B-anomalies vs High-pT Lepton Tails

Admir Greljo

24.10.2018, Workshop on high-energy implications of flavor anomalies, CERN

The main idea

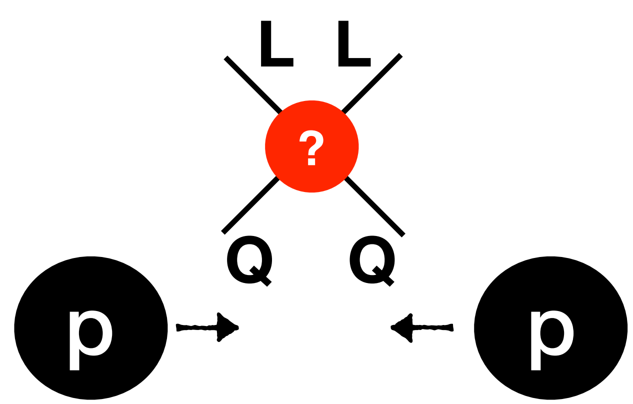
???

Terra incognita

Energy scale

High-p_T Tails

$p\ p \to \ell^+\ell^-$
$pp \to \tau^+\tau^-$
$pp \to \tau\nu$



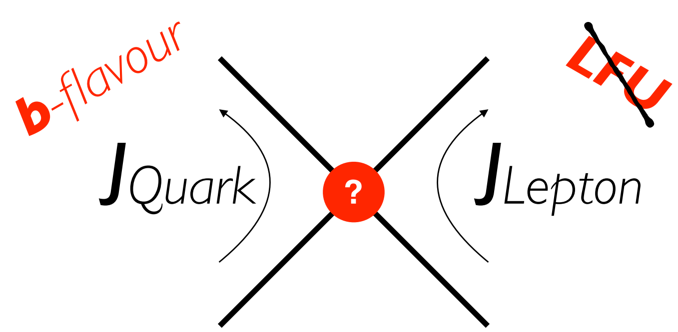
ATLAS EXPERIMENT
CMS

'Target'

V_{EW}

B meson

$b \to c\tau\bar{\nu}_\tau$
$b \to s\mu\bar{\mu}$

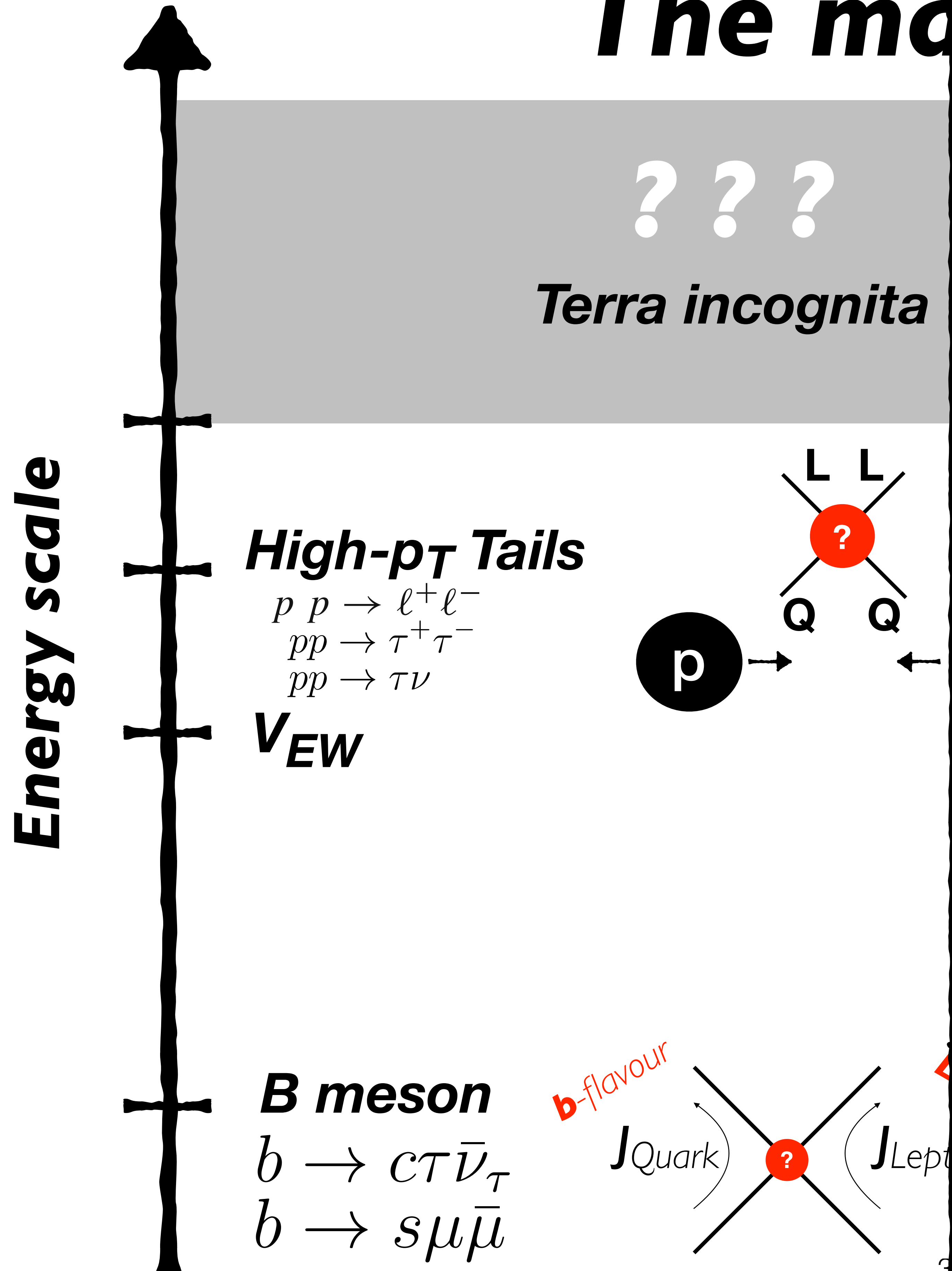


B-anomalies
2012 -
[1205.5442, 1303.0571, 1308.1707, 1406.6482, 1506.08614, 1512.04442, 1612.00529, 1607.07923, 1705.05802, …]

Data

'Hints'

The main idea



- **Solid theoretical framework for comparison!**

SMEFT

(Known RGE, matching, etc.)

WET

(Disclaimer: When the EFT fails, use explicit models)

The ma

Energy scale

? ? ?

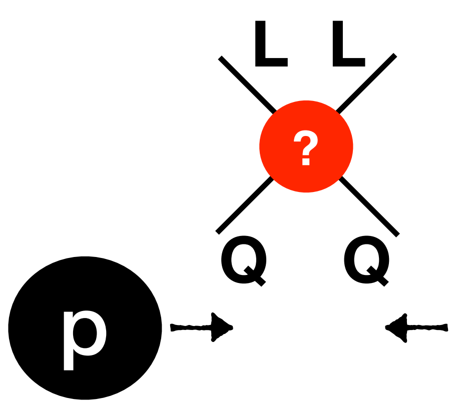
Terra incognita

High-p_T Tails

$p\,p \to \ell^+\ell^-$

$pp \to \tau^+\tau^-$

$pp \to \tau\nu$

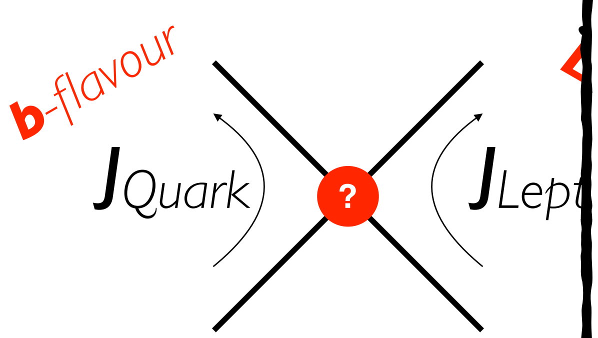


V_{EW}

B meson

$b \to c\tau\bar{\nu}_\tau$

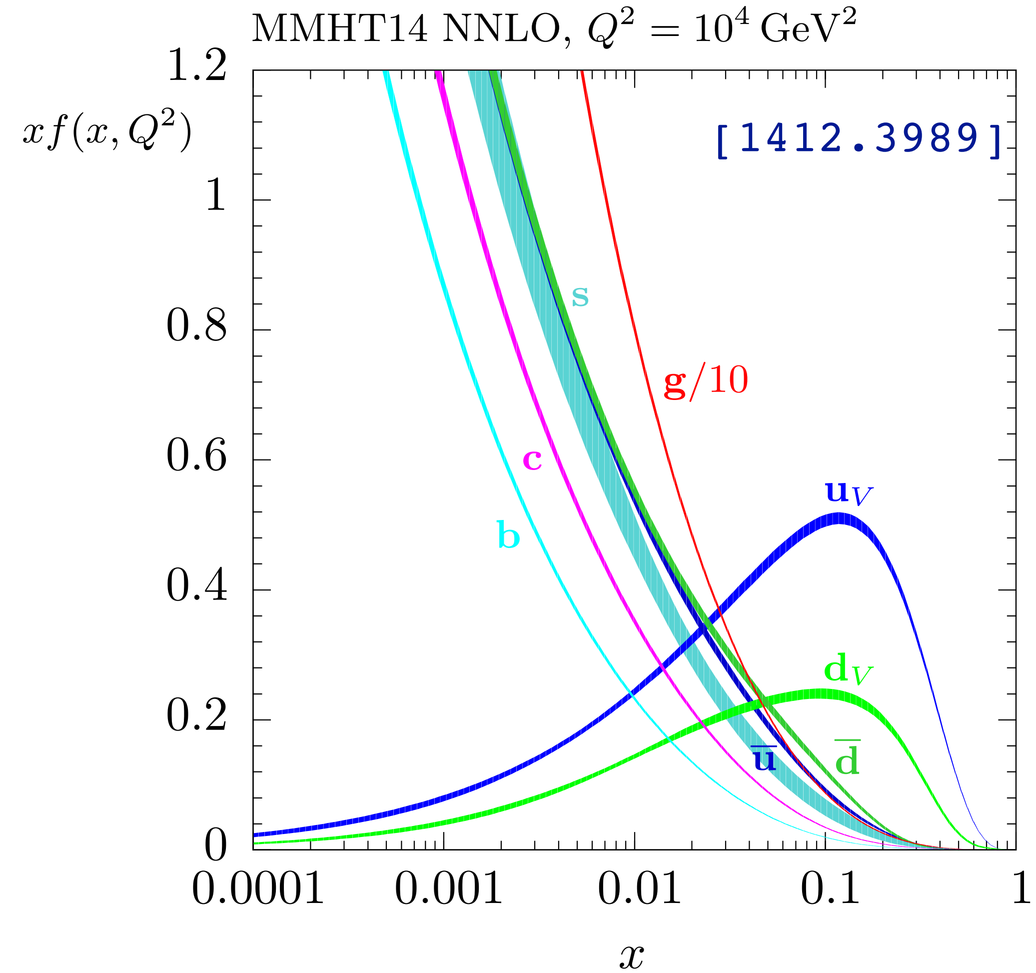
$b \to s\mu\bar{\mu}$



LHC is a …

…collider of five quark flavours

Parton distribution functions



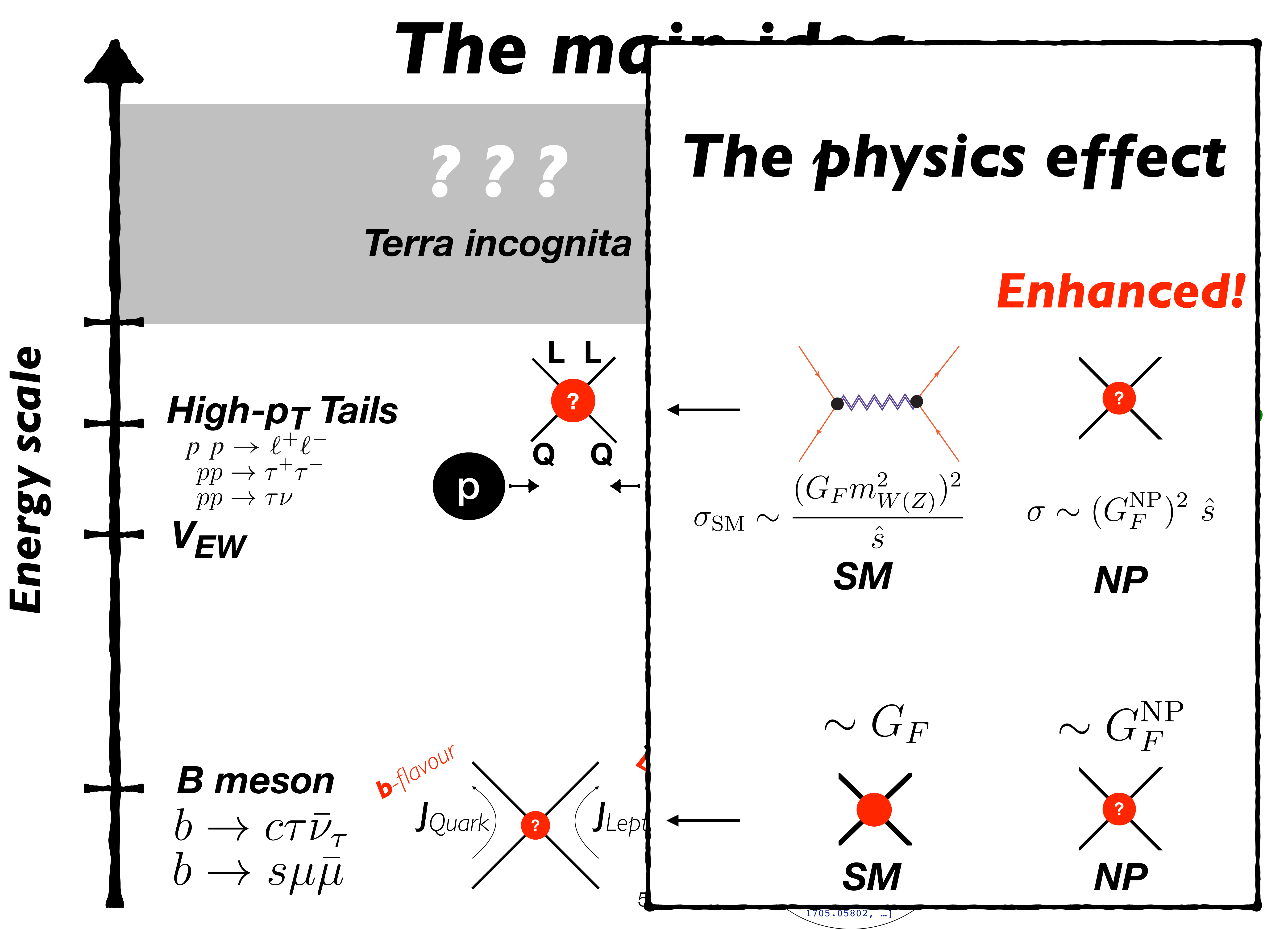
SM: Valence quark

NP: Heavy flavour

*typically

:(pdf suppression

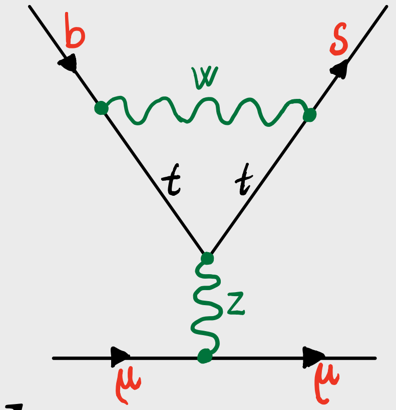
:) Excess of events


? ? ?
Terra incognita
Energy scale
High-p_T Tails
$p\ p \to \ell^+\ell^-$
$pp \to \tau^+\tau^-$
$pp \to \tau\nu$
V_{EW}
B meson
$b \to c\tau\bar{\nu}_\tau$
$b \to s\mu\bar{\mu}$
b-flavour
J_{Quark}
L L
Q Q
p
The physics effect
Enhanced!
$\sigma_{\rm SM} \sim \frac{(G_F m^2_{W(Z)})^2}{\hat{s}}$
SM
$\sigma \sim (G_F^{\rm NP})^2\ \hat{s}$
NP
$\sim G_F$
$\sim G_F^{\rm NP}$
SM
NP
1705.05802, …]

The Scope

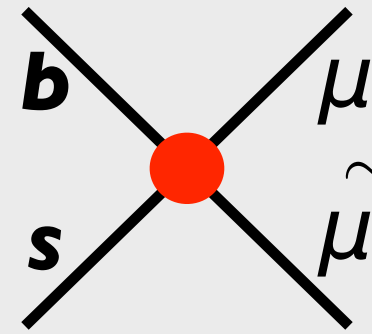
B-decays	High-p_T Tails	Reference
$b \to s\mu\bar{\mu}$ *(ee)	$pp \to \ell^+\ell^-$	[AG, Marzocca] 1704.09015
$b \to c\tau\bar{\nu}_\tau$	$pp \to \tau^+\tau^-$	[Faroughy, AG, F. Kamenik] 1609.07138
$b \to c\tau\bar{\nu}_\tau$	$pp \to \tau\nu$	[AG, Martin Camalich, Ruiz-Alvarez] 1811.XXXXX

SM:



$$b \to s\mu\bar{\mu}$$

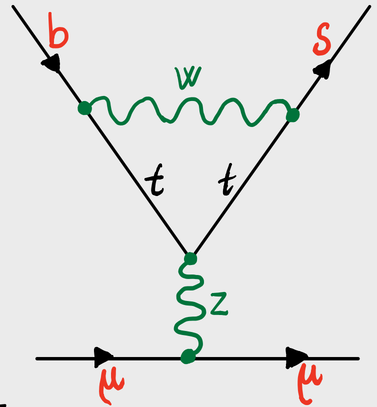
NP:



$$\sim \frac{1}{(32\,\mathrm{TeV})^2}(\bar{s}_L\gamma_\mu b_L)(\bar{\mu}_L\gamma^\mu\mu_L)$$

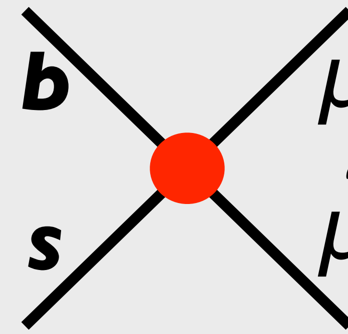
[tree-level or 1-loop]

SM:



$$b \to s\mu\bar{\mu}$$

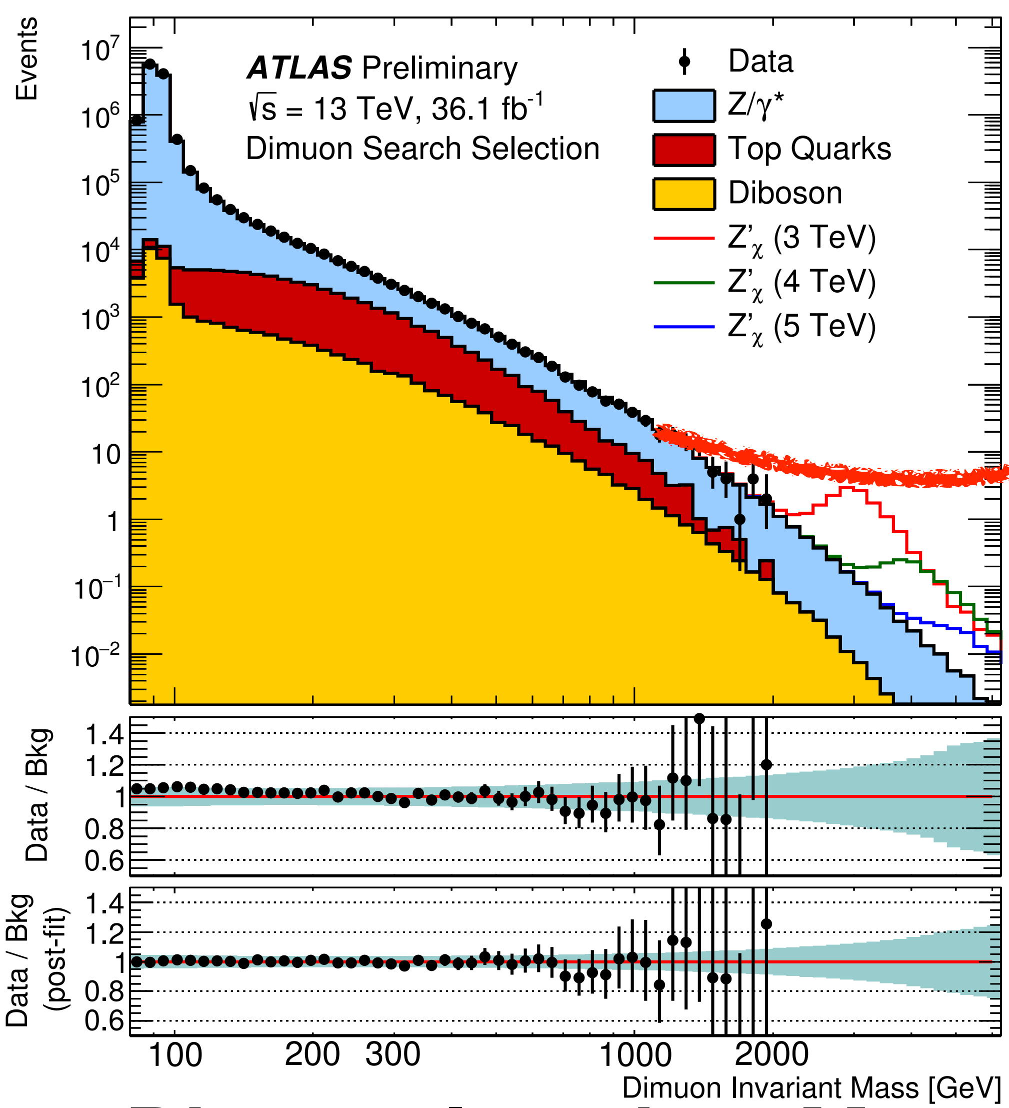
NP:



$$\sim \frac{1}{(32\,\mathrm{TeV})^2}(\bar{s}_L\gamma_\mu b_L)(\bar{\mu}_L\gamma^\mu\mu_L)$$

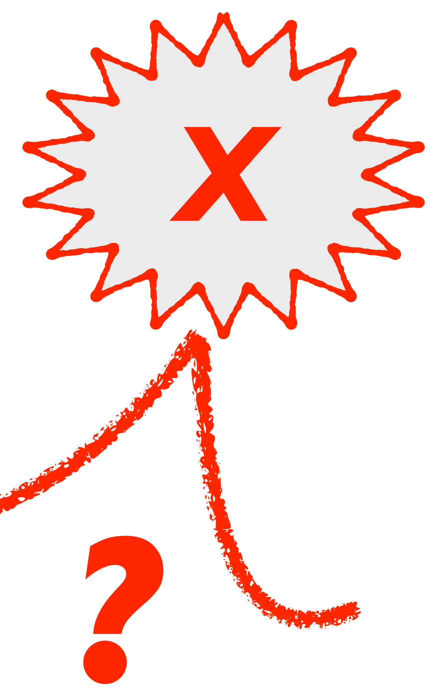
[tree-level or 1-loop]

- ***We fit this spectrum***



Dimuon Invariant Mass

[ATLAS-CONF-2017-027]



EFT validity

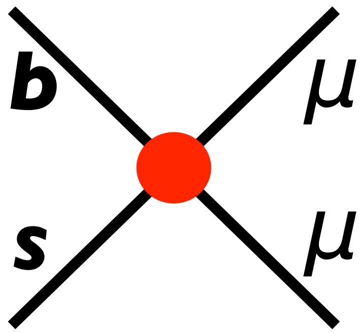
$$\hat{s} \lesssim M_X^2$$

- Typically OK

An explicit model (counter)example later

$$pp \to \ell^+\ell^-$$

Direct LHC limit on the FCNC operator?



[AG, Marzocca] 1704.09015

$$\left| \frac{\pi}{\alpha V_{tb} V_{ts}^*} C_{bs\mu} \right| < 100\ (39)$$

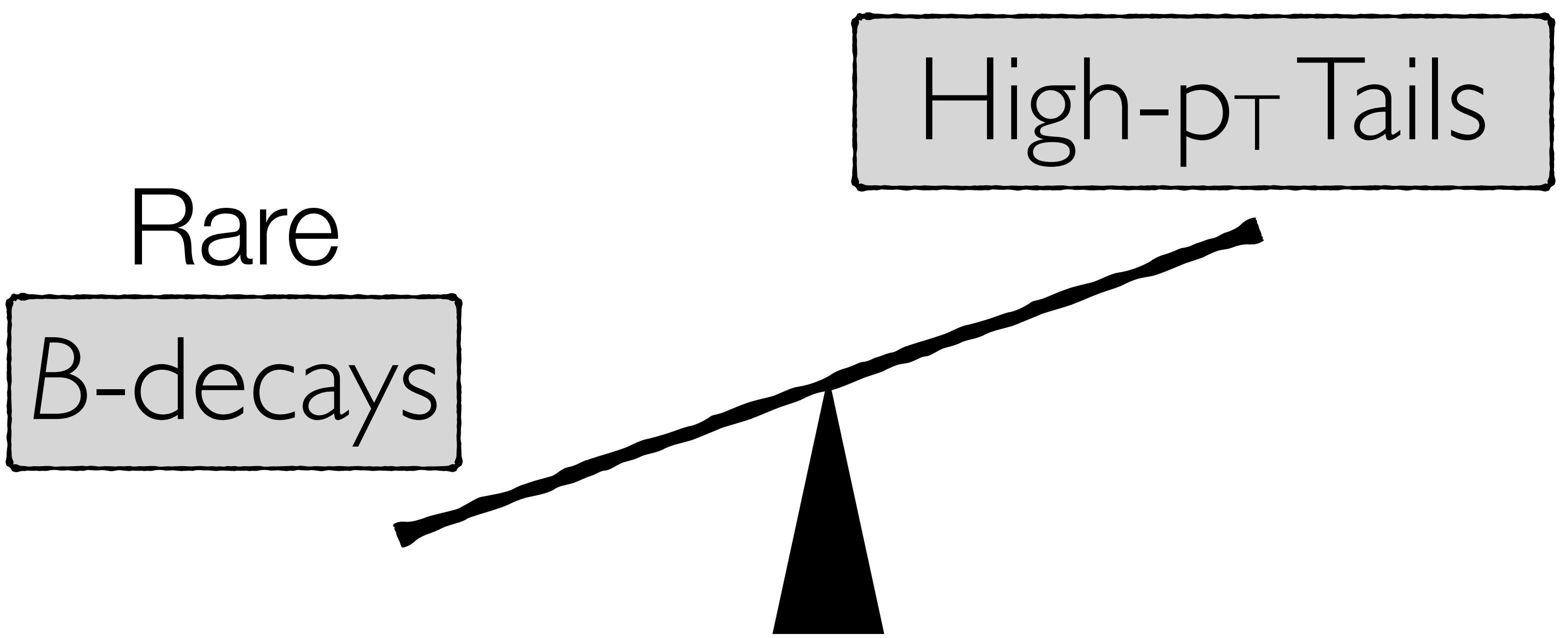
36 fb^{-1} (3000 fb^{-1})

*target ~ 1

< 67 (11)

*dedicated experimental feasibility study

[Afik, Cohen, Gozani, Kajomovitz, Rozen] 1805.11402



*Obviously!

How about flavour diagonal operators?

I would say… High-p$_T$ Tails

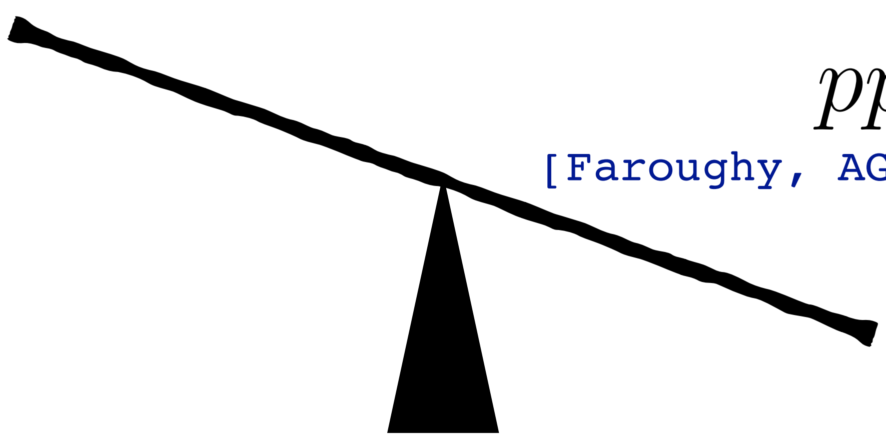
Example: $\bar{b}_L \gamma^\mu b_L \bar{\tau}_L \gamma_\mu \tau_L$

$\Upsilon \to \tau\tau$

[Aloni, Efrati, Grossman, Nir]
1702.07356

$pp \to \tau^+\tau^-$

[Faroughy, AG, F. Kamenik]
1609.07138



High-p_T Tails *for flavour diagonal operators*

$$\mathcal{L}^{\rm eff} \supset \frac{\mathbf{C}^{U\mu}_{ij}}{v^2}(\bar{u}^i_L\gamma_\mu u^j_L)(\bar{\mu}_L\gamma^\mu\mu_L) + \frac{\mathbf{C}^{D\mu}_{ij}}{v^2}(\bar{d}^i_L\gamma_\mu d^j_L)(\bar{\mu}_L\gamma^\mu\mu_L).$$

$$\mathbf{C}^{U\mu}_{ij} = \begin{pmatrix} C_{u\mu} & 0 & 0 \\ 0 & C_{c\mu} & 0 \\ 0 & 0 & C_{t\mu} \end{pmatrix}, \quad \mathbf{C}^{D\mu}_{ij} = \begin{pmatrix} C_{d\mu} & 0 & 0 \\ 0 & C_{s\mu} & C^*_{bs\mu} \\ 0 & C_{bs\mu} & C_{b\mu} \end{pmatrix}$$

- **Learn about the flavour structure**

$$\lambda^q_{bs} \equiv C_{bs\mu}/C_{q\mu}$$

$$pp \to \mu^+\mu^-$$

$$\begin{aligned}
\lambda^u_{bs} &> 0.072\ (0.77), & \lambda^u_{bs} &< -0.097\ (-0.76), \\
\lambda^d_{bs} &> 0.049\ (0.36), & \lambda^d_{bs} &< -0.032\ (-0.34), \\
\lambda^s_{bs} &> 0.007\ (0.04), & \lambda^s_{bs} &< -0.004\ (-0.03), \\
\lambda^c_{bs} &> 0.003\ (0.02), & \lambda^c_{bs} &< -0.004\ (-0.02), \\
\lambda^b_{bs} &> 0.002\ (0.01), & \lambda^b_{bs} &< -0.002\ (-0.006).
\end{aligned}$$

$36\ \text{fb}^{-1}\ (3000\ \text{fb}^{-1})$

[AG, Marzocca] 1704.09015

See also talk by D. Marzocca @ CKM 2018

*SMEFT limits in the backup

High-p_T Tails *for flavour diagonal operators*

$$\mathcal{L}^{\rm eff} \supset \frac{\mathbf{C}^{U\mu}_{ij}}{v^2}(\bar{u}^i_L \gamma_\mu u^j_L)(\bar{\mu}_L \gamma^\mu \mu_L) + \frac{\mathbf{C}^{D\mu}_{ij}}{v^2}(\bar{d}^i_L \gamma_\mu d^j_L)(\bar{\mu}_L \gamma^\mu \mu$$

$$\mathbf{C}^{U\mu}_{ij} = \begin{pmatrix} C_{u\mu} & 0 & 0 \\ 0 & C_{c\mu} & 0 \\ 0 & 0 & C_{t\mu} \end{pmatrix}, \quad \mathbf{C}^{D\mu}_{ij} = \begin{pmatrix} C_{d\mu} \\ 0 \\ 0 \end{pmatrix}$$

Looks like

MFV (thumbs down)

*3rd gen.

U(2) (thumbs up)

$pp \to \mu^+\mu^-$

77),	$\lambda^u_{bs} < -0.097\ (-0.76)$,
36),	$\lambda^d_{bs} < -0.032\ (-0.34)$,
.04),	$\lambda^s_{bs} < -0.004\ (-0.03)$,
0.02),	$\lambda^c_{bs} < -0.004\ (-0.02)$,
2 (0.01),	$\lambda^b_{bs} < -0.002\ (-0.006)$.

36 fb^{-1} (3000 fb^{-1})

[AG, Marzocca] 1704.09015

- **Learn about the flavour structure**

$$\lambda^q_{bs} \equiv C_{bs\mu}/C_{q\mu}$$

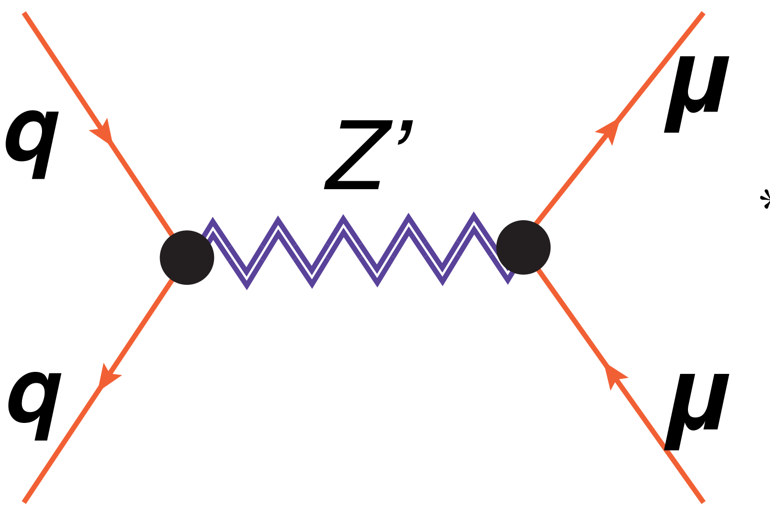
See also talk by D. Marzocca @ CKM 2018

*SMEFT limits in the backup

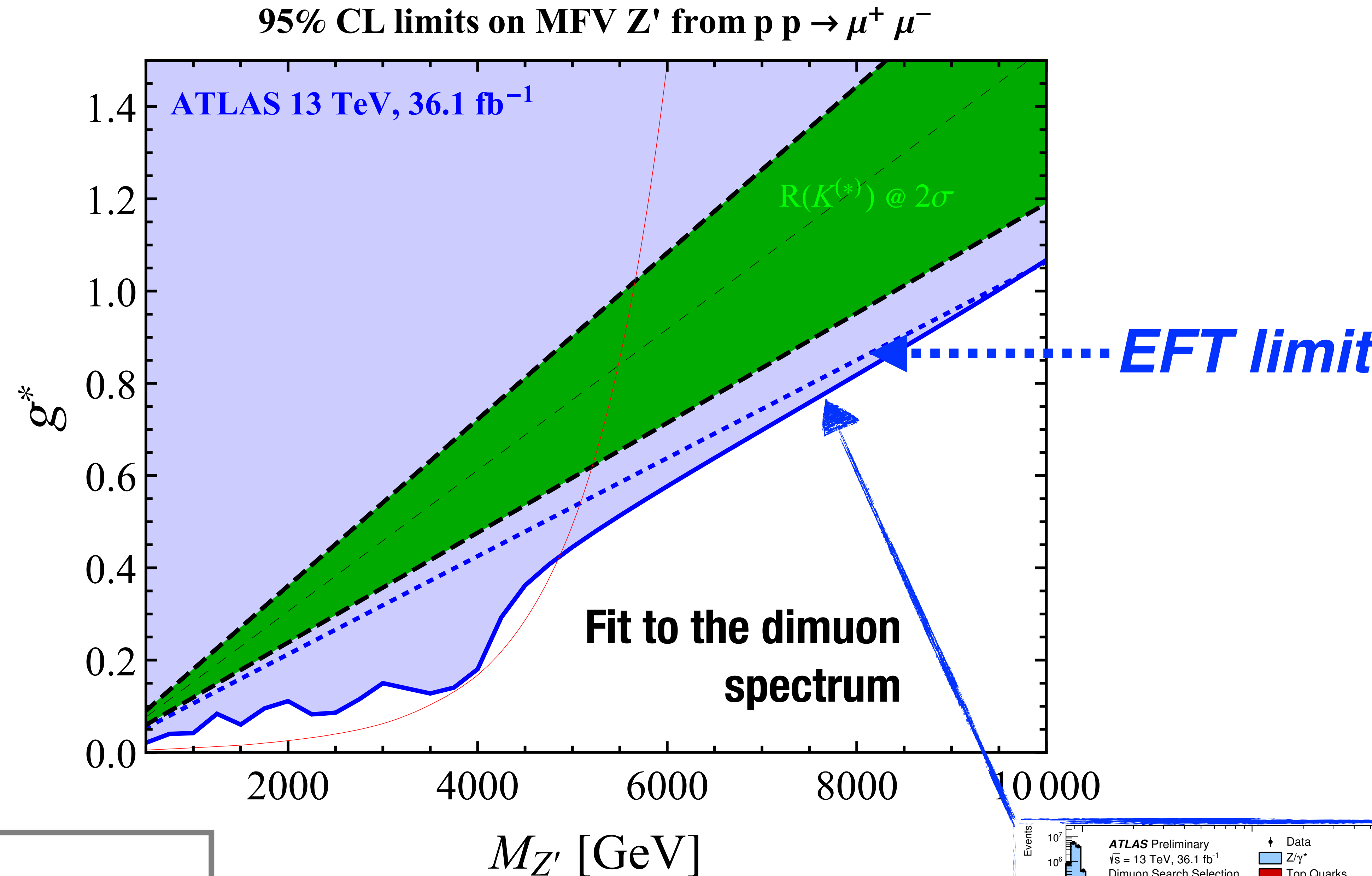
Example: ***MFV Z'***

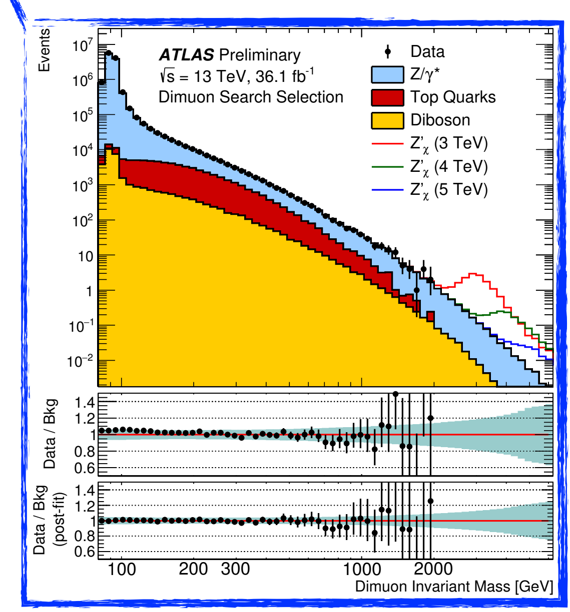
[AG, Marzocca] 1704.09015

$pp \to \mu^+ \mu^-$



$$\Gamma_{Z'}/M_{Z'} \approx 5 g_*^2/(6\pi)$$





Z' couplings

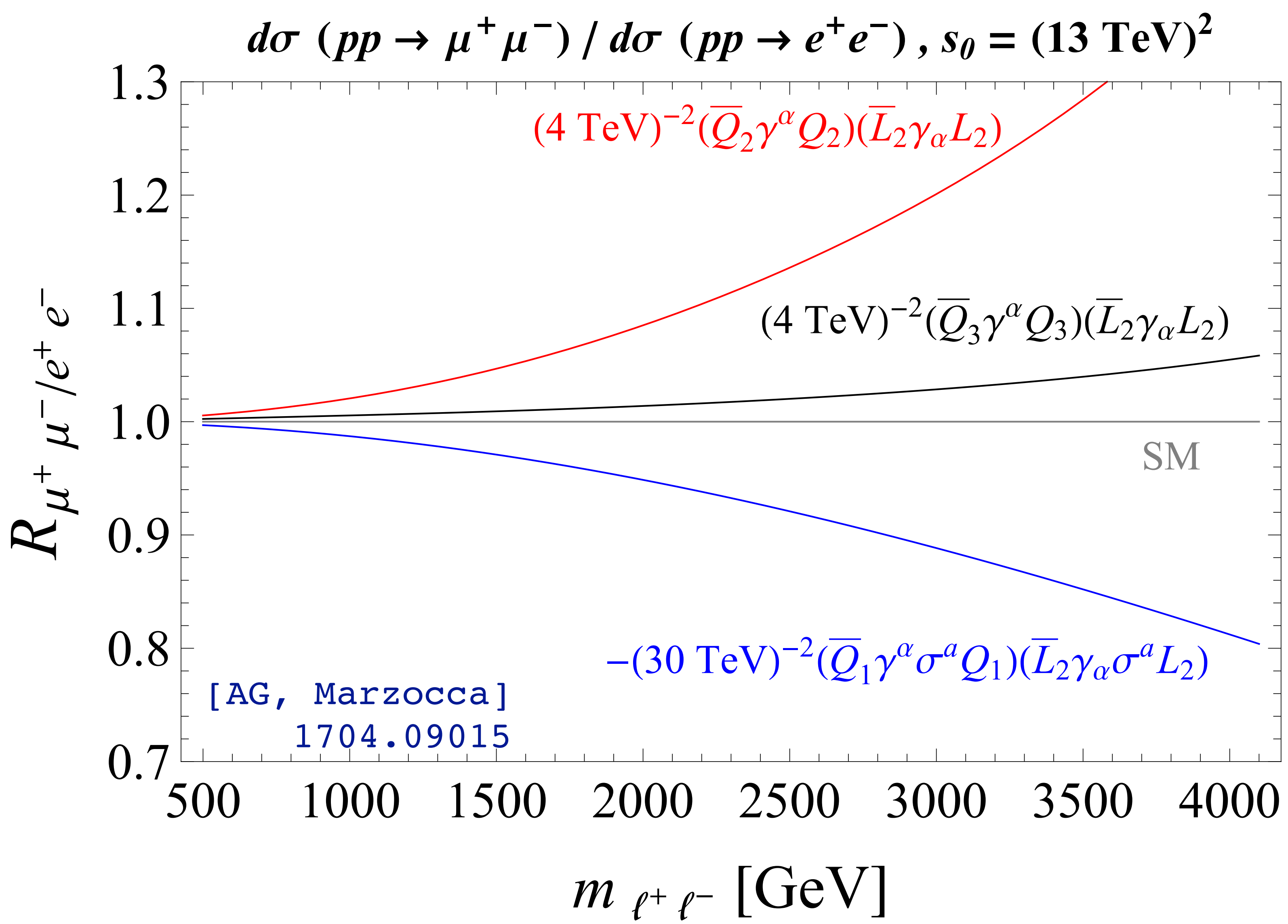
$$\mathscr{L} \supset Z'_\mu J_\mu$$

$$J_\mu = g_Q^{(1),ij} (\bar{Q}_i \gamma_\mu Q_j) + g_L^{(1),kl} (\bar{L}_k \gamma^\mu L_l)$$

$$g_Q^{(1),ii} = g_L^{(1),22} = g_* \qquad g_Q^{(1),23} = V_{ts} g_*$$

$$\Delta F = 2$$

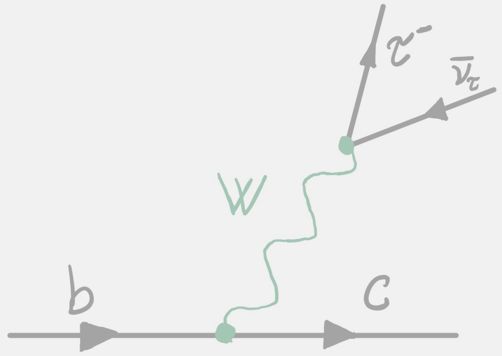
Lepton flavour universality tests



Proposal: ***R-ratios at high-p_T***

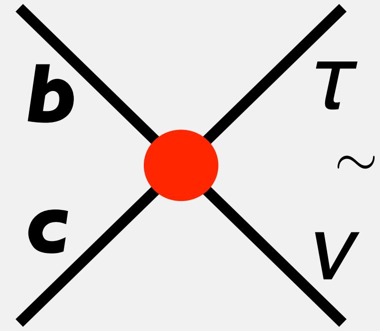
*SMEFT limits in the backup

SM:



$$b \to c \tau \bar{\nu}_\tau$$

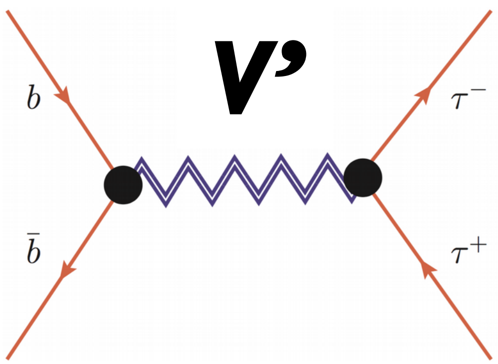
NP:

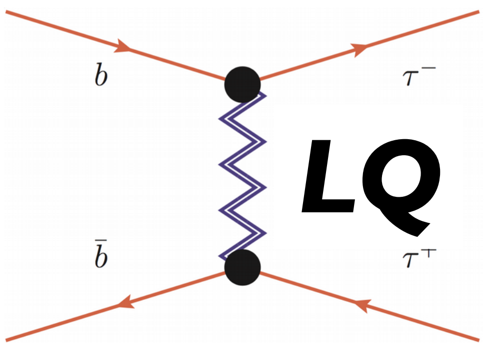


$$\sim \frac{2}{(3.5\,\text{TeV})^2} (\bar{c}_L \gamma_\mu b_L)(\bar{\tau}_L \gamma^\mu \nu_L)$$

[tree-level]

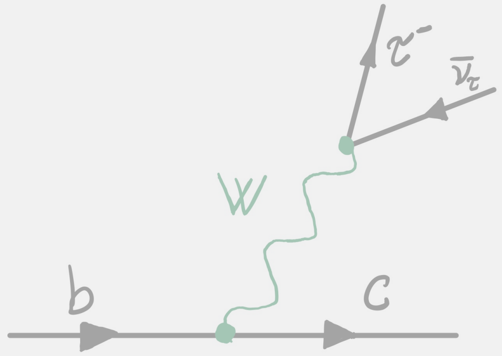
EFT fails *typically





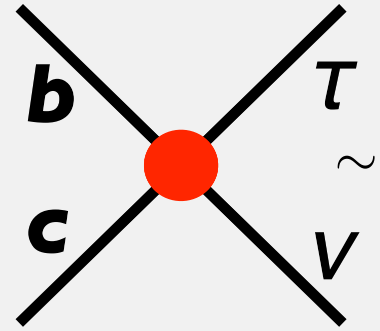
Simplified models

SM:



$$b \to c\tau\bar{\nu}_\tau$$

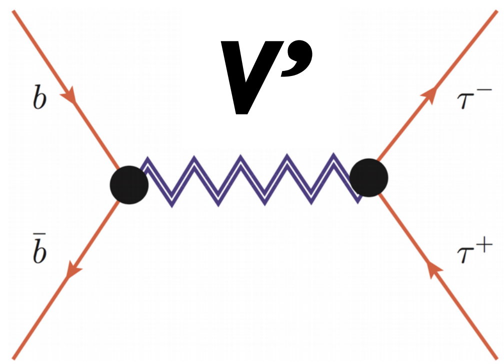
NP:

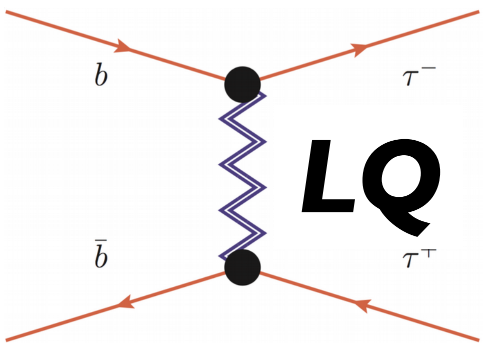


$$\sim \frac{2}{(3.5\,\mathrm{TeV})^2}(\bar{c}_L\gamma_\mu b_L)(\bar{\tau}_L\gamma^\mu\nu_L)$$

[tree-level]

EFT fails*typically



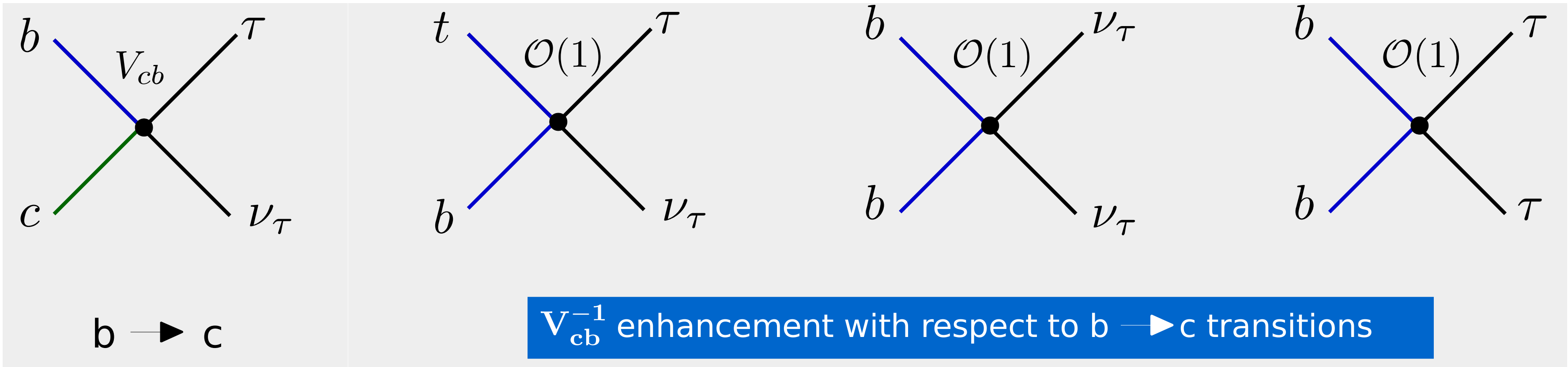


Simplified models

- ***Important observation***

[Faroughy, AG, F. Kamenik] 1609.07138

SU(2) invariance & Flavor structure



Talk by Darius Faroughy @ CKM 2018

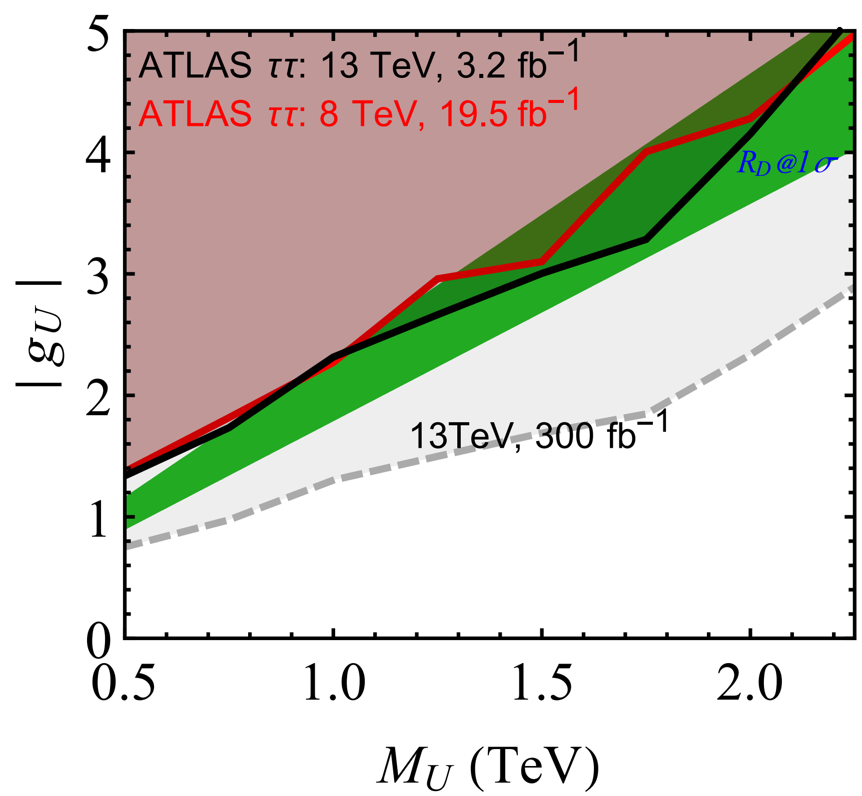
Large!

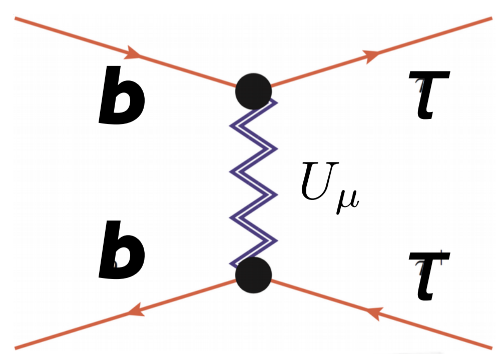
$$pp \to \tau^+\tau^-$$

Example: ***Vector LQ*** $U_1^\mu \equiv (\mathbf{3}, \mathbf{1}, 2/3)$

$$\mathcal{L}_U = g_U (J_U^\mu U_{1,\mu} + \mathrm{h.c.})$$
$$J_U^\mu \equiv \beta_{i\alpha} \, \bar{Q}_i \gamma^\mu L_\alpha$$

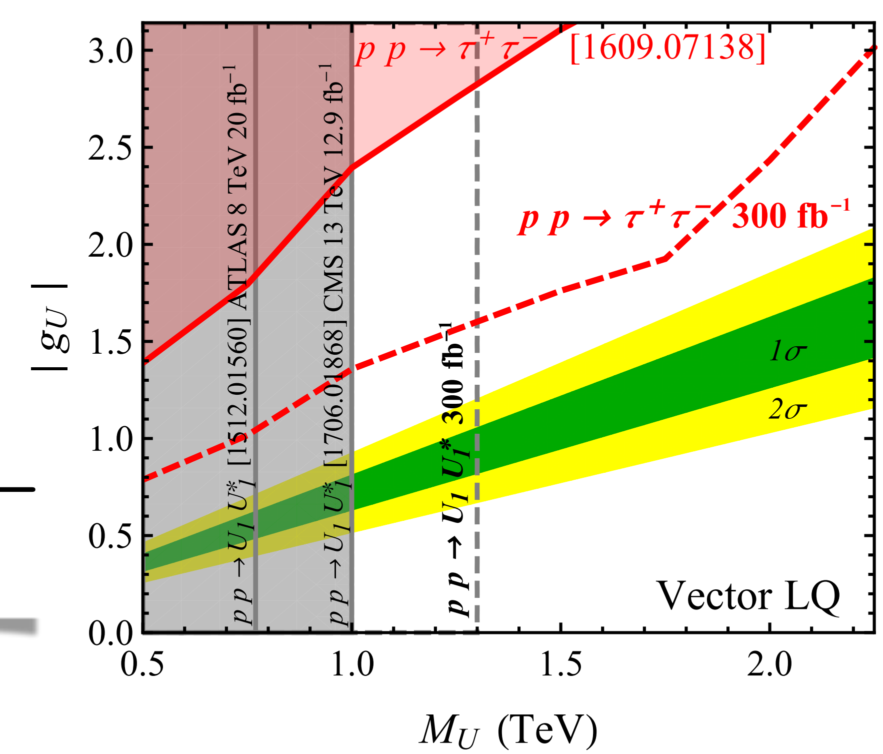
[Faroughy, AG, F. Kamenik] 1609.07138





$$pp \to \tau^+\tau^-$$

[Buttazzo, AG, Isidori, Marzocca] 1706.07808



$$\frac{(\bar{c}_L \gamma^\mu b_L)(\bar{\tau}_L \gamma_\mu \nu_L)}{(\bar{b}_L \gamma^\mu b_L)(\bar{\tau}_L \gamma_\mu \tau_L)} \sim V_{cb}$$

$$\frac{(\bar{c}_L \gamma^\mu b_L)(\bar{\tau}_L \gamma_\mu \nu_L)}{(\bar{b}_L \gamma^\mu b_L)(\bar{\tau}_L \gamma_\mu \tau_L)} \sim 5\, V_{cb}$$

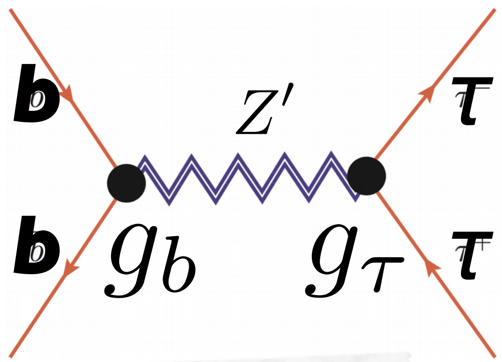
Talk by Di Luzio

Example: ***VTM*** $W' = (\mathbf{1}, \mathbf{3}, 0)$

[AG, Isidori, Marzocca] 1506.01705

$$J^{a\mu}_{W'} \equiv \lambda^q_{ij} \bar{Q}_i \gamma^\mu \sigma^a Q_j + \lambda^\ell_{ij} \bar{L}_i \gamma^\mu \sigma^a L_j$$

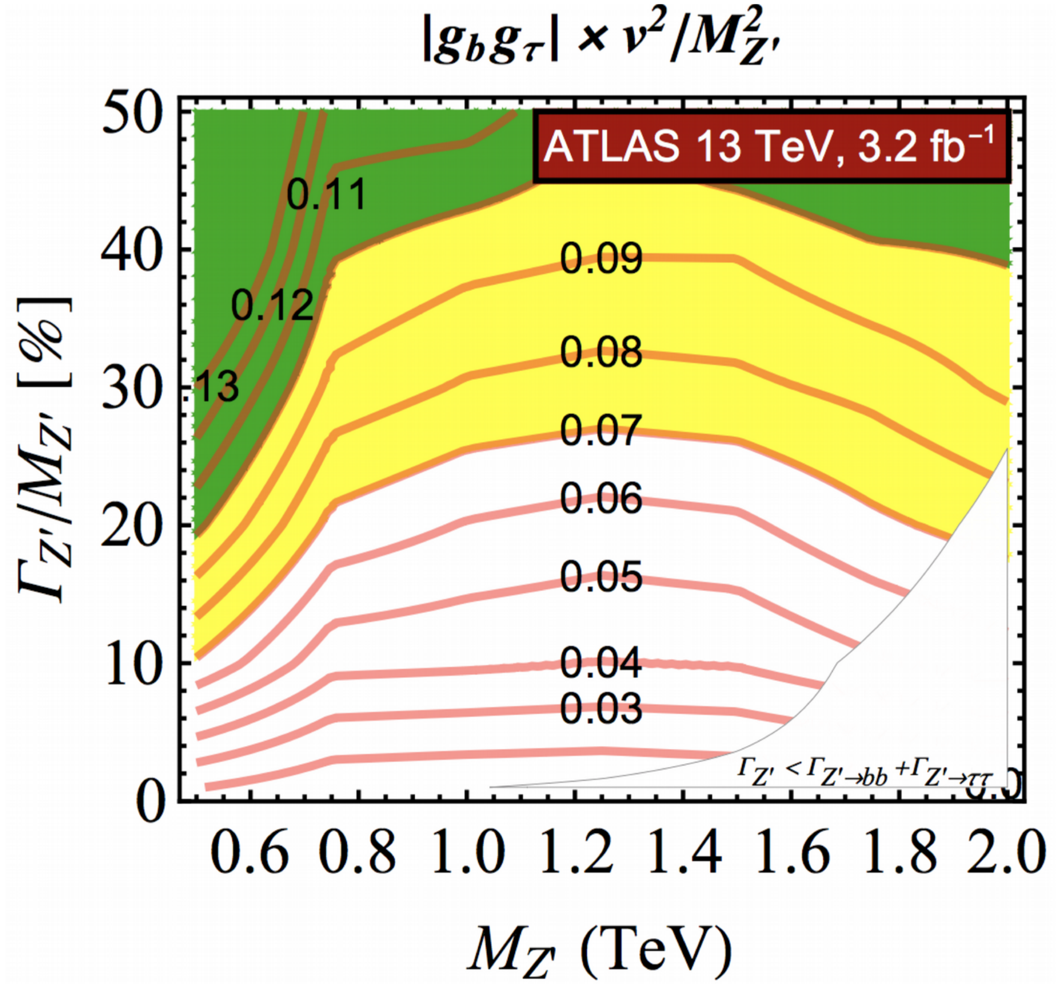
$\lambda^{q(\ell)}_{ij} \simeq g_{b(\tau)} \delta_{i3} \delta_{j3}$



$pp \to \tau^+ \tau^-$

Broad!

[Faroughy, AG, F. Kamenik] 1609.07138



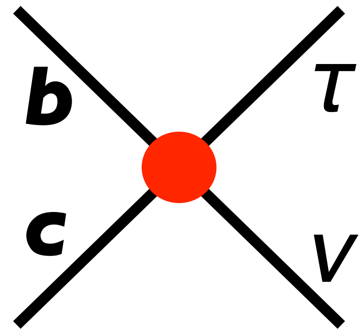
*New ATLAS analysis available

Talks by Tetiana Hrynova, Roman Kogler

For updates ask D. Faroughy

exclusive
$*$ + jet
Talk by
Amarjit Soni

$R(D^{(*)})$

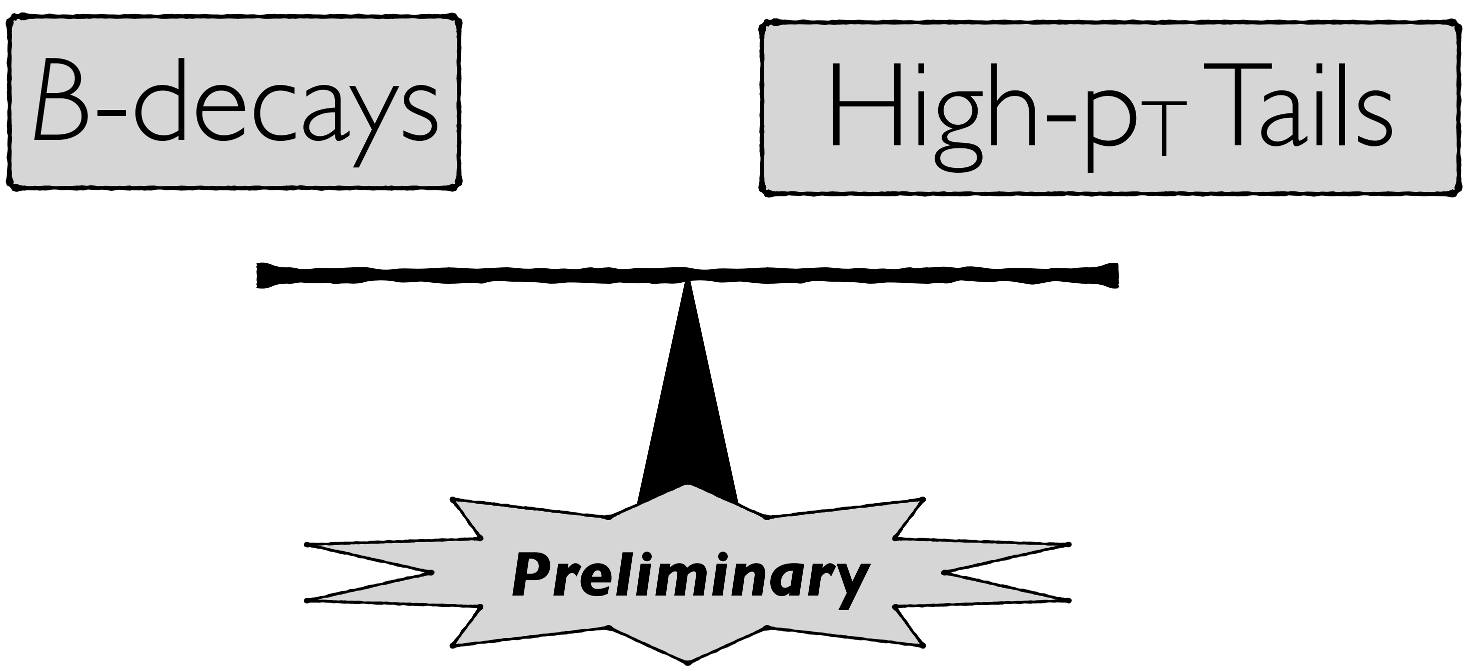


$pp \to \tau\nu$ **inclusive**

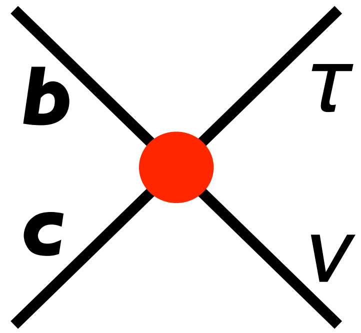
[AG, Martin Camalich, Ruiz-Alvarez]
1811.XXXXX

- ***Direct probe!***

Semi-tauonic



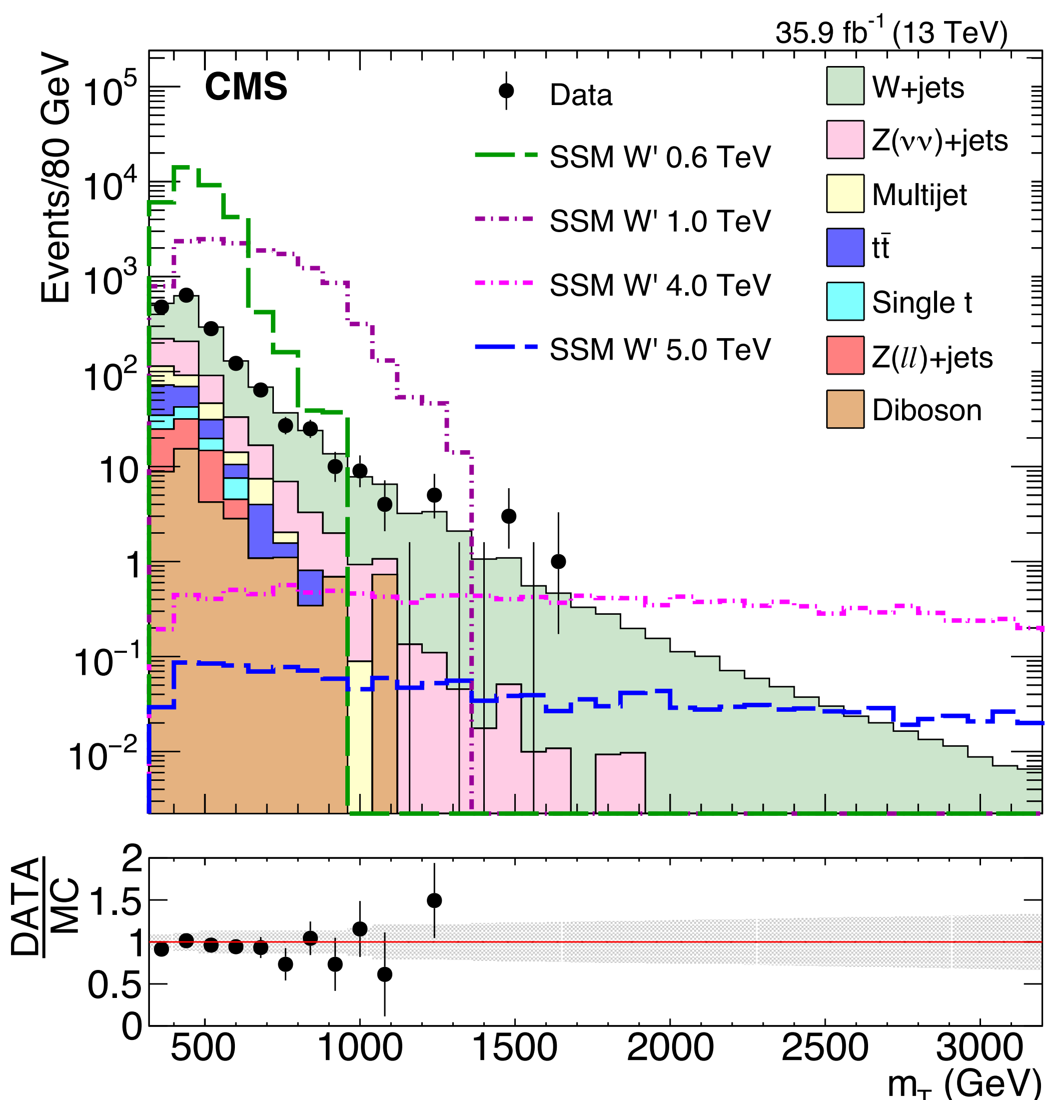
$R(D^{(*)})$



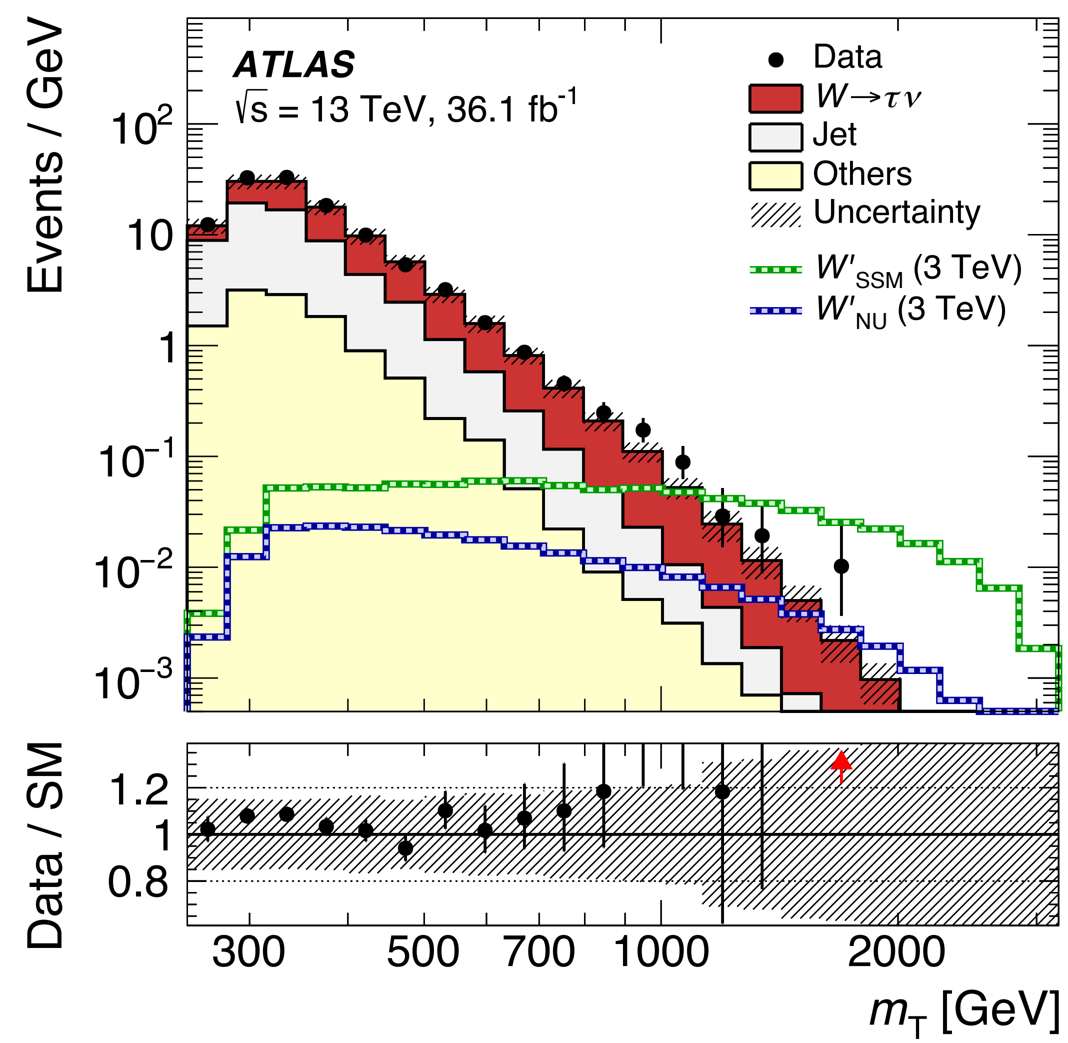
$pp \to \tau\nu$ **inclusive**

[AG, Martin Camalich, Ruiz-Alvarez]
1811.XXXXX

- ***Direct probe!***



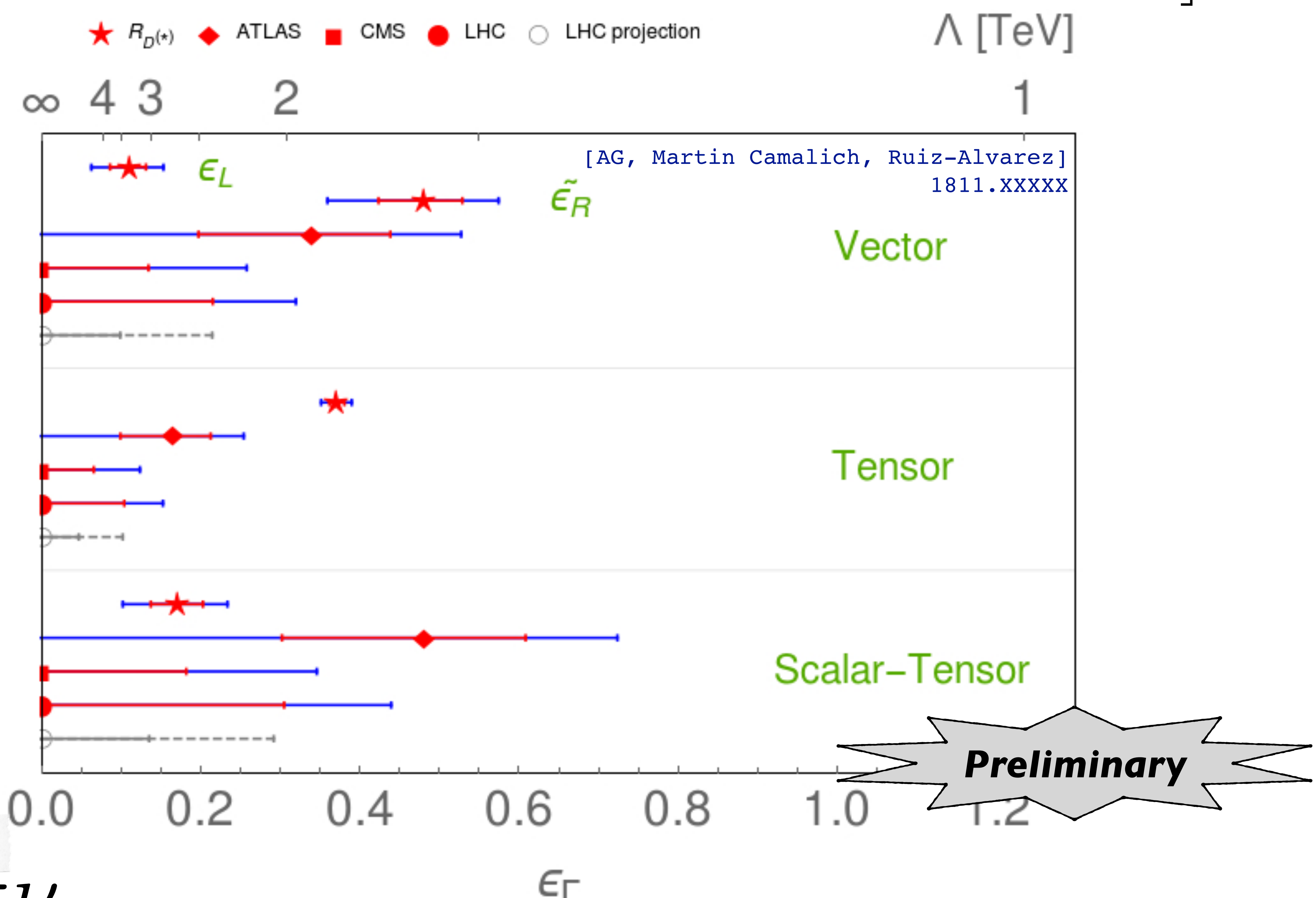
1807.11421



1801.06992

$$\mathcal{L}_{\mathrm{LEEFT}} \supset -\frac{2V_{kl}}{v^2}\Big[\Big(1+\epsilon_L^{kl\tau}\Big)\bar{\tau}\gamma_\mu P_L\nu_\tau\cdot\bar{u}_k\gamma^\mu P_L d_l+\epsilon_R^{kl\tau}\bar{\tau}\gamma_\mu P_L\nu_\tau\cdot\bar{u}_k\gamma^\mu P_R d_l$$

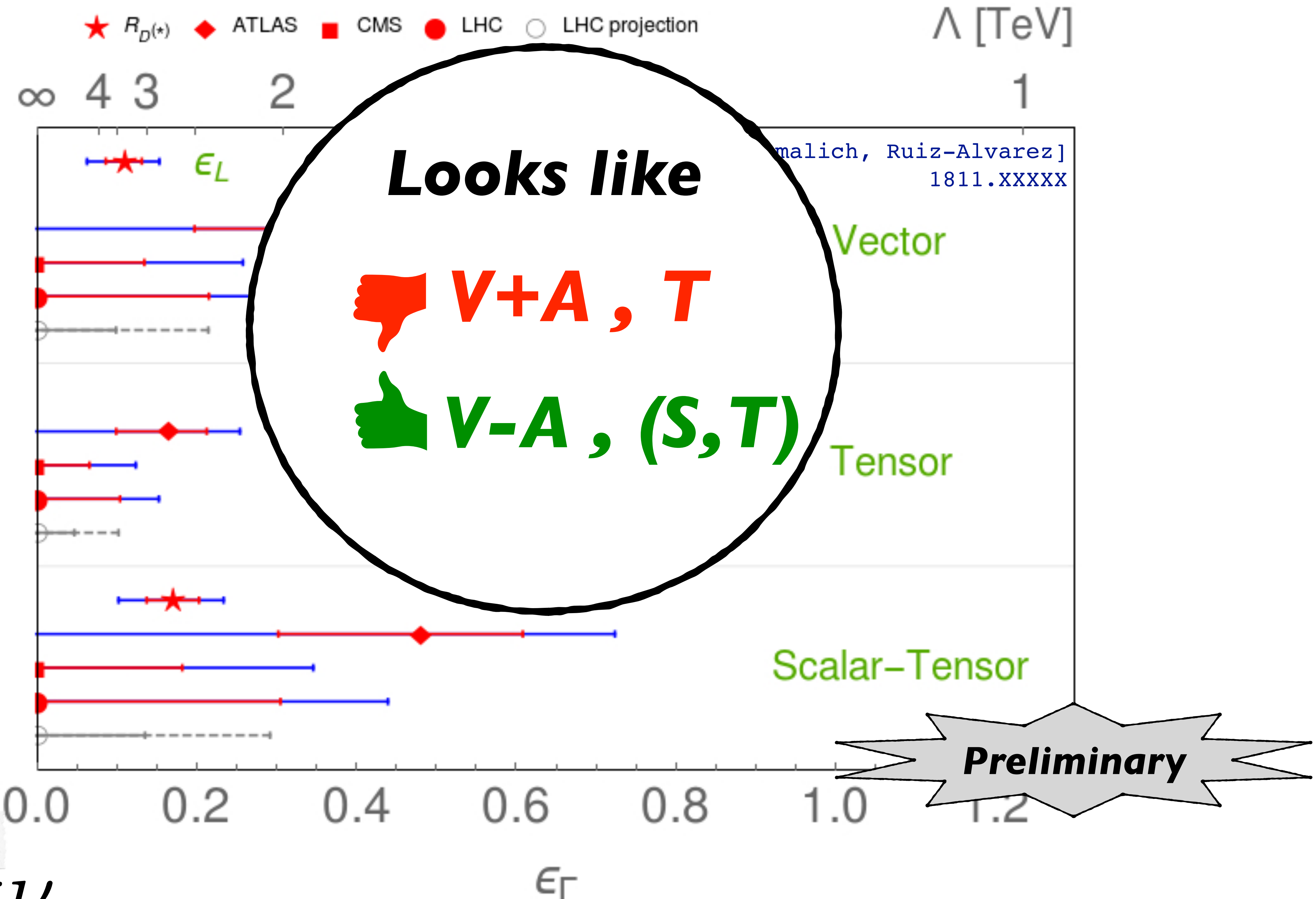
$$+\epsilon_T^{kl\tau}\,\bar{\tau}\sigma_{\mu\nu}P_L\nu_\tau\cdot\bar{u}_k\sigma^{\mu\nu}P_L d+\epsilon_{S_L}^{kl\tau}\bar{\tau}P_L\nu_\tau\cdot\bar{u}_kP_Ld_l+\epsilon_{S_R}^{kl\tau}\bar{\tau}P_L\nu_\tau\cdot\bar{u}_kP_Rd_l\Big]+\mathrm{h.c.},$$



$pp \to \tau\nu$

$$\mathcal{L}_{\rm LEEFT} \supset -\frac{2V_{kl}}{v^2}\Big[\Big(1+\epsilon_L^{kl\tau}\Big)\bar\tau\gamma_\mu P_L\nu_\tau\cdot\bar u_k\gamma^\mu P_L d_l+\epsilon_R^{kl\tau}\bar\tau\gamma_\mu P_L\nu_\tau\cdot\bar u_k\gamma^\mu P_R d_l$$

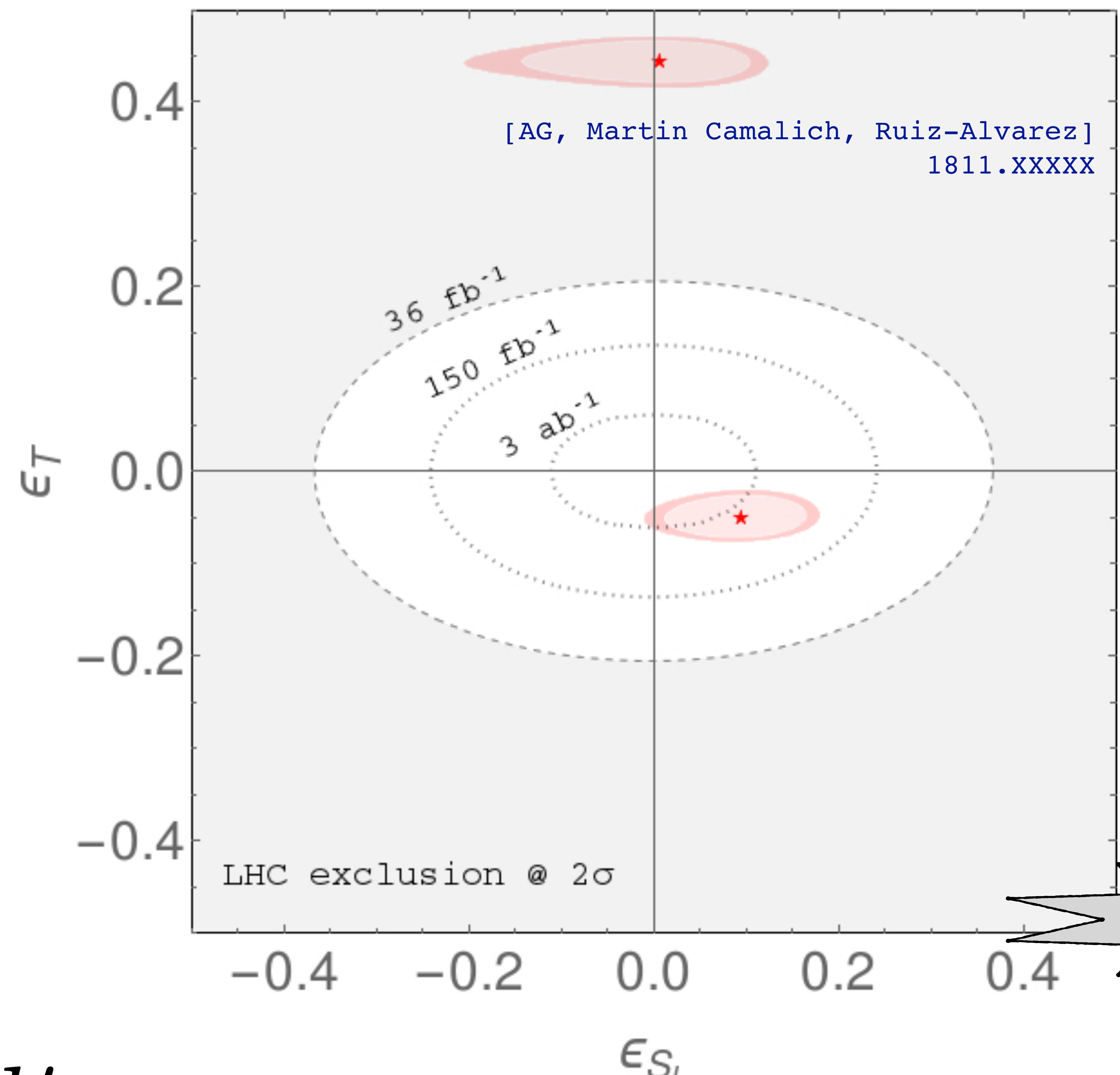
$$+\,\epsilon_T^{kl\tau}\,\bar\tau\sigma_{\mu\nu}P_L\nu_\tau\cdot\bar u_k\sigma^{\mu\nu}P_L d+\epsilon_{S_L}^{kl\tau}\bar\tau P_L\nu_\tau\cdot\bar u_k P_L d_l+\epsilon_{S_R}^{kl\tau}\bar\tau P_L\nu_\tau\cdot\bar u_k P_R d_l\Big]+\text{h.c.},$$



$pp \to \tau\nu$

$$\mathcal{L}_{\rm LEEFT} \supset -\frac{2V_{kl}}{v^2}\Big[\Big(1+\epsilon_L^{kl\tau}\Big)\bar\tau\gamma_\mu P_L\nu_\tau\cdot\bar u_k\gamma^\mu P_L d_l + \epsilon_R^{kl\tau}\bar\tau\gamma_\mu P_L\nu_\tau\cdot\bar u_k\gamma^\mu P_R d_l$$

$$+\epsilon_T^{kl\tau}\,\bar\tau\sigma_{\mu\nu}P_L\nu_\tau\cdot\bar u_k\sigma^{\mu\nu}P_L d + \epsilon_{S_L}^{kl\tau}\bar\tau P_L\nu_\tau\cdot\bar u_k P_L d_l + \epsilon_{S_R}^{kl\tau}\bar\tau P_L\nu_\tau\cdot\bar u_k P_R d_l\Big] + \text{h.c.},$$



(S,T)
closer look

$pp \to \tau\nu$

Example:

$$W' = (\mathbf{1}, \mathbf{1}, +1)$$

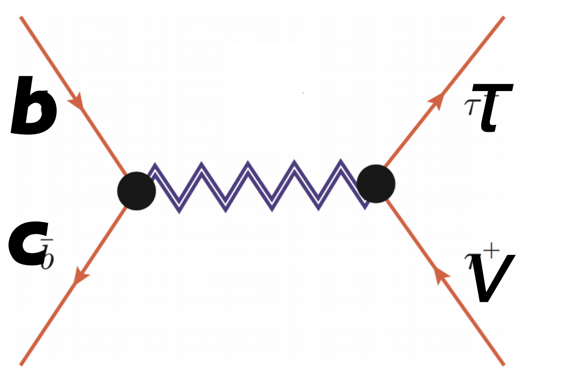
+ light

$$N_R = (\mathbf{1}, \mathbf{1}, 0)$$

[Asadi, Buckley, Shih] 1804.04135
[AG, Robinson, Shakya, Zupan] 1804.04642

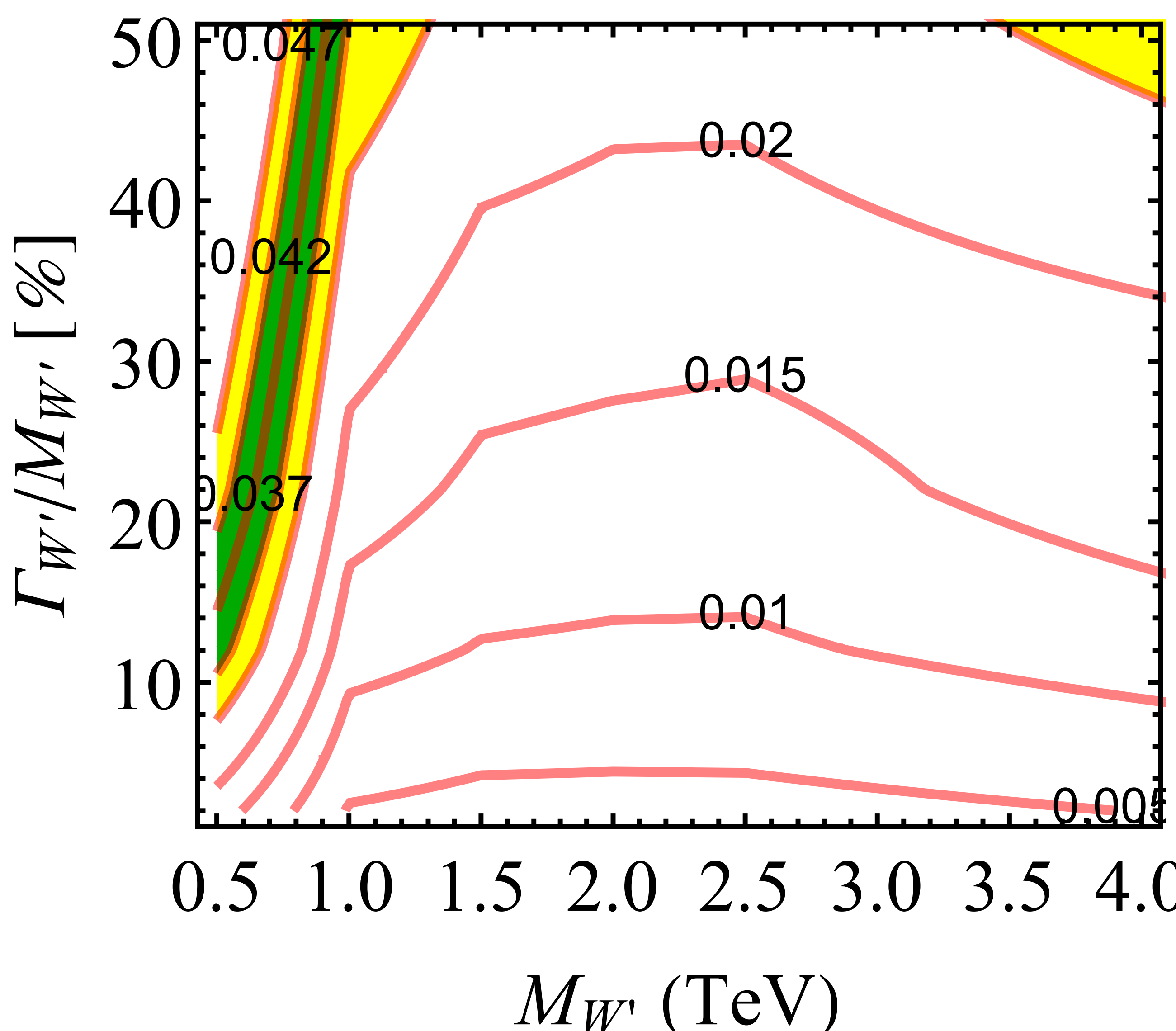
Talk by David Shih

$$\mathcal{L} \supset (g_c\, \bar{c}_L \gamma^\mu b_L + \; g_\tau\, \bar{\nu}_L^\tau \gamma^\mu \tau_L)\, W'^+_\mu + \text{h.c.}$$



$$pp \to \tau\nu$$

$$|g_c g_\tau| \times v^2/M^2_{W'}$$



ATLAS 36 fb^{-1} + CMS 36 fb^{-1}

[AG, Martin Camalich, Ruiz-Alvarez] 1811.XXXXX

Broad!
again

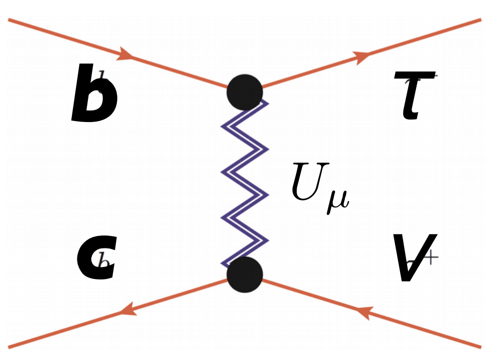
Preliminary

Example:

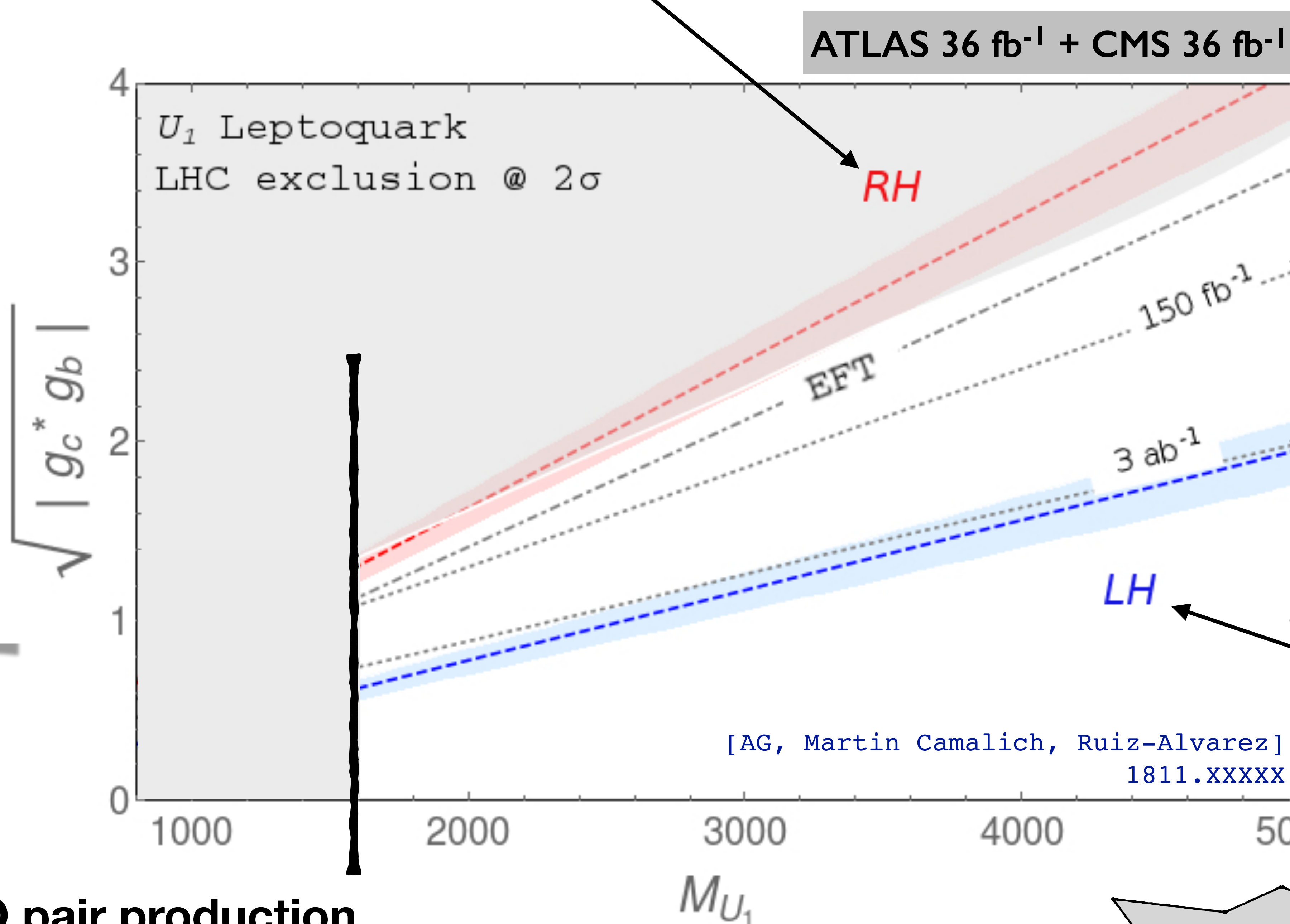
$U_1^\mu \sim (\mathbf{3}, \mathbf{1}, 2/3)$
+ light
$N_R = (\mathbf{1}, \mathbf{1}, 0)$

[Robinson, Shakya, Zupan] 1807.04753

[Azatov, Barducci, Ghosh, Marzocca, Ubaldi] 1807.10745



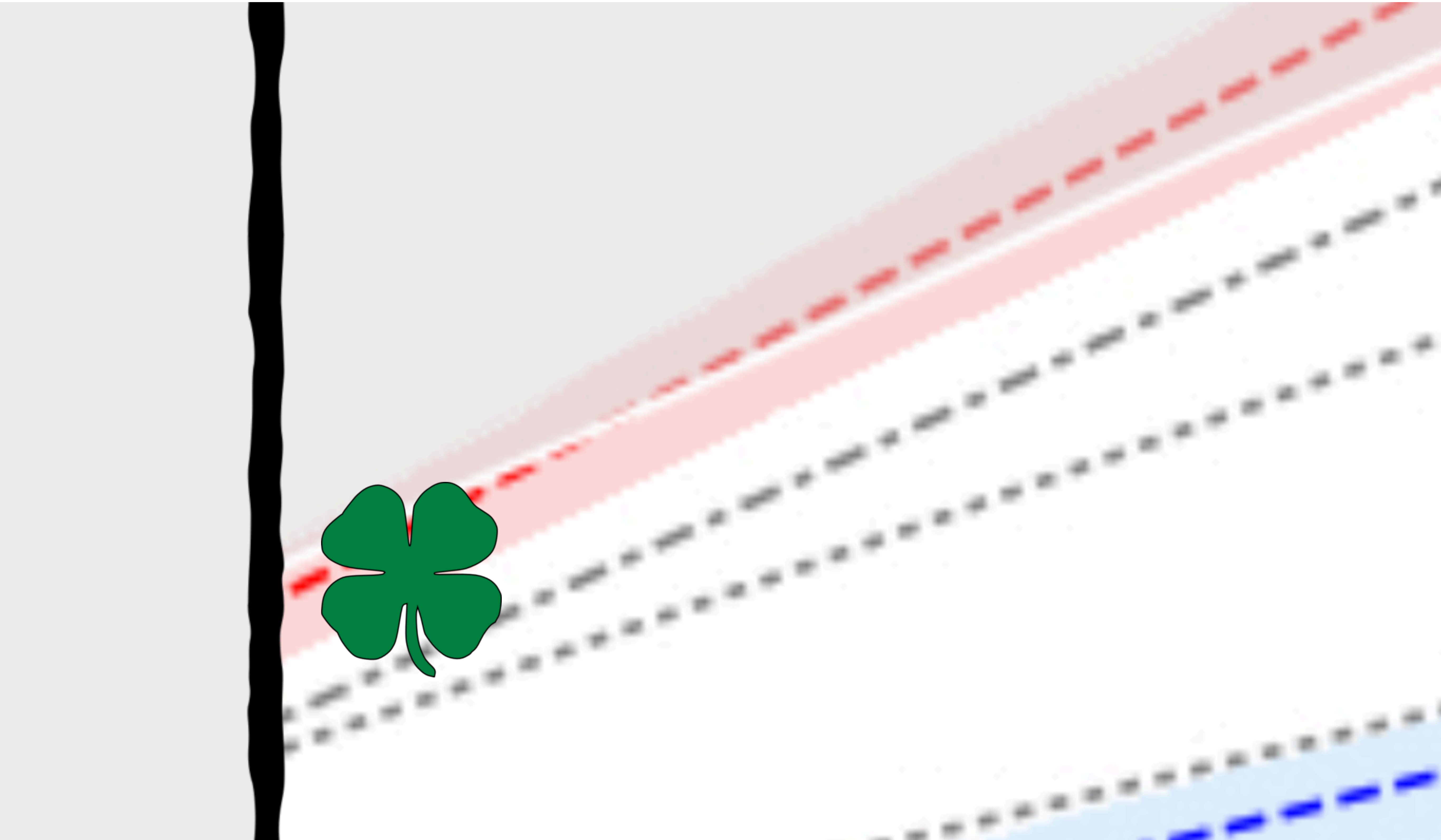
$$pp \to \tau\nu$$



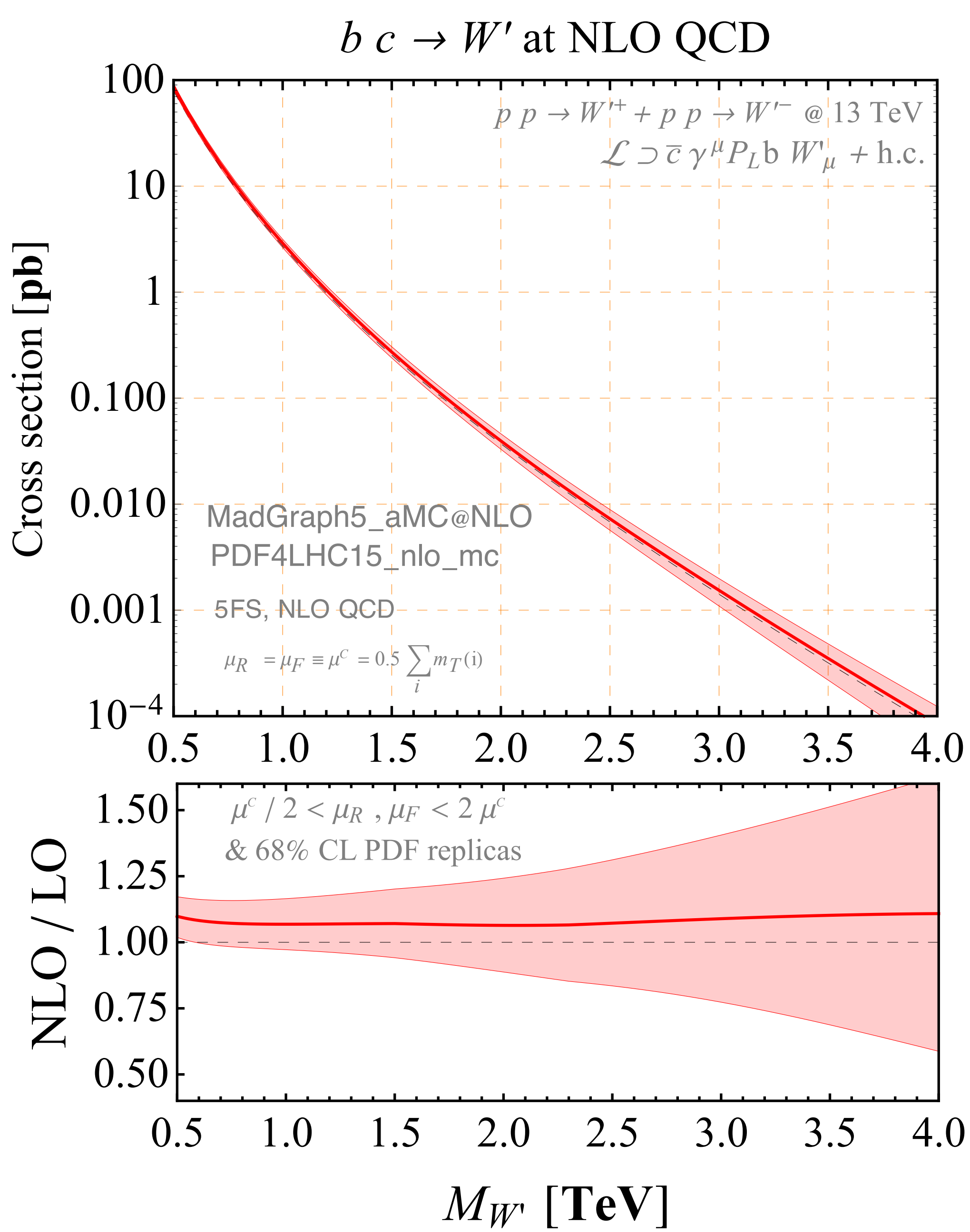
[Buttazzo, AG, Isidori, Marzocca] 1706.07808

LQ pair production
Talks by Roman Kogler

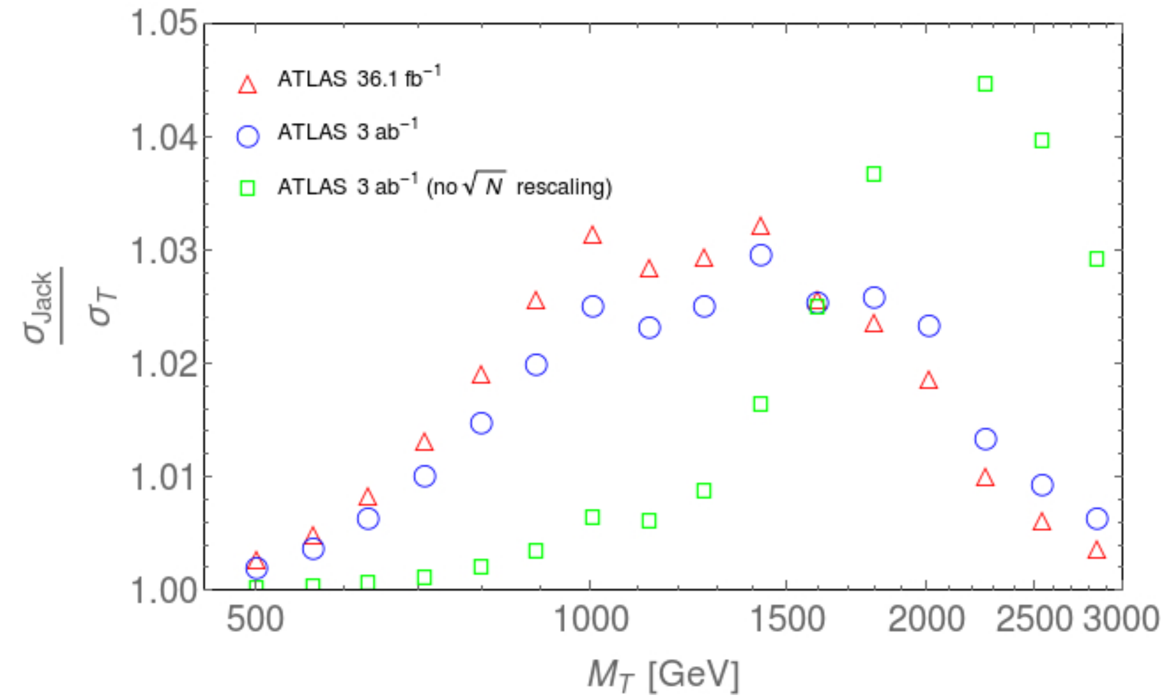
Preliminary

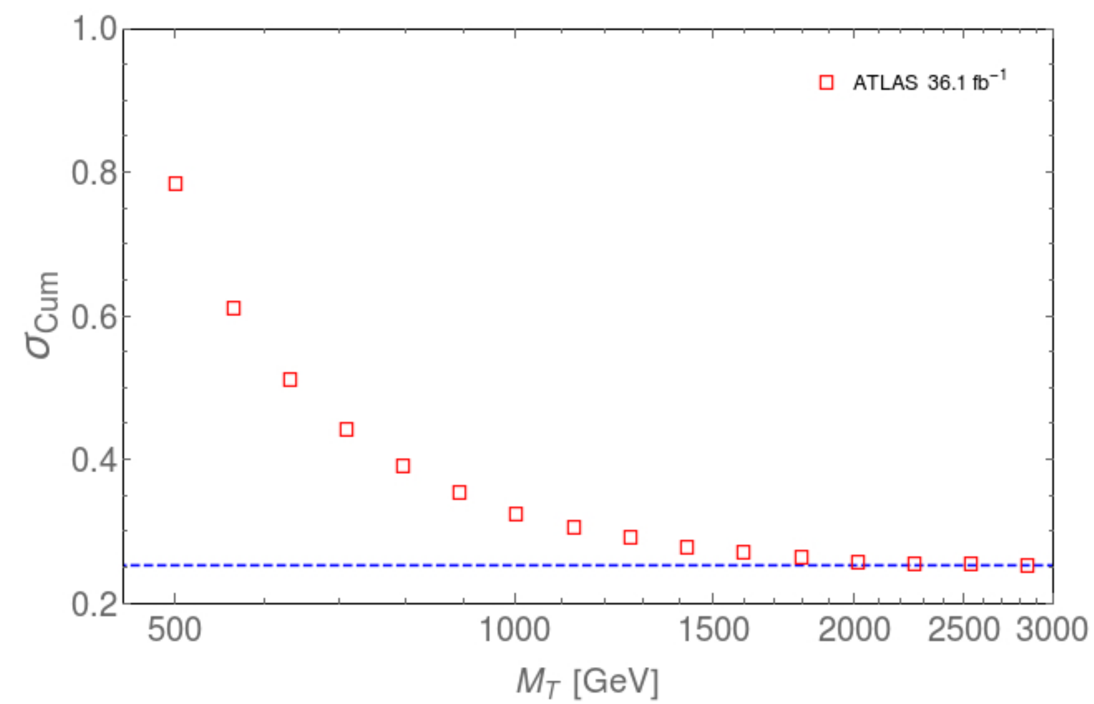


- Systematic uncertainties
- Signal prediction @ NLO QCD
- PDF determination not effected by this NP



- Analysis of the most sensitive bins





Conclusions

Looks like

 $R(D^{(*)})$

 $R(K^{(*)})$

- High-p_T Tails relevant for several models presented here. See talks
  Z', W': Cox, Ziegler, Shih
  LQ: Kosnik, Sumensari, Marzocca

Backup slides

$$\mathcal{A}(q^i_{p_1}\bar{q}^j_{p_2}\to\ell^-_{p'_1}\ell^+_{p'_2}) = i\sum_{q_L,q_R}\sum_{\ell_L,\ell_R}(\bar{q}^i\gamma^\mu q^j)\,(\bar{\ell}\gamma_\mu\ell)\;F_{q\ell}(p^2),$$

$$F_{q\ell}(p^2) = \delta^{ij}\frac{e^2 Q_q Q_\ell}{p^2} + \delta^{ij}\frac{g^q_Z g^\ell_Z}{p^2 - m^2_Z + i m_Z\Gamma_Z} + \frac{\epsilon^{q\ell}_{ij}}{v^2}$$

$$\hat{\sigma} = \frac{s}{144\pi}\Big(|F_{q_L\ell_L}(s)|^2 + |F_{q_R\ell_R}(s)|^2 + |F_{q_L\ell_R}(s)|^2 + |F_{q_R\ell_L}(s)|^2\Big),$$

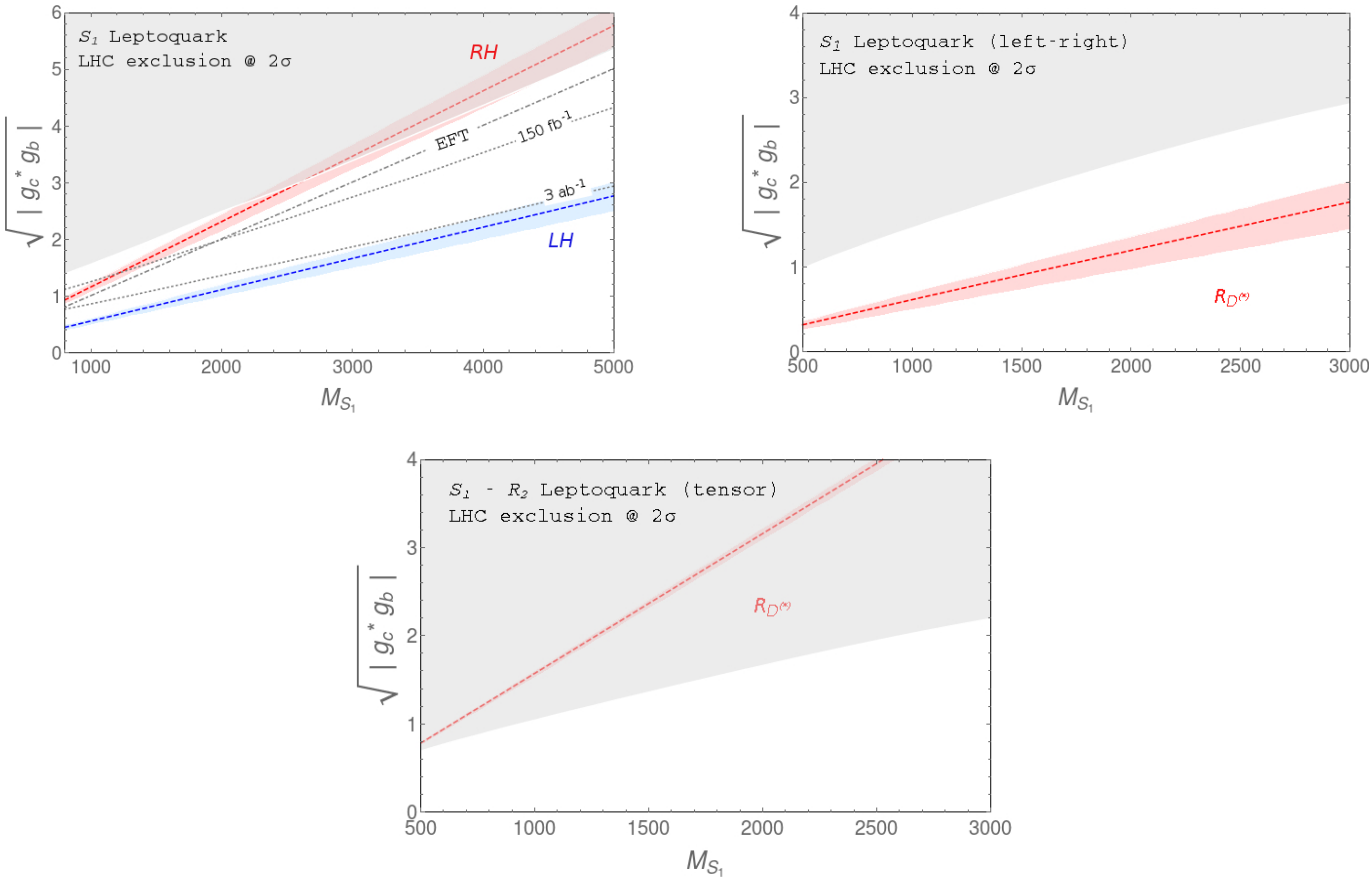
$$\mathcal{L}_{q\bar{q}}(\tau,\mu_F) = \int_\tau^1 \frac{\mathrm{d}x}{x}\; f_q(x,\mu_F) f_{\bar{q}}(\tau/x,\mu_F).$$

$$\sigma^{\text{bin}}(p\,p\to\ell^+\ell^-) = \sum_q \int_{\tau^{\text{bin}}_{\text{min}}}^{\tau^{\text{bin}}_{\text{max}}} \mathrm{d}\tau\; 2\mathcal{L}_{q\bar{q}}(\tau,\mu_F)\,\hat{\sigma}(\tau s_0)$$

[AG, Marzocca]
1704.09015

Table 1 One-parameter 2σ limits from $pp \to \mu^+\mu^-, e^+e^-$

C_i	ATLAS 36.1 fb^{-1}	3000 fb^{-1}
$C^{(1)}_{Q^1L^2}$	$[-5.73, 14.2] \times 10^{-4}$	$[-1.30, 1.51] \times 10^{-4}$
$C^{(3)}_{Q^1L^2}$	$[-7.11, 2.84] \times 10^{-4}$	$[-5.25, 5.25] \times 10^{-5}$
$C_{u_R L^2}$	$[-0.84, 1.61] \times 10^{-3}$	$[-2.00, 2.66] \times 10^{-4}$
$C_{u_R \mu_R}$	$[-0.52, 1.36] \times 10^{-3}$	$[-1.04, 1.08] \times 10^{-4}$
$C_{Q^1 \mu_R}$	$[-0.82, 1.27] \times 10^{-3}$	$[-2.25, 4.10] \times 10^{-4}$
$C_{d_R L^2}$	$[-2.13, 1.61] \times 10^{-3}$	$[-8.98, 5.11] \times 10^{-4}$
$C_{d_R \mu_R}$	$[-2.31, 1.34] \times 10^{-3}$	$[-4.89, 3.33] \times 10^{-4}$
$C^{(1)}_{Q^2L^2}$	$[-8.84, 7.35] \times 10^{-3}$	$[-3.83, 2.39] \times 10^{-3}$
$C^{(3)}_{Q^2L^2}$	$[-9.75, 5.56] \times 10^{-3}$	$[-1.43, 1.15] \times 10^{-3}$
$C_{Q^2 \mu_R}$	$[-7.53, 8.67] \times 10^{-3}$	$[-2.58, 3.73] \times 10^{-3}$
$C_{s_R L^2}$	$[-1.04, 0.93] \times 10^{-2}$	$[-4.42, 3.33] \times 10^{-3}$
$C_{s_R \mu_R}$	$[-1.09, 0.87] \times 10^{-2}$	$[-4.67, 2.73] \times 10^{-3}$
$C_{c_R L^2}$	$[-1.33, 1.52] \times 10^{-2}$	$[-4.58, 6.54] \times 10^{-3}$
$C_{c_R \mu_R}$	$[-1.21, 1.62] \times 10^{-2}$	$[-3.48, 6.32] \times 10^{-3}$
$C_{b_L L^2}$	$[-2.61, 2.07] \times 10^{-2}$	$[-11.1, 6.33] \times 10^{-3}$
$C_{b_L \mu_R}$	$[-2.28, 2.42] \times 10^{-2}$	$[-8.53, 10.0] \times 10^{-3}$
$C_{b_R L^2}$	$[-2.41, 2.29] \times 10^{-2}$	$[-9.90, 8.68] \times 10^{-3}$
$C_{b_R \mu_R}$	$[-2.47, 2.23] \times 10^{-2}$	$[-10.5, 7.97] \times 10^{-3}$
$C^{(1)}_{Q^1L^1}$	$[-0.0, 1.75] \times 10^{-3}$	$[-1.01, 1.13] \times 10^{-4}$
$C^{(3)}_{Q^1L^1}$	$[-8.92, -0.54] \times 10^{-4}$	$[-3.99, 3.93] \times 10^{-5}$
$C_{u_R L^1}$	$[-0.19, 1.92] \times 10^{-3}$	$[-1.56, 1.92] \times 10^{-4}$
$C_{u_R e_R}$	$[0.15, 2.06] \times 10^{-3}$	$[-7.89, 8.23] \times 10^{-5}$
$C_{Q^1 e_R}$	$[-0.40, 1.37] \times 10^{-3}$	$[-1.8, 2.85] \times 10^{-4}$
$C_{d_R L^1}$	$[-2.1, 1.04] \times 10^{-3}$	$[-7.59, 4.23] \times 10^{-4}$
$C_{d_R e_R}$	$[-2.55, 0.46] \times 10^{-3}$	$[-3.37, 2.59] \times 10^{-4}$
$C^{(1)}_{Q^2L^1}$	$[-6.62, 4.36] \times 10^{-3}$	$[-3.31, 1.92] \times 10^{-3}$
$C^{(3)}_{Q^2L^1}$	$[-8.24, 2.05] \times 10^{-3}$	$[-8.87, 7.90] \times 10^{-4}$
$C_{Q^2 e_R}$	$[-4.67, 6.34] \times 10^{-3}$	$[-2.11, 3.30] \times 10^{-3}$
$C_{s_R L^1}$	$[-7.4, 5.9] \times 10^{-3}$	$[-3.96, 2.8] \times 10^{-3}$
$C_{s_R e_R}$	$[-8.17, 5.06] \times 10^{-3}$	$[-3.82, 2.13] \times 10^{-3}$
$C_{c_R L^1}$	$[-0.83, 1.13] \times 10^{-2}$	$[-3.74, 5.77] \times 10^{-3}$
$C_{c_R e_R}$	$[-0.67, 1.27] \times 10^{-2}$	$[-2.59, 4.17] \times 10^{-3}$
$C_{b_L L^1}$	$[-1.93, 1.19] \times 10^{-2}$	$[-8.62, 4.82] \times 10^{-3}$
$C_{b_L e_R}$	$[-1.47, 1.67] \times 10^{-2}$	$[-7.29, 8.99] \times 10^{-3}$
$C_{b_R L^1}$	$[-1.65, 1.49] \times 10^{-2}$	$[-8.86, 7.48] \times 10^{-3}$
$C_{b_R e_R}$	$[-1.73, 1.40] \times 10^{-2}$	$[-9.38, 6.63] \times 10^{-3}$



[AG, Martin Camalich, Ruiz-Alvarez]
1811.XXXXX