$\Upsilon(2S)$

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

$\Upsilon(2S)$ MASS

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
10023.26±0.31 OUR AVERAGE				
10023.5 ±0.5	[1] ARTAMONOV	00	MD1	$e^+e^- \to$ hadrons
10023.1 ±0.4	BARBER	84	REDE	$e^+e^- \to$ hadrons
• • • We do not use the following data for averages, fits, limits, etc. • • •				
10023.6 ±0.5	[2,3] BARU	86B	REDE	$e^+e^- \to$ hadrons

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[3] Superseded by ARTAMONOV 00.

$m_{\Upsilon(3S)} - m_{\Upsilon(2S)}$

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
331.50±0.02±0.13	LEES	11C	BABR	$e^+e^- \to \pi^+\pi^- X$

$\Upsilon(2S)$ WIDTH

VALUE (keV)	DOCUMENT ID
31.98±2.63 OUR EVALUATION	See the Note on "Width Determinations of the Υ States"

$\Upsilon(2S)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Scale factor/ Confidence level
Γ_1	$\Upsilon(1S)\pi^+\pi^-$	(17.85± 0.26) %	
Γ_2	$\Upsilon(1S)\pi^0\pi^0$	(8.6 ± 0.4) %	
Γ_3	$\tau^+\tau^-$	(2.00± 0.21) %	
Γ_4	$\mu^+\mu^-$	(1.93± 0.17) %	S=2.2
Γ_5	e^+e^-	(1.91± 0.16) %	
Γ_6	$\Upsilon(1S)\pi^0$	< 4 $\times 10^{-5}$	CL=90%
Γ_7	$\Upsilon(1S)\eta$	(2.9 ± 0.4) $\times 10^{-4}$	S=2.0
Γ_8	$J/\psi(1S)$ anything	< 6 $\times 10^{-3}$	CL=90%
Γ_9	$J/\psi(1S)\eta_c$	< 5.4 $\times 10^{-6}$	CL=90%
Γ_{10}	$J/\psi(1S)\chi_{c0}$	< 3.4 $\times 10^{-6}$	CL=90%
Γ_{11}	$J/\psi(1S)\chi_{c1}$	< 1.2 $\times 10^{-6}$	CL=90%
Γ_{12}	$J/\psi(1S)\chi_{c2}$	< 2.0 $\times 10^{-6}$	CL=90%
Γ_{13}	$J/\psi(1S)\eta_c(2S)$	< 2.5 $\times 10^{-6}$	CL=90%
Γ_{14}	$J/\psi(1S)X(3940)$	< 2.0 $\times 10^{-6}$	CL=90%
Γ_{15}	$J/\psi(1S)X(4160)$	< 2.0 $\times 10^{-6}$	CL=90%
Γ_{16}	χ_{c1} anything	(2.2 ± 0.5) $\times 10^{-4}$	

Γ_{17}	$\chi_{c1}(1P)^0 X_{tetra}$	$< 3.67 \times 10^{-5}$	CL=90%
Γ_{18}	χ_{c2} anything	$(2.3 \pm 0.8) \times 10^{-4}$	
Γ_{19}	$\psi(2S)\eta_c$	$< 5.1 \times 10^{-6}$	CL=90%
Γ_{20}	$\psi(2S)\chi_{c0}$	$< 4.7 \times 10^{-6}$	CL=90%
Γ_{21}	$\psi(2S)\chi_{c1}$	$< 2.5 \times 10^{-6}$	CL=90%
Γ_{22}	$\psi(2S)\chi_{c2}$	$< 1.9 \times 10^{-6}$	CL=90%
Γ_{23}	$\psi(2S)\eta_c(2S)$	$< 3.3 \times 10^{-6}$	CL=90%
Γ_{24}	$\psi(2S)X(3940)$	$< 3.9 \times 10^{-6}$	CL=90%
Γ_{25}	$\psi(2S)X(4160)$	$< 3.9 \times 10^{-6}$	CL=90%
Γ_{26}	$\overline{^2H}$ anything	$(2.78^{+0.30}_{-0.26}) \times 10^{-5}$	S=1.2
Γ_{27}	hadrons	(94 ± 11) %	
Γ_{28}	$g g g$	(58.8 ± 1.2) %	
Γ_{29}	$\gamma g g$	(1.87 ± 0.28) %	
Γ_{30}	$\phi K^+ K^-$	$(1.6 \pm 0.4) \times 10^{-6}$	
Γ_{31}	$\omega \pi^+ \pi^-$	$< 2.58 \times 10^{-6}$	CL=90%
Γ_{32}	$K^*(892)^0 K^- \pi^+ +$ c.c.	$(2.3 \pm 0.7) \times 10^{-6}$	
Γ_{33}	$\phi f_2'(1525)$	$< 1.33 \times 10^{-6}$	CL=90%
Γ_{34}	$\omega f_2(1270)$	$< 5.7 \times 10^{-7}$	CL=90%
Γ_{35}	$\rho(770) a_2(1320)$	$< 8.8 \times 10^{-7}$	CL=90%
Γ_{36}	$K^*(892)^0 \overline{K}{}^*_2(1430)^0 +$ c.c.	$(1.5 \pm 0.6) \times 10^{-6}$	
Γ_{37}	$K_1(1270)^\pm K^\mp$	$< 3.22 \times 10^{-6}$	CL=90%
Γ_{38}	$K_1(1400)^\pm K^\mp$	$< 8.3 \times 10^{-7}$	CL=90%
Γ_{39}	$b_1(1235)^\pm \pi^\mp$	$< 4.0 \times 10^{-7}$	CL=90%
Γ_{40}	$\rho \pi$	$< 1.16 \times 10^{-6}$	CL=90%
Γ_{41}	$\pi^+ \pi^- \pi^0$	$< 8.0 \times 10^{-7}$	CL=90%
Γ_{42}	$\omega \pi^0$	$< 1.63 \times 10^{-6}$	CL=90%
Γ_{43}	$\pi^+ \pi^- \pi^0 \pi^0$	$(1.30 \pm 0.28) \times 10^{-5}$	
Γ_{44}	$K^0_S K^+ \pi^- +$ c.c.	$(1.14 \pm 0.33) \times 10^{-6}$	
Γ_{45}	$K^*(892)^0 \overline{K}{}^0 +$ c.c.	$< 4.22 \times 10^{-6}$	CL=90%
Γ_{46}	$K^*(892)^- K^+ +$ c.c.	$< 1.45 \times 10^{-6}$	CL=90%
Γ_{47}	$f_1(1285)$ anything	$(2.2 \pm 1.6) \times 10^{-3}$	
Γ_{48}	$f_1(1285) X_{tetra}$	$< 6.47 \times 10^{-5}$	CL=90%
Γ_{49}	Sum of 100 exclusive modes	$(2.90 \pm 0.30) \times 10^{-3}$	

Radiative decays

Γ_{50}	$\gamma \chi_{b1}(1P)$	(6.9 ± 0.4) %	
Γ_{51}	$\gamma \chi_{b2}(1P)$	(7.15 ± 0.35) %	
Γ_{52}	$\gamma \chi_{b0}(1P)$	(3.8 ± 0.4) %	
Γ_{53}	$\gamma f_0(1710)$	$< 5.9 \times 10^{-4}$	CL=90%
Γ_{54}	$\gamma f_2'(1525)$	$< 5.3 \times 10^{-4}$	CL=90%
Γ_{55}	$\gamma f_2(1270)$	$< 2.41 \times 10^{-4}$	CL=90%
Γ_{56}	$\gamma f_J(2220)$		
Γ_{57}	$\gamma \eta_c(1S)$	$< 2.7 \times 10^{-5}$	CL=90%
Γ_{58}	$\gamma \chi_{c0}$	$< 1.0 \times 10^{-4}$	CL=90%

Γ_{59}	$\gamma\chi_{c1}$		$<$	3.6	$\times 10^{-6}$	CL=90%
Γ_{60}	$\gamma\chi_{c2}$		$<$	1.5	$\times 10^{-5}$	CL=90%
Γ_{61}	$\gamma\chi_{c1}(3872) \to \pi^+\pi^- J/\psi$		$<$	8	$\times 10^{-7}$	CL=90%
Γ_{62}	$\gamma\chi_{c1}(3872) \to \pi^+\pi^-\pi^0 J/\psi$		$<$	2.4	$\times 10^{-6}$	CL=90%
Γ_{63}	$\gamma X(3915) \to \omega J/\psi$		$<$	2.8	$\times 10^{-6}$	CL=90%
Γ_{64}	$\gamma\chi_{c1}(4140) \to \phi J/\psi$		$<$	1.2	$\times 10^{-6}$	CL=90%
Γ_{65}	$\gamma X(4350) \to \phi J/\psi$		$<$	1.3	$\times 10^{-6}$	CL=90%
Γ_{66}	$\gamma\eta_b(1S)$			(3.9 $\pm$ 1.5)	$\times 10^{-4}$	
Γ_{67}	$\gamma\eta_b(1S) \to \gamma$Sum of 26 exclusive modes		$<$	3.7	$\times 10^{-6}$	CL=90%
Γ_{68}	$\gamma X_{b\overline{b}} \to \gamma$Sum of 26 exclusive modes		$<$	4.9	$\times 10^{-6}$	CL=90%
Γ_{69}	$\gamma X \to \gamma + \geq 4$ prongs	[a]	$<$	1.95	$\times 10^{-4}$	CL=95%
Γ_{70}	$\gamma A^0 \to \gamma$hadrons		$<$	8	$\times 10^{-5}$	CL=90%
Γ_{71}	$\gamma a_1^0 \to \gamma\mu^+\mu^-$		$<$	8.3	$\times 10^{-6}$	CL=90%

Lepton Family number (*LF*) violating modes

Γ_{72}	$e^\pm\tau^\mp$	*LF*	$<$	3.2	$\times 10^{-6}$	CL=90%
Γ_{73}	$\mu^\pm\tau^\mp$	*LF*	$<$	3.3	$\times 10^{-6}$	CL=90%

[a] 1.5 GeV $< m_X <$ 5.0 GeV

CONSTRAINED FIT INFORMATION

An overall fit to 3 branching ratios uses 13 measurements and one constraint to determine 3 parameters. The overall fit has a $\chi^2 =$ 11.8 for 11 degrees of freedom.

The following *off-diagonal* array elements are the correlation coefficients $\left\langle\delta x_i \delta x_j\right\rangle/(\delta x_i \cdot \delta x_j)$, in percent, from the fit to the branching fractions, $x_i \equiv \Gamma_i/\Gamma_{total}$. The fit constrains the x_i whose labels appear in this array to sum to one.

x_7	2
	x_1

$\Upsilon(2S)$ $\Gamma(i)\Gamma(e^+e^-)/\Gamma(total)$

$\Gamma(\mu^+\mu^-) \times \Gamma(e^+e^-)/\Gamma_{total}$ $\qquad \Gamma_4\Gamma_5/\Gamma$

VALUE (eV)	*DOCUMENT ID*		*TECN*	*COMMENT*
6.5±1.5±1.0	KOBEL	92	CBAL	$e^+e^- \to \mu^+\mu^-$

$\Gamma(\Upsilon(1S)\pi^+\pi^-) \times \Gamma(e^+e^-)/\Gamma_{total}$ $\qquad \Gamma_1\Gamma_5/\Gamma$

VALUE (eV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
105.4±1.0±4.2	11.8K	[1] AUBERT	08BP	BABR	10.58 $e^+e^- \to \gamma\pi^+\pi^-\ell^+\ell^-$

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

$\Gamma(\text{hadrons}) \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ — $\Gamma_{27}\Gamma_5/\Gamma$

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
0.577±0.009 OUR AVERAGE				
0.581±0.004±0.009	[1] ROSNER	06	CLEO	10.0 $e^+e^- \rightarrow$ hadrons
0.552±0.031±0.017	[1] BARU	96	MD1	$e^+e^- \rightarrow$ hadrons
0.54 ±0.04 ±0.02	[1] JAKUBOWSKI	88	CBAL	$e^+e^- \rightarrow$ hadrons
0.58 ±0.03 ±0.04	[2] GILES	84B	CLEO	$e^+e^- \rightarrow$ hadrons
0.60 ±0.12 ±0.07	[2] ALBRECHT	82	DASP	$e^+e^- \rightarrow$ hadrons
0.54 ±0.07 $^{+0.09}_{-0.05}$	[2] NICZYPORUK	81C	LENA	$e^+e^- \rightarrow$ hadrons
0.41 ±0.18	[2] BOCK	80	CNTR	$e^+e^- \rightarrow$ hadrons

[1] Radiative corrections evaluated following KURAEV 85.
[2] Radiative corrections reevaluated by BUCHMUELLER 88 following KURAEV 85.

$\Upsilon(2S)$ PARTIAL WIDTHS

$\Gamma(e^+e^-)$ — Γ_5

VALUE (keV)	DOCUMENT ID
0.612±0.011 OUR EVALUATION	

$\Upsilon(2S)$ BRANCHING RATIOS

$\Gamma(\Upsilon(1S)\pi^+\pi^-)/\Gamma_{\text{total}}$ — Γ_1/Γ

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

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
17.85±0.26 OUR FIT					
17.92±0.26 OUR AVERAGE					
16.8 ±1.1 ±1.3	906k	[1] LEES	11C	BABR	$e^+e^- \rightarrow \pi^+\pi^- X$
17.80±0.05±0.37	170k	[2] LEES	11L	BABR	$\Upsilon(2S) \rightarrow \pi^+\pi^-\mu^+\mu^-$
18.02±0.02±0.61	851k	[3] BHARI	09	CLEO	$e^+e^- \rightarrow \pi^+\pi^-$ MM
17.22±0.17±0.75	11.8K	[4] AUBERT	08BP	BABR	$e^+e^- \rightarrow \gamma\pi^+\pi^-\ell^+\ell^-$
19.2 ±0.2 ±1.0	52.6k	[5] ALEXANDER	98	CLE2	$\pi^+\pi^-\ell^+\ell^-$, $\pi^+\pi^-$ MM
18.1 ±0.5 ±1.0	11.6k	ALBRECHT	87	ARG	$e^+e^- \rightarrow \pi^+\pi^-$ MM
16.9 ±4.0		GELPHMAN	85	CBAL	$e^+e^- \rightarrow e^+e^-\pi^+\pi^-$
19.1 ±1.2 ±0.6		BESSON	84	CLEO	$\pi^+\pi^-$ MM
18.9 ±2.6		FONSECA	84	CUSB	$e^+e^- \rightarrow \ell^+\ell^-\pi^+\pi^-$
21 ±7	7	NICZYPORUK	81B	LENA	$e^+e^- \rightarrow \ell^+\ell^-\pi^+\pi^-$

[1] LEES 11C reports $[\Gamma(\Upsilon(2S) \rightarrow \Upsilon(1S)\pi^+\pi^-)/\Gamma_{\text{total}}] \times [B(\Upsilon(3S) \rightarrow \Upsilon(2S)\text{anything})] = (1.78 \pm 0.02 \pm 0.11) \times 10^{-2}$ which we divide by our best value $B(\Upsilon(3S) \rightarrow \Upsilon(2S)\text{anything}) = (10.6 \pm 0.8) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.
[2] Using $B(\Upsilon(1S) \rightarrow \mu^+\mu^-) = (2.48 \pm 0.05)\%$.
[3] A weighted average of the inclusive and exclusive results.
[4] Using $B(\Upsilon(2S) \rightarrow e^+e^-) = (1.91 \pm 0.16)\%$, $B(\Upsilon(2S) \rightarrow \mu^+\mu^-) = (1.93 \pm 0.17)\%$ and, $\Gamma_{ee}(\Upsilon(2S)) = 0.612 \pm 0.011$ keV.
[5] Using $B(\Upsilon(1S) \rightarrow e^+e^-) = (2.52 \pm 0.17)\%$ and $B(\Upsilon(1S) \rightarrow \mu^+\mu^-) = (2.48 \pm 0.07)\%$.

$\Gamma(\Upsilon(1S)\pi^0\pi^0)/\Gamma_{total}$ — Γ_2/Γ

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
8.6 ±0.4 OUR AVERAGE					
8.43±0.16±0.42	38k	[1] BHARI	09	CLEO	$e^+e^- \rightarrow \pi^0\pi^0\ell^+\ell^-$
9.2 ±0.6 ±0.8	275	[2] ALEXANDER	98	CLE2	$e^+e^- \rightarrow \pi^0\pi^0\ell^+\ell^-$
9.5 ±1.9 ±1.9	25	ALBRECHT	87	ARG	$e^+e^- \rightarrow \pi^0\pi^0\ell^+\ell^-$
8.0 ±1.5		GELPHMAN	85	CBAL	$e^+e^- \rightarrow \pi^0\pi^0\ell^+\ell^-$
10.3 ±2.3		FONSECA	84	CUSB	$e^+e^- \rightarrow \pi^0\pi^0\ell^+\ell^-$

[1] Authors assume B($\Upsilon(1S) \rightarrow e^+e^-$) + B($\Upsilon(1S) \rightarrow \mu^+\mu^-$) = 4.96%.
[2] Using B($\Upsilon(1S) \rightarrow e^+e^-$) = (2.52 ± 0.17)% and B($\Upsilon(1S) \rightarrow \mu^+\mu^-$) = (2.48 ± 0.07)%.

$\Gamma(\Upsilon(1S)\pi^0\pi^0)/\Gamma(\Upsilon(1S)\pi^+\pi^-)$ — Γ_2/Γ_1

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.462±0.037	[1] BHARI	09	CLEO	$e^+e^- \rightarrow \Upsilon(2S)$

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

$\Gamma(\tau^+\tau^-)/\Gamma_{total}$ — Γ_3/Γ

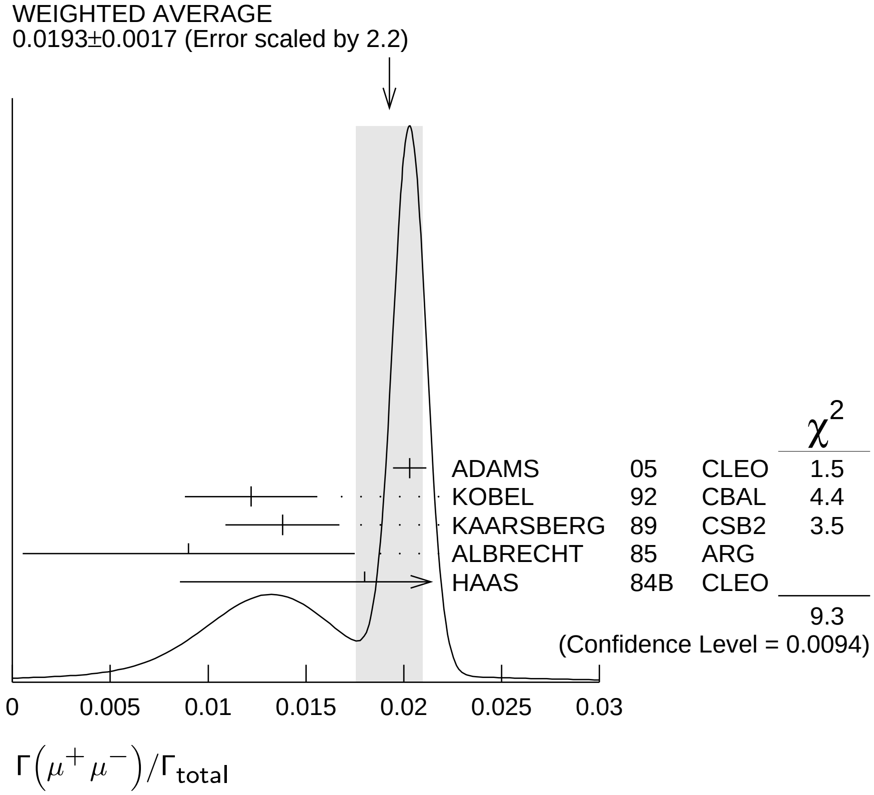
VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
2.00±0.21 OUR AVERAGE					
2.00±0.12±0.18	22k	[1] BESSON	07	CLEO	$e^+e^- \rightarrow \Upsilon(2S) \rightarrow \tau^+\tau^-$
1.7 ±1.5 ±0.6		HAAS	84B	CLEO	$e^+e^- \rightarrow \tau^+\tau^-$

[1] BESSON 07 reports [$\Gamma(\Upsilon(2S) \rightarrow \tau^+\tau^-)/\Gamma_{total}$] / [B($\Upsilon(2S) \rightarrow \mu^+\mu^-$)] = 1.04 ± 0.04 ± 0.05 which we multiply by our best value B($\Upsilon(2S) \rightarrow \mu^+\mu^-$) = $(1.93 \pm 0.17) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(\mu^+\mu^-)/\Gamma_{total}$ — Γ_4/Γ

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.0193±0.0017 OUR AVERAGE Error includes scale factor of 2.2. See the ideogram below.						
0.0203±0.0003±0.0008		120k	ADAMS	05	CLEO	$e^+e^- \rightarrow \mu^+\mu^-$
0.0122±0.0028±0.0019			[1] KOBEL	92	CBAL	$e^+e^- \rightarrow \mu^+\mu^-$
0.0138±0.0025±0.0015			KAARSBERG	89	CSB2	$e^+e^- \rightarrow \mu^+\mu^-$
0.009 ±0.006 ±0.006			[2] ALBRECHT	85	ARG	$e^+e^- \rightarrow \mu^+\mu^-$
0.018 ±0.008 ±0.005			HAAS	84B	CLEO	$e^+e^- \rightarrow \mu^+\mu^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<0.038	90		NICZYPORUK	81C	LENA	$e^+e^- \rightarrow \mu^+\mu^-$

[1] Taking into account interference between the resonance and continuum.
[2] Re-evaluated using B($\Upsilon(1S) \rightarrow \mu^+\mu^-$) = 0.026.



$\Gamma(\tau^+\tau^-)/\Gamma(\mu^+\mu^-)$ Γ_3/Γ_4

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1.04±0.04±0.05	22k	BESSON	07	CLEO	$e^+e^- \to \Upsilon(2S)$

$\Gamma(\Upsilon(1S)\pi^0)/\Gamma_{total}$ Γ_6/Γ

VALUE (units 10^{-5})	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<$ 4	90	[1] TAMPONI	13	BELL	$e^+e^- \to \Upsilon(1S)\pi^0$
$<$ 18	90	[2] HE	08A	CLEO	$e^+e^- \to \ell^+\ell^-\gamma\gamma$
$<$110	90	ALEXANDER	98	CLE2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$
$<$800	90	LURZ	87	CBAL	$e^+e^- \to \ell^+\ell^-\gamma\gamma$

[1] TAMPONI 13 reports $[\Gamma(\Upsilon(2S) \to \Upsilon(1S)\pi^0)/\Gamma_{total}]$ / $[B(\Upsilon(2S) \to \Upsilon(1S)\pi^+\pi^-)]$ $< 2.3 \times 10^{-4}$ which we multiply by our best value $B(\Upsilon(2S) \to \Upsilon(1S)\pi^+\pi^-) = 17.85 \times 10^{-2}$.

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

$\Gamma(\Upsilon(1S)\pi^0)/\Gamma(\Upsilon(1S)\pi^+\pi^-)$ Γ_6/Γ_1

VALUE (units 10^{-4})	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<2.3	90	TAMPONI	13	BELL	$e^+e^- \to \Upsilon(1S)\pi^0$

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

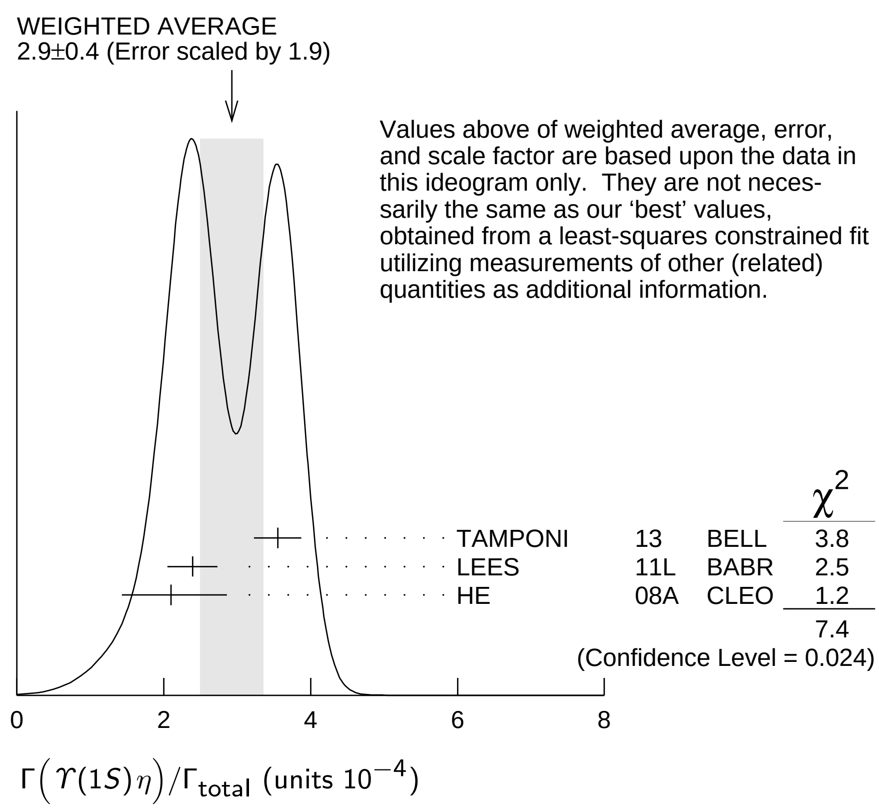
VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
2.9 ±0.4 OUR FIT Error includes scale factor of 2.0.						
2.9 ±0.4 OUR AVERAGE Error includes scale factor of 1.9. See the ideogram below.						
$2.39\pm0.31\pm0.14$		112	[1] LEES	11L	BABR	$\Upsilon(2S)\to\ell^+\ell^-\eta$
$2.1\ ^{+0.7}_{-0.6}\ \pm0.3$		14	[2] HE	08A	CLEO	$e^+e^-\to\ell^+\ell^-\eta$
• • • We use the following data for averages but not for fits. • • •						
$3.55\pm0.32\pm0.05$		241	[3] TAMPONI	13	BELL	$e^+e^-\to\Upsilon(1S)\eta$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<9	90		[1,4] AUBERT	08BP	BABR	$e^+e^-\to\gamma\pi^+\pi^-\pi^0\ell^+\ell^-$
<28	90		ALEXANDER	98	CLE2	$e^+e^-\to\ell^+\ell^-\eta$
<50	90		ALBRECHT	87	ARG	$e^+e^-\to\pi^+\pi^-\ell^+\ell^-$ MM
<70	90		LURZ	87	CBAL	$e^+e^-\to\ell^+\ell^-(\gamma\gamma,\ 3\pi^0)$
<100	90		BESSON	84	CLEO	$e^+e^-\to\pi^+\pi^-\ell^+\ell^-$ MM
<20	90		FONSECA	84	CUSB	$e^+e^-\to\ell^+\ell^-(\gamma\gamma,\pi^+\pi^-\pi^0)$

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

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

[3] TAMPONI 13 reports $[\Gamma(\Upsilon(2S)\to\Upsilon(1S)\eta)/\Gamma_{total}]$ / $[B(\Upsilon(2S)\to\Upsilon(1S)\pi^+\pi^-)]$ $= (1.99\pm0.14\pm0.11)\times10^{-3}$ which we multiply by our best value B($\Upsilon(2S)\to\Upsilon(1S)\pi^+\pi^-$) = $(17.85\pm0.26)\times10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[4] Using $\Gamma_{ee}(\Upsilon(2S)) = 0.612\pm0.011$ keV.



$\Gamma(\Upsilon(1S)\eta)/\Gamma(\Upsilon(1S)\pi^+\pi^-)$ — Γ_7/Γ_1

VALUE (units 10^{-3})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
1.64±0.25 OUR FIT			Error includes scale factor of 2.0.			
1.99±0.14±0.11		241	TAMPONI	13	BELL	$e^+e^- \rightarrow \Upsilon(1S)\eta$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
1.35±0.17±0.08			[1] LEES	11L	BABR	$\Upsilon(2S) \rightarrow (\pi^+\pi^-)(\gamma\gamma)\mu^+\mu^-$
< 5.2	90		[2] AUBERT	08BP	BABR	$e^+e^- \rightarrow \gamma\pi^+\pi^-(\pi^0)\ell^+\ell^-$

[1] Not independent of other values reported by LEES 11L.
[2] Not independent of other values reported by AUBERT 08BP.

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

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.13	90	TAMPONI	13	BELL	$e^+e^- \rightarrow \Upsilon(1S)\pi^0$

$\Gamma(J/\psi(1S)\text{ anything})/\Gamma_{total}$ — Γ_8/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.006	90	MASCHMANN	90	CBAL	$e^+e^- \rightarrow$ hadrons

$\Gamma(J/\psi(1S)\eta_c)/\Gamma_{total}$ — Γ_9/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<5.4 \times 10^{-6}$	90	YANG	14	BELL	$e^+e^- \rightarrow J/\psi X$

$\Gamma(J/\psi(1S)\chi_{c0})/\Gamma_{total}$ — Γ_{10}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<3.4 \times 10^{-6}$	90	YANG	14	BELL	$e^+e^- \rightarrow J/\psi X$

$\Gamma(J/\psi(1S)\chi_{c1})/\Gamma_{total}$ — Γ_{11}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<1.2 \times 10^{-6}$	90	YANG	14	BELL	$e^+e^- \rightarrow J/\psi X$

$\Gamma(J/\psi(1S)\chi_{c2})/\Gamma_{total}$ — Γ_{12}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<2.0 \times 10^{-6}$	90	YANG	14	BELL	$e^+e^- \rightarrow J/\psi X$

$\Gamma(J/\psi(1S)\eta_c(2S))/\Gamma_{total}$ — Γ_{13}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<2.5 \times 10^{-6}$	90	YANG	14	BELL	$e^+e^- \rightarrow J/\psi X$

$\Gamma(J/\psi(1S)X(3940))/\Gamma_{total}$ — Γ_{14}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<2.0 \times 10^{-6}$	90	YANG	14	BELL	$e^+e^- \rightarrow J/\psi X$

$\Gamma(J/\psi(1S)X(4160))/\Gamma_{total}$ — Γ_{15}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<2.0 \times 10^{-6}$	90	YANG	14	BELL	$e^+e^- \rightarrow J/\psi X$

$\Gamma(\chi_{c1}\,\text{anything})/\Gamma_{\text{total}}$ Γ_{16}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
2.24±0.44±0.20	376	JIA	17	BELL	$\Upsilon(2S) \to \gamma J/\psi(1S)$

$\Gamma(\chi_{c1}(1P)^0 X_{tetra})/\Gamma_{\text{total}}$ Γ_{17}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<36.7 × 10^{-6}	90	[1] JIA	17A	BELL	$e^+ e^- \to$ hadrons

[1] For a tetraquark state X_{tetra}, with mass in the range 1.16–2.46 GeV and width in the range 0–0.3 GeV. Measured 90% CL limits as a function of X_{tetra} mass and width range from 4.4×10^{-6} to 36.7×10^{-6}.

$\Gamma(\chi_{c2}\,\text{anything})/\Gamma_{\text{total}}$ Γ_{18}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
2.28±0.73±0.34	JIA	17	BELL	$\Upsilon(2S) \to \gamma J/\psi(1S)$

$\Gamma(\psi(2S)\eta_c)/\Gamma_{\text{total}}$ Γ_{19}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<5.1 × 10^{-6}	90	YANG	14	BELL	$e^+ e^- \to \psi(2S) X$

$\Gamma(\psi(2S)\chi_{c0})/\Gamma_{\text{total}}$ Γ_{20}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<4.7 × 10^{-6}	90	YANG	14	BELL	$e^+ e^- \to \psi(2S) X$

$\Gamma(\psi(2S)\chi_{c1})/\Gamma_{\text{total}}$ Γ_{21}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<2.5 × 10^{-6}	90	YANG	14	BELL	$e^+ e^- \to \psi(2S) X$

$\Gamma(\psi(2S)\chi_{c2})/\Gamma_{\text{total}}$ Γ_{22}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<1.9 × 10^{-6}	90	YANG	14	BELL	$e^+ e^- \to \psi(2S) X$

$\Gamma(\psi(2S)\eta_c(2S))/\Gamma_{\text{total}}$ Γ_{23}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<3.3 × 10^{-6}	90	YANG	14	BELL	$e^+ e^- \to \psi(2S) X$

$\Gamma(\psi(2S)X(3940))/\Gamma_{\text{total}}$ Γ_{24}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<3.9 × 10^{-6}	90	YANG	14	BELL	$e^+ e^- \to \psi(2S) X$

$\Gamma(\psi(2S)X(4160))/\Gamma_{\text{total}}$ Γ_{25}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<3.9 × 10^{-6}	90	YANG	14	BELL	$e^+ e^- \to \psi(2S) X$

$\Gamma(\overline{^2H}$ anything$)/\Gamma_{total}$ Γ_{26}/Γ

VALUE (units 10^{-5})	EVTS	DOCUMENT ID		TECN	COMMENT
$2.78^{+0.30}_{-0.26}$ OUR AVERAGE Error includes scale factor of 1.2.					
$2.64 \pm 0.11 ^{+0.26}_{-0.21}$		LEES	14G	BABR	$e^+e^- \to \overline{^2H}\ X$
$3.37 \pm 0.50 \pm 0.25$	58	ASNER	07	CLEO	$e^+e^- \to \overline{^2H}\ X$

$\Gamma(ggg)/\Gamma_{total}$ Γ_{28}/Γ

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
58.8 ± 1.2	6M	[1] BESSON	06A	CLEO	$\Upsilon(2S) \to$ hadrons

[1] Calculated using the value $\Gamma(\gamma gg)/\Gamma(ggg) = (3.18 \pm 0.04 \pm 0.22 \pm 0.41)\%$ from BESSON 06A and PDG 08 values of $B(\pi^+\pi^-\ \Upsilon(1S)) = (18.1 \pm 0.4)\%$, $B(\pi^0\pi^0\ \Upsilon(1S)) = (8.6 \pm 0.4)\%$, $B(\mu^+\mu^-) = (1.93 \pm 0.17)\%$, and $R_{hadrons} = 3.51$. The statistical error is negligible and the systematic error is partially correlated with that of $\Gamma(\gamma gg)/\Gamma_{total}$ measurement of BESSON 06A.

$\Gamma(\gamma gg)/\Gamma(ggg)$ Γ_{29}/Γ_{28}

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
$3.18 \pm 0.04 \pm 0.47$	6M	BESSON	06A	CLEO	$\Upsilon(2S) \to (\gamma +)$ hadrons

$\Gamma(\phi K^+ K^-)/\Gamma_{total}$ Γ_{30}/Γ

VALUE (units 10^{-6})	EVTS	DOCUMENT ID		TECN	COMMENT
$1.58 \pm 0.33 \pm 0.18$	58	SHEN	12A	BELL	$\Upsilon(1S) \to\ 2(K^+K^-)$

$\Gamma(\omega \pi^+ \pi^-)/\Gamma_{total}$ Γ_{31}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT
<2.58	90	SHEN	12A	BELL	$\Upsilon(1S) \to\ 2(\pi^+\pi^-)\pi^0$

$\Gamma(K^*(892)^0 K^- \pi^+ +$ c.c.$)/\Gamma_{total}$ Γ_{32}/Γ

VALUE (units 10^{-6})	EVTS	DOCUMENT ID		TECN	COMMENT
$2.32 \pm 0.40 \pm 0.54$	135	SHEN	12A	BELL	$\Upsilon(1S) \to\ K^+K^-\pi^+\pi^-$

$\Gamma(\phi f_2'(1525))/\Gamma_{total}$ Γ_{33}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT
<1.33	90	SHEN	12A	BELL	$\Upsilon(1S) \to\ 2(K^+K^-)$

$\Gamma(\omega f_2(1270))/\Gamma_{total}$ Γ_{34}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT
<0.57	90	SHEN	12A	BELL	$\Upsilon(1S) \to\ 2(\pi^+\pi^-)\pi^0$

$\Gamma(\rho(770) a_2(1320))/\Gamma_{total}$ Γ_{35}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT
<0.88	90	SHEN	12A	BELL	$\Upsilon(1S) \to\ 2(\pi^+\pi^-)\pi^0$

$\Gamma\big(K^*(892)^0 \overline{K}{}^*_2(1430)^0 + \text{c.c.}\big)/\Gamma_{\text{total}}$ — Γ_{36}/Γ

VALUE (units 10^{-6})	EVTS	DOCUMENT ID		TECN	COMMENT
1.53±0.52±0.19	32	SHEN	12A	BELL	$\Upsilon(1S) \rightarrow K^+ K^- \pi^+ \pi^-$

$\Gamma\big(K_1(1270)^\pm K^\mp\big)/\Gamma_{\text{total}}$ — Γ_{37}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT
<3.22	90	SHEN	12A	BELL	$\Upsilon(1S) \rightarrow K^+ K^- \pi^+ \pi^-$

$\Gamma\big(K_1(1400)^\pm K^\mp\big)/\Gamma_{\text{total}}$ — Γ_{38}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT
<0.83	90	SHEN	12A	BELL	$\Upsilon(1S) \rightarrow K^+ K^- \pi^+ \pi^-$

$\Gamma\big(b_1(1235)^\pm \pi^\mp\big)/\Gamma_{\text{total}}$ — Γ_{39}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT
<0.40	90	SHEN	12A	BELL	$\Upsilon(1S) \rightarrow 2(\pi^+ \pi^-)\pi^0$

$\Gamma\big(\rho\pi\big)/\Gamma_{\text{total}}$ — Γ_{40}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT
<1.16	90	SHEN	13	BELL	$\Upsilon(2S) \rightarrow \pi^+ \pi^- \pi^0$

$\Gamma\big(\pi^+ \pi^- \pi^0\big)/\Gamma_{\text{total}}$ — Γ_{41}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT
<0.80	90	SHEN	13	BELL	$\Upsilon(2S) \rightarrow \pi^+ \pi^- \pi^0$

$\Gamma\big(\omega\pi^0\big)/\Gamma_{\text{total}}$ — Γ_{42}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT
<1.63	90	SHEN	13	BELL	$\Upsilon(2S) \rightarrow \pi^+ \pi^- \pi^0 \pi^0$

$\Gamma\big(\pi^+ \pi^- \pi^0 \pi^0\big)/\Gamma_{\text{total}}$ — Γ_{43}/Γ

VALUE (units 10^{-6})	EVTS	DOCUMENT ID		TECN	COMMENT
13.0±1.9±2.1	261 ± 37	SHEN	13	BELL	$\Upsilon(2S) \rightarrow \pi^+ \pi^- \pi^0 \pi^0$

$\Gamma\big(K^0_S K^+ \pi^- + \text{c.c.}\big)/\Gamma_{\text{total}}$ — Γ_{44}/Γ

VALUE (units 10^{-6})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
1.14±0.30±0.13		40 ± 10	SHEN	13	BELL	$\Upsilon(2S) \rightarrow K^0_S K^- \pi^+$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<3.2	90		[1] DOBBS	12A		$\Upsilon(2S) \rightarrow K^0_S K^- \pi^+$

[1] Obtained by analyzing CLEO III data but not authored by the CLEO Collaboration.

$\Gamma\big(K^*(892)^0 \overline{K}{}^0 + \text{c.c.}\big)/\Gamma_{\text{total}}$ — Γ_{45}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT
<4.22	90	SHEN	13	BELL	$\Upsilon(2S) \rightarrow K^0_S K^- \pi^+$

$\Gamma\big(K^*(892)^- K^+ + \text{c.c.}\big)/\Gamma_{\text{total}}$ — Γ_{46}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT
<1.45	90	SHEN	13	BELL	$\Upsilon(2S) \rightarrow K^0_S K^- \pi^+$

$\Gamma(f_1(1285)\text{anything})/\Gamma_{total}$ Γ_{47}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
2.20±1.50±0.63	2.9k	JIA	17A	BELL	$e^+e^- \to$ hadrons

$\Gamma(f_1(1285)X_{tetra})/\Gamma_{total}$ Γ_{48}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<64.7\times10^{-6}$	90	[1] JIA	17A	BELL	$e^+e^- \to$ hadrons

[1] For a tetraquark state X_{tetra}, with mass in the range 1.16–2.46 GeV and width in the range 0–0.3 GeV. Measured 90% CL limits as a function of X_{tetra} mass and width range from 7.8×10^{-6} to 64.7×10^{-6}.

$\Gamma(\text{Sum of 100 exclusive modes})/\Gamma_{total}$ Γ_{49}/Γ

VALUE (units 10^{-2})	DOCUMENT ID		COMMENT
0.29±0.03	[1,2] DOBBS	12A	$\Upsilon(2S) \to$ hadrons

[1] DOBBS 12A presents individual exclusive branching fractions or upper limits for 100 modes of four to ten pions, kaons, or protons.

[2] Obtained by analyzing CLEO III data but not authored by the CLEO Collaboration.

$\Gamma(\gamma\chi_{b1}(1P))/\Gamma_{total}$ Γ_{50}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.069 ±0.004 OUR AVERAGE					
0.0693±0.0012±0.0041	407k	ARTUSO	05	CLEO	$e^+e^- \to \gamma X$
0.069 ±0.005 ±0.009		EDWARDS	99	CLE2	$\Upsilon(2S) \to \gamma\chi(1P)$
0.091 ±0.018 ±0.022		ALBRECHT	85E	ARG	$e^+e^- \to \gamma$conv. X
0.065 ±0.007 ±0.012		NERNST	85	CBAL	$e^+e^- \to \gamma$X
0.080 ±0.017 ±0.016		HAAS	84	CLEO	$e^+e^- \to \gamma$conv. X
0.059 ±0.014		KLOPFEN...	83	CUSB	$e^+e^- \to \gamma$X

$\Gamma(\gamma\chi_{b2}(1P))/\Gamma_{total}$ Γ_{51}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.0715±0.0035 OUR AVERAGE					
0.0724±0.0011±0.0040	410k	ARTUSO	05	CLEO	$e^+e^- \to \gamma X$
0.074 ±0.005 ±0.008		EDWARDS	99	CLE2	$\Upsilon(2S) \to \gamma\chi(1P)$
0.098 ±0.021 ±0.024		ALBRECHT	85E	ARG	$e^+e^- \to \gamma$conv. X
0.058 ±0.007 ±0.010		NERNST	85	CBAL	$e^+e^- \to \gamma$X
0.102 ±0.018 ±0.021		HAAS	84	CLEO	$e^+e^- \to \gamma$conv. X
0.061 ±0.014		KLOPFEN...	83	CUSB	$e^+e^- \to \gamma$X

$\Gamma(\gamma\chi_{b0}(1P))/\Gamma_{total}$ Γ_{52}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.038 ±0.004 OUR AVERAGE					
0.0375±0.0012±0.0047	198k	ARTUSO	05	CLEO	$e^+e^- \to \gamma X$
0.034 ±0.005 ±0.006		EDWARDS	99	CLE2	$\Upsilon(2S) \to \gamma\chi(1P)$
0.064 ±0.014 ±0.016		ALBRECHT	85E	ARG	$e^+e^- \to \gamma$conv. X
0.036 ±0.008 ±0.009		NERNST	85	CBAL	$e^+e^- \to \gamma$X
0.044 ±0.023 ±0.009		HAAS	84	CLEO	$e^+e^- \to \gamma$conv. X
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.035 ±0.014		KLOPFEN...	83	CUSB	$e^+e^- \to \gamma$X

$\Gamma(\gamma f_0(1710))/\Gamma_{total}$ — Γ_{53}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID		TECN	COMMENT
<59	90	[1] ALBRECHT	89	ARG	$\Upsilon(2S) \to \gamma K^+ K^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<$ 5.9	90	[2] ALBRECHT	89	ARG	$\Upsilon(2S) \to \gamma \pi^+ \pi^-$

[1] Re-evaluated assuming B($f_0(1710) \to K^+ K^-$) = 0.19.
[2] Includes unknown branching ratio of $f_0(1710) \to \pi^+ \pi^-$.

$\Gamma(\gamma f'_2(1525))/\Gamma_{total}$ — Γ_{54}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID		TECN	COMMENT
<53	90	[1] ALBRECHT	89	ARG	$\Upsilon(2S) \to \gamma K^+ K^-$

[1] Re-evaluated assuming B($f'_2(1525) \to K\overline{K}$) = 0.71.

$\Gamma(\gamma f_2(1270))/\Gamma_{total}$ — Γ_{55}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID		TECN	COMMENT
<24.1	90	[1] ALBRECHT	89	ARG	$\Upsilon(2S) \to \gamma \pi^+ \pi^-$

[1] Using B($f_2(1270) \to \pi\pi$) = 0.84.

$\Gamma(\gamma f_J(2220))/\Gamma_{total}$ — Γ_{56}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<$6.8	90	[1] ALBRECHT	89	ARG	$\Upsilon(2S) \to \gamma K^+ K^-$

[1] Includes unknown branching ratio of $f_J(2220) \to K^+ K^-$.

$\Gamma(\gamma \eta_c(1S))/\Gamma_{total}$ — Γ_{57}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<2.7 \times 10^{-5}$	90	WANG	11B	BELL	$\Upsilon(2S) \to \gamma X$

$\Gamma(\gamma \chi_{c0})/\Gamma_{total}$ — Γ_{58}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<1.0 \times 10^{-4}$	90	WANG	11B	BELL	$\Upsilon(2S) \to \gamma X$

$\Gamma(\gamma \chi_{c1})/\Gamma_{total}$ — Γ_{59}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<3.6 \times 10^{-6}$	90	WANG	11B	BELL	$\Upsilon(2S) \to \gamma X$

$\Gamma(\gamma \chi_{c2})/\Gamma_{total}$ — Γ_{60}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<1.5 \times 10^{-5}$	90	WANG	11B	BELL	$\Upsilon(2S) \to \gamma X$

$\Gamma(\gamma \chi_{c1}(3872) \to \pi^+ \pi^- J/\psi)/\Gamma_{total}$ — Γ_{61}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<0.8 \times 10^{-6}$	90	WANG	11B	BELL	$\Upsilon(2S) \to \gamma X$

$\Gamma(\gamma\chi_{c1}(3872) \to \pi^+\pi^-\pi^0 J/\psi)/\Gamma_{total}$ — Γ_{62}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<2.4 × 10^{-6}	90	WANG	11B	BELL	$\Upsilon(2S) \to \gamma X$

$\Gamma(\gamma X(3915) \to \omega J/\psi)/\Gamma_{total}$ — Γ_{63}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<2.8 × 10^{-6}	90	WANG	11B	BELL	$\Upsilon(2S) \to \gamma X$

$\Gamma(\gamma\chi_{c1}(4140) \to \phi J/\psi)/\Gamma_{total}$ — Γ_{64}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<1.2 × 10^{-6}	90	WANG	11B	BELL	$\Upsilon(2S) \to \gamma X$

$\Gamma(\gamma X(4350) \to \phi J/\psi)/\Gamma_{total}$ — Γ_{65}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<1.3 × 10^{-6}	90	WANG	11B	BELL	$\Upsilon(2S) \to \gamma X$

$\Gamma(\gamma\eta_b(1S))/\Gamma_{total}$ — Γ_{66}/Γ

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$3.9\pm1.1^{+1.1}_{-0.9}$		13 ± 5k	[1] AUBERT	09AQ	BABR	$\Upsilon(2S) \to \gamma X$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<21	90		LEES	11J	BABR	$\Upsilon(2S) \to X\gamma$
< 8.4	90		[1] BONVICINI	10	CLEO	$\Upsilon(2S) \to \gamma X$
< 5.1	90		[2] ARTUSO	05	CLEO	$e^+e^- \to \gamma X$

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

[2] Superseded by BONVICINI 10.

$\Gamma(\gamma\eta_b(1S) \to \gamma\,\text{Sum of 26 exclusive modes})/\Gamma_{total}$ — Γ_{67}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<3.7 × 10^{-6}	90	SANDILYA	13	BELL	$\Upsilon(2S) \to \gamma$ hadrons

$\Gamma(\gamma X_{b\bar{b}} \to \gamma\,\text{Sum of 26 exclusive modes})/\Gamma_{total}$ — Γ_{68}/Γ

VALUE (units 10^{-6})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
< 4.9	90		SANDILYA	13	BELL	$\Upsilon(2S) \to \gamma$ hadrons
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$46.2^{+29.7}_{-14.2}\pm10.6$		10	[1] DOBBS	12		$\Upsilon(2S) \to \gamma$ hadrons

[1] Obtained by analyzing CLEO III data but not authored by the CLEO Collaboration.

$\Gamma(\gamma X \to \gamma + \geq 4\ \text{prongs})/\Gamma_{total}$ — Γ_{69}/Γ

(1.5 GeV $< m_X <$ 5.0 GeV)

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<1.95	95	ROSNER	07A	CLEO	$e^+e^- \to \gamma X$

$\Gamma(\gamma A^0 \to \gamma \text{hadrons})/\Gamma_{total}$ Γ_{70}/Γ

(0.3 GeV < m_{A^0} < 7 GeV)

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<8 × 10^{-5}	90	[1] LEES	11H	BABR	$\Upsilon(2S) \to \gamma$ hadrons

[1] For a narrow scalar or pseudoscalar A^0, excluding known resonances, with mass in the range 0.3–7 GeV. Measured 90% CL limits as a function of m_{A^0} range from 1×10^{-6} to 8×10^{-5}.

$\Gamma(\gamma a_1^0 \to \gamma \mu^+ \mu^-)/\Gamma_{total}$ Γ_{71}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT
<8.3	90	[1] AUBERT	09Z	BABR	$e^+ e^- \to \gamma a_1^0 \to \gamma \mu^+ \mu^-$

[1] For a narrow scalar or pseudoscalar a_1^0 with mass in the range 212–9300 MeV, excluding J/ψ and $\psi(2S)$. Measured 90% CL limits as a function of $m_{a_1^0}$ range from 0.26–8.3 × 10^{-6}.

LEPTON FAMILY NUMBER (*LF*) VIOLATING MODES

$\Gamma(e^\pm \tau^\mp)/\Gamma_{total}$ Γ_{72}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT
<3.2	90	LEES	10B	BABR	$e^+ e^- \to e^\pm \tau^\mp$

$\Gamma(\mu^\pm \tau^\mp)/\Gamma_{total}$ Γ_{73}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT
< 3.3	90	LEES	10B	BABR	$e^+ e^- \to \mu^\pm \tau^\mp$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<14.4	95	LOVE	08A	CLEO	$e^+ e^- \to \mu^\pm \tau^\mp$

$\Upsilon(2S)$ Cross-Particle Branching Ratios

$B(\Upsilon(2S) \to \pi^+ \pi^-) \times B(\Upsilon(3S) \to \Upsilon(2S) X)$

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
1.78±0.02±0.11	906k	LEES	11C	BABR	$e^+ e^- \to \pi^+ \pi^- X$

$\Upsilon(2S)$ REFERENCES

JIA	17	PR D95 012001	S. Jia et al.	(BELLE Collab.)
JIA	17A	PR D96 112002	S. Jia et al.	(BELLE Collab.)
LEES	14G	PR D89 111102	J.P. Lees et al.	(BABAR Collab.)
YANG	14	PR D90 112008	S.D. Yang et al.	(BELLE Collab.)
SANDILYA	13	PRL 111 112001	S. Sandilya et al.	(BELLE Collab.)
SHEN	13	PR D88 011102	C.P. Shen et al.	(BELLE Collab.)
TAMPONI	13	PR D87 011104	U. Tamponi et al.	(BELLE Collab.)
DOBBS	12	PRL 109 082001	S. Dobbs et al.	
DOBBS	12A	PR D86 052003	S. Dobbs et al.	
SHEN	12A	PR D86 031102	C.P. Shen et al.	(BELLE Collab.)
LEES	11C	PR D84 011104	J.P. Lees et al.	(BABAR Collab.)
LEES	11H	PRL 107 221803	J.P. Lees et al.	(BABAR Collab.)
LEES	11J	PR D84 072002	J.P. Lees et al.	(BABAR Collab.)
LEES	11L	PR D84 092003	J.P. Lees et al.	(BABAR Collab.)
WANG	11B	PR D84 071107	X.L. Wang et al.	(BELLE Collab.)
BONVICINI	10	PR D81 031104	G. Bonvicini et al.	(CLEO Collab.)

LEES	10B	PRL 104 151802	J.P. Lees *et al.*	(BABAR Collab.)
AUBERT	09AQ	PRL 103 161801	B. Aubert *et al.*	(BABAR Collab.)
AUBERT	09Z	PRL 103 081803	B. Aubert *et al.*	(BABAR Collab.)
BHARI	09	PR D79 011103	S.R. Bhari *et al.*	(CLEO Collab.)
AUBERT	08BP	PR D78 112002	B. Aubert *et al.*	(BABAR Collab.)
HE	08A	PRL 101 192001	Q. He *et al.*	(CLEO Collab.)
LOVE	08A	PRL 101 201601	W. Love *et al.*	(CLEO Collab.)
PDG	08	PL B667 1	C. Amsler *et al.*	(PDG Collab.)
ASNER	07	PR D75 012009	D.M. Asner *et al.*	(CLEO Collab.)
BESSON	07	PRL 98 052002	D. Besson *et al.*	(CLEO Collab.)
ROSNER	07A	PR D76 117102	J.L. Rosner *et al.*	(CLEO Collab.)
BESSON	06A	PR D74 012003	D. Besson *et al.*	(CLEO Collab.)
ROSNER	06	PRL 96 092003	J.L. Rosner *et al.*	(CLEO Collab.)
ADAMS	05	PRL 94 012001	G.S. Adams *et al.*	(CLEO Collab.)
ARTUSO	05	PRL 94 032001	M. Artuso *et al.*	(CLEO Collab.)
ARTAMONOV	00	PL B474 427	A.S. Artamonov *et al.*	
EDWARDS	99	PR D59 032003	K.W. Edwards *et al.*	(CLEO Collab.)
ALEXANDER	98	PR D58 052004	J.P. Alexander *et al.*	(CLEO Collab.)
BARU	96	PRPL 267 71	S.E. Baru *et al.*	(NOVO)
KOBEL	92	ZPHY C53 193	M. Kobel *et al.*	(Crystal Ball Collab.)
MASCHMANN	90	ZPHY C46 555	W.S. Maschmann *et al.*	(Crystal Ball Collab.)
ALBRECHT	89	ZPHY C42 349	H. Albrecht *et al.*	(ARGUS Collab.)
KAARSBERG	89	PRL 62 2077	T.M. Kaarsberg *et al.*	(CUSB Collab.)
BUCHMUEL...	88	HE e^+e^- Physics 412	W. Buchmueller, S. Cooper	(HANN, DESY, MIT)
Editors: A. Ali and P. Soeding, World Scientific, Singapore				
JAKUBOWSKI	88	ZPHY C40 49	Z. Jakubowski *et al.*	(Crystal Ball Collab.) IGJPC
ALBRECHT	87	ZPHY C35 283	H. Albrecht *et al.*	(ARGUS Collab.)
COHEN	87	RMP 59 1121	E.R. Cohen, B.N. Taylor	(RISC, NBS)
LURZ	87	ZPHY C36 383	B. Lurz *et al.*	(Crystal Ball Collab.)
BARU	86B	ZPHY C32 622 (erratum)	S.E. Baru *et al.*	(NOVO)
ALBRECHT	85	ZPHY C28 45	H. Albrecht *et al.*	(ARGUS Collab.)
ALBRECHT	85E	PL 160B 331	H. Albrecht *et al.*	(ARGUS Collab.)
GELPHMAN	85	PR D32 2893	D. Gelphman *et al.*	(Crystal Ball Collab.)
KURAEV	85	SJNP 41 466	E.A. Kuraev, V.S. Fadin	(NOVO)
		Translated from YAF 41 733.		
NERNST	85	PRL 54 2195	R. Nernst *et al.*	(Crystal Ball Collab.)
ARTAMONOV	84	PL 137B 272	A.S. Artamonov *et al.*	(NOVO)
BARBER	84	PL 135B 498	D.P. Barber *et al.*	(DESY, ARGUS Collab.+)
BESSON	84	PR D30 1433	D. Besson *et al.*	(CLEO Collab.)
FONSECA	84	NP B242 31	V. Fonseca *et al.*	(CUSB Collab.)
GILES	84B	PR D29 1285	R. Giles *et al.*	(CLEO Collab.)
HAAS	84	PRL 52 799	J. Haas *et al.*	(CLEO Collab.)
HAAS	84B	PR D30 1996	J. Haas *et al.*	(CLEO Collab.)
KLOPFEN...	83	PRL 51 160	C. Klopfenstein *et al.*	(CUSB Collab.)
ALBRECHT	82	PL 116B 383	H. Albrecht *et al.*	(DESY, DORT, HEIDH+)
NICZYPORUK	81B	PL 100B 95	B. Niczyporuk *et al.*	(LENA Collab.)
NICZYPORUK	81C	PL 99B 169	B. Niczyporuk *et al.*	(LENA Collab.)
BOCK	80	ZPHY C6 125	P. Bock *et al.*	(HEIDP, MPIM, DESY, HAMB)