第六届LHCb前沿物理研讨会

LHCb Overview

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2026年5月23日

Outline

- Introduction
- CKM matrix & CPV
- FCNC & LFU
- Spectroscopy
- EW & Heavy ions
- Prospects

Publication increased since last workshop

768 → 848

The LHCb detector @ Run1+2

- A single-arm forward spectrometer covering $2 < \eta < 5$
- Designed for heavy flavour physics

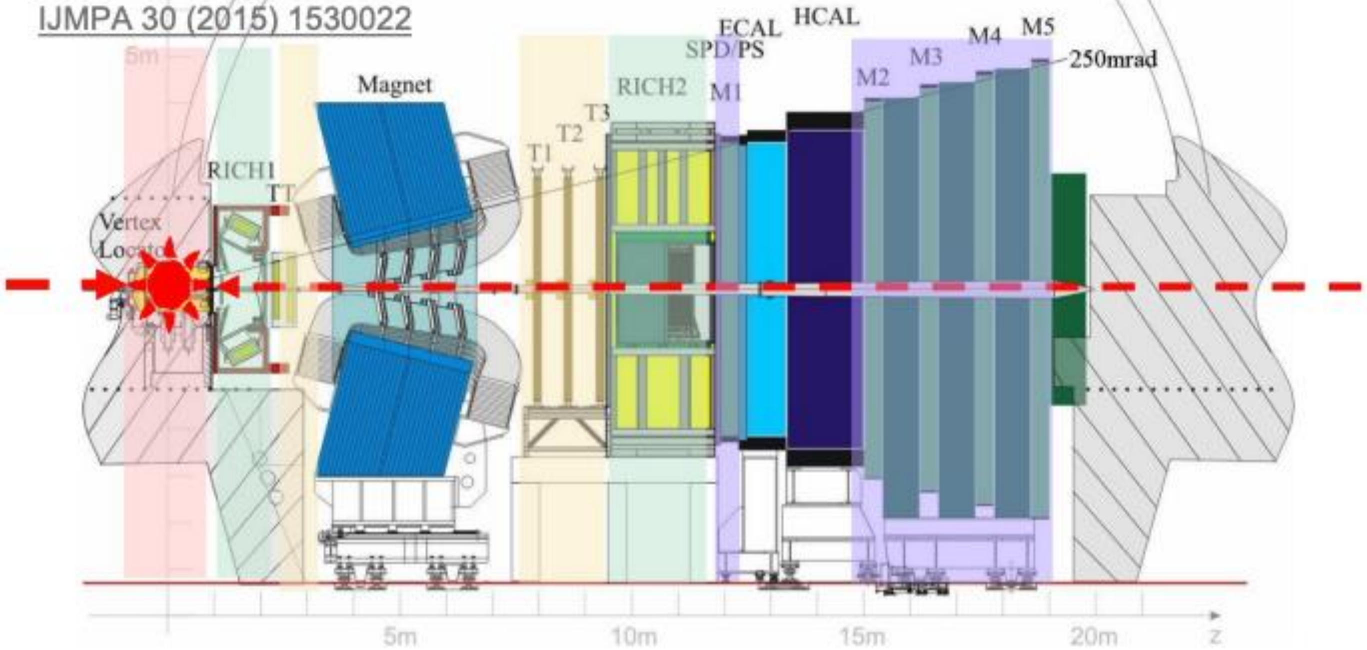
Vertex Locator
$\sigma_{IP} \sim 15 + 29/p_T$ μm
$\sigma_\tau \sim 45$ fs

Tracking system
$\epsilon_{tracking} \sim 96\%$
$\sigma_p/p \sim 0.5\% - 1\%$ (5 – 200 GeV)

RICHs
$\epsilon(K \to K) \sim 95\%$
mis-ID $\epsilon(\pi \to K) \sim 5\%$

Muon system
$\epsilon(\mu \to \mu) \sim 97\%$
mis-ID $\epsilon(\pi \to \mu) \sim 1 - 3\%$

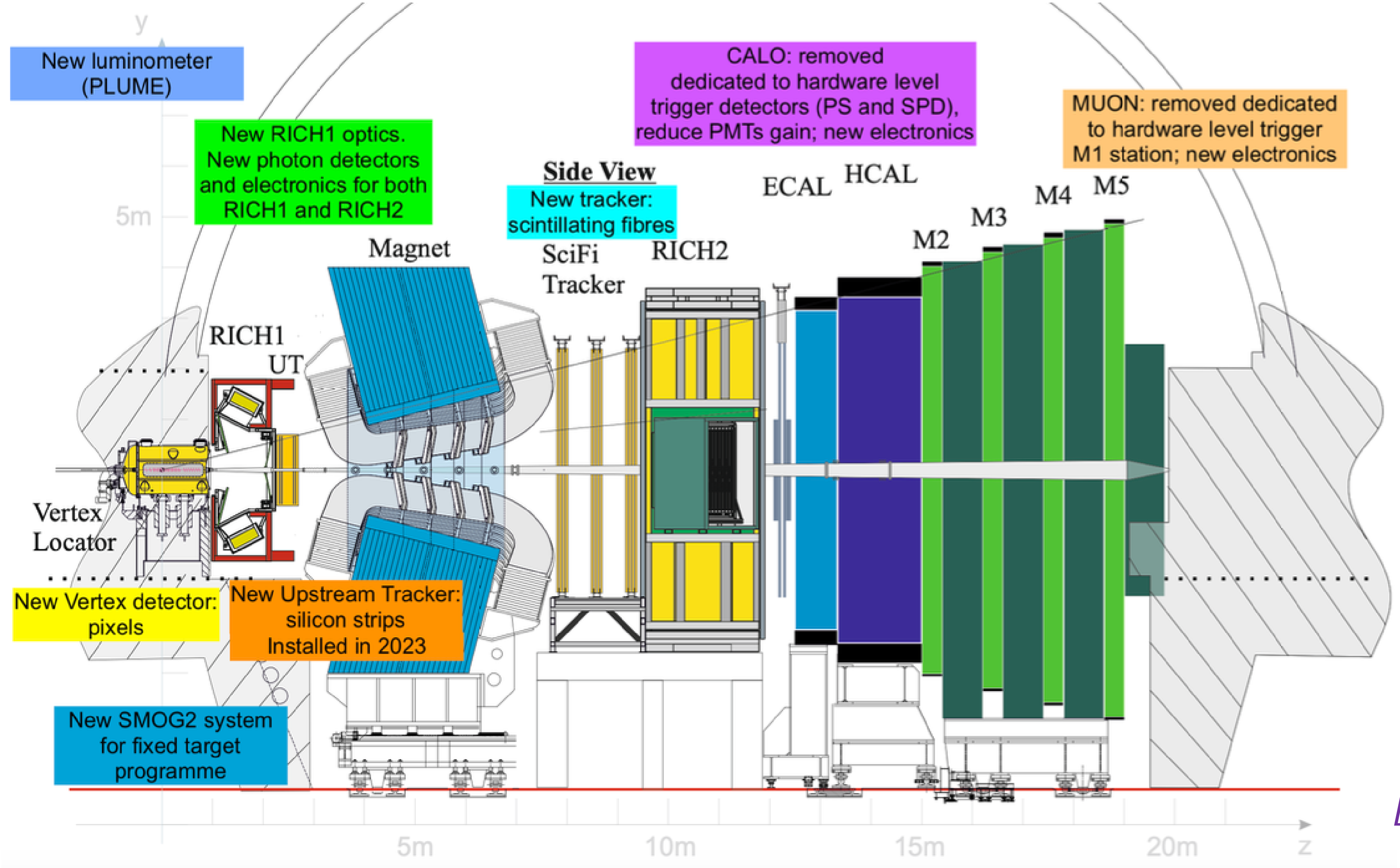
JINST 3 (2008) S08005
IJMPA 30 (2015) 1530022



LHC: heavy hadron factory
LHCb:
- precise vertex resolution
- good momentum and mass resolution
- powerful particle identification

LHCb is highly competitive in heavy flavour spectroscopy

The LHCb detector @ Run 3



[LHCb-DP-2022-002]

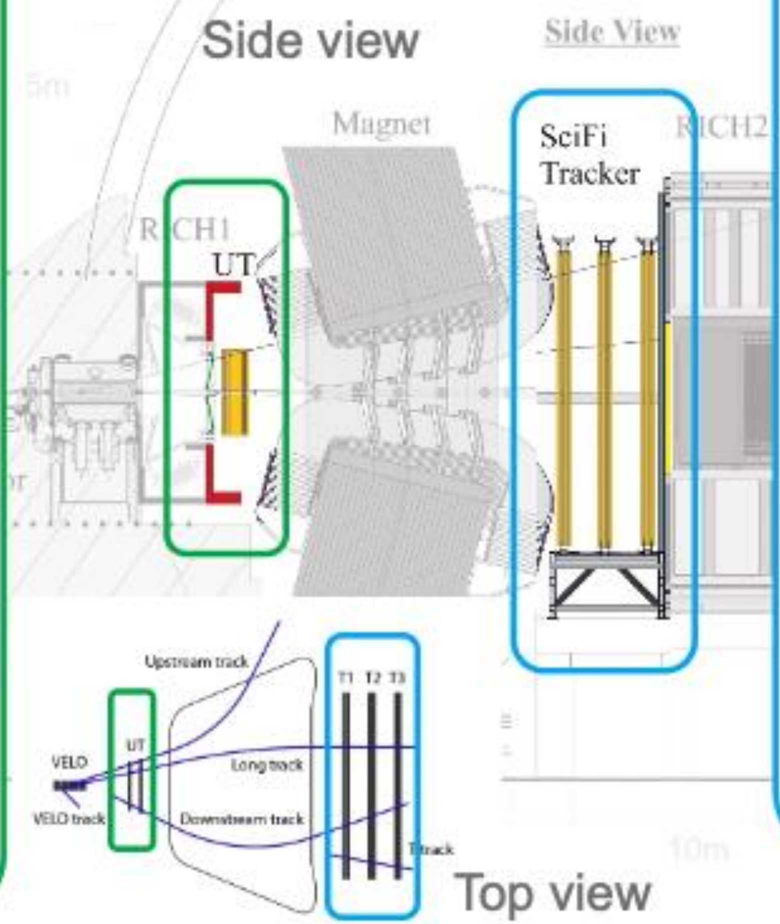
Excellent momentum resolution

Excellent particle idenfication

Contributions from China

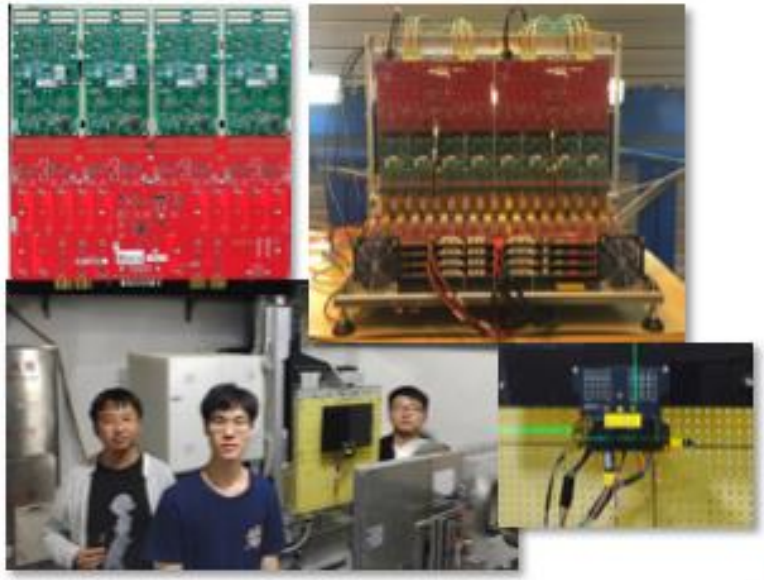
Upstream Tracker / UT

- UT installation & operation
- Irradiation study of SALT chip with Chinese facilities
- Control & safety software



Scintillator Fiber Tracker / SciFi

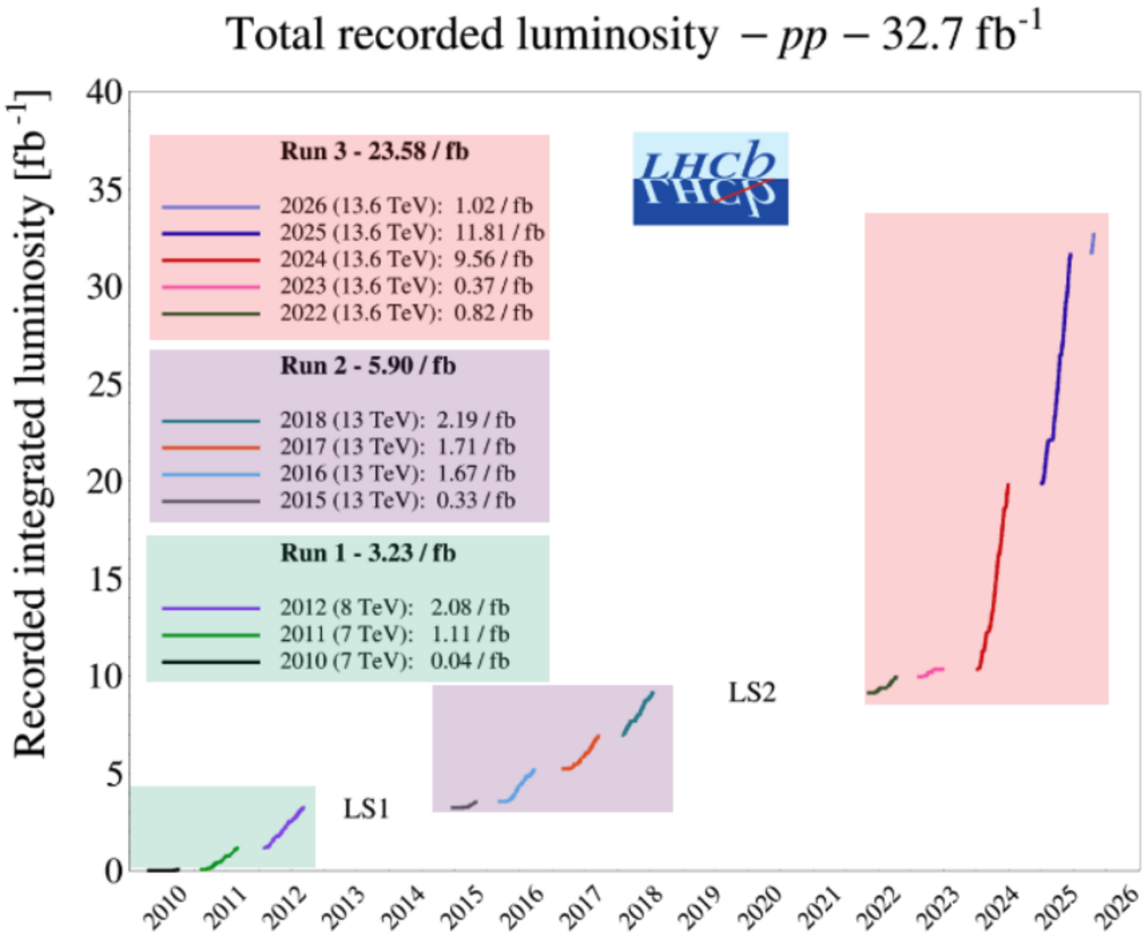
- FE board design and production (>2500 PCB)
- Quality assurance system
- Study of radiation damage on SiPM



Taken from Yiming's talk

LHCb Run 3

- **Higher luminosity**
  - $5\times$ larger instantaneous luminosity $2\times10^{33}\mathrm{cm}^{-2}\mathrm{s}^{-1}$
  - Run 3: >2× integrared luminosity of Run 1+2
- **Fully software-based trigger**
  - Removal of the hardware trigger improves trigger efficiency for fully hadronic final states by $> 2\times$



Run 3 finale today : From protons to ions

V and CKM matrix

Details in Youhua's talk

Testing the CKM paradigm

➢ Yukawa couplings break the symmetry between different flavours

$$\mathcal{L}_{\rm SM} = \mathcal{L}_{\rm gauge}(\Psi_i, A_\alpha) + \underline{\mathcal{L}_{\rm Higgs}(\varphi, A_\alpha, \Psi_i)}$$

Yukawa basis ≠ weak interaction basis

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

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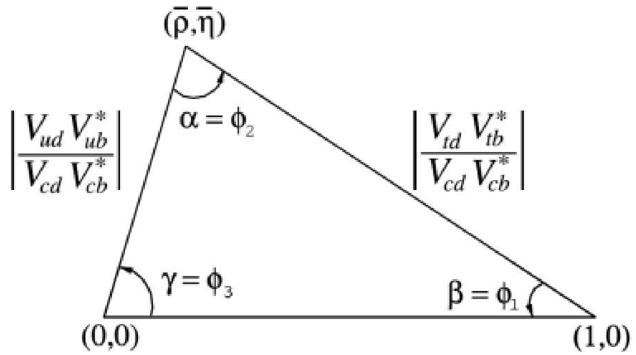
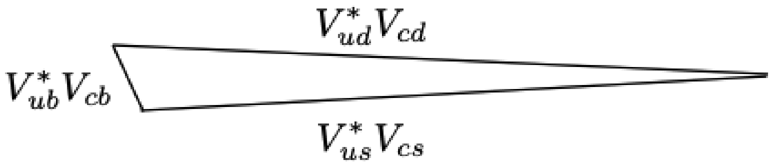
Unitarity $V_{ud}V_{ub}^* + V_{cd}V_{cb}^* + V_{td}V_{tb}^* = 0$

B^0 meson



D^0 meson (not to scale)



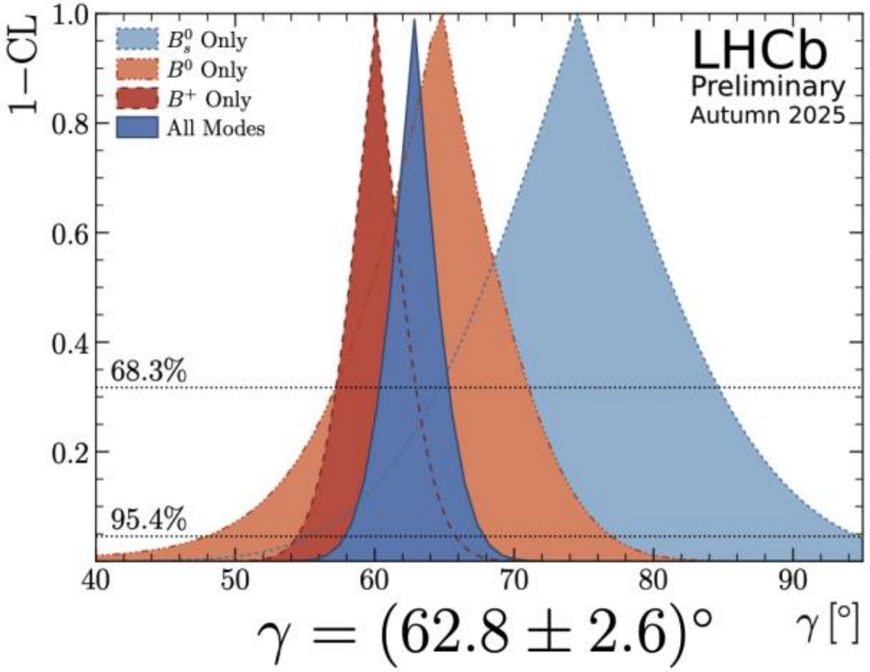
Precision test of the consistency ~ probe (CP-violating) NP

Not just B decays: test consistency across all generations

New CKM angle γ combination

3 new inputs

B decay	D decay	Ref.	Dataset
$B^\pm \to Dh^\pm$	$D \to h^\pm h'^\mp$	[29]	Run 1&2
$B^\pm \to Dh^\pm$	$D \to h^+h^-\pi^+\pi^-$	[30]	Run 1&2
$B^\pm \to Dh^\pm$	$D \to h^+h^-\pi^+\pi^-$	[20]	Run 1&2
$B^\pm \to Dh^\pm$	$D \to K^\pm\pi^\mp\pi^+\pi^-$	[24]	Run 1&2
$B^\pm \to Dh^\pm$	$D \to h^\pm h'^\mp\pi^0$	[31]	Run 1&2
$B^\pm \to Dh^\pm$	$D \to K^0_S h^+h^-$	[32]	Run 1&2
$B^\pm \to Dh^\pm$	$D \to K^0_S K^\pm\pi^\mp$	[33]	Run 1&2
$B^\pm \to D^*h^\pm$	$D \to h^\pm h'^\mp$ (PR)	[29]	Run 1&2
$B^\pm \to D^*h^\pm$	$D \to K^0_S h^+h^-$ (PR)	[34]	Run 1&2
$B^\pm \to D^*h^\pm$	$D \to K^0_S h^+h^-$ (FR)	[35]	Run 1&2
$B^\pm \to DK^{*\pm}$	$D \to h^\pm h'^\mp$	[36]	Run 1&2
$B^\pm \to DK^{*\pm}$	$D \to h^\pm\pi^\mp\pi^+\pi^-$	[36]	Run 1&2
$B^\pm \to DK^{*\pm}$	$D \to K^0_S h^+h^-$	[36]	Run 1&2
$B^\pm \to Dh^\pm\pi^+\pi^-$	$D \to h^\pm h'^\mp$	[37]	Run 1
$B^0 \to DK^{*0}$	$D \to h^\pm h'^\mp$	[38]	Run 1&2
$B^0 \to DK^{*0}$	$D \to h^\pm\pi^\mp\pi^+\pi^-$	[38]	Run 1&2
$B^0 \to DK^{*0}$	$D \to K^0_S h^+h^-$	[39]	Run 1&2
$B^0 \to D^\mp\pi^\pm$	$D^+ \to K^-\pi^+\pi^+$	[40]	Run 1
$B^0_s \to D_s^\mp K^\pm$	$D_s^+ \to h^+h^-\pi^+$	[41, 42]	Run 1&2
$B^0_s \to D_s^\mp K^\pm\pi^+\pi^-$	$D_s^+ \to h^+h^-\pi^+$	[43]	Run 1&2
D decay	**Observable(s)**	**Ref.**	**Dataset**
$D^0 \to h^+h^-$	ΔA_{CP}	[44–46]	Run 1&2
$D^0 \to K^+K^-$	$A_{CP}(K^+K^-)$	[46–48]	Run 2
$D^0 \to h^+h^-$	$y_{CP} - y_{CP}^{K^-\pi^+}$	[49, 50]	Run 1&2
$D^0 \to h^+h^-$	ΔY	[51–54]	Run 1&2
$D^0 \to K^\pm\pi^\mp$ (double tag)	$R^\pm$, $(x'^\pm)^2$, $y'^\pm$	[21, 27]	Run 1&2
$D^0 \to K^\pm\pi^\mp$ (single tag)	$R_{K\pi}$, $\overset{(\sim)}{A}_{K\pi}$, $c_{K\pi}^{(\prime)}$, $\Delta\overset{(\sim)}{c}{}^{(\prime)}_{K\pi}$	[55, 56]	Run 1&2
$D^0 \to K^\pm\pi^\mp\pi^+\pi^-$	r, $\kappa y'$, $(x^2+y^2)/4$	[28]	Run 1
$D^0 \to K^\pm\pi^\mp\pi^+\pi^-$	$r_i^\pm$, $(\kappa y'^\pm)_i$, $x^{2\pm}+y^{2\pm}$	[22]	Run 2
$D^0 \to K^0_S\pi^+\pi^-$	x, y	[57]	Run 1
$D^0 \to K^0_S\pi^+\pi^-$	x_{CP}, y_{CP}, Δx, Δy	[58]	Run 1
$D^0 \to K^0_S\pi^+\pi^-$	x_{CP}, y_{CP}, Δx, Δy	[59, 60]	Run 2
$D^0 \to \pi^+\pi^-\pi^0$	$\Delta Y^{\rm eff}$	[61]	Run 2



[LHCb-CONF-2025-003]

2024 LHCb average: $\gamma = (64.6 \pm 2.8)°$

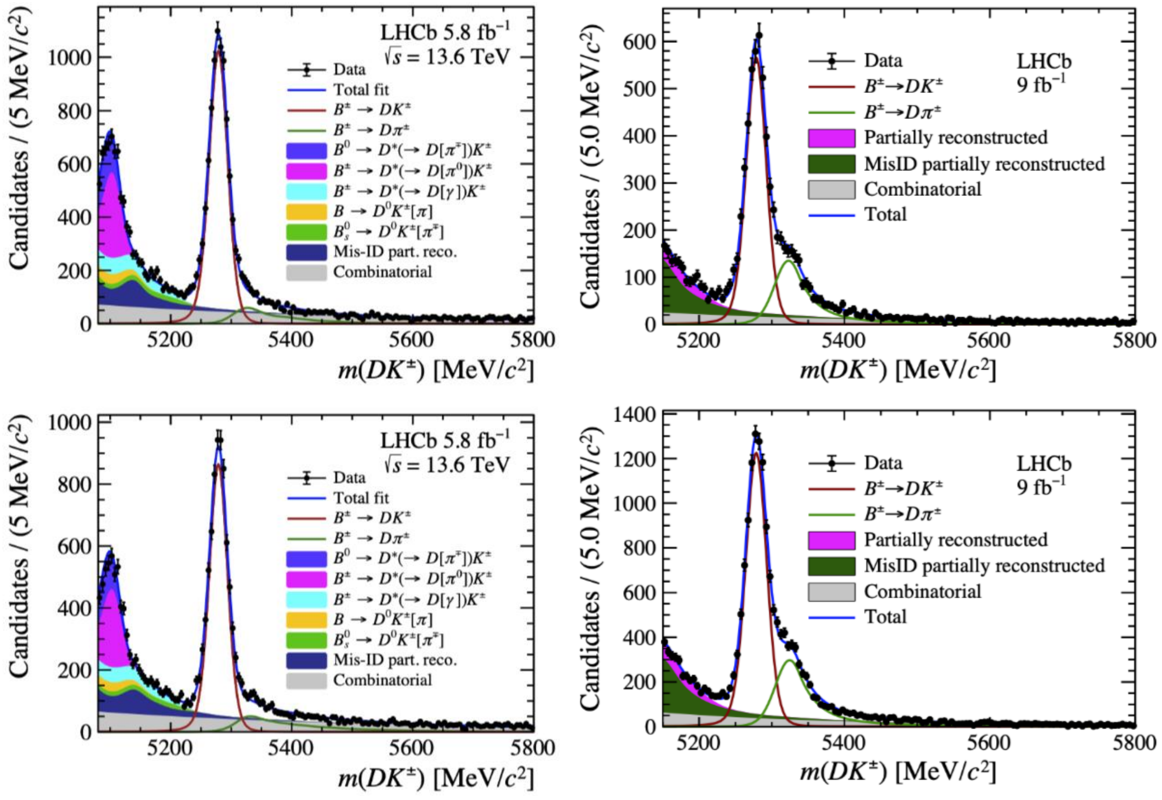
2025 LHCb average: $\gamma = (62.8 \pm 2.6)°$

Precision brought to below $3°$, not using LHCb Run 3 data

CKM angle γ with Run 3 data

- $5.8\ \mathrm{fb}^{-1}$ data in 2024

2024 Run 1+ Run 2



[LHCb-PAPER-2026-010]

- Method: Classic binned Dalitz-plot approach (same strategy as Run 1+2)
  - $D \to K_S^0\pi^+\pi^-$ (optimal binning), $D \to K_S^0K^+K^-$ (2-bin)
  - External strong-phase inputs c_i, s_i from BESIII

CKMFitter

$\gamma_{\mathrm{indirect}} = (66.3^{+0.7}_{-1.9})^\circ$

UTFit

$\gamma_{\mathrm{indirect}} = (65.6 \pm 1.4)^\circ$

Preliminary

$\gamma = (68.1 \pm 6.7)^\circ$

Huge potential for LHCb Run 3
primarily hadronic modes, large gain by new trigger

Unbinned measurement of CKM angle γ

- Joint analysis between BESIII and LHCb experiment

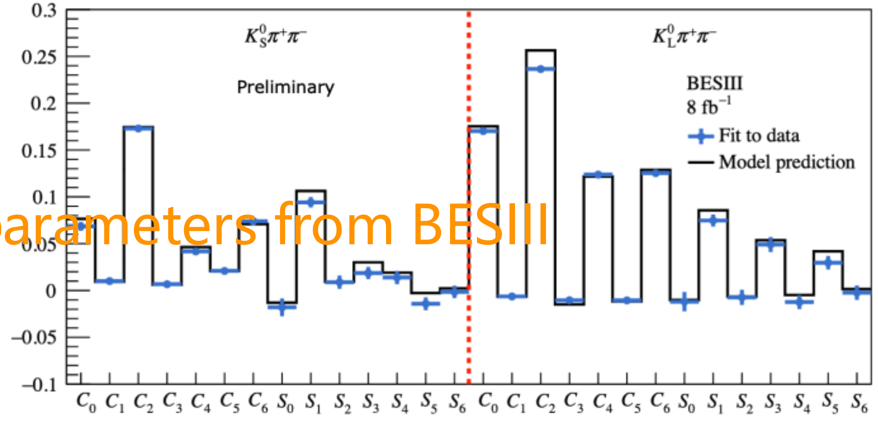
[LHCb-PAPER-2025-063]
[LHCb-PAPER-2025-064]

- In $B^\pm \to D(\to K_S^0 hh)h^\pm$ decay:

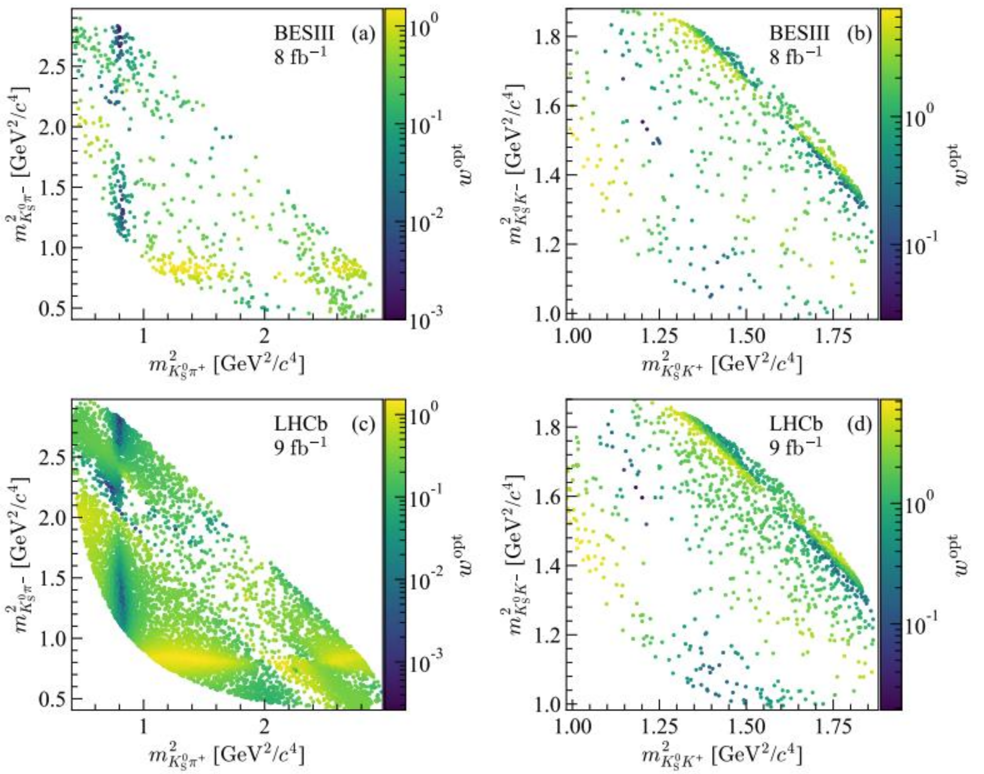
$$B^-: p_B(\mathbf{z}) \propto p_D(\mathbf{z}) + (x_-^2 + y_-^2)\bar{p}_D(\mathbf{z}) + 2[x_-\mathcal{C}(\mathbf{z}) + y_-\mathcal{S}(\mathbf{z})]$$
$$B^+: \bar{p}_B(\mathbf{z}) \propto \bar{p}_D(\mathbf{z}) + (x_+^2 + y_+^2)p_D(\mathbf{z}) + 2[x_+\mathcal{C}(\mathbf{z}) - y_+\mathcal{S}(\mathbf{z})]$$

$D^0/\bar{D}^0 \to K_S^0 h^+ h^-$ decay density

$\{\mathcal{C},\mathcal{S}\} = \sqrt{p_D \bar{p}_D}\{\cos,\sin\}(\phi)$



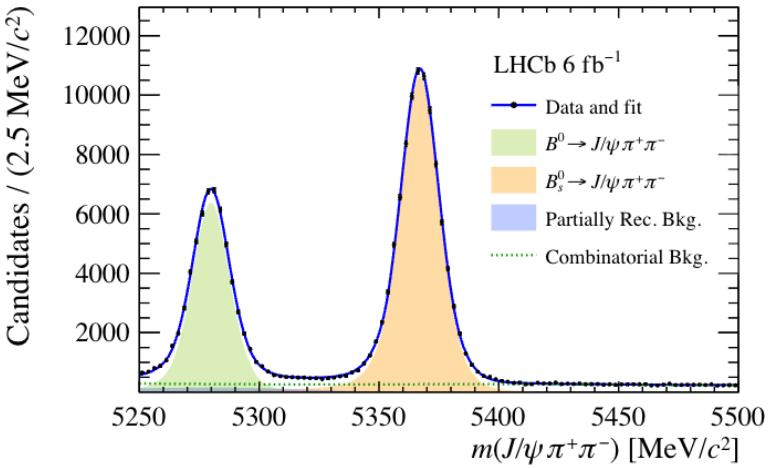
Strong Phase parameters from BESIII

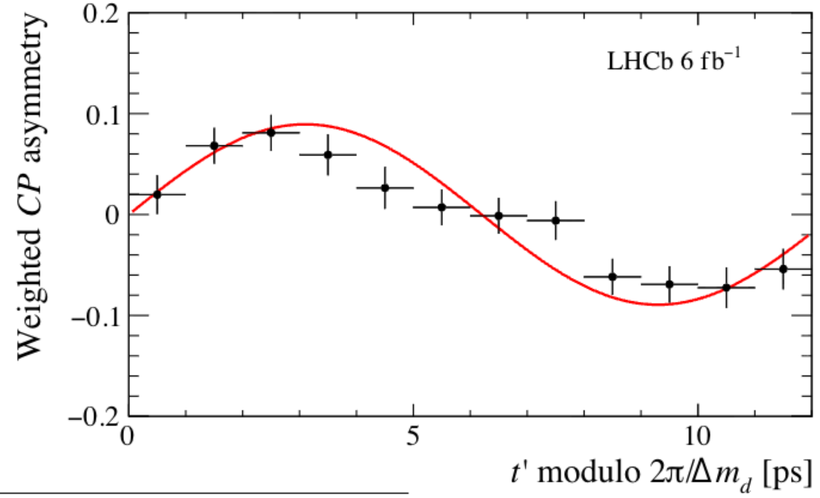


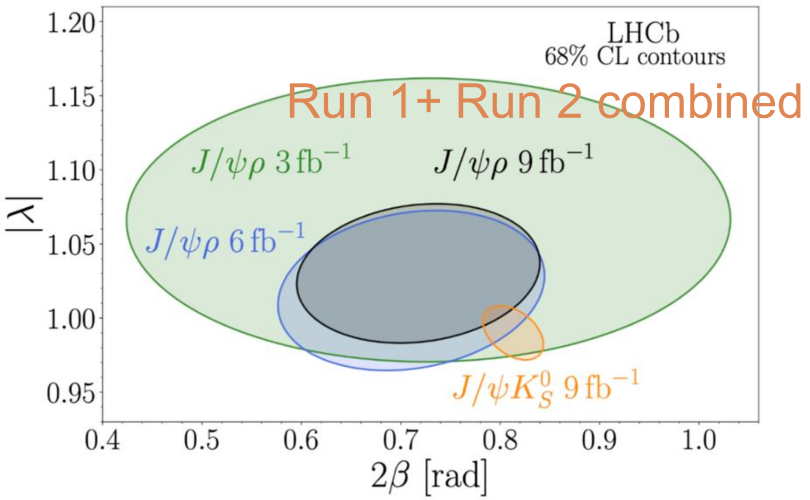
- Unbinned Fourier (novel):
  - Improved statistical precision than binned methods (~5% improvement)

Observation of CPV in $B^0 \to J/\psi\rho^0$ Decays

- First time-dependent CPV observed in charmonium + vector final state via $b \to c\bar{c}d$ transition (Run 2 data)
- Full 6D amplitude analysis: decay time $+m(\pi^+\pi^-)$ + 3 helicity angles







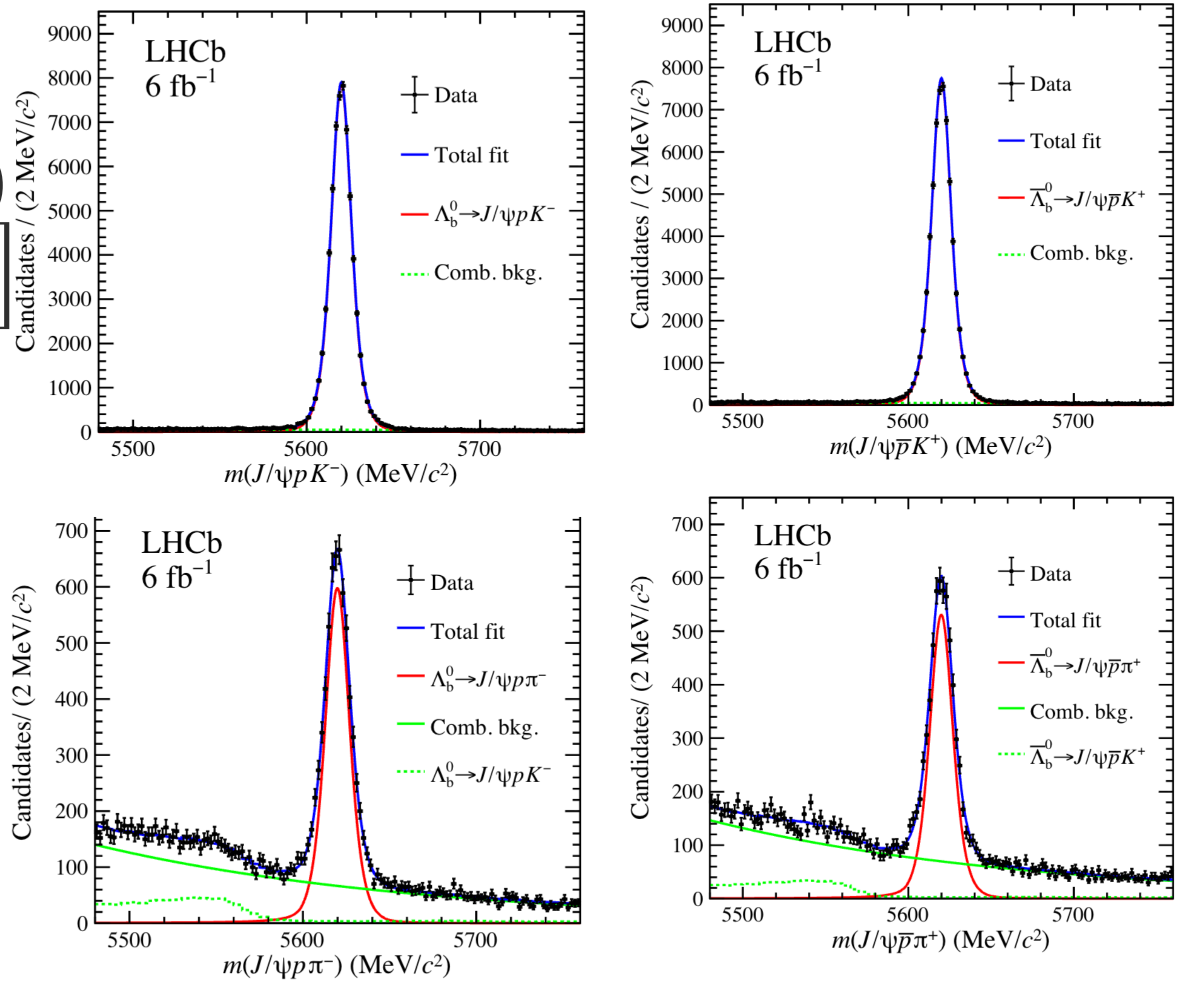
Parameter	Value		
$2\beta^{\rm eff}_{c\bar{c}d}$ [rad]	0.710	$\pm$ 0.084	$\pm$ 0.028
$\lvert\lambda\rvert$	1.019	$\pm$ 0.034	$\pm$ 0.009

Penguin-induced phase shift : $\boldsymbol{\Delta\phi_s = 5.0 \pm 4.2}$ ***mrad***

[LHCb-PAPER-2025-059]

CPV in *b* baryon to charmonium decays

- Penguin contributions expected to enhance asymmetry in $\Lambda_b^0 \to J/\psi p\pi^-$
- Observable:
  - $\Delta A_{CP} \equiv A_{CP}\left(\Lambda_b^0 \to J/\psi p\pi^-\right) - A_{CP}\left(\Lambda_b^0 \to J/\psi p\pi^-\right)$
  - $A_{\tilde{T}-\mathrm{odd}} \equiv \frac{1}{2}\left[\frac{N(C_{\tilde{T}}>0)-N(C_{\tilde{T}}\leq 0)}{N(C_{\tilde{T}}>0)+N(C_{\tilde{T}}\leq 0)} - \frac{N(-C_{\tilde{T}}>0)-N(-C_{\tilde{T}}\leq 0)}{N(-C_{\tilde{T}}>0)+N(-C_{\tilde{T}}\leq 0)}\right]$



- Run 2 results $\Delta A_{CP} = (4.03 \pm 1.18 \pm 0.23)\%$
- Combined with previous LHCb result:

$\Delta A_{CP} = (4.31 \pm 1.06 \pm 0.28)\%$ $\Rightarrow$ 3.9σ First

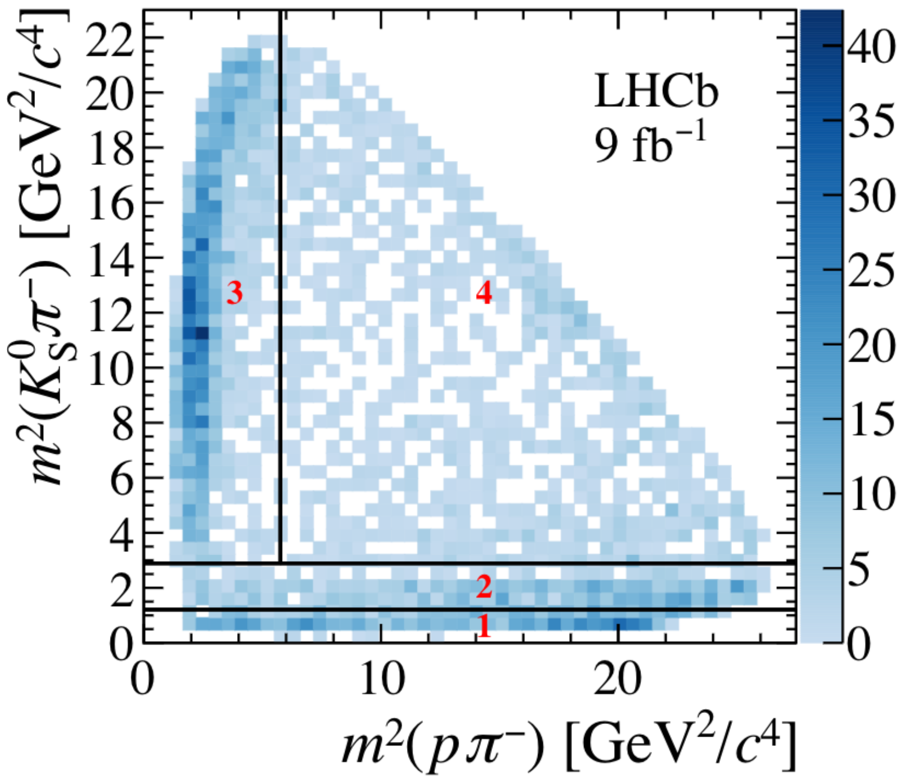
[Science Bulletin 71 (2026) 547]

CPV in $\Lambda_b^0(\Xi_b^0) \to pK_S^0 h^-$ Decays

- New observations (both 8σ):
  $\Lambda_b^0 \to pK_S^0 K^-$, $\Xi_b^0 \to pK_S^0 K^-$

- Integrated A_{CP}(all consistent with zero)

$$A_{CP}(\Lambda_b^0 \to pK_S^0\pi^-) = (3.4 \pm 1.9 \pm 0.9)\%$$
$$A_{CP}(\Lambda_b^0 \to pK_S^0 K^-) = (2 \pm 13 \pm 9)\%$$
$$A_{CP}(\Xi_b^0 \to pK_S^0 K^-) = (22 \pm 15 \pm 11)\%$$



[LHCb-PAPER-2025-016]

	$m(p\pi^-)$	$m(K_S^0\pi^-)$	Yield	$\mathcal{A}^{CP}$ [%]
Bin 1	-	$< 1.1\,\mathrm{GeV}/c^2$	821 ± 34	$-0.6 \pm 4.0 \pm 1.9$
Bin 2	-	$[1.1, 1.7]\,\mathrm{GeV}/c^2$	870 ± 40	$12.4 \pm 4.2 \pm 1.8$
Bin 3	$\leq 2.4\,\mathrm{GeV}/c^2$	$> 1.7\,\mathrm{GeV}/c^2$	2200 ± 50	$0.5 \pm 2.4 \pm 1.1$
Bin 4	$> 2.4\,\mathrm{GeV}/c^2$	$> 1.7\,\mathrm{GeV}/c^2$	840 ± 50	$3.3 \pm 5.5 \pm 2.0$

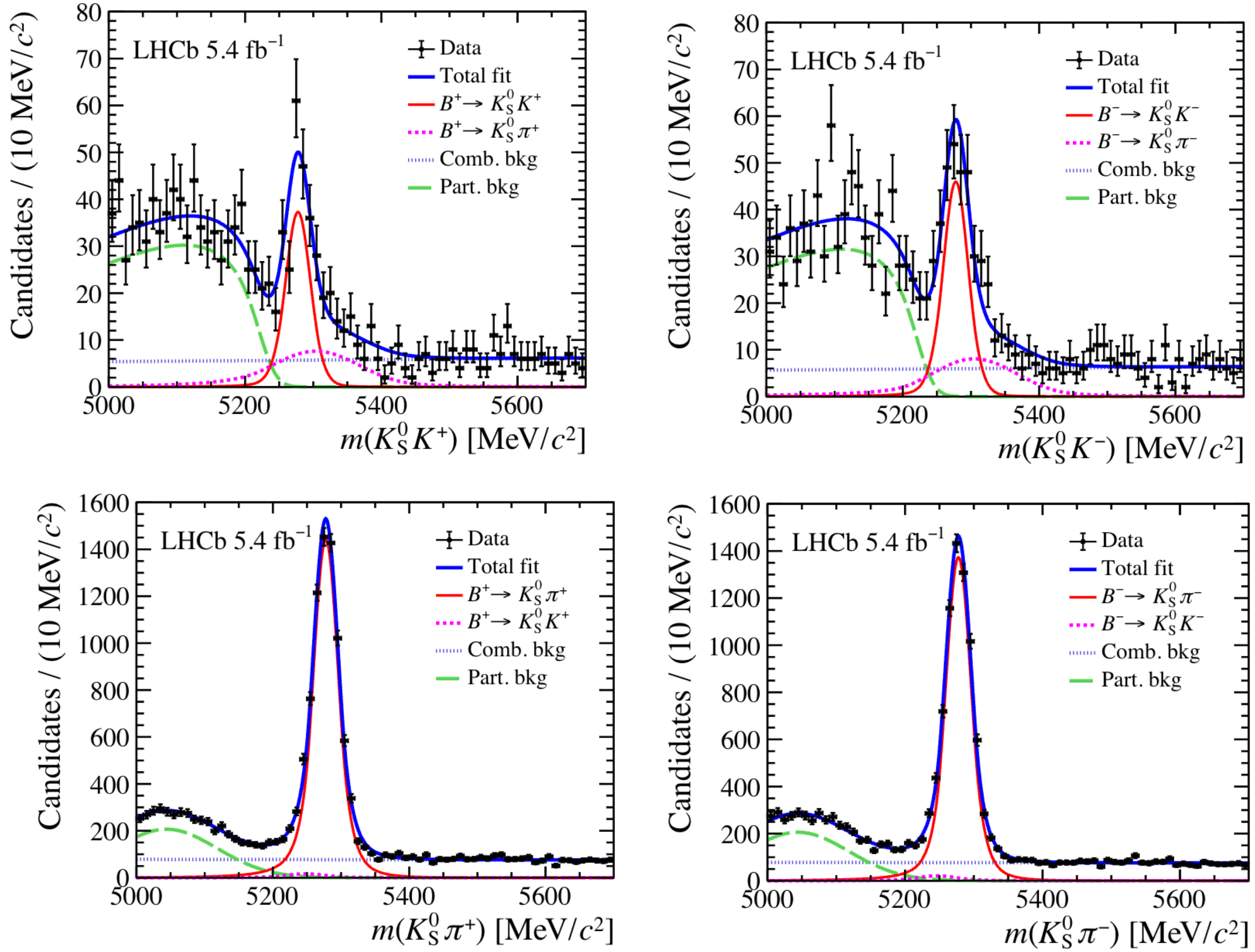
CPV in $B^{\pm} \to K_S^0 h^{\pm}$ (SM Null-Test)

- Data: 5.4 fb^{-1} at 13 TeV (Run 2)

- Key channel: $B^+ \to K_S^0 \pi^+$
  - Pure penguin $b \to sd\bar{d}$
  - SM prediction: $\mathcal{A}^{CP} \approx 0$

$$\mathcal{A}^{CP}\left(B^{\pm} \to K_S^0 \pi^{\pm}\right) = -0.028 \pm 0.009 \pm 0.009$$
$$\mathcal{A}^{CP}\left(B^{\pm} \to K_S^0 K^{\pm}\right) = 0.118 \pm 0.062 \pm 0.031$$

consistent with SM predictions



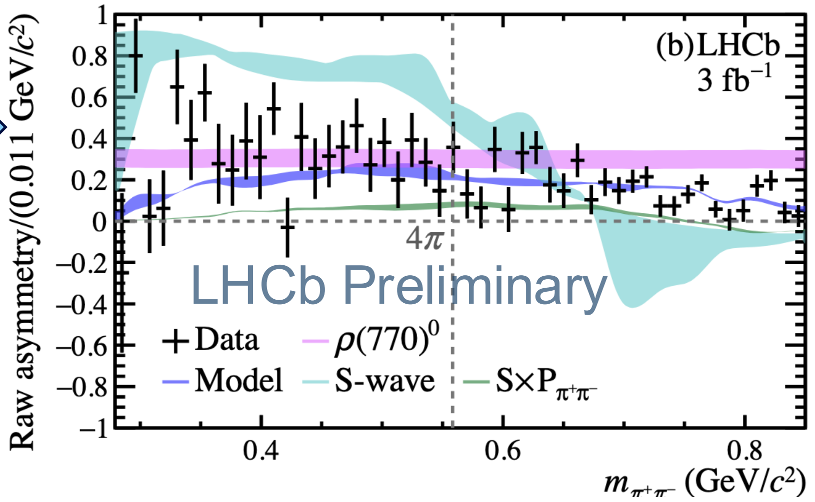
[LHCb-PAPER-2025-049]

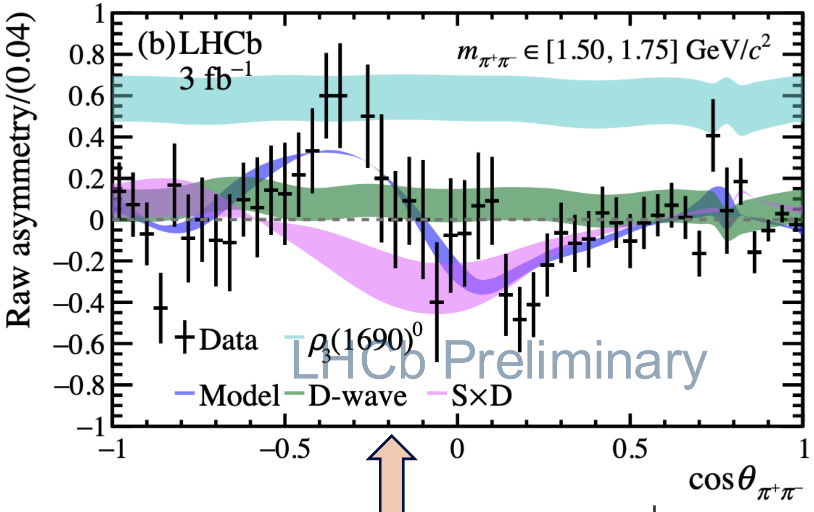
Observation of CPVs in $B^+ \to K^+\pi^+\pi^-$ decays

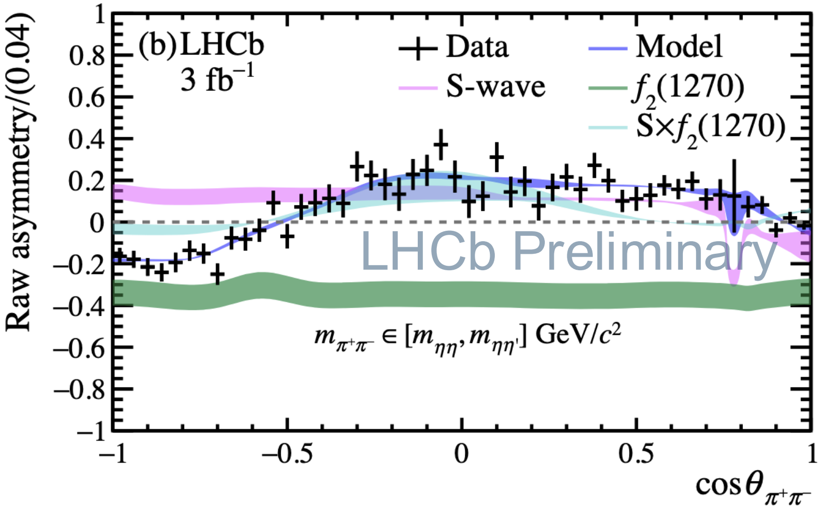
Raw asymmetry = $\frac{N^- - N^+}{N^- + N^+}$

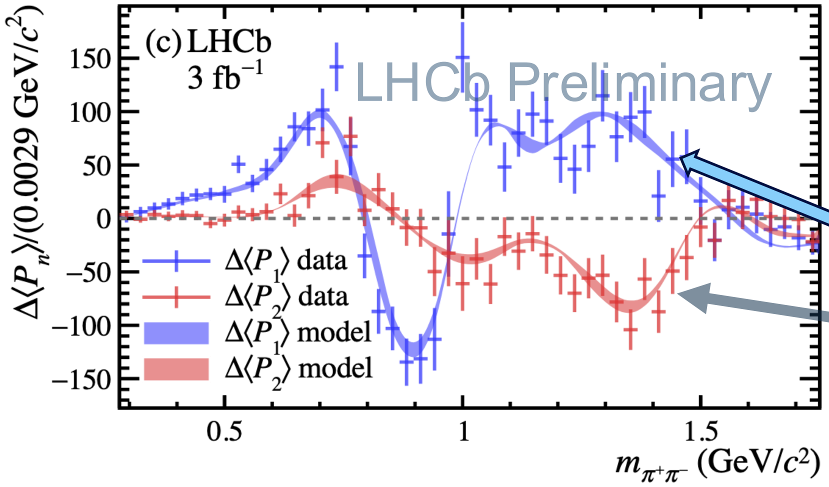
CPV in $B^+ \to \rho(770)^0 K^+$

CPV in $B^+ \to f_2(1270)^0 K^+$









- Raw asymmetry = $\frac{N^- - N^+}{N^- + N^+}$
  - CPV in $B^+ \to \rho_3(1690)^0 K^+$
- Different of Legendre moment $\Delta\langle P_n\rangle \equiv \langle P_n\rangle_{B^-} - \langle P_n\rangle_{B^+}$
  - CPV in the interference between S-P and S-D waves

[LHCb-PAPER-2025-067/068]

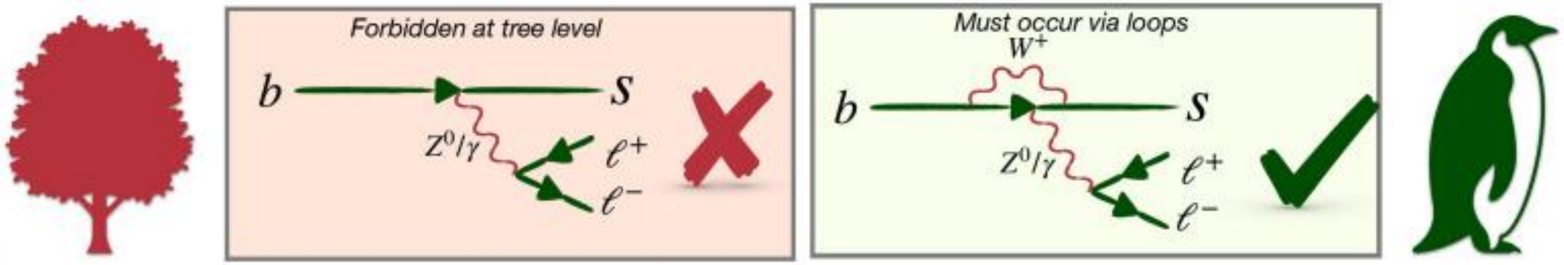
Details in Youhua's talk

FCNC & LFU

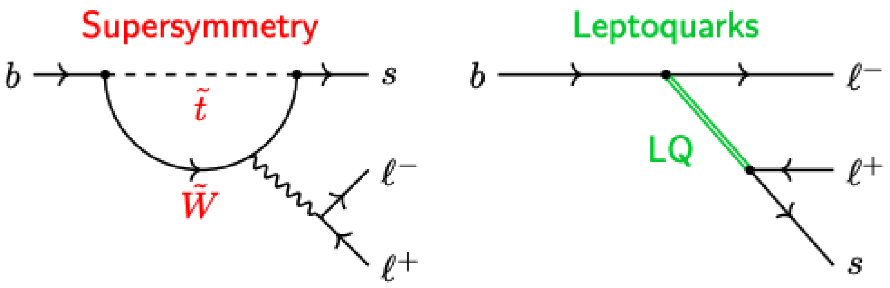
Details in Jibo's talk

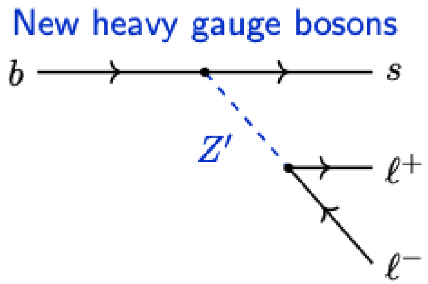
FCNC decays as sensitive probes for New Physics

In the Standard Model



Possible contributions from NP





Look for deviations from SM predictions

- FCNC forbidden at tree level in the SM
- FCNC decays heavily (loop) suppressed in the SM
- New heavy particles can significantly contribute and affect branching fractions, angular distributions, and rate asymmetries

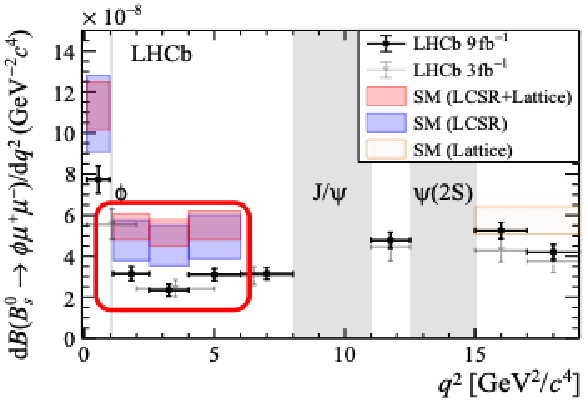
$b \to s\ell\ell$ Observables

Increasing precision of SM prediction

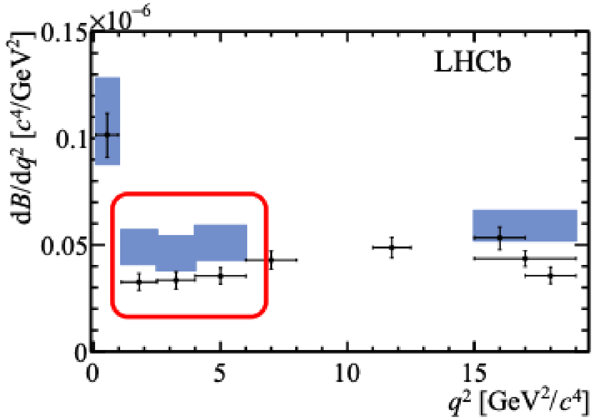
Consistently low $\mathfrak{B}$ found in $b \to s\mu\mu$

Branching fractions

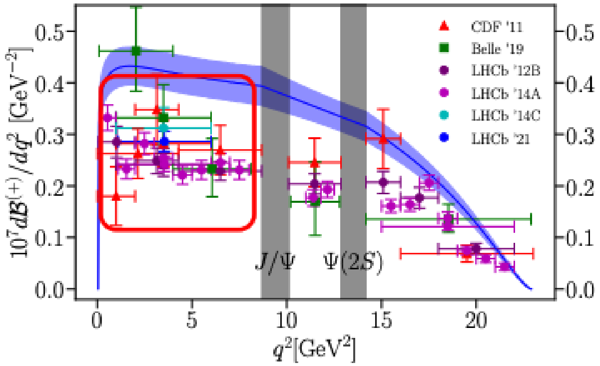
LHCb $B_s^0 \to \phi\mu^+\mu^-$ [PRL 127 (2021) 151801]



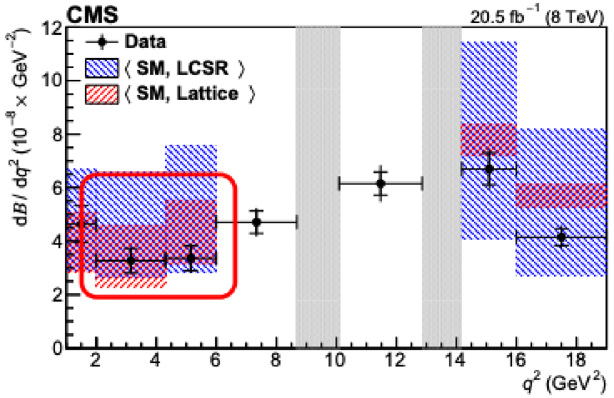
LHCb $B^0 \to K^{*0}\mu^+\mu^-$ [JHEP 11 (2016) 047]



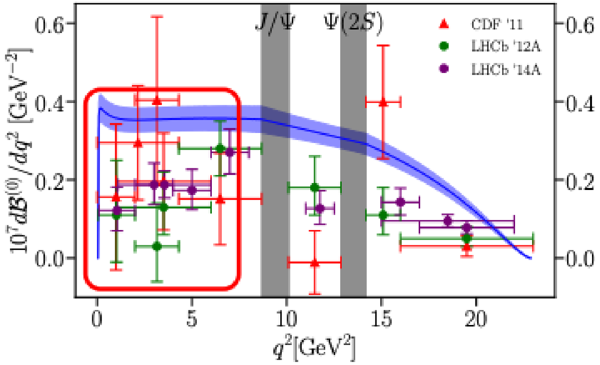
$B^+ \to K^+\mu^+\mu^-$ [HPQCD, PRD 107 (2023) 1]



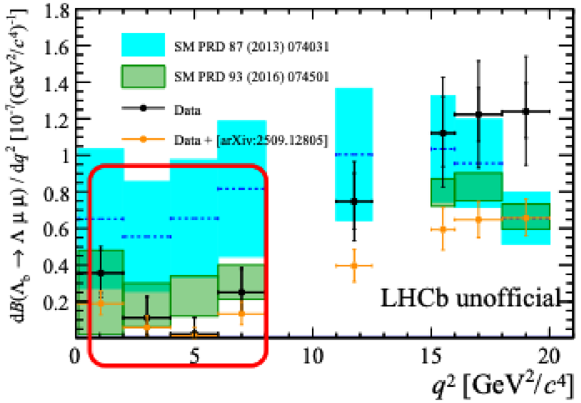
CMS $B^0 \to K^{*0}\mu^+\mu^-$ [PLB 753 (2016) 424]



$B^0 \to K^0\mu^+\mu^-$ [HPQCD, PRD 107 (2023) 1]



LHCb $\Lambda_b^0 \to \Lambda\mu^+\mu^-$ [JHEP 06 (2015) 115]

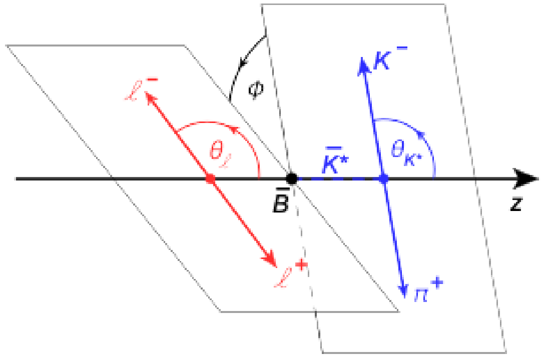


- Consistently below SM, tensions at $1-3\sigma$ level (significant hadronic uncertainties)
- $B^+ \to \bar{\Lambda}p\mu^+\mu^-$ explored recently, in agreement with the SM *[arXiv:2601.06878]*

Angular analysis of $B \to K^{*0}[\to K\pi]\mu^+\mu^-$

Angular distribution

- Fit of 5D PDF to determine CP-symmetries S_i and CP-asymmetries A_i

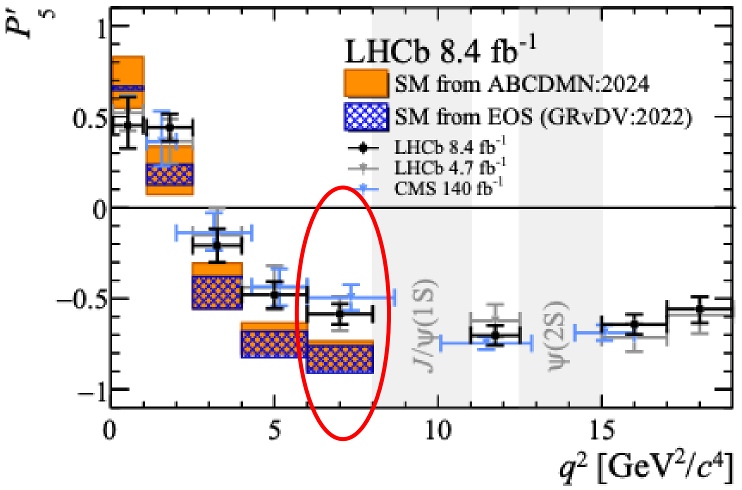


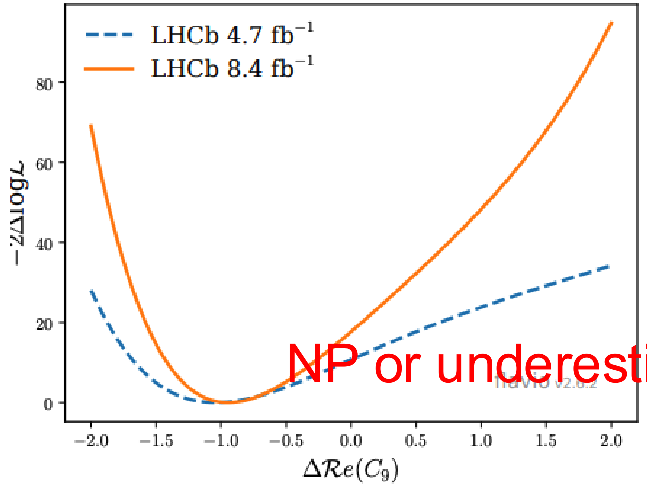
$$\frac{1}{\mathrm{d}(\Gamma+\bar{\Gamma})/\mathrm{d}q^2}\frac{\mathrm{d}^5\overleftrightarrow{\Gamma}}{\mathrm{d}q^2\mathrm{d}m_{K\pi}\mathrm{d}\vec{\Omega}} = (1-\hat{F}_S)\frac{9}{64\pi}\sum_i (S_i \pm A_i) f_i(\vec{\Omega})|\mathcal{BW}_P(m_{K\pi})|^2 \quad \text{P-wave}$$

$$+\frac{1}{8\pi}\sum_j (\tilde{S}_j \pm \tilde{A}_j) f_j(\vec{\Omega}) F(m_{K\pi}) \quad \text{S-wave+interference}$$

$$P_5' = \frac{S_5}{\sqrt{F_L(1-F_L)}}$$

Optimized angular





Wilson coefficients

$$\Delta\mathcal{R}eC_9 = -0.93^{+0.18}_{-0.16}$$

Significance $4.1\,\sigma$

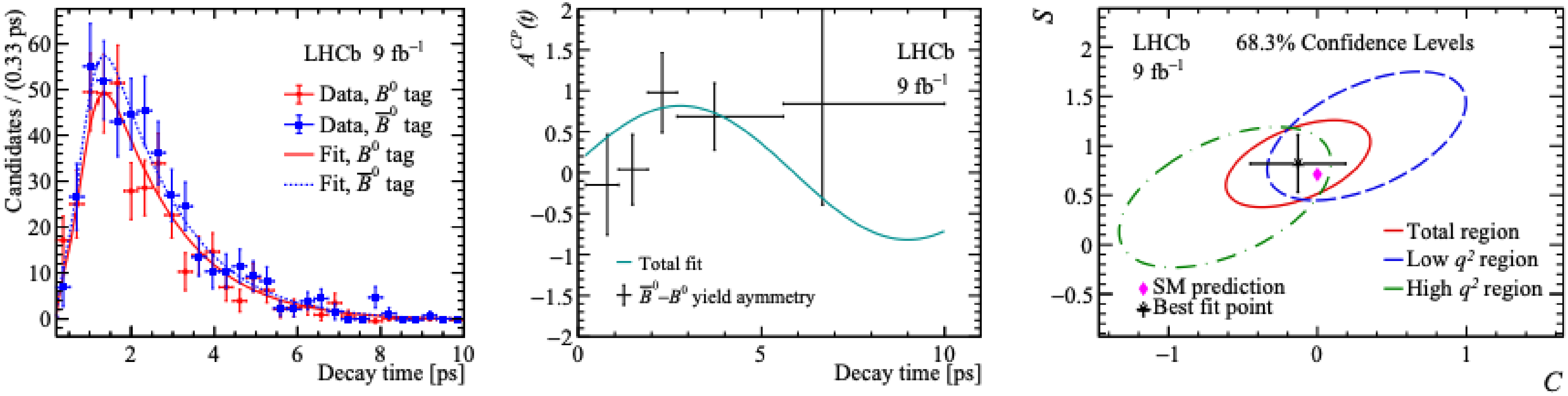
NP or underestimated hadronic effect?

- Local deviations 3.1 (2.7) σ in [6, 8] GeV for EOS(ABCDMN)
- Legacy analysis of $B \to K^{*0}\mu^+\mu^-$ sees tension of around 4σ

[arXiv:2512.18053]

Time-dependent CP-asymmetry in $B^0 \to K_s^0 \mu\mu$

Rate asymmetries

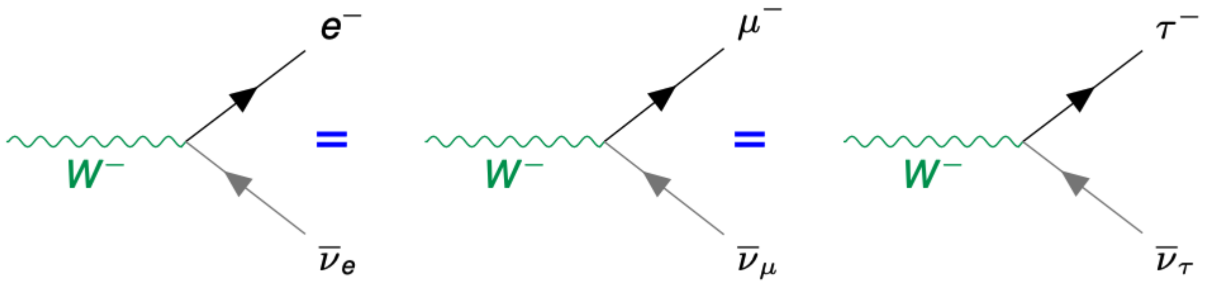


- First time-dep. measurement of CPV in $b \to sll$ processes using Run 1+2
- Legacy Time-dep. CP-asymmetry $A_{CP} = S \times sin(\Delta m_d t) - C \times cos(\Delta m_d t)$
- Resulting in $S = +0.32 \pm 0.29 \pm 0.05$ and $C = +0.13 \pm 0.32 \pm 0.04$; in good agreement with SM prediction

[LHCb-PAPER-2025-062]

Lepton flavour universality (LFU)

- In the SM, weak interactions towards three generations of leptons are identical



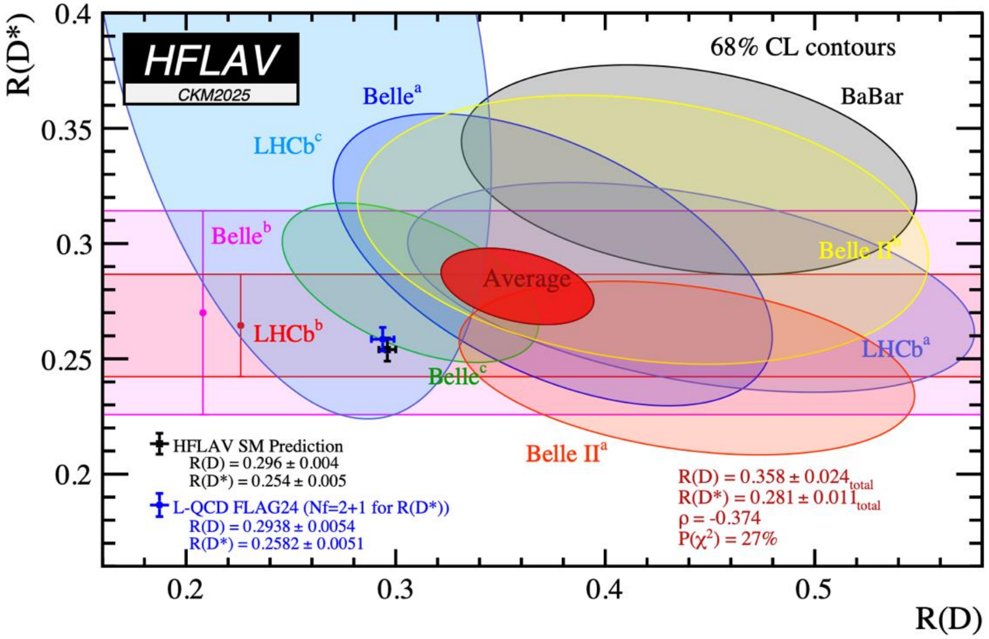
- Interesting measurement: $\mathcal{R}(X_c) \equiv \frac{\mathcal{B}(X_b \to X_c \tau^+ \nu_\tau)}{\mathcal{B}(X_b \to X_c \ell^+ \nu_\ell)}$

- Recent LHCb results using Run2 data:

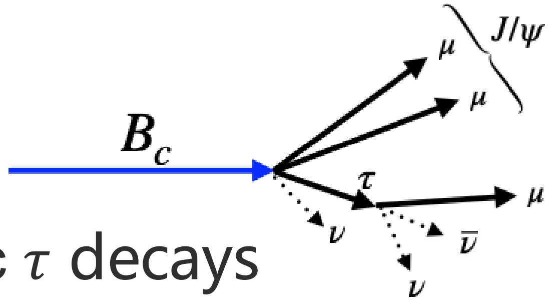
Muonic: $R(D^{*+}) = 0.402 \pm 0.081 \pm 0.085,$

Hadronic: $\mathcal{R}(D^{*-}) = 0.260 \pm 0.015 \pm 0.016 \pm 0.012\,,$

- Recent 3.8σ in $R(D^*)$ measurements HFLAV 2025

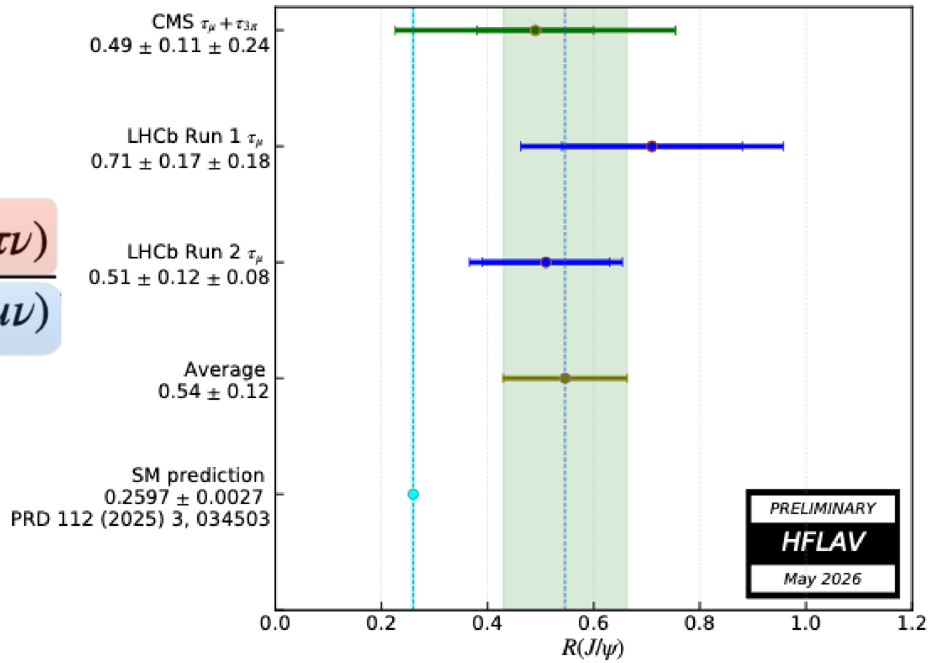


$R(J/\psi)$ measurement



Muonic τ decays

$$\frac{\mathcal{B}(B_c \to J/\psi\tau\nu)}{\mathcal{B}(B_c \to J/\psi\mu\nu)}$$



Final value: 0.51 ± 0.12(stat) $\pm\, 0.08$(syst)

1.8σ compatibility with Standard Model (0.26)

- World leading Result!
- Consistent with world average
- Statistically limited

Source of uncertainty on $\mathcal{R}(J/\psi)$	Value ($\times 10^{-2}$)
Simulation statistical uncertainty	5.9
$B_c^+ \to \psi(2S)\ell^+\nu$ modeling	2.6
MisID composition estimation	2.5
Simulation corrections	2.0
$B_c^+ \to J/\psi\,\ell^+\,\nu$ form factors	1.8
$B_c^+ \to \chi_c\,\mu^+\nu$ scaling	1.5
Efficiency ratio	1.3
Fragmentation background modeling	1.3
MisID decay-in-flight correction	1.1
$(J/\psi + \mu^+)$ combinatorial modeling	0.6
MisID decay-in-flight smearing	0.3
$B_c^+ \to \psi(2S)\,\ell^+\nu$ scaling	0.3
$\mathcal{B}(\tau^+ \to \mu^+\nu_\mu\bar{\nu}_\tau)$	0.2
Trimuon effect	0.1
Systematic uncertainty	7.9
Statistical uncertainty	11.9
Total uncertainty	14.3

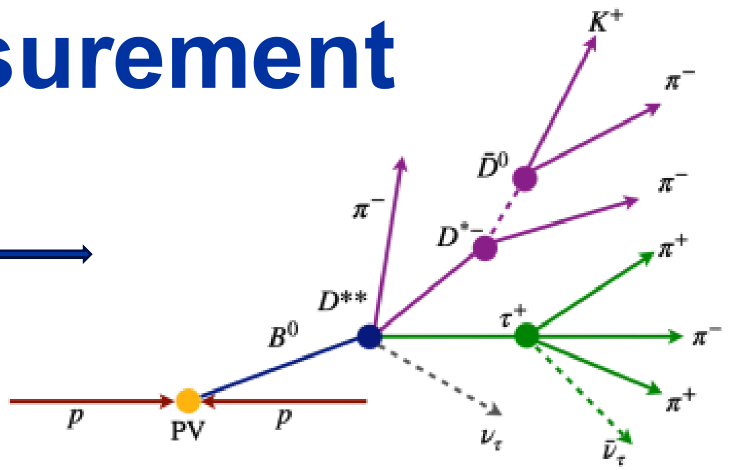
[LHC Seminar, 19 May 2026]

$B^- \to D^{**0}\tau^-\bar{\nu}_\tau$ decay measurement

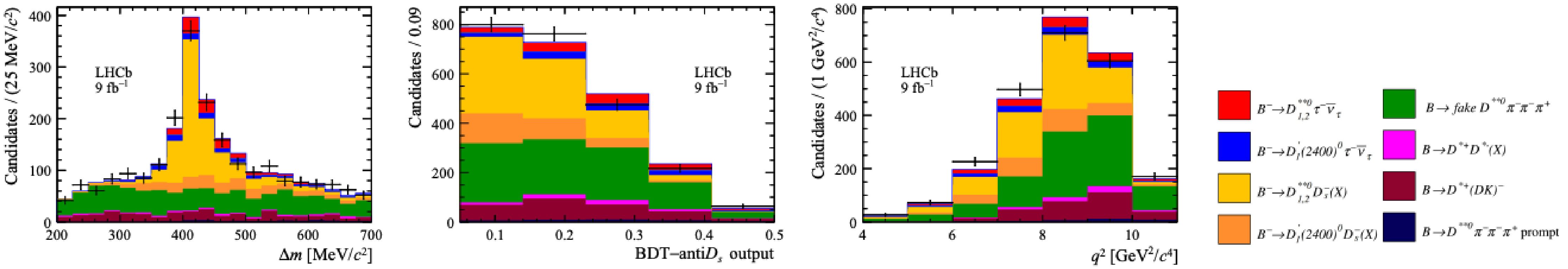
$$\mathcal{R}(D^{**0}_{1,2}) = \frac{\mathcal{B}(B^- \to D^{**0}_{1,2}\tau^-\bar{\nu}_\tau)}{\mathcal{B}(B^- \to D^{**0}_{1,2}\mu^-\bar{\nu}_\mu)}$$

Searching

Known [PRD 107 (2023) 092003]



- Signal extracted from binned fit to: $\Delta m = m(D^{*-}\pi^+) - m(D^{*-})$, anti-$D_s$ BDT, $q^2 = (p_B - p_{D^{**}})^2$



$$\mathcal{R}(D^{**0}_{1,2}) = \frac{\mathcal{B}(B^- \to D^{**0}_{1,2}\tau^-\bar{\nu}_\tau)}{\mathcal{B}(B^- \to D^{**0}_{1,2}\mu^-\bar{\nu}_\mu)} = 0.13 \pm 0.04$$

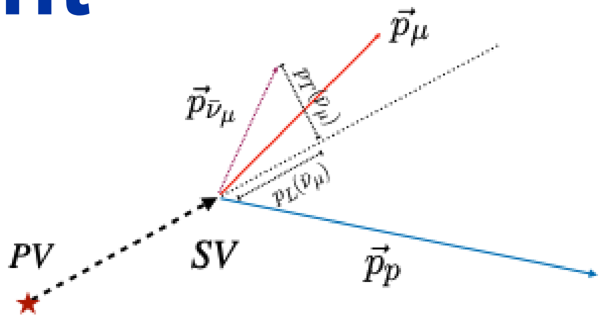
[PRL 135 (2025) 021802]

➢ In agreement with SM prediction 0.09 ± 0.02 [PRD 97 (2018) 075011]

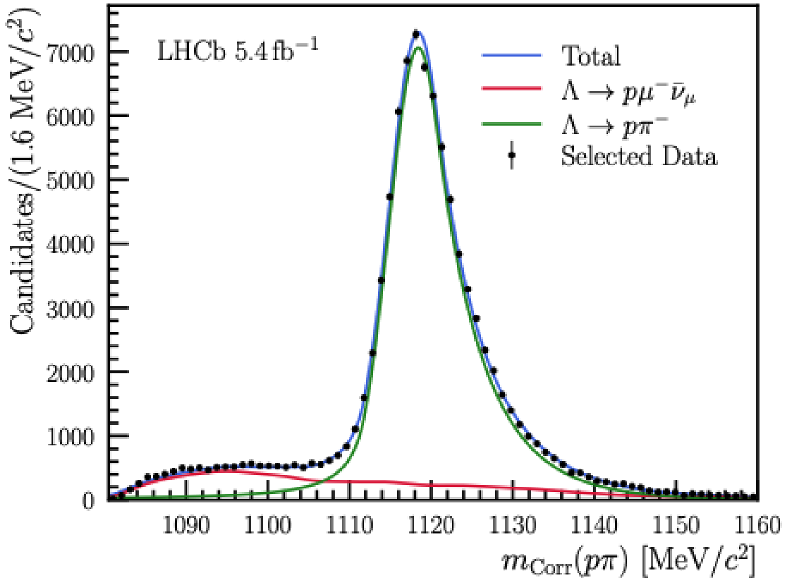
$\Lambda \to p\mu^- \bar{\nu}_\mu$ decay measurement

- LFU test in hyperon decays: $R^{\mu/e} = \frac{\mathcal{B}(\Lambda \to p\mu^- \bar{\nu}_\mu)}{\mathcal{B}(\Lambda \to pe^- \bar{\nu}_e)}$

Well known



- Run 2 data:



- $R^{\mu/e}$ compatible within 1.5σ with SM prediction arXiv:2507.09970

$$R^{\mu/e}_{measured} = 0.175 \pm 0.012$$

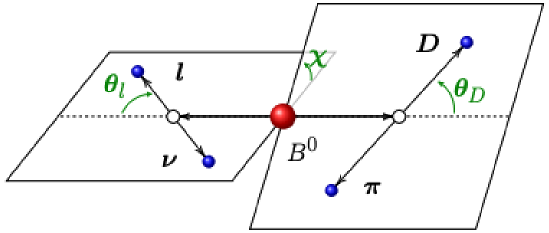
$$\mathcal{B}(\Lambda \to p\mu^- \bar{\nu}_\mu) = (1.462 \pm 0.016(stat) \pm 0.100(syst) \pm 0.011(norm)) \times 10^{-4}$$

[arXiv: 2511.15681]

in agreement with BESIII ($\mathcal{B}(\Lambda \to p\mu^- \bar{\nu}_\mu) = (1.48 \pm 0.21) \times 10^{-4}$)

$B^0 \to D^*\mu\nu$ angular analysis

➢ Differential decay rate as function of the decay angles and q^2 is sensitive to NP



$B^0 \to D^*\mu\nu$

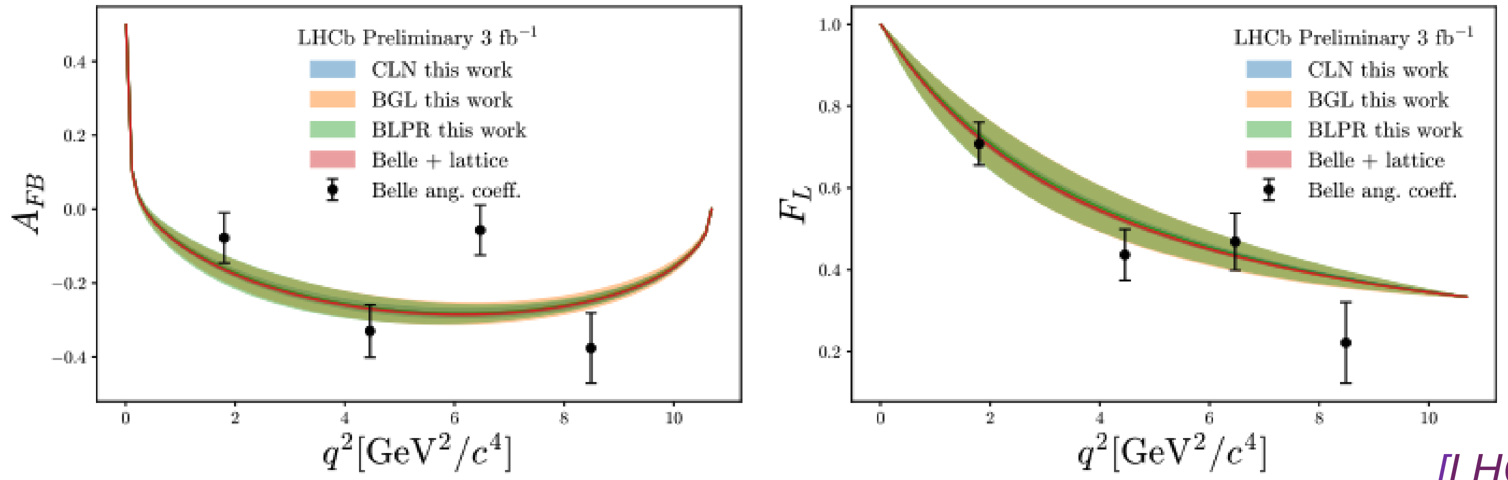
$D^* \to D^0\pi_s$

$D^0 \to K\pi$

$$\frac{d\Gamma(B^0\to D^*\mu\nu_\mu)}{dq^2} = \frac{G_F^2|V_{cb}|^2|\eta_{EW}|^2|\vec{p}|^2q^2}{96\pi^3m_{B^0}^2}\left(1-\frac{m_\mu^2}{q^2}\right)\times\left[(|H_+|^2+|H_-|^2+|H_0|^2)\left(1-\frac{m_\mu}{2q^2}\right)+\frac{3}{2}\frac{m_\mu^2}{q^2}|H_t|^2\right]$$

- Helicity amplitudes $H_{\pm,0,t}$ can be parametrized in terms of function of q^2, i.e. form factors

BGL PRL 74 (1995) 4603 **CLN** Nucl. Phys. B 530 (1998) 1 **BLPR** PRD 95 (2018) 115008



[LHCb-CONF-2026-001]

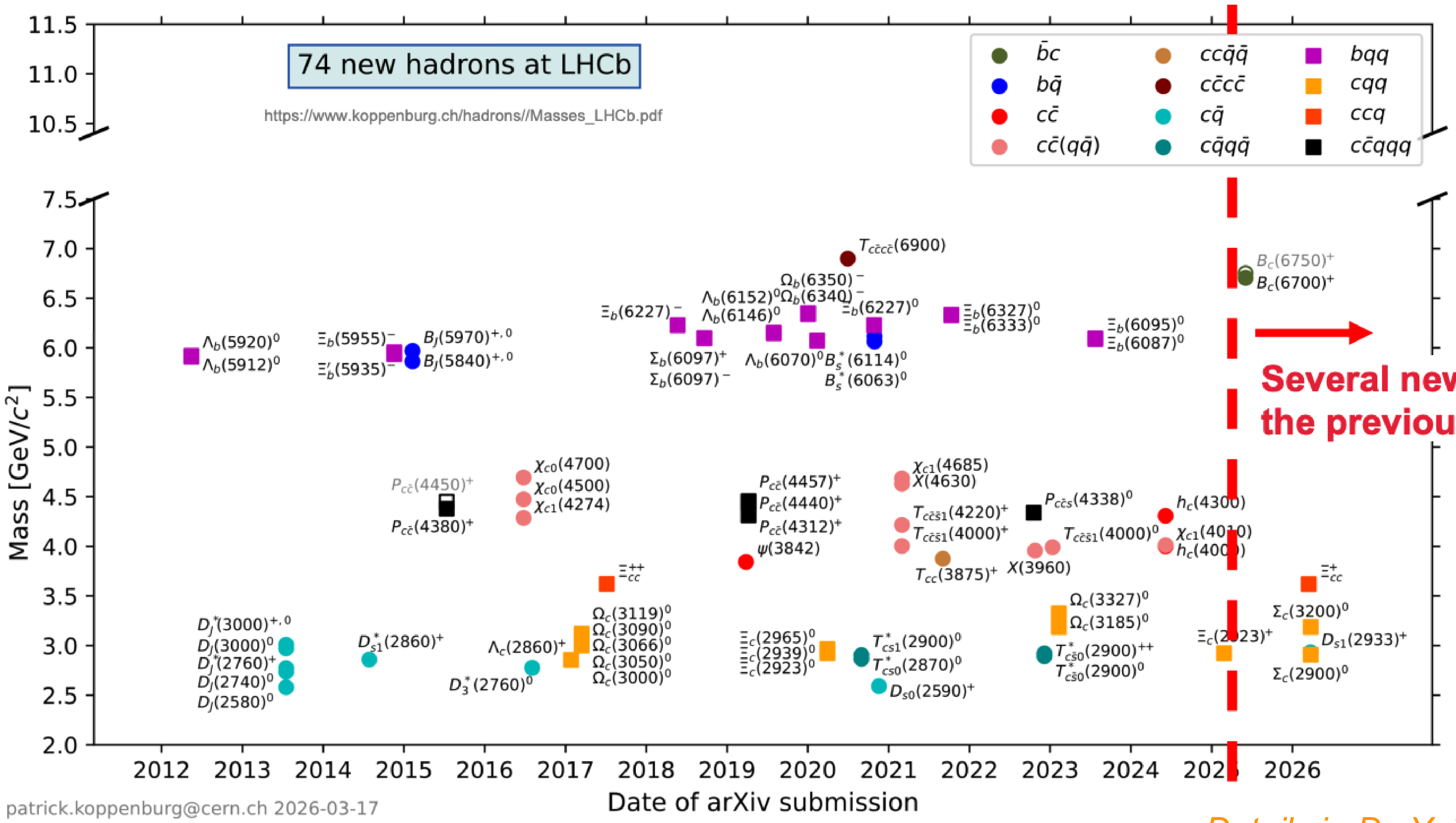
➢ Angular observables in agreement with previous works

[PRL 133 (2024) 131801]
[PRD 95 (2018) 115008]

Spectroscopy

Details in Da Yu's talk

New hadrons observed at LHCb



Several new hadrons since the previous conference

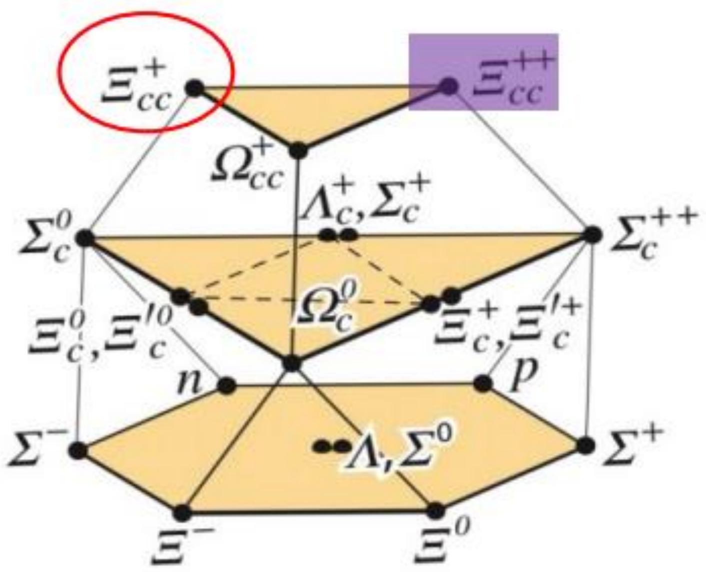
Details in Da Yu's talk

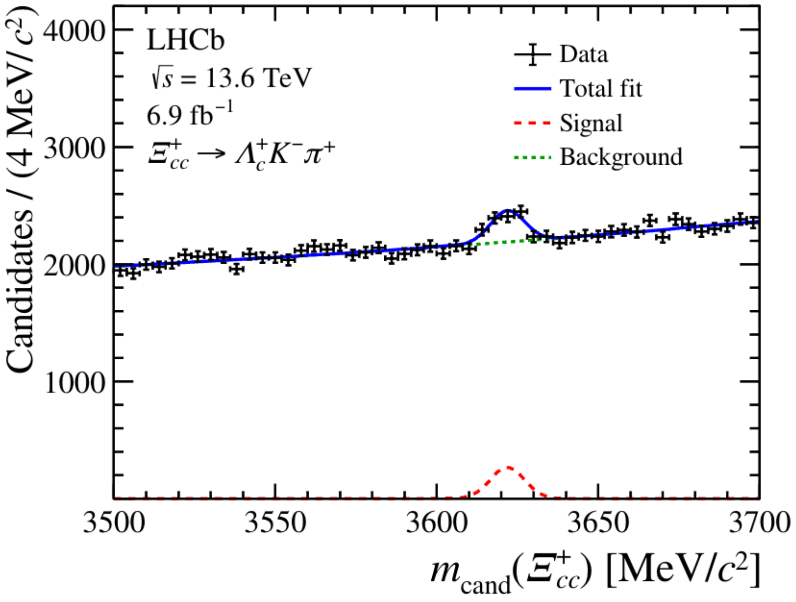
New doubly charmed baryon

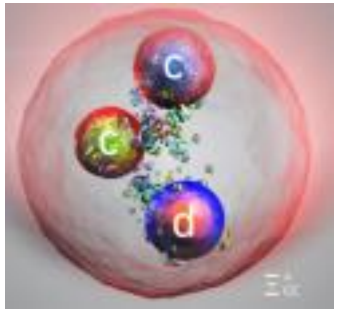
- Ξ_{cc}^{++} observed by LHCb in $\Xi_{cc}^{++} \to \Lambda_c^+ K^- \pi^+ \pi^+$ *[Phys. Rev. Lett. 119 (2017) 112001]*
- A subset of data collected in 2024, a structure is observed in $\Lambda_c^+ K^- \pi^+$ state
  - Enabled by the LHCb upgrade, trigger efficiency ~2.5× higher than in Run 2

$$m(\Xi_{cc}^{+}) - m(\Xi_{cc}^{++}) = -1.77 \pm 0.84(\mathrm{stat}) \pm 0.15(\mathrm{syst})\ ^{+1.90}_{-1.30}(\mathrm{lifetime})\ \mathrm{MeV}$$

[arXiv:2603.28456]







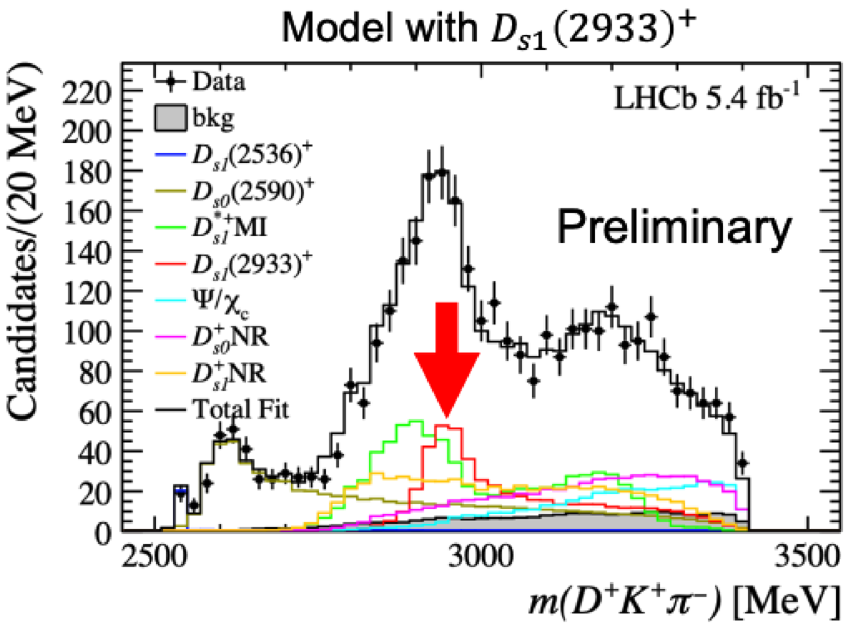
Details in Jibo's talk

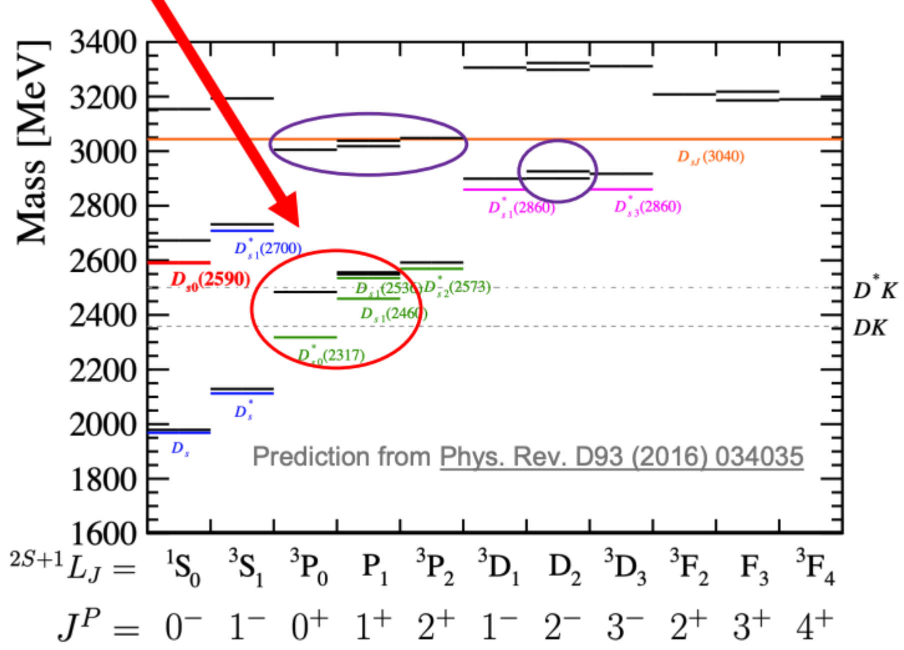
New excited charm-strange meson $D_{s1}(2933)^+$

- A long-standing puzzle about the nature of $D_{s0}^*(2317)^+$ and $D_{s1}(2460)^+$
  - ~100 MeV below quark-model predictions for P-wave states

[LHCb-PAPER-2025-073]

- Search for excited D_s^+ in $B^0 \to D^+D^-K^+\pi^-$

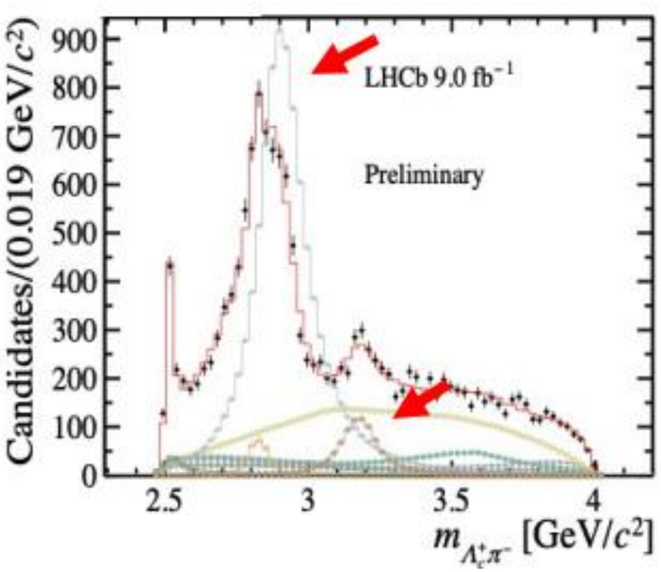




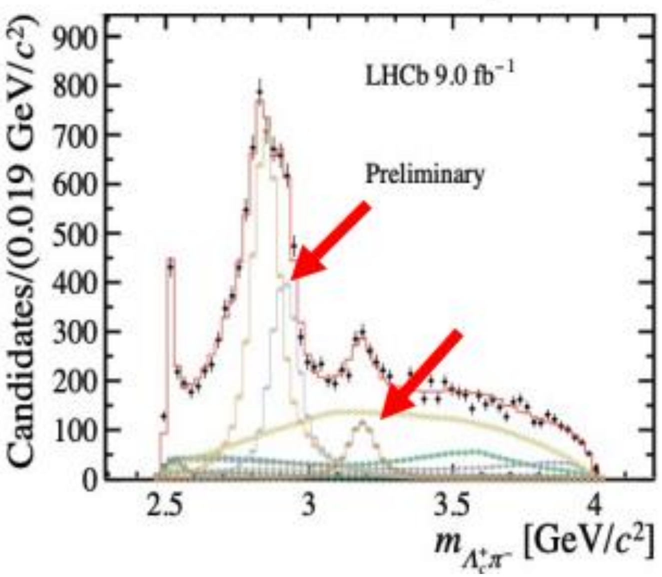
- Mass and width: $\mathrm{M} = 2933^{+6}_{-5}(\mathrm{stat.})^{+4}_{-3}(\mathrm{syst.})$ MeV; $\Gamma = 72^{+18}_{-12}(\mathrm{stat.})^{+7}_{-10}(\mathrm{syst.})$ MeV
- Spin-parity: $J^P = 1^+$, other J^P hypotheses rejected at $> 5\sigma$

New excited states: $\Sigma_c(2900)^0, \Sigma_c(3200)^0$

- Search for Σ_c^0 in the $\Lambda_c^+\pi^-$ system of $B^- \to \Lambda_c^+\bar{p}\pi^-$ using LHCb Run 1+2 data
- Amplitude analysis:
  - $\Sigma_c(2900)^0$ and $\Sigma_c(3200)^0$ found with siginificances of 7.5σ and 12σ respectively



Solution group A



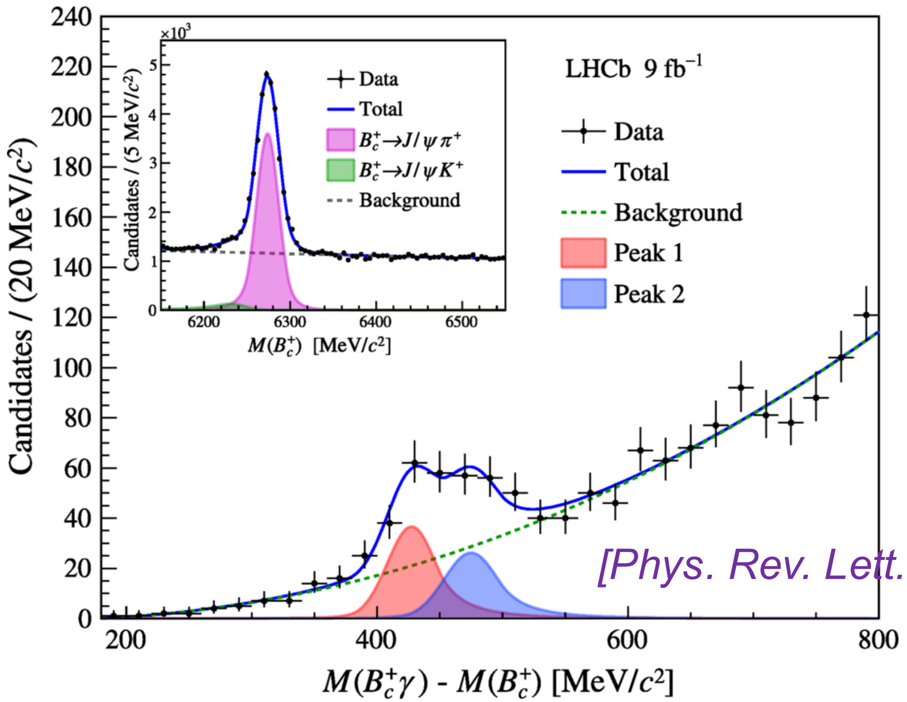
Solution group B

Parameter	Group A	Group B
$m_{\Sigma_c(2800)^0}$[GeV/c^2]	$2.8192 \pm 0.0060 \pm 0.0020$	$2.8483 \pm 0.0037 \pm 0.0055$
$\Gamma_{\Sigma_c(2800)^0}$[GeV]	$0.0326 \pm 0.0068 \pm 0.0080$	$0.0990 \pm 0.0072 \pm 0.0209$
$m_{\Sigma_c(2900)^0}$[GeV/c^2]	$2.9077 \pm 0.0048 \pm 0.0087$	$2.9143 \pm 0.0032 \pm 0.0081$
$\Gamma_{\Sigma_c(2900)^0}$[GeV]	$0.1754 \pm 0.0082 \pm 0.0225$	$0.0921 \pm 0.0061 \pm 0.0234$
$m_{\Sigma_c(3200)^0}$[GeV/c^2]	$3.1859 \pm 0.0059 \pm 0.0144$	$3.1898 \pm 0.0054 \pm 0.0107$
$\Gamma_{\Sigma_c(3200)^0}$[GeV]	$0.1331 \pm 0.0176 \pm 0.0267$	$0.1001 \pm 0.0154 \pm 0.0323$

[LHCb-PAPER-2026-001]

Observation of orbitally excited B_c^+ states

- The B_c^+ meson is the only meson with two different heavy quarks $\bar{b}c$
- Search for $B_c(1P)^+ \to B_c^+\gamma$ where $B_c^+ \to J/\psi\pi^+$ and γ is reconstructed from calorimeter



[Phys. Rev. Lett. 135 (2025) 231902]

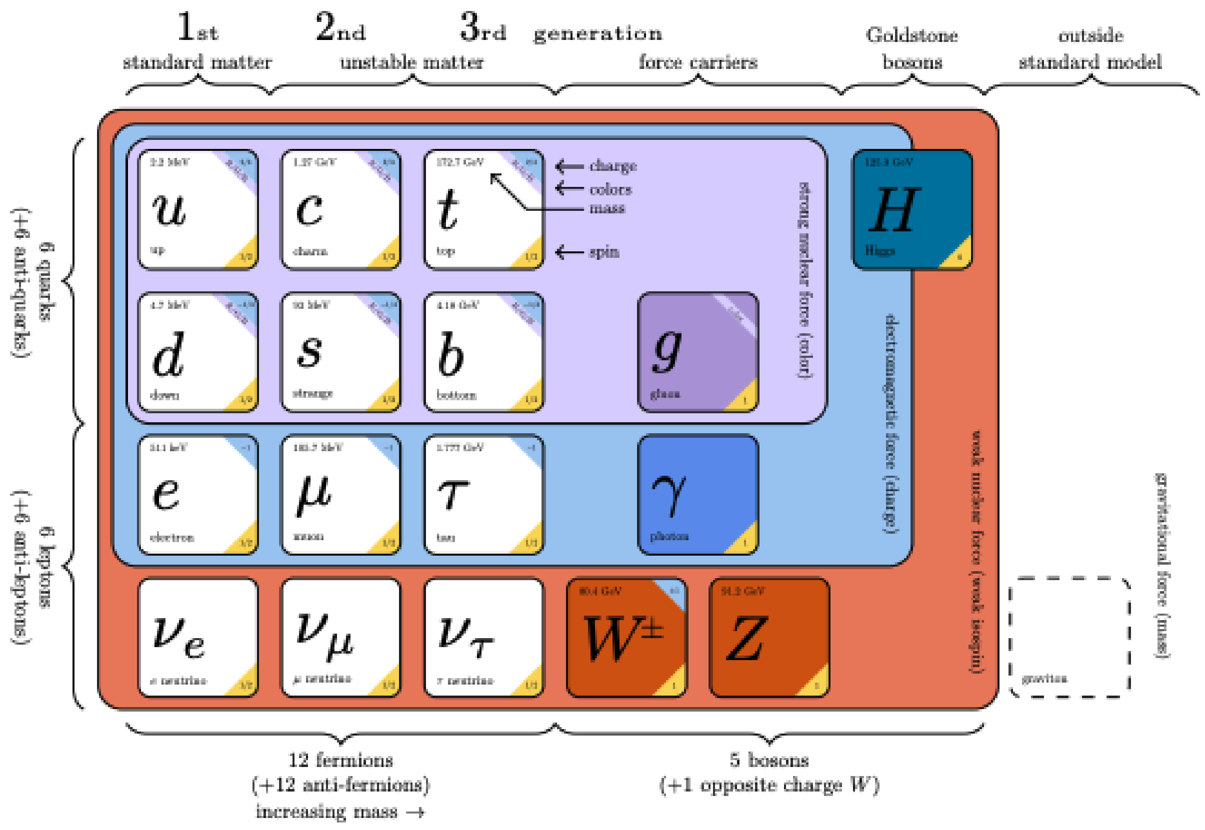
$$M_1 = 6704.8 \pm 5.5(\text{stat}) \pm 2.8(\text{syst}) \pm 0.3\ (B_c\ \text{mass})\ \text{MeV}$$
$$M_2 = 6752.4 \pm 9.5(\text{stat}) \pm 3.1(\text{syst}) \pm 0.3\ (B_c\ \text{mass})\ \text{MeV}$$

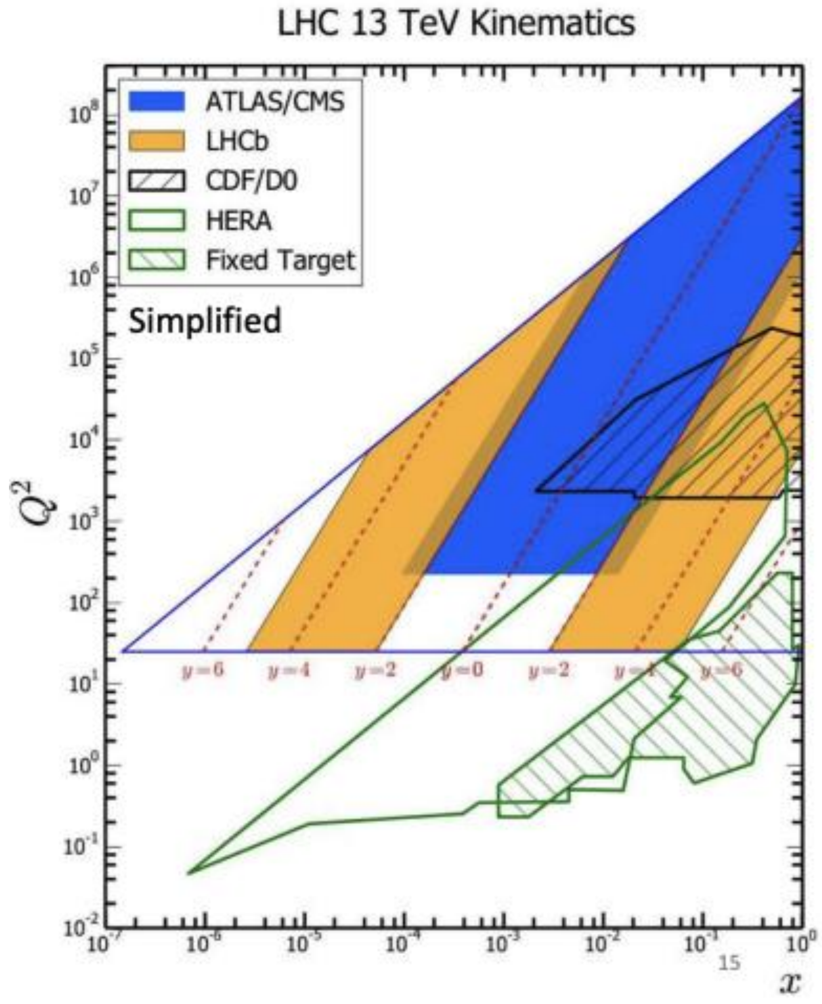
EW physics & Heavy ions

Details in Hang's talk

Electroweak: Stress test of the SM

- To test consistency of Standard Model





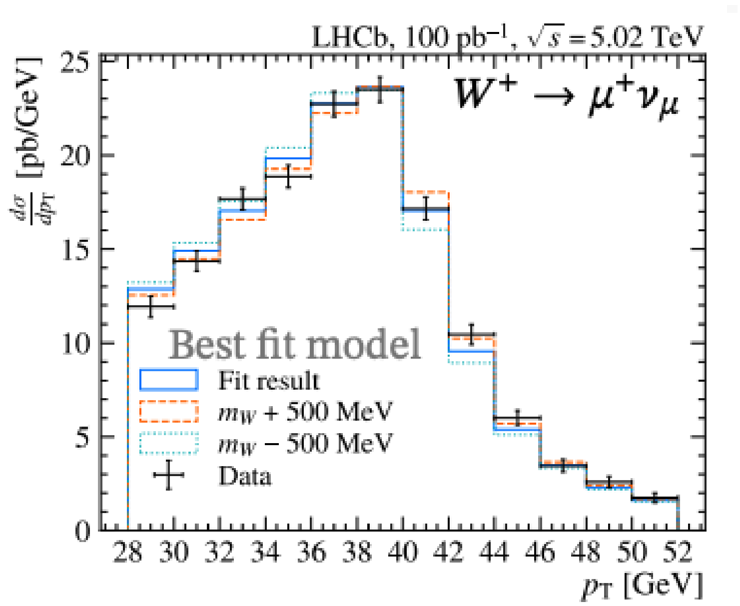
- LHCb's forward acceptance is complementary to ATLAS and CMS

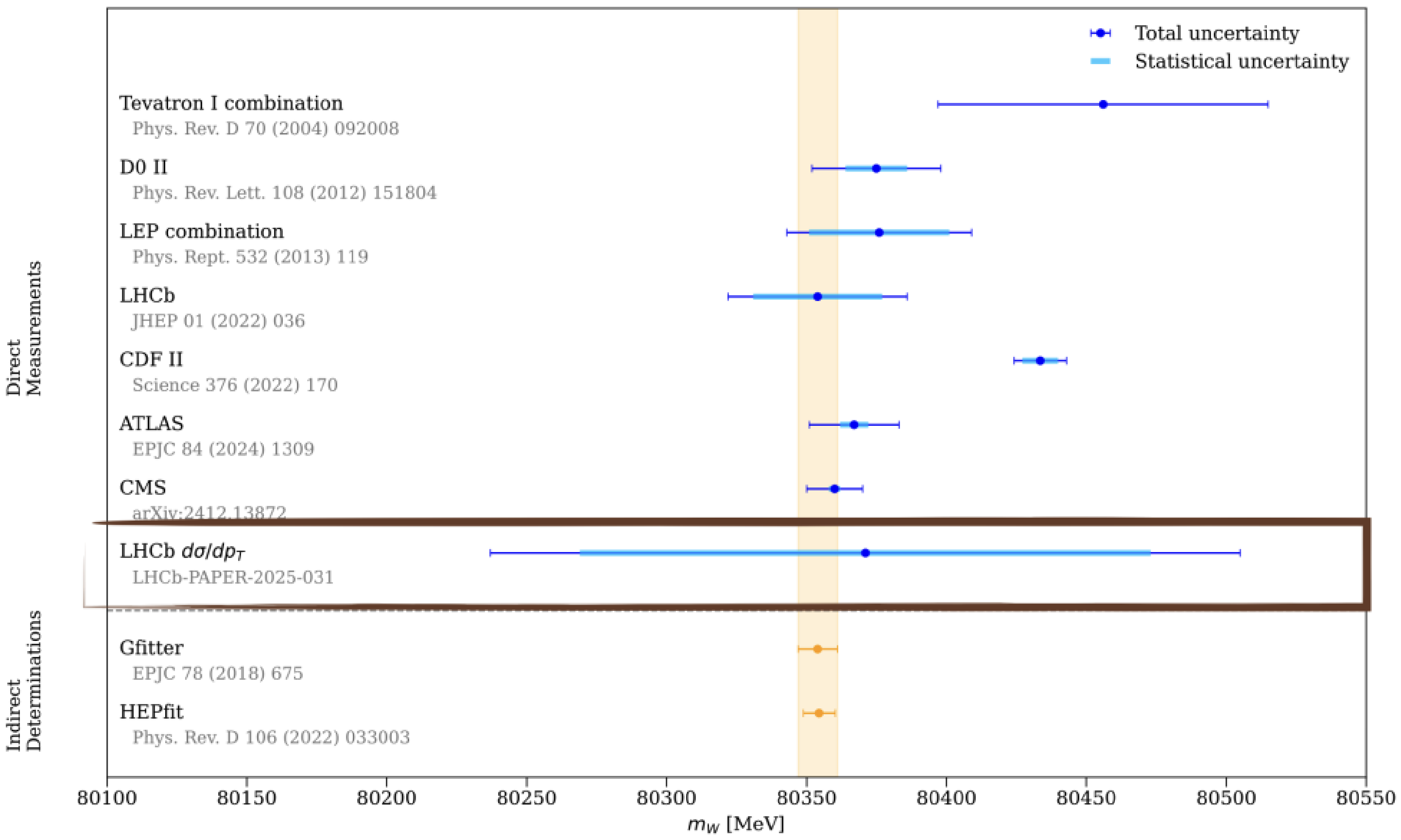
[arXiv:0808.1847]

Model-independent m_W measurement

[JHEP 03 (2026) 148]

- $pp \to W^{\pm}(\to \mu\nu)X$ cross-sections at $\sqrt{s} = 5.02$ TeV





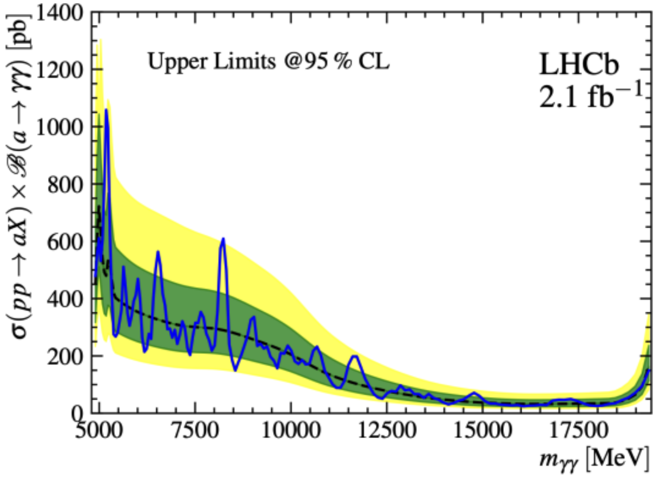
m_W = 80369 ± 130(exp) ± 33(th) MeV

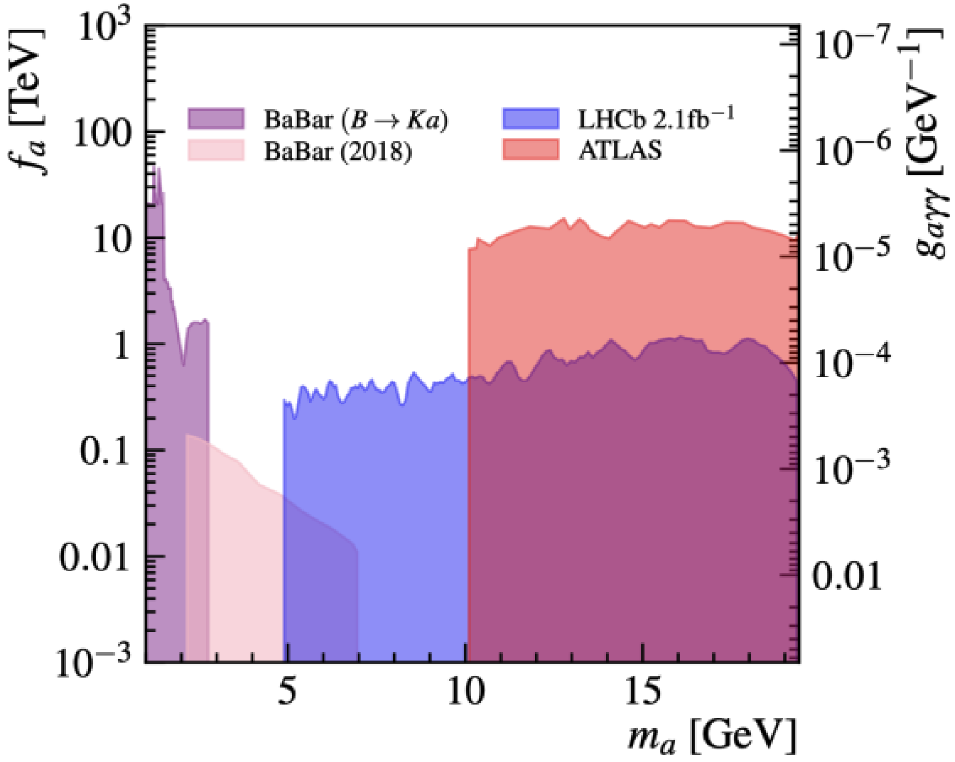
Consistent with previous measurement

Axion-Like-Particles searching

- Axion-Like-Particles can solve the strong CP-problem and be a DM candidate

  ALP→ $\gamma\gamma$ searching at LHCb using Run 2 data





Upper limits at 95% CL:

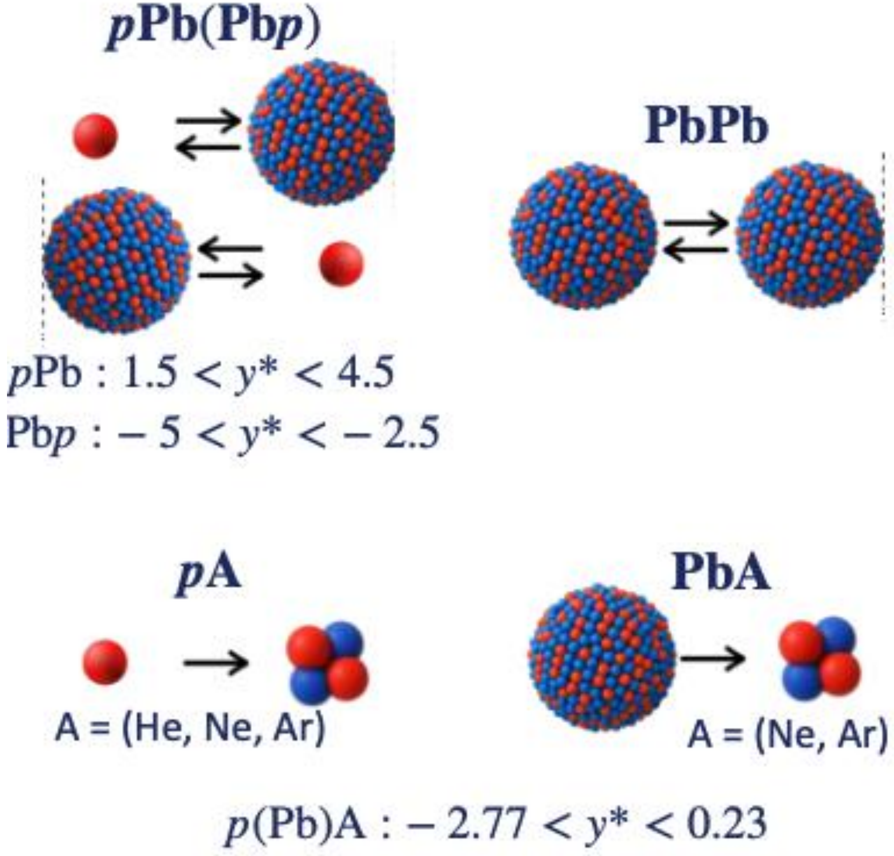
- f_a vs. m_a (left) using $c_1 = c_2 = c_3 = 10$.
- $\mathcal{B}(B^0 \to \gamma\gamma) < 0.83 \times 10^{-5}$.
- $\mathcal{B}(B_s^0 \to \gamma\gamma) < 2.68 \times 10^{-5}$.
- $\sigma(pp \to \eta_b(1S)(\gamma\gamma)X) < 765$pb.

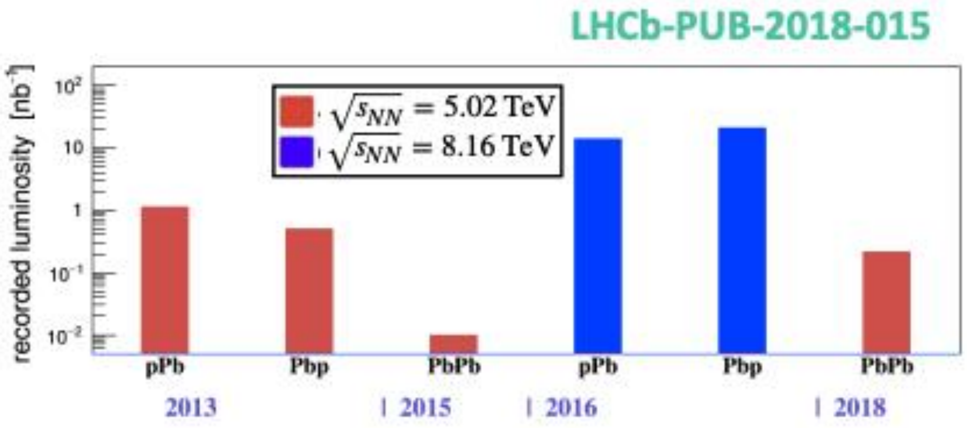
[arXiv: 2507.14390]

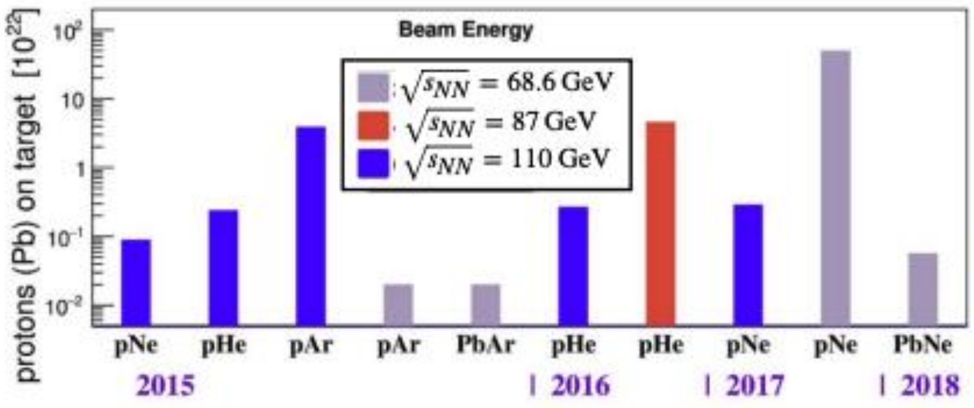
Best limits on f_a in $m_a \in [4.9, 10]$ GeV.

First measurement of purely neutral final-state at LHCb.

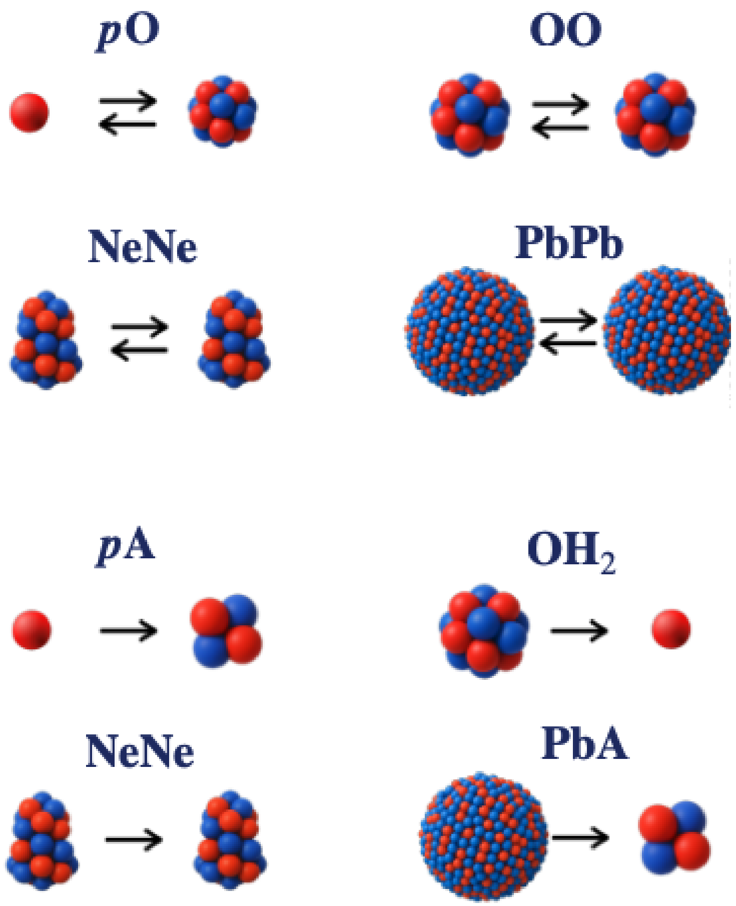
LHCb ion mode at Run2



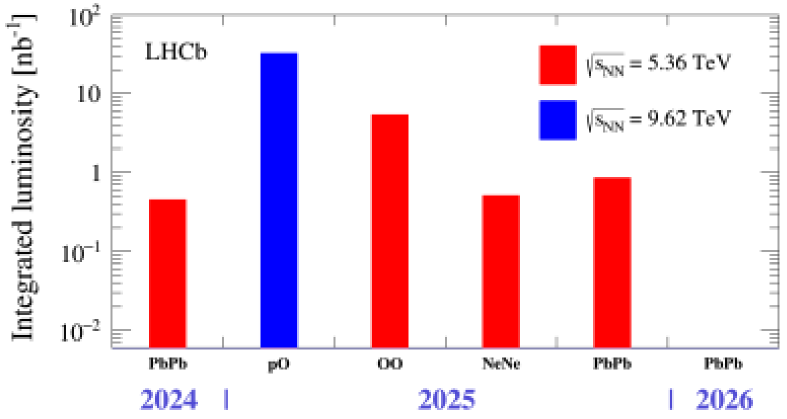


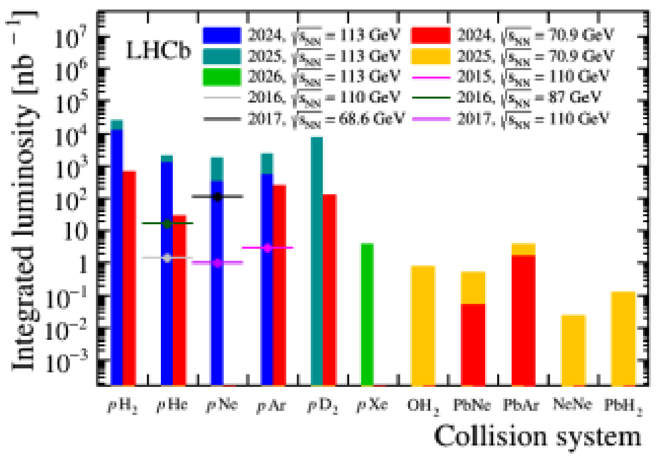


LHCb ion mode at Run 3



[LHCb official operation page]

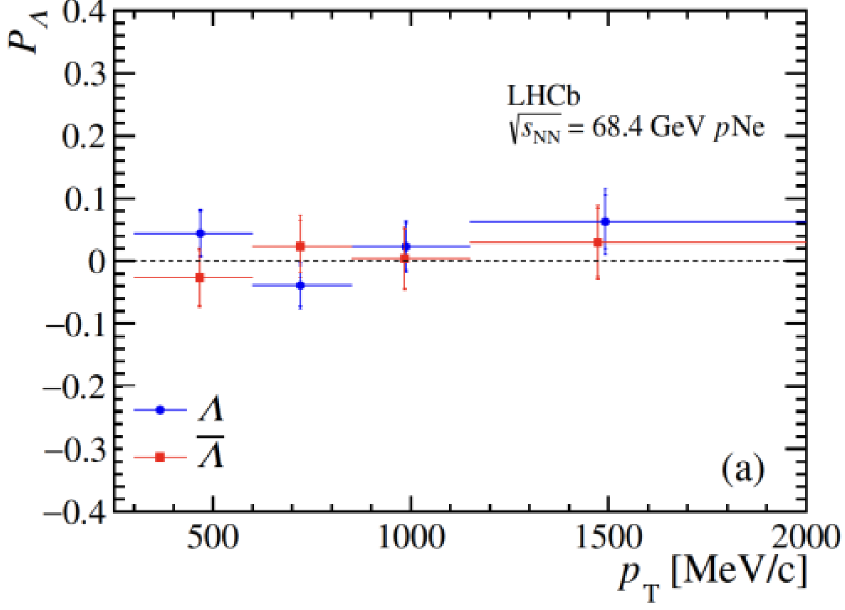




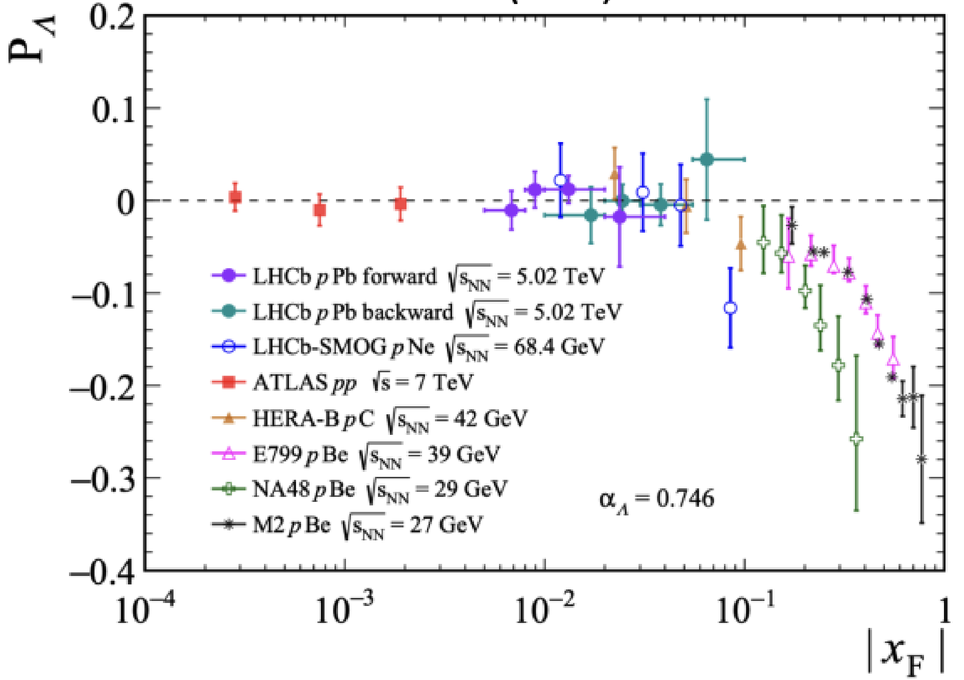
Λ polarization in fixed target pNe and collider pPb

- Probe for heavy-quark spin-dependent physics and QCD dynamics in non-perturbative regime

JHEP 09 (2024) 082

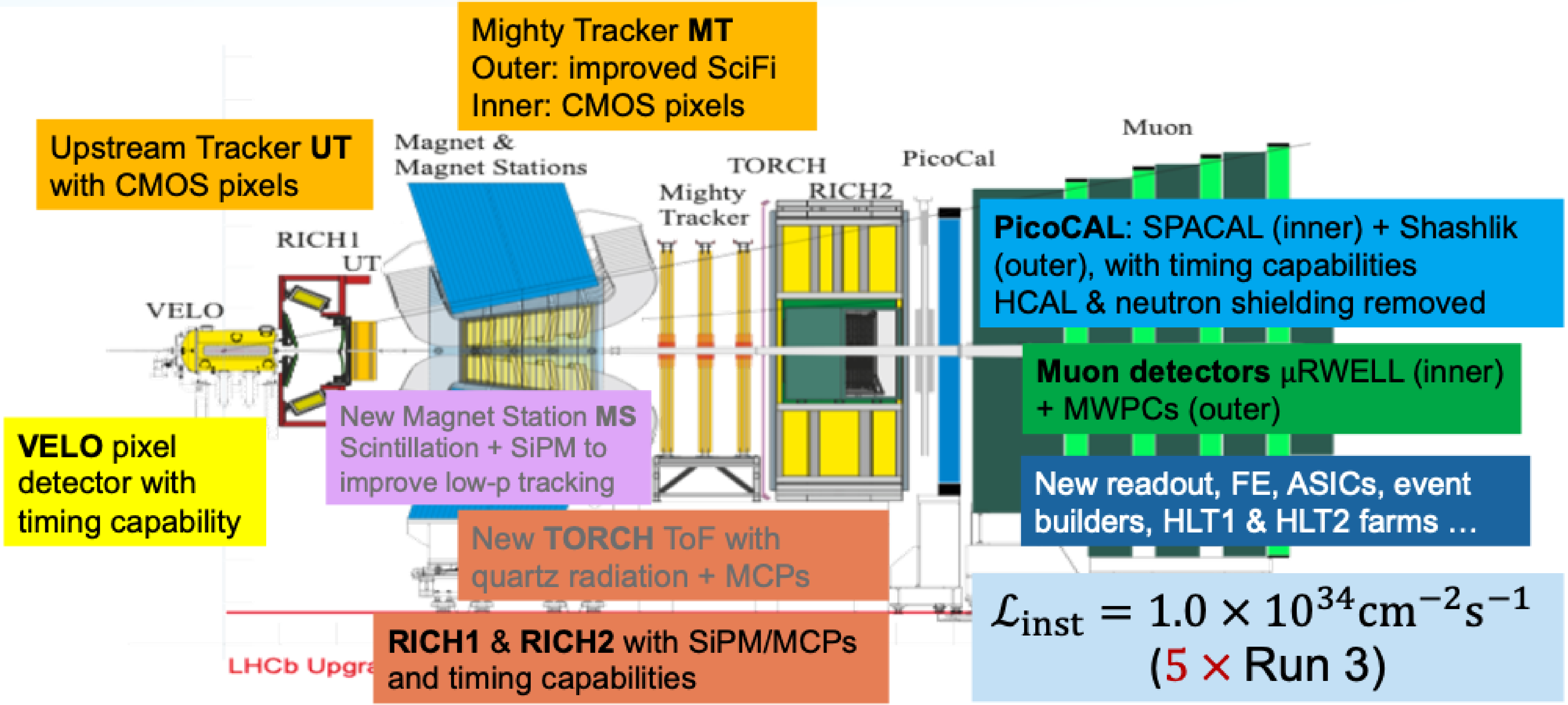


PRD112 (2025) 112022



Λ polarization cannot be explained by QCD
LHCb data agrees with HERA data and follow world trend
No apparent difference between Λ and $\bar{\Lambda}$
Results from Λ_C coming soon ….

LHCb Upgrade II

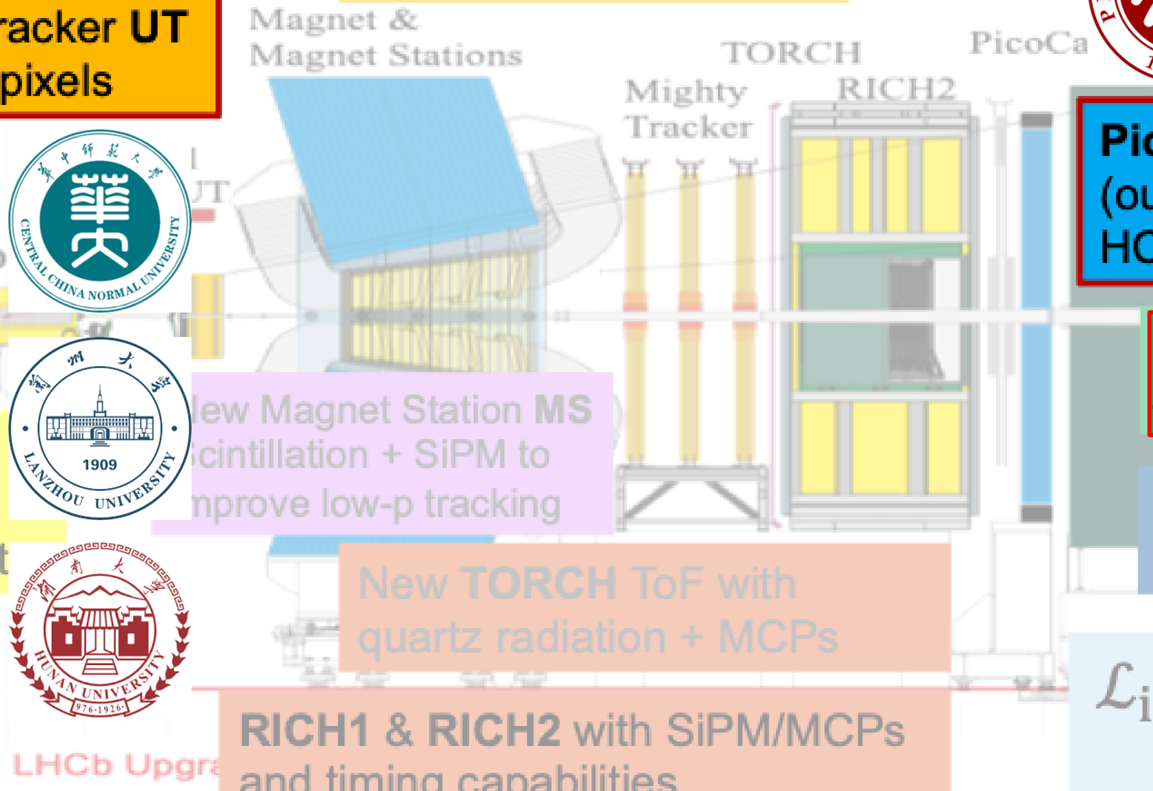


Taken from Yiming's talk

LHCb-China contributions to Upgrade II

Mighty Tracker **MT**
Outer: improved SciFi
Inner: CMOS pixels

Upstream Tracker **UT**
with CMOS pixels



PicoCAL: SPACAL (inner) + Shashlik (outer), with timing capabilities
HCAL & neutron shielding removed

Muon detectors: μRWELL(inner)
+ MWPCs (outer)

VELO pixel
ith
abilit

lew Magnet Station **MS**
cintillation + SiPM to
nprove low-p tracking

New readout, FE, ASICs, event builders, HLT1 & HLT2 farms ..

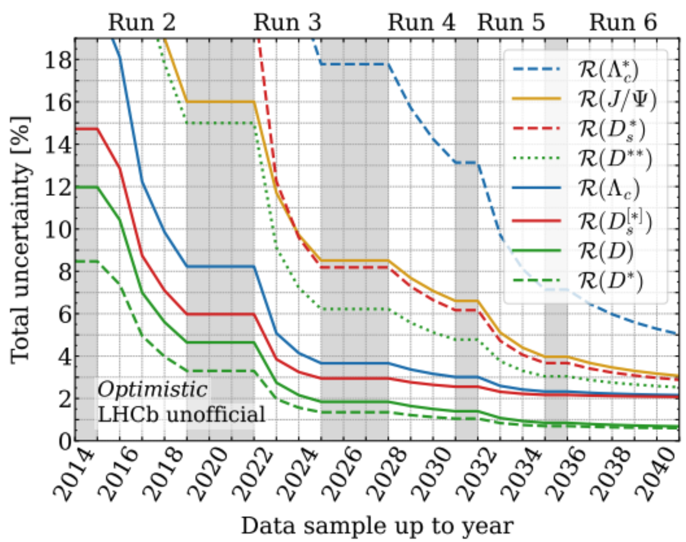
New **TORCH** ToF with
quartz radiation + MCPs

RICH1 & **RICH2** with SiPM/MCPs
and timing capabilities

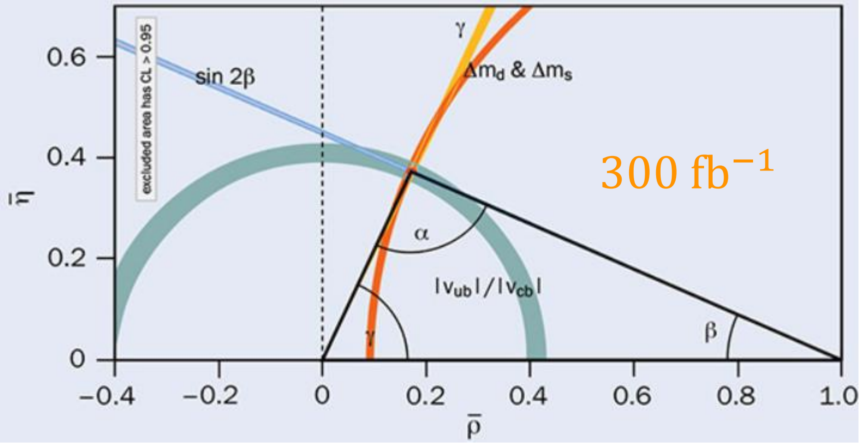
$$\mathcal{L}_{\mathrm{inst}} = 1.0 \times 10^{34} \mathrm{cm}^{-2} \mathrm{s}^{-1}$$
(5 × Run 3)

Summary

- World-leading precision measurement of CKM matrix: γ, $\beta_{(s)}$
- CPV in both beauty and charm sectors
- Latest $b \to sll$ and $b \to cl\nu$ in good agreement with SM prediction
- Various observations in hadron spectroscopy
- Explorations in W/Z measurement and Heavy-ion



PRD 94 (2022) 015003



Brand New

Thank you for your attention!

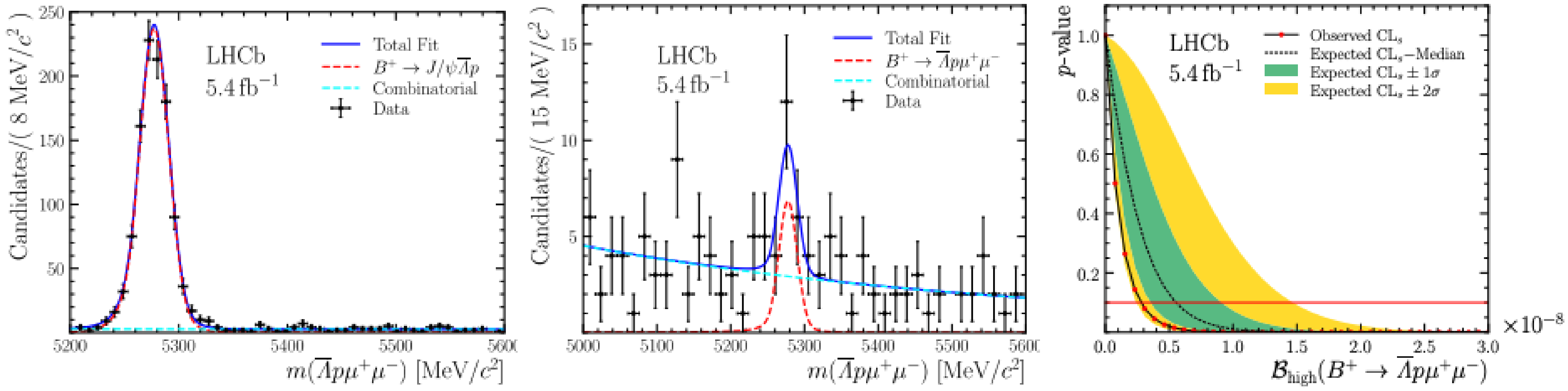
Backup

Evidence for $B^+ \to \bar{\Lambda} p \mu^+ \mu^-$

branching fractions

[arXiv:2601.06878]

$B^+ \to \bar{\Lambda} p J/\psi$ | $m(\bar{\Lambda}p) < 2.8\,\text{GeV}$ | $m(\bar{\Lambda}p) > 2.8\,\text{GeV}$



$$\mathcal{B}_{m(\bar{\Lambda}p)<2.8\,\text{GeV}} = (1.70^{+0.65}_{-0.56} \pm 0.17 \pm 0.14) \times 10^{-8} \quad (3.5\,\sigma \text{ significance})$$

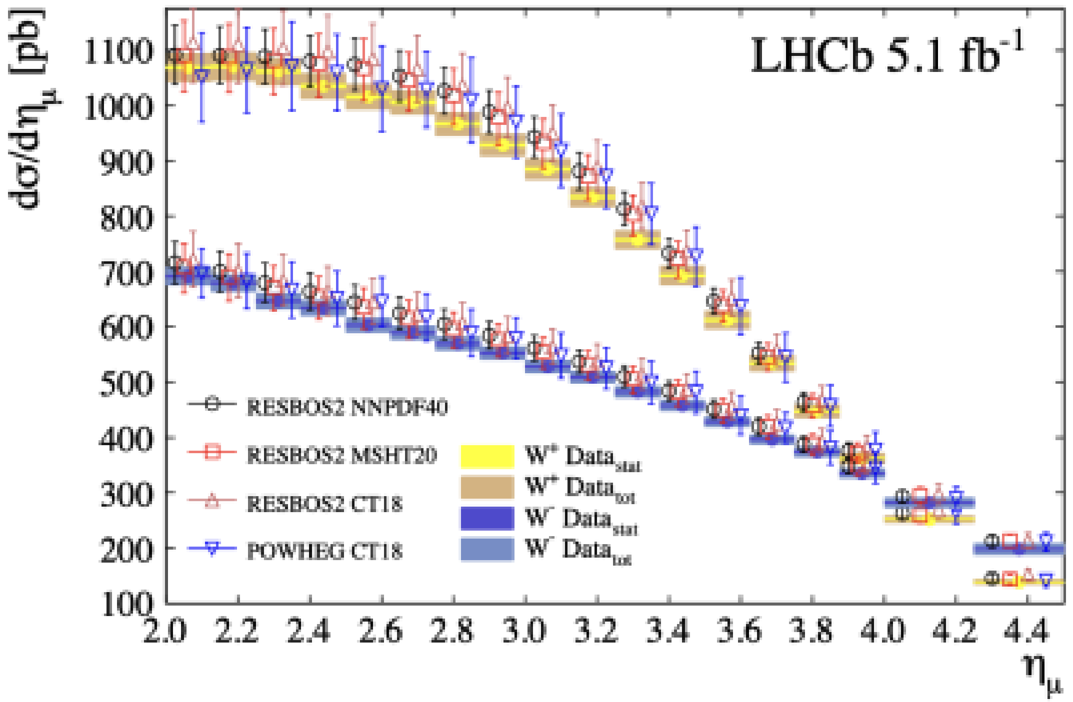
$$\mathcal{B}_{m(\bar{\Lambda}p)>2.8\,\text{GeV}} < 2.8 \times 10^{-9} \text{ at } 90\% \text{ CL}$$

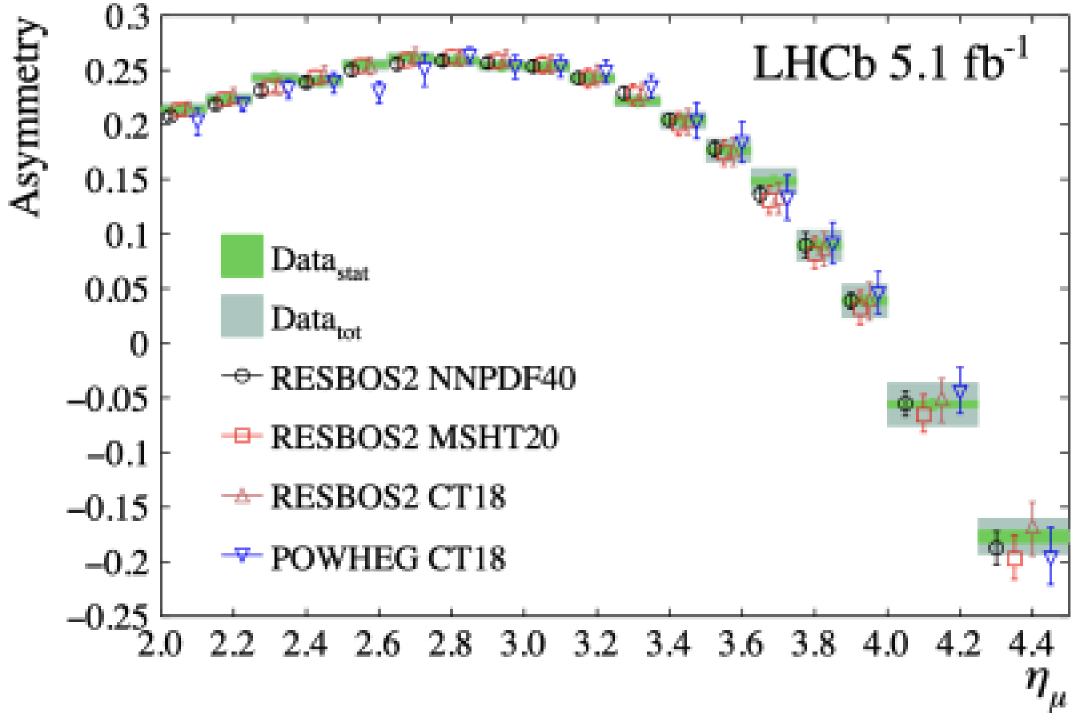
In agreement with, but $2\,\sigma$ below SM prediction

W production cross-section

[LHCb-PAPER-2025-070]

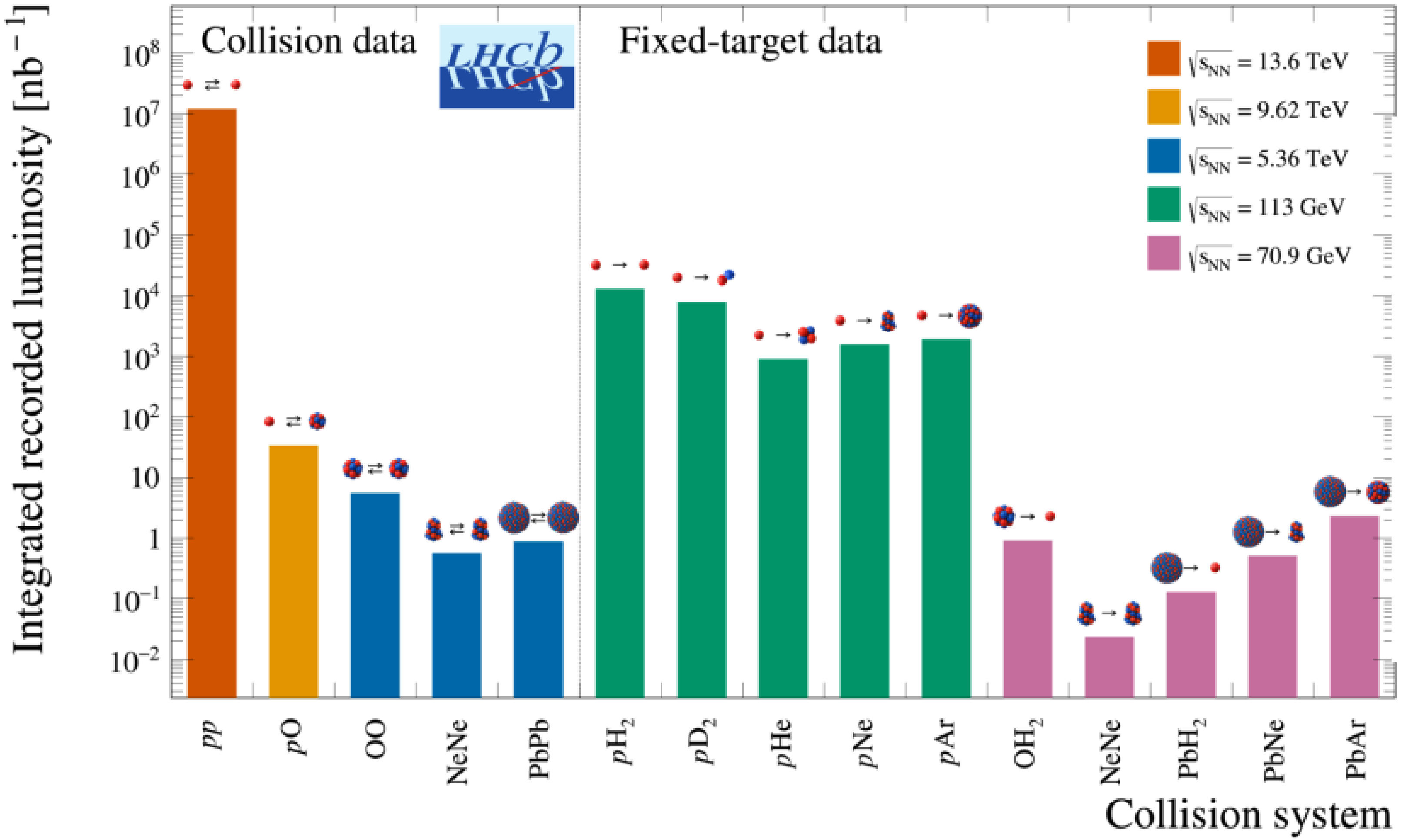
- $W \to \mu\nu$ decays using $5.1\ \mathrm{fb}^{-1}$ Run 2 data

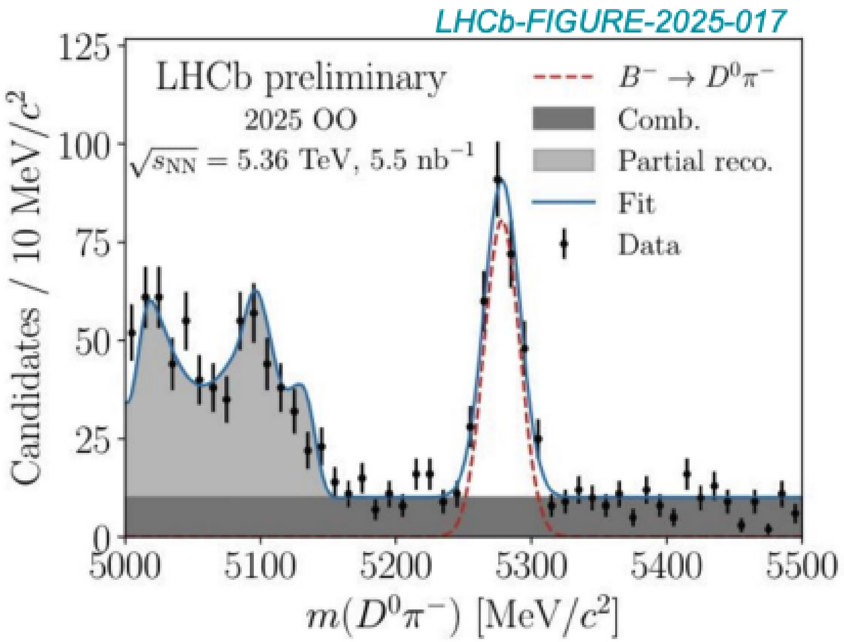




$$\mathcal{A}(\eta_\mu) = \frac{d\sigma_{W^+}/d\eta_{\mu^+} - d\sigma_{W^-}/d\eta_{\mu^-}}{d\sigma_{W^+}/d\eta_{\mu^+} + d\sigma_{W^-}/d\eta_{\mu^-}}$$

A lot of analysis and Physics exploration from Run3

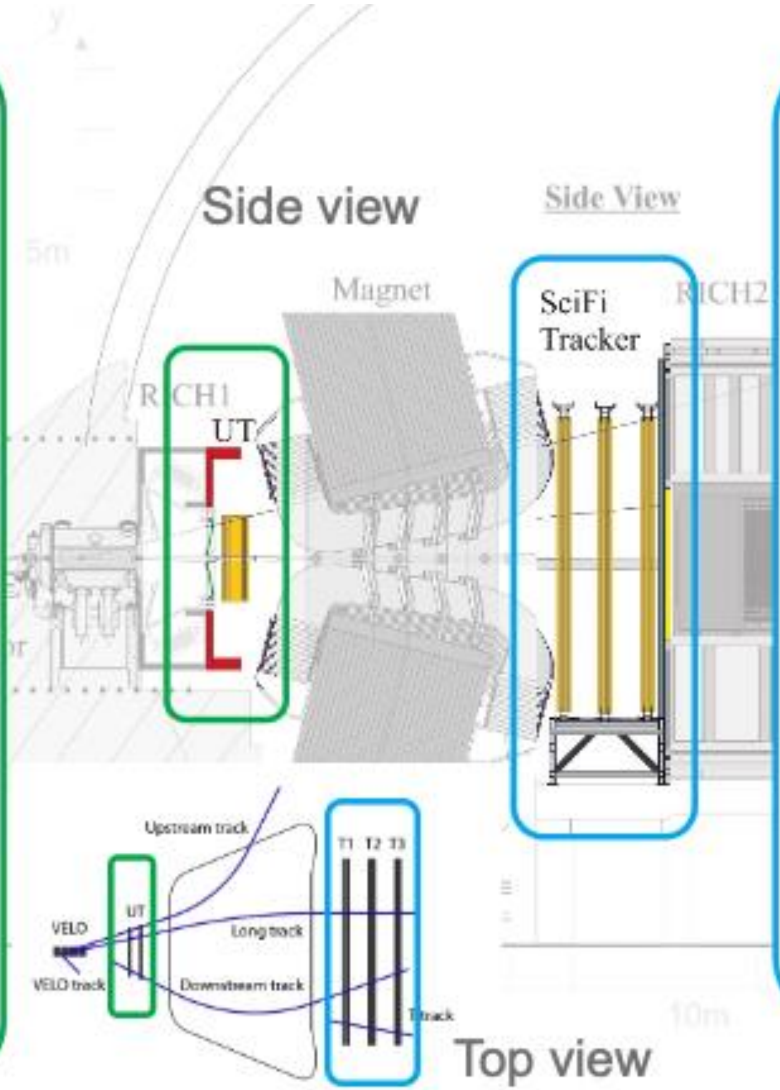




LHCb Run 3

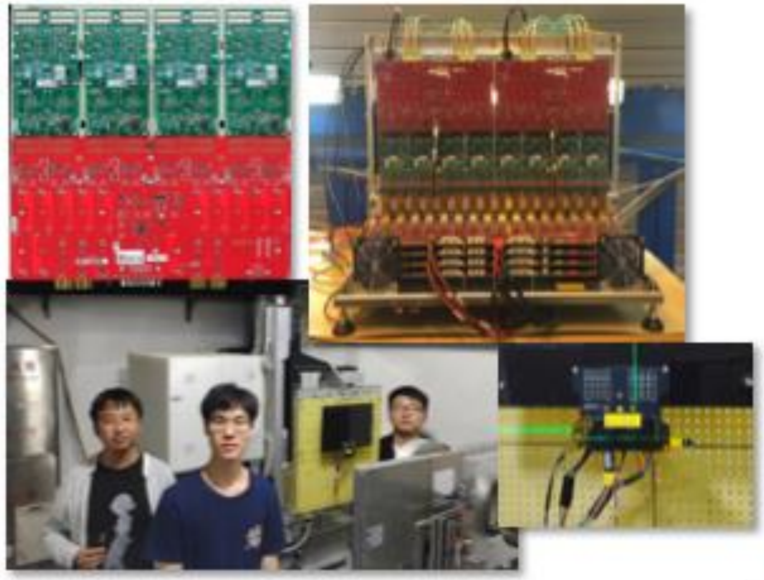
Upstream Tracker / UT

- UT installation & operation
- Irradiation study of SALT chip with Chinese facilities
- Control & safety software



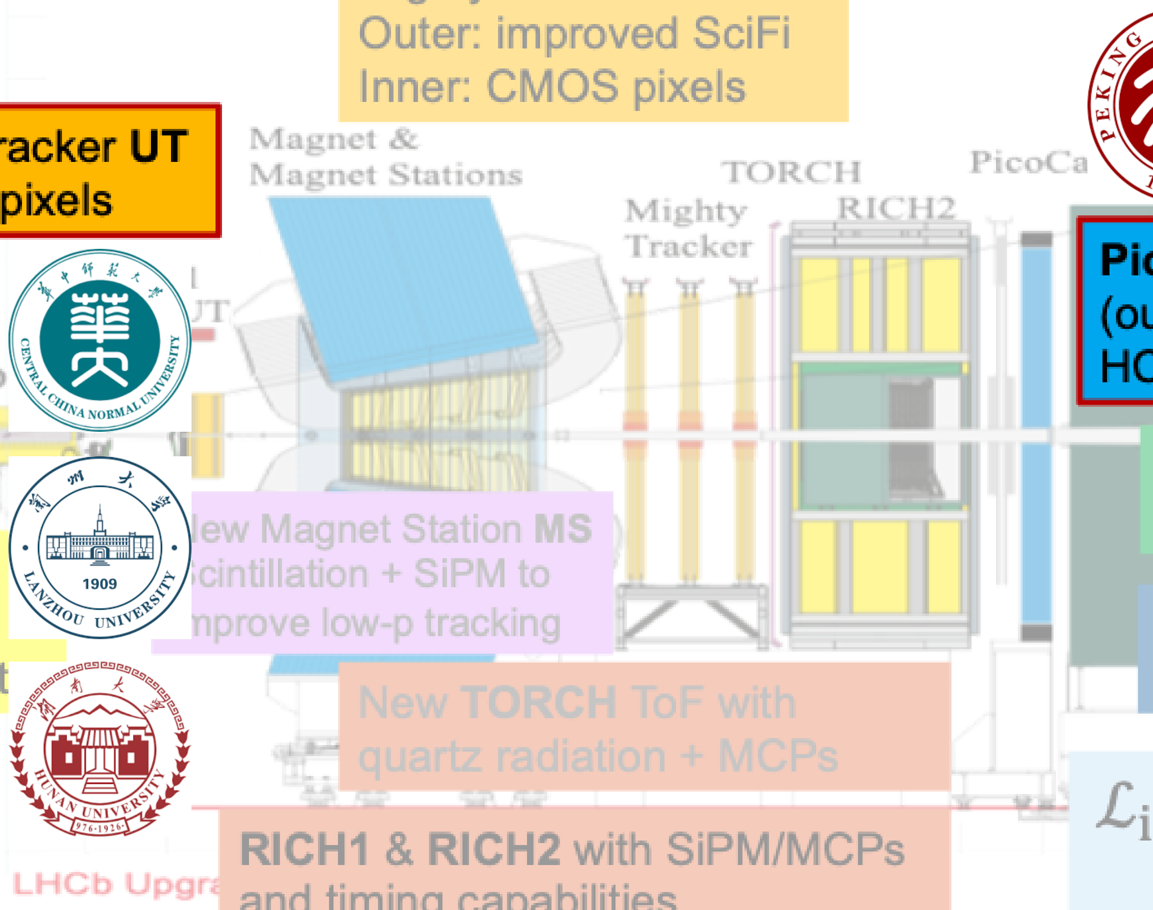
Scintillator Fiber Tracker / SciFi

- FE board design and production (>2500 PCB)
- Quality assurance system
- Study of radiation damage on SiPM



Taken from [Yiming Li's talk]

LHCb Upgrade II



Mighty Tracker **MT**
Outer: improved SciFi
Inner: CMOS pixels

Upstream Tracker **UT**
with CMOS pixels

VELO pixel
ith
abilit

lew Magnet Station **MS**
cintillation + SiPM to
nprove low-p tracking

New **TORCH** ToF with
quartz radiation + MCPs

RICH1 & **RICH2** with SiPM/MCPs
and timing capabilities

PicoCAL: SPACAL (inner) + Shashlik
(outer), with timing capabilities
HCAL & neutron shielding removed

Muon detectors μRWELL (inner)
+ MWPCs (outer)

New readout, FE, ASICs, event
builders, HLT1 & HLT2 farms …

$\mathcal{L}_{\text{inst}} = 1.0 \times 10^{34}\text{cm}^{-2}\text{s}^{-1}$
(5 × Run 3)