$\Upsilon(3S)$

$I^G(J^{PC}) = 0^-(1^{--})$

$\Upsilon(3S)$ MASS

VALUE (GeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
10.3552±0.0005	[1] ARTAMONOV	00	MD1	$e^+e^- \rightarrow$ hadrons
• • • We do not use the following data for averages, fits, limits, etc. • • •				
10.3553±0.0005	[2,3] BARU	86B	REDE	$e^+e^- \rightarrow$ hadrons

[1] Reanalysis of BARU 86B using new electron mass (COHEN 87).
[2] Reanalysis of ARTAMONOV 84.
[3] Superseded by ARTAMONOV 00.

$\Upsilon(3S)$ WIDTH

VALUE (keV)	*DOCUMENT ID*
20.32±1.85 OUR EVALUATION	See the Note on "Width Determinations of the Υ States"

$\Upsilon(3S)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Scale factor/ Confidence level
Γ_1	$\Upsilon(2S)$anything	(10.6 ±0.8) %	
Γ_2	$\Upsilon(2S)\pi^+\pi^-$	(2.45±0.23) %	S=1.1
Γ_3	$\Upsilon(2S)\pi^0\pi^0$	(1.85±0.14) %	
Γ_4	$\Upsilon(2S)\gamma\gamma$	(5.0 ±0.7) %	
Γ_5	$\Upsilon(2S)\pi^0$	$<$ 5.1 $\times 10^{-4}$	CL=90%
Γ_6	$\Upsilon(1S)\pi^+\pi^-$	(4.40±0.10) %	
Γ_7	$\Upsilon(1S)\pi^0\pi^0$	(2.20±0.13) %	
Γ_8	$\Upsilon(1S)\eta$	$<$ 1.8 $\times 10^{-4}$	CL=90%
Γ_9	$\Upsilon(1S)\pi^0$	$<$ 7 $\times 10^{-5}$	CL=90%
Γ_{10}	$\tau^+\tau^-$	(2.29±0.30) %	
Γ_{11}	$\mu^+\mu^-$	(2.18±0.21) %	S=2.1
Γ_{12}	e^+e^-	seen	
Γ_{13}	ggg	(35.7 ±2.6) %	
Γ_{14}	γgg	(9.7 ±1.8) $\times 10^{-3}$	
	Radiative decays		
Γ_{15}	hadrons		
Γ_{16}	$\gamma\chi_{b2}(2P)$	(13.1 ±1.6) %	S=3.4
Γ_{17}	$\gamma\chi_{b1}(2P)$	(12.6 ±1.2) %	S=2.4
Γ_{18}	$\gamma\chi_{b0}(2P)$	(5.9 ±0.6) %	S=1.4
Γ_{19}	$\gamma\chi_{b2}(1P)$	$<$ 1.9 %	CL=90%

Γ_{20}	$\gamma \chi_{b1}(1P)$		< 1.7	$\times 10^{-3}$	CL=90%
Γ_{21}	$\gamma \chi_{b0}(1P)$		(3.0 ±1.1)	$\times 10^{-3}$	
Γ_{22}	$\gamma \eta_b(2S)$		< 6.2	$\times 10^{-4}$	CL=90%
Γ_{23}	$\gamma \eta_b(1S)$		(5.1 ±0.7)	$\times 10^{-4}$	
Γ_{24}	$\gamma X \rightarrow \gamma + \geq 4$ prongs		[a] < 2.2	$\times 10^{-4}$	CL=95%
Γ_{25}	$\gamma a_1^0 \rightarrow \gamma \tau^+ \tau^-$		[b] < 1.6	$\times 10^{-4}$	CL=90%

Lepton Family number (LF) violating modes

Γ_{26}	$e^{\pm} \tau^{\mp}$	LF	< 4.2	$\times 10^{-6}$	CL=90%
Γ_{27}	$\mu^{\pm} \tau^{\mp}$	LF	< 3.1	$\times 10^{-6}$	CL=90%

[a] 1.5 GeV < m_X < 5.0 GeV

[b] For $m_{\tau^+ \tau^-}$ in the ranges 4.03–9.52 and 9.61–10.10 GeV.

$\Upsilon(3S)$ $\Gamma(i)\Gamma(e^+ e^-)/\Gamma(\text{total})$

$\Gamma(\text{hadrons}) \times \Gamma(e^+ e^-)/\Gamma_{\text{total}}$ — $\Gamma_{15}\Gamma_{12}/\Gamma$

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
0.414±0.007 OUR AVERAGE				
0.413±0.004±0.006	ROSNER	06	CLEO	10.4 $e^+ e^- \rightarrow$ hadrons
0.45 ±0.03 ±0.03	[4] GILES	84B	CLEO	$e^+ e^- \rightarrow$ hadrons

[4] Radiative corrections reevaluated by BUCHMUELLER 88 following KURAEV 85.

$\Gamma(\Upsilon(1S)\pi^+\pi^-) \times \Gamma(e^+ e^-)/\Gamma_{\text{total}}$ — $\Gamma_6\Gamma_{12}/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
18.46±0.27±0.77	6.4K	[5] AUBERT	08BP	BABR	$e^+ e^- \rightarrow \gamma \pi^+ \pi^- \ell^+ \ell^-$

[5] Using B($\Upsilon(1S) \rightarrow e^+ e^-$) = (2.38 ± 0.11)% and B($\Upsilon(1S) \rightarrow \mu^+ \mu^-$) = (2.48 ± 0.05)%.

$\Upsilon(3S)$ PARTIAL WIDTHS

$\Gamma(e^+ e^-)$ — Γ_{12}

VALUE (keV)	DOCUMENT ID
0.443±0.008 OUR EVALUATION	

$\Upsilon(3S)$ BRANCHING RATIOS

$\Gamma(\Upsilon(2S)\text{anything})/\Gamma_{\text{total}}$ — Γ_1/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.106 ±0.008 OUR AVERAGE					
0.1023±0.0105	4625	[6,7,8] BUTLER	94B	CLE2	$e^+ e^- \rightarrow \ell^+ \ell^- X$
0.111 ±0.012	4891	[7,8,9] BROCK	91	CLEO	$e^+ e^- \rightarrow \pi^+ \pi^- X$, $\pi^+ \pi^- \ell^+ \ell^-$

[6] Using B($\Upsilon(2S) \to \Upsilon(1S)\gamma\gamma$) = (0.038 ± 0.007)%, and B($\Upsilon(2S) \to \Upsilon(1S)\pi^0\pi^0$) = (1/2)B($\Upsilon(2S) \to \Upsilon(1S)\pi^+\pi^-$).
[7] Using B($\Upsilon(1S) \to \mu^+\mu^-$) = (2.48 ± 0.06)%. With the assumption of $e\mu$ universality.
[8] Using B($\Upsilon(2S) \to \Upsilon(1S)\pi^+\pi^-$) = (18.5 ± 0.8)%.
[9] Using B($\Upsilon(2S) \to \mu^+\mu^-$) = (1.31 ± 0.21)%, B($\Upsilon(2S) \to \Upsilon(1S)\gamma\gamma$)×2B($\Upsilon(1S) \to \mu^+\mu^-$) = (0.188 ± 0.035)%, and B($\Upsilon(2S) \to \Upsilon(1S)\pi^0\pi^0$)×2B($\Upsilon(1S) \to \mu^+\mu^-$) = (0.436 ± 0.056)%. With the assumption of $e\mu$ universality.

$\Gamma(\Upsilon(2S)\pi^+\pi^-)/\Gamma_{total}$ — Γ_2/Γ

VALUE (units 10^{-2})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
2.45±0.23 OUR AVERAGE	Error includes scale factor of 1.1.				
2.40±0.10±0.26	800	[10] AUBERT	08BP	BABR	$e^+e^- \to \gamma\pi^+\pi^-e^+e^-$
3.12±0.49	980	[11,12] BUTLER	94B	CLE2	$e^+e^- \to \pi^+\pi^-\ell^+\ell^-$
2.13±0.38	974	[13] BROCK	91	CLEO	$e^+e^- \to \pi^+\pi^-X$, $\pi^+\pi^-\ell^+\ell^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
4.82±0.65±0.53	138	[13] WU	93	CUSB	$\Upsilon(3S) \to \pi^+\pi^-\ell^+\ell^-$
3.1 ±2.0	5	MAGERAS	82	CUSB	$\Upsilon(3S) \to \pi^+\pi^-\ell^+\ell^-$

[10] Using B($\Upsilon(1S) \to e^+e^-$) = (2.38 ± 0.11)%, B($\Upsilon(1S) \to \mu^+\mu^-$) = (2.48 ± 0.05)%, and $\Gamma_{ee}(\Upsilon(3S))$ = 0.443 ± 0.008 keV.
[11] From the exclusive mode.
[12] Using B($\Upsilon(2S) \to \Upsilon(1S)\gamma\gamma$) = (0.038 ± 0.007)%, and B($\Upsilon(2S) \to \Upsilon(1S)\pi^0\pi^0$) = (1/2)B($\Upsilon(2S) \to \Upsilon(1S)\pi^+\pi^-$).
[13] Using B($\Upsilon(2S) \to \mu^+\mu^-$) = (1.31 ± 0.21)%, B($\Upsilon(2S) \to \Upsilon(1S)\gamma\gamma$)×2B($\Upsilon(1S) \to \mu^+\mu^-$) = (0.188 ± 0.035)%, and B($\Upsilon(2S) \to \Upsilon(1S)\pi^0\pi^0$)×2B($\Upsilon(1S) \to \mu^+\mu^-$) = (0.436 ± 0.056)%. With the assumption of $e\mu$ universality.

$\Gamma(\Upsilon(2S)\pi^0\pi^0)/\Gamma_{total}$ — Γ_3/Γ

VALUE (units 10^{-2})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1.85±0.14 OUR AVERAGE					
1.82±0.09±0.12	4391	[14] BHARI	09	CLEO	$e^+e^- \to \pi^0\pi^0\ell^+\ell^-$
2.16±0.39		[15,16] BUTLER	94B	CLE2	$e^+e^- \to \pi^0\pi^0\ell^+\ell^-$
1.7 ±0.5 ±0.2	10	[17] HEINTZ	92	CSB2	$e^+e^- \to \pi^0\pi^0\ell^+\ell^-$

[14] Authors assume B($\Upsilon(1S) \to e^+e^-$) + B($\Upsilon(1S) \to \mu^+\mu^-$) = 4.06%.
[15] B($\Upsilon(2S) \to \mu^+\mu^-$) = (1.31 ± 0.21)% and assuming $e\mu$ universality.
[16] From the exclusive mode.
[17] B($\Upsilon(2S) \to \mu^+\mu^-$) = (1.44 ± 0.10)% and assuming $e\mu$ universality. Supersedes HEINTZ 91.

$\Gamma(\Upsilon(2S)\gamma\gamma)/\Gamma_{total}$ — Γ_4/Γ

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
0.0502±0.0069	[18] BUTLER	94B	CLE2	$e^+e^- \to \ell^+\ell^-2\gamma$

[18] From the exclusive mode.

$\Gamma(\Upsilon(2S)\pi^0)/\Gamma_{total}$ — Γ_5/Γ

VALUE (units 10^{-3})	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<0.51	90	[19] HE	08A	CLEO	$e^+e^- \to \ell^+\ell^-\gamma\gamma$

[19] Authors assume B($\Upsilon(2S) \to e^+e^-$) + B($\Upsilon(1S) \to \mu^+\mu^-$) = 4.06%.

$\Gamma(\Upsilon(1S)\pi^+\pi^-)/\Gamma_{total}$ — Γ_6/Γ

Abbreviation MM in the *COMMENT* field below stands for missing mass.

VALUE (units 10^{-2})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
4.40±0.10 OUR AVERAGE					
4.46±0.01±0.13	190k	[20] BHARI	09	CLEO	$e^+e^- \to \pi^+\pi^-$ MM
4.17±0.06±0.19	6.4K	[21] AUBERT	08BP	BABR	10.58 $e^+e^- \to \gamma\pi^+\pi^-\ell^+\ell^-$
4.52±0.35	11830	[22] BUTLER	94B	CLE2	$e^+e^- \to \pi^+\pi^-X$, $\pi^+\pi^-\ell^+\ell^-$
4.46±0.34±0.50	451	[22] WU	93	CUSB	$\Upsilon(3S) \to \pi^+\pi^-\ell^+\ell^-$
4.46±0.30	11221	[22] BROCK	91	CLEO	$e^+e^- \to \pi^+\pi^-X$, $\pi^+\pi^-\ell^+\ell^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
4.9 ±1.0	22	GREEN	82	CLEO	$\Upsilon(3S) \to \pi^+\pi^-\ell^+\ell^-$
3.9 ±1.3	26	MAGERAS	82	CUSB	$\Upsilon(3S) \to \pi^+\pi^-\ell^+\ell^-$

[20] A weighted average of the inclusive and exclusive results.

[21] Using B($\Upsilon(2S) \to e^+e^-$) = (1.91 ± 0.16)%, B($\Upsilon(2S) \to \mu^+\mu^-$) = (1.93 ± 0.17)%, and $\Gamma_{ee}(\Upsilon(3S))$ = 0.443 ± 0.008 keV.

[22] Using B($\Upsilon(1S) \to \mu^+\mu^-$) = (2.48 ± 0.06)%. With the assumption of $e\mu$ universality.

$\Gamma(\Upsilon(2S)\pi^+\pi^-)/\Gamma(\Upsilon(1S)\pi^+\pi^-)$ — Γ_2/Γ_6

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.577±0.026±0.060	800	[23] AUBERT	08BP	BABR	$e^+e^- \to \gamma\pi^+\pi^-\ell^+\ell^-$

[23] Using B($\Upsilon(1S) \to e^+e^-$) = (2.38 ± 0.11)%, B($\Upsilon(1S) \to \mu^+\mu^-$) = (2.48 ± 0.05)%, B($\Upsilon(2S) \to e^+e^-$) = (1.91 ± 0.16)%, and B($\Upsilon(2S) \to \mu^+\mu^-$) = (1.93 ± 0.17)%. Not independent of other values reported by AUBERT 08BP.

$\Gamma(\Upsilon(1S)\pi^0\pi^0)/\Gamma_{total}$ — Γ_7/Γ

VALUE (units 10^{-2})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
2.20±0.13 OUR AVERAGE					
2.24±0.09±0.11	6584	[24] BHARI	09	CLEO	$e^+e^- \to \pi^0\pi^0\ell^+\ell^-$
1.99±0.34	56	[25] BUTLER	94B	CLE2	$e^+e^- \to \pi^0\pi^0\ell^+\ell^-$
2.2 ±0.4 ±0.3	33	[26] HEINTZ	92	CSB2	$e^+e^- \to \pi^0\pi^0\ell^+\ell^-$

[24] Authors assume B($\Upsilon(1S) \to e^+e^-$) + B($\Upsilon(1S) \to \mu^+\mu^-$) = 4.96%.

[25] Using B($\Upsilon(1S) \to \mu^+\mu^-$) = (2.48 ± 0.06)% and assuming $e\mu$ universality.

[26] Using B($\Upsilon(1S) \to \mu^+\mu^-$) = (2.57 ± 0.07)% and assuming $e\mu$ universality. Supersedes HEINTZ 91.

$\Gamma(\Upsilon(1S)\pi^0\pi^0)/\Gamma(\Upsilon(1S)\pi^+\pi^-)$ — Γ_7/Γ_6

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.501±0.043	[27] BHARI	09	CLEO	$e^+e^- \to \Upsilon(3S)$

[27] Not independent of other values reported by BHARI 09.

$\Gamma(\Upsilon(1S)\eta)/\Gamma_{total}$ — Γ_8/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<0.18	90	[28] HE	08A	CLEO	$e^+e^- \to \ell^+\ell^-\eta$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.8	90	[29] AUBERT	08BP	BABR	$e^+e^- \to \gamma\pi^+\pi^-\pi^0\ell^+\ell^-$
<2.2	90	BROCK	91	CLEO	$e^+e^- \to \ell^+\ell^-\eta$

[28] Authors assume B($\Upsilon(1S) \to e^+e^-$) + B($\Upsilon(1S) \to \mu^+\mu^-$) = 4.96%.

[29] Using B($\Upsilon(1S) \to e^+e^-$) = (2.38 ± 0.11)%, B($\Upsilon(1S) \to \mu^+\mu^-$) = (2.48 ± 0.05)%, and $\Gamma_{ee}(\Upsilon(3S)) = 0.443 \pm 0.008$ keV.

$\Gamma(\Upsilon(1S)\eta)/\Gamma(\Upsilon(1S)\pi^+\pi^-)$ — Γ_8/Γ_6

VALUE (units 10^{-2})	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<1.9	90	[30] AUBERT	08BP	BABR	$e^+e^- \to \gamma\pi^+\pi^-(\pi^0)\ell^+\ell^-$

[30] Not independent of other values reported by AUBERT 08BP.

$\Gamma(\Upsilon(1S)\pi^0)/\Gamma_{total}$ — Γ_9/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<0.07	90	[31] HE	08A	CLEO	$e^+e^- \to \ell^+\ell^-\gamma\gamma$

[31] Authors assume B($\Upsilon(1S) \to e^+e^-$) + B($\Upsilon(1S) \to \mu^+\mu^-$) = 4.96%.

$\Gamma(\tau^+\tau^-)/\Gamma_{total}$ — Γ_{10}/Γ

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
2.29±0.21±0.22	15k	[32] BESSON	07	CLEO	$e^+e^- \to \Upsilon(3S) \to \tau^+\tau^-$

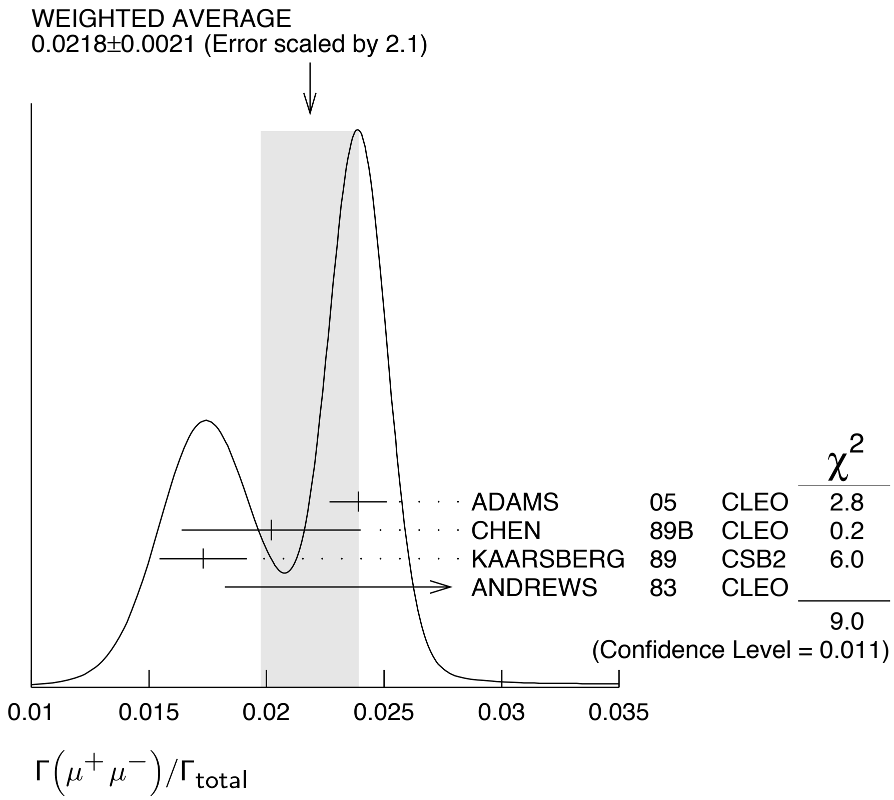
[32] BESSON 07 reports [$\Gamma(\Upsilon(3S) \to \tau^+\tau^-)/\Gamma_{total}$] / [B($\Upsilon(3S) \to \mu^+\mu^-$)] = $1.05 \pm 0.08 \pm 0.05$ which we multiply by our best value B($\Upsilon(3S) \to \mu^+\mu^-$) = $(2.18 \pm 0.21) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(\tau^+\tau^-)/\Gamma(\mu^+\mu^-)$ — Γ_{10}/Γ_{11}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
1.05±0.08±0.05	15k	BESSON	07	CLEO	$e^+e^- \to \Upsilon(3S)$

$\Gamma(\mu^+\mu^-)/\Gamma_{total}$ — Γ_{11}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.0218±0.0021 OUR AVERAGE Error includes scale factor of 2.1. See the ideogram below.					
0.0239±0.0007±0.0010	81k	ADAMS	05	CLEO	$e^+e^- \to \mu^+\mu^-$
0.0202±0.0019±0.0033		CHEN	89B	CLEO	$e^+e^- \to \mu^+\mu^-$
0.0173±0.0015±0.0011		KAARSBERG	89	CSB2	$e^+e^- \to \mu^+\mu^-$
0.033 ±0.013 ±0.007	1096	ANDREWS	83	CLEO	$e^+e^- \to \mu^+\mu^-$



$\Gamma(ggg)/\Gamma_{total}$ Γ_{13}/Γ

VALUE (units 10^{-2})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
35.7±2.6	3M	[33] BESSON	06A	CLEO	$\Upsilon(3S) \to$ hadrons

[33] Calculated using BESSON 06A value of $\Gamma(\gamma gg)/\Gamma(ggg) = (2.72 \pm 0.06 \pm 0.32 \pm 0.37)\%$ and the PDG 08 values of B($\Upsilon(2S)$ + anything) = (10.6 ± 0.8)%, B($\pi^+\pi^- \Upsilon(1S)$) = (4.40 ± 0.10)%, B($\pi^0\pi^0 \Upsilon(1S)$) = (2.20 ± 0.13)%, B($\gamma\chi_{b2}(2P)$) = (13.1 ± 1.6)%, B($\gamma\chi_{b1}(2P)$) = (12.6 ± 1.2)%, B($\gamma\chi_{b0}(2P)$) = (5.9 ± 0.6)%, B($\gamma\chi_{b0}(1P)$) = (0.30 ± 0.11)% ,B($\mu^+\mu^-$) = (2.18 ± 0.21)%, and $R_{hadrons}$ = 3.51. The statistical error is negligible and the systematic error is partially correlated with $\Gamma(\gamma gg)/\Gamma_{total}$ BESSON 06A value.

$\Gamma(\gamma gg)/\Gamma_{total}$ Γ_{14}/Γ

VALUE (units 10^{-2})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.97±0.18	60k	[34] BESSON	06A	CLEO	$\Upsilon(3S) \to \gamma$ + hadrons

[34] Calculated using BESSON 06A values of $\Gamma(\gamma gg)/\Gamma(ggg) = (2.72 \pm 0.06 \pm 0.32 \pm 0.37)\%$ and $\Gamma(ggg)/\Gamma_{total}$. The statistical error is negligible and the systematic error is partially correlated with $\Gamma(ggg)/\Gamma_{total}$ BESSON 06A value.

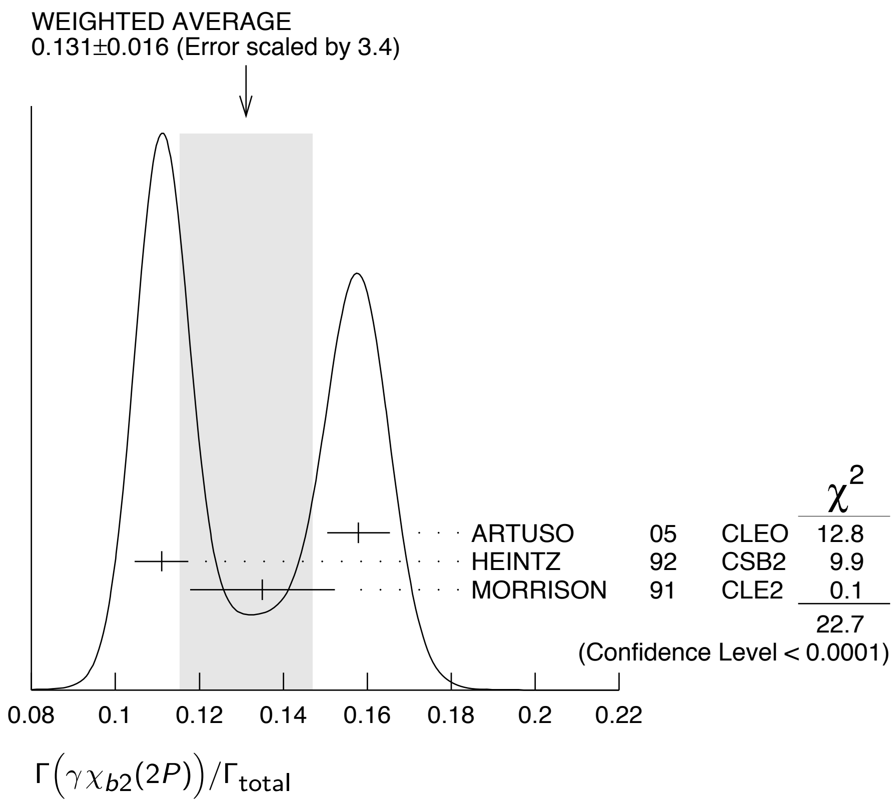
$\Gamma(\gamma gg)/\Gamma(ggg)$ Γ_{14}/Γ_{13}

VALUE (units 10^{-2})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
2.72±0.06±0.49	3M	BESSON	06A	CLEO	$\Upsilon(3S) \to (\gamma +)$ hadrons

$\Gamma(\gamma\chi_{b2}(2P))/\Gamma_{total}$ Γ_{16}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.131 ±0.016 OUR AVERAGE Error includes scale factor of 3.4. See the ideogram below.					
0.1579±0.0017±0.0073	568k	ARTUSO	05	CLEO	$e^+e^- \rightarrow \gamma X$
0.111 ±0.005 ±0.004	10319	[35] HEINTZ	92	CSB2	$e^+e^- \rightarrow \gamma X$
0.135 ±0.003 ±0.017	30741	MORRISON	91	CLE2	$e^+e^- \rightarrow \gamma X$

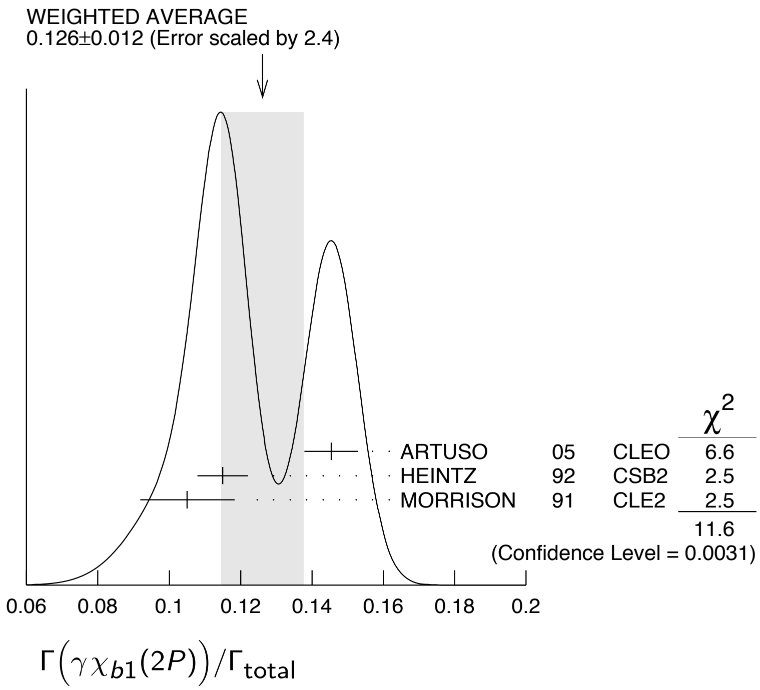
[35] Supersedes NARAIN 91.



$\Gamma(\gamma\chi_{b1}(2P))/\Gamma_{total}$ Γ_{17}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.126 ±0.012 OUR AVERAGE Error includes scale factor of 2.4. See the ideogram below.					
0.1454±0.0018±0.0073	537k	ARTUSO	05	CLEO	$e^+e^- \rightarrow \gamma X$
0.115 ±0.005 ±0.005	11147	[36] HEINTZ	92	CSB2	$e^+e^- \rightarrow \gamma X$
0.105 $^{+0.003}_{-0.002}$ ±0.013	25759	MORRISON	91	CLE2	$e^+e^- \rightarrow \gamma X$

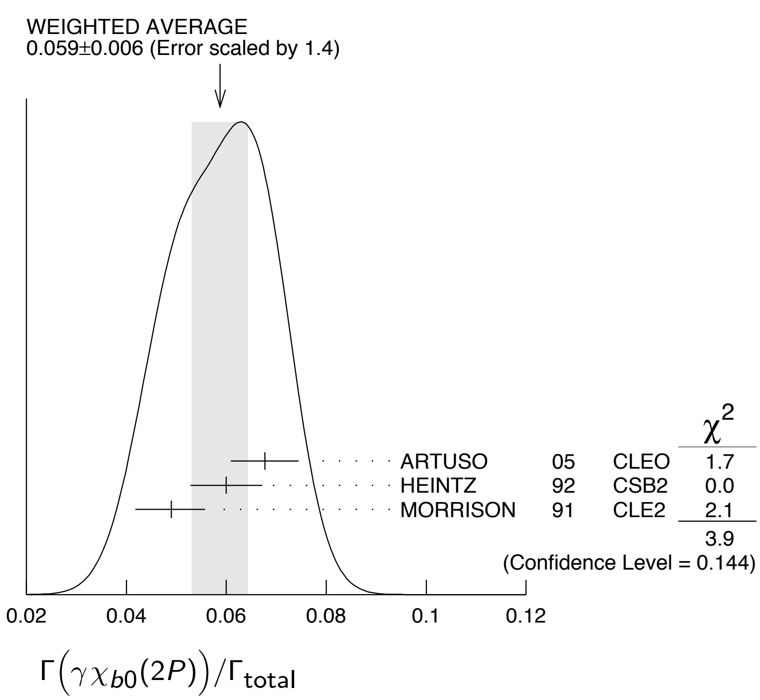
[36] Supersedes NARAIN 91.



$\Gamma(\gamma\chi_{b0}(2P))/\Gamma_{total}$ Γ_{18}/Γ

VALUE	*EVTS*	*DOCUMENT ID*	*TECN*	*COMMENT*
0.059 ±0.006 OUR AVERAGE Error includes scale factor of 1.4. See the ideogram below.				
0.0677±0.0020±0.0065	225k	ARTUSO 05	CLEO	$e^+e^- \rightarrow \gamma X$
0.060 ±0.004 ±0.006	4959	[37] HEINTZ 92	CSB2	$e^+e^- \rightarrow \gamma X$
0.049 $^{+0.003}_{-0.004}$ ±0.006	9903	MORRISON 91	CLE2	$e^+e^- \rightarrow \gamma X$

[37] Supersedes NARAIN 91.



$\Gamma(\gamma\chi_{b2}(1P))/\Gamma_{total}$ — Γ_{19}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<190	90	[38] ASNER	08A	CLEO	$\Upsilon(3S) \to \gamma +$ hadrons

[38] ASNER 08A reports $[\Gamma(\Upsilon(3S) \to \gamma\chi_{b2}(1P))/\Gamma_{total}] / [B(\Upsilon(2S) \to \gamma\chi_{b2}(1P))] < 27.1 \times 10^{-2}$ which we multiply by our best value $B(\Upsilon(2S) \to \gamma\chi_{b2}(1P)) = 7.15 \times 10^{-2}$.

$\Gamma(\gamma\chi_{b1}(1P))/\Gamma_{total}$ — Γ_{20}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<17	90	[39] ASNER	08A	CLEO	$\Upsilon(3S) \to \gamma +$ hadrons

[39] ASNER 08A reports $[\Gamma(\Upsilon(3S) \to \gamma\chi_{b1}(1P))/\Gamma_{total}] / [B(\Upsilon(2S) \to \gamma\chi_{b1}(1P))] < 2.5 \times 10^{-2}$ which we multiply by our best value $B(\Upsilon(2S) \to \gamma\chi_{b1}(1P)) = 6.9 \times 10^{-2}$.

$\Gamma(\gamma\chi_{b0}(1P))/\Gamma_{total}$ — Γ_{21}/Γ

VALUE (units 10^{-2})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.30±0.04±0.10		8.7k	ARTUSO	05	CLEO	$e^+e^- \to \gamma X$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<0.8	90		[40] ASNER	08A	CLEO	$\Upsilon(3S) \to \gamma +$ hadrons

[40] ASNER 08A reports $[\Gamma(\Upsilon(3S) \to \gamma\chi_{b0}(1P))/\Gamma_{total}] / [B(\Upsilon(2S) \to \gamma\chi_{b0}(1P))] < 21.9 \times 10^{-2}$ which we multiply by our best value $B(\Upsilon(2S) \to \gamma\chi_{b0}(1P)) = 3.8 \times 10^{-2}$.

$\Gamma(\gamma\eta_b(2S))/\Gamma_{total}$ — Γ_{22}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<6.2	90	ARTUSO	05	CLEO	$e^+e^- \to \gamma X$

$\Gamma(\gamma\eta_b(1S))/\Gamma_{total}$ — Γ_{23}/Γ

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
(5.1±0.7) OUR AVERAGE						
7.1±1.8±1.3		2.3 ± 0.5k	[41] BONVICINI	10	CLEO	$\Upsilon(3S) \to \gamma X$
4.8±0.5±0.6		19 ± 3k	[41] AUBERT	09AQ	BABR	$\Upsilon(3S) \to \gamma X$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
4.8±0.5±1.2		19 ± 3k	[41,42] AUBERT	08V	BABR	$\Upsilon(3S) \to \gamma X$
<4.3	90		[43] ARTUSO	05	CLEO	$e^+e^- \to \gamma X$

[41] Assuming $\Gamma_{\eta_b(1S)} = 10$ MeV.

[42] Systematic error re-evaluated by AUBERT 09AQ.

[43] Superseded by BONVICINI 10.

$\Gamma(\gamma X \to \gamma + \geq 4 \text{ prongs})/\Gamma_{total}$ — Γ_{24}/Γ

(1.5 GeV $< m_X <$ 5.0 GeV)

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<2.2	95	ROSNER	07A	CLEO	$e^+e^- \to \gamma X$

$\Gamma(\gamma a_1^0 \to \gamma\tau^+\tau^-)/\Gamma_{total}$ — Γ_{25}/Γ

VALUE	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<1.6 × 10⁻⁴	90	[44] AUBERT	09P	BABR	$e^+e^- \to \gamma a_1^0 \to \gamma\tau^+\tau^-$

[44] For a narrow scalar or pseudoscalar a_1^0 with M($\tau^+\tau^-$) in the ranges 4.03–9.52 and 9.61–10.10 GeV. Measured 90% CL limits as a function of M($\tau^+\tau^-$) range from 1.5–16 $\times 10^{-5}$.

LEPTON FAMILY NUMBER (*LF*) VIOLATING MODES

$\Gamma(e^\pm\tau^\mp)/\Gamma_{total}$ — Γ_{26}/Γ

VALUE (units 10^{-6})	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<4.2	90	LEES	10B	BABR	$e^+e^- \to e^\pm\tau^\mp$

$\Gamma(\mu^\pm\tau^\mp)/\Gamma_{total}$ — Γ_{27}/Γ

VALUE (units 10^{-6})	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
< 3.1	90	LEES	10B	BABR	$e^+e^- \to \mu^\pm\tau^\mp$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<20.3	95	LOVE	08A	CLEO	$e^+e^- \to \mu^\pm\tau^\mp$

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