暨南大學
JINAN UNIVERSITY

Global Fits of $b \to s\ell^+\ell^-$

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合作者：温侨毅， PRD 108, 095038 (2023)

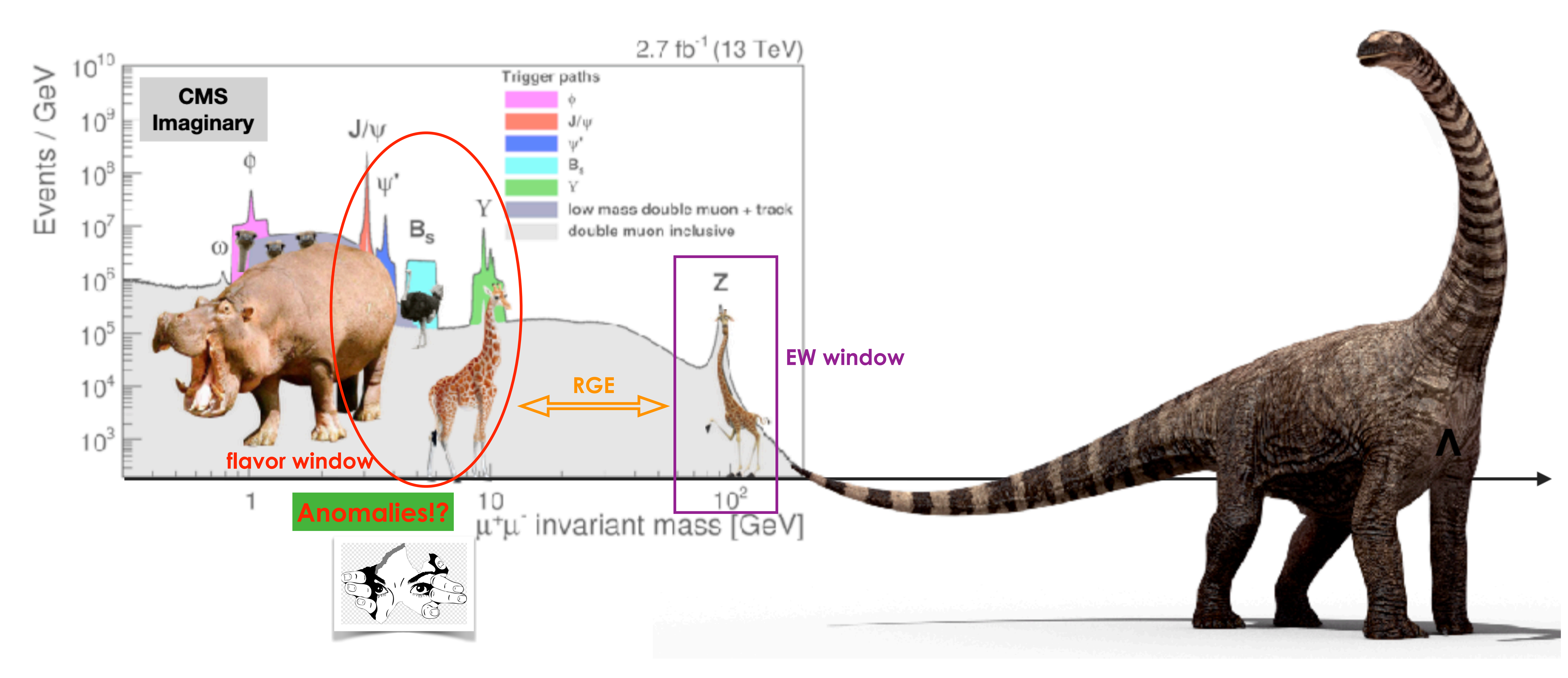
华中师范大学, 2023.11.26

OUTLINE

- Introduction
- Theory overview
- Fitting overview
- Our results and implications
- Summary

INTRODUCTION

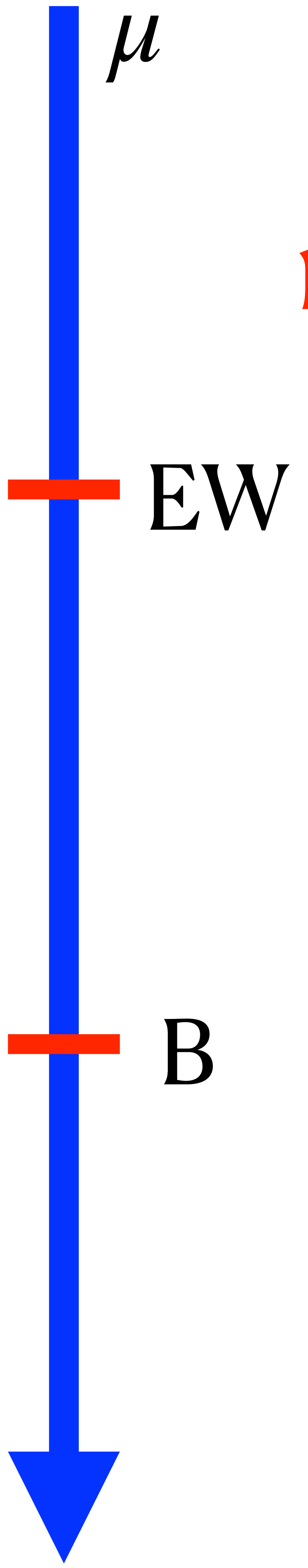
Flavor physics is a probe of new physics.



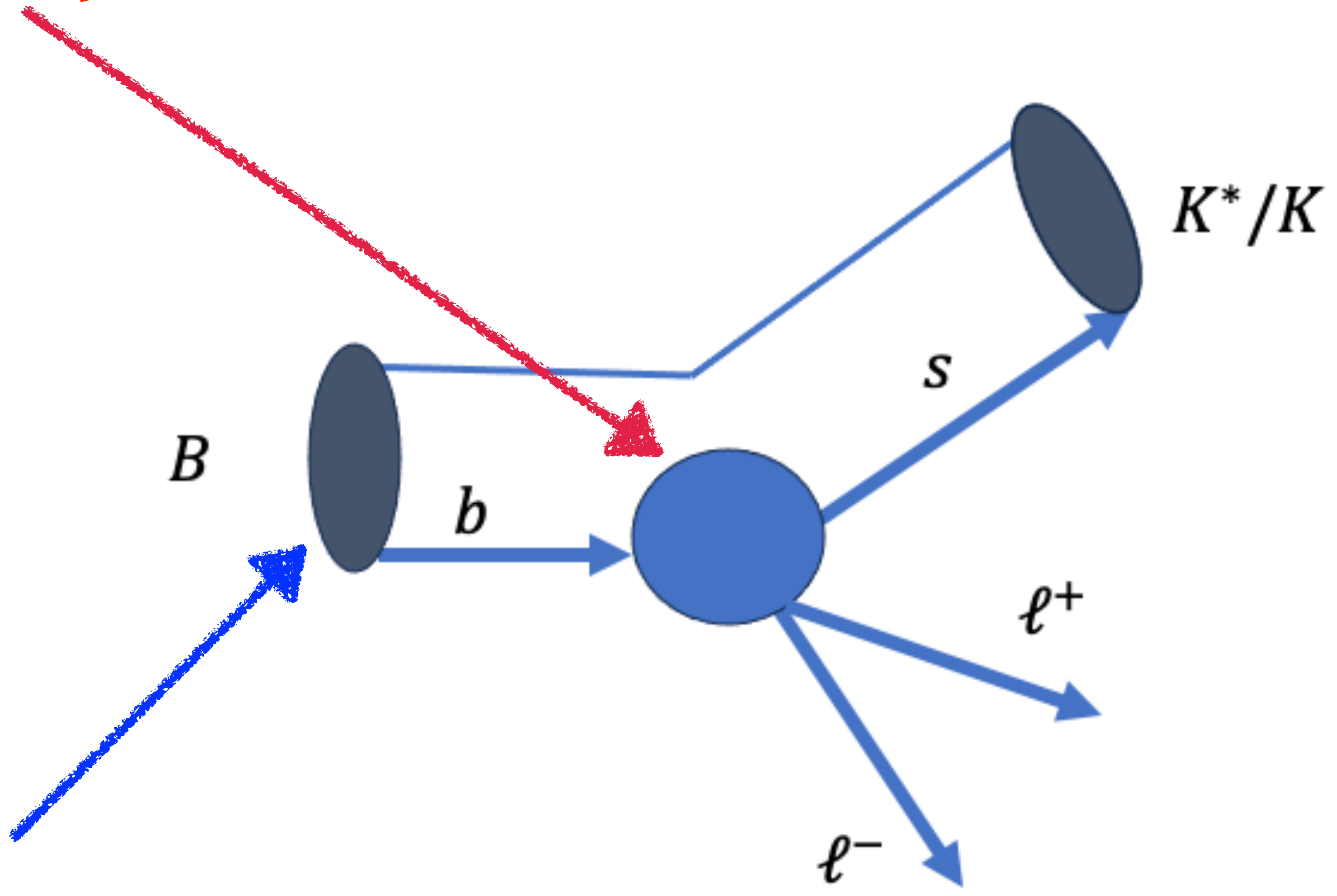
$$[\text{quark}]_{\text{flavour}} = V_{CKM}\,[\text{quark}]_{\text{mass}}$$

weakly interacting — strongly produced

$$V_{CKM} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix}$$



new physics



QCD

Yu-Ming Wang's talk

灵魂在天上
肉身在尘世

EARLY PURSUIT OF NEW PHYSICS: LARGE BR & NON-ZERO AFB

RAPID COMMUNICATIONS

PHYSICAL REVIEW D, VOLUME 59, 011701

Promising process to distinguish supersymmetric models with large tan β from the standard model: $B \to X_s \mu^+ \mu^-$

Chao-Shang Huang,* Wei Liao,† and Qi-Shu Yan‡
Institute of Theoretical Physics, Academia Sinica, P.O. Box 2735, Beijing 100080, People's Republic of China
(Received 15 June 1998; published 17 November 1998)

It is shown that in supersymmetric models the large supersymmetric contributions to $B \to X_s \mu^+ \mu^-$ come from the Feynman diagrams which consist of exchanging neutral Higgs boson loops and are proportional to $m_b m_\mu \tan^3\beta / m_h^2$ when tan β is large and the mass of the lightest neutral Higgs boson m_h is not too large (say, less than 150 GeV). Numerical results show that the branching ratios of $B \to X_s \mu^+ \mu^-$ can be enhanced by more than 100% compared to the standard model (SM) and the backward-forward asymmetry of the lepton is significantly different from that in the SM when tan $\beta \geqslant 30$. [S0556-2821(98)50123-3]

PACS number(s): 12.60.Jv, 13.20.He

PHYSICAL REVIEW D, VOLUME 62, 094023

Exclusive semileptonic rare decays $B \to (K, K^*) l^+ l^-$ in supersymmetric theories

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Physics Department of Tsinghua University, People's Republic of China

Chao-Shang Huang,† Wei Liao,‡ and Shou-Hua Zhu§
Institute of Theoretical Physics, the Chinese Academy Science, People's Republic of China
(Received 1 May 2000; published 11 October 2000)

The invariant mass spectrum, forward-backward asymmetry, and lepton polarizations of the exclusive processes $B \to K(K^*) l^+ l^-, l = \mu, \tau$ are analyzed in a supersymmetric context. Special attention is paid to the effects of neutral Higgs bosons (NHB's). Our analysis shows that the branching ratio of the process $B \to K \mu^+ \mu^-$ can be quite largely modified by the effects of neutral Higgs bosons and the forward-backward asymmetry would not vanish. For the process $B \to K^* \mu^+ \mu^-$, the lepton transverse polarization is quite sensitive to the effects of NHB's, while the invariant mass spectrum, forward-backward asymmetry, and lepton longitudinal polarization are not. For both $B \to K \tau^+ \tau^-$ and $B \to K^* \tau^+ \tau^-$, the effects of NHB's are quite significant. The partial decay widths of these processes are also analyzed, and our analysis manifests that, even taking into account the theoretical uncertainties in calculating weak form factors, the effects of NHB's could make supersymmetry show up.

PACS number(s): 13.20.He, 12.60.Jv, 13.25.Hw

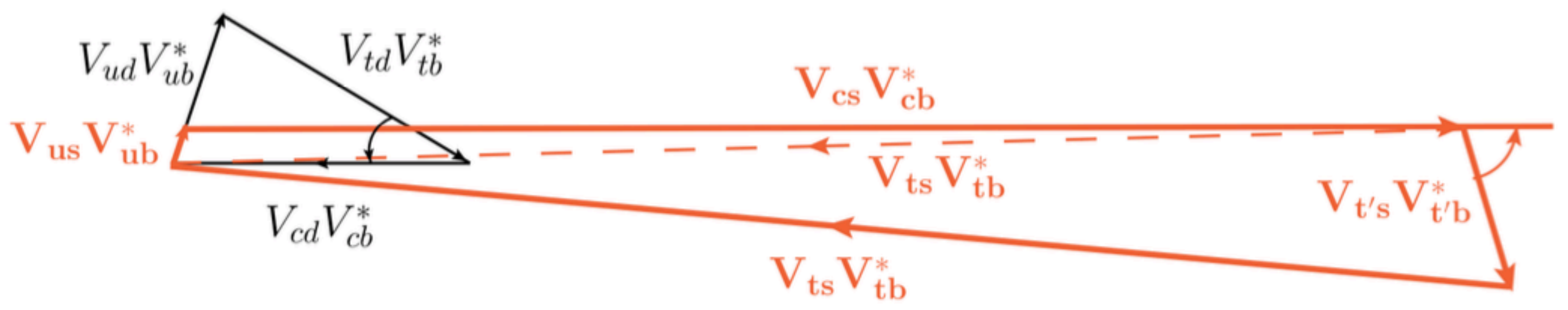
PHYSICAL REVIEW D, VOLUME 63, 114021

$B_s \to l^+ l^-$ in a type-II two-Higgs-doublet model and the minimal supersymmetric standard model

Chao-Shang Huang,[1,*] Liao Wei,[1,†] Qi-Shu Yan,[2,‡] and Shou-Hua Zhu[1,3,§]
[1]*Institute of Theoretical Physics, Academia Sinica, 100080 Beijing, China*
[2]*Physics Department of Tsinghua University, 100080 Beijing, China*
[3]*Institut für Theoretische Physik, Universität Karlsruhe, D-76128 Karlsruhe, Germany*
(Received 17 December 2000; published 7 May 2001)

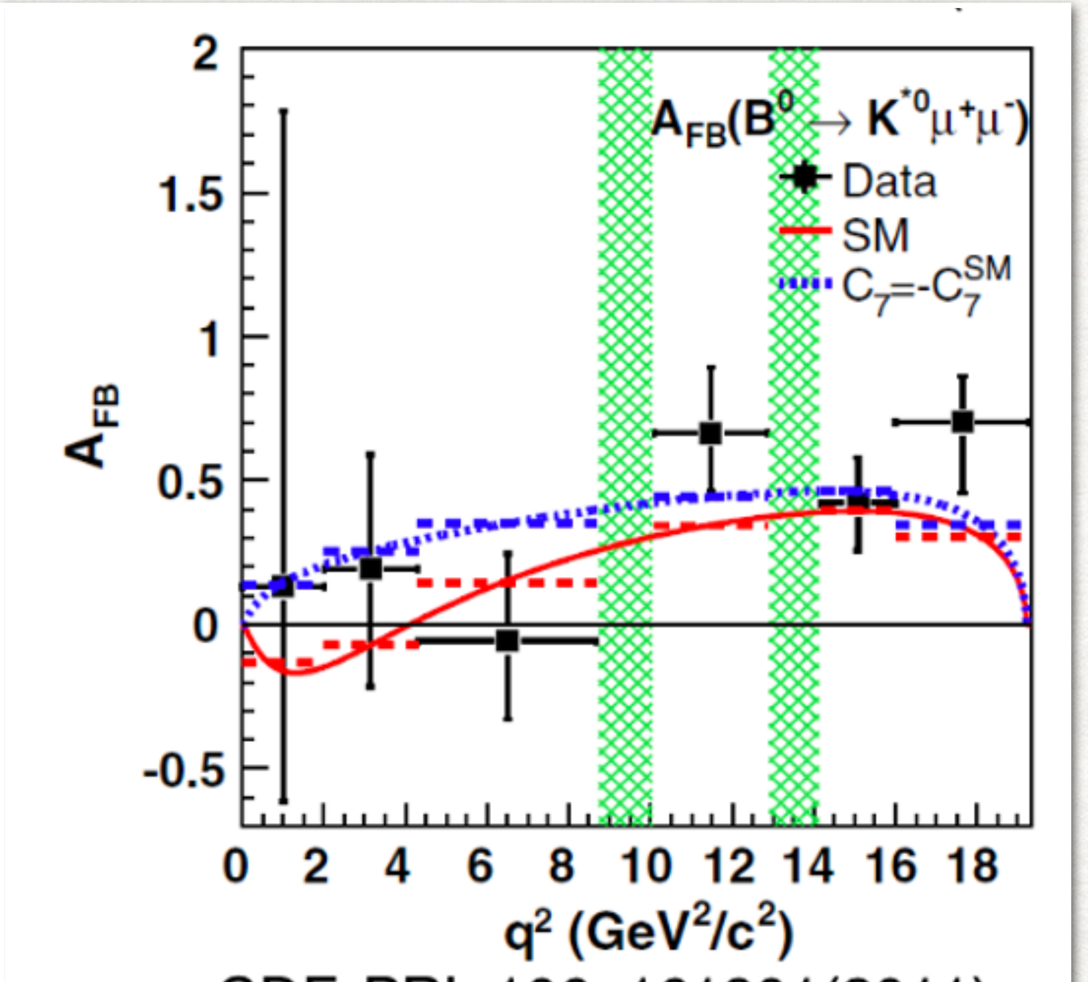
In this paper we analyze the process $B_s \to l^+ l^-$ in a type-II two-Higgs-doublet model (2HDM) and the minimal supersymmetric standard model (MSSM). All the leading terms of Wilson coefficients relevant to the process are given in the large tan β limit. It is shown that the decay width for $B_s \to l^+ l^-$ depends on all parameters except m_{A^0} in the 2HDM. The branching ratio of $B_s \to \mu^+ \mu^-$ can reach its experimental bound in some large tan β regions of the parameter space in the MSSM because the amplitude increases as $\tan^3\beta$ in the regions. For $l = \tau$, the branching ratio can even reach 10^{-4} in the regions. Therefore, the experimental measurements of leptonic decays of B_s could put a constraint on the contributions of neutral Higgs bosons and consequently the parameter space in the MSSM.

DOI: 10.1103/PhysRevD.63.114021 PACS number(s): 13.20.He, 13.25.Hw

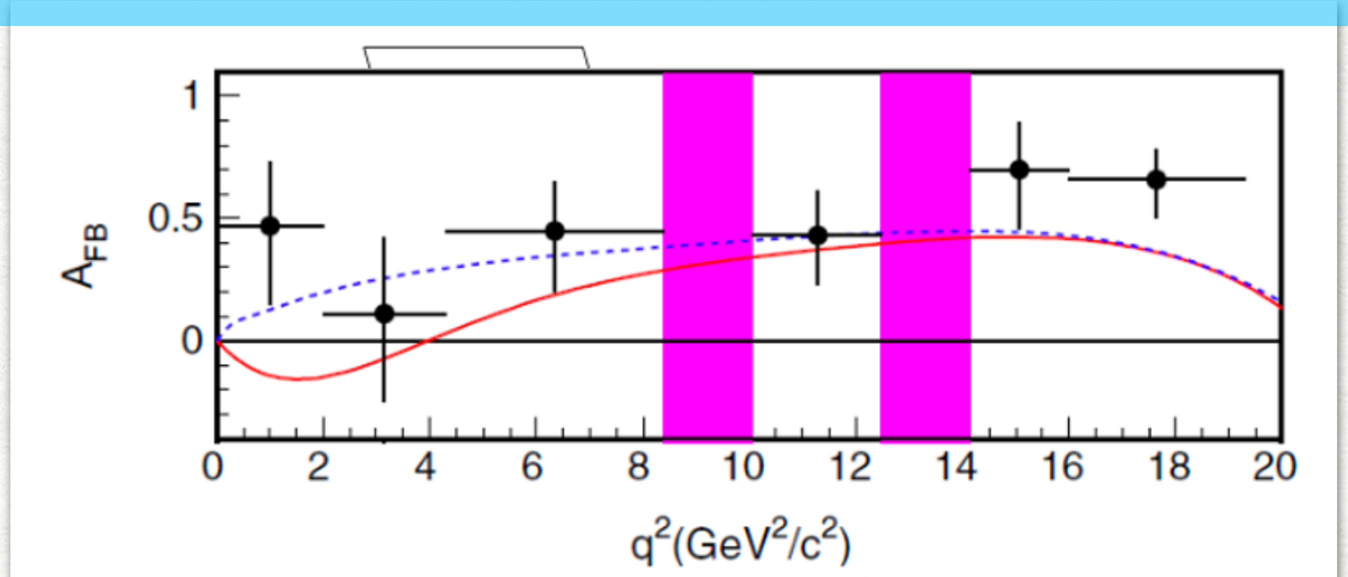


W.-S. Hou, M. Kohda, FX, PRD84 (2011), 094027

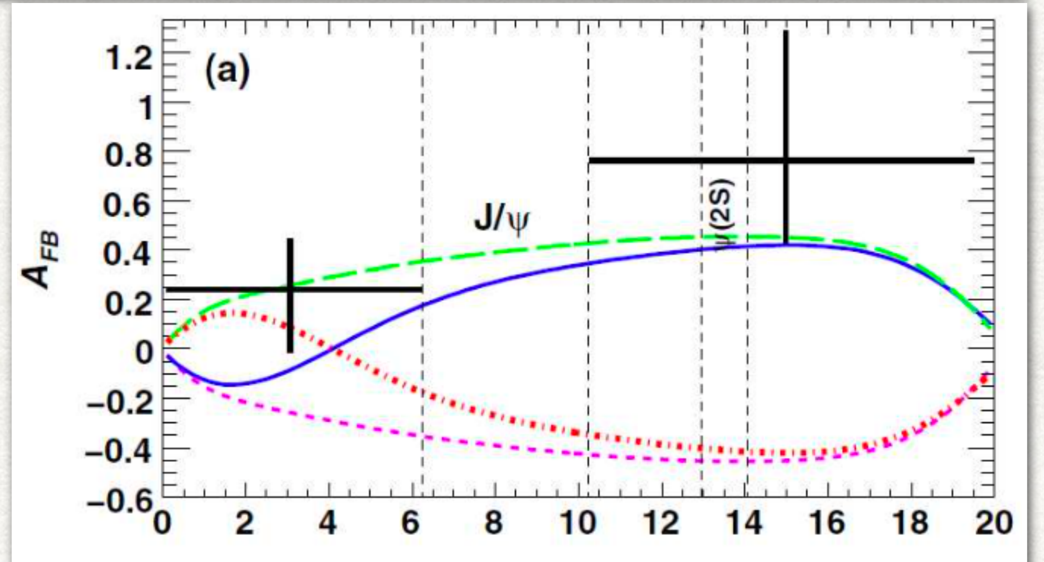
EARLY PURSUIT OF NEW PHYSICS: LARGE BR & NON-ZERO AFB



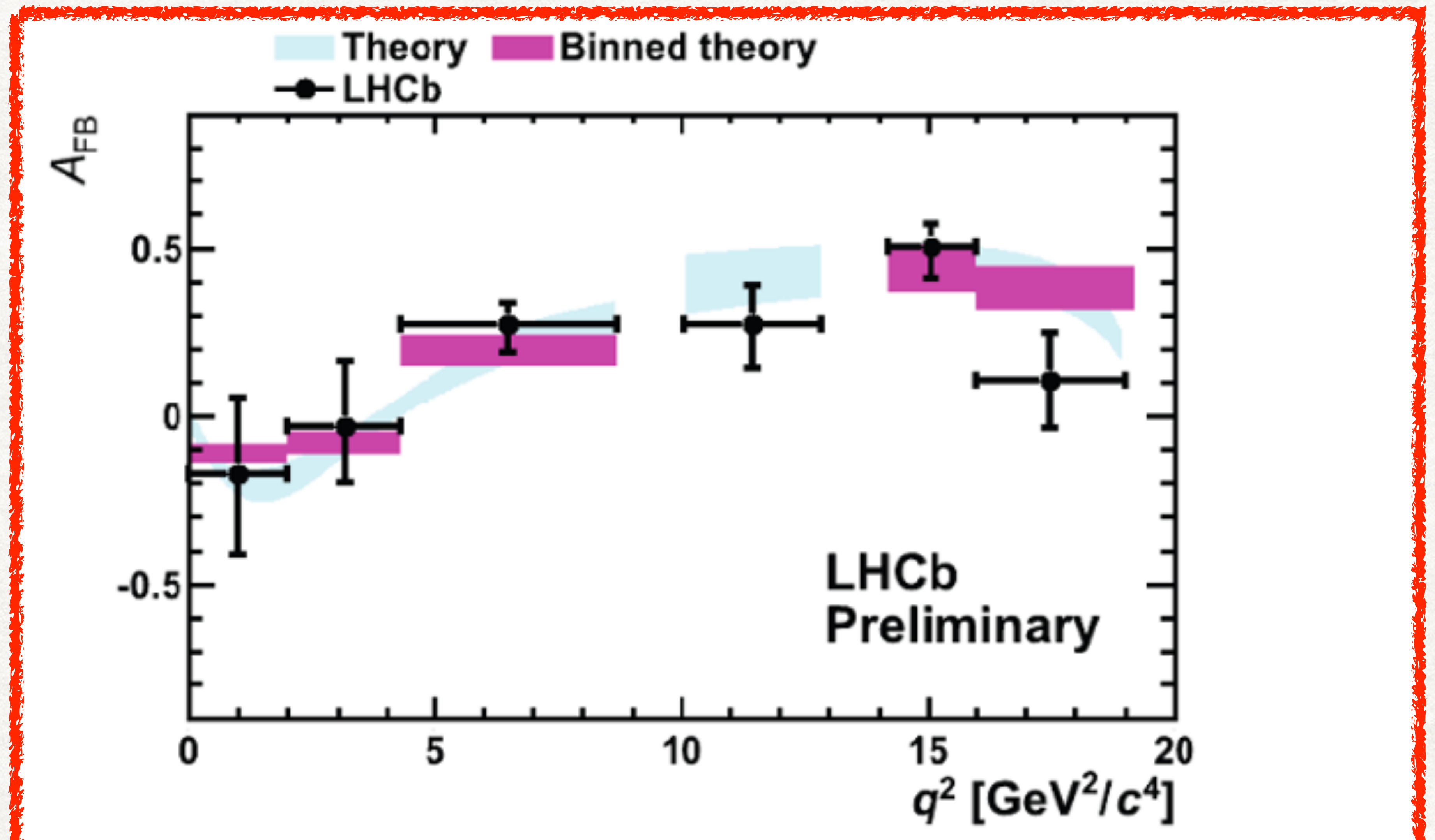
CDF, PRL 106, 161801(2011)



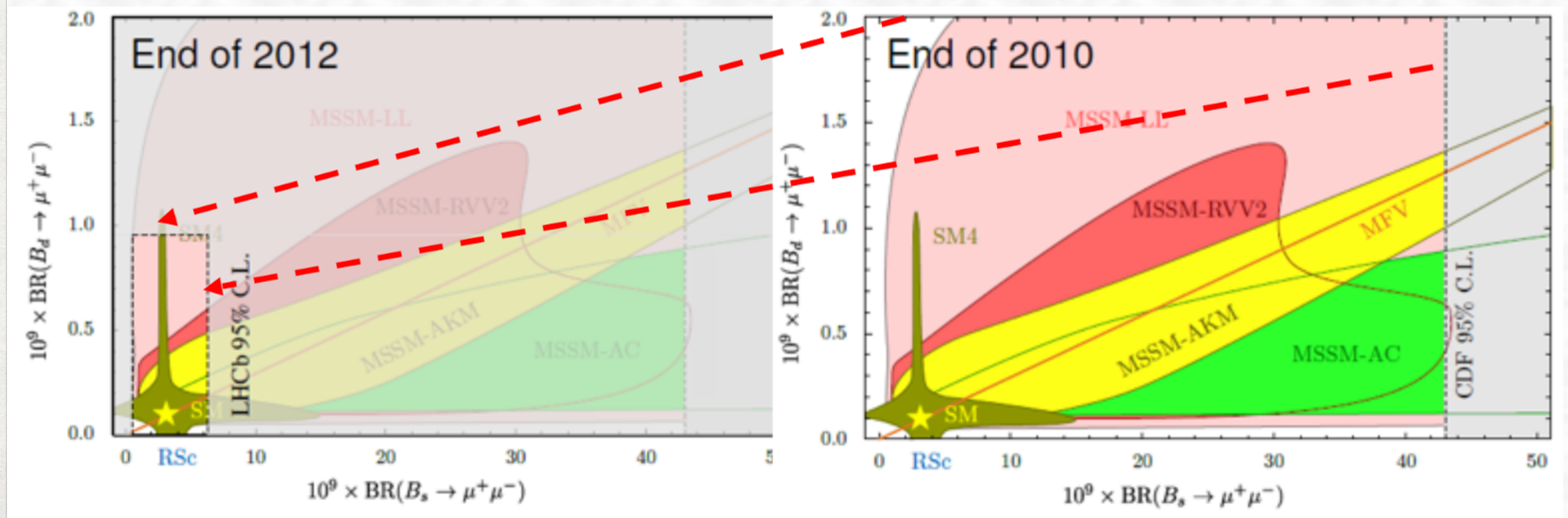
Belle, PRL 103, 171801 (2009)



BaBar, PRD 79, 031102(R) (2009)

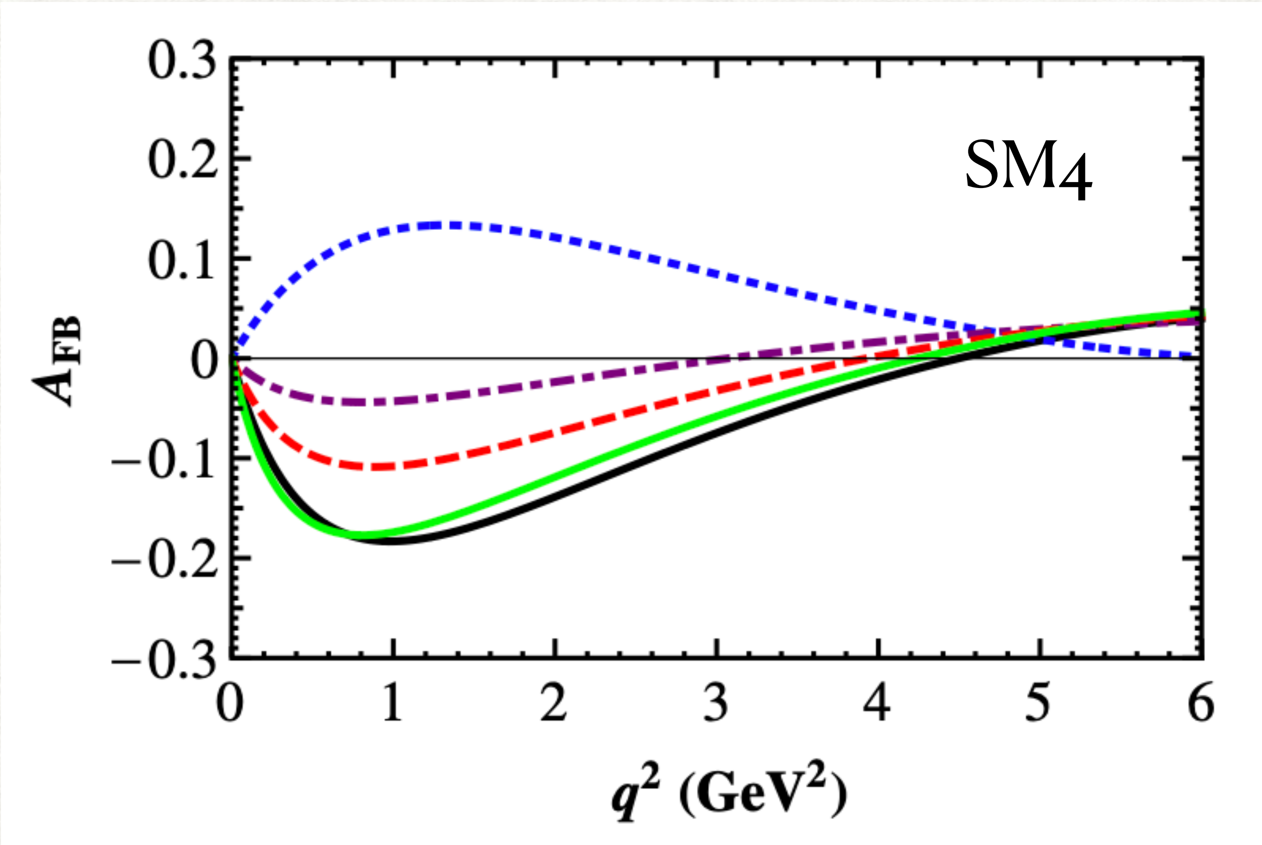


$309pb^{-1}$ data, M. Patel, LHCb@EPS-HEP2011



Straub [Moriond 2012]

Straub [Nuovo Cim. C35 1 (2012) 249-256]



THE EMERGENCE OF LFU PROBLEM

Selected for a Viewpoint in *Physics*
PRL **113**, 151601 (2014) PHYSICAL REVIEW LETTERS week ending 10 OCTOBER 2014

Test of Lepton Universality Using $B^+ \to K^+\ell^+\ell^-$ Decays

R. Aaij *et al.**
(LHCb Collaboration)
(Received 25 June 2014; published 6 October 2014)

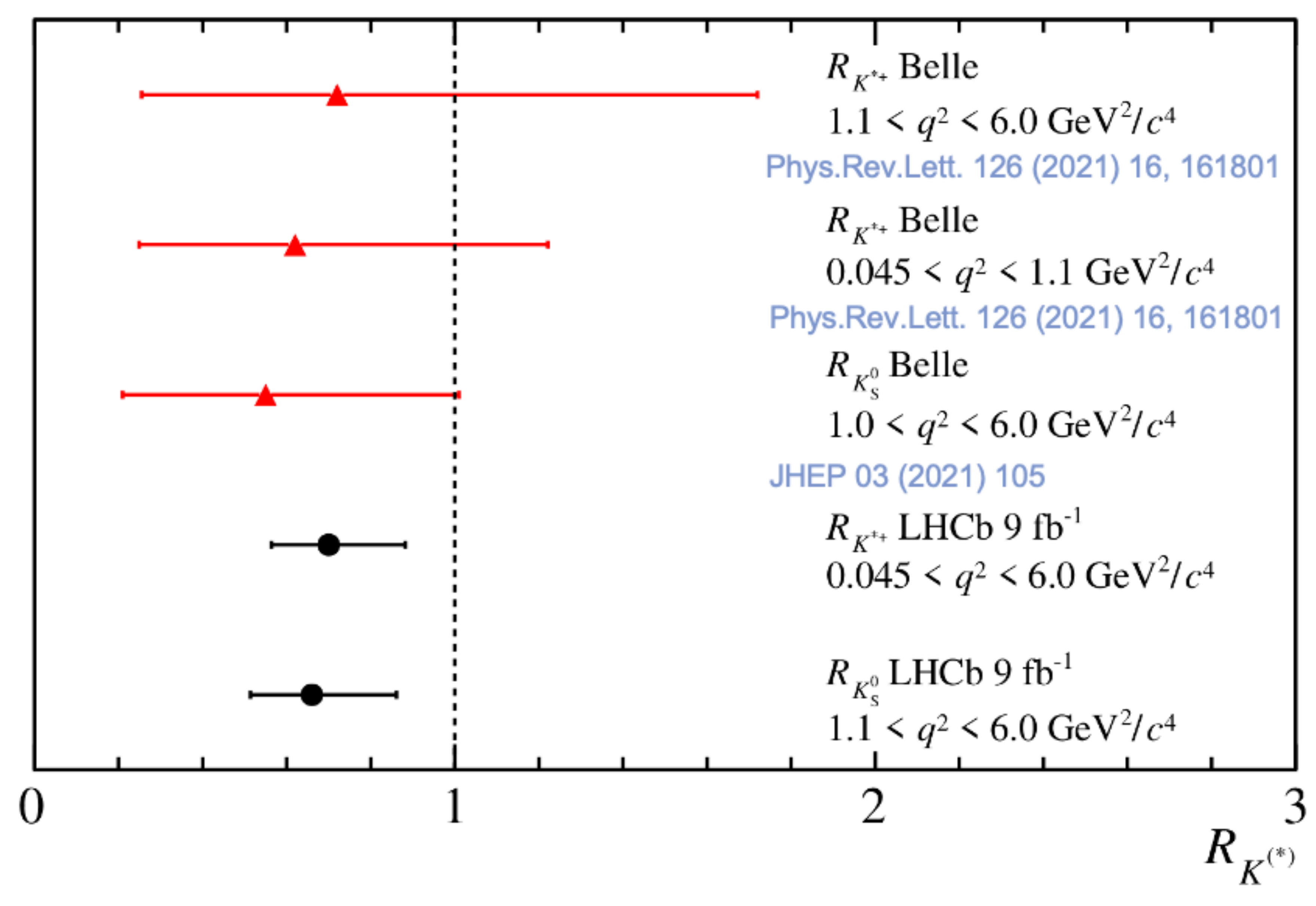
A measurement of the ratio of the branching fractions of the $B^+ \to K^+\mu^+\mu^-$ and $B^+ \to K^+e^+e^-$ decays is presented using proton-proton collision data, corresponding to an integrated luminosity of 3.0 fb^{-1}, recorded with the LHCb experiment at center-of-mass energies of 7 and 8 TeV. The value of the ratio of branching fractions for the dilepton invariant mass squared range $1 < q^2 < 6\ \mathrm{GeV}^2/c^4$ is measured to be $0.745^{+0.090}_{-0.074}(\mathrm{stat}) \pm 0.036(\mathrm{syst})$. This value is the most precise measurement of the ratio of branching fractions to date and is compatible with the standard model prediction within 2.6 standard deviations.

DOI: 10.1103/PhysRevLett.113.151601 PACS numbers: 11.30.Hv

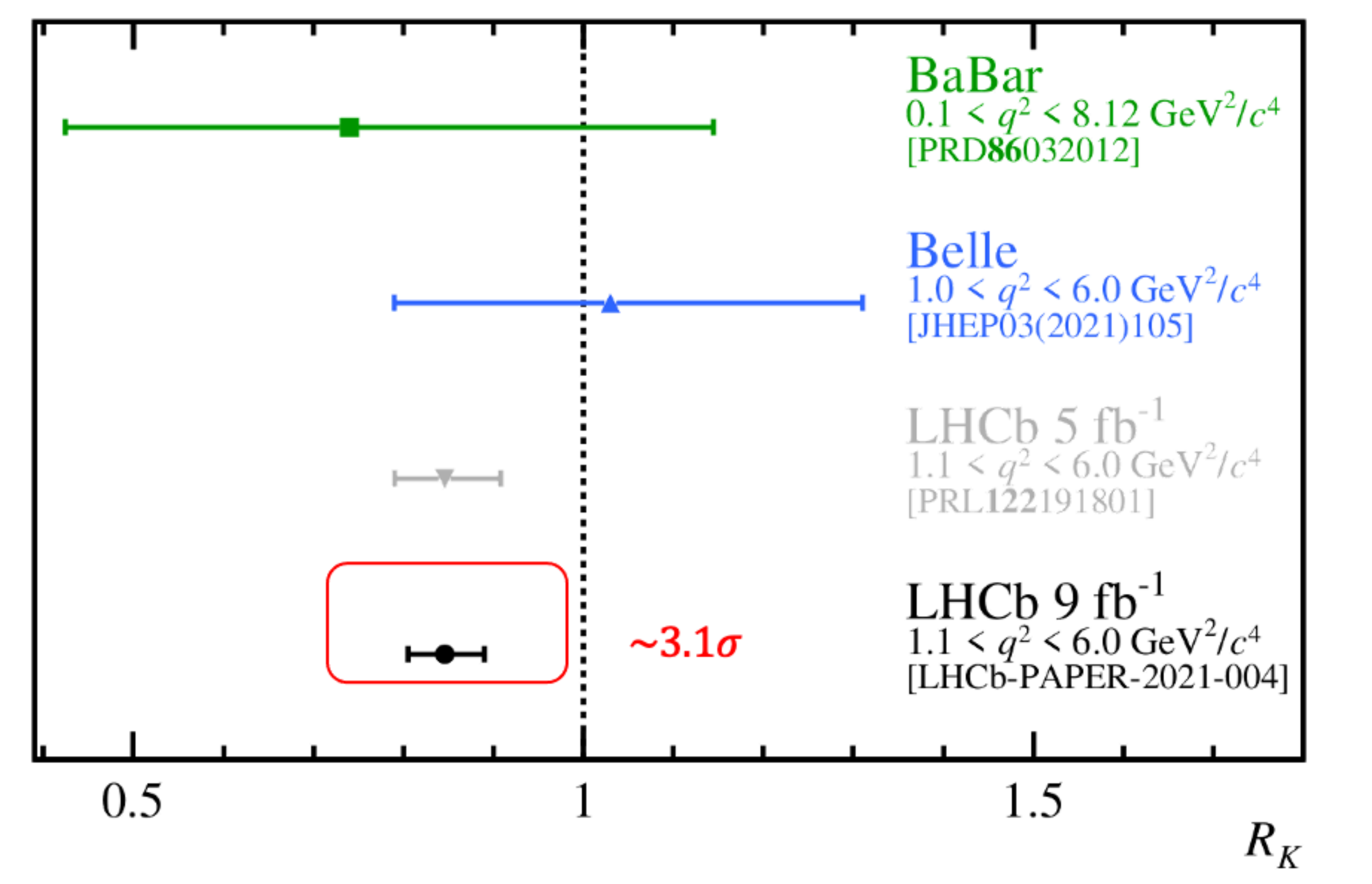
$$R_K = \frac{BR(B \to K\mu^+\mu^-)}{BR(B \to Ke^+e^-)}$$

G. Hiller, F. Kruger
hep-ph/0310219

$$R_{K^*} = \frac{BR(B \to K^*\mu^+\mu^-)}{BR(B \to K^*e^+e^-)}$$

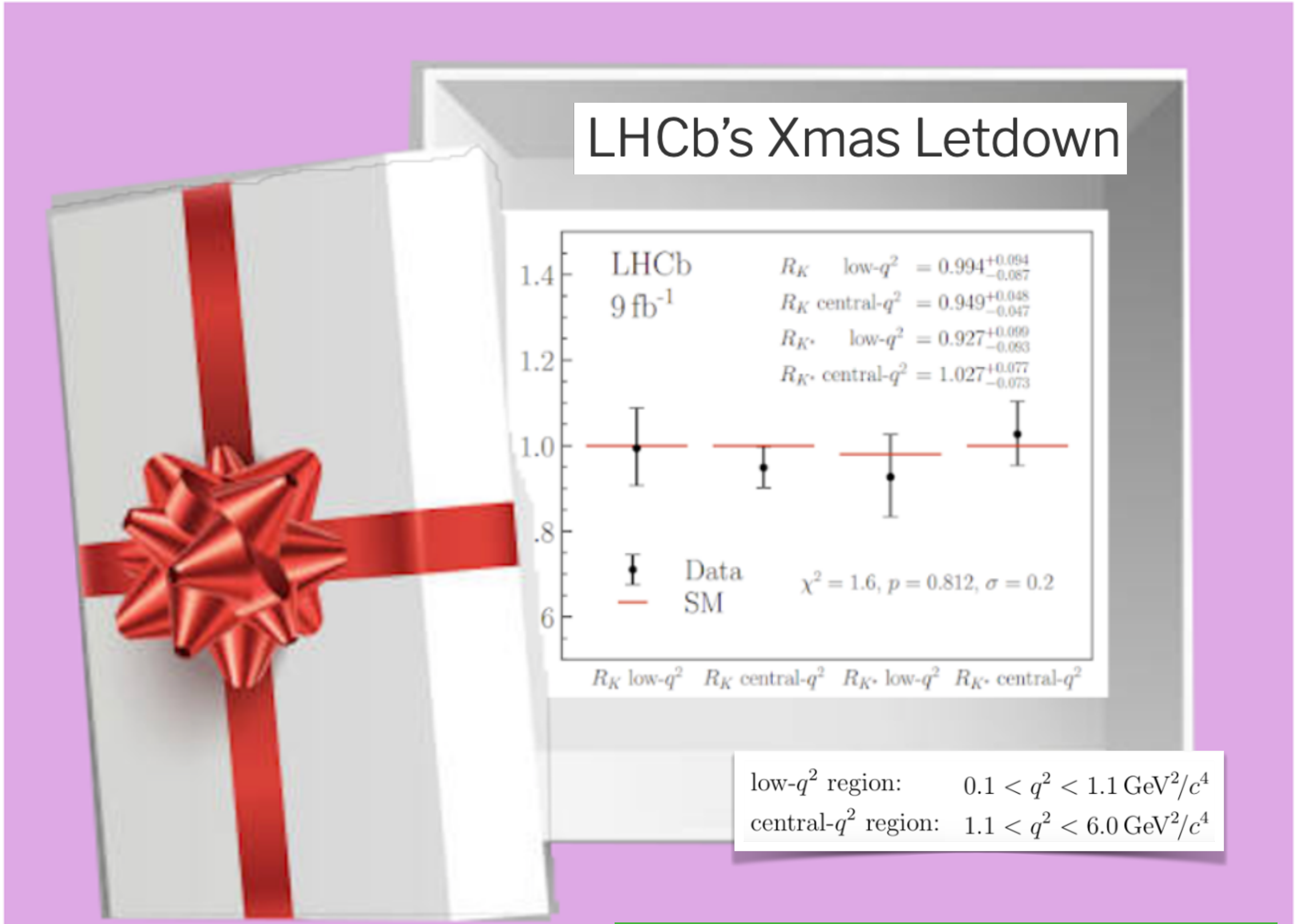


LHCb, Phys.Rev.Lett. 128 (2022) 19, 191802

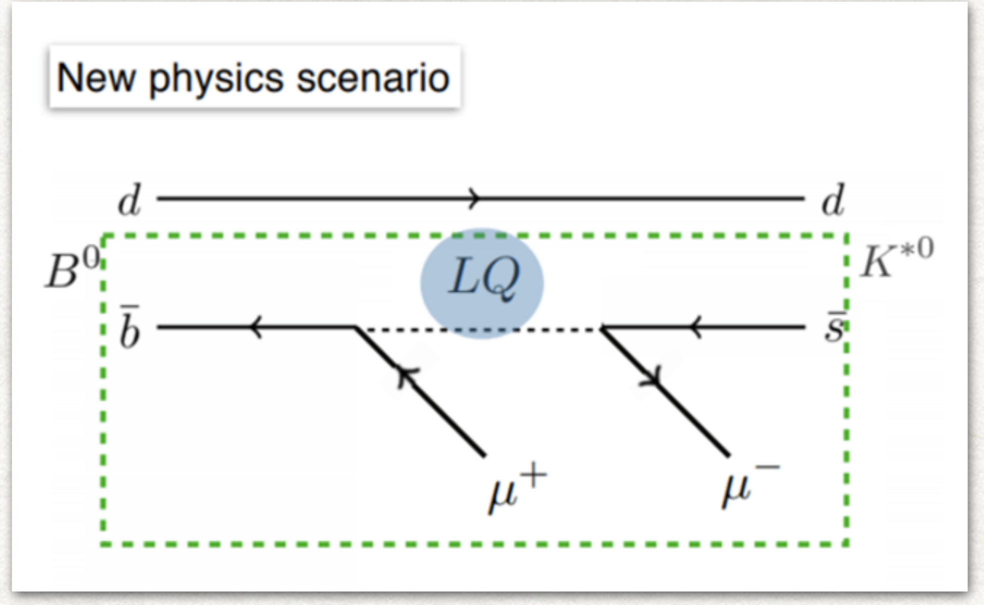


LHCb, Nature Physics 18, (2022) 277-282

LEPTON NON-UNIVERSALITY

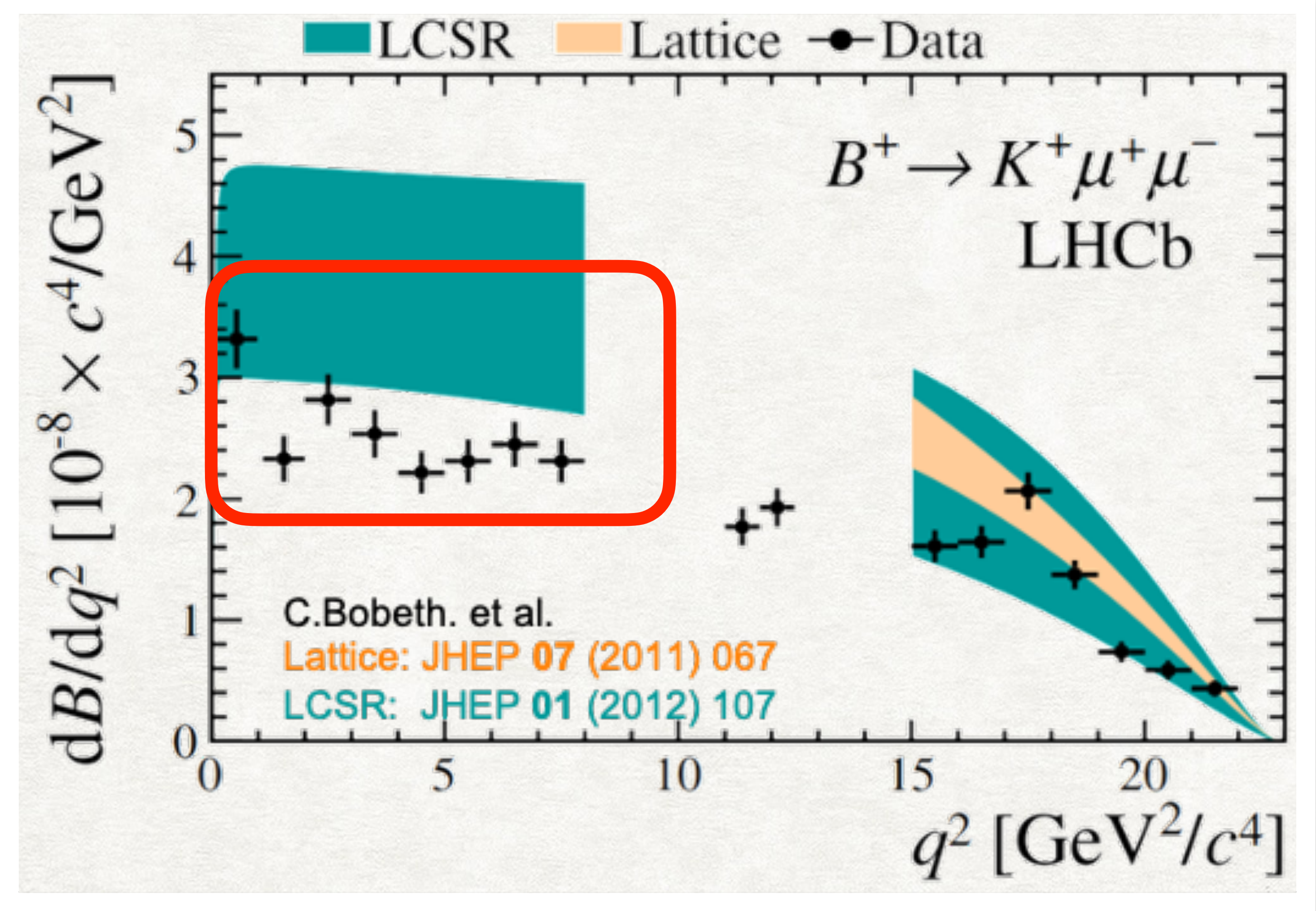


LHCb , arXiv: 2212.09153V1

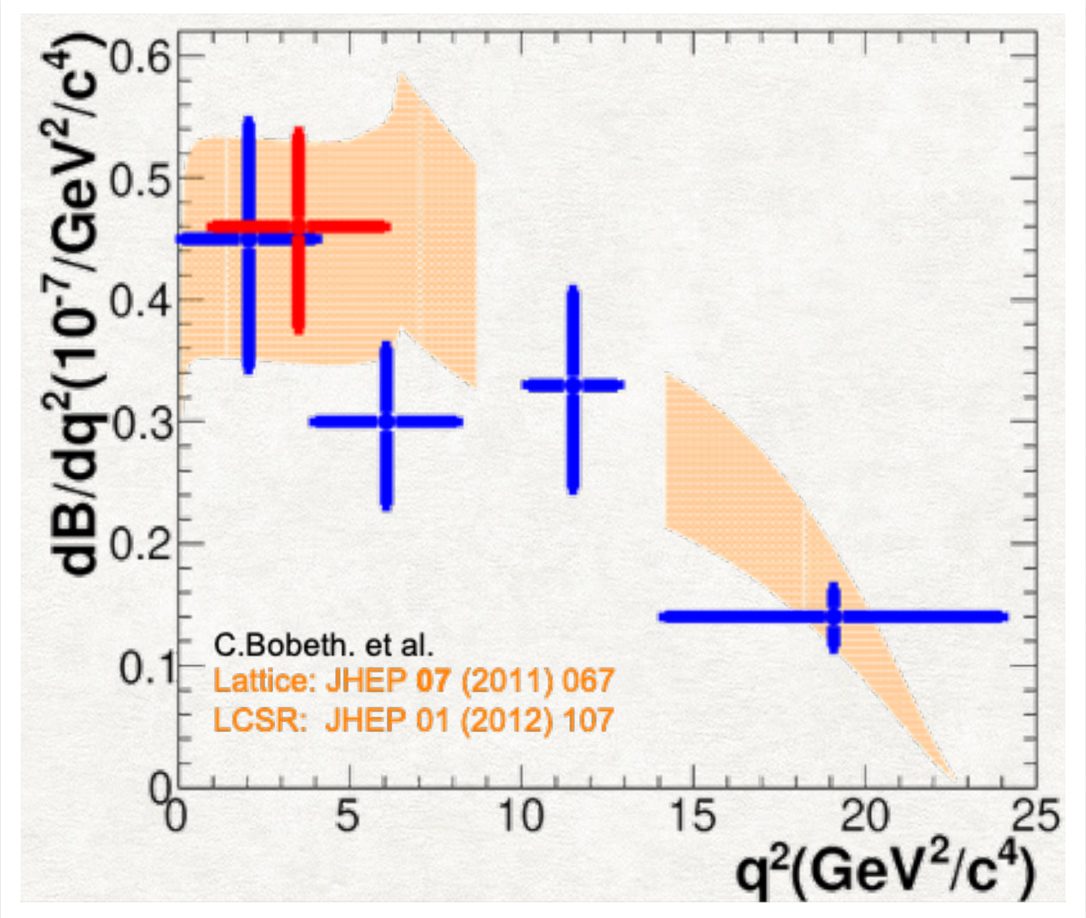


BRANCHING FRACTION

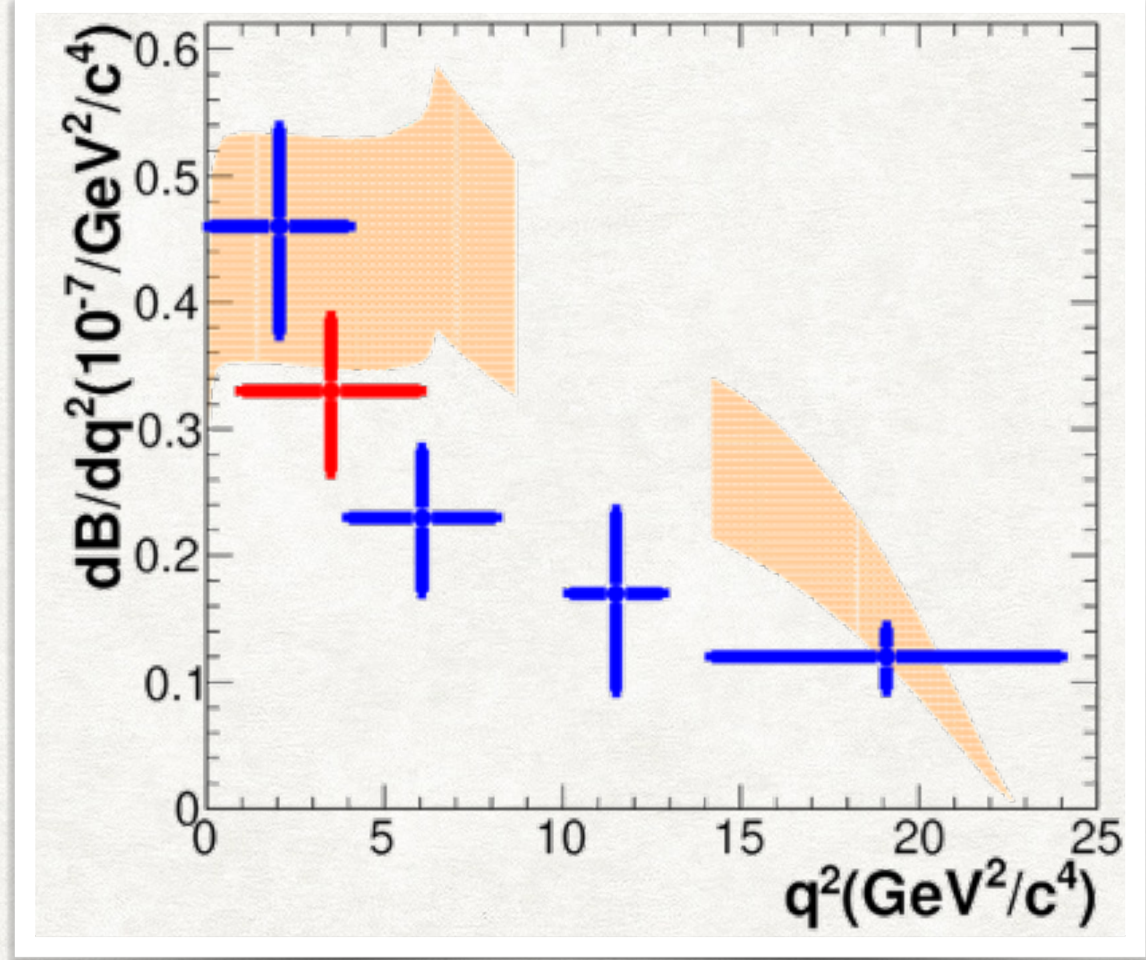
$B^+ \to K^+\mu^+\mu^-$



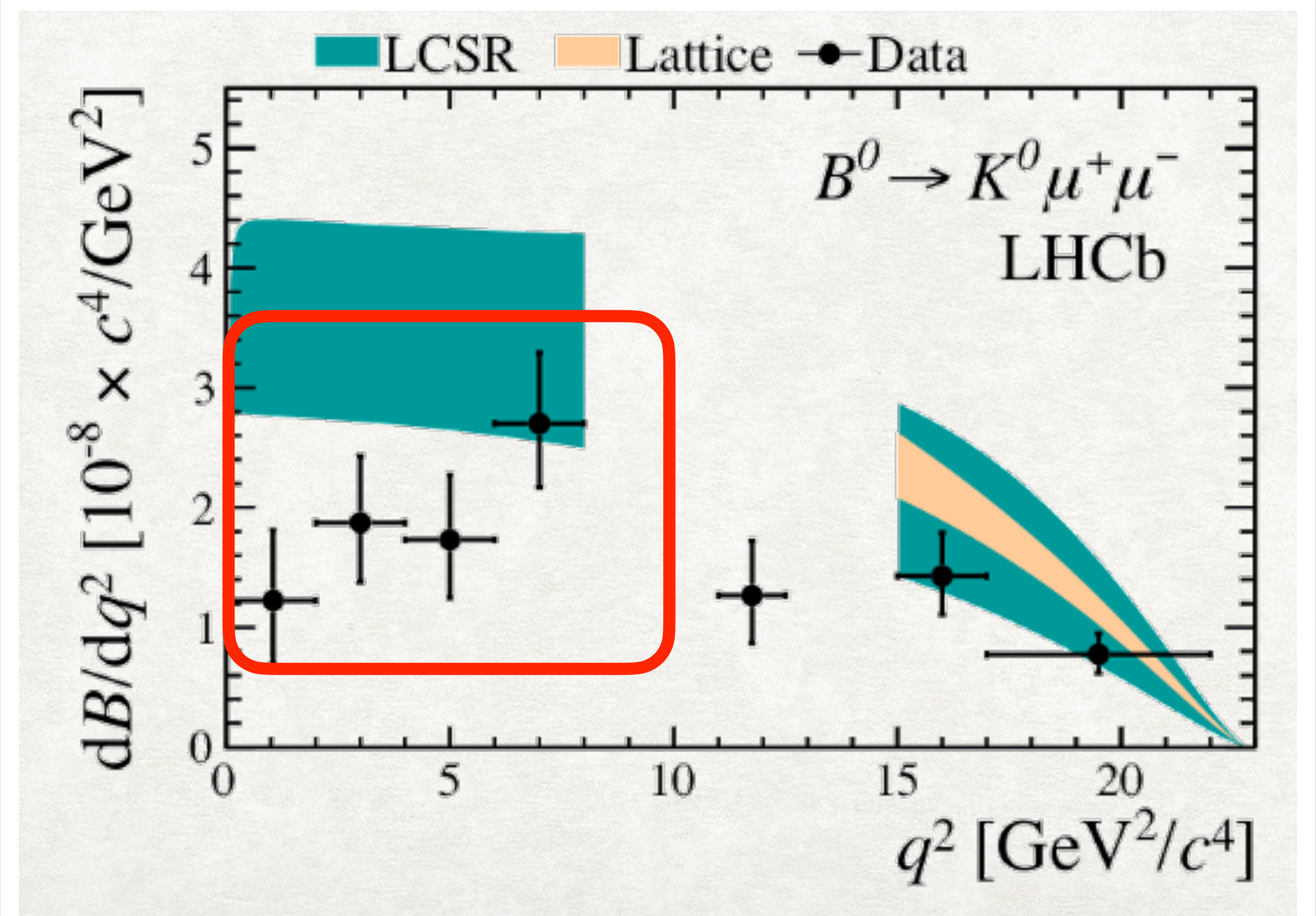
$B^+ \to K^+\mu^+\mu^-$



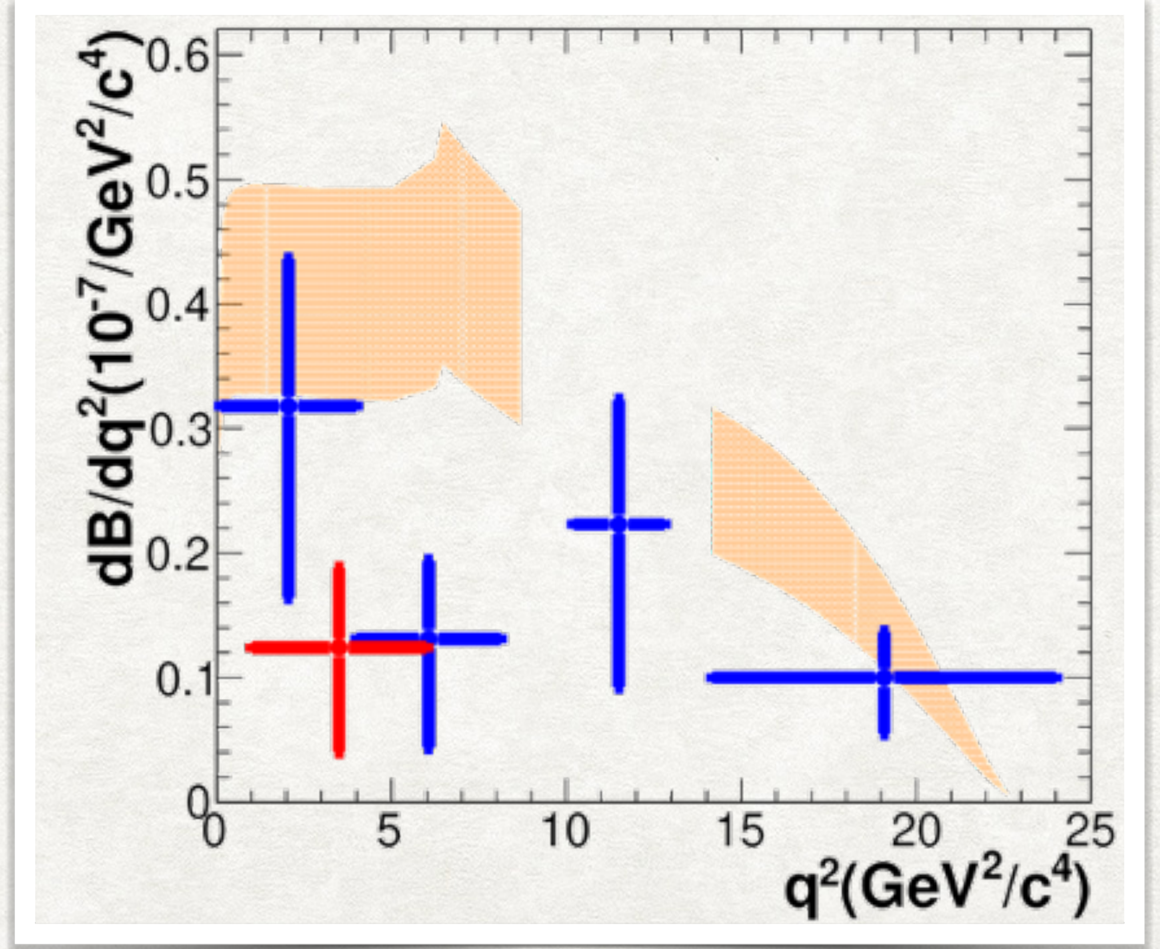
$B^0 \to K^0e^+e^-$



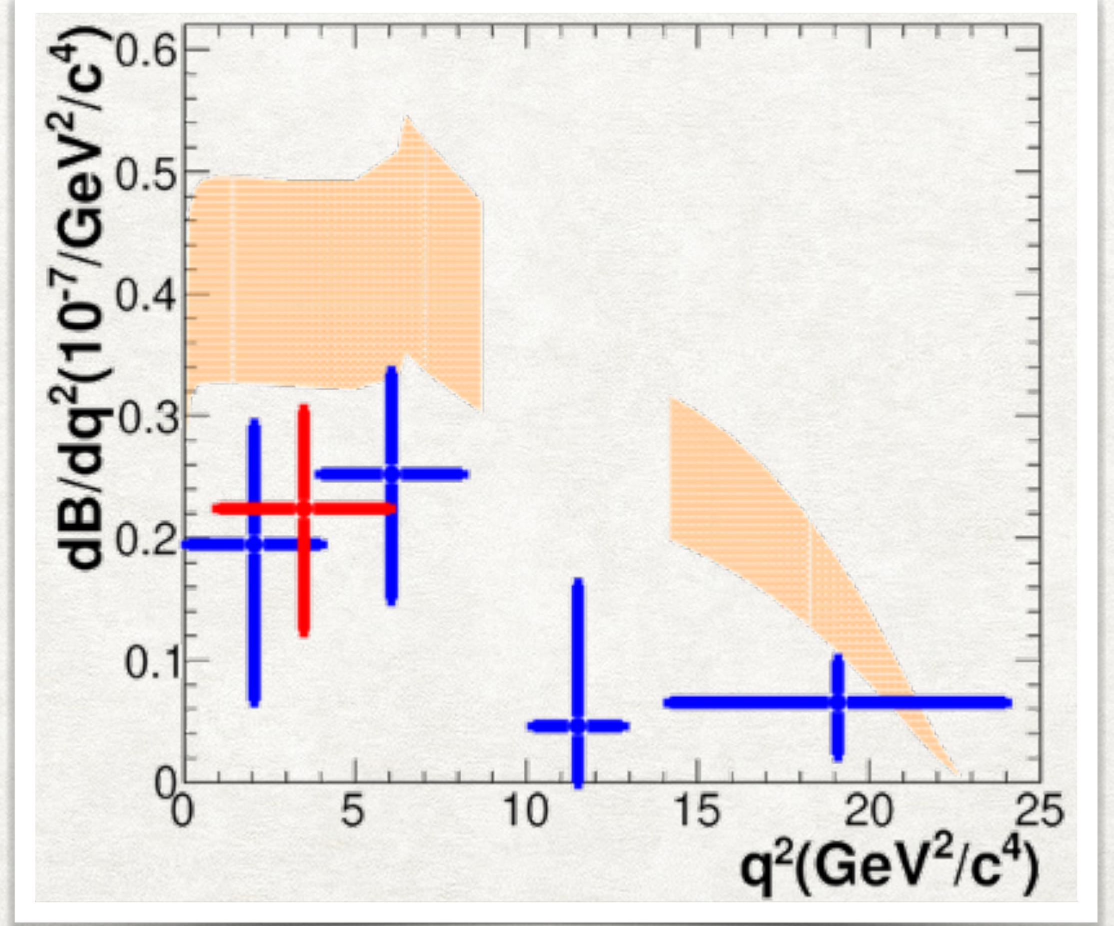
$B^0 \to K^0\mu^+\mu^-$



$B^0 \to K^0\mu^+\mu^-$



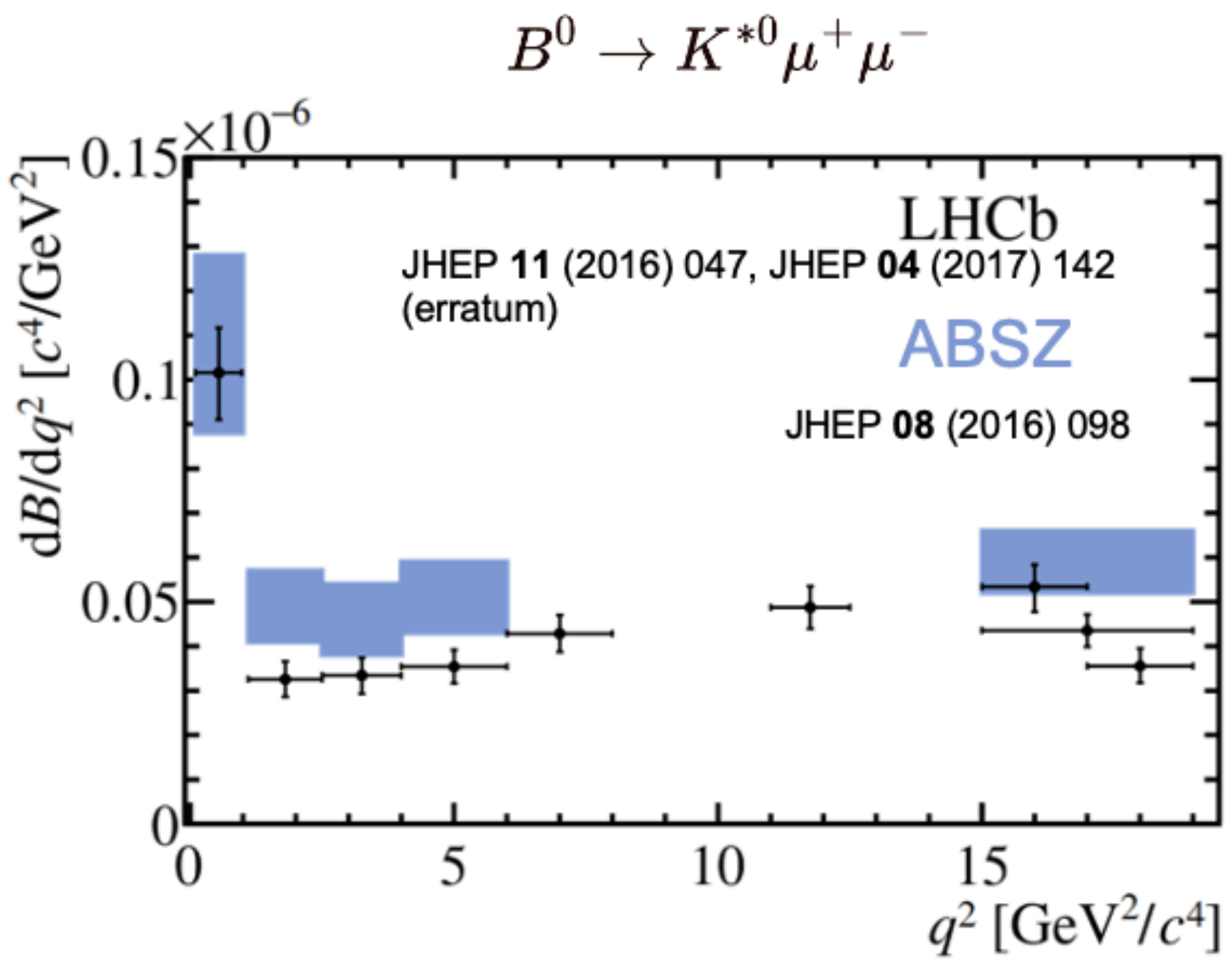
$B^+ \to K^+e^+e^-$

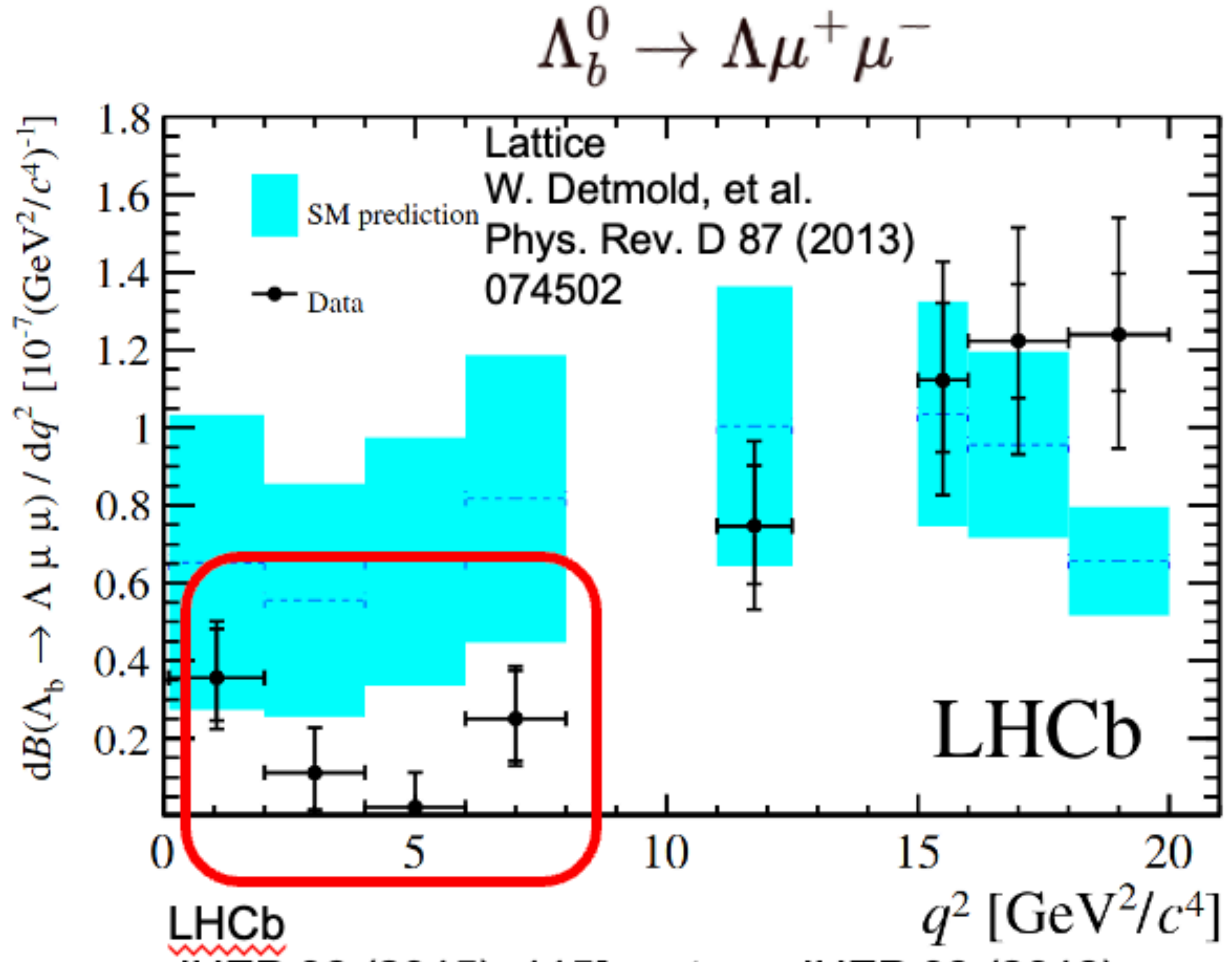


LHCb
JHEP **06** (2014) 133 arXiv: 1403.8044v1

Belle
JHEP **03** (2021) 105

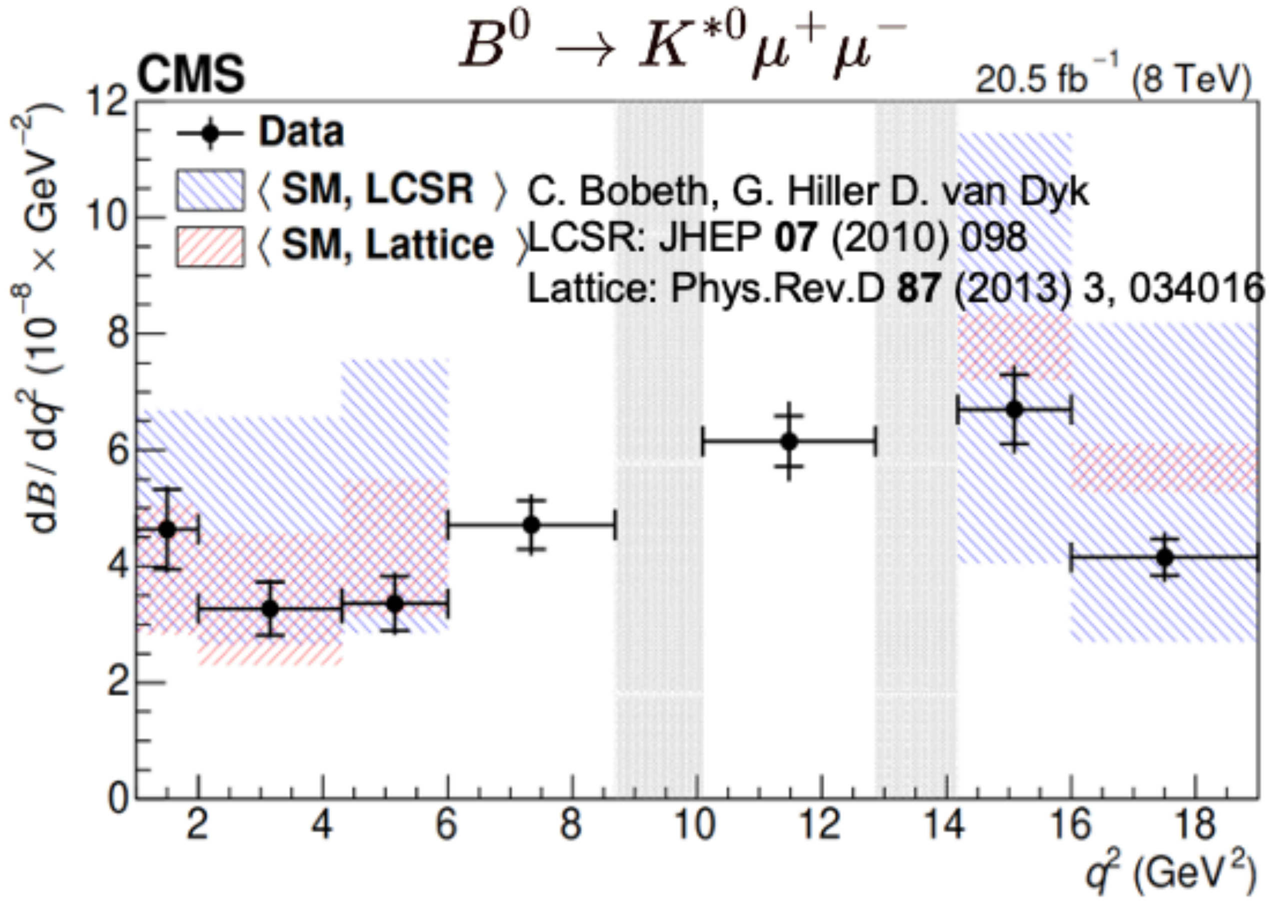
BRANCHING FRACTION



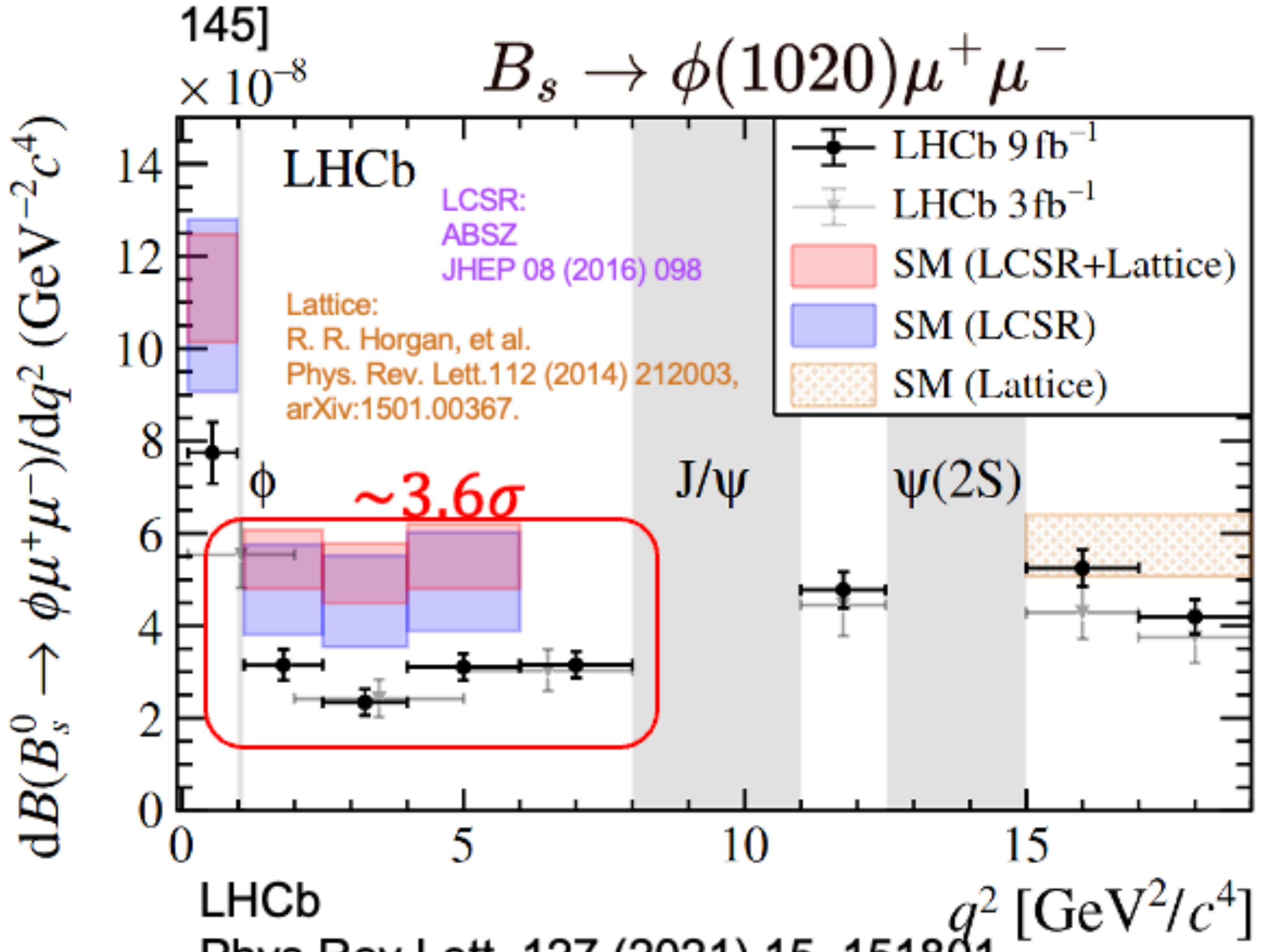


LHCb
JHEP 06 (2015), 115[erratum: JHEP 09 (2018), 145]

Angular analysis refers to:
LHCb, JHEP **09** (2018), 146



CMS
Phys.Lett.B 753 (2016) 424-448

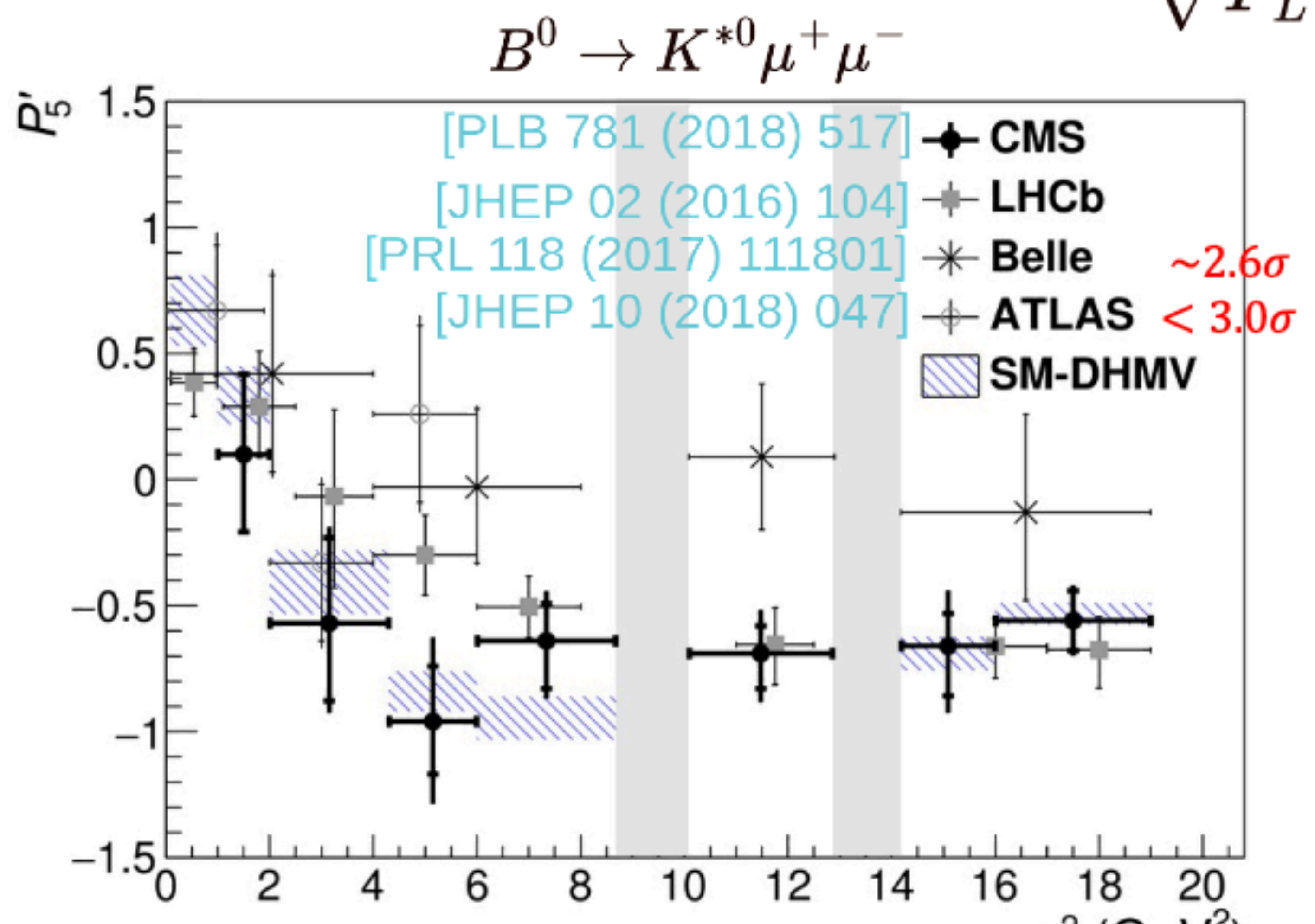


LHCb
Phys.Rev.Lett. 127 (2021) 15, 151801

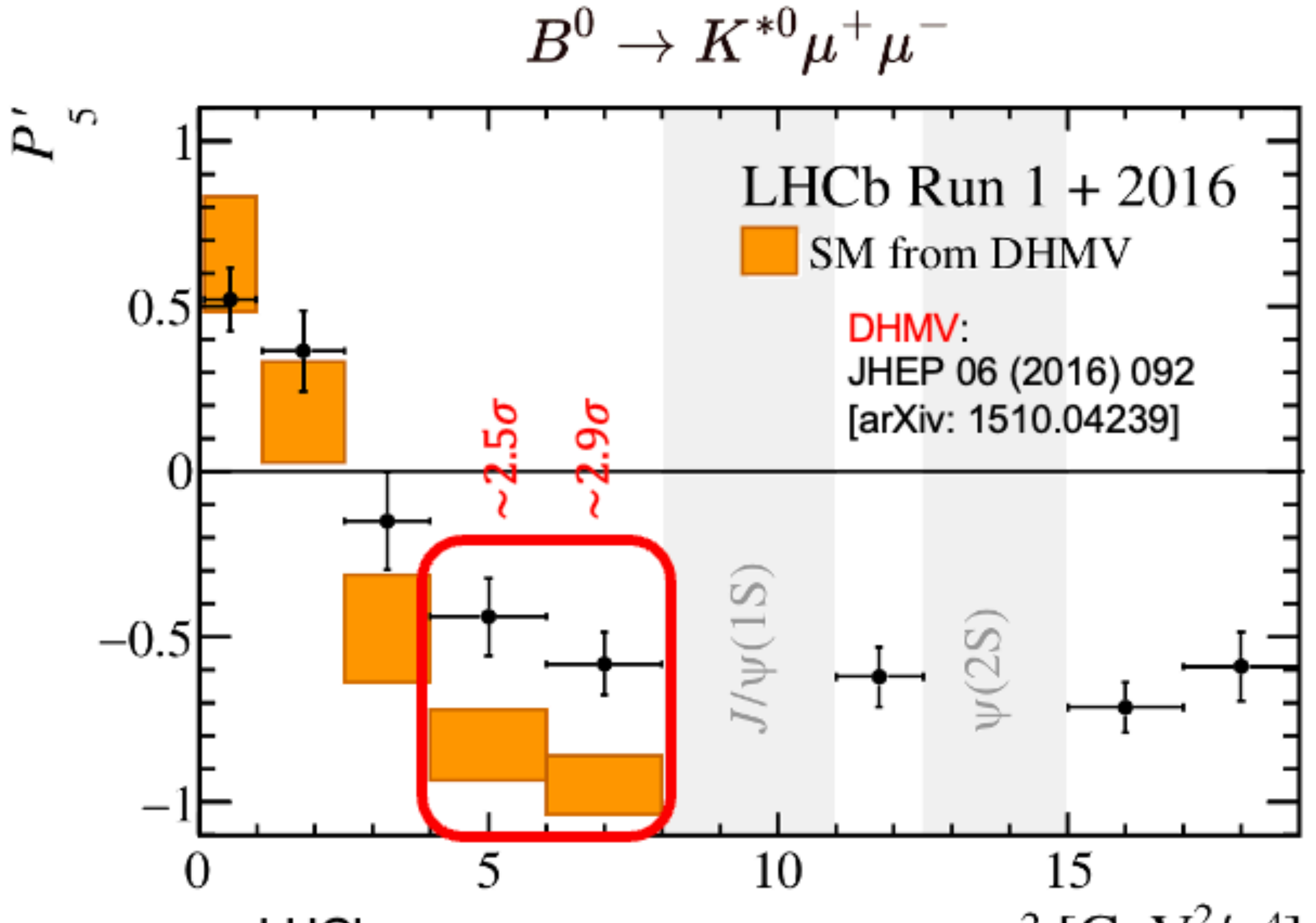
Angular analysis could be found in:
LHCb, JHEP **11** (2021) 043
arXiv: 2107.13428

ANGULAR DISTRIBUTION

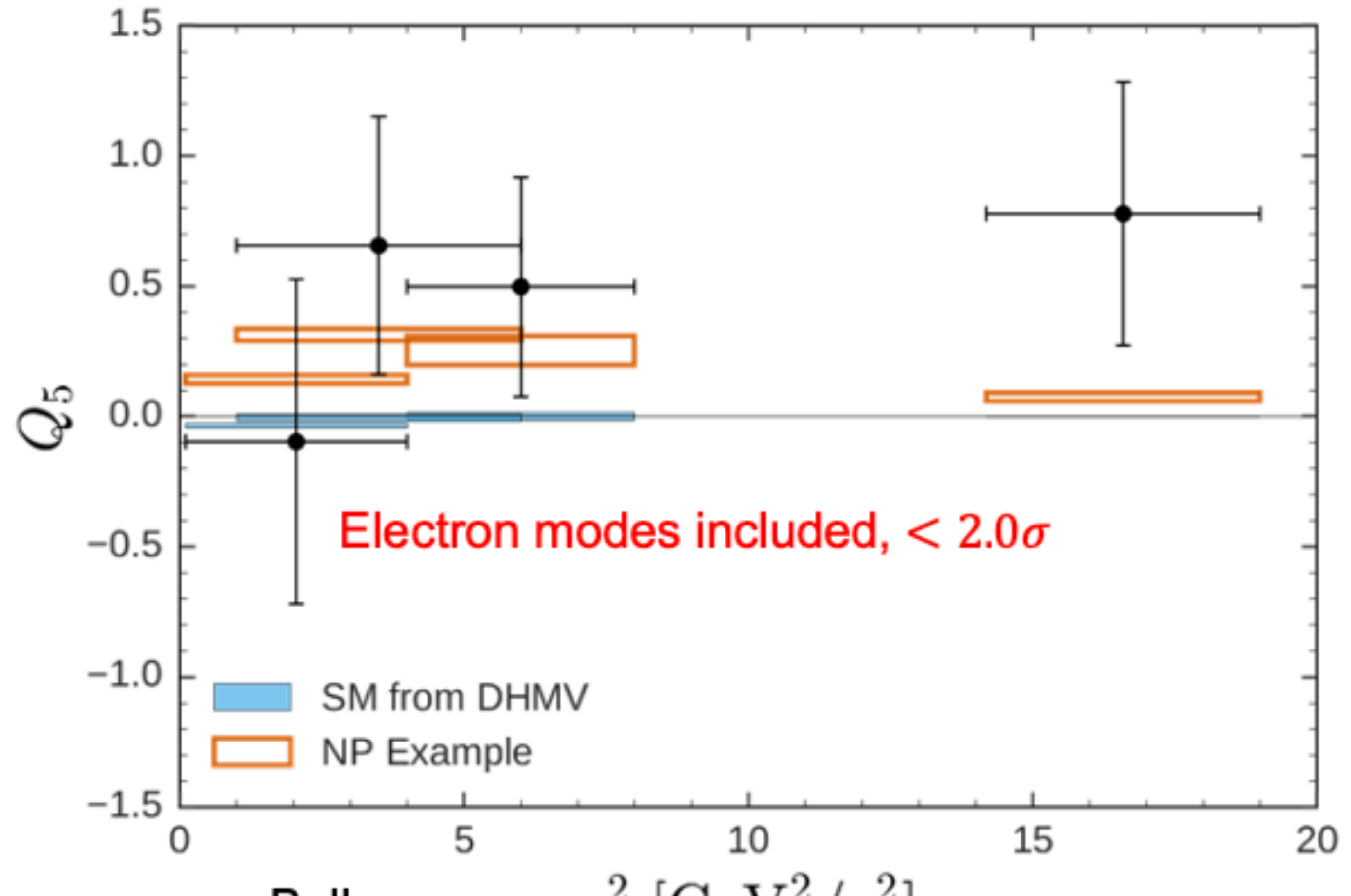
$$P_5' = \frac{S_5}{\sqrt{F_L(1-F_L)}} \qquad Q_5 = P_i'^{\mu} - P_i'^{e}$$



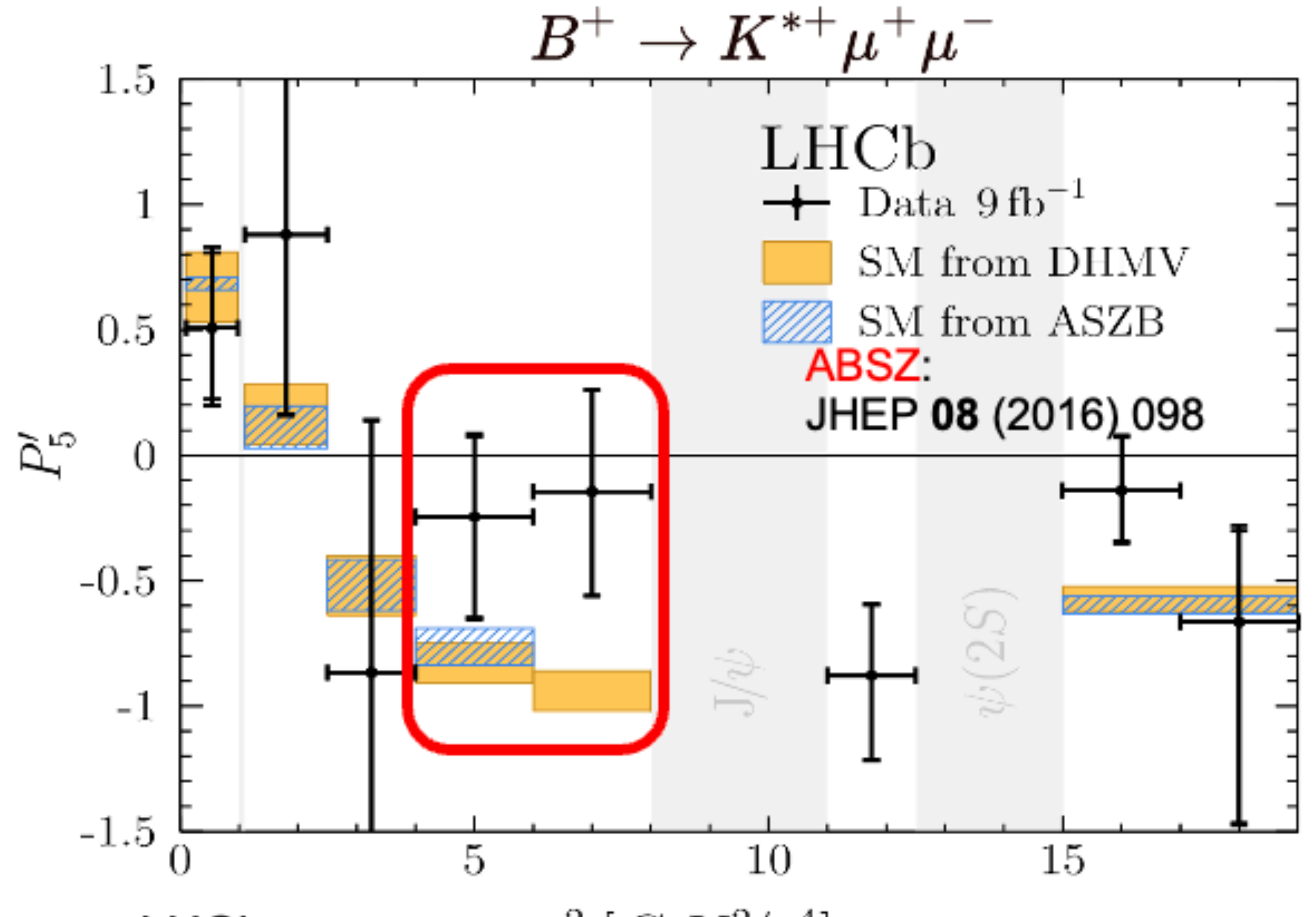
Alessio Boletti(CMS), ICHEP 2022
https://agenda.infn.it/event/28874/contributions/169340/



LHCb
Phys.Rev.Lett. 125 (2020) 1, 011802



Belle
Phys.Rev.Lett. 118 (2017) 11, 111801



LHCb
Phys.Rev.Lett. 126 (2021) 16, 161802

THEORETICAL SKELETON OF FCNC PROCESS $b \to s$

effective Hamiltonian:

$$\mathcal{H} = -\frac{4G_F}{\sqrt{2}} V_{tb} V_{ts}^* \frac{e^2}{16\pi^2} \sum_i \left(C_i \mathcal{O}_i + C_i' \mathcal{O}_i' \right) + h.c.$$

high energy information

$$C_i^{(\prime)\ell} = C_i^{(\prime)\ell;\mathrm{SM}} + \Delta C_i^{(\prime)\ell;\mathrm{NP}} = C_i^{(\prime)\ell;\mathrm{SM}} + \Delta C_i^{(\prime)\ell}$$

SM

$$\mathcal{O}_7 = \frac{m_b}{e}(\bar{s}\sigma_{\mu\nu}P_R b)F^{\mu\nu}, \qquad \mathcal{O}_7' = \frac{m_b}{e}(\bar{s}\sigma_{\mu\nu}P_L b)F^{\mu\nu},$$

$$\mathcal{O}_8 = \frac{g_s m_b}{e^2}(\bar{s}\sigma_{\mu\nu}T^a P_R b)G_a^{\mu\nu}, \qquad \mathcal{O}_8' = \frac{g_s m_b}{e^2}(\bar{s}\sigma_{\mu\nu}T^a P_L b)G_a^{\mu\nu},$$

$$\mathcal{O}_9 = (\bar{s}\gamma_\mu P_L b)(\bar{\ell}\gamma^\mu \ell), \qquad \mathcal{O}_9' = (\bar{s}\gamma_\mu P_R b)(\bar{\ell}\gamma^\mu \ell),$$

$$\mathcal{O}_{10} = (\bar{s}\gamma_\mu P_L b)(\bar{\ell}\gamma^\mu \gamma_5 \ell), \qquad \mathcal{O}_{10}' = (\bar{s}\gamma_\mu P_R b)(\bar{\ell}\gamma^\mu \gamma_5 \ell),$$

$$\mathcal{O}_S = m_b(\bar{s}P_R b)(\bar{\ell}\ell), \qquad \mathcal{O}_S' = m_b(\bar{s}P_L b)(\bar{\ell}\ell),$$

$$\mathcal{O}_P = m_b(\bar{s}P_R b)(\bar{\ell}\gamma_5 \ell), \qquad \mathcal{O}_P' = m_b(\bar{s}P_L b)(\bar{\ell}\gamma_5 \ell).$$

QCDF

decay amplitude:

$$\mathcal{M}(\bar{B} \to P\ell^+\ell^-) = \frac{G_F \alpha}{2\sqrt{2}\pi} c_P^{-1} \xi_P \left[\left(\lambda_t \mathcal{C}_{9,P}^{(t)} + \lambda_u \mathcal{C}_{9,P}^{(u)} \right) (p^\mu + p'^\mu)(\bar{\ell}\gamma_\mu \ell) + \lambda_t C_{10} (p^\mu + p'^\mu)(\bar{\ell}\gamma_\mu \gamma_5 \ell) \right]$$

$$\mathcal{C}_{9,P}^{(t)}(q^2) = C_9 + \frac{2m_b}{M_B} \frac{\mathcal{T}_P^{(t)}(q^2)}{\xi_P(q^2)},$$

$$\mathcal{C}_{9,P}^{(u)}(q^2) = \frac{2m_b}{M_B} \frac{\mathcal{T}_P^{(u)}(q^2)}{\xi_P(q^2)}.$$

$$\mathcal{T}_P^{(i)} = \xi_P C_P^{(i)} + \frac{\pi^2 f_B f_P}{N_c M_B} \sum_\pm \int_0^\infty \frac{d\omega}{\omega} \Phi_{B,\pm}(\omega) \int_0^1 du\, \phi_P(u) T_{P,\pm}^{(i)}(u,\omega)$$

observables:

$$\frac{d\mathcal{B}}{dq^2}(\bar{B} \to P\ell^+\ell^-) = S_P \tau_B \frac{G_F^2 M_B^3}{96\pi^3} \left(\frac{\alpha}{4\pi} \right)^2 \lambda(q^2, m_P^2)^3 \xi_P(q^2)^2 \left(\left| \lambda_t \mathcal{C}_{9,P}^{(t)}(q^2) + \lambda_u \mathcal{C}_{9,P}^{(u)}(q^2) \right|^2 + |\lambda_t|^2 C_{10}^2 \right)$$

PHYSICS FROM EW SCALE

- High energy information: Wilson coefficients in SM
  - EW scale
    - $C_{9,10}$: NNLL;
    - $C_{1-6}, C_{7,8}$: NLL
    - 2-loop matching: C. Bobeth, M. Misiak, J. Urban, NPB 574, 291 (2000)
  - RGE running
    - 3-loop anomalous dimension matrix:

      K.G. Chetyrkin, M. Misiak, M. Munz, PLB 400, 206 (1997); 425, 414(E) (1998);

      P. Gambino, M. Gorbahn, U. Haisch, NPB673, 238 (2003);

      M. Gorbahn, U. Haisch, NPB713, 291 (2005);

TABLE III. The SM Wilson coefficients at the scale $\mu = 4.6$ GeV in leading logarithmic (LL), next-to-leading logarithmic (NLL) and next-to-next-to-leading logarithmic order (NNLL). Input parameters listed in Table II are used.

	C_1	C_2	C_3	C_4	C_5	C_6	$C_7^{\rm eff}$	$C_8^{\rm eff}$	C_9	C_{10}
LL	−0.5093	1.0256	−0.0050	−0.0686	0.0005	0.0010	−0.3189	−0.1505	2.0111	0
NLL	−0.3001	1.0080	−0.0047	−0.0827	0.0003	0.0009	−0.2969	−0.1642	4.1869	−4.3973
NNLL	–	–	–	–	–	–	–	–	4.2607	−4.2453

THE ENCODED NEW PHYSICS

- New physics effect
  - Deviations from SM Wilson coefficients

$$C_i^{(\prime)\ell} = C_i^{(\prime)\ell;\mathrm{SM}} + \Delta C_i^{(\prime)\ell;\mathrm{NP}} = C_i^{(\prime)\ell;\mathrm{SM}} + \Delta C_i^{(\prime)\ell}$$

  - BSM operators

$$\mathcal{O}_7 = \frac{m_b}{e}(\bar{s}\sigma_{\mu\nu}P_R b)F^{\mu\nu}, \qquad \mathcal{O}'_7 = \frac{m_b}{e}(\bar{s}\sigma_{\mu\nu}P_L b)F^{\mu\nu},$$

$$\mathcal{O}_8 = \frac{g_s m_b}{e^2}(\bar{s}\sigma_{\mu\nu}T^a P_R b)G_a^{\mu\nu}, \qquad \mathcal{O}'_8 = \frac{g_s m_b}{e^2}(\bar{s}\sigma_{\mu\nu}T^a P_L b)G_a^{\mu\nu},$$

$$\mathcal{O}_9 = (\bar{s}\gamma_\mu P_L b)(\bar{\ell}\gamma^\mu \ell), \qquad \mathcal{O}'_9 = (\bar{s}\gamma_\mu P_R b)(\bar{\ell}\gamma^\mu \ell),$$

$$\mathcal{O}_{10} = (\bar{s}\gamma_\mu P_L b)(\bar{\ell}\gamma^\mu \gamma_5 \ell), \qquad \mathcal{O}'_{10} = (\bar{s}\gamma_\mu P_R b)(\bar{\ell}\gamma^\mu \gamma_5 \ell),$$

$$\mathcal{O}_S = m_b(\bar{s}P_R b)(\bar{\ell}\ell), \qquad \mathcal{O}'_S = m_b(\bar{s}P_L b)(\bar{\ell}\ell),$$

$$\mathcal{O}_P = m_b(\bar{s}P_R b)(\bar{\ell}\gamma_5 \ell), \qquad \mathcal{O}'_P = m_b(\bar{s}P_L b)(\bar{\ell}\gamma_5 \ell).$$

Scenario I: muon-specific

$$\Delta C_{9,10,S,P}^{(\prime)e} = 0$$

Scenario II: lepton-universal

$$\Delta C_{9,10,S,P}^{(\prime)\mu} = \Delta C_{9,10,S,P}^{(\prime)e}$$

Scenario III: lepton-specific

all parameters are taken except C7,C8

Scenario IV: full scenario

all parameters are taken

THE $b \to s$ PROCESSES

- B meson leptonic decays
- B meson radiative decays
- B meson inclusive semi-leptonic decay
- B meson exclusive semi-leptonic decay: **QCDF approach**
    - $B \to P\ell^+\ell^-$
    - $B \to V\ell^+\ell^-$
- Bottomed baryon semi-leptonic decays: **naive factorization**

KINEMATICS & OBSERVABLES

- Kinematics

$$\frac{d^4\Gamma}{dq^2\, d\cos\theta_l\, d\cos\theta_{K^*}\, d\phi} = \frac{9}{32\pi} I(q^2, \theta_l, \theta_{K^*}, \phi)$$

$$\begin{aligned} I(q^2,\theta_l,\theta_{K^*},\phi) = {} & I_1^s \sin^2\theta_{K^*} + I_1^c \cos^2\theta_{K^*} + (I_2^s \sin^2\theta_{K^*} + I_2^c \cos^2\theta_{K^*}) \cos 2\theta_l \\ & + I_3 \sin^2\theta_{K^*} \sin^2\theta_l \cos 2\phi + I_4 \sin 2\theta_{K^*} \sin 2\theta_l \cos\phi \\ & + I_5 \sin 2\theta_{K^*} \sin\theta_l \cos\phi \\ & + (I_6^s \sin^2\theta_{K^*} + I_6^c \cos^2\theta_{K^*}) \cos\theta_l + I_7 \sin 2\theta_{K^*} \sin\theta_l \sin\phi \\ & + I_8 \sin 2\theta_{K^*} \sin 2\theta_l \sin\phi + I_9 \sin^2\theta_{K^*} \sin^2\theta_l \sin 2\phi \,. \end{aligned}$$

  - transversity amplitude

W. Altmannshofer, P. Ball, A. Bharucha, A.J. Buras, D. Straub, M. Wick, 0811.1214

$$\begin{aligned} I_1^s &= \frac{(2+\beta_\mu^2)}{4}\left[|A_\perp^L|^2 + |A_\parallel^L|^2 + (L\to R)\right] + \frac{4m_\mu^2}{q^2}\mathrm{Re}\left(A_\perp^L A_\perp^{R*} + A_\parallel^L A_\parallel^{R*}\right) \\ I_1^c &= |A_0^L|^2 + |A_0^R|^2 + \frac{4m_\mu^2}{q^2}\left[|A_t|^2 + 2\mathrm{Re}(A_0^L A_0^{R*})\right] + \beta_\mu^2 |A_S|^2, \\ I_2^s &= \frac{\beta_\mu^2}{4}\left[|A_\perp^L|^2 + |A_\parallel^L|^2 + (L\to R)\right], \\ I_2^c &= -\beta_\mu^2\left[|A_0^L|^2 + (L\to R)\right], \\ I_3 &= \frac{1}{2}\beta_\mu^2\left[|A_\perp^L|^2 - |A_\parallel^L|^2 + (L\to R)\right], \\ I_4 &= \frac{1}{\sqrt{2}}\beta_\mu^2\left[\mathrm{Re}(A_0^L A_\parallel^{L*}) + (L\to R)\right], \end{aligned}$$

$$\begin{aligned} A_{\parallel L,R} = {} & -N\sqrt{2}(m_B^2 - m_{K^*}^2)\left[\left[(C_9^{\rm eff} - C_9^{\rm eff\prime}) \mp (C_{10}^{\rm eff} - C_{10}^{\rm eff\prime})\right]\frac{A_1(q^2)}{m_B - m_{K^*}} \right. \\ & \left. + \frac{2m_b}{q^2}(C_7^{\rm eff} - C_7^{\rm eff\prime})T_2(q^2)\right], \\ A_{0L,R} = {} & -\frac{N}{2m_{K^*}\sqrt{q^2}}\left\{\left[(C_9^{\rm eff} - C_9^{\rm eff\prime}) \mp (C_{10}^{\rm eff} - C_{10}^{\rm eff\prime})\right]\right. \\ & \times\left[(m_B^2 - m_{K^*}^2 - q^2)(m_B + m_{K^*})A_1(q^2) - \lambda\frac{A_2(q^2)}{m_B + m_{K^*}}\right] \\ & \left. + 2m_b(C_7^{\rm eff} - C_7^{\rm eff\prime})\left[(m_B^2 + 3m_{K^*}^2 - q^2)T_2(q^2) - \frac{\lambda}{m_B^2 - m_{K^*}^2}T_3(q^2)\right]\right\}, \\ A_t = {} & \frac{N}{\sqrt{q^2}}\lambda^{1/2}\left[2(C_{10}^{\rm eff} - C_{10}^{\rm eff\prime}) + \frac{q^2}{m_\mu}(C_P - C_P')\right]A_0(q^2), \\ A_S = {} & -2N\lambda^{1/2}(C_S - C_S')A_0(q^2), \end{aligned}$$

  - helicity amplitude

S. Jager, J. M. Camalich 1212.2263

$$\begin{aligned} I_1^c &= F\left\{\frac{1}{2}\left(|H_V^0|^2 + |H_A^0|^2\right) + |H_P|^2 + \frac{2m_\ell^2}{q^2}\left(|H_V^0|^2 - |H_A^0|^2\right) + \beta^2|H_S|^2\right\}, \\ I_1^s &= F\left\{\frac{\beta^2+2}{8}\left(|H_V^+|^2 + |H_V^-|^2 + (V\to A)\right) + \frac{m_\ell^2}{q^2}\left(|H_V^+|^2 + |H_V^-|^2 - (V\to A)\right)\right\} \\ I_2^c &= -F\frac{\beta^2}{2}\left(|H_V^0|^2 + |H_A^0|^2\right), \\ I_2^s &= F\frac{\beta^2}{8}\left(|H_V^+|^2 + |H_V^-|^2\right) + (V\to A), \\ I_3 &= -\frac{F}{2}\mathrm{Re}\left[H_V^+(H_V^-)^*\right] + (V\to A), \end{aligned}$$

$$\begin{aligned} H_V(\lambda) &= -i\,N\left\{C_9\tilde{V}_{L\lambda} + C_9'\tilde{V}_{R\lambda} + \frac{m_B^2}{q^2}\left[\frac{2\,\hat{m}_b}{m_B}(C_7\tilde{T}_{L\lambda} + C_7'\tilde{T}_{R\lambda}) - 16\pi^2 h_\lambda\right]\right\}, \\ H_A(\lambda) &= -i\,N(C_{10}\tilde{V}_{L\lambda} + C_{10}'\tilde{V}_{R\lambda}), \\ H_{TR}(\lambda) &= -i\,N\frac{4\,\hat{m}_b\,m_B}{m_W\sqrt{q^2}}C_T\tilde{T}_{L\lambda}, \\ H_{TL}(\lambda) &= -i\,N\frac{4\,\hat{m}_b\,m_B}{m_W\sqrt{q^2}}C_T'\tilde{T}_{R\lambda}, \\ H_S &= i\,N\frac{\hat{m}_b}{m_W}(C_S\tilde{S}_L + C_S'\tilde{S}_R), \\ H_P &= i\,N\left\{\frac{\hat{m}_b}{m_W}(C_P\tilde{S}_L + C_P'\tilde{S}_R) \right. \\ & \left. + \frac{2\,m_\ell\hat{m}_b}{q^2}\left[C_{10}\left(\tilde{S}_L - \frac{m_s}{m_b}\tilde{S}_R\right) + C_{10}'\left(\tilde{S}_R - \frac{m_s}{m_b}\tilde{S}_L\right)\right]\right\} \end{aligned}$$

FITS BEFORE XMAS 2022

$b \to s\ell^+\ell^-$ Global Fits after R_{K_S} and $R_{K^{*+}}$

Marcel Algueró[a,b,*], Bernat Capdevila[c], Sébastien Descotes-Genon[d], Joaquim Matias[a,b], Martín Novoa-Brunet[d,e]

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[b] Institut de Física d'Altes Energies (IFAE), The Barcelona Institute of Science and Technology, Campus UAB, E-08193 Bellaterra (Barcelona), Catalunya.
[c] Università di Torino and INFN Sezione di Torino, Via P. Giuria 1, Torino I-10125, Italy.
[d] Université Paris-Saclay, CNRS/IN2P3, IJCLab, 91405 Orsay, France.
[e] Istituto Nazionale di Fisica Nucleare, Sezione di Bari, Via Orabona 4, I-70126 Bari, Italy

ACDMN, 2104.08921

private code

Implications of new evidence for lepton-universality violation in $b \to s\ell^+\ell^-$ decays

Li-Sheng Geng,[1,2] Benjamín Grinstein,[3] Sebastian Jäger,[4] Shuang-Yi Li,[5] Jorge Martin Camalich,[6,7] and Rui-Xiang Shi[5]

[1] School of Physics & Beijing Key Laboratory of Advanced Nuclear Materials and Physics, Beihang University, Beijing 102206, China
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[3] Department of Physics, University of California, San Diego, La Jolla, California, 92093, USA
[4] Department of Physics and Astronomy, University of Sussex, Brighton BN1 9QH, United Kingdom
[5] School of Physics, Beihang University, Beijing 102206, China
[6] Instituto de Astrofisica de Canarias, C/ Via Lactea, s/n E38205 - La Laguna (Tenerife), Spain
[7] Universidad de La Laguna, Departamento de Astrofisica, La Laguna, Tenerife E-38205, Spain

GGJLCS, 2103.12378

private code

New Physics in Rare B Decays after Moriond 2021

Wolfgang Altmannshofer[a], Peter Stangl[b]

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[b] Albert Einstein Center for Fundamental Physics, Institute for Theoretical Physics, University of Bern, Sidlerstrasse 5, CH-3012 Bern, Switzerland

AS, 2103.13370

Flavio

Neutral current B-decay anomalies

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[c] CERN, Theoretical Physics Department, CH-1211 Geneva 23, Switzerland,
[d] Instituto Galego de Física de Altas Enerxías, Universidade de Santiago de Compostela, Spain
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HMMN, 2210.07221

SuperIso

FITTING PACKAGES ON THE MARKET

Brands	flavio	Smelli	HEPfit	EOS	SuperIso
Developers	David M. Straub, Peter Stangl, Jason Aebischer, Jacky Kumar et al.		Jorge de Blas, Debtosh Chowdhury, Marco Ciuchini et al.	Danny van Dyk, Christoph Bobeth, Frederik Beaujean et al.	Farvah Nazila Mahmoudi, A. Arbey et al.
Related works (& Manuals)	arXiv:1810.08132 1704.07397 1608.02556 1704.07397	arXiv:1810.07698 1911.07866 2103.13370 2212.10497	arXiv: 1910.14012 1902.05564 1512.07157 1306.4644	arXiv: 2111.15428 2305.06301 2208.08937 1912.09335	arXiv: 0710.2067 0808.3144 1410.4545 1806.11489
First edition (as far as we know)	v0.1.3 (2016.2)	(2018.10)	SUSYfit (2013.06)	D. van Dyk, thesis, 2011	2007.10 2008.08
latest update (as far as we know)	v2.5.5 (2023.6.1)	v2.4.0 (2023.4.27)	v1.0 (2023.5.19)	v1.0.9 (2023.8.8)	v4.1 (2020.11.4)
Code PL	Pure Python3	Based on Flavio	Pure C++11	C++20 with python API	C
Statistic FrameWork	**MLE** (Bayesian Estimation can be self-defined)	Same as flavio	**Bayesian Estimation**	**Bayesian Estimation**	**MLE**
Scientific Library	NumPy, SciPy, iminuit, matplotlib, PyMC, emcee	flavio, wilson	BAT (Bayesian Analysis Toolkit), GSL, boost, ROOT Data Analysis Framework	boost, GSL	GSL

FITTING PACKAGES ON THE MARKET

Brands	flavio	Smelli	HEPfit	EOS	SuperIso
Theo. FrameWork	**WEFT** (below EW scale) **SMEFT(dim-6)** (above EW scale)	**SMEFT(dim-6)** (above EW scale)	1. **WEFT/SMEFT(dim6)** 2. **2HDM/MSSM** 3. **Georgi-Machacek model**	**WEFT** (below EW scale)	1. **WEFT/SMEFT(dim6)** 2. **2HDM** 3. **Different scenarios in MSSM**
Basis of WEFT	**arXiv: 1606.00916** (with tensor Operators?)	**arXiv: 1606.00916** (with tensor Operators?)	**arXiv: 1903.09632** (no tensor Operators)	**arXiv: 2107.04822** (with tensor Operators?)	**arXiv: 0808.3144** (no tensor Operators)
FFs (part of it)	(Heavy to light) **B -> Vll** **arXiv: 1503.05534, etc.** **B -> Pll** **arXiv: 1811.00983, etc.** **Lambda_b -> Lambda ll** **arXiv: 1602.01399** (Heavy to Heavy) **B -> D^{(*)} l nu** arXiv:1703.05330 (HQET)	Same as flavio	(Heavy to light) **B -> Vll** **arXiv: 1503.05534** **B -> Pll** **arXiv: hep-ph/0406232**	(Heavy to light) **B -> Vll** **arXiv: 1503.05534, etc.** **B -> Pll** **arXiv: 1004.3249, etc.** **Lambda_b -> Lambda ll** **arXiv: 1602.01399, etc.** (Heavy to Heavy) **B -> D^{(*)} l nu** arXiv: 1503.07237, etc.	(Heavy to light) **B -> Vll** **arXiv: 1503.05534, etc.** **B -> Pll** **arXiv: 1811.00983, etc.**
Focused Processes	More than 1400 observables. Observables library. Higgs production/decays, b/c/s hadron decays, dipole moments, W/Z decays, nucleon decays, EWPO, etc.	EWPO, FCCC, FCNC, LFV processes, Z decays, tau muon decays, meson mixing, Higgs signal strengths.	EWPO, oblique parameter, Higgs observables (strengths and direct searches). Flavour observables.	Mainly flavour observables	FCNC, LFU, $B \to V(P)ll$, $b \to s\gamma$, $B \to X_s ll$, g-2.

OUR HOME-MADE FIT

- Statistics: Bayesian statistics
  - weak prior dependence confirmed
  - relied package: emcee
- Theoretical framework: dynamics
  - most generic WEFT/LEFT operator basis (tensor to be added)
  - self-controllable Wilson coefficients
  - the up-to-date FF parameterization
- Observables & kinematics
  - transversity amplitude convention adopted
  - all observables (Br, ADO, LFU…) have been encompassed

OUR RESULTS (I)

Before Dec. 2022

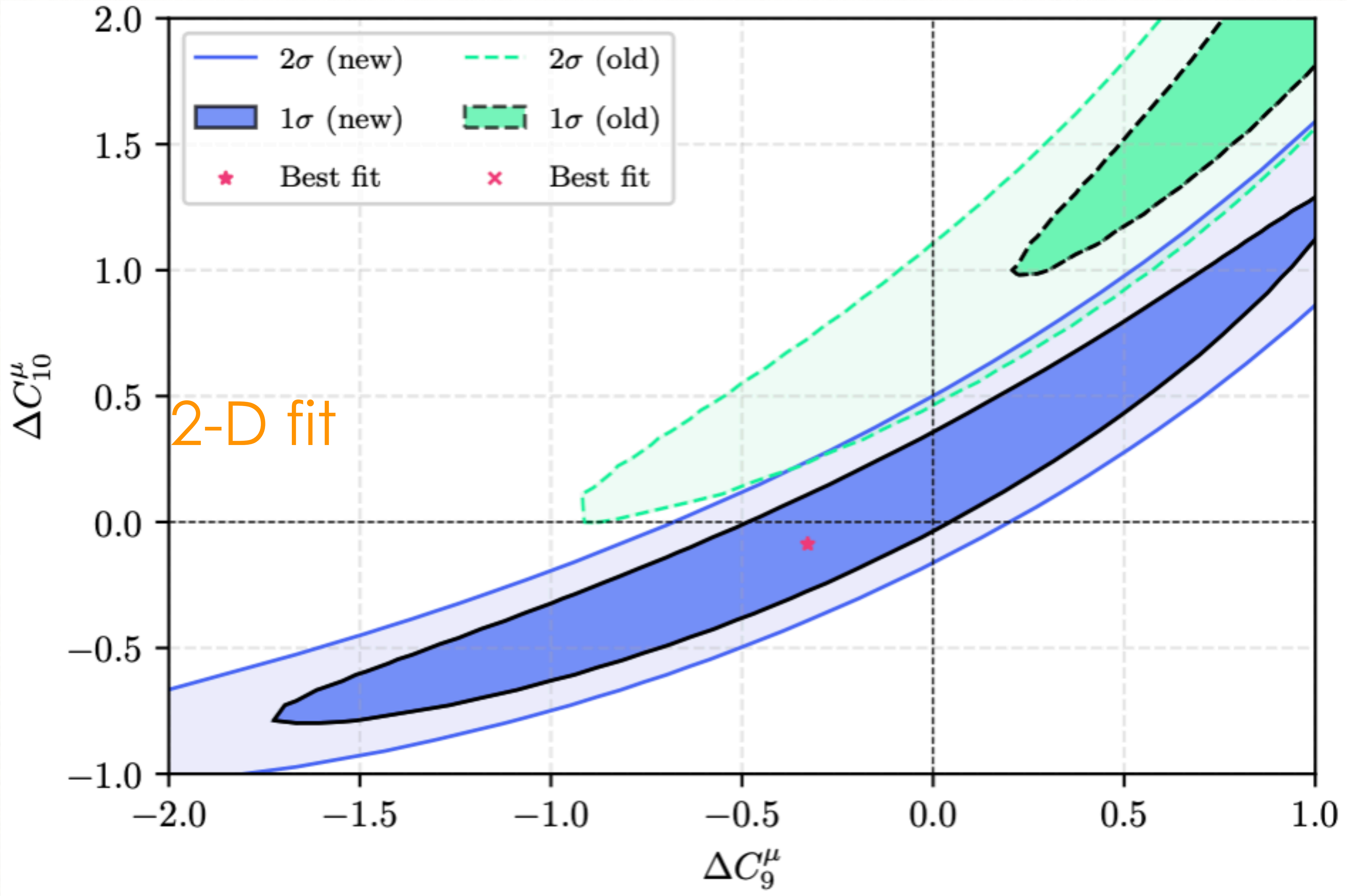
Params	S-I'	S-II'	S-III'	S-IV'
Reduced χ^2	183.404/(n-12)	197.556/(n-12)	182.869/(n-16)	176.807/(n-20)
χ^2_{min}/d.o.f	= 0.970	= 1.045	= 0.988	= 0.977
ΔC_7	$-0.003^{+0.020}_{-0.019}$	$-0.001^{+0.015}_{-0.015}$	···	$0.001^{+0.016}_{-0.015}$
$\Delta C'_7$	$0.017^{+0.018}_{-0.019}$	$0.020^{+0.014}_{-0.015}$	···	$0.020^{+0.014}_{-0.014}$
ΔC_8	$-0.788^{+0.595}_{-0.514}$	$-0.885^{+0.435}_{-0.398}$	···	$-0.773^{+0.451}_{-0.449}$
$\Delta C'_8$	$-0.073^{+1.089}_{-1.000}$	$-0.093^{+0.921}_{-0.831}$	···	$-0.089^{+0.996}_{-0.922}$
ΔC^μ_9	$-0.806^{+0.257}_{-0.272}$	$-0.795^{+0.205}_{-0.210}$	$-1.068^{+0.161}_{-0.164}$	$-0.863^{+0.214}_{-0.227}$
$\Delta C'^\mu_9$	$0.194^{+0.395}_{-0.416}$	$0.056^{+0.338}_{-0.342}$	$0.112^{+0.393}_{-0.397}$	$0.020^{+0.346}_{-0.362}$
ΔC^μ_{10}	$0.236^{+0.216}_{-0.193}$	$0.145^{+0.166}_{-0.156}$	$0.164^{+0.181}_{-0.180}$	$0.213^{+0.166}_{-0.155}$
$\Delta C'^\mu_{10}$	$-0.096^{+0.251}_{-0.237}$	$-0.108^{+0.186}_{-0.177}$	$-0.115^{+0.200}_{-0.198}$	$-0.089^{+0.177}_{-0.176}$
ΔC^μ_S	$0.066^{+1.091}_{-1.142}$	$-0.004^{+1.102}_{-1.131}$	$-0.008^{+0.883}_{-0.899}$	$-0.043^{+0.842}_{-0.875}$
$\Delta C'^\mu_S$	$0.065^{+1.087}_{-1.140}$	$0.003^{+1.103}_{-1.126}$	$-0.002^{+0.873}_{-0.936}$	$-0.059^{+0.844}_{-0.869}$
ΔC^μ_P	$0.167^{+1.172}_{-1.225}$	$1.017^{+0.735}_{-0.816}$	$0.092^{+1.076}_{-0.994}$	$0.117^{+0.847}_{-0.894}$
$\Delta C'^\mu_P$	$0.053^{+1.169}_{-1.227}$	$0.891^{+0.729}_{-0.812}$	$0.010^{+1.083}_{-1.002}$	$0.040^{+0.854}_{-0.895}$
ΔC^e_9	···	$-0.795^{+0.205}_{-0.210}$	$-1.753^{+0.781}_{-0.772}$	$-1.551^{+0.627}_{-0.599}$
$\Delta C'^e_9$	···	$0.056^{+0.338}_{-0.342}$	$1.725^{+1.724}_{-2.286}$	$1.710^{+1.466}_{-1.764}$
ΔC^e_{10}	···	$0.145^{+0.166}_{-0.156}$	$0.108^{+1.456}_{-0.661}$	$0.058^{+1.193}_{-0.661}$
$\Delta C'^e_{10}$	···	$-0.108^{+0.186}_{-0.177}$	$0.600^{+1.208}_{-1.099}$	$0.655^{+0.958}_{-0.841}$
ΔC^e_S	···	$-0.004^{+1.102}_{-1.131}$	$-0.719^{+1.861}_{-1.227}$	$-0.549^{+1.602}_{-1.232}$
$\Delta C'^e_S$	···	$0.003^{+1.103}_{-1.126}$	$-0.699^{+1.837}_{-1.224}$	$-0.550^{+1.618}_{-1.326}$
ΔC^e_P	···	$1.017^{+0.735}_{-0.816}$	$-1.592^{+1.552}_{-1.079}$	$-1.688^{+1.366}_{-0.978}$
$\Delta C'^e_P$	···	$0.891^{+0.729}_{-0.812}$	$-1.360^{+1.318}_{-1.149}$	$-1.431^{+1.212}_{-1.017}$

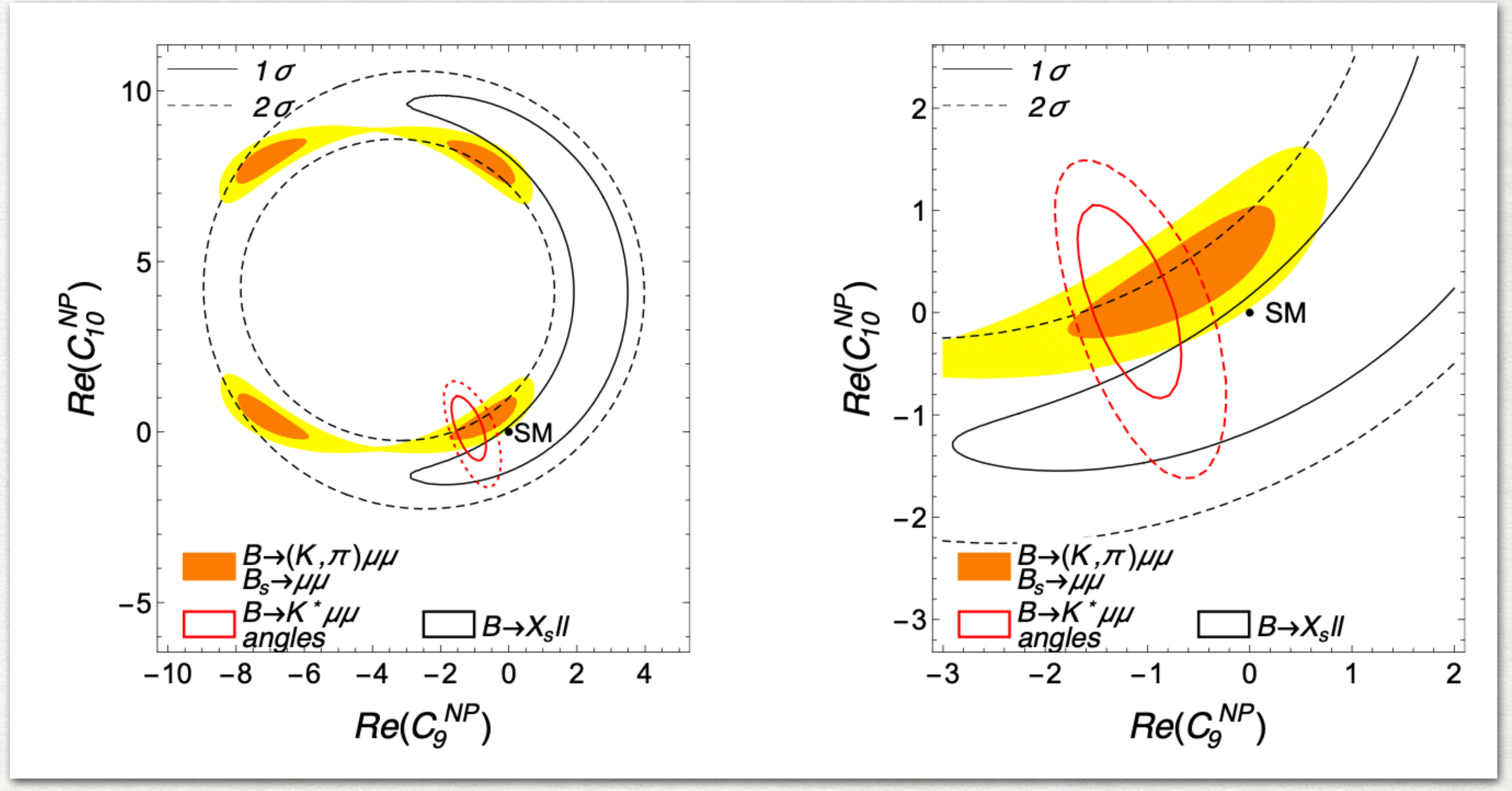
After Dec. 2022

Params	S-I	S-II	S-III	S-IV	ADCMN [23]	AS [24]	HMMN [25]	GGJLCS [26]
Reduced χ^2	190.044/(n-12)	177.891/(n-12)	185.386/(n-16)	178.953/(n-20)	260.66/(254-6)		179.1/(183-20)	96.88/90
χ^2_{min}/d.o.f	= 0.995	= 0.931	= 0.991	= 0.978	= 1.05		= 1.1	= 1.08
ΔC_7	$-0.000^{+0.020}_{-0.020}$	$-0.001^{+0.015}_{-0.015}$	···	$-0.000^{+0.016}_{-0.015}$	$0.00^{+0.01}_{-0.02}$	···	$0.06^{-0.03}_{+0.03}$	···
$\Delta C'_7$	$0.017^{+0.020}_{-0.018}$	$0.020^{+0.015}_{-0.014}$	···	$0.023^{+0.014}_{-0.016}$	$+0.00^{+0.02}_{-0.01}$	···	$-0.01^{-0.01}_{+0.01}$	···
ΔC_8	$-0.995^{+0.540}_{-0.463}$	$-0.921^{+0.443}_{-0.378}$	···	$-0.773^{+0.465}_{-0.424}$	···	···	$-0.80^{-0.40}_{+0.40}$	···
$\Delta C'_8$	$-0.080^{+1.046}_{-0.942}$	$-0.076^{+0.893}_{-0.833}$	···	$-0.258^{+1.007}_{-0.802}$	···	···	$-0.30^{+1.30}_{-1.30}$	···
ΔC^μ_9	$-0.752^{+0.262}_{-0.265}$	$-0.789^{+0.198}_{-0.210}$	$-1.054^{+0.163}_{-0.171}$	$-0.872^{+0.215}_{-0.215}$	$-1.08^{+0.18}_{-0.17}$	$-0.82^{+0.23}_{-0.23}$	$-1.14^{-0.19}_{+0.19}$	$-1.07^{+0.29}_{-0.29}$
$\Delta C'^\mu_9$	$0.174^{+0.434}_{-0.441}$	$0.048^{+0.338}_{-0.348}$	$0.130^{+0.439}_{-0.437}$	$0.088^{+0.342}_{-0.378}$	$0.16^{+0.37}_{-0.36}$	$-0.10^{+0.34}_{-0.34}$	$0.05^{+0.32}_{-0.32}$	$0.32^{-0.21}_{+0.21}$
ΔC^μ_{10}	$-0.019^{+0.206}_{-0.175}$	$0.163^{+0.165}_{-0.160}$	$0.112^{+0.166}_{-0.184}$	$0.171^{+0.157}_{-0.175}$	$0.15^{+0.13}_{-0.13}$	$+0.14^{+0.23}_{-0.23}$	$0.21^{-0.20}_{+0.20}$	$0.21^{-0.14}_{+0.14}$
$\Delta C'^\mu_{10}$	$-0.118^{+0.266}_{-0.247}$	$-0.093^{+0.183}_{-0.179}$	$-0.115^{+0.215}_{-0.213}$	$-0.062^{+0.197}_{-0.180}$	$-0.18^{+0.20}_{-0.18}$	$-0.33^{+0.23}_{-0.23}$	$-0.03^{+0.19}_{-0.19}$	$-0.26^{-0.14}_{+0.14}$
ΔC^μ_S	$0.023^{+1.064}_{-1.097}$	$0.060^{+1.188}_{-1.230}$	$-0.066^{+0.944}_{-0.929}$	$0.009^{+0.858}_{-0.845}$	···	···	$0.01^{+0.05}_{-0.05}$	···
$\Delta C'^\mu_S$	$0.014^{+1.064}_{-1.086}$	$0.061^{+1.188}_{-1.225}$	$-0.070^{+0.957}_{-0.930}$	$0.012^{+0.858}_{-0.862}$	···	···	$-0.01^{+0.05}_{-0.05}$	···
ΔC^μ_P	$0.079^{+1.159}_{-1.146}$	$0.478^{+0.808}_{-0.899}$	$0.189^{+1.018}_{-1.028}$	$0.124^{+0.902}_{-0.910}$	···	···	$-0.04^{+0.02}_{-0.02}$	···
$\Delta C'^\mu_P$	$-0.032^{+1.158}_{-1.145}$	$0.370^{+0.803}_{-0.897}$	$0.098^{+1.009}_{-1.024}$	$0.038^{+0.894}_{-0.913}$	···	···	$-0.04^{+0.02}_{-0.02}$	···
ΔC^e_9	···	$-0.789^{+0.198}_{-0.210}$	$-1.623^{+0.662}_{-0.734}$	$-1.511^{+0.561}_{-0.533}$	···	$-0.24^{+1.17}_{-1.17}$	$-6.50^{+1.90}_{-1.90}$	···
$\Delta C'^e_9$	···	$0.048^{+0.338}_{-0.348}$	$1.090^{+1.610}_{-1.793}$	$0.864^{+1.483}_{-1.608}$	···	···	$1.40^{+2.30}_{-2.30}$	···
ΔC^e_{10}	···	$0.163^{+0.165}_{-0.160}$	$0.555^{+1.042}_{-0.576}$	$0.383^{+0.840}_{-0.424}$	···	$-0.24^{+0.78}_{-0.78}$	~ 0	···
$\Delta C'^e_{10}$	···	$-0.093^{+0.183}_{-0.179}$	$0.088^{+0.969}_{-0.956}$	$0.002^{+0.881}_{-0.815}$	···	···	~ 0	···
ΔC^e_S	···	$0.060^{+1.188}_{-1.230}$	$-0.952^{+2.122}_{-1.139}$	$-0.806^{+1.900}_{-1.238}$	···	···	$-0.38^{+0.41}_{-0.41}$	···
$\Delta C'^e_S$	···	$0.061^{+1.188}_{-1.225}$	$-1.051^{+2.251}_{-1.075}$	$-0.803^{+1.861}_{-1.194}$	···	···	$-0.36^{+0.50}_{-0.50}$	···
ΔC^e_P	···	$0.478^{+0.808}_{-0.899}$	$-1.568^{+1.544}_{-1.149}$	$-1.837^{+1.376}_{-0.930}$	···	···	$-0.98^{+0.21}_{-0.21}$	···
$\Delta C'^e_P$	···	$0.370^{+0.803}_{-0.897}$	$-1.477^{+1.409}_{-1.083}$	$-1.652^{+1.200}_{-0.979}$	···	···	$-0.95^{+0.29}_{-0.29}$	···

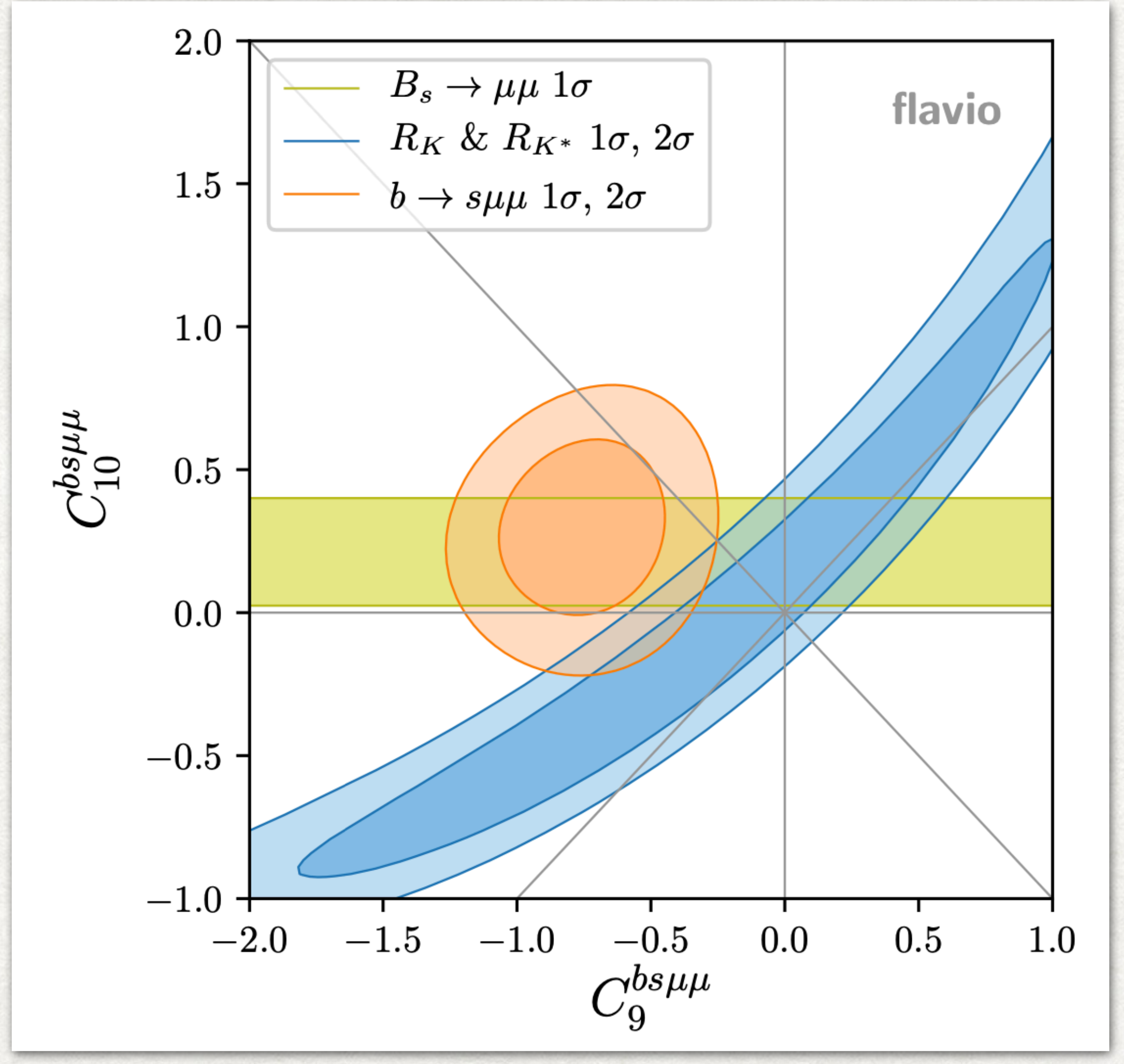
- we carried out a 20-D fit
- fitting results depend on the numbers of fitting d.o.f.
- both old and new fits imply NP exists in ΔC_9^μ in various fitting scenarios
- both old and new fits imply: NP possibility in ΔC_{10}^μ is less hopeful
- new fits implies: NP may be hidden in ΔC_9^e, and its inverse process $e^+e^- \to bs$ calls for **CEPC**

UNDERSTANDING THE ROLE OF $R_{K^{(*)}}$





Daping Du, et.al. 1510.02349



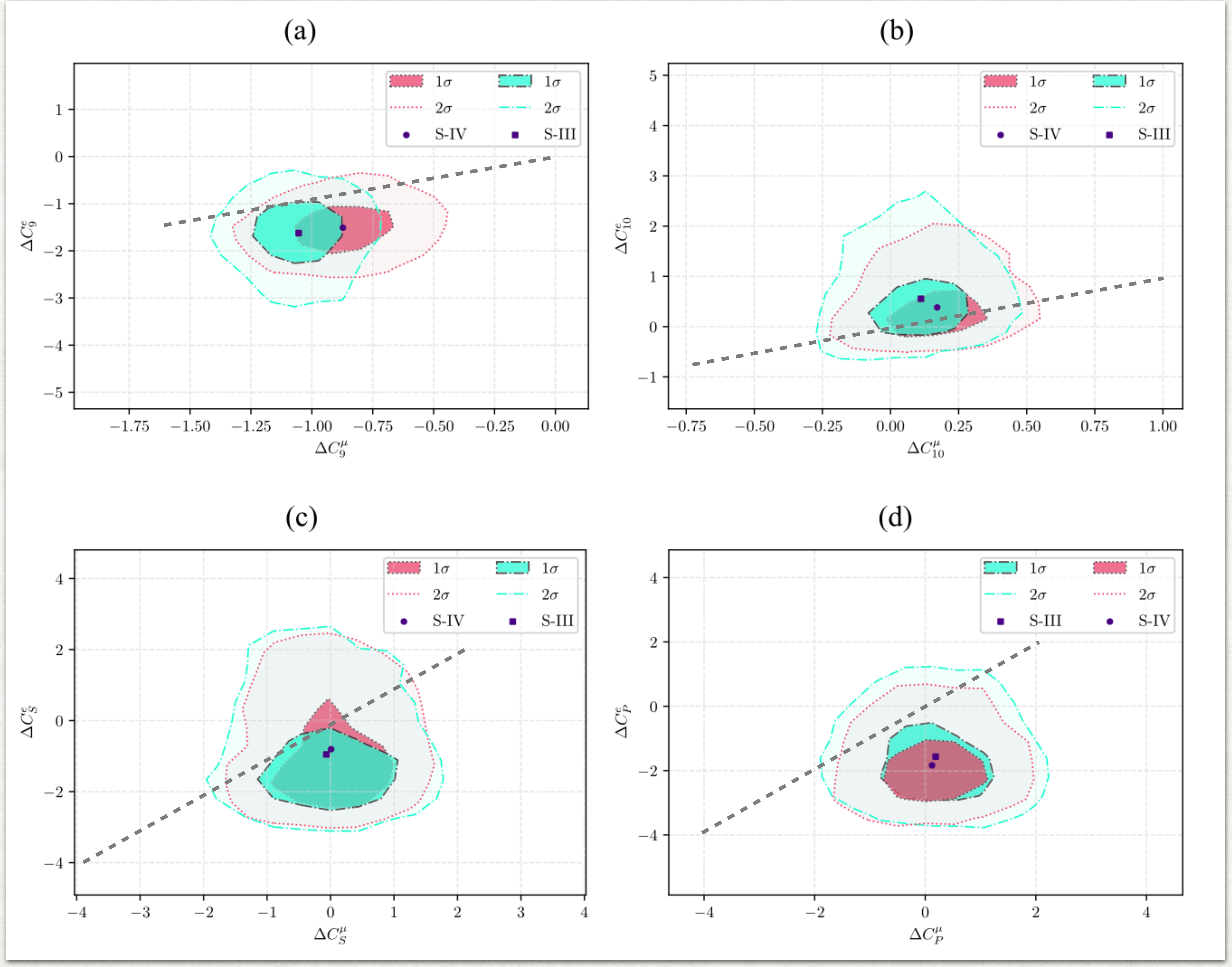
Admir Greljo, et.al. 2212.10497

Pure $R_{K^{(*)}}$ constraints on $(\Delta C_9^{\mu}, \Delta C_{10}^{\mu})$:

still with large uncertainty

$R_{K^{(*)}}$ is not main determiner of ΔC_9^{μ} , slightly shift ΔC_{10}^{μ}

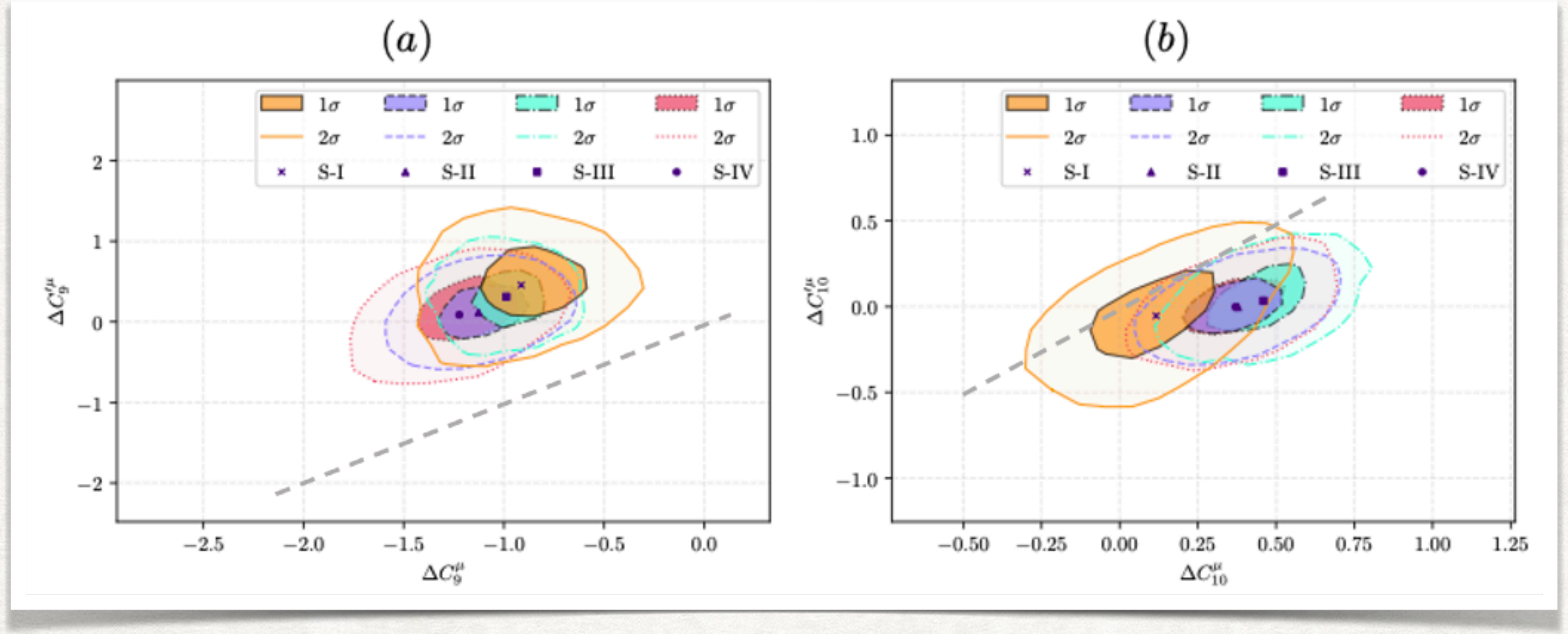
OUR RESULTS (II): FLAVOR CORRELATION

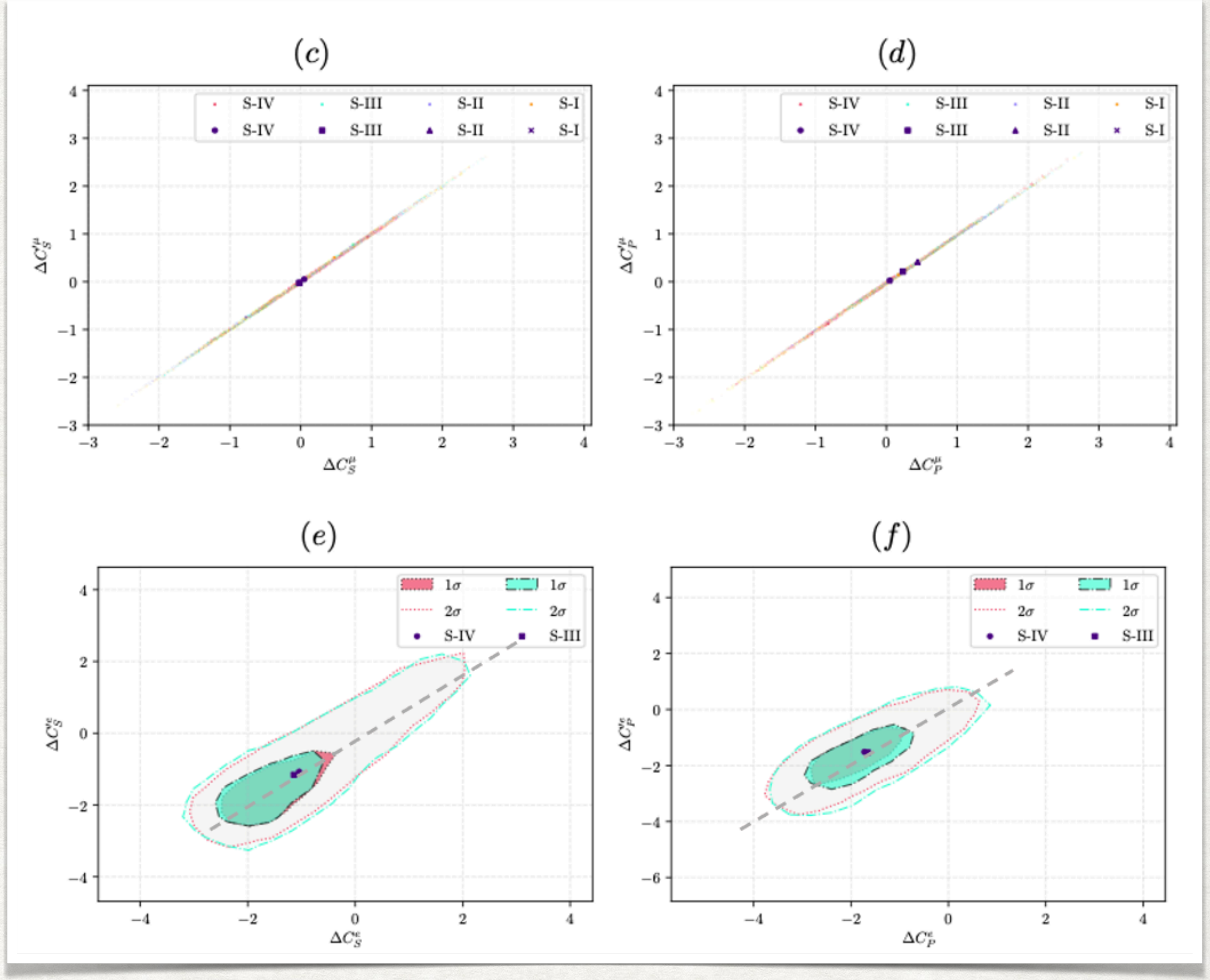


Muon-type operator as an example

- The lepton flavor for ΔC_{10}^{μ} is indistinguishable at 1σ level.
- All WCs are flavor identical at 2σ level

OUR RESULTS (III): CHIRAL CORRELATION

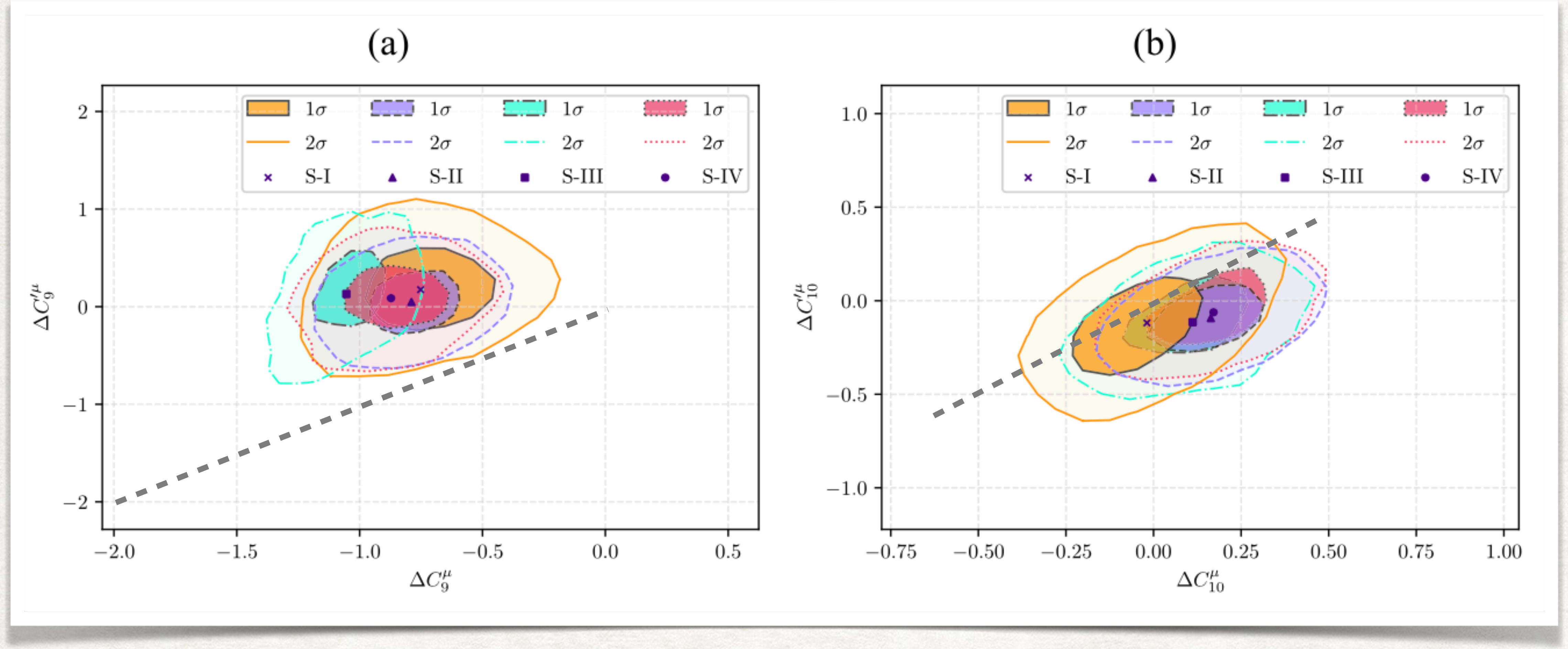


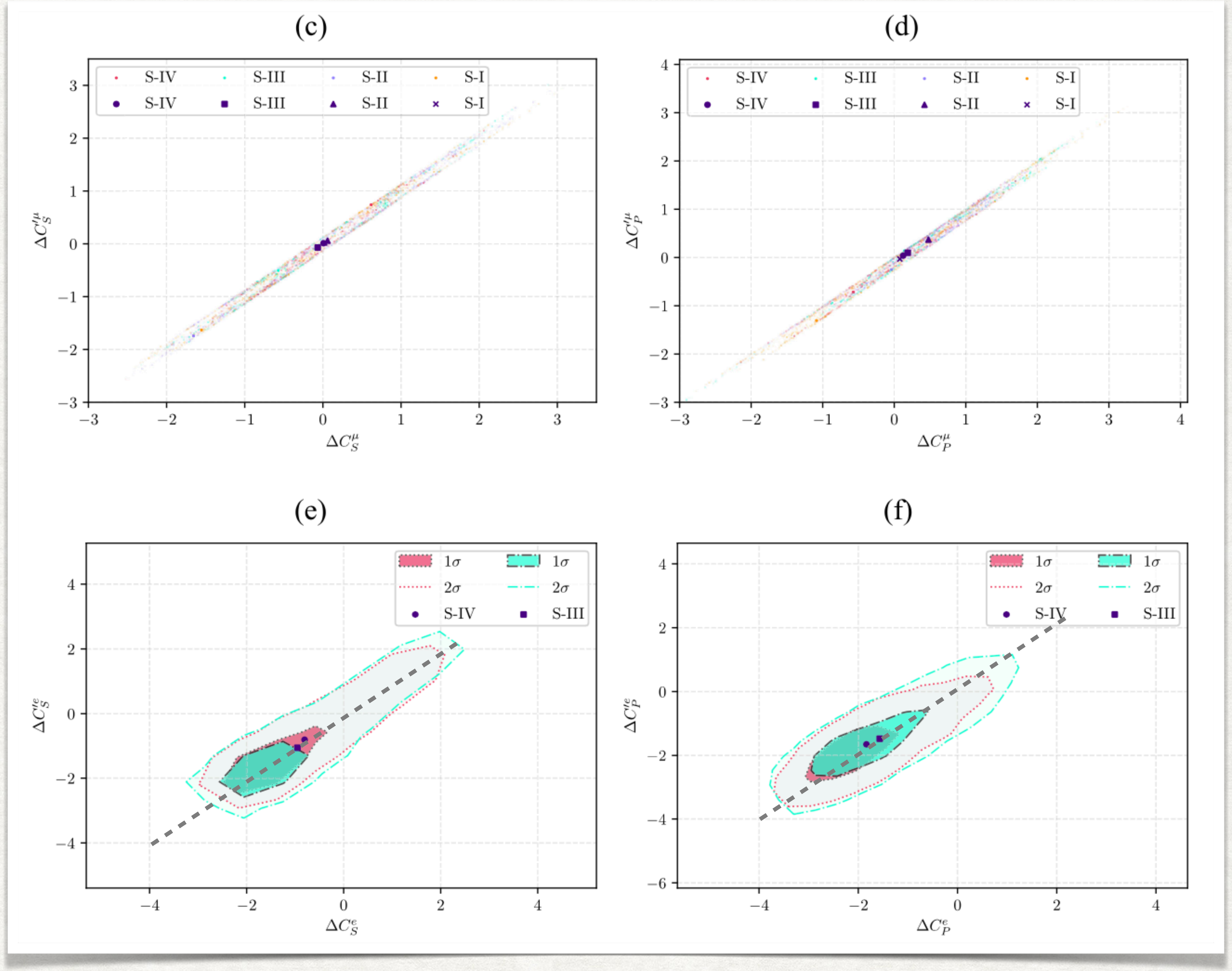


- ΔC_9^μ deviates from its chiral dual one more than 2σ level, while ΔC_{10}^μ is within 1σ region which is scenario dependent.

- scalar WCs have better chiral identity, and muon type is strictly respected.

OUR RESULTS (III): CHIRAL CORRELATION



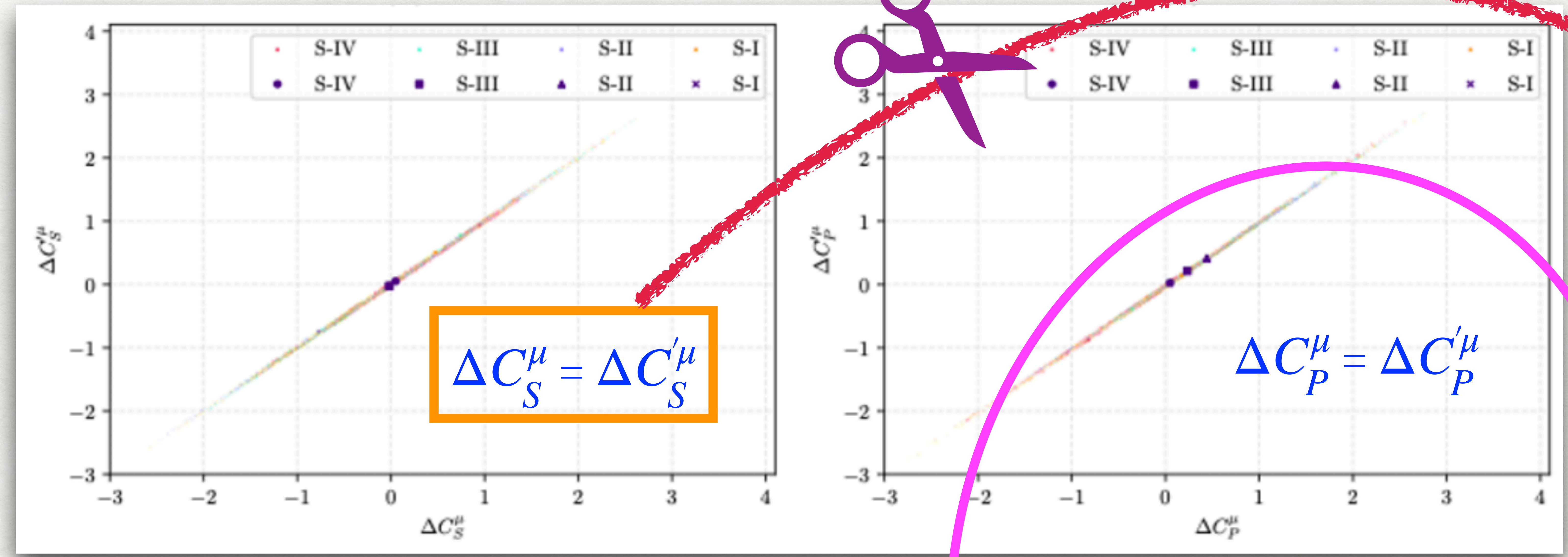


- ΔC_9^μ deviates from its chiral dual one more than 2σ level, while ΔC_{10}^μ is within 1σ region which is scenario dependent.
- scalar WCs have better chiral identity, and muon type is strictly respected.

IMPLICATIONS

Two options:

- Non-SMEFT NP
- SMEFT: vanishing scalar operator



$\Delta C_S^{\mu} = -\Delta C_S^{\prime\mu}$

- SMEFT (Jenkins, Manohar and Stoffer, 1709.04486)

$$
\begin{aligned}
\lambda_1 C_7 &= c_7\,, & \lambda_1 C_7' &= c_7'\,,\\
\lambda_2 C_9 &= c_\ell^{V,LL} + c_\ell^{\prime V,LR}\,, & \lambda_2 C_{10} &= -c_\ell^{V,LL} + c_\ell^{\prime V,LR}\,,\\
\lambda_2 C_9' &= c_\ell^{V,LR} + c_\ell^{V,RR}\,, & \lambda_2 C_{10}' &= -c_\ell^{V,LR} + c_\ell^{V,RR}\,,\\
\lambda_2 C_S &= c_\ell^{S,RR} + c_\ell^{\prime S,RL}\,, & \lambda_2 C_P &= c_\ell^{S,RR} - c_\ell^{\prime S,RL}\,,\\
\lambda_2 C_S' &= c_\ell^{S,RL} + c_\ell^{\prime S,RR}\,, & \lambda_2 C_P' &= c_\ell^{S,RL} - c_\ell^{\prime S,RR}\,,\\
\lambda_2 C_T &= c_\ell^{\prime T,RR} + c_\ell^{T,RR}\,, & \lambda_2 C_{T5} &= -c_\ell^{\prime T,RR} + c_\ell^{T,RR}\,,
\end{aligned}
$$

$$C_S + C_P = 0\,, \qquad C_S' - C_P' = 0\,, \qquad C_T = 0\,, \qquad C_{T5} = 0\,.$$

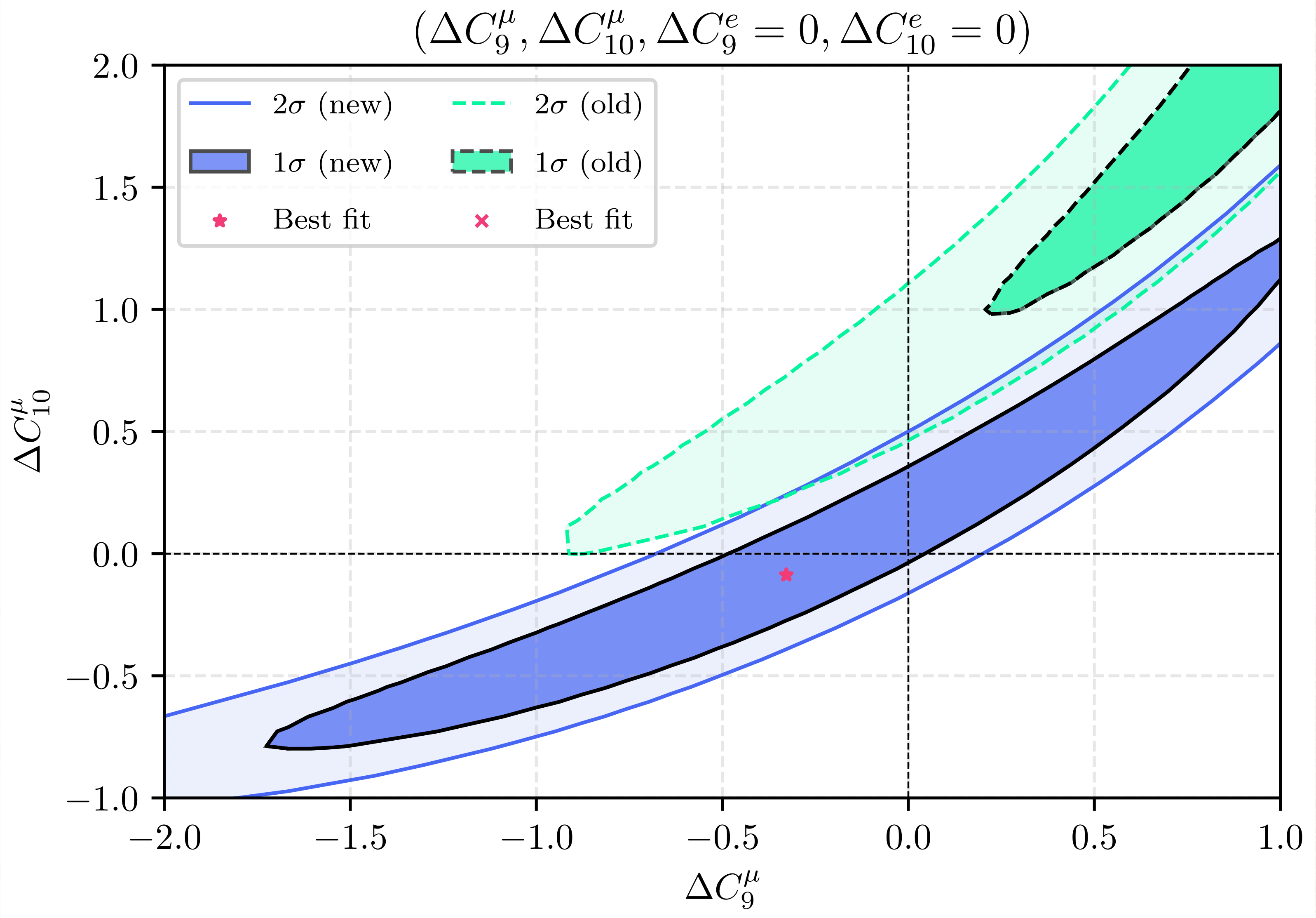
SUMMARY

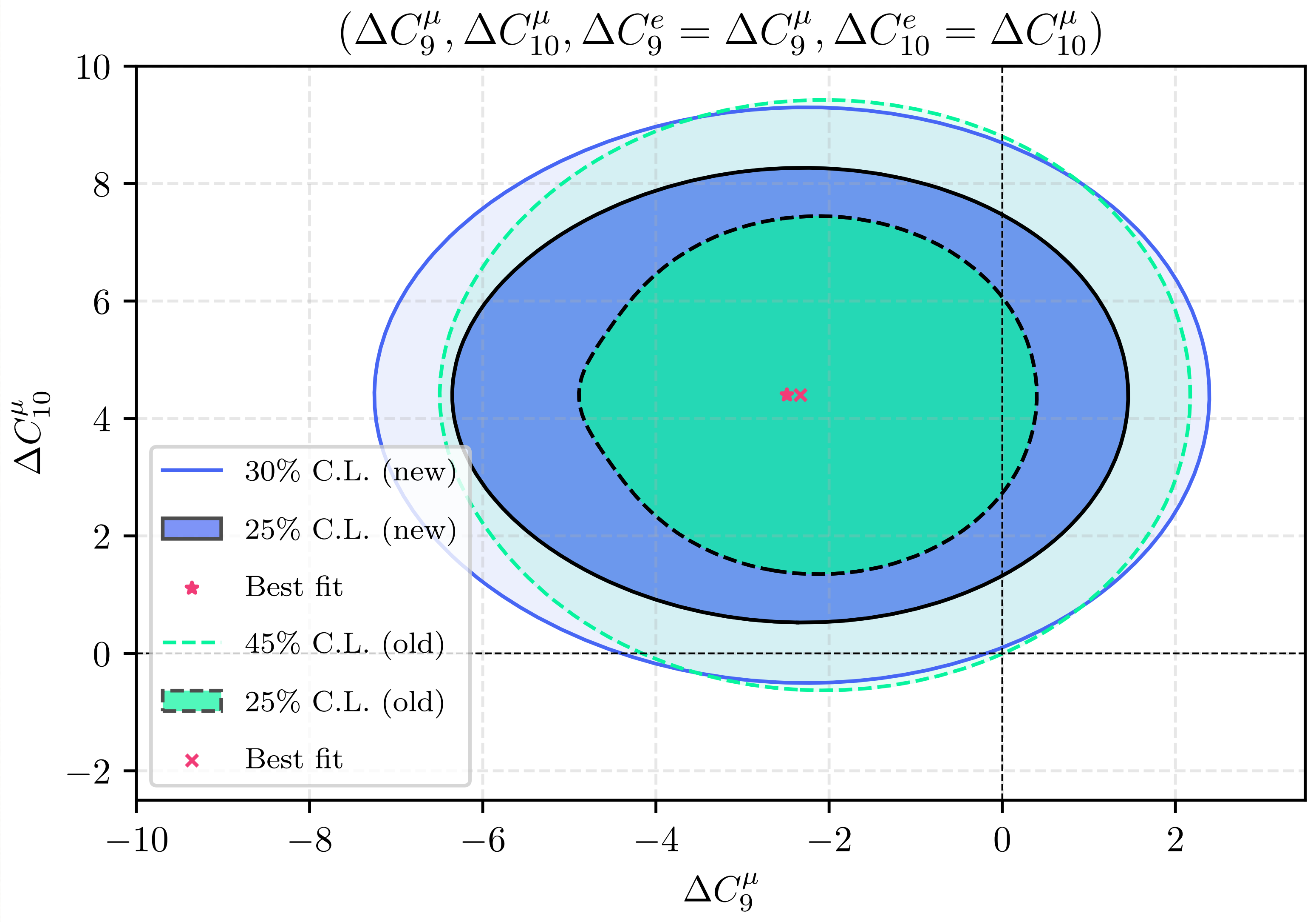
- Based on 2 datasets, global fits have been carried out in four different operator basis/scenarios, including the 20-D fit with specific lepton flavors.
- NP possibility in $b \to s$ window still exists. It turns up most likely in terms of ΔC_9^{μ} , and ΔC_9^{e} is also possible.
- Experimentally, CEPC may provide complementary view via $e^+e^- \to bs$ process.
- Theoretically, the obtained linear relation between scalar operator provides useful information to NP exploration: non-SMEFT or certain vanishing SMEFT operators.
- More serious studies on bottomed baryon decays are expected!

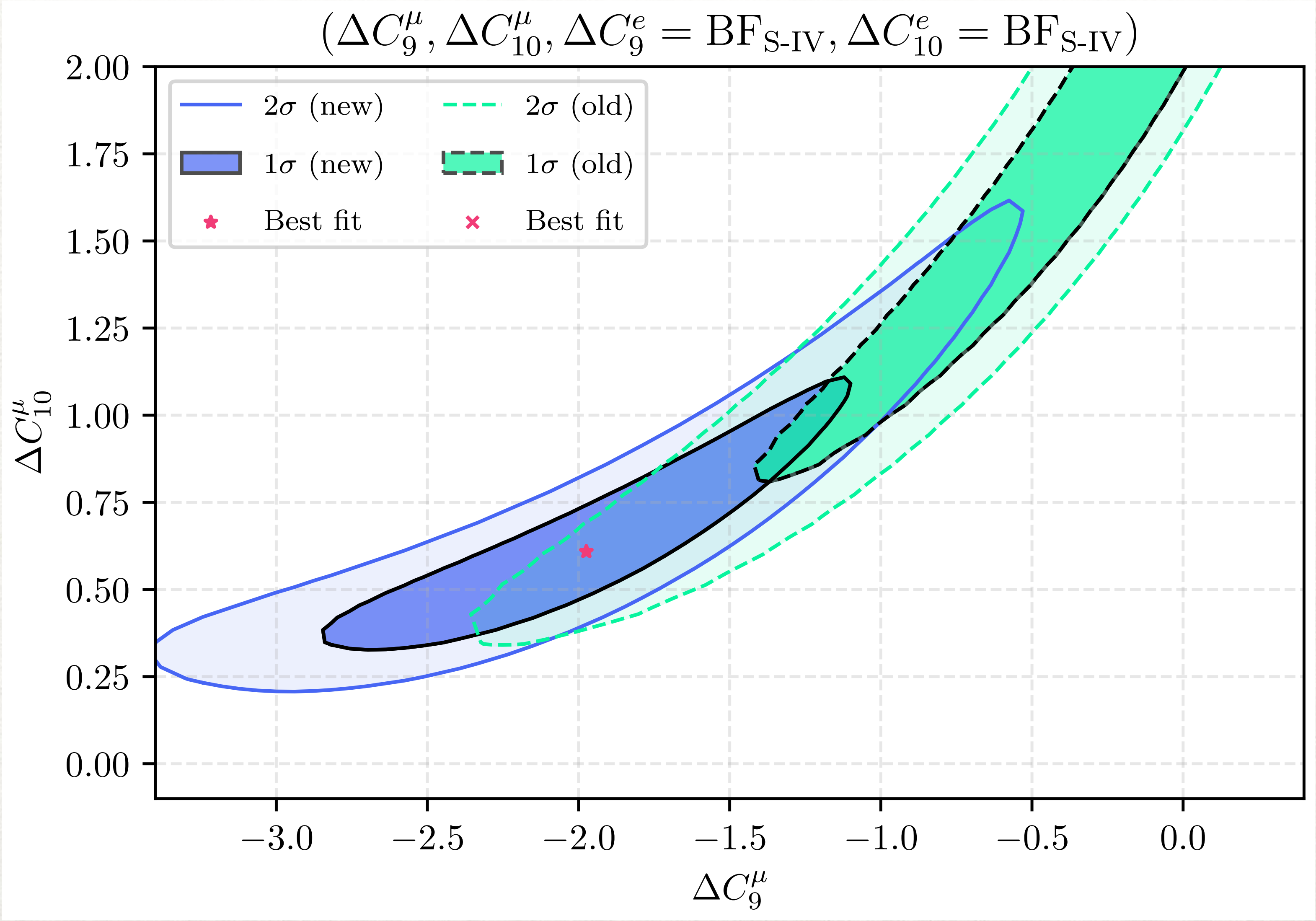
Thank you for your attention!

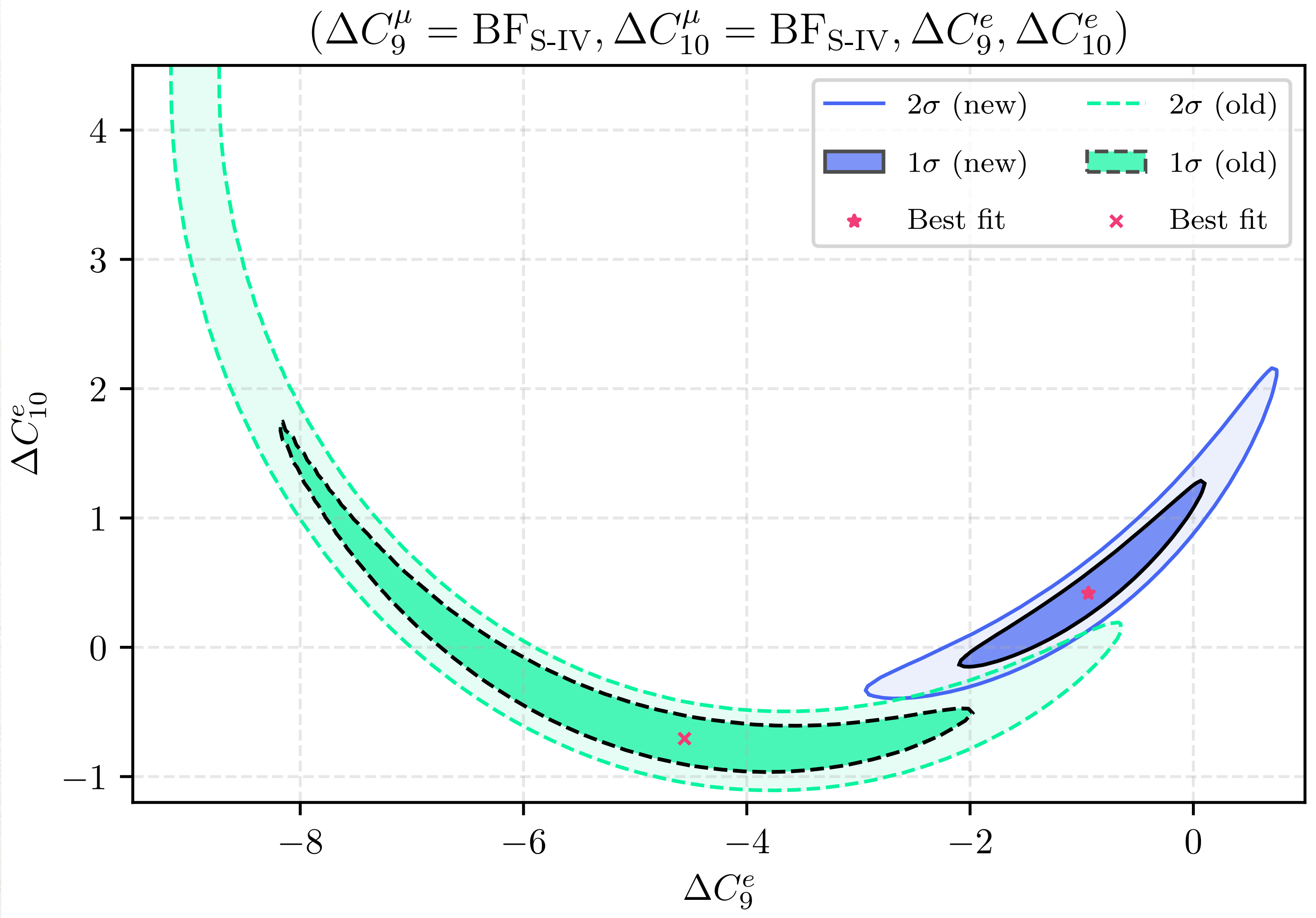
BACKUP SLIDES

LEPTON FLAVOR DEPENDENCE

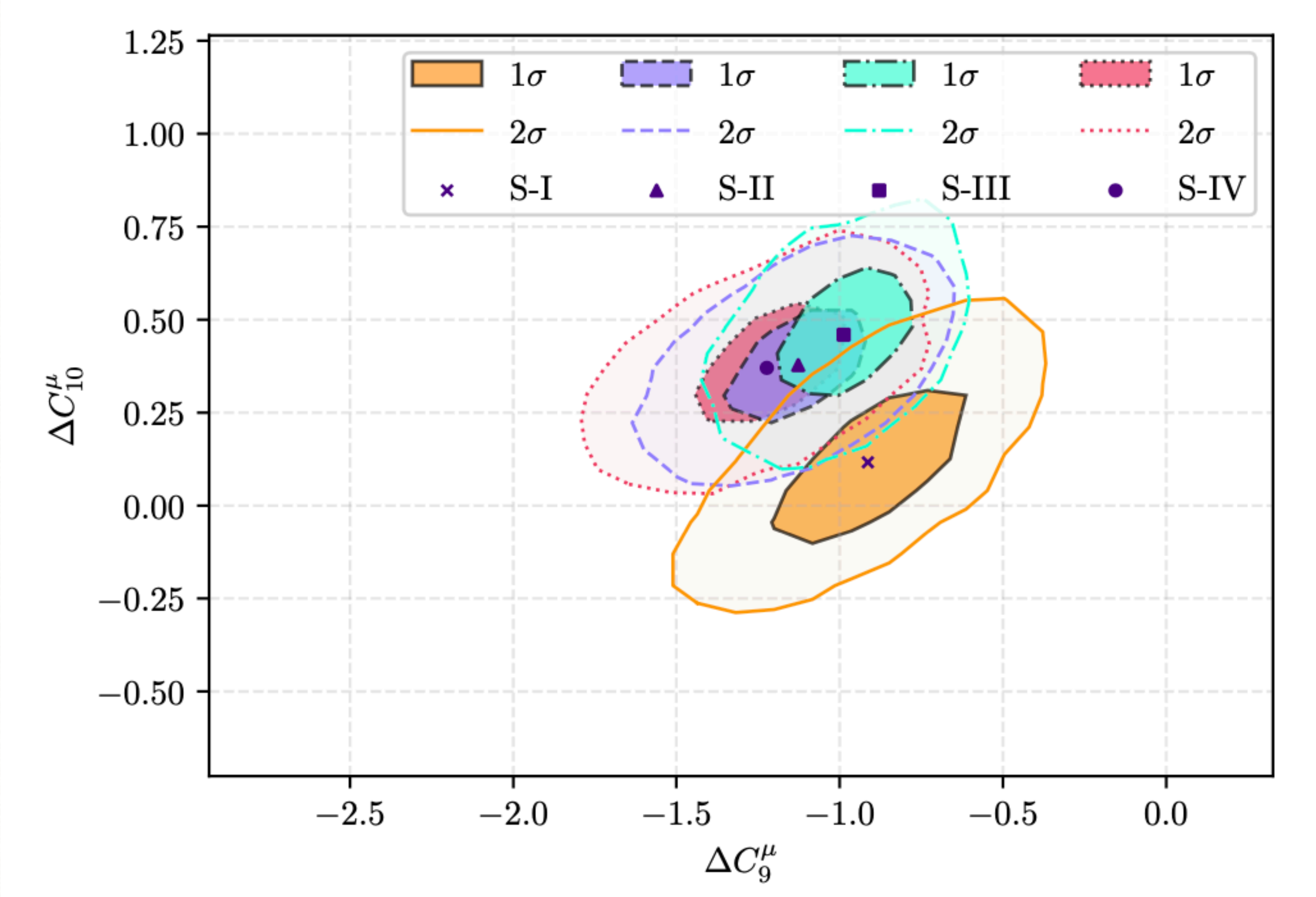


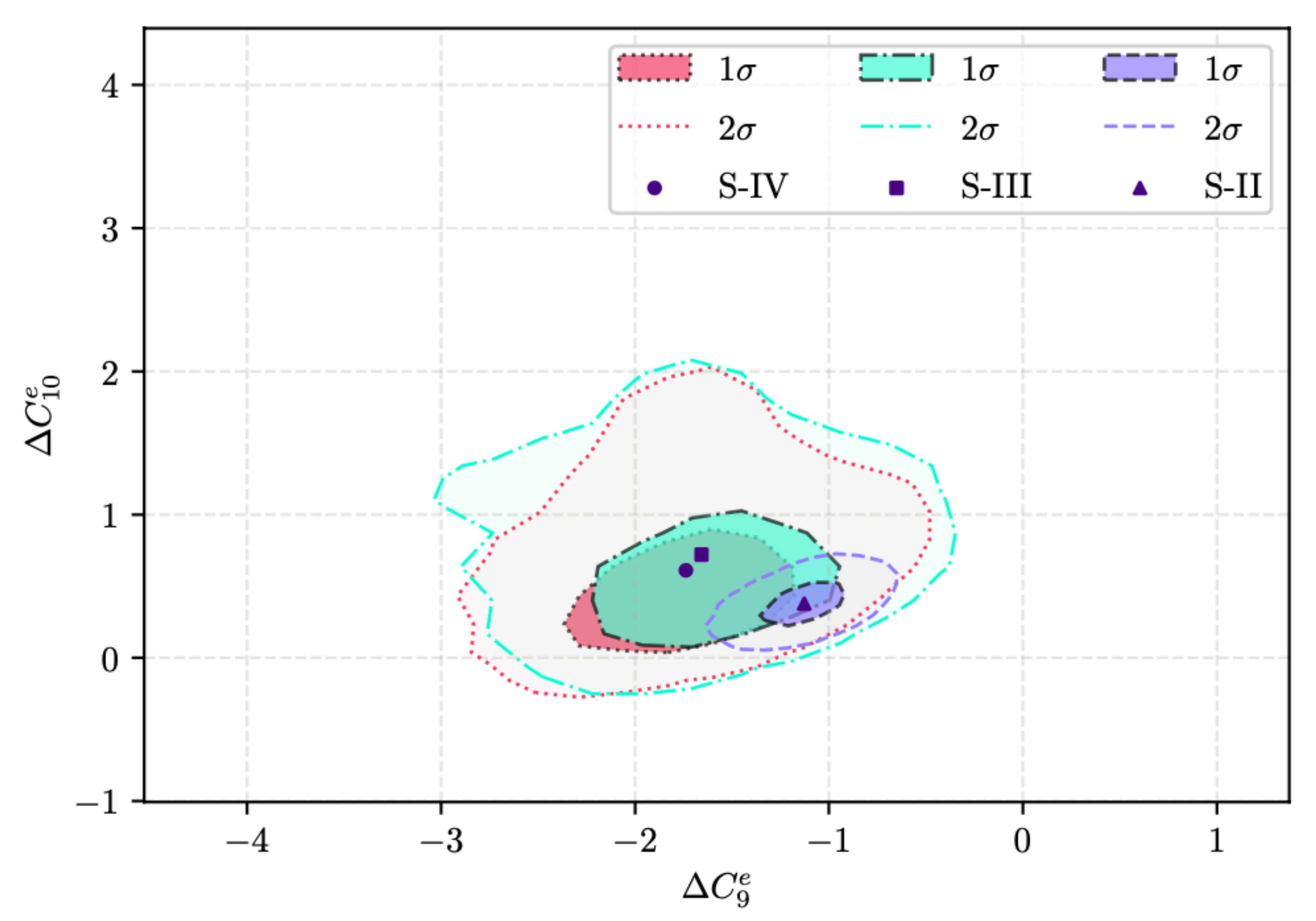




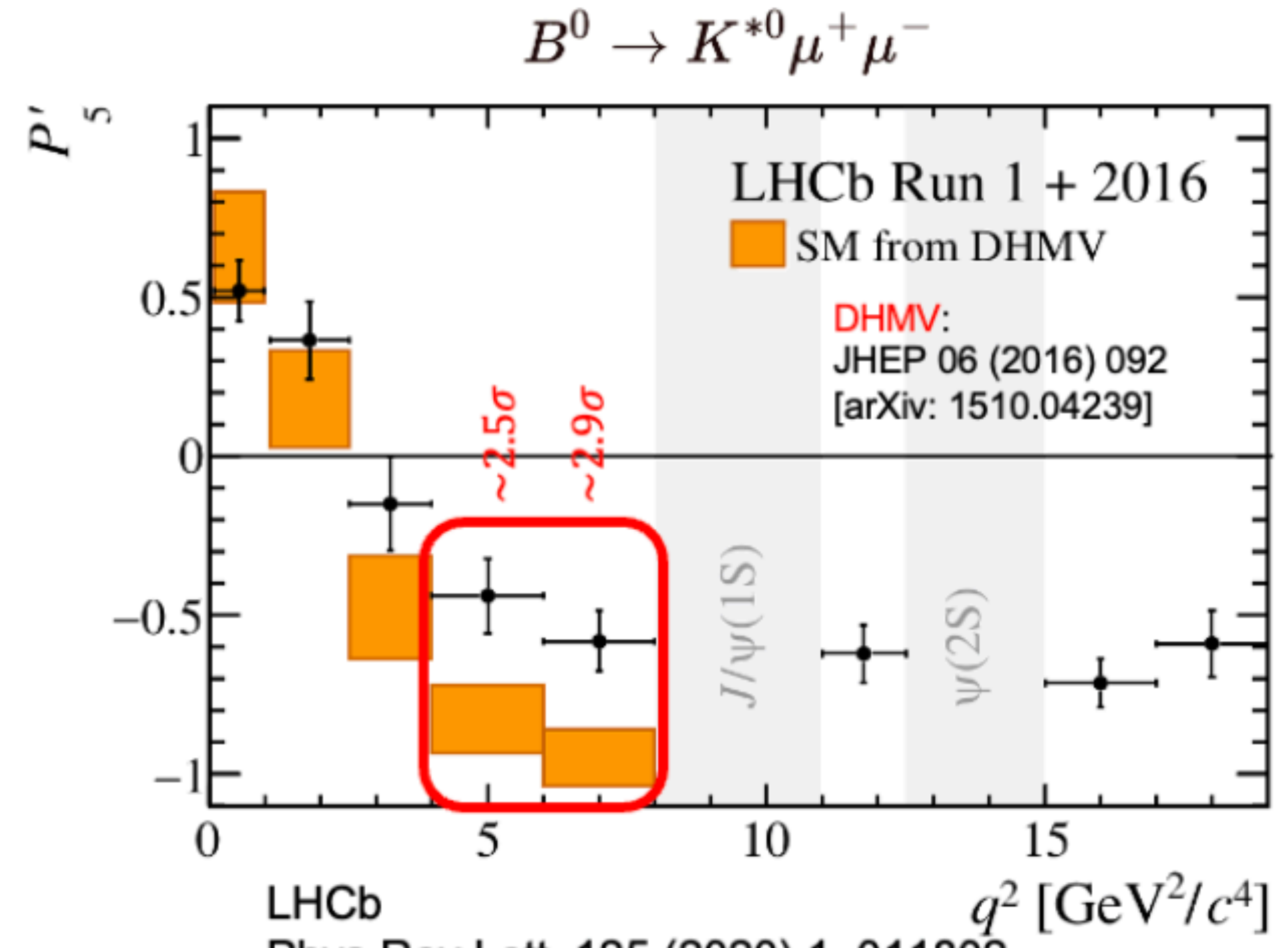


THE LATEST (ΔC_9, ΔC_{10}) RANGE

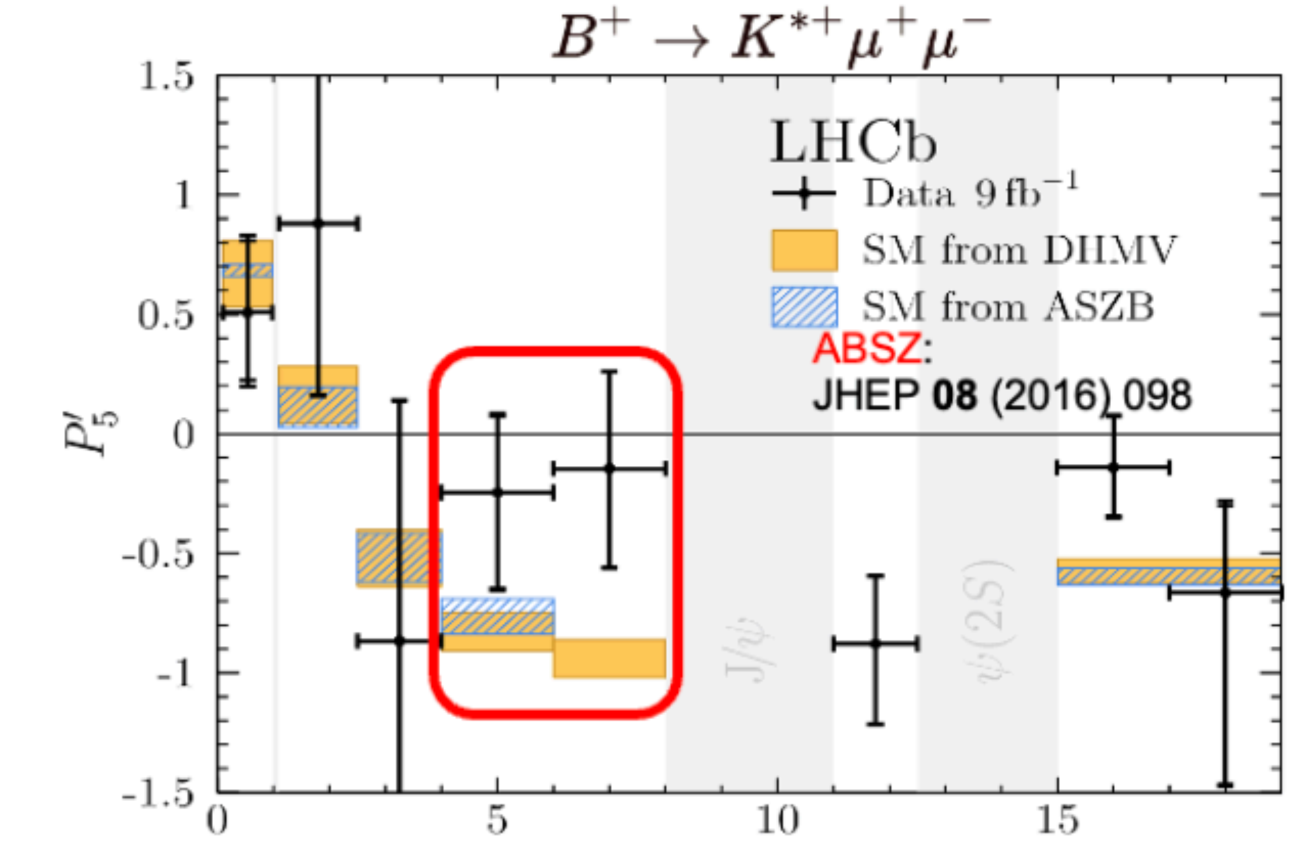




DATA & PREDICTION: P5’



LHCb
Phys.Rev.Lett. 125 (2020) 1, 011802



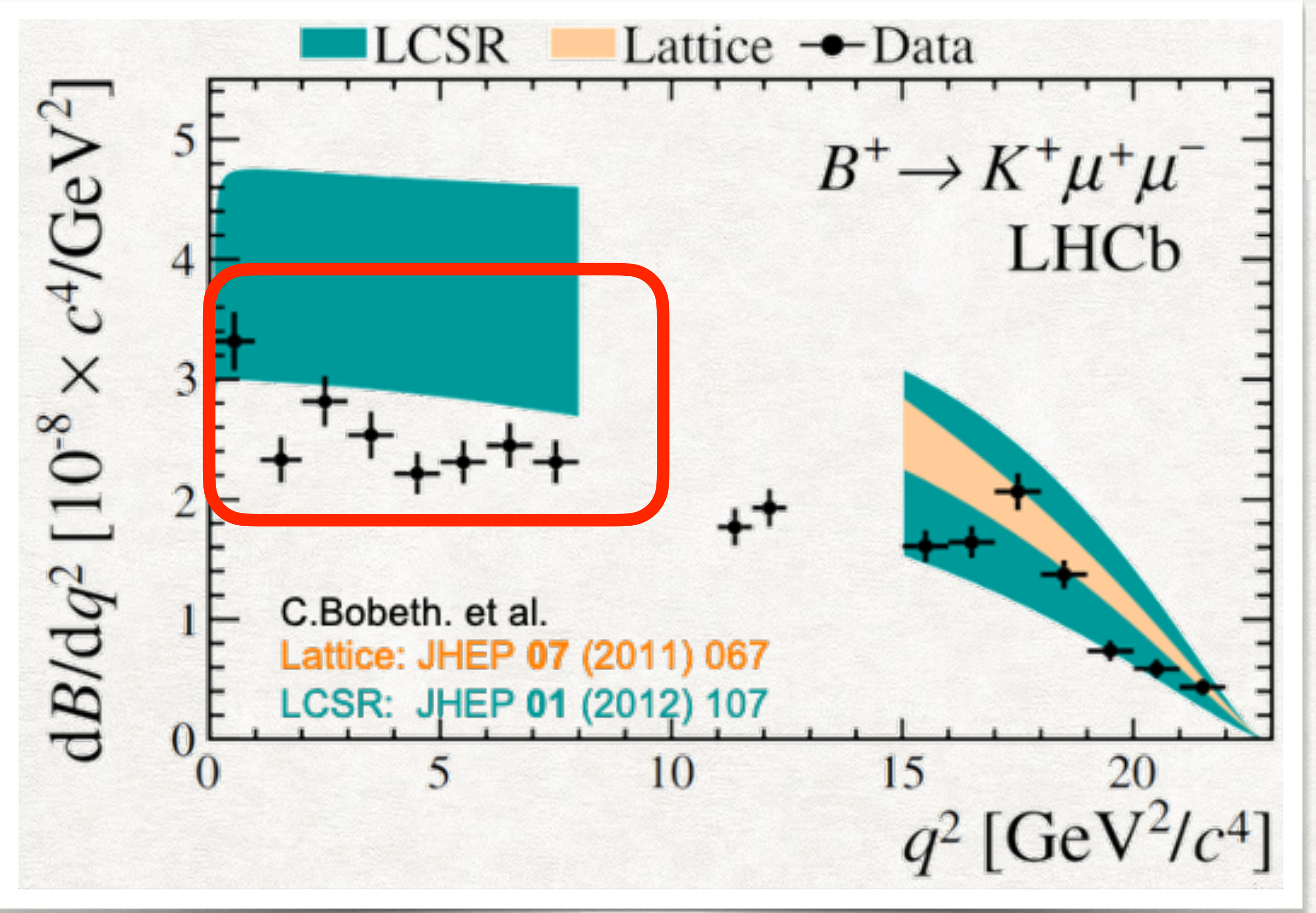
LHCb
Phys.Rev.Lett. 126 (2021) 16, 161802

P'_5	[1.1, 6.0]	$-0.114 \pm 0.068 \pm 0.026$	-0.406 ± 0.110	-0.447 ± 0.096
	[1.1, 2.5]	$0.365 \pm 0.122 \pm 0.013$	0.208 ± 0.055	0.139 ± 0.075
	[2.5, 4.0]	$-0.150 \pm 0.144 \pm 0.032$	-0.451 ± 0.126	-0.501 ± 0.102
	[4.0, 6.0]	$-0.439 \pm 0.111 \pm 0.036$	-0.752 ± 0.191	-0.759 ± 0.069

Observable	q^2 (GeV^2)	Experimental value	This work	*Flavio* [49]
P'_4	[1.1, 2.5]	$0.58^{+0.62}_{-0.56} \pm 0.11$	-0.052 ± 0.015	-0.063 ± 0.043
	[2.5, 4.0]	$-0.81^{+1.09}_{-0.84} \pm 0.14$	-0.371 ± 0.098	-0.391 ± 0.044
	[4.0, 6.0]	$-0.79^{+0.47}_{-0.28} \pm 0.09$	-0.487 ± 0.120	-0.502 ± 0.027
	[1.1, 6.0]	$-0.41^{+0.28}_{-0.28} \pm 0.07$	-0.335 ± 0.096	-0.353 ± 0.042
P'_5	[1.1, 2.5]	$0.88^{+0.70}_{-0.71} \pm 0.10$	0.180 ± 0.050	0.113 ± 0.113
	[2.5, 4.0]	$-0.87^{+1.00}_{-1.68} \pm 0.09$	-0.467 ± 0.125	-0.517 ± 0.098
	[4.0, 6.0]	$-0.25^{+0.32}_{-0.40} \pm 0.09$	-0.756 ± 0.187	-0.764 ± 0.083
	[1.1, 6.0]	$-0.07^{+0.25}_{-0.25} \pm 0.04$	-0.421 ± 0.123	-0.461 ± 0.086

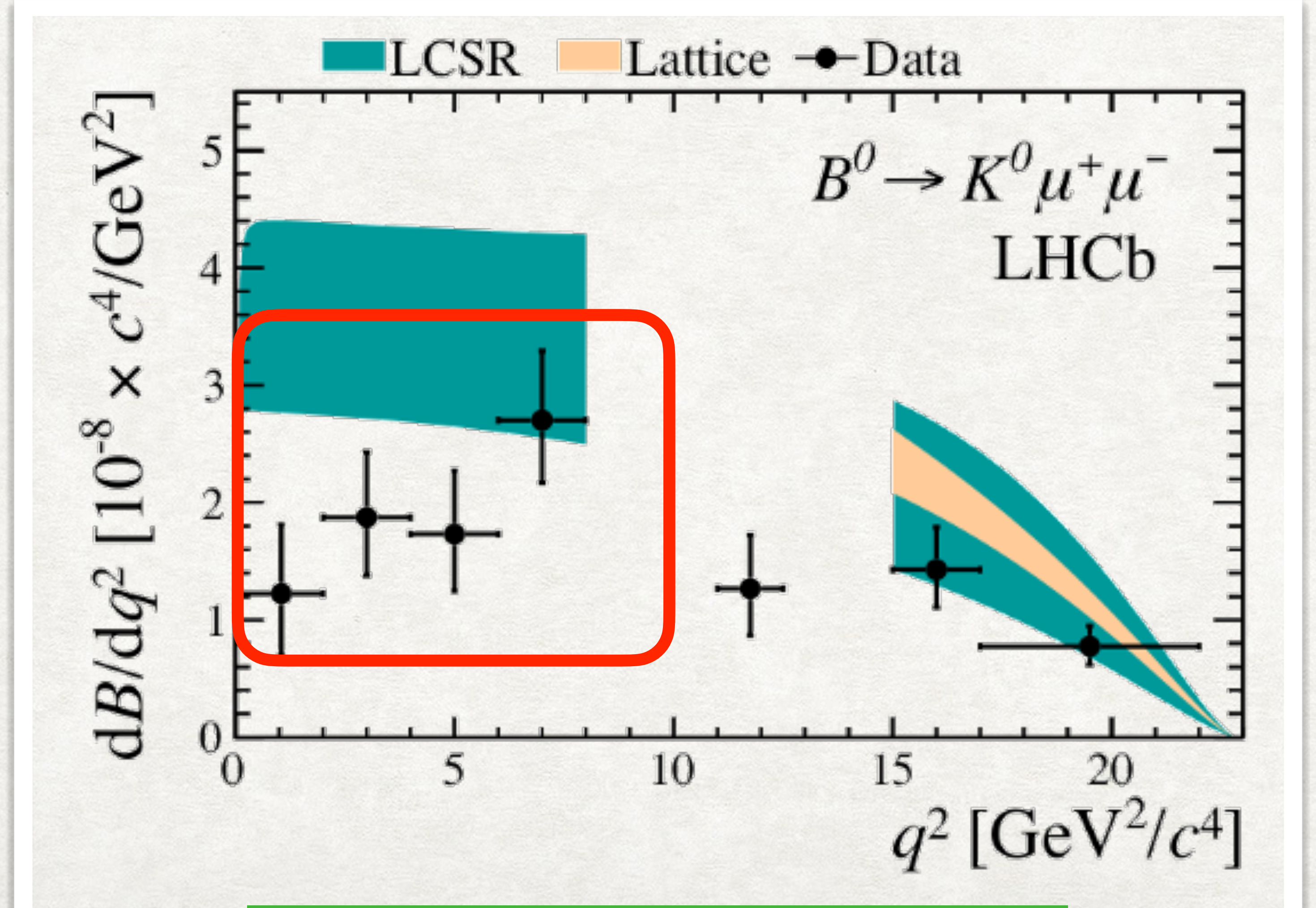
DATA & PREDICTION: BR

$B^+ \to K^+\mu^+\mu^-$



Observable	q^2 (GeV^2)	Experimental value	This work	*Flavio* [49]
		LHCb ($B^+ \to K^+\mu^+\mu^-$) [13]		
$10^9 d\mathcal{B}/dq^2$	[1.1, 2.0]	$23.3 \pm 1.5 \pm 1.2$	37.243 ± 11.219	35.256 ± 6.385
	[2.0, 3.0]	$28.2 \pm 1.6 \pm 1.4$	36.911 ± 11.308	35.095 ± 6.056
	[3.0, 4.0]	$25.4 \pm 1.5 \pm 1.3$	36.540 ± 11.480	34.908 ± 6.329
	[4.0, 5.0]	$22.1 \pm 1.4 \pm 1.1$	36.128 ± 11.715	34.689 ± 5.610
	[5.0, 6.0]	$23.1 \pm 1.4 \pm 1.2$	35.664 ± 11.996	34.429 ± 5.908
	[1.1, 6.0]	$24.2 \pm 0.7 \pm 1.2$	36.482 ± 11.472	34.868 ± 5.777
		LHCb ($B^0 \to K^0\mu^+\mu^-$) [13]		
$10^9 d\mathcal{B}/dq^2$	[0.1, 2.0]	$12.2^{+5.9}_{-5.2} \pm 0.6$	34.658 ± 10.247	32.668 ± 5.650
	[2.0, 4.0]	$18.7^{+5.5}_{-4.9} \pm 0.9$	34.073 ± 10.450	32.448 ± 6.185
	[4.0, 6.0]	$17.3^{+5.3}_{-4.8} \pm 0.9$	33.283 ± 10.899	32.034 ± 6.330
	[1.1, 6.0]	$18.7^{+3.5}_{-3.2} \pm 0.9$	33.842 ± 10.537	32.323 ± 5.907

$B^0 \to K^0\mu^+\mu^-$



LHCb
JHEP **06** (2014) 133 arXiv: 1403.8044v1