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PSI

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Conclusions and Outlook

Workshop "Impact of B→μμ on New Physics searches"

b→sμμ CMS (Urs Langeneger)

- Current results

$$\mathcal{B}(B_s^0 \to \mu^+\mu^-) = (3.0^{+1.0}_{-0.9}) \times 10^{-9}$$
$$\mathcal{B}(B^0 \to \mu^+\mu^-) = (3.5^{+2.1}_{-1.8}) \times 10^{-10}$$

- Future prospects

L (fb^{-1})	No. of B_s^0	No. of B^0	$\delta\mathcal{B}/\mathcal{B}(B_s{}^0 \to \mu^+\mu^-)$	$\delta\mathcal{B}/\mathcal{B}(B^0 \to \mu^+\mu^-)$	B^0 sign.	$\delta\frac{\mathcal{B}(B^0\to\mu^+\mu^-)}{\mathcal{B}(B_s^0\to\mu^+\mu^-)}$
20	16.5	2.0	35%	>100%	0.0–1.5 σ	>100%
100	144	18	15%	66%	0.5–2.4 σ	71%
300	433	54	12%	45%	1.3–3.3 σ	47%
3000	2096	256	12%	18%	5.4–7.6 σ	21%

O(10%) accuracy in the future

B→μμ LHCb (Matteo Rama)

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- Current results

$$BF(B_s^0 \to \mu^+\mu^-) = (3.0 \pm 0.6^{+0.3}_{-0.2}) \times 10^{-9} \qquad 7.8\,\sigma$$

$$BF(B^0 \to \mu^+\mu^-) = (1.5^{+1.2+0.2}_{-1.0-0.1}) \times 10^{-10} \qquad 1.6\,\sigma$$

$$< 3.4 \times 10^{-10} \quad \text{at 95\% CL}$$

- Exotic modes

$$\boldsymbol{BF(B_s^0 \to \tau^+\tau^-) < 5.2(6.8) \times 10^{-3}}$$ **at 90(95)% CL**

$$\boldsymbol{BF(B^0 \to \tau^+\tau^-) < 1.6(2.1) \times 10^{-3}}$$ **at 90 (95%) CL**

$$BF(B_s^0 \to e^{\pm}\mu^{\mp}) < 1.1(1.4)\ 10^{-8} \text{ @ } 90(95)\% \text{ CL}$$

$$BF(B^0 \to e^{\pm}\mu^{\mp}) < 2.8(3.7)\ 10^{-9} \text{ @ } 90(95)\% \text{ CL}$$

Further improvements in the future

b→sμμ LHCb (Mick Mulder)

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Branching fractions:

$B^+ \to K^+\mu^+\mu^-$
$B^0 \to K^{*0}\mu^+\mu^-$
$B^0 \to K^0_S\mu^+\mu^-$
$B^+ \to K^{*+}\mu^+\mu^-$
$B^0_s \to \phi\mu^+\mu^-$
$\Lambda^0_b \to \Lambda^0\mu^+\mu^-$
$B^+ \to \pi^+\mu^+\mu^-$
$B^0_{(s)} \to \pi^+\pi^-\mu^+\mu^-$
$B^+ \to K^+\pi^+\pi^-\mu^+\mu^-$
$B^+ \to \phi K^+\mu^+\mu^-$
$B^0 \to K^{*0}\mu^+\mu^-$ (high mass)
$\Lambda^0_b \to pK\mu^+\mu^-$
$\Lambda^0_b \to p\pi\mu^+\mu^-$

All results at:
http://lhcbproject.web.cern.ch/lhcbproject/Publications/LHCbProjectPublic/Summary_RD.html

Angular:

$B^+ \to K^+\mu^+\mu^-$
$B^0 \to K^{*0}\mu^+\mu^-$
$B^0 \to K^0_S\mu^+\mu^-$
$B^0_s \to \phi\mu^+\mu^-$
$\Lambda^0_b \to \Lambda^0\mu^+\mu^-$
$B^0 \to K^{*0}\mu^+\mu^-$ (high mass)

Lepton flavour universality:

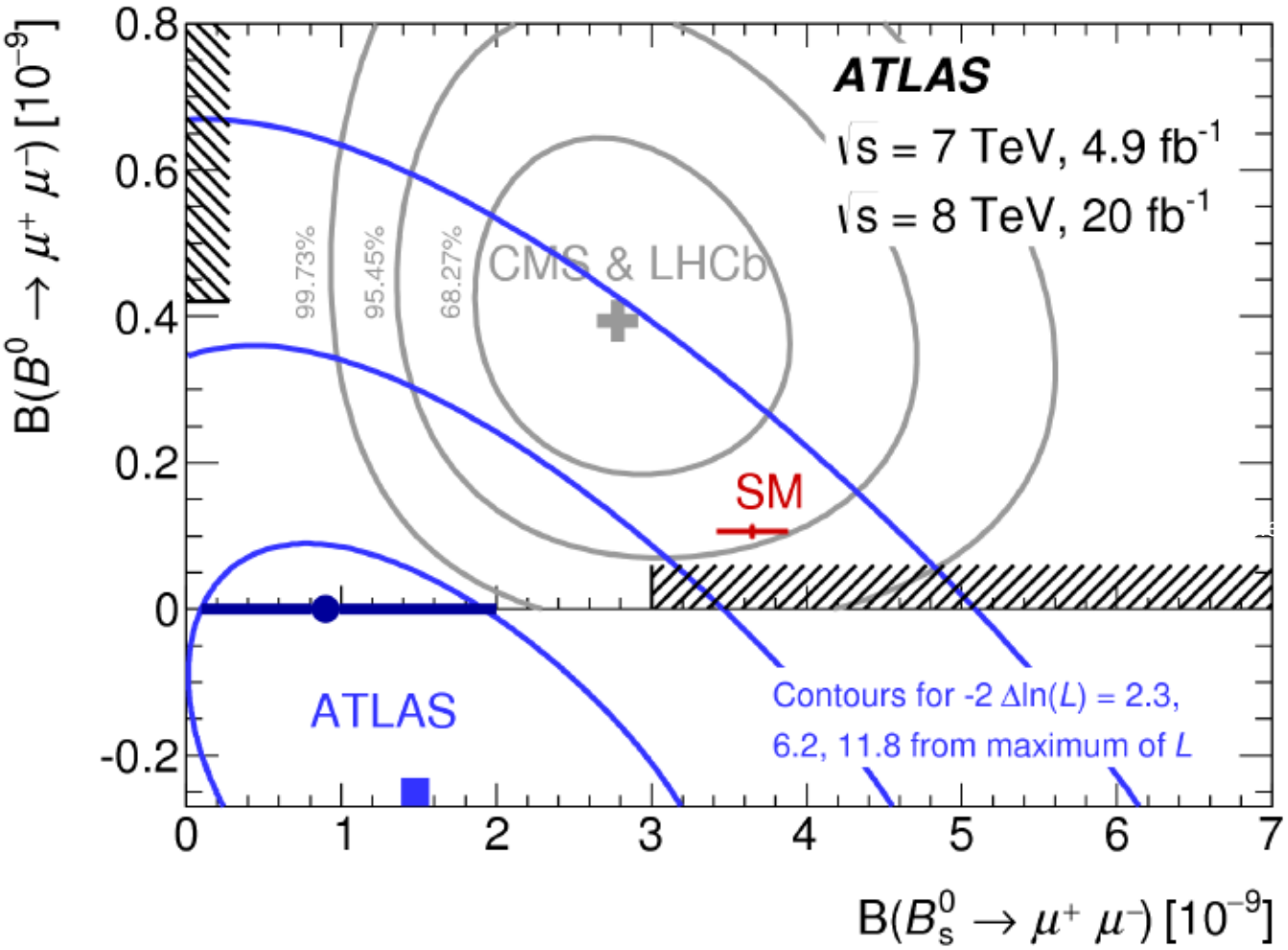
R_{K^+}
$R_{K^{*0}}$

Other:

S-wave fraction in $B^0 \to K^{*0}\mu^+\mu^-$
Interference of short- and long-distance contributions in $B^+ \to K^+\mu^+\mu^-$

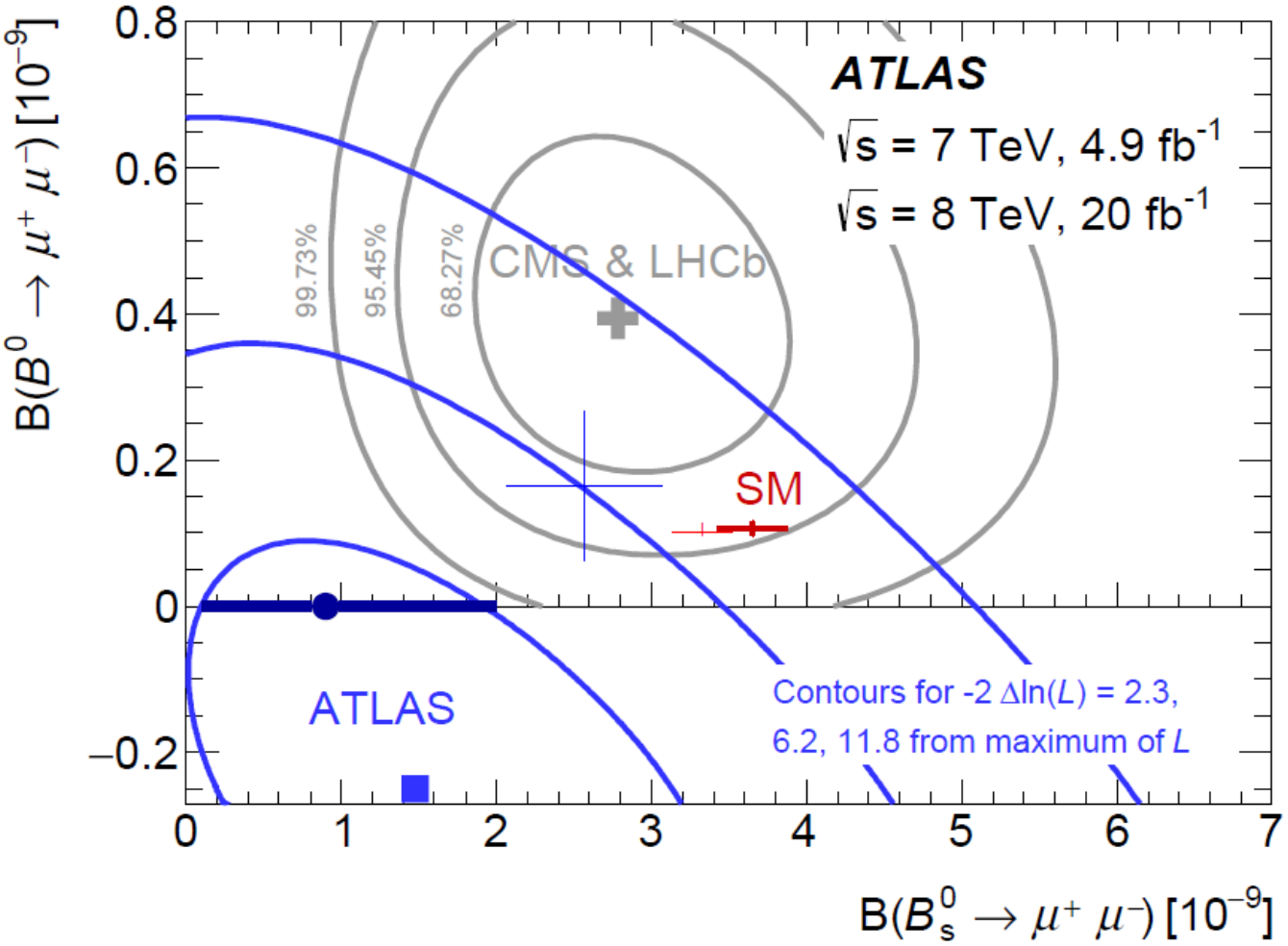
4σ for LFUV + many forthcoming results

b→sμμ ATLAS (Pavel Reznicek)



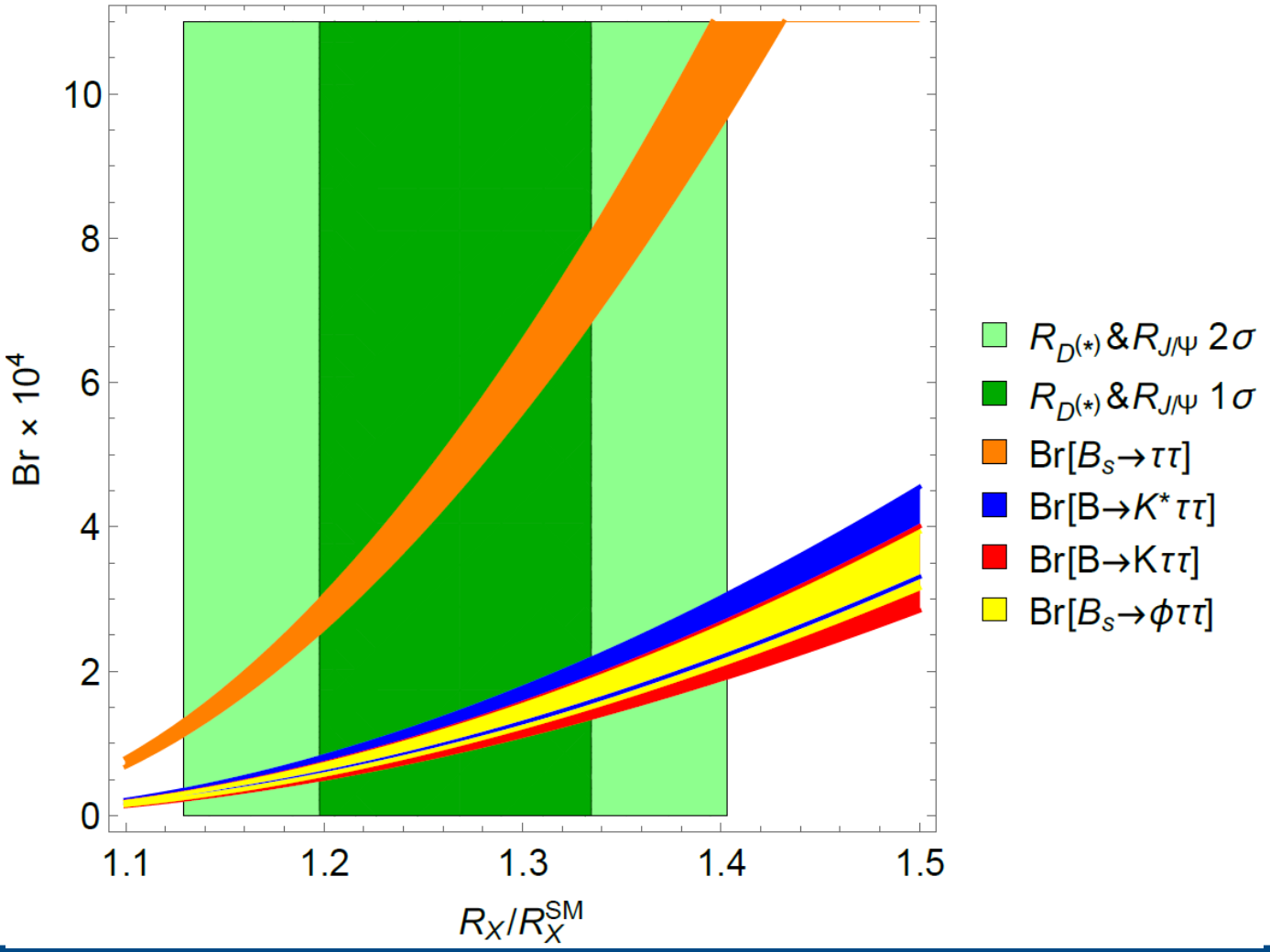
B→μμ below the SM?

B→μμ in the SM (Mikolaj Misiak)



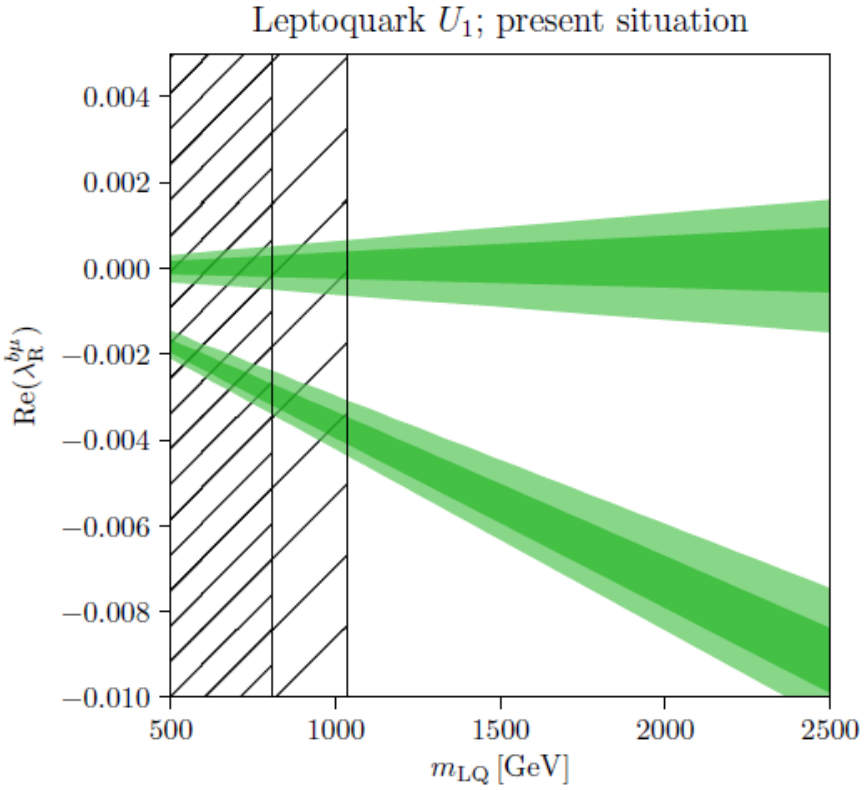
Solve V_{cb} in-/exclusive problem

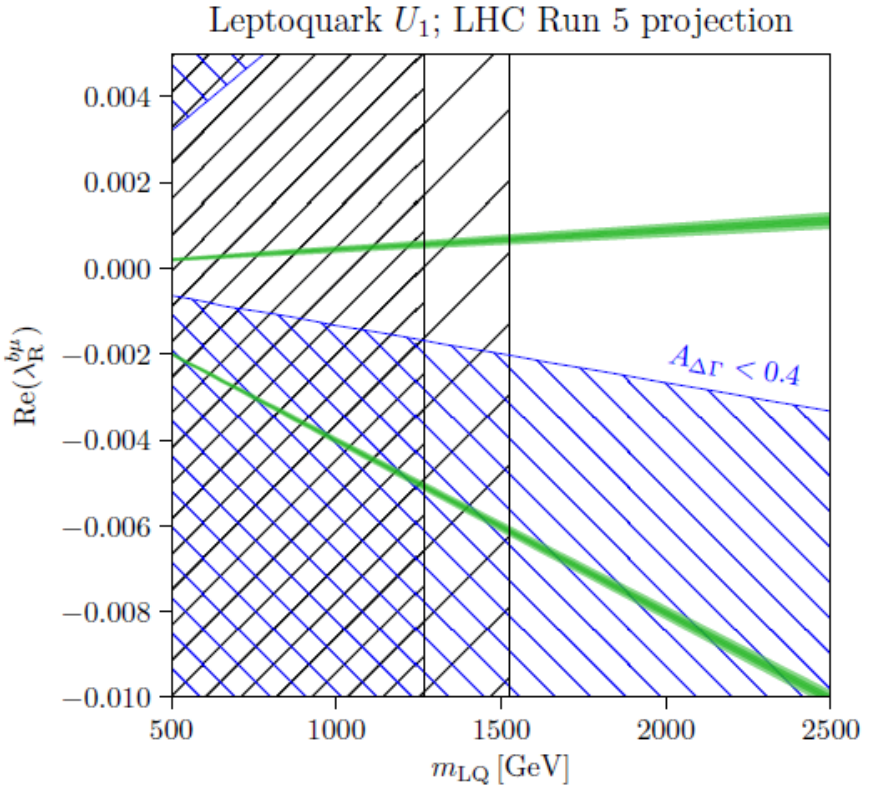
b→sμμ global fit (Descotes-Genon)



Global fit give a consistent picture for NP

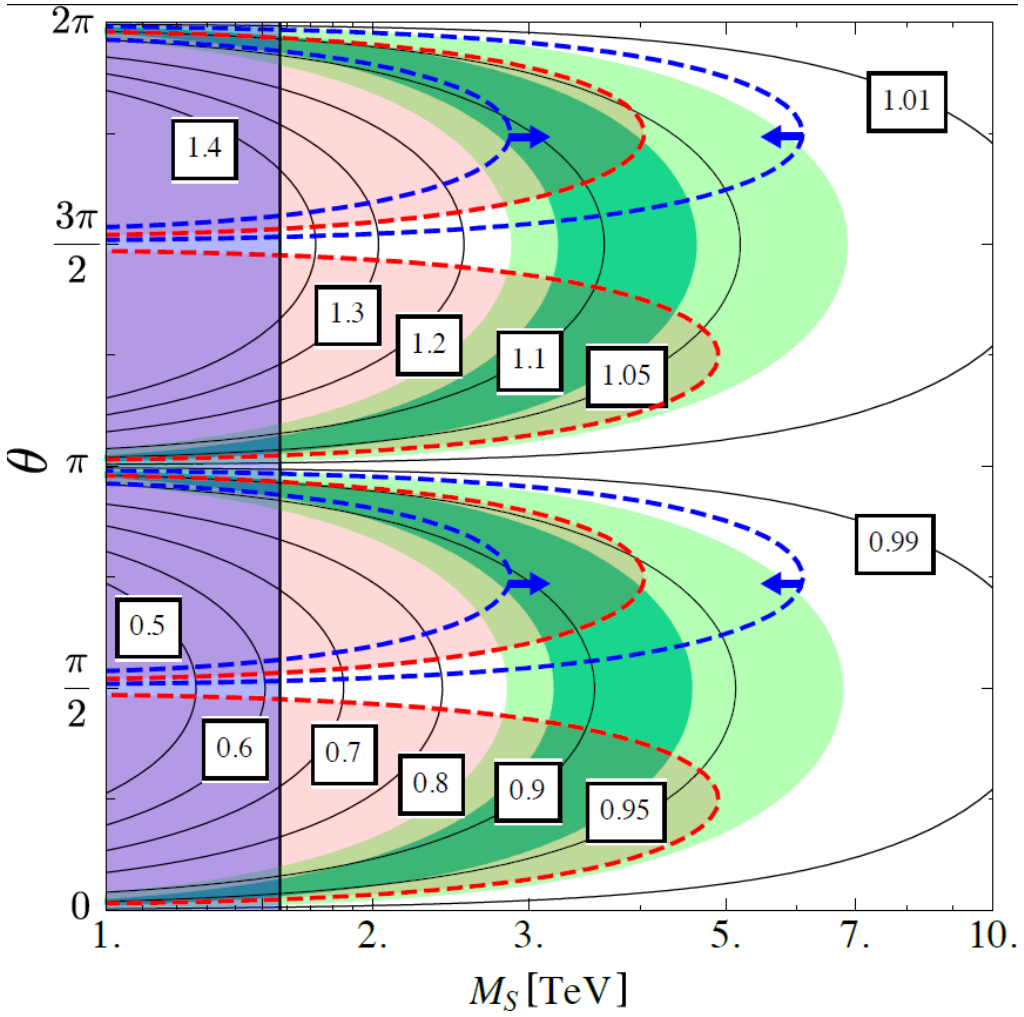
B→μμ future (David Straub)





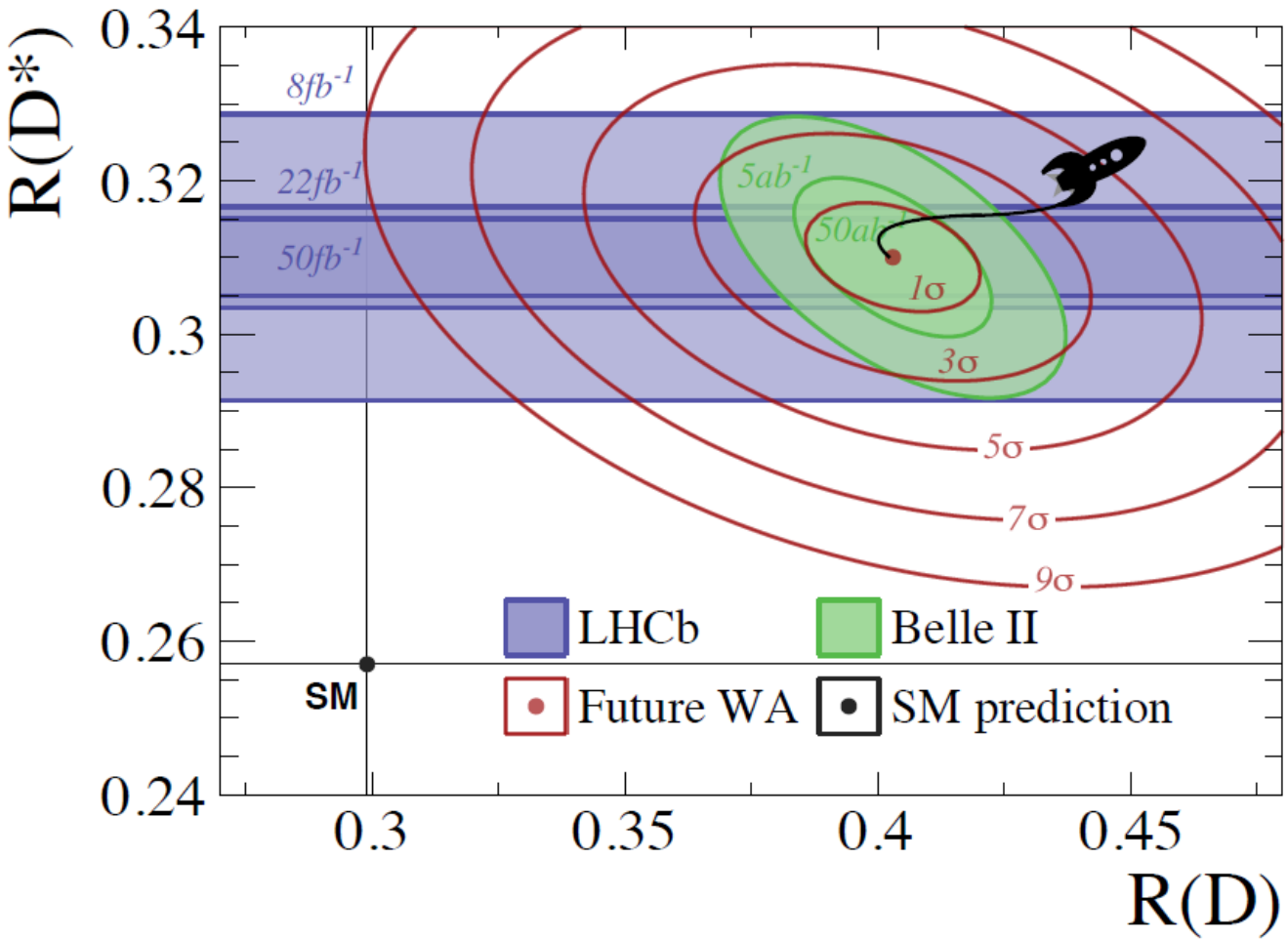
ΔΓ can distinguish between NP models

Overview (Ulrich Nierste)



ε‘/ε last hope for the MSSM?

b→cτν experiment (F. Bernlochner)



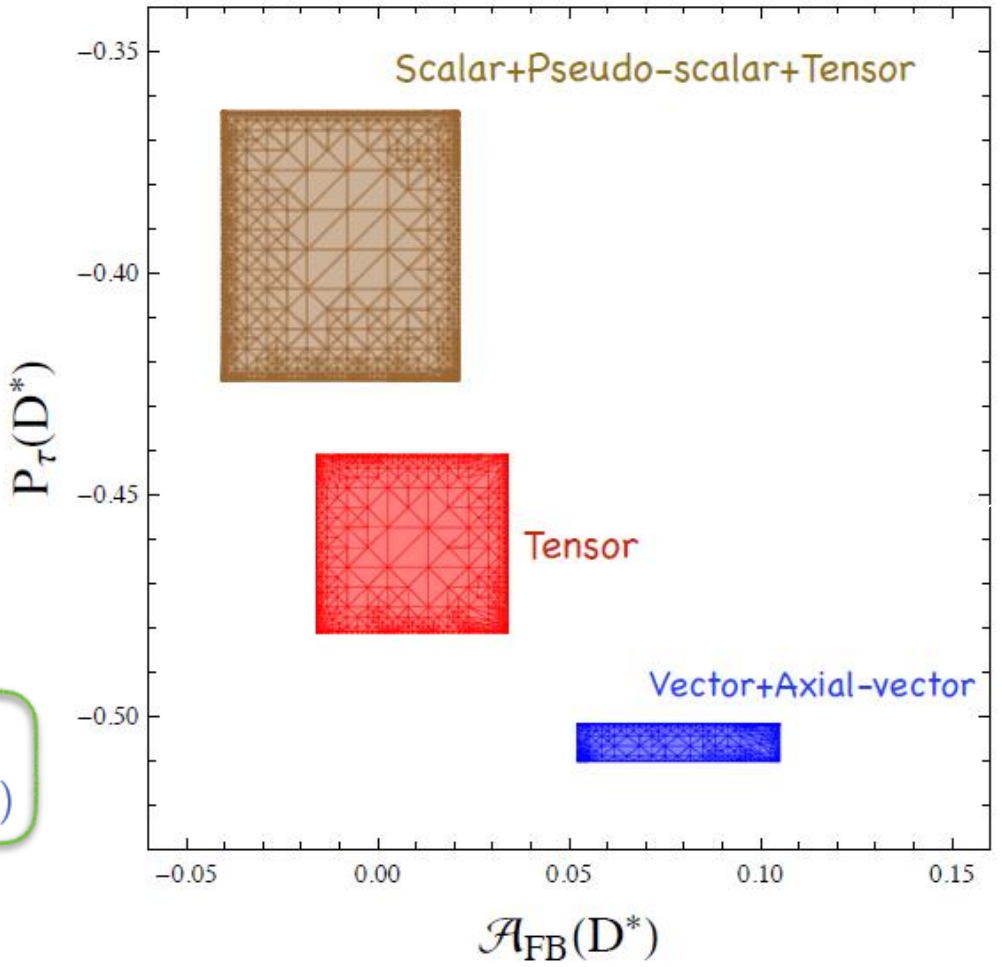
LHCb
10/fb & 22/fb
4% & 2%

Belle II
5/ab & 50/ab
R(D): 5.6% & 3.2%
R(D*): 3.9% & 2.2%

We will soon know if the anomalies are true

b→cτν theory (Diptimoy Ghosh)

- Vector operators work well
- Scalars have problems
- Tensor+ scalar can work



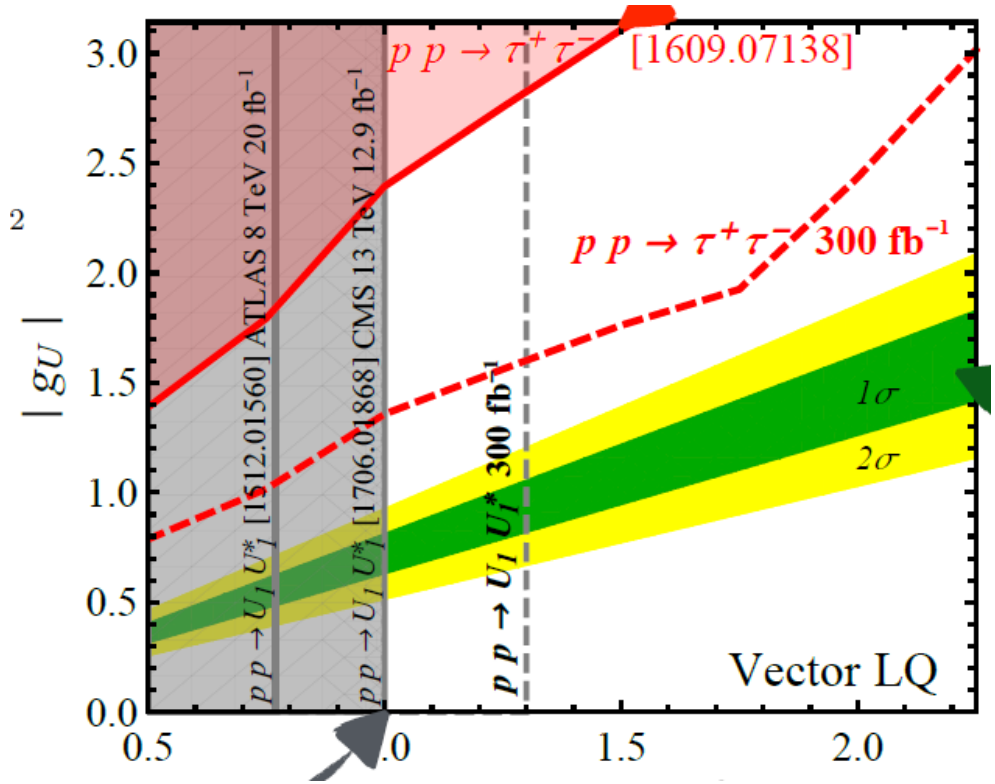
Belle-II prospect for $P_\tau^{D^*}$

50 ab^{-1} : $\pm 0.06(\text{stat.}) \pm 0.04(\text{syst.})$

Future data can tell us the operator structure

High p_T searches (Admir Greljo)

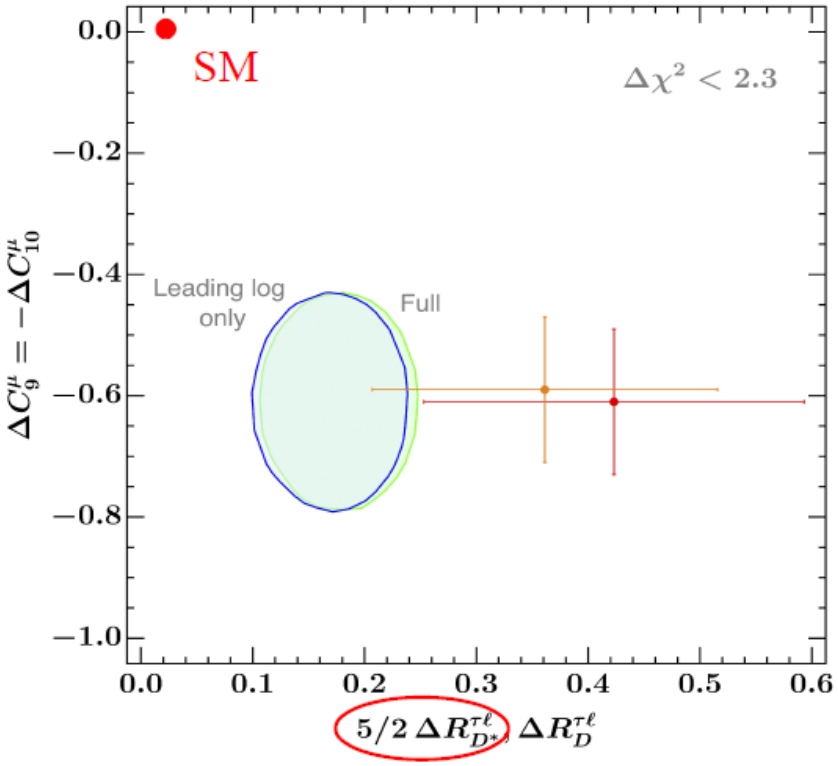
- MFV Z' with 1th generation couplings excluded



Good opportunity to at a HL LHC

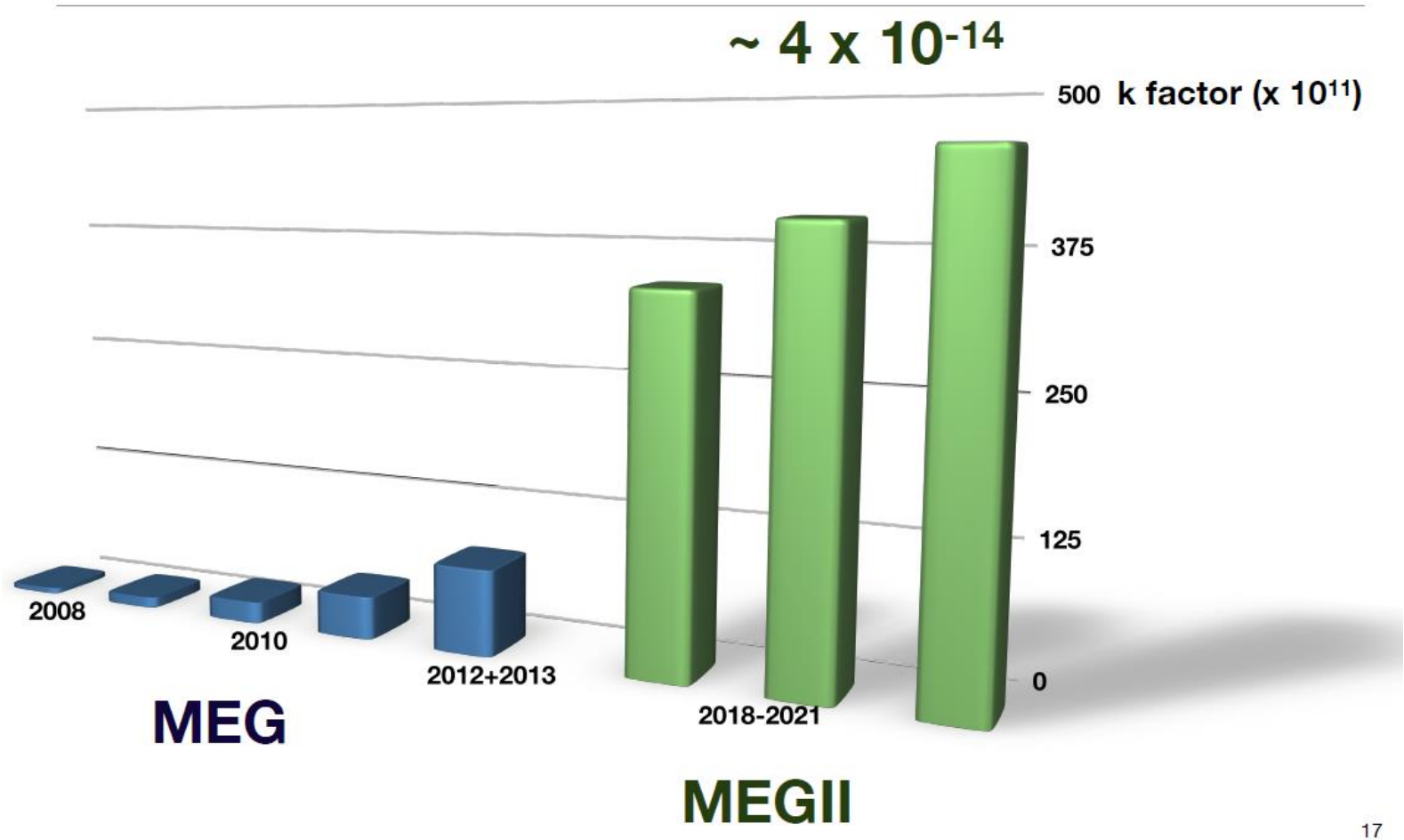
Combined explanations (G. Isidori)

- NP giving $C^{(1)}=C^{(3)}$ can explain $b\to c\tau\nu$ & $b\to s\mu\mu$ simultaneously without violating EW precission
- SU(2) symmetry
- Extended Pati-Salam model nice possible UV completion



Combined explanation possible

μ→e experiments (Angela Papa)



Great experimental progress in the next years

R(K$^{(*)}$) and μ→e (Ivo de Medeiros)

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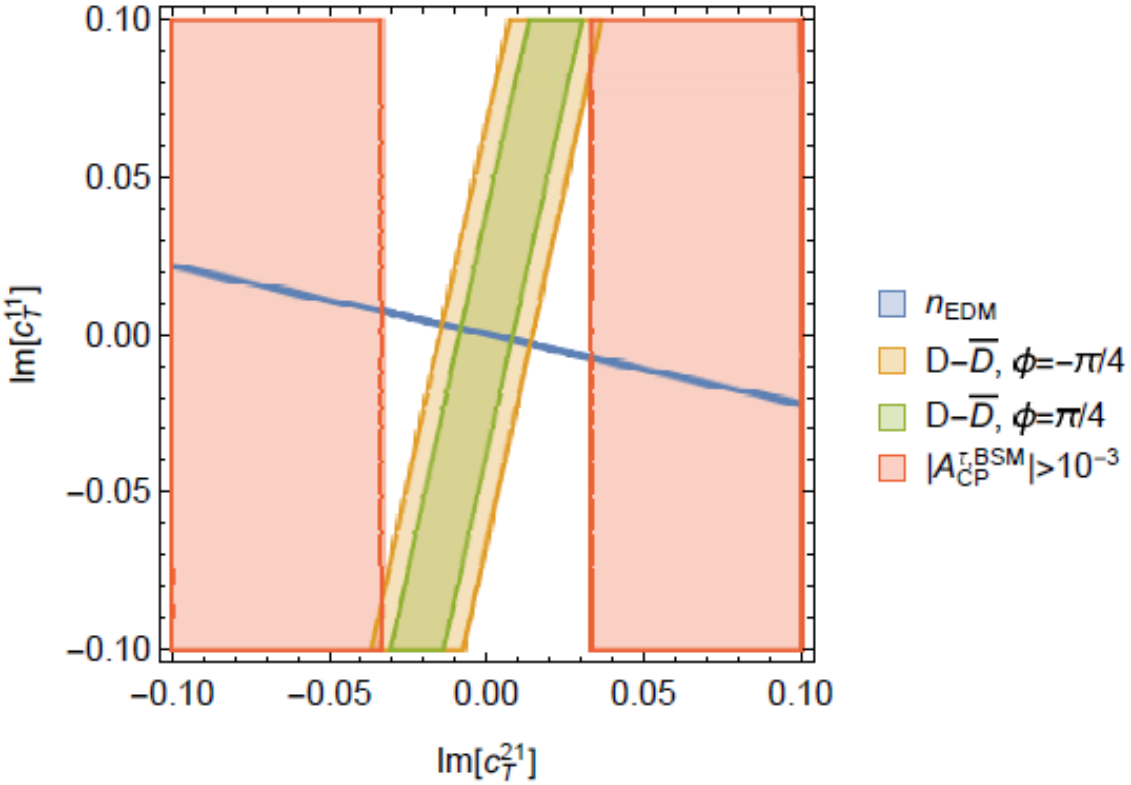
- Leptoquarks work nicely and give effects in μ→e processes

observable	current 90 % CL limit	constraint	future sensitivity
$\mathcal{B}(\mu \to e\gamma)$	$5.7 \cdot 10^{-13}$ [22]	$\lvert\lambda_{qe}\lambda^*_{q\mu}\rvert \lesssim \frac{M^2}{(34\,\mathrm{TeV})^2}$	$6 \cdot 10^{-14}$ [23]
$\mathcal{B}(\tau \to e\gamma)$	$1.2 \cdot 10^{-7}$ [24]	$\lvert\lambda_{qe}\lambda^*_{q\tau}\rvert \lesssim \frac{M^2}{(0.6\,\mathrm{TeV})^2}$	
$\mathcal{B}(\tau \to \mu\gamma)$	$4.4 \cdot 10^{-8}$ [25]	$\lvert\lambda_{q\mu}\lambda^*_{q\tau}\rvert \lesssim \frac{M^2}{(0.7\,\mathrm{TeV})^2}$	$5 \cdot 10^{-9}$ [26]
$\mathcal{B}(\tau \to \mu\eta)$	$6.5 \cdot 10^{-8}$ [27]	$\lvert\lambda_{s\mu}\lambda^*_{s\tau}\rvert \lesssim \frac{M^2}{(3.7\,\mathrm{TeV})^2}$	$2 \cdot 10^{-9}$ [26]
$\mathcal{B}(B \to K\mu^\pm e^\mp)$	$3.8 \cdot 10^{-8}$ [28]	$\sqrt{\lvert\lambda_{s\mu}\lambda^*_{be}\rvert^2 + \lvert\lambda_{b\mu}\lambda^*_{se}\rvert^2} \lesssim \frac{M^2}{(19.4\,\mathrm{TeV})^2}$	
$\mathcal{B}(B \to K\tau^\pm e^\mp)$	$3.0 \cdot 10^{-5}$ [14]	$\sqrt{\lvert\lambda_{s\tau}\lambda^*_{be}\rvert^2 + \lvert\lambda_{b\tau}\lambda^*_{se}\rvert^2} \lesssim \frac{M^2}{(3.3\,\mathrm{TeV})^2}$	
$\mathcal{B}(B \to K\mu^\pm \tau^\mp)$	$4.8 \cdot 10^{-5}$ [14]	$\sqrt{\lvert\lambda_{s\mu}\lambda^*_{b\tau}\rvert^2 + \lvert\lambda_{b\mu}\lambda^*_{s\tau}\rvert^2} \lesssim \frac{M^2}{(2.9\,\mathrm{TeV})^2}$	
$\mathcal{B}(B \to \pi\mu^\pm e^\mp)$	$9.2 \cdot 10^{-8}$ [29]	$\sqrt{\lvert\lambda_{d\mu}\lambda^*_{be}\rvert^2 + \lvert\lambda_{b\mu}\lambda^*_{de}\rvert^2} \lesssim \frac{M^2}{(15.6\,\mathrm{TeV})^2}$	

Hope to discover μ→e flavour violation

Kaons (Martin Hoferichter)

- Study Lepton Flavour (Universality) violation associated with Kaons (K→πμμ/K→πee, …)



NP cannot explain CP asymmetry in τ→K_sπν

Conclusions (my personal view)

The Nobel price for physics in 2020 is awarded to …. for the discovery of LFUV

Complete despair or triumph ahead?

Thank you all for participating!

Many thanks also to

- Adrian Signer for the support from his installation grant
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- Antia van Loon (secretary)