$\eta_b(1S)$

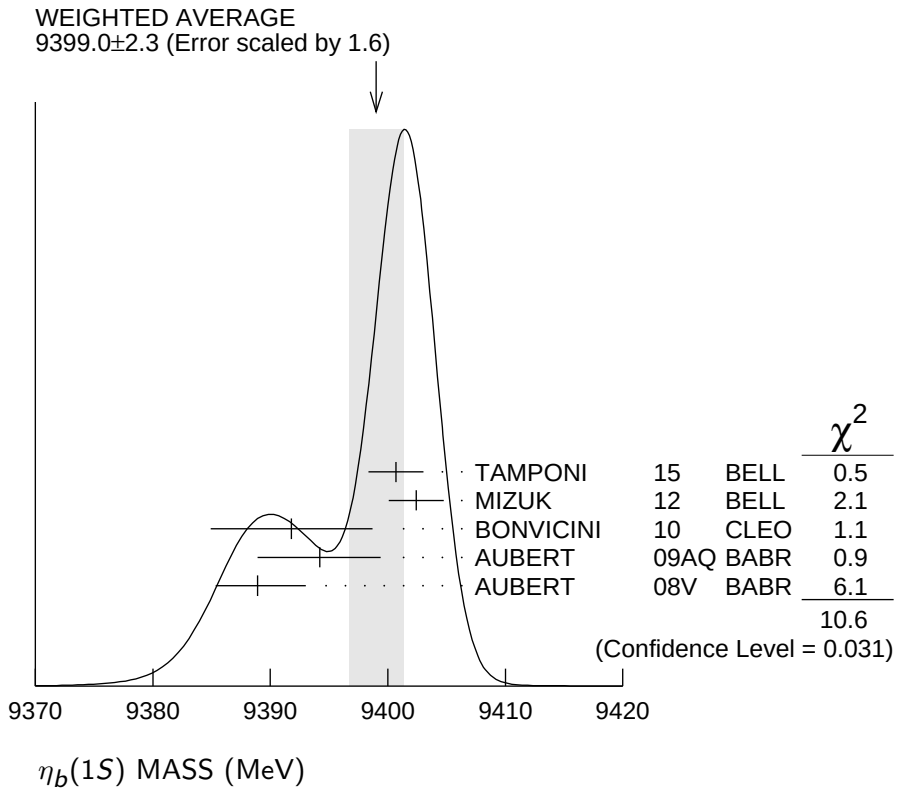
$I^G(J^{PC}) = 0^+(0^{-+})$

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*
9399.0± 2.3 OUR AVERAGE		Error includes scale factor of 1.6. See the ideogram below.			
9400.7± 1.7± 1.6	33.1k	TAMPONI	15	BELL	$e^+e^- \to \gamma\eta +$ hadrons
9402.4± 1.5± 1.8	34k	[1] MIZUK	12	BELL	$e^+e^- \to \gamma\pi^+\pi^- +$ hadrons
9391.8± 6.6± 2.0	2.3k	[2] BONVICINI	10	CLEO	$\Upsilon(3S) \to \gamma X$
$9394.2^{+\ 4.8}_{-\ 4.9}$ ± 2.0	13k	[2] AUBERT	09AQ	BABR	$\Upsilon(2S) \to \gamma X$
$9388.9^{+\ 3.1}_{-\ 2.3}$ ± 2.7	19k	[2] AUBERT	08V	BABR	$\Upsilon(3S) \to \gamma X$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
9393.2± 3.4± 2.3	10	[2,3] DOBBS	12		$\Upsilon(2S) \to \gamma$ hadrons
9300 ±20 ±20		HEISTER	02D	ALEP	181–209 e^+e^-

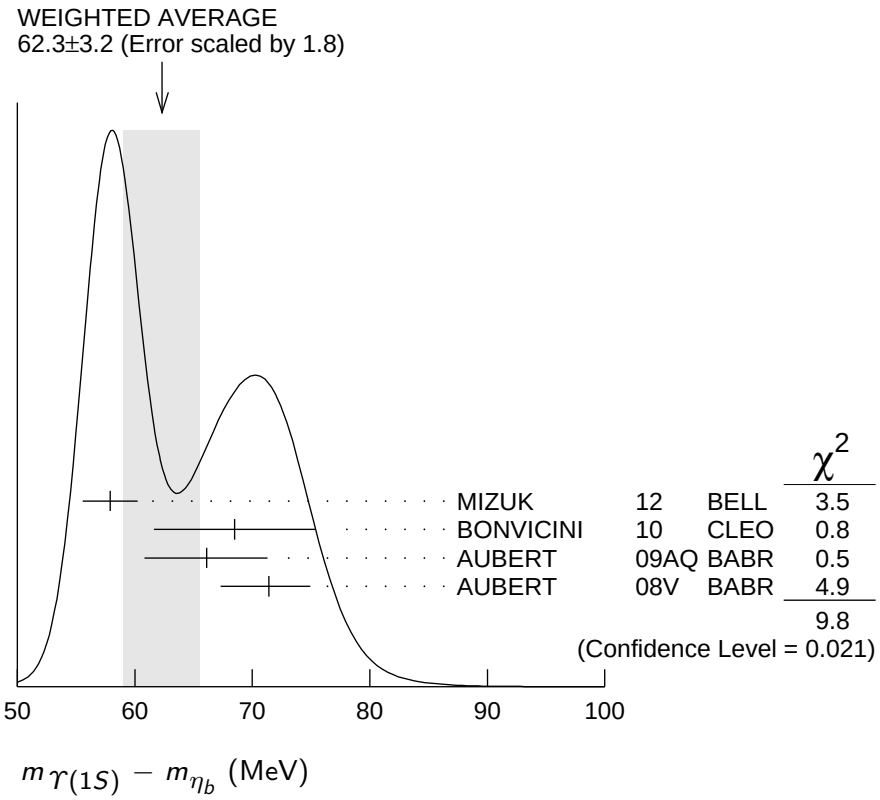
[1] With floating width. Not independent of the corresponding mass difference measurement.
[2] Assuming $\Gamma_{\eta_b(1S)} = 10$ MeV. Not independent of the corresponding γ energy or mass difference measurements.
[3] Obtained by analyzing CLEO III data but not authored by the CLEO Collaboration.



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

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	$e^+e^- \to \gamma\pi^+\pi^-$ + hadrons
68.5±6.6±2.0	2.3 ± 0.5k	[5] BONVICINI	10	CLEO	$\Upsilon(3S) \to \gamma X$
$66.1^{+4.8}_{-4.9}\pm2.0$	13 ± 5k	[5] AUBERT	09AQ	BABR	$\Upsilon(2S) \to \gamma X$
$71.4^{+2.3}_{-3.1}\pm2.7$	19 ± 3k	[5] AUBERT	08V	BABR	$\Upsilon(3S) \to \gamma X$
• • • 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		$\Upsilon(2S) \to \gamma$ 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	$\Upsilon(3S) \to \gamma X$
$921.2^{+2.1}_{-2.8}\pm2.4$	19 ± 3k	[7] AUBERT	08V	BABR	$\Upsilon(3S) \to \gamma X$

[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
$609.3^{+4.6}_{-4.5}\pm1.9$	13 ± 5k	[8] AUBERT	09AQ	BABR	$\Upsilon(2S) \to \gamma X$

[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
$10\ ^{+5}_{-4}$ OUR AVERAGE					
$8\ ^{+6}_{-5}\ \pm5$	33.1k	[9] TAMPONI	15	BELL	$e^+e^- \to \gamma\eta +$ hadrons
$10.8^{+4.0}_{-3.7}{}^{+4.5}_{-2.0}$	34k	[9] MIZUK	12	BELL	$e^+e^- \to \gamma\pi^+\pi^- +$ 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	$\mu^+\mu^-$	$<9\times10^{-3}$	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^-

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

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

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

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
seen	34k	MIZUK	12	BELL	$e^+e^- \to \gamma\pi^+\pi^-$ + hadrons

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

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

[10] Obtained using $B(\Upsilon(2S) \to \gamma\eta_b) = (4.2^{+1.1}_{-1.0} \pm 0.9) \times 10^{-4}$ and $B(\Upsilon(3S) \to \gamma\eta_b) = (4.8 \pm 0.5 \pm 0.6) \times 10^{-4}$. This limit is equivalent to $B(\eta_b \to \mu^+\mu^-) = (-0.25 \pm 0.51 \pm 0.33)\%$ measurement.

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

VALUE	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
$<8 \times 10^{-2}$	90	AUBERT	09P	BABR	$e^+e^- \to \gamma\tau^+\tau^-$

$\eta_b(1S)$ REFERENCES

TAMPONI	15	PRL 115 142001	U. Tamponi *et al.*	(BELLE Collab.)
DOBBS	12	PRL 109 082001	S. Dobbs *et al.*	
MIZUK	12	PRL 109 232002	R. Mizuk *et al.*	(BELLE Collab.)
BONVICINI	10	PR D81 031104	G. Bonvicini *et al.*	(CLEO Collab.)
AUBERT	09AQ	PRL 103 161801	B. Aubert *et al.*	(BABAR Collab.)
AUBERT	09P	PRL 103 181801	B. Aubert *et al.*	(BABAR Collab.)
AUBERT	09Z	PRL 103 081803	B. Aubert *et al.*	(BABAR Collab.)
AUBERT	08V	PRL 101 071801	B. Aubert *et al.*	(BABAR Collab.)
ABDALLAH	06	PL B634 340	J.M. Abdallah *et al.*	(DELPHI Collab.)
HEISTER	02D	PL B530 56	A. Heister *et al.*	(ALEPH Collab.)