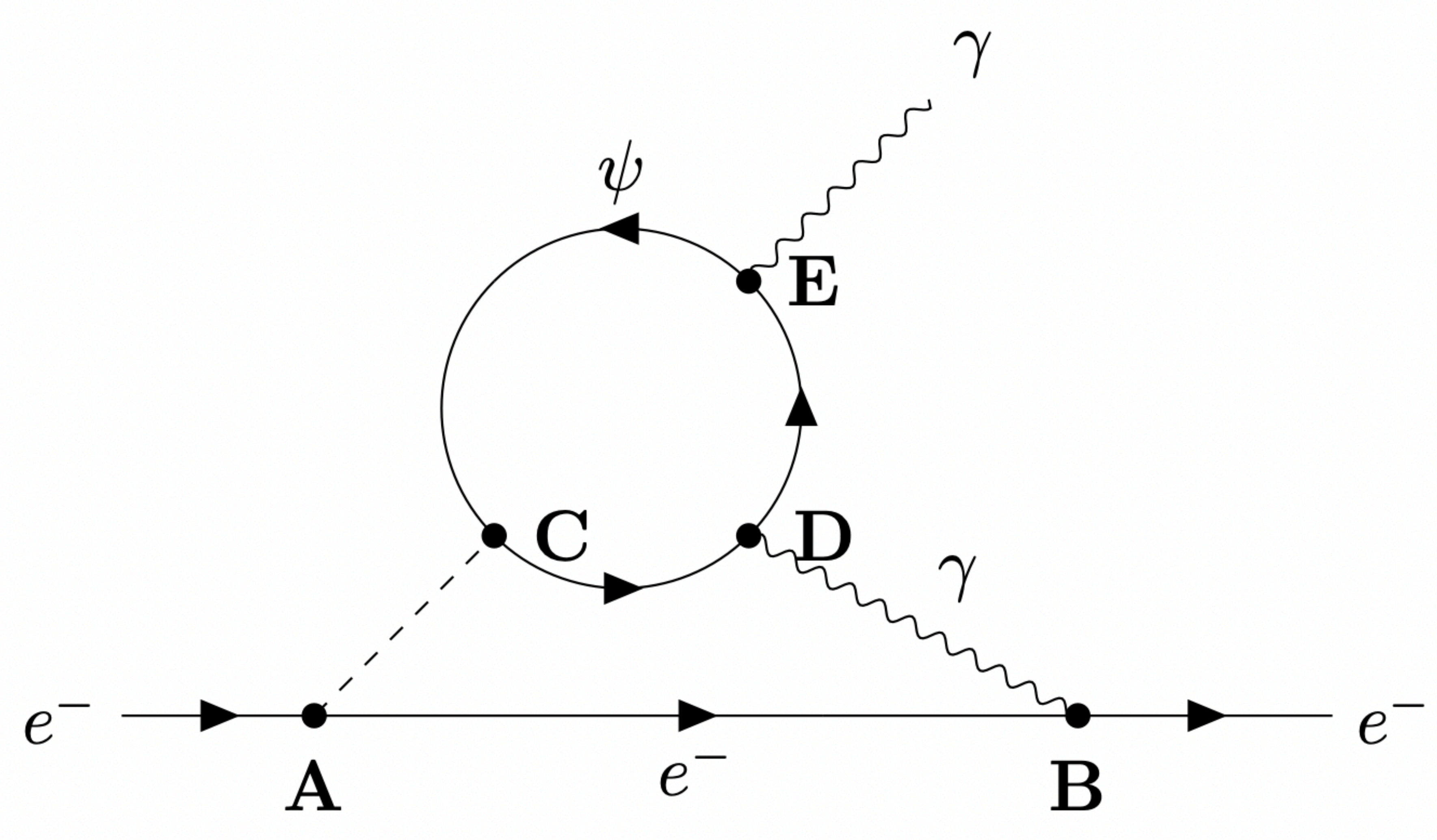

90% C.L.

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SUPER WEAK!

STRONG!

J. Alonso-Gonzalez, L. Merlo, and S. Pokorski (2103.16569)

Electron Dipole Moment (EDM) (2/2)

J. Alonso-Gonzalez, L. Merlo, and S. Pokorski (2103.16569)

- **Stronger** bounds on other **generations**!

$$|\tilde{\kappa}_{t,c,u}| \lesssim 0.0012\,, \qquad |\tilde{\kappa}_{b,s,d}| \lesssim 0.24\,, \qquad |\tilde{\kappa}_{\tau,e,\mu}| \lesssim 0.0017$$

Deviations:

$$0.998 \lesssim r_q^2 \lesssim 1.002$$
$$0.997 \lesssim r_\ell^2 \lesssim 1.003$$

NP Scale:

$\sin\theta_{u,33} = 1$	$\Lambda_q \gtrsim 7.4$ TeV
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Elina Fuchs, M. Losada, Y. Nir, and Y. Viernik (2003.00099)

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J. Alonso-Gonzalez, L. Merlo, and S. Pokorski (2103.16569)

Electron Dipole Moment (EDM) (2/2)

- **Stronger** bounds on other **generations**!

$$|\tilde{\kappa}_{t,c,u}| \lesssim 0.0012\,, \qquad |\tilde{\kappa}_{b,s,d}| \lesssim 0.24\,, \qquad |\tilde{\kappa}_{\tau,e,\mu}| \lesssim 0.0017$$

*EW-Baryogenesis full explanation requires $|\tilde{\kappa}_\tau| \gtrsim 0.08$!

Elina Fuchs, M. Losada, Y. Nir, and Y. Viernik (2003.00099)

Deviations:

$$0.998 \lesssim r_q^2 \lesssim 1.002$$
$$0.997 \lesssim r_\ell^2 \lesssim 1.003$$

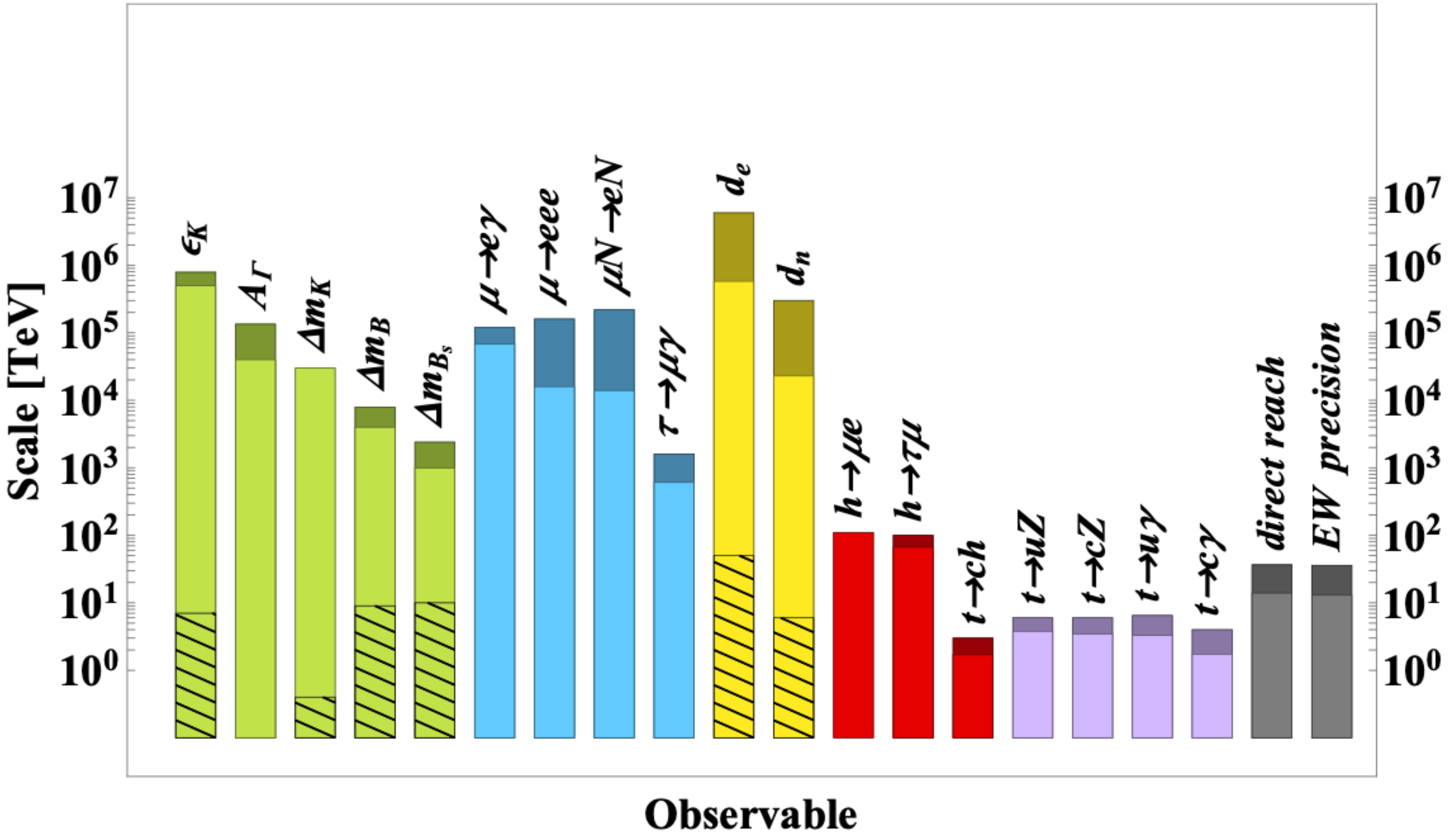
NP Scale:

$\sin\theta_{u,33} = 1$	$\Lambda_q \gtrsim 7.4\ \text{TeV}$
$\sin\theta_{e,11} = 1 = \sin\theta_{e,33}$	$\Lambda_\ell \gtrsim 6.0\ \text{TeV}$

* provided the 1st order phase transition is strong enough

Flavour Observables (1/2)

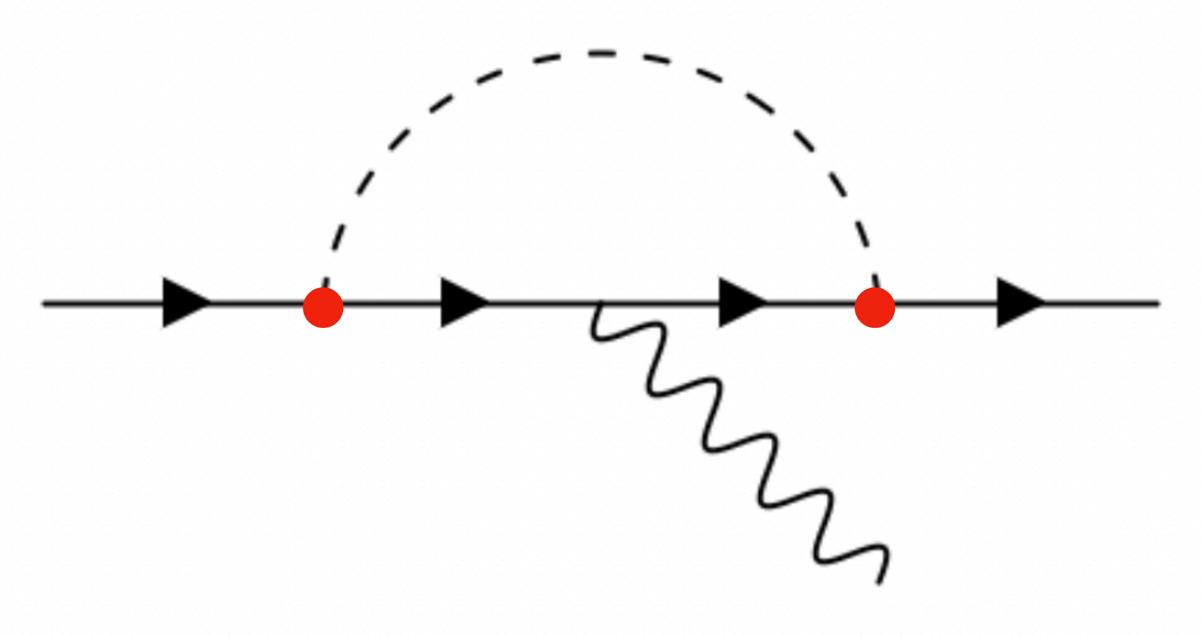
- Data from **flavour-violating processes:**



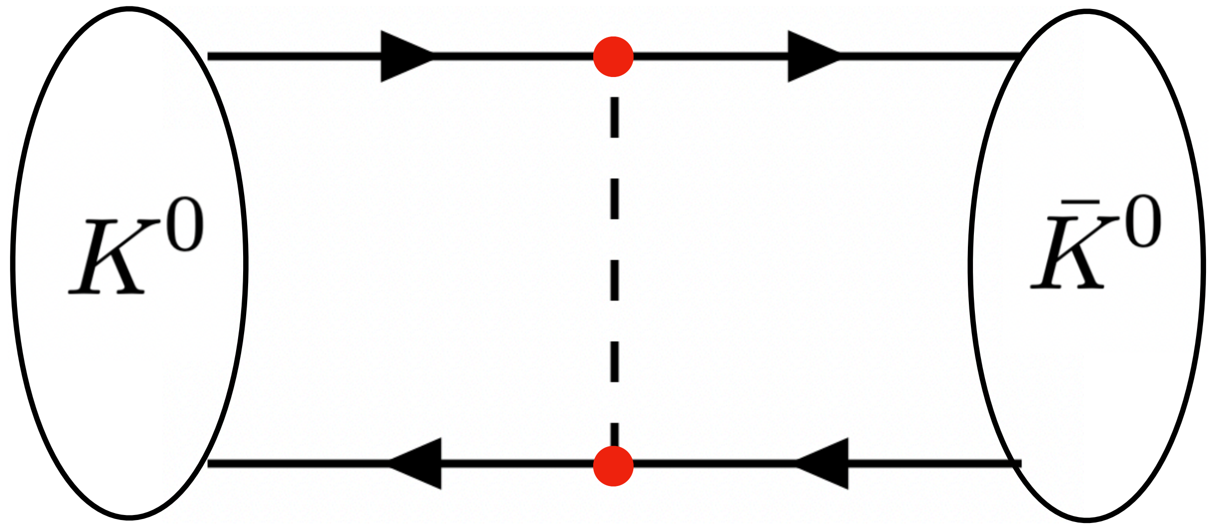
Input for the European Strategy for Particle Physics Update 2020 - 1910.11775

Higgs Flavour Violating couplings:

$\mu^- \to e^-\gamma$



K-mixing



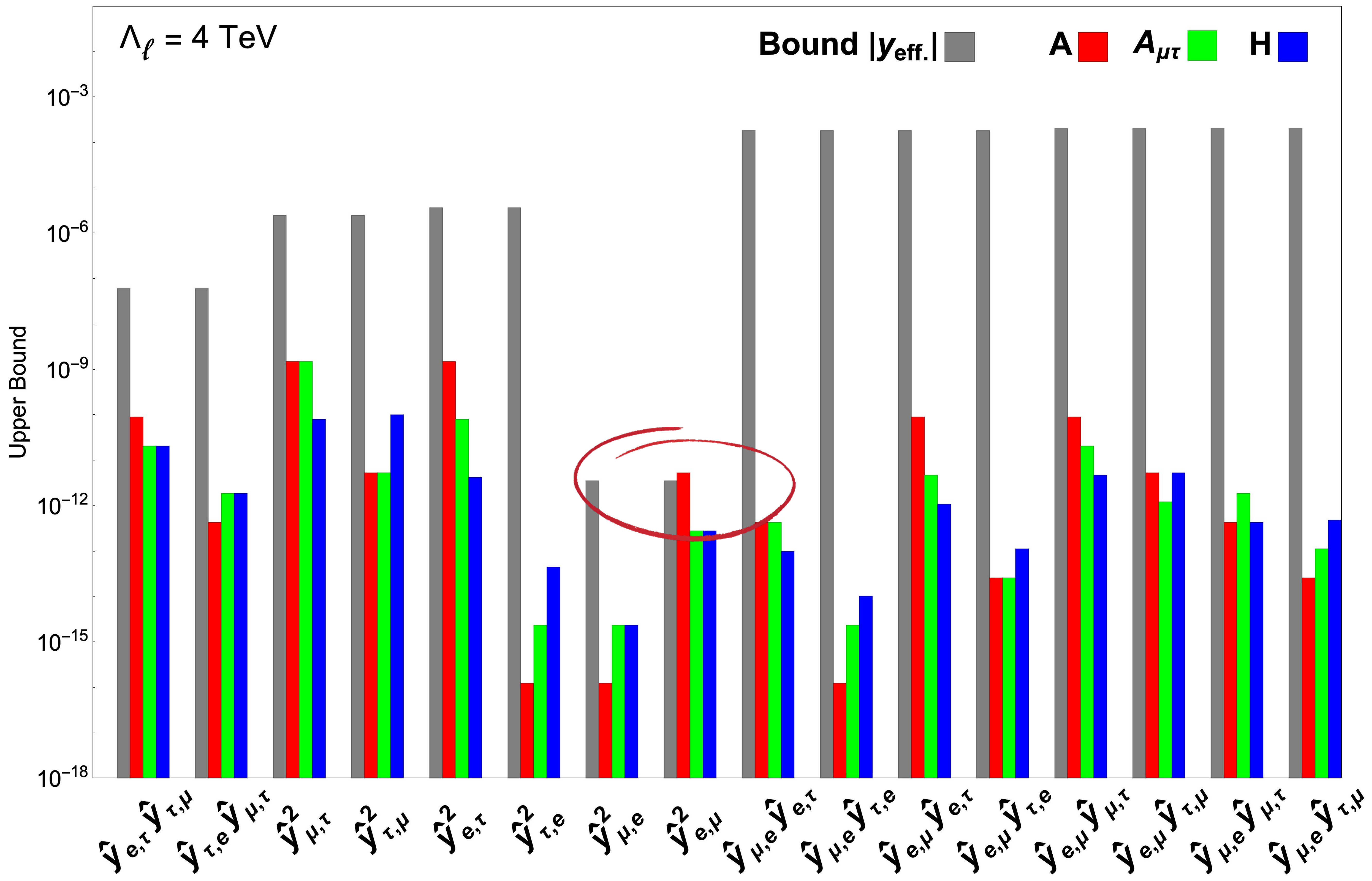
...

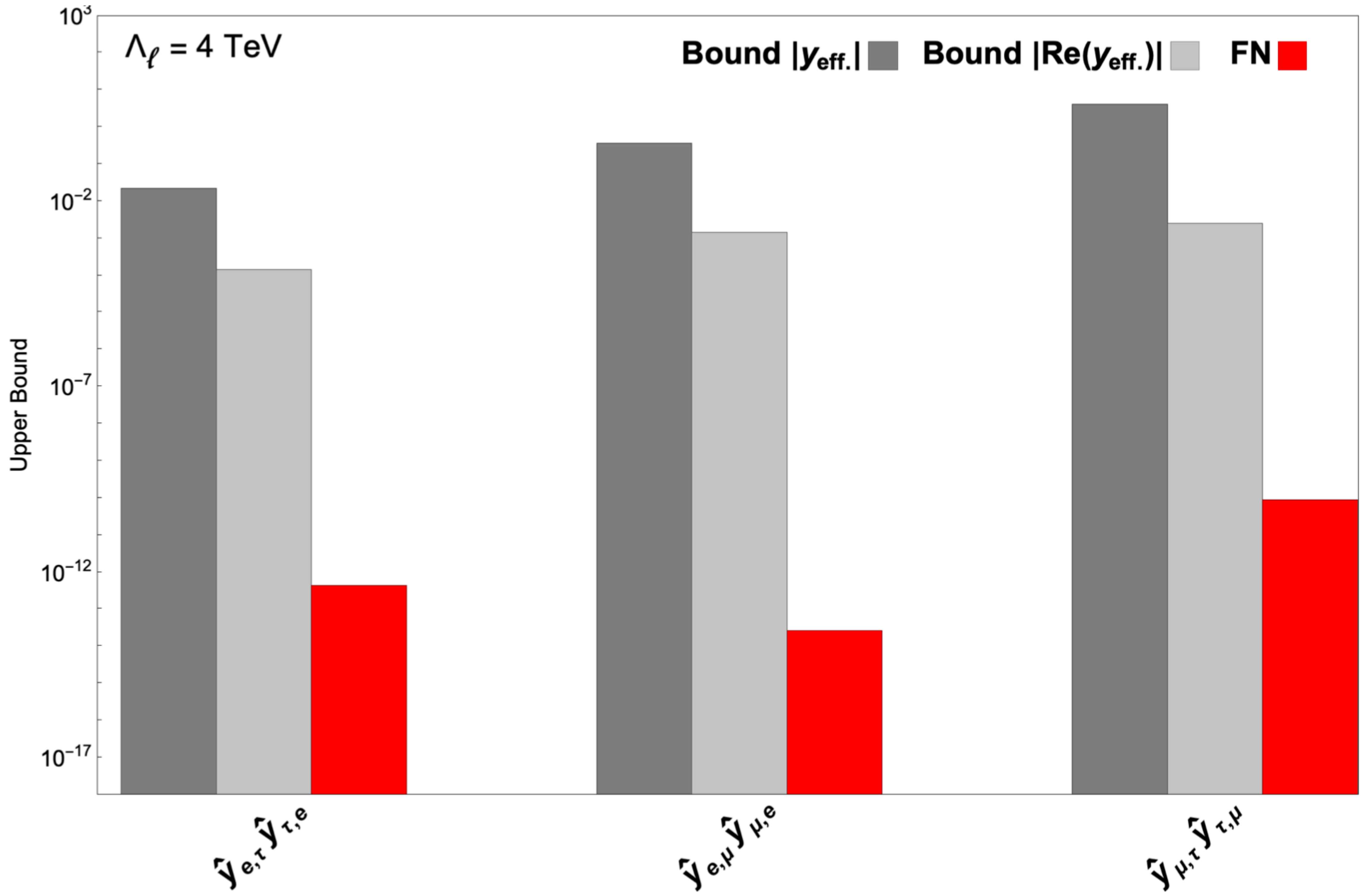
- without flavour symmetry: $|\hat{Y}|^2 \sim \frac{v^4}{\Lambda_q^4} \implies \Lambda_q \approx (60 - 300)\ \mathrm{TeV}$

Flavour Observables (2/2)

CP-Conserving

$$\Lambda_q \gtrsim 1\ \text{TeV}$$
$$\Lambda_\ell \gtrsim 4\ \text{TeV}$$



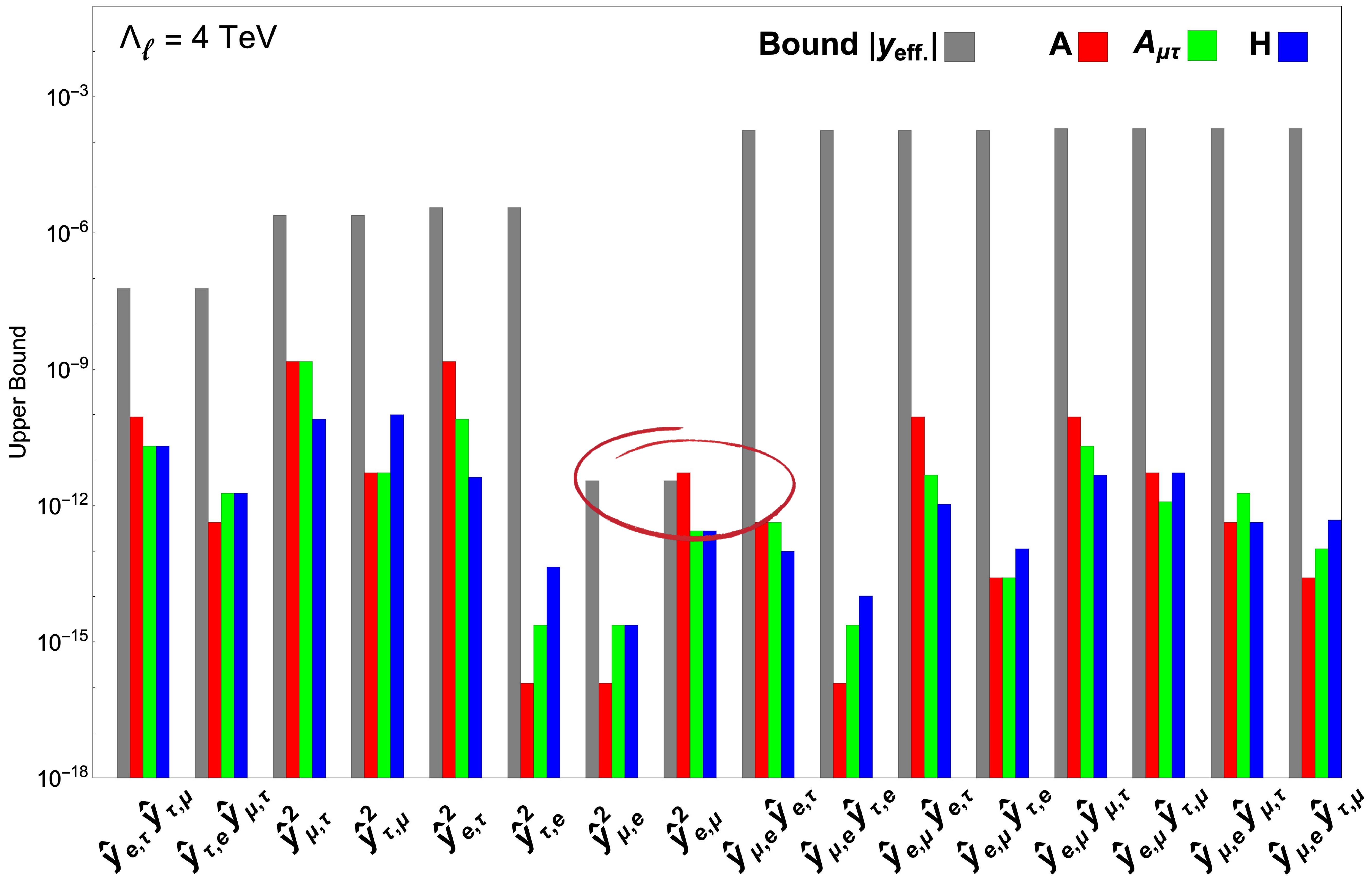


G. Blankenburga, J. Ellisc, G. Isidori (1202.5704)

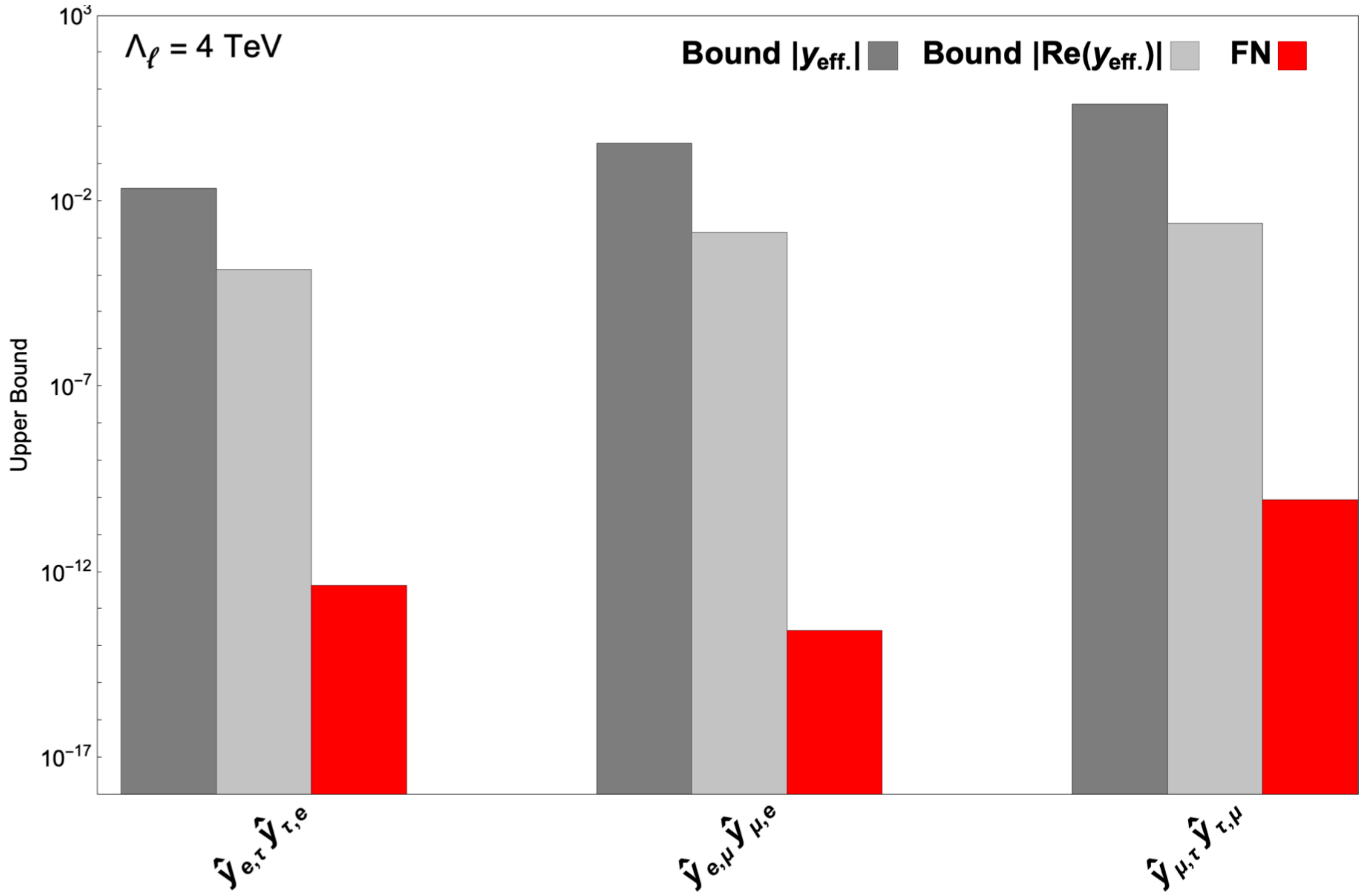
Flavour Observables (2/2)

CP-Conserving

$$\Lambda_q \gtrsim 1 \text{ TeV}$$
$$\Lambda_\ell \gtrsim 4 \text{ TeV}$$



Several orders of magnitude stronger!



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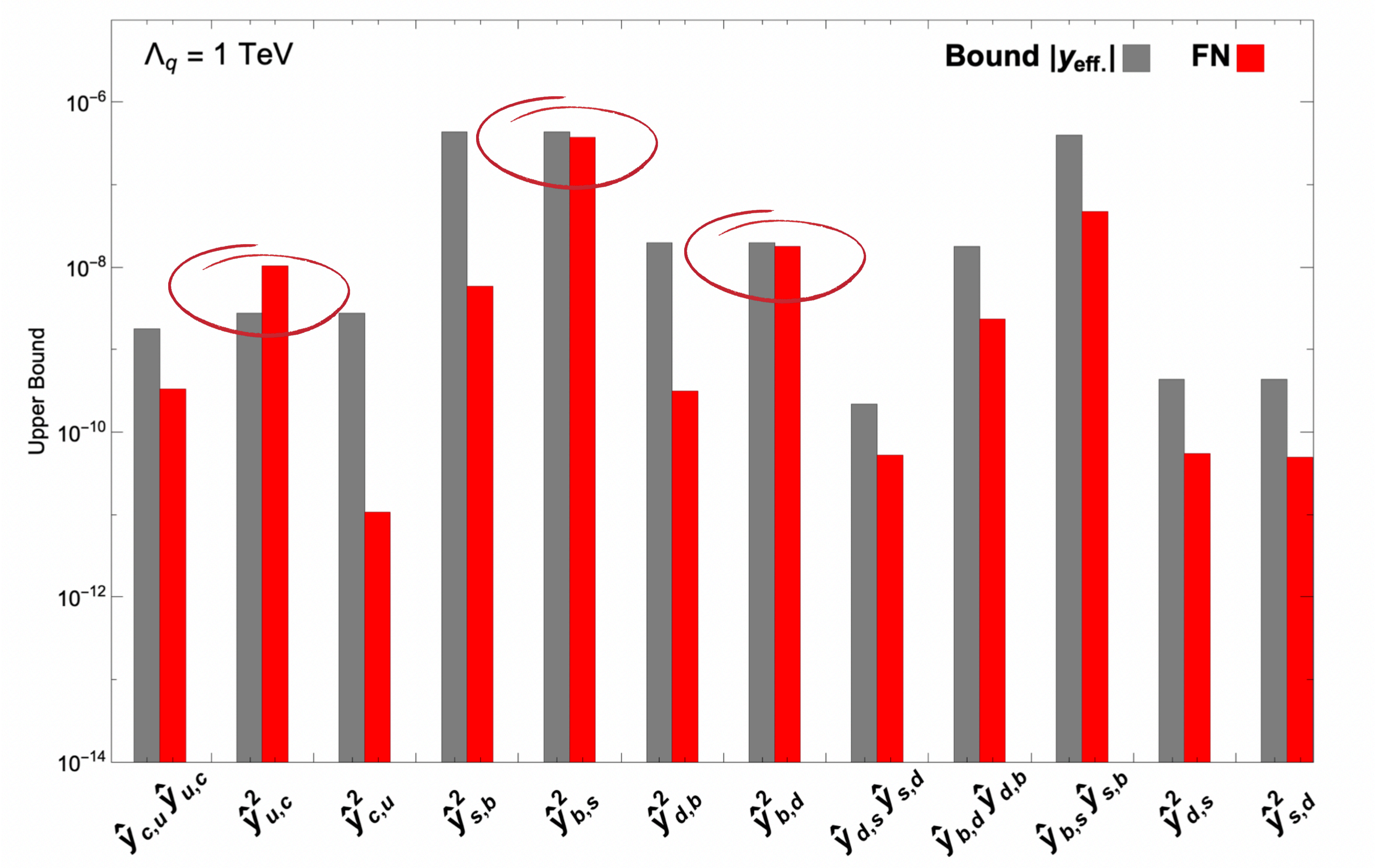

G. Blankenburga, J. Ellisc, G. Isidori (1202.5704)

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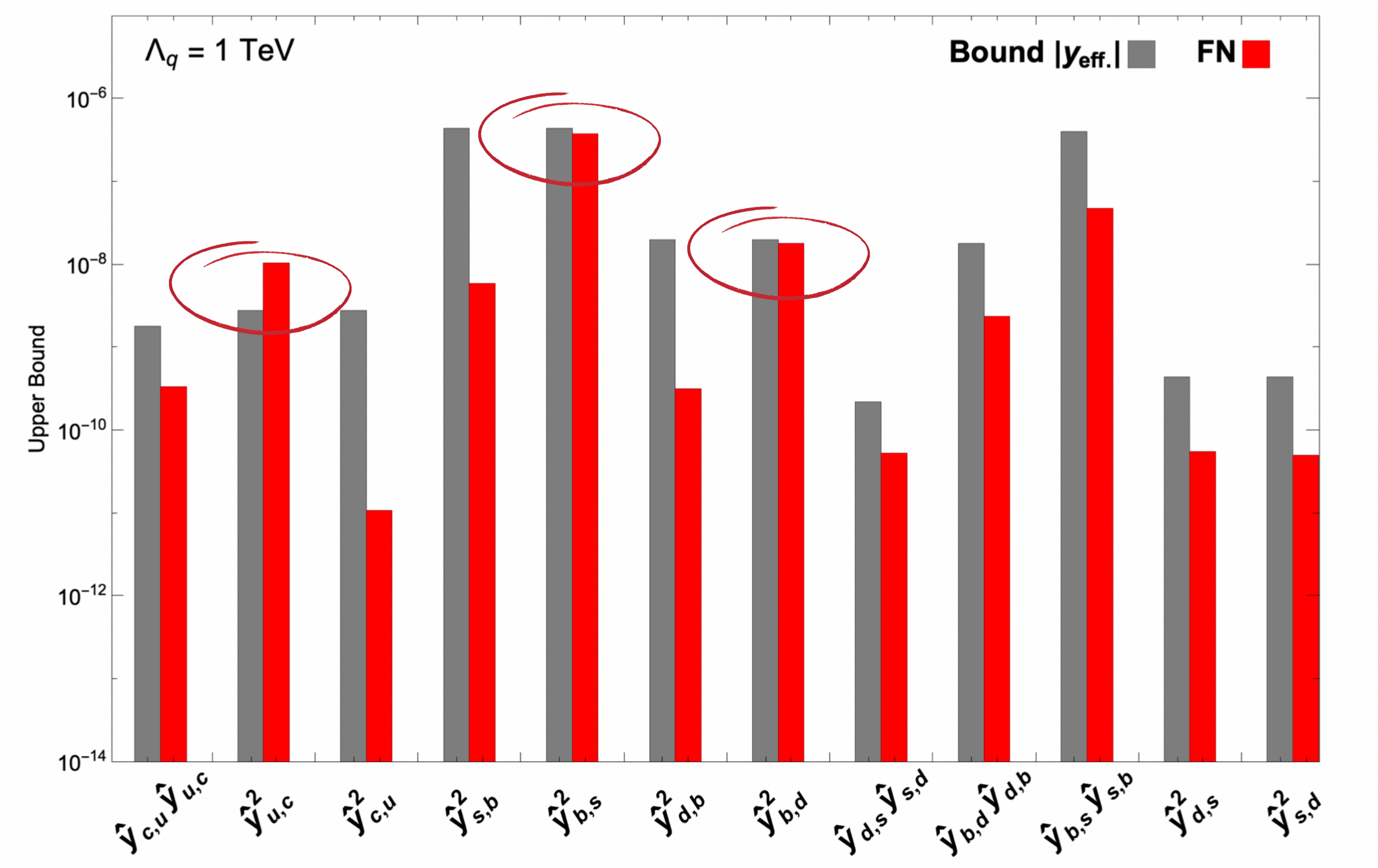


Experimental searches not that far away!

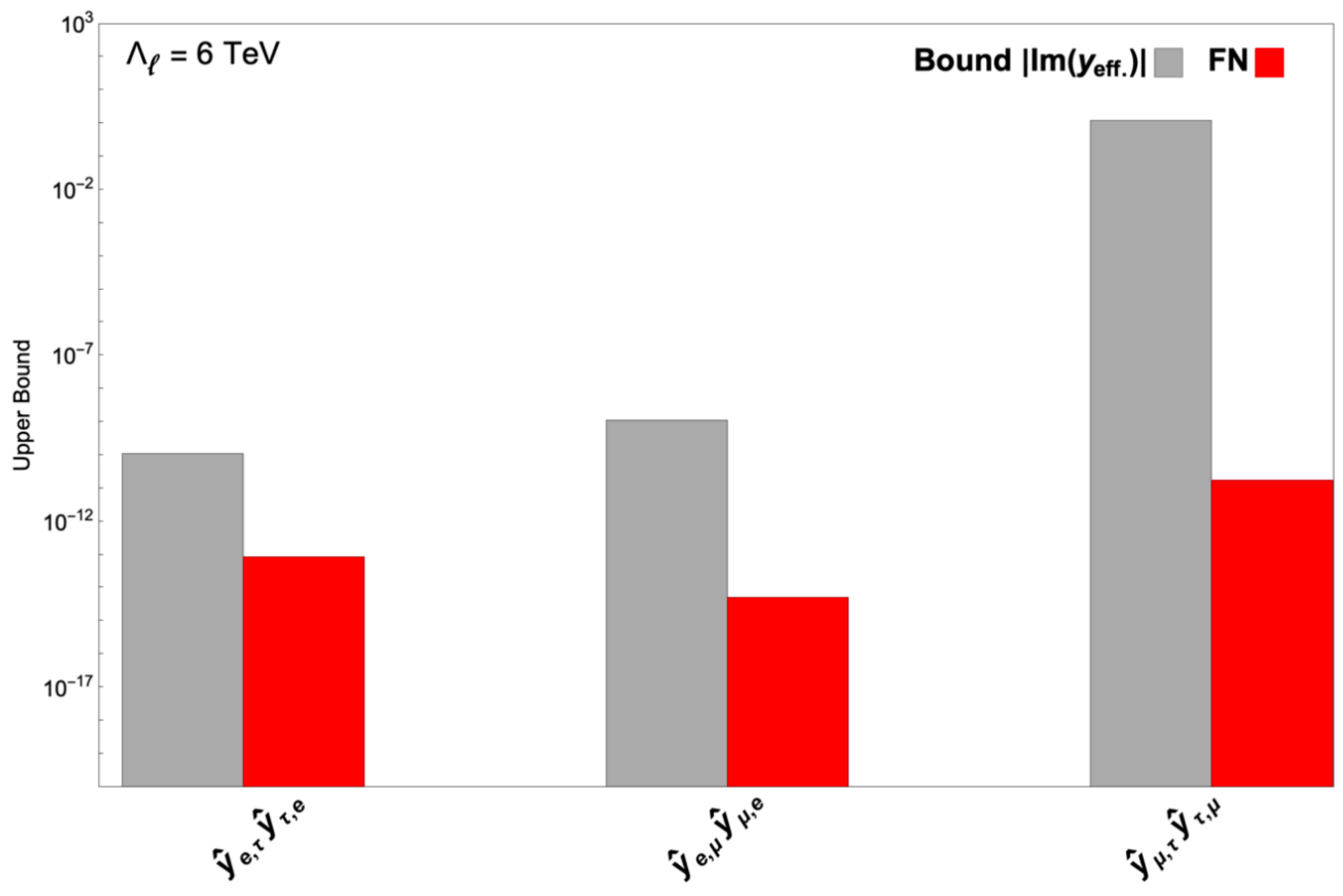
G. Blankenburga, J. Ellisc, G. Isidori (1202.5704)

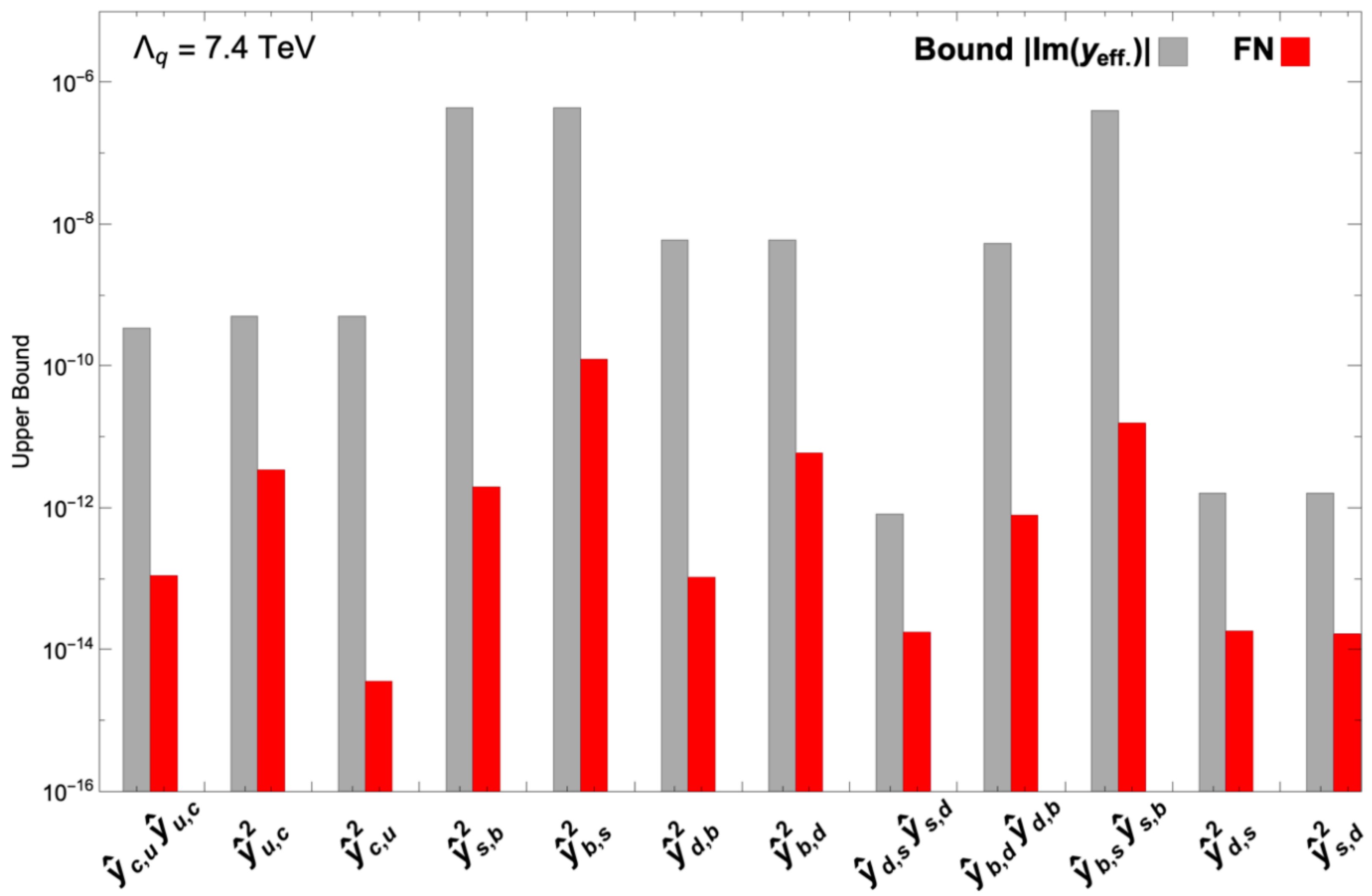
What can we learn?

- **Flavour Observables** + **EDM**

CP-Violating

Flavour Observables	EDM
$\Lambda_q \gtrsim 3$ TeV	$\Lambda_q \gtrsim 7.4$ TeV
$\Lambda_\ell \gtrsim 1$ TeV	$\Lambda_\ell \gtrsim 6.0$ TeV





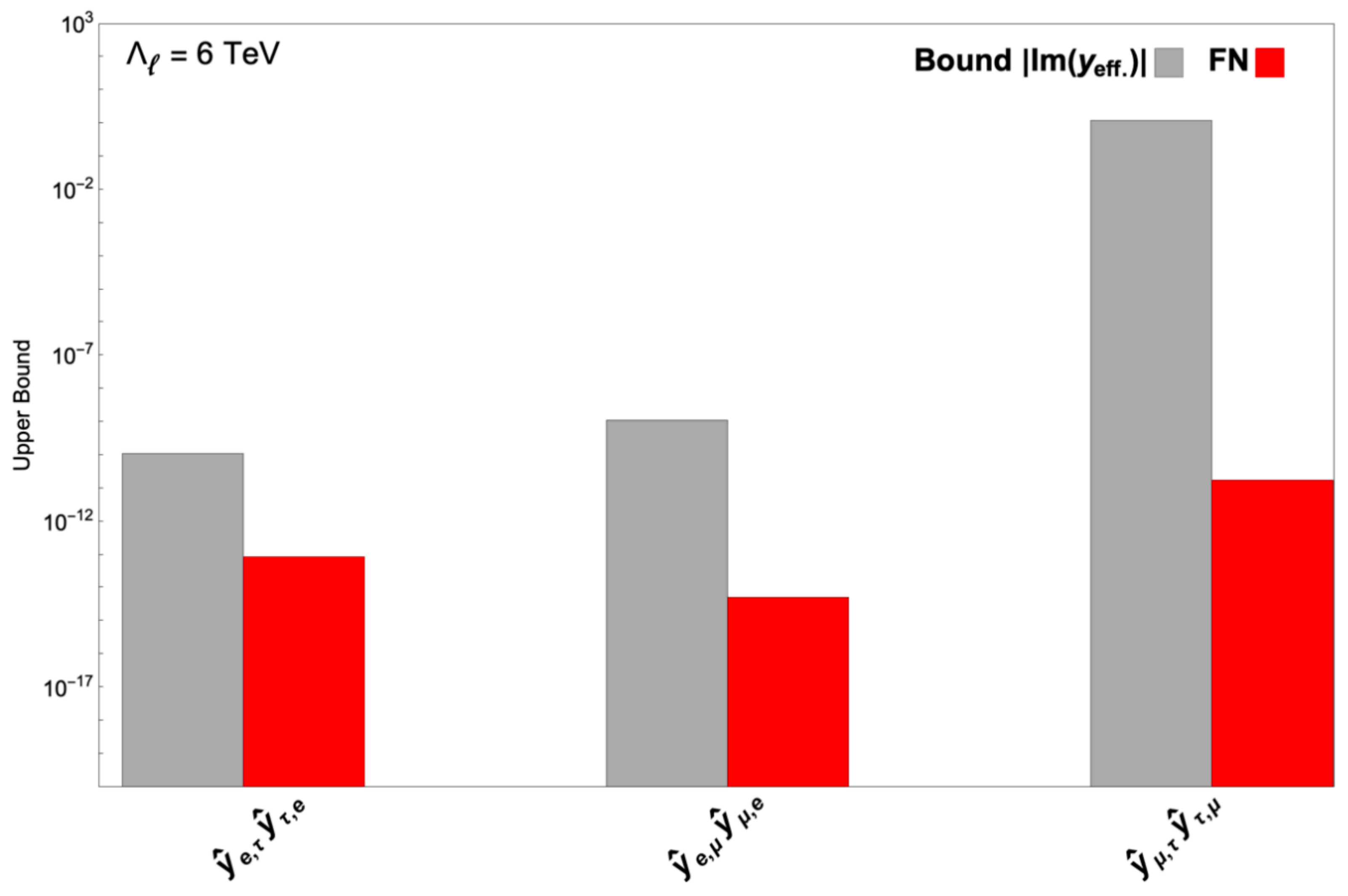
What can we learn?

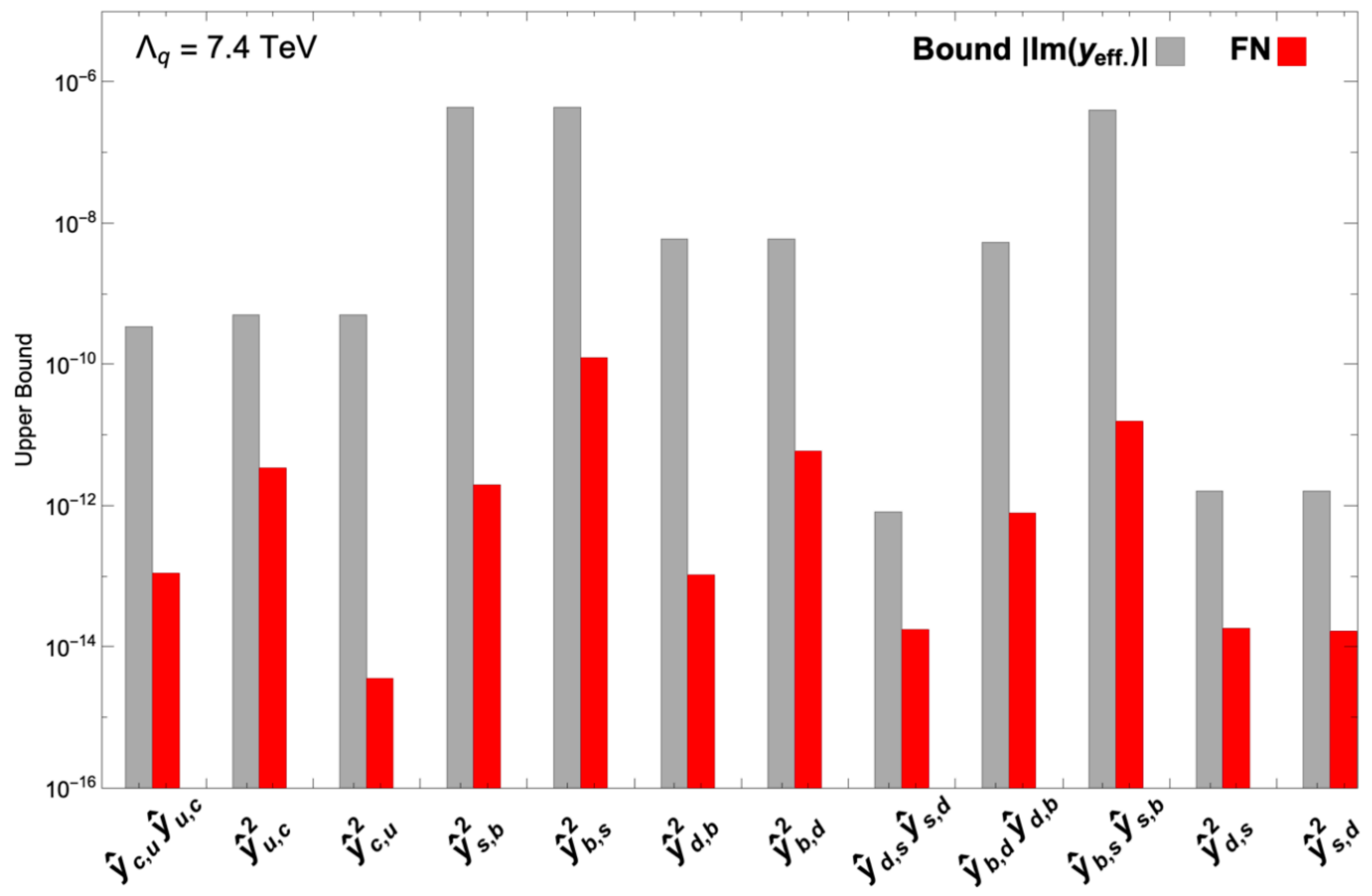
- **Flavour Observables** + **EDM**

Avoiding all current experimental bounds!

CP-Violating

Flavour Observables	EDM
$\Lambda_q \gtrsim 3\ \text{TeV}$ $\Lambda_\ell \gtrsim 1\ \text{TeV}$	$\Lambda_q \gtrsim 7.4\ \text{TeV}$ $\Lambda_\ell \gtrsim 6.0\ \text{TeV}$





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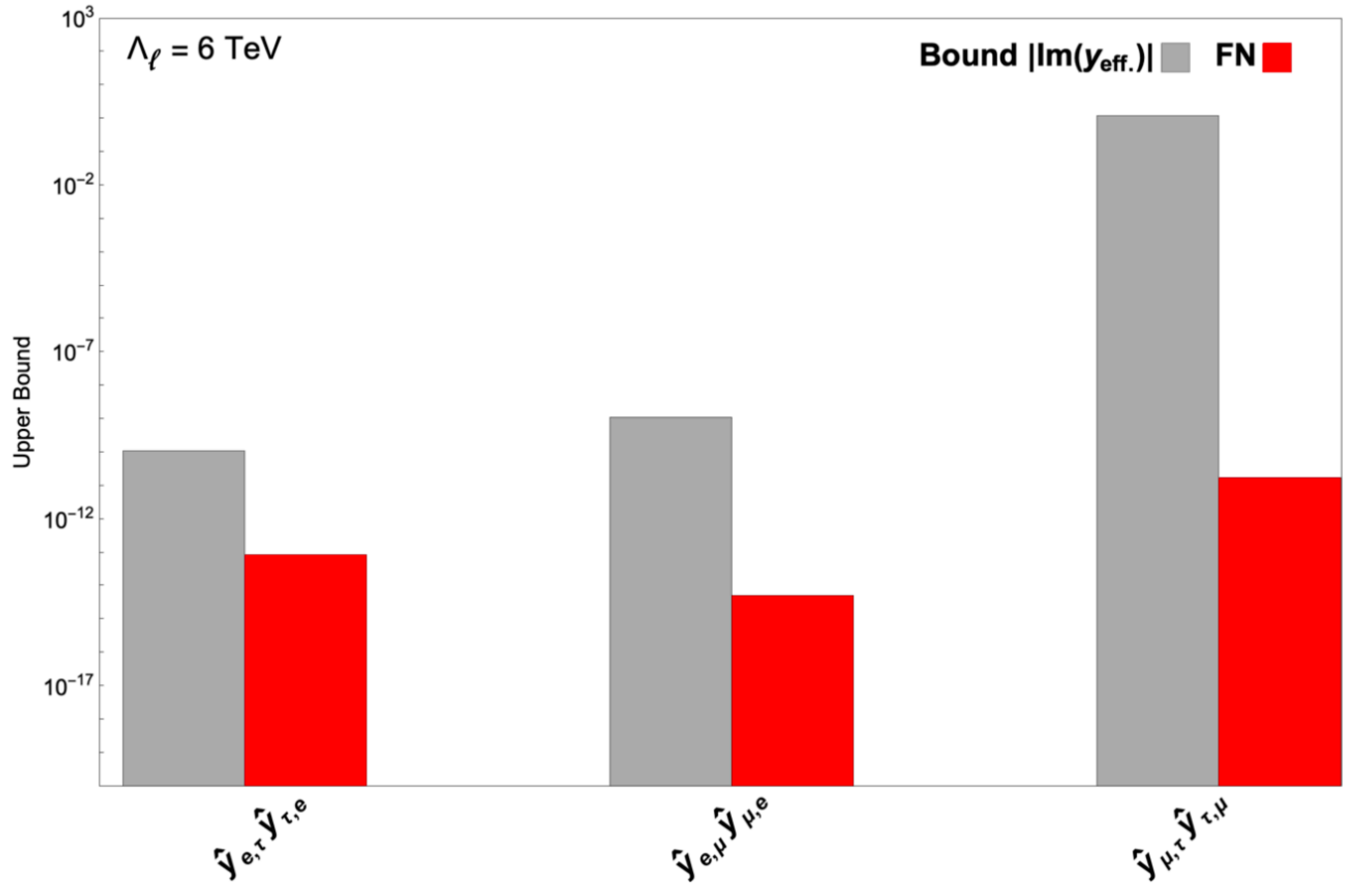

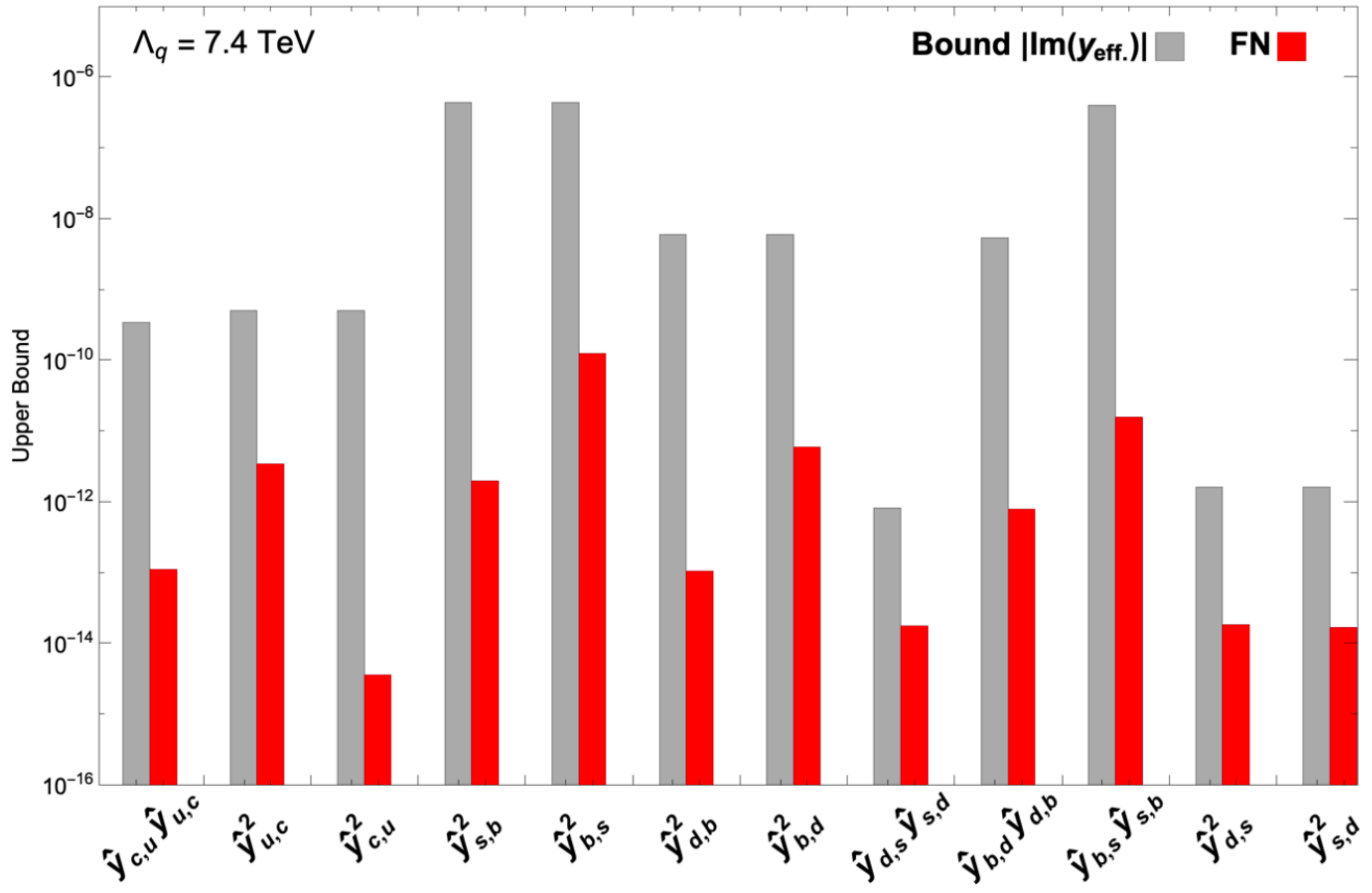

- **Flavour Observables + Higgs Physics**

$\Lambda_q \gtrsim 1$ TeV

$\Lambda_\ell \gtrsim 4$ TeV

$0.88 \lesssim r_q^2 \lesssim 1.12$

$0.99 \lesssim r_\ell^2 \lesssim 1.01$

vs

$\Lambda_q \gtrsim 0.8$ TeV

$\Lambda_\ell \gtrsim 0.5$ TeV

$0.82 \lesssim r_{t,c,u}^2 \lesssim 1.61$

$0.67 \lesssim r_{b,s,d}^2 \lesssim 1.52$

$0.49 \lesssim r_{\tau,\mu,e}^2 \lesssim 1.51$

$\Longrightarrow$ **Bounds** are of the **same order**!

$\Longrightarrow$ **Future LHC** searches could become **more sensitive** to **NP** than **flavour observables**!

Prediction Higgs & Top Decays

- We can make **predictions** on processes that have not been measured yet!

$\Longrightarrow$ **Higgs** flavour-violating **decays**!

$\Longrightarrow$ **Top-decay** into higgs+quark!

BR	Experimental Bound 95%C.L.	FN Prediction
$h \to uc$	–	6×10^{-8}
$h \to ds$	–	6×10^{-10}
$h \to db$	–	4×10^{-8}
$h \to sb$	–	8×10^{-7}

BR	Experimental Bound 95%C.L.	A	$A_{\mu\tau}$	H
$h \to e\mu$	6.1×10^{-5}	3×10^{-9}	10^{-10}	1×10^{-10}
$h \to e\tau$	2.2×10^{-3}	8×10^{-7}	4×10^{-8}	2×10^{-9}
$h \to \mu\tau$	1.5×10^{-3}	8×10^{-7}	8×10^{-7}	9×10^{-8}

BR	Experimental Bound 95%C.L.	FN Prediction
$t \to hu$	4.5×10^{-3}	2×10^{-6}
$t \to hc$	4.6×10^{-3} , 5.6×10^{-3}	4×10^{-5}

Prediction Higgs & Top Decays

- We can make **predictions** on processes that have not been measured yet!

$\Longrightarrow$ **Higgs** flavour-violating **decays**!

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Experimental sensitivity still far away :(

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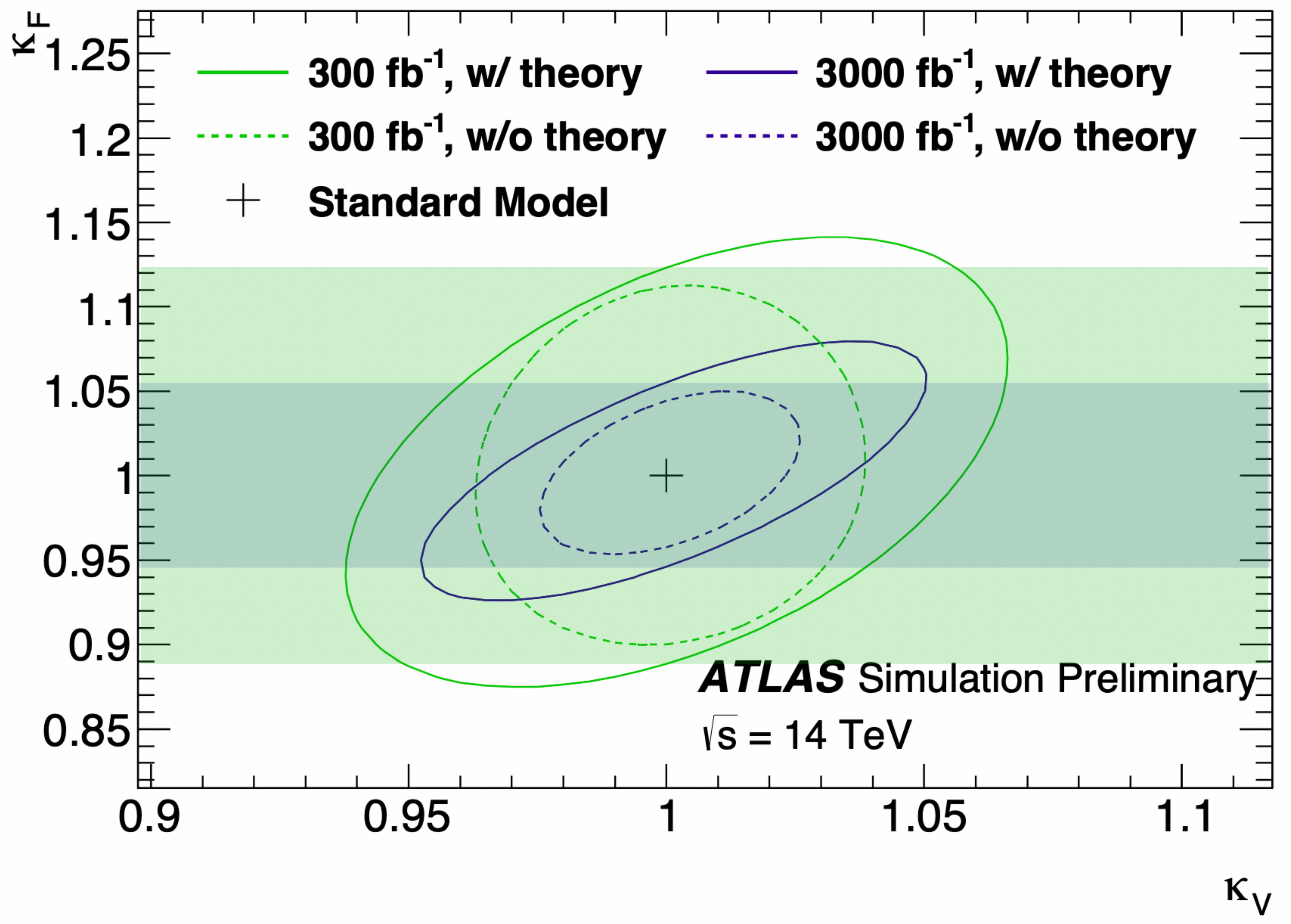
Waiting for HL-LHC - Run III

ATLAS Collaboration, ATL-PHYS-PUB-2014-016



Flavour Observables + **Higgs Physics**

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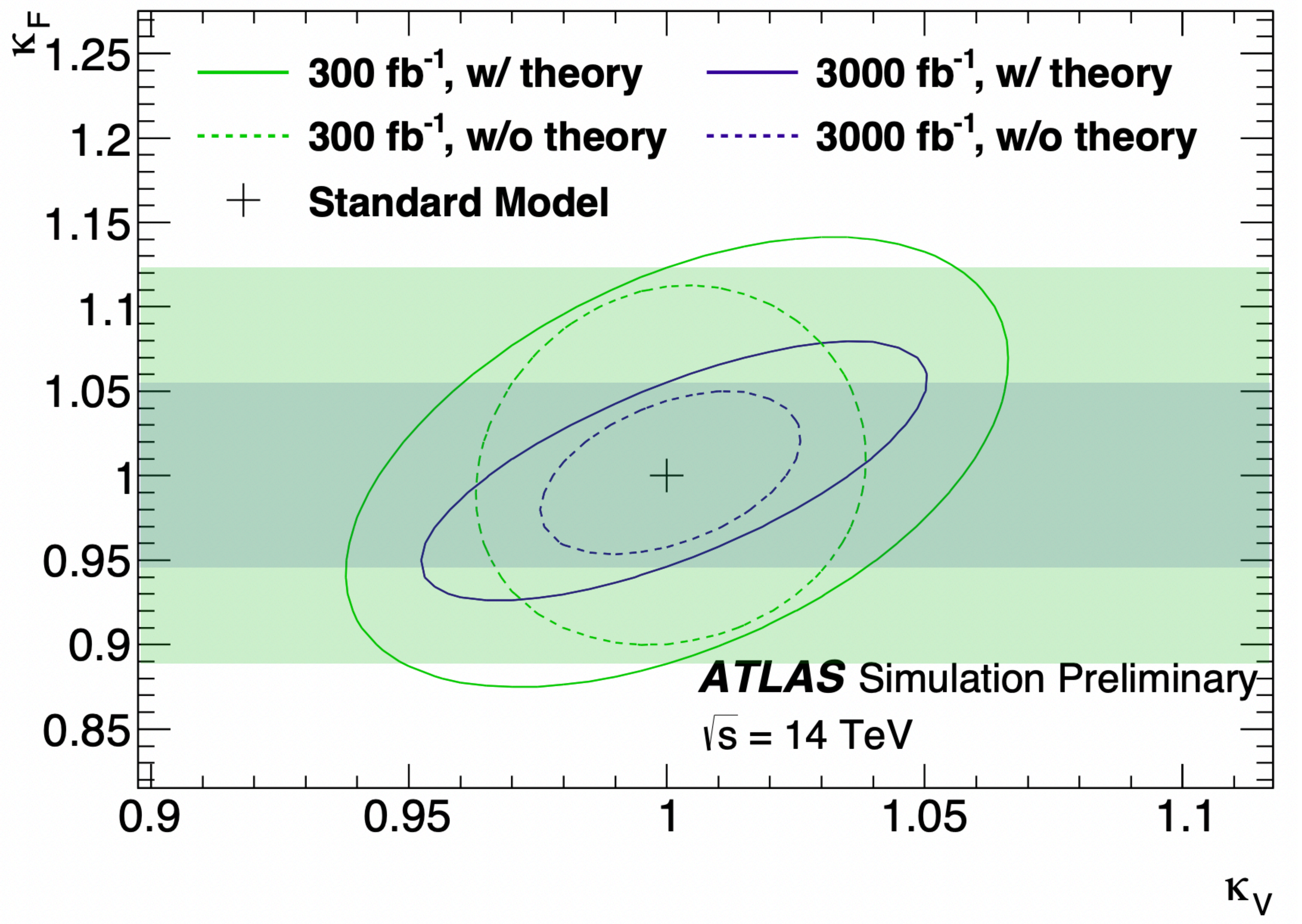
$$\frac{\Delta\kappa_q}{\kappa_q} \approx 6\% \qquad \frac{\Delta\kappa_l}{\kappa_l} \approx 0.5\%$$

Coupling	300 fb^{-1} Theory unc.:			3000 fb^{-1} Theory unc.:		
	All	Half	None	All	Half	None
$\kappa_V = \kappa_Z = \kappa_W$	4.3%	3.0%	2.5%	3.3%	2.2%	1.7%
$\kappa_F = \kappa_t = \kappa_b = \kappa_\tau = \kappa_\mu$	8.8%	7.5%	7.1%	5.1%	3.8%	3.2%

Coupling	300 fb^{-1} Theory unc.:			3000 fb^{-1} Theory unc.:		
	All	Half	None	All	Half	None
κ_V	4.3%	3.1%	2.5%	3.3%	2.2%	1.7%
κ_q	11%	8.7%	7.8%	6.6%	4.5%	3.6%
κ_l	10%	9.6%	9.3%	6.0%	5.3%	5.1%

Waiting for HL-LHC - Run III

ATLAS Collaboration, ATL-PHYS-PUB-2014-016



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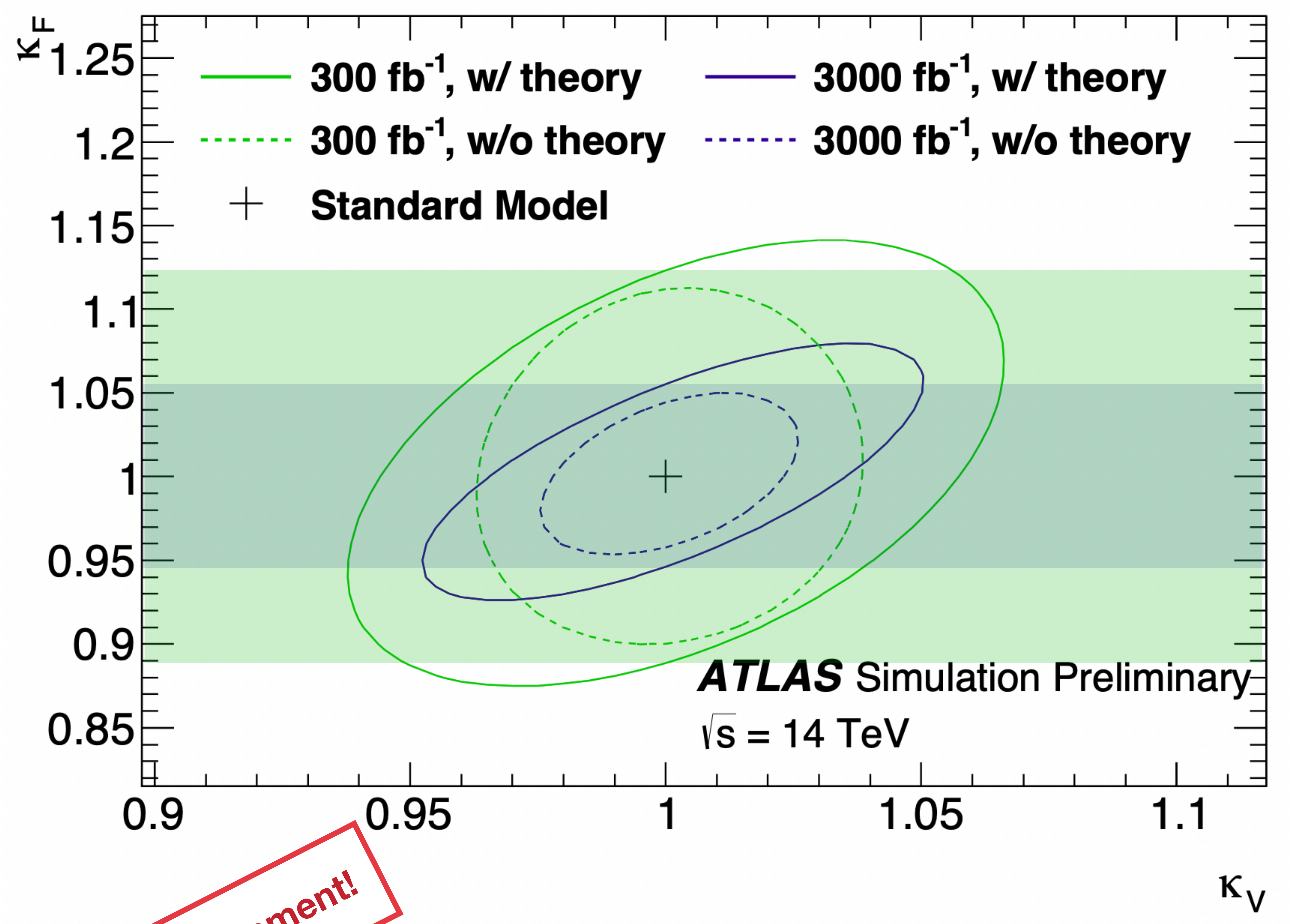
Waiting for HL-LHC - Run III

ATLAS Collaboration, ATL-PHYS-PUB-2014-016



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Amazing Improvement!

pling	300 fb^{-1} Theory unc.: All	Half	None	3000 fb^{-1} Theory unc.: All	Half	None
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κ_l	10%	9.6%	9.3%	6.0%	5.3%	5.1%

Take Home Messages

Flavour symmetries:

- are well motivated both to **explore BSM physics** and to **understand the SM Yukawa** structure!
- allow to **connect** and **correlate** very different **experimental searches** and **constraints** and can **lower** considerably the **NP scale** to **1-10 TeV**!!

- **CP violating** → unless the **phases** of the **diagonal** couplings are zero, the **EDM** put the **strongest bounds**, followed by flavour observables.
- **CP conserving** → most constrained by **flavour observables**, but **Higgs physics**’ bounds are of the **same order** of magnitude → optimistic for the **quark** scale!

Bounds from **Collider Searches** could become **competitive** with **Flavour Observables**!

Thank You!

contact at: arturo.degiorgi@uam.es

Back Up
Slides

Higgs Physics - Parametrization

- Data on **signal strength** from **CMS** and **ATLAS**:

$$\mu_P^F = \frac{\sigma_P}{\sigma_P^{\mathrm{SM}}} \frac{\Gamma(h \to F)}{\Gamma^{\mathrm{SM}}(h \to F)} \left(\frac{\Gamma_{h,\mathrm{tot}}}{\Gamma_{h,\mathrm{tot}}^{\mathrm{SM}}}\right)^{-1}$$

h - Branching Fractions

$\mathrm{BR}_{bb}^{\mathrm{SM}}$	$\mathrm{BR}_{gg}^{\mathrm{SM}}$	$\mathrm{BR}_{\tau\tau}^{\mathrm{SM}}$	$\mathrm{BR}_{cc}^{\mathrm{SM}}$	$\mathrm{BR}_{\gamma\gamma}^{\mathrm{SM}}$	$\mathrm{BR}_{\mu\mu}^{\mathrm{SM}}$
0.58	0.082	0.062	0.029	0.002	0.0002

- Each ratio can be parametrised as a function of the **deviation parameters**:

$$\frac{\Gamma_{h,\mathrm{tot.}}}{\Gamma_{h,\mathrm{tot.}}^{\mathrm{SM}}} = 1 + \mathrm{BR}_{bb}^{\mathrm{SM}}\left(r_b^2 - 1\right) + \left(\mathrm{BR}_{gg}^{\mathrm{SM}} + \mathrm{BR}_{cc}^{\mathrm{SM}}\right)\left(r_t^2 - 1\right) + \mathrm{BR}_{\gamma\gamma}^{\mathrm{SM}}\left(0.639 - 0.718\, r_t^*\right) + \mathrm{BR}_{\tau\tau}^{\mathrm{SM}}\left(r_\tau^2 - 1\right)$$

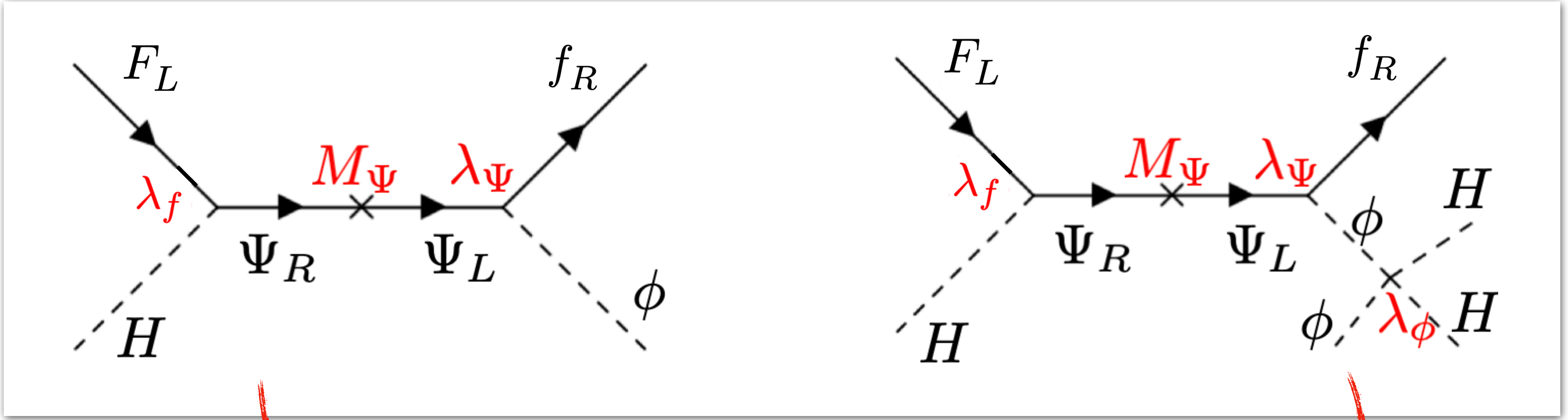
$$\frac{\Gamma(h \to F)}{\Gamma^{\mathrm{SM}}(h \to F)} = \begin{cases} 1, & \text{for } F = VV^*, \\ 1.639 - 0.718\, r_t^*, & \text{for } F = \gamma\gamma, \\ r_b^2, & \text{for } F = b\bar{b}, \\ r_\tau^2, & \text{for } F = \tau\bar{\tau}, \\ r_\mu^2, & \text{for } F = \mu\bar{\mu}. \end{cases}$$

$$\frac{\sigma_P}{\sigma_P^{\mathrm{SM}}} = \begin{cases} 1, & \text{for } P = \mathrm{VBF}, \mathrm{VH} \\ r_t^2, & \text{for } P = \mathrm{ggF}, \mathrm{ttH} + \mathrm{tH}. \end{cases}$$

*full expression with extra $+\, 0.079\, r_t^2$

Toy-Model UV Completion

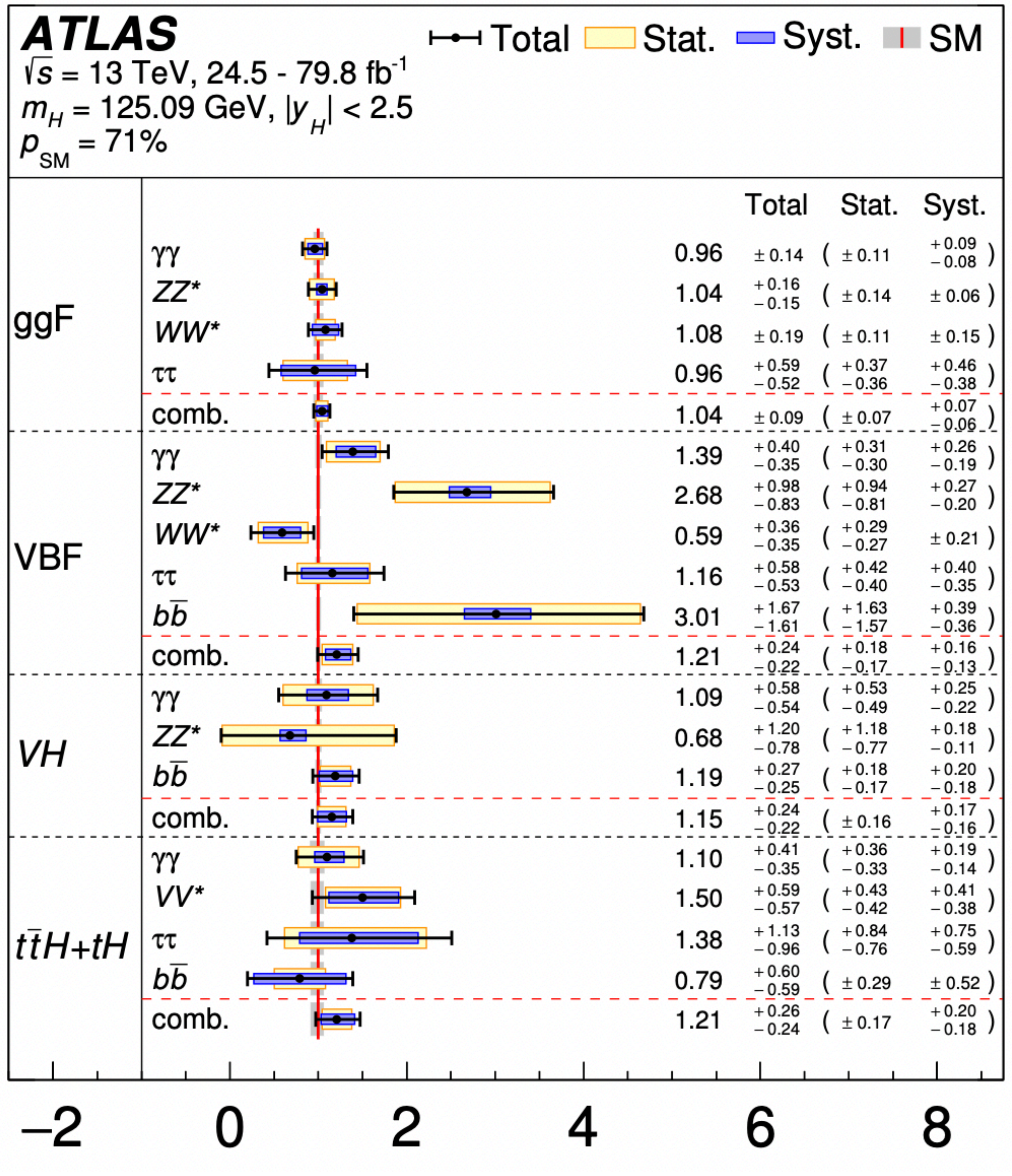
- **Vector-like** exotic fermions: $\Psi_{L,R}$
- MFV-inspired **symmetry**: $F_L, \Psi_{L,R} \sim 3 \subset SU(3)_L$ and $f_R \sim 3 \subset SU(3)_R$
- New **bi-triplet scalar**: $\phi \sim (3,\bar{3})$



$$Y_f \sim \lambda_f \frac{1}{M_\Psi} \lambda_\Psi v_\phi$$

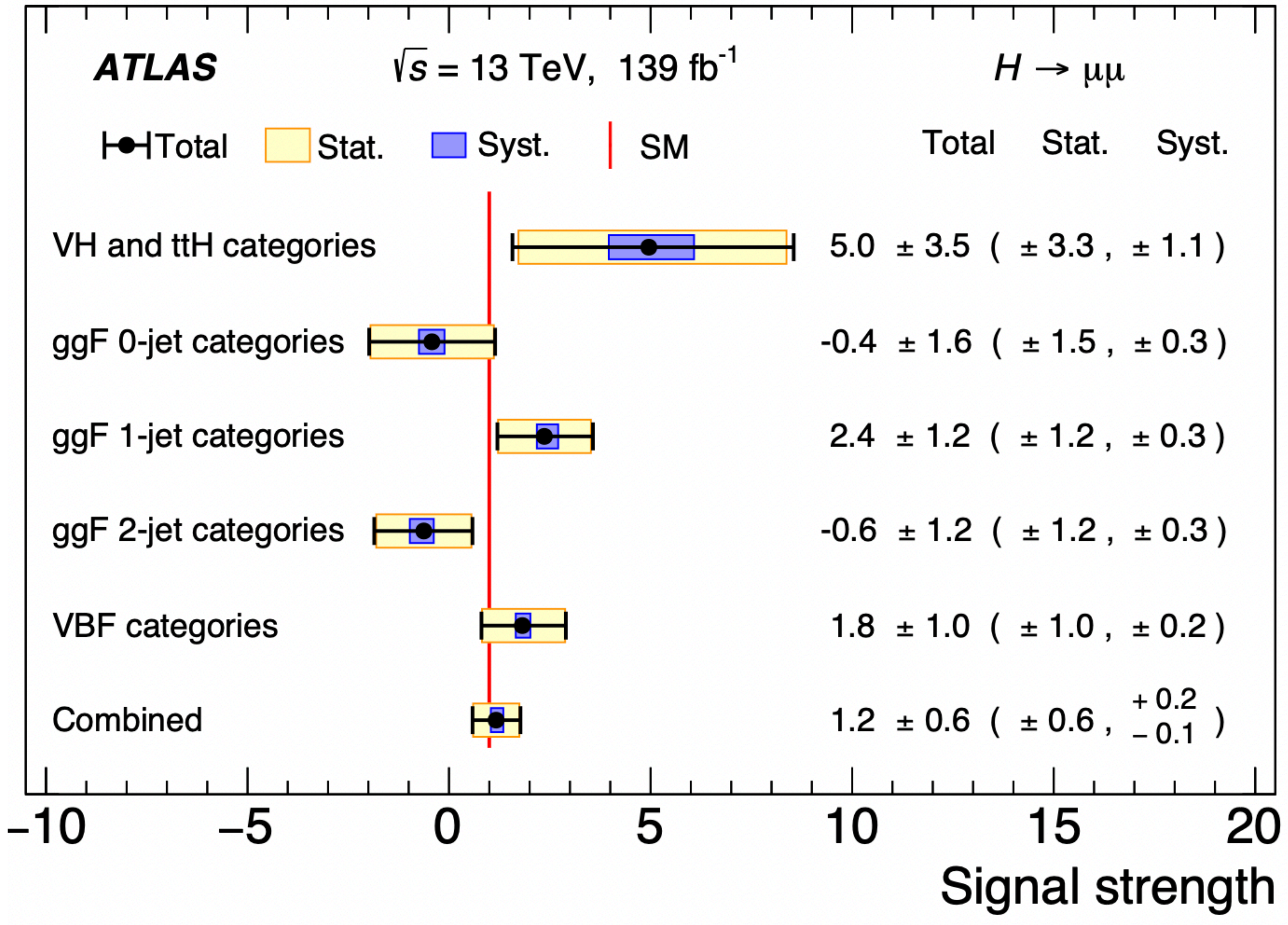
$$\frac{C_f^{d=6}}{\Lambda^2} \sim \lambda_f \frac{1}{M_\Psi} \lambda_\Psi v_\phi \frac{1}{M_\phi^2} \lambda_\phi$$

Waiting for HL-LHC - Run III: ATLAS



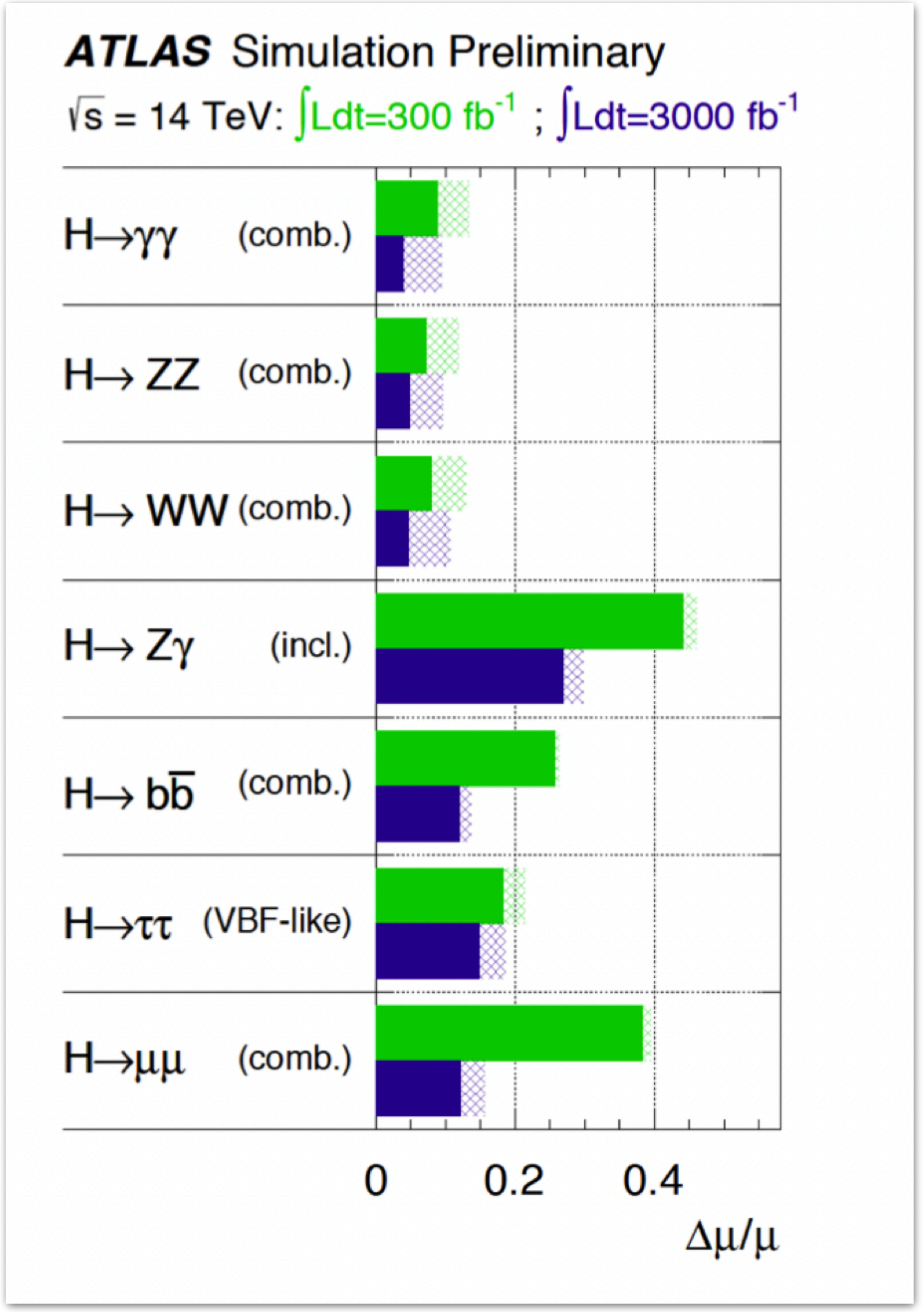
ATLAS (1909.02845)

ATLAS (2007.07830)

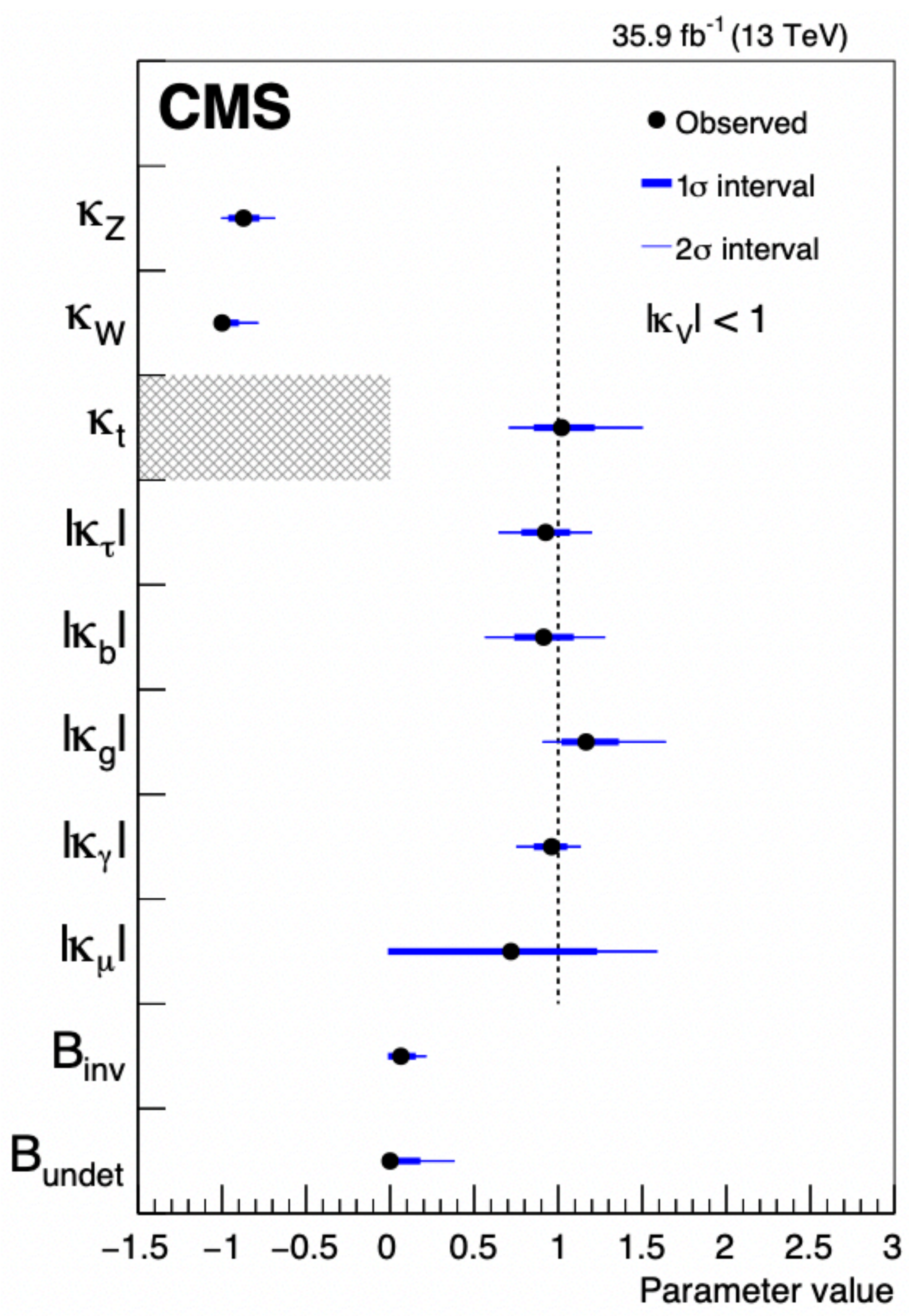


Prospects of LHC Higgs Physics
at the end of Run III (1703.07689)

ATLAS Collaboration, ATL-PHYS-PUB-2014-016



Waiting for HL-LHC - Run III: CMS



Parameter	Best fit	Uncertainty stat	Uncertainty syst
κ_Z	$-0.87\ ^{+0.08}_{-0.08}\ \left(^{+0.00}_{-0.12}\right)$	$^{+0.07}_{-0.06}\ \left(^{+0.00}_{-0.10}\right)$	$^{+0.04}_{-0.04}\ \left(^{+0.00}_{-0.06}\right)$
κ_W	$-1.00\ ^{+0.09}_{-0.00}\ \left(^{+0.00}_{-0.12}\right)$	$^{+0.07}_{-0.00}\ \left(^{+0.00}_{-0.09}\right)$	$^{+0.05}_{-0.00}\ \left(^{+0.00}_{-0.07}\right)$
κ_t	$1.02\ ^{+0.19}_{-0.15}\ \left(^{+0.18}_{-0.15}\right)$	$^{+0.13}_{-0.09}\ \left(^{+0.13}_{-0.09}\right)$	$^{+0.13}_{-0.13}\ \left(^{+0.13}_{-0.12}\right)$
κ_τ	$0.93\ ^{+0.13}_{-0.13}\ \left(^{+0.14}_{-0.15}\right)$	$^{+0.08}_{-0.09}\ \left(^{+0.09}_{-0.10}\right)$	$^{+0.11}_{-0.10}\ \left(^{+0.11}_{-0.11}\right)$
κ_b	$0.91\ ^{+0.17}_{-0.16}\ \left(^{+0.19}_{-0.22}\right)$	$^{+0.11}_{-0.12}\ \left(^{+0.14}_{-0.16}\right)$	$^{+0.13}_{-0.11}\ \left(^{+0.13}_{-0.15}\right)$
κ_g	$1.16\ ^{+0.18}_{-0.13}\ \left(^{+0.17}_{-0.12}\right)$	$^{+0.14}_{-0.09}\ \left(^{+0.13}_{-0.09}\right)$	$^{+0.12}_{-0.10}\ \left(^{+0.11}_{-0.09}\right)$
κ_γ	$0.96\ ^{+0.09}_{-0.09}\ \left(^{+0.09}_{-0.11}\right)$	$^{+0.06}_{-0.08}\ \left(^{+0.07}_{-0.09}\right)$	$^{+0.06}_{-0.06}\ \left(^{+0.05}_{-0.07}\right)$
κ_μ	$0.72\ ^{+0.50}_{-0.72}\ \left(^{+0.49}_{-1.01}\right)$	$^{+0.50}_{-0.71}\ \left(^{+0.48}_{-1.00}\right)$	$^{+0.00}_{-0.07}\ \left(^{+0.06}_{-0.08}\right)$

CMS (1809.10733)

Prospects of LHC Higgs Physics
at the end of Run III (1703.07689)