Implications of LHCb Data for Lepton Flavour Universality Violation

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Based on: [arXiv:1904.08399, arXiv:2012.12207 and arXiv:2104.10058]

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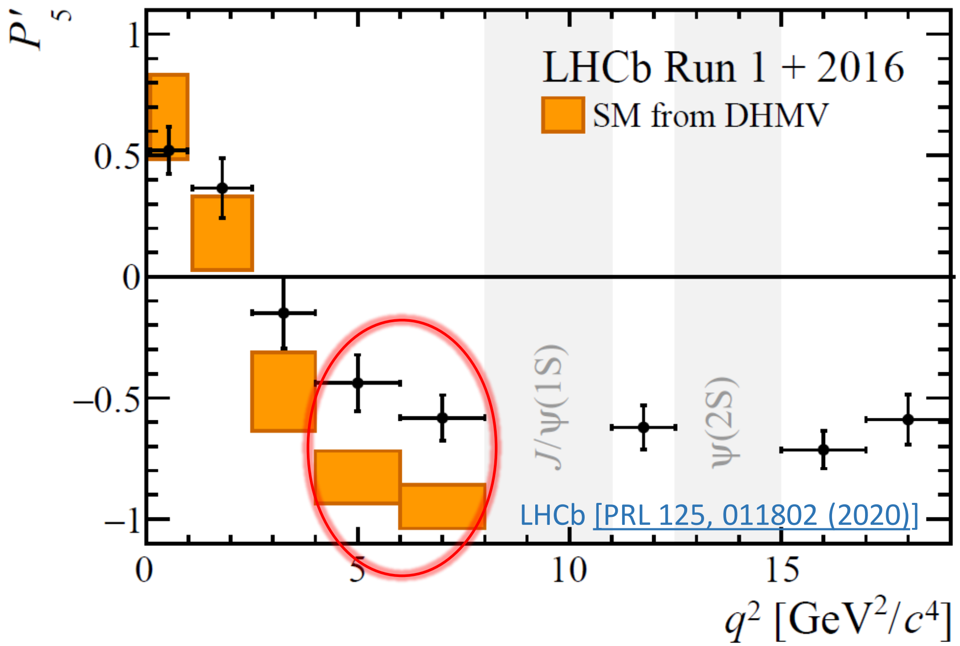
VIRTUAL EDITION

Several deviations ("anomalies") with respect to the SM predictions in $b \to s\ell\ell$ measurements

- Long standing anomaly in the $B \to K^*\mu^+\mu^-$ angular observable P_5' / S_5 $\left(= P_5' \times \sqrt{F_L(1-F_L)}\right)$
  - 2013 LHCb ($1\ \mathrm{fb}^{-1}$)
  - 2016 LHCb ($3\ \mathrm{fb}^{-1}$)
  - 2020 LHCb ($4.7\ \mathrm{fb}^{-1}$)

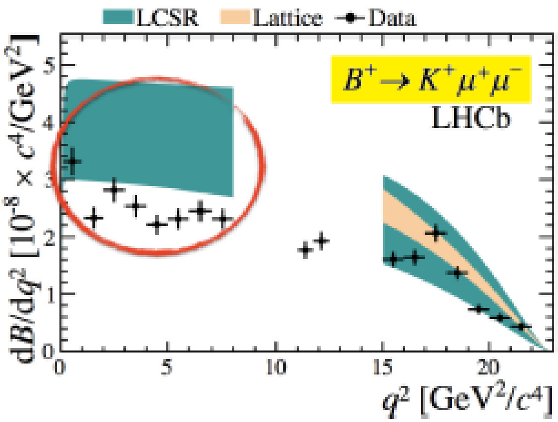


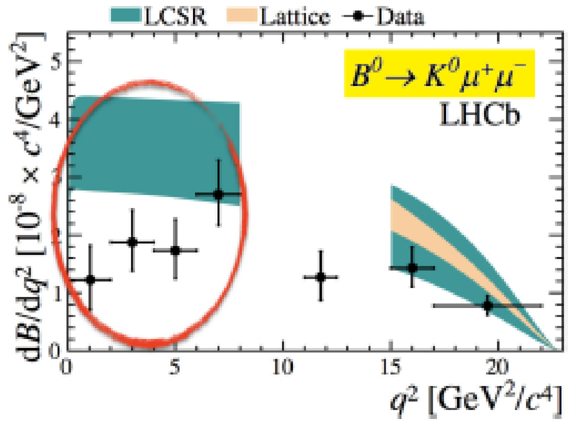
- ≈2.9σ local tension in P_5' with the respect SM predictions

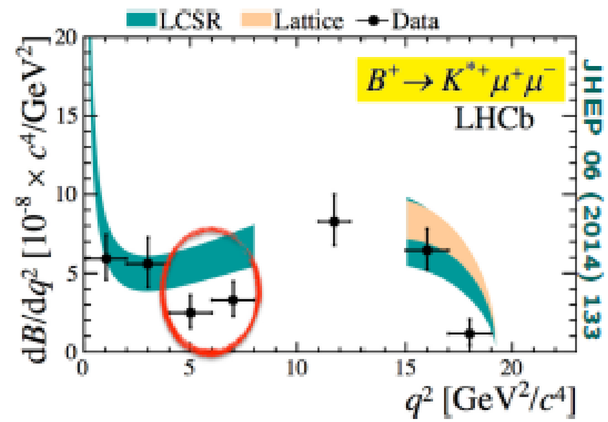
  ⟶ significance depends on estimation of hadronic contributions

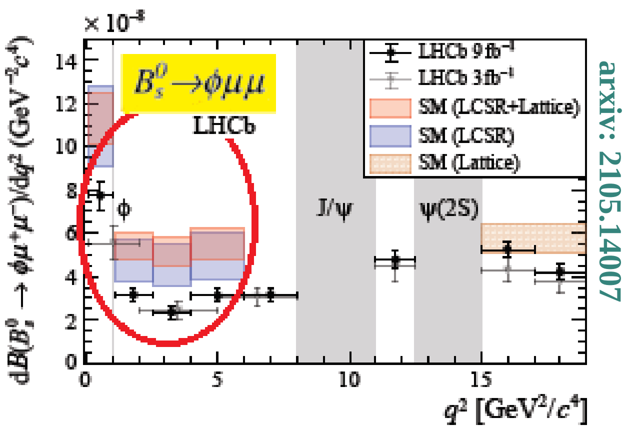
Several deviations (“anomalies”) with respect to the SM predictions in $b \to s\ell\ell$ measurements

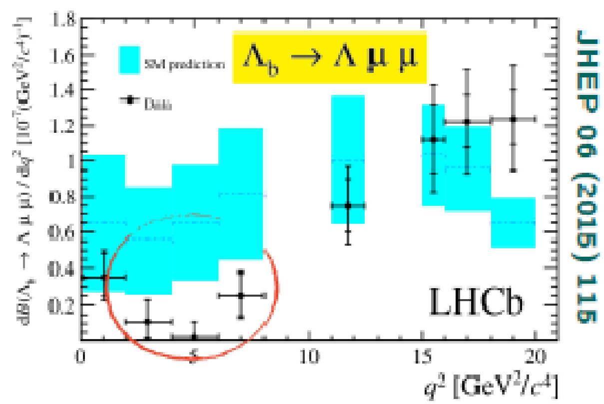
- Branching fractions







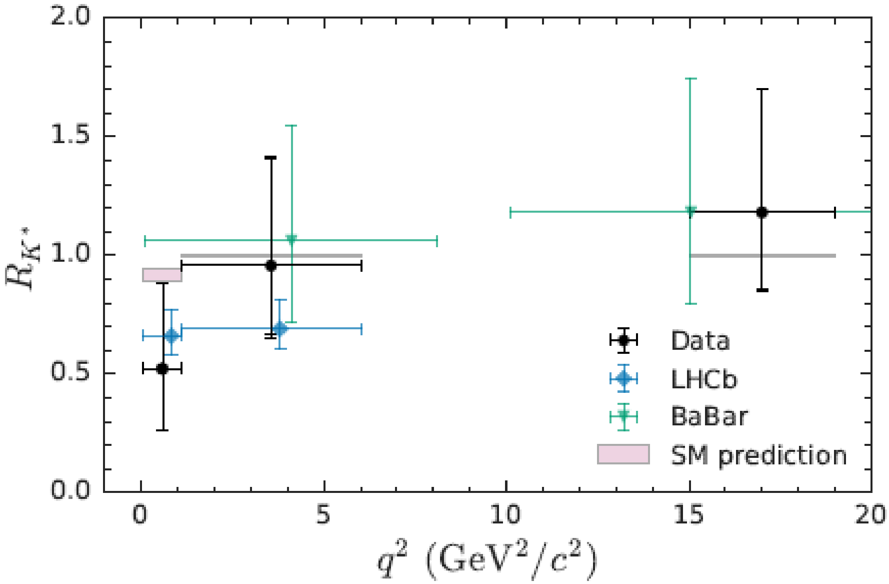




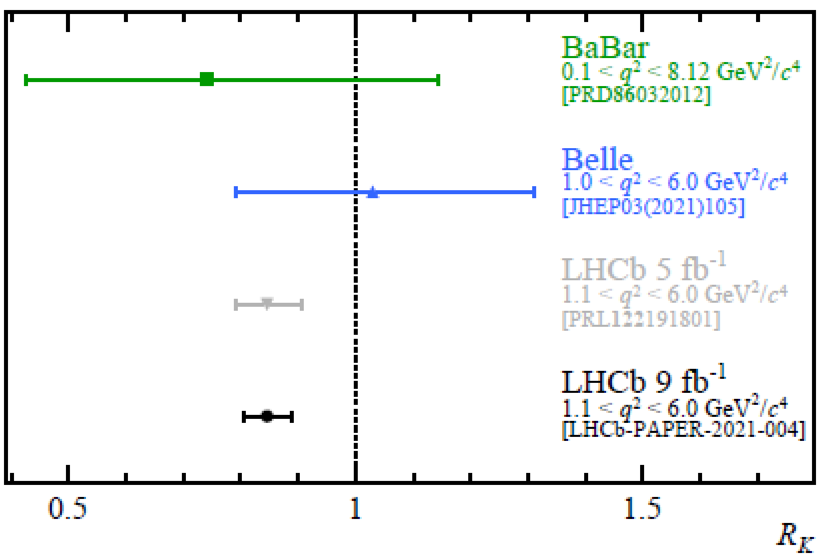
- Measurements below SM predictions with $\sim 2-3\sigma$ significance
- Large theory uncertainties (several form factors involved)

- Lepton flavour universality violating ratios $R_{K^{(*)}} \equiv \frac{BR(B\to K^{(*)}\mu^+\mu^-)}{BR(B\to K^{(*)}e^+e^-)}$

  - LHCb (3 fb^{-1}) April 2017:



  - LHCb (1 fb^{-1}) June 2014:
  - LHCb (5 fb^{-1}) March 2019:
  - LHCb (9 fb^{-1}) March 2021



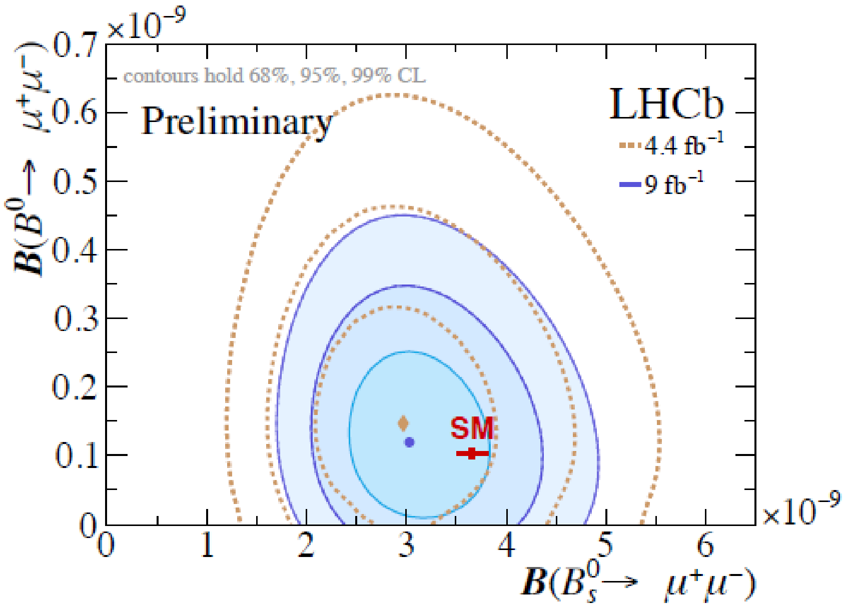
- LHCb meas. below SM with (2.3σ) & 2.5σ for R_{K^*} and 3.1σ for R_K $\longrightarrow$ #cautiouslyexcited
- SM prediction very accurate with uncertainty less than (3%) 1%

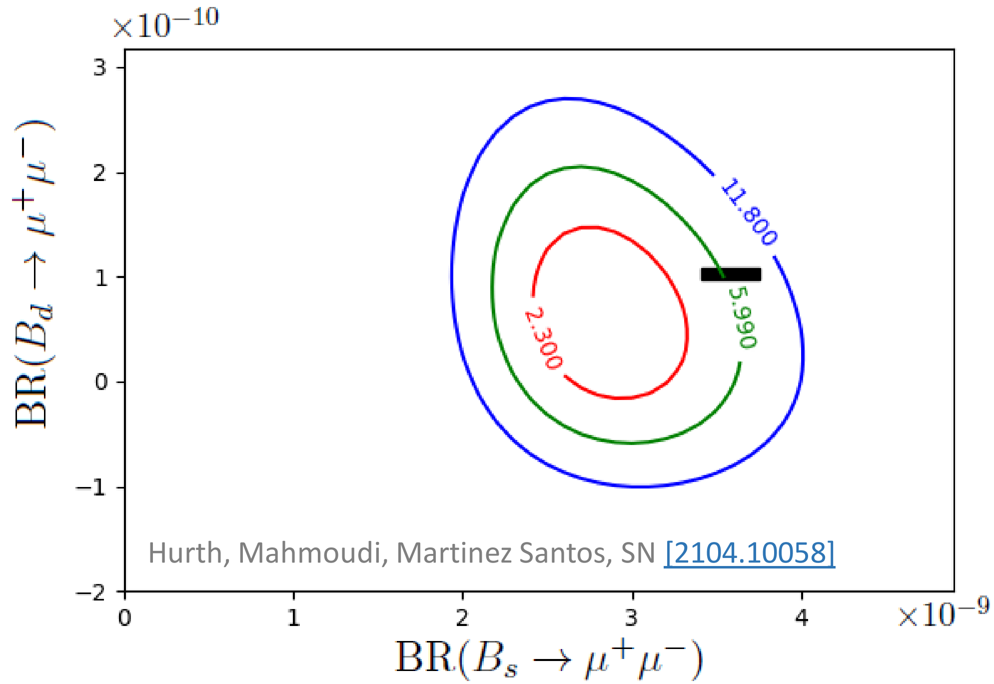
Combination of LHCb, CMS and ATLAS measurement for BR($B_{s,d} \to \mu^+\mu^-$)

- LHCb (9 fb^{-1}) March 2021 [M. Santamaria, LHC seminar]

✚

- CMS [JHEP 04 (2020) 188]
- ATLAS [JHEP 04 (2019) 098]



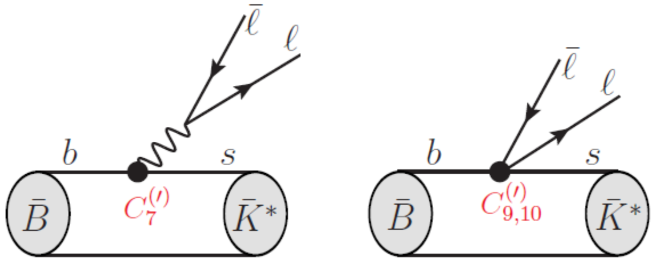


- ❑ The SM prediction is near 2σ contour
- ❑ Theory uncertainties $\lesssim 5\%$

Theoretical prediction

Sources of hadronic uncertainties in exclusive modes

Sources of hadronic uncertainties in exclusive modes



1) Local contributions $\langle K^* \ell\ell | O_{7,9,10} | B \rangle$

$\longrightarrow$ form factors $\tilde{V}_{\pm,0}, \tilde{T}_{\pm,0}, \tilde{S}$

$$H_V(\lambda) = -i\, N' \Big\{ C_9\, \tilde{V}_\lambda(q^2) \;\; + \frac{m_B^2}{q^2} \Big[\frac{2\,\hat{m}_b}{m_B} C_7^{\rm eff}\, \tilde{T}_\lambda(q^2) \Big] \Big\}$$

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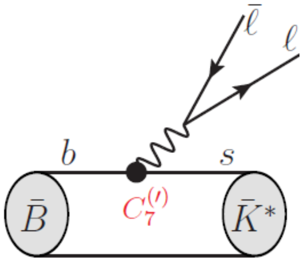
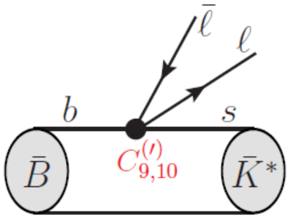
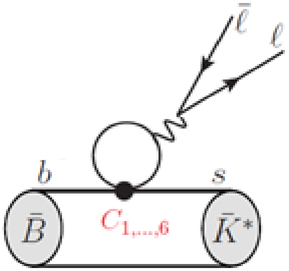


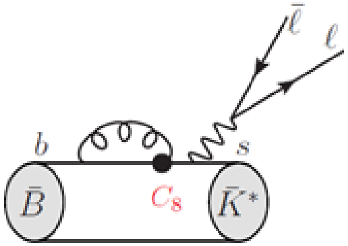


2) Non-local contributions

$\longrightarrow$ calculated at LO in QCDf, but higher powers unknown (“guesstimated”)

↪ recent progress by Bobeth et al. 1707.07305 and Gubernari et al. 2011.09813





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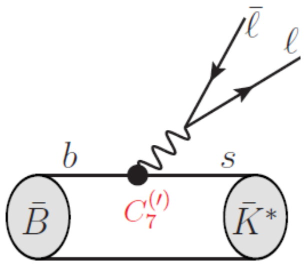

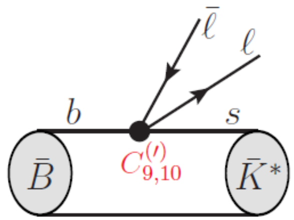

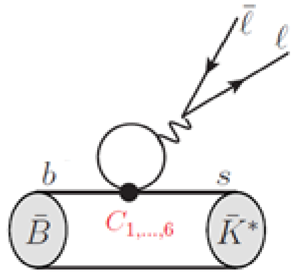

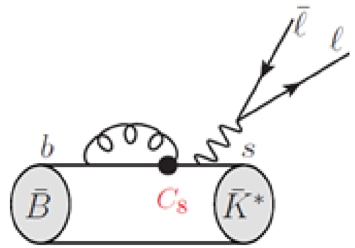

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- To distinguish hadronic effects from NP in $C_{7,9}$ good control over hadronic contributions needed
- In the LFUV ratios hadronic uncertainties cancel out
- For $\mathrm{BR}(B_s \to \mu^+\mu^-)$ only one hadronic parameter f_{B_s}

"clean observables"

Global analysis of $b \to s\ell^+\ell^-$ observables

NP fit with a single operator

Considering all the relevant data on $b \to s$ transitions (173 observables)

- R_K, R_{K^*}
- $\mathrm{BR}(B_{s,d} \to \mu^+\mu^-)$
- $\mathrm{BR}(B_s \to e^+e^-)$
- $\mathrm{BR}(B \to X_s\, \mu^+\mu^-)$
- $\mathrm{BR}(B \to X_s\, e^+e^-)$
- $\mathrm{BR}(B \to K^* e^+e^-)$
- $B_s \to \phi\, \mu^+\mu^-$: BR, ang. obs.
- $B^{0(+)} \to K^{0(+)}\mu^+\mu^-$: BR, ang. obs.
- $B^{(+)} \to K^{*(+)}\mu^+\mu^-$: BR, ang. obs.
- $\Lambda_b \to \Lambda\, \mu^+\mu^-$: BR, ang. obs.

Using SuperIso public program

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Using SuperIso public program

	All observables 2019 data ($\chi^2_{\rm SM} = 117.03$)			All observables 2021 data ($\chi^2_{\rm SM} = 225.8$)		
	b.f. value	$\chi^2_{\rm min}$	$\mathrm{Pull}_{\rm SM}$	b.f. value	$\chi^2_{\rm min}$	$\mathrm{Pull}_{\rm SM}$
δC_9	-1.01 ± 0.20	99.2	4.2σ	-0.99 ± 0.13	186.2	6.3σ
δC_9^e	0.78 ± 0.26	106.6	3.2σ	0.79 ± 0.20	207.7	4.3σ
δC_9^μ	-0.93 ± 0.17	89.4	5.3σ	-0.95 ± 0.12	168.6	7.6σ
δC_{10}	0.25 ± 0.23	115.7	1.1σ	0.32 ± 0.18	222.3	1.9σ
δC_{10}^e	-0.73 ± 0.23	105.2	3.4σ	-0.74 ± 0.18	206.3	4.4σ
δC_{10}^μ	0.53 ± 0.17	105.8	3.3σ	0.55 ± 0.13	205.2	4.5σ
$\delta C_{\rm LL}^e$	0.40 ± 0.13	105.8	3.3σ	0.40 ± 0.10	206.9	4.3σ
$\delta C_{\rm LL}^\mu$	-0.41 ± 0.10	96.6	4.5σ	-0.49 ± 0.08	180.5	6.7σ

$(C_{LL} \equiv C_9 = -C_{10})$

- Hierarchy of the preferred NP scenarios have remained the same as is in 2019; C_9^μ followed by C_{LL}^μ
- Significance increased by more than 2σ in the preferred scenarios
- NP significance depend on the assumptions on the non-factorisable power corrections

NP fit with two operators

Considering all the relevant data on $b \to s$ transitions (173 observables)

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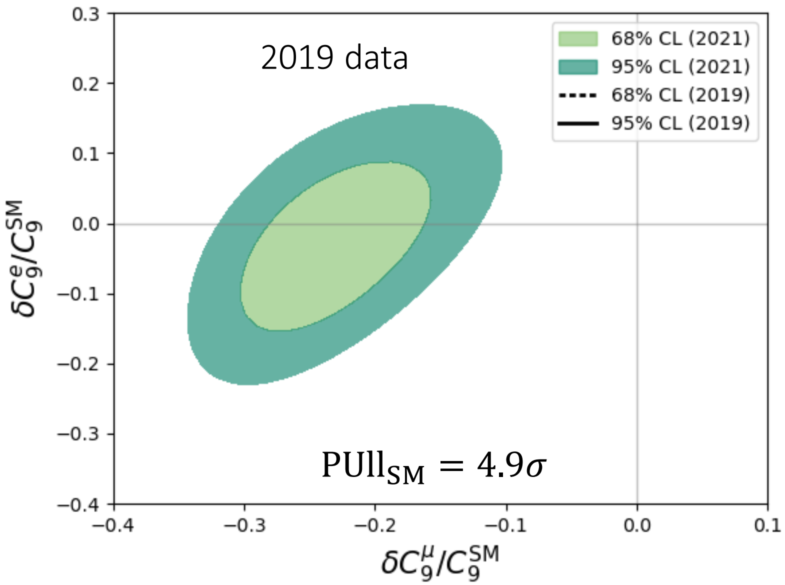

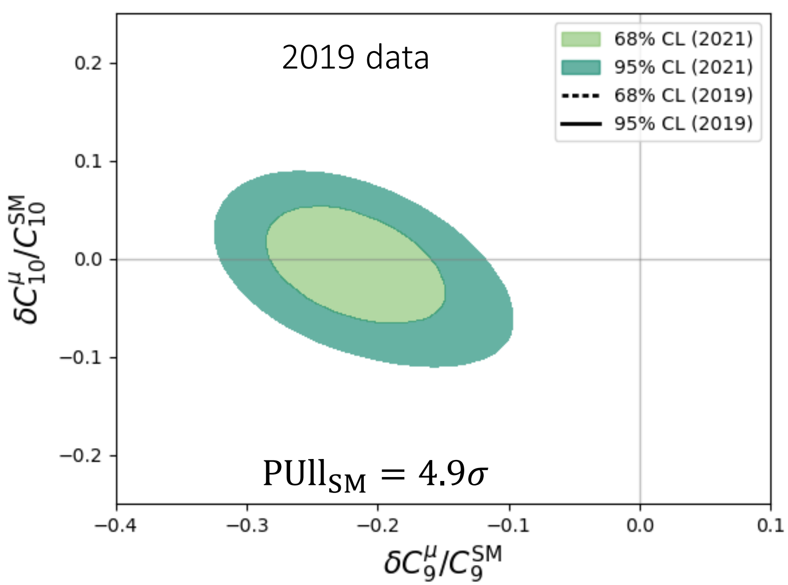

Similar fits by other groups:

Geng et al. arXiv:2103.12738, Altmannshofer et al. arXiv: 2103.13370, Algueró et al. arXiv:2104.08921, Ciuchini et al. arXiv:2011.01212, Datta et al. 1903.10086, Kowalska et al., arXiv:1903.10932

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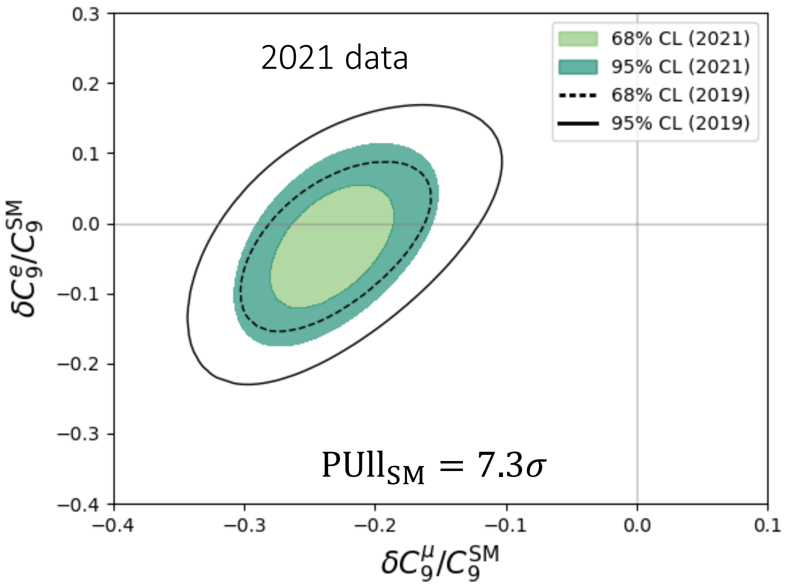

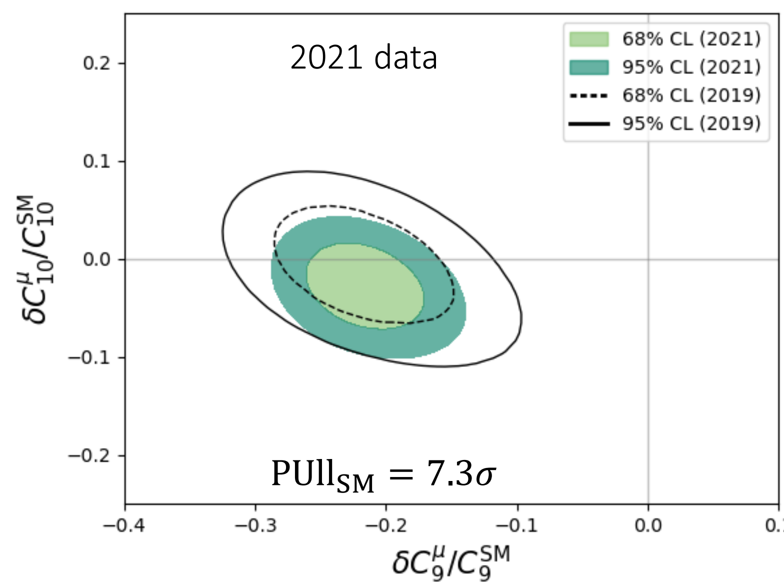

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Multi-dimensional fit

Considering only one or two Wilson coefficients may not give the full picture!

All relevant Wilson coefficients:

$$C_7, C_8, C_9^\ell, C_{10}^\ell, C_S^\ell, C_P^\ell + \text{primed coefficients} \longrightarrow 20 \text{ degrees of freedom}$$

- Considering the most general NP description, look-elsewhere effect is avoided

All observables with $\chi^2_{\rm SM} = 225.8$			
$\chi^2_{\rm min} = 151.6$; $\boxed{\text{Pull}_{\rm SM} = 5.5(5.6)\sigma}$			
δC_7		δC_8	
0.05 ± 0.03		-0.70 ± 0.40	
$\delta C_7'$		$\delta C_8'$	
-0.01 ± 0.02		0.00 ± 0.80	
δC_9^μ	δC_9^e	δC_{10}^μ	δC_{10}^e
-1.16 ± 0.17	-6.70 ± 1.20	0.20 ± 0.21	degenerate w/ $C_{10}^{\prime e}$
$\delta C_9^{\prime\mu}$	$\delta C_9^{\prime e}$	$\delta C_{10}^{\prime\mu}$	$\delta C_{10}^{\prime e}$
0.09 ± 0.34	1.90 ± 1.50	-0.12 ± 0.20	degenerate w/ C_{10}^e
$C_{Q_1}^\mu$	$C_{Q_1}^e$	$C_{Q_2}^\mu$	$C_{Q_2}^e$
0.04 ± 0.10 $[-0.08 \pm 0.11]$	-1.50 ± 1.50 $[-0.20 \pm 1.60]$	-0.09 ± 0.10 $[-0.11 \pm 0.10]$	-4.10 ± 1.5 $[4.50 \pm 1.5]$
$C_{Q_1}^{\prime\mu}$	$C_{Q_1}^{\prime e}$	$C_{Q_2}^{\prime\mu}$	$C_{Q_2}^{\prime e}$
0.15 ± 0.10 $[0.02 \pm 0.12]$	-1.70 ± 1.20 $[-0.30 \pm 1.10]$	-0.14 ± 0.11 $[-0.16 \pm 0.10]$	-4.20 ± 1.2 $[4.40 \pm 1.2]$

- Insensitive Wilson coefficients and flat directions eliminated via likelihood profiles and corr. matrices

↪ Effective dof = (19) giving 5.6σ significance

New Physics fit of Clean Observables

One operator fit

Fit to clean observables $R_K, R_{K^*}, B_s \to \mu^+\mu^-$

Only $R_{K^{(*)}}, B_{s,d} \to \mu^+\mu^-$ **2021 data** ($\chi^2_{\rm SM} = 28.19$)			
	b.f. value	$\chi^2_{\rm min}$	$\mathrm{Pull}_{\rm SM}$
δC_9	-1.00 ± 6.00	28.1	0.2σ
δC_9^e	0.80 ± 0.21	11.2	4.1σ
δC_9^μ	-0.77 ± 0.21	11.9	4.0σ
δC_{10}	0.43 ± 0.24	24.6	1.9σ
δC_{10}^e	-0.78 ± 0.20	9.5	4.3σ
δC_{10}^μ	0.64 ± 0.15	7.3	4.6σ
$\delta C_{\rm LL}^e$	0.41 ± 0.11	10.3	4.2σ
$\delta C_{\rm LL}^\mu$	-0.38 ± 0.09	7.1	4.6σ

One operator fit

Fit to clean observables $R_K, R_{K^*}, B_s \to \mu^+\mu^-$ and to the rest of the $b \to s\ell\ell$ obs.

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All observables except $R_{K^{(*)}}, B_{s,d} \to \mu^+\mu^-$ 2021 data $(\chi^2_{\rm SM} = 200.1)$			
	b.f. value	$\chi^2_{\rm min}$	$\mathrm{Pull}_{\rm SM}$
δC_9	-1.01 ± 0.13	158.2	6.5σ
δC_9^e	0.70 ± 0.60	198.8	1.1σ
δC_9^μ	-1.03 ± 0.13	156.0	6.6σ
δC_{10}	0.34 ± 0.23	197.7	1.5σ
δC_{10}^e	-0.50 ± 0.50	199.0	1.0σ
δC_{10}^μ	0.41 ± 0.23	196.5	1.9σ
$\delta C_{\rm LL}^e$	0.33 ± 0.29	198.9	1.1σ
$\delta C_{\rm LL}^\mu$	-0.75 ± 0.13	167.9	5.7σ

Depends on the assumptions on the non-factorisable power corrections

Fit to clean observables $R_K, R_{K^*}, B_s \to \mu^+\mu^-$ and to the rest of the $b \to s\ell\ell$ obs.

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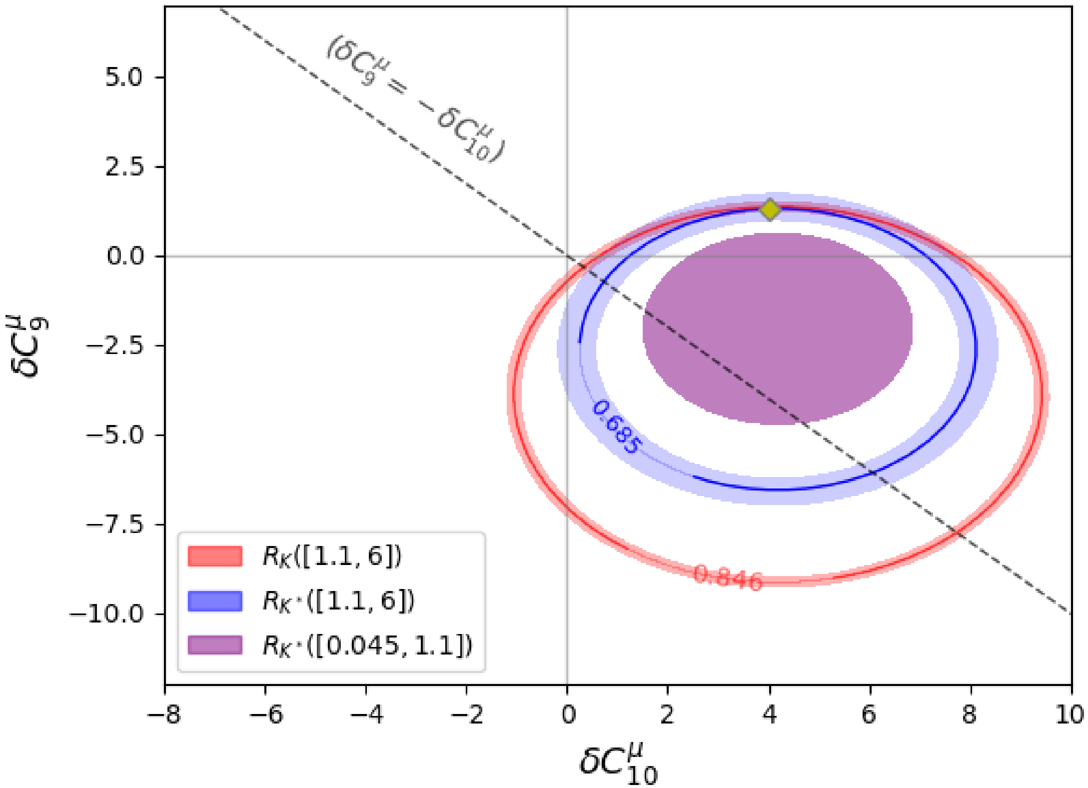
Depends on the assumptions on the non-factorisable power corrections

- Compatible NP scenarios between the two sets

Fit to clean observables $R_K, R_{K^*}, B_s \to \mu^+\mu^-$

Coloured regions: 1σ range of fit to individual observables



Yellow diamond ◇ : best fit point of (C_9^μ, C_{10}^μ) fit to $R_K + R_{K^*}$

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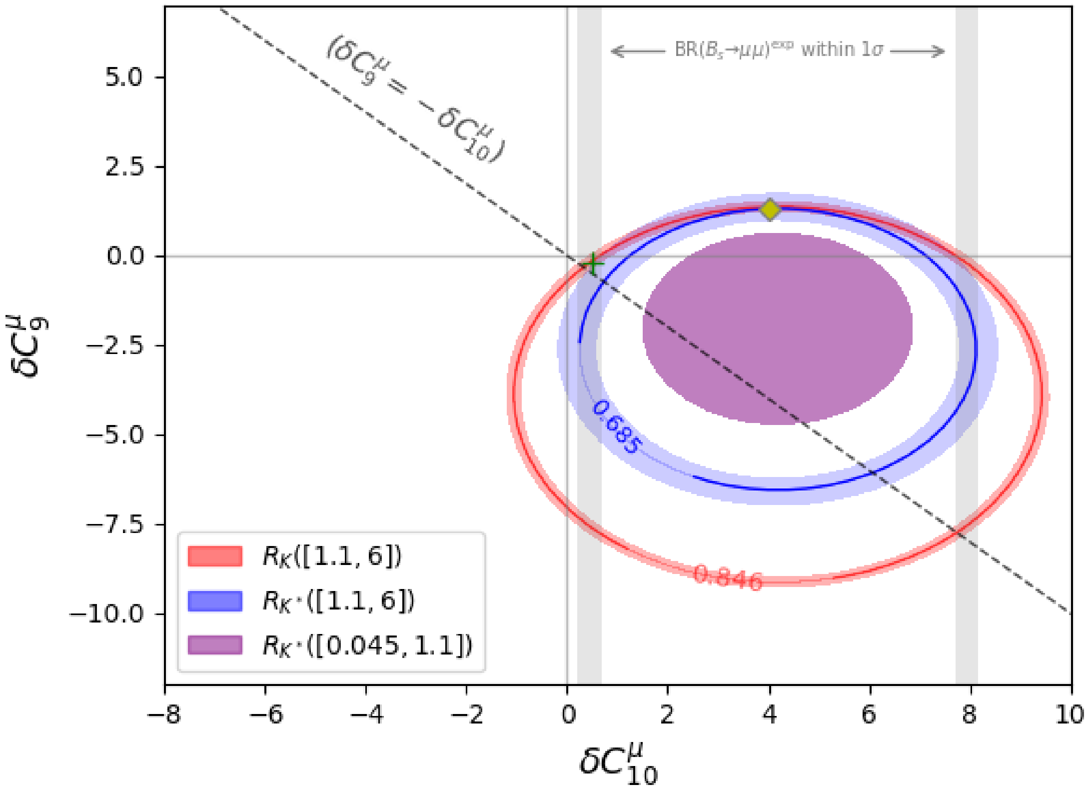

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Green cross +: best fit point of (C_9^μ, C_{10}^μ) fit to $R_K + R_{K^*} + B_s \to \mu^+\mu^-$

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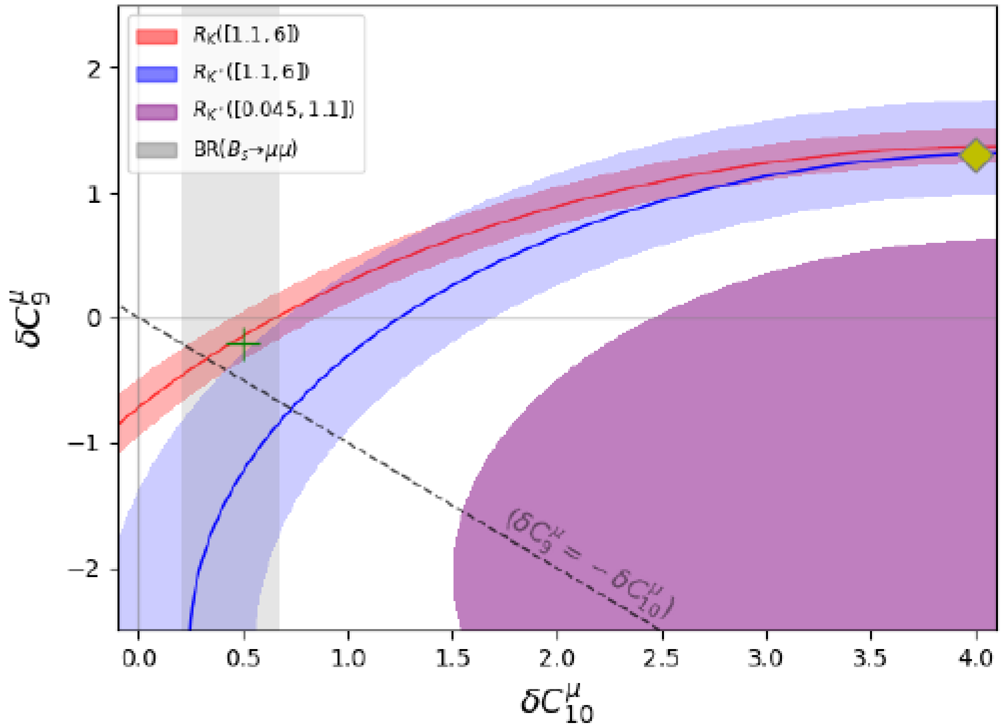
Coloured regions: 1σ range of fit to individual observables



Yellow diamond ◇ : best fit point of (C_9^μ, C_{10}^μ) fit to R_K, R_{K^*}

Green cross +: best fit point of (C_9^μ, C_{10}^μ) fit to $R_K + R_{K^*} + B_s \to \mu^+\mu^-$

Prospect of clean observables

Projections: individual clean observable

Keeping present central values, future projections don't give acceptable fits (p-value ≈ 0)

We assume future experimental results are in agreement with one of the current NP scenarios from the fit to clean observables

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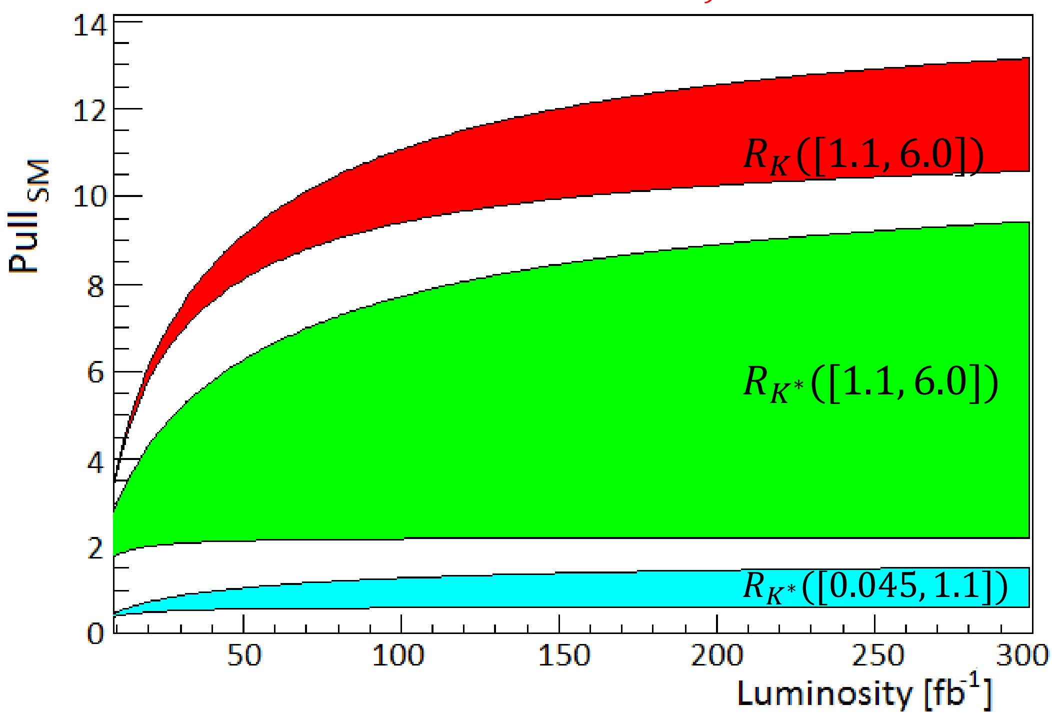
Upper limit: assuming ultimate systematic uncert. envisaged for 50 & 300 fb^{-1} (1% for ratios & 4% for $B_s \to \mu^+\mu^-$)

Lower limit: assuming current systematic uncertainties do not improve

assuming the best fit point of C_9^μ



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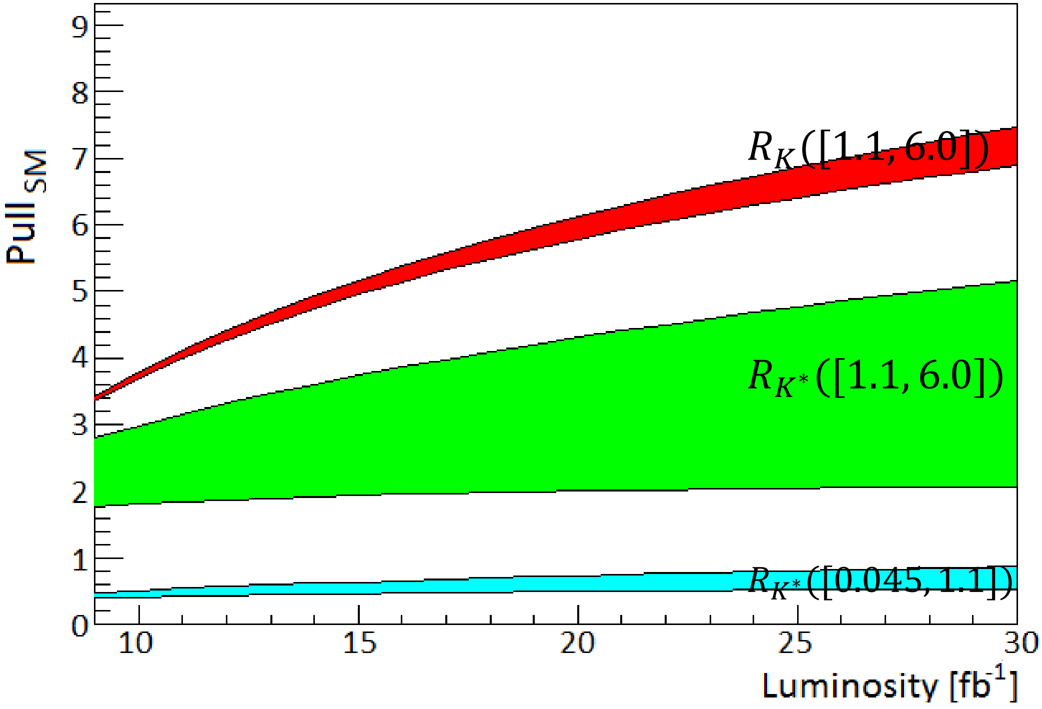


- For the C_9^μ case, R_K can individually reach 5σ at $\sim 16\ \mathrm{fb}^{-1}$

Projections: one operator fit to clean observables

Projections for 3 benchmark points: 18, 50 and 300 fb^{-1}

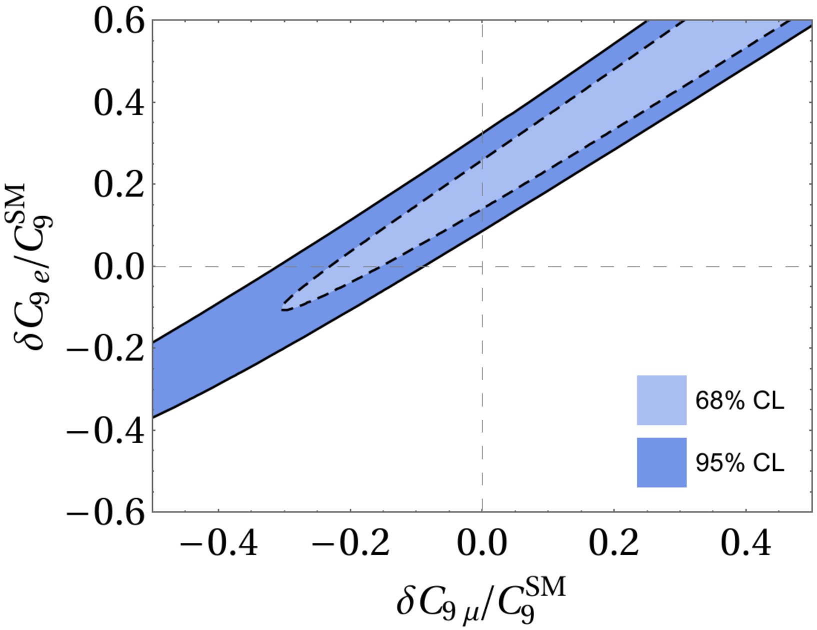
Using fit to clean observables R_K, R_{K^*} and $B_s \to \mu^+\mu^-$ only

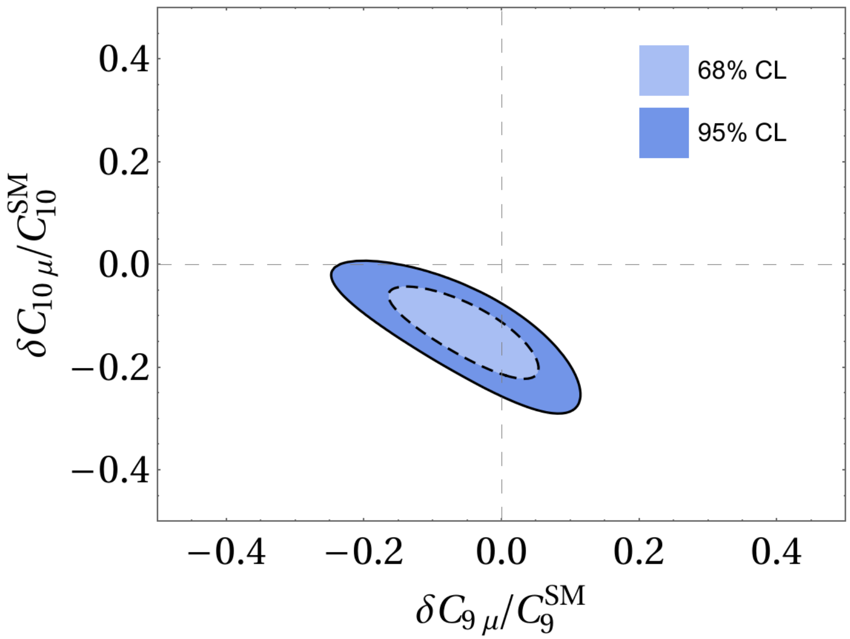
Pull$_{\rm SM}$ with $R_{K^{(*)}}$ and BR$(B_s \to \mu^+\mu^-)$ prospects			
LHCb lum.	18 fb^{-1}	50 fb^{-1}	300 fb^{-1}
δC_9^μ	6.5σ	14.7σ	21.9σ
δC_{10}^μ	7.1σ	16.6σ	25.1σ
δC_{LL}^μ	7.5σ	17.7σ	26.6σ

- For all three scenarios NP significance will be larger than 6σ already with 18 fb^{-1}

Projections for 3 benchmark points: 18, 50 and 300 fb^{-1}

Using fit to clean observables R_K, R_{K^*} and $B_s \to \mu^+\mu^-$ only

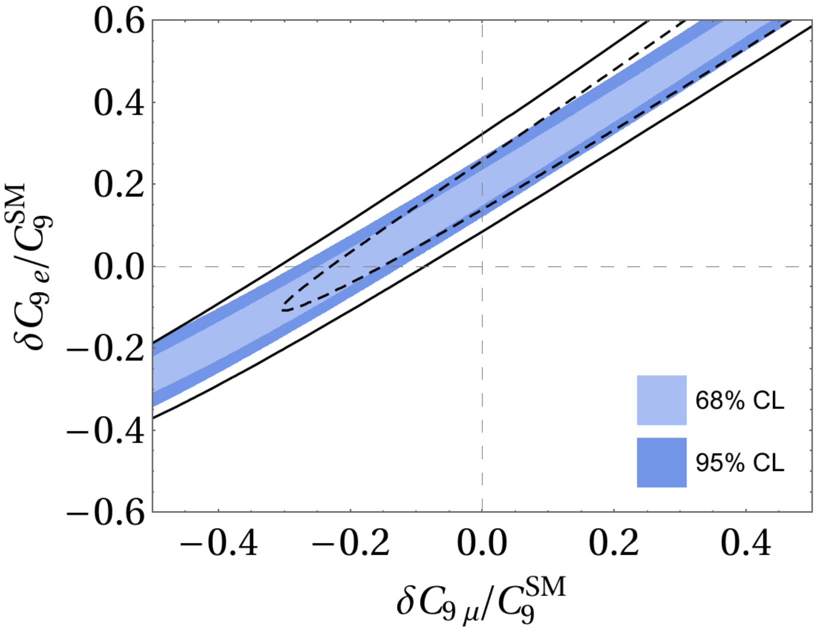


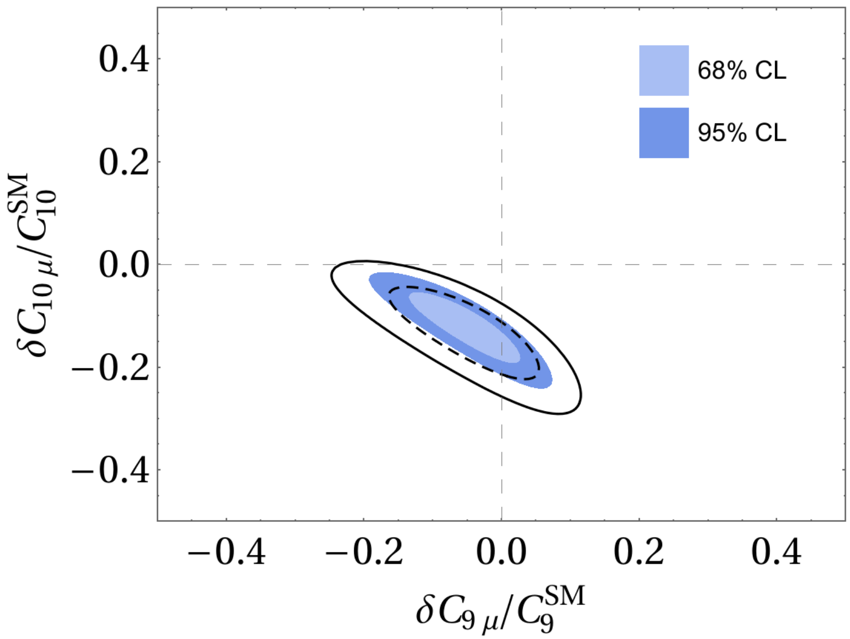


Current data

Projections for 3 benchmark points: 18, 50 and 300 fb^{-1}

Using fit to clean observables R_K, R_{K^*} and $B_s \to \mu^+\mu^-$ only

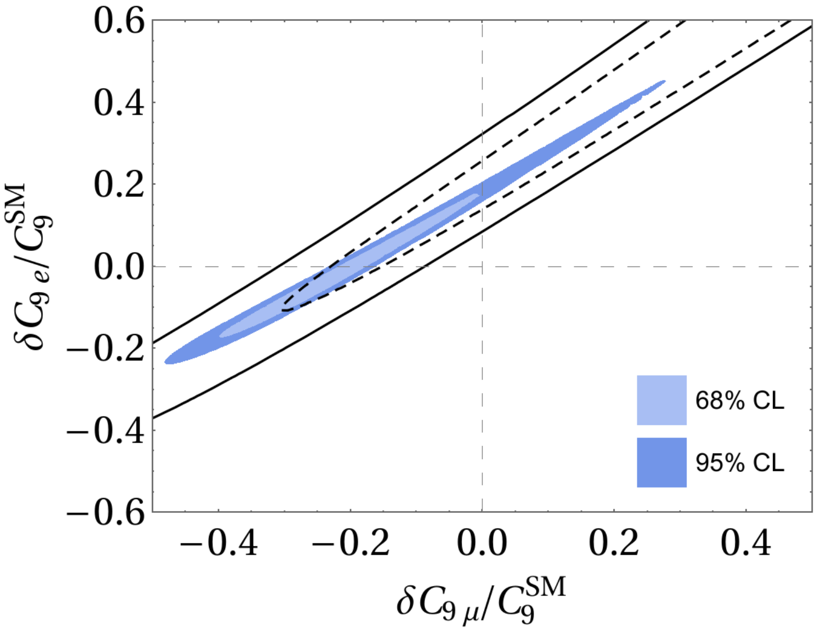


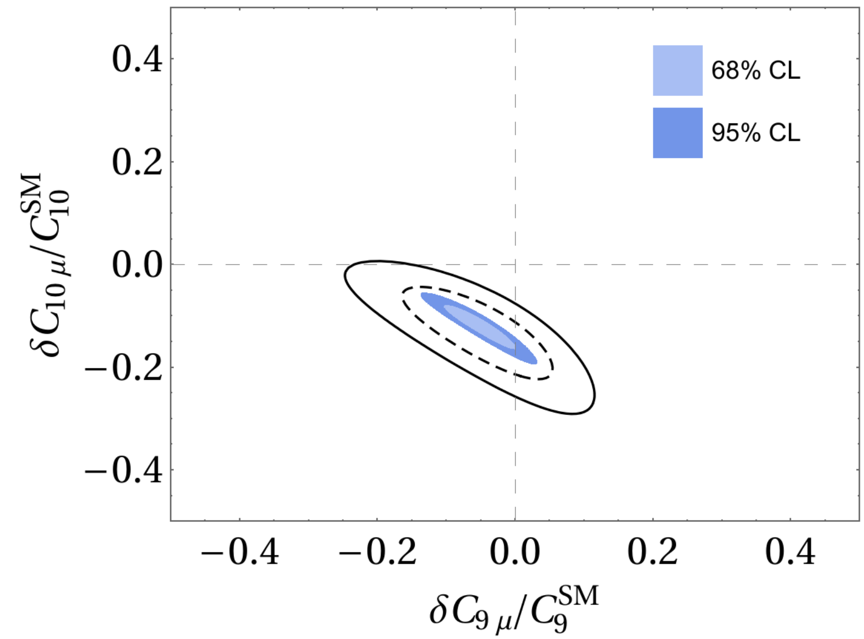


Projections for 18 fb^{-1}

Projections for 3 benchmark points: 18, 50 and 300 fb^{-1}

Using fit to clean observables R_K, R_{K^*} and $B_s \to \mu^+\mu^-$ only



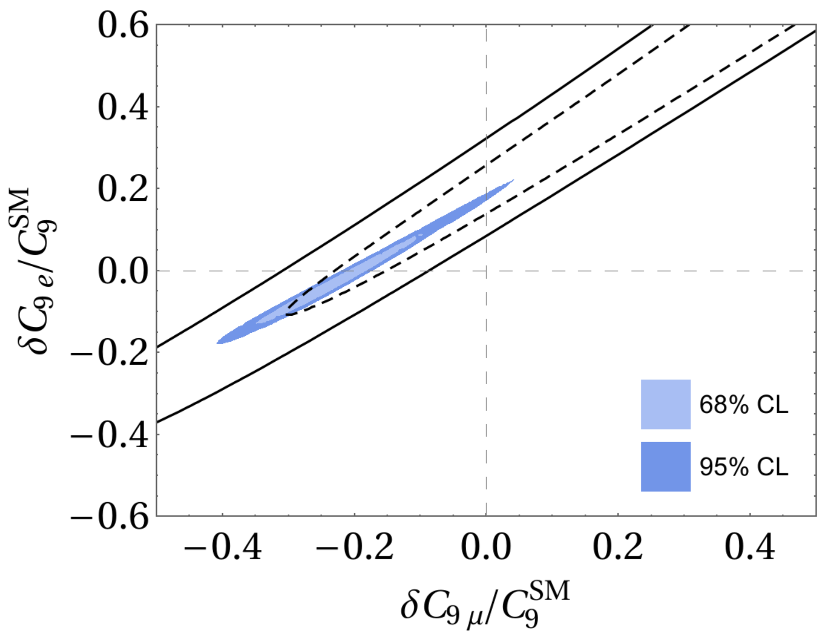


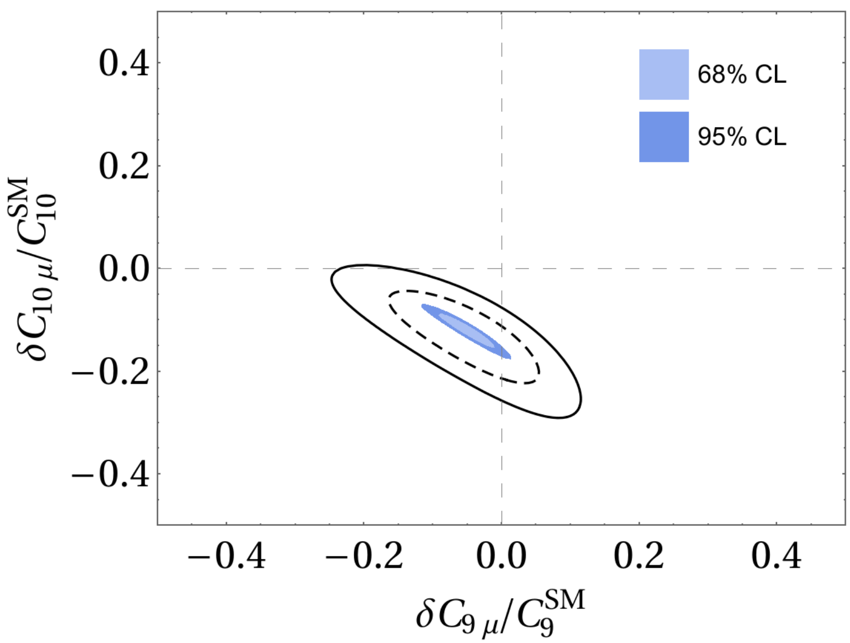
Projections for 50 fb^{-1}

Projections: two operator fit to clean observables

Projections for 3 benchmark points: 18, 50 and 300 fb^{-1}

Using fit to clean observables R_K, R_{K^*} and $B_s \to \mu^+\mu^-$ only





Projections for 300 fb^{-1}

Conclusions

- Updated data have kept the hierarchy of the preferred NP scenario while increasing the significance
- Fit to clean observables and the rest of the $b \to s\ell\ell$ observables point towards compatible NP scenarios
- Using clean observables, future data can pin down C_9, C_{10} assuming that's where new physics is

Conclusions

- Updated data have kept the hierarchy of the preferred NP scenario while increasing the significance
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Thank you!

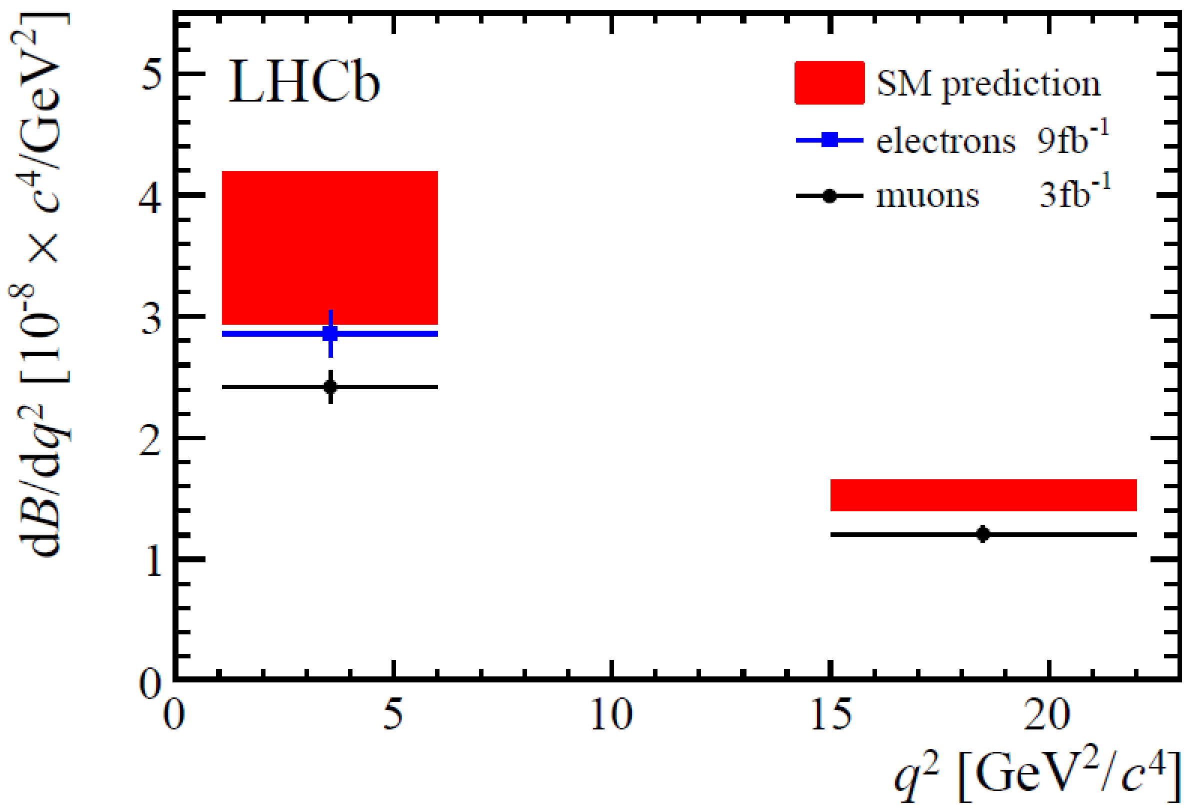
Backup

Projections: further ratios

Other clean $R_{\mu/e}$ to differentiate between preferred NP scenario

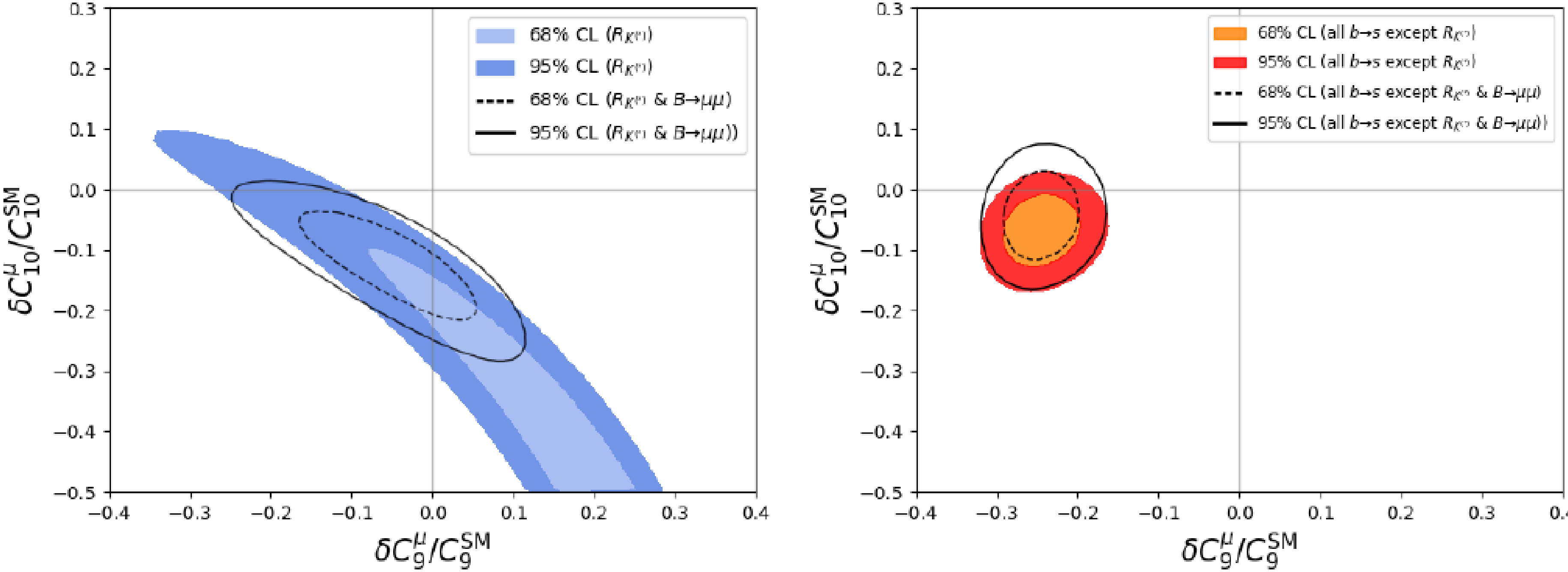
	Predictions assuming 50 fb^{-1} luminosity					
Obs.	C_9^μ	C_9^e	C_{10}^μ	C_{10}^e	C_{LL}^μ	C_{LL}^e
$R_{F_L}^{[1.1,6.0]}$	$[0.922, 0.932]$	$[0.941, 0.944]$	$[0.995, 0.998]$	$[0.996, 0.997]$	$[0.961, 0.964]$	$[1.006, 1.010]$
$R_{A_{FB}}^{[1.1,6.0]}$	$[4.791, 5.520]$	$[-0.416, -0.358]$	$[0.938, 0.939]$	$[0.963, 0.970]$	$[2.822, 3.089]$	$[0.279, 0.307]$
$R_{S_3}^{[1.1,6.0]}$	$[0.922, 0.931]$	$[0.914, 0.922]$	$[0.832, 0.852]$	$[0.858, 0.870]$	$[0.853, 0.870]$	$[1.027, 1.032]$
$R_{S_5}^{[1.1,6.0]}$	$[0.453, 0.543]$	$[0.723, 0.742]$	$[1.014, 1.014]$	$[1.040, 1.048]$	$[0.773, 0.801]$	$[1.298, 1.361]$
$R_{F_L}^{[15,19]}$	$[0.998, 0.999]$	$[0.998, 0.998]$	$[0.998, 0.998]$	$[0.998, 0.998]$	$[0.998, 0.998]$	$[0.998, 0.998]$
$R_{A_{FB}}^{[15,19]}$	$[0.929, 0.944]$	$[0.988, 0.989]$	$[1.009, 1.010]$	$[1.036, 1.042]$	$[0.996, 0.996]$	$[1.023, 1.028]$
$R_{S_3}^{[15,19]}$	$[0.998, 0.998]$	$[0.998, 0.998]$	$[0.999, 0.999]$	$[0.999, 0.999]$	$[0.999, 0.999]$	$[0.998, 0.998]$
$R_{S_5}^{[15,19]}$	$[0.929, 0.944]$	$[0.988, 0.989]$	$[1.009, 1.010]$	$[1.036, 1.042]$	$[0.996, 0.996]$	$[1.023, 1.028]$
$R_{K^*}^{[15,19]}$	$[0.825, 0.847]$	$[0.815, 0.835]$	$[0.828, 0.846]$	$[0.799, 0.820]$	$[0.804, 0.825]$	$[1.093, 1.107]$
$R_{K}^{[15,19]}$	$[0.823, 0.847]$	$[0.819, 0.838]$	$[0.854, 0.870]$	$[0.825, 0.844]$	$[0.820, 0.839]$	$[1.098, 1.113]$
$R_{\phi}^{[1.1,6.0]}$	$[0.862, 0.879]$	$[0.841, 0.858]$	$[0.824, 0.843]$	$[0.795, 0.816]$	$[0.819, 0.839]$	$[1.070, 1.080]$
$R_{\phi}^{[15,19]}$	$[0.825, 0.847]$	$[0.815, 0.835]$	$[0.826, 0.845]$	$[0.797, 0.819]$	$[0.803, 0.824]$	$[1.093, 1.107]$

Electrons are more SM-like than muons



One operator fit

Fit to clean observables $R_K, R_{K^{(*)}}, B_s \to \mu^+\mu^-$ and the rest of the $b \to s\ell\ell$ obs.



Depends on the assumptions on the non-factorisable power corrections

Global analysis of $b \to s$ transitions: multi-dimensional fit

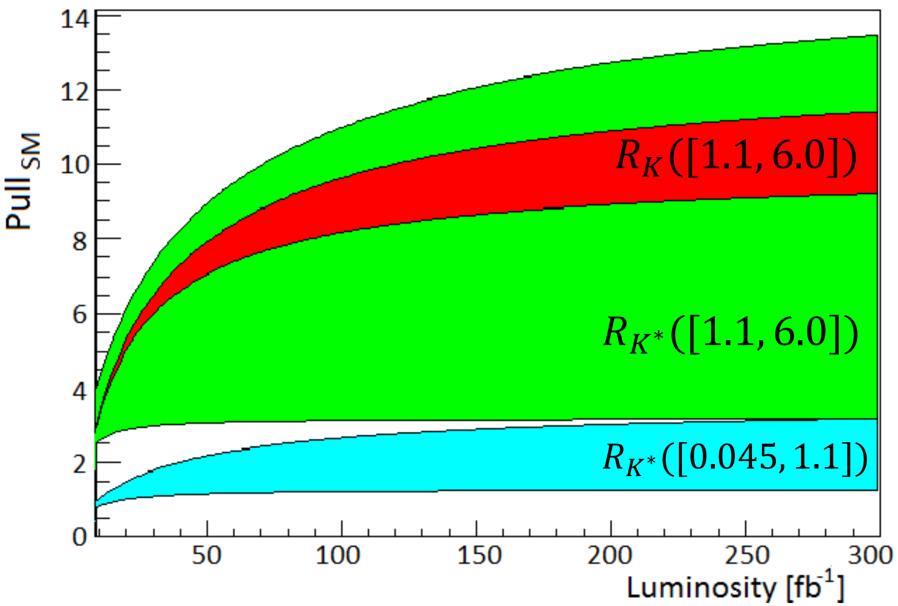
Multi-dimensional fit: $C_7, C_8, C_9^\ell, C_{10}^\ell, C_S^\ell, C_P^\ell$ + primed coefficients

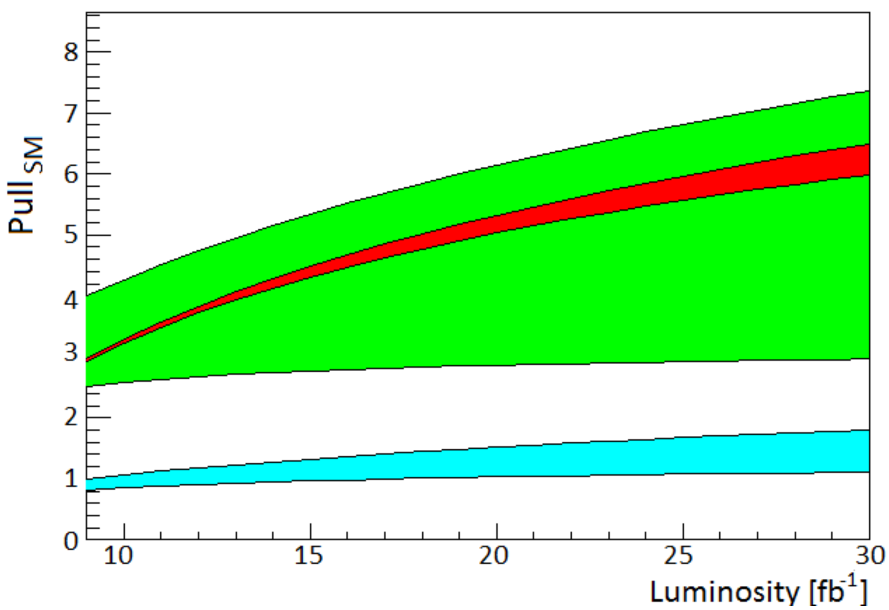
Set of WC	param.	$\chi^2_{\rm min}$	Pull$_{\rm SM}$	Improvement
SM	0	225.8	-	-
C_9^μ	1	168.6	7.6σ	7.6σ
C_9^μ, C_{10}^μ	2	167.5	7.3σ	1.0σ
$C_7, C_8, C_9^{(e,\mu)}, C_{10}^{(e,\mu)}$	6	158.0	7.1σ	2.0σ
All non-primed WC	10	157.2	6.5σ	0.1σ
All WC (incl. primed)	20 (19)	151.6	$5.5\,(5.6)\sigma$	$0.2\,(0.3)\sigma$

Keeping present central values, future projections don't give acceptable fits (p-value ≈ 0)

We assume future experimental results are in agreement with one of the current NP scenarios from the fit to clean observables

assuming the best fit point of C_{10}^{μ}





NP effect vs. hadronic fit

Instead of making assumptions on the size of the power corrections h_λ, they can be parameterised by a general ansatz (compatible with the analyticity structure): [Jäger, Camalich, 1412.3183], [Ciuchini et al. 1512.07157]

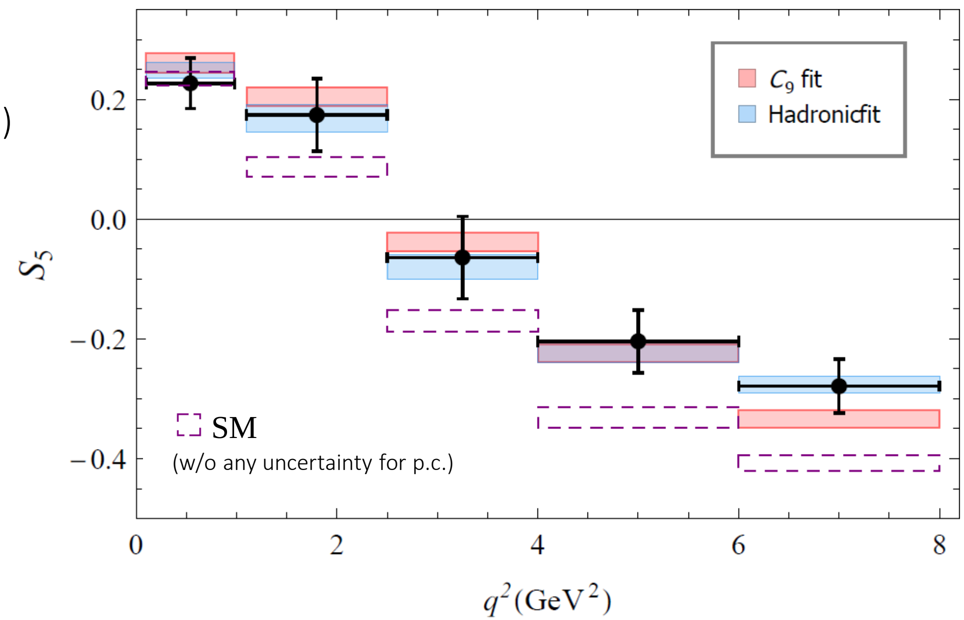
$$h_{\pm,[0]} = \left[\sqrt{q^2}\times\right]\left(h^{(0)}_{\pm,[0]} + q^2\, h^{(1)}_{\pm,[0]} + q^4\, h^{(2)}_{\pm,[0]}\right)$$

$\Longrightarrow$ NP effects in C_9 are embedded in the hadronic contributions [A. Arbey, T. Hurth, F. Mahmoudi, SN, 1806.02791]

Due to the embedding, fits to NP and hadronic contributions can be compared with the Wilks' test

Fit to
- Wilson coefficient $\delta C_9^{\rm NP}$
- Hadronic quantities $h^{(0,1,2)}_{+,-,0}$ (18 parameters)

$B \to K^*\mu^+\mu^-$ observables (low q^2) and BR($B \to K^*\gamma$)		
	Real δC_9 (1)	Hadronic fit (18)
Plain SM	6.0σ	4.7σ
Real δC_9	--	1.5σ

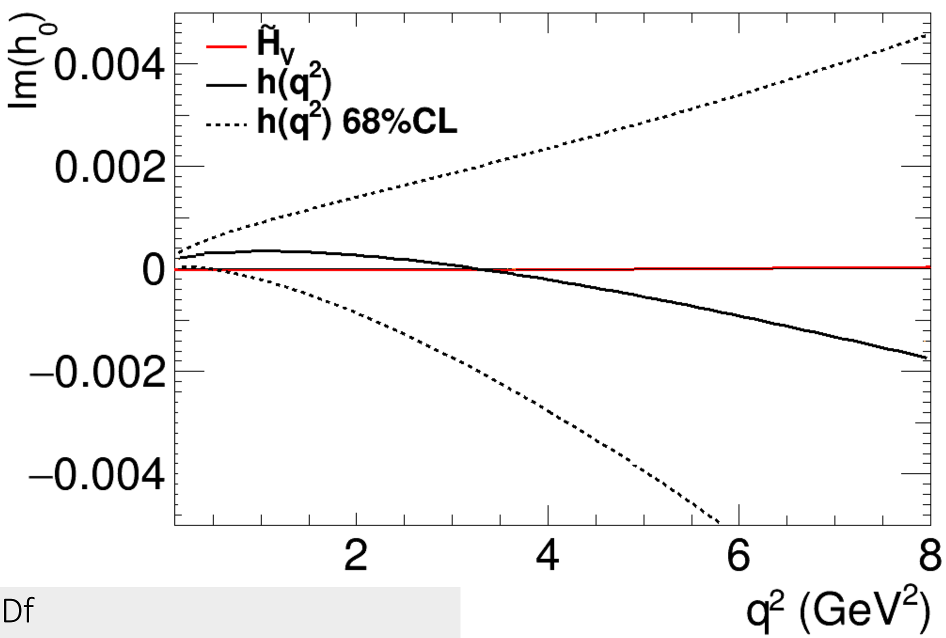


- Fit to δC_9 improves description of the data with 6σ compared to the SM (w/o any uncertainty for p.c.)
- Hadronic fit also describes the data well
- Adding 17 more parameters compared to the NP in C_9 doesn't significantly improve the fit ($\sim 1.5\sigma$)

NP fit vs. hadronic fit

The hadronic fit includes 18 free parameters

$B \to K^* \bar{\mu}\mu/\gamma$ observables ($\chi^2_{\rm SM} = 85.15,\ \chi^2_{\rm min} = 25.96;\ {\rm Pull}_{\rm SM} = 4.7\sigma$)		
	Real	Imaginary
$h_+^{(0)}$	$(-2.37 \pm 13.50) \times 10^{-5}$	$(7.86 \pm 13.79) \times 10^{-5}$
$h_+^{(1)}$	$(1.09 \pm 1.81) \times 10^{-4}$	$(1.58 \pm 1.69) \times 10^{-4}$
$h_+^{(2)}$	$(-1.10 \pm 2.66) \times 10^{-5}$	$(-2.45 \pm 2.51) \times 10^{-5}$
$h_-^{(0)}$	$(1.43 \pm 12.85) \times 10^{-5}$	$(-2.34 \pm 3.09) \times 10^{-4}$
$h_-^{(1)}$	$(-3.99 \pm 8.11) \times 10^{-5}$	$(1.44 \pm 2.82) \times 10^{-4}$
$h_-^{(2)}$	$(2.04 \pm 1.16) \times 10^{-5}$	$(-3.25 \pm 3.98) \times 10^{-5}$
$h_0^{(0)}$	$(2.38 \pm 2.43) \times 10^{-4}$	$(5.10 \pm 3.18) \times 10^{-4}$
$h_0^{(1)}$	$(1.40 \pm 1.98) \times 10^{-4}$	$(-1.66 \pm 2.41) \times 10^{-4}$
$h_0^{(2)}$	$(-1.57 \pm 2.43) \times 10^{-5}$	$(3.04 \pm 29.87) \times 10^{-6}$



Red line: LO QCDf
Solid black line: h_λ
Dashed black line: 68% C.L. region of h_λ fit

- h_λ compatible with zero at 1σ level

⟶ too many free parameters to get strongly constrained with current data

NP fit vs. hadronic fit

A (minimal) description of hadronic contributions with fewer free parameters

$$h_\lambda(q^2) = -\frac{\tilde{V}_\lambda(q^2)}{16\pi^2}\frac{q^2}{m_B^2}\Delta C_9^{\lambda,\mathrm{PC}}$$

for each helicity ($\lambda = +,-,0$) a different ΔC_9^{PC}
$\rightarrow$ three real (six complex) parameters

- If NP in C_9 is the favoured scenario, the three different fitted helicities should give the same value
  $\Rightarrow$ Can work as a null test for NP

$B \to K^* \bar{\mu}\mu/\gamma$ observables ($\chi^2_{\mathrm{SM}} = 85.15,\ \chi^2_{\mathrm{min}} = 39.40;\ \mathrm{Pull}_{\mathrm{SM}} = 5.5\sigma$)	
	best fit value
$\Delta C_9^{+,\mathrm{PC}}$	$(3.39 \pm 6.44) + i(-14.98 \pm 8.40)$
$\Delta C_9^{-,\mathrm{PC}}$	$(-1.02 \pm 0.22) + i(-0.68 \pm 0.79)$
$\Delta C_9^{0,\mathrm{PC}}$	$(-0.83 \pm 0.53) + i(-0.89 \pm 0.69)$

Fitted parameters not the same for different helicities but in agreement with each other within 1σ

Fit to only BR($B \to K^*\gamma$) and $B \to K^*\mu^+\mu^-$ observables (low q^2)		
	Real δC_9 (1)	Hadronic fit; Complex $\Delta C_9^{\lambda,\mathrm{PC}}$ (6)
Plain SM (0)	(6.0σ)	(5.5σ)
Real δC_9 (1)	--	(1.8σ)

- Adding the hadronic parameters improve the fit with less than 2σ significance

Strong indication that the NP interpretation is a valid option, although the situation remains inconclusive