

$\eta_b(1S)$

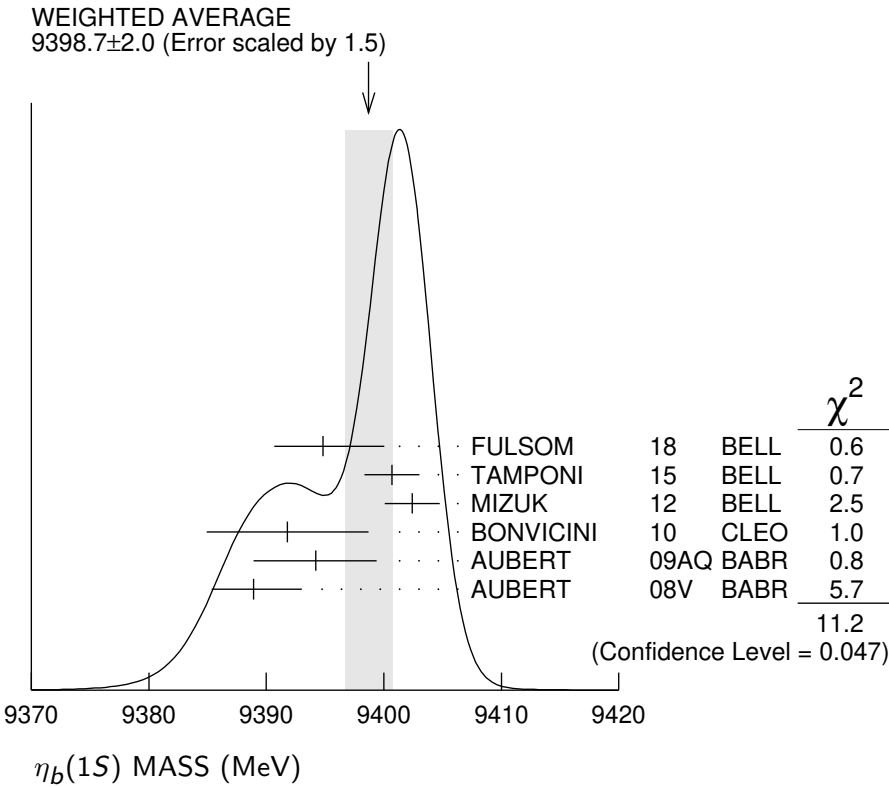
$I^G(J^{PC}) = 0^+(0^{-+})$

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 ⁺ _{−3.1} 2.7 ⁺ _{−2.7} 4.5	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 ⁺ _{−4.9} 4.8± 2.0 13k		² AUBERT	09AQ BABR	$\Upsilon(2S) \rightarrow \gamma X$
9388.9 ⁺ _{−2.3} 3.1± 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^-

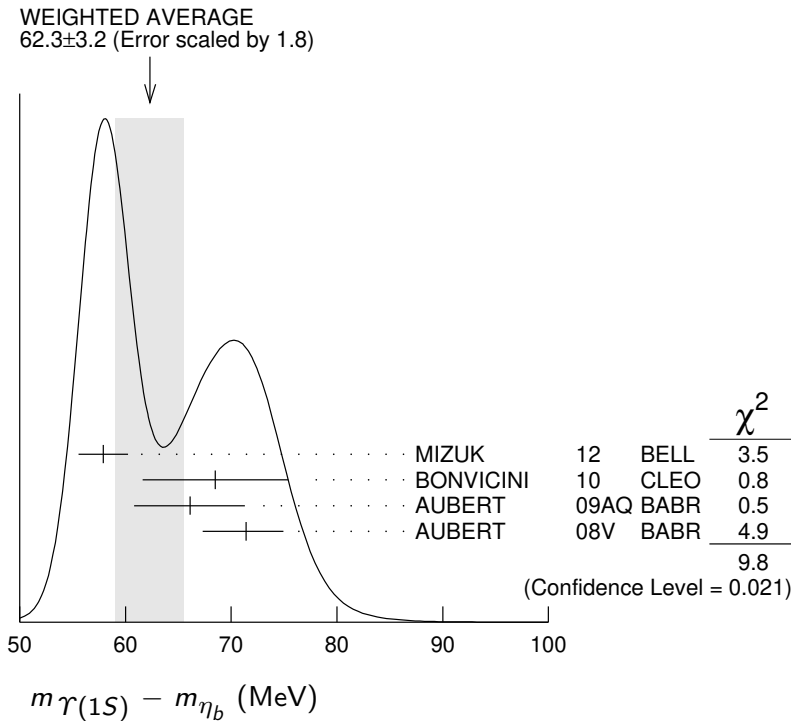
¹With floating width. Not independent of the corresponding mass difference measurement.
²Assuming $\Gamma_{\eta_b(1S)} = 10$ MeV. Not independent of the corresponding γ energy or mass difference measurements.
³Obtained by analyzing CLEO III data but not authored by the CLEO Collaboration.



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

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	¹ MIZUK	12 BELL	$e^+e^- \rightarrow \gamma\pi^+\pi^- + \text{hadrons}$
68.5±6.6±2.0	2.3 ± 0.5k	² BONVICINI	10 CLEO	$\Upsilon(3S) \rightarrow \gamma X$
66.1 ^{+4.8} _{-4.9} ±2.0	13 ± 5k	² AUBERT	09AQ BABR	$\Upsilon(2S) \rightarrow \gamma X$
71.4 ^{+2.3} _{-3.1} ±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. • • •				
67.1±3.4±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±6.0±1.9	2.3 ± 0.5k	¹ BONVICINI	10 CLEO	$\Upsilon(3S) \rightarrow \gamma X$
921.2 ^{+2.1} _{-2.8} ±2.4	19 ± 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

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
$609.3^{+4.6}_{-4.5} \pm 1.9$	$13 \pm 5k$	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

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
10 $^{+5}_{-4}$ OUR AVERAGE				
$8^{+6}_{-5} \pm 5$	$33.1k$	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%

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

$\Gamma(3h^+3h^-) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$					$\Gamma_2\Gamma_5/\Gamma$
VALUE (eV)	CL%	DOCUMENT ID	TECN	COMMENT	
• • • 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	
• • • 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	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<660	95	ABDALLAH	06 DLPH	161–209 e^+e^-	

$\eta_b(1S)$ BRANCHING RATIOS $\Gamma(\text{hadrons})/\Gamma_{\text{total}}$ Γ_1/Γ

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
seen	34k	MIZUK	12	BELL $e^+e^- \rightarrow \gamma\pi^+\pi^- + \text{hadrons}$

 $\Gamma(\mu^+\mu^-)/\Gamma_{\text{total}}$ Γ_6/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<9 \times 10^{-3}$	90	¹ AUBERT	09Z	BABR $e^+e^- \rightarrow \Upsilon(2S, 3S) \rightarrow \gamma\eta_b$

¹ Obtained using $B(\Upsilon(2S) \rightarrow \gamma\eta_b) = (4.2^{+1.1}_{-1.0} \pm 0.9) \times 10^{-4}$ 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
$<8 \times 10^{-2}$	90	AUBERT	09P	BABR $e^+e^- \rightarrow \gamma\tau^+\tau^-$

 $\eta_b(1S)$ 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.)