

$\eta_b(1S)$

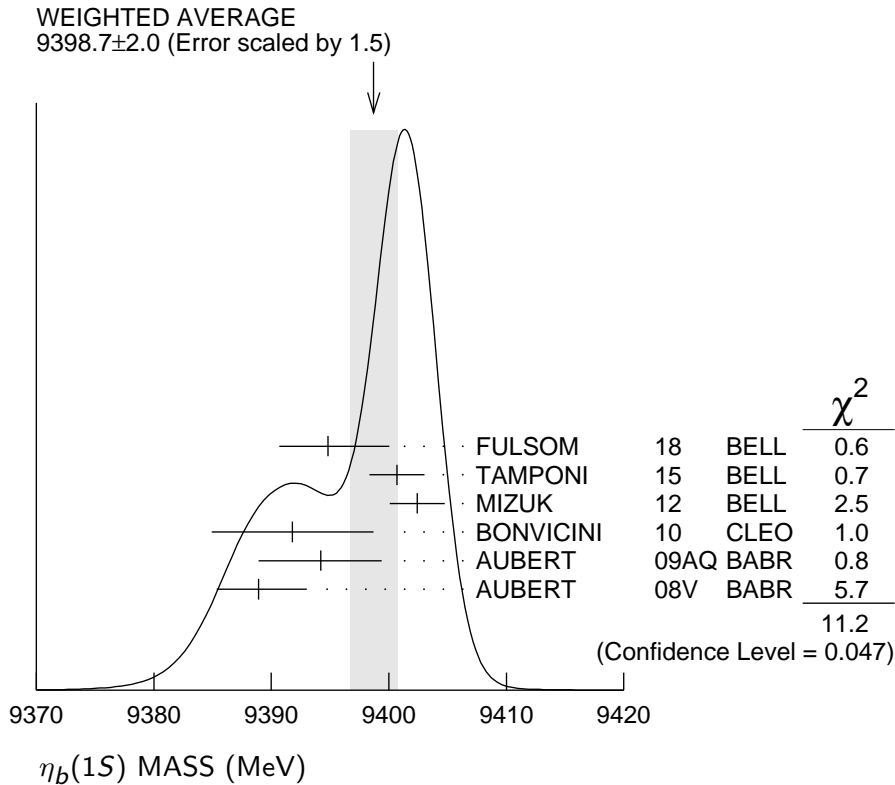
$$I^G(J^{PC}) = 0^+(0^{-+})$$

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
9398.7 ± 2.0 OUR AVERAGE		Error includes scale factor of 1.5. See the ideogram below.		
9394.8 ⁺ ₋ 2.7 ⁺ ₋ 3.1 ⁻ ₋ 4.5 ⁻ ₋ 2.7	29K	FULSOM	18 BELL	$\Upsilon(2S) \rightarrow \gamma X$
9400.7 ± 1.7 ± 1.6	33.1k	TAMPONI	15 BELL	$e^+ e^- \rightarrow \gamma \eta + \text{hadrons}$
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	2.3k	² BONVICINI	10 CLEO	$\Upsilon(3S) \rightarrow \gamma X$
9394.2 ⁺ ₋ 4.8 ⁺ ₋ 4.9 ⁻ ₋ ± 2.0	13k	² AUBERT	09AQ BABR	$\Upsilon(2S) \rightarrow \gamma X$
9388.9 ⁺ ₋ 3.1 ⁺ ₋ 2.3 ⁻ ₋ ± 2.7	19k	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	^{2,3} DOBBS	12	$\Upsilon(2S) \rightarrow \gamma \text{hadrons}$
9300 ± 20 ± 20		HEISTER	02D ALEP	181–209 $e^+ e^-$

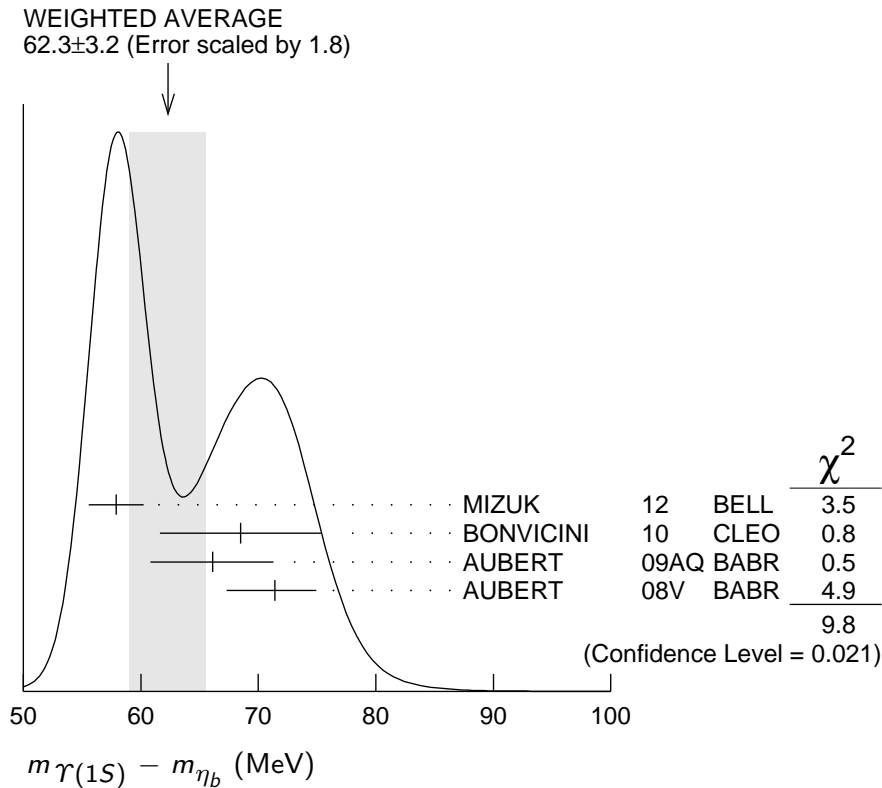
- ¹ With floating width. Not independent of the corresponding mass difference measurement.
- ² Assuming $\Gamma_{\eta_b(1S)} = 10$ MeV. Not independent of the corresponding γ energy or mass difference measurements.
- ³ Obtained by analyzing CLEO III data but not authored by the CLEO Collaboration.



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

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
62.3 ± 3.2 OUR AVERAGE	Error includes scale factor of 1.8. See the ideogram below.			
$57.9 \pm 1.5 \pm 1.8$	34k	¹ MIZUK	12 BELL	$e^+e^- \rightarrow \gamma\pi^+\pi^- + \text{hadrons}$
$68.5 \pm 6.6 \pm 2.0$	$2.3 \pm 0.5k$	² BONVICINI	10 CLEO	$\Upsilon(3S) \rightarrow \gamma X$
$66.1^{+4.8}_{-4.9} \pm 2.0$	$13 \pm 5k$	² AUBERT	09AQ BABR	$\Upsilon(2S) \rightarrow \gamma X$
$71.4^{+2.3}_{-3.1} \pm 2.7$	$19 \pm 3k$	² AUBERT	08V BABR	$\Upsilon(3S) \rightarrow \gamma X$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
$67.1 \pm 3.4 \pm 2.3$	10^{+5}_{-4}	^{2,3} DOBBS	12	$\Upsilon(2S) \rightarrow \gamma \text{hadrons}$

- ¹ With floating width. Not independent of the corresponding mass measurement.
² Assuming $\Gamma_{\eta_b(1S)} = 10$ MeV. Not independent of the corresponding γ energy or mass measurements.
³ 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				
$918.6 \pm 6.0 \pm 1.9$	$2.3 \pm 0.5k$	¹ BONVICINI	10 CLEO	$\Upsilon(3S) \rightarrow \gamma X$
$921.2^{+2.1}_{-2.8} \pm 2.4$	$19 \pm 3k$	¹ AUBERT	08V BABR	$\Upsilon(3S) \rightarrow \gamma X$

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

γ ENERGY IN $\Upsilon(2S)$ DECAY

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
609.3^{+4.6}_{-4.5} ± 1.9	13 ± 5k	¹ AUBERT	09AQ BABR	$\Upsilon(2S) \rightarrow \gamma X$

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

$\eta_b(1S)$ WIDTH

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
10⁺⁵₋₄ OUR AVERAGE				
8 ⁺⁶ ₋₅ ± 5	33.1k	¹ TAMPONI	15 BELL	$e^+e^- \rightarrow \gamma\eta + \text{hadrons}$
10.8 ^{+4.0+4.5} _{-3.7-2.0}	34k	¹ MIZUK	12 BELL	$e^+e^- \rightarrow \gamma\pi^+\pi^- + \text{hadrons}$

¹ 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 $4h^+4h^-$	not seen	
Γ_5 $\gamma\gamma$	not seen	
Γ_6 $\mu^+\mu^-$	$<9 \times 10^{-3}$	90%
Γ_7 $\tau^+\tau^-$	$<8\%$	90%

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

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

<u>VALUE (eV)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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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^-

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

<u>VALUE (eV)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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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	¹ AUBERT 09Z	BABR	$e^+e^- \rightarrow \Upsilon(2S,3S) \rightarrow \gamma\eta_b$
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¹Obtained 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

FULSOM	18	PRL 121 232001	B.G. Fulsom <i>et al.</i>	(BELLE Collab.)
TAMPONI	15	PRL 115 142001	U. Tamponi <i>et al.</i>	(BELLE Collab.)
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.)