Istituto Nazionale di Fisica Nucleare
SEZIONE DI TORINO

Recent results from Belle II

Glueballs and Charmonium: lattice QCD, Experiment and Phenomenology
Trento, March 5th 2026

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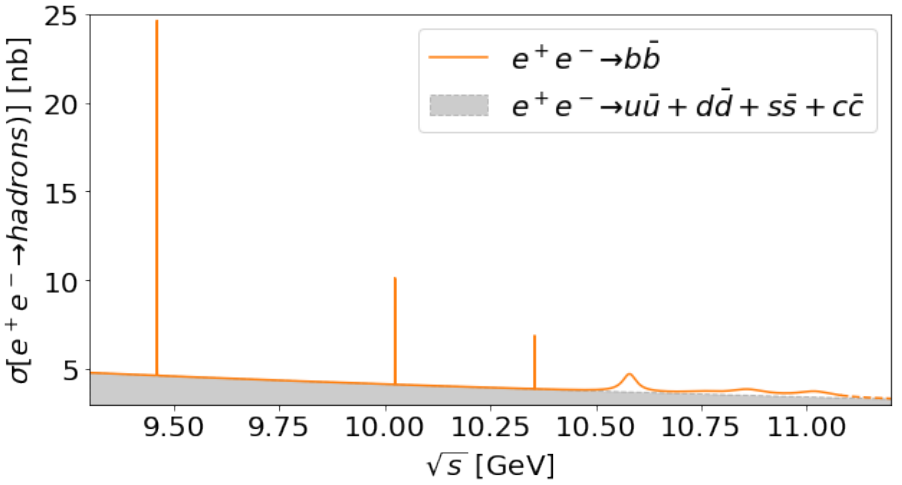
The (super) B-factories

Belle II collects data from e^+e^- collisions between 9 and 11 GeV

→ Mostly at 10.580 GeV, $B\bar{B}$ threshold

→ Produce entangled $B\bar{B}$ pairs



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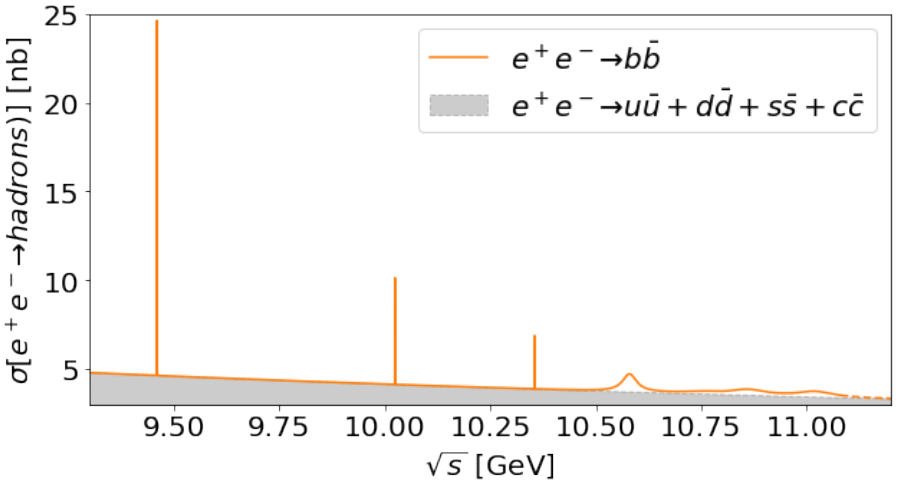
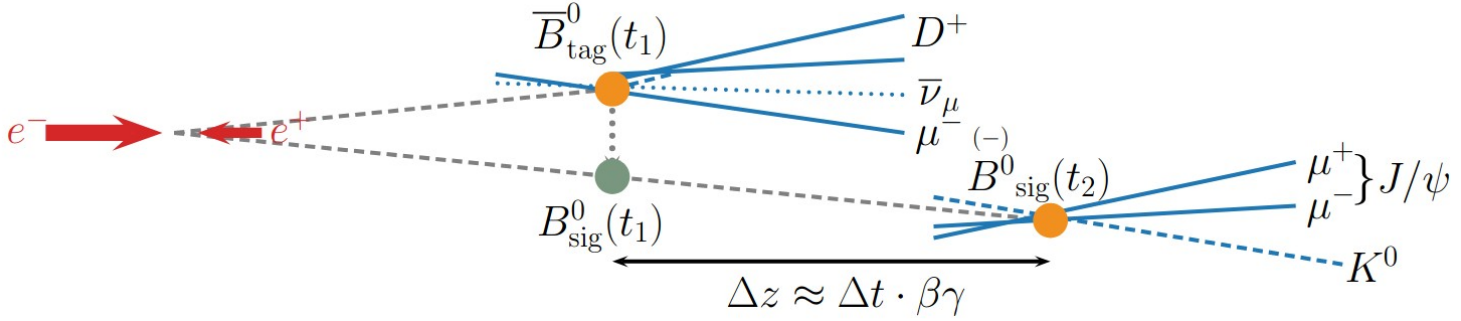


Key features

→ Boosted CM frame

→ Micrometric vertex precision

→ Hermeticity and particle identification



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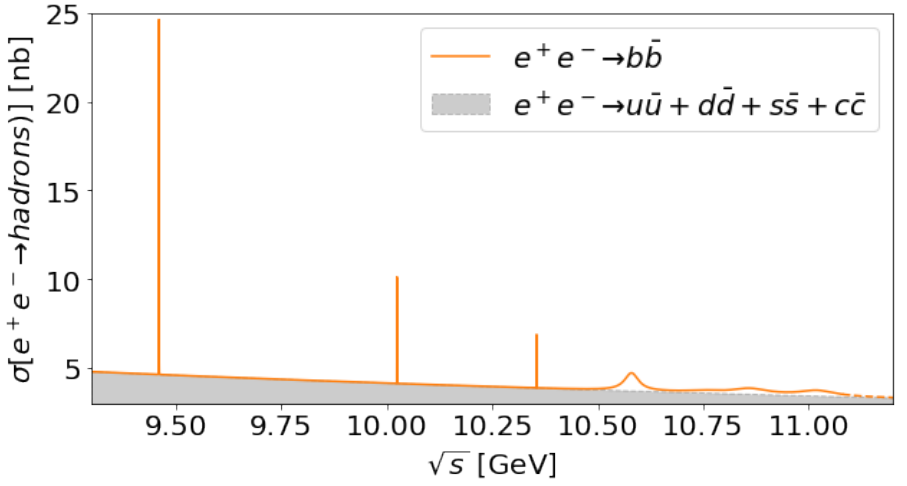

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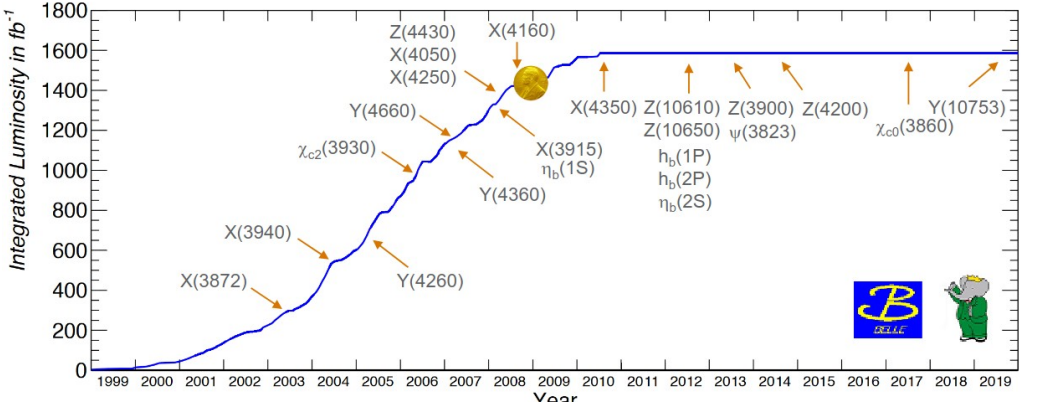


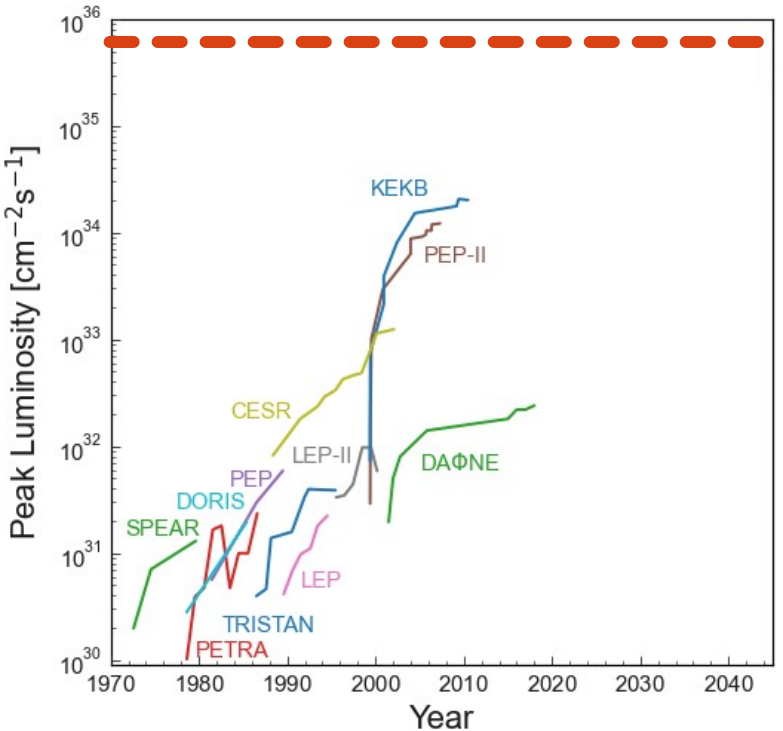
Successor to Belle and BaBar

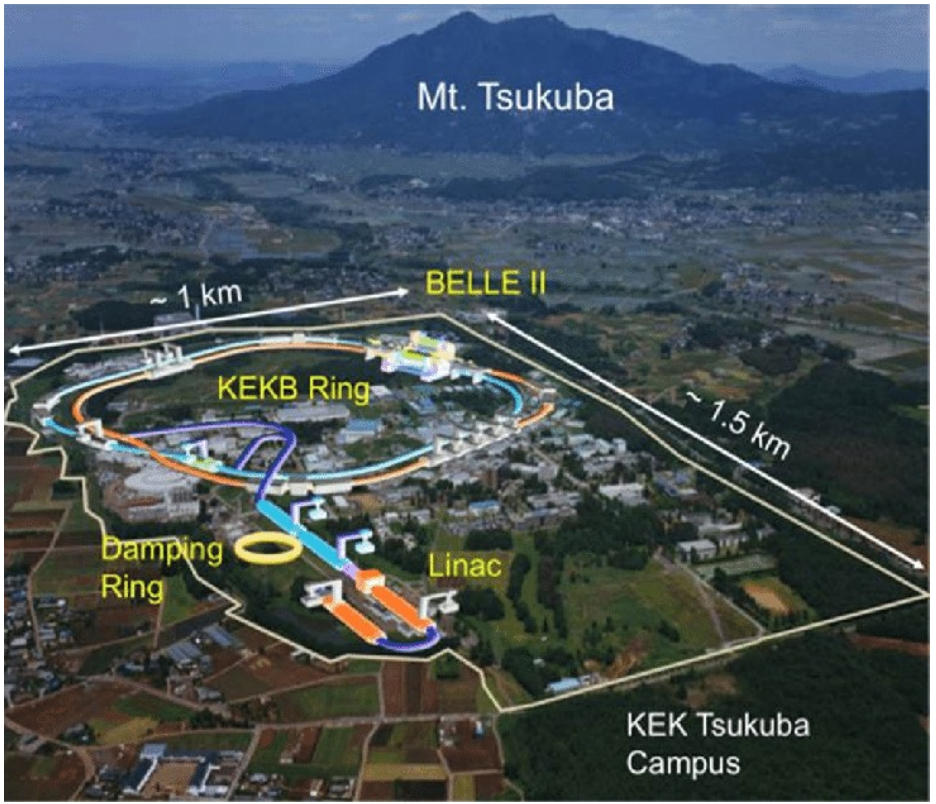
→ CPV in bottom quark decays

→ Heavy exotic hadrons

Super-KEKB and the nanobeam scheme

Belle II goal: collect 50 ab^{-1} (~50x Belle data)
Super-KEKB goal: >30x KEKB luminosity (reach $6x10^{35}$ $cm^{-2}s^{-1}$)





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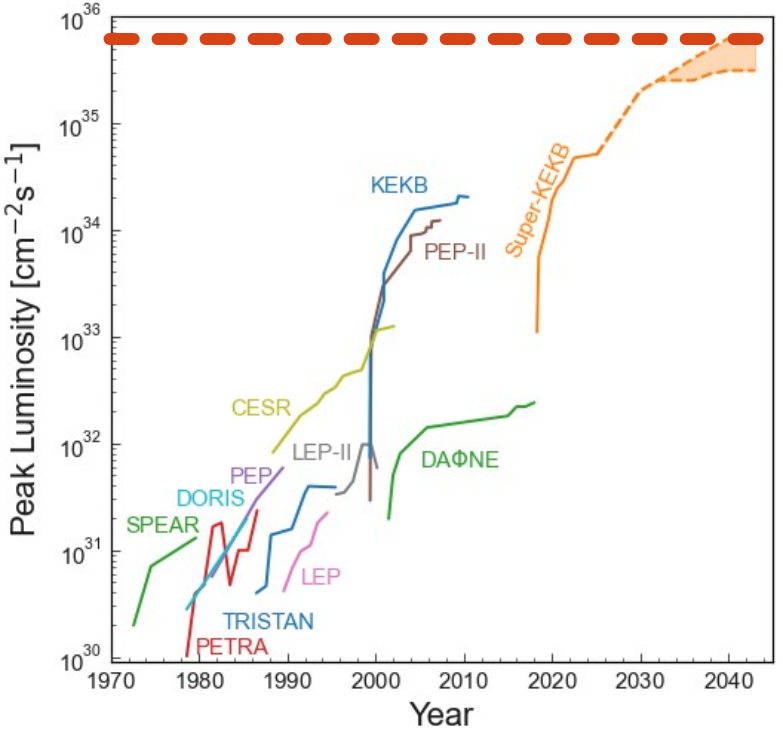


Beam aspect ratio
(flat beam ~ 1-2%)

Beam currents

$$L = \frac{\gamma_\pm}{2er_e}\left(1+\frac{\sigma_y^*}{\sigma_x^*}\right)\left(\frac{I_\pm \xi_{y\pm}}{\beta_y^*}\right)\left(\frac{R_L}{R_{\xi_{y\pm}}}\right)$$

Vertical β function at IP

Geometrical corrections

Brute force:
- Current 2 x larger

Nanobeam scheme:
- β_y^* 10-20 x smaller
- Vertical beam size ~ 50 nm

Belle II VS Belle, a matter of backgrounds

[P.Lewis et al, NIM A 914, 69-144 (2019)]

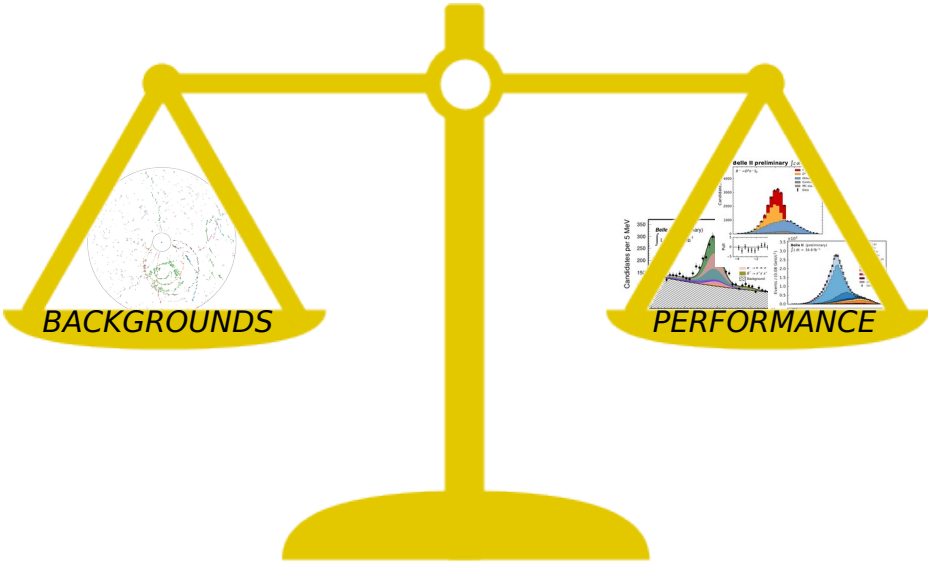
Single beam backgrounds:

- Touschek $\propto I^2 \sigma_y^{-1} n_b^{-1}$ ⬆
- Beam Gas $\propto I$ ⬆
- Synchrotron radiation $\propto I$ ⬆

Luminosity backgrounds:

- Radiative Bhabha $\propto L$ ⬆
- Two-photon $\propto L$ ⬆
- Injection ⟺

Belle II is designed to perform as well as or better than Belle with much higher backgrounds!



Belle II performance VS Belle



Tracking *[Comp. Phys. Comm. 259 (2021) 107610]*

- Better resolution at both low and high p_t
- Better efficiency at low p_t
- 2x better vertexing and decay time resolution



Full event reconstruction *[Comput. Softw. Big Sci 3*, 6 (2019)*]*

- Better purity and efficiency



Neutrals *[paper in preparation]*

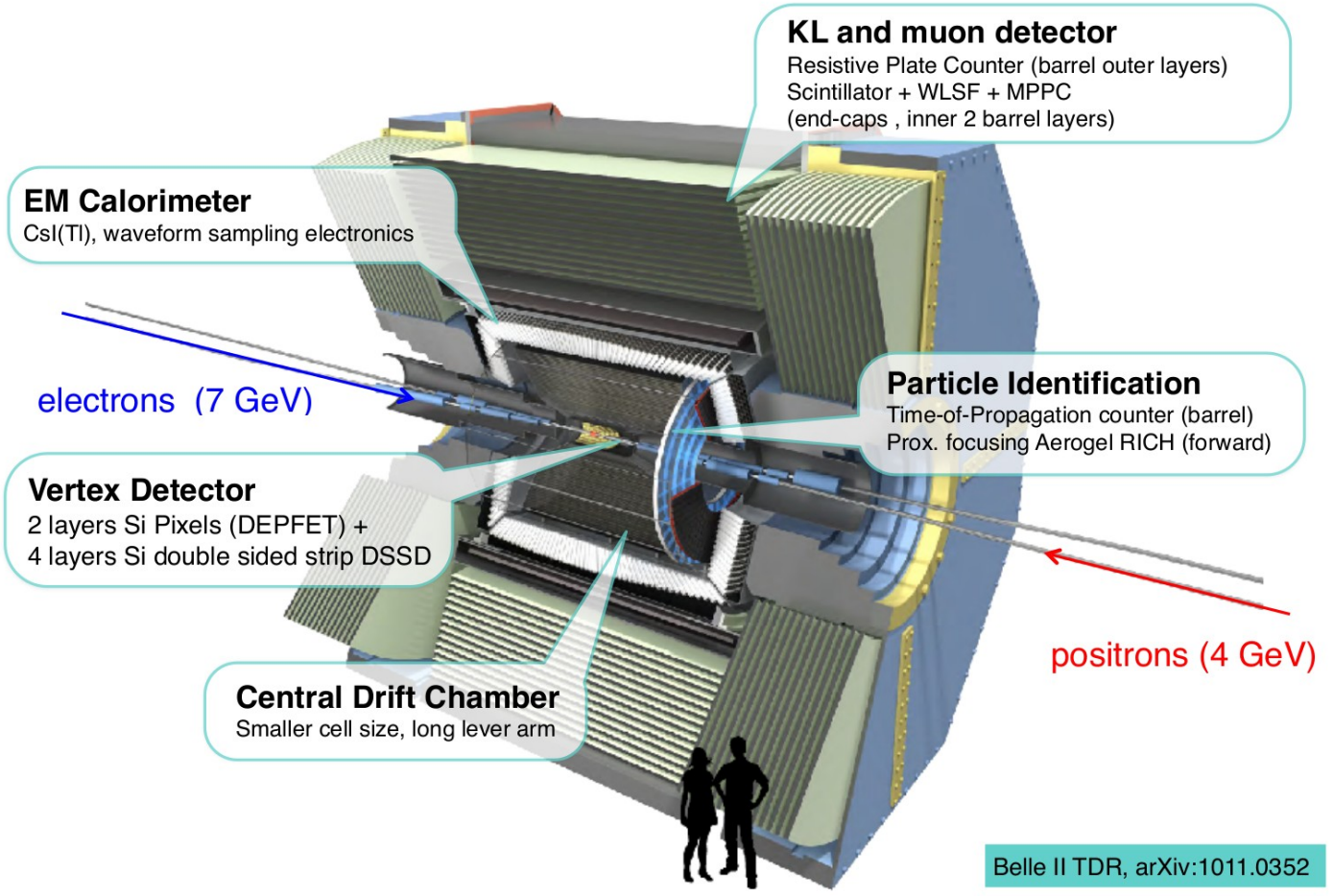
- Better algorithms and electronics
- (Currently) only enough to compensate the increased backgrounds



Particle identification *[arXiv:2506.04355]*

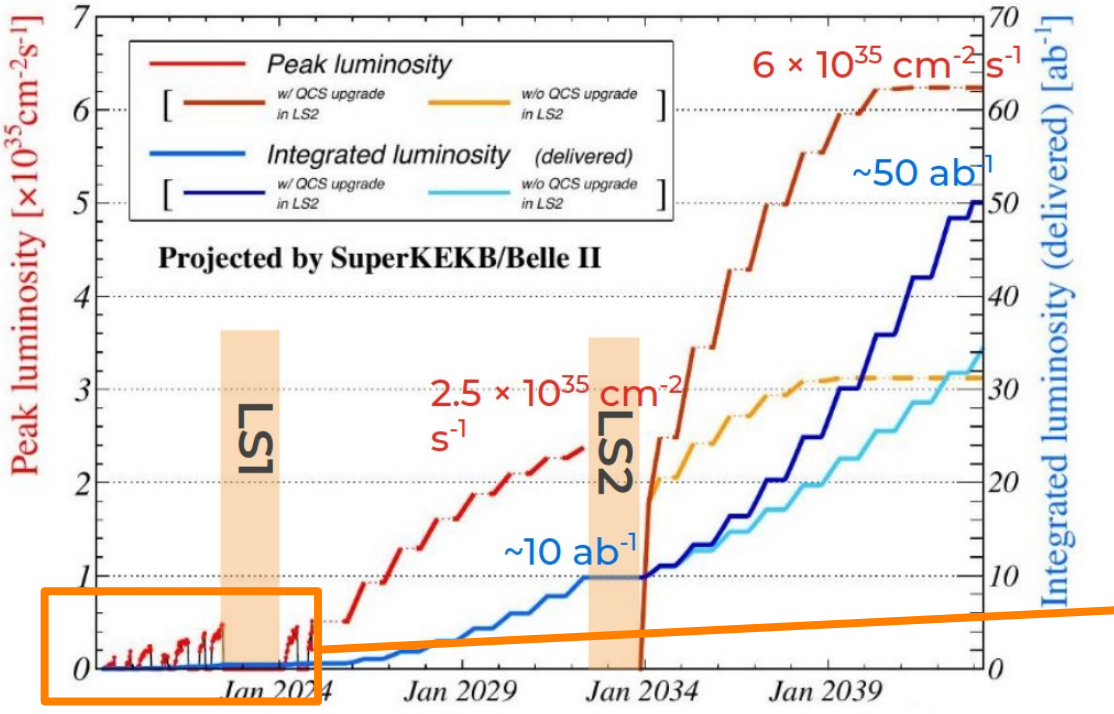
- Better algorithms and new detectors (working on NN-based approaches)
- (Currently) only enough to compensate the increased backgrounds

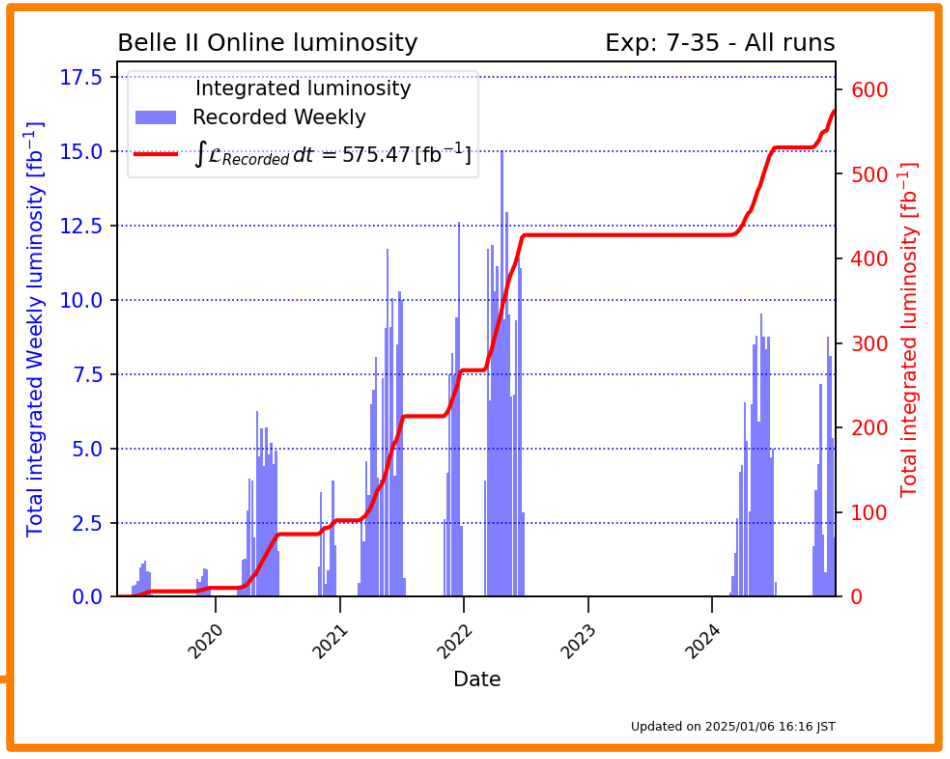
The Belle II detector



Belle II TDR, arXiv:1011.0352

The data taking





The physics of Belle II

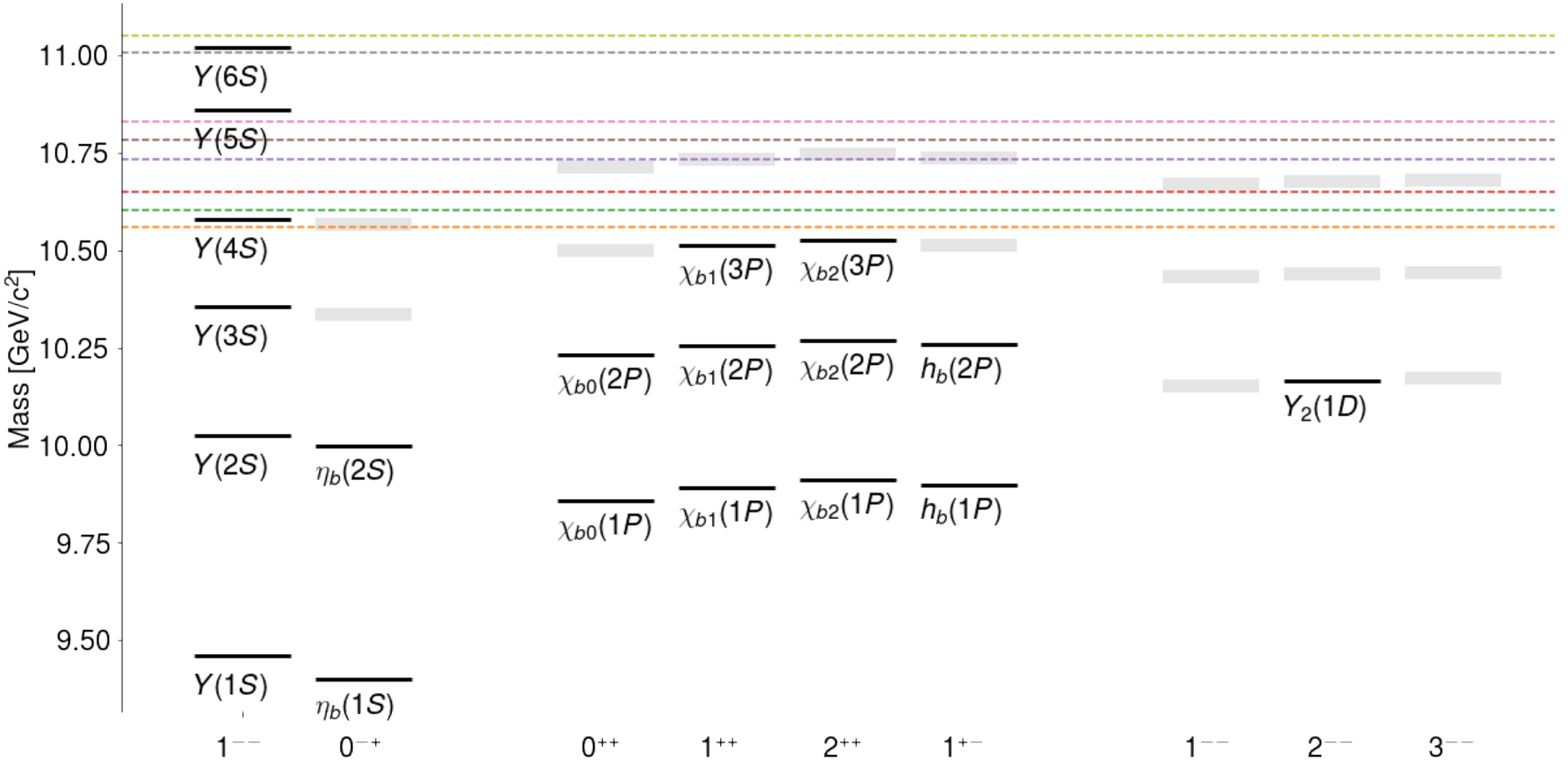
This talk



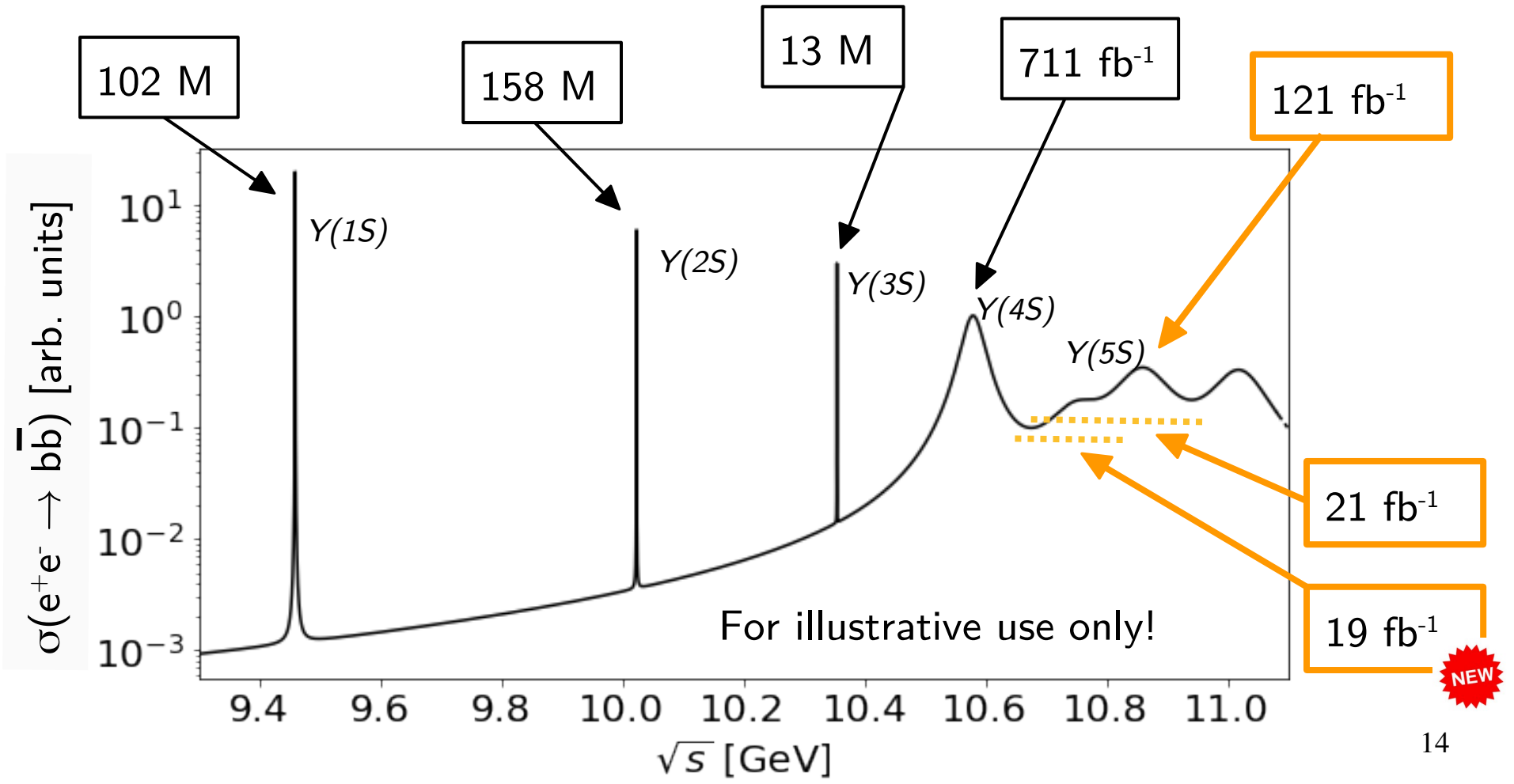
More information in: The Belle II Physics Book *[Prog Theor Exp Phys (2019)]*

Recent quarkonium results

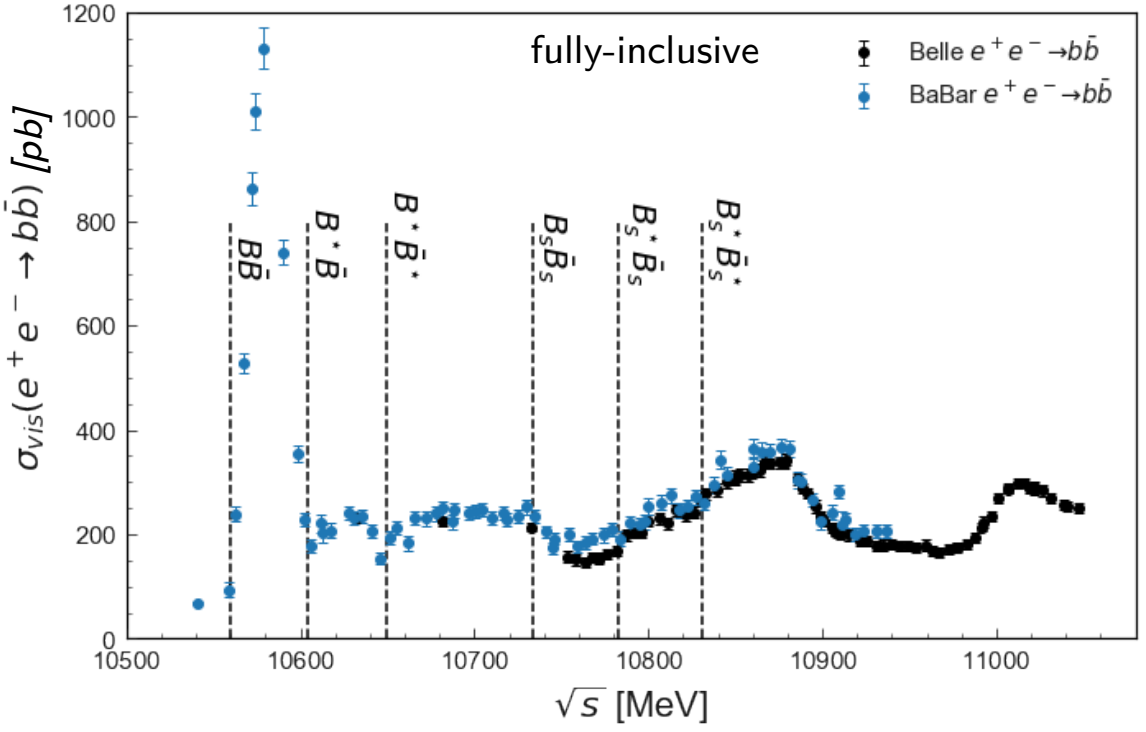
The threshold region

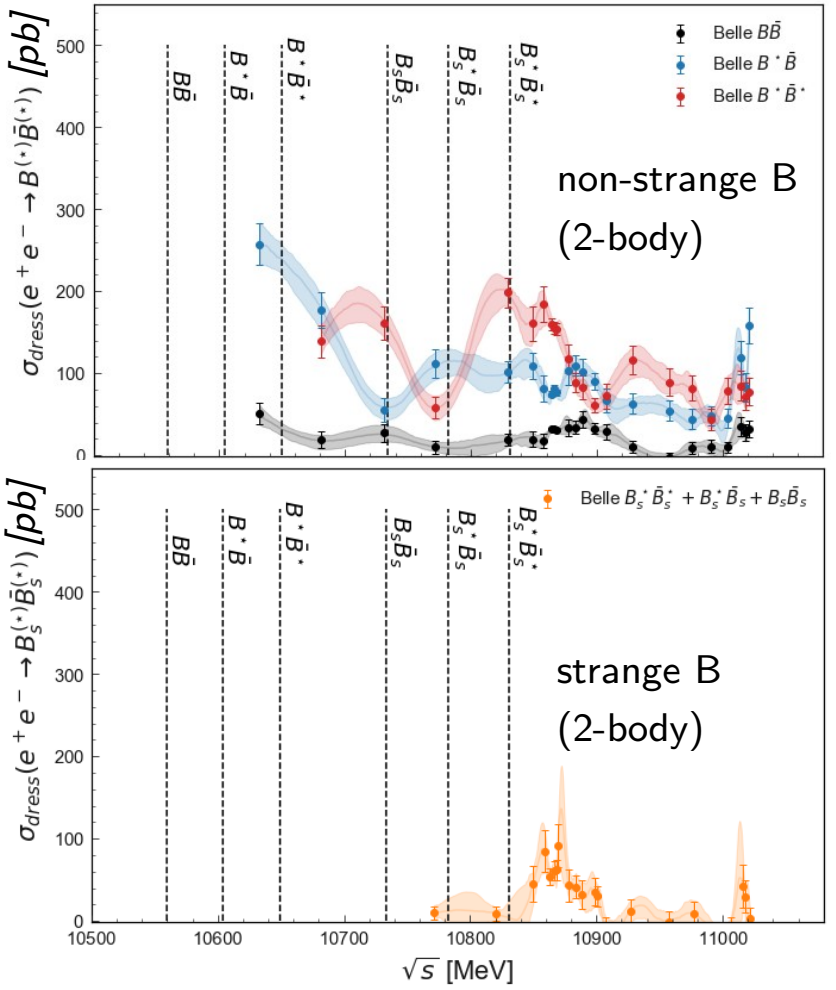


Belle (II) relevant datasets

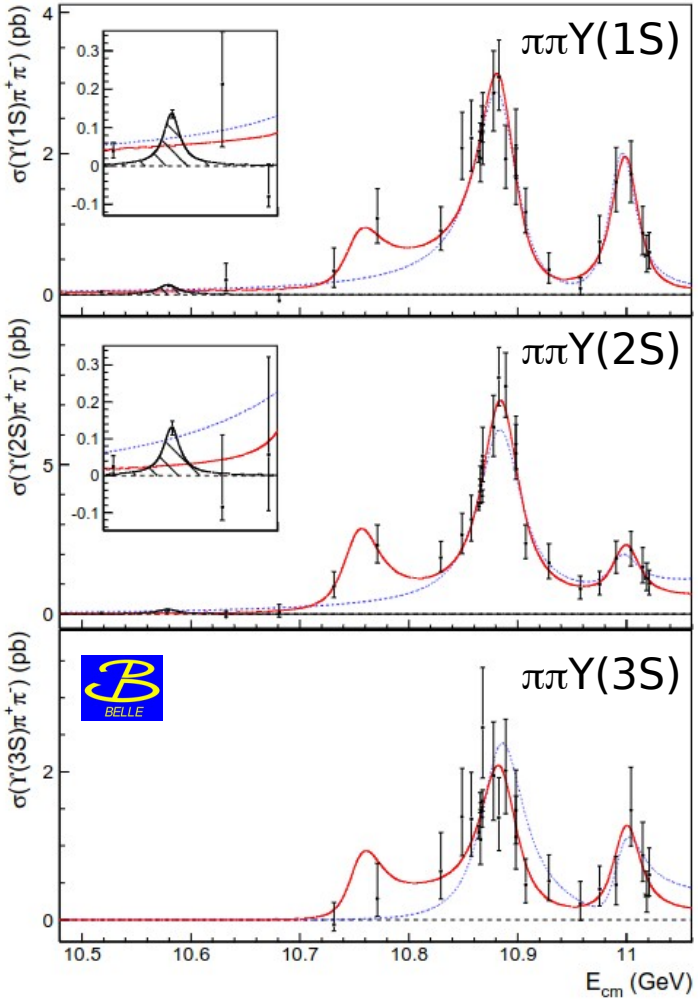


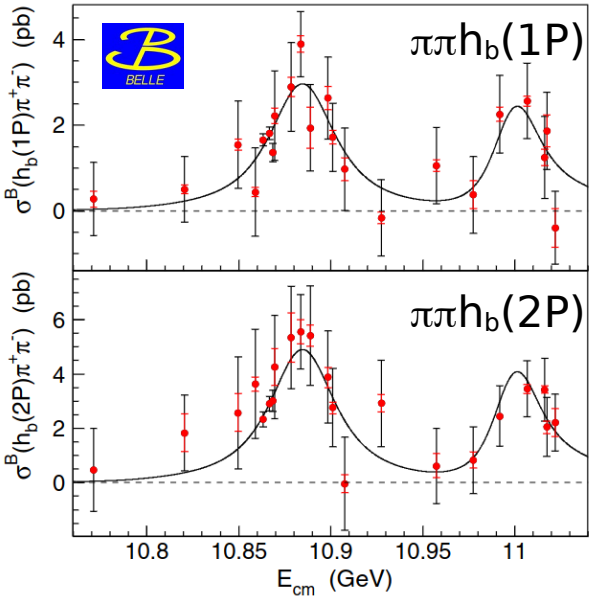
The threshold region: open flavour

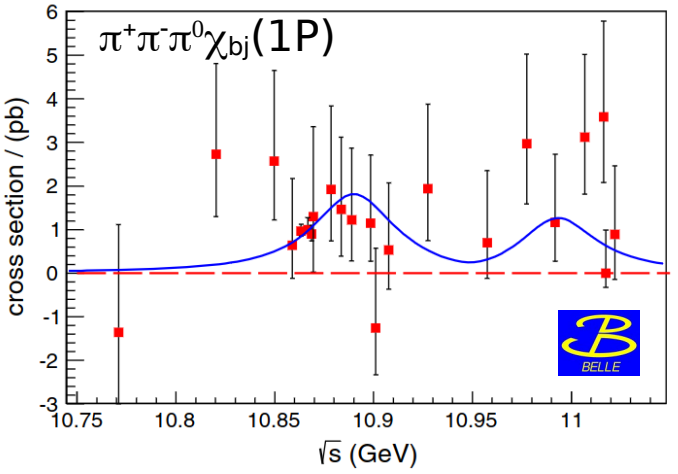




The threshold region: hidden flavour







New structure in ππΥ(nS), the Υ(10750)

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

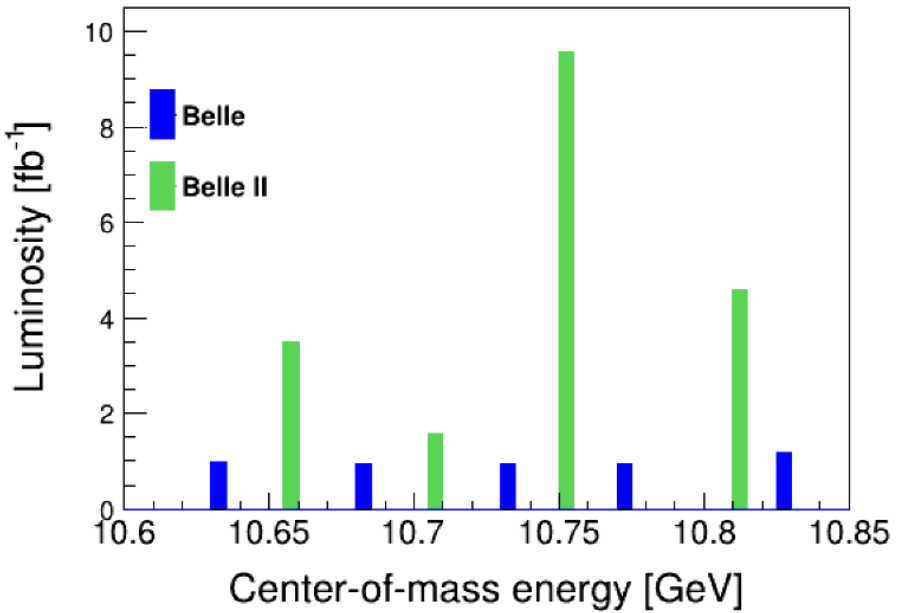
The new Belle II dataset

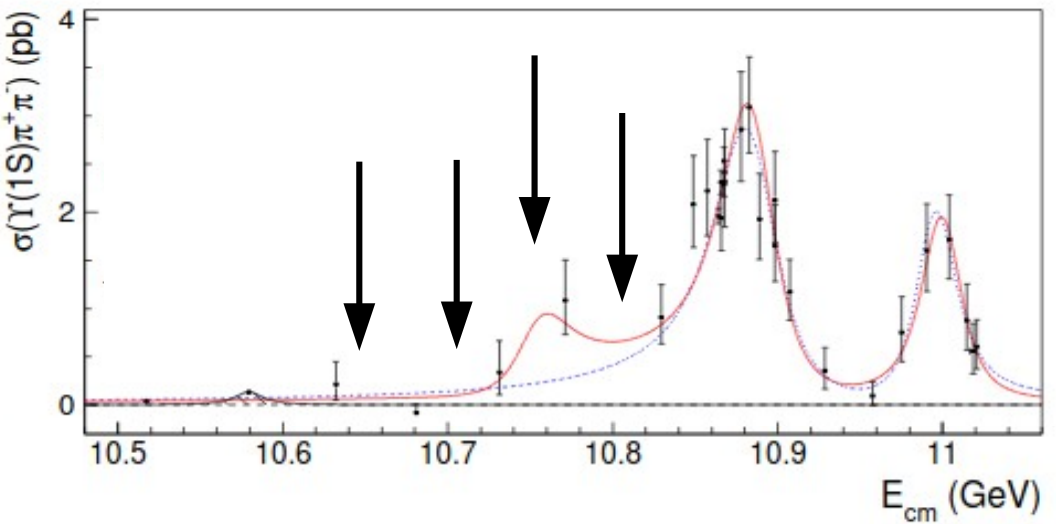
In fall 2021 Belle II took data above the Υ(4S)

→ Goal: study the golden channels to characterize the Υ(10750)

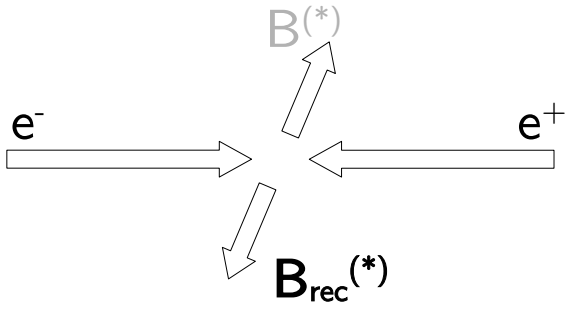
→ Special data taking, lots of discussions and preparation

→ If you have an idea and you like it, don't give up ;)





BB decomposition updated



Semi-inclusive reconstruction:

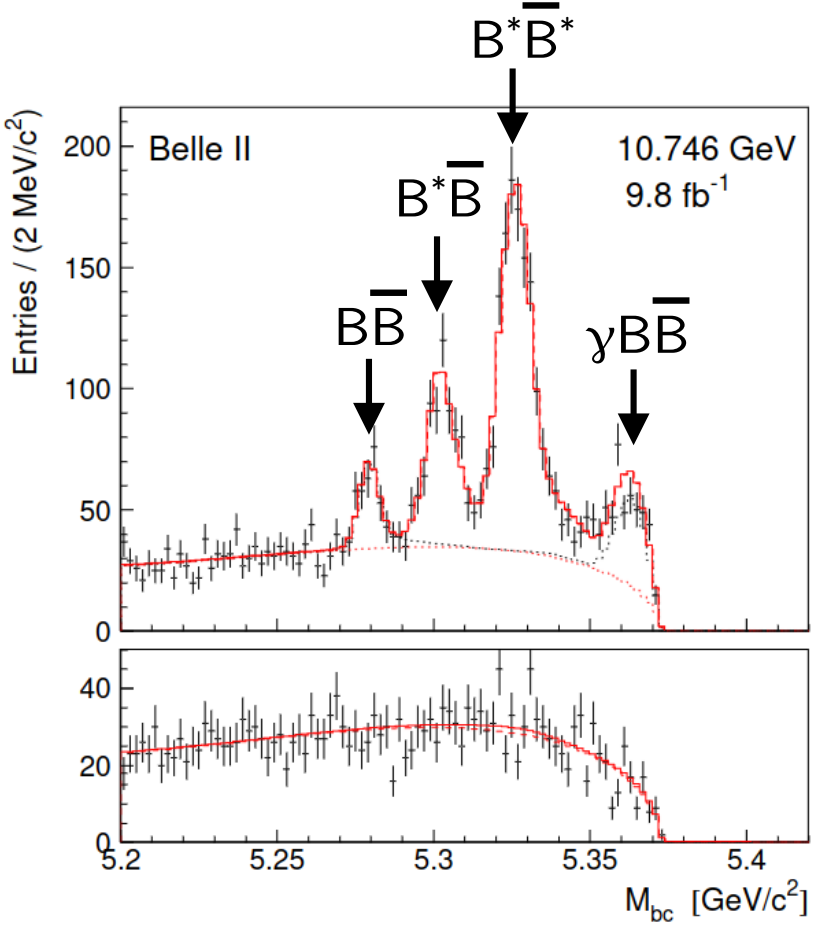
→ Reconstruct one $B^{(*)}$ in 16 modes with $D_{(s)}^{(*)}$ or J/ψ

→ Ignore γ from B^* to B

→ Separate processes by momentum (M_{bc})

$$M_{\mathrm{bc}} = \sqrt{(E_{\mathrm{cm}}/2)^2 - p_B^2}$$

[JHEP 10, 114 (2024)]



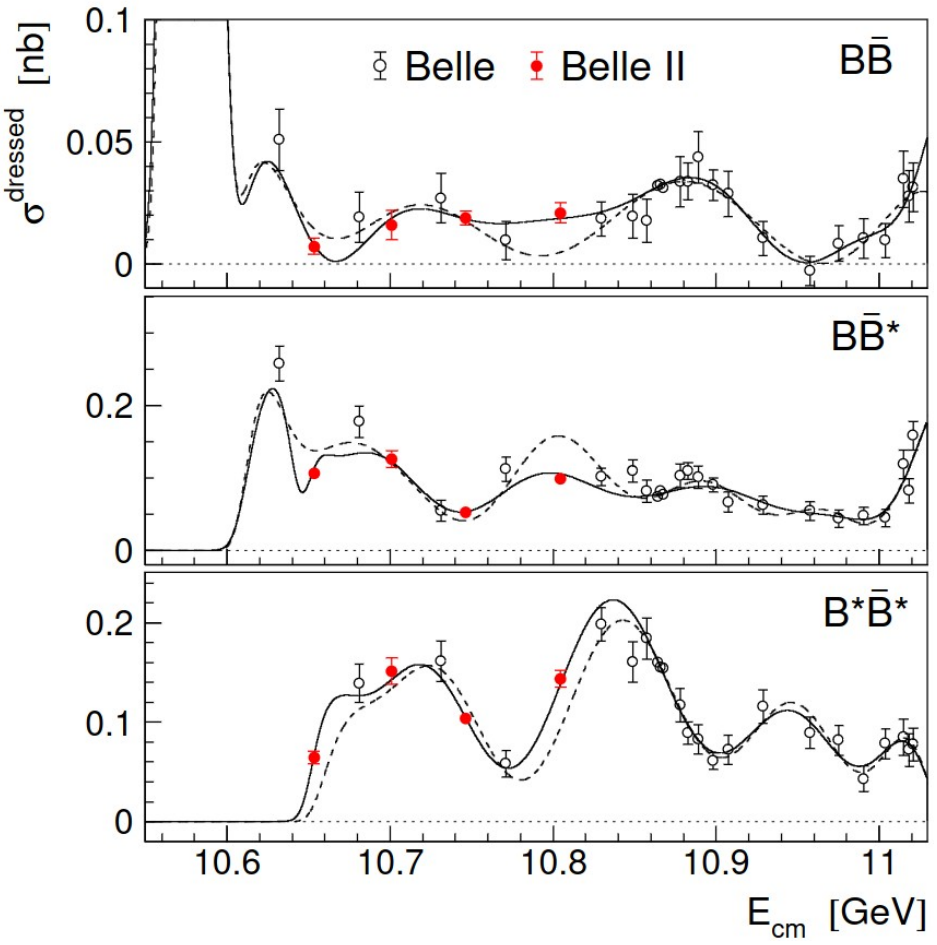
BB decomposition updated

[JHEP 10, 114 (2024)]

Prominent features:

→ Sharp rise in B^*B^*
  → first point only ~2 MeV above $B^{0*}B^{0*}$ threshold
  → Indication of bound state?

→ Dip in B^*B at the B^*B^* threshold

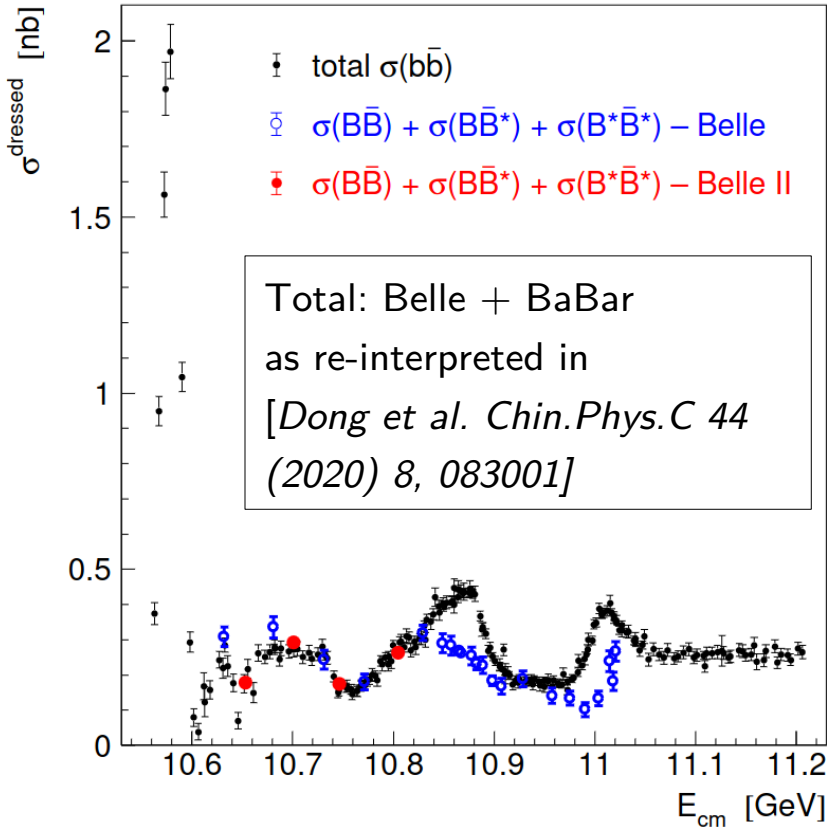


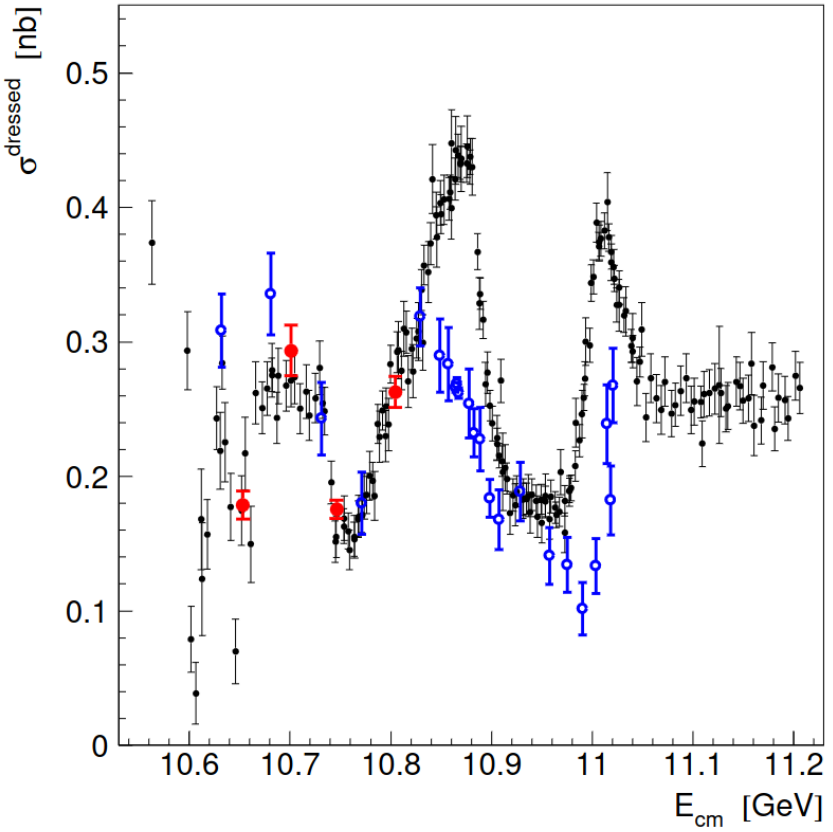
BB decomposition updated

[JHEP 10, 114 (2024)]

Do we saturate the total cross section?

→ not yet!





$e^+e^- \to B^{(*)}B^{(*)}+X$ and $B_s^{(*)}B_s^{(*)}+X$

[JHEP 08 2023, 131 (2023)]

Measure the fully-inclusive $e^+e^- \to B_{(s)}^{(*)}B_{(s)}^{(*)}+X$

→ Use D^0 as proxy for a B^0

→ Use D_s^- as proxy for B_s^0

→ Use D momentum to identify the quark-level process

$e^+e^- \to b\bar{b} \to D_{(s)} + X$

$e^+e^- \to u\bar{u},d\bar{d},s\bar{s},c\bar{c} \to D_{(s)} + X$

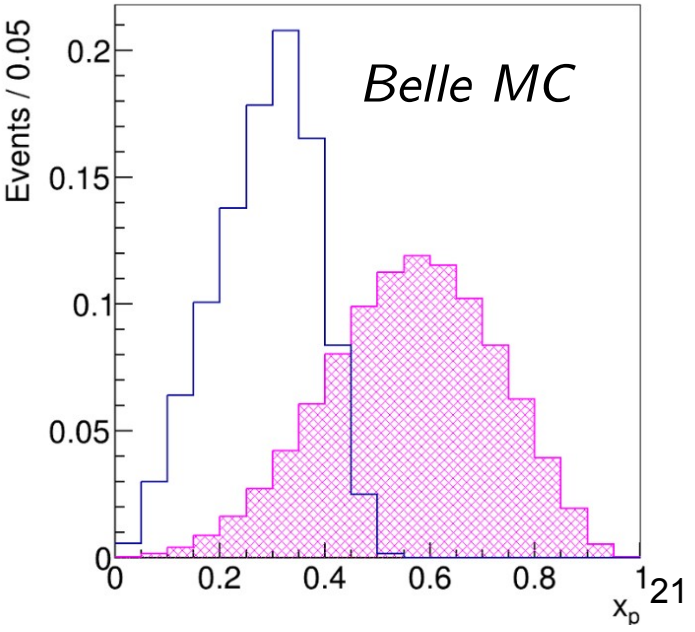
→ Solve the equation system:

$$\sigma(e^+e^- \to b\bar{b} \to D_s^\pm X) = 2\,\sigma(e^+e^- \to B_s^0\bar{B}_s^0 X)\mathcal{B}(B_s^0 \to D_s^\pm X) + 2\,\sigma(e^+e^- \to B\bar{B} X)\mathcal{B}(B \to D_s^\pm X),$$

$$\sigma(e^+e^- \to b\bar{b} \to D^0/\bar{D}^0 X) = 2\,\sigma(e^+e^- \to B_s^0\bar{B}_s^0 X)\mathcal{B}(B_s^0 \to D^0/\bar{D}^0 X) + 2\,\sigma(e^+e^- \to B\bar{B} X)\mathcal{B}(B \to D^0/\bar{D}^0 X).$$

$BF[B^0 \to D^0 + X] \sim 67\%$

$BF[B_s^0 \to D_s^- + X] \sim 60\%$



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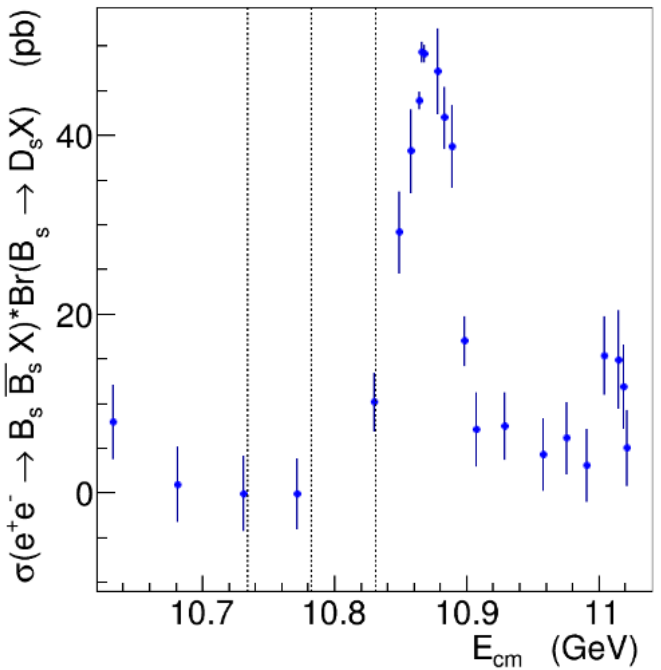

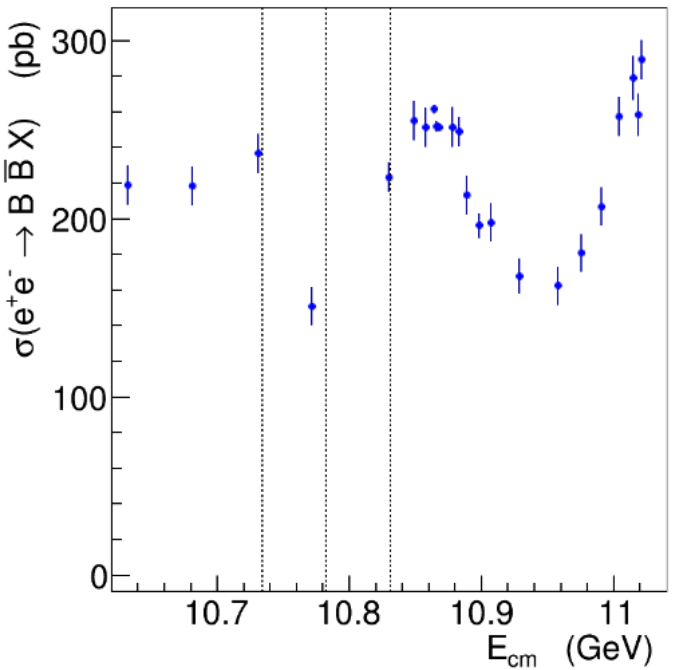

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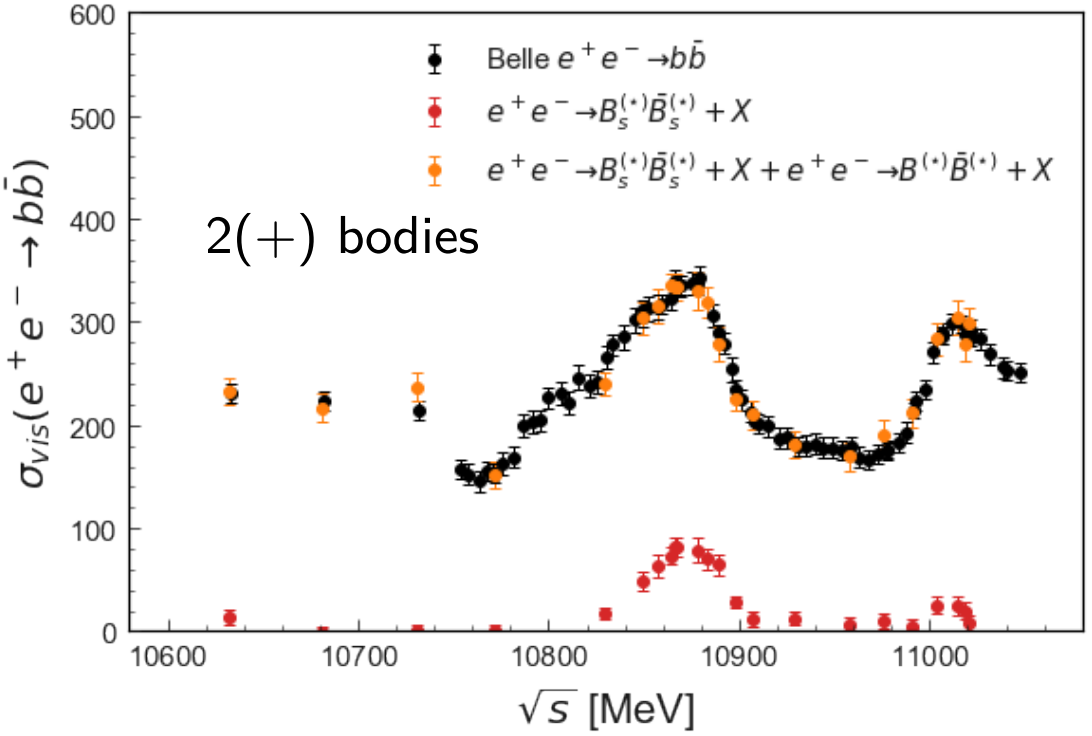
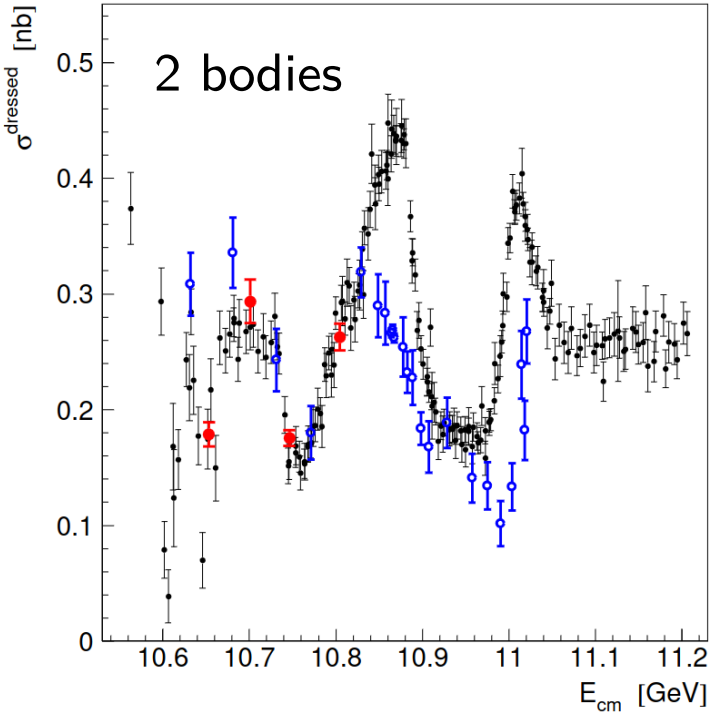




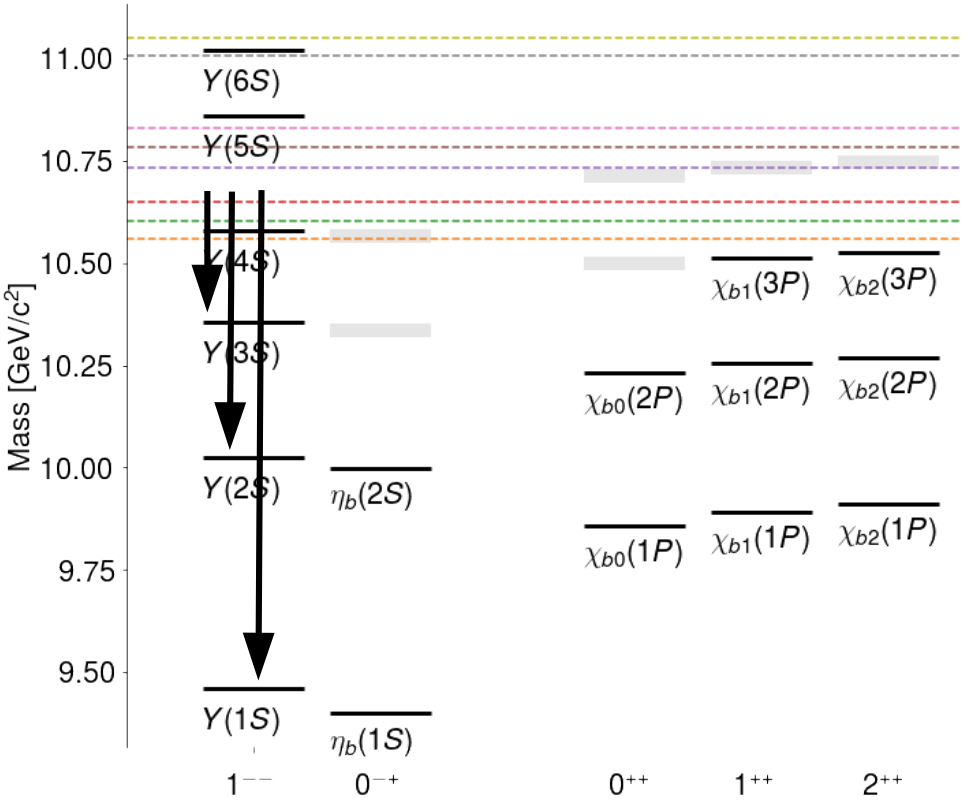
$e^+e^- \to Y(nS)\ \pi^+\pi^-$

Discovery mode of the Y(10750)

→ Confirm its existence

→ Measure the di-pion spectrum

→ look for Z_b contributions



$e^+e^- \to Y(nS)\,\pi^+\pi^-$

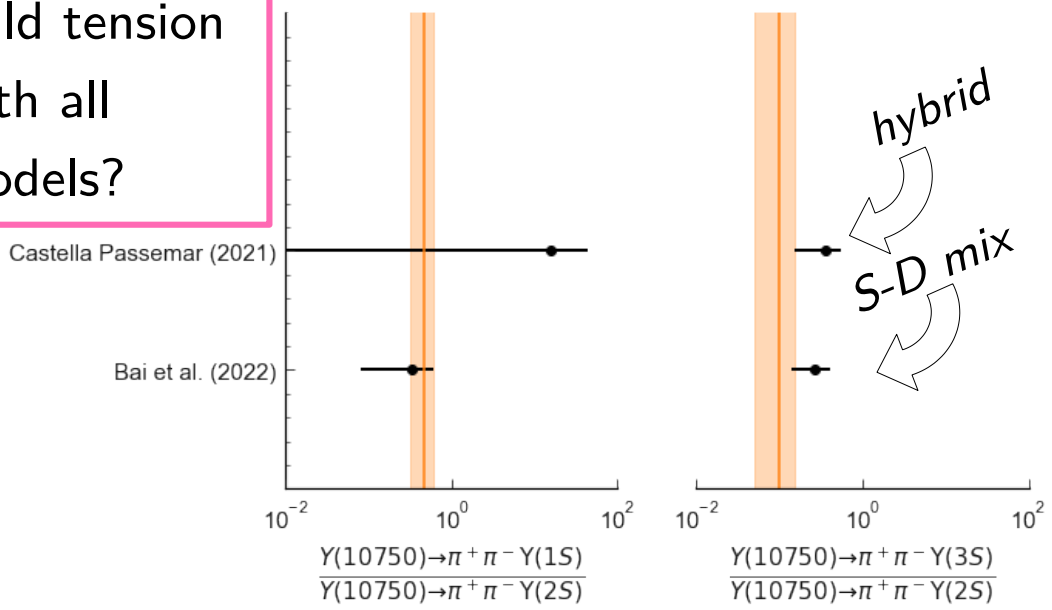
Discovery mode of the Y(10750)

→ Confirm its existence

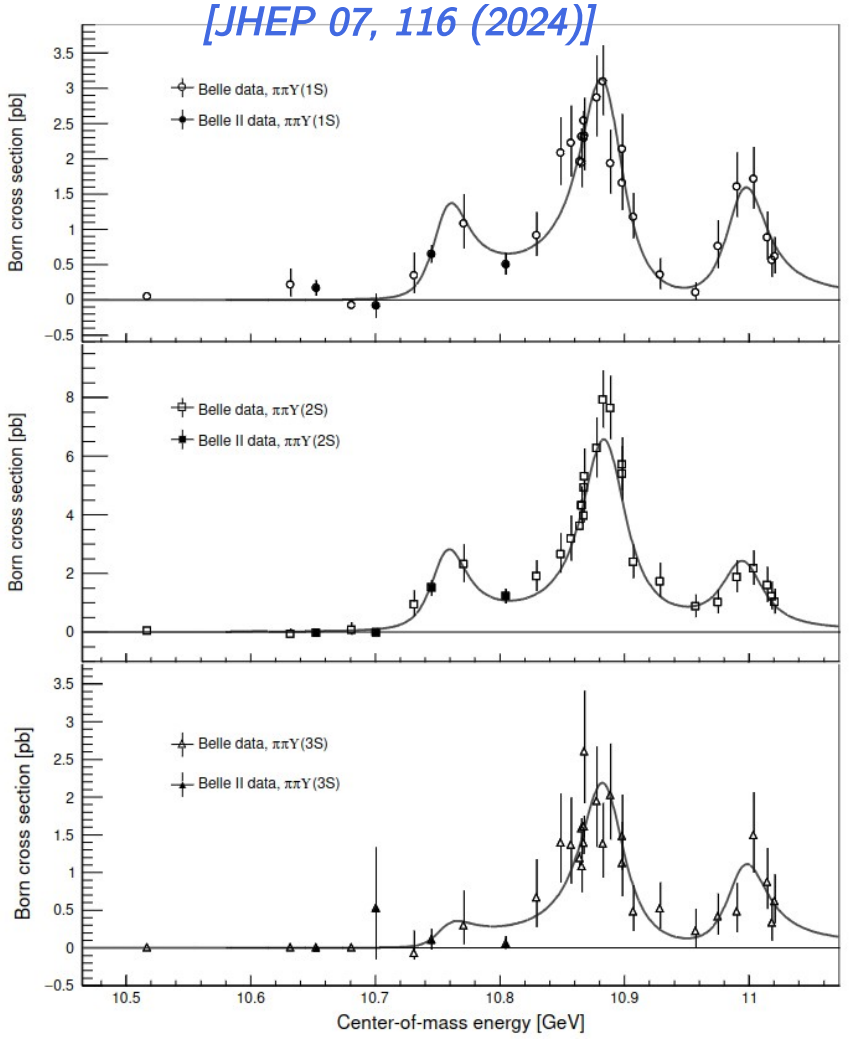
→ >8 σ combined significance (B+BII)

	$\mathcal{R}^{\Upsilon(10753)}_{\sigma(1S/2S)}$	$\mathcal{R}^{\Upsilon(10753)}_{\sigma(3S/2S)}$	$\mathcal{R}^{\Upsilon(5S)}_{\sigma(1S/2S)}$	$\mathcal{R}^{\Upsilon(5S)}_{\sigma(3S/2S)}$	$\mathcal{R}^{\Upsilon(6S)}_{\sigma(1S/2S)}$	$\mathcal{R}^{\Upsilon(6S)}_{\sigma(3S/2S)}$
Ratio	$0.46^{+0.15}_{-0.12}$	$0.10^{+0.05}_{-0.04}$	$0.45^{+0.04}_{-0.04}$	$0.32^{+0.04}_{-0.03}$	$0.64^{+0.23}_{-0.13}$	$0.41^{+0.16}_{-0.12}$

Mild tension with all models?



[JHEP 07, 116 (2024)]



$e^+e^- \to Y(nS)\ \pi^+\pi^-$

Discovery mode of the Y(10750)

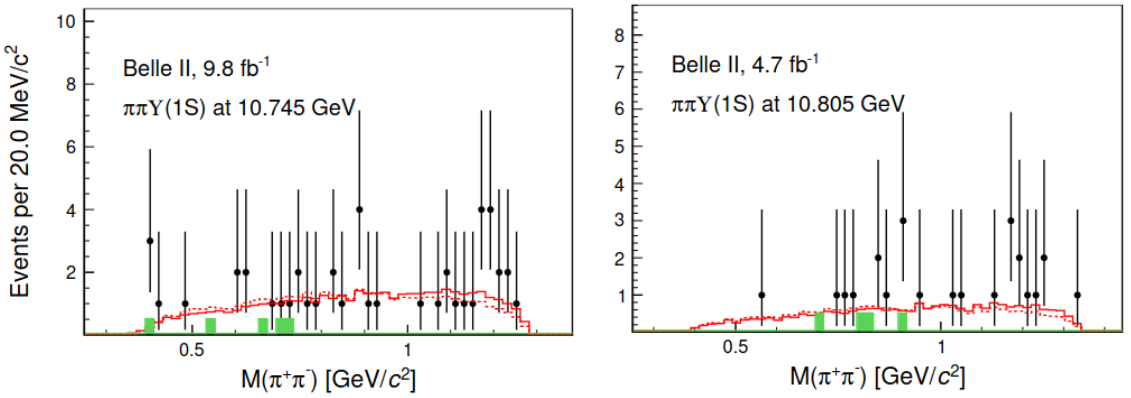
→ Confirm its existence

→ Measure the di-pion spectrum

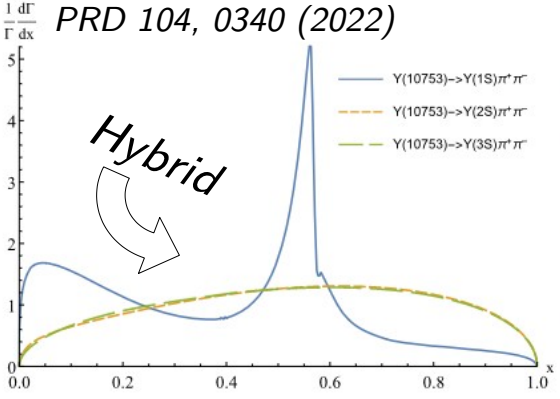
→ **No sign of f_0 in $\pi\pi$Y(1S)**

Disagreement with all available predictions

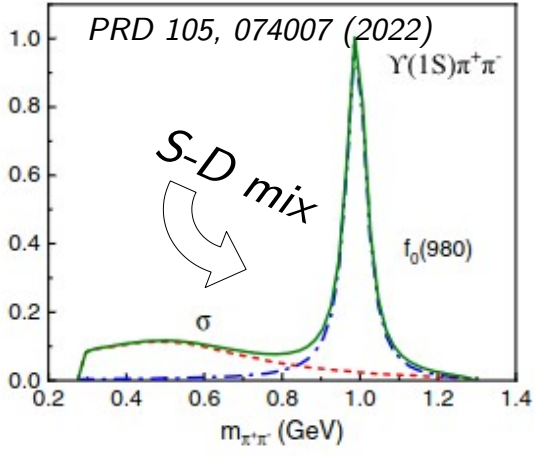
[JHEP 07, 116 (2024)]



PRD 104, 0340 (2022)



PRD 105, 074007 (2022)



$e^+e^- \to Y(nS)\,\pi^+\pi^-$

Discovery mode of the Y(10750)

→ Confirm its existence

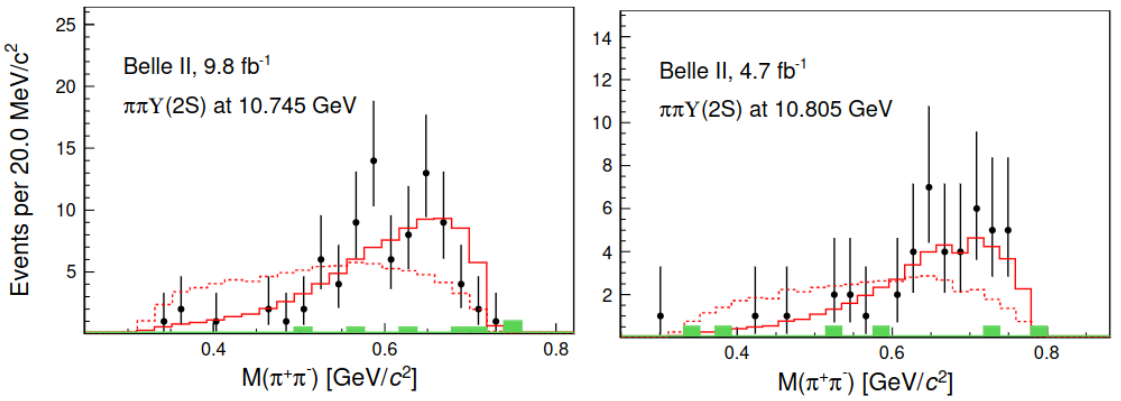
→ Measure the di-pion spectrum

→ **No sign of f_0 in $\pi\pi$Y(1S)**

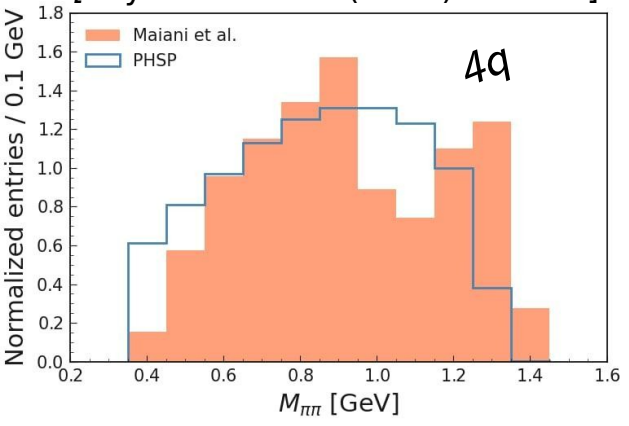
→ **M($\pi\pi$) similar to what's seen in Y(2S) → $\pi\pi$ Y(1S)**

Disagreement with S-D model.
Compatible with 4q?

[JHEP 07, 116 (2024)]



[Phys.Lett.B 802 (2020) 135217]



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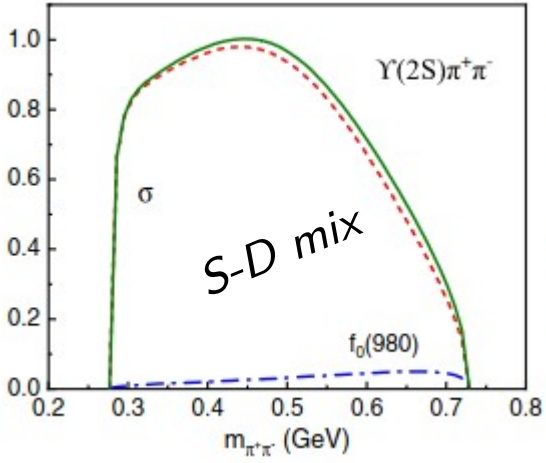

$e^+e^- \to Y(nS)\,\pi^+\pi^-$

Discovery mode of the Y(10750)

→ Confirm its existence

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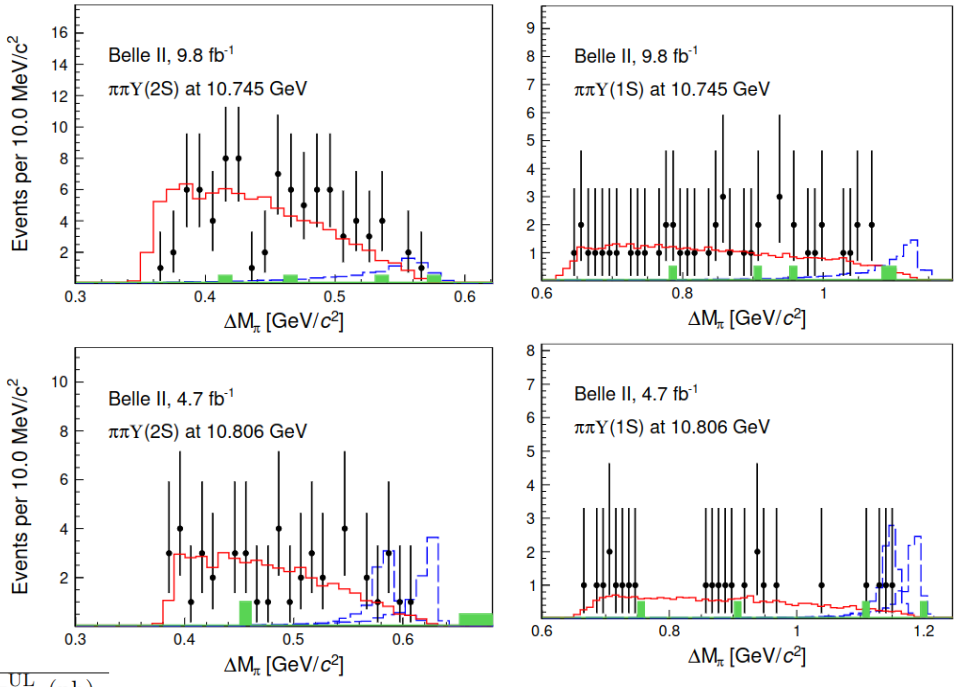
→ look for Z_b contributions

→ **No indication of Z_b**

[JHEP 07, 116 (2024)]



Mode	$N_{Z_{b1}}$	$N^{\rm UL}_{Z_{b1}}$	$\sigma_{Z_{b1}}$ (pb)	$\sigma^{\rm UL}_{Z_{b1}}$ (pb)	$N^{\rm UL}_{Z_{b2}}$	$N_{Z_{b2}}$	$\sigma_{Z_{b2}}$ (pb)	$\sigma^{\rm UL}_{Z_{b2}}$ (pb)
10.745 GeV								
$\pi\Upsilon(1S)$	$0.0^{+1.6}_{-0.0}$	< 4.9	$0.00^{+0.04}_{-0.00}$	< 0.13	–	–	–	
$\pi\Upsilon(2S)$	$5.8^{+5.9}_{-4.6}$	< 13.8	$0.06^{+0.06}_{-0.05}$	< 0.14	–	–	–	
10.805 GeV								
$\pi\Upsilon(1S)$	$2.5^{+2.4}_{-1.6}$	< 5.2	$0.21^{+0.20}_{-0.13}$	< 0.43	$0.0^{+0.7}_{-0.0}$	< 5.8	$0.00^{+0.03}_{-0.00}$	< 0.28
$\pi\Upsilon(2S)$	$5.2^{+3.8}_{-3.0}$	< 12.3	$0.15^{+0.11}_{-0.09}$	< 0.35	$0.0^{+0.8}_{-0.0}$	< 6.0	$0.00^{+0.04}_{-0.00}$	< 0.30

$e^+e^- \to \chi_{b1,2}(1P)\ \omega$

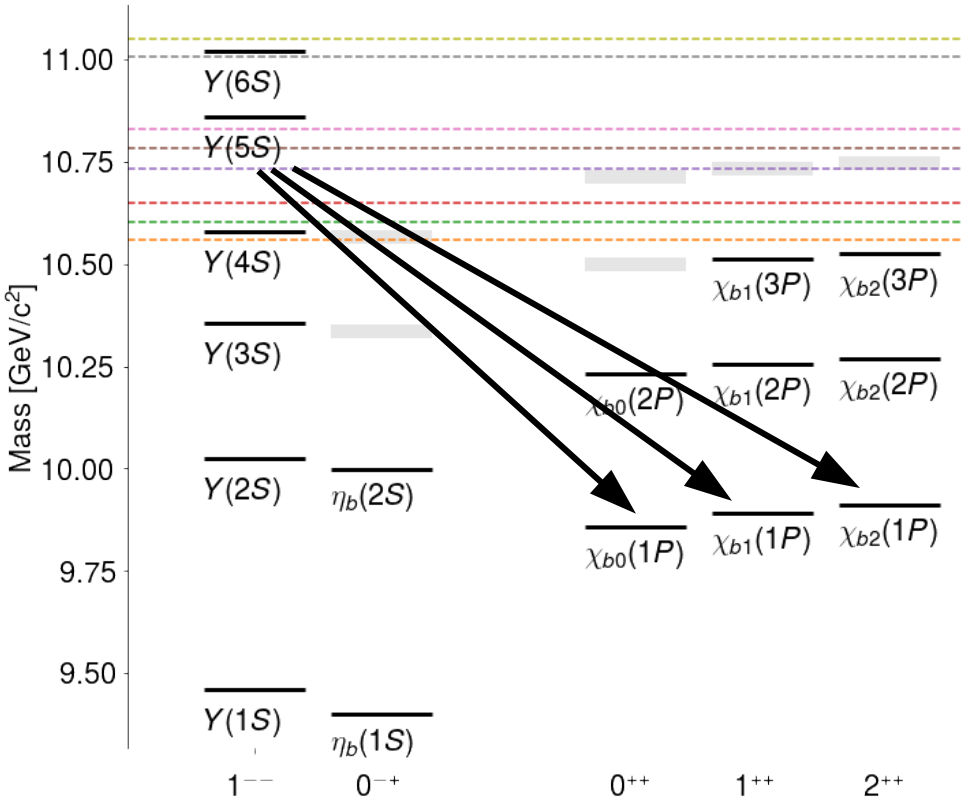
Y(10750) $\to \omega\ \chi_b$ in the conventional quarkonium model (S-D mixing state)

[Y.S. Li, et al., PRD 104, 034036 (2021)]

$$\mathcal{B}[\Upsilon(10753) \to \chi_{b0}\omega] = (0.73\text{–}6.94) \times 10^{-3},$$
$$\mathcal{B}[\Upsilon(10753) \to \chi_{b1}\omega] = (0.25\text{–}2.16) \times 10^{-3},$$
$$\mathcal{B}[\Upsilon(10753) \to \chi_{b2}\omega] = (1.08\text{–}11.5) \times 10^{-3}.$$

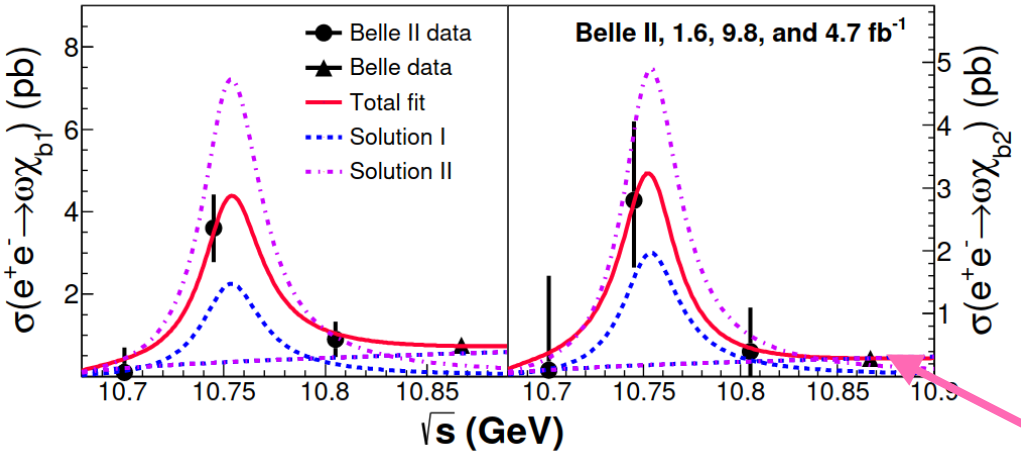
$$R_{12} = \frac{\mathcal{B}[\Upsilon(10753) \to \chi_{b1}\omega]}{\mathcal{B}[\Upsilon(10753) \to \chi_{b2}\omega]} = (0.18\text{–}0.22)$$

$$R_{02} = \frac{\mathcal{B}[\Upsilon(10753) \to \chi_{b0}\omega]}{\mathcal{B}[\Upsilon(10753) \to \chi_{b2}\omega]} = (0.55\text{–}0.63)$$



$e^+e^- \to \chi_{b1,2}(1P)\ \omega$

[PRL 130, 091902 (2023)]



$\sigma[ee \to \omega\chi_{b0}(1P)] < 11.3\,pb\,@\,10.750\,GeV$

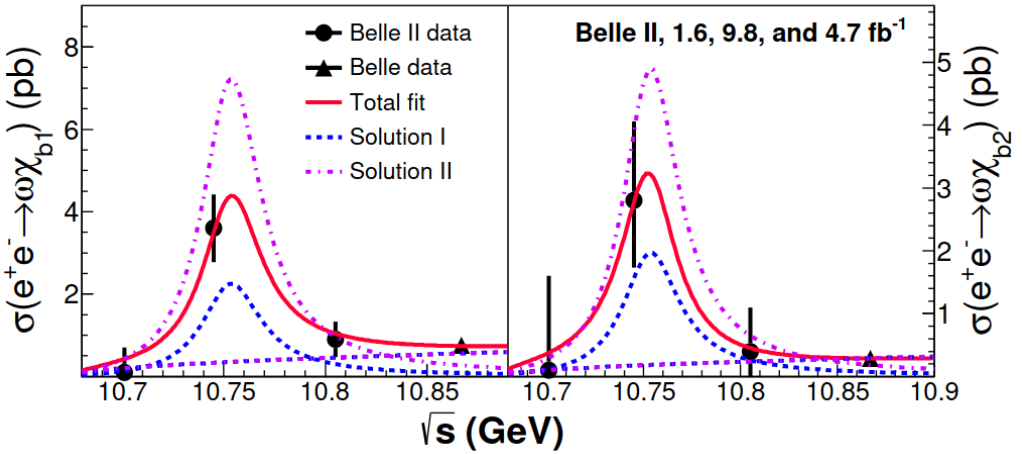
Two solutions (constr. or destr. interference):

$$\Gamma_{ee}\times B[Y(10750)\to\omega\chi_{b1}(1P)] = \begin{matrix}(0.63\pm0.39\pm0.20)\,eV\\(2.01\pm0.38\pm0.76)\,eV\end{matrix}$$

$$\Gamma_{ee}\times B[Y(10750)\to\omega\chi_{b2}(1P)] = \begin{matrix}(0.53\pm0.40\pm0.15)\,eV\\(1.32\pm0.44\pm0.53)\,eV\end{matrix}$$

What we thought was $\Upsilon(5S) \to \omega\chi_{bj}(1P)$ is probably just the tail of the $\Upsilon(10750)$!

$e^+e^- \to \chi_{b1,2}(1P)\ \omega$



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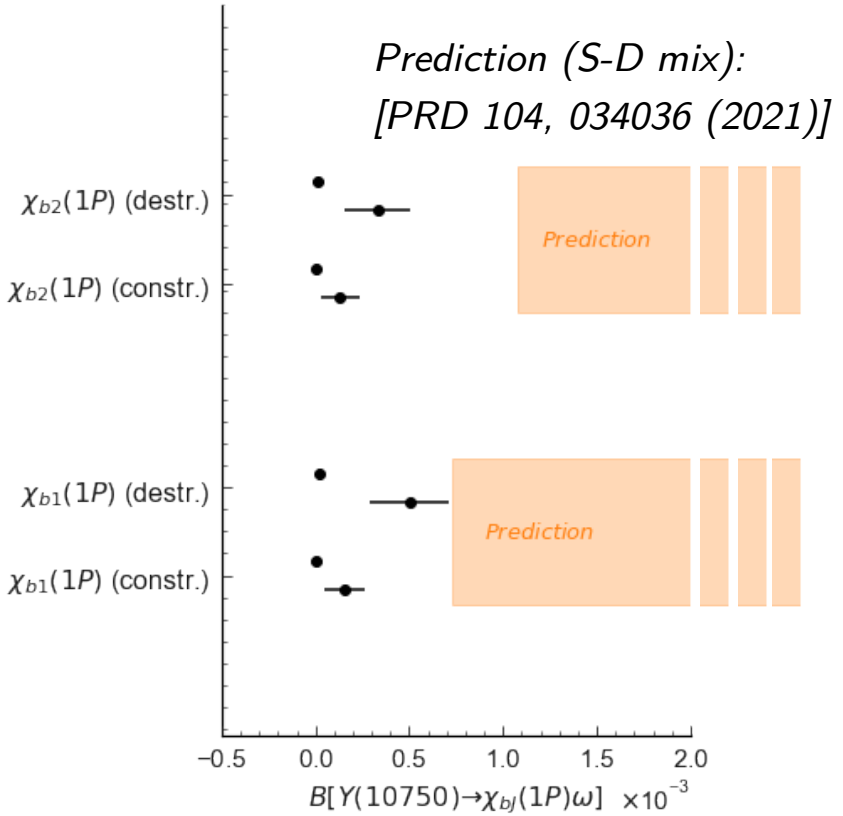
$$\Gamma_{ee}\times B[Y(10750)\to\omega\chi_{b2}(1P)] = \begin{matrix}(0.53\pm0.40\pm0.15)\,eV\\(1.32\pm0.44\pm0.53)\,eV\end{matrix}$$

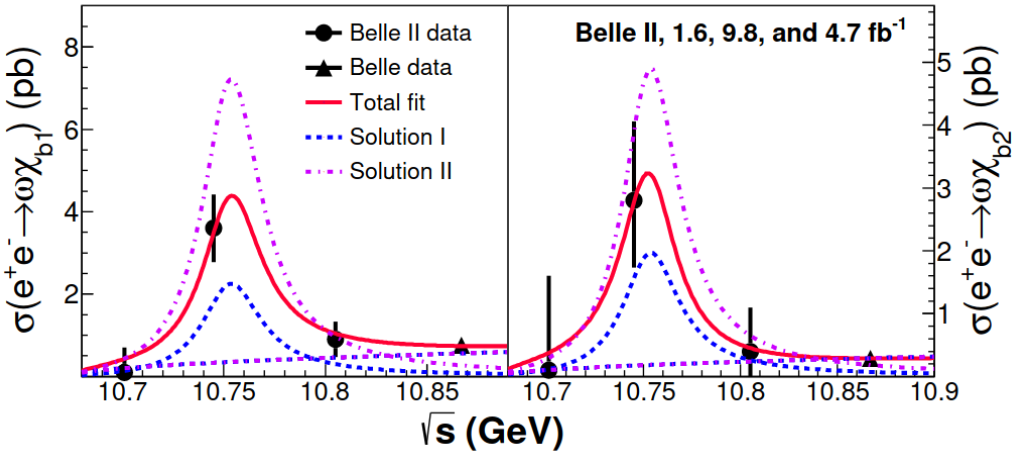
[PRL 130, 091902 (2023)]

Disagreement with S-D model



$e^+e^- \to \chi_{b1,2}(1P)\ \omega$

[PRL 130, 091902 (2023)]

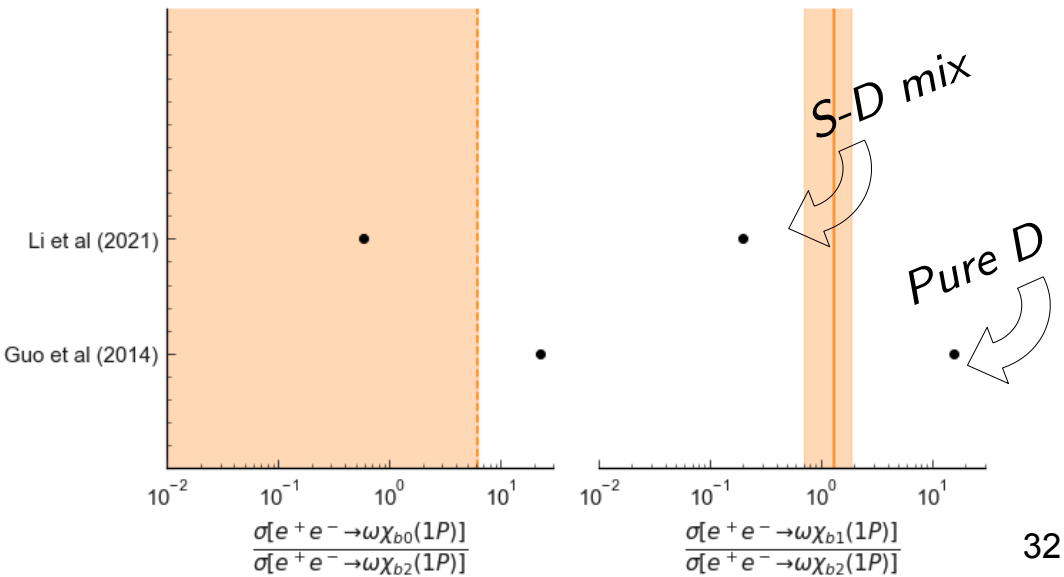


Disagreement with both pure D and S-D mixed predictions

Measured ratios:

$$\frac{B[Y(10750)\to\omega\chi_{b1}(1P)]}{B[Y(10750)\to\omega\chi_{b2}(1P)]}=1.3\pm0.6$$

$$\frac{B[Y(10750)\to\omega\chi_{b0}(1P)]}{B[Y(10750)\to\omega\chi_{b2}(1P)]}<7 \quad \textit{(private extrapolation)}$$

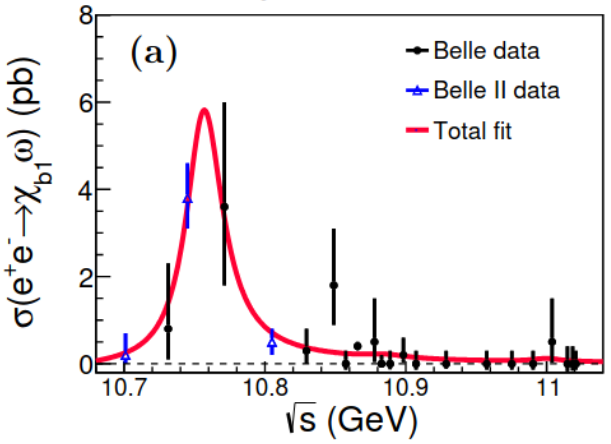


$e^+e^- \to \chi_{b1,2}(1P)\ \pi^+\pi^-\pi^0$

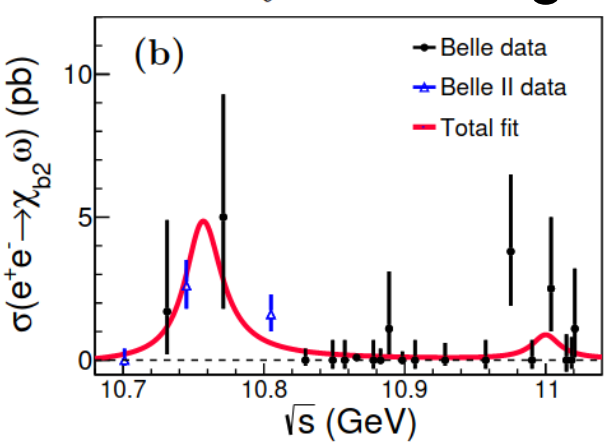
[Arxiv:2510.25461 (2025)]

NEW

Preliminary



Preliminary ω mass region



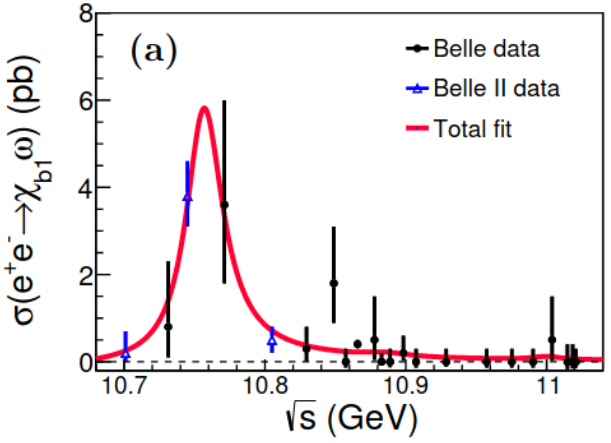
Analysis extended including Belle Data

$e^+e^- \to \chi_{b1,2}(1P)\ \pi^+\pi^-\pi^0$

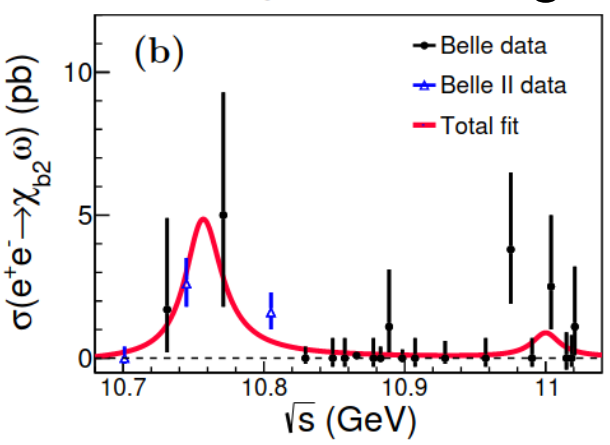
[Arxiv:2510.25461 (2025)]

NEW

Preliminary

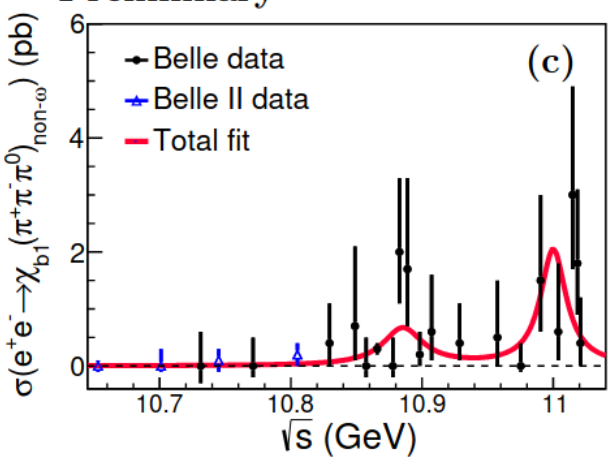


Preliminary ω mass region

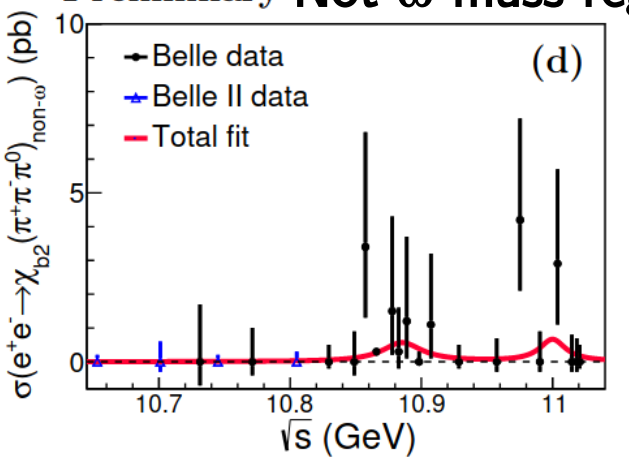


Analysis extended including Belle Data

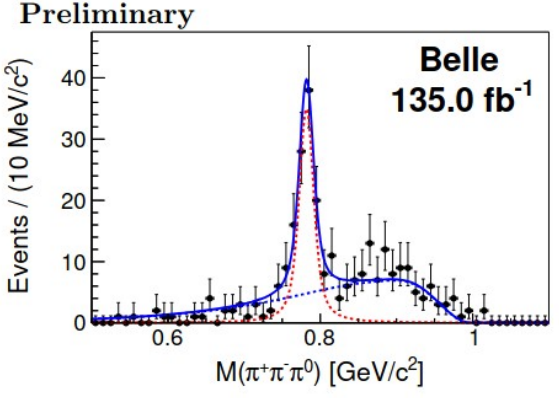
Preliminary



Preliminary Not-ω mass region



Preliminary

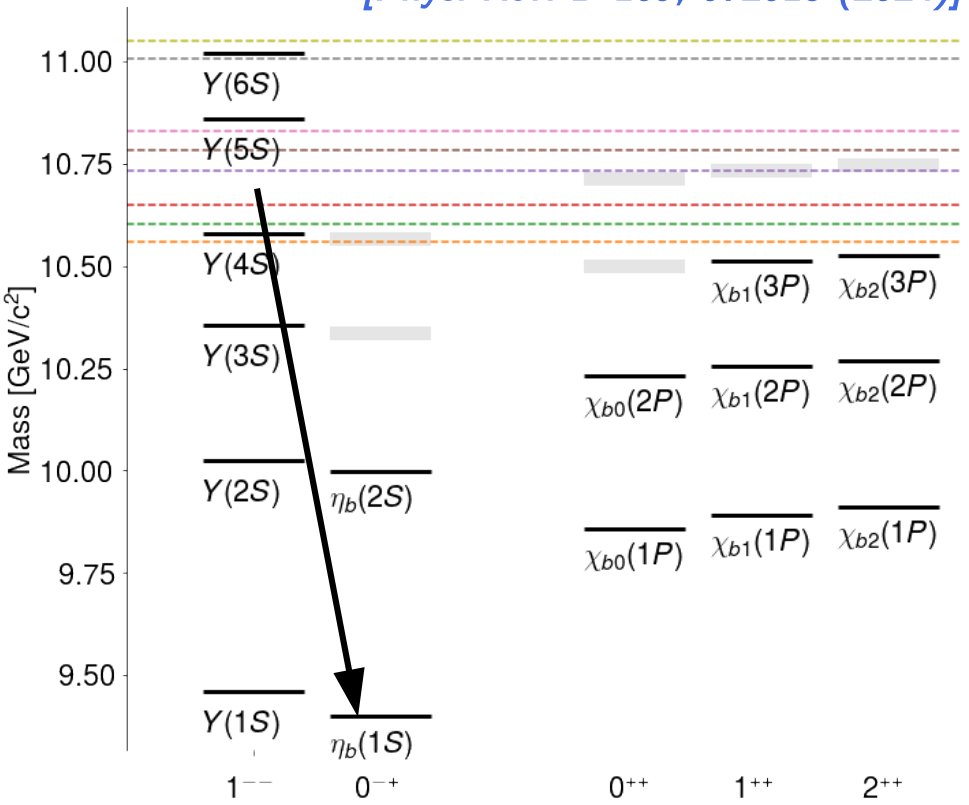


$e^+e^- \to \eta_b(1S)\ \omega$

[Wang, Chin. Phys. C 43, 123102 (2019)]

Mode	$\mathcal{B}(4q)$ (%)	$\mathcal{B}(b\bar{b})$ (%)
$B\overline{B}$	$39.3^{+38.7}_{-22.9}$	21.3
$B\overline{B}^*$	~ 0.2	14.3
$B^*\overline{B}^*$	$52.3^{+54.9}_{-31.7}$	64.1
$B_s\overline{B}_s$	-	0.3
$\omega\eta_b$	$7.9^{+14.0}_{-5.0}$	-
$f_0(1370)\Upsilon$	$0.2^{+0.6}_{-0.2}$	-
$\omega\Upsilon$	~ 0	-

[Phys. Rev. D 109, 072013 (2024)]



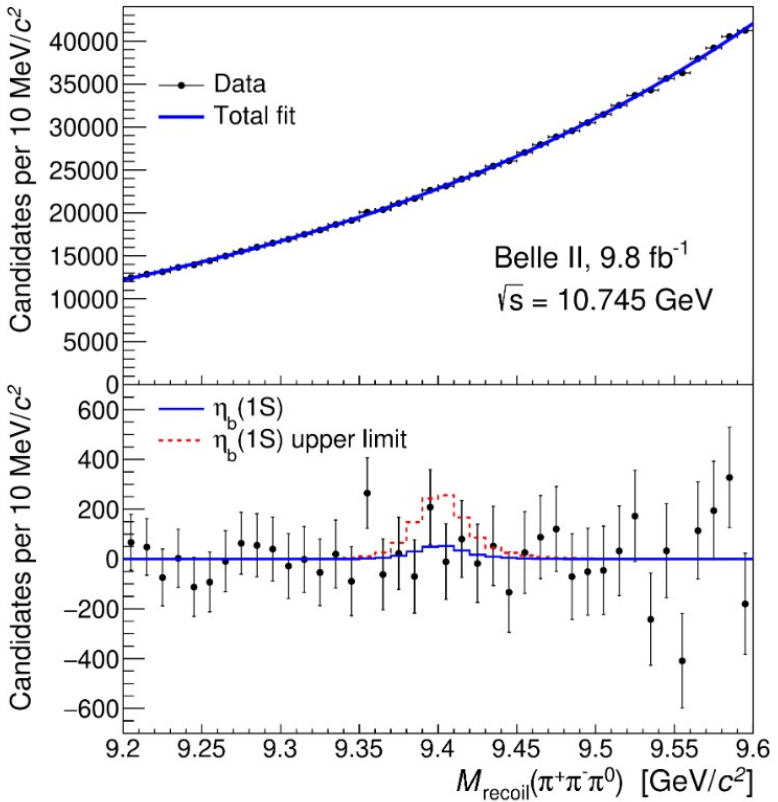
Strategy:

→ Reconstruct ω

→ Measure its recoil mass

$e^+e^- \to \eta_b(1S)\,\omega$

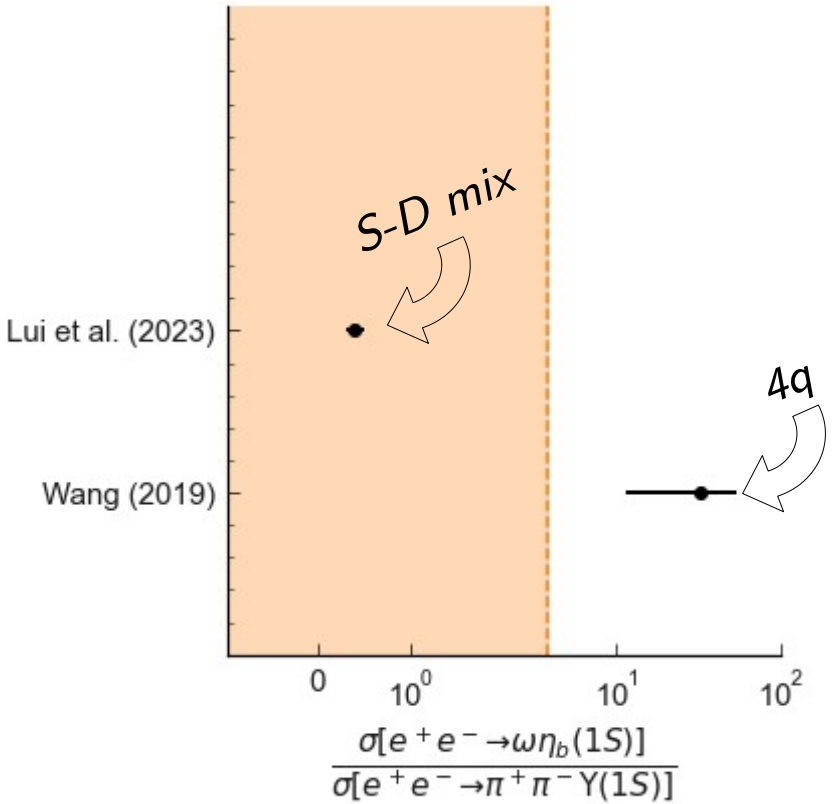
[Phys. Rev. D 109, 072013 (2024)]



No evidence of ω transition to $\eta_b(1S)$!

$$\sigma_{\mathrm{B}}(e^+e^- \to \eta_b(1S)\omega) < 2.5\,\mathrm{pb}$$

Compatible with S-D mixed

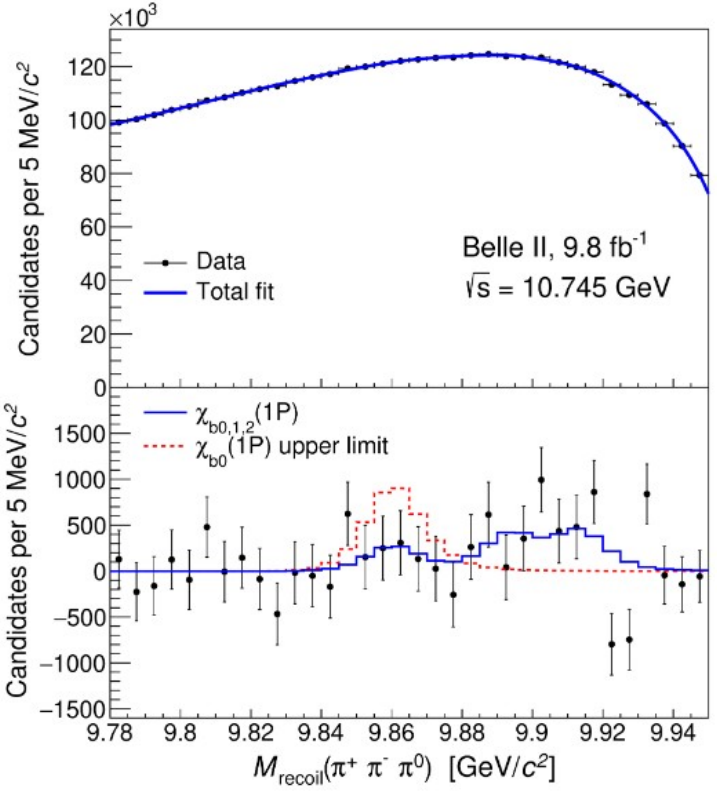


$e^+e^- \to \chi_{b0}(1P)\ \omega$

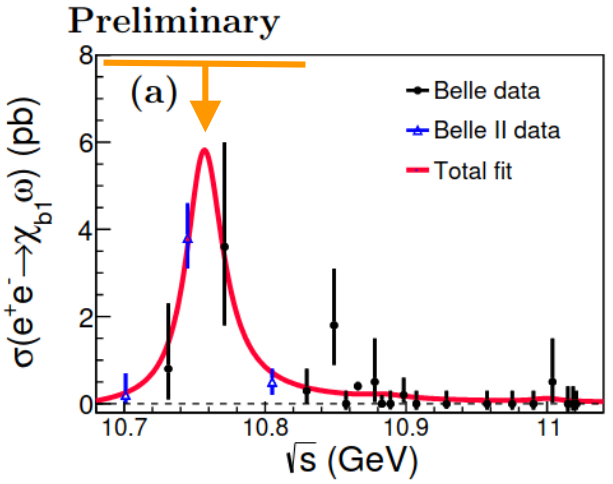
[Phys. Rev. D 109, 072013 (2024)]

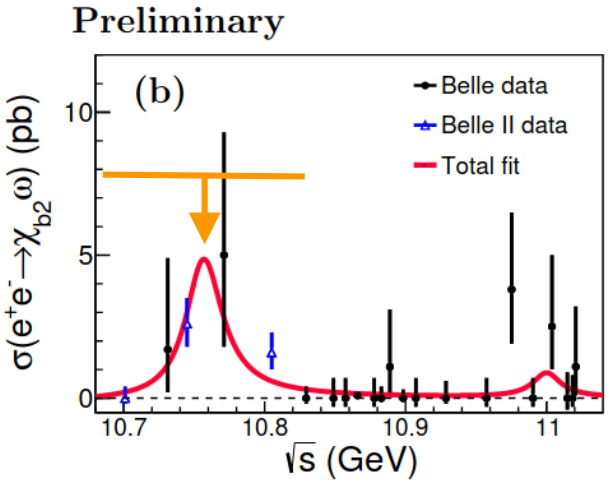
Side result: transition to the $\chi_{b0}(1P)$

→ Small BF to γ Y(1S), better done inclusively



$$\sigma_B(e^+e^- \to \chi_{b0}(1P)\omega) < 7.8 \text{ pb.}$$





$e^+e^- \to \Upsilon(1,2S)\ \eta$

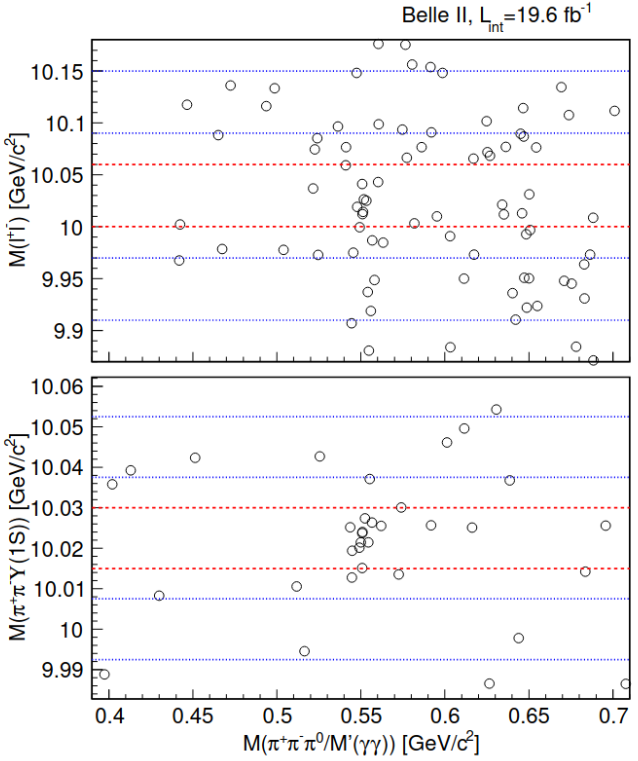
[ArXiv 2509.01917]

NEW

Spin-flipping counterpart of the di-pion transition

→ Reconstruct full decay chain down to Y(1S) or Y(2S)

→ No sign of Y(1S), evidence of Y(2S)



Mode	$N_{\rm prod}$ $(\times 10^3)$	$(1+\delta)$	$\epsilon(\%)$	$\sigma_{\rm B}^{\rm (UL)}$ (pb)
$\sqrt{s} = (10653.30 \pm 1.14)$ MeV,		$\mathcal{L} = 3.512$ fb^{-1}		
$\eta\Upsilon(2S)$	$(3.7^{+1.6}_{-1.3}), 4.2\sigma$	0.843	19.2/15.1	$1.16^{+0.51}_{-0.41} \pm 0.38$
$\eta\Upsilon(1S)$	< 0.4	0.895	23.9	< 0.10
γX_b	< 0.3	0.784	32.0	< 0.14
$\sqrt{s} = (10700.90 \pm 0.63)$ MeV,		$\mathcal{L} = 1.632$ fb^{-1}		
$\eta\Upsilon(2S)$	$(0.0^{+1.0}_{-0.0})$	1.691	13.2/7.6	$0.00^{+0.34}_{-0.00} \pm 0.50$
$\eta\Upsilon(1S)$	< 0.4	0.901	24.0	< 0.22
γX_b	< 0.1	0.803	31.3	< 0.09
$\sqrt{s} = (10746.30 \pm 0.48)$ MeV,		$\mathcal{L} = 9.818$ fb^{-1}		
$\eta\Upsilon(2S)$	$(3.2^{+1.6}_{-1.2}), 4.8\sigma$	0.673	17.4/14.2	$0.45^{+0.23}_{-0.17} \pm 0.05$
$\eta\Upsilon(1S)$	< 0.9	0.906	23.8	< 0.09
γX_b	< 1.4	0.817	29.8	< 0.17
$\sqrt{s} = (10804.50 \pm 0.70)$ MeV,		$\mathcal{L} = 4.689$ fb^{-1}		
$\eta\Upsilon(2S)$	$(1.5^{+1.3}_{-0.9}), 2.8\sigma$	0.822	17.1/15.2	$0.36^{+0.33}_{-0.21} \pm 0.04$
$\eta\Upsilon(1S)$	< 0.4	0.912	24.6	< 0.08
γX_b	< 1.3	0.833	28.2	< 0.32

$e^+e^- \to Y(1,2S)\ \eta$

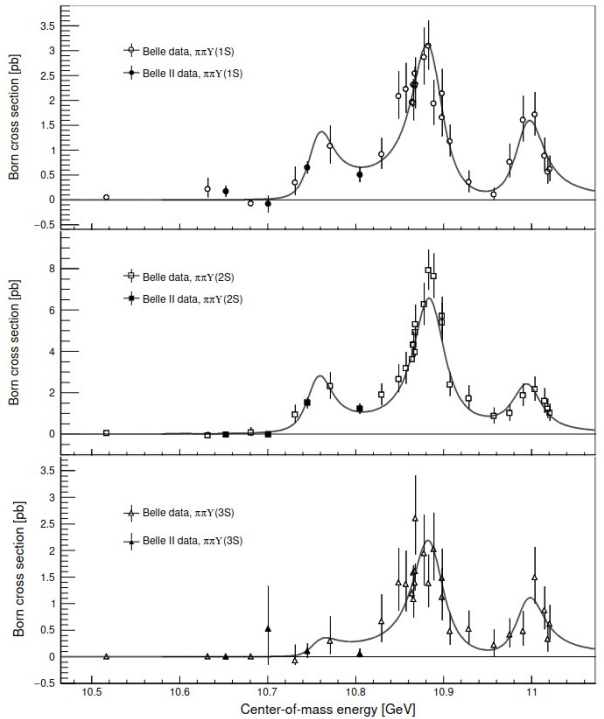
[ArXiv 2509.01917]

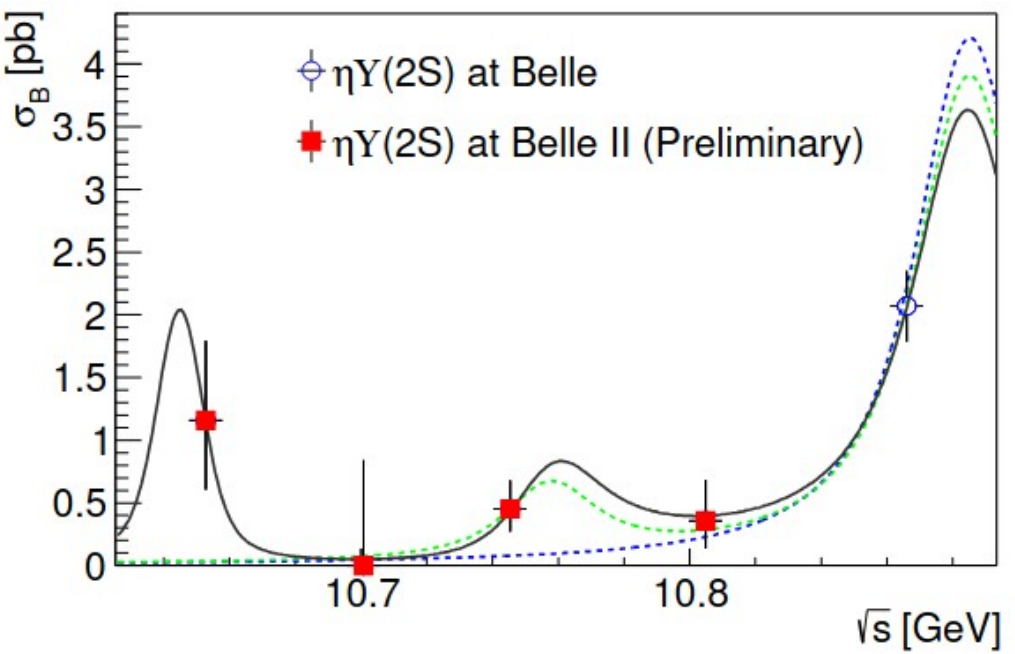
NEW

$\sigma(e^+e^-) \to \eta\ Y(1S) < 0.1\text{-}0.2$ pb

$\sigma(e^+e^-) \to \eta\ Y(2S) \sim 0.5\text{-}1$ pb @ Y(10753)

$\to$ Comparable with di-pion transition ($\sim$ 2 pb on peak)





$e^+e^- \to Y(1,2S)\ \eta$

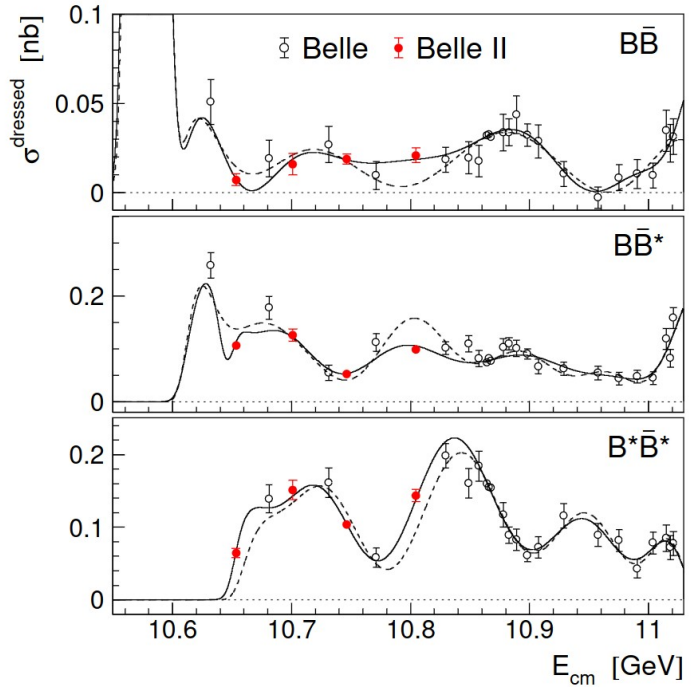
[ArXiv 2509.01917] NEW

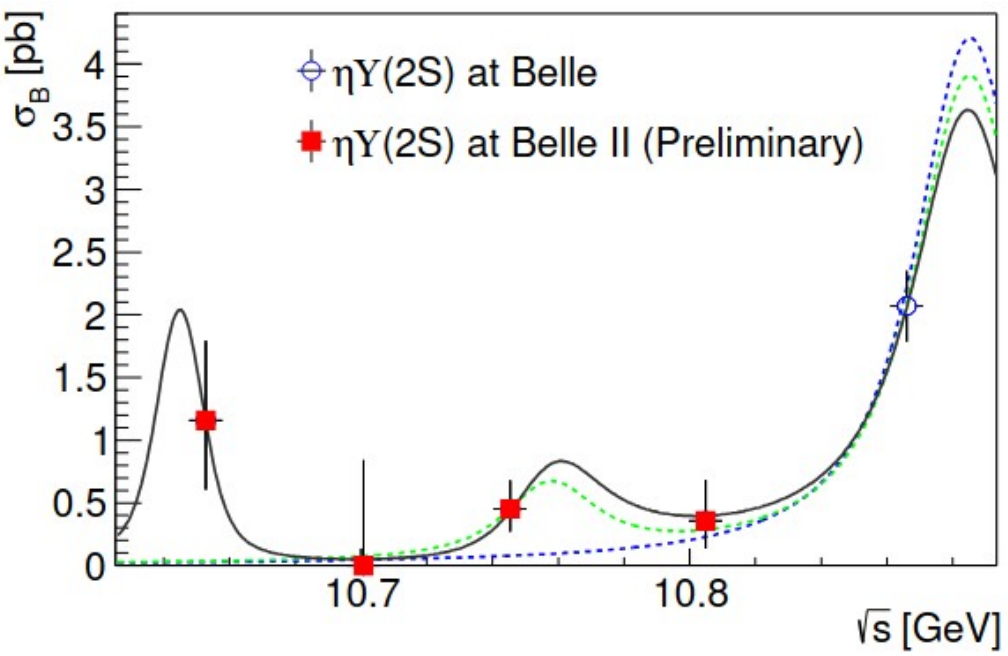
$\sigma(e^+e^-) \to \eta\ Y(1S) < 0.1\text{-}0.2$ pb

$\sigma(e^+e^-) \to \eta\ Y(2S) \sim 0.5\text{-}1$ pb @ Y(10753)

$\to$ Comparable with di-pion transition ($\sim$ 2 pb on peak)

$\to$ Hint of enhancement at the B*B* Threshold?





$e^+e^- \to Y(1D)\pi^+\pi^-$

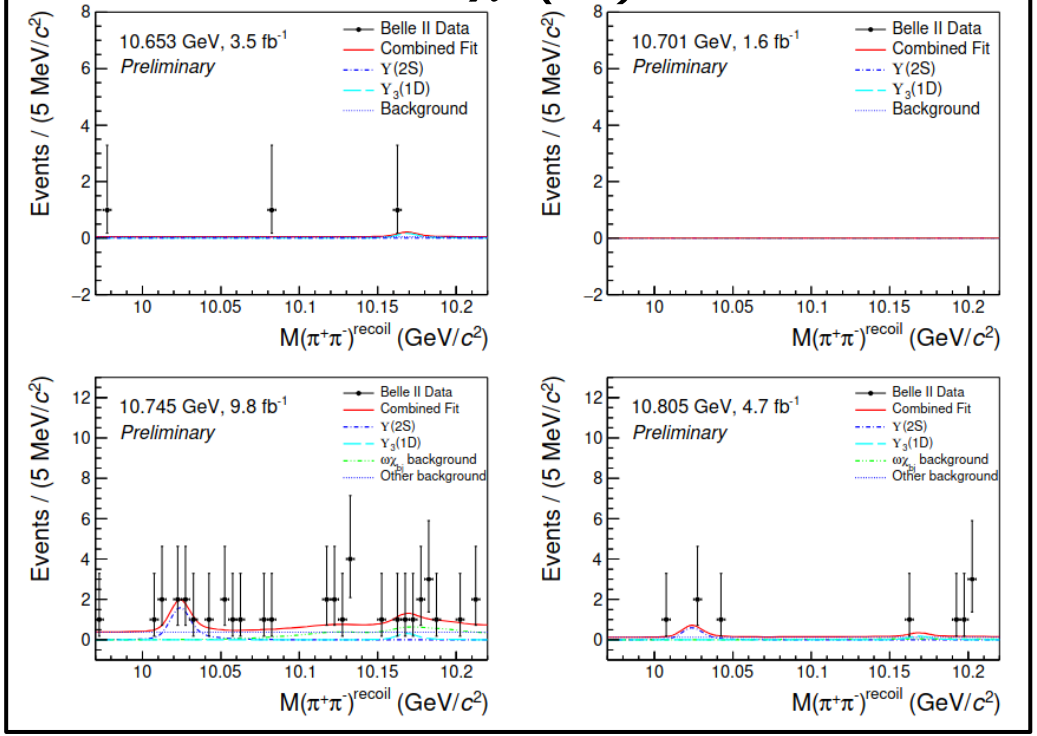
[ArXiv 2602.19807]

NEW

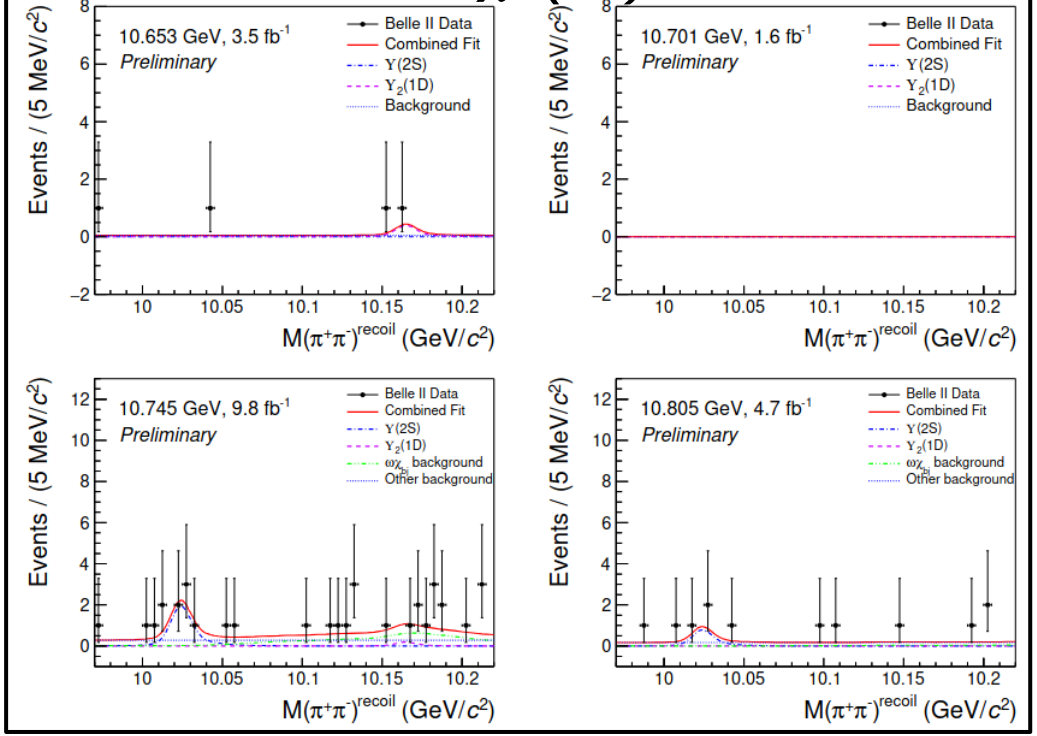
Reconstruct Y(1D) → γ $\chi_{b1,2}$(1P) → γγ Y(1S)

→ Separate between Y_2(1D) and Y_3(1D)

$\chi_{b2}(1P)$



$\chi_{b1}(1P)$



$e^+e^- \to Y(1D)\pi^+\pi^-$

Reconstruct Y(1D) → γ $\chi_{b1,2}$(1P) → γγ Y(1S)

→ Separate between Y_2(1D) and Y_3(1D)

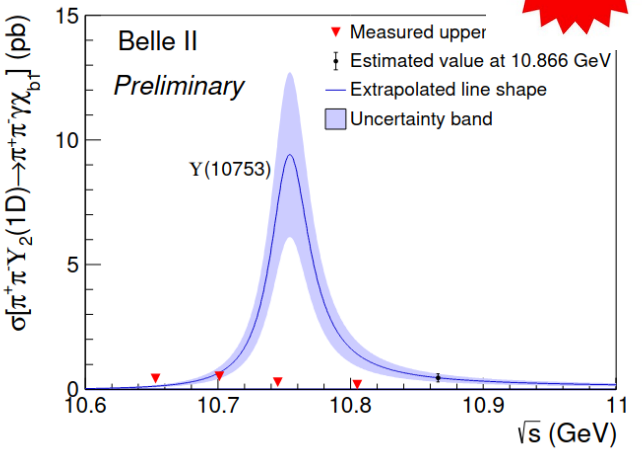
→ Separate upper limits: pure Y(5S) or pure Y(10750)

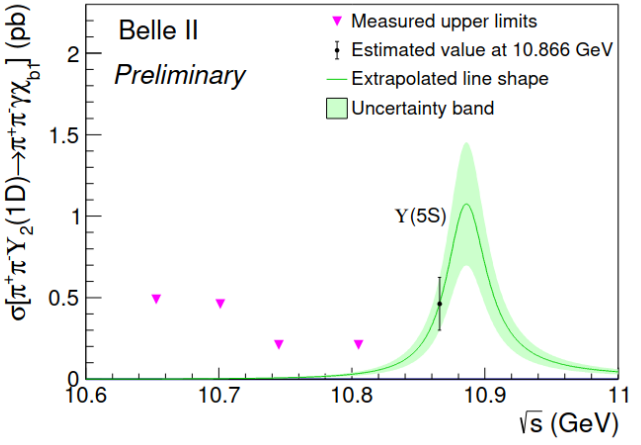
[ArXiv 2602.19807]

NEW

$\sqrt{s}$ (GeV)	$\mathcal{L}$ (fb^{-1})	ϵ^w	$(1+\delta)$	$N_{\Upsilon_3(1D)}$	$\sigma \times \mathcal{B}$ (pb)
10.653	3.5	0.177 (0.169)	0.893 (0.827)	< 3.6	< 0.73 (< 0.83)
10.701	1.6	0.202 (0.180)	0.724 (0.901)	< 2.3	< 1.12 (< 1.01)
10.745	9.8	0.212 (0.194)	0.587 (0.883)	< 7.4	< 0.69 (< 0.53)
10.805	4.7	0.170 (0.209)	1.042 (0.728)	< 5.2	< 0.71 (< 0.83)

$\sqrt{s}$ (GeV)	$\mathcal{L}$ (fb^{-1})	ϵ^w	$(1+\delta)$	$N_{\Upsilon_2(1D)}$	$R_{\chi_{b2}}$	$\sigma \times \mathcal{B}$ (pb)
10.653	3.5	0.180 (0.172)	0.895 (0.819)	< 4.6	0.099	< 0.43 (< 0.49)
10.701	1.6	0.202 (0.177)	0.723 (0.923)	< 2.3	0.100	< 0.52 (< 0.46)
10.745	9.8	0.215 (0.191)	0.587 (0.885)	< 6.8	0.099	< 0.29 (< 0.21)
10.805	4.7	0.176 (0.216)	1.039 (0.732)	< 3.0	0.100	< 0.18 (< 0.21)





The Y(10750) scan results

Di-pion transitions $e^+e^- \to \Upsilon(nS)\ \pi^+\pi^-$ *[JHEP 07 (2024) 116]*

→ No f_0 contribution in the di-pion mass

3-π transitions $e^+e^- \to \chi_{bJ}(1P)\ \omega,\pi^+\pi^-\pi^0$ *[Arxiv 2510.25461]*

→ Large ω VS non-ω differences

$e^+e^- \to \Upsilon(nS)\ \eta$ *[ArXiv 2509.01917]*

→ Hint of another resonant state and no HQSS suppression?

$e^+e^- \to B^{(*)}B^{(*)}$ *[JHEP 10 114 (2024)]*

→ Indication of a B*B* bound state

see *[Salnikov, Nucl. Phys. A 1041 (2024) 122764]*

$e^+e^- \to \omega\eta_b(1S)$ *[PRD 109, 072013 (2024)]*

→ favoured in tetraquark models, not observed

$e^+e^- \to \pi\pi\ \Upsilon(1D)$

→ No signs

Work in progress...

$e^+e^- \to \eta h_b(1P)$

$e^+e^- \to \pi\pi h_b(1P)$

$e^+e^- \to \Upsilon(nS) + X$

[...]

Future prospects and conclusions

So far Belle II has mostly focused on the bottomonium threshold region

→ Lots of results out of one month of dedicated data taking

→ Nature of Y(10753) seems still unclear

We aim at integrating 1 ab^{-1} by summer 2026

→ Competitive with Belle on ISR charmonium studies and B → charmonium +X

Several ideas for dedicated data taking

→ R_b scan: 50 points between 10.5 – 10.68 GeV, 0.1 fb^{-1} each

→ Y(6S): 20-50 fb^{-1} (10-20 x Belle, all on-peak)

→ BB* and B*B* threshold scan: 40 fb^{-1} around each threshold

→ Scan at max energy (~11.18): B_{s0} and B_{s1} production

Future prospects and conclusions

So far Belle II has mostly focused on the bottomonium threshold region

→ Lots of results out of one month of dedicated data taking

→ Nature of Y(10753) seems still unclear

We aim at integrating 1 ab^{-1} by summer 2026

→ Competitive with Belle on ISR charmonium studies and B → charmonium +X

Several ideas for dedicated data taking

→ R_b scan: 50 points between 10.5 – 10.68 GeV, 0.1 fb^{-1} each

→ Y(6S): 20-50 fb^{-1} (10-20 x Belle, all on-peak)

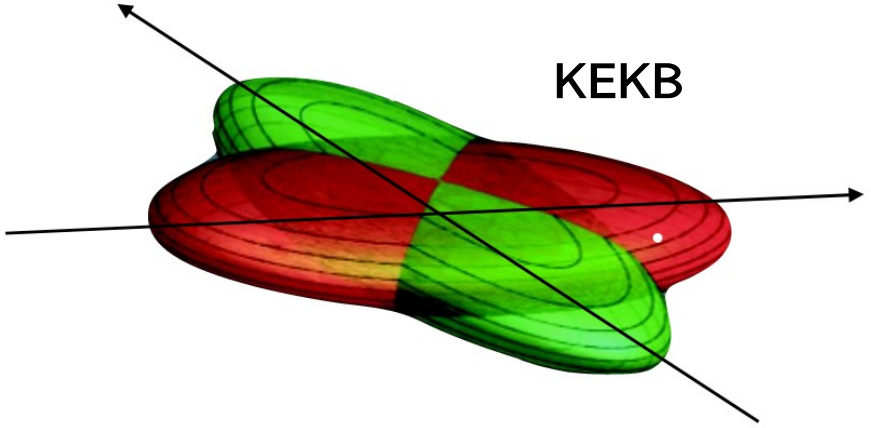
→ BB* and B*B* threshold scan: 40 fb^{-1} around each threshold

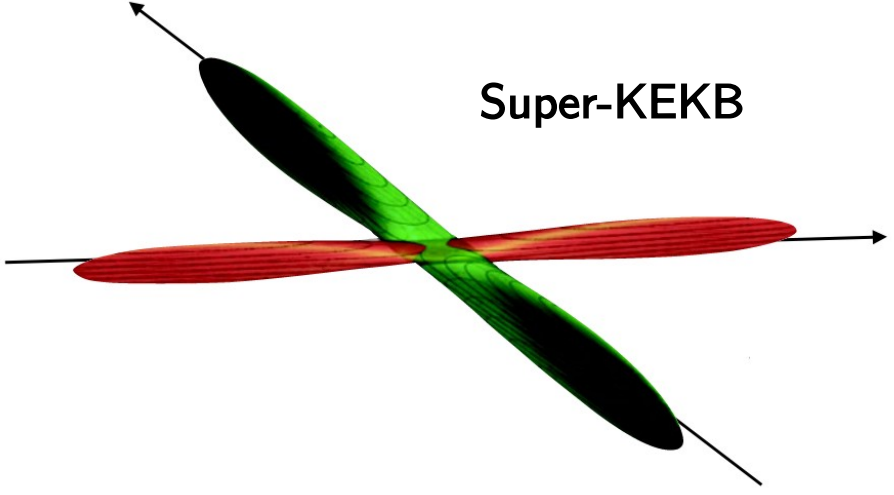
→ Scan at max energy (~11.18): B_{s0} and B_{s1} production

Nothing decided or approved: inputs are welcome!

End

Super-KEKB: the nano-beam scheme

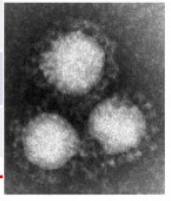




Low emittance ("nano-beam") scheme
⇒ first proposed by P. Raimondi.

	KEKB (LER/HER)	SuperKEKB(LER/HER)
Beam Energy (GeV)	3.5/8.0	4.0/7.0
Beam Current (A)	1.64/1.19	3.6/2.6
# of bunches	1584/1584	2500/2500
β_x^* / β_y^* (mm)	1200/5.9, 1200/5.9	32/0.27, 25/0.3
σ_x^* / σ_y^* (μm)	147/0.94, 170/0.94	10.1/0.048, 10.7/0.062
Half crossing angle θ_x $(mrad)$	11	41.5
Piwinski angle (rad)	0 (w crab crossing)	~20
Luminosity ($\times 10^{34} cm^{-2} s^{-1}$)	2.1	60

$\phi_{Piw} \equiv \theta_x \sigma_z / \sigma_x^*$



COVID-19

Bottomonium exotica

Exotic search with Ecm $<$ 12 GeV are challenging

$\rightarrow$ rely on rare, soft EM transitions

[Ali et. Al., Prog. Part. Nucl. Phys. 97 (2017) 123-198]

Label	J^{PC}	charmonium-like State	charmonium-like Mass [MeV]	bottomonium-like State	bottomonium-like Mass [MeV]
X_0	0^{++}	—	3756	—	10562
X_0'	0^{++}	—	4024	—	10652
X_1	1^{++}	$X(3872)$	3890	—	10607
Z	1^{+-}	$Z_c^+(3900)$	3890	$Z_b^{+,0}(10610)$	10607
Z'	1^{+-}	$Z_c^+(4020)$	4024	$Z_b^+(10650)$	10652
X_2	2^{++}	—	4024	—	10652
Y_1	1^{--}	$Y(4008)$	4024	$Y_b(10890)$	10891
Y_2	1^{--}	$Y(4260)$	4263	$\Upsilon(11020)$	10987
Y_3	1^{--}	$Y(4290)$ (or $Y(4220)$)	4292	—	10981
Y_4	1^{--}	$Y(4630)$	4607	—	11135
Y_5	1^{--}	—	6472	—	13036

[Voloshin, PRD 84 031502]

