CKM and flavour at Belle II

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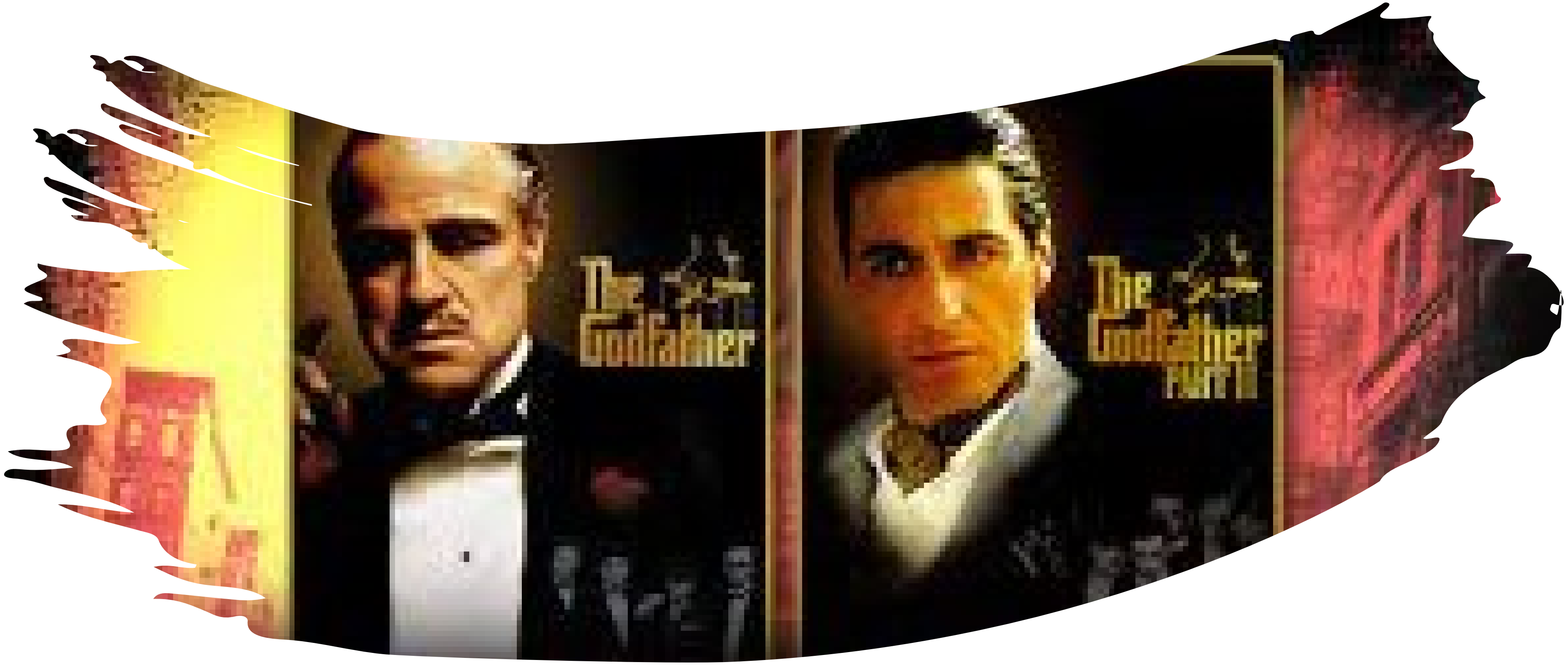
Outline

- Belle II
- Highlights so far
  - Lepton flavour:
    - tau physics highlights
  - *B* physics highlights
    - *CP* violation
    - Tests of lepton-flavour universality
    - Evidence for $B^+ \to K^+ \nu\nu$
- Prospects

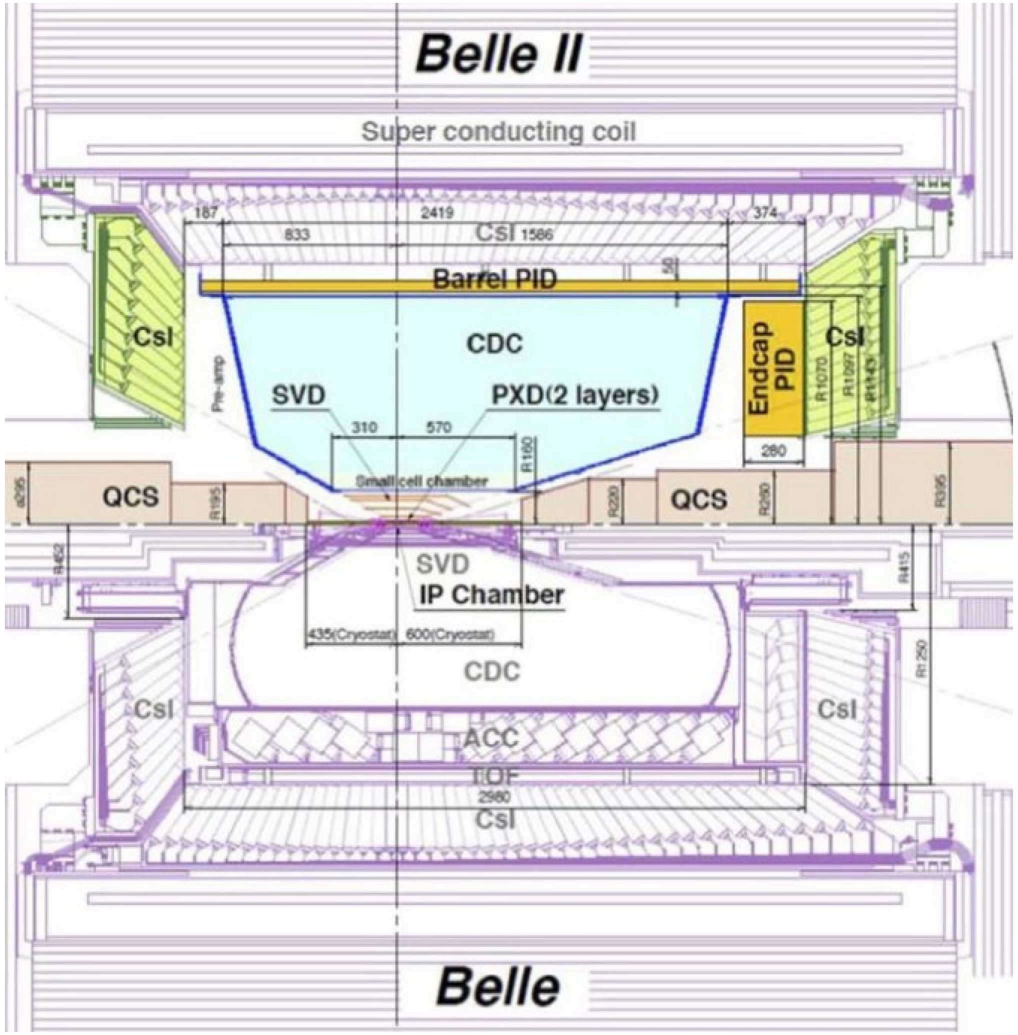


Belle II

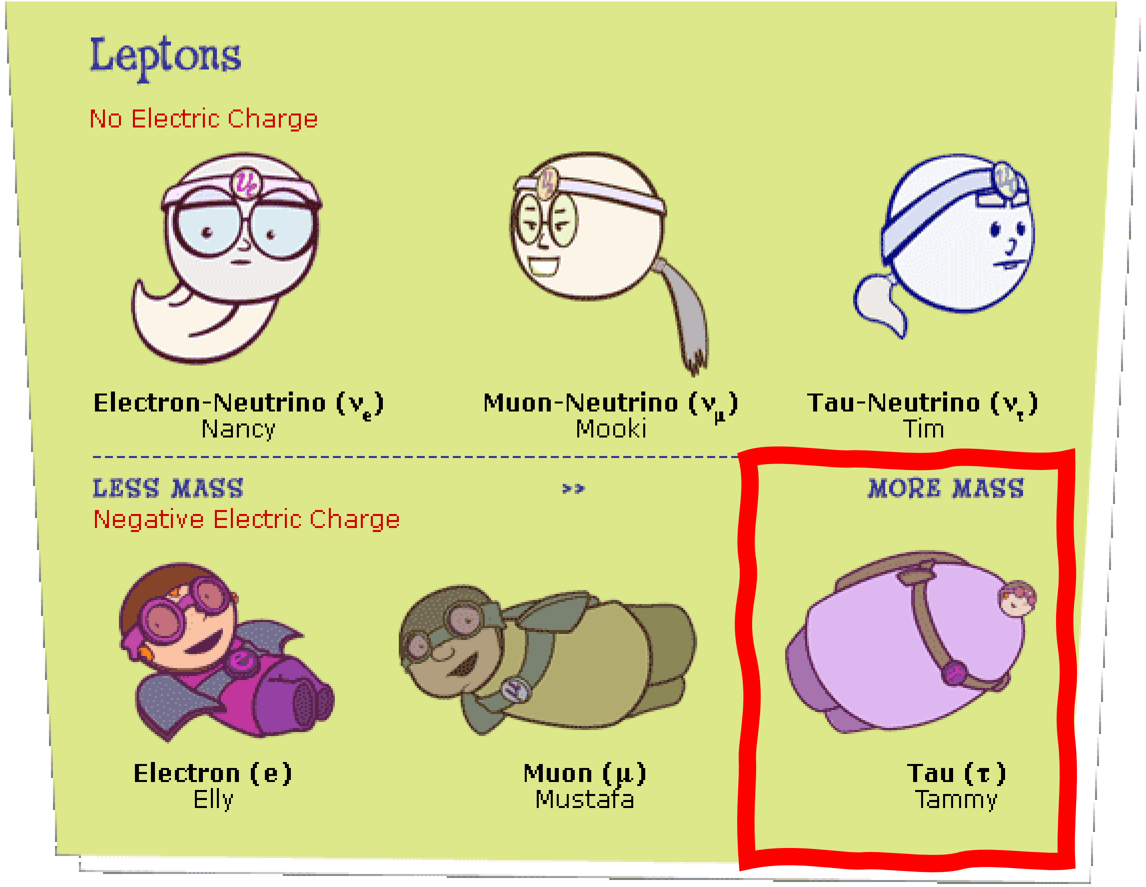
Will the next generation perform as well as the first?

Detectors and data samples

- Belle + BaBar collected 0.71+0.43=1.14 ab^{-1} Υ(4S) samples
  - Many achievements: confirmation of KM mechanism, $b \to c\tau\nu$, direct CPV in B decay
- SuperKEKB + Belle II@KEK, Tsukuba
  - nanobeam scheme to increase instantaneous luminosity by factor 30 to collect multi-ab^{-1} sample
  - **World record 4.7×10^{34} cm^{-2}s^{-1}**
  - Target 6×10^{35} cm^{-2}s^{-1}
  - So far integrated 362 fb^{-1} at Υ(4S)
  - + 42 fb^{-1} off-resonance to characterize continuum

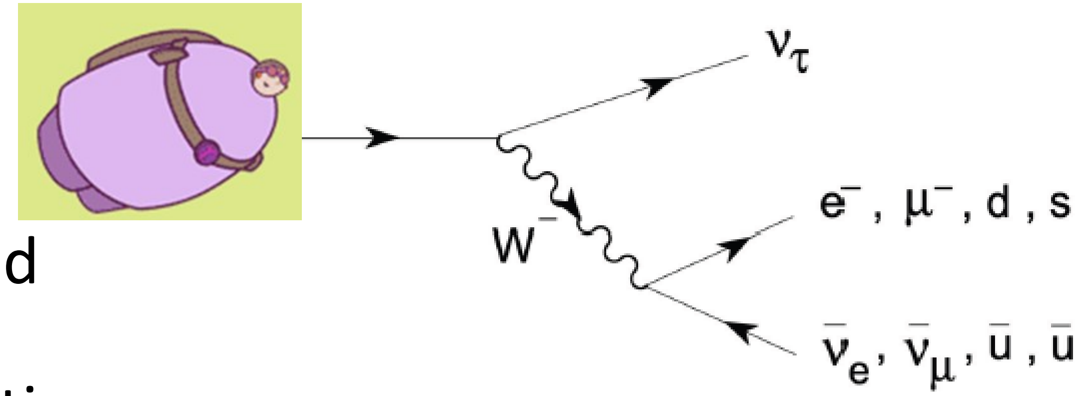


https://www.quarked.org/

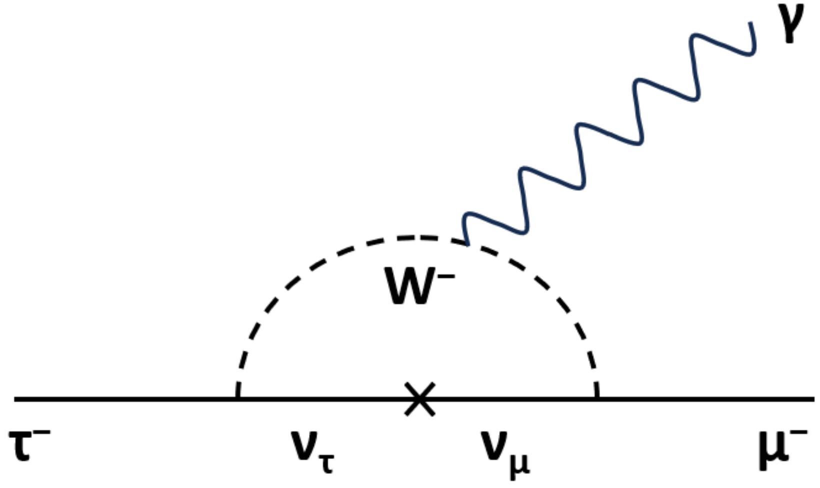


τ physics

Tau physics



- 185 standard model decay modes studied
  - **principally hadronic final states**
- Unique laboratory to study weak interaction
- Third-generation therefore beyond-SM-sensitivity anticipated
  - Any observation of lepton-flavour violation in **$\tau \rightarrow 3\mu$**, $\tau \rightarrow \mu\gamma$, $\tau \rightarrow l\phi$ etc **new physics**
  - SM highly suppressed
- Connections to g-2 and lepton universality violation in b decay
- Also, precision measurements of lepton universality in lepton decay, V_{us}, moments, lifetime and **mass**



Phys. Rev. D **108**, 032006 (2023)

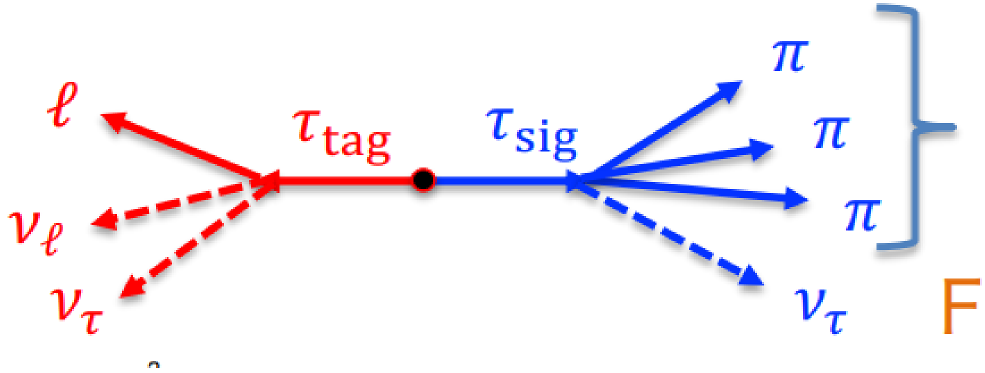
τ mass measurement

- Fundamental parameter of the standard model
  - Important input to lepton-flavour universality tests

$$R_e = \frac{\mathcal{B}[\tau^- \to e^- \bar{\nu}_e \nu_\tau]}{\mathcal{B}[\mu^- \to e^- \bar{\nu}_e \nu_\mu]} \qquad \left(\frac{g_\tau}{g_\mu}\right)_e = \sqrt{R_e \frac{\tau_\mu}{\tau_\tau} \frac{m_\mu^3}{m_\tau^3} (1+\delta_W)(1+\delta_\gamma)}$$

(δs are radiative corrections)

- We use the pseudomass variable to determine mass

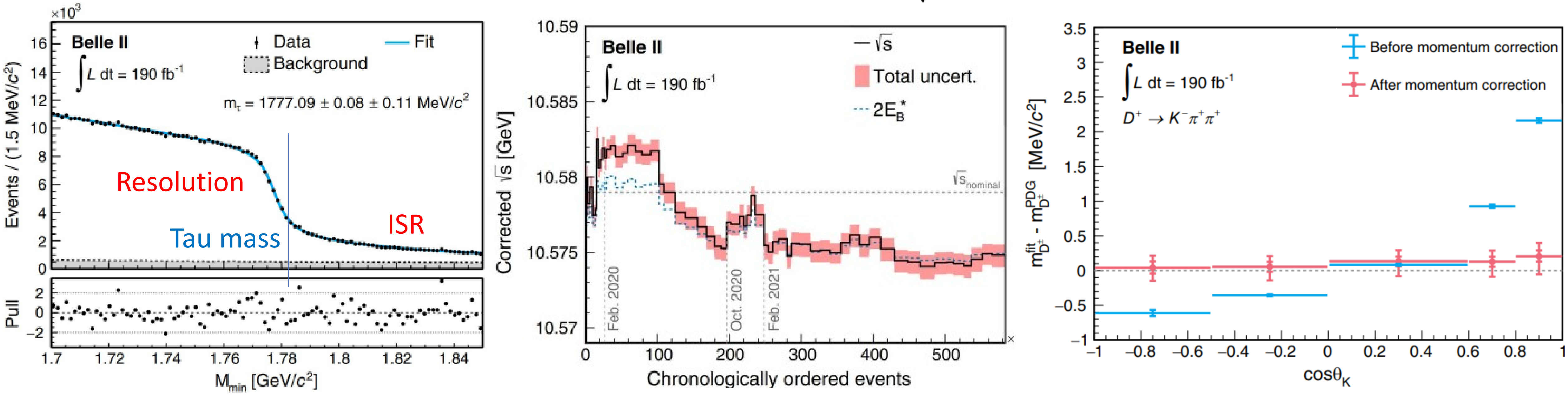


$$M_{\mathrm{min}} = \sqrt{m_{3\pi}^2 + 2(\sqrt{s}/2 - E_{3\pi})(E_{3\pi} - |\vec{p}_{3\pi}|)} \leq m_\tau$$

Fit to the endpoint with empirical function

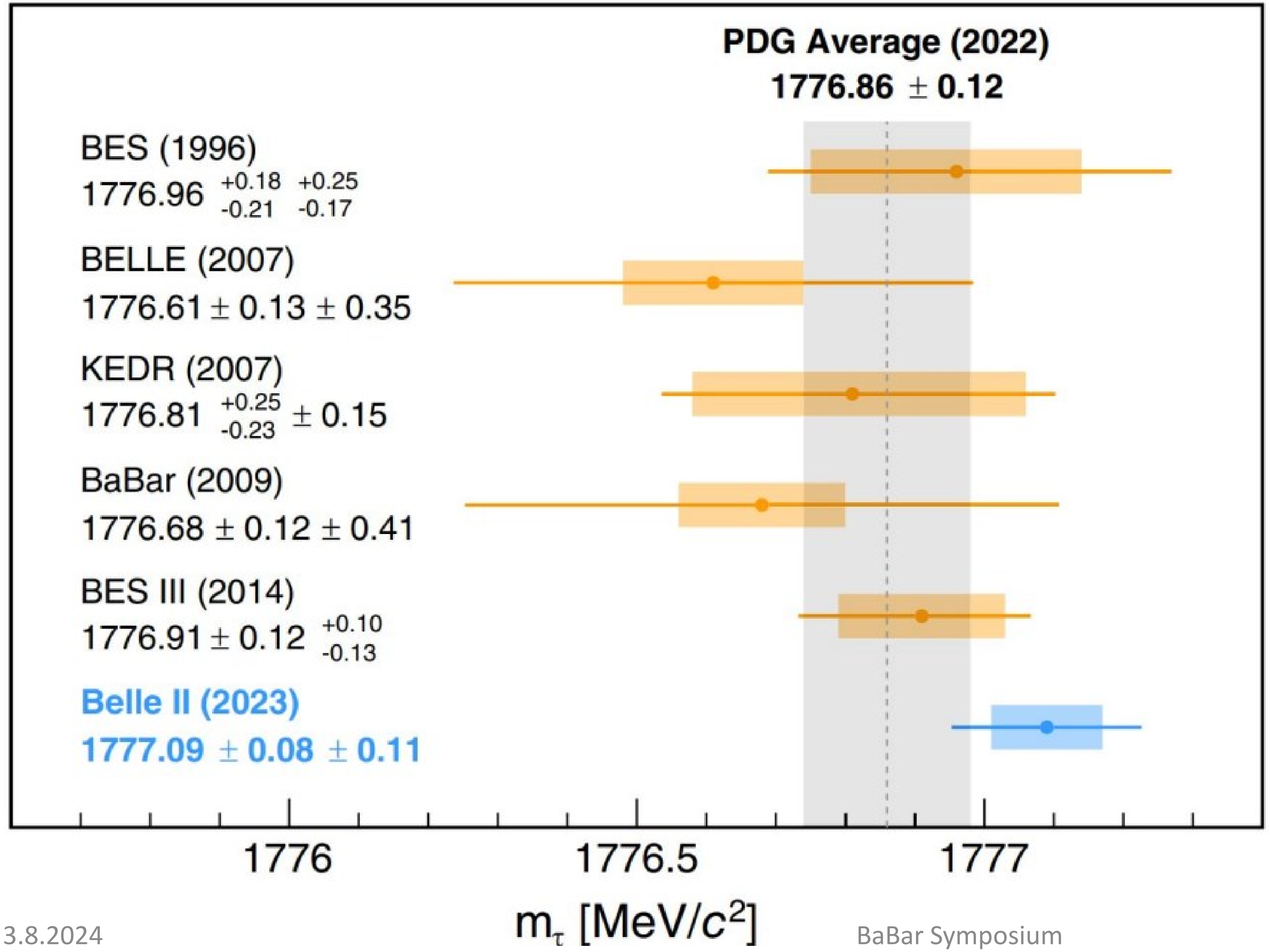
τ mass measurement

$$M_{\min} = \sqrt{m_{3\pi}^2 + 2(\sqrt{s}/2 - E_{3\pi})(E_{3\pi} - |\vec{p}_{3\pi}|)} \leq m_\tau$$



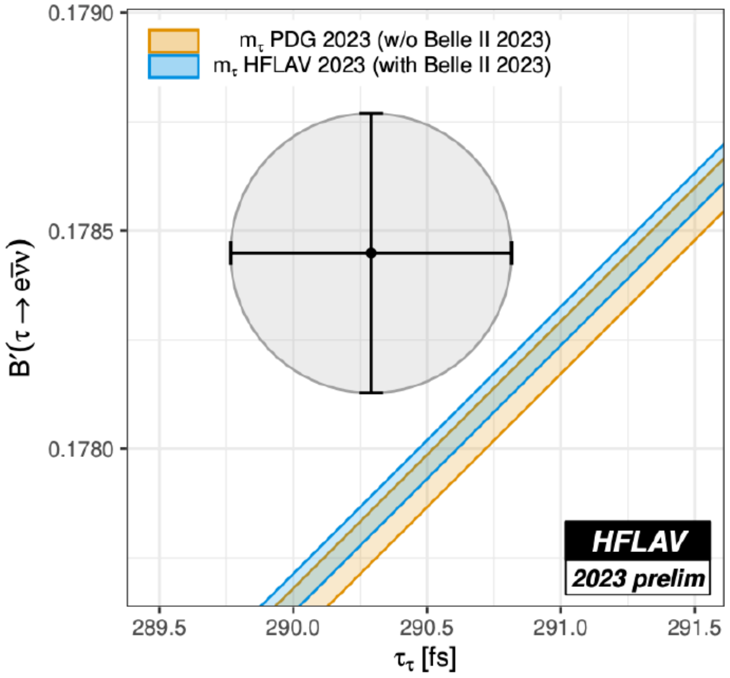
- Fit to distribution with analytic form that accounts for ISR, FSR and resolution
- Knowing the scale key: beam energy (from E_B*) and momentum (from D mass)

τ mass measurement



World's most precise measurement to date

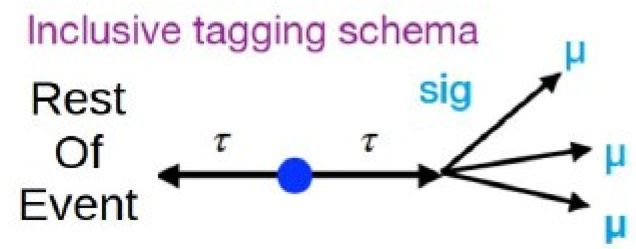
Impact on other precision measurements

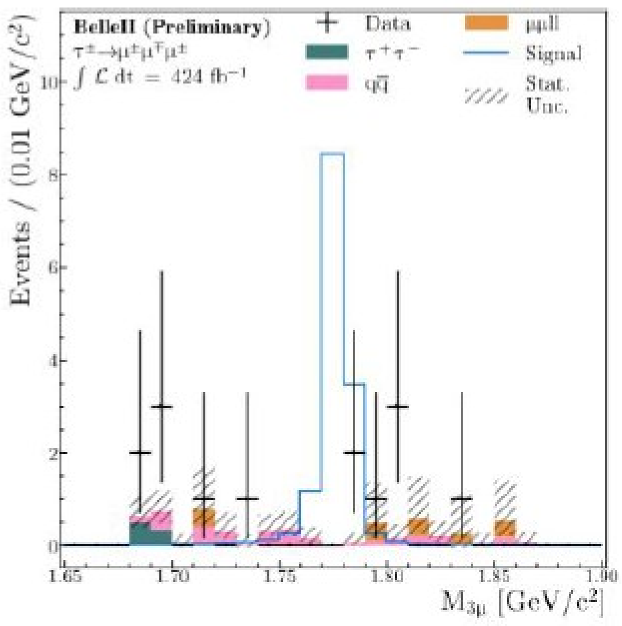


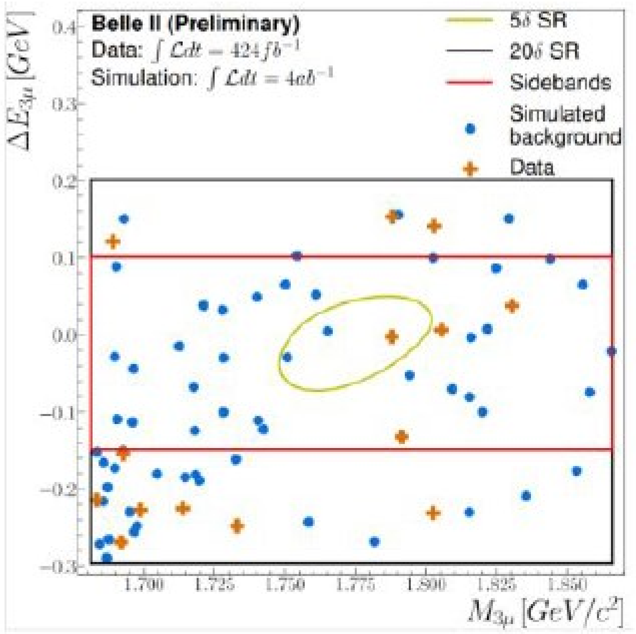
Paper in preparation

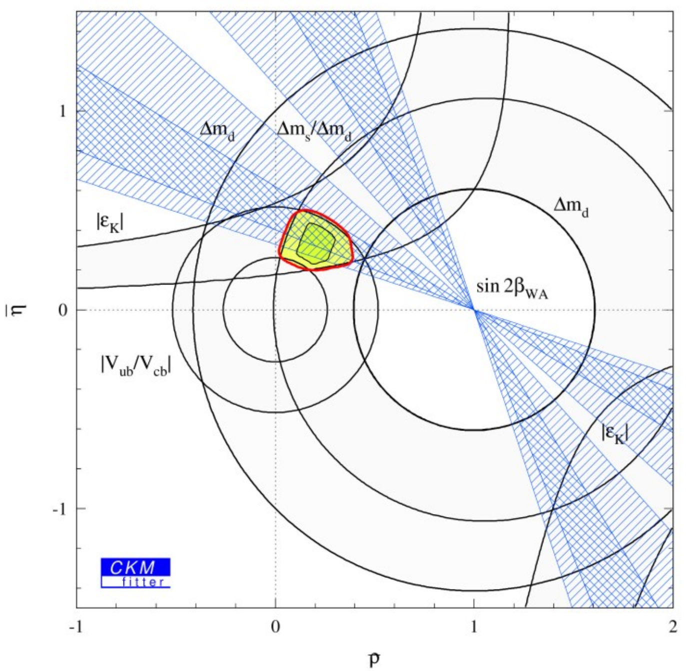
τ→3μ– lepton flavour violation search

- Inclusive tag of the non-signal τ to increase efficiency – multivariate
- Cut ‘n’ count in 2D plane of
  - $M_{3\mu}$ and $\Delta E = E_{3\mu} - E_{beam}$ (in c.m.)
  - Sideband derived background estimate $0.5^{+1.4}_{-0.5}$ events
- One event observed
- World best limit
  - **BF < 1.9×10^{-8} (90% c.l.)**
- Area of competition
  - [LHCb]() BF < 4.1×10^{-8} (Run 1 only)
  - [CMS]() BF < 2.9×10^{-8} (Run 1+2)

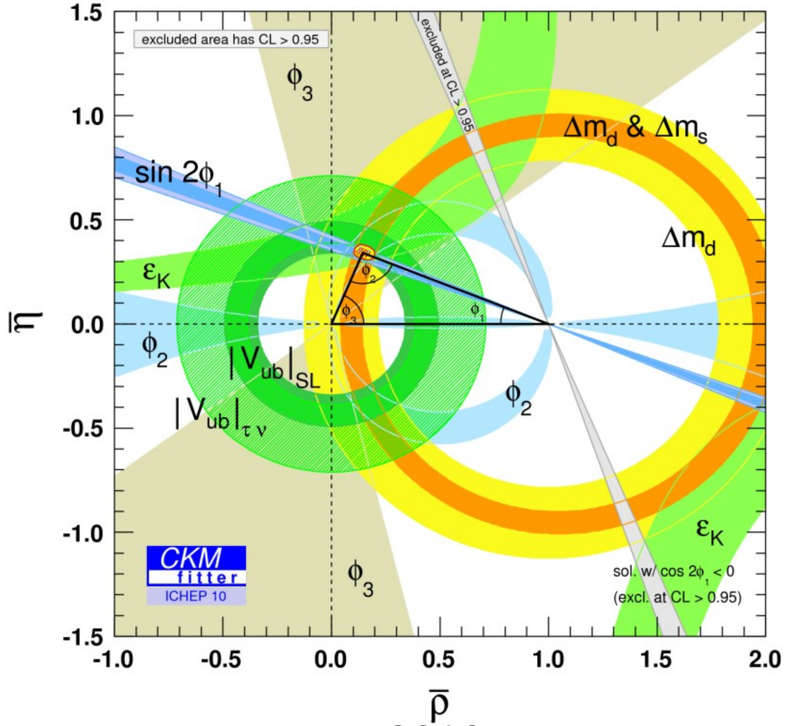




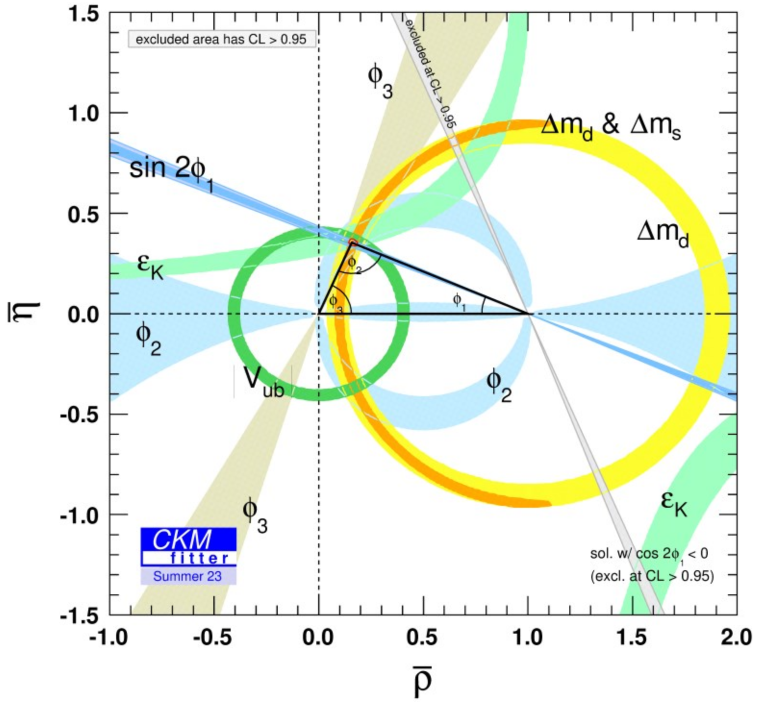




2001



2010

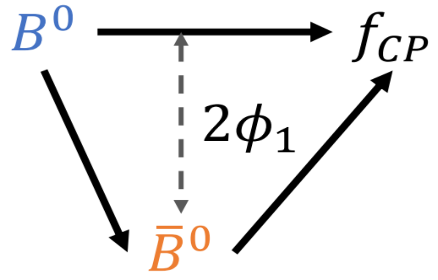


2023

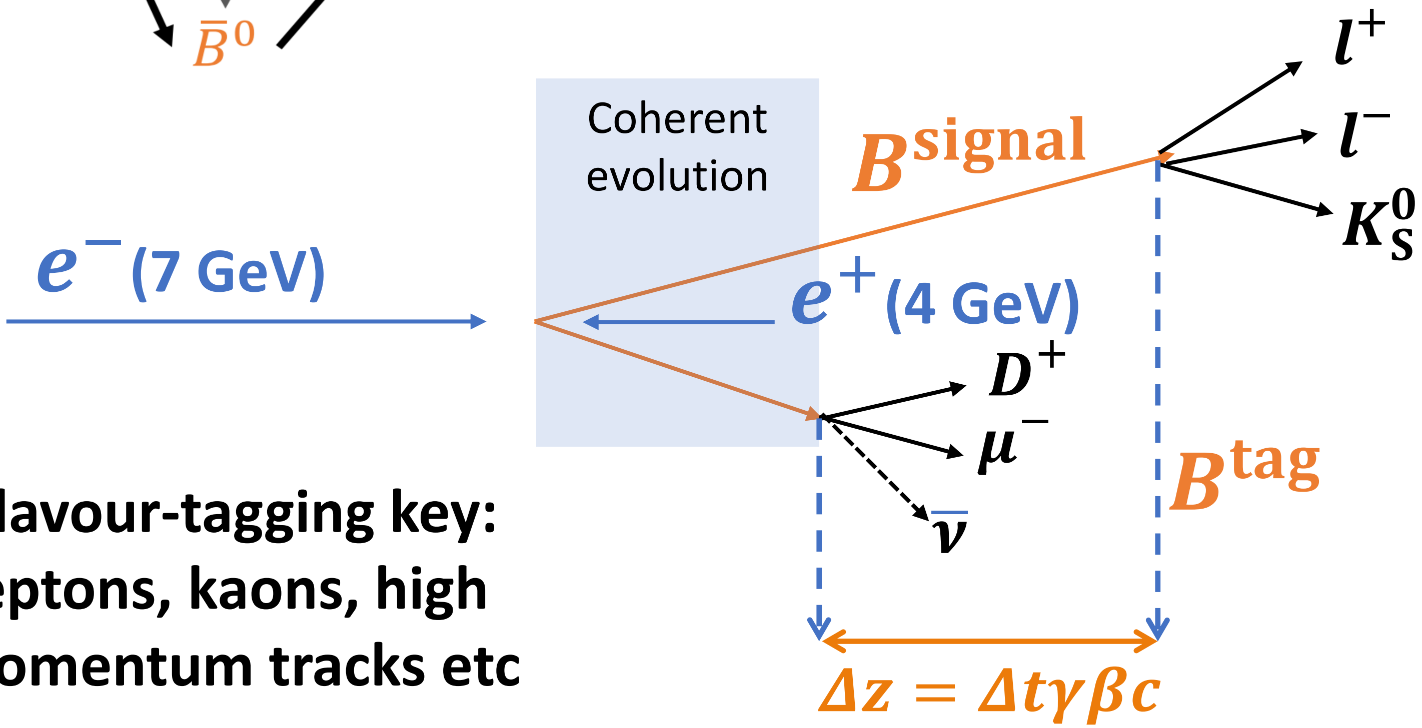
CKM and *CP* violation

[arXiv:2402.17260 [hep-ex]](https://arxiv.org/abs/2402.17260)

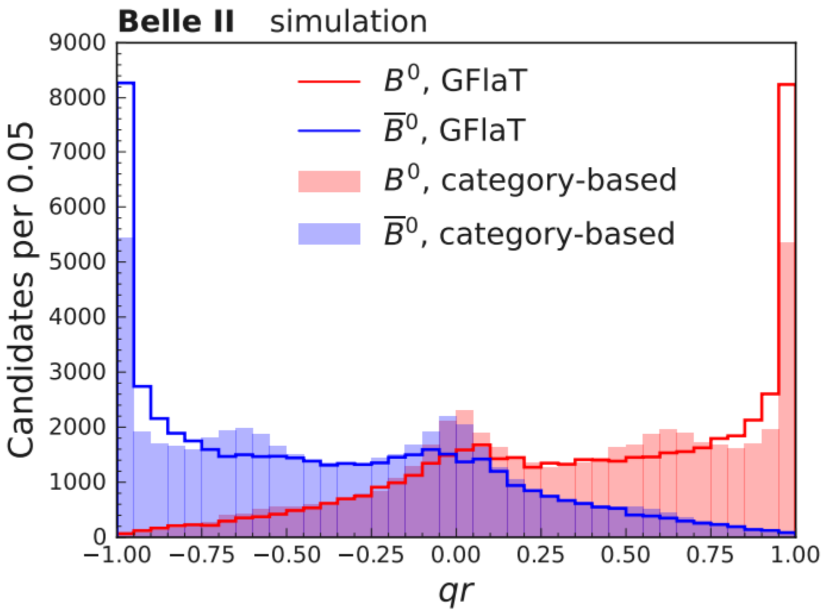
Flavour tagging improvements



$$\propto \; |V_{td}|^2 e^{2i\phi_1}$$



Flavour-tagging key: leptons, kaons, high momentum tracks etc



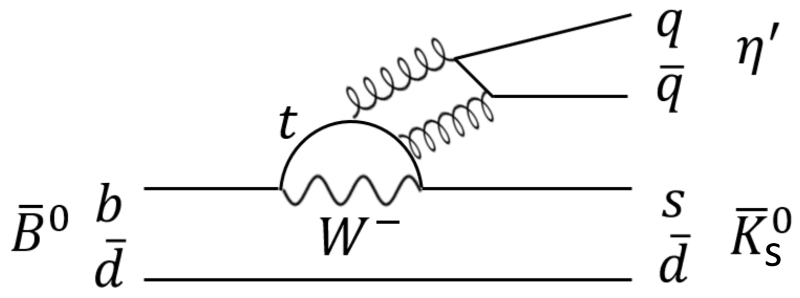
Graph-neural-network approach has improved our tagging by 18%

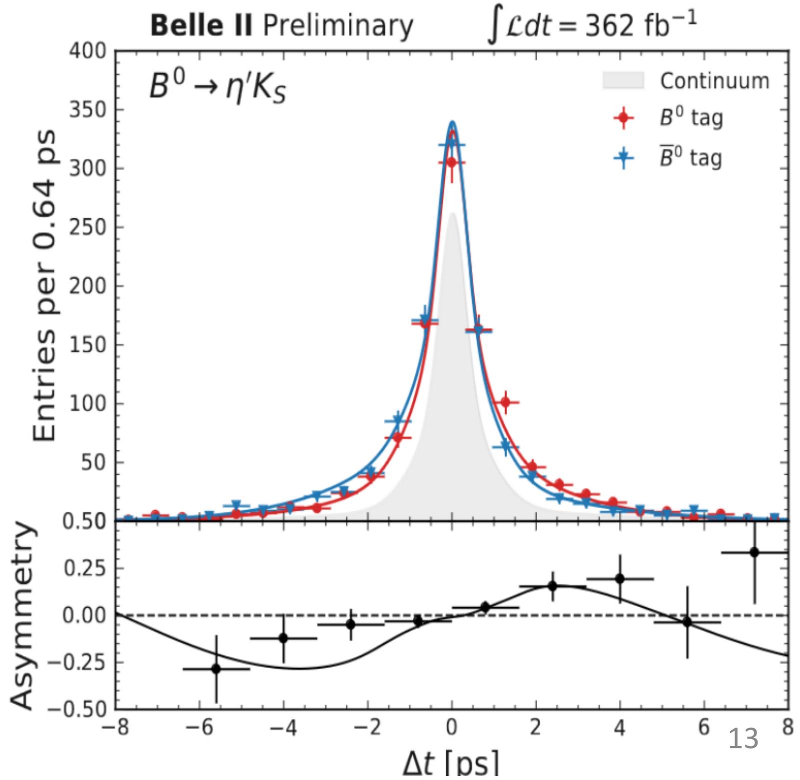
$$\boldsymbol{\epsilon(1-2\omega) = 37.4\%}$$

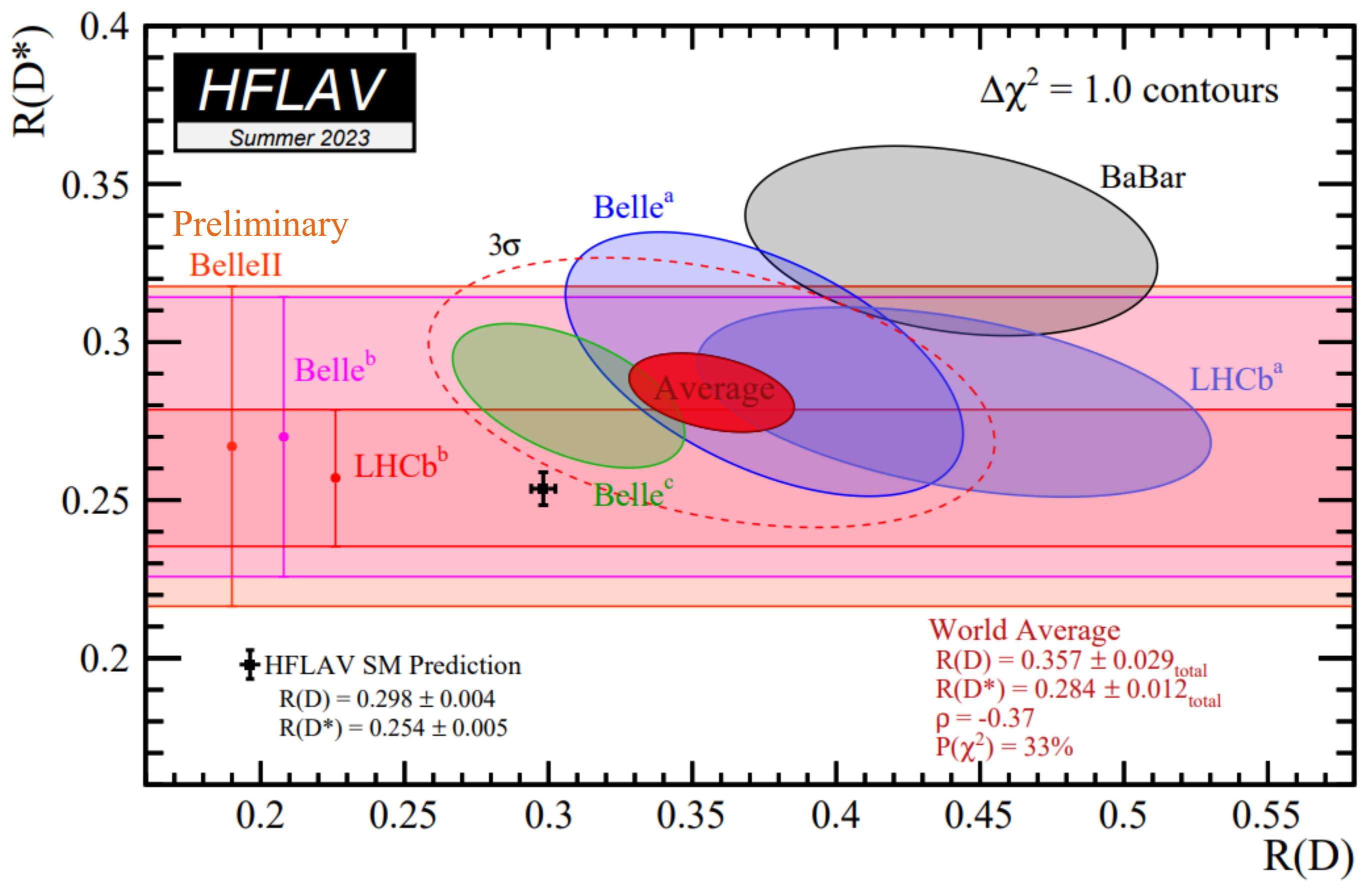
arXiv:2402.03713 [hep-ex]

Time-dependent *CP* violation - $B^0 \to \eta' K_S^0$

- Decay may also have a BSM phase as it is a gluonic penguin
  - alter the value of ϕ$_1$ from that measured in $b \to c\bar{c}s$ transitions such as $B^0 \to J/\psi K_S^0$
- Reconstructing $\eta' \to \eta(\gamma\gamma)\pi^+\pi^-$ and $\eta' \to \rho(\pi^+\pi^-)\gamma$ we select 829 ± 35 events in 362 fb^{-1} sample
  - 3D fit to ΔE, m_{BC} and continuum suppression output
- **sin 2ϕ′$_1$ = 0.67±0.10±0.04**
- Consistent with current HFLAV average and that from $b \to c\bar{c}s$ result





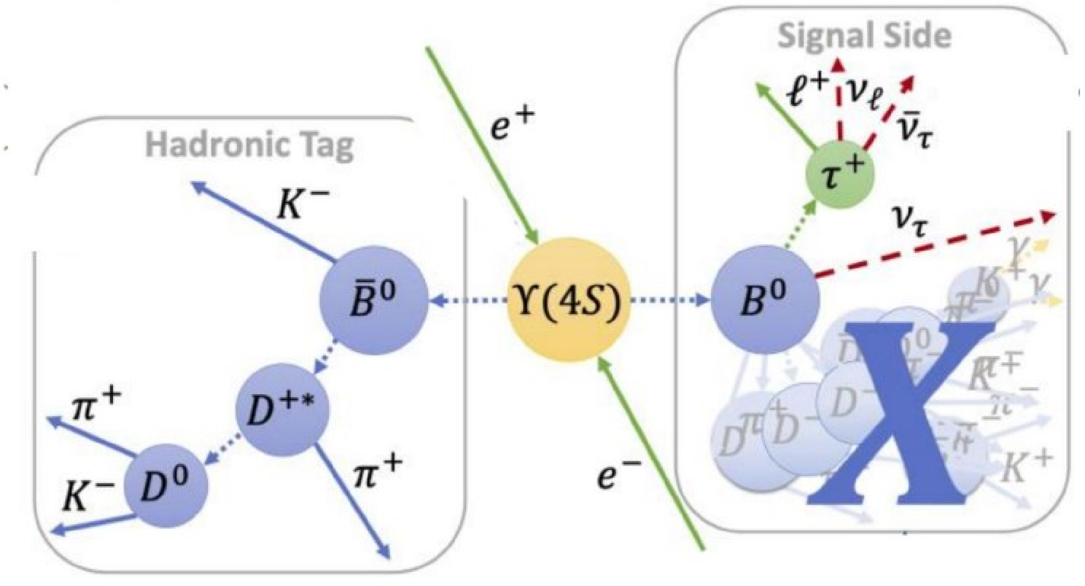


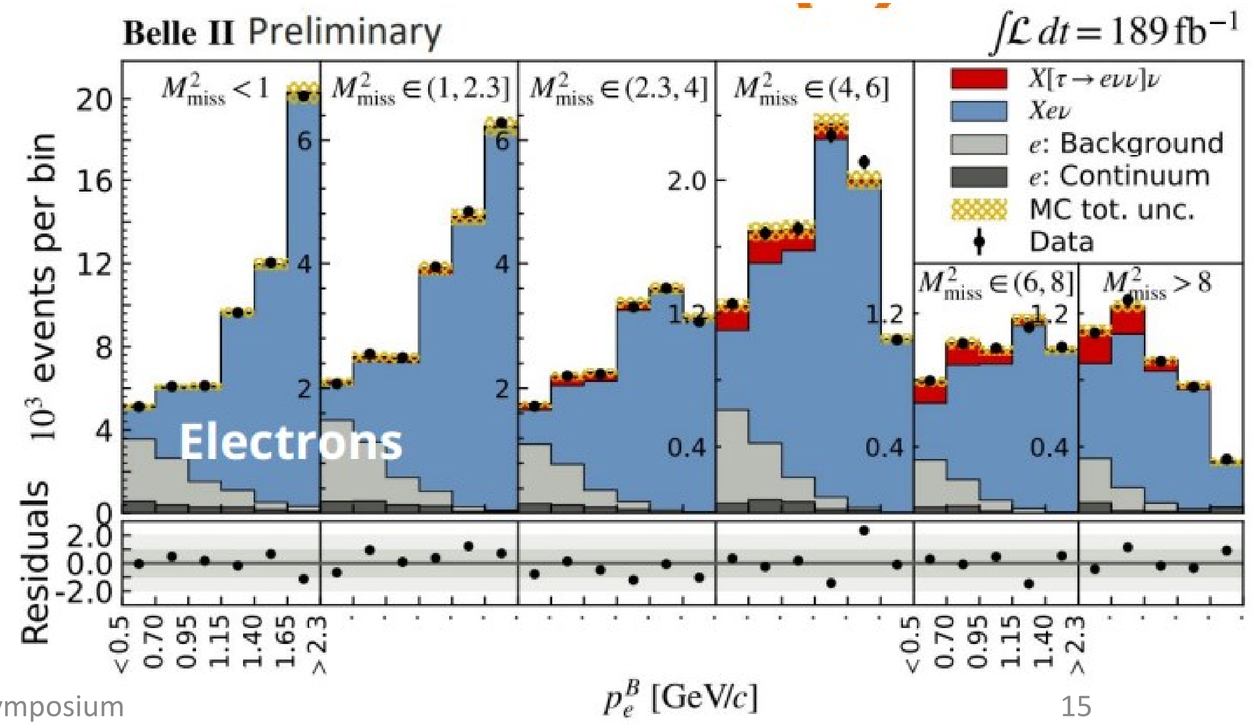
Lepton flavour/universality violation and rare decays

arXiv:2311.07248 [hep-ex]

Measurement of R(X)

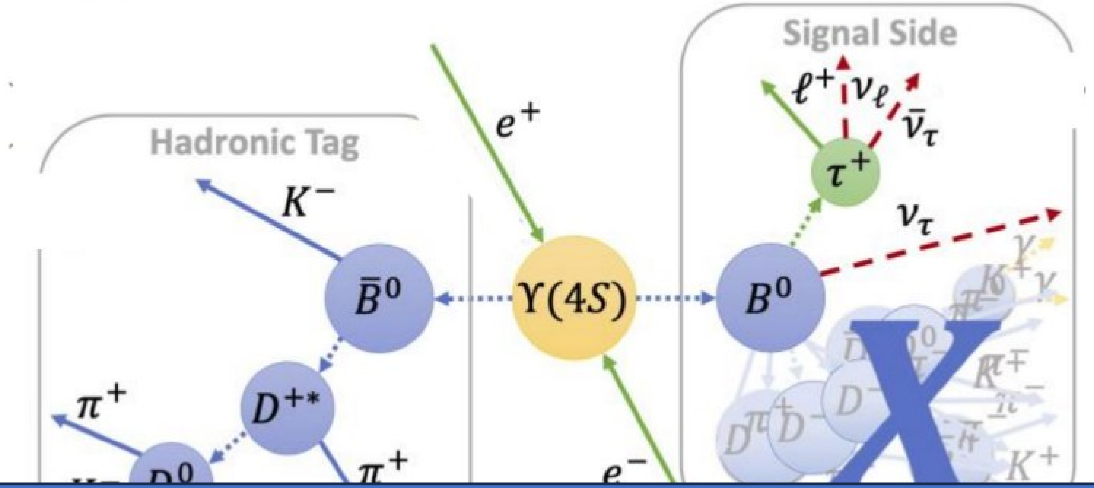
- Inclusive ratio $R(X) = \frac{BF(B\to X\tau\nu)}{BF(B\to Xl\nu)}$
  - A complementary alternative to R(D$^{(*)}$)
- Hadronic-tagging method with a 189 fb^{-1} Belle II sample
  - Hadronic tag pioneered by BaBar
    - PRL **92** 071802
  - MVA version at Belle II
    - Comput. Softw. Big Sci. 3 (2019) 1, 6
- Use missing-mass squared and lepton momentum to isolate signal above B→Xlν background
- Background templates calibrated to control samples and sidebands





arXiv:2311.07248 [hep-ex]

Measurement of R(X)



- Inclusive ratio $R(X) = \dfrac{BF(B\to X\tau\nu)}{BF(B\to Xl\nu)}$
  - A complementary alternative to R(D$^{(*)}$)

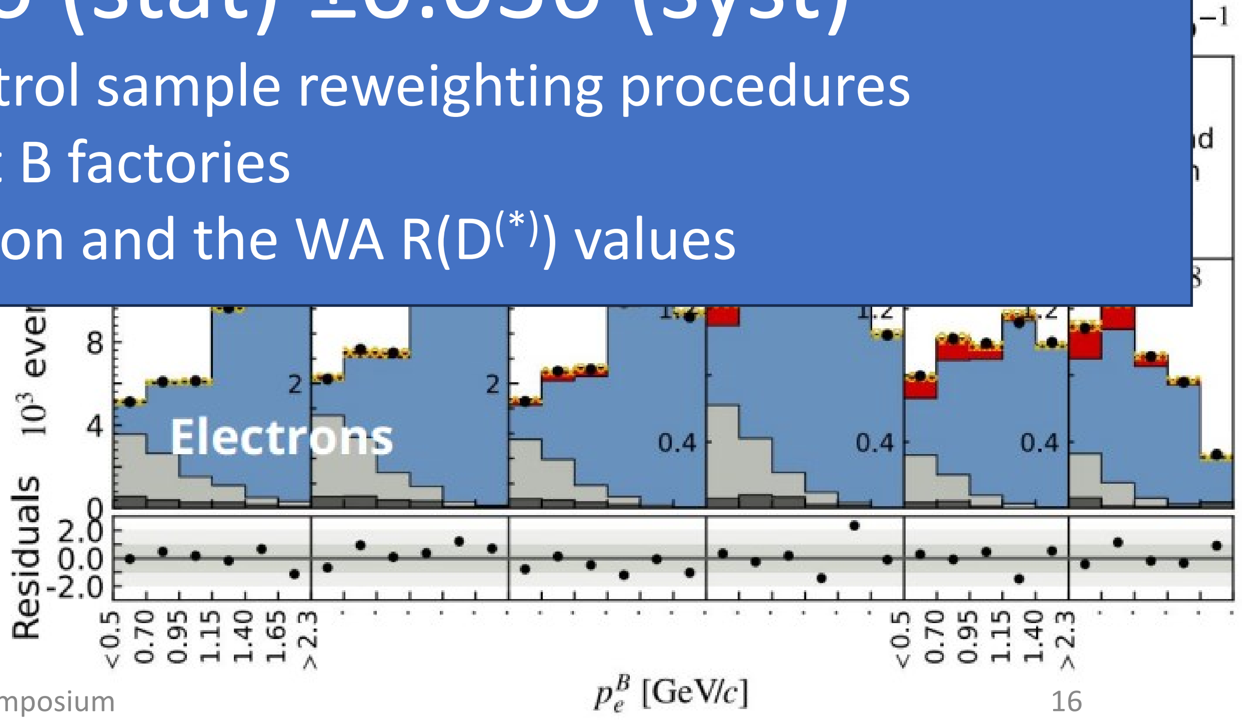
R(X)=0.228±0.016 (stat) ±0.036 (syst)

Systematics dominated by control sample reweighting procedures

First at B factories

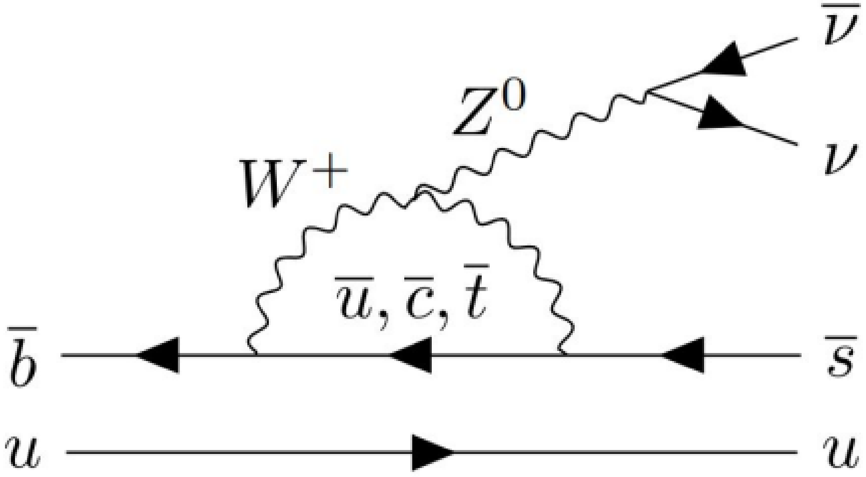
Agrees with SM prediction and the WA R(D$^{(*)}$) values

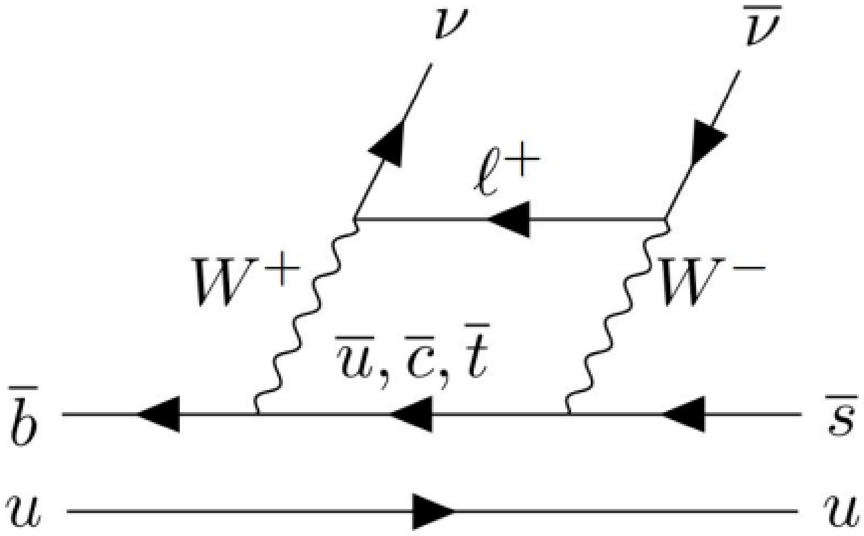
- Use missing-mass squared and lepton momentum to isolate signal above B→Xlν background
- Background templates calibrated to control samples and sidebands



arXiv:2311.14647 [hep-ex]
Accepted PRD

$B^+ \to K^+\nu\bar{\nu}$: Motivation



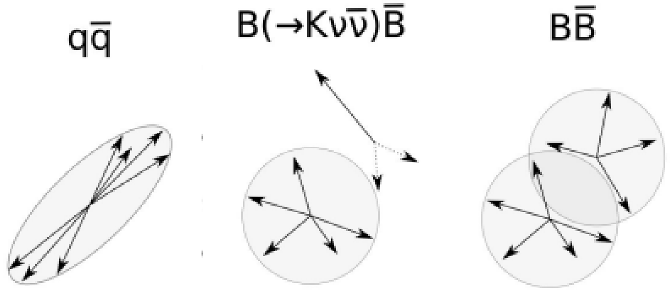


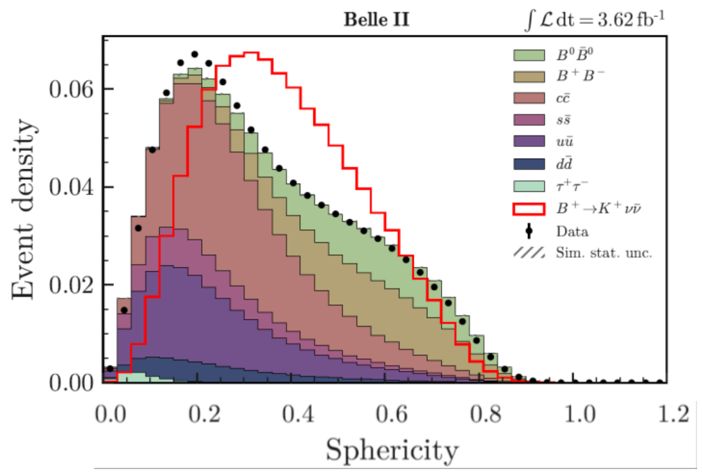
- Well known in SM but very sensitive to BSM enhancements – 3rd gen
  - B(B→K⁺νν)=(5.6±0.4) × 10^{-6} [arXiv:2207.13371]
- Challenging experimentally
  - Low branching fraction with large background
  - No peak – two neutrinos leads to no good kinematic constraint

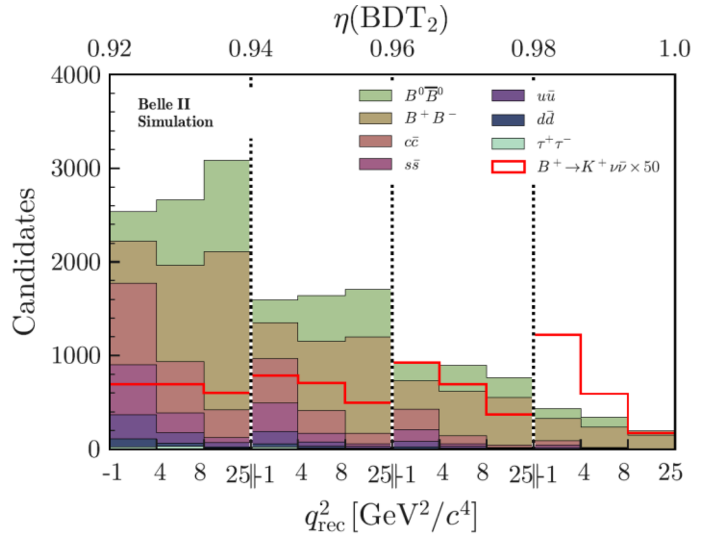
arXiv:2311.14647 [hep-ex]
Accepted PRD

$B^+ \to K^+ \nu\bar{\nu}$: Analysis strategy

- Two methods: an inclusive tag (8% efficiency) and conventional hadronic tag (0.4% efficiency)
  - many common features except tag
- Inclusive event variables to suppress background
  1. preselect events where missing momentum and signal kaon well reconstructed
  2. First boosted decision tree (BDT1): 12 variables
  3. Second BDT2: 35 variables – 3 times sensitivity
  4. BDT2 fit extraction variable in bins of $\nu\bar{\nu}$ mass-squared – q^2
- Many systematic studies with data-driven corrections and checks with control samples

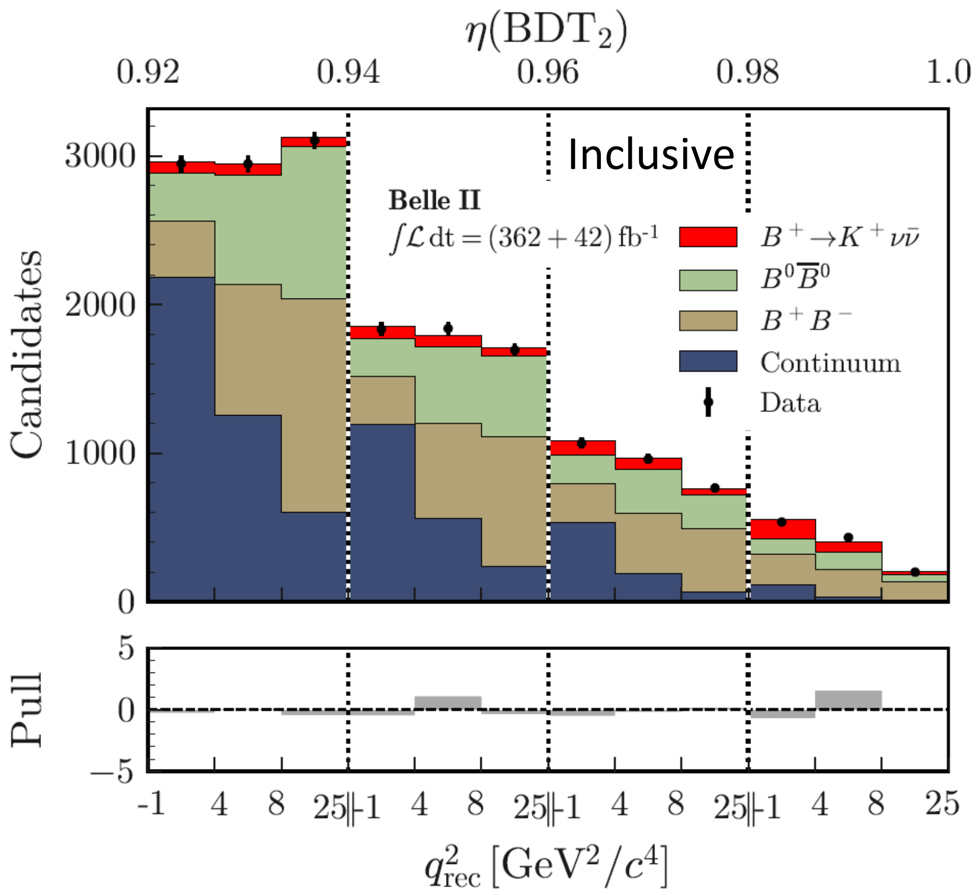


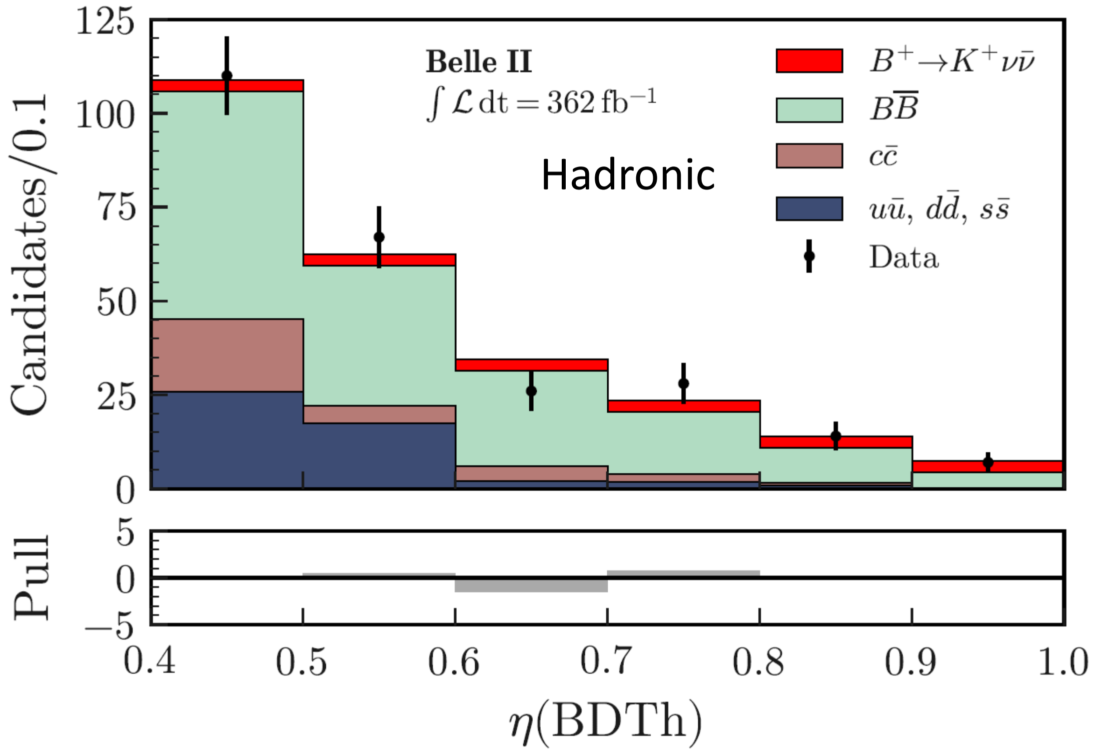




$B^+ \to K^+ \nu\bar{\nu}$: Results

arXiv:2311.14647 [hep-ex]
Accepted PRD



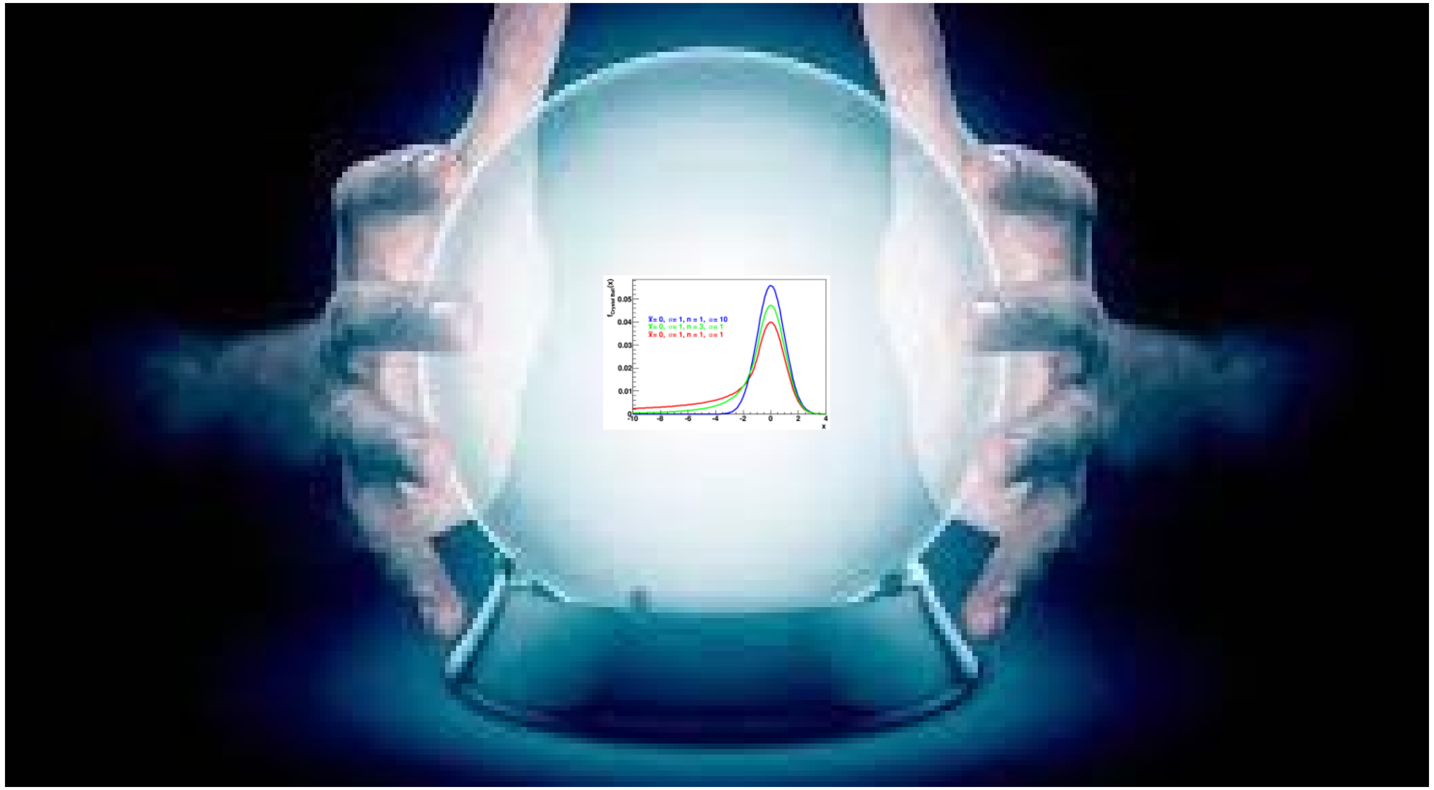


$$\mathrm{BF_{inc}} = (2.7 \pm 0.5(\mathrm{stat}) \pm 0.5(\mathrm{syst})) \times 10^{-5}$$

$$\mathrm{BF_{had}} = \left(1.1^{+0.9}_{-0.8}(\mathrm{stat})^{+0.8}_{-0.5}(\mathrm{syst})\right) \times 10^{-5}$$

$$\mathrm{BF_{comb}} = \left(2.3 \pm 0.5(\mathrm{stat})^{+0.5}_{-0.4}(\mathrm{syst})\right) \times 10^{-5}$$

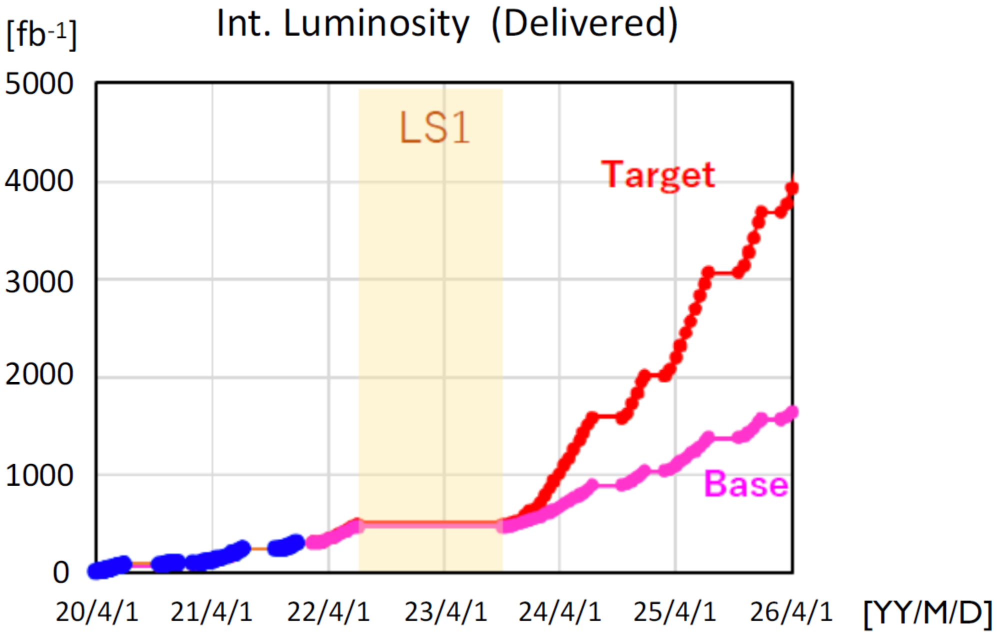
Combined result
Evidence @ 3.5σ
Tension with SM (0.6×10^{-5})
@ 2.7σ



5) Prospects and conclusion

Belle II: after current shutdown

- We have not collected the sample size planned to date
  - Beam conditions
- Since summer 2022 until **Feb 2024** shutdown for accelerator upgrades to mitigate background and increase luminosity
- Detector upgrades too
  - two-layer pixel detector installed
- **Path to 2×10^{35} cm $^{-2}$s^{-1} but new final focus to go beyond**
  - **Proposed upgrade from 2028+**
  - **see C. Checci and M. Roney next**



Goals with current data to a few inverse ab^{-1}

- Semileptonic decay:
  - V_{cb} can we make progress on the inclusive vs. exclusive tension
    - KEK report in preparation
  - **R(D)-R(D*)**
- Electroweak penguin
  - **Missing energy modes** like $B \to K\tau\tau$ and $K\nu\nu$
- CP violation
  - α and the **gluonic penguins**
- tau
  - **LFV and precision**
- Charm
  - final states with neutrals, e.g., $D \to \pi^0\pi^0$
- Quarkonium
  - Y(10753) scan and isospin partners (ISR and *B* decay)
- Dark sector and low multiplicity
  - dark photon and $e^+e^- \to \pi^+\pi^-$

Our [Snowmass submission] is the most up to date prospects document

Conclusion

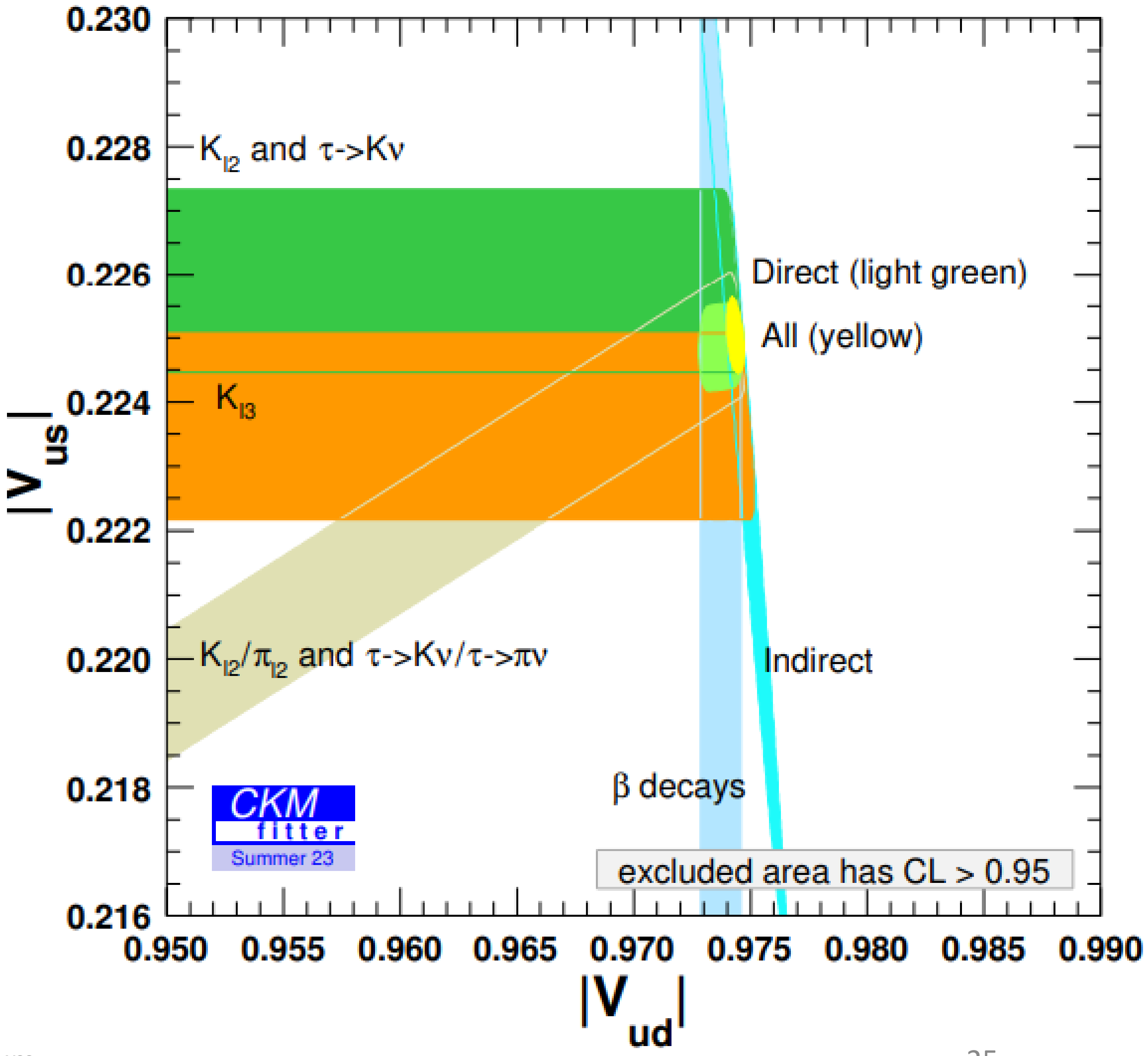
- e^+e^- has an important role to play in the future of flavour
  - Belle II is catching up to first generation sample size, we are producing competitive and exciting results
    - 37 papers and 10 preliminary results with a paper in preparation
    - More before the summer with the Run 1 data
  - A lot more to come once we enter the “10^{35} era” of Run 2 which is just starting

Backup

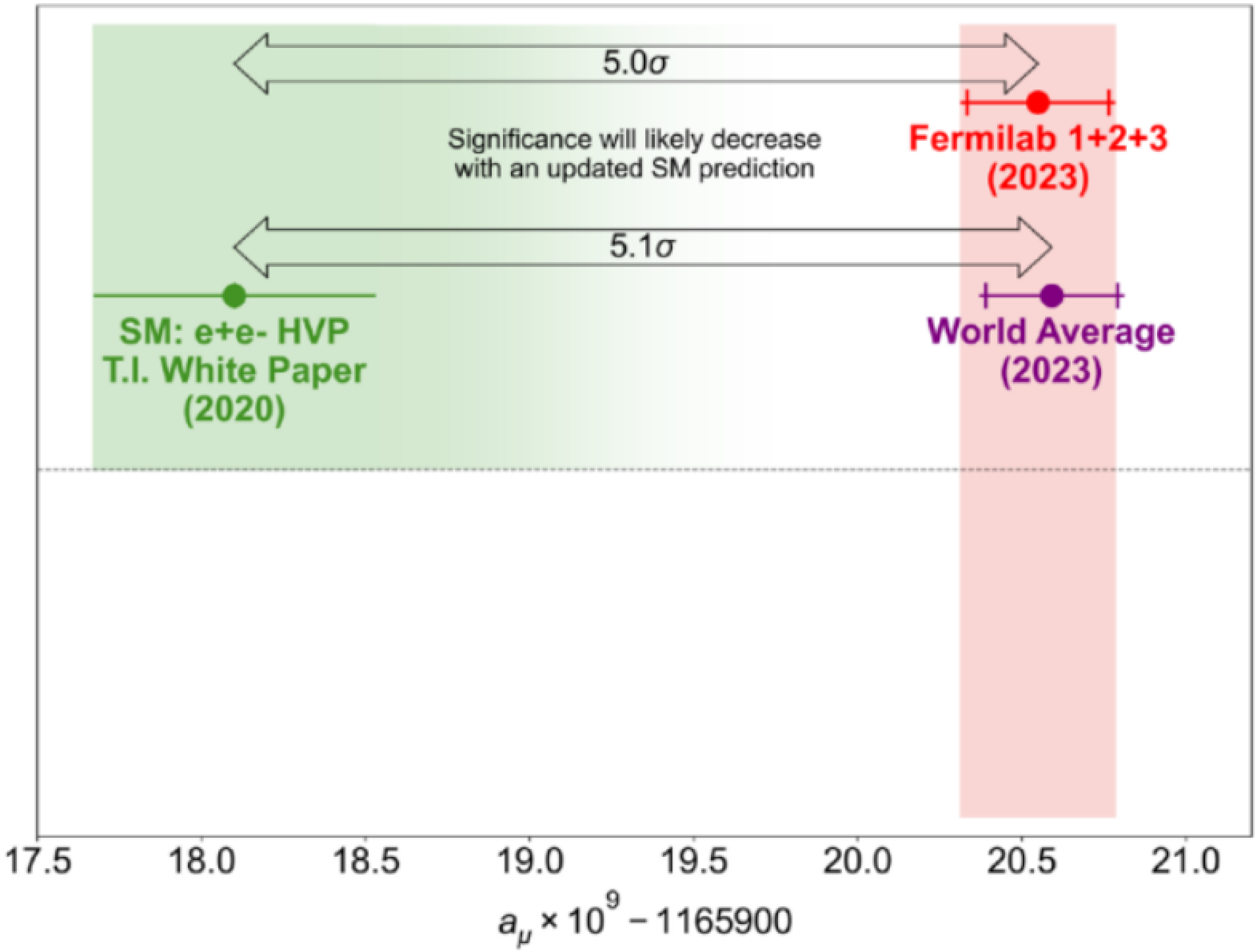
Tau physics motivation II

- **Precision measurements** of the τ lepton can have significant impact
- Example:
  - first row unitarity of CKM matrix – ‘Cabibbo angle anomaly’
  - $B(\tau \to K\nu)/B(\tau \to \pi\nu)$ proportional to $|V_{us}/V_{ud}|^2$
  - Combine with lattice QCD information to provide additional constraint
- Additionally, lepton-flavour universality and dipole moments
- **Mass** and lifetime important inputs to these calculations

Luiz Vale Silva (CKM 2023)

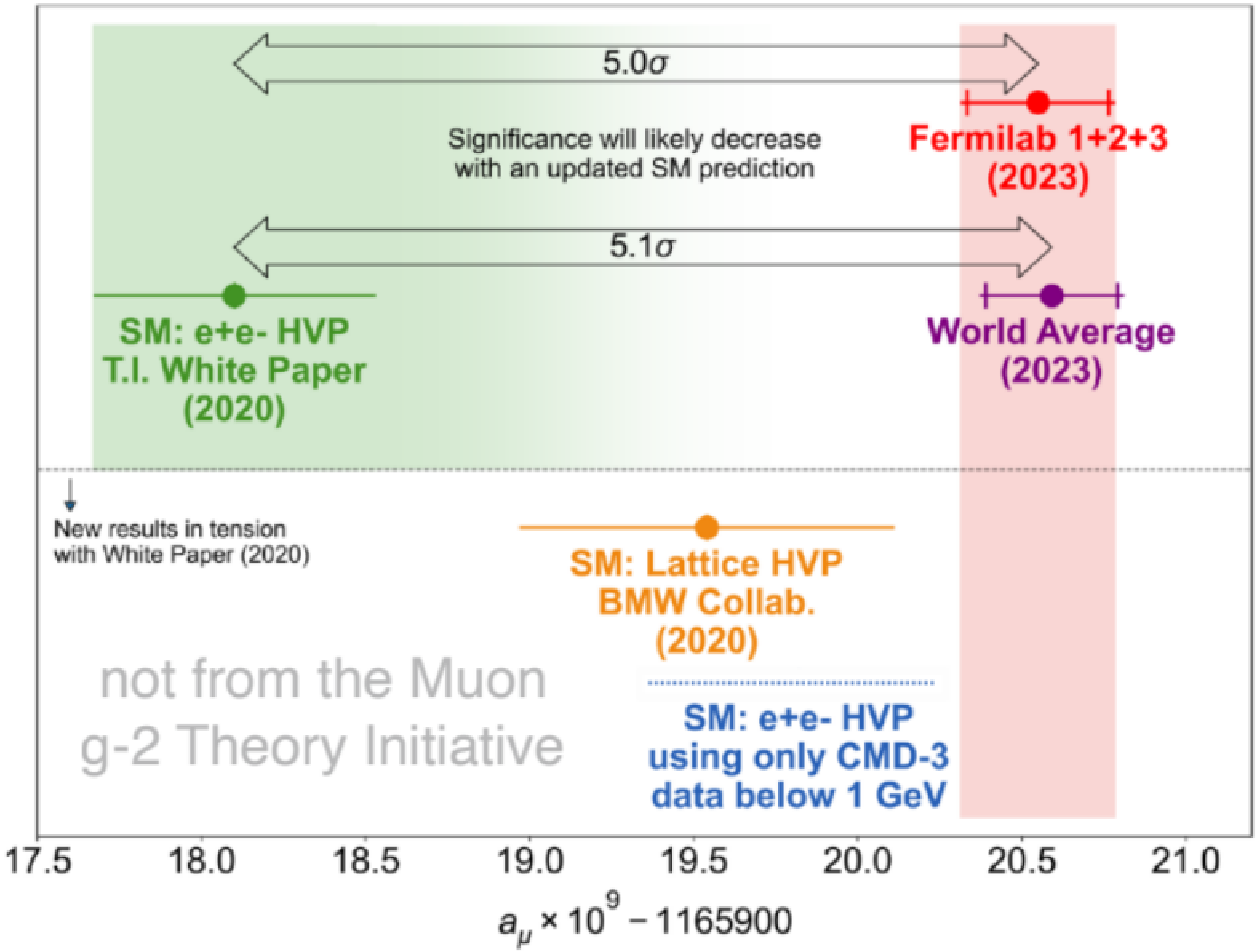


...away from heavy flavour muon g–2



Plot from A. Keshavarzi talk at Lattice 2023

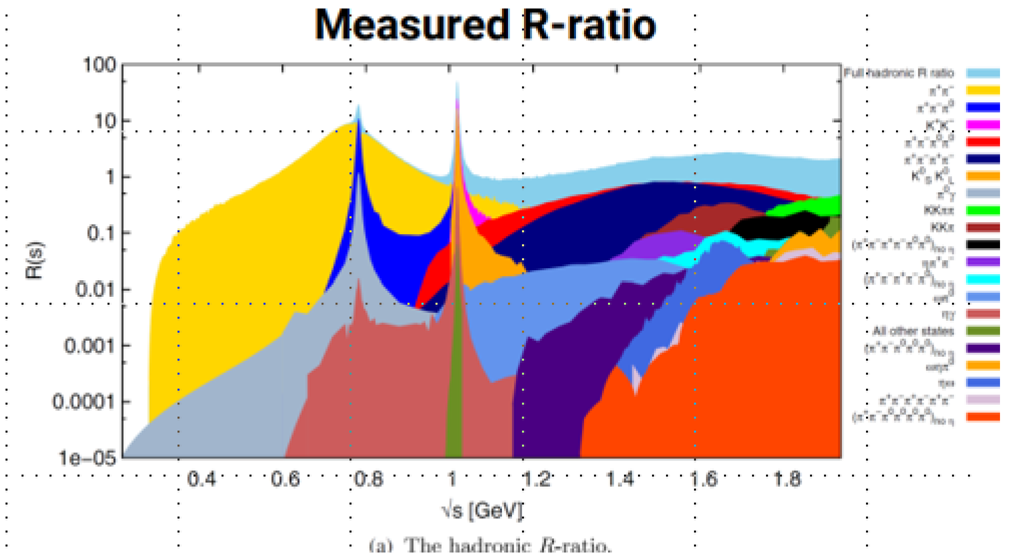
…away from heavy flavour muon g–2



Plot from A. Keshavarzi talk at Lattice 2023

Paper in preparation

$\sigma(e^+e^- \to \pi^+\pi^-\pi^0)$



Muon anomalous magnetic moment

$$a_\mu = \frac{g-2}{2} = a_\mu^{\mathrm{QED}} + a_\mu^{\mathrm{EW}} + a_\mu^{\mathrm{QCD}}$$

Hadron contribution term

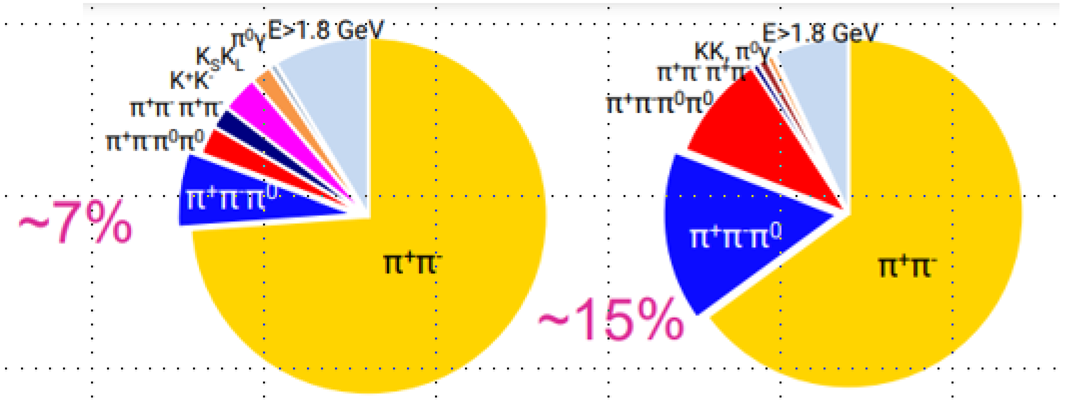
$$a_\mu^{\mathrm{QCD}} = a_\mu^{\mathrm{HVP}} + a_\mu^{\mathrm{HLbL}}$$

Leading-order HVP rerm

$$a_\mu^{\mathrm{HVP,LO}} = \frac{\alpha^2}{3\pi^2}\int_{m_\pi^2}^{\infty}\frac{ds}{s}R(s)K(s)$$

Hadronic R-ratio

$$R(s) = \frac{\sigma(e^+e^- \to hadrons)}{\sigma(e^+e^- \to \mu^+\mu^-)}$$



2nd largest contribution to the hadronic vacuum polarization estimate as region below 1 GeV in c.m. energy dominates

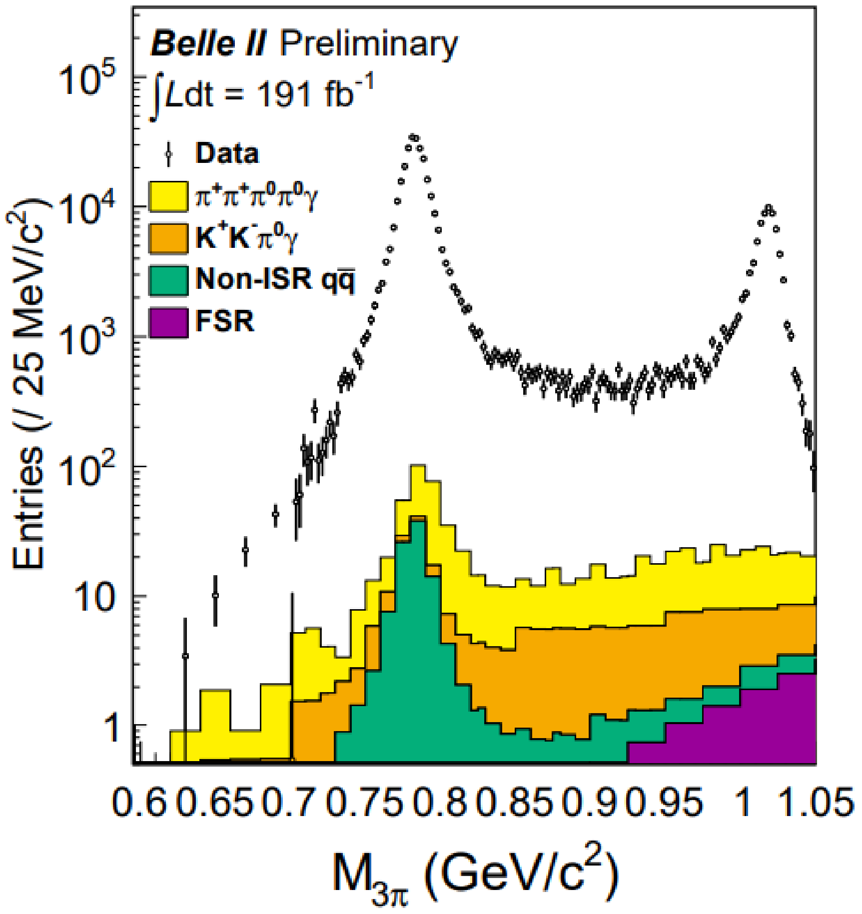
$\boldsymbol{\sigma(e^+e^- \to \pi^+\pi^-\pi^0)}$

Signal process : $e^+e^- \to \gamma_{\mathrm{ISR}}\pi^+\pi^-\pi^0(\to \gamma\gamma)$

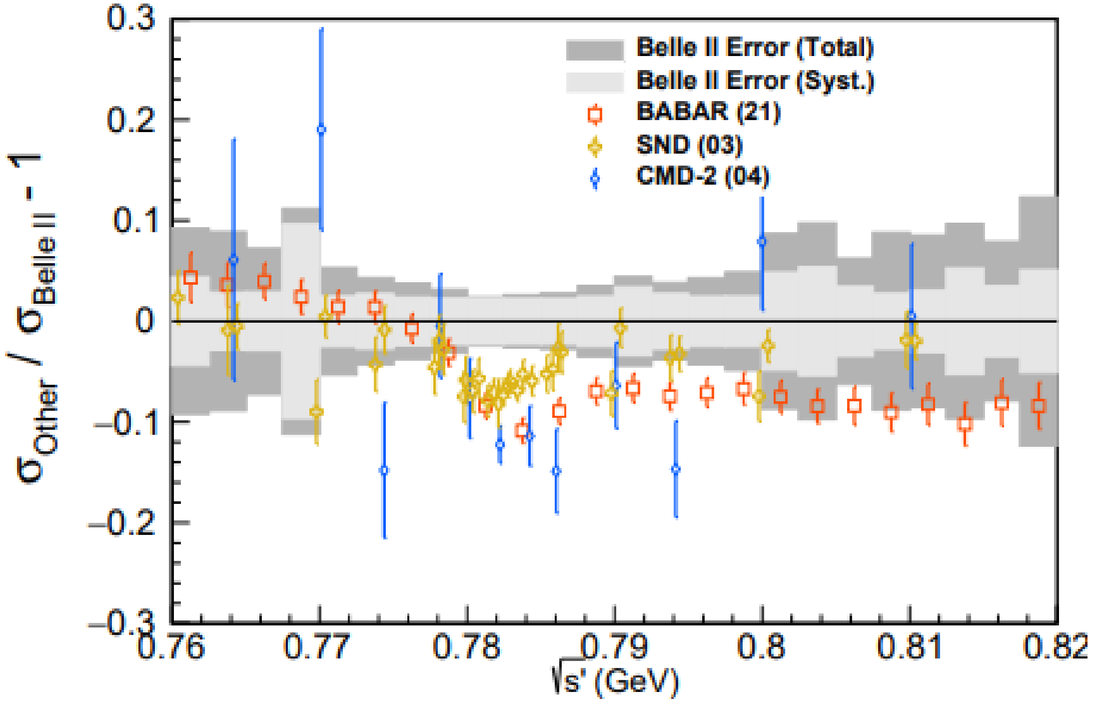
$$\frac{dN_{\mathrm{signal}}}{dm} = \sigma_{ee\to 3\pi} \cdot \varepsilon \cdot \frac{d\mathcal{L}_{\mathrm{eff}}}{dm}$$

Signal spectrum — **Efficiency** — **3π mass** — **Cross section** — **Effective luminosity**

- Initial-state radiation technique – wide invariant mass range
- Partial Run 1 data set – 191 fb^{-1}
- Selection via kinematic fits
- Key challenge is π^0 efficiency
  - Custom determination using ω decay
- Background control samples for $e^+e^- \to \pi^+\pi^-\pi^0\,\pi^0\gamma_{ISR}$, $e^+e^- \to q\bar{q}\gamma_{ISR}$ and $e^+e^- \to K^+K^-\pi^0\gamma_{ISR}$



$\sigma(e^+e^- \to \pi^+\pi^-\pi^0)$

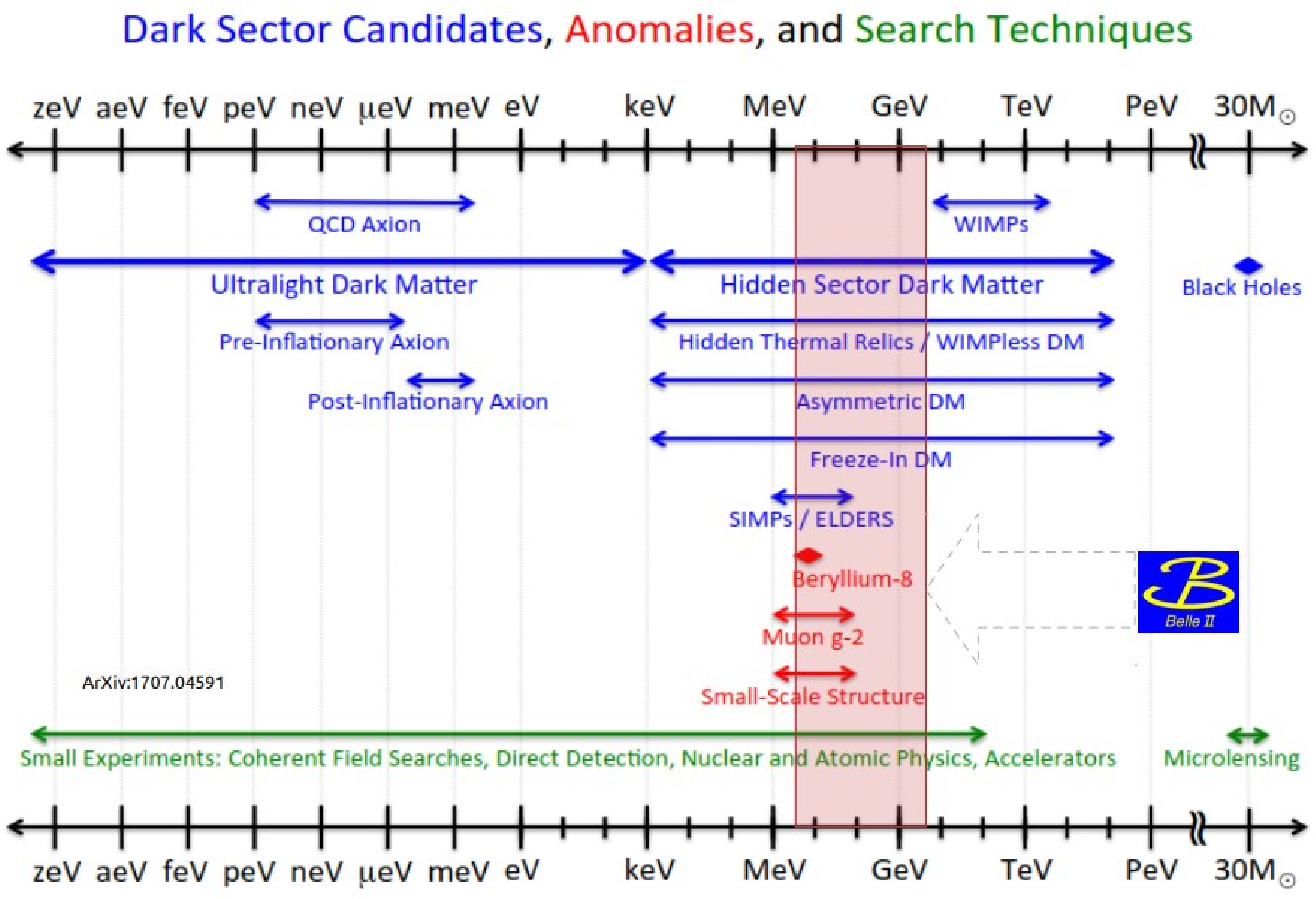


Source	0.62–1.05 GeV/c^2	
Trigger	0.1	(−0.09)
ISR photon detection	0.7	(+0.15)
Tracking	0.8	(−1.35)
π^0 detection	1.0	(−1.43)
Kinematic fit (χ^2)	0.6	(+0.0)
Event selection	0.2	(−1.90)
Generator	1.2	
Integrated luminosity	0.6	
Radiative corrections	0.5	
MC statistics	0.2	
Background subtraction	0.3–0.5	
Unfolding	0.7–15	
Total uncertainty	2.2-15	
(Total correction $\varepsilon/\varepsilon_{\rm MC} - 1$)		(−4.61)

$$a_\mu^{3\pi} = (49.02 \pm 0.23 \pm 1.07) \times 10^{-10},$$

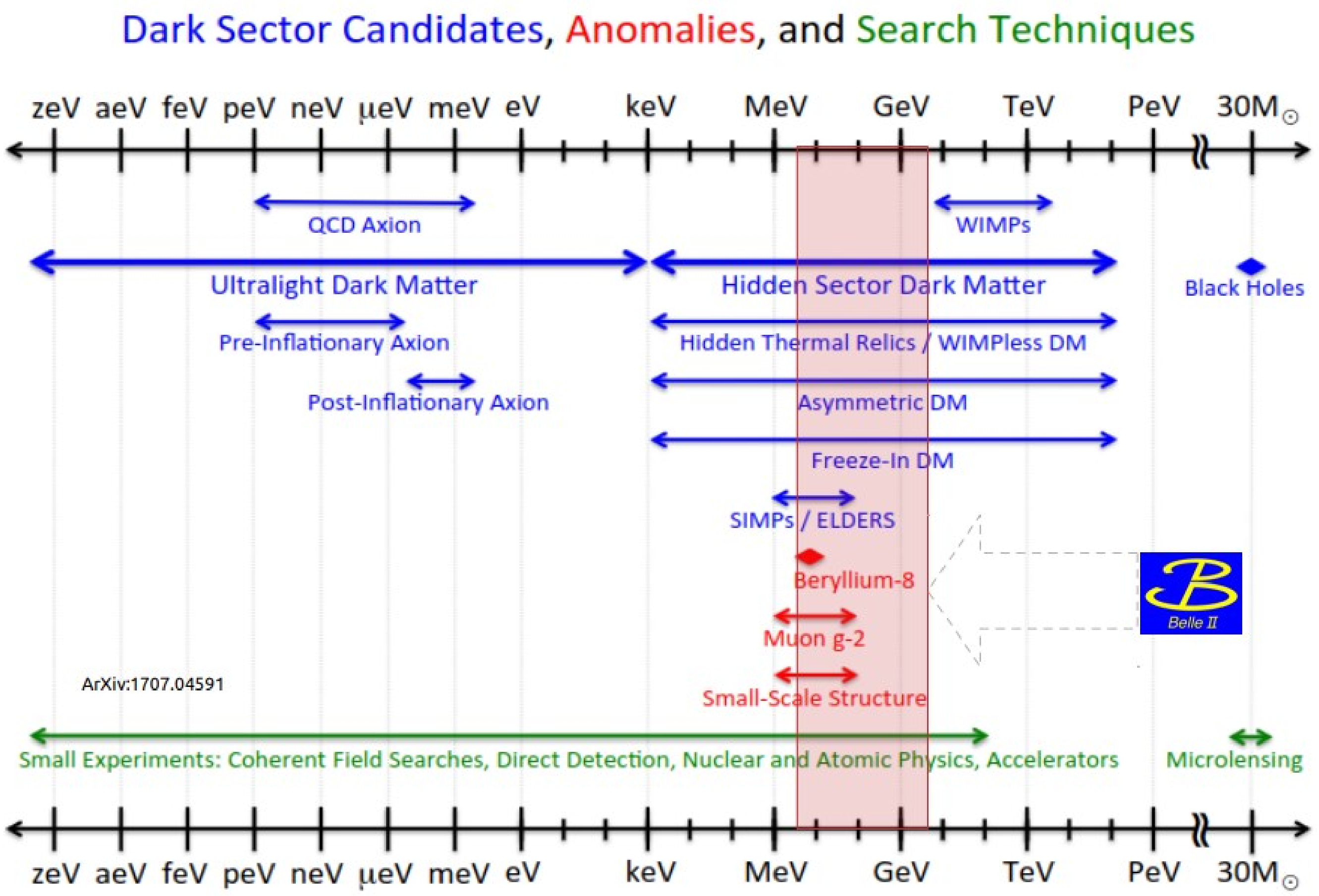
2.6σ tension with BaBar

Light dark sector searches



- Can access the mass range favored by light dark sector
  - Possible sub-GeV scenario

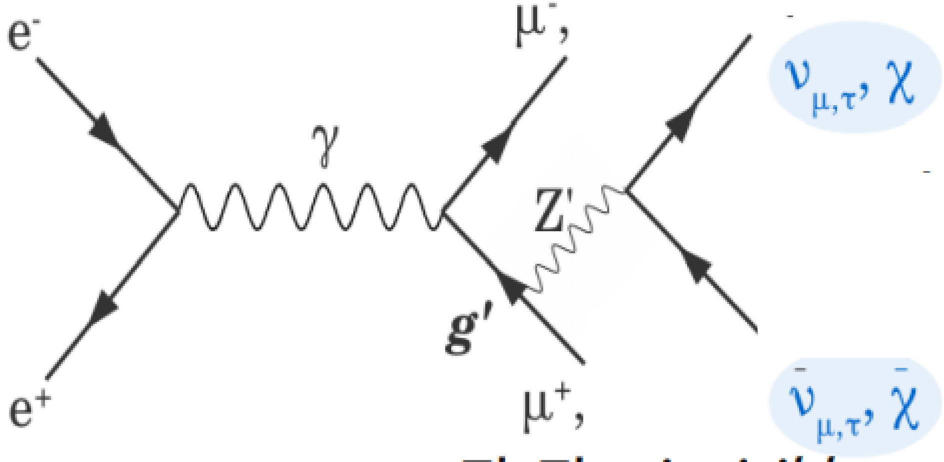
Light dark sector searches



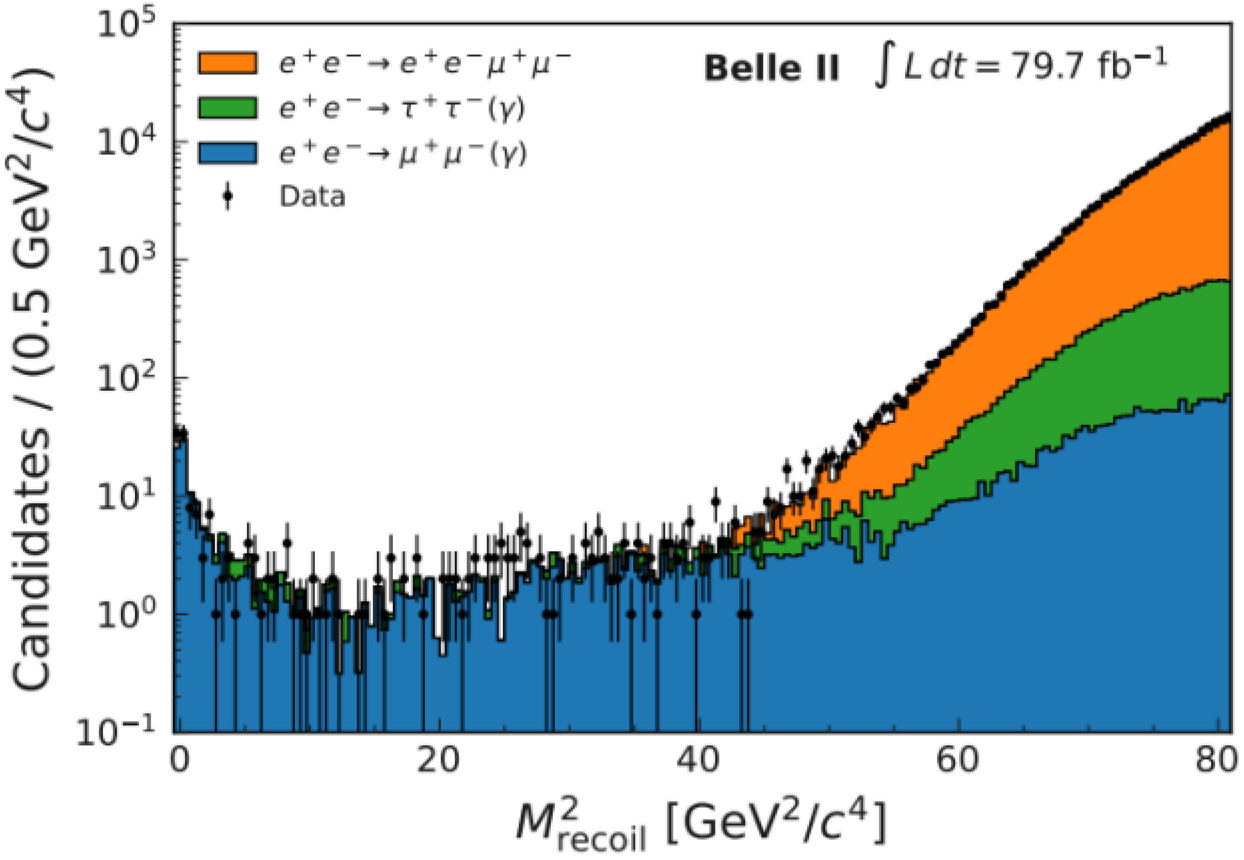
- Can access the mass range favored by light dark sector
  - Possible sub-GeV scenario
- DM weakly coupled to SM through a light mediator X:
  - vector (Z'/dark photon), axion like particles (ALPs), scalar (dark Higgs) or fermions (sterile ν)
- Some links to anomalies, e.g., g−2

Invisible decay of Z’ to dark matter

- Search for narrow peak in the recoil mass of dimuon pairs

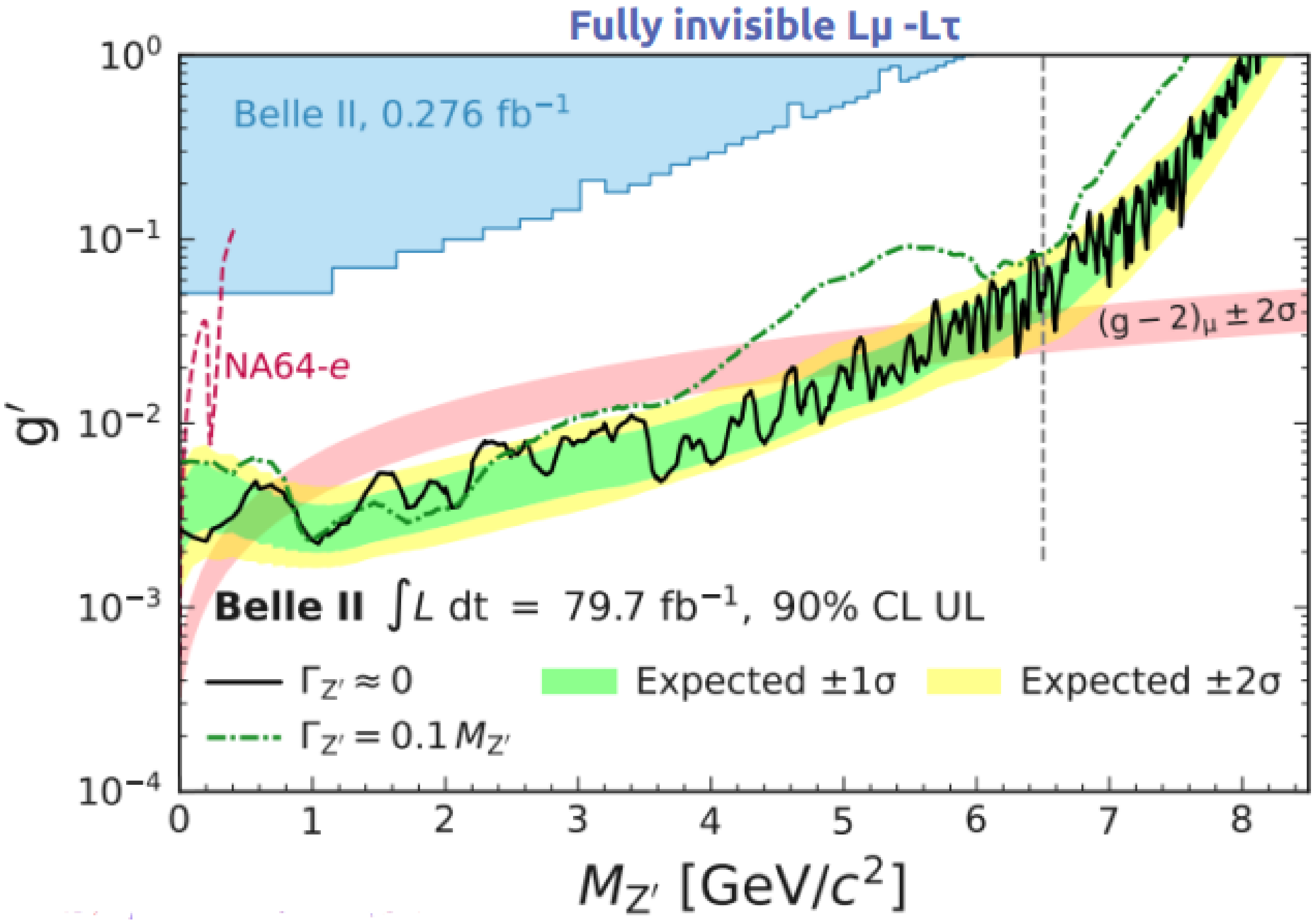


$e^+e^- \to \mu^+\mu^- Z'$; $Z' \to$ *invisible*



Invisible decay of Z’ to dark matter

- Limits on Z’ coupling g’ and mass
- g_μ-2 region ruled out for masses from 0.8 to 5 GeV

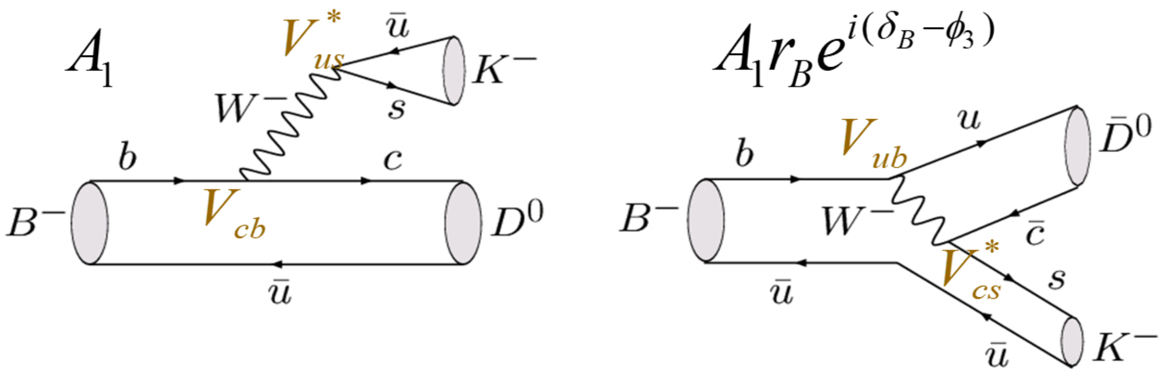


Phys. Rev. Lett. 130, 231801 (2023)

Paper in preparation

γ/ϕ_3: power of Belle + Belle II

- Standard candle in the SM
  - Tree-level only + no theory unc.
- LHCb leads the way: γ=(63.8±3.6)°
  - [LHCB-CONF-2022-003]

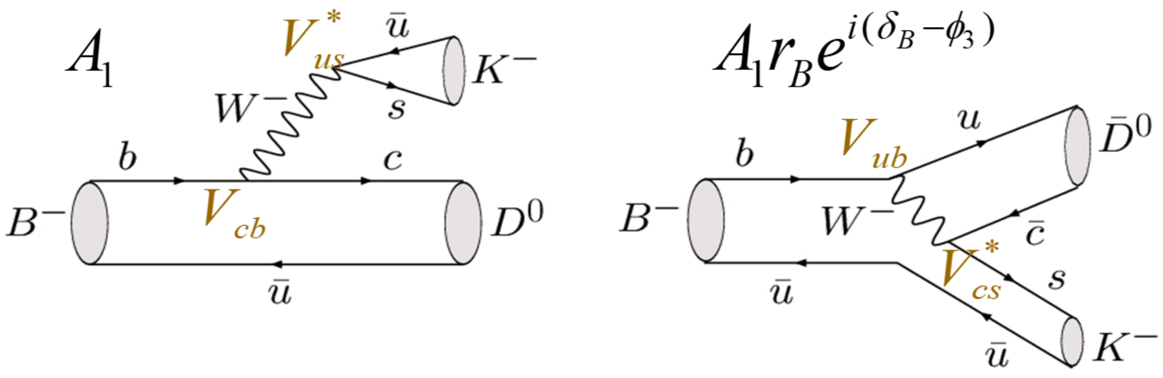


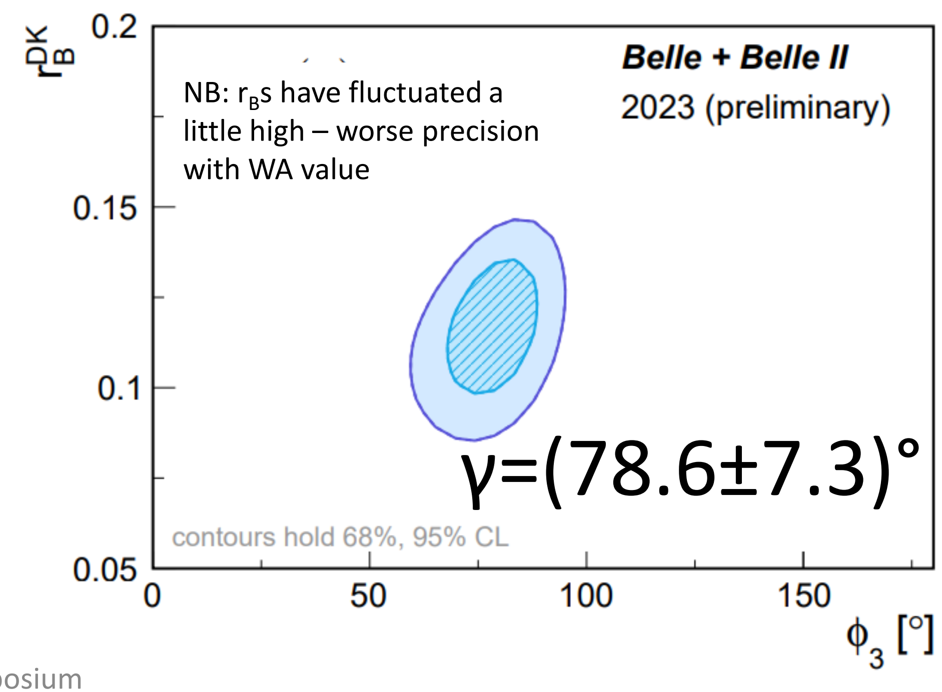
Paper in preparation

More on γ Y. Shimizu thesis

γ/ϕ_3: power of Belle + Belle II

- Standard candle in the SM
  - Tree-level only + no theory unc.
- LHCb leads the way: γ=(63.8±3.6)°
  - [LHCB-CONF-2022-003]
- Several Belle (711 fb^{-1}) + Belle II measurements (varying sample size) – total O(1 ab^{-1})
  - $D \rightarrow K^0_S hh$ - [JHEP 02 (2022) 063]
  - $D \rightarrow K^0_S K\pi$ - [accepted by JHEP]
  - $D \rightarrow K^0_S \pi^0, KK$ - [arXiv:2308.05048]
  - + Belle-only $D \rightarrow K\pi$ and others
- A few ab^{-1} will give a good cross check of this SM parameter





Phys. Rev. D 109, 012001 (2024) **and** Phys. Rev. Lett. 131, 111803 (2023)

B→Kπ isospin sum rule

- Relates these various penguin modes to give a null test of the SM with O(1%) SM precision – PRD **59,** 113002 (1999)

$$I_{K\pi} = \mathcal{A}_{K^+\pi^-} + \mathcal{A}_{K^0\pi^+}\frac{\mathcal{B}(K^0\pi^+)}{\mathcal{B}(K^+\pi^-)}\frac{\tau_{B^0}}{\tau_{B^+}} - 2\mathcal{A}_{K^+\pi^0}\frac{\mathcal{B}(K^+\pi^0)}{\mathcal{B}(K^+\pi^-)}\frac{\tau_{B^0}}{\tau_{B^+}} - 2\mathcal{A}_{K^0\pi^0}\frac{\mathcal{B}(K^0\pi^0)}{\mathcal{B}(K^+\pi^-)}$$

- All inputs measured at Belle II including 'no vertex' time-dependent *CP* asymmetry for B→ $K^0_S\pi^0$ – 362 fb^{-1} sample

Belle II paper in preparation and PRL 131, 111803 (2023)

M. Dorigo's talk – WG5

B→Kπ isospin sum rule

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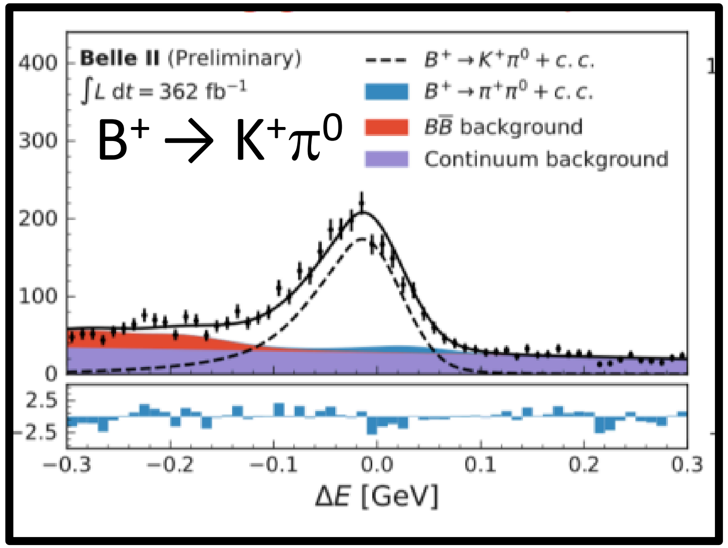
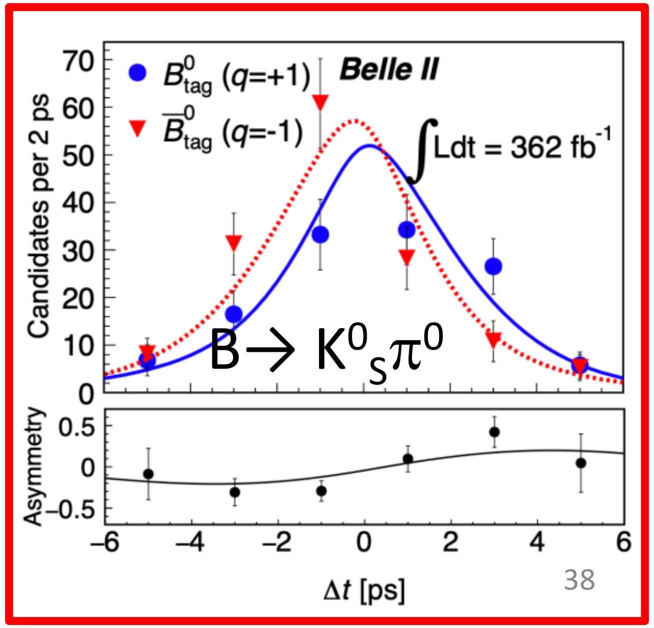


$B = (14.2 \pm 0.4 \pm 0.9) \times 10^{-6}$
Large π^0 efficiency syst.

$A_{K^0} = -0.01 \pm 0.12 \pm 0.05$
Combination of time-dependent and time-integrated analyses



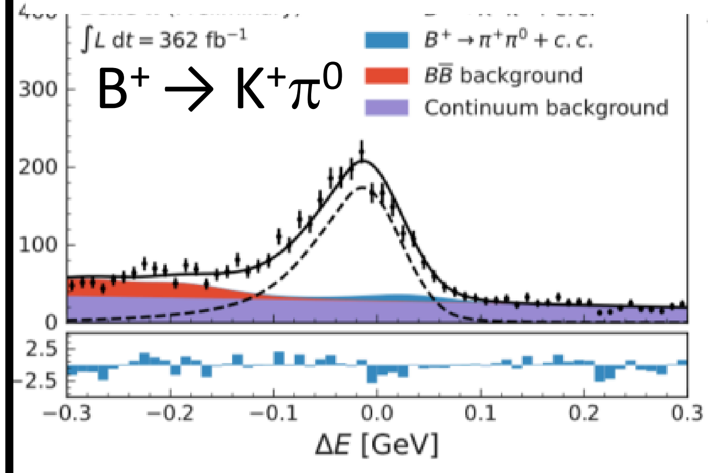
Belle II paper in preparation and arXiv:2305.07555 (accepted PRL)

B→Kπ isospin sum rule

- Relates these various penguin modes to give a null test of the SM with O(1%) SM precision – PRD **59,** 113002 (1999)

$$I_{K\pi} = (-3 \pm 13 \pm 5)\,\%$$

Agrees with SM. Competitive with WA: $(-13 \pm 11)\,\%$.



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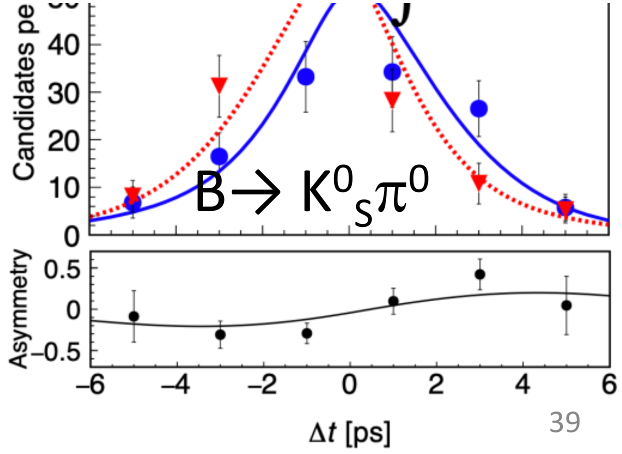
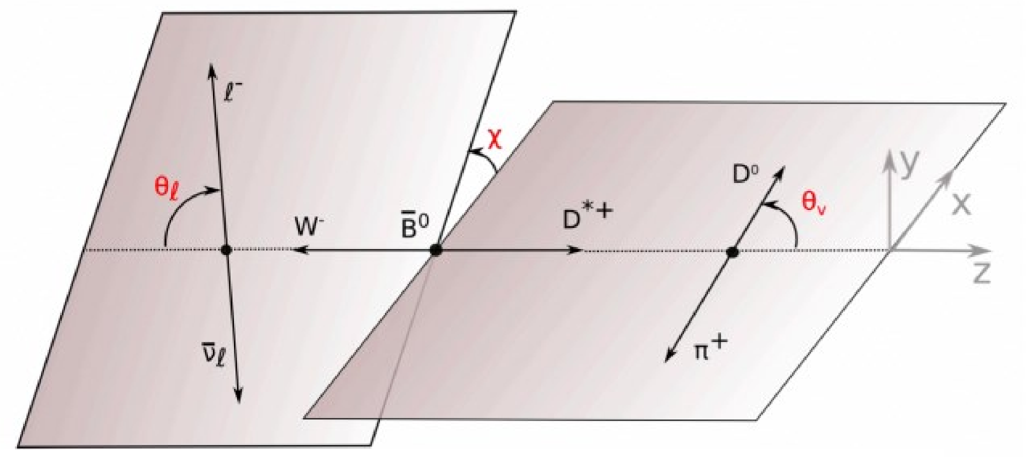


Angular coefficients in B→D*lν and V_{cb}

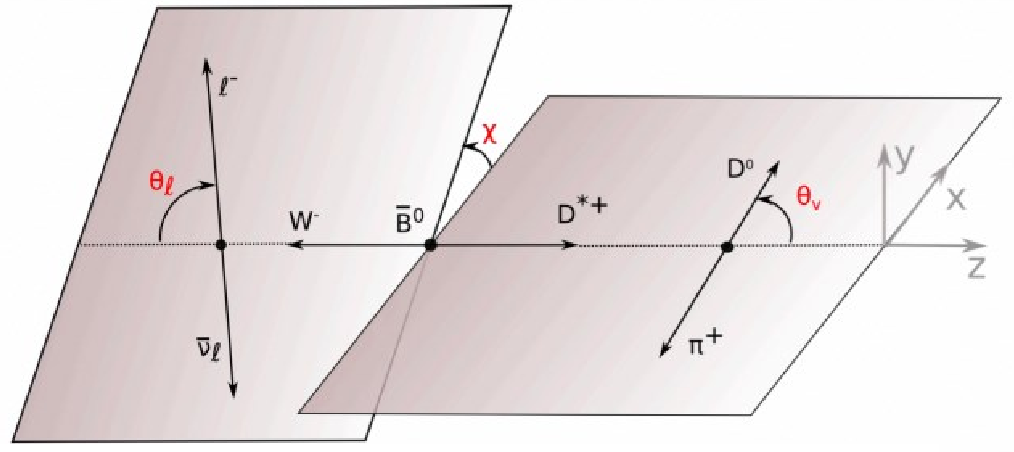
- Measure 4D-differential distribution in terms of decay angles and w
  - overall proportionality to $|V_{cb}|^2$
  - $w \geq 1$ is the hadronic recoil parameter – relates to mom. transfer to the leptonic system



Belle paper in preparation

Angular coefficients in $B \to D^* l \nu$ and V_{cb}

- Measure 4D-differential distribution in terms of decay angles and w
  - overall proportionality to $|V_{cb}|^2$
  - $w \geq 1$ is the hadronic recoil parameter – relates to mom. transfer to the leptonic system
- Extract 12 angular coefficients of the distribution in bins of w for the first time using full Belle 711 fb^{-1} sample
  - hadronically tagged



Belle paper in preparation

Angular coefficients in $B \to D^* l \nu$ and V_{cb}

- Measure 4D-differential distribution in terms of decay angles and w
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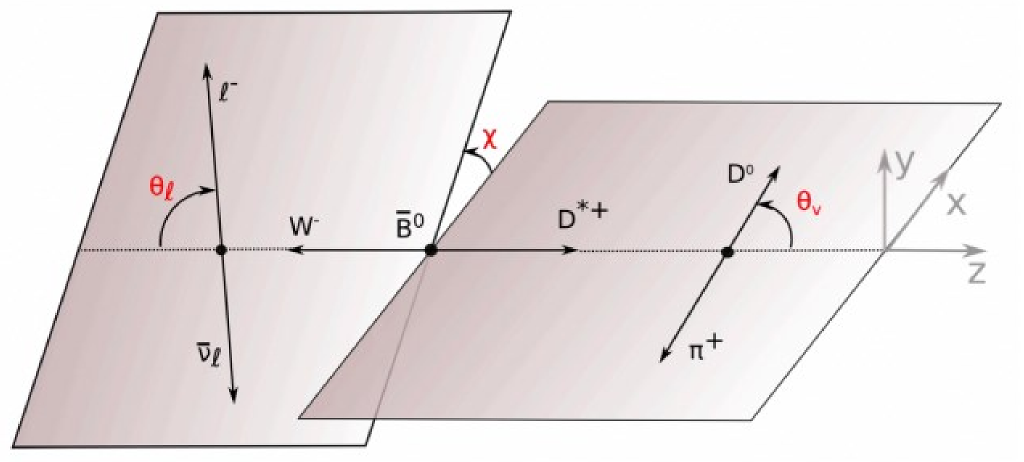
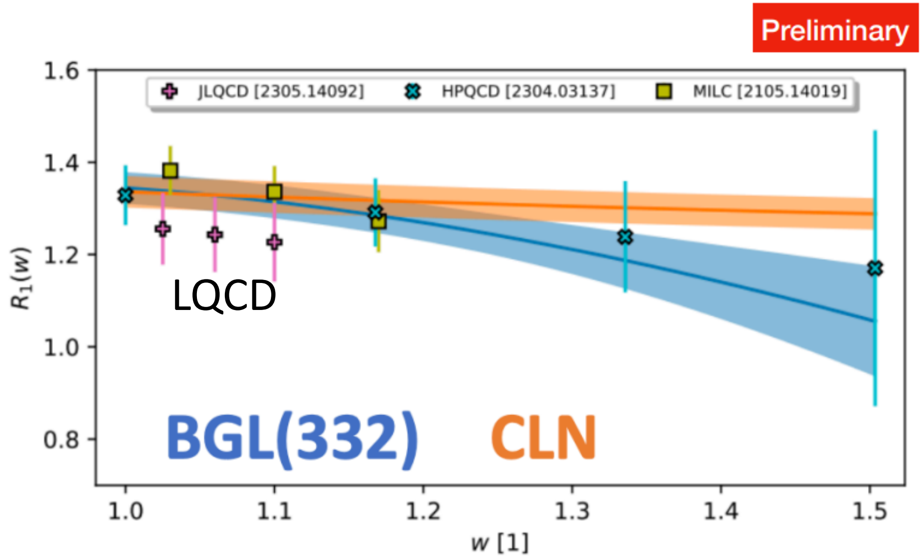
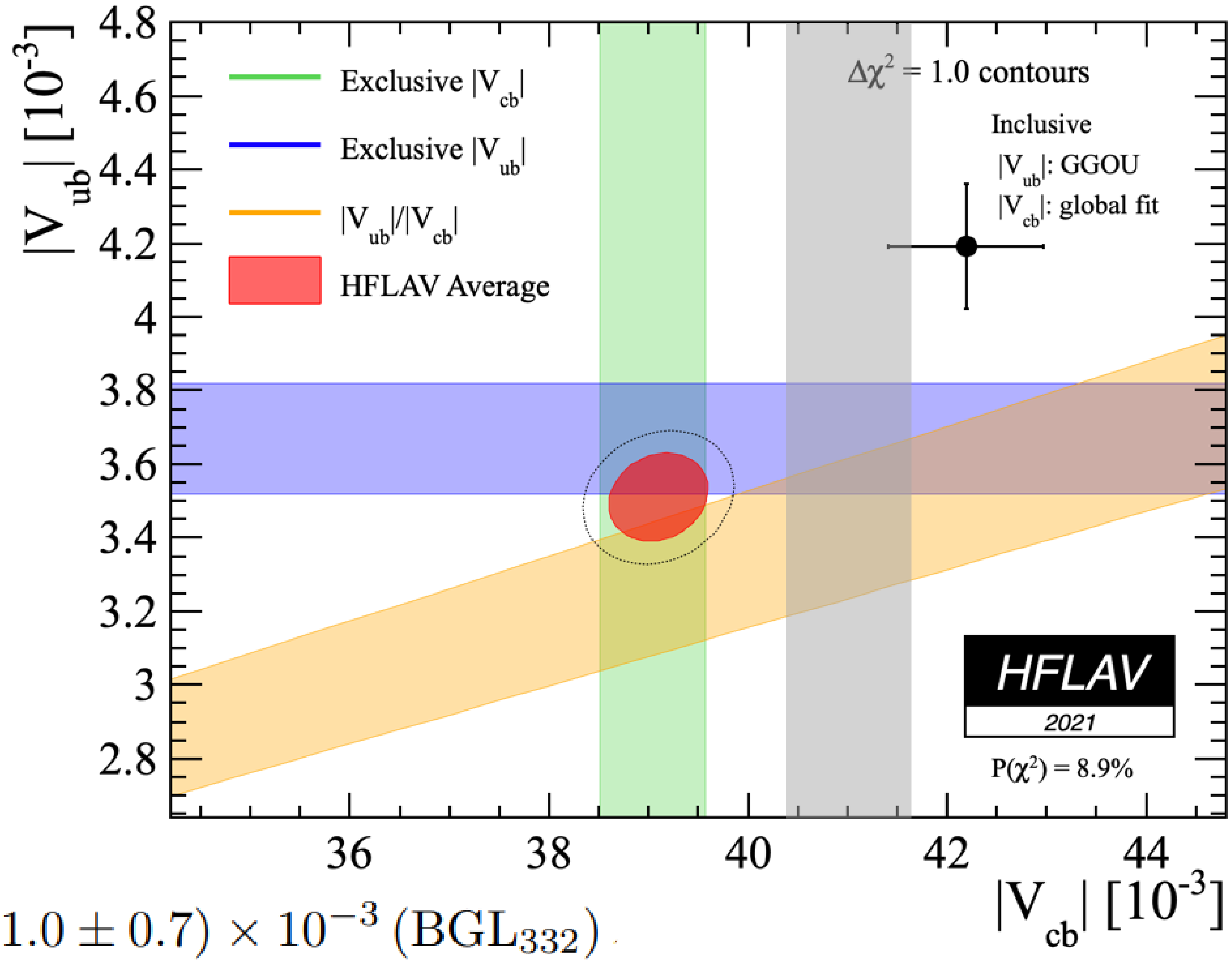
- Extract 12 angular coefficients of the distribution in bins of w for the first time using full Belle 711 fb^{-1} sample
  - hadronically tagged
- Fit performed to coefficients in different form-factor parameterizations and with LQCD inputs to extract V_{cb} as well as parameters of the form-factor model
  - WA BF also taken externally





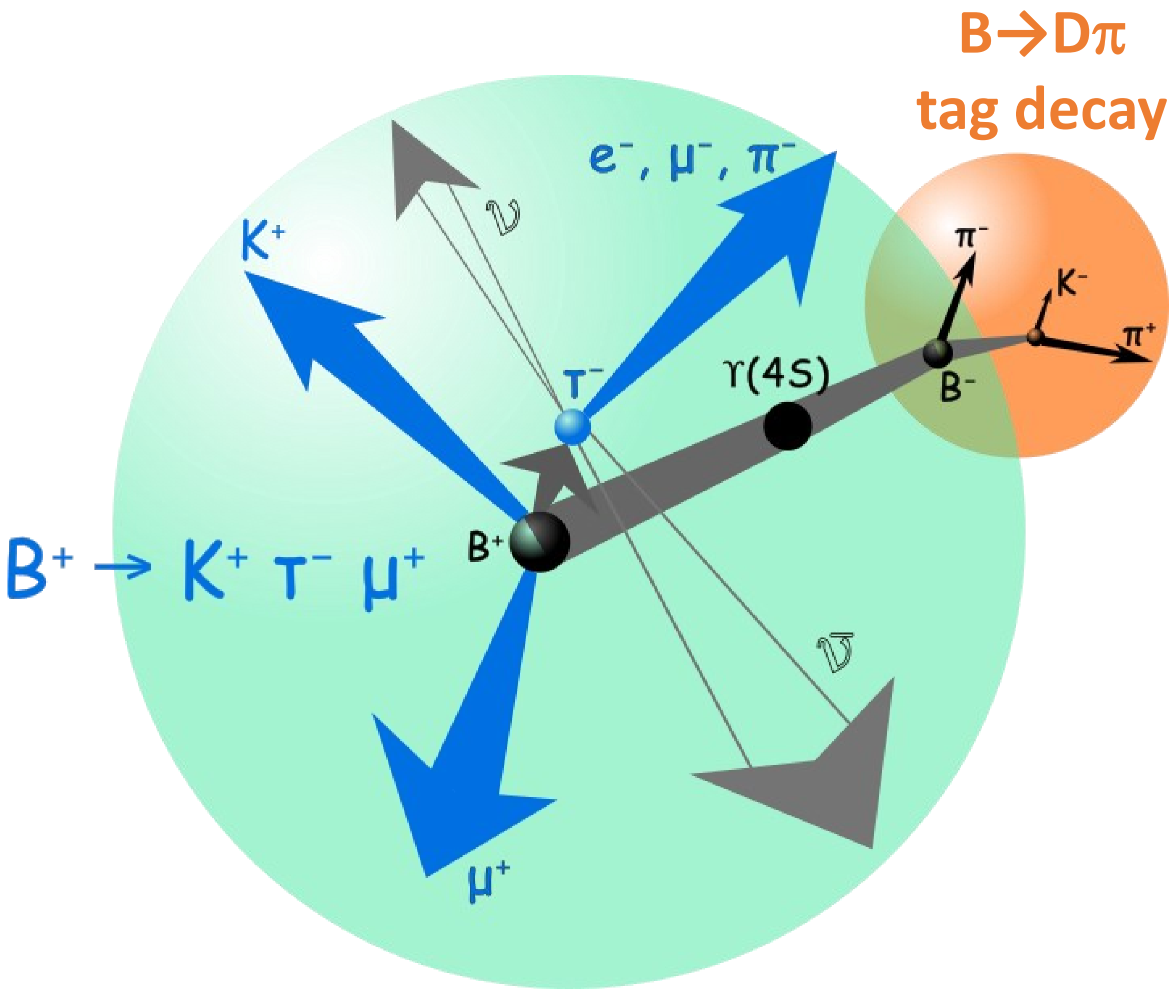


$$|V_{cb}| = (41.0 \pm 0.7) \times 10^{-3}\,(\mathrm{BGL}_{332})$$

$$|V_{cb}| = (40.9 \pm 0.7) \times 10^{-3}\,(\mathrm{CLN})$$

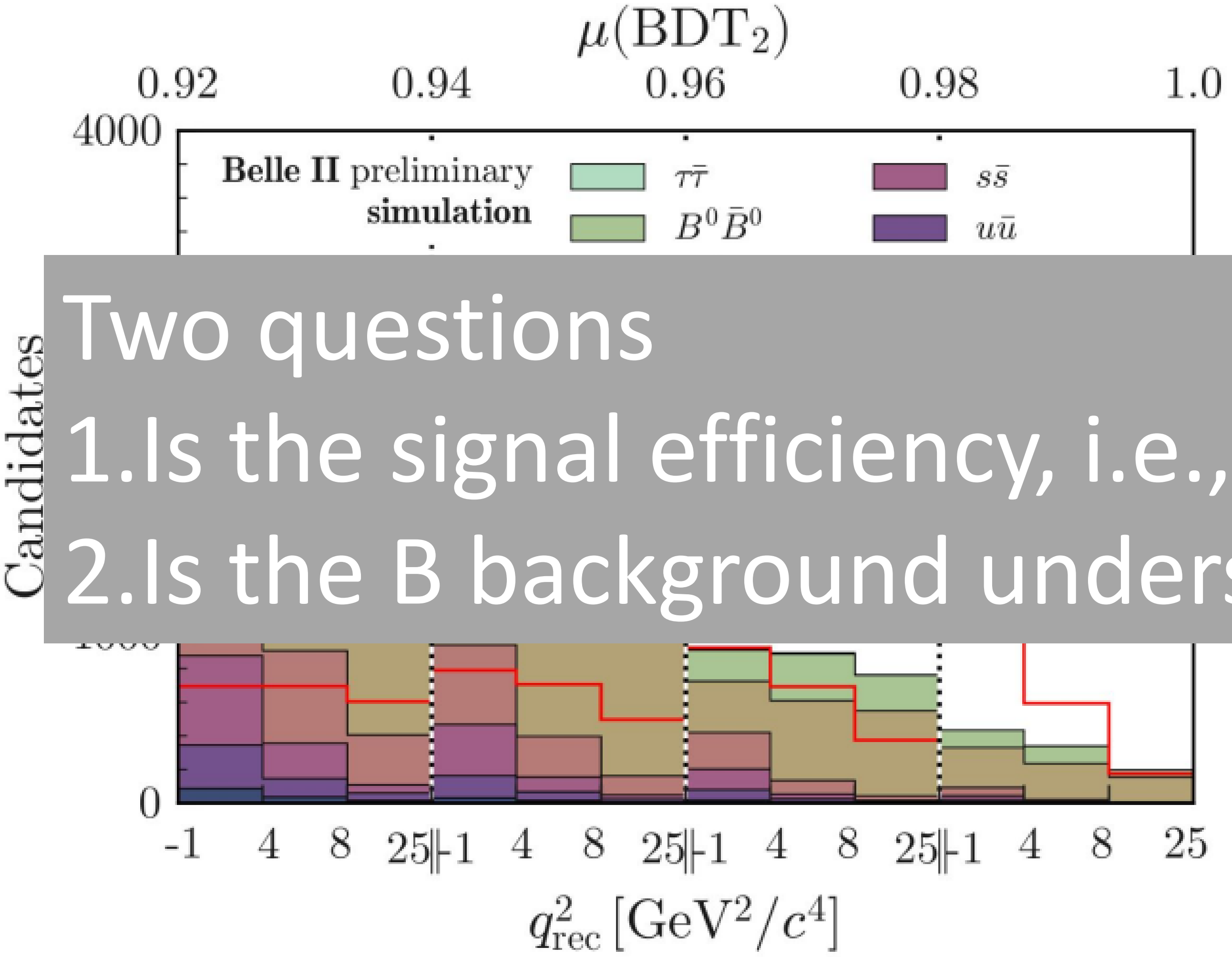
Hadronic tag

- Full-reconstruction of one B decay in a large number of high BF modes on one side
  - $B \to D^{(*)0} m\pi^{\pm} n\pi^{0}$, where $m \geq 1$ $n \geq 0$
  - BaBar Reconstruct other B as signal with missing energy
- Machine learning algorithm used to boost efficiency as much as possible
- Total efficiency < 1% but a powerful tool
- Requires calibration



arXiv:2311.14647 [hep-ex]

$B^+ \to K^+ \nu\bar{\nu}$: Inclusive signal extraction



(3 bins in q^2_{rec}) x (4 bins in $\mu(\mathrm{BDT}_2)$)

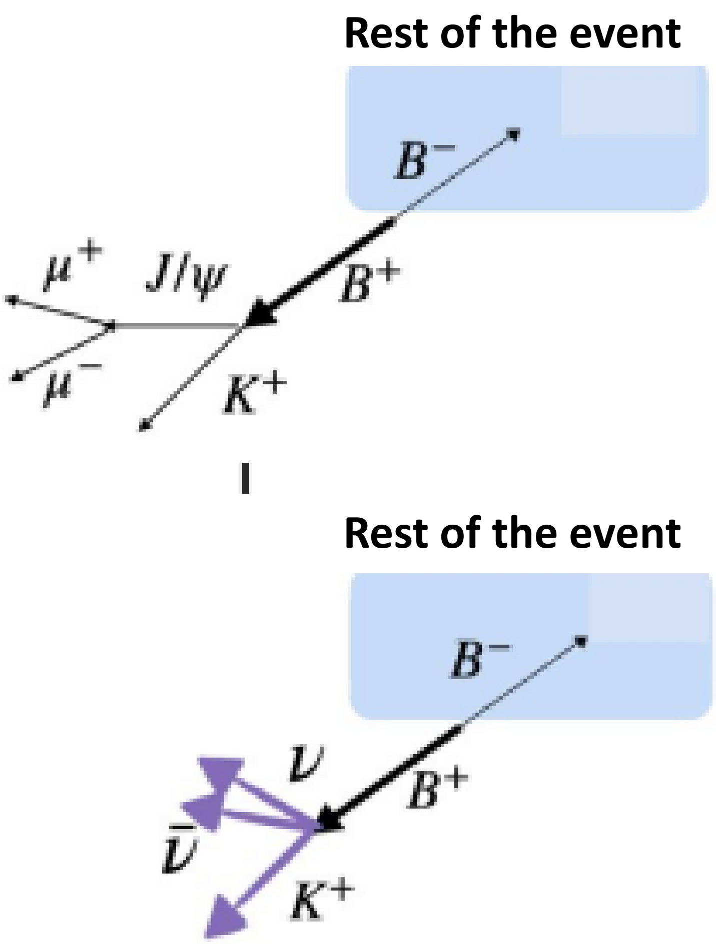
- 1 signal and 7 background templates from simulation
- Continuum template constrained by off-resonance

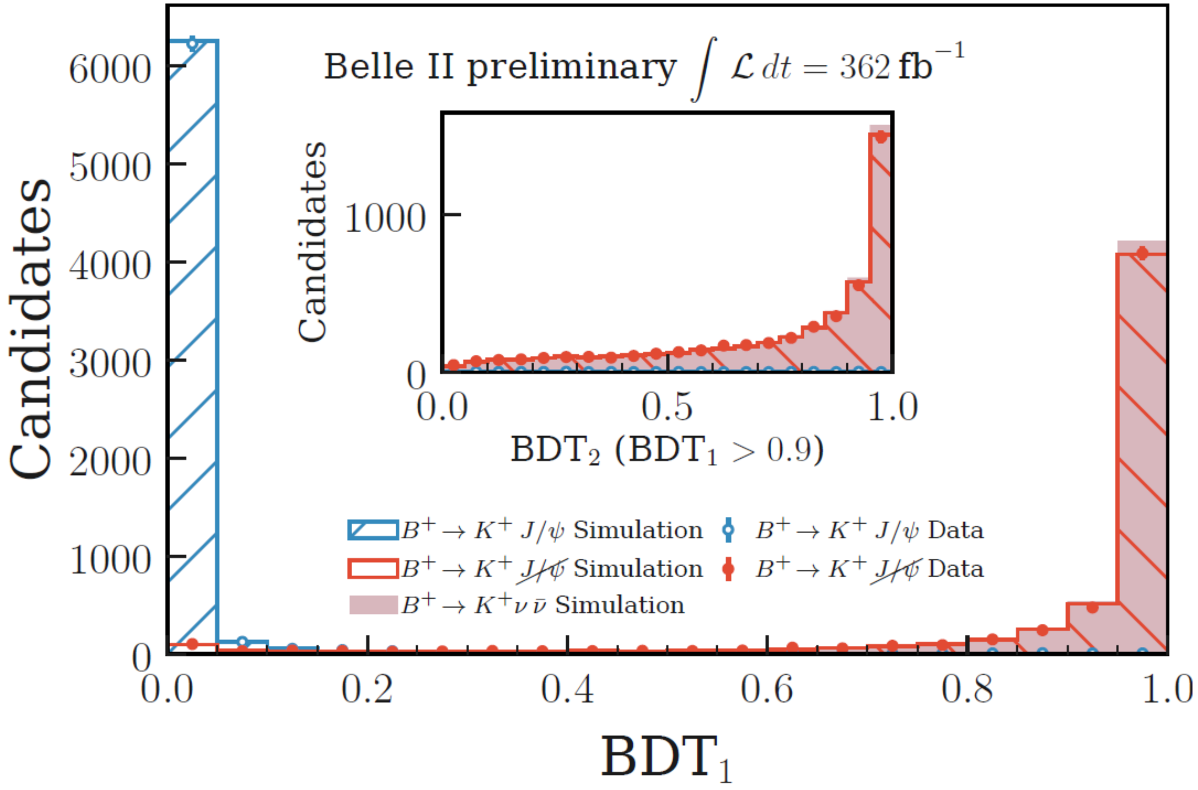
Two questions

1. Is the signal efficiency, i.e., BDT, well modelled?
2. Is the B background understood?

arXiv:2311.14647 [hep-ex]

$B^+ \to K^+ \nu\bar{\nu}$: Efficiency validation

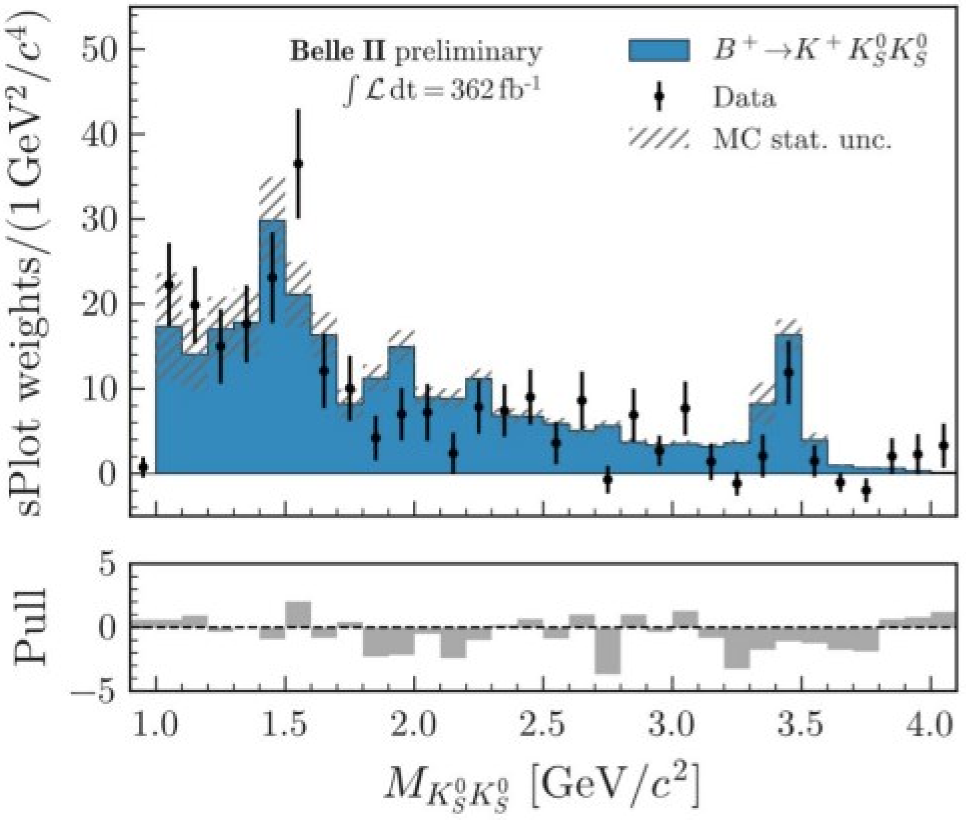




Ratio between selection on data and simulation for the control sample 1 with 3% uncertainty

arXiv:2311.14647 [hep-ex]

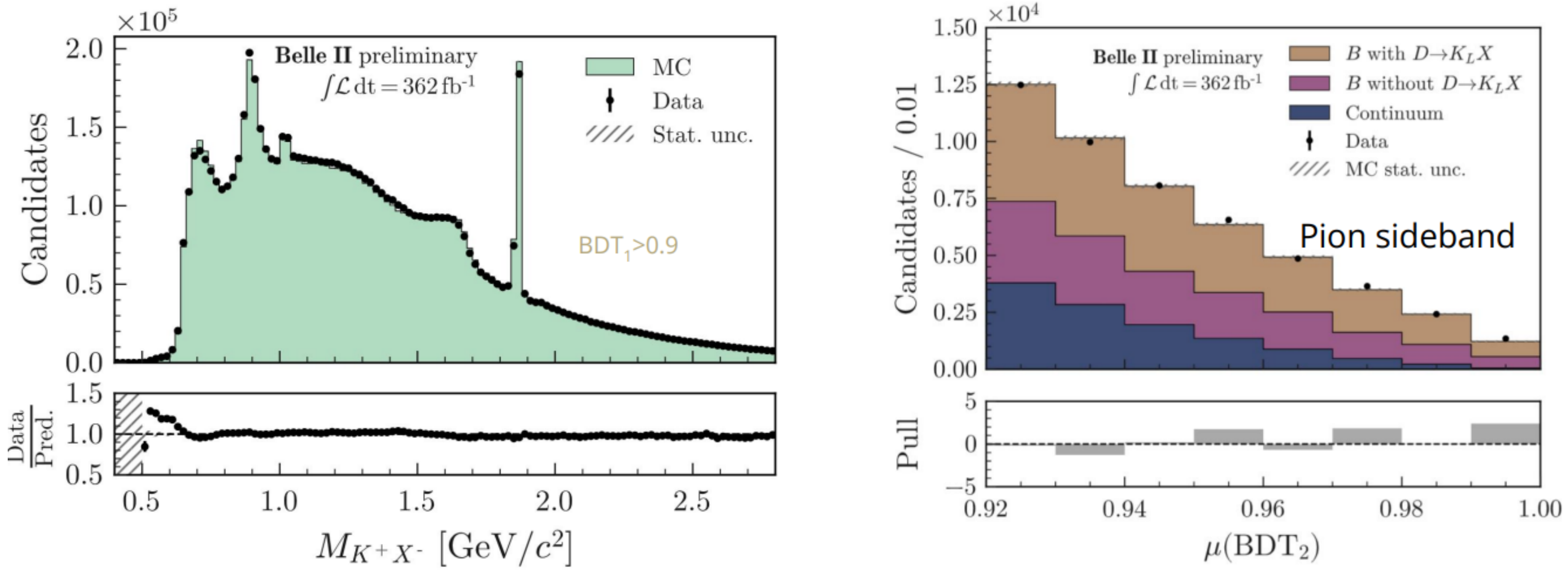
$B^+ \to K^+\nu\bar{\nu}$: Background validation example



- An example of a difficult background is charmless $B^+ \to K^+K^0_L K^0_L$, where K^0_L mesons escape detection
  - has an order of magnitude larger BF than signal
- Dedicated studies $B^+ \to K^+K^0_S K^0_S$ show good modelling
  - generous systematics assigned
- Similar studies for $B^+ \to K^+ n\bar{n}, B^+ \to K^+K^0_L K^0_S$

arXiv:2311.14647 [hep-ex]

$B^+ \to K^+\nu\bar{\nu}$: >90% background from B→D(K^+X)lν + B →D(K_LX)K^+



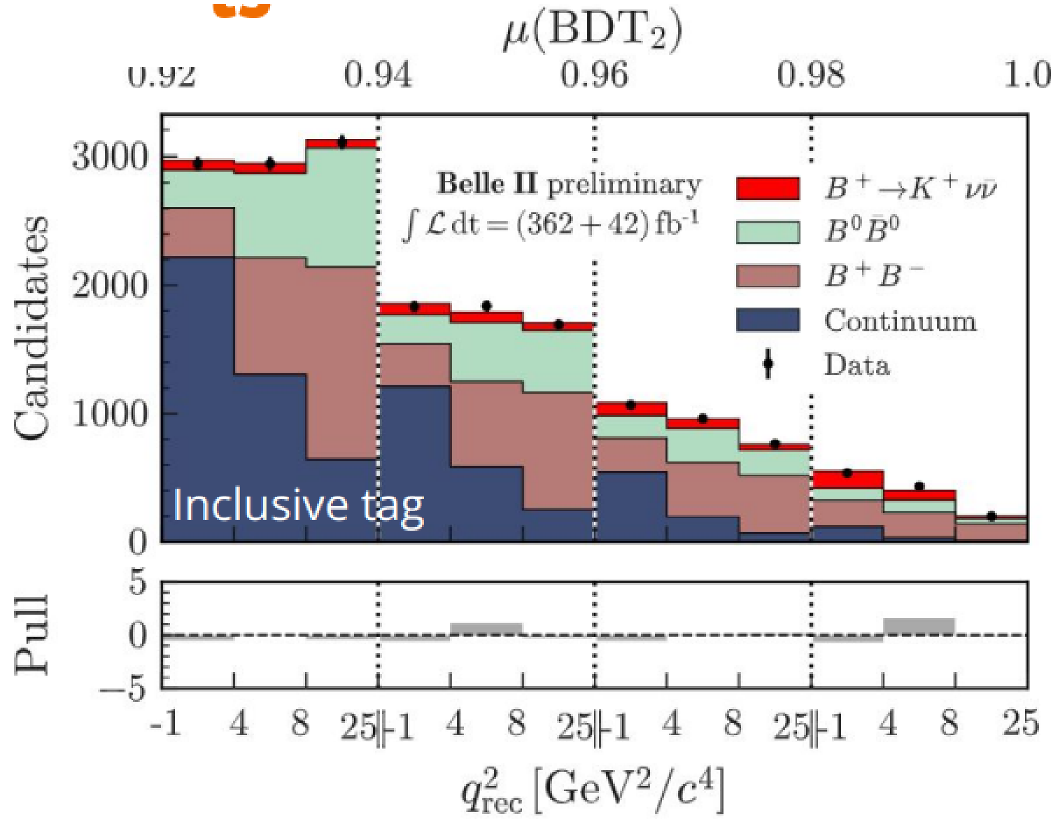
- KX system agrees well between data and MC
- Prompt K^+ production studied using prompt π^+ from $B^+ \to \pi^+ X$ decays
- Systematic uncertainties on decay branching fractions, enlarged for D→K_LX and B →D**l ν

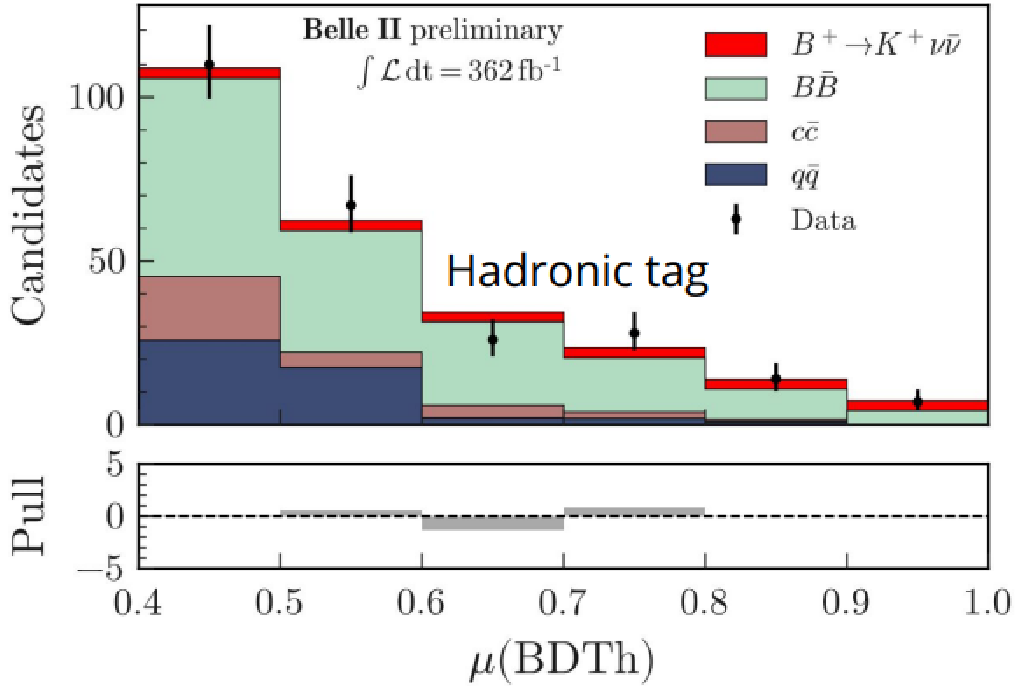
$B^+ \to K^+ \nu\bar{\nu}$: Systematic uncertainties

Source	Correction	Uncertainty type	Uncertainty size	Impact on σ_μ
Normalization of $B\bar{B}$ background	—	Global, 2 NP	50%	0.88
Normalization of continuum background	—	Global, 5 NP	50%	0.10
Leading B-decays branching fractions	—	Shape, 5 NP	$O(1\%)$	0.22
Branching fraction for $B^+ \to K^+ K^0_L K^0_L$	q^2 dependent $O(100\%)$	Shape, 1 NP	20%	0.49
p-wave component for $B^+ \to K^+ K^0_S K^0_L$	q^2 dependent $O(100\%)$	Shape, 1 NP	30%	0.02
Branching fraction for $B \to D^{(**)}$	—	Shape, 1 NP	50%	0.42
Branching fraction for $B^+ \to n\bar{n}K^+$	q^2 dependent $O(100\%)$	Shape, 1 NP	100%	0.20
Branching fraction for $D \to K_L X$	+30%	Shape, 1 NP	10%	0.14
Continuum background modeling, BDT$_c$	Multivariate $O(10\%)$	Shape, 1 NP	100% of correction	0.01
Integrated luminosity	—	Global, 1 NP	1%	< 0.01
Number of $B\bar{B}$	—	Global, 1 NP	1.5%	0.02
Off-resonance sample normalization	—	Global, 1 NP	5%	0.05
Track finding efficiency	—	Shape, 1 NP	0.3%	0.20
Signal kaon PID	p, θ dependent $O(10-100\%)$	Shape, 7 NP	$O(1\%)$	0.07
Photon energy scale	—	Shape, 1 NP	0.5%	0.08
Hadronic energy scale	-10%	Shape, 1 NP	10%	0.36
K^0_L efficiency in ECL	-17%	Shape, 1 NP	8%	0.21
Signal SM form factors	q^2 dependent $O(1\%)$	Shape, 3 NP	$O(1\%)$	0.02
Global signal efficiency	—	Global, 1 NP	3%	0.03
MC statistics	—	Shape, 156 NP	$O(1\%)$	0.52

$B^+ \to K^+\nu\bar{\nu}$: Results

[arXiv:2311.14647](https://arxiv.org/abs/2311.14647) [hep-ex]





$$\mathrm{BF_{inc}} = (2.8 \pm 0.5(\mathrm{stat}) \pm 0.5(\mathrm{syst})) \times 10^{-5}$$

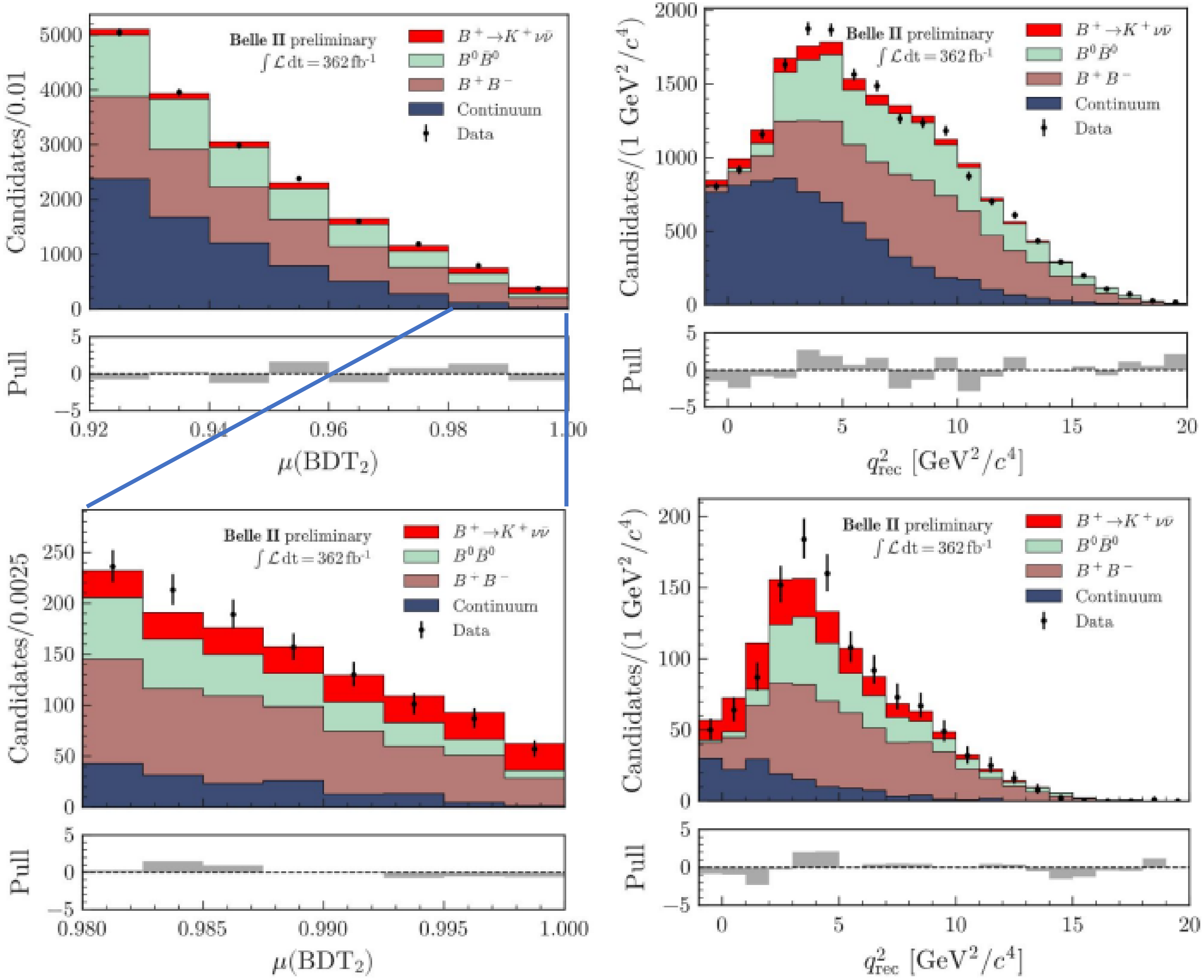
$$\mathrm{BF_{had}} = \left(1.1^{+0.9}_{-0.8}(\mathrm{stat})^{+0.8}_{-0.5}(\mathrm{syst})\right) \times 10^{-5}$$

$$\mathrm{BF_{comb}} = \left(2.4 \pm 0.5(\mathrm{stat})^{+0.5}_{-0.4}(\mathrm{syst})\right) \times 10^{-5}$$

Post-fit distributions

Upper: full fit region

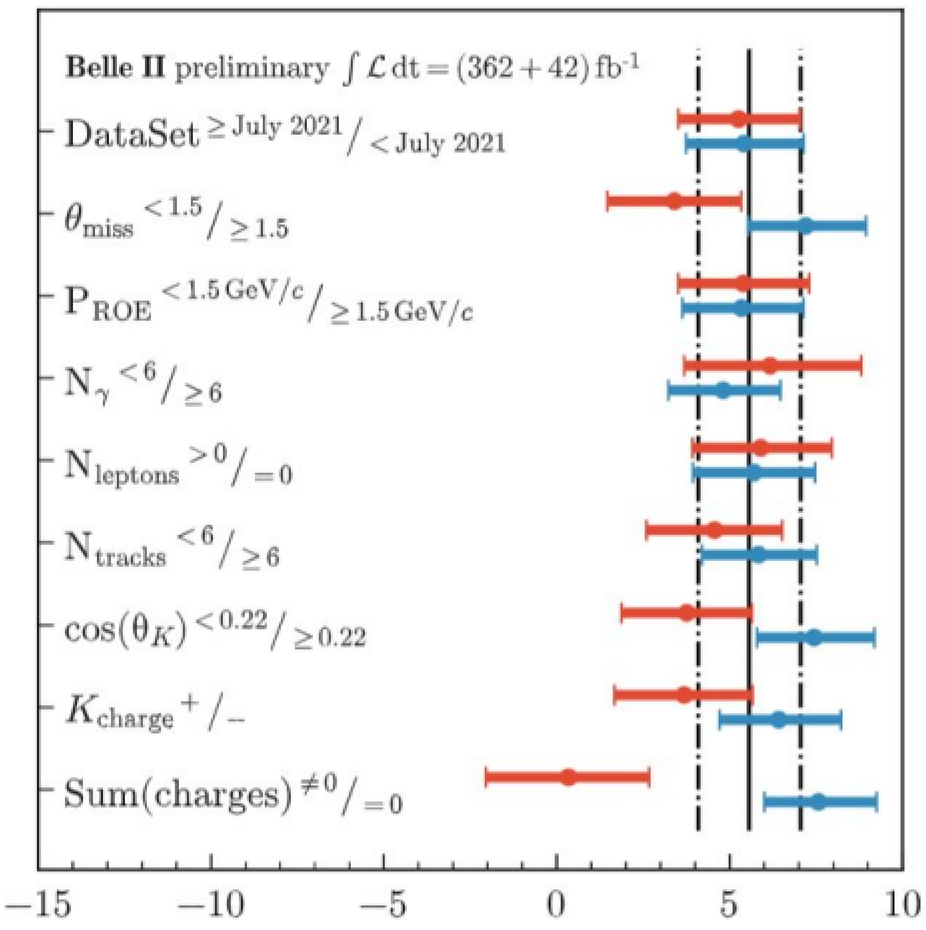
Lower: most sensitive region



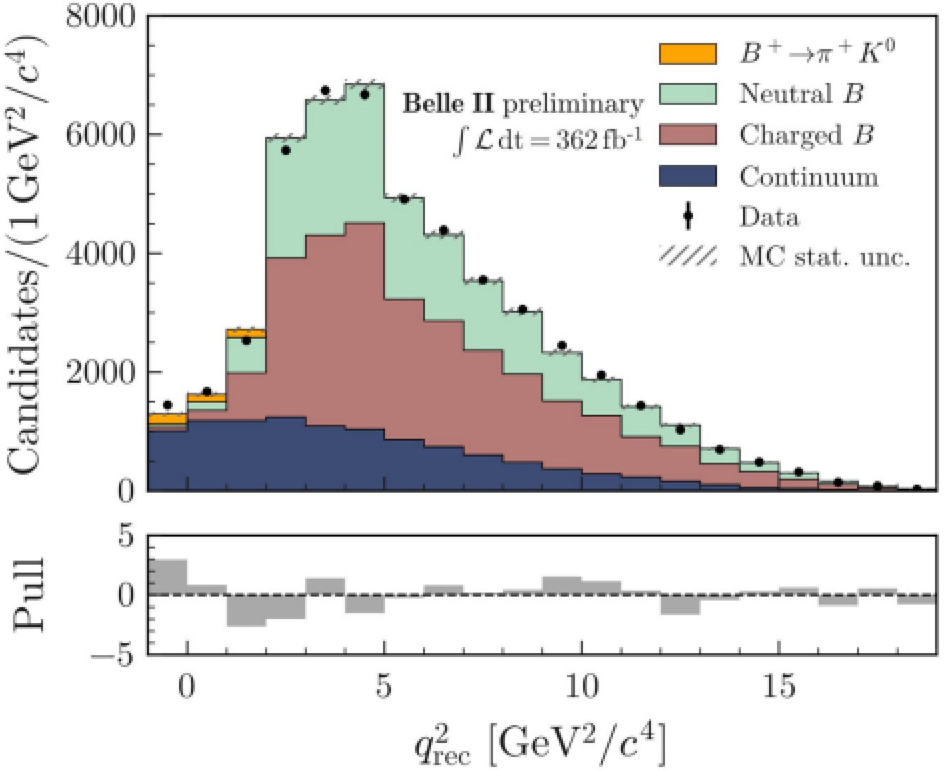
[arXiv:2311.14647](https://arxiv.org/abs/2311.14647) [hep-ex]

Cross checks

arXiv:2311.14647 [hep-ex]



μ =B/B$_{SM}$



B($B^+ \to \pi^+ K^0$) = (2.5±0.5)x10^{-5}

PDG: (2.38±0.08)x10^{-5}

- Multiple checks of the analyses stability, including tests dividing data into approximately equal sub-samples. Reported here as measured branching fraction divided by SM expectation, μ=B/B$_{SM}$.
- Control measurement of $B^+ \to \pi^+ K^0$ decay

Slide from S. Glazov EPS