复旦大學

FUDAN UNIVERSITY

Recent results from the Belle II experiment

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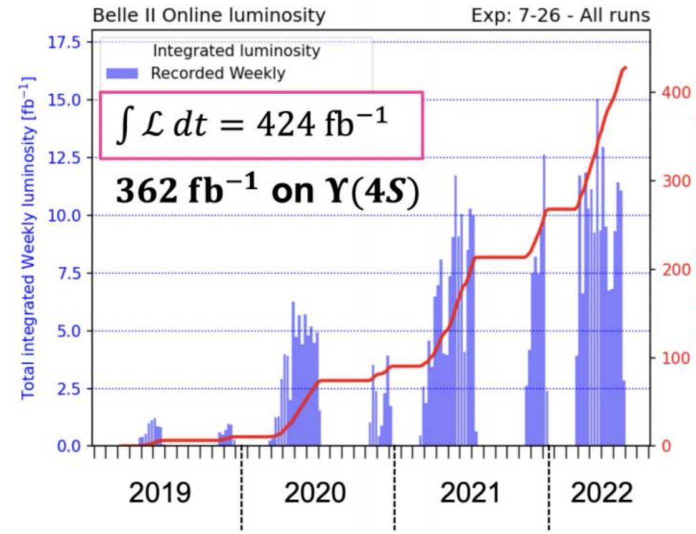
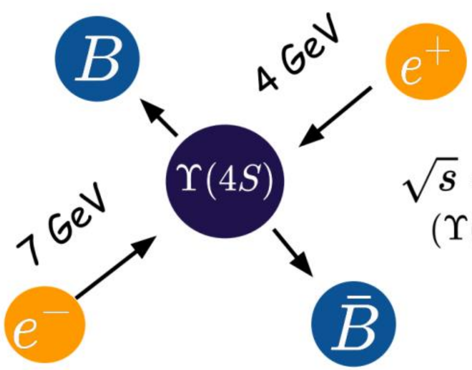
The 29th International Workshop on Weak Interactions and Neutrinos, Zhuhai, China, 2 Jul 2023 - 8 Jul 2023

Belle II experiment

> 1100 active members
124 institutes
27 countries

KEK
Tsukuba, Japan





$\sqrt{s} = 10.58\,\mathrm{GeV}$
($\Upsilon(4S)$ resonance)

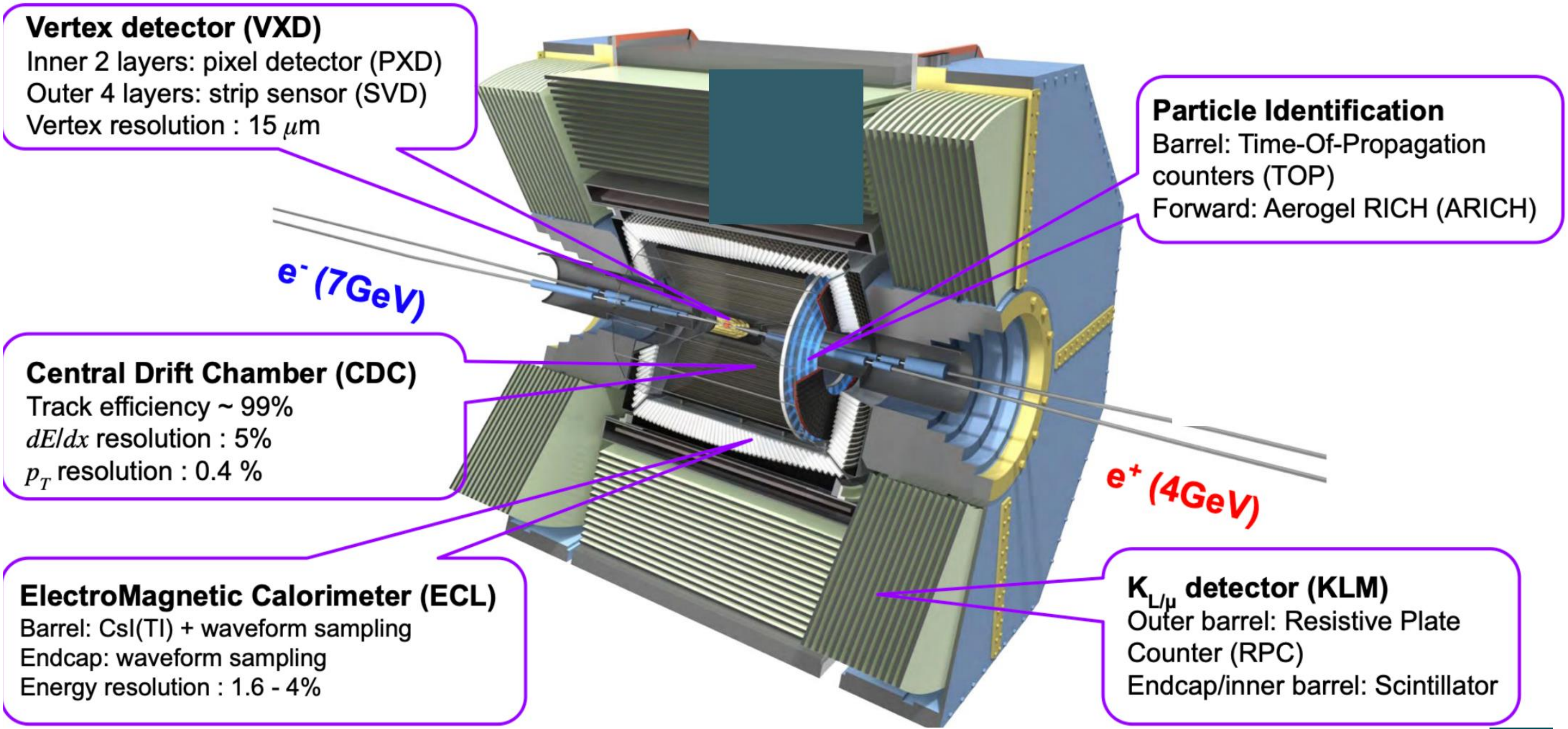
- Max instantaneous luminosity
  $\mathcal{L}$=4.7×10^{34} cm^{-2}s^{-1} (world record)
- LS1 starts from summer 2022 to fully install the PXD detector
- Operation will be resumed around the end of 2023.

- 362/fb at Y(4S)*
- 42/fb off-resonance, 60 MeV below Y(4S)
- 19/fb energy scan between 10.6 to 10.8 GeV for exotic hadron studies

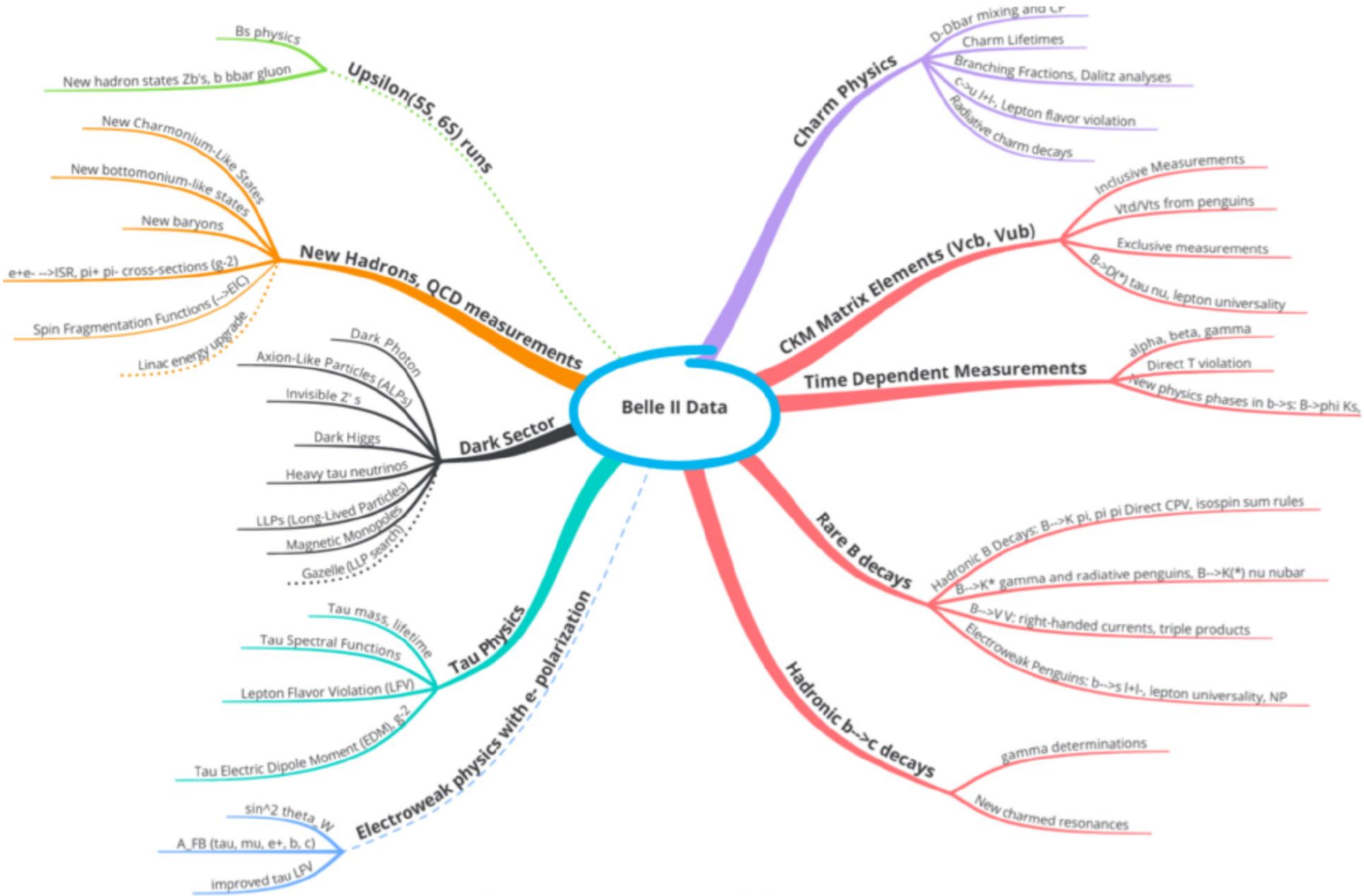
The instrument

It looks like the “old” Belle, but it is effectively a brand new detector

Only structure, magnet and calorimeter crystals are re-used



A diversified physics program



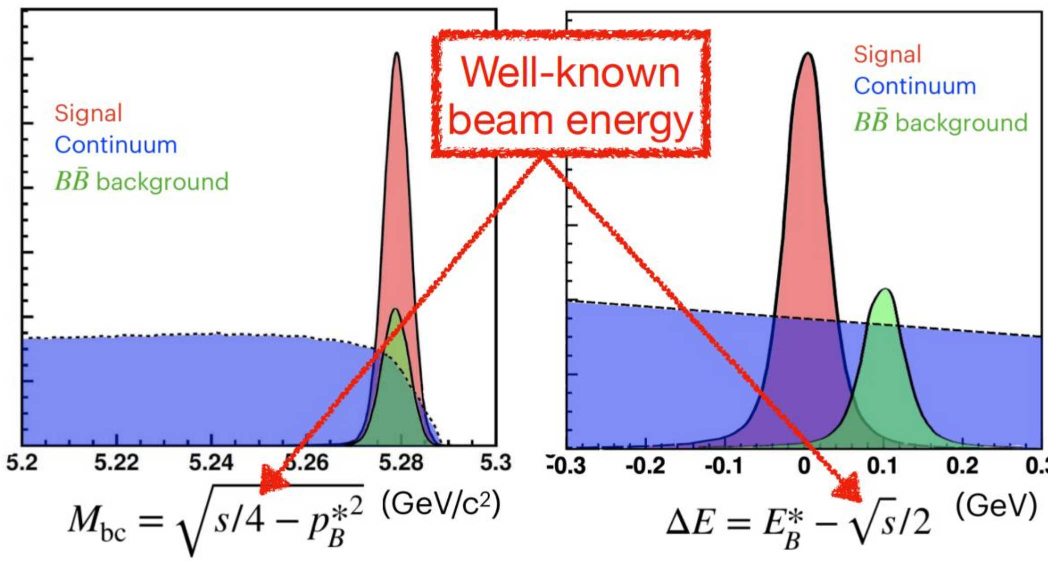
[Snowmass white paper]

PTEP 2019 123C01

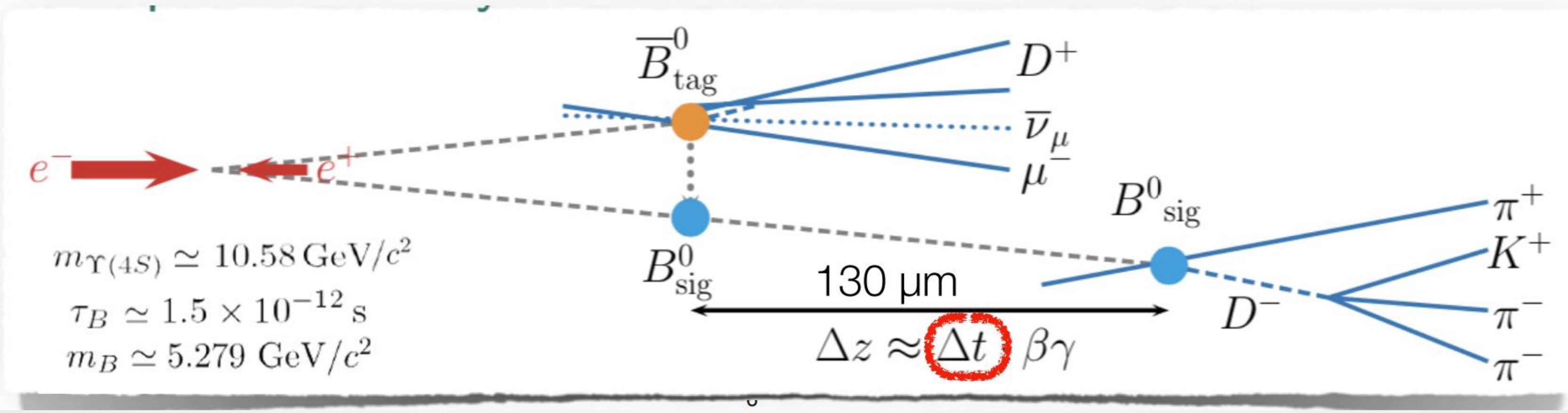
(Some) *B*-factory basics

Low-background production of 30 (now)—600 (design) $B\bar{B}$ per second.

Threshold *B* production from point-like colliding particles, $e^+e^- \rightarrow Y(4S) \rightarrow B\bar{B}$. Kinematic well constrained.

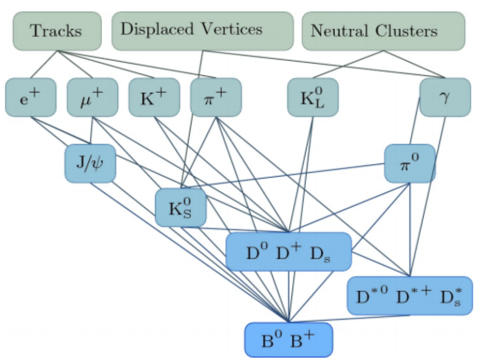


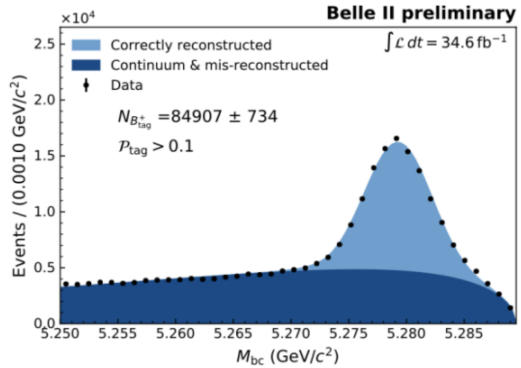
The asymmetric collision gives the boost to measure the displacement.

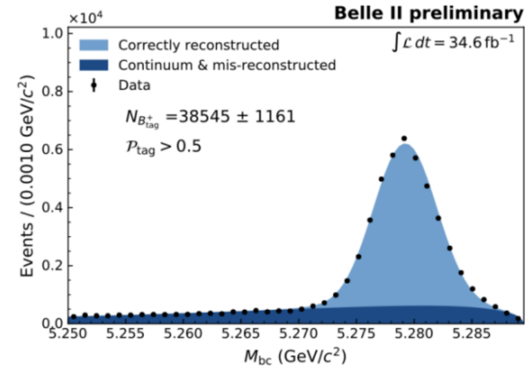


Full Event Interpretation

- Full Event Interpretation algorithm [Comput Softw Big Sci 3, 6 (2019)] to reconstruct B_{tag}
  - Reconstruct B candidate with all combination of daughters
  - Calculate signal probability with multivariate classifiers





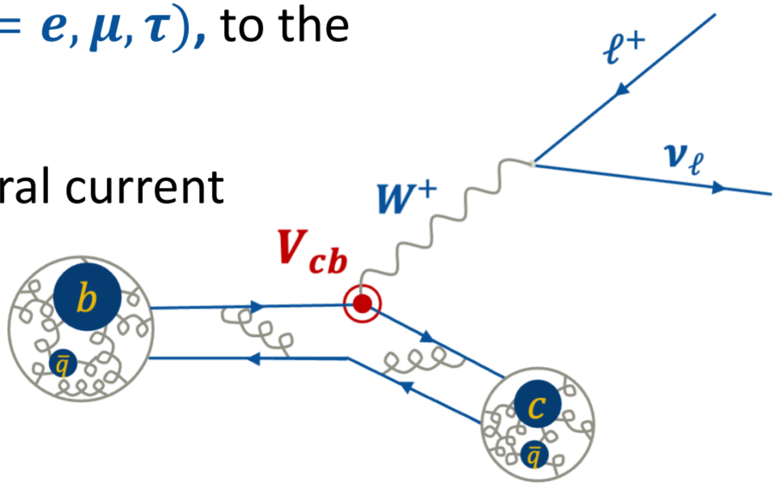


$$M_{bc} = \sqrt{E_{beam}^2/4 - (p_{B_{\mathrm{tag}}}^{\mathrm{cm}})^2} > 5.27\ \mathrm{GeV}/c^2$$

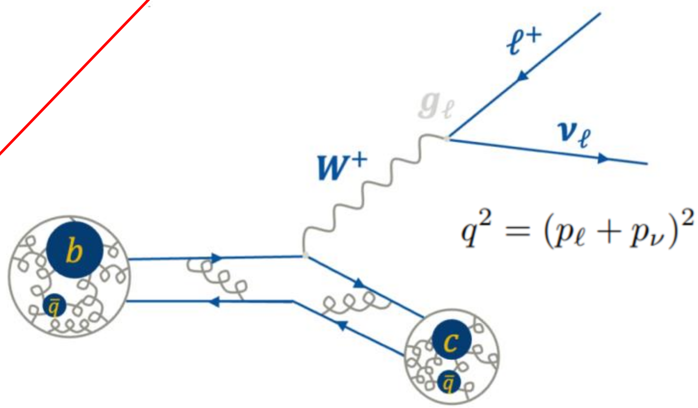
- Hadronic FEI
  - Over 200 BDTs to reconstruct $\mathcal{O}(10000)$ distinct decay chains
  - $\epsilon_{B^+} \approx 0.5\%$, $\epsilon_{B^0} \approx 0.3\%$ at $\sim 15\%$ purity
    - $\sim 50\%$ increase over Belle tag

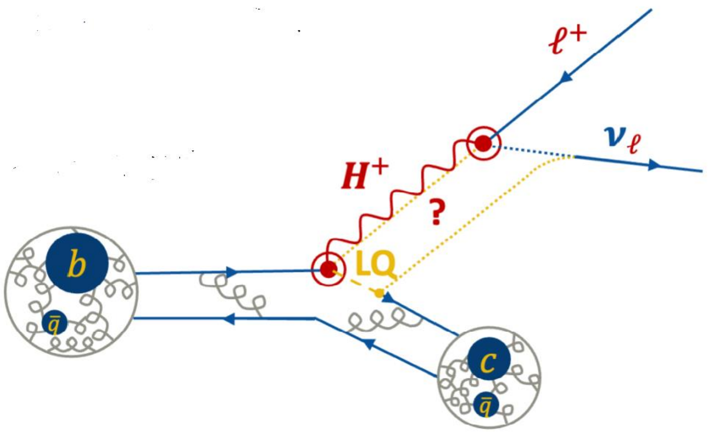
SEMILEPTONIC B-MESON DECAYS

- The **universality of the lepton coupling, g_ℓ ($\ell = e, \mu, \tau$),** to the electroweak gauge bosons **can be probed**
  - Lepton universality (LU) is challenged by several current measurements. Deviations would be a clear sign of BSM physics



- SL B decays are studied to **determine the CKM elements $|V_{cb}|$ and $|V_{ub}|$**
  - $|V_{xb}|$ are limiting the global constraining power of UT fits
  - Important inputs in predictions of the SM rates for ultrarare decays such as $B_s \to \mu\nu$ and $K \to \pi\nu\nu$

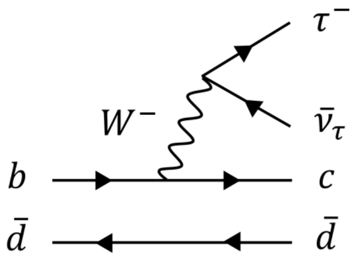


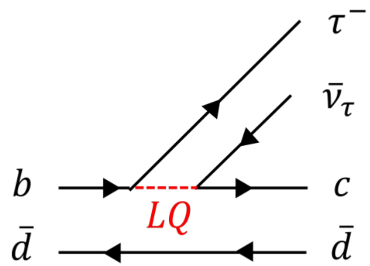


Anomalies in $b \rightarrow c$ decays

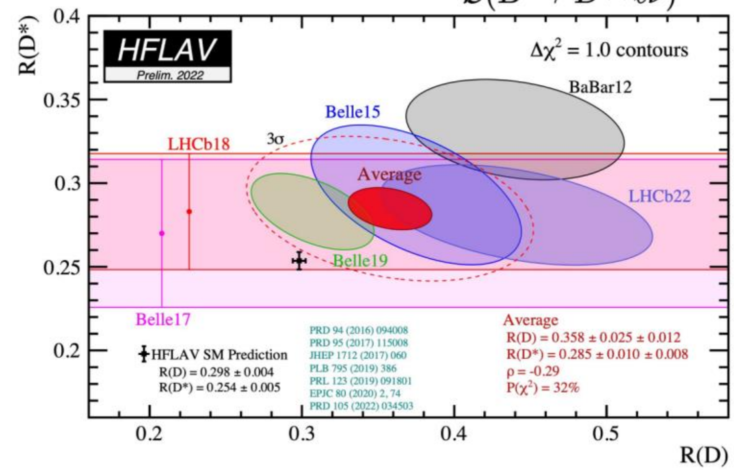
Standard Model assumes **lepton flavor universality** (LFU): $g_e = g_\mu = g_\tau$

- Observed ~3σ tension in $R(D^{(*)})$ could hint possible new physics scenarios



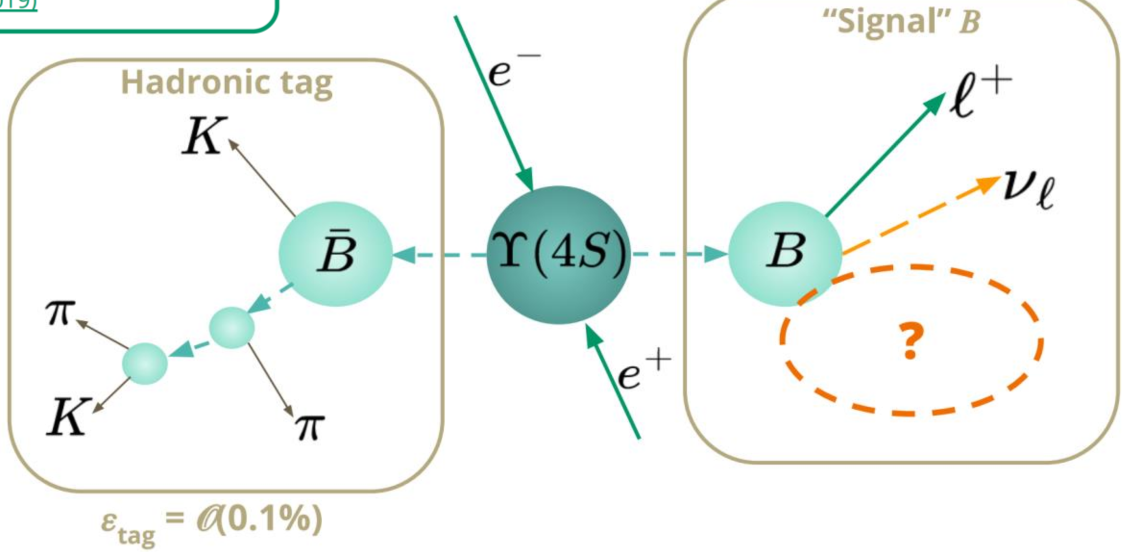


$$\mathcal{R}(D^{(*)}) = \frac{\mathcal{B}(B \to D^{(*)}\tau\nu)}{\mathcal{B}(B \to D^{(*)}\ell\nu)}$$



BDT-based algorithm: **Full Event Interpretation**
[Comput Softw Big Sci 3, 6 (2019)]

$$p_{B_{\text{sig}}} = p_{\text{CM}} - p_{B_{\text{tag}}}$$



B-mesons are produced in pairs with opposite flavors

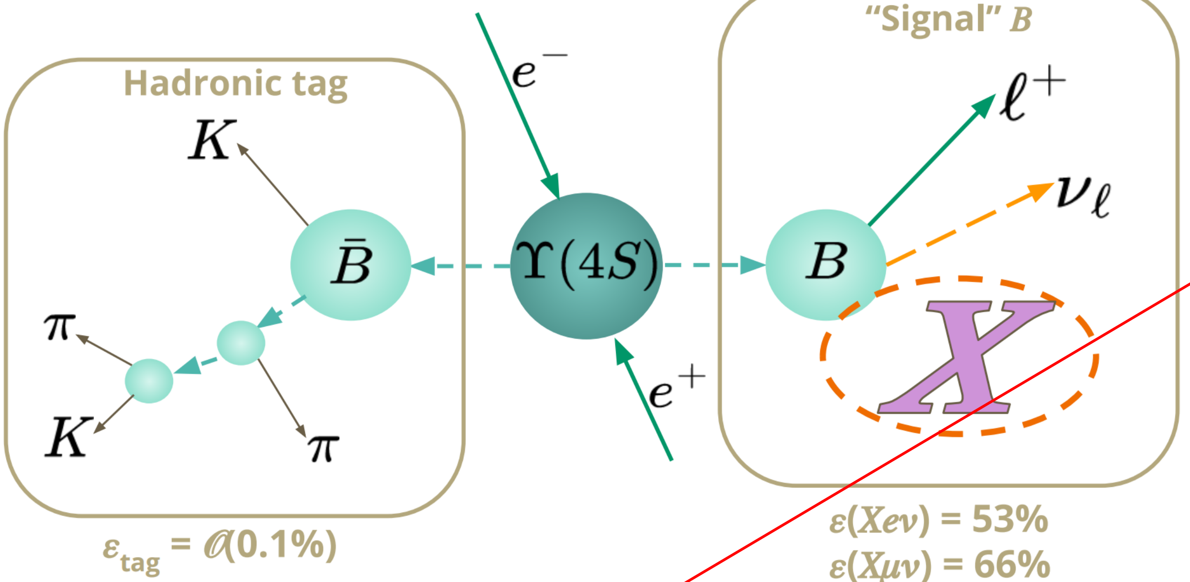
- Tag a B-meson (B_{tag}) in fully hadronic decays
  - $\mathcal{O}(0.1\%)$ efficiency of correctly reconstructed B_{tag}
- The other B-meson has well-defined energy and momentum

$R(X_{e/\mu})$

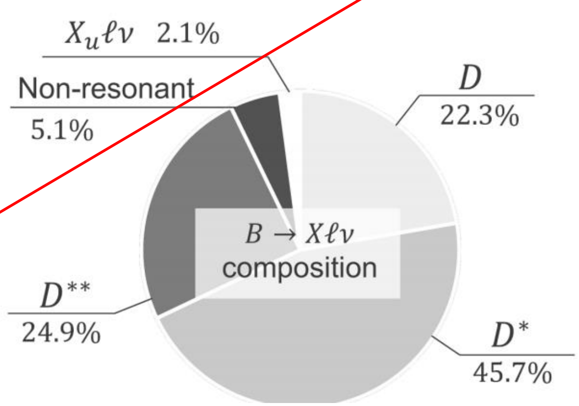
$$R(X_{e/\mu}) = \frac{\mathrm{Br}(B \to X e \nu)}{\mathrm{Br}(B \to X \mu \nu)}$$

arXiv:2301.08266
(submitted to PRL)

$$p_{B_{\rm sig}} = p_{\rm CM} - p_{B_{\rm tag}}$$



- Tag a B-meson (B_{tag}) in **fully hadronic** decays
- Lepton momentum in B_{sig} rest-frame: p_ℓ^B **> 1.3 GeV/c**
  - reduce fakes and secondaries
  - suppress $B \to X\tau\nu$
  - if more leptons, keep the one with highest lepton-ID probability
- Rest of the event assigned to fully–inclusive X



Signal modelling

$R(X_{e/\mu})$

Extract signal yields N^{meas} by fit in 10 bins of p_ℓ^B (simultaneously for e and μ-channel)

- Maximize binned likelihood, systematics included as nuisance parameters
- 3 model templates (for e, μ separately):
  - $X\ell\nu$ signal
  - continuum background
  - **other backgrounds** (fakes and secondaries)

Most precise BF based lepton universality test in semileptonic decays to date

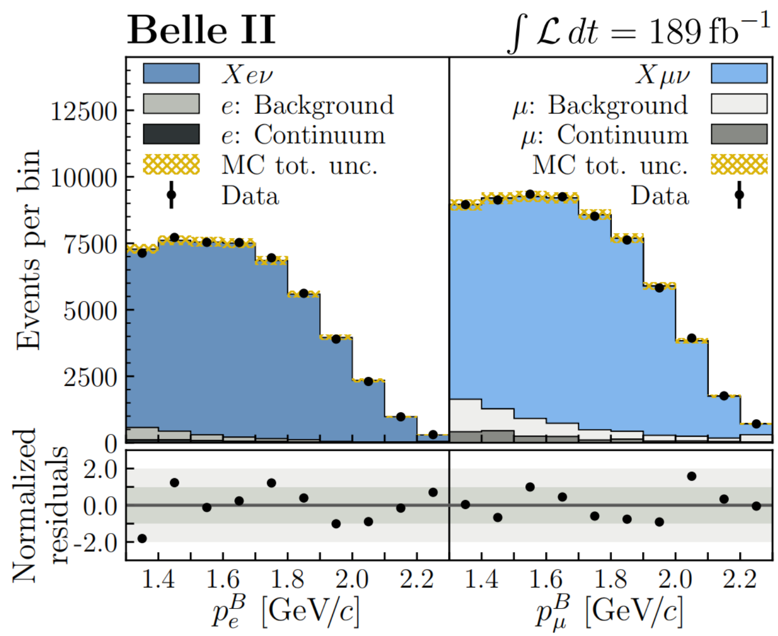
Obtain N^{meas} by fit on signal-region data and evaluate $R(X)$, reweighting for signal efficiency:

$$R(X_{e/\mu}) = \frac{N_e^{\text{meas}}}{N_\mu^{\text{meas}}} \cdot \frac{\varepsilon_\mu}{\varepsilon_e}$$

Signal **efficiency** ε for each channel is:

$$\varepsilon_\ell = \frac{N_\ell^{\text{sel}}}{N_\ell^{\text{gen}}} \qquad \begin{aligned} \varepsilon_e &= (1.62 \pm 0.03) \times 10^{-3} \\ \varepsilon_\mu &= (2.04 \pm 0.05) \times 10^{-3} \end{aligned}$$

- N^{sel} → signal yield extracted by fit on MC
- N^{gen} → total generated signal events

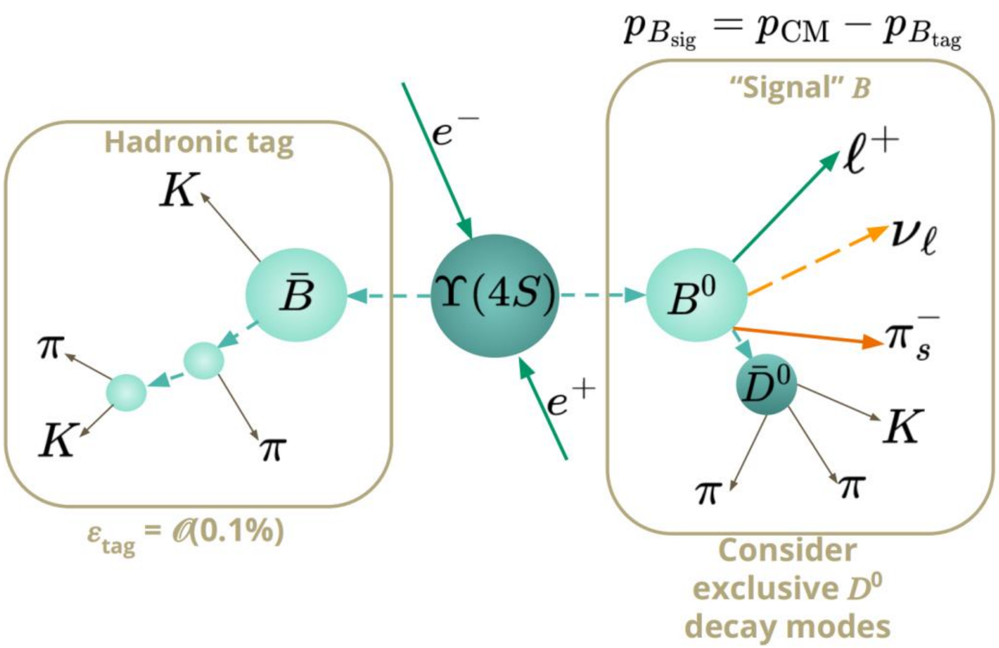


$$R(X_{e/\mu}) = 1.033 \pm 0.010(\text{stat}) \pm 0.019(\text{syst})$$

$R(X_{e/\mu})_{\text{SM}} = 1.006 \pm 0.001$

JHEP11(2022)007

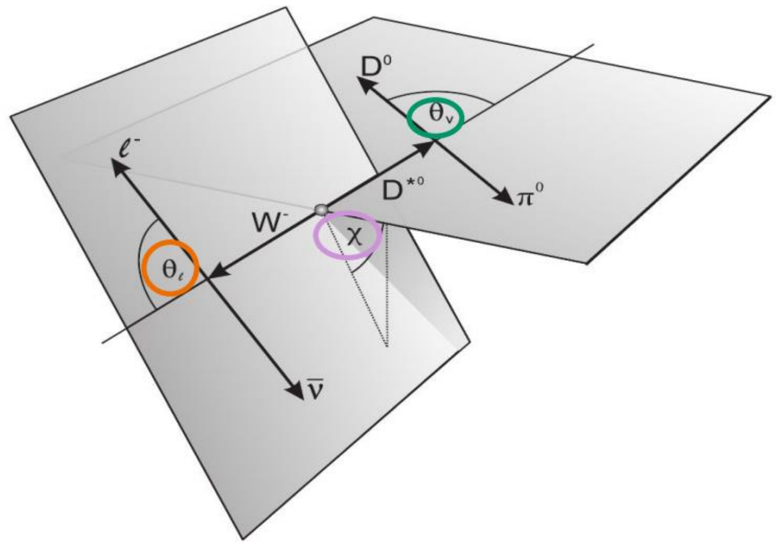
$B^0 \rightarrow D^* \ell \nu$ angular asymmetries



- Fully reconstruct a B-meson ($B_{\rm tag}$) in **hadronic decay**
- Reconstruct signal-side $D^*\ell\nu$ **exclusively**
  - select one lepton with $p_\ell >$ 1.0 GeV/c
  - look for clean and abundant D^0 decay modes
  - combine with a charged slow pion: $D^* \rightarrow D^0\pi_s$

Study semileptonic B decays to D* vector

- **4 parameters** to fully describe $B \rightarrow D^*\ell\nu$ decay:
  - $q^2 = (p_B - p_{D^*})^2$
  - Three angle $\theta_\ell, \theta_V, \chi$

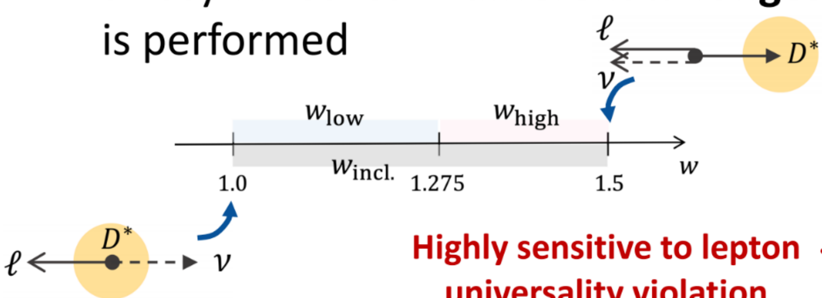


We measure **angular distributions asymmetries** as function of q^2
World's first experimental measurement of complete set of angular asymmetries

$B^0 \rightarrow D^* \ell \nu$ angular asymmetries

Define a set of 5 asymmetries for angular observables x

- Light lepton universality tested by comparing **five angular asymmetries** of e and μ, $\Delta\mathcal{A}_x = \mathcal{A}_x^e - \mathcal{A}_x^\mu$ using $B^0 \rightarrow D^{*-}\ell^+\nu$ decays.
- The simultaneous determination of all asymmetries in **different w ranges** is performed



w : Recoil parameter $w = \frac{m_B^2 + m_{D^*}^2 - q^2c^2}{2m_B m_{D^*}}$

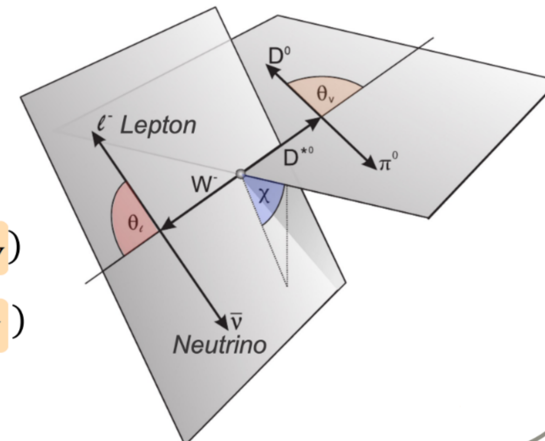
$$\mathcal{A}_x(w) = \left(\frac{d\Gamma}{dw}\right)^{-1}\left[\int_0^1 - \int_{-1}^0\right] dx \frac{d^2\Gamma}{dwdx}$$

Highly sensitive to lepton universality violation

- $A_{FB}(w)$: $dx = d(\cos\theta_\ell)$
- $S_3(w)$: $dx = d(\cos 2\chi)$
- $S_5(w)$: $dx = d(\cos\chi\cos\theta_V)$

Less sensitive or insensitive to NP. Control tests of the analysis method

- $S_7(w)$: $dx = d(\sin\chi\cos\theta_V)$
- $S_9(w)$: $dx = d(\sin 2\chi)$



$S_7(w)$ 0 in SM and NP

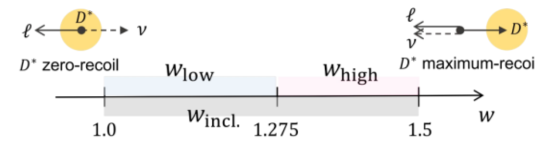
$S_9(w)$ 0 in SM and ~0 in NP

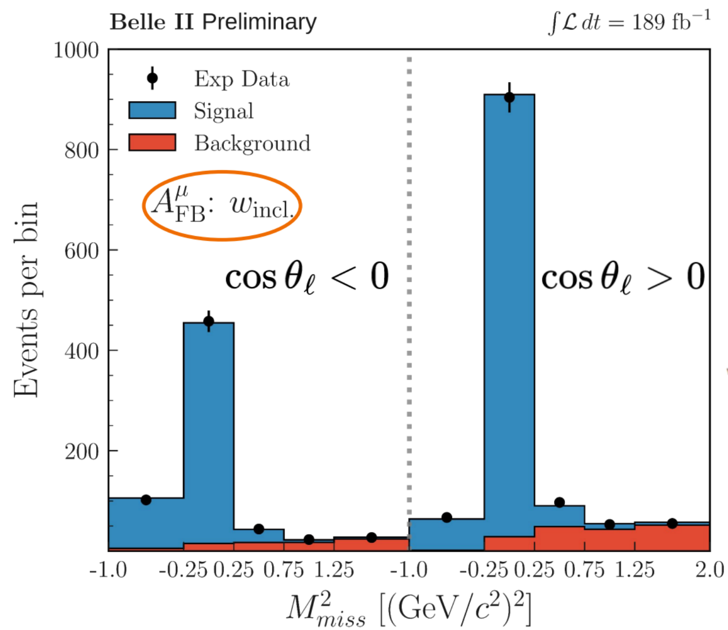
- Asymmetries $\mathcal{A}$ are **experimentally clean** (most systematics cancel)
- $\Delta\mathcal{A}$ difference is **theoretically well-known** (form factors uncertainty cancel)

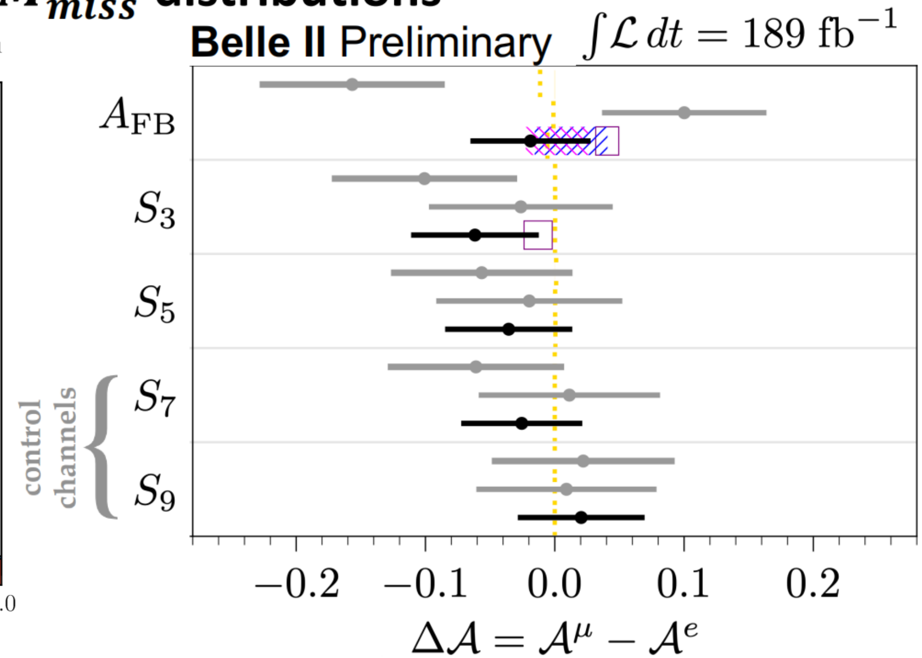
~4σ deviation in ΔA_{FB} was claimed by theoretical reinterpretation of Belle data [Eur. Phys. J. C 81, 984 (2021), Phys. Rev. D 103, 079901 (2021)]

$B^0 \to D^* \ell \nu$ angular asymmetries

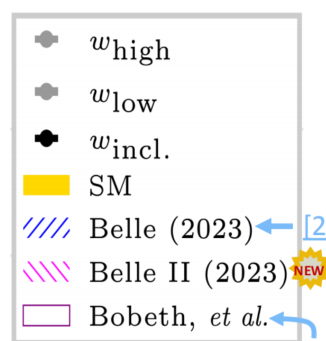
- The signal yields are extracted through a binned maximum-likelihood fit to M^2_{miss} **distributions**







Uncertainties **statistically** dominated



[2301.07529]

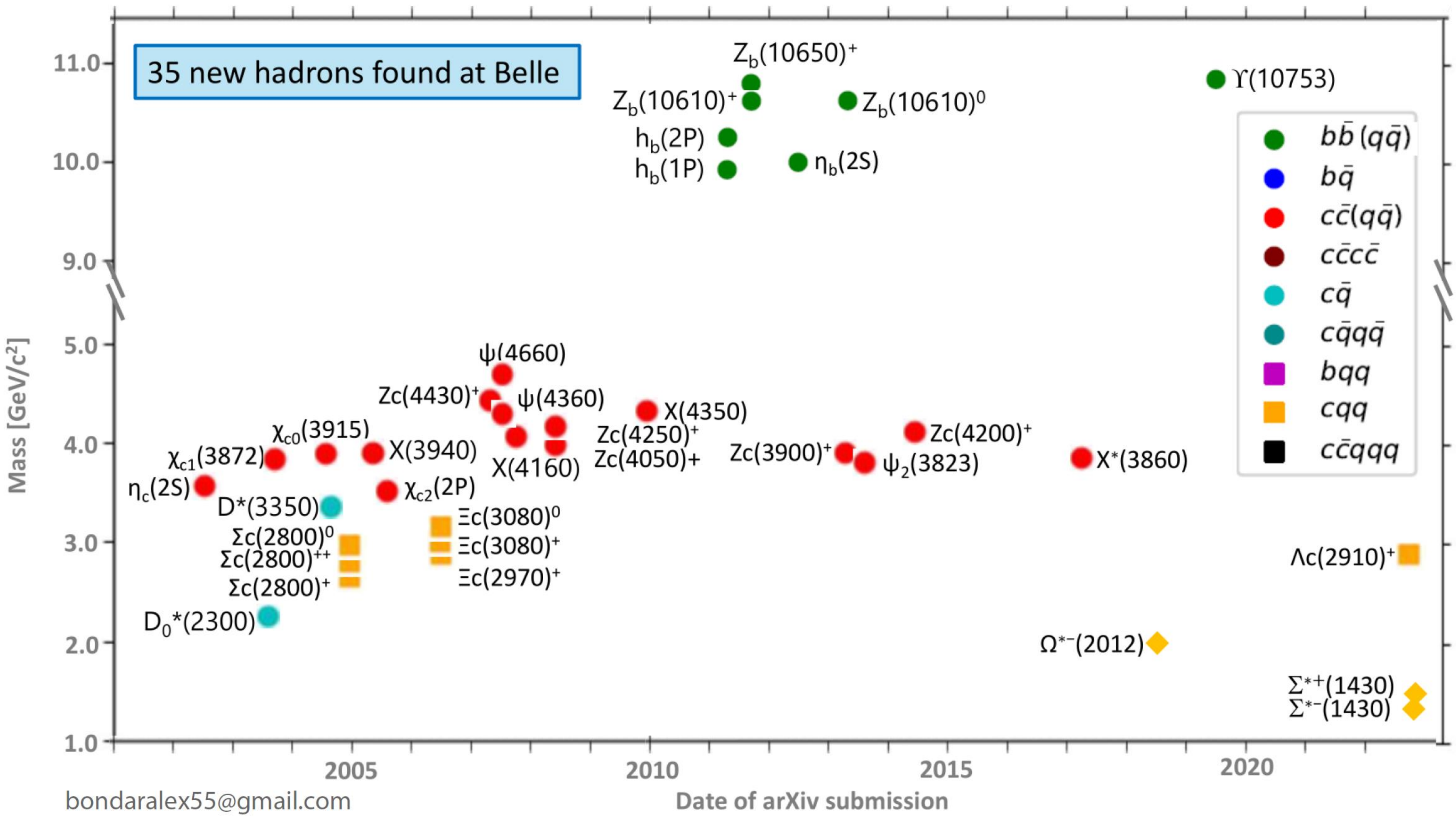
arXiv:2301.04716

EPJC **81**, 984 (2021)

Observed overall **agreement** with **Standard Model**

χ^2/ndof	$w_{incl.}$	$w_{low} + w_{high}$
ΔA_{FB} , ΔS_3 , ΔS_5	2.1 / 3 (p=0.56)	10.2 / 6 (p=0.12)
ΔS_7 , ΔS_9	0.6 / 2 (p=0.32)	1.1 / 4 (p=0.89)

35 new hadrons at Belle



The most famous X(3872)

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Observation of a Narrow Charmoniumlike State in Exclusive $B^\pm \to K^\pm \pi^+ \pi^- J/\psi$ Decays

S.-K. Choi *et al.* (Belle Collaboration)

Phys. Rev. Lett. **91**, 262001 – Published 23 December 2003

Article | References | Citing Articles (1,284) | PDF | HTML | Export

ABSTRACT

We report the observation of a narrow charmoniumlike state produced in the exclusive decay process $B^\pm \to K^\pm \pi^+ \pi^- J/\psi$. This state, which decays into $\pi^+ \pi^- J/\psi$, has a mass of $3872.0 \pm 0.6(\mathrm{stat}) \pm 0.5(\mathrm{syst})$ MeV, a value that is very near the $M_{D^0} + M_{D^{*0}}$ mass threshold. The results are based on an analysis of 152M B-$\overline{B}$ events collected at the $\Upsilon(4S)$ resonance in the Belle detector at the KEKB collider. The signal has a statistical significance that is in excess of 10σ.

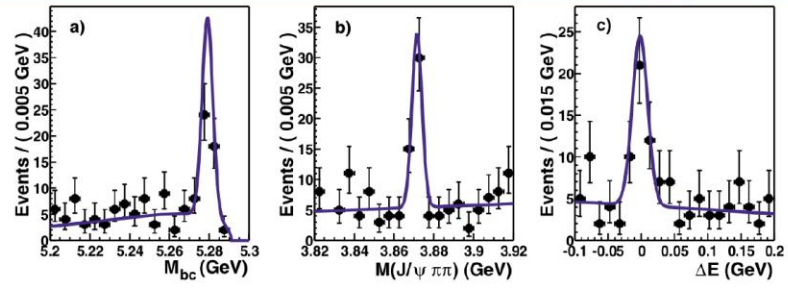


FIG. 2 (color online). Signal-band projections of (a) M_{bc}, (b) $M_{\pi^+\pi^- J/\psi}$, and (c) ΔE for the $X(3872) \to \pi^+ \pi^- J/\psi$ signal region with the results of the unbinned fit superimposed.

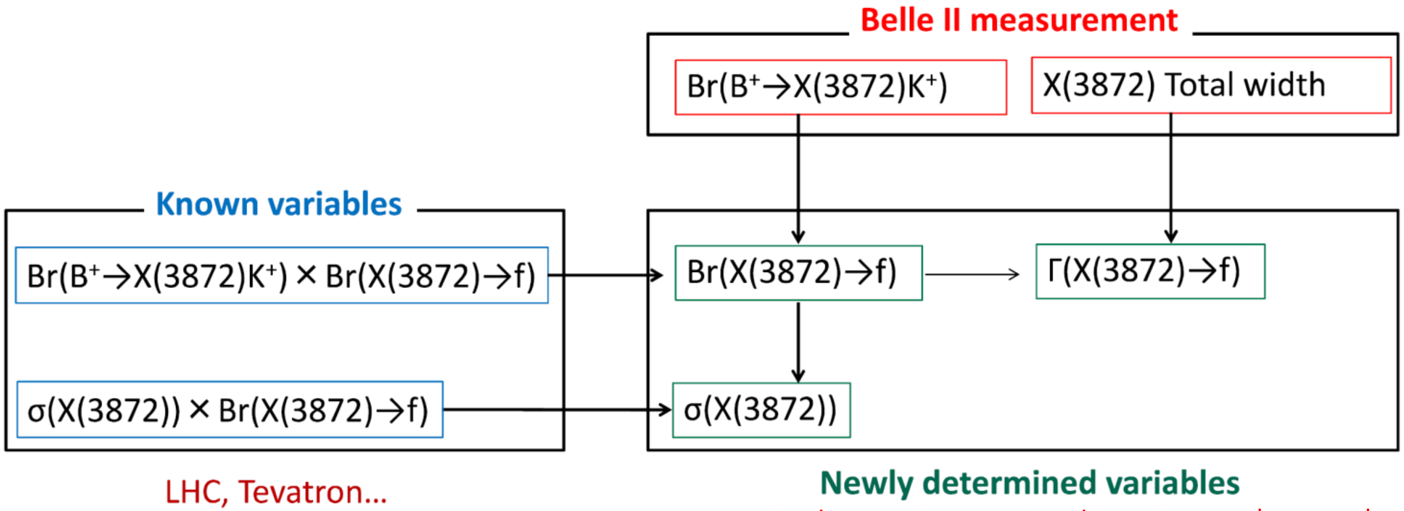
Observation of a Narrow Charmoniumlike State in Exclusive $B^\pm \to K^\pm \pi^+ \pi^- J/\psi$ Decays

S.-K. Choi,[5] S. L. Olsen,[6] K. Abe,[7] T. Abe,[7] I. Adachi,[7] Byoung Sup Ahn,[14] H. Aihara,[43] K. Akai,[7] M. Akatsu,[20] M. Akemoto,[7] Y. Asano,[48] T. Aso,[47] V. Aulchenko,[1] T. Aushev,[11] A. M. Bakich,[38] Y. Ban,[31] S. Banerjee,[39] A. Bondar,[1] A. Bozek,[25] M. Bračko,[18,12] J. Brodzicka,[25] T. E. Browder,[6] P. Chang,[24] Y. Chao,[24] K.-F. Chen,[24] B. G. Cheon,[37] R. Chistov,[11] Y. Choi,[37] Y. K. Choi,[37] M. Danilov,[11] L. Y. Dong,[9] A. Drutskoy,[11] S. Eidelman,[1] V. Eiges,[11] J. Flanagan,[7] C. Fukunaga,[45] K. Furukawa,[7] N. Gabyshev,[7] T. Gershon,[7] B. Golob,[17,12] H. Guler,[6] R. Guo,[22] C. Hagner,[50] F. Handa,[42] T. Hara,[29] N. C. Hastings,[7] H. Hayashii,[21] M. Hazumi,[7] L. Hinz,[16] Y. Hoshi,[41] W.-S. Hou,[24] Y. B. Hsiung,[24,*] H.-C. Huang,[24] T. Iijima,[20] K. Inami,[20] A. Ishikawa,[20] R. Itoh,[7] M. Iwasaki,[43] Y. Iwasaki,[7] J. H. Kang,[52] S. U. Kataoka,[21] N. Katayama,[7] H. Kawai,[2] T. Kawasaki,[27] H. Kichimi,[7] E. Kikutani,[7] H. J. Kim,[52] Hyunwoo Kim,[14] J. H. Kim,[37] S. K. Kim,[36] K. Kinoshita,[3] H. Koiso,[7] P. Koppenburg,[7] S. Korpar,[18,12] P. Križan,[17,12] P. Krokovny,[1] S. Kumar,[30] A. Kuzmin,[1] J. S. Lange,[4,33] G. Leder,[10] S. H. Lee,[36] T. Lesiak,[25] S.-W. Lin,[24] D. Liventsev,[11] J. MacNaughton,[10] G. Majumder,[39] F. Mandl,[10] D. Marlow,[32] T. Matsumoto,[45] S. Michizono,[7] T. Mimashi,[7] W. Mitaroff,[10] K. Miyabayashi,[21] H. Miyake,[29] D. Mohapatra,[50] G. R. Moloney,[19] T. Nagamine,[42] Y. Nagasaka,[8] T. Nakadaira,[43] T. T. Nakamura,[7] M. Nakao,[7] Z. Natkaniec,[25] S. Nishida,[7] O. Nitoh,[46] T. Nozaki,[7] S. Ogawa,[40] Y. Ogawa,[7] K. Ohmi,[7] Y. Ohnishi,[7] T. Ohshima,[20] N. Ohuchi,[7] K. Oide,[7] T. Okabe,[20] S. Okuno,[13] W. Ostrowicz,[25] H. Ozaki,[7] H. Palka,[25] H. Park,[15] N. Parslow,[38] L. E. Piilonen,[50] H. Sagawa,[7] S. Saitoh,[7] Y. Sakai,[7] T. R. Sarangi,[49] M. Satapathy,[49] A. Satpathy,[7,3] O. Schneider,[16] A. J. Schwartz,[3] S. Semenov,[11] K. Senyo,[20] R. Seuster,[6] M. E. Sevior,[19] H. Shibuya,[40] T. Shidara,[7] B. Shwartz,[1] V. Sidorov,[1] N. Soni,[30] S. Stanič,[48,†] M. Starič,[12] A. Sugiyama,[34] T. Sumiyoshi,[45] S. Suzuki,[51] F. Takasaki,[7] K. Tamai,[7] N. Tamura,[27] M. Tanaka,[7] M. Tawada,[7] G. N. Taylor,[19] Y. Teramoto,[28] T. Tomura,[43] K. Trabelsi,[6] T. Tsukamoto,[7] S. Uehara,[7] K. Ueno,[24] Y. Unno,[2] S. Uno,[7] G. Varner,[6] K. E. Varvell,[38] C. C. Wang,[24] C. H. Wang,[23] J. G. Wang,[50] Y. Watanabe,[44] E. Won,[14] B. D. Yabsley,[50] Y. Yamada,[7] A. Yamaguchi,[42] Y. Yamashita,[26] H. Yanai,[27] Heyoung Yang,[36] J. Ying,[31] M. Yoshida,[7] C. C. Zhang,[9] Z. P. Zhang,[35] and D. Žontar[17,12]

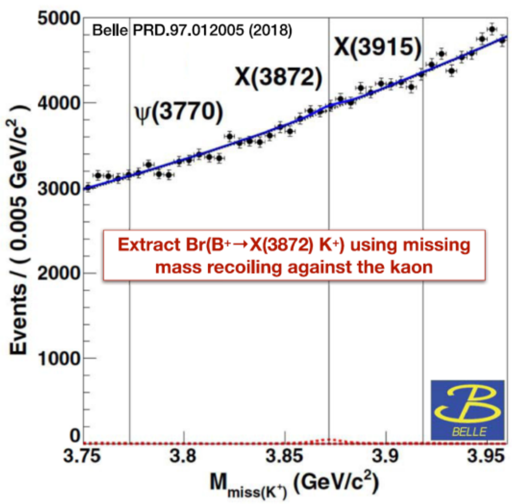
(Belle Collaboration)

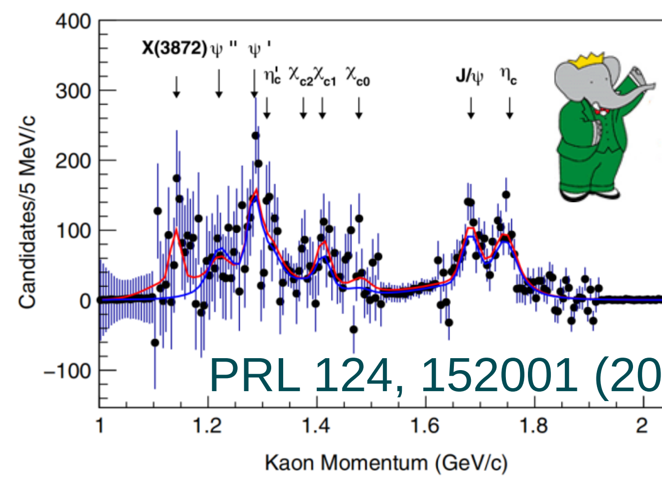
The Nature of X(3872): Prospects with Belle II

- Many decay modes have been observed: $J/\psi\ \rho$, $J/\psi\ \omega$, $J/\psi\ \gamma$, $\psi(2S)\ \gamma$, DD^*, $DD\pi^0$. etc.
- Branching fractions and decay widths not known
  - Essential dynamic information!
- Belle II can contribute to a deeper understanding of this state!



- $B(B^{\pm} \to X(3872)K^{\pm}) = (2.1 \pm 0.6 \pm 0.3) \times 10^{-4}$



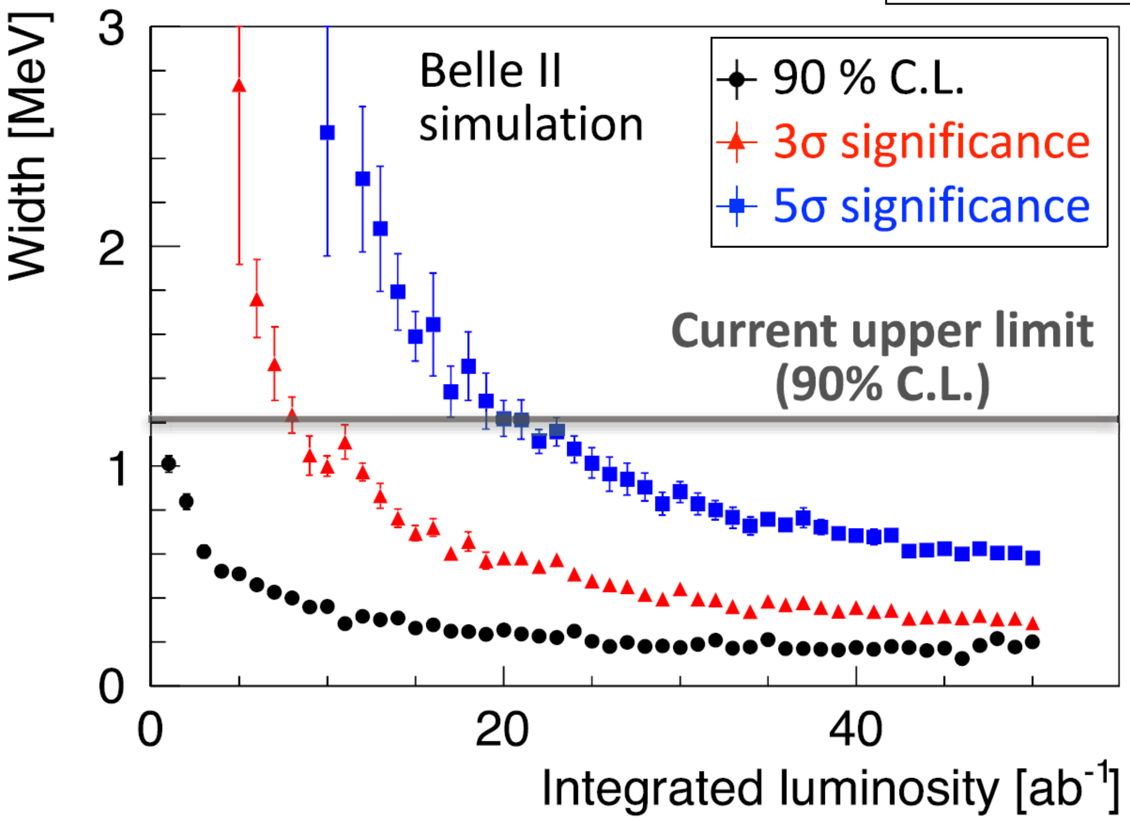


PRL 124, 152001 (2020)

Toward X(3872) Total and Partial Widths Measurements with Belle II

Mass resolution for $D\bar{D}\pi^0$ is ~680 keV: ~3 times better than $J/\psi\pi^+\pi^-$ Previously unmeasured due to low statistics

With the full data sample of Belle II (50 ab^{-1}), total width with values up to
[90% C.L.] ~ 180 keV
[3σ significance] ~ 280 keV
[5σ significant] ~ 570 keV
can be measured.



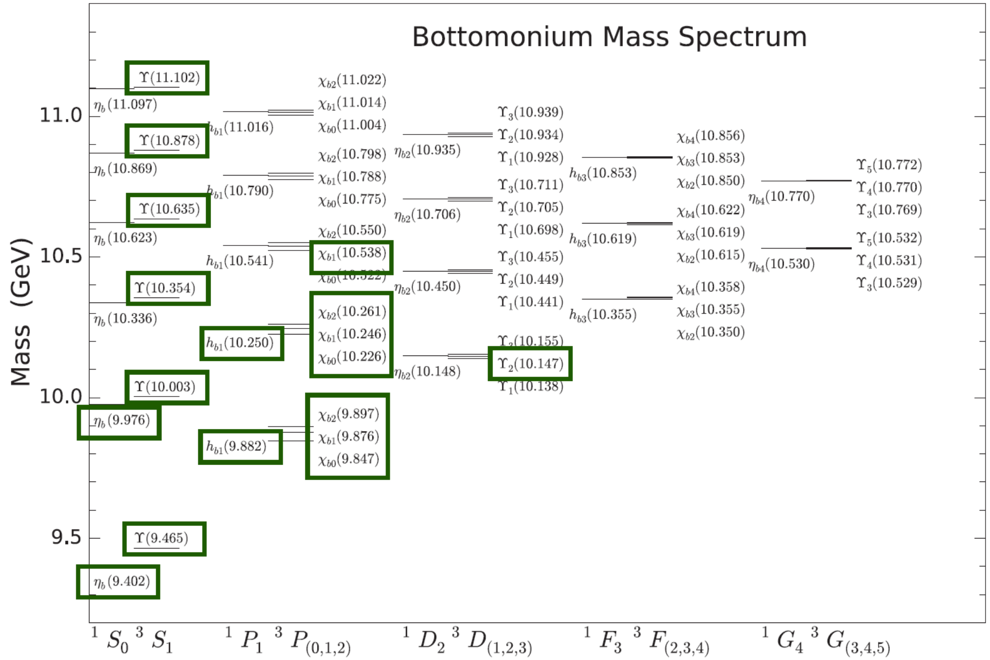
Bottomonium(-like) prospects at Belle II

Run at Υ(6S) and Υ(5S) and high energy scan:

- Search for new missing bottomonia $\eta_b(3S)$, $h_b(3P)$, $\Upsilon(D)$, exotic states Y_b, Z_b, etc
- Improve precision of already known processes and states, e.g., Z_b
- Measure the effect of the coupled channel contribution
- Study $B^{(*)}\overline{B}^{(**)}$ and $B_s^{(*)}B_s^{(**)}$ threshold regions (challenging for Super-KEKB)

Run at Υ(3S) and Υ(2S):

- Search for missing $\pi\pi/\eta$ transitions in inclusive decays to constrain further models
- Search for new physics: LFV, LFU, light Higgs, …



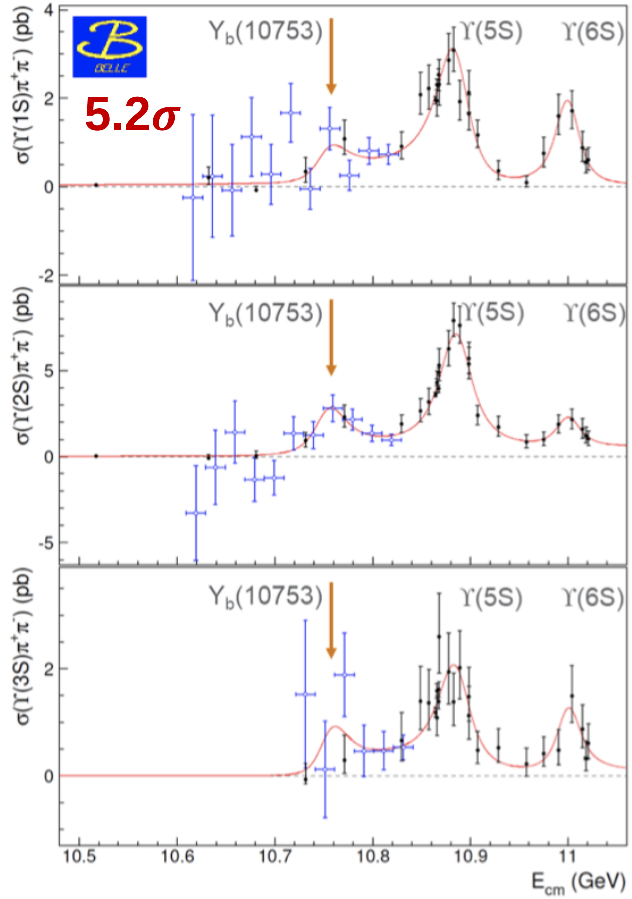
S. Godfrey and K. Moats, Bottomonium mesons and strategies for their observation, Phys. Rev. D 92, 054034 (2015)
S. Godfrey and N. Isgur, Mesons in a relativized quark model with chromodynamics, Phys. Rev. D 32, 189 (1985).

Observation of $e^+e^- \to \omega\chi_{bJ}$ at $\sqrt{s}$ near 10.75 GeV

- Belle: several ~1fb^{-1} scan points below Υ(5S)
- New structure observed in $\pi^+\pi^-\Upsilon(nS)$ transitions

	Υ(10860)	Υ(11020)	New structure
M (MeV/c^2)	$10885.3 \pm 1.5\,^{+2.2}_{-0.9}$	$11000.0^{+4.0}_{-4.5}\,^{+1.0}_{-1.3}$	$10752.7 \pm 5.9\,^{+0.7}_{-1.1}$
Γ (MeV)	$36.6^{+4.5}_{-3.9}\,^{+0.5}_{-1.1}$	$23.8^{+8.0}_{-6.8}\,^{+0.7}_{-1.8}$	$35.5^{+17.6}_{-11.3}\,^{+3.9}_{-3.3}$

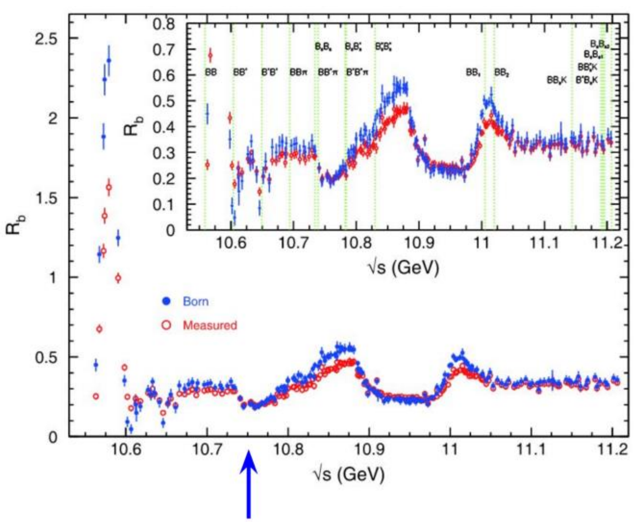
JHEP 10, 220 (2019)



- Theoretical interpretations

Conventional D- or S-D mixed bottomonium:
PRD 105, 074007 (2022), PRD 104, 034036 (2021)
EPJC 80, 59 (2020), PRD 101,397 014020 (2020)
PRD 102, 014036399 (2020), EPJP 137, 357 (2022)
PRD 105, 114041 (2022), PLB 803, 135340 (2020)
arXiv:2204.11915, Prog. Part. Nucl. Phys. 117, 103845 (2021)

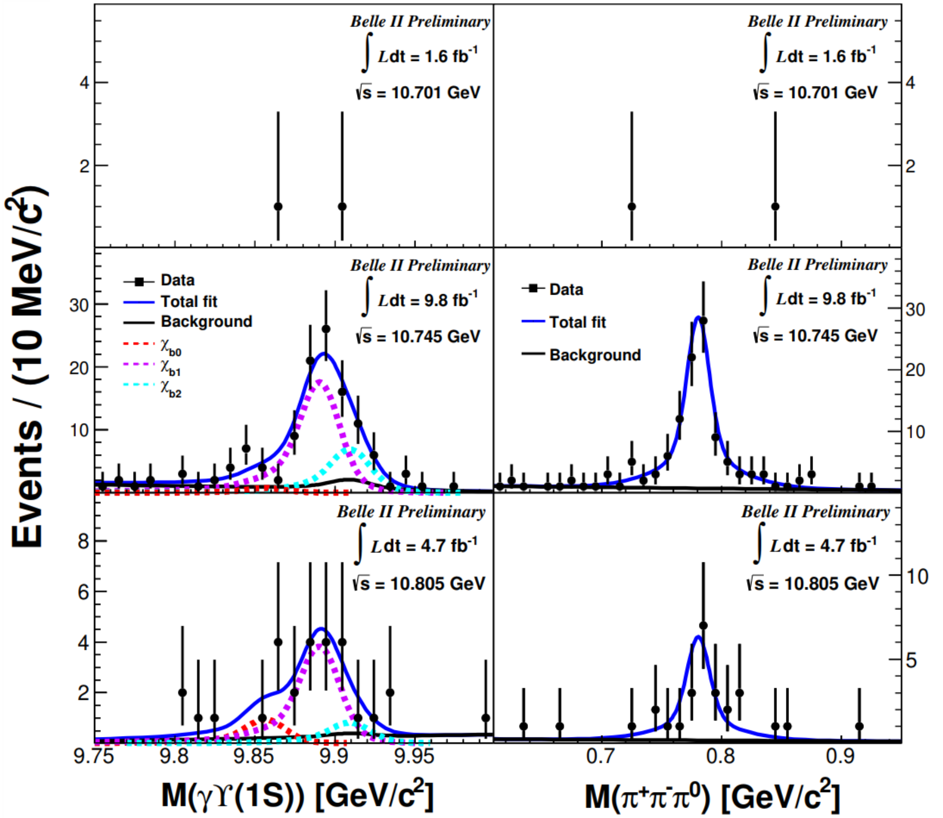
A tetraquark:
PLB 802, 135217 (2020)
PRD 103, 074507 (2021
arXiv:2205.11475
Chin. Phys. C 43, 123102 (2019)

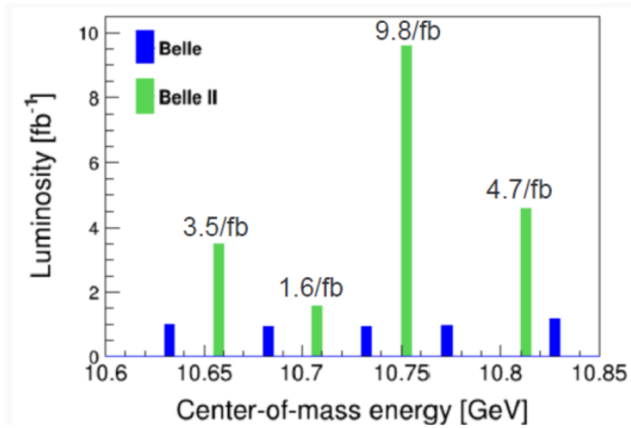


- Interpretations as an admixture of the conventional 4S and 3D states predict comparable branching fractions of 10^{-3} for $\Upsilon(10753) \to \pi^+\pi^-\Upsilon(nS)$ and $\Upsilon(10753) \to \omega\chi_{bJ}$ [PRD 104, 034036 (2021), PRD 105, 074007 (2022)].

Observation of $e^+e^- \to \omega\chi_{bJ}$

PRL 130, 091902 (2023)





Channel	$\sqrt{s}$ (GeV)	N^{sig}	$\sigma^{(UL)}_{Born}$ (pb)
$\omega\chi_{b1}$	10.745	$68.9^{+13.7}_{-13.5}$	$3.6^{+0.7}_{-0.7} \pm 0.5$
$\omega\chi_{b2}$		$27.6^{+11.6}_{-10.0}$	$2.8^{+1.2}_{-1.0} \pm 0.4$
$\omega\chi_{b1}$	10.805	$15.0^{+6.8}_{-6.2}$	1.6 @90% C.L.
$\omega\chi_{b2}$		$3.3^{+5.3}_{-3.8}$	1.5 @90% C.L.

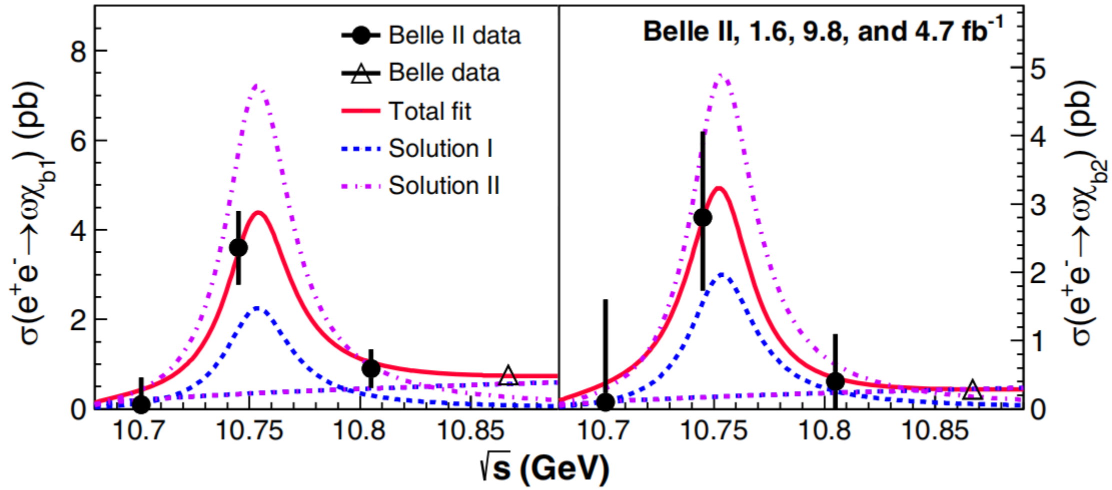
Two dimensional unbinned maximum likelihood fits to the M($\gamma\Upsilon(1S)$) and M($\pi^+\pi^-\pi^0$) distributions.

The total χ_{bJ} signal significances are 11.1σ and 4.5σ at $\sqrt{s}$ = 10.745 and 10.805 GeV.

Note that the $\sigma_{Born}(e^+e^- \to \omega\chi_{b1}/\omega\chi_{b2})$ is only (0.76±0.16)/(0.29±0.14) pb at $\sqrt{s}$ = 10.867 GeV [PRL 113, 142001(2014)].

Observation of $\Upsilon(10753) \to \omega\chi_{bJ}$

PRL 130, 091902 (2023)



The $e^+e^- \to \omega\chi_{bJ}$ (J = 1, 2) cross sections peak at $\Upsilon(10753)$.

Fit cross section with function:

$$\sigma_{e^+e^-\to\omega\chi_{b1}}(\sqrt{s}) = \left|\sqrt{PS_2(\sqrt{s})} + BW(\sqrt{s})e^{i\phi}\right|^2, \quad BW(\sqrt{s}) = \frac{\sqrt{12\pi\Gamma_{ee}\mathcal{B}_f\Gamma}}{s - M^2 + iM\Gamma}\sqrt{\frac{PS_2(\sqrt{s})}{PS_2(M)}}$$

M and Γ of $\Upsilon(10753)$ are fixed according to Ref. [JHEP 10, 220(2019)].

$\Gamma_{ee}\mathcal{B}_f$	**Solution I** (constructive interference)	**Solution II** (destructive interference)
$\Gamma_{ee}\mathcal{B}(\Upsilon(10753) \to \omega\chi_{b1})$	(0.63±0.39±0.20) eV	(2.01±0.38±0.76) eV
$\Gamma_{ee}\mathcal{B}(\Upsilon(10753) \to \omega\chi_{b2})$	(0.53±0.46±0.15) eV	(1.32±0.44±0.55) eV

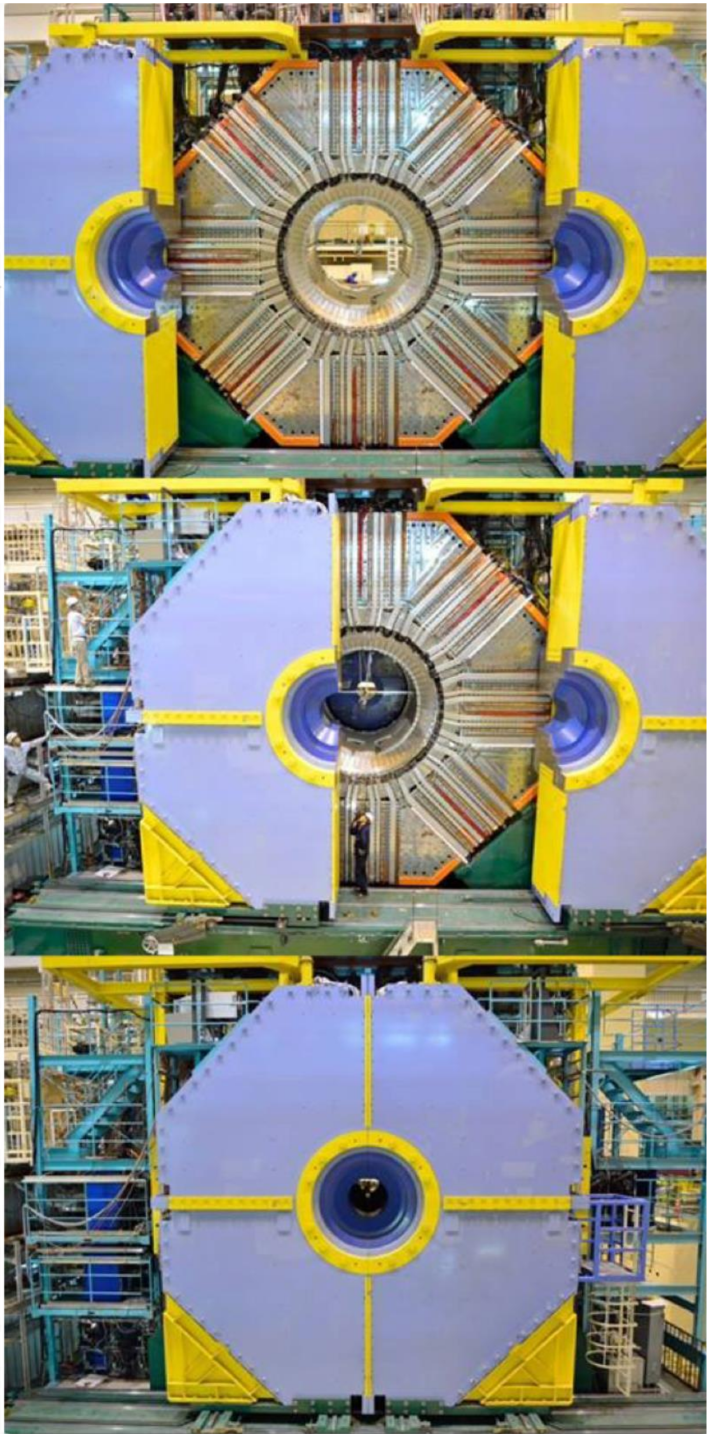
1. $\sigma(e^+e^- \to \omega\chi_{b1})/\sigma(e^+e^- \to \omega\chi_{b2})$=1.3±0.6 at 10.745 GeV, contradicts the expectation for a pure D-wave bottomonium state of 15 [PLB 738, 172 (2014)]
2. There is also a 1.8σ difference with the prediction for a S-D-mixed state of 0.2 [PRD 104, 034036 (2021)]

There's more to it

Journal-paper results approved in past 12 months

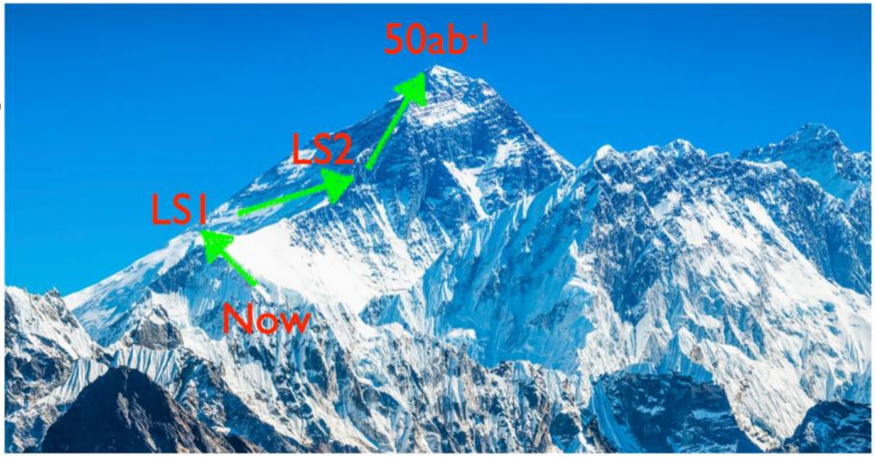
Energy-dependence of *B(*)B(*)*bar cross section — unique
Observation of *ee* → $\omega\chi_b$ at 10.75 GeV — unique, PRL. **130**, 091902 (2023)
Test of light-lepton universality in $B \to D^*\ell\nu$ decays — unique
Test of light lepton universality in inclusive $B \to [Xc]\ell\nu$ decays — unique, arXiv: 2301.08266
Measurement of CKM angle γ using GLW — Belle + Belle II sample
Measurement of CKM angle γ using GLS — Belle + Belle II sample
Search for long-lived spin-0 mediator in b → s transitions— world leading
Measurement of of the τ mass — world leading
BF and ACP in $B^0 \to h^+h^{0-}$ decays and isospin sum rule — world leading
BF and ACP of $B^0 \to \pi^0\pi^0$ decays — competitive, arXiv: 2303.08354
ACP in $B^0 \to K^0_S K^0_S K^0_S$
|Vcb| using untagged $B \to D^*\ell\nu$ decays — competitive
CPV in $B^0 \to K^0\pi^0$ decays — competitive, arXiv: 2305.07555
CPV in $B^0 \to \phi K^0_S$
Novel method for charm flavor tagging — unique, arXiv: 2304.02042
B^0 lifetime and oscillations in $B^0 \to D^{(*)}h$ decays PRD **107**, L091102 (2023)
Search for a dark-sector ττ resonance in ee → ee ττ decays — world leading
Search for a dark-sector Z' to invisible — world leading, arXiv: 2212.03066
Search for τ → ℓ α — world leading PRL **130**, 181803 (2023)
Search for a dark γ and invisible darkHiggs in μμ+MET— world leading, PRL **130**, 071804 (2023)
Measurement of the Omega_c^0 lifetime — PRD **107**, L031103 (2023)

(Plus a bunch of conference-note results)



Summary & propsects

- SuperKEKB/Belle II is the luminosity frontier project to search for physics beyond SM with ultimate sensitivity.
- The project has achieved so far, by Summer 2022;
  - L_{peak} = 4.7 x $10^{34} cm^{-2} s^{-1}$ (the world highest luminosity)
  - L_{int} = 428 fb^{-1} (similar to BaBar, about 1/2 of Belle)
- Many physics results are coming.
  - Benefited by improved detector performance and analysis technique!
  - Some of them are already world-leading!
- Currently, we are in the long shutdown1 (LS1). Many components are to be improved.
  - We plan to resume in the coming winter, and will try to achieve higher luminosity.
- LS2 is planed for the major upgrade of the IR region and detector subsystems to further boost the luminosity frontier!



感谢您的批评指正

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