

$\eta_b(1S)$

$$I^G(J^{PC}) = 0^+(0^{-+})$$

OMITTED FROM SUMMARY TABLE

Quantum numbers shown are quark-model predictions. Observed in radiative decay of the $\Upsilon(3S)$, therefore $C = +$.

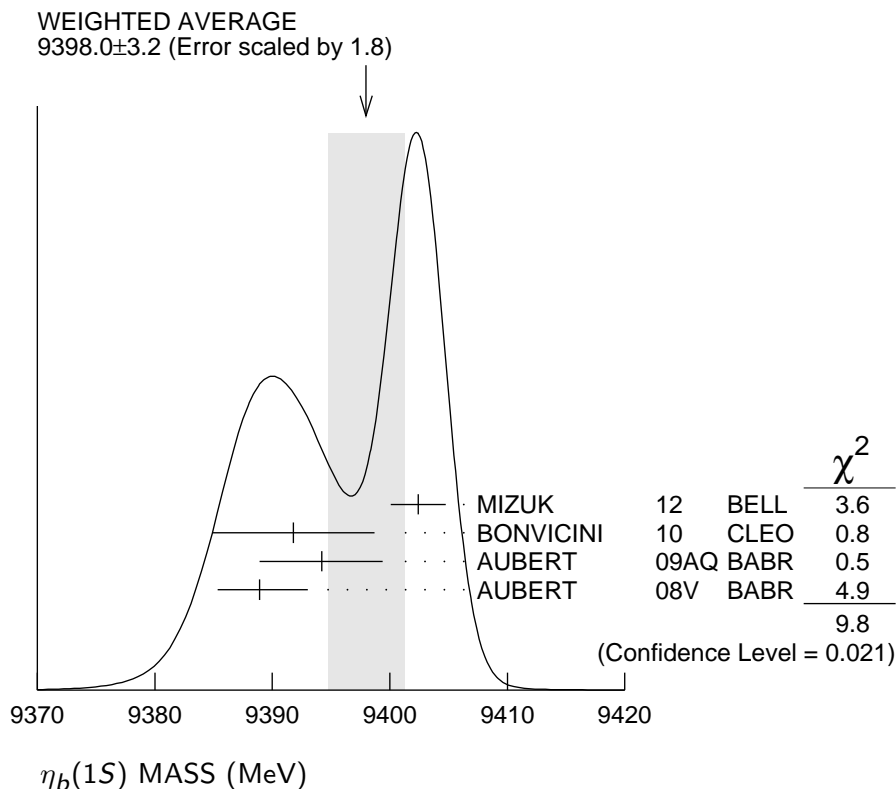
$\eta_b(1S)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
9398.0 ± 3.2 OUR AVERAGE		Error includes scale factor of 1.8. See the ideogram below.		
9402.4 ± 1.5 ± 1.8	34k	¹ MIZUK	12 BELL	$e^+e^- \rightarrow \gamma\pi^+\pi^- + \text{hadrons}$
9391.8 ± 6.6 ± 2.0	2.3 ± 0.5k	² BONVICINI	10 CLEO	$\Upsilon(3S) \rightarrow \gamma X$
9394.2 ⁺ ₋ 4.8 ⁺ ₋ 4.9 ± 2.0	13 ± 5k	² AUBERT	09AQ BABR	$\Upsilon(2S) \rightarrow \gamma X$
9388.9 ⁺ ₋ 3.1 ⁺ ₋ 2.3 ± 2.7	19 ± 3k	² AUBERT	08V BABR	$\Upsilon(3S) \rightarrow \gamma X$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
9393.2 ± 3.4 ± 2.3	10 ⁺ ₋₄	^{2,3} DOBBS	12	$\Upsilon(2S) \rightarrow \gamma \text{hadrons}$
9300 ± 20 ± 20		HEISTER	02D ALEP	181–209 e^+e^-

¹ With floating width. Not independent of the corresponding mass difference measurement.

² Assuming $\Gamma_{\eta_b(1S)} = 10$ MeV. Not independent of the corresponding γ energy or mass difference measurements.

³ Obtained by analyzing CLEO III data but not authored by the CLEO Collaboration.



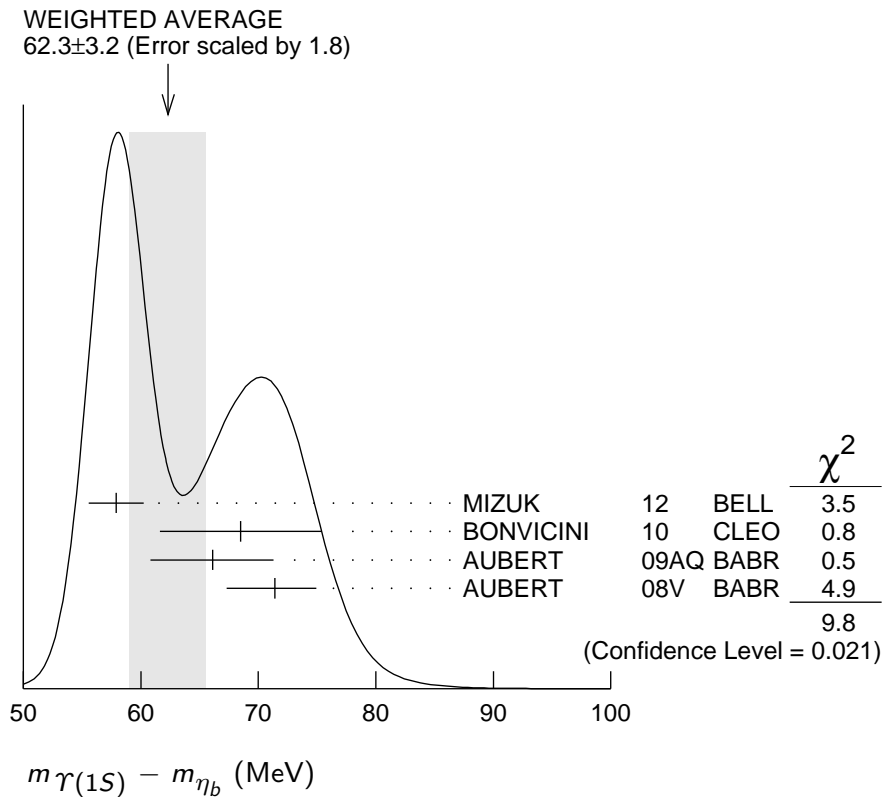
$m_{\Upsilon(1S)} - m_{\eta_b}$

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
62.3±3.2 OUR AVERAGE	Error includes scale factor of 1.8. See the ideogram below.			
57.9±1.5±1.8	34k	⁴ MIZUK	12 BELL	$e^+e^- \rightarrow \gamma\pi^+\pi^- + \text{hadrons}$
68.5±6.6±2.0	2.3±0.5k	⁵ BONVICINI	10 CLEO	$\Upsilon(3S) \rightarrow \gamma X$
66.1 ^{+4.8} _{-4.9} ±2.0	13±5k	⁵ AUBERT	09AQ BABR	$\Upsilon(2S) \rightarrow \gamma X$
71.4 ^{+2.3} _{-3.1} ±2.7	19±3k	⁵ AUBERT	08V BABR	$\Upsilon(3S) \rightarrow \gamma X$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
67.1±3.4±2.3	10 ⁺⁵ ₋₄	^{5,6} DOBBS	12	$\Upsilon(2S) \rightarrow \gamma \text{hadrons}$

⁴ With floating width. Not independent of the corresponding mass measurement.

⁵ Assuming $\Gamma_{\eta_b(1S)} = 10$ MeV. Not independent of the corresponding γ energy or mass measurements.

⁶ Obtained by analyzing CLEO III data but not authored by the CLEO Collaboration.



γ ENERGY IN $\Upsilon(3S)$ DECAY

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
920.6^{+2.8}_{-3.2} OUR AVERAGE				
918.6±6.0±1.9	2.3±0.5k	⁷ BONVICINI	10 CLEO	$\Upsilon(3S) \rightarrow \gamma X$
921.2 ^{+2.1} _{-2.8} ±2.4	19±3k	⁷ AUBERT	08V BABR	$\Upsilon(3S) \rightarrow \gamma X$

⁷ Assuming $\Gamma_{\eta_b(1S)} = 10$ MeV. Not independent of the corresponding mass or mass difference measurements.

γ ENERGY IN $\Upsilon(2S)$ DECAY

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
$609.3^{+4.6}_{-4.5} \pm 1.9$	$13 \pm 5k$	⁸ AUBERT	09AQ BABR	$\Upsilon(2S) \rightarrow \gamma X$

⁸ Assuming $\Gamma_{\eta_b(1S)} = 10$ MeV. Not independent of the corresponding mass or mass difference measurements.

$\eta_b(1S)$ WIDTH

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
$10.8^{+4.0+4.5}_{-3.7-2.0}$	34k	⁹ MIZUK	12 BELL	$e^+e^- \rightarrow \gamma\pi^+\pi^- + \text{hadrons}$

⁹ With floating mass.

$\eta_b(1S)$ DECAY MODES

Mode	Fraction (Γ_i/Γ)	Confidence level
Γ_1 hadrons	seen	
Γ_2 $3h^+3h^-$	not seen	
Γ_3 $2h^+2h^-$	not seen	
Γ_4 $4h^+4h^-$		
Γ_5 $\gamma\gamma$	not seen	
Γ_6 $\mu^+\mu^-$	$<9 \times 10^{-3}$	90%
Γ_7 $\tau^+\tau^-$	$<8\%$	90%

$\eta_b(1S)$ $\Gamma(i)\Gamma(\gamma\gamma)/\Gamma(\text{total})$

$\Gamma(3h^+3h^-) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ $\Gamma_2\Gamma_5/\Gamma$

VALUE (eV)	CL%	DOCUMENT ID	TECN	COMMENT
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• • • We do not use the following data for averages, fits, limits, etc. • • •

<470	95	ABDALLAH	06 DLPH	161–209 e^+e^-
<132	95	HEISTER	02D ALEP	181–209 e^+e^-

$\Gamma(2h^+2h^-) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ $\Gamma_3\Gamma_5/\Gamma$

VALUE (eV)	CL%	DOCUMENT ID	TECN	COMMENT
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• • • We do not use the following data for averages, fits, limits, etc. • • •

<190	95	ABDALLAH	06 DLPH	161–209 e^+e^-
<48	95	HEISTER	02D ALEP	181–209 e^+e^-

$\Gamma(4h^+4h^-) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ $\Gamma_4\Gamma_5/\Gamma$

VALUE (eV)	CL%	DOCUMENT ID	TECN	COMMENT
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• • • We do not use the following data for averages, fits, limits, etc. • • •

<660	95	ABDALLAH 06	DLPH	161–209 e^+e^-
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$\eta_b(1S)$ BRANCHING RATIOS

$\Gamma(\text{hadrons})/\Gamma_{\text{total}}$ Γ_1/Γ

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
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seen	34k	MIZUK 12	BELL	$e^+e^- \rightarrow \gamma\pi^+\pi^- + \text{hadrons}$
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$\Gamma(\mu^+\mu^-)/\Gamma_{\text{total}}$ Γ_6/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
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$<9 \times 10^{-3}$	90	¹⁰ AUBERT 09Z	BABR	$e^+e^- \rightarrow \Upsilon(2S,3S) \rightarrow \gamma\eta_b$
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¹⁰ Obtained using $B(\Upsilon(2S) \rightarrow \gamma\eta_b) = (4.2_{-1.0}^{+1.1} \pm 0.9) \times 10^{-4}$ and $B(\Upsilon(3S) \rightarrow \gamma\eta_b) = (4.8 \pm 0.5 \pm 0.6) \times 10^{-4}$. This limit is equivalent to $B(\eta_b \rightarrow \mu^+\mu^-) = (-0.25 \pm 0.51 \pm 0.33)\%$ measurement.

$\Gamma(\tau^+\tau^-)/\Gamma_{\text{total}}$ Γ_7/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
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$<8 \times 10^{-2}$	90	AUBERT 09P	BABR	$e^+e^- \rightarrow \gamma\tau^+\tau^-$
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$\eta_b(1S)$ REFERENCES

DOBBS 12	PRL 109 082001	S. Dobbs <i>et al.</i>	
MIZUK 12	PRL 109 232002	R. Mizuk <i>et al.</i>	(BELLE Collab.)
BONVICINI 10	PR D81 031104	G. Bonvicini <i>et al.</i>	(CLEO Collab.)
AUBERT 09AQ	PRL 103 161801	B. Aubert <i>et al.</i>	(BABAR Collab.)
AUBERT 09P	PRL 103 181801	B. Aubert <i>et al.</i>	(BABAR Collab.)
AUBERT 09Z	PRL 103 081803	B. Aubert <i>et al.</i>	(BABAR Collab.)
AUBERT 08V	PRL 101 071801	B. Aubert <i>et al.</i>	(BABAR Collab.)
ABDALLAH 06	PL B634 340	J.M. Abdallah <i>et al.</i>	(DELPHI Collab.)
HEISTER 02D	PL B530 56	A. Heister <i>et al.</i>	(ALEPH Collab.)