Recent results in B physics at the LHC regarding EFTs

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on behalf of the LHC Collaborations

LHCEFT2023

6th General meeting of the LHC EFT Working Group, 15-17 Nov 2023, CERN

Search for NP in Flavour Physics at the LHC

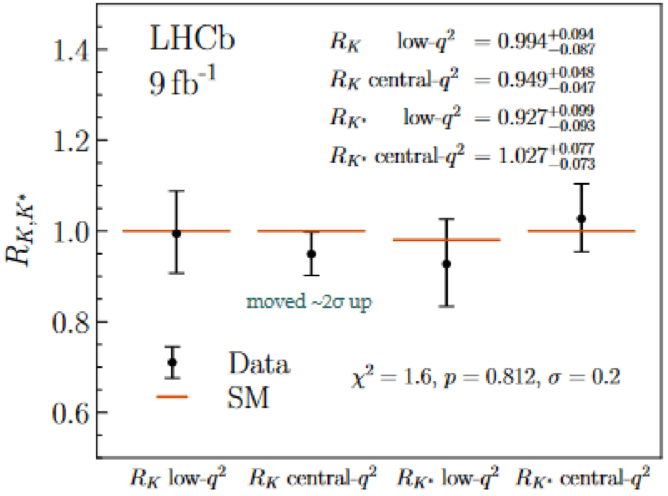
- Look for observables in B physics
  - where a SM precise prediction is available
  - Experimentally acccessible with good accuracy
  - Interpretation of any potential deviation in terms of EFTs
- Three large categories of such observables:
  - CP violation and CKM angles : will not adress these today
  - FCNC decays and in particular $b \rightarrow s\ell^+\ell^-$ transitions
  - **Semileptonic decays and in particular $b \rightarrow c\tau\nu$ transitions**

FCNC decays at the LHC: $b\rightarrow s\ell^+\ell^-$ decays

- Heavily suppressed in the SM: good ground to search for new Physics
- Detailed in Rafael Coutinho's presentation at this workshop
- Several interesting other recent results to be mentioned:

- R(K) from CMS CMS-PAS-BPH-22-005
- $\Lambda_b \rightarrow \Lambda(1520)\mu^+\mu^-$ LHCb-PAPER-2022-050
- $\Lambda_b \rightarrow pK\gamma$ LHCb-ANA-2020-046
- C_7 from $B° \rightarrow K^{*°}e^+e^-$ at low q^2 LHCb-PAPER_2020-020

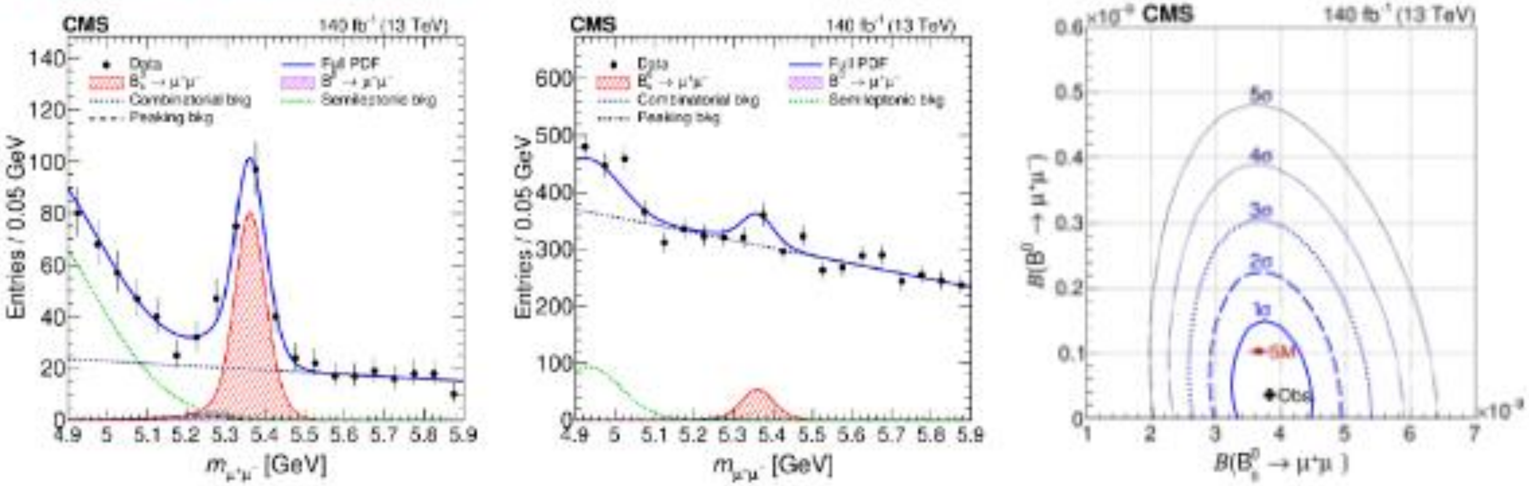
Phys.Rev.D 108 (2023) 3, 032002
Phys.Rev.Lett. 131 (2023) 5, 051803

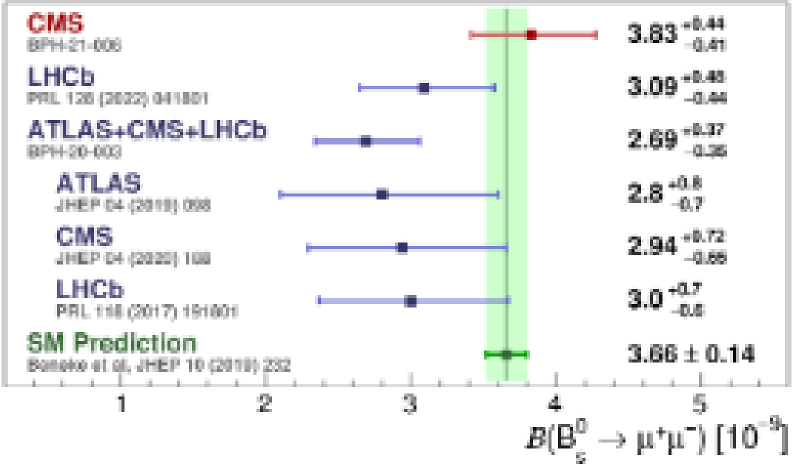


Another important b➔s transition: $B_s \rightarrow \mu^+\mu^-$

Nice BR result from CMS

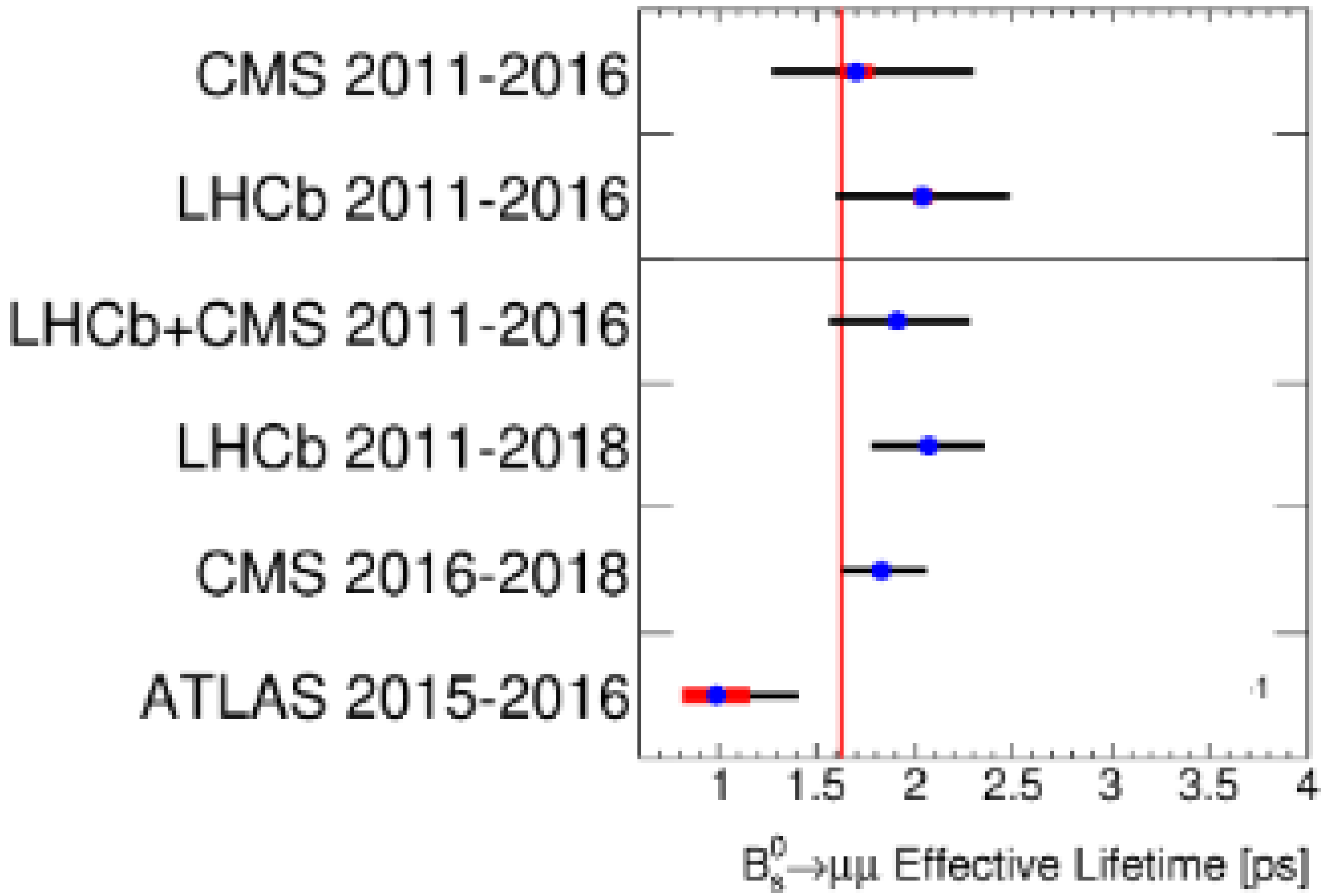
Phys.Lett.B842(2023)137955





- $\mathcal{B}(B_s^0 \to \mu^+\mu^-) = \left[3.83^{+0.38}_{-0.36}(stat)^{+0.19}_{-0.16}(syst)^{+0.14}_{-0.13}(f_s/f_u)\right] \times 10^{-9}$
  - BF can be rescaled with a different f_u/f_s
  - $\mathcal{B}(B_s^0 \to \mu^+\mu^-)$ normalised with $B_s^0 \to J/\psi\phi(1020)$ channel in statistical agreement
- $\mathcal{B}(B^0 \to \mu^+\mu^-) = \left[0.37^{+0.75}_{-0.67}(stat)^{+0.08}_{-0.09}(syst)\right] \times 10^{-10}$
- $\mathcal{B}(B^0 \to \mu^+\mu^-) < 1.9 \times 10^{-10}$ @ 95% CL

$B_s \to \mu^+\mu^-$ lifetimes



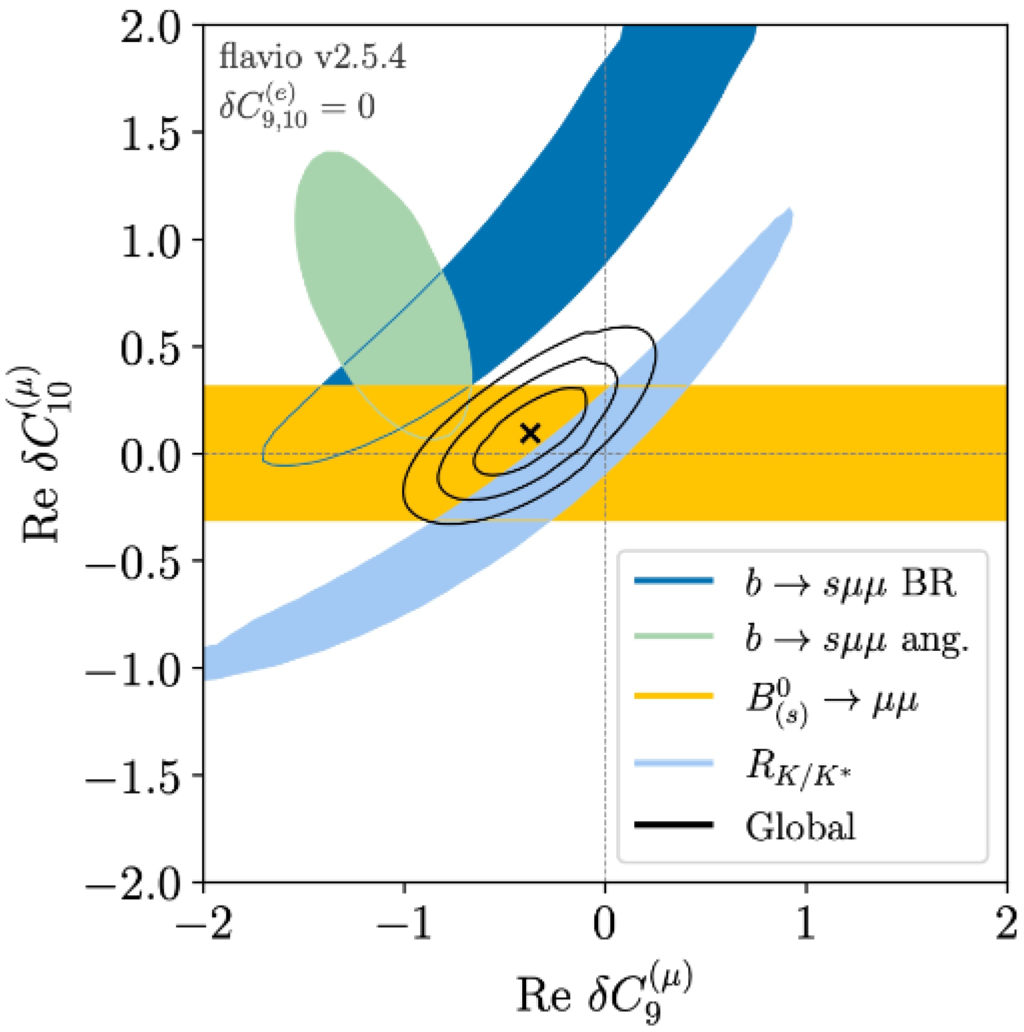
Phys.Lett.B842(2023)137955

PhysRevLett128(2022)041801

JHEP 09 (2023) 199

no NP in electrons

C_9 and C_{10} real



from Camille Normand
PhD thesis (2023)

Disfavours a large shift on C_{10}

Lepton Flavour Universality

- Lepton Flavour Universality is one of many « ad hoc » symmetries and « pillars » of the Standard Model
  - Baryon number, lepton number, (charged) lepton flavour,…
- It postulates that the properties of the three charged leptons (e,μ,τ) are the exactly the same beside their mass.This does not need to be the case in many New Physics models
- First hints of Lepton Flavour Universality violation appeared 10 years ago with BABAR publication regarding semi-tauonic B decays. This field became « the hottest game » in town with results coming both from charged and neutral currents

R(D$^{(*)}$) measurements in LHCb

$R(D) = BR(B \to D\tau\nu) / BR(B \to D\mu\nu)$

$\tau^- \to \mu^- \nu_\tau \nu_\mu$

- Pros
  - Direct measurement of R(D,D*)
  - High statistics
- Cons
  - Double charm background control must be very good (mostly D^+)
  - Sensitive to D** $\mu^- \nu_\mu$

$\tau^- \to \pi^- \pi^+ \pi^- (\pi^0) \nu_\tau$

- Pros
  - The possibility to measure the τ vertex is the key to reject the background and obtain a high purity sample
  - The 3π dynamics of the τ decay is very specific : possible to distinguish τ decays from the main double charm background from D_s decays
- Cons
  - Access to R(D) requires an external BR
  - Lower statistics

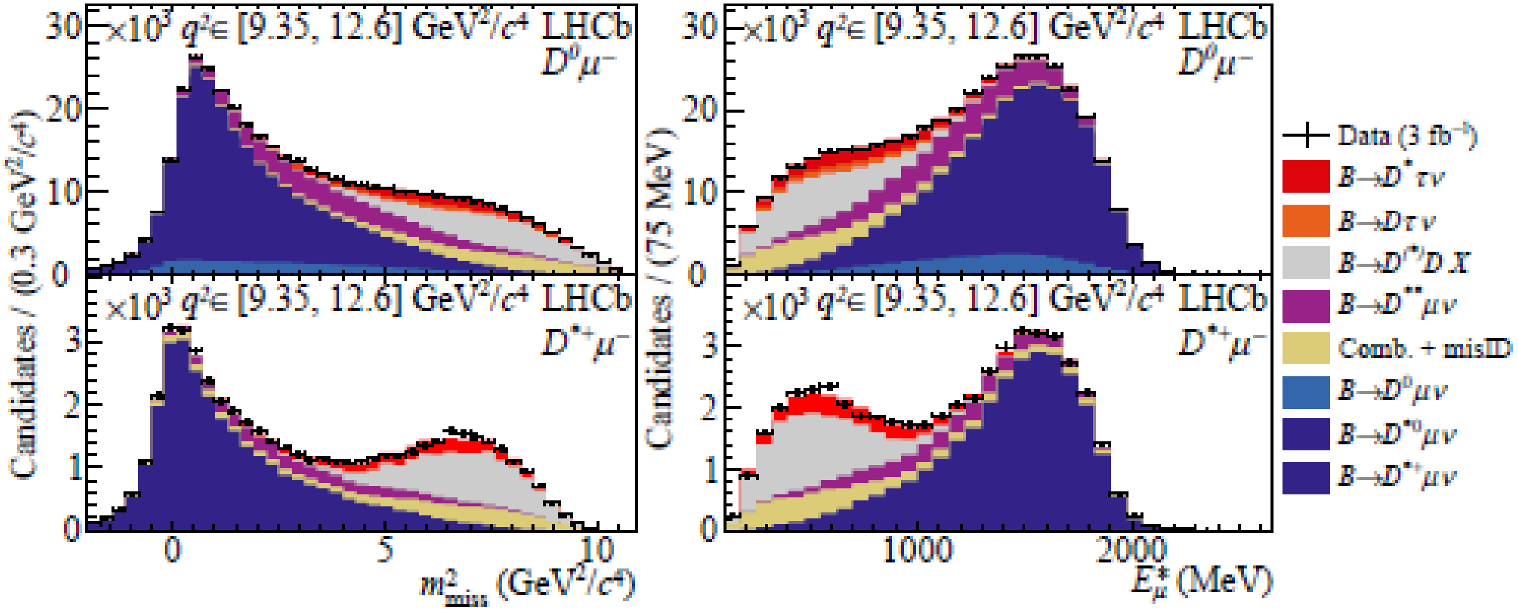
$R(D^{(*)})$ with muonic τ decays

[arXiv:2302.02886] (Submitted to PRL)

- Simultaneous measurement of $R(D)$ and $R(D^*)$ with Run 1 data using muonic $\tau^+ \to \mu^+ \nu_\mu \bar{\nu}_\tau$

3D template fit to

- $q^2 \equiv (p_B - p_{D^{(*)}})^2$
- $m^2_{\text{miss}} \equiv (p_B - p_{D^{(*)}} - p_\mu)^2$
- E^*_μ energy of μ

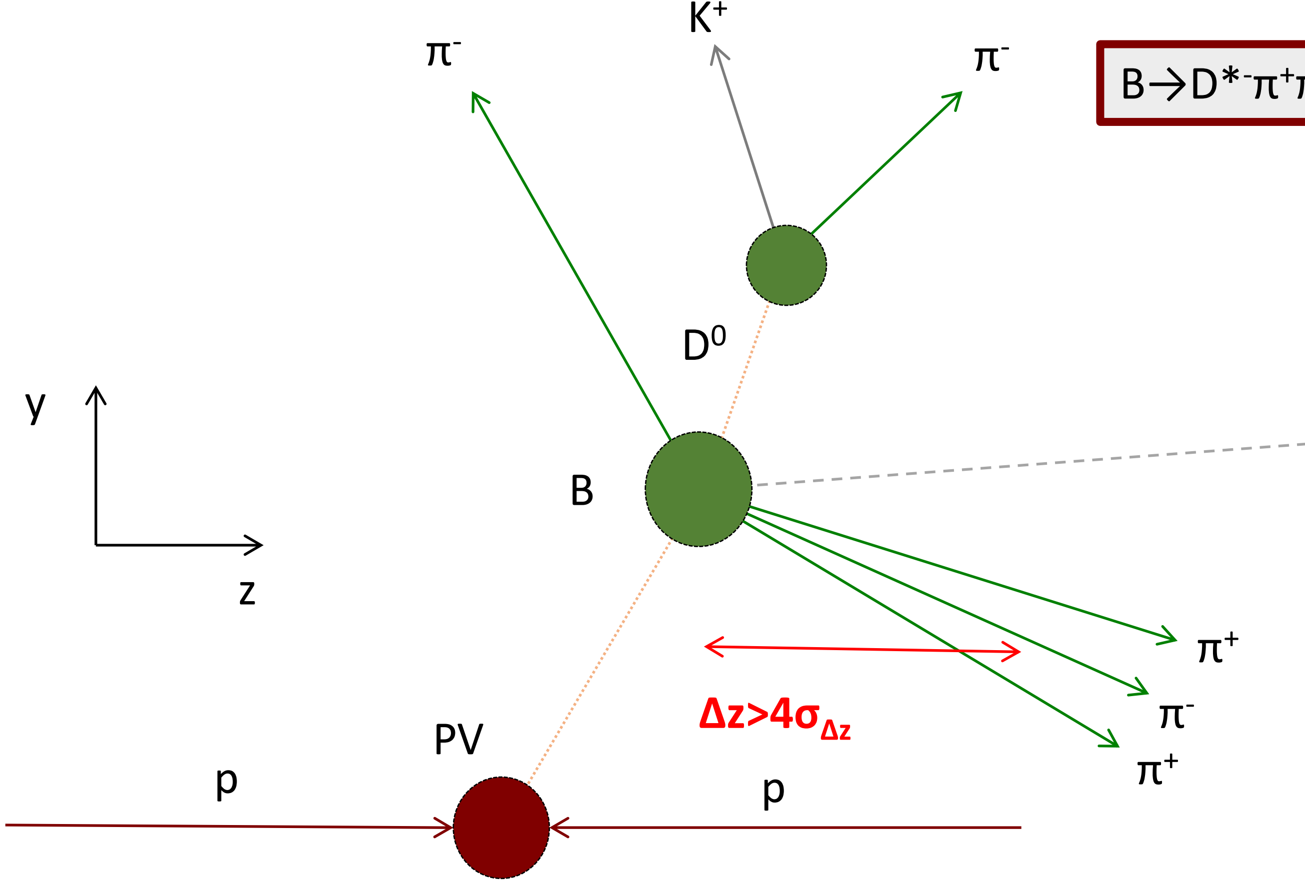


$$R(D) = 0.441 \pm 0.060(\text{stat}) \pm 0.066(\text{syst})$$
$$R(D^*) = 0.281 \pm 0.018(\text{stat}) \pm 0.023(\text{syst})$$

Agreement with SM at 1.9σ

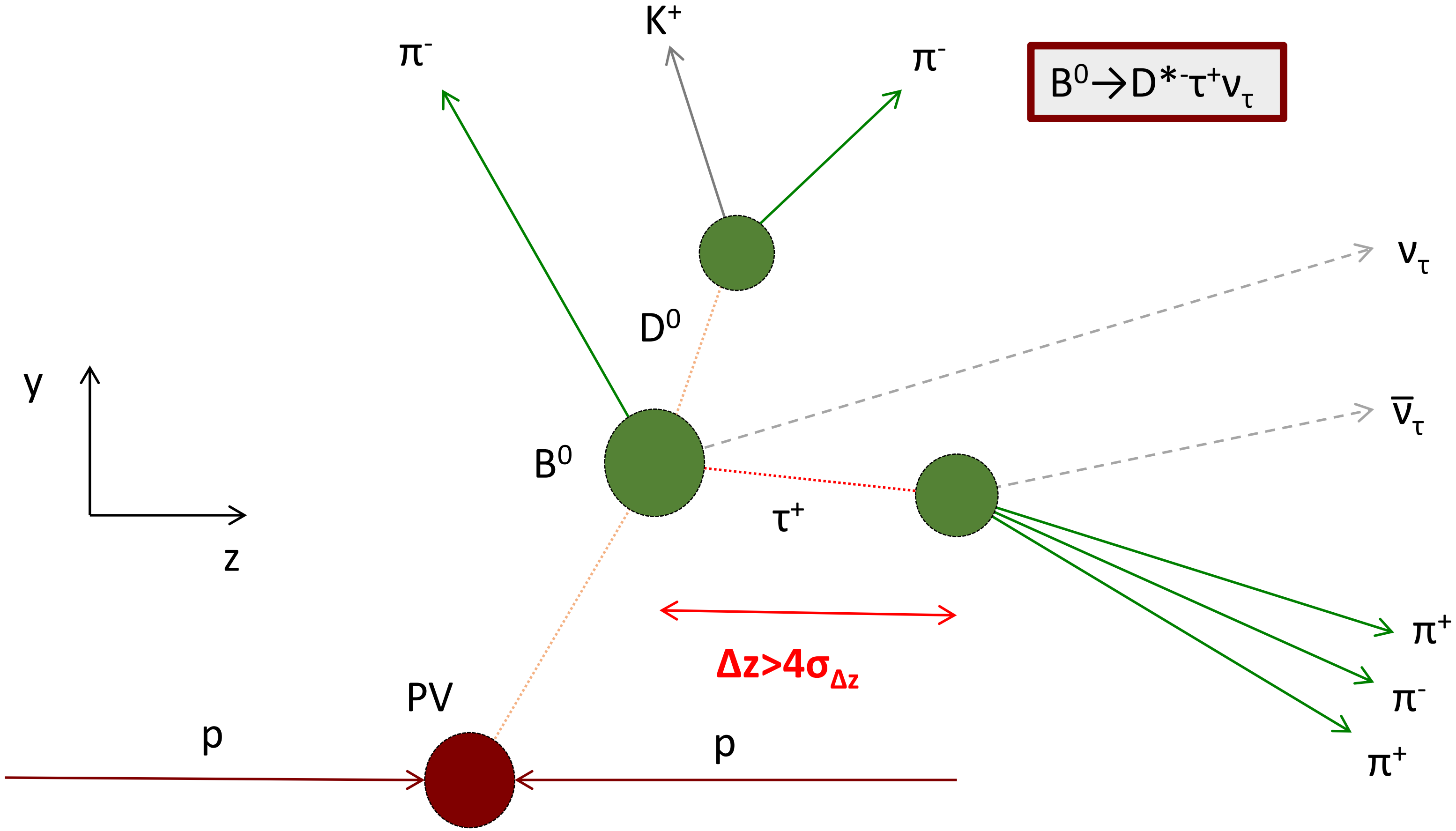
R(D*) measurement with hadronic τ decays

Vertex topology of the usual B decay
100 times larger than the signal



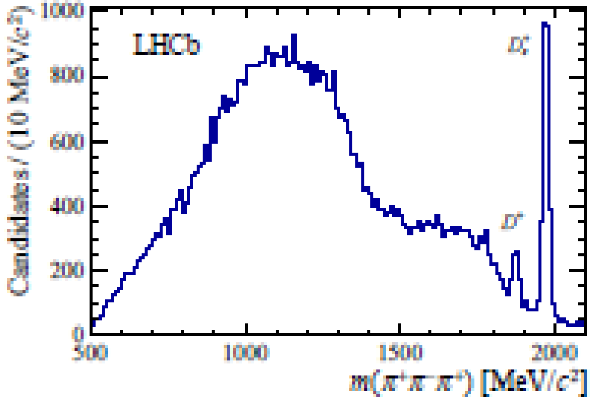
$B \rightarrow D^{*-}\pi^+\pi^-\pi^+(+X)$

Selection: detached vertex

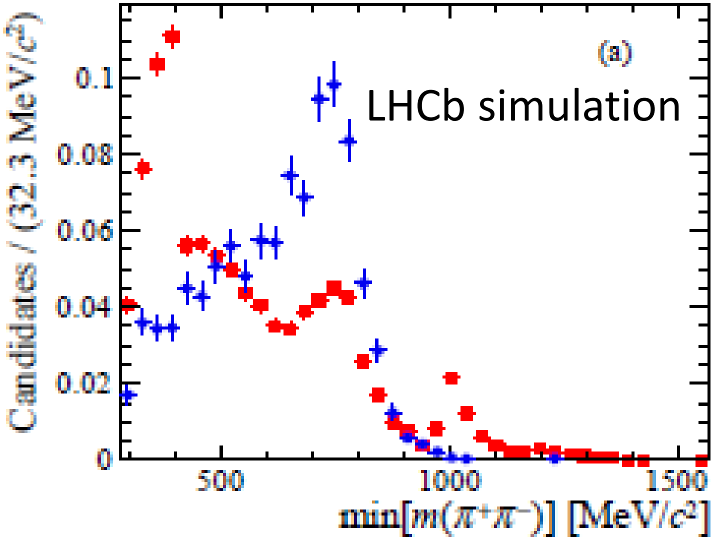


Double-charm backgrounds

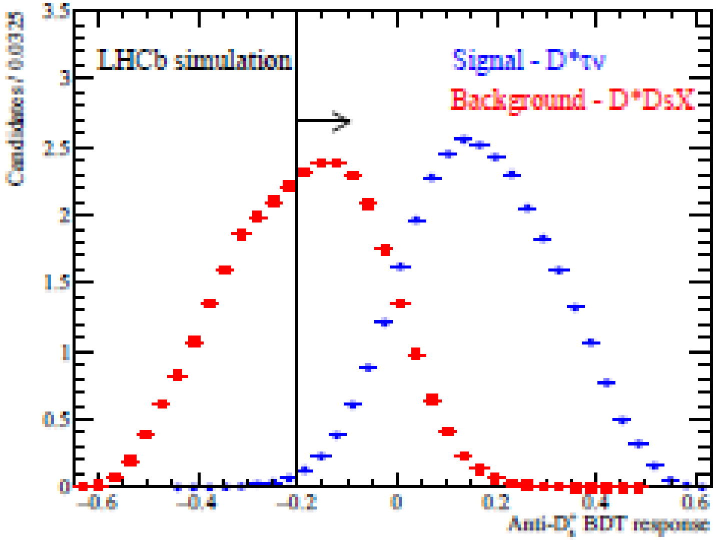
- $B \to D^{*-}(D_s^+, D^+, D^0)X$ backgrounds
- $B \to D^{*-}D_s^+X$ the largest contributor
- A BDT classifier based on kinematics and resonant structure to separate signal from $B \to D^{*-}D_s^+X$



[PRD 97, 072013 (2018)]



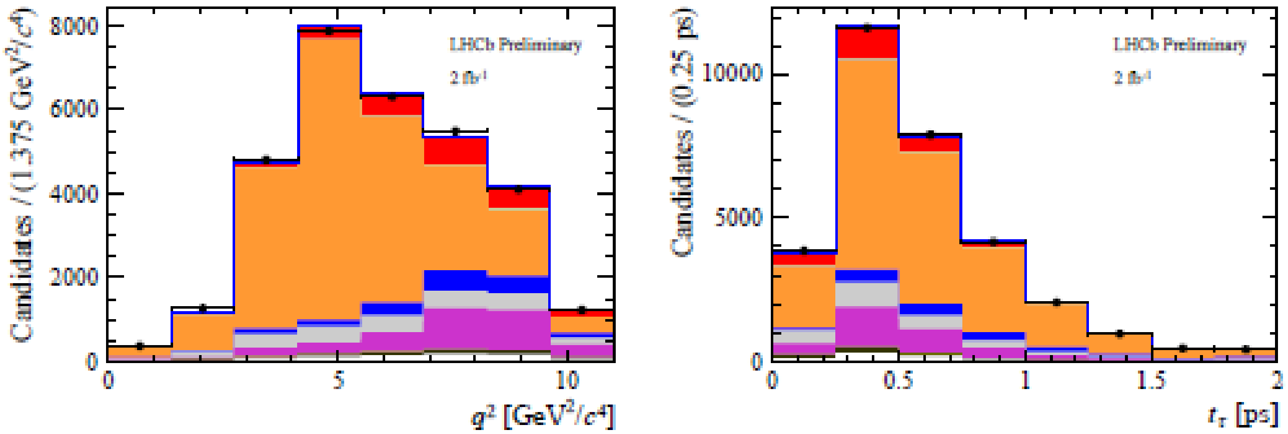
[PRD 97, 072013 (2018)]



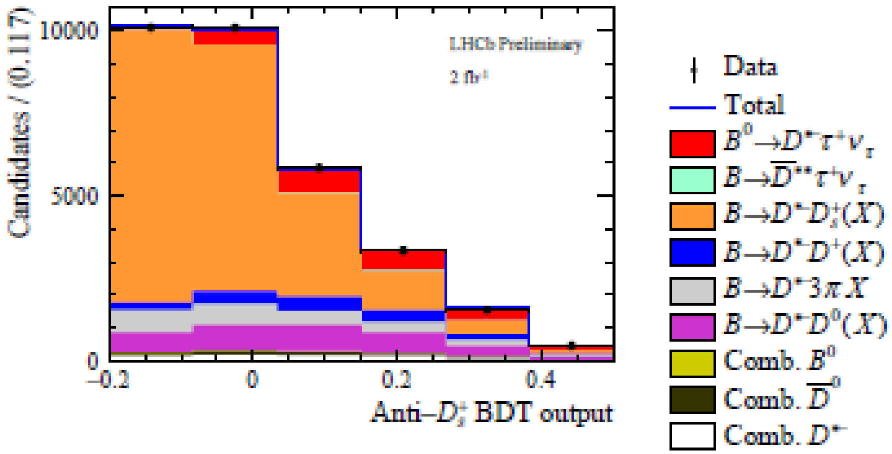
BR(D_s→3πX)=32.8% ± 0.9%
BES-III arxiv:2212.13072

- This BDT output is one of the fit variables for signal extraction

Signal extraction



LHCb-PAPER-2022-052
arxiv:2305.01463

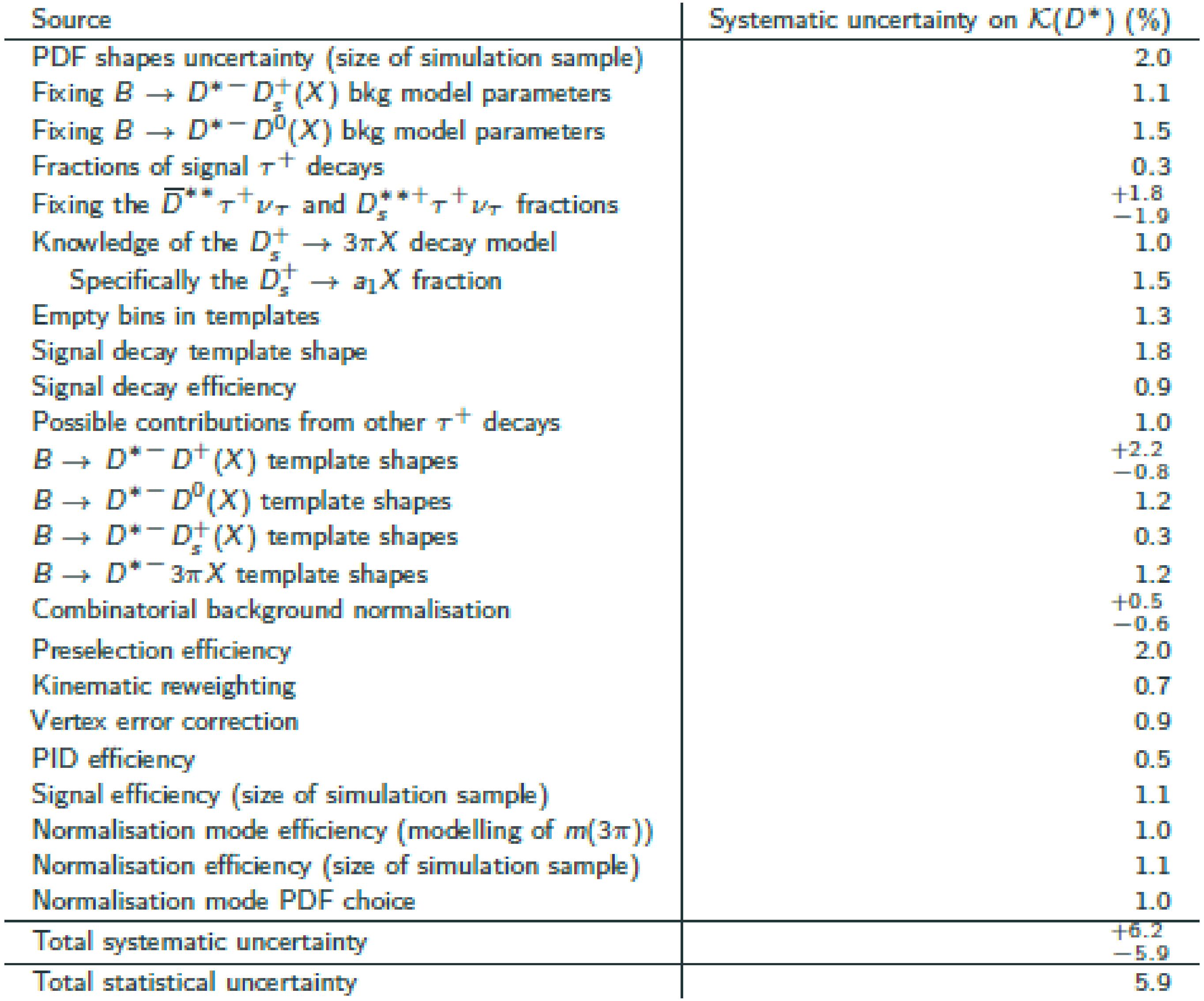


$$N(B^0 \to D^{*-}\tau^+\nu_\tau) = 2469 \pm 154$$

Run 1 yield = 1296 ± 86

- Larger dataset
- Improved selection

Systematic uncertainties



Source	Systematic uncertainty on $\mathcal{K}(D^*)$ (%)
PDF shapes uncertainty (size of simulation sample)	2.0
Fixing $B \to D^{*-} D_s^+(X)$ bkg model parameters	1.1
Fixing $B \to D^{*-} D^0(X)$ bkg model parameters	1.5
Fractions of signal τ^+ decays	0.3
Fixing the $\overline{D}^{**}\tau^+\nu_\tau$ and $D_s^{**+}\tau^+\nu_\tau$ fractions	$^{+1.8}_{-1.9}$
Knowledge of the $D_s^+ \to 3\pi X$ decay model	1.0
Specifically the $D_s^+ \to a_1 X$ fraction	1.5
Empty bins in templates	1.3
Signal decay template shape	1.8
Signal decay efficiency	0.9
Possible contributions from other τ^+ decays	1.0
$B \to D^{*-} D^+(X)$ template shapes	$^{+2.2}_{-0.8}$
$B \to D^{*-} D^0(X)$ template shapes	1.2
$B \to D^{*-} D_s^+(X)$ template shapes	0.3
$B \to D^{*-} 3\pi X$ template shapes	1.2
Combinatorial background normalisation	$^{+0.5}_{-0.6}$
Preselection efficiency	2.0
Kinematic reweighting	0.7
Vertex error correction	0.9
PID efficiency	0.5
Signal efficiency (size of simulation sample)	1.1
Normalisation mode efficiency (modelling of $m(3\pi)$)	1.0
Normalisation efficiency (size of simulation sample)	1.1
Normalisation mode PDF choice	1.0
Total systematic uncertainty	$^{+6.2}_{-5.9}$
Total statistical uncertainty	5.9

LHCb-PAPER-2022-052
arxiv:2305.01463

$R(D^*)$ with hadronic τ decays

$$\mathcal{K}(D^*) = \frac{\mathcal{B}(B^0 \to D^{*-}\tau^+\nu_\tau)}{\mathcal{B}(B^0 \to D^{*-}3\pi^\pm)} = 1.700 \pm 0.101(\mathrm{stat})^{+0.105}_{-0.100}(\mathrm{syst})$$

- The absolute branching fraction of $B^0 \to D^{*-}\tau^+\nu_\tau$ decays

$$\boldsymbol{\mathcal{B}(B^0 \to D^{*-}\tau^+\nu_\tau) = (1.23 \pm 0.07\,(\mathrm{stat}) \pm 0.08\,(\mathrm{syst}) \pm 0.05(\mathrm{ext})) \times 10^{-2}}$$

$$R(D^*) = \mathcal{K}(D^*)\frac{\mathcal{B}(B^0 \to D^{*-}3\pi^\pm)}{\mathcal{B}(B^0 \to D^{*-}\mu^+\nu_\mu)}$$

- The BFs of $B^0 \to D^{*-}3\pi^\pm$ and $B^0 \to D^{*-}\mu^+\nu_\mu$ - external inputs

$$\boldsymbol{R(D^*) = 0.247 \pm 0.015(\mathrm{stat}) \pm 0.015(\mathrm{syst}) \pm 0.012(\mathrm{ext})}$$

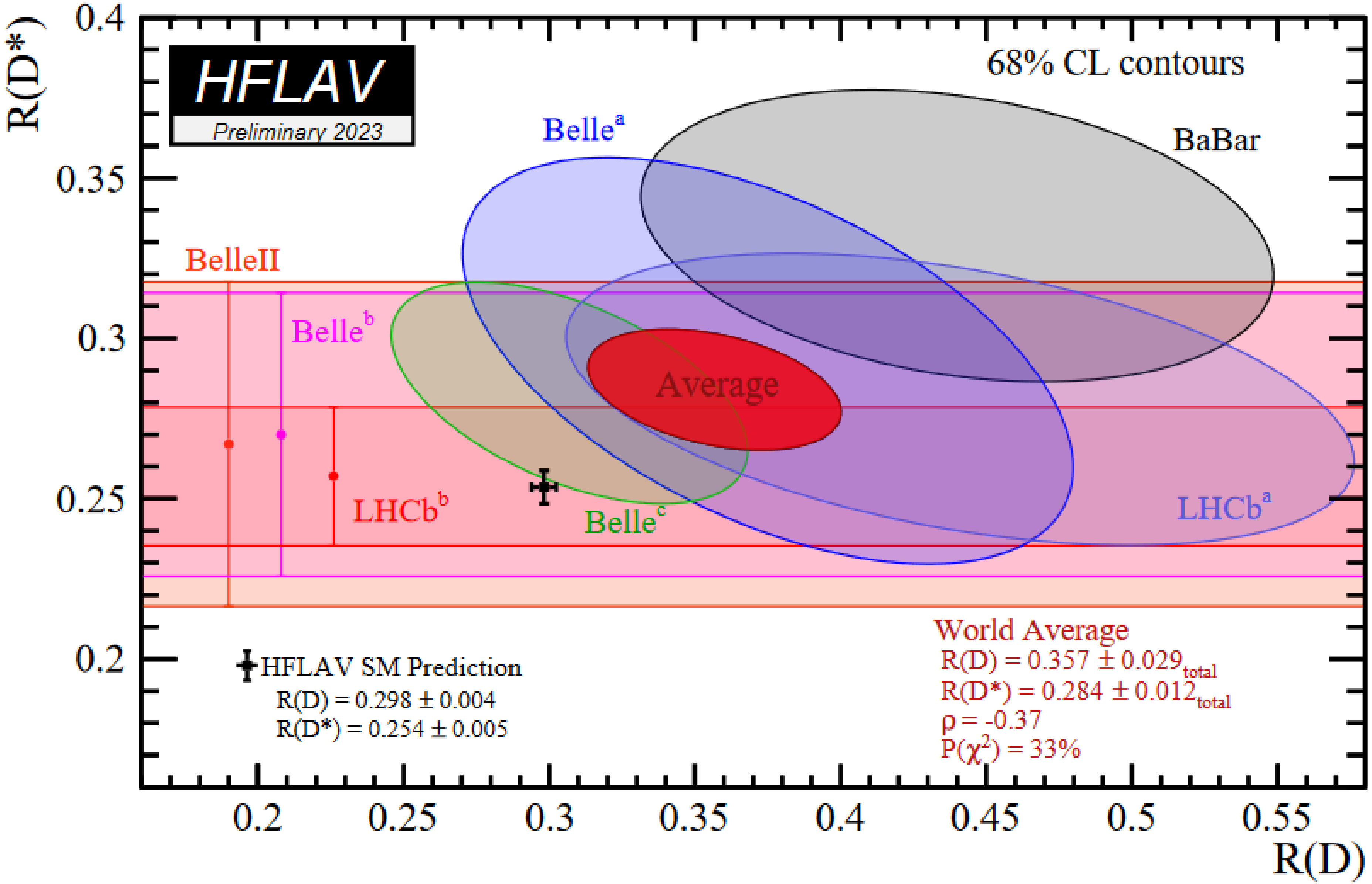
In agreement with Run 1 result

LHCb-PAPER-2022-052
arxiv:2305.01463

- Combining with the Run 1 result

$$\boldsymbol{R(D^*)_{2011-2016} = 0.257 \pm 0.012\,(\mathrm{stat}) \pm 0.014\,(\mathrm{syst}) \pm 0.012\,(\mathrm{ext})}$$

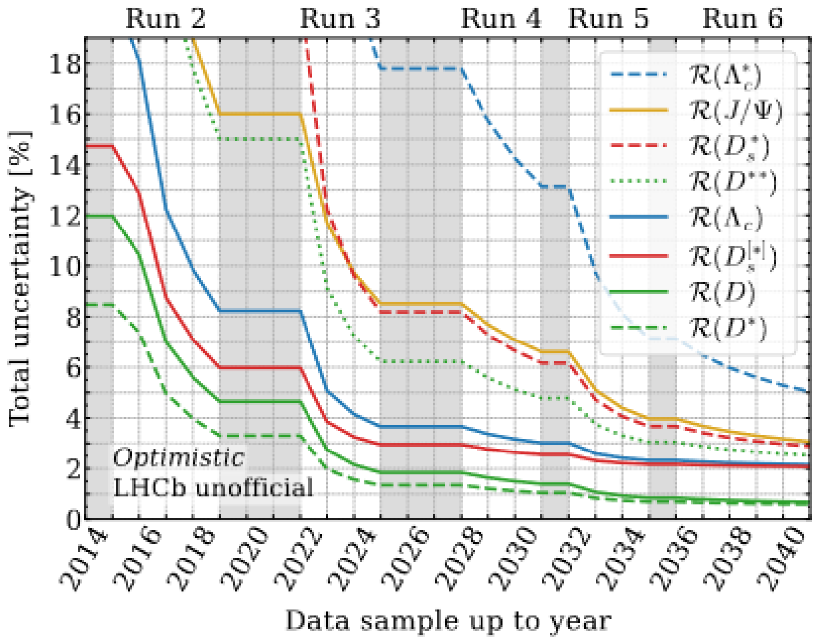
Agreement within 1σ to SM $R(D^*)_{\mathrm{SM}} = 0.254 \pm 0.005$ [HFLAV]



Deviation from SM : 3.3 σ

Semitauonic prospects in LHCb

- Many more semitauonic results expected soon using the muonic and hadronic τ decay channel :
  - $\mathcal{R}(D^*)$, $R(D^\circ)$, $R(D^+)$ using the full Run2 data
  - $\mathcal{R}(D^+)$
- Work is also ongoing on $\mathcal{R}(D_s)$, $\mathcal{R}(J/\psi)$, full angular analysis



Rev. Mod. Phys. 94, 015003 (2022)

D* polarization LHCb-PAPER-2023-020 arXiv:2311.05224

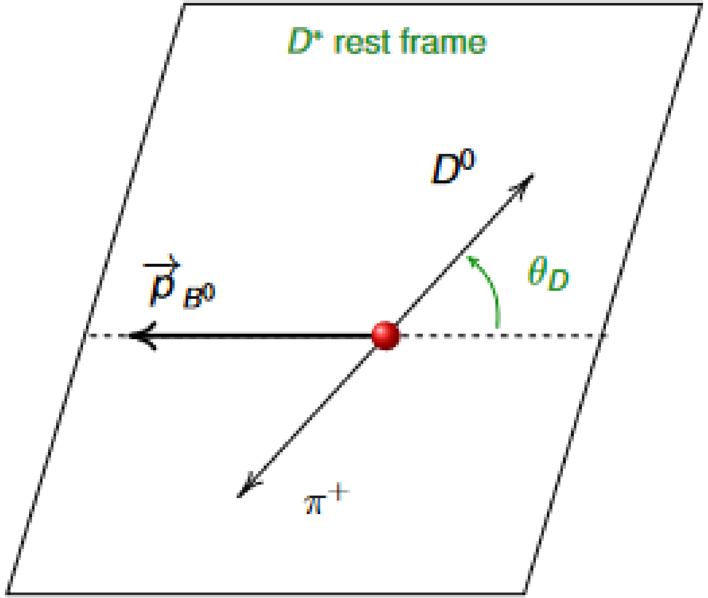
- Measurement of the longitudinal D^* polarization can provide complementary information to $R(D^*)$, showing NP contribution even if $R(D^*)$ is found compatible with SM expectation

- The differential decay rate can be expressed as 2° polynomial in $\cos\theta_D$:

$$\frac{d^2\Gamma}{dq^2 d\cos\theta_D} = a_{\theta_D}(q^2) + c_{\theta_D}(q^2)\cos^2\theta_D$$

  - D^* longitudinal polarization fraction as function of $a_{\theta_D}(q^2)$ and $c_{\theta_D}(q^2)$:

$$F_L^{D^*}(q^2) = \frac{a_{\theta_D}(q^2) + c_{\theta_D}(q^2)}{3a_{\theta_D}(q^2) + c_{\theta_D}(q^2)}$$



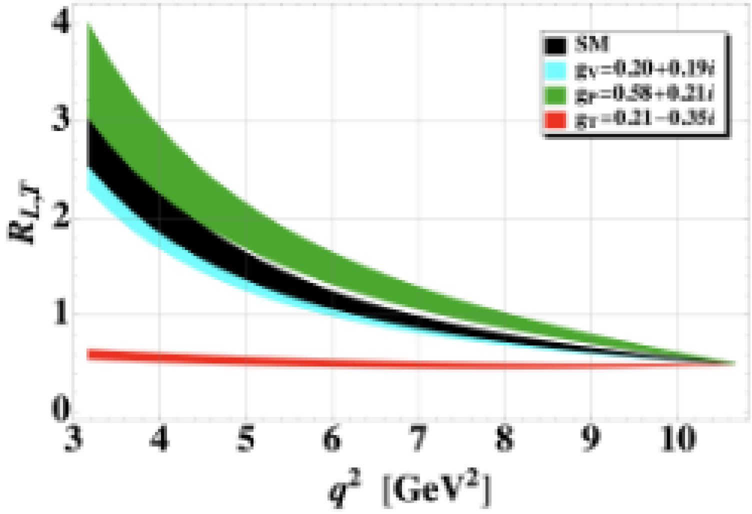
- State of art is determined by Belle results:

$$F_L^{D^*} = 0.60 \pm 0.08 \pm 0.04$$

axXiv:1903.03102

D* polarization and NP

- $F_L^{D^*}$ value within the SM scenario has been predicted with different methods
- The most recent theoretical predictions are:
  - 0.441 ± 0.006 arXiv:1808.03565 *Zhuo-Ran Huang, Ying Li, Cai-Dian Lu, M. Ali Paracha, Chao Wang*
  - 0.457 ± 0.010 arXiv:1805.08222 *Srimoy Bhattacharya, Soumitra Nandi, Sunando Kumar Patra*
- Predictions for NP scenarios can be found in arXiv:1907.02257
  Damir Becirevic, Marco Fedele, Ivan Nisandzic, Andrey Tayduganovd



arXiv:1907.02257

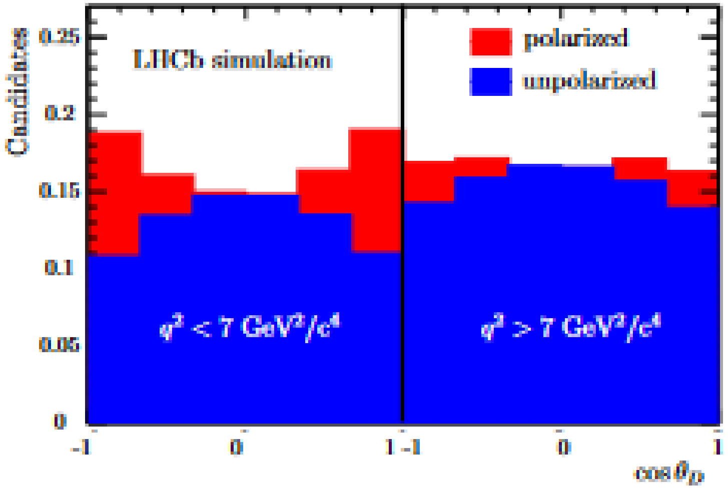
- Expected dependence of $R_{L,T}$ as function of q^2 for three NP models

$$R_{L,T}(q^2) = \frac{d\Gamma_L/dq^2}{d\Gamma_T/dq^2}$$

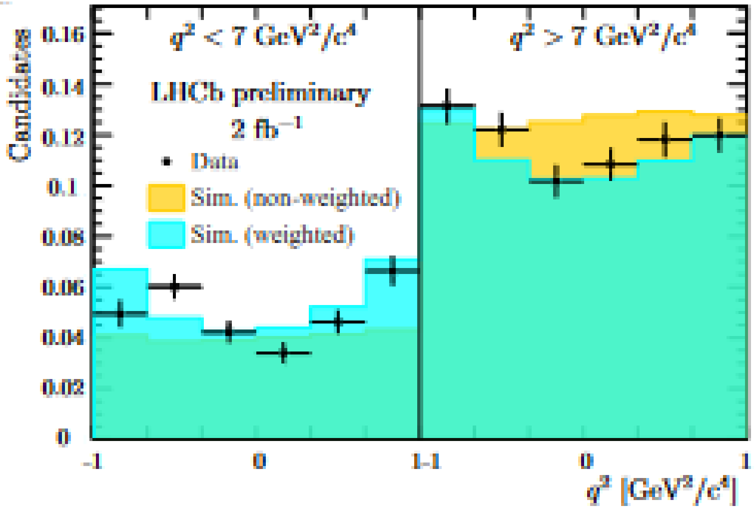
$$F_L^{D^*}(q^2) = \frac{R_{L,T}(q^2)}{1+R_{L,T}(q^2)}$$

LHCb-PAPER-2023-020 arXiv:2311.05224

- $F_L^{D^*}$ determined in two q^2 regions: $\lessgtr 7\ \mathrm{GeV}^2/c^4$
- $F_L^{D^*}$ is extracted from $a_{\theta_D}(q^2)$ and $c_{\theta_D}(q^2)$, determined splitting the signal sample in:
  - **unpolarized** $\Longrightarrow N_{sig}^{unpol} \propto a_{\theta_D}(q^2)$
  - **polarized** $\Longrightarrow N_{sig}^{pol} \propto c_{\theta_D}(q^2)$
- $\cos\theta_D$ signal distribution corrected for reconstruction effect

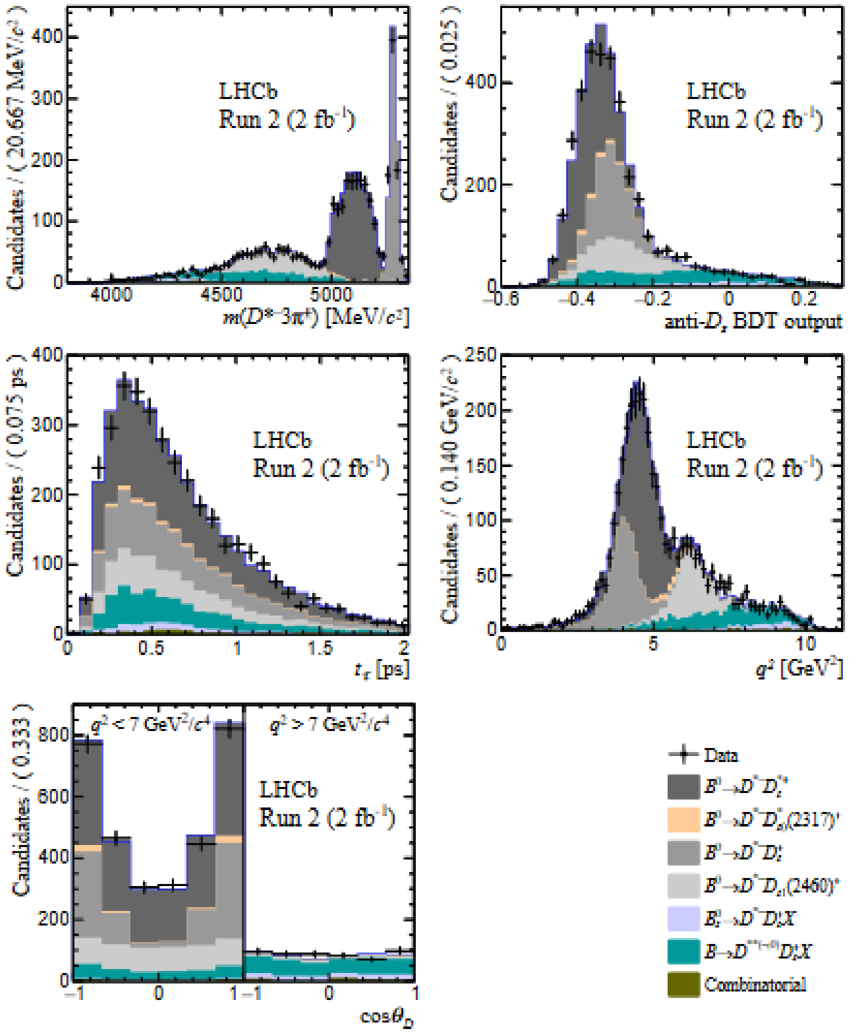


- $D^{*-}DX$ background templates determined from simulation
- Assuming no $F_L^{D^*}$ dependence on the D meson decay mode
- $\cos\theta_D$ distribution corrected through fully reconstructed control samples:
  - $D_s \to 3\pi^+$
  - $D^+ \to K^- 2\pi^+$
  - $D^0 \to 3\pi^+ K^-$

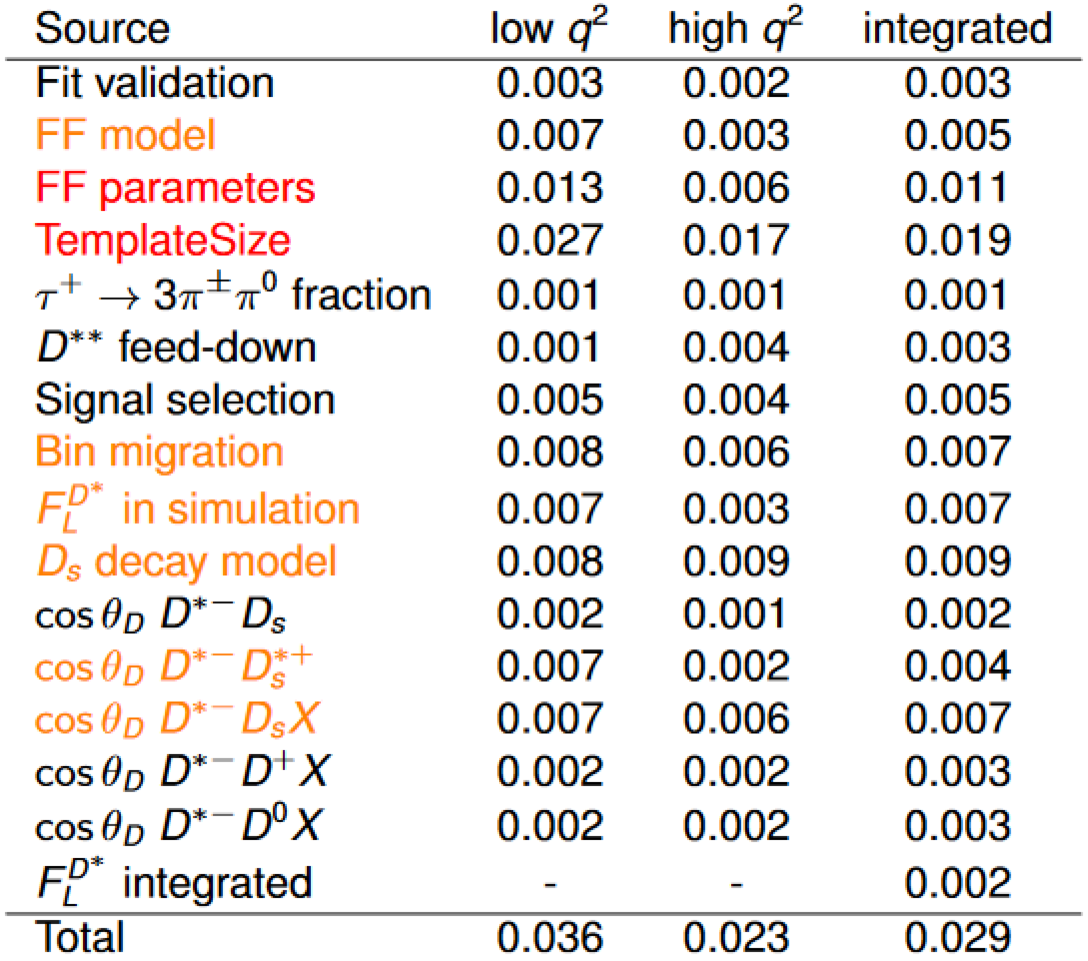


Importance of the $D_s \rightarrow \pi\pi\pi$ control sample

LHCb-PAPER-2023-020 arXiv:2311.05224



Systematic uncertainty



Source	low q^2	high q^2	integrated
Fit validation	0.003	0.002	0.003
FF model	0.007	0.003	0.005
FF parameters	0.013	0.006	0.011
TemplateSize	0.027	0.017	0.019
$\tau^+ \to 3\pi^\pm\pi^0$ fraction	0.001	0.001	0.001
D^{**} feed-down	0.001	0.004	0.003
Signal selection	0.005	0.004	0.005
Bin migration	0.008	0.006	0.007
$F_L^{D^*}$ in simulation	0.007	0.003	0.007
D_s decay model	0.008	0.009	0.009
$\cos\theta_D$ $D^{*-}D_s$	0.002	0.001	0.002
$\cos\theta_D$ $D^{*-}D_s^{*+}$	0.007	0.002	0.004
$\cos\theta_D$ $D^{*-}D_sX$	0.007	0.006	0.007
$\cos\theta_D$ $D^{*-}D^+X$	0.002	0.002	0.003
$\cos\theta_D$ $D^{*-}D^0X$	0.002	0.002	0.003
$F_L^{D^*}$ integrated	-	-	0.002
Total	0.036	0.023	0.029

LHCb-PAPER-2023-020 arXiv:2311.05224

Dominant source of systematic are:

- Limited size of the simulation samples
- Form factor parameterization
- Modelling of the D_s
- $\cos\theta_D$ shape in $D^{*-}D_sX$ backgrounds
- Bin migration
- Signal acceptance
- Form factor model

D* polarization LHCb results

LHCb-PAPER-2023-020 arXiv:2311.05224

- Signal yields from a 4D-binned template fit:
  - τ^+ lifetime (first row)
  - q^2 & $\cos\theta_D$ (second row)
  - anti-D_s BDT output (third row)
- Fit performed simultaneously on Run 1 and Run 2
- Results are integrated over Run 1 and Run 2

$F_L^{D^*}$ value extracted for the 3 q^2 region

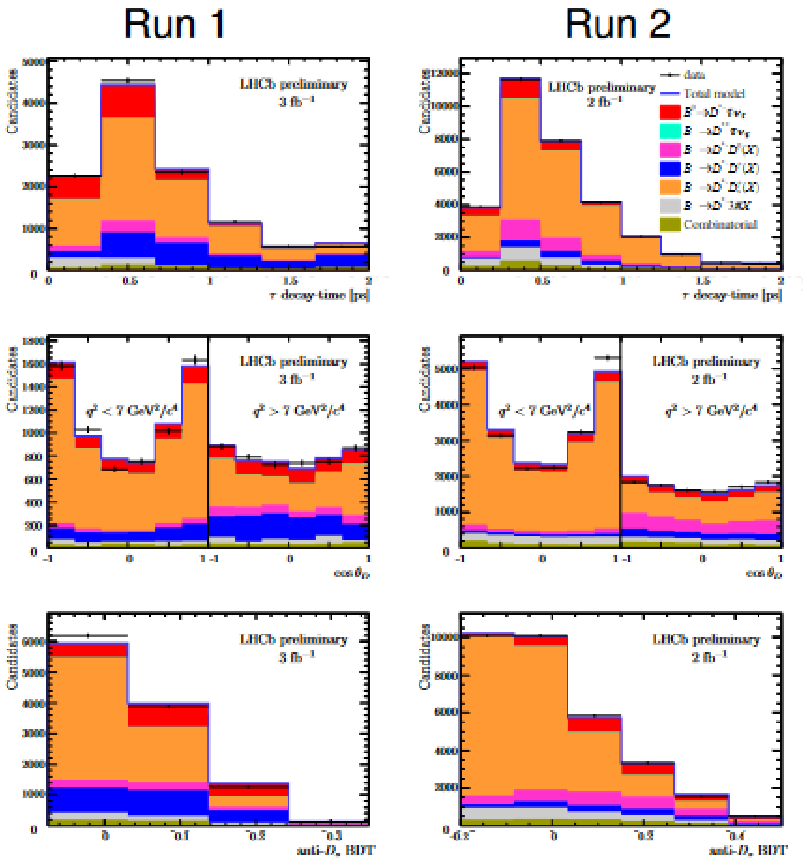
$$q^2 < 7\,\text{GeV}^2/c^4 : \quad 0.51 \pm 0.07(stat) \pm 0.03(syst)$$

$$q^2 > 7\,\text{GeV}^2/c^4 : \quad 0.35 \pm 0.08(stat) \pm 0.02(syst)$$

$$q^2\text{integrated} : \quad 0.43 \pm 0.06(stat) \pm 0.03(syst)$$

- All values are found to be compatible with the SM within 1σ
  - expected value in the integrated region ~ 0.44

[arXiv:1808.03565, arXiv:1805.08222, arXiv:1907.02257]

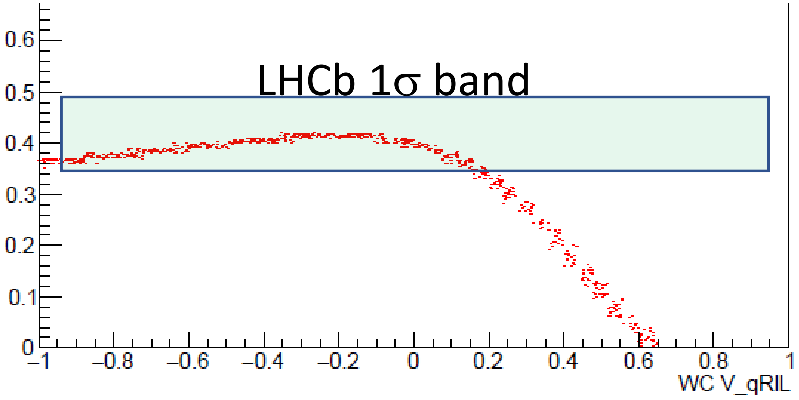


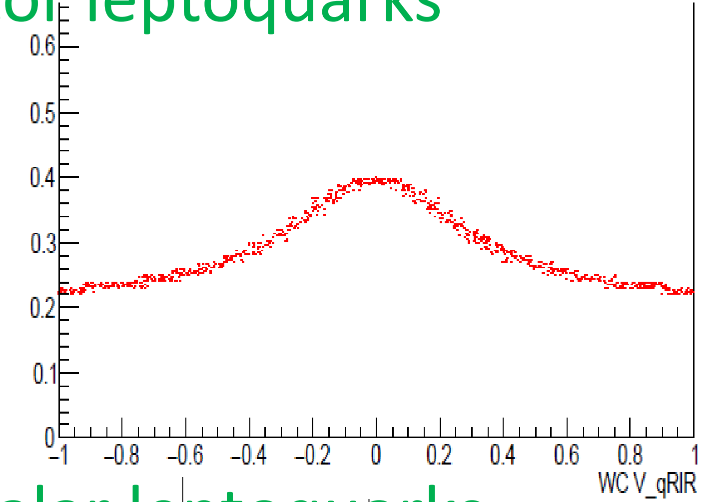
Reminder Belle Unpublished : F_L D*=0.60 ± 0.09 arXiv:1903.03102

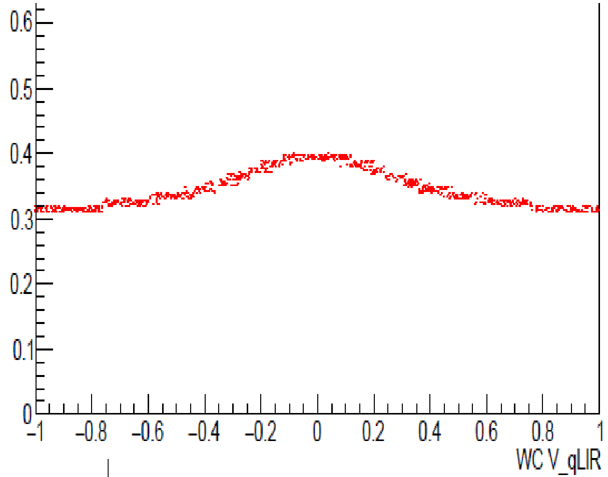
Variation of the D* polarization wrt to Wilson coefficients in leptoquark-based EFTs

based on HAMMER F. Bernlochner et al., *Eur. Phys. J. C* **80**, 883 (2020)

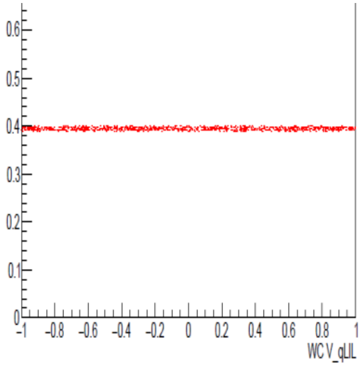
Vector leptoquarks

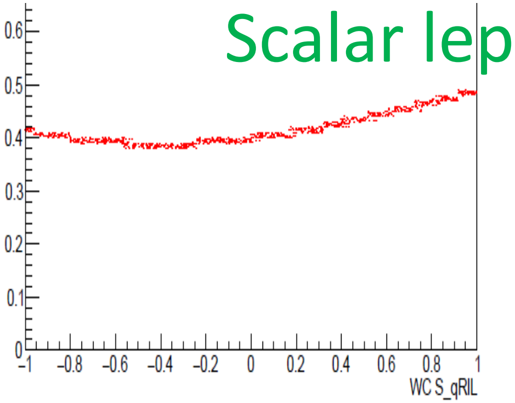

LHCb 1σ band

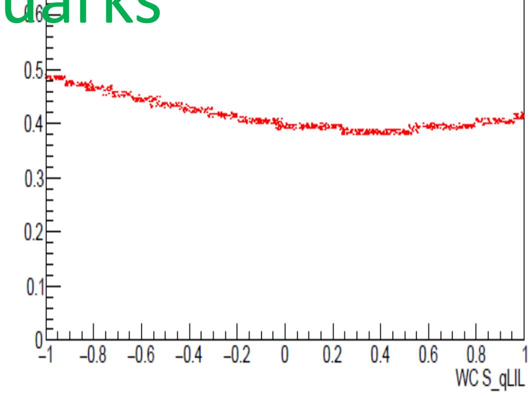




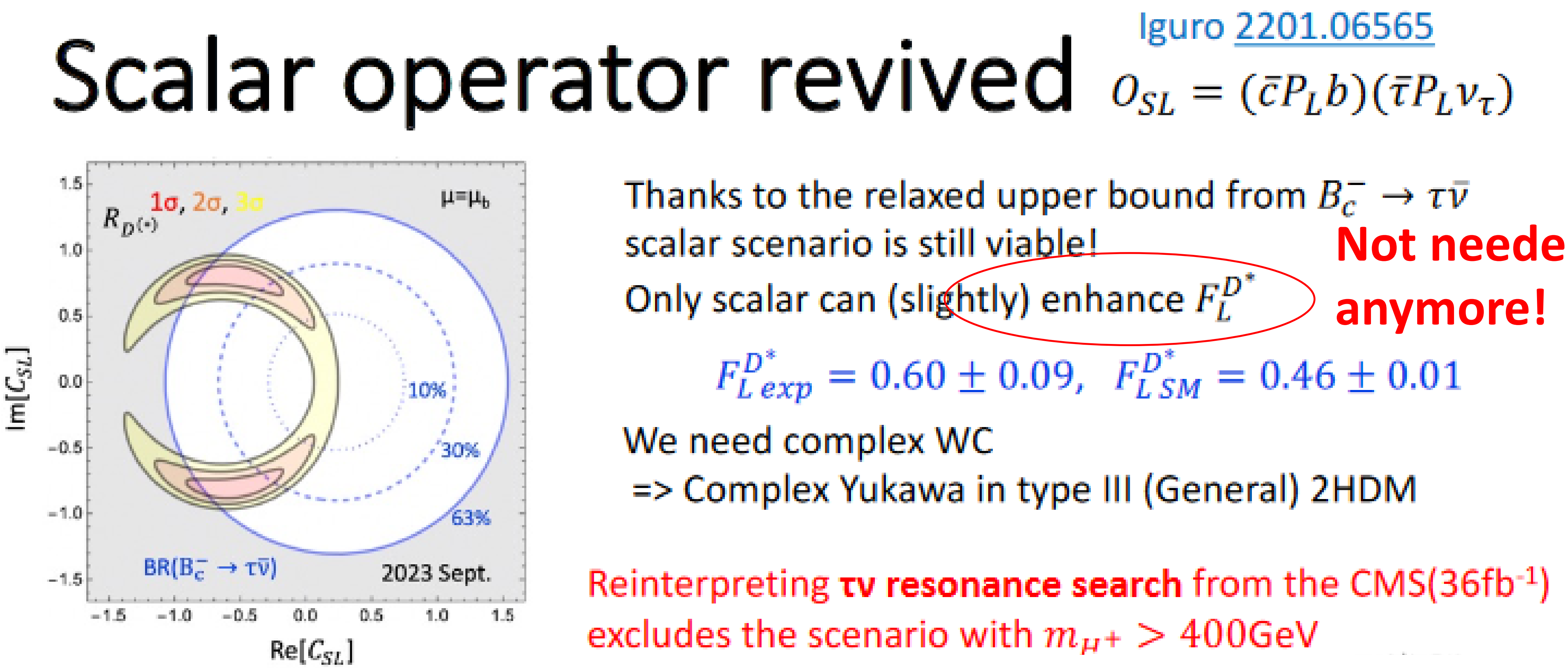
Scalar leptoquarks







Slide from S.Iguro, CKM 2023



Iguro 2201.06565

Scalar operator revived

$O_{SL} = (\bar{c}P_L b)(\bar{\tau}P_L\nu_\tau)$

Thanks to the relaxed upper bound from $B_c^- \to \tau\bar{\nu}$ scalar scenario is still viable!

Only scalar can (slightly) enhance $F_L^{D^*}$

Not needed anymore!

$$F_{L\,exp}^{D^*} = 0.60 \pm 0.09, \quad F_{L\,SM}^{D^*} = 0.46 \pm 0.01$$

We need complex WC

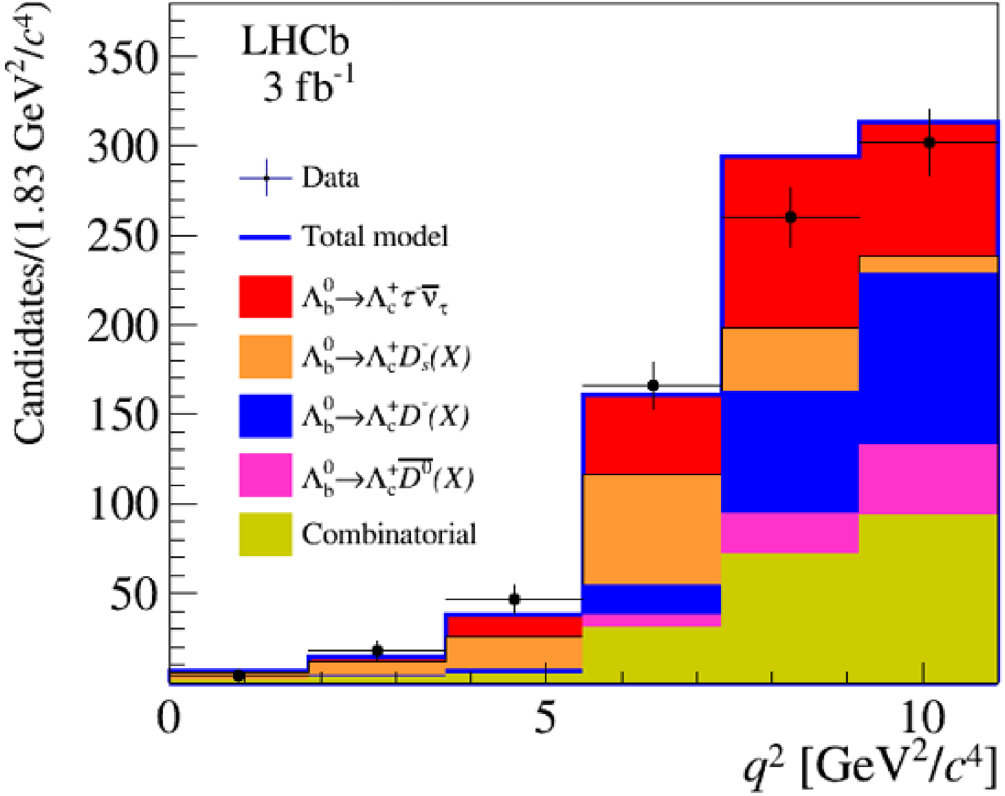
=> Complex Yukawa in type III (General) 2HDM

Reinterpreting **τν resonance search** from the CMS(36fb^{-1}) excludes the scenario with $m_{H^+} > 400$GeV

LHCb measurement of $R(\Lambda_c)$ with hadronic τ decays

LHCb-PAPER-2021-044
arxiv:2201:03497

$\mathcal{R}(\Lambda_c^+)$=0.242 ± 0.026 (stat) ± 0.040 (syst) ± 0.059 (ext)



(SM expectation=0.324 ± 0.004)

F. Bernlochner et al., Physical Review D 99 055008 (2019)
with input from W. Detmold, C. Lehner, S. Meinel,
Physical Review D 92 034503 (2015)

R(Λ_c) measurement in LHCb

$$\mathscr{R}(\Lambda_c) \simeq \mathscr{R}_{\rm SM}(\Lambda_c)\left(0.280\,\frac{\mathscr{R}(D)}{\mathscr{R}_{\rm SM}(D)} + 0.720\,\frac{\mathscr{R}(D^*)}{\mathscr{R}_{\rm SM}(D^*)}\right)$$
$$= \mathscr{R}_{\rm SM}(\Lambda_c)(1.172 \pm 0.038)$$
$$= 0.380 \pm 0.012 \pm 0.005$$

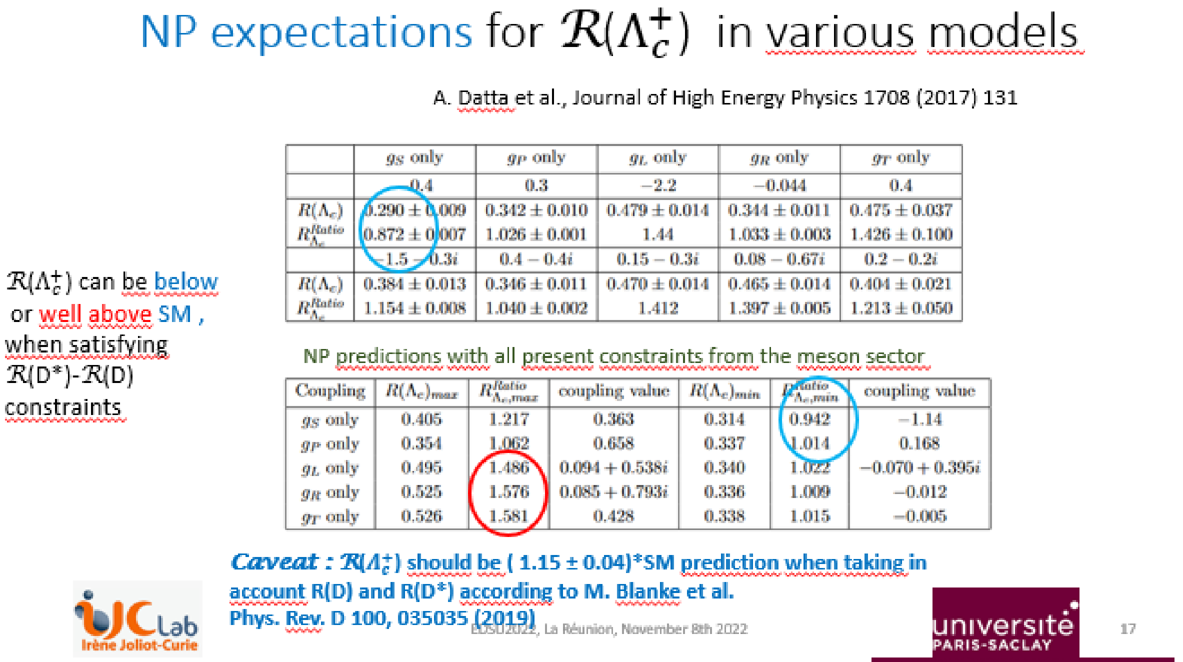
LHCb-PAPER-2021-044
arxiv:2201:03497

$$R(\Lambda_c)_{\rm exp} = 0.242 \pm 0.076$$

to be compared with

$$R(\Lambda_c)_{\rm exp'} = (0.285 \pm 0.073)\left|\frac{0.04}{V_{cb}}\right|^2$$

2211.14172
MF, Blanke, Crivellin, Iguro, Kitahara, Nierste, Watanabe



NP expectations for $\mathcal{R}(\Lambda_c^+)$ in various models

A. Datta et al., Journal of High Energy Physics 1708 (2017) 131

	g_S only	g_P only	g_L only	g_R only	g_T only
	0.4	0.3	-2.2	-0.044	0.4
$R(\Lambda_c)$	0.290 ± 0.009	0.342 ± 0.010	0.479 ± 0.014	0.344 ± 0.011	0.475 ± 0.037
$R^{Ratio}_{\Lambda_c}$	0.872 ± 0.007	1.026 ± 0.001	1.44	1.033 ± 0.003	1.426 ± 0.100
	$-1.5 - 0.3i$	$0.4 - 0.4i$	$0.15 - 0.3i$	$0.08 - 0.67i$	$0.2 - 0.2i$
$R(\Lambda_c)$	0.384 ± 0.013	0.346 ± 0.011	0.470 ± 0.014	0.465 ± 0.014	0.404 ± 0.021
$R^{Ratio}_{\Lambda_c}$	1.154 ± 0.008	1.040 ± 0.002	1.412	1.397 ± 0.005	1.213 ± 0.050

$\mathcal{R}(\Lambda_c^+)$ can be below
or well above SM ,
when satisfying
$\mathcal{R}$(D*)-$\mathcal{R}$(D)
constraints

NP predictions with all present constraints from the meson sector

Coupling	$R(\Lambda_c)_{max}$	$R^{Ratio}_{\Lambda_c,max}$	coupling value	$R(\Lambda_c)_{min}$	$R^{Ratio}_{\Lambda_c,min}$	coupling value
g_S only	0.405	1.217	0.363	0.314	0.942	-1.14
g_P only	0.354	1.062	0.658	0.337	1.014	0.168
g_L only	0.495	1.486	$0.094 + 0.538i$	0.340	1.022	$-0.070 + 0.395i$
g_R only	0.525	1.576	$0.085 + 0.793i$	0.336	1.009	-0.012
g_T only	0.526	1.581	0.428	0.338	1.015	-0.005

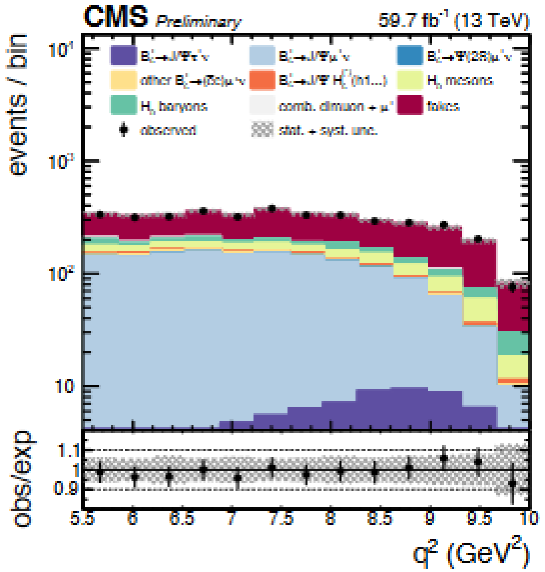
Caveat : $\mathcal{R}(\Lambda_c^+)$ should be (1.15 ± 0.04)*SM prediction when taking in account R(D) and R(D*) according to M. Blanke et al.
Phys. Rev. D 100, 035035 (2019)

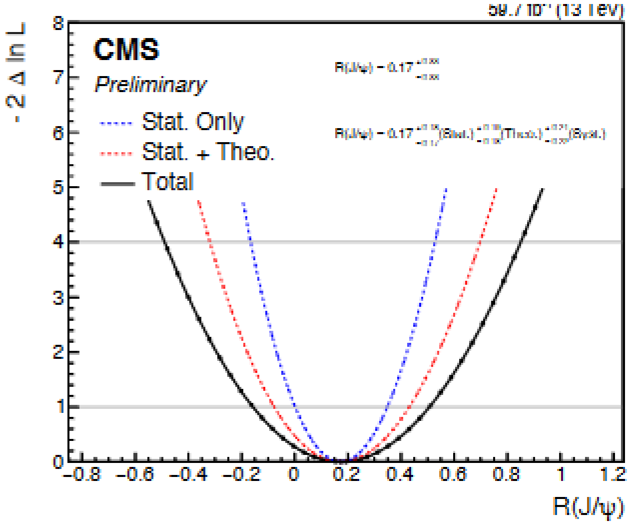
EDSU2022, La Réunion, November 8th 2022

17

R(J/ψ) in CMS

CMS-PAS-BPH-22-012





$$R(J/\psi) = 0.17\,^{+0.18}_{-0.17}\,(\text{stat.})\,^{+0.19}_{-0.19}\,(\text{theo.})\,^{+0.21}_{-0.22}\,(\text{syst.})$$

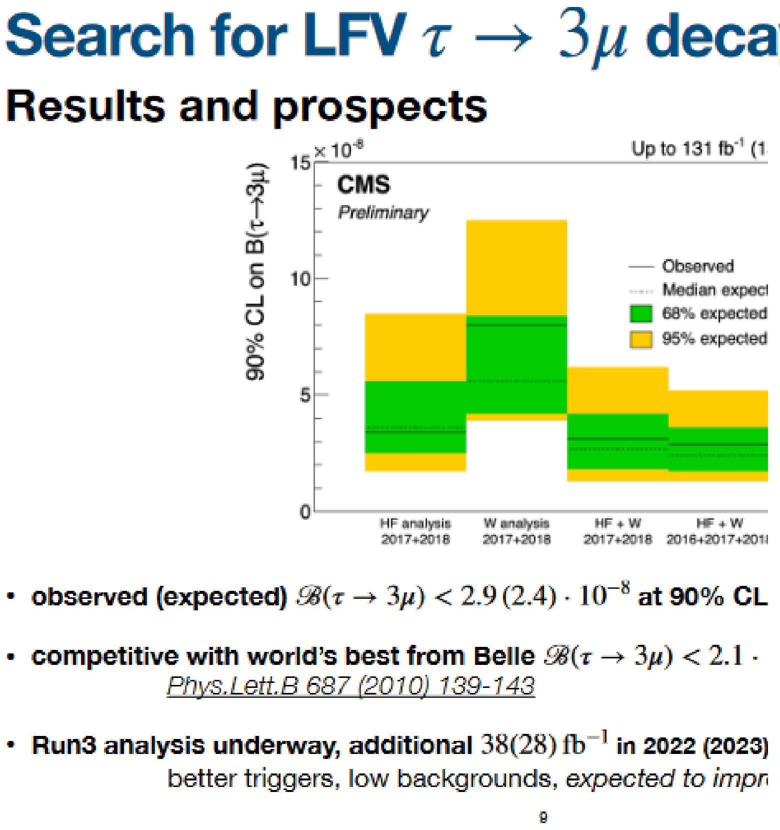
$$R(J/\psi) = 0.17 \pm 0.33$$

Reminder LHCb-PAPER-2017-035

$$\mathcal{R}(J/\psi) = \frac{\mathcal{B}(B_c^+ \to J/\psi\,\tau^+\nu_\tau)}{\mathcal{B}(B_c^+ \to J/\psi\,\mu^+\nu_\mu)} = 0.71 \pm 0.17\,(\text{stat}) \pm 0.18\,(\text{syst})$$

Search for Lepton Number Violation

CMS-PAS-BPH-21-005



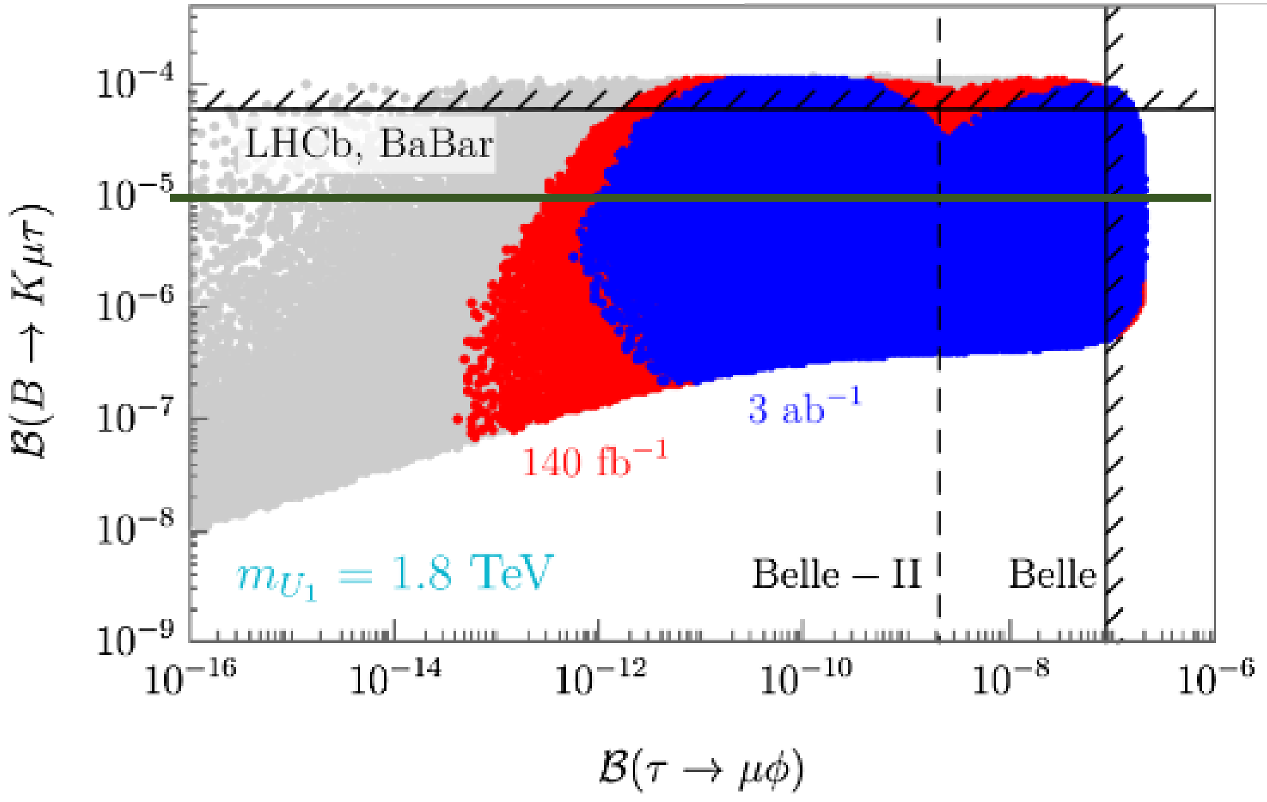
Search for LFV $\tau \to 3\mu$ decays

Results and prospects

- observed (expected) $\mathscr{B}(\tau \to 3\mu) < 2.9\,(2.4) \cdot 10^{-8}$ at 90% CL
- competitive with world's best from Belle $\mathscr{B}(\tau \to 3\mu) < 2.1 \cdot$
  Phys.Lett.B 687 (2010) 139-143
- Run3 analysis underway, additional $38(28)\ \mathrm{fb}^{-1}$ in 2022 (2023)
  better triggers, low backgrounds, *expected to impr*

LHCb BR(B°➔K*μτ)<10^{-5} **LHCb-PAPER-2022-021**
BELLE BR(B^+➔Kμτ)<0.6 10^{-5} **Phys. Rev. Lett. 130, 261802**

A. Angelescu et al. PHYSICAL REVIEW D **104**, 055017 (2021)

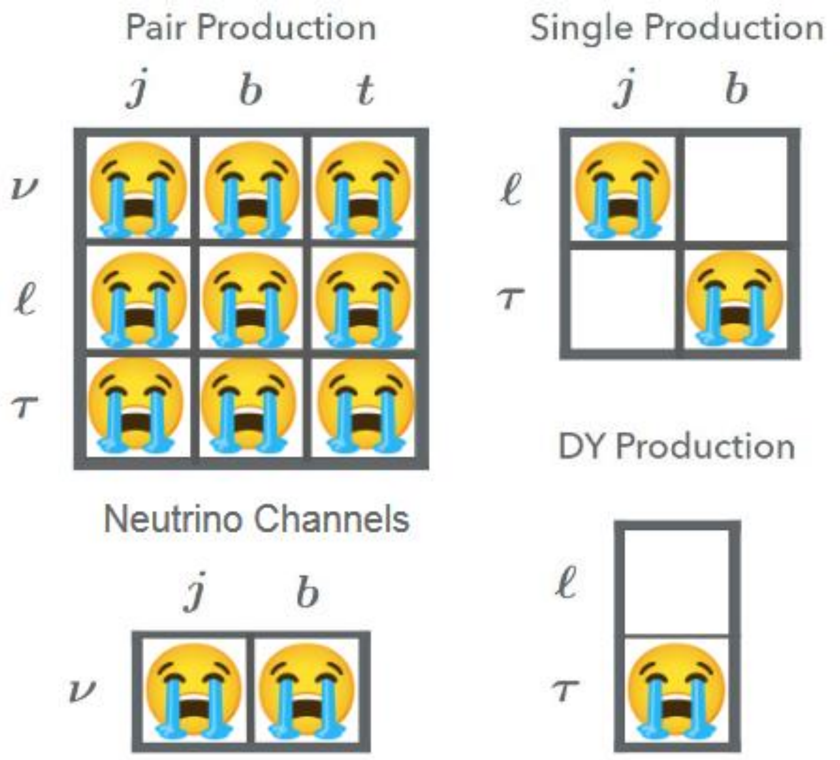


Direct searches for leptoquarks at the LHC

Slide borrowed from Vojtech Pleskot, Talk given of CKM2023

CMS arXiv:2308.06143
arXiv:2308.07826

ATLAS arXiv:2305.15962
arXiv:2303.09444



Pair Production

	j	b	t
ν	😭	😭	😭
ℓ	😭	😭	😭
τ	😭	😭	😭

Single Production

	j	b
ℓ	😭	
τ		😭

Neutrino Channels

	j	b
ν	😭	😭

DY Production

ℓ	
τ	😭

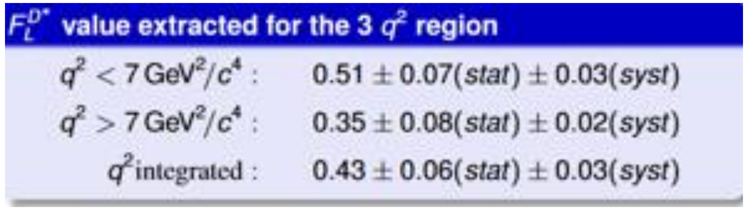
😭 = excluded by LHC searches within a certain (m, λ) range
Limits are mostly at masses of 1 - 1.5 TeV for scalar and 1.5 - 2 TeV for vector LQs

Conclusion

- Strong potential to constraint EFT models with leptoquarks and other NP mediators using semitauonic decays:
  - Using measured yields with various final states spins
  - Using differential information D* polarization : New LHCb result !

  Significant potential to exclude some of the
  Wilson coeffcents range in leptoquarks-based EFTs
  Joint work with theorists would be great!
  - Ambitious program in LHCb to measure the full angular distributions in $D^*\tau\nu$ decays

  D. Hill et al, JHEP11(2019)133



$F_L^{D^*}$ value extracted for the 3 q^2 region

$q^2 < 7\,\mathrm{GeV}^2/c^4$:	$0.51 \pm 0.07(stat) \pm 0.03(syst)$
$q^2 > 7\,\mathrm{GeV}^2/c^4$:	$0.35 \pm 0.08(stat) \pm 0.02(syst)$
q^2 integrated :	$0.43 \pm 0.06(stat) \pm 0.03(syst)$

LHCb-PAPER-2023-020 arXiv:2311.05224

- Search is going on in parallel
  - for lepton number violation $\tau^- \to \mu^- \mu^+ \mu^-$, $B \to K \mu \tau$, ...
  - for direct observation of NP at high P_T
  - Very large experimental effort on FCNC studies