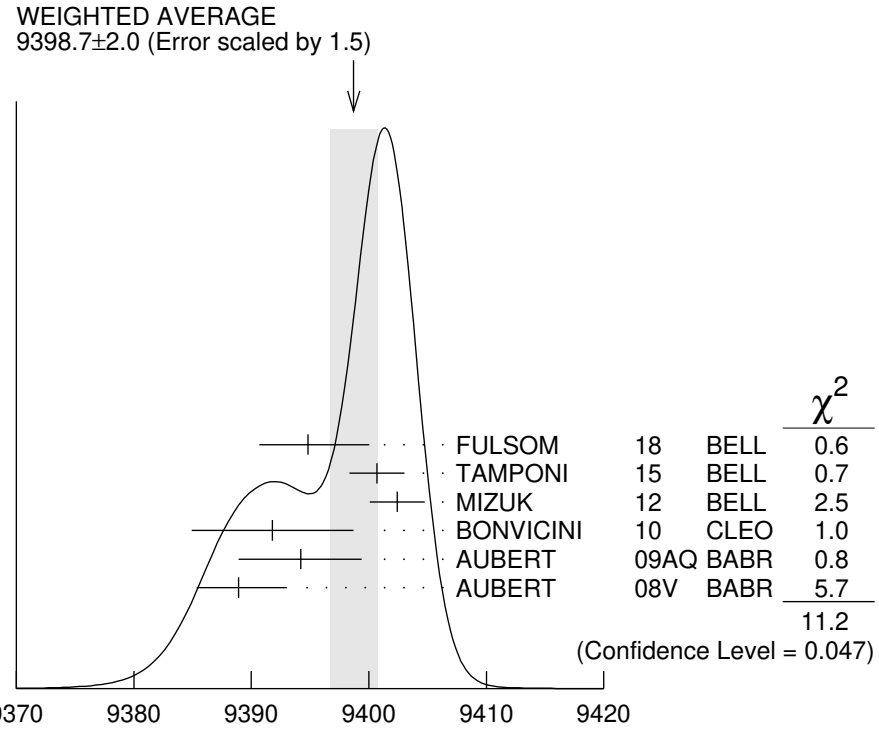
$\eta_b(1S)$

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

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	$\Upsilon(2S) \to \gamma X$
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^-

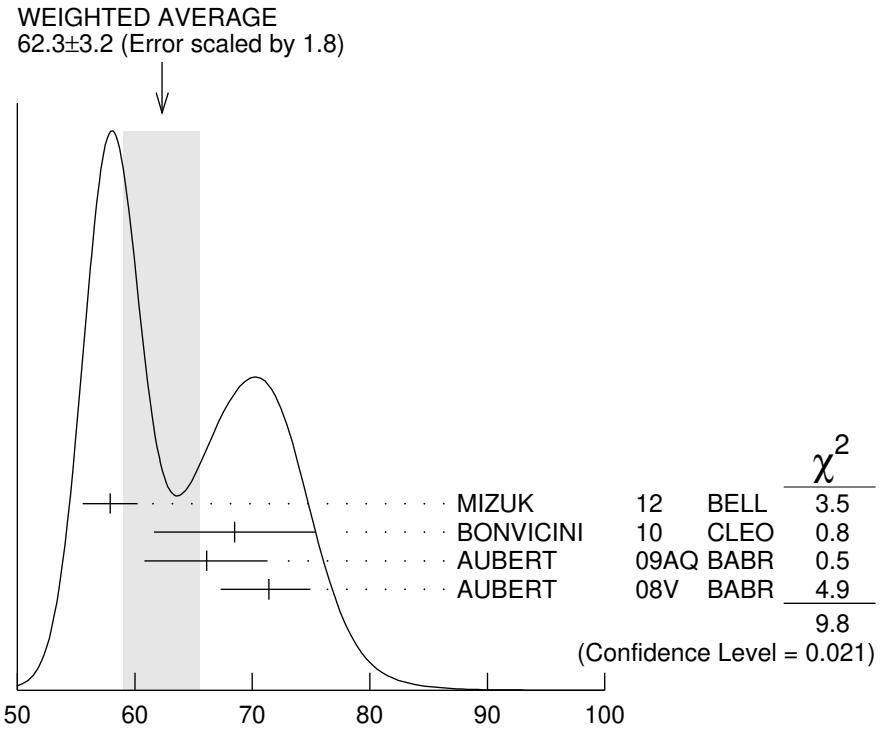


[1] With floating width. Not independent of the corresponding mass difference measurement.
[2] Assuming $\Gamma_{\eta_b(1S)} = 10$ MeV. Not independent of the corresponding γ energy or mass difference measurements.
[3] Obtained by analyzing CLEO III data but not authored by the CLEO Collaboration.

$\eta_b(1S)$ MASS (MeV)

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

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	$e^+e^- \to \gamma\pi^+\pi^-$ + hadrons
$68.5 \pm 6.6 \pm 2.0$	2.3 ± 0.5k	[2] BONVICINI	10	CLEO	$\Upsilon(3S) \to \gamma X$
$66.1^{+4.8}_{-4.9} \pm 2.0$	13 ± 5k	[2] AUBERT	09AQ	BABR	$\Upsilon(2S) \to \gamma X$
$71.4^{+2.3}_{-3.1} \pm 2.7$	19 ± 3k	[2] AUBERT	08V	BABR	$\Upsilon(3S) \to \gamma X$
• • • 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		$\Upsilon(2S) \to \gamma$ 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.

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

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 ± 0.5k	[1] BONVICINI	10	CLEO	$\Upsilon(3S) \to \gamma X$

$921.2^{+2.1}_{-2.8}\pm2.4$	19 ± 3k	[1] AUBERT	08V	BABR	$\Upsilon(3S) \to \gamma X$

[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*
$609.3^{+4.6}_{-4.5}\pm1.9$	13 ± 5k	[1] AUBERT	09AQ	BABR	$\Upsilon(2S) \to \gamma X$

[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					
$8^{+6}_{-5}\pm5$	33.1k	[1] TAMPONI	15	BELL	$e^+e^- \to \gamma\eta +$ hadrons
$10.8^{+4.0+4.5}_{-3.7-2.0}$	34k	[1] MIZUK	12	BELL	$e^+e^- \to \gamma\pi^+\pi^- +$ 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	$\mu^+\mu^-$	$<9\times10^{-3}$	90%
Γ_7	$\tau^+\tau^-$	<8 %	90%

$\eta_b(1S)$ Γ(i)Γ($\gamma\gamma$)/Γ(total)

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

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^-

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

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	$e^+e^- \to \gamma\pi^+\pi^-$ + 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	$e^+e^- \to \Upsilon(2S,3S) \to \gamma\eta_b$

[1] 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.

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

FULSOM	18	PRL 121 232001	B.G. Fulsom *et al.*	(BELLE Collab.)
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.)