Status and Prospects of Belle II

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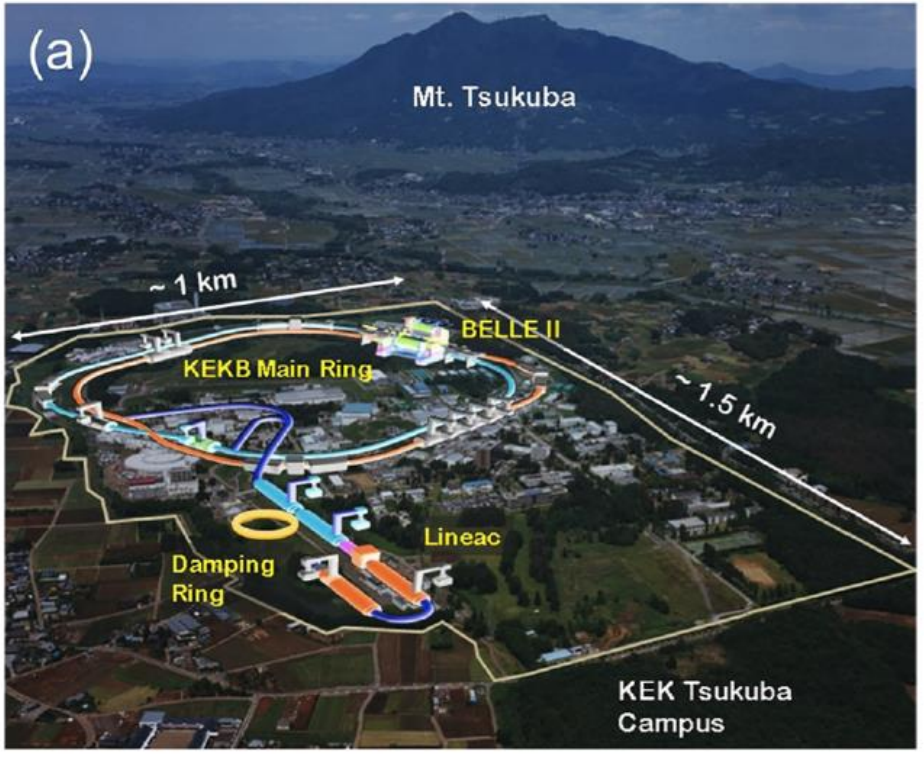
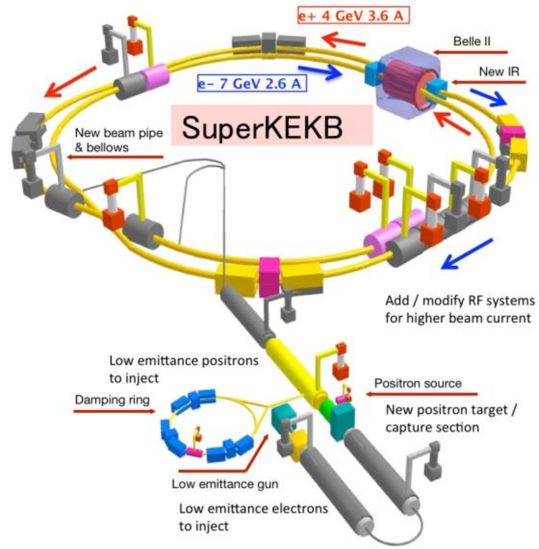
(KEK)
on behalf of the Belle II collaboration

Belle II Experiment

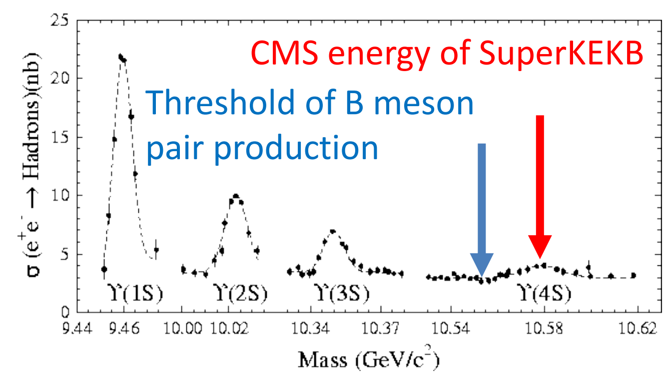
- Here at KEK Tsukuba campus
  - SuperKEKB accelerator
  - Belle II detector



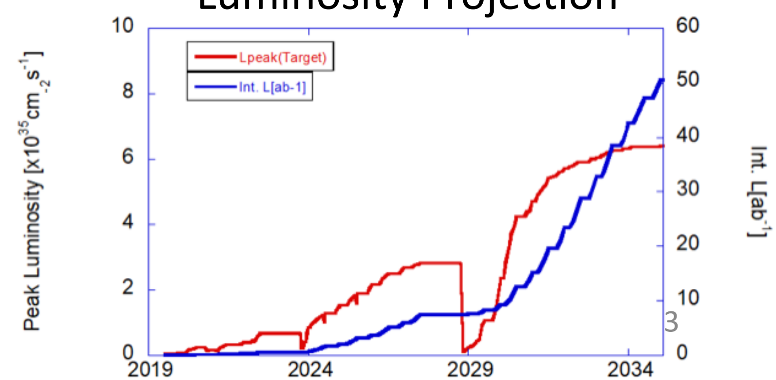
SuperKEKB Accelerator



- Highest luminosity collider
  - $L_{target} = 6x10^{35}$ $cm^{-2}s^{-1}$
  - E_{CM}=10.58GeV on Y(4S)
    - Just above the BB threshold to produce B meson pairs efficiently
    - Can go higher, Y(5S) upto 11.24GeV
  - Energy-asymmetric collisions
    - 7.0GeV (e^-) x 4.0GeV (e^+)
    - To boost B mesons to measure time dependent CPV
  - 50ab^{-1} will be accumulated around 2035
    - Containing $1x10^{11}$ B mesons, $1.4x10^{11}$ charm hadrons, and $0.9x10^{11}$ τ
    - Processes with cross sections of O(1)ab or less are reachable

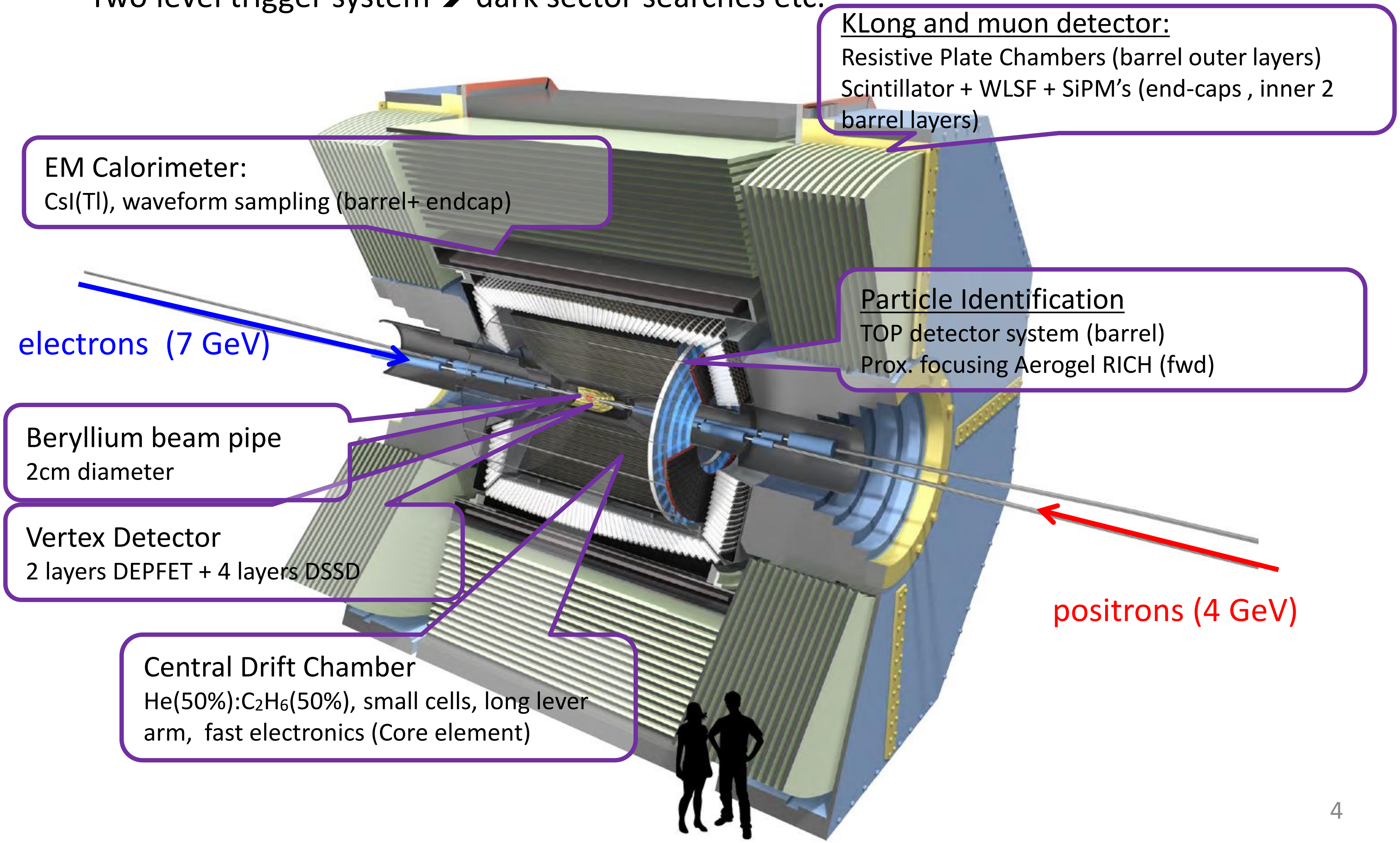


Luminosity Projection



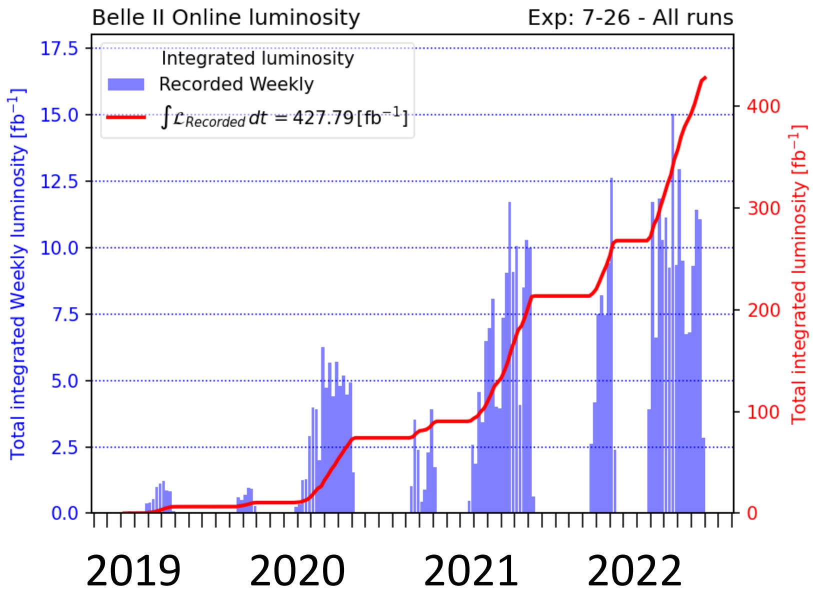
Belle II Detector

- Significant detector improvements from Belle
  - Better and Larger Vertex Detector ➔ Time dependent CPV, especially with long lived Ks.
  - Two level trigger system➔ dark sector searches etc.



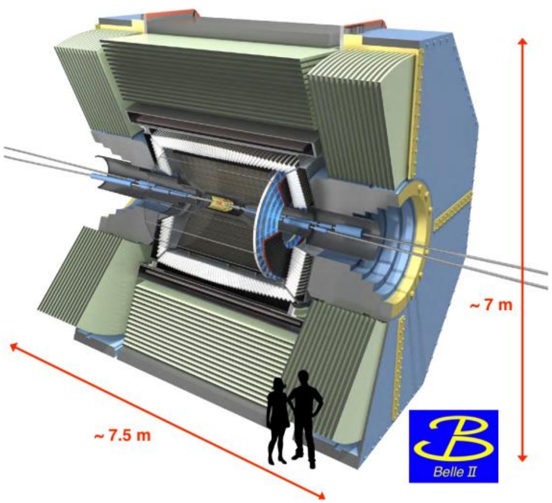
Luminosity and Dataset

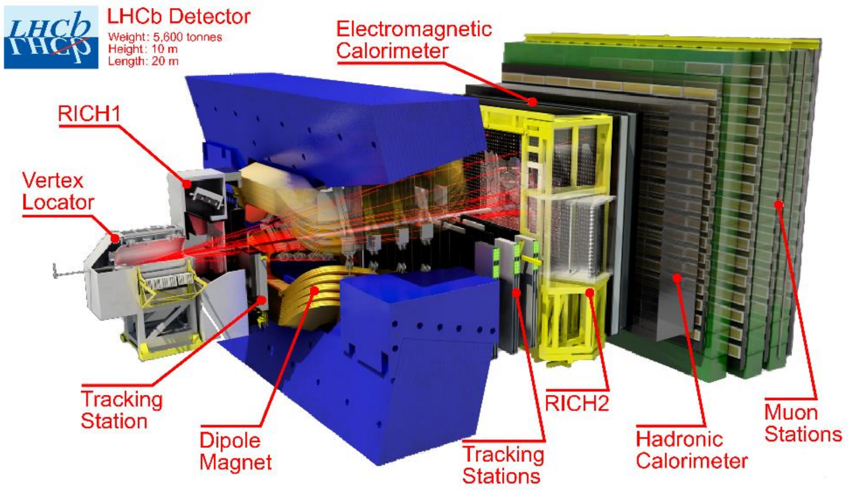
- June 2022 : Run1 operation stopped
  - World's highest luminosity of 4.7×10^{34} $cm^{-2}s^{-1}$
  - $428fb^{-1}$ data were accumulated so far
    - $362fb^{-1}$ on resonance, $42fb^{-1}$ off-resonance, $19fb^{-1}$ energy scan
    - C.f. Belle collected $1040fb^{-1}$



Belle II Cons and Pros (vs. LHCb)

- Cons.
  - Statistics of b hadrons!! (cross section 1nb vs. 144μb)
    - We will only have 10^{11} B mesons with $50ab^{-1}$ on Y(4S) and $5x10^8$ B_s with $5ab^{-1}$ on Y(5S)
  - No large samples of b baryons and B_c
    - Production of these hadrons are not yet established at e^+e^- collisions around Y(nS).
  - Proper time resolution is worse and B meson is not so boosted.
    - Background suppression with B vertex displacement is not so easy
    - Bs mixing (Δm_s) can not be measured (while $\Delta\Gamma_s$ can be measured).





Belle II Cons and Pros (vs. LHCb)

- Pros.
  - Smaller background cross section (O(1)nb vs. O(10)mb)
    - ~3.4nb for ee→qq, ~1.08nb for ee→Υ(4S)→BB
  - Almost 100% trigger efficiency for BB events (11 charged + 5 photons in average).
    - Main triggers
      - 3-track || 2-track with opening angle|| ECL energy sum >1GeV || ECL # of Clusters >=4
    - Absolute BF measurement possible.
  - Two level trigger system for low multiplicity events
    - Many dark sectors signature (X+missing) can be triggered
  - High hermeticity 4π x 94%
    - High reconstruction efficiency of O(1)~O(10)%.
    - Full reconstruction of B meson possible (tagging of the other B meson)
      - More than one missing neutrino modes ➔ $B \to D(*)\tau\nu$, $B \to \tau\nu$, $B \to K^{(*)}\nu\nu$, $B \to K\tau\tau$, $B \to \nu\nu$
    - 4 momentum conservation usable ➔ dark sector searches
  - Detection of electron
    - Detection efficiency of electron is almost the same as that of muon ➔ test of LFU
    - Easy to recover bremsstrahlung photon
  - Detection of neutrals
    - reconstruction of γ, π^0 and Ks efficiently ➔ sum-of-exclusive method for $B \to X_s l^+ l^-$, $B \to \pi^0\pi^0$, $B_{(s)} \to \gamma\gamma$
    - Better energy resolution of hard γ ➔ $B \to K^*\gamma$ background to $B \to \rho\gamma$ can be suppressed

Rich Physics Program

- Flavor physics
  - B
    - CKM Unitarity Triangle
    - Rare decays
    - Lepton Flavor Universality
    - etc
  - Charm
    - CPV
    - mixing
    - Lifetime
    - etc
  - τ
    - Mass
    - Lifetime
    - CPV
    - EDM
    - etc
- QCD
  - Bottomonia, charmonia and exotic hadrons containing heavy quark
  - HVP with radiative return for muon g-2
  - fragmentation
  - etc
- EW
  - Weak mixing angle
  - etc
- Light new particle searches
  - Dark sector mediators
  - etc
- And more

Recent Highlights

CKM Matrix and Unitarity Triangle

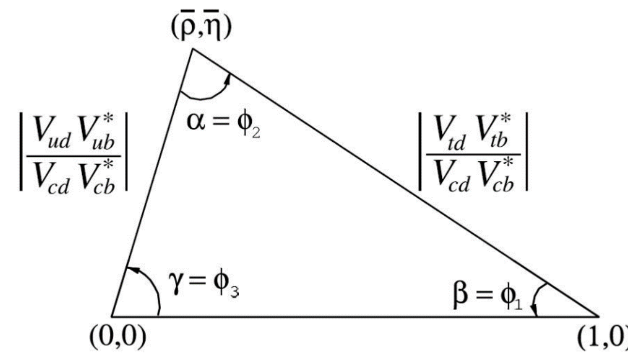
- Unitarity condition of CKM Matrix
  - Product of d and b columns

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

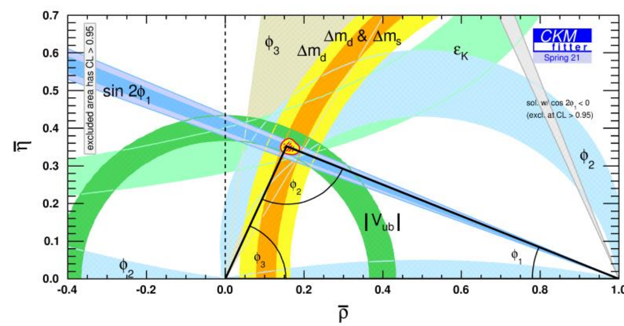
$$\frac{V_{ub}^* V_{ud}}{V_{cb}^* V_{cd}} + 1 + \frac{V_{tb}^* V_{td}}{V_{cb}^* V_{cd}} = 0$$

- This draws triangle in complex plain
  - called unitarity triangle (UT)
  - Three angles (ϕ_1, ϕ_2 , ϕ_3) → CP violations
  - Three sides ($|V_{cb}|$, $|V_{ub}|$, $|V_{td}|$) → Amplitudes
- Test of UT is one of the most important missions at Belle II
  - All angles and sides can be measured only at Belle II

$$\begin{pmatrix} d' \\ s' \\ b' \end{pmatrix} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} \begin{pmatrix} d \\ s \\ b \end{pmatrix}$$

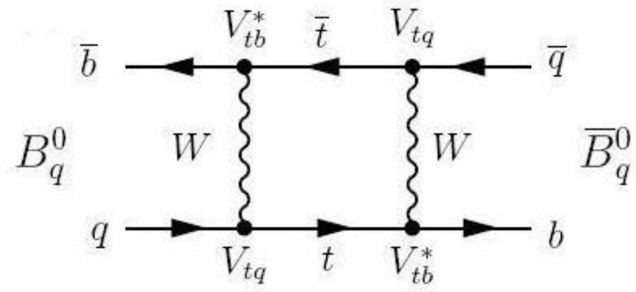


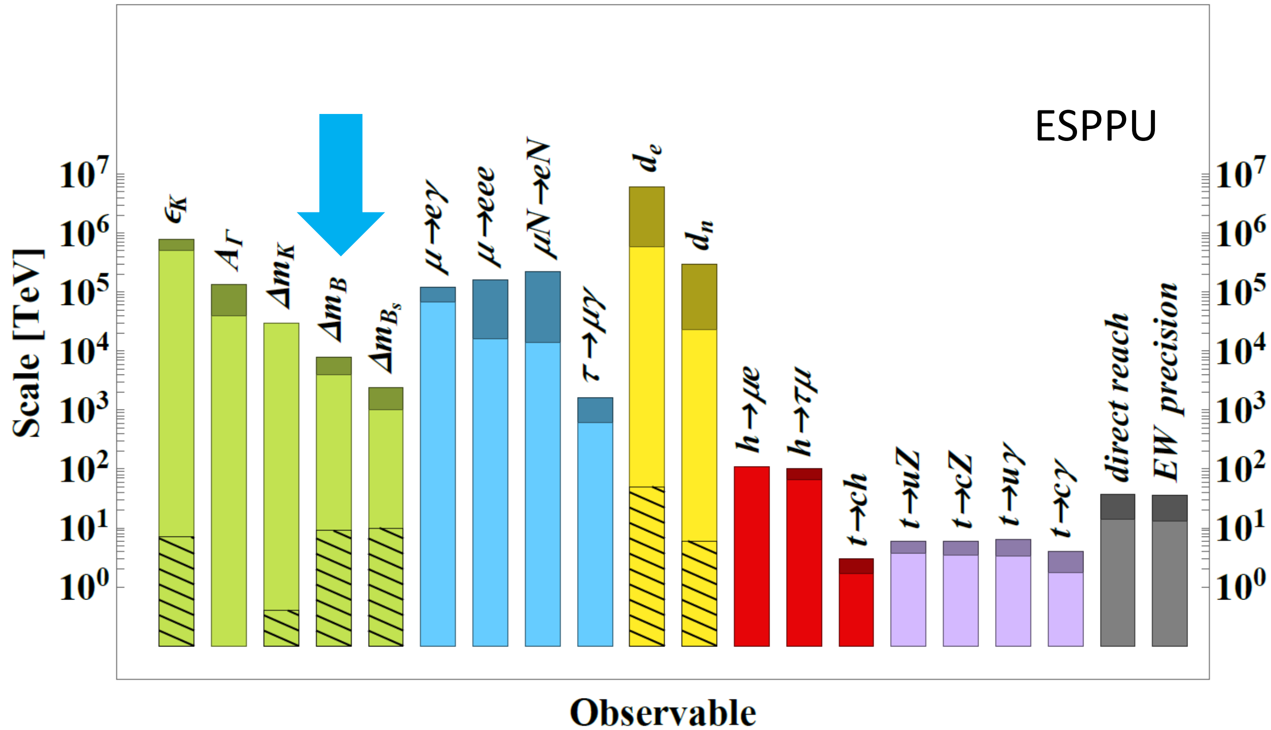
Current status



New Physics Reach with UT

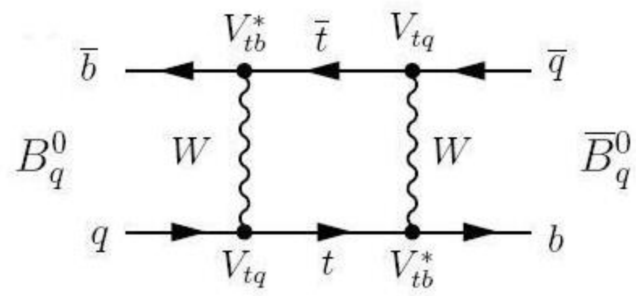
- Search for new physics in B^0 mixing
  - Can reach to O(1000) TeV new physics scale

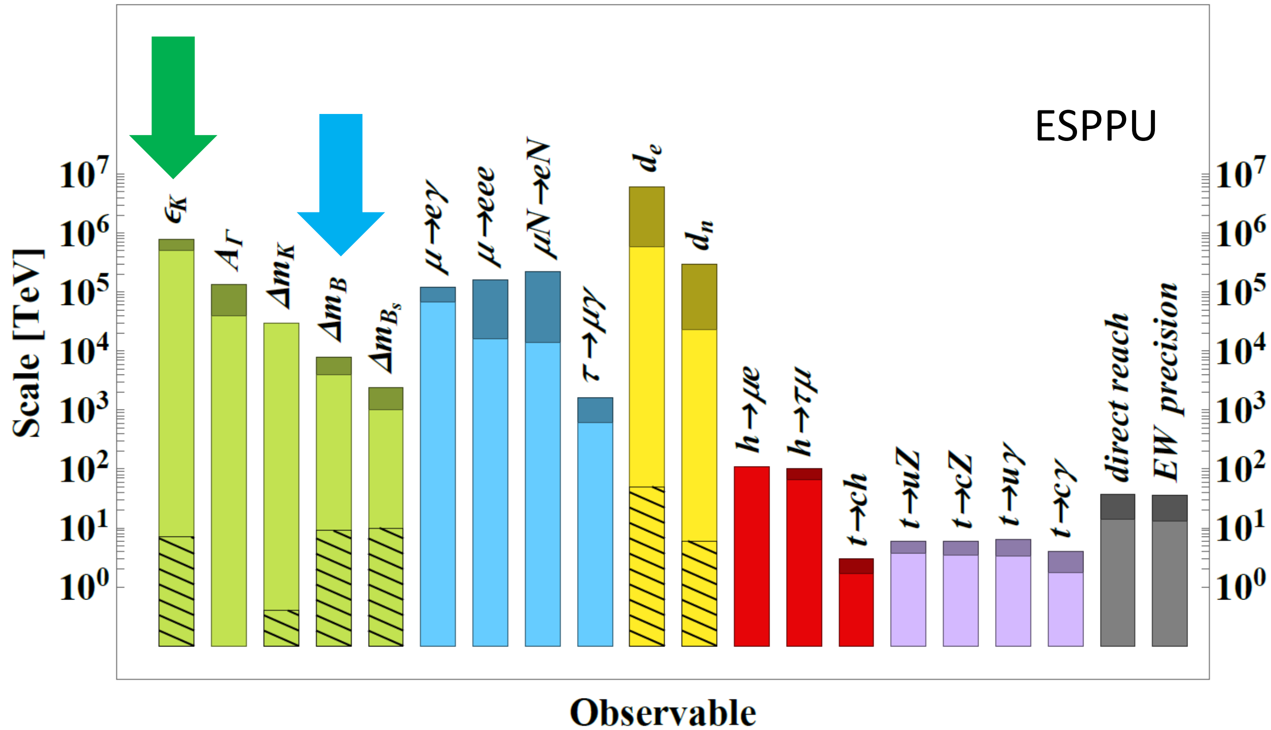




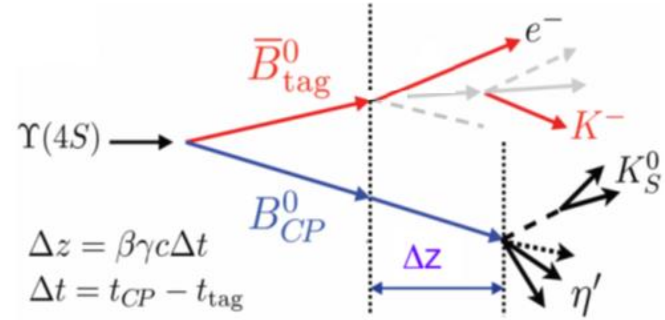
New Physics Reach with UT

- Search for new physics in B^0 mixing
  - Can reach to O(1000) TeV new physics scale
  - Improve ε_K by precise measurement of $|V_{cb}|$
    - $O(10^5)$ TeV





UT Angle ϕ_1



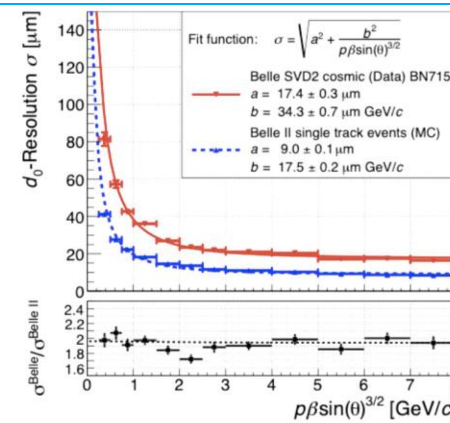
- Time dependent CPV in b→c$\bar{c}$s process

$$\frac{\Gamma(\bar{B}^0 \to f_{CP};t) - \Gamma(B^0 \to f_{CP};t)}{\Gamma(\bar{B}^0 \to f_{CP};t) + \Gamma(B^0 \to f_{CP};t)} = S \cdot \sin(\Delta m_d \cdot t) - C \cdot \cos(\Delta m_d \cdot t)$$

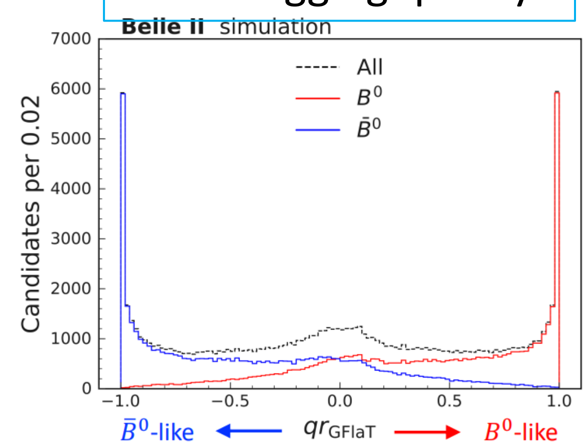
$$\underline{\boldsymbol{S = -\xi_{CP} \sin 2\phi_1}}$$, C=0

- Requires proper time difference (Δt) and flavor tagging information
  - Vertex resolution improved with pixel detector
  - flavor tagging efficiency improved by 18% with Graph Neural Net
    - $(31.68 \pm 0.45 \pm 0.41)$ % (old)
    - → $(37.40 \pm 0.43 \pm 0.34)$ % (GNN)

Impact parameter resolution
Belle and Belle II



flavor tagging quality

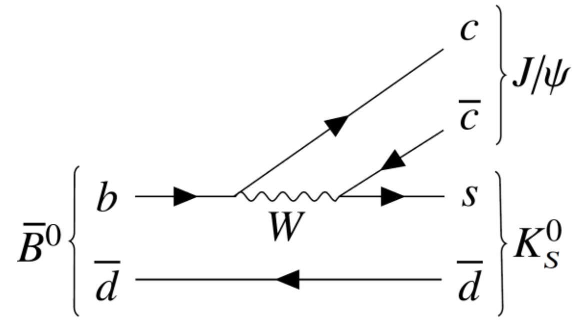


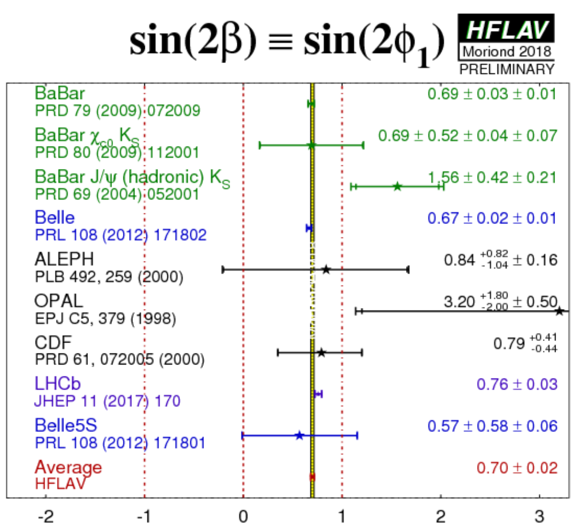
Preliminary
$362 fb^{-1}$

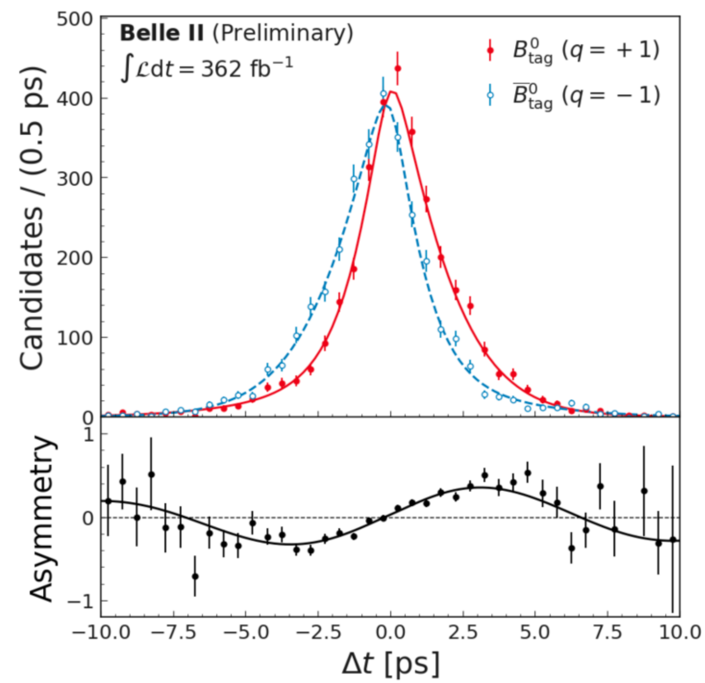
Measurement of $\sin 2\phi_1$ in $B \rightarrow J/\psi$ Ks

- Time dependent CPV in $B \rightarrow J/\psi$ Ks
  - $S = \sin 2\phi_1 = 0.724 \pm 0.035 \pm 0.014$
  - $C = 0.035 \pm 0.026 \pm 0.012$
- Consistent with current World Average

HFLAV: $S = 0.695 \pm 0.019$ $C = 0.000 \pm 0.020$
LHCb: $S = 0.716 \pm 0.015$ $C = 0.012 \pm 0.012$







Preliminary

Measurement of ϕ_3

- Utilize an interference between b→c and b→u, such as $B^+ \to D^0 K^+$
  - The amplitude ratio is around 0.1
- D^0 and $\overline{D}^0$ interfere when decaying to common final states
  - $D \to K^+K^-$, $K_S\pi^+\pi^-$, $K_S K^\pm \pi^\mp$
  - Measurement of Direct CPVs and BF ratios
- LHCb gives the best ϕ_3 results with combination
  - ϕ_3 =(63.8±3.6)deg LHCB-CONF-2022-003
- Combining Belle and Belle II analyses

  ϕ_3=(78.6±7.3)deg

B decay	D decay	Method	Data set (Belle + Belle II) [fb^{-1}]
$B^+ \to Dh^+$	$D \to K_S^0 h^- h^+$	BPGGSZ	$711 + 128$
$B^+ \to Dh^+$	$D \to K_S^0 \pi^- \pi^+ \pi^0$	BPGGSZ	$711 + 0$
$B^+ \to Dh^+$	$D \to K_S^0 \pi^0, K^- K^+$	GLW	$711 + 189$
$B^+ \to Dh^+$	$D \to K^+ \pi^-, K^+ \pi^- \pi^0$	ADS	$711 + 0$
$B^+ \to Dh^+$	$D \to K_S^0 K^- \pi^+$	GLS	$711 + 362$
$B^+ \to D^* K^+$	$D \to K_S^0 \pi^- \pi^+$	BPGGSZ	$605 + 0$
$B^+ \to D^* K^+$	$D \to K_S^0 \pi^0, K_S^0 \phi, K_S^0 \omega, K^- K^+, \pi^- \pi^+$	GLW	210+0

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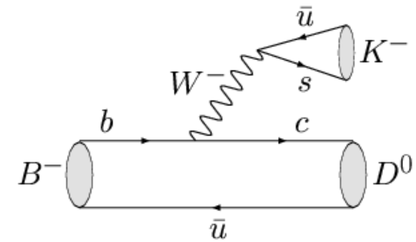
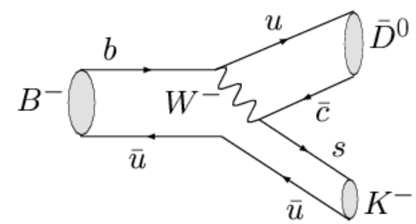
- With a several ab^{-1}, Belle II can give the competitive result



CKM factor

$A\lambda^3$

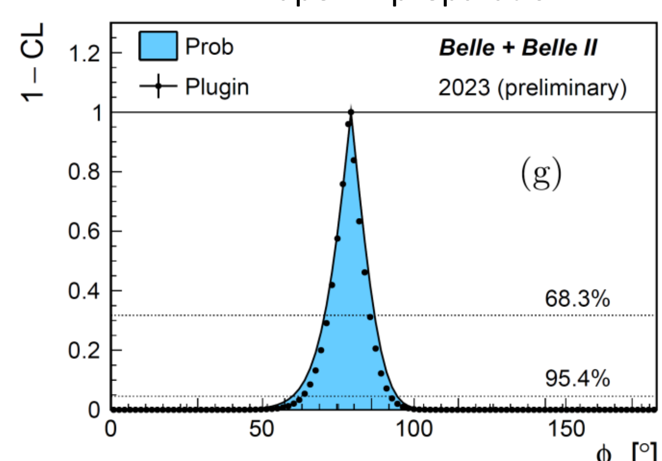
Color allowed b→c



$(\rho+i\eta)A\lambda^3$

Color suppressed b→u

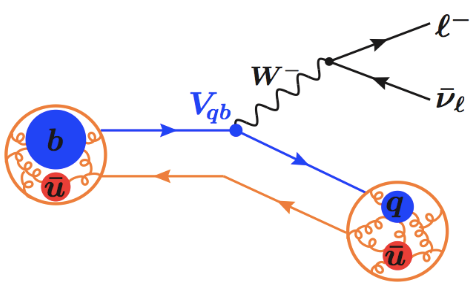
Paper in preparation

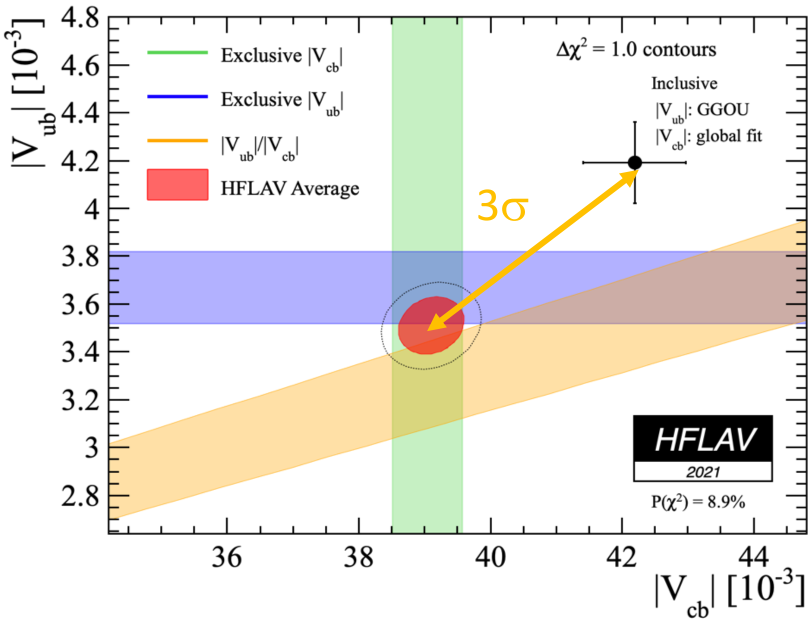


ϕ_3=(78.6±7.3)deg

$|V_{cb}|$

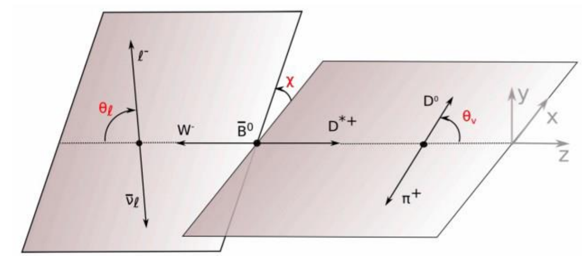
- Measure with semileptonic decays
  - $b \rightarrow c l \nu$
  - Two techniques : exclusive and inclusive
    - About 3σ difference between exclusive and inclusive measurements
    - Thoery ? Experiment ? Lattice QCD?





Preliminary
189fb^{-1}

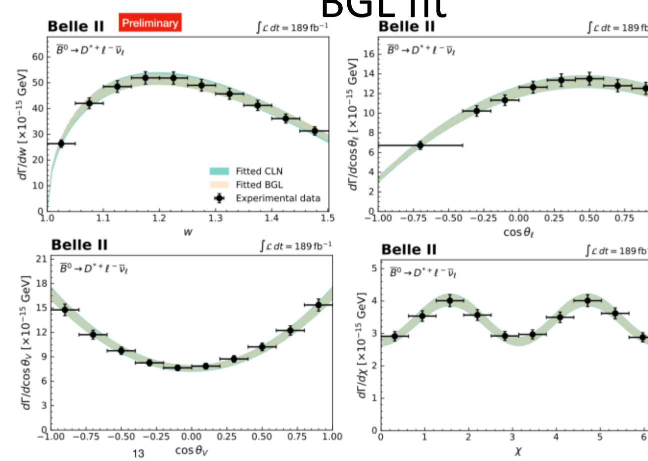
$|V_{cb}|$ in Angular analysis of $B \rightarrow D^* l \nu$



- Measure 4D differential decay rate

$$\frac{d^4\Gamma}{dw\, d\cos\theta_\ell\, d\cos\theta_V\, d\chi} \propto |V_{cb}|^2 A(w, \cos\theta_\ell, \cos\theta_V, \chi)$$

BGL fit



- Using BGL and CLN parameterizations with Lattice QCD input at zero recoil w=1

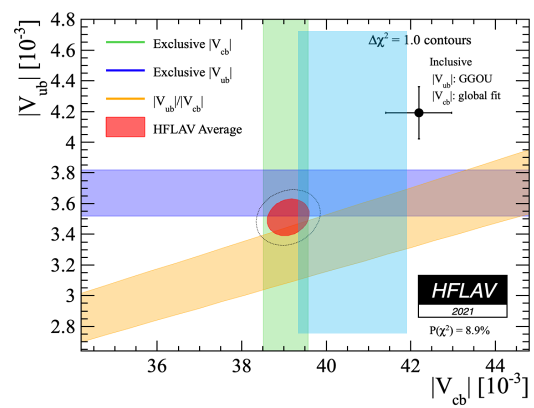
$$|V_{cb}|_{\mathrm{BGL}} = (40.57 \pm 0.31 \pm 0.95 \pm 0.58) \times 10^{-3}$$
$$|V_{cb}|_{\mathrm{CLN}} = (40.13 \pm 0.27 \pm 0.93 \pm 0.58) \times 10^{-3}$$

  - Consistent with WA

WA values [HFLAV 2021]

$$|V_{cb}|_{\mathrm{excl}} = (39.10 \pm 0.50) \times 10^{-3}$$

  - Slightly better agreement with inclusive measurement



Lepton Flavor Universality in B Decays

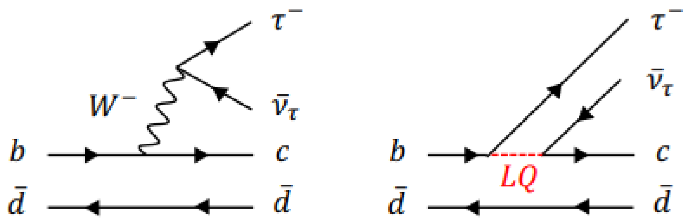
Lepton Flavor Universality

- SM respects LFU

$$R(D^{(*)}) = \frac{\mathcal{B}\left(B \to D^{(*)}\tau\nu_\tau\right)}{\mathcal{B}\left(B \to D^{(*)}\ell\nu_\ell\right)}$$

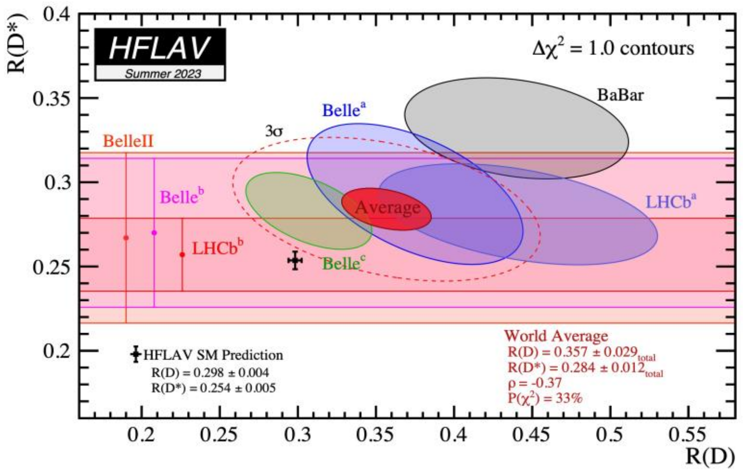
$$R(X) = \frac{\mathcal{B}\left(B \to X\tau\nu_\tau\right)}{\mathcal{B}\left(B \to X\ell\nu_\ell\right)}$$

  - Deviation from unity for the Ratio only comes from lepton masses



- While new physics such as leptoquark can differ the Ratio from the SM prediction

- Current WA is about 3σ to 4σ deviated from the SM predictions



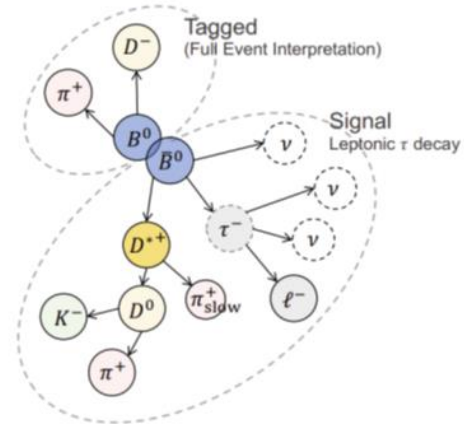
Preliminary
$189 fb^{-1}$

First Measurement of R(D*) at Belle II

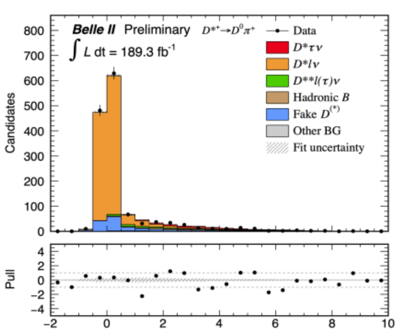
- Signal side
  - Three D* channels, $D^{*+} \rightarrow D^0\pi^+ / D^+\pi^0$, $D^{*0} \rightarrow D^0\pi^0$
  - Two leptonic τ decays, $\tau \rightarrow e\nu\nu$, $\tau \rightarrow \mu\nu\nu$
- Tag side
  - hadronic decays
- Results

$$R(D^*) = 0.267\,^{+0.041}_{-0.039}(\text{stat.})\,^{+0.028}_{-0.033}(\text{syst.})$$

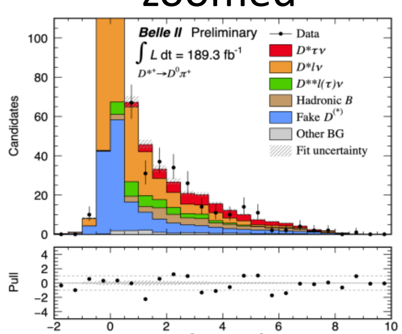
- Consistent with both SM and WA



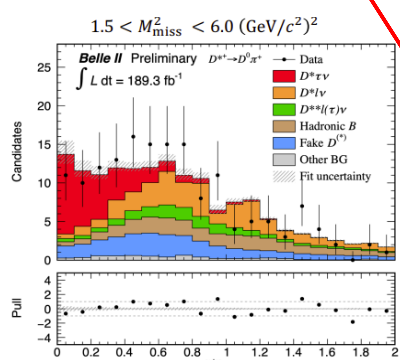
zoomed



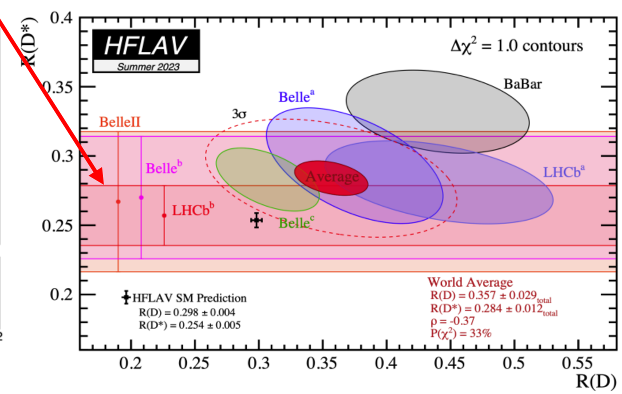
M^2_{miss} [GeV^2]



M^2_{miss} [GeV^2]



E_{ECL} [GeV]



Preliminary
189fb^{-1}

Measurement of R(X)

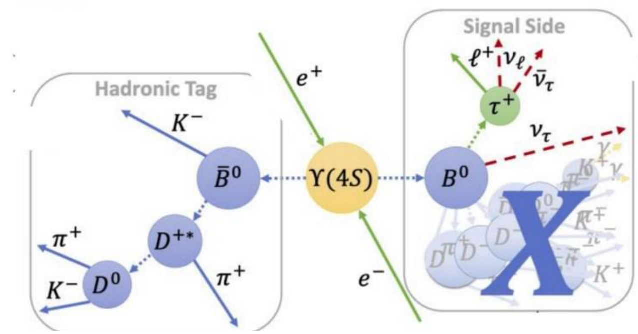
- First measurement of R(X) at B factory
  - Complementary to exclusive R(D$^{(*)}$)

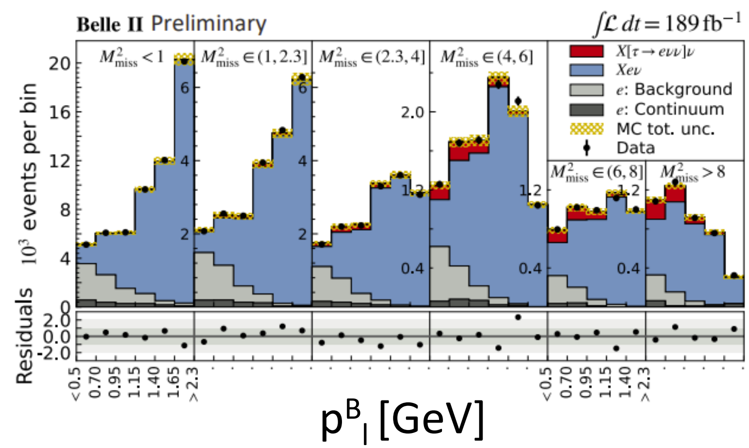
$$R(X) = \frac{\mathcal{B}(B \to X\tau\nu_\tau)}{\mathcal{B}(B \to X\ell\nu_\ell)}$$

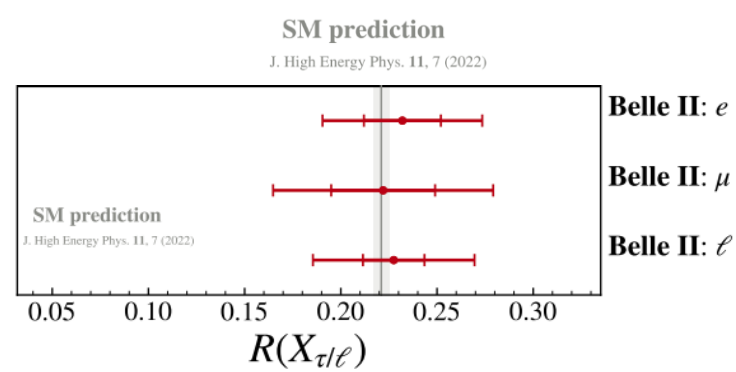
- Reconstruction
  - Signal $\tau \to e\nu\nu$, $\tau \to \mu\nu\nu$
  - Hadronic tagging
- Use missing mass squared and lepton momentum to isolate signal from $B \to Xl\nu$ background
  - Template fitting performed
- Result

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

  - Consistent with SM prediction
  - Major systematics
    - MC statistics, PDF shape, BF of $B \to D^{**}l\nu$







Rare B Decays

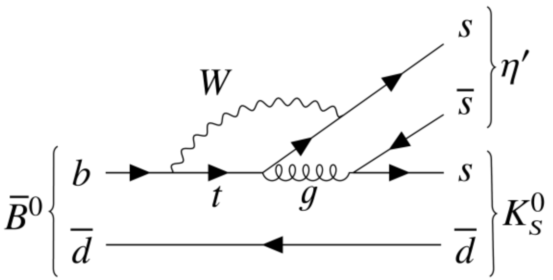
Time Dependent CPV in B→η’Ks

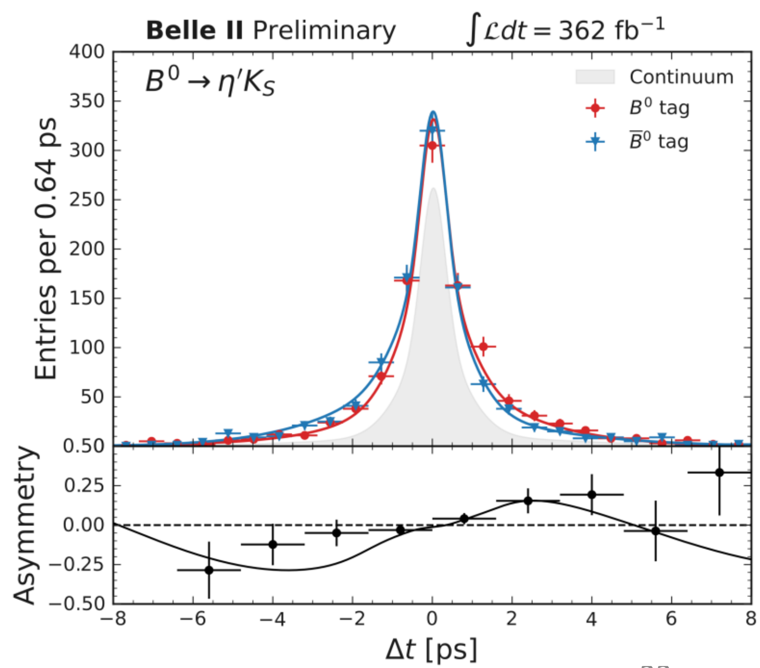
- b→sqq process dominated by QCD penguin
- If measured S is deviated from $\sin 2\phi_1$, it might be a new physics signal
- Reconstruction
  - $\eta' \to \eta(\gamma\gamma)\pi^+\pi^-$
  - $\eta' \to \rho(\pi^+\pi^-)\gamma$
- Result

$$S = \quad 0.67 \pm 0.10 \pm 0.04$$
$$C = -0.19 \pm 0.08 \pm 0.03$$

HFLAV: $S = 0.63 \pm 0.06$ $C = -0.05 \pm 0.04$

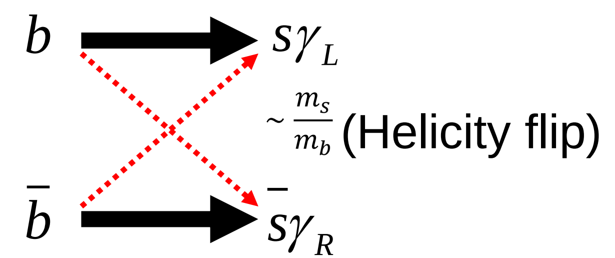
  - Consistent with $\sin 2\phi_1$ and WA





Time Dependent CPV in B→K*γ

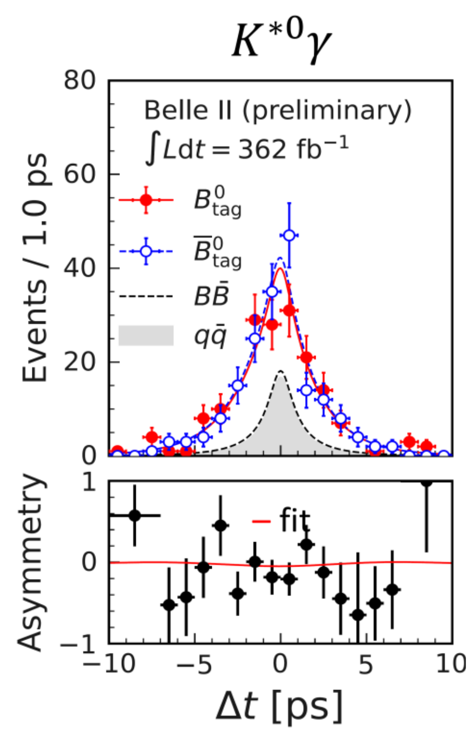
New Physics



- Photon in b→sγ process is predominantly left-handed in SM
- New physics enchases the right-handed photons
- Time dependent CPV in B→K*^{0}γ is sensitive to the photon polarization
- S~ in SM while lrager value for NP

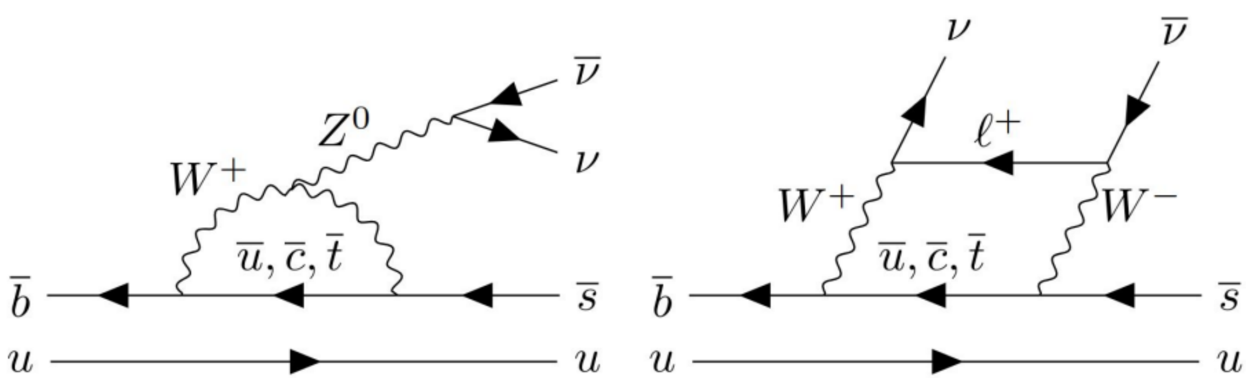
$$S^{\mathrm{SM}}_{K^*(K^0_S\pi^0)\gamma} = (-2.3 \pm 1.6)\%$$

- Reconstruction
  - B→(Ksπ^0)γ
  - Vertex is determined from long lived Ks decaying to $\pi^+\pi^-$ using beam spot constraint
- Result
  - $S = 0.00^{+0.27}_{-0.26} \pm 0.03$
  - $C = 0.10 \pm 0.13 \pm 0.03$
    - HFLAV: $S = -0.16 \pm 0.22$ $C = -0.04 \pm 0.14$
  - Consistent with the SM prediction
  - Most precise to date!



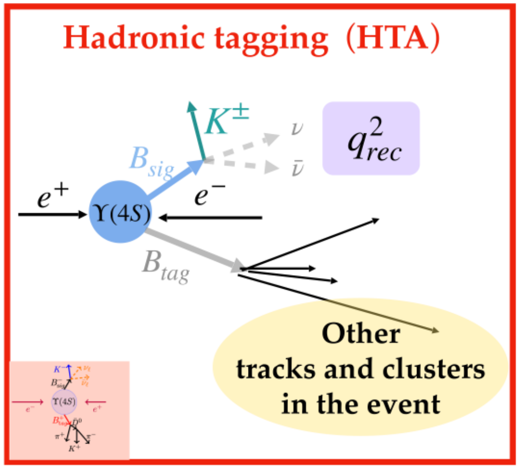
$B^+ \to K^+\nu\nu$

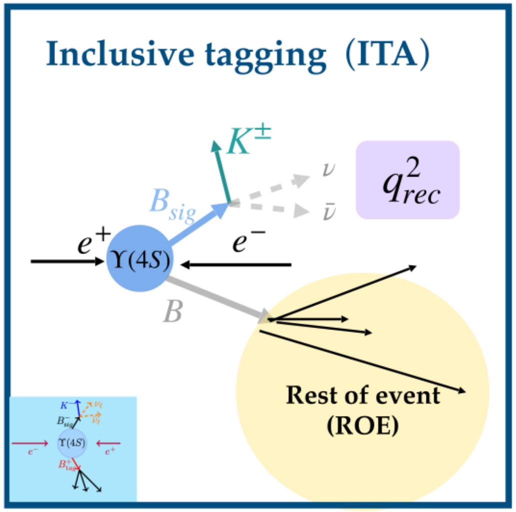
- FCNC process with no charm loop ← $b \to s l^+ l^-$
- Precise SM prediction
  - $B(B^+ \to K^+\nu\nu) = (5.58 \pm 0.37) \times 10^{-6}$ PRD 107, 014511 (2023) PRD 107, 119903 (2023)
- Sensitive to New physics
  - Axion, ALPs, dark scalar, Z', LQ
- Experimentally challenging
  - Only Kaon in the final state → Huge backgrounds
  - Analysis performed with $63 fb^{-1}$
  - Update with $362 fb^{-1}$



$B^+ \rightarrow K^+\nu\nu$ Analysis Methods

- Hadronic tagging analysis (HTA)
  - The other B meson reconstructed with hadronic decays
  - BDT to suppress backgrounds
  - Efficiency 0.4%
  - High purity S/N=7%
- Inclusive tagging analysis (ITA)
  - Highest momentum kaon candidate is selected as signal candidate.
  - Charged and neutral particles are collected as rest of events.
  - Two consecutive BDTs are used (BDT_1, BDT_2) to suppress backgrounds
  - High efficiency of 8%
  - Purity S/N=0.8%
- BDT distributions are transformed by flattening the signal component and then are fitted (with q^2 for ITA) to extract signal





Preliminary
362fb^{-1}

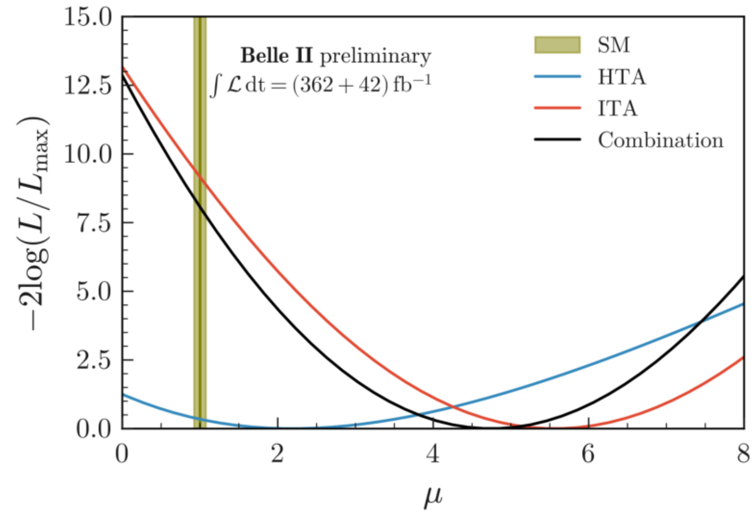
$B^+ \rightarrow K^+\nu\nu$ Result

- First evidence for $B^+ \rightarrow K^+\nu\nu$

HTA and ITA combined

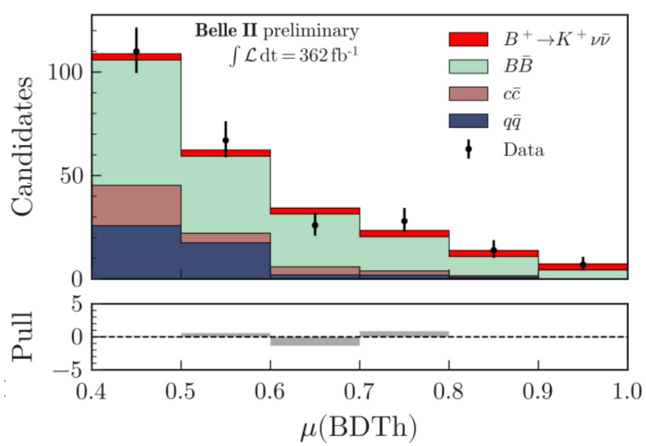
$$\mu = 4.7 \pm 1.0(\text{stat}) \pm 0.9(\text{syst})$$
$$\mathcal{B}(B^+ \to K^+\nu\bar{\nu}) = [2.4 \pm 0.5(\text{stat})^{+0.5}_{-0.4}(\text{syst})] \times 10^{-5}$$

  - 3.6σ from null
  - 2.8σ from SM prediction
  - When taking the combination, common events are removed from ITA sample (~ 2% of the total)



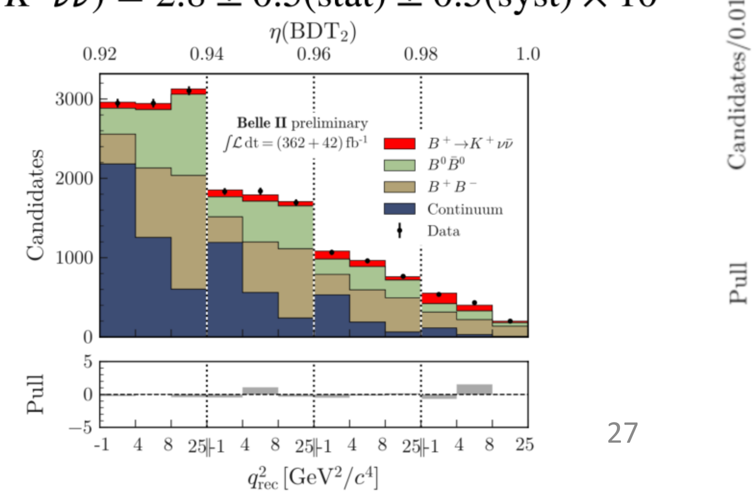
HTA

$$\mu = 2.2 \pm 2.3(\text{stat})^{+1.6}_{-0.7}(\text{syst})$$
$$\mathcal{B}(B^+ \to K^+\nu\bar{\nu}) = [1.1^{+0.9}_{-0.8}(\text{stat})^{+0.8}_{-0.5}(\text{syst})] \times 10^{-5}$$



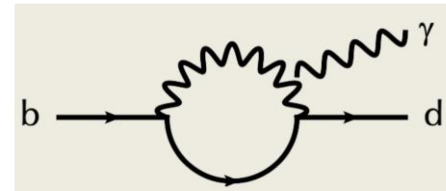
ITA

$$\mu = 5.6 \pm 1.1(\text{stat})^{+1.1}_{-0.9}(\text{syst})$$
$$\mathcal{B}(B^+ \to K^+\nu\bar{\nu}) = 2.8 \pm 0.5(\text{stat}) \pm 0.5(\text{syst}) \times 10^{-5}$$



Preliminary
$711 fb^{-1} + 362 fb^{-1}$

$B \to \rho\gamma$



- FCNC process with $b \to d$ transition
  - Isospin violation large?

$$a_I^{\bar{0}-} = \frac{c_V^2\,\Gamma(\bar{B}^0 \to \bar{V}^0\gamma) - \Gamma(B^- \to V^-\gamma)}{c_V^2\,\Gamma(\bar{B}^0 \to \bar{V}^0\gamma) + \Gamma(B^- \to V^-\gamma)}$$

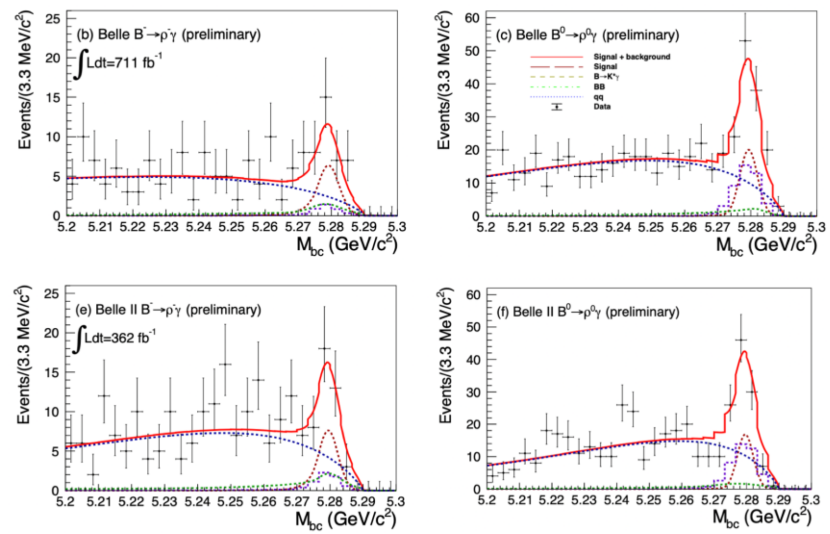
  - WA $A_I = (30^{+16}_{-13})\%$
  -

$$\bar{a}_I^{\mathrm{SM}}(\rho\gamma) = (5.2 \pm 2.8)\,\%$$

$B^+ \to \rho^+\gamma$ $B^0 \to \rho^0\gamma$

Belle

Belle II



- Analysis
  - Combination of Belle ($711 fb^{-1}$) and Belle II ($362 fb^{-1}$)
  - $B^0 \to \rho^0\gamma$, $B^+ \to \rho^+\gamma$
  - Large $B \to K^*\gamma$ background is suppressed using PID and ΔE
- Results
  - A_I is consistent with both SM and WA
  - Most precise results to date

$$BR(\rho^+\gamma) = (12.87^{+2.02+1.00}_{-1.92-1.17})\times 10^{-7}$$
$$BR(\rho^0\gamma) = (7.45^{+1.33+1.00}_{-1.27-0.80})\times 10^{-7}$$
$$A_I = (14.2^{+11.0+8.9}_{-11.7-9.1})\%$$
$$A_{CP} = (-8.4^{+15.2+1.3}_{+15.3-1.4})\%$$

Cham, τ and Dark Sector

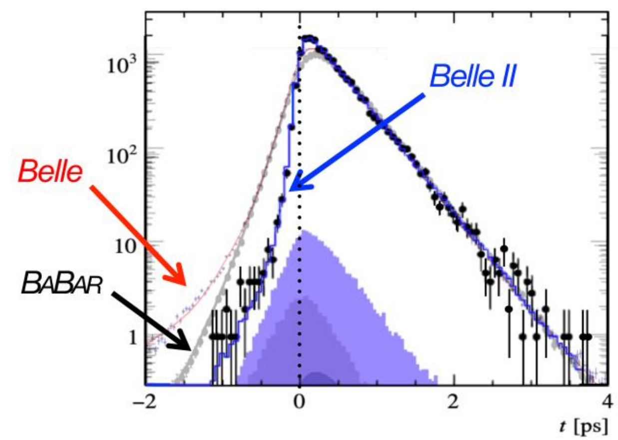
Charm Hadron Lifetime

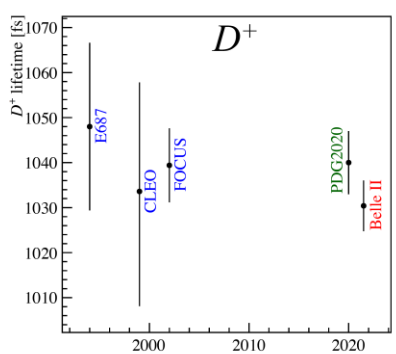
- Good vertex resolution allows precise measurement of charm hadron lifetime
- Measurements of lifetime improve the understanding of QCD in charm hadron decays

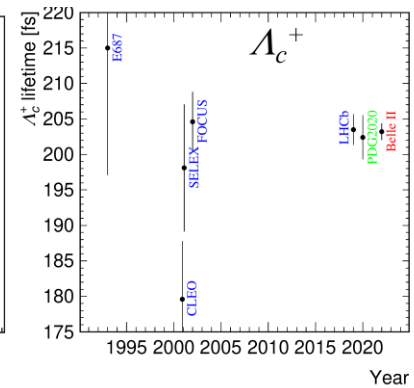
$$
\begin{aligned}
\Gamma(D) &= \frac{1}{2m_D}\sum_X \int_{\rm PS} (2\pi)^4 \delta^{(4)}(p_D - p_X)\,|\langle X(p_X)|\mathcal{H}_{\rm eff}|D(p_D)\rangle|^2, \\
&\to \frac{1}{2m_D}{\rm Im}\langle D|\mathcal{T}|D\rangle \quad \text{where} \quad \mathcal{T} = i\int d^4x\, T\left\{\mathcal{H}_{\rm eff}(x), \mathcal{H}_{\rm eff}(0)\right\} \\
&\to \Gamma_3 + \Gamma_5\frac{\langle\mathcal{O}_5\rangle}{m_c^2} + \Gamma_6\frac{\langle\mathcal{O}_6\rangle}{m_c^3} + \ldots + 16\pi^2\left(\tilde{\Gamma}_6\frac{\langle\tilde{\mathcal{O}}_6\rangle}{m_c^3} + \tilde{\Gamma}_7\frac{\langle\tilde{\mathcal{O}}_7\rangle}{m_c^4} + \ldots\right)
\end{aligned}
$$

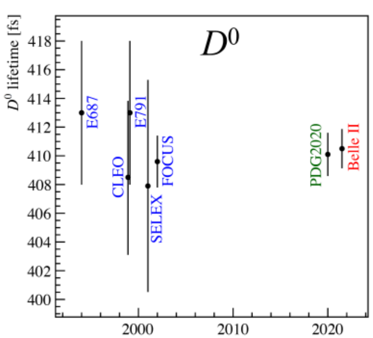
- Except for Ω_c, Belle II has made the world's best precision
  - For Ω_c, Belle II confirms longer lifetime measured by LHCb

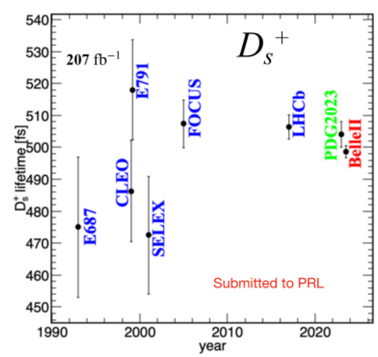
$D^0 \to K^-\pi^+$

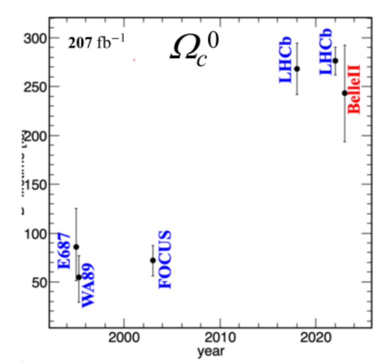












τ mass

- Fundamental parameter of the SM
- Crucial for LFU test in τ decays
- Use pseudo-mass technique with τ→3πν

$$M_{\min} = \sqrt{M_{3\pi}^2 + 2(\sqrt{s}/2 - E_{3\pi}^*)(E_{3\pi}^* - p_{3\pi}^*)} \leq m_\tau.$$

- Result

$m_\tau = 1777.09 \pm 0.08 \pm 0.11$ MeV

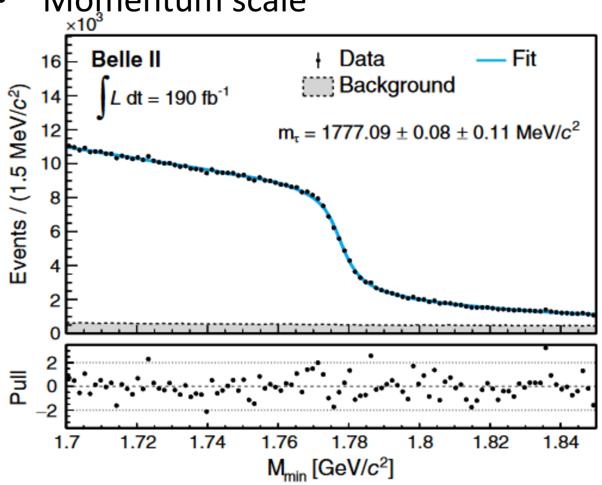
  - Dominant uncertainties
    - Beam energy
    - Momentum scale

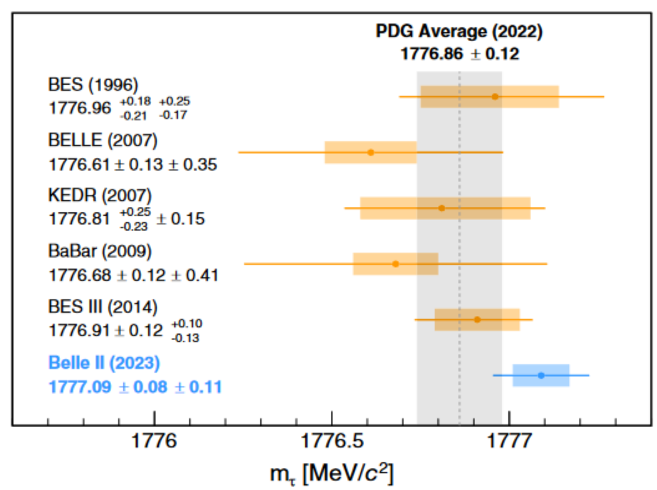
Most precise to date

$$\left(\frac{g_\mu}{g_e}\right)_\tau = \sqrt{R_\mu \frac{f(m_e^2/m_\tau^2)}{f(m_\mu^2/m_\tau^2)}},$$

$$R_\mu = \frac{\mathcal{B}[\tau^- \to \mu^- \bar{\nu}_\mu \nu_\tau]}{\mathcal{B}[\tau^- \to e^- \bar{\nu}_e \nu_\tau]}$$

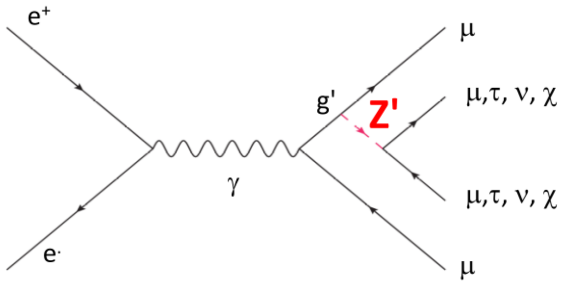
$$f(x) = 1 - 8x + 8x^3 - x^4 - 12x^2 \ln x$$

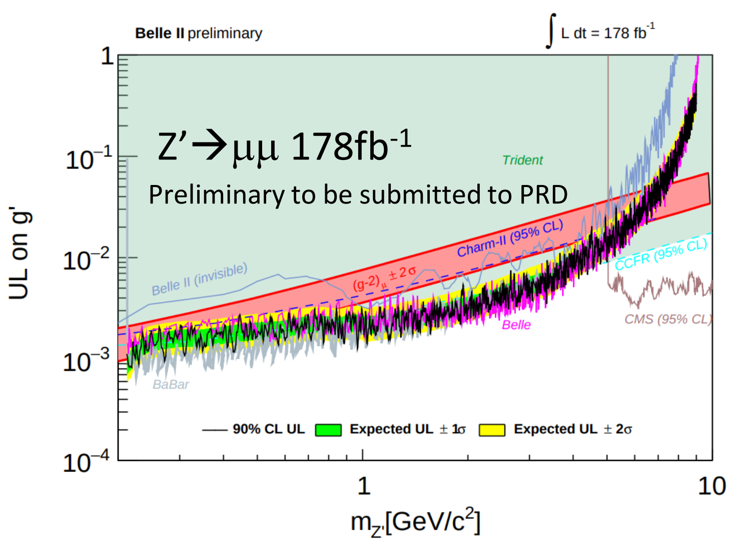




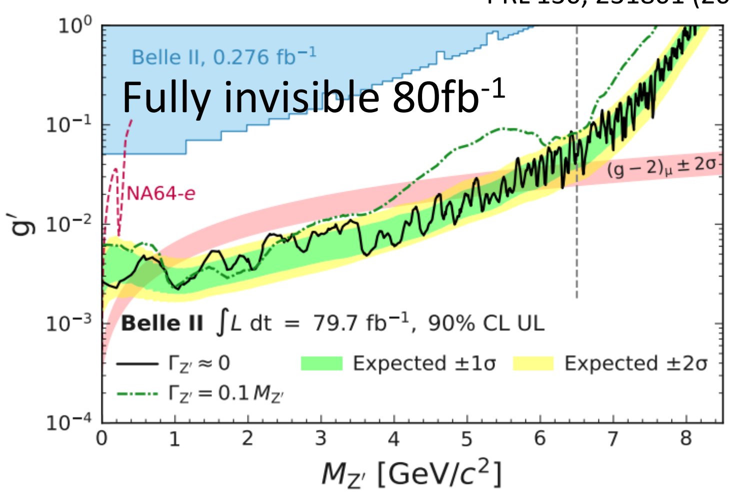
Dark Sector

- Z' in L_μ-L_τ
  - Gauging the difference of μ and τ numbers
  - Might couple to dark sector particles
  - Can explain muon g-2 anomaly
- Search for ee→μμZ' with Z'→μμ and invisible decays
  - Z'→μμ similar limit with Belle and Babar
    - Exclude almost all region of $M_{Z'} > 2m_\mu$ explaining muon g-2
  - Fully invisible Z'
    - First exclusion explaining muon g-2, $0.8 < M_{Z'} < 4.5$GeV



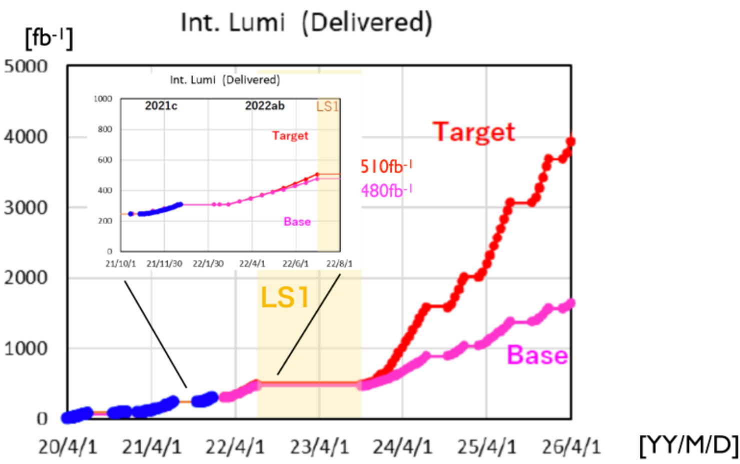


PRL 130, 231801 (2023)



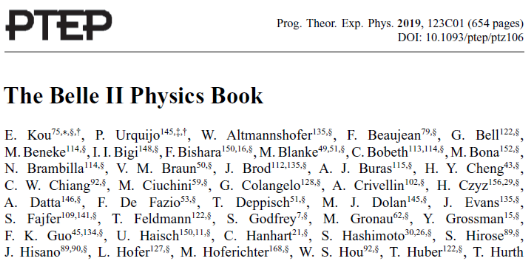
Near Future Prospects

- June 2022 – Jan 2024: Long Shutdown 1 for SuperKEKB and Belle II upgrades
  - New collimators to reduce beam induced backgrounds which limit beam current
    - → can go higher luminosity
  - Two-layer pixel detector was installed
    - → better vertex resolution under higher beam induced background
  - TOP PMT replacement → better Kaon ID
- Jan 2024 : SuperKEKB operation resumed
  - Plan to accumulate more data than Belle in run2



Future Prospects on Physics

- Summarized in Physics Book
  - https://doi.org/10.1093/ptep/ptz106
- One example on UT measurements
  - Uncertainty of Sides : ~1% for $|V_{cb}|$ and $|V_{ub}|$
  - Uncertainty of Angles : 0.2deg, 0.6deg, 1.5deg for ϕ_1, ϕ_2 and ϕ_3
  - Should consider
    - ϕ_1 : Penguin pollution
    - ϕ_2 : isospin breaking effect

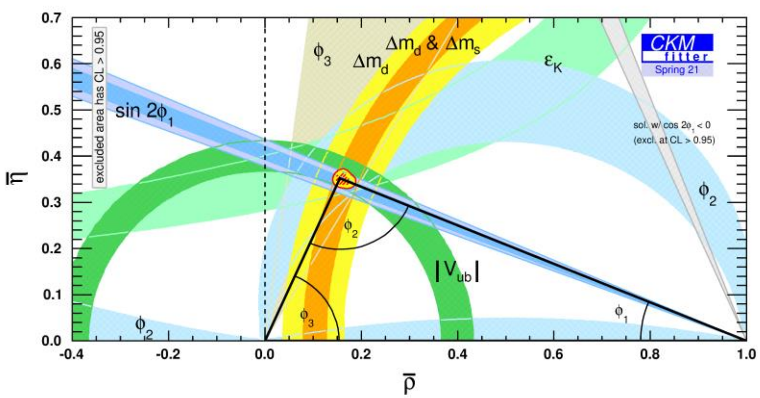

PTEP Prog. Theor. Exp. Phys. 2019, 123C01 (654 pages)
DOI: 10.1093/ptep/ptz106

The Belle II Physics Book

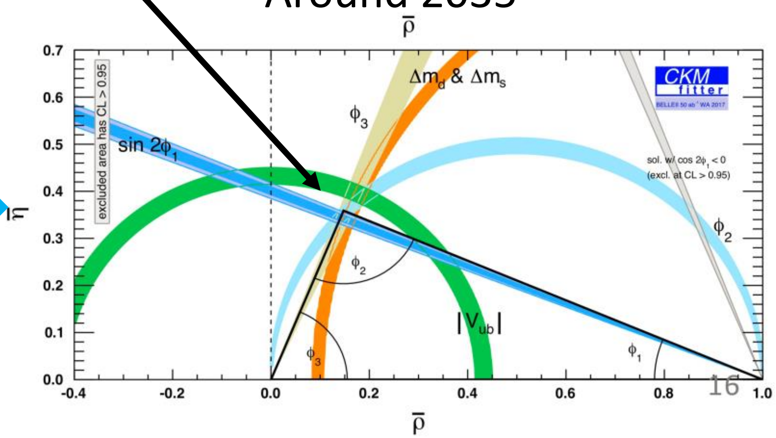
E. Kou[75,*,§,†], P. Urquijo[145,‡,†], W. Altmannshofer[135,§], F. Beaujean[79,§], G. Bell[122,§], M. Beneke[114,§], I. I. Bigi[148,§], F. Bishara[150,16,§], M. Blanke[49,51,§], C. Bobeth[113,114,§], M. Bona[152,§], N. Brambilla[114,§], V. M. Braun[50,§], J. Brod[112,135,§], A. J. Buras[115,§], H. Y. Cheng[43,§], C. W. Chiang[92,§], M. Ciuchini[59,§], G. Colangelo[128,§], A. Crivellin[102,§], H. Czyz[156,29,§], A. Datta[146,§], F. De Fazio[53,§], T. Deppisch[51,§], M. J. Dolan[145,§], J. Evans[135,§], S. Fajfer[109,141,§], T. Feldmann[122,§], S. Godfrey[7,§], M. Gronau[62,§], Y. Grossman[15,§], F. K. Guo[45,134,§], U. Haisch[150,11,§], C. Hanhart[21,§], S. Hashimoto[30,26,§], S. Hirose[89,§], J. Hisano[89,90,§], L. Hofer[127,§], M. Hoferichter[168,§], W. S. Hou[92,§], T. Huber[122,§], T. Hurth

See deviation?

Current status



Around 2035



Summary

- Belle II at SuperKEKB has rich physics program
- With a data corresponding to a half of Belle data, world leading and unique physics results are presented

- SuperKEKB operation will resume in Jan 2024
- Belle II will collect more data than Belle in Run2

- Stay tuned

backup

Comparison of B→Kνν

Combined
HTA
ITA