The buzz of b →sll and why it still matters

Focus on $B^0 \to K^{*0} ee$ angular analysis
@ LHCb experiment

PIC24, Athens

2024 October 23rd

Alice Biolchini

N. Lytras, The Waiting, 1900

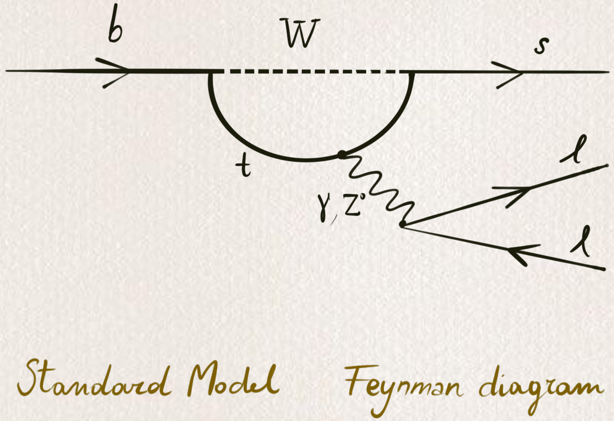
VU VRIJE UNIVERSITEIT AMSTERDAM

LHCb

Nikhef

Rare beauty decays

$b \rightarrow sll$ transitions are good laboratory to explore higher energy scale

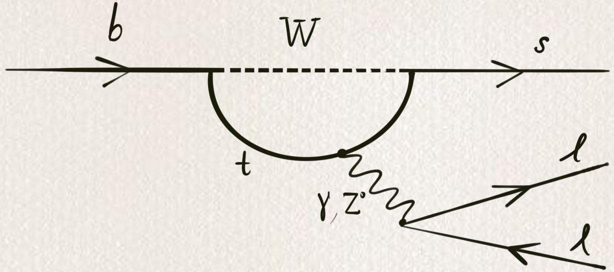


$\mathcal{B} \sim \boldsymbol{O}(10^{-6})$

Sensitive to *New Physics* (***NP***) at the TeV scale

NP can affect the decay rates and angular distributions

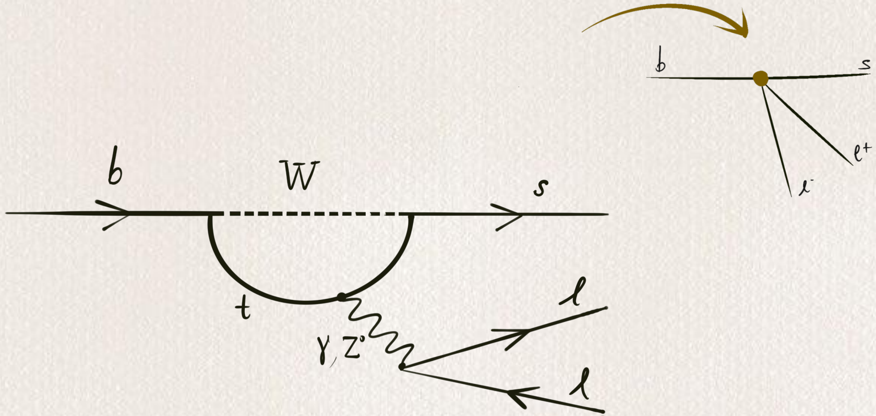
Rare beauty decays



$$\mathcal{H}_{eff} = -\frac{G_F}{\sqrt{2}} V_{tb} V_{ts}^{*} (\Delta_i^{SM} + C_i^{NP}) O_i$$

EFFECTIVE FIELD THEORY

Rare beauty decays



Wilson coefficients

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EFFECTIVE FIELD THEORY

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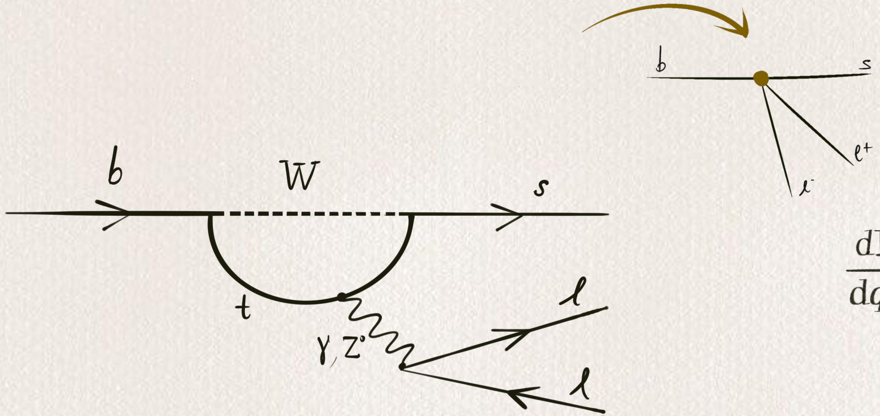

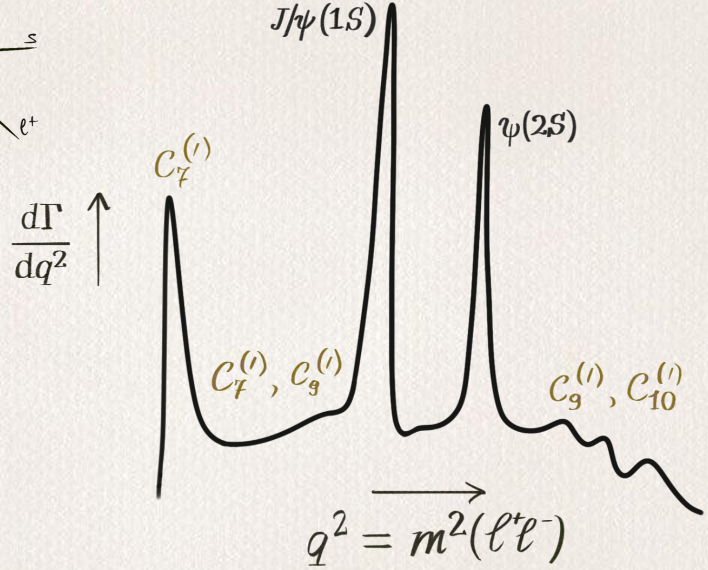

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EFFECTIVE FIELD THEORY

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Last measurements

Recent results of Belle2 and LHCb in rare decays by [Chandiprasad Kar, today]

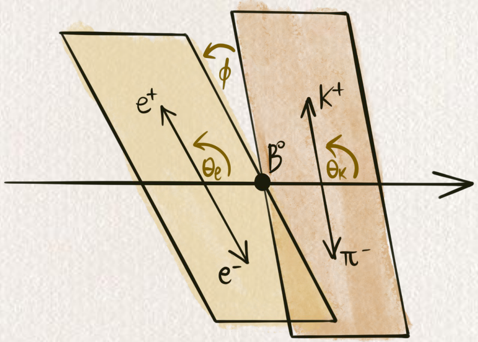
Theoretical uncertainties

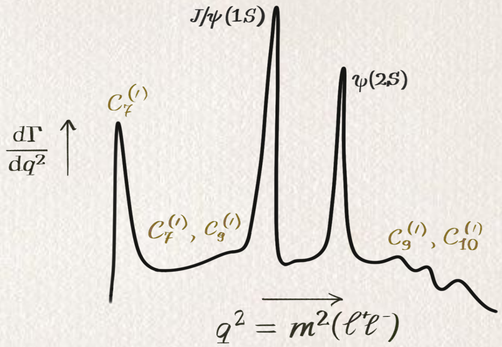
Ratio of BFs

Angular Analyses

Differential branching fractions

$$R_H = \frac{\mathcal{B}(b \to s\mu\mu)}{\mathcal{B}(b \to see)}$$





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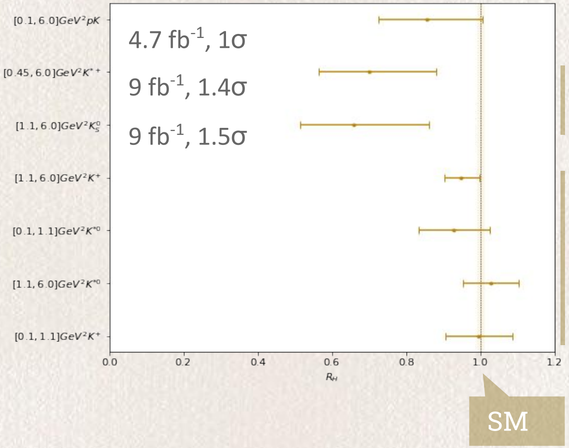
LHCb only @ 2024

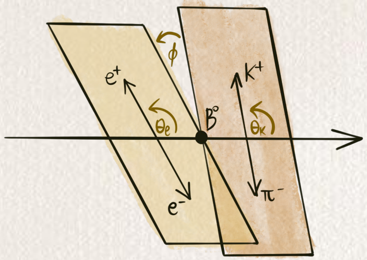


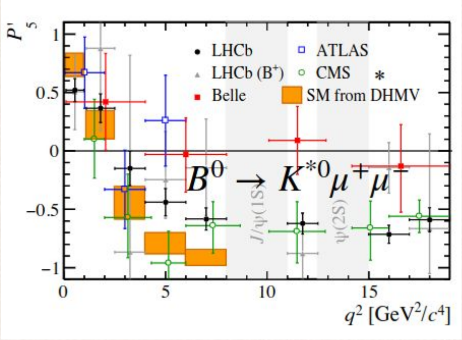
JHEP05(2020)040

PRL 128 (2022) 191802

LHCb-PAPER-2022-045

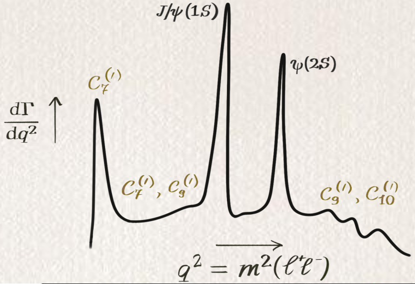
Angular Analyses

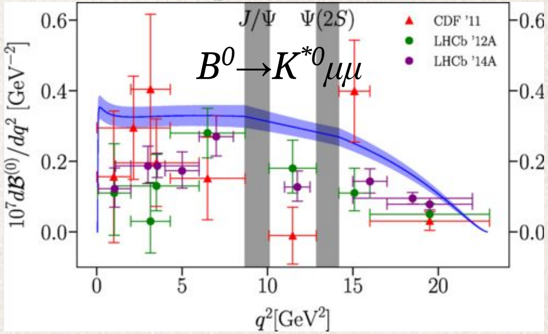




arXiv:1805.05073

Branching fractions





Phys. Rev. D 107, 014511 (2023)

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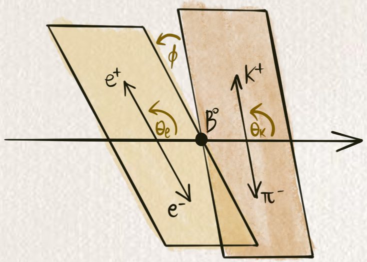
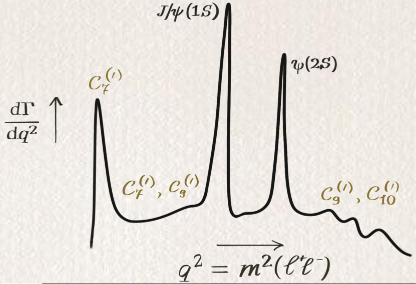
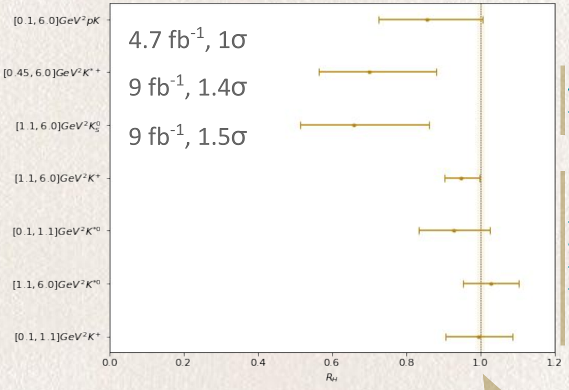




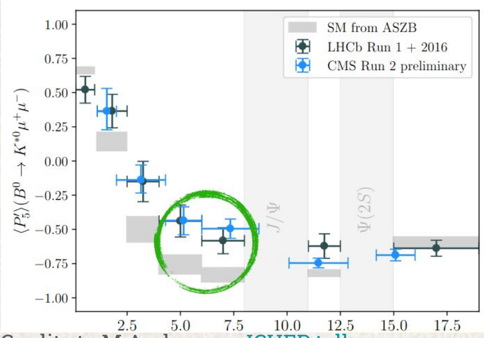
LHCb only @ 2024



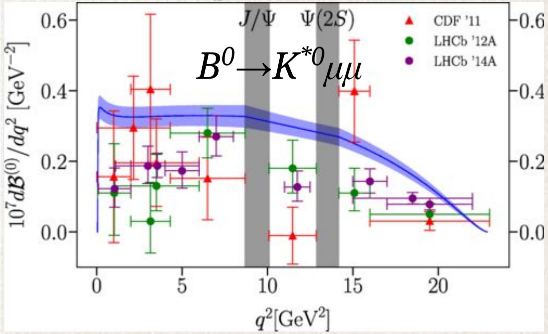
JHEP05(2020) 040

PRL 128 (2022) 191802

PRL 131 (2023) 051803
PRD 108 (2023) 032002



Credits to M.Andersson, ICHEP talk
CMS results
LHCb results



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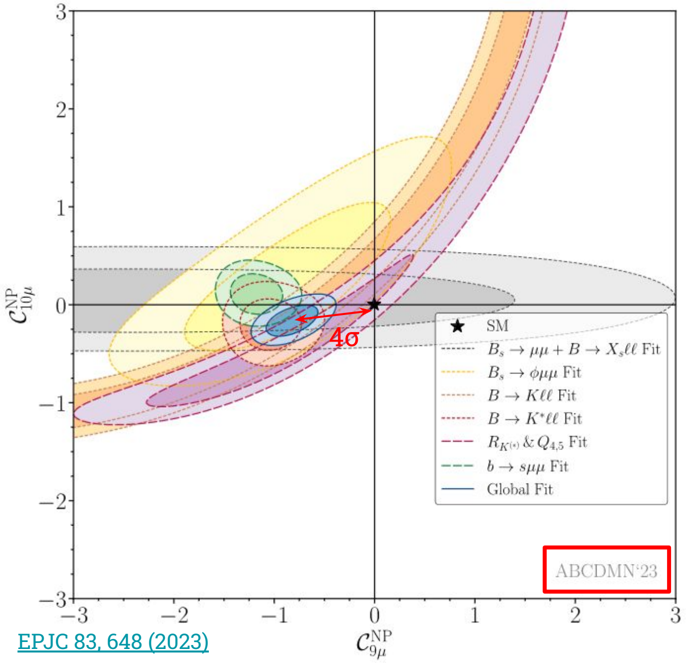
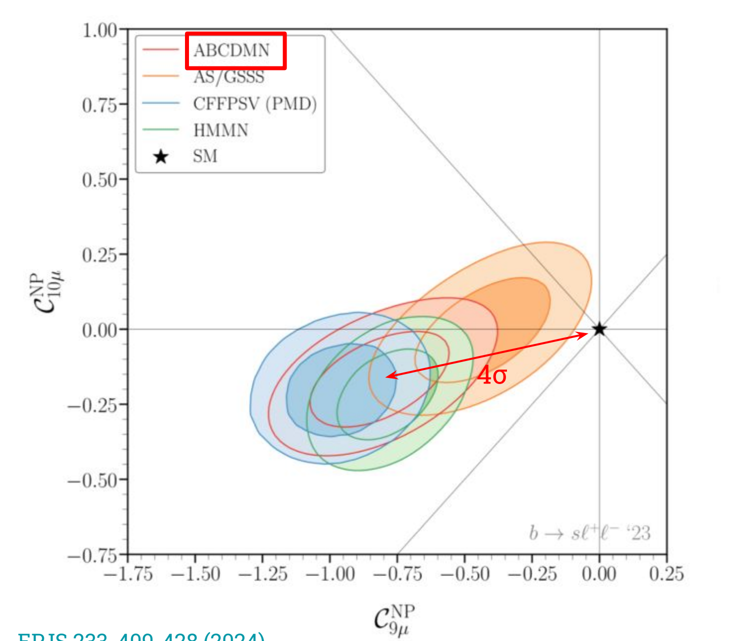
Wilson Coefficients global fits



EPJC 83, 648 (2023)



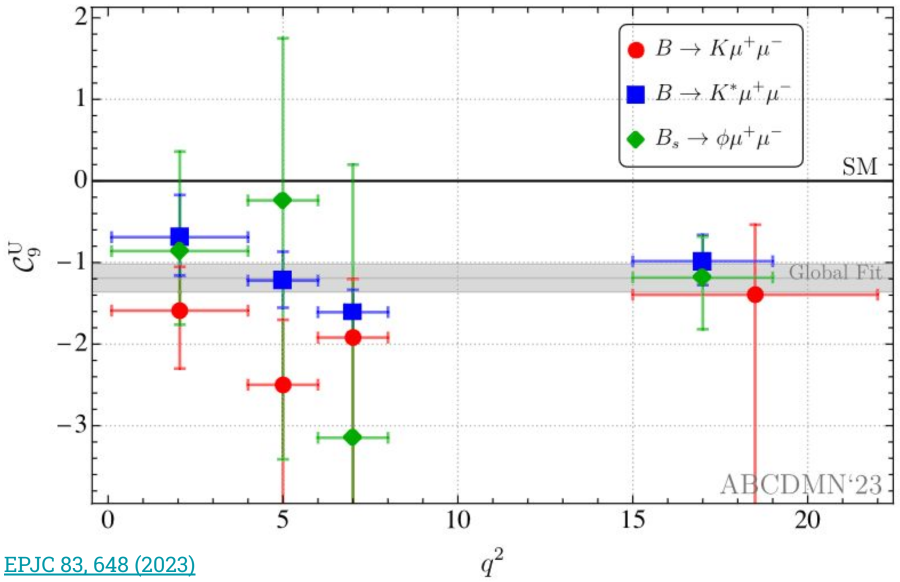
EPJS 233, 409-428 (2024)

LFU conservation hypothesis

- B→Kμμ:
  - BF
- B→K*μμ
  - BF
  - Angular observables
- Bs → ϕμμ
  - BF
  - Angular observables

- Gray band:
  - 1σ confidence interval for the global fit to $\mathcal{C}_9^{(U)}$

$$(\mathcal{C}_{9\mu}^{NP} = \mathcal{C}_{9e}^{NP} = \mathcal{C}_9^{U})$$



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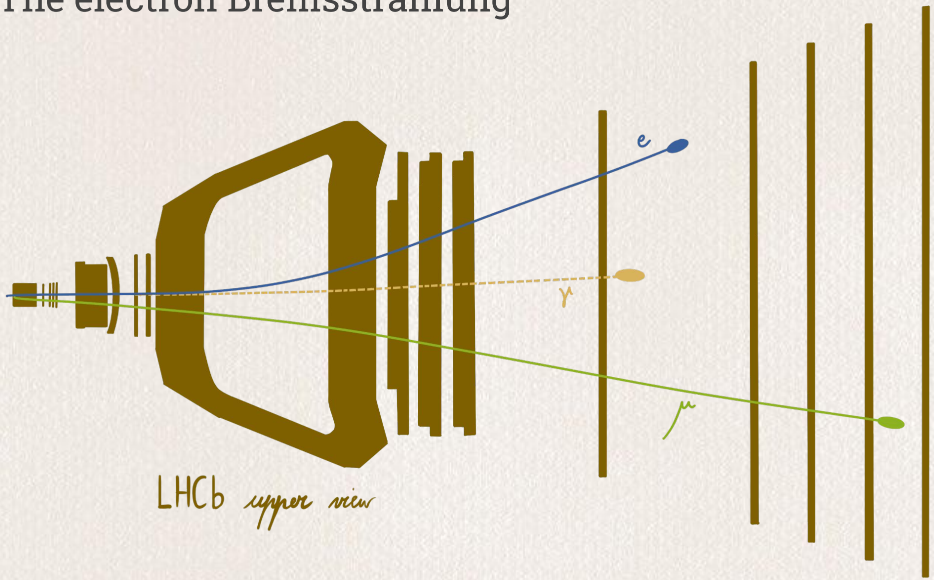
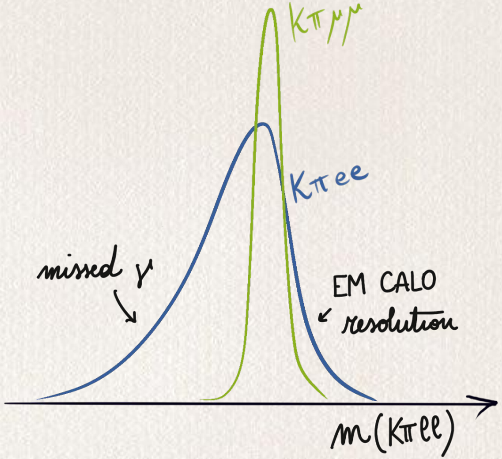
Electrons are a challenge

The electron Bremsstrahlung

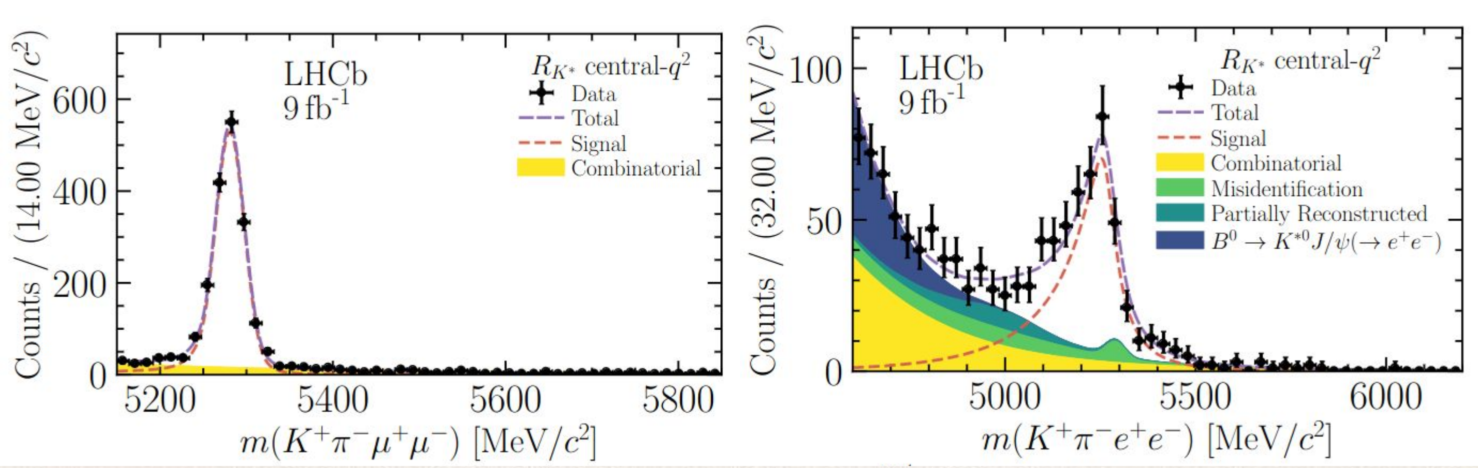




Electrons are a challenge

Few signal events and a lot of background

$B^0 \to K^{*0}\mu\mu$ $B^0 \to K^{*0}ee$



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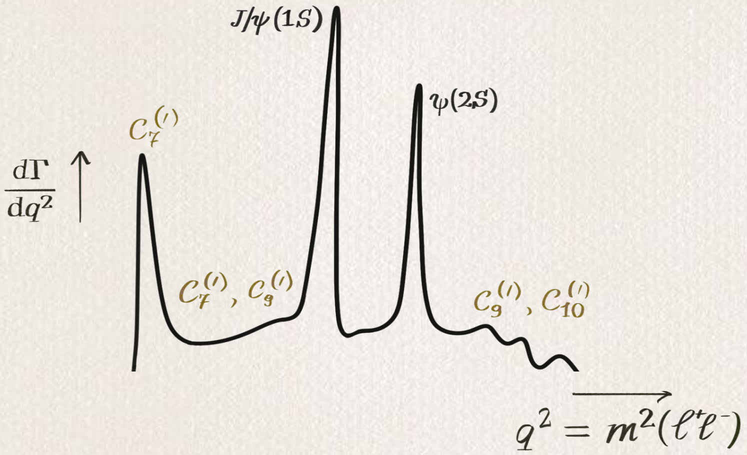
New LHCb results in b→sll decays

N. Lytras, The Waiting, 1900

The waiting is over!

- $B^0 \to K^{*0}ee$ angular [LHCB-PAPER-2024-022-001, Preliminary]



- $B^0 \to K^{*0}\mu\mu$ analysis of local and non-local amplitudes → *Zahra Ghorbanimoghaddam's talk, tomorrow!*

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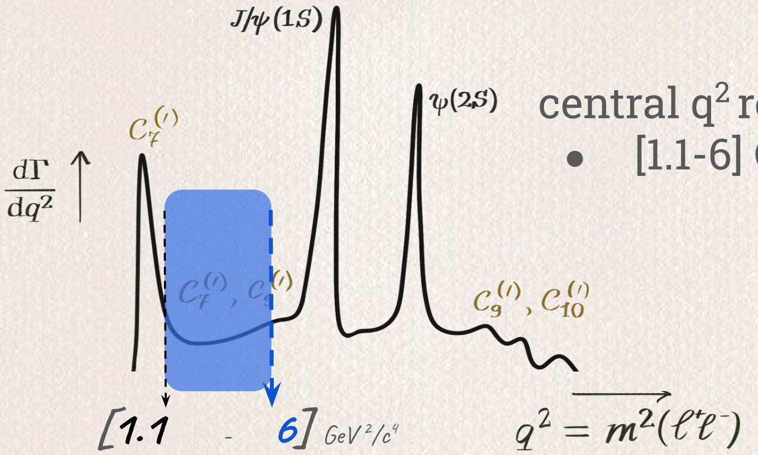

central q^2 regions
- [1.1-6] GeV^2/c^4

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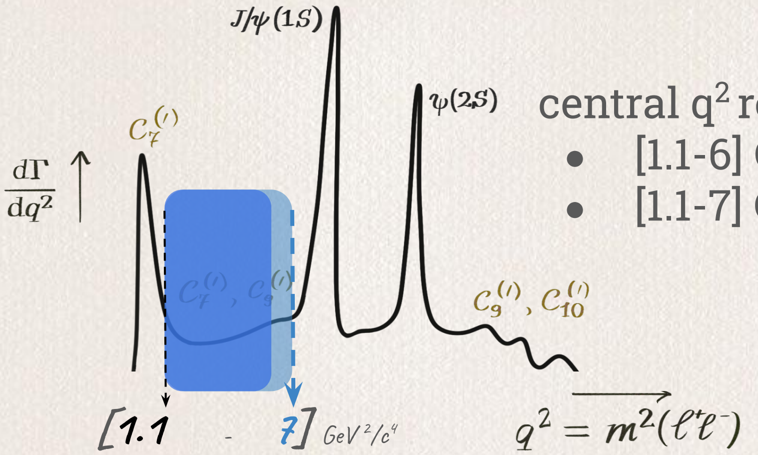

central q^2 regions
- [1.1-6] GeV^2/c^4
- [1.1-7] GeV^2/c^4

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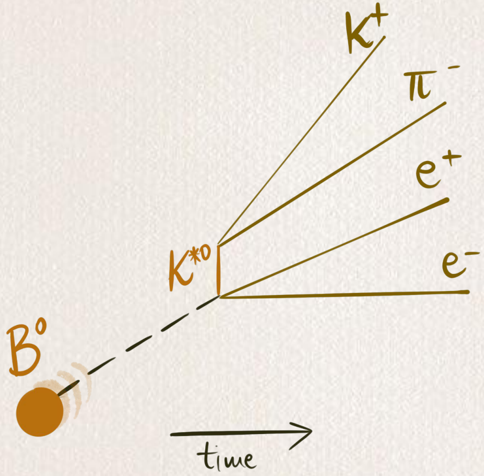
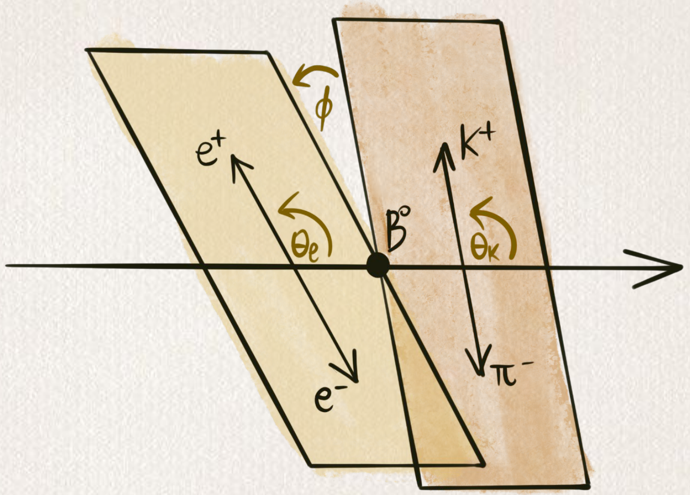
N. Lytras, The Waiting, 1900

$B^0 \to K^{*0} ee$ angular analysis

The decay is described by 3 angles (θ_l, θ_K and ϕ)



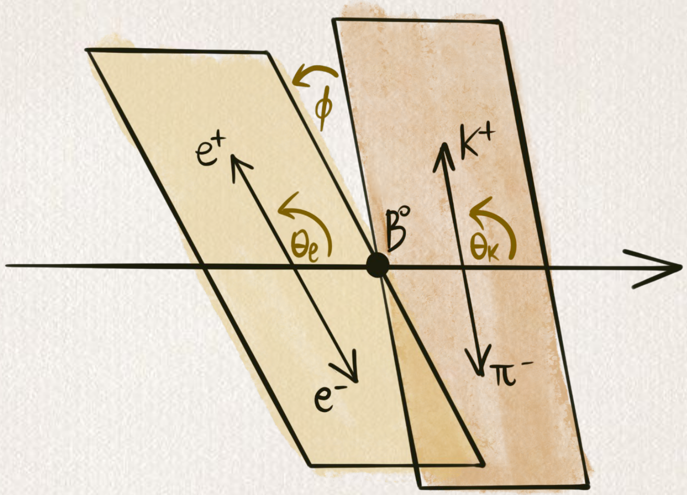


$B^0 \to K^{*0}ee$ angular analysis

The decay is described by 3 angles (θ_l, θ_K and ϕ)

$$\frac{d^3(\Gamma+\bar{\Gamma})}{d\vec{\Omega}} = K \sum_{i=1}^{8} p_i f_i(\theta_\ell, \theta_K, \phi)$$

coefficients



THE GOAL: Measure coefficients describing the angular distribution

Parametrise detector acceptance

- 4D space → $(\theta_l, \theta_K, \phi, q^2)$
- Legendre polynomials and Fourier terms

$$\epsilon(\cos\theta_\ell, \cos\theta_K, \phi, q_c^2) = \sum_{k,l,m,n} c_{k,l,m,n} L_k(\cos\theta_K) L_l(\cos\theta_\ell) F_m(\phi) L_n(q_c^2)$$

- Coefficients obtained via Monte Carlo integration:

$$c_{k,l,m,n} = \frac{1}{N'} \sum_{i=1}^{N} w_i \left[\left(\frac{2k+1}{2}\right) \left(\frac{2l+1}{2}\right) \left(\frac{2m+1}{2}\right) \left(\frac{2n+1}{2}\right) \right] L_k(\cos\theta_{li}) L_l(\cos\theta_{ki}) F_m(\phi_i) L_n(q_i^2)$$

weights accounting for DATA-SIMULATION differences

- Acceptance efficiency used as a per event weight:

$$\omega_{\text{gen}} = 1/\epsilon_{\text{gen}}$$

Fit strategy

- Full Run1 + Run2 LHCb data (9 fb^{-1})
  - Simultaneous fit to [2011-2012], [2015-2016], [2017,2018] data subsets
- 4D Unbinned weights fit to mass and angles

Likelihood

$$-\sum_{events,e} \frac{1}{\epsilon_e(\vec{\Omega}, q^2)} \cdot \ln \mathrm{PDF}(\vec{\Omega}, m|\vec{\Theta}, \vec{\lambda})$$

Mass and angular distributions, are assumed to factorise

- Determination of CP-averaged S_i and optimised $P_i^{(\prime)}$ observables

$$P_1 = \frac{2S_3}{(1-F_L)} = A_T^{(2)},$$

$$P_2 = \frac{2}{3}\frac{A_{FB}}{(1-F_L)},$$

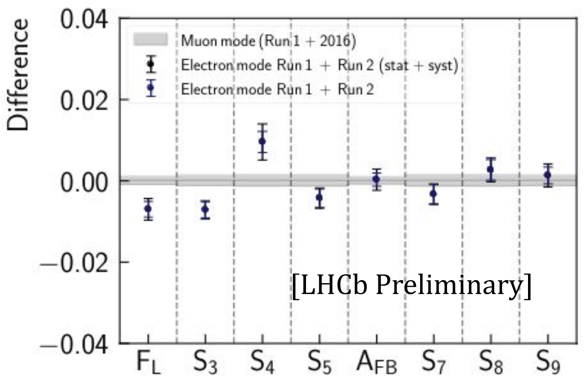
$$P_3 = \frac{-S_9}{(1-F_L)},$$

$$P'_{4,5,8} = \frac{S_{4,5,8}}{\sqrt{F_L(1-F_L)}},$$

$$P'_6 = \frac{S_7}{\sqrt{F_L(1-F_L)}},$$

[LHCB-PAPER-2024-022-001, Preliminary]

Test fit strategy



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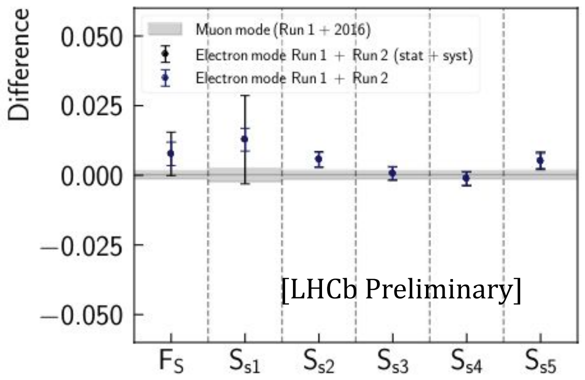
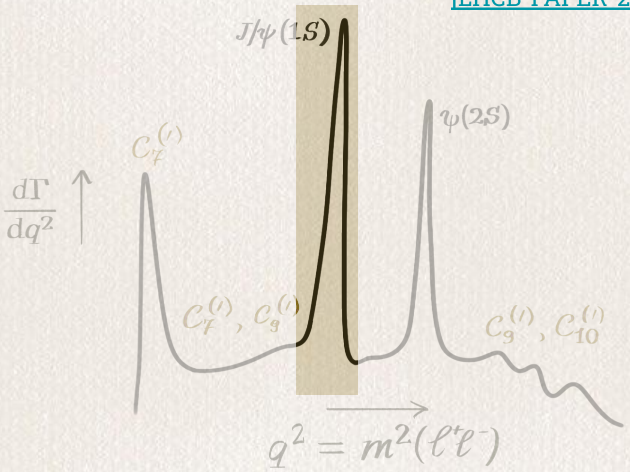
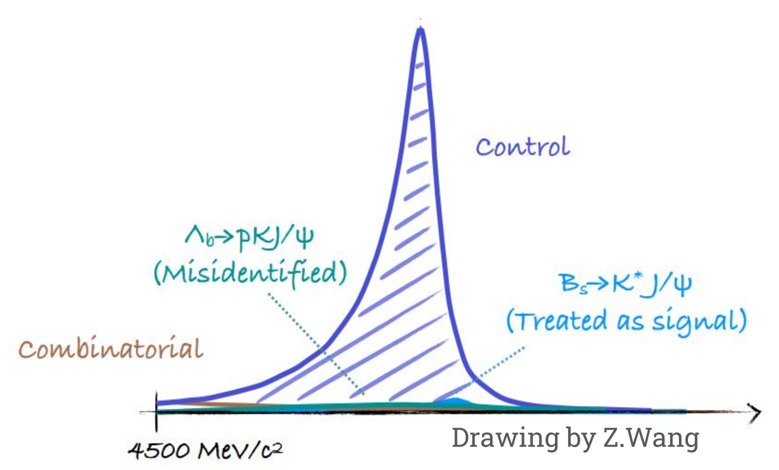
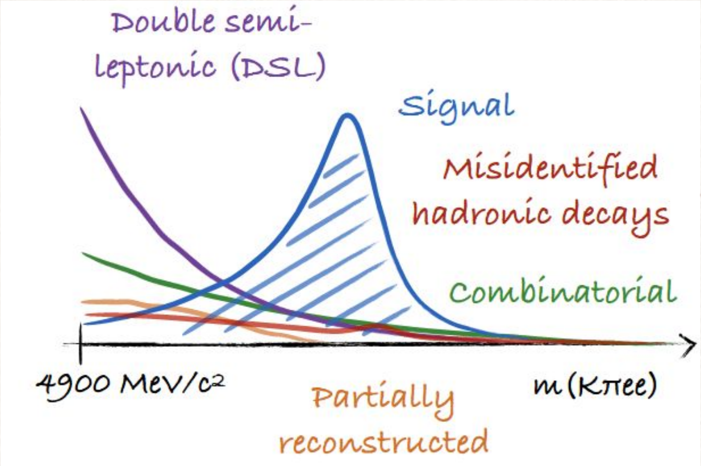


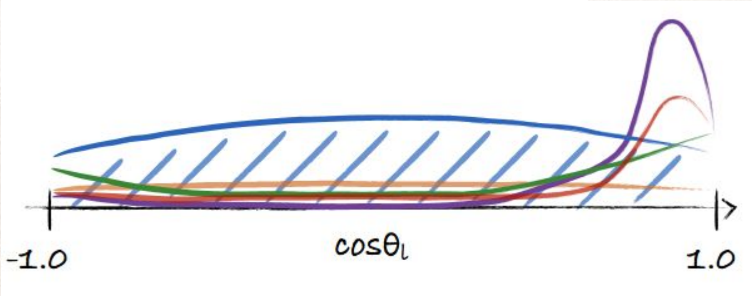




Rare mode components

- Combinatorial
- Partially reconstructed [*e.g.* $B^+ \rightarrow K_{1,2}(\rightarrow K\pi\pi)ee$]
- **Cos(ϑ_l) peaking components:**
  a. Single and double ***hadronic misidentified*** decays (K,*π identified as e*)
  b. **Double semileptonic** decays - *e.g.* $B \rightarrow D^{*-}(\rightarrow K\pi e\nu)\, e^+\nu$

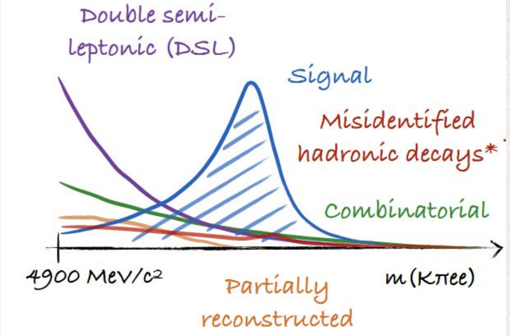


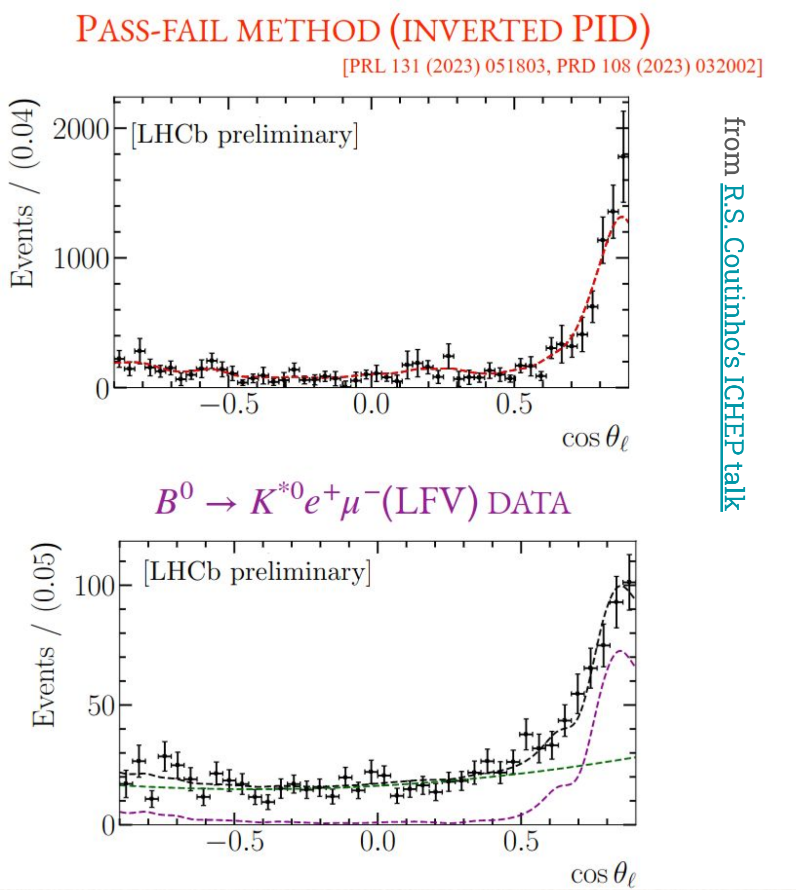


Drawings by Z.Wang

Rare mode components

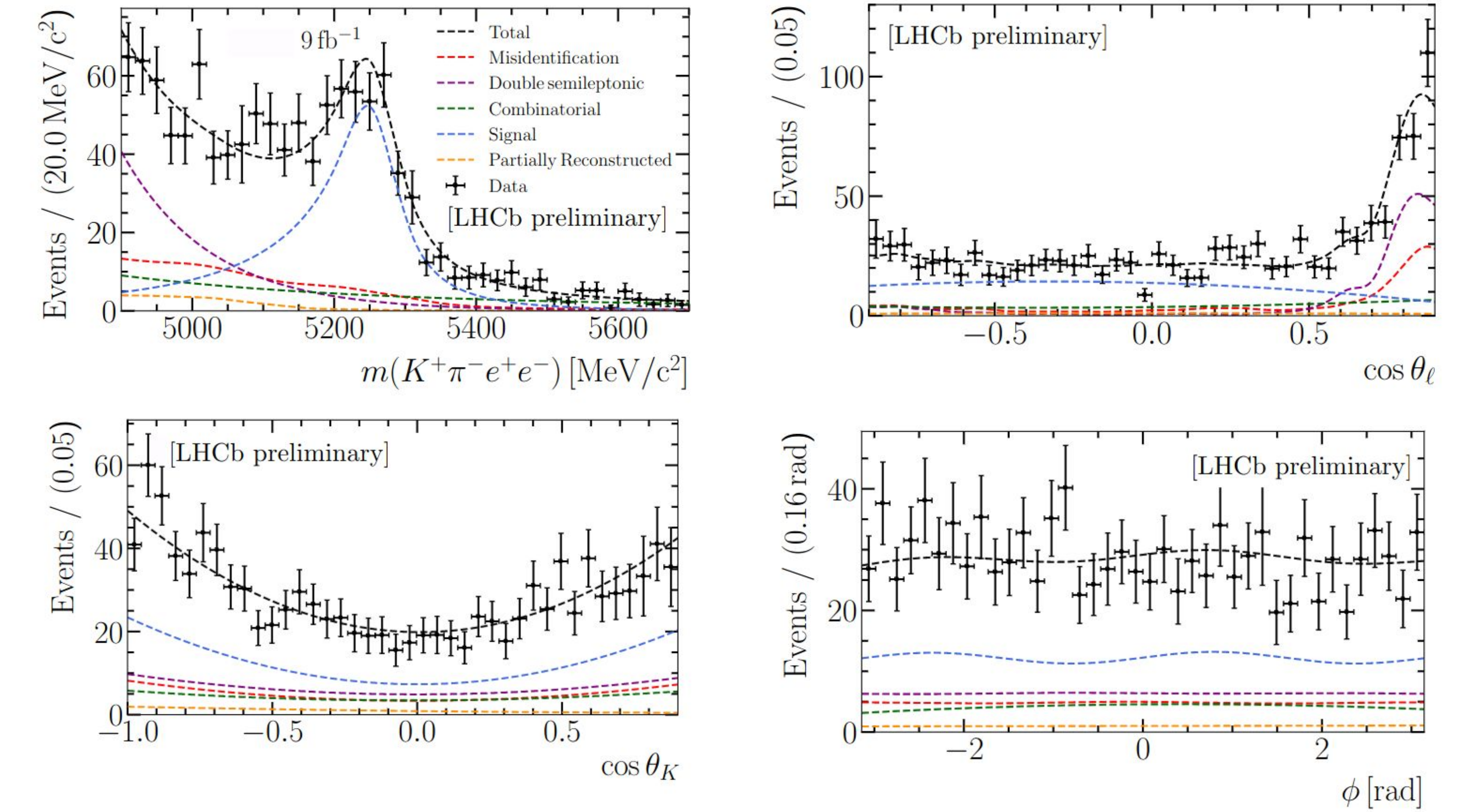
- **Paramount the control over backgrounds**
  - mass & angular structure
- LFV Data
  - Combinatorial and DSL
- Data-driven estimation
  - Hadronic misidentified
- Monte Carlo simulation
  - Partially-Reconstructed





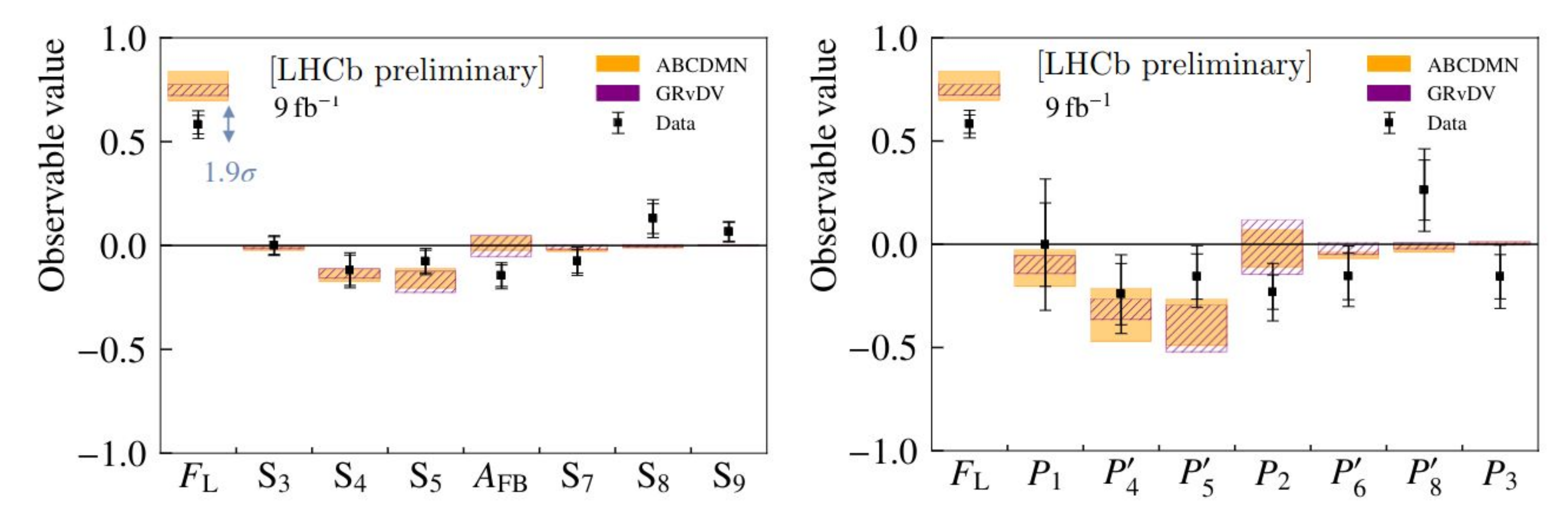
from R.S. Coutinho's ICHEP talk

Rare mode fit projections



Rare mode angular observables

[1.1-6] GeV^2/c^4 Tables in backup

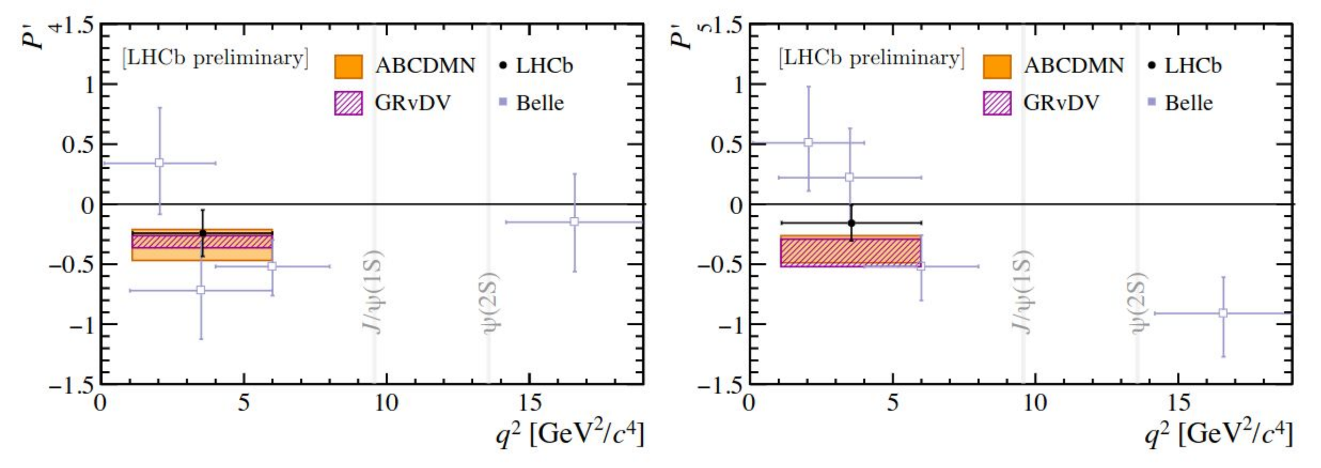


Overall good agreement with SM predictions

GRvDV → [N. Gubernari, M. Reboud, D. Van Dyk, J. Virto, JHEP 09 (2022) 133]
ABCDMN → [M. Algueró, A. Biswas, B.Capdevila, S. Descotes-Genon, J. Matias, EPJC 83 (2023) 7, 648]

Rare mode angular observables

Comparison with Belle result



Agreement with Belle result and SM prediction

[Belle Collaboration, PRL 118 (2017) 111801]
GRvDV ⟶ [N. Gubernari, M. Reboud, D. Van Dyk, J. Virto, JHEP 09 (2022) 133]
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[LHCB-PAPER-2024-022-001, Preliminary]

Systematic uncertainties

	F_L	S_3	S_4	S_5	A_{FB}	S_7	S_8	S_9
DSL and comb.	0.687	0.372	0.297	0.321	0.449	0.177	0.668	0.294
Part. reco.	0.091	0.039	0.039	0.049	0.051	0.021	0.034	0.037
Had. misid.	0.376	0.254	0.107	0.178	0.155	0.336	0.129	0.141
Effective acceptance	0.399	0.249	0.419	0.410	0.331	0.508	0.393	0.214
Signal mass modelling	0.254	0.057	0.071	0.111	0.122	0.044	0.045	0.062
Residual backgrounds	0.179	0.039	0.045	0.062	0.137	0.032	0.032	0.047
S-wave component	0.351	0.050	0.129	0.084	0.105	0.159	0.008	0.103
B^+ veto	0.499	0.133	0.152	0.179	0.242	0.159	0.154	0.117
Fit bias	0.007	0.008	0.030	0.038	0.042	0.007	0.019	0.031
Total*	1.118	0.540	0.570	0.601	0.665	0.676	0.804	0.430

*VALUES ARE GIVEN RELATIVE TO THE STATISTICAL UNCERTAINTIES

from R.S. Coutinho's ICHEP talk

Major contributions:

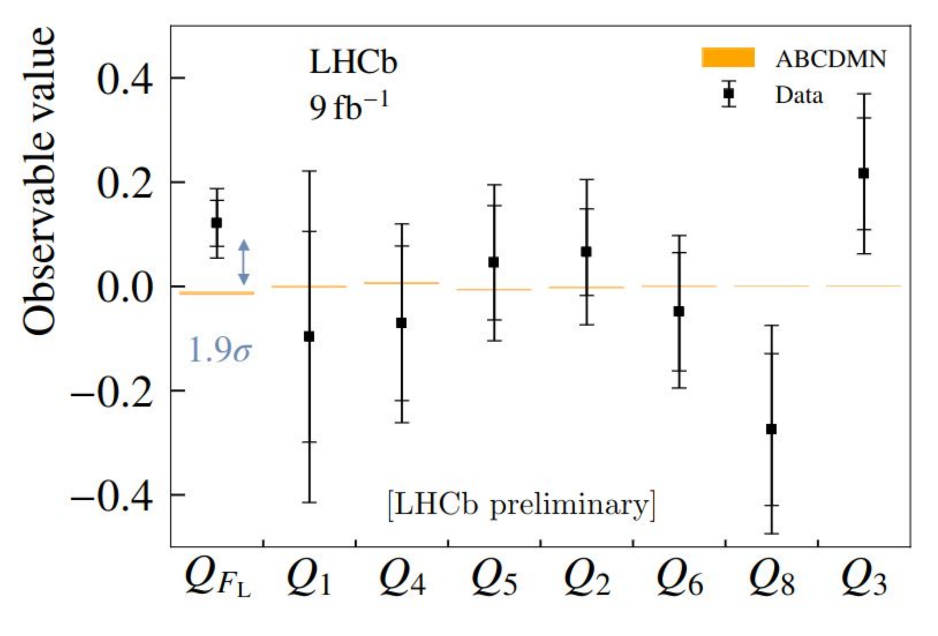
- Double semi-leptonic and combinatorial parametrisation
- Acceptance

Q_i angular observables

- LFU angular observables
- Results consistent with LFU conservation hypothesis

Tables in backup

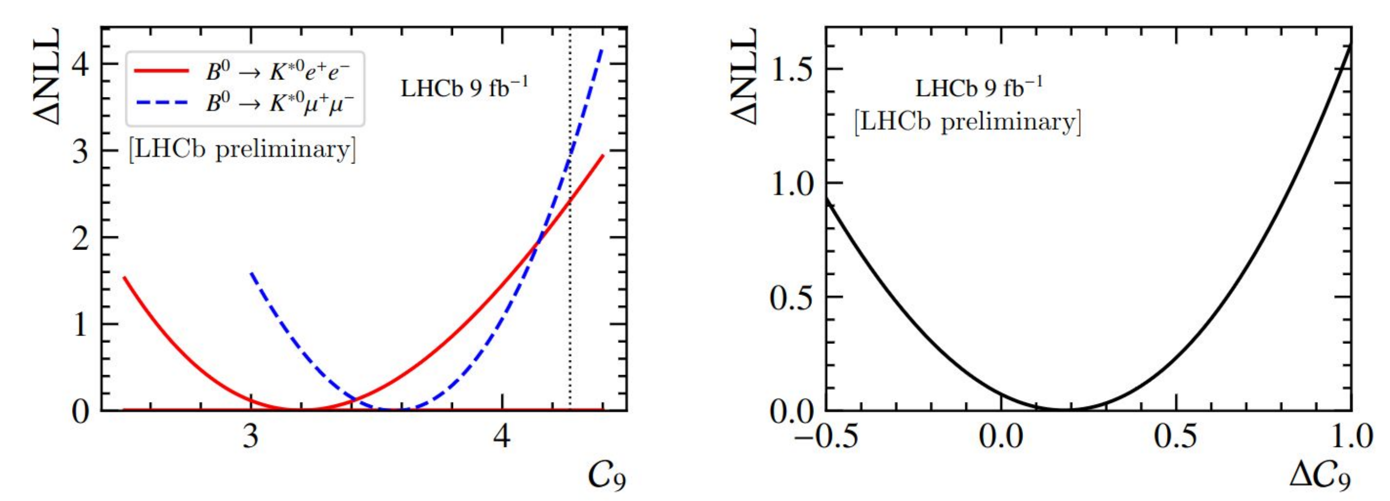
$$Q_i = P_i^{(\mu)} - P_i^{(e)}$$



ABCDMN → [M. Algueró, A. Biswas, B.Capdevila, S. Descotes-Genon, J. Matias, EPJC 83 (2023) 7, 648]

Interpretation

- WC global fit with all angular observables
- Likelihood scan varying $\mathcal{R}e(\mathcal{C}_9)$



Similar shift between e and μ

$\Delta\mathcal{C}_9 = \mathcal{C}_9^{(e)} - \mathcal{C}_9^{(\mu)}$ compatible with zero

- Form factors constrained from [JHEP 12 (2023) 153] and non-local QCD terms from [JHEP 02 (2021) 088, JHEP 09 (2022) 133]
- Local and non-local hadronic contributions shared for e and μ

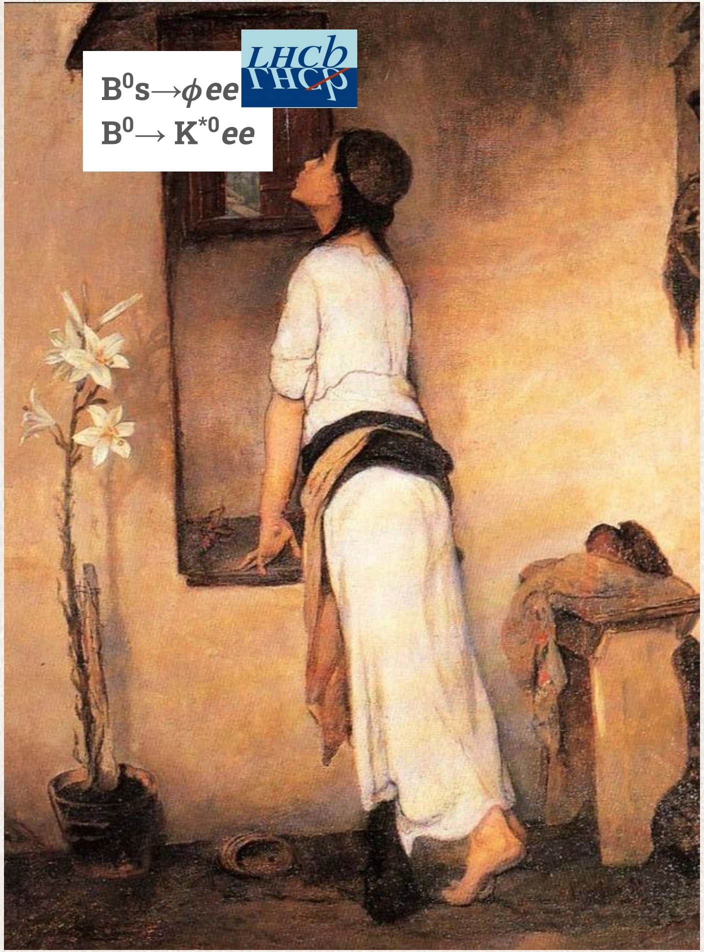
Summary and conclusions

- **First angular analysis for electrons in the central q^2 region at hadronic machines**
  - Sensitivity at same level at first $P_5^{(\prime)}$ measurements with muons
- Results compatible with SM and LFU hypothesis

[LHCB-PAPER-2024-022-001, Preliminary]

- Wilson Coefficients global fit highlights similar shift in $\mathcal{R}e(\mathcal{C}_9)$ as in the $B^0 \to K^{*0}\mu\mu$ decay
- This analysis paved the way for **new angular analysis in the electron sector** (*e.g.*)
  - $B^0_s \to \phi ee$ - under review
  - $B^0 \to K^{*0} ee$ legacy -ongoing

Stay tuned!



Thanks for your attention.
Any questions?

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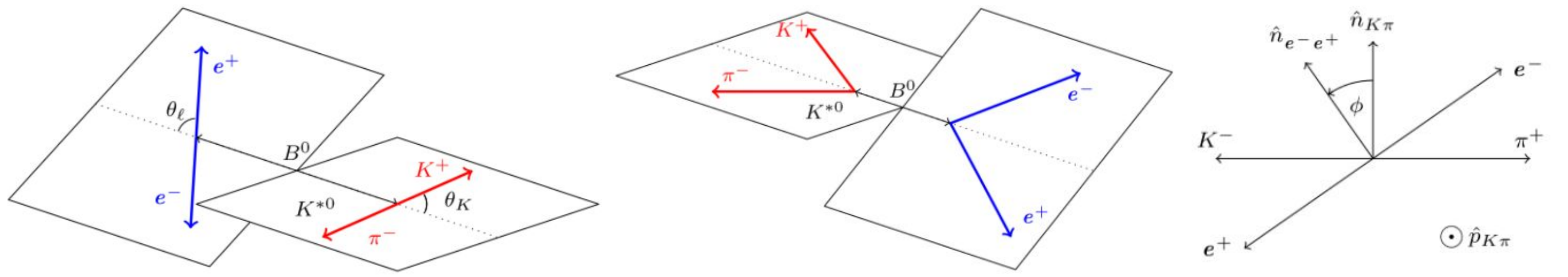
Backup slide: Decay angles

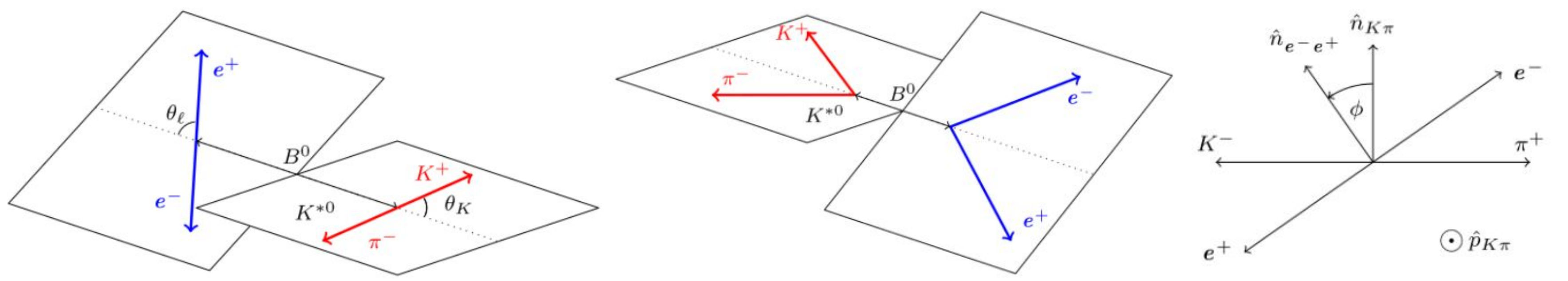


$\theta_l \rightarrow$ between the direction of the e^+ and the direction opposite to that of the B^0 in the rest frame of the dimuon system

$\theta_K \rightarrow$ between the direction of the K^+ and the direction of the B^0 in the rest frame of the K^{*0}

$\varphi \rightarrow$ between the plane defined by the electrons pair and the plane defined by the kaon and pion in the B^0 rest frame

Backup slide: Decay angles



$$\cos\phi = \left(\hat{p}_{e^+}^{(B^0)} \times \hat{p}_{e^-}^{(B^0)}\right) \cdot \left(\hat{p}_{K^+}^{(B^0)} \times \hat{p}_{\pi^-}^{(B^0)}\right),$$

$$\sin\phi = \left[\left(\hat{p}_{e^+}^{(B^0)} \times \hat{p}_{e^-}^{(B^0)}\right) \times \left(\hat{p}_{K^+}^{(B^0)} \times \hat{p}_{\pi^-}^{(B^0)}\right)\right] \cdot \hat{p}_{K^{*0}}^{(B^0)}$$

$$\cos\theta_\ell = \left(\hat{p}_{e^+}^{(e^+e^-)}\right) \cdot \left(\hat{p}_{e^+e^-}^{(B^0)}\right) = \left(\hat{p}_{e^+}^{(e^+e^-)}\right) \cdot \left(-\hat{p}_{B^0}^{(e^+e^-)}\right)$$

$$\cos\theta_K = \left(\hat{p}_{K^+}^{(K^{*0})}\right) \cdot \left(\hat{p}_{K^{*0}}^{(B^0)}\right) = \left(\hat{p}_{K^+}^{(K^{*0})}\right) \cdot \left(-\hat{p}_{B^0}^{(K^{*0})}\right)$$

$$\cos\phi = \left(\hat{p}_{e^-}^{(\bar{B}^0)} \times \hat{p}_{e^+}^{(\bar{B}^0)}\right) \cdot \left(\hat{p}_{K^-}^{(\bar{B}^0)} \times \hat{p}_{\pi^+}^{(\bar{B}^0)}\right),$$

$$\sin\phi = \left[\left(\hat{p}_{e^-}^{(\bar{B}^0)} \times \hat{p}_{e^+}^{(\bar{B}^0)}\right) \times \left(\hat{p}_{K^-}^{(\bar{B}^0)} \times \hat{p}_{\pi^+}^{(\bar{B}^0)}\right)\right] \cdot \hat{p}_{\bar{K}^{*0}}^{(\bar{B}^0)}$$

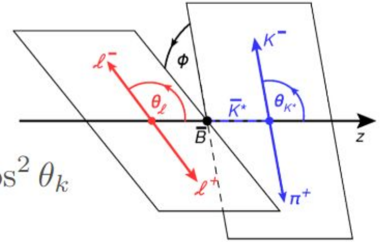
$$\cos\theta_\ell = \left(\hat{p}_{e^-}^{(e^+e^-)}\right) \cdot \left(\hat{p}_{e^+e^-}^{(\bar{B}^0)}\right) = \left(\hat{p}_{e^-}^{(e^+e^-)}\right) \cdot \left(-\hat{p}_{\bar{B}^0}^{(e^+e^-)}\right)$$

$$\cos\theta_K = \left(\hat{p}_{K^-}^{(K^{*0})}\right) \cdot \left(\hat{p}_{K^{*0}}^{(\bar{B}^0)}\right) = \left(\hat{p}_{K^-}^{(\bar{K}^{*0})}\right) \cdot \left(-\hat{p}_{\bar{B}^0}^{(\bar{K}^{*0})}\right)$$

from R.S. Coutinho's ICHEP talk

THE RARE DECAY $B^0 \to K^{*0}[K^+\pi^-]e^+e^-$

DECAY FULLY DESCRIBED BY THREE HELICITY ANGLES



$$\frac{1}{d(\Gamma+\bar{\Gamma})/dq^2}\frac{d^4(\Gamma+\bar{\Gamma})}{dq^2\,d\vec{\Omega}} = \frac{9}{32\pi}\Big[\tfrac{3}{4}(1-F_{\rm L})\sin^2\theta_k + F_{\rm L}\cos^2\theta_k$$
$$+\tfrac{1}{4}(1-F_{\rm L})\sin^2\theta_k\cos 2\theta_l$$
$$-F_{\rm L}\cos^2\theta_k\cos 2\theta_l + S_3\sin^2\theta_k\sin^2\theta_l\cos 2\phi$$
$$+S_4\sin 2\theta_k\sin 2\theta_l\cos\phi + S_5\sin 2\theta_k\sin\theta_l\cos\phi$$
$$+\tfrac{4}{3}A_{\rm FB}\sin^2\theta_k\cos\theta_l + S_7\sin 2\theta_k\sin\theta_l\sin\phi$$
$$+S_8\sin 2\theta_k\sin 2\theta_l\sin\phi + S_9\sin^2\theta_k\sin^2\theta_l\sin 2\phi\Big]$$

Fraction of longitudinal polarisation of the K*

Forward-backward asymmetry of the di-lepton system

F_L, A_{FB} AND S_i ARE COMBINATIONS OF K^{*0} SPIN AMPLITUDES SENSITIVE TO $C^{(\prime)}_{7,9,10}$ AND FORM FACTORS

PERFORM RATIOS OF OBSERVABLES (E.G. P_5') WHERE FORM FACTORS CANCEL AT LEADING ORDER

$$P_5' = \frac{S_5}{\sqrt{F_{\rm L}(1-F_{\rm L})}}$$

[JHEP 1204 (2012) 104]

*S-WAVE CONTRIBUTION IS CONSIDERED IN THE SYSTEMATICS

R. Silva Coutinho 8

The buzz of b →sll and why it still matters

PIC24
2023 Oct 23
Athens

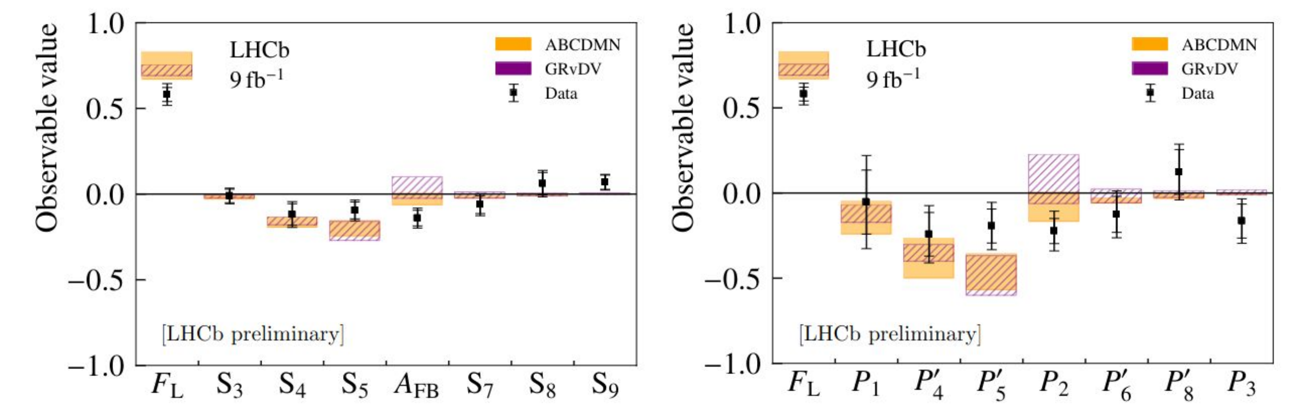
Alice Biolchini

Control Mode angular fit - $B^0 \to K^{*0}(J/\psi \to ee)$

	Result	Total uncertainty	Differences	Differences (σ)
F_L	0.5539 ± 0.0019	0.0049	0.0070	1.4
S_3	-0.0074 ± 0.0020	0.0026	0.0071	2.7
S_4	-0.2393 ± 0.0026	0.0049	-0.0096	-2.0
S_5	-0.0036 ± 0.0023	0.0029	0.0043	1.5
A_{FB}	0.0008 ± 0.0016	0.0029	-0.0003	-0.1
S_7	-0.0022 ± 0.0023	0.0029	0.0033	1.1
S_8	-0.0517 ± 0.0025	0.0032	-0.0027	-0.8
S_9	-0.0839 ± 0.0021	0.0032	-0.0013	-0.4
F_S	0.0690 ± 0.0040	0.0105	-0.0077	-0.7
S_{S_1}	-0.2150 ± 0.0040	0.0161	-0.0128	-0.8
S_{S_2}	0.0278 ± 0.0026	0.0033	-0.0057	-1.7
S_{S_3}	0.0014 ± 0.0023	0.0029	-0.0007	-0.2
S_{S_4}	-0.0012 ± 0.0024	0.0030	0.0012	0.4
S_{S_5}	-0.0619 ± 0.0027	0.0036	-0.0052	-1.5

CP averaged angular observables

	$1.1 < q^2 < 7.0\,\mathrm{GeV}^2/c^4$		
F_L	$0.581 \pm 0.041 \pm 0.049$		
S_3	$-0.011 \pm 0.039 \pm 0.023$	P_1	$-0.053 \pm 0.188 \pm 0.199$
S_4	$-0.119 \pm 0.063 \pm 0.041$	P'_4	$-0.242 \pm 0.128 \pm 0.109$
S_5	$-0.096 \pm 0.049 \pm 0.035$	P'_5	$-0.194 \pm 0.100 \pm 0.097$
A_{FB}	$-0.140 \pm 0.046 \pm 0.036$	P_2	$-0.223 \pm 0.074 \pm 0.090$
S_7	$-0.062 \pm 0.052 \pm 0.038$	P'_6	$-0.125 \pm 0.106 \pm 0.088$
S_8	$0.061 \pm 0.065 \pm 0.042$	P'_8	$0.123 \pm 0.131 \pm 0.098$
S_9	$0.069 \pm 0.042 \pm 0.019$	P_3	$-0.165 \pm 0.100 \pm 0.084$



The buzz of b →sll and why it still matters

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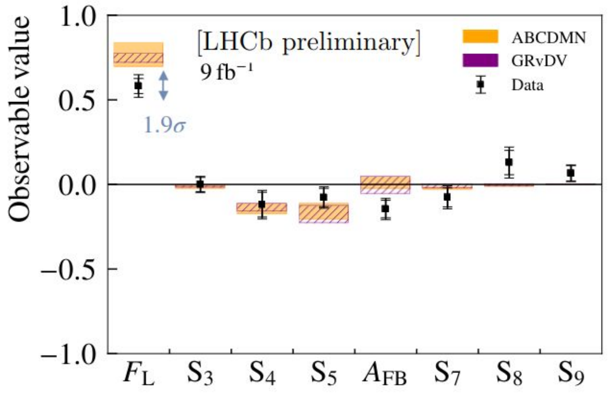
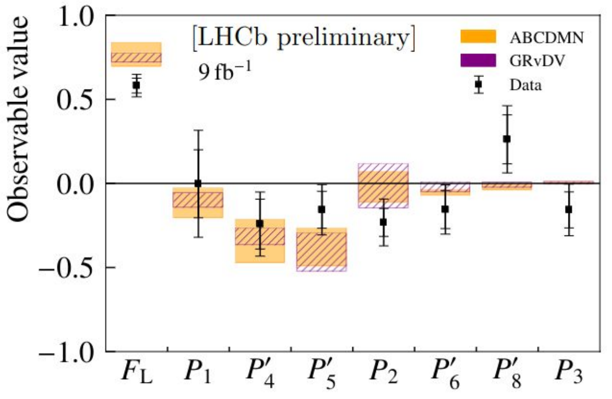
CP averaged angular observables

	$1.1 < q^2 < 6.0\,\mathrm{GeV}^2/c^4$		
F_L	$0.582 \pm 0.045 \pm 0.050$		
S_3	$-0.000 \pm 0.042 \pm 0.023$	P_1	$-0.002 \pm 0.202 \pm 0.246$
S_4	$-0.119 \pm 0.073 \pm 0.042$	P'_4	$-0.242 \pm 0.148 \pm 0.120$
S_5	$-0.077 \pm 0.054 \pm 0.033$	P'_5	$-0.157 \pm 0.110 \pm 0.102$
A_{FB}	$-0.146 \pm 0.052 \pm 0.035$	P_2	$-0.232 \pm 0.083 \pm 0.112$
S_7	$-0.077 \pm 0.056 \pm 0.038$	P'_6	$-0.155 \pm 0.114 \pm 0.092$
S_8	$0.129 \pm 0.072 \pm 0.056$	P'_8	$0.262 \pm 0.146 \pm 0.137$
S_9	$0.066 \pm 0.045 \pm 0.020$	P_3	$-0.157 \pm 0.107 \pm 0.110$





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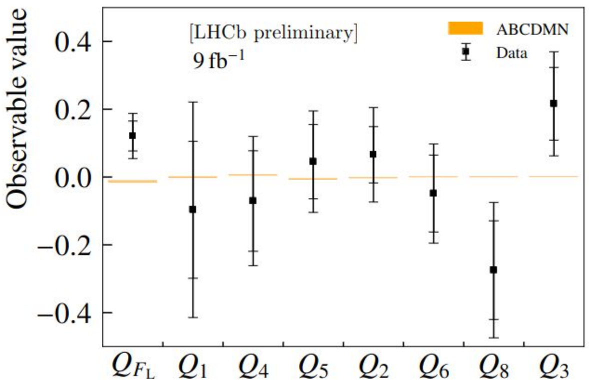
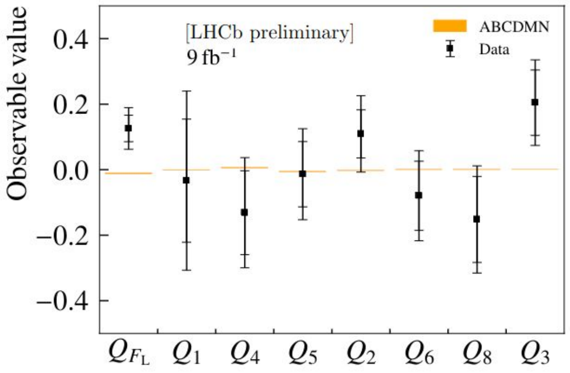
LFU Observables

	$1.1 < q^2 < 6.0\,\mathrm{GeV}^2/c^4$
Q_{F_L}	$0.121 \pm 0.050 \pm 0.050$
Q_1	$-0.097 \pm 0.264 \pm 0.246$
Q_4	$-0.071 \pm 0.173 \pm 0.120$
Q_5	$0.045 \pm 0.132 \pm 0.102$
Q_2	$0.066 \pm 0.098 \pm 0.112$
Q_6	$-0.049 \pm 0.137 \pm 0.092$
Q_8	$-0.275 \pm 0.166 \pm 0.137$
Q_3	$0.216 \pm 0.144 \pm 0.110$

	$1.1 < q^2 < 7.0\,\mathrm{GeV}^2/c^4$
Q_{F_L}	$0.126 \pm 0.046 \pm 0.049$
Q_1	$-0.034 \pm 0.246 \pm 0.199$
Q_4	$-0.131 \pm 0.149 \pm 0.109$
Q_5	$-0.014 \pm 0.119 \pm 0.097$
Q_2	$0.109 \pm 0.086 \pm 0.091$
Q_6	$-0.080 \pm 0.124 \pm 0.088$
Q_8	$-0.152 \pm 0.149 \pm 0.098$
Q_3	$0.205 \pm 0.131 \pm 0.084$





S_i (P_i') correlation matrix

S_i OBSERVABLES IN THE REGION BETWEEN [1.1, 6.0] GeV

[STATISTICAL]

	F_L	S_3	S_4	S_5	A_{FB}	S_7	S_8	S_9
F_L	1.00	0.01	−0.07	0.00	0.06	−0.01	−0.04	−0.06
S_3		1.00	−0.07	−0.02	0.05	0.10	−0.08	−0.01
S_4			1.00	−0.10	−0.10	−0.07	0.09	0.09
S_5				1.00	−0.05	0.06	−0.04	−0.03
A_{FB}					1.00	0.11	−0.07	−0.06
S_7						1.00	−0.07	−0.14
S_8							1.00	−0.01
S_9								1.00

[SYSTEMATICS]

	F_L	S_3	S_4	S_5	A_{FB}	S_7	S_8	S_9
F_L	1.000	0.008	−0.105	−0.151	−0.226	−0.015	0.014	−0.051
S_3		1.000	0.004	−0.055	0.002	0.007	0.015	0.014
S_4			1.000	0.354	0.013	−0.038	0.001	0.006
S_5				1.000	0.084	0.000	−0.033	0.007
A_{FB}					1.000	−0.017	−0.006	0.014
S_7						1.000	0.089	−0.044
S_8							1.000	−0.004
S_9								1.000

$P_i^{(\prime)}$ OBSERVABLES IN THE REGION BETWEEN [1.1, 6.0] GeV

[STATISTICAL]

	F_L	P_1	P_2	P_3	P_4'	P_5'	P_6'	P_8'
F_L	1.00	0.02	−0.20	−0.08	−0.09	−0.02	−0.02	−0.01
P_1		1.00	0.04	0.01	−0.07	−0.02	0.10	−0.08
P_2			1.00	0.06	−0.07	−0.05	0.11	−0.06
P_3				1.00	−0.08	0.03	0.14	0.02
P_4'					1.00	−0.10	−0.07	0.09
P_5'						1.00	0.06	−0.03
P_6'							1.00	−0.07
P_8'								1.00

[SYSTEMATICS]

	F_L	P_1	P_2	P_3	P_4'	P_5'	P_6'	P_8'
F_L	1.00	−0.041	−0.142	0.023	−0.223	−0.326	−0.025	0.011
P_1		1.000	0.009	−0.012	0.001	−0.030	−0.009	0.009
P_2			1.000	0.017	0.067	0.127	0.016	−0.001
P_3				1.000	−0.004	0.002	0.042	0.004
P_4'					1.000	0.418	−0.010	0.000
P_5'						1.000	0.018	−0.025
P_6'							1.000	0.089
P_8'								1.000

from R.S. Coutinho's ICHEP talk

DSL and Combinatorial modelling

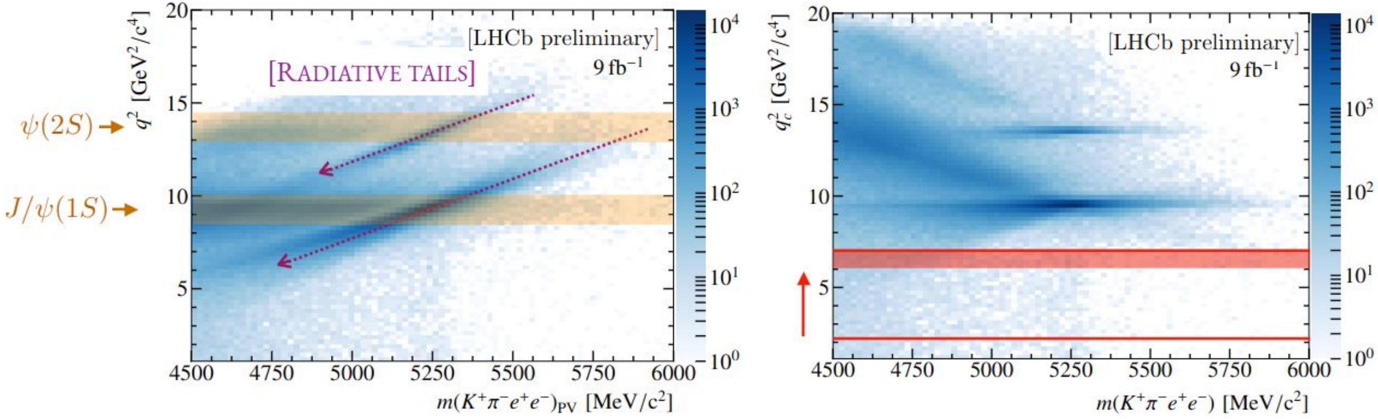
- **Data-drive method:**
  - Possibility to examine full $\cos\theta_\ell$ distribution→exploting full statistic potential of the analysis.
  - LFV Data $K^{*0}e\mu$ *which contains both combinatorial and DSL*

- **Strategy:**
  a. ***Isolate a sample enriched in DSL*** with minimal combinatorial contamination
     - lower B invariant mass range of [4500, 5200] MeV/c2
     - tight cut to the combinatorial MVA output (MVA > 0.9985)
  b. **Fit to angular distributions alone** is performed to obtain the lineshapes of the contribution
  c. **Select independent LFV sub sample <u>not</u> DSL enriched** (containing contributions from both combinatorial and DSL)
  d. Invariant mass and angular fit to obtain the *slope of the DSL*, and the *angular shape and slope of the combinatorial background*

Data Selection

Improved strategy to control signal resolution in electrons:

q^2 defined with B^0 primary vertex and B^0 mass constraint, allowing for the extension of the analysis range up to 7.0 GeV^2/c^4 and reduced bin migration



Analysis performed in two q^2 regimes: [1.1, 6.0] and [1.1, 7.0] GeV^2/c^4

from R.S. Coutinho's ICHEP talk

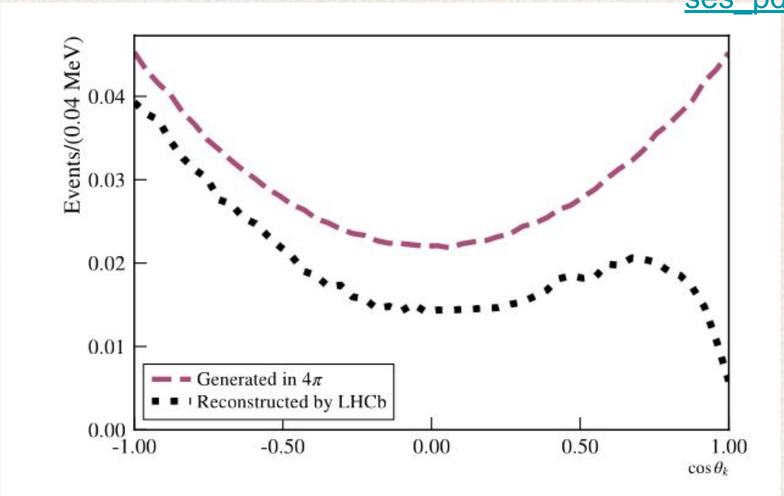
q^2 selection

Constrained q2:

- Variable computed by constraining the signal candidates to originate from the primary vertex and to have an invariant mass corresponding to the nominal mass of the B0 meson.
- The lower bound in the central q2 bin, which is set to 1.1 GeV2/c4 motivated to make the contribution from the background $\phi \rightarrow$ e+e- negligible

Acceptance parametrisation

Plot from https://www.nikhef.nl/pub/services/biblio/theses_pdf/thesis_A_Snoch.pdf



Distortion of angular distributions from:

- selection and reconstructions
- Resolution effects

Effective approach that parametrise all these effects together