

$\Upsilon(1S)$

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

 $\Upsilon(1S)$ MASS

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
9460.30 ± 0.26 OUR AVERAGE	Error includes scale factor of 3.3.		
9460.51 ± 0.09 ± 0.05	¹ ARTAMONOV 00	MD1	$e^+e^- \rightarrow$ hadrons
9459.97 ± 0.11 ± 0.07	MACKAY 84	REDE	$e^+e^- \rightarrow$ hadrons
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
9460.60 ± 0.09 ± 0.05	^{2,3} BARU	92B	REDE $e^+e^- \rightarrow$ hadrons
9460.59 ± 0.12	BARU	86	REDE $e^+e^- \rightarrow$ hadrons
9460.6 ± 0.4	^{3,4} ARTAMONOV 84	REDE	$e^+e^- \rightarrow$ hadrons
¹ Reanalysis of BARU 92B and ARTAMONOV 84 using new electron mass (COHEN 87).			
² Superseding BARU 86.			
³ Superseded by ARTAMONOV 00.			
⁴ Value includes data of ARTAMONOV 82.			

 $\Upsilon(1S)$ WIDTH

<u>VALUE (keV)</u>	<u>DOCUMENT ID</u>
54.02 ± 1.25 OUR EVALUATION	See the Note on "Width Determinations of the Υ States"

 $\Upsilon(1S)$ DECAY MODES

Mode	Fraction (Γ_i/Γ)	Scale factor/ Confidence level
Γ_1 $\tau^+\tau^-$	(2.60 ± 0.10) %	
Γ_2 e^+e^-	(2.38 ± 0.11) %	
Γ_3 $\mu^+\mu^-$	(2.48 ± 0.05) %	

Hadronic decays

Γ_4 ggg	(81.7 ± 0.7) %	
Γ_5 γgg	(2.2 ± 0.6) %	
Γ_6 $\eta'(958)$ anything	(2.94 ± 0.24) %	
Γ_7 $J/\psi(1S)$ anything	(5.4 ± 0.4) × 10 ⁻⁴	S=1.4
Γ_8 $J/\psi(1S)\eta_c$	< 2.2	× 10 ⁻⁶ CL=90%
Γ_9 $J/\psi(1S)\chi_{c0}$	< 3.4	× 10 ⁻⁶ CL=90%
Γ_{10} $J/\psi(1S)\chi_{c1}$	(3.9 ± 1.2) × 10 ⁻⁶	
Γ_{11} $J/\psi(1S)\chi_{c2}$	< 1.4	× 10 ⁻⁶ CL=90%
Γ_{12} $J/\psi(1S)\eta_c(2S)$	< 2.2	× 10 ⁻⁶ CL=90%
Γ_{13} $J/\psi(1S)X(3940)$	< 5.4	× 10 ⁻⁶ CL=90%
Γ_{14} $J/\psi(1S)X(4160)$	< 5.4	× 10 ⁻⁶ CL=90%
Γ_{15} $X(4350)$ anything, $X \rightarrow J/\psi(1S)\phi$	< 8.1	× 10 ⁻⁶ CL=90%

Γ_{16}	$Z_c(3900)^\pm$ anything, $Z_c \rightarrow J/\psi(1S)\pi^\pm$	< 1.3	$\times 10^{-5}$	CL=90%
Γ_{17}	$Z_c(4200)^\pm$ anything, $Z_c \rightarrow J/\psi(1S)\pi^\pm$	< 6.0	$\times 10^{-5}$	CL=90%
Γ_{18}	$Z_c(4430)^\pm$ anything, $Z_c \rightarrow J/\psi(1S)\pi^\pm$	< 4.9	$\times 10^{-5}$	CL=90%
Γ_{19}	X_{cs}^\pm anything, $X \rightarrow J/\psi K^\pm$	< 5.7	$\times 10^{-6}$	CL=90%
Γ_{20}	$\chi_{c1}(3872)$ anything, $\chi_{c1} \rightarrow J/\psi(1S)\pi^+\pi^-$	< 9.5	$\times 10^{-6}$	CL=90%
Γ_{21}	$\psi(4260)$ anything, $\psi \rightarrow J/\psi(1S)\pi^+\pi^-$	< 3.8	$\times 10^{-5}$	CL=90%
Γ_{22}	$\psi(4260)$ anything, $\psi \rightarrow J/\psi(1S)K^+K^-$	< 7.5	$\times 10^{-6}$	CL=90%
Γ_{23}	$\chi_{c1}(4140)$ anything, $\chi_{c1} \rightarrow J/\psi(1S)\phi$	< 5.2	$\times 10^{-6}$	CL=90%
Γ_{24}	χ_{c0} anything	< 4	$\times 10^{-3}$	CL=90%
Γ_{25}	χ_{c1} anything	(1.90 ± 0.35)	$\times 10^{-4}$	
Γ_{26}	$\chi_{c1}(1P)X_{tetra}$	< 3.78	$\times 10^{-5}$	CL=90%
Γ_{27}	χ_{c2} anything	(2.8 ± 0.8)	$\times 10^{-4}$	
Γ_{28}	$\psi(2S)$ anything	(1.23 ± 0.20)	$\times 10^{-4}$	
Γ_{29}	$\psi(2S)\eta_c$	< 3.6	$\times 10^{-6}$	CL=90%
Γ_{30}	$\psi(2S)\chi_{c0}$	< 6.5	$\times 10^{-6}$	CL=90%
Γ_{31}	$\psi(2S)\chi_{c1}$	< 4.5	$\times 10^{-6}$	CL=90%
Γ_{32}	$\psi(2S)\chi_{c2}$	< 2.1	$\times 10^{-6}$	CL=90%
Γ_{33}	$\psi(2S)\eta_c(2S)$	< 3.2	$\times 10^{-6}$	CL=90%
Γ_{34}	$\psi(2S)X(3940)$	< 2.9	$\times 10^{-6}$	CL=90%
Γ_{35}	$\psi(2S)X(4160)$	< 2.9	$\times 10^{-6}$	CL=90%
Γ_{36}	$\psi(4260)$ anything, $\psi \rightarrow \psi(2S)\pi^+\pi^-$	< 7.9	$\times 10^{-5}$	CL=90%
Γ_{37}	$\psi(4360)$ anything, $\psi \rightarrow \psi(2S)\pi^+\pi^-$	< 5.2	$\times 10^{-5}$	CL=90%
Γ_{38}	$\psi(4660)$ anything, $\psi \rightarrow \psi(2S)\pi^+\pi^-$	< 2.2	$\times 10^{-5}$	CL=90%
Γ_{39}	$X(4050)^\pm$ anything, $X \rightarrow \psi(2S)\pi^\pm$	< 8.8	$\times 10^{-5}$	CL=90%
Γ_{40}	$Z_c(4430)^\pm$ anything, $Z_c \rightarrow \psi(2S)\pi^\pm$	< 6.7	$\times 10^{-5}$	CL=90%
Γ_{41}	$Z_c(4200)^+ Z_c(4200)^-$	< 2.23	$\times 10^{-5}$	CL=90%
Γ_{42}	$Z_c(3900)^\pm Z_c(4200)^\mp$	< 8.1	$\times 10^{-6}$	CL=90%
Γ_{43}	$Z_c(3900)^+ Z_c(3900)^-$	< 1.8	$\times 10^{-6}$	CL=90%
Γ_{44}	$X(4050)^+ X(4050)^-$	< 1.58	$\times 10^{-5}$	CL=90%
Γ_{45}	$X(4250)^+ X(4250)^-$	< 2.66	$\times 10^{-5}$	CL=90%
Γ_{46}	$X(4050)^\pm X(4250)^\mp$	< 4.42	$\times 10^{-5}$	CL=90%
Γ_{47}	$Z_c(4430)^+ Z_c(4430)^-$	< 2.03	$\times 10^{-5}$	CL=90%

Γ_{48}	$X(4055)^\pm X(4055)^\mp$	< 2.33	$\times 10^{-5}$	CL=90%
Γ_{49}	$X(4055)^\pm Z_c(4430)^\mp$	< 4.55	$\times 10^{-5}$	CL=90%
Γ_{50}	$\rho\pi$	< 3.68	$\times 10^{-6}$	CL=90%
Γ_{51}	$\omega\pi^0$	< 3.90	$\times 10^{-6}$	CL=90%
Γ_{52}	$\pi^+\pi^-$	< 5	$\times 10^{-4}$	CL=90%
Γ_{53}	K^+K^-	< 5	$\times 10^{-4}$	CL=90%
Γ_{54}	$\rho\bar{p}$	< 5	$\times 10^{-4}$	CL=90%
Γ_{55}	$\pi^+\pi^-\pi^0$	(2.1 ± 0.8)	$\times 10^{-6}$	
Γ_{56}	ϕK^+K^-	(2.4 ± 0.5)	$\times 10^{-6}$	
Γ_{57}	$\omega\pi^+\pi^-$	(4.5 ± 1.0)	$\times 10^{-6}$	
Γ_{58}	$K^*(892)^0 K^-\pi^+ + \text{c.c.}$	(4.4 ± 0.8)	$\times 10^{-6}$	
Γ_{59}	$\phi f_2'(1525)$	< 1.63	$\times 10^{-6}$	CL=90%
Γ_{60}	$\omega f_2(1270)$	< 1.79	$\times 10^{-6}$	CL=90%
Γ_{61}	$\rho(770)a_2(1320)$	< 2.24	$\times 10^{-6}$	CL=90%
Γ_{62}	$K^*(892)^0 \bar{K}_2^*(1430)^0 + \text{c.c.}$	(3.0 ± 0.8)	$\times 10^{-6}$	
Γ_{63}	$K_1(1270)^\pm K^\mp$	< 2.41	$\times 10^{-6}$	CL=90%
Γ_{64}	$K_1(1400)^\pm K^\mp$	(1.0 ± 0.4)	$\times 10^{-6}$	
Γ_{65}	$b_1(1235)^\pm \pi^\mp$	< 1.25	$\times 10^{-6}$	CL=90%
Γ_{66}	$\pi^+\pi^-\pi^0\pi^0$	(1.28 ± 0.30)	$\times 10^{-5}$	
Γ_{67}	$K_S^0 K^+\pi^- + \text{c.c.}$	(1.6 ± 0.4)	$\times 10^{-6}$	
Γ_{68}	$K^*(892)^0 \bar{K}^0 + \text{c.c.}$	(2.9 ± 0.9)	$\times 10^{-6}$	
Γ_{69}	$K^*(892)^- K^+ + \text{c.c.}$	< 1.11	$\times 10^{-6}$	CL=90%
Γ_{70}	$f_1(1285)$ anything	(4.6 ± 3.1)	$\times 10^{-3}$	
Γ_{71}	$D^*(2010)^\pm$ anything	(2.52 ± 0.20)	%	
Γ_{72}	$\underline{f}_1(1285) X_{tetra}$	< 6.24	$\times 10^{-5}$	CL=90%
Γ_{73}	2H anything	(2.85 ± 0.25)	$\times 10^{-5}$	
Γ_{74}	Sum of 100 exclusive modes	(1.200 ± 0.017)	%	

Radiative decays

Γ_{75}	$\gamma\pi^+\pi^-$	(6.3 ± 1.8)	$\times 10^{-5}$	
Γ_{76}	$\gamma\pi^0\pi^0$	(1.7 ± 0.7)	$\times 10^{-5}$	
Γ_{77}	$\gamma\pi\pi$ (S-wave)	(4.6 ± 0.7)	$\times 10^{-5}$	
Γ_{78}	$\gamma\pi^0\eta$	< 2.4	$\times 10^{-6}$	CL=90%
Γ_{79}	γK^+K^-	[a] (1.14 ± 0.13)	$\times 10^{-5}$	
Γ_{80}	$\gamma\rho\bar{p}$	[b] < 6	$\times 10^{-6}$	CL=90%
Γ_{81}	$\gamma 2h^+2h^-$	(7.0 ± 1.5)	$\times 10^{-4}$	
Γ_{82}	$\gamma 3h^+3h^-$	(5.4 ± 2.0)	$\times 10^{-4}$	
Γ_{83}	$\gamma 4h^+4h^-$	(7.4 ± 3.5)	$\times 10^{-4}$	
Γ_{84}	$\gamma\pi^+\pi^-K^+K^-$	(2.9 ± 0.9)	$\times 10^{-4}$	
Γ_{85}	$\gamma 2\pi^+2\pi^-$	(2.5 ± 0.9)	$\times 10^{-4}$	
Γ_{86}	$\gamma 3\pi^+3\pi^-$	(2.5 ± 1.2)	$\times 10^{-4}$	
Γ_{87}	$\gamma 2\pi^+2\pi^-K^+K^-$	(2.4 ± 1.2)	$\times 10^{-4}$	
Γ_{88}	$\gamma\pi^+\pi^-\rho\bar{p}$	(1.5 ± 0.6)	$\times 10^{-4}$	
Γ_{89}	$\gamma 2\pi^+2\pi^-\rho\bar{p}$	(4 ± 6)	$\times 10^{-5}$	

Γ_{90}	$\gamma 2K^+ 2K^-$	$(2.0 \pm 2.0) \times 10^{-5}$	
Γ_{91}	$\gamma \eta'(958)$	< 1.9	$\times 10^{-6}$ CL=90%
Γ_{92}	$\gamma \eta$	< 1.0	$\times 10^{-6}$ CL=90%
Γ_{93}	$\gamma f_0(980)$	< 3	$\times 10^{-5}$ CL=90%
Γ_{94}	$\gamma f_2'(1525)$	$(2.9 \pm 0.6) \times 10^{-5}$	
Γ_{95}	$\gamma f_2(1270)$	$(1.01 \pm 0.06) \times 10^{-4}$	
Γ_{96}	$\gamma \eta(1405)$	< 8.2	$\times 10^{-5}$ CL=90%
Γ_{97}	$\gamma f_0(1500)$	< 1.5	$\times 10^{-5}$ CL=90%
Γ_{98}	$\gamma f_0(1500) \rightarrow \gamma K^+ K^-$	$(1.0 \pm 0.4) \times 10^{-5}$	
Γ_{99}	$\gamma f_0(1710)$	< 2.6	$\times 10^{-4}$ CL=90%
Γ_{100}	$\gamma f_0(1710) \rightarrow \gamma K^+ K^-$	$(1.01 \pm 0.32) \times 10^{-5}$	
Γ_{101}	$\gamma f_0(1710) \rightarrow \gamma \pi^+ \pi^-$	$(5.3 \pm 2.0) \times 10^{-6}$	
Γ_{102}	$\gamma f_0(1710) \rightarrow \gamma \pi^0 \pi^0$	< 1.4	$\times 10^{-6}$ CL=90%
Γ_{103}	$\gamma f_0(1710) \rightarrow \gamma \eta \eta$	< 1.8	$\times 10^{-6}$ CL=90%
Γ_{104}	$\gamma f_4(2050)$	< 5.3	$\times 10^{-5}$ CL=90%
Γ_{105}	$\gamma f_0(2200) \rightarrow \gamma K^+ K^-$	< 2	$\times 10^{-4}$ CL=90%
Γ_{106}	$\gamma f_J(2220) \rightarrow \gamma K^+ K^-$	< 8	$\times 10^{-7}$ CL=90%
Γ_{107}	$\gamma f_J(2220) \rightarrow \gamma \pi^+ \pi^-$	< 6	$\times 10^{-7}$ CL=90%
Γ_{108}	$\gamma f_J(2220) \rightarrow \gamma p \bar{p}$	< 1.1	$\times 10^{-6}$ CL=90%
Γ_{109}	$\gamma \eta(2225) \rightarrow \gamma \phi \phi$	< 3	$\times 10^{-3}$ CL=90%
Γ_{110}	$\gamma \eta_c(1S)$	< 5.7	$\times 10^{-5}$ CL=90%
Γ_{111}	$\gamma \chi_{c0}$	< 6.5	$\times 10^{-4}$ CL=90%
Γ_{112}	$\gamma \chi_{c1}$	< 2.3	$\times 10^{-5}$ CL=90%
Γ_{113}	$\gamma \chi_{c2}$	< 7.6	$\times 10^{-6}$ CL=90%
Γ_{114}	$\gamma \chi_{c1}(3872) \rightarrow \pi^+ \pi^- J/\psi$	< 1.6	$\times 10^{-6}$ CL=90%
Γ_{115}	$\gamma \chi_{c1}(3872) \rightarrow \pi^+ \pi^- \pi^0 J/\psi$	< 2.8	$\times 10^{-6}$ CL=90%
Γ_{116}	$\gamma X(3915) \rightarrow \omega J/\psi$	< 3.0	$\times 10^{-6}$ CL=90%
Γ_{117}	$\gamma \chi_{c1}(4140) \rightarrow \phi J/\psi$	< 2.2	$\times 10^{-6}$ CL=90%
Γ_{118}	γX	[c] < 4.5	$\times 10^{-6}$ CL=90%
Γ_{119}	$\gamma X \bar{X} (m_X < 3.1 \text{ GeV})$	[d] < 1	$\times 10^{-3}$ CL=90%
Γ_{120}	$\gamma X \bar{X} (m_X < 4.5 \text{ GeV})$	[e] < 2.4	$\times 10^{-4}$ CL=90%
Γ_{121}	$\gamma X \rightarrow \gamma + \geq 4 \text{ prongs}$	[f] < 1.78	$\times 10^{-4}$ CL=95%
Γ_{122}	$\gamma a_1^0 \rightarrow \gamma \mu^+ \mu^-$	[g] < 9	$\times 10^{-6}$ CL=90%
Γ_{123}	$\gamma a_1^0 \rightarrow \gamma \tau^+ \tau^-$	[a] < 1.30	$\times 10^{-4}$ CL=90%
Γ_{124}	$\gamma a_1^0 \rightarrow \gamma g g$	[h] < 1	% CL=90%
Γ_{125}	$\gamma a_1^0 \rightarrow \gamma s \bar{s}$	[h] < 1	$\times 10^{-3}$ CL=90%

Lepton Family number (LF) violating modes

Γ_{126}	$\mu^\pm \tau^\mp$	LF	< 6.0	$\times 10^{-6}$	CL=95%
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Other decays

Γ_{127}	invisible		< 3.0	$\times 10^{-4}$	CL=90%
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[a] $2m_\tau < M(\tau^+ \tau^-) < 9.2 \text{ GeV}$

- [b] $2 \text{ GeV} < m_{K^+ K^-} < 3 \text{ GeV}$
- [c] $X = \text{scalar with } m < 8.0 \text{ GeV}$
- [d] $X \bar{X} = \text{vectors with } m < 3.1 \text{ GeV}$
- [e] $X \text{ and } \bar{X} = \text{zero spin with } m < 4.5 \text{ GeV}$
- [f] $1.5 \text{ GeV} < m_X < 5.0 \text{ GeV}$
- [g] $201 \text{ MeV} < M(\mu^+ \mu^-) < 3565 \text{ MeV}$
- [h] $0.5 \text{ GeV} < m_X < 9.0 \text{ GeV}$, where m_X is the invariant mass of the hadronic final state.

$\Upsilon(1S) \Gamma(i)\Gamma(e^+ e^-)/\Gamma(\text{total})$

$\Gamma(e^+ e^-) \times \Gamma(\mu^+ \mu^-)/\Gamma_{\text{total}}$				$\Gamma_2 \Gamma_3 / \Gamma$
<u>VALUE (eV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
31.2 ± 1.6 ± 1.7	KOBEL	92	CBAL	$e^+ e^- \rightarrow \mu^+ \mu^-$

$\Gamma(\text{hadrons}) \times \Gamma(e^+ e^-)/\Gamma_{\text{total}}$				$\Gamma_0 \Gamma_2 / \Gamma$
<u>VALUE (keV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
1.240 ± 0.016 OUR AVERAGE				
1.252 ± 0.004 ± 0.019	¹ ROSNER	06	CLEO	$9.5 e^+ e^- \rightarrow \text{hadrons}$
1.187 ± 0.023 ± 0.031	¹ BARU	92B	MD1	$e^+ e^- \rightarrow \text{hadrons}$
1.23 ± 0.02 ± 0.05	¹ JAKUBOWSKI	88	CBAL	$e^+ e^- \rightarrow \text{hadrons}$
1.37 ± 0.06 ± 0.09	² GILES	84B	CLEO	$e^+ e^- \rightarrow \text{hadrons}$
1.23 ± 0.08 ± 0.04	² ALBRECHT	82	DASP	$e^+ e^- \rightarrow \text{hadrons}$
1.13 ± 0.07 ± 0.11	² NICZYPORUK	82	LENA	$e^+ e^- \rightarrow \text{hadrons}$
1.09 ± 0.25	² BOCK	80	CNTR	$e^+ e^- \rightarrow \text{hadrons}$
1.35 ± 0.14	³ BERGER	79	PLUT	$e^+ e^- \rightarrow \text{hadrons}$

¹ Radiative corrections evaluated following KURAEV 85.

² Radiative corrections reevaluated by BUCHMUELLER 88 following KURAEV 85.

³ Radiative corrections reevaluated by ALEXANDER 89 using $B(\mu\mu) = 0.026$.

$\Upsilon(1S) \text{ PARTIAL WIDTHS}$

$\Gamma(e^+ e^-)$		Γ_2
<u>VALUE (keV)</u>	<u>DOCUMENT ID</u>	
1.340 ± 0.018 OUR EVALUATION		

$\Upsilon(1S)$ BRANCHING RATIOS **$\Gamma(\tau^+\tau^-)/\Gamma_{\text{total}}$** **$\Gamma_1/\Gamma$**

<u>VALUE (units 10^{-2})</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
2.60±0.10 OUR AVERAGE				
2.53±0.13±0.05	60k	¹ BESSON	07 CLEO	$e^+e^- \rightarrow \Upsilon(1S) \rightarrow \tau^+\tau^-$
2.61±0.12 ^{+0.09} _{-0.13}	25k	CINABRO	94B CLE2	$e^+e^- \rightarrow \tau^+\tau^-$
2.7 ±0.4 ±0.2		² ALBRECHT	85C ARG	$\Upsilon(2S) \rightarrow \pi^+\pi^-\tau^+\tau^-$
3.4 ±0.4 ±0.4		GILES	83 CLEO	$e^+e^- \rightarrow \tau^+\tau^-$

¹ BESSON 07 reports $[\Gamma(\Upsilon(1S) \rightarrow \tau^+\tau^-)/\Gamma_{\text{total}}] / [B(\Upsilon(1S) \rightarrow \mu^+\mu^-)] = 1.02 \pm 0.02 \pm 0.05$ which we multiply by our best value $B(\Upsilon(1S) \rightarrow \mu^+\mu^-) = (2.48 \pm 0.05) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

² Using $B(\Upsilon(1S) \rightarrow ee) = B(\Upsilon(1S) \rightarrow \mu\mu) = 0.0256$; not used for width evaluations.

 $\Gamma(e^+e^-)/\Gamma_{\text{total}}$ **Γ_2/Γ**

<u>VALUE (units 10^{-2})</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
2.38±0.11 OUR AVERAGE				
2.29±0.08±0.11		ALEXANDER	98 CLE2	$\Upsilon(2S) \rightarrow \pi^+\pi^-e^+e^-$
2.42±0.14±0.14	307	ALBRECHT	87 ARG	$\Upsilon(2S) \rightarrow \pi^+\pi^-e^+e^-$
2.8 ±0.3 ±0.2	826	BESSON	84 CLEO	$\Upsilon(2S) \rightarrow \pi^+\pi^-e^+e^-$
5.1 ±3.0		BERGER	80C PLUT	$e^+e^- \rightarrow e^+e^-$

 $\Gamma(\mu^+\mu^-)/\Gamma_{\text{total}}$ **Γ_3/Γ**

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.0248±0.0005 OUR AVERAGE				
0.0249±0.0002±0.0007	345k	ADAMS	05 CLEO	$e^+e^- \rightarrow \mu^+\mu^-$
0.0249±0.0008±0.0013		ALEXANDER	98 CLE2	$\Upsilon(2S) \rightarrow \pi^+\pi^-\mu^+\mu^-$
0.0212±0.0020±0.0010		¹ BARU	92 MD1	$e^+e^- \rightarrow \mu^+\mu^-$
0.0231±0.0012±0.0010		¹ KOBEL	92 CBAL	$e^+e^- \rightarrow \mu^+\mu^-$
0.0252±0.0007±0.0007		CHEN	89B CLEO	$e^+e^- \rightarrow \mu^+\mu^-$
0.0261±0.0009±0.0011		KAARSBERG	89 CSB2	$e^+e^- \rightarrow \mu^+\mu^-$
0.0230±0.0025±0.0013	86	ALBRECHT	87 ARG	$\Upsilon(2S) \rightarrow \pi^+\pi^-\mu^+\mu^-$
0.029 ±0.003 ±0.002	864	BESSON	84 CLEO	$\Upsilon(2S) \rightarrow \pi^+\pi^-\mu^+\mu^-$
0.027 ±0.003 ±0.003		ANDREWS	83 CLEO	$e^+e^- \rightarrow \mu^+\mu^-$
0.032 ±0.013 ±0.003		ALBRECHT	82 DASP	$e^+e^- \rightarrow \mu^+\mu^-$
0.038 ±0.015 ±0.002		NICZYPORUK	82 LENA	$e^+e^- \rightarrow \mu^+\mu^-$
0.014 ^{+0.034} _{-0.014}		BOCK	80 CNTR	$e^+e^- \rightarrow \mu^+\mu^-$
0.022 ±0.020		BERGER	79 PLUT	$e^+e^- \rightarrow \mu^+\mu^-$

¹ Taking into account interference between the resonance and continuum.

$\Gamma(\tau^+\tau^-)/\Gamma(\mu^+\mu^-)$ Γ_1/Γ_3

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1.008±0.023 OUR AVERAGE				
1.005±0.013±0.022	0.7M	¹ DEL-AMO-SA..10C	BABR	$\Upsilon(3S) \rightarrow \pi^+\pi^-\Upsilon(1S)$
1.02 ±0.02 ±0.05	60k	BESSON	07	CLEO $e^+e^- \rightarrow \Upsilon(1S)$

¹ Allows any number of extra photons with total energy < 500 MeV.

$\Gamma(ggg)/\Gamma_{total}$ Γ_4/Γ

<u>VALUE (units 10⁻²)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
81.7±0.7	20M	¹ BESSON	06A	CLEO $\Upsilon(1S) \rightarrow$ hadrons

¹ Calculated using the value $\Gamma(\gamma gg)/\Gamma(ggg) = (2.70 \pm 0.01 \pm 0.13 \pm 0.24)\%$ from BESSON 06A and PDG 08 values of $B(\mu^+\mu^-) = (2.48 \pm 0.05)\%$ 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.

$\Gamma(\gamma gg)/\Gamma_{total}$ Γ_5/Γ

<u>VALUE (units 10⁻²)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
2.20±0.60	400k	¹ BESSON	06A	CLEO $\Upsilon(1S) \rightarrow \gamma +$ hadrons

¹ Calculated using BESSON 06A values of $\Gamma(\gamma gg)/\Gamma(ggg) = (2.70 \pm 0.01 \pm 0.13 \pm 0.24)\%$ and $\Gamma(ggg)/\Gamma_{total}$. The statistical error is negligible and the systematic error is partially correlated with that of $\Gamma(ggg)/\Gamma_{total}$ measurement of BESSON 06A.

$\Gamma(\gamma gg)/\Gamma(ggg)$ Γ_5/Γ_4

<u>VALUE (units 10⁻²)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
2.70±0.01±0.27	20M	BESSON	06A	CLEO $\Upsilon(1S) \rightarrow (\gamma +)$ hadrons

$\Gamma(\eta'(958) \text{ anything})/\Gamma_{total}$ Γ_6/Γ

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.0294±0.0024 OUR AVERAGE			
0.030 ±0.002 ±0.002	AQUINES	06A	CLE3 $\Upsilon(1S) \rightarrow \eta'$ anything
0.028 ±0.004 ±0.002	ARTUSO	03	CLE2 $\Upsilon(1S) \rightarrow \eta'$ anything

$\Gamma(J/\psi(1S) \text{ anything})/\Gamma_{total}$ Γ_7/Γ

<u>VALUE (units 10⁻⁴)</u>	<u>CL%</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
5.4 ±0.4 OUR FIT					Error includes scale factor of 1.4.
5.4 ±0.4 OUR AVERAGE					Error includes scale factor of 1.5.
5.25±0.13±0.25		3k	SHEN	16	BELL $e^+e^- \rightarrow J/\psi X$
6.4 ±0.4 ±0.6		730	BRIERE	04	CLEO $e^+e^- \rightarrow J/\psi X$
11 ±4 ±2			¹ FULTON	89	CLEO $e^+e^- \rightarrow \mu^+\mu^- X$

• • • We do not use the following data for averages, fits, limits, etc. • • •

<6.8	90	ALBRECHT	92J	ARG	$e^+e^- \rightarrow e^+e^- X, \mu^+\mu^- X$
<17	90	MASCHMANN	90	CBAL	$e^+e^- \rightarrow$ hadrons
<200	90	NICZYPORUK	83	LENA	

¹ Using $B((J/\psi) \rightarrow \mu^+\mu^-) = (6.9 \pm 0.9)\%$.

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

<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<2.2 × 10⁻⁶	90	YANG	14	BELL $e^+e^- \rightarrow J/\psi X$

$\Gamma(J/\psi(1S)\chi_{c0})/\Gamma_{\text{total}}$			Γ_9/Γ		
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<3.4 \times 10^{-6}$	90	YANG	14	BELL	$e^+e^- \rightarrow J/\psi X$
$\Gamma(J/\psi(1S)\chi_{c1})/\Gamma_{\text{total}}$			Γ_{10}/Γ		
VALUE (units 10^{-6})	EVTS	DOCUMENT ID	TECN	COMMENT	
$3.90 \pm 1.21 \pm 0.23$	20	YANG	14	BELL	$e^+e^- \rightarrow J/\psi X$
$\Gamma(J/\psi(1S)\chi_{c2})/\Gamma_{\text{total}}$			Γ_{11}/Γ		
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<1.4 \times 10^{-6}$	90	YANG	14	BELL	$e^+e^- \rightarrow J/\psi X$
$\Gamma(J/\psi(1S)\eta_c(2S))/\Gamma_{\text{total}}$			Γ_{12}/Γ		
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<2.2 \times 10^{-6}$	90	YANG	14	BELL	$e^+e^- \rightarrow J/\psi X$
$\Gamma(J/\psi(1S)X(3940))/\Gamma_{\text{total}}$			Γ_{13}/Γ		
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<5.4 \times 10^{-6}$	90	YANG	14	BELL	$e^+e^- \rightarrow J/\psi X$
$\Gamma(J/\psi(1S)X(4160))/\Gamma_{\text{total}}$			Γ_{14}/Γ		
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<5.4 \times 10^{-6}$	90	YANG	14	BELL	$e^+e^- \rightarrow J/\psi X$
$\Gamma(X(4350) \text{ anything, } X \rightarrow J/\psi(1S)\phi)/\Gamma_{\text{total}}$			Γ_{15}/Γ		
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<8.1 \times 10^{-6}$	90	SHEN	16	BELL	$\Upsilon(1S) \rightarrow J/\psi K^+ K^- X$
$\Gamma(Z_c(3900)^\pm \text{ anything, } Z_c \rightarrow J/\psi(1S)\pi^\pm)/\Gamma_{\text{total}}$			Γ_{16}/Γ		
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<1.3 \times 10^{-5}$	90	SHEN	16	BELL	$\Upsilon(1S) \rightarrow J/\psi \pi^\pm X$
$\Gamma(Z_c(4200)^\pm \text{ anything, } Z_c \rightarrow J/\psi(1S)\pi^\pm)/\Gamma_{\text{total}}$			Γ_{17}/Γ		
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<6.0 \times 10^{-5}$	90	SHEN	16	BELL	$\Upsilon(1S) \rightarrow J/\psi \pi^\pm X$
$\Gamma(Z_c(4430)^\pm \text{ anything, } Z_c \rightarrow J/\psi(1S)\pi^\pm)/\Gamma_{\text{total}}$			Γ_{18}/Γ		
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<4.9 \times 10^{-5}$	90	SHEN	16	BELL	$\Upsilon(1S) \rightarrow J/\psi \pi^\pm X$
$\Gamma(X_{cs}^\pm \text{ anything, } X \rightarrow J/\psi K^\pm)/\Gamma_{\text{total}}$			Γ_{19}/Γ		
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<5.7 \times 10^{-6}$	90	SHEN	16	BELL	$\Upsilon(1S) \rightarrow J/\psi K^- X$
$\Gamma(\chi_{c1}(3872) \text{ anything, } \chi_{c1} \rightarrow J/\psi(1S)\pi^+\pi^-)/\Gamma_{\text{total}}$			Γ_{20}/Γ		
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<9.5 \times 10^{-6}$	90	SHEN	16	BELL	$\Upsilon(1S) \rightarrow J/\psi \pi^+ \pi^- X$

$\Gamma(\psi(4260) \text{ anything}, \psi \rightarrow J/\psi(1S)\pi^+\pi^-)/\Gamma_{\text{total}}$					Γ_{21}/Γ
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<3.8 \times 10^{-5}$	90	SHEN	16	BELL	$\Upsilon(1S) \rightarrow J/\psi\pi^+\pi^- X$
$\Gamma(\psi(4260) \text{ anything}, \psi \rightarrow J/\psi(1S)K^+K^-)/\Gamma_{\text{total}}$					Γ_{22}/Γ
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<7.5 \times 10^{-6}$	90	SHEN	16	BELL	$\Upsilon(1S) \rightarrow J/\psi K^+ K^- X$
$\Gamma(\chi_{c1}(4140) \text{ anything}, \chi_{c1} \rightarrow J/\psi(1S)\phi)/\Gamma_{\text{total}}$					Γ_{23}/Γ
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<5.2 \times 10^{-6}$	90	SHEN	16	BELL	$\Upsilon(1S) \rightarrow J/\psi K^+ K^- X$
$\Gamma(\chi_{c0} \text{ anything})/\Gamma(J/\psi(1S) \text{ anything})$					Γ_{24}/Γ_7
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
<7.4	90	BRIERE	04	CLEO	$e^+e^- \rightarrow J/\psi X$
$\Gamma(\chi_{c1} \text{ anything})/\Gamma_{\text{total}}$					Γ_{25}/Γ
VALUE (units 10^{-4})	EVTS	DOCUMENT ID	TECN	COMMENT	
1.90 ± 0.35 OUR FIT					
$1.90 \pm 0.43 \pm 0.14$	215	JIA	17	BELL	$\Upsilon(1S) \rightarrow \gamma J/\psi(1S)$
$\Gamma(\chi_{c1} \text{ anything})/\Gamma(J/\psi(1S) \text{ anything})$					Γ_{25}/Γ_7
VALUE	EVTS	DOCUMENT ID	TECN	COMMENT	
0.35 ± 0.07 OUR FIT					
$0.35 \pm 0.08 \pm 0.06$	52 ± 12	BRIERE	04	CLEO	$e^+e^- \rightarrow J/\psi X$
$\Gamma(\chi_{c1}(1P)\chi_{tetra})/\Gamma_{\text{total}}$					Γ_{26}/Γ
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<37.8 \times 10^{-6}$	90	¹ JIA	17A	BELL	$e^+e^- \rightarrow \text{hadrons}$
¹ For a tetraquark state χ_{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 χ_{tetra} mass and width range from 4.4×10^{-6} to 37.8×10^{-6} .					
$\Gamma(\chi_{c2} \text{ anything})/\Gamma(J/\psi(1S) \text{ anything})$					Γ_{27}/Γ_7
VALUE	EVTS	DOCUMENT ID	TECN	COMMENT	
$0.52 \pm 0.12 \pm 0.09$	47 ± 11	BRIERE	04	CLEO	$e^+e^- \rightarrow J/\psi X$
$\Gamma(\psi(2S) \text{ anything})/\Gamma_{\text{total}}$					Γ_{28}/Γ
VALUE (units 10^{-4})	EVTS	DOCUMENT ID	TECN	COMMENT	
$1.23 \pm 0.17 \pm 0.11$	215	SHEN	16	BELL	$e^+e^- \rightarrow \psi(2S) X$
$\Gamma(\psi(2S) \text{ anything})/\Gamma(J/\psi(1S) \text{ anything})$					Γ_{28}/Γ_7
VALUE	EVTS	DOCUMENT ID	TECN	COMMENT	
$0.41 \pm 0.11 \pm 0.08$	42 ± 11	BRIERE	04	CLEO	$e^+e^- \rightarrow J/\psi\pi^+\pi^- X$
$\Gamma(\psi(2S)\eta_c)/\Gamma_{\text{total}}$					Γ_{29}/Γ
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<3.6 \times 10^{-6}$	90	YANG	14	BELL	$e^+e^- \rightarrow \psi(2S) X$

$\Gamma(\psi(2S)\chi_{c0})/\Gamma_{\text{total}}$					Γ_{30}/Γ
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<6.5 \times 10^{-6}$	90	YANG 14	BELL	$e^+e^- \rightarrow \psi(2S)X$	
$\Gamma(\psi(2S)\chi_{c1})/\Gamma_{\text{total}}$					Γ_{31}/Γ
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<4.5 \times 10^{-6}$	90	YANG 14	BELL	$e^+e^- \rightarrow \psi(2S)X$	
$\Gamma(\psi(2S)\chi_{c2})/\Gamma_{\text{total}}$					Γ_{32}/Γ
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<2.1 \times 10^{-6}$	90	YANG 14	BELL	$e^+e^- \rightarrow \psi(2S)X$	
$\Gamma(\psi(2S)\eta_c(2S))/\Gamma_{\text{total}}$					Γ_{33}/Γ
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<3.2 \times 10^{-6}$	90	YANG 14	BELL	$e^+e^- \rightarrow \psi(2S)X$	
$\Gamma(\psi(2S)X(3940))/\Gamma_{\text{total}}$					Γ_{34}/Γ
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<2.9 \times 10^{-6}$	90	YANG 14	BELL	$e^+e^- \rightarrow \psi(2S)X$	
$\Gamma(\psi(2S)X(4160))/\Gamma_{\text{total}}$					Γ_{35}/Γ
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<2.9 \times 10^{-6}$	90	YANG 14	BELL	$e^+e^- \rightarrow \psi(2S)X$	
$\Gamma(\psi(4260) \text{ anything, } \psi \rightarrow \psi(2S)\pi^+\pi^-)/\Gamma_{\text{total}}$					Γ_{36}/Γ
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<7.9 \times 10^{-5}$	90	SHEN 16	BELL	$\Upsilon(1S) \rightarrow \psi(2S)\pi^+\pi^-X$	
$\Gamma(\psi(4360) \text{ anything, } \psi \rightarrow \psi(2S)\pi^+\pi^-)/\Gamma_{\text{total}}$					Γ_{37}/Γ
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<5.2 \times 10^{-5}$	90	SHEN 16	BELL	$\Upsilon(1S) \rightarrow \psi(2S)\pi^+\pi^-X$	
$\Gamma(\psi(4660) \text{ anything, } \psi \rightarrow \psi(2S)\pi^+\pi^-)/\Gamma_{\text{total}}$					Γ_{38}/Γ
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<2.2 \times 10^{-5}$	90	SHEN 16	BELL	$\Upsilon(1S) \rightarrow \psi(2S)\pi^+\pi^-X$	
$\Gamma(X(4050)^\pm \text{ anything, } X \rightarrow \psi(2S)\pi^\pm)/\Gamma_{\text{total}}$					Γ_{39}/Γ
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<8.8 \times 10^{-5}$	90	SHEN 16	BELL	$\Upsilon(1S) \rightarrow \psi(2S)\pi^\pm X$	
$\Gamma(Z_c(4430)^\pm \text{ anything, } Z_c \rightarrow \psi(2S)\pi^\pm)/\Gamma_{\text{total}}$					Γ_{40}/Γ
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<6.7 \times 10^{-5}$	90	SHEN 16	BELL	$\Upsilon(1S) \rightarrow \psi(2S)\pi^\pm X$	
$\Gamma(Z_c(4200)^+ Z_c(4200)^-)/\Gamma_{\text{total}}$					Γ_{41}/Γ
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
$<22.3 \times 10^{-6}$	90	¹ JIA 18	BELL	$\Upsilon(1S) \rightarrow J/\psi\pi^\pm X$	

¹ Assuming $B(Z_c(4200)^\pm \rightarrow J/\psi\pi^\pm) = 1$.

$\Gamma(Z_c(3900)^\pm Z_c(4200)^\mp)/\Gamma_{\text{total}}$ Γ_{42}/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<8.1 \times 10^{-6}$	90	¹ JIA	18	BELL $\Upsilon(1S) \rightarrow J/\psi \pi^\pm X$
¹ Assuming $B(Z_c(4200)^\pm \rightarrow J/\psi \pi^\pm) = 1 = B(Z_c(3900)^\pm \rightarrow J/\psi \pi^\pm)$.				

 $\Gamma(Z_c(3900)^+ Z_c(3900)^-)/\Gamma_{\text{total}}$ Γ_{43}/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<1.8 \times 10^{-6}$	90	¹ JIA	18	BELL $\Upsilon(1S) \rightarrow J/\psi \pi^\pm X$
¹ Assuming $B(Z_c(3900)^\pm \rightarrow J/\psi \pi^\pm) = 1$				

 $\Gamma(X(4050)^+ X(4050)^-)/\Gamma_{\text{total}}$ Γ_{44}/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<15.8 \times 10^{-6}$	90	¹ JIA	18	BELL $\Upsilon(1S) \rightarrow \chi_{c1}(1P) \pi^\pm X$
¹ Assuming $B(X(4050)^\pm \rightarrow \chi_{c1}(1P) \pi^\pm) = 1$				

 $\Gamma(X(4250)^+ X(4250)^-)/\Gamma_{\text{total}}$ Γ_{45}/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<26.6 \times 10^{-6}$	90	¹ JIA	18	BELL $\Upsilon(1S) \rightarrow \chi_{c1}(1P) \pi^\pm X$
¹ Assuming $B(X(4250)^\pm \rightarrow \chi_{c1}(1P) \pi^\pm) = 1$				

 $\Gamma(X(4050)^\pm X(4250)^\mp)/\Gamma_{\text{total}}$ Γ_{46}/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<44.2 \times 10^{-6}$	90	¹ JIA	18	BELL $\Upsilon(1S) \rightarrow \chi_{c1}(1P) \pi^\pm X$
¹ Assuming $B(X(4050)^\pm \rightarrow \chi_{c1}(1P) \pi^\pm) = 1 = B(X(4250)^\pm \rightarrow \chi_{c1}(1P) \pi^\pm)$				

 $\Gamma(Z_c(4430)^+ Z_c(4430)^-)/\Gamma_{\text{total}}$ Γ_{47}/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<20.3 \times 10^{-6}$	90	¹ JIA	18	BELL $\Upsilon(2S) \rightarrow \psi(2S) \pi^\pm X$
¹ Assuming $B(Z_c(4430)^\pm \rightarrow \psi(2S) \pi^\pm) = 1$				

 $\Gamma(X(4055)^\pm X(4055)^\mp)/\Gamma_{\text{total}}$ Γ_{48}/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<23.3 \times 10^{-6}$	90	¹ JIA	18	BELL $\Upsilon(1S) \rightarrow \psi(2S) \pi^\pm X$
¹ Assuming $B(X(4055)^\pm \rightarrow \psi(2S) \pi^\pm) = 1$				

 $\Gamma(X(4055)^\pm Z_c(4430)^\mp)/\Gamma_{\text{total}}$ Γ_{49}/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<45.5 \times 10^{-6}$	90	¹ JIA	18	BELL $\Upsilon(1S) \rightarrow \psi(2S) \pi^\pm X$
¹ Assuming $B(X(4055)^\pm \rightarrow \psi(2S) \pi^\pm) = 1 = B(Z_c(4430)^\pm \rightarrow \psi(2S) \pi^\pm)$				

 $\Gamma(\rho\pi)/\Gamma_{\text{total}}$ Γ_{50}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID	TECN	COMMENT
<3.68	90	SHEN	13	BELL $\Upsilon(1S) \rightarrow \pi^+ \pi^- \pi^0$

• • • We do not use the following data for averages, fits, limits, etc. • • •

$<1 \times 10^3$	90	BLINOV	90	MD1	$\Upsilon(1S) \rightarrow \rho^0 \pi^0$
$<2 \times 10^2$	90	FULTON	90B		$\Upsilon(1S) \rightarrow \rho^0 \pi^0$
$<2.1 \times 10^3$	90	NICZYPORUK	83	LENA	$\Upsilon(1S) \rightarrow \rho^0 \pi^0$

$\Gamma(\omega\pi^0)/\Gamma_{\text{total}}$ Γ_{51}/Γ

<u>VALUE (units 10^{-6})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<3.90	90	SHEN	13	BELL $\Upsilon(1S) \rightarrow \pi^+ \pi^- \pi^0 \pi^0$

$\Gamma(\pi^+ \pi^-)/\Gamma_{\text{total}}$ Γ_{52}/Γ

<u>VALUE (units 10^{-4})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<5	90	BARU	92	MD1 $\Upsilon(1S) \rightarrow \pi^+ \pi^-$

$\Gamma(K^+ K^-)/\Gamma_{\text{total}}$ Γ_{53}/Γ

<u>VALUE (units 10^{-4})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<5	90	BARU	92	MD1 $\Upsilon(1S) \rightarrow K^+ K^-$

$\Gamma(p\bar{p})/\Gamma_{\text{total}}$ Γ_{54}/Γ

<u>VALUE (units 10^{-4})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<5	90	¹ BARU	96	MD1 $\Upsilon(1S) \rightarrow p\bar{p}$

¹Supersedes BARU 92 in this node.

$\Gamma(\pi^+ \pi^- \pi^0)/\Gamma_{\text{total}}$ Γ_{55}/Γ

<u>VALUE (units 10^{-6})</u>	<u>CL%</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$2.14 \pm 0.72 \pm 0.34$		26 ± 9	SHEN	13	BELL $\Upsilon(1S) \rightarrow \pi^+ \pi^- \pi^0$

• • • We do not use the following data for averages, fits, limits, etc. • • •

<18.4	90	ANASTASSOV	99	CLE2	$e^+ e^- \rightarrow \text{hadrons}$
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$\Gamma(\phi K^+ K^-)/\Gamma_{\text{total}}$ Γ_{56}/Γ

<u>VALUE (units 10^{-6})</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$2.36 \pm 0.37 \pm 0.29$	56	SHEN	12A	BELL $\Upsilon(1S) \rightarrow 2(K^+ K^-)$

$\Gamma(\omega\pi^+ \pi^-)/\Gamma_{\text{total}}$ Γ_{57}/Γ

<u>VALUE (units 10^{-6})</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$4.46 \pm 0.67 \pm 0.72$	64	SHEN	12A	BELL $\Upsilon(1S) \rightarrow 2(\pi^+ \pi^-) \pi^0$

$\Gamma(K^*(892)^0 K^- \pi^+ + \text{c.c.})/\Gamma_{\text{total}}$ Γ_{58}/Γ

<u>VALUE (units 10^{-6})</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$4.42 \pm 0.50 \pm 0.58$	173	SHEN	12A	BELL $\Upsilon(1S) \rightarrow K^+ K^- \pi^+ \pi^-$

$\Gamma(\phi f'_2(1525))/\Gamma_{\text{total}}$ Γ_{59}/Γ

<u>VALUE (units 10^{-6})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<1.63	90	SHEN	12A	BELL $\Upsilon(1S) \rightarrow 2(K^+ K^-)$

$\Gamma(\omega f_2(1270))/\Gamma_{\text{total}}$ Γ_{60}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID	TECN	COMMENT
<1.79	90	SHEN	12A	BELL $\Upsilon(1S) \rightarrow 2(\pi^+\pi^-)\pi^0$

$\Gamma(\rho(770) a_2(1320))/\Gamma_{\text{total}}$ Γ_{61}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID	TECN	COMMENT
<2.24	90	SHEN	12A	BELL $\Upsilon(1S) \rightarrow 2(\pi^+\pi^-)\pi^0$

$\Gamma(K^*(892)^0 \bar{K}_2^*(1430)^0 + \text{c.c.})/\Gamma_{\text{total}}$ Γ_{62}/Γ

VALUE (units 10^{-6})	EVTS	DOCUMENT ID	TECN	COMMENT
$3.02 \pm 0.68 \pm 0.34$	42	SHEN	12A	BELL $\Upsilon(1S) \rightarrow K^+ K^- \pi^+ \pi^-$

$\Gamma(K_1(1270)^\pm K^\mp)/\Gamma_{\text{total}}$ Γ_{63}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID	TECN	COMMENT
<2.41	90	SHEN	12A	BELL $\Upsilon(1S) \rightarrow K^+ K^- \pi^+ \pi^-$

$\Gamma(K_1(1400)^\pm K^\mp)/\Gamma_{\text{total}}$ Γ_{64}/Γ

VALUE (units 10^{-6})	EVTS	DOCUMENT ID	TECN	COMMENT
$1.02 \pm 0.35 \pm 0.22$	24	SHEN	12A	BELL $\Upsilon(1S) \rightarrow K^+ K^- \pi^+ \pi^-$

$\Gamma(b_1(1235)^\pm \pi^\mp)/\Gamma_{\text{total}}$ Γ_{65}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID	TECN	COMMENT
<1.25	90	SHEN	12A	BELL $\Upsilon(1S) \rightarrow 2(\pi^+\pi^-)\pi^0$

$\Gamma(\pi^+\pi^-\pi^0\pi^0)/\Gamma_{\text{total}}$ Γ_{66}/Γ

VALUE (units 10^{-6})	EVTS	DOCUMENT ID	TECN	COMMENT
$12.8 \pm 2.0 \pm 2.3$	143 \pm 22	SHEN	13	BELL $\Upsilon(1S) \rightarrow \pi^+\pi^-\pi^0\pi^0$

$\Gamma(K_S^0 K^+ \pi^- + \text{c.c.})/\Gamma_{\text{total}}$ Γ_{67}/Γ

VALUE (units 10^{-6})	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
$1.59 \pm 0.33 \pm 0.18$		37 \pm 8	SHEN	13	BELL $\Upsilon(1S) \rightarrow K_S^0 K^- \pi^+$

• • • We do not use the following data for averages, fits, limits, etc. • • •

<3.4	90	¹ DOBBS	12A	BELL $\Upsilon(1S) \rightarrow K_S^0 K^- \pi^+$
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¹ Obtained by analyzing CLEO III data but not authored by the CLEO Collaboration.

$\Gamma(K^*(892)^0 \bar{K}^0 + \text{c.c.})/\Gamma_{\text{total}}$ Γ_{68}/Γ

VALUE (units 10^{-6})	EVTS	DOCUMENT ID	TECN	COMMENT
$2.92 \pm 0.85 \pm 0.37$	16 \pm 5	SHEN	13	BELL $\Upsilon(1S) \rightarrow K_S^0 K^- \pi^+$

$\Gamma(K^*(892)^- K^+ + \text{c.c.})/\Gamma_{\text{total}}$ Γ_{69}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID	TECN	COMMENT
<1.11	90	SHEN	13	BELL $\Upsilon(1S) \rightarrow K_S^0 K^- \pi^+$

$\Gamma(f_1(1285) \text{ anything})/\Gamma_{\text{total}}$ Γ_{70}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID	TECN	COMMENT
$4.6 \pm 2.8 \pm 1.3$	3.1k	JIA	17A	BELL $e^+ e^- \rightarrow \text{hadrons}$

$\Gamma(D^*(2010)^\pm \text{ anything})/\Gamma_{\text{total}}$ Γ_{71}/Γ

VALUE (units 10^{-3})	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
$25.2 \pm 1.3 \pm 1.5$	$\approx 2k$		¹ AUBERT	10C BABR	$\gamma(2S) \rightarrow \pi^+ \pi^- \gamma(1S)$

• • • We do not use the following data for averages, fits, limits, etc. • • •

<19	90		² ALBRECHT	92J ARG	$e^+ e^- \rightarrow D^0 \pi^\pm X$
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¹ For $x_p > 0.1$.

² For $x_p > 0.2$.

$\Gamma(f_1(1285) X_{tetra})/\Gamma_{\text{total}}$ Γ_{72}/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<62.4 \times 10^{-6}$	90	¹ JIA	17A BELL	$e^+ e^- \rightarrow \text{hadrons}$

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 4.6×10^{-6} to 62.4×10^{-6} .

$\Gamma(\overline{2H} \text{ anything})/\Gamma_{\text{total}}$ Γ_{73}/Γ

VALUE (units 10^{-5})	EVTS	DOCUMENT ID	TECN	COMMENT
2.85 ± 0.25 OUR AVERAGE				
$2.81 \pm 0.49^{+0.20}_{-0.24}$		LEES	14G BABR	$e^+ e^- \rightarrow \overline{2H} X$
$2.86 \pm 0.19 \pm 0.21$	455	ASNER	07 CLEO	$e^+ e^- \rightarrow \overline{2H} X$

$\Gamma(\text{Sum of 100 exclusive modes})/\Gamma_{\text{total}}$ Γ_{74}/Γ

VALUE (units 10^{-2})	DOCUMENT ID	COMMENT
1.200 ± 0.017	^{1,2} DOBBS	12A $\gamma(1S) \rightarrow \text{hadrons}$

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.

$\Gamma(ggg, \gamma gg \rightarrow \bar{d} \text{ anything})/\Gamma(ggg, \gamma gg \rightarrow \text{anything})$

VALUE (units 10^{-5})	EVTS	DOCUMENT ID	TECN	COMMENT
$3.36 \pm 0.23 \pm 0.25$	455	ASNER	07 CLEO	$e^+ e^- \rightarrow \bar{d} X$

$\Gamma(\gamma \pi^+ \pi^-)/\Gamma_{\text{total}}$ Γ_{75}/Γ

VALUE (units 10^{-5})	DOCUMENT ID	TECN	COMMENT
$6.3 \pm 1.2 \pm 1.3$	¹ ANASTASSOV	99 CLE2	$e^+ e^- \rightarrow \text{hadrons}$

¹ For $m_{\pi\pi} > 1$ GeV.

$\Gamma(\gamma \pi^0 \pi^0)/\Gamma_{\text{total}}$ Γ_{76}/Γ

VALUE (units 10^{-5})	DOCUMENT ID	TECN	COMMENT
$1.7 \pm 0.6 \pm 0.3$	¹ ANASTASSOV	99 CLE2	$e^+ e^- \rightarrow \text{hadrons}$

¹ For $m_{\pi\pi} > 1$ GeV.

$\Gamma(\gamma \pi \pi (\text{S-wave}))/\Gamma_{\text{total}}$ Γ_{77}/Γ

VALUE (units 10^{-5})	DOCUMENT ID	TECN	COMMENT
$4.63 \pm 0.56 \pm 0.48$	LEES	18A BABR	$\gamma(1S) \rightarrow \gamma \pi^+ \pi^-$

$\Gamma(\gamma\pi^0\eta)/\Gamma_{\text{total}}$					Γ_{78}/Γ
VALUE (units 10^{-6})	CL%	DOCUMENT ID	TECN	COMMENT	
<2.4	90	¹ BESSON	07A CLEO	$e^+e^- \rightarrow \Upsilon(1S)$	
¹ BESSON 07A obtained this limit for $0.7 < m_{\pi^0\eta} < 3$ GeV.					

$\Gamma(\gamma K^+ K^-)/\Gamma_{\text{total}}$ ($2 < m_{K^+ K^-} < 3$ GeV)					Γ_{79}/Γ
VALUE (units 10^{-5})	CL%	DOCUMENT ID	TECN	COMMENT	
1.14±0.08±0.10	90	ATHAR	06 CLE3	$\Upsilon(1S) \rightarrow \gamma K^+ K^-$	

$\Gamma(\gamma p\bar{p})/\Gamma_{\text{total}}$ ($2 < m_{p\bar{p}} < 3$ GeV)					Γ_{80}/Γ
VALUE (units 10^{-5})	CL%	DOCUMENT ID	TECN	COMMENT	
<0.6	90	ATHAR	06 CLE3	$\Upsilon(1S) \rightarrow \gamma p\bar{p}$	

$\Gamma(\gamma 2h^+ 2h^-)/\Gamma_{\text{total}}$					Γ_{81}/Γ
VALUE (units 10^{-4})	EVTS	DOCUMENT ID	TECN	COMMENT	
7.0±1.1±1.0	80 ± 12	FULTON	90B CLEO	$e^+e^- \rightarrow$ hadrons	

$\Gamma(\gamma 3h^+ 3h^-)/\Gamma_{\text{total}}$					Γ_{82}/Γ
VALUE (units 10^{-4})	EVTS	DOCUMENT ID	TECN	COMMENT	
5.4±1.5±1.3	39 ± 11	FULTON	90B CLEO	$e^+e^- \rightarrow$ hadrons	

$\Gamma(\gamma 4h^+ 4h^-)/\Gamma_{\text{total}}$					Γ_{83}/Γ
VALUE (units 10^{-4})	EVTS	DOCUMENT ID	TECN	COMMENT	
7.4±2.5±2.5	36 ± 12	FULTON	90B CLEO	$e^+e^- \rightarrow$ hadrons	

$\Gamma(\gamma\pi^+\pi^-K^+K^-)/\Gamma_{\text{total}}$					Γ_{84}/Γ
VALUE (units 10^{-4})	EVTS	DOCUMENT ID	TECN	COMMENT	
2.9±0.7±0.6	29 ± 8	FULTON	90B CLEO	$e^+e^- \rightarrow$ hadrons	

$\Gamma(\gamma 2\pi^+ 2\pi^-)/\Gamma_{\text{total}}$					Γ_{85}/Γ
VALUE (units 10^{-4})	EVTS	DOCUMENT ID	TECN	COMMENT	
2.5±0.7±0.5	26 ± 7	FULTON	90B CLEO	$e^+e^- \rightarrow$ hadrons	

$\Gamma(\gamma 3\pi^+ 3\pi^-)/\Gamma_{\text{total}}$					Γ_{86}/Γ
VALUE (units 10^{-4})	EVTS	DOCUMENT ID	TECN	COMMENT	
2.5±0.9±0.8	17 ± 5	FULTON	90B CLEO	$e^+e^- \rightarrow$ hadrons	

$\Gamma(\gamma 2\pi^+ 2\pi^- K^+ K^-)/\Gamma_{\text{total}}$					Γ_{87}/Γ
VALUE (units 10^{-4})	EVTS	DOCUMENT ID	TECN	COMMENT	
2.4±0.9±0.8	18 ± 7	FULTON	90B CLEO	$e^+e^- \rightarrow$ hadrons	

$\Gamma(\gamma\pi^+\pi^-p\bar{p})/\Gamma_{\text{total}}$					Γ_{88}/Γ
VALUE (units 10^{-4})	EVTS	DOCUMENT ID	TECN	COMMENT	
1.5±0.5±0.3	22 ± 6	FULTON	90B CLEO	$e^+e^- \rightarrow$ hadrons	

$\Gamma(\gamma 2\pi^+ 2\pi^- p\bar{p})/\Gamma_{\text{total}}$ Γ_{89}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID	TECN	COMMENT
$0.4 \pm 0.4 \pm 0.4$	7 ± 6	FULTON	90B	CLEO $e^+ e^- \rightarrow$ hadrons

$\Gamma(\gamma 2K^+ 2K^-)/\Gamma_{\text{total}}$ Γ_{90}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID	TECN	COMMENT
0.2 ± 0.2	2 ± 2	FULTON	90B	CLEO $e^+ e^- \rightarrow$ hadrons

$\Gamma(\gamma\eta'(958))/\Gamma_{\text{total}}$ Γ_{91}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID	TECN	COMMENT
< 1.9	90	ATHAR	07A	CLEO $\Upsilon(1S) \rightarrow \gamma\eta' \rightarrow \gamma\pi^+\pi^-\eta, \gamma\rho$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
< 16	90	RICHICHI	01B	CLE2 $\Upsilon(1S) \rightarrow \gamma\eta' \rightarrow \gamma\eta\pi^+\pi^-$

$\Gamma(\gamma\eta)/\Gamma_{\text{total}}$ Γ_{92}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID	TECN	COMMENT
< 1.0	90	ATHAR	07A	CLEO $\Upsilon(1S) \rightarrow \gamma\eta \rightarrow \gamma\gamma\gamma, \gamma\pi^+\pi^-\pi^0, \gamma 3\pi^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
< 21	90	MASEK	02	CLEO $\Upsilon(1S) \rightarrow \gamma\eta$

$\Gamma(\gamma f_0(980))/\Gamma_{\text{total}}$ Γ_{93}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID	TECN	COMMENT
< 3	90	¹ ATHAR	06	CLE3 $\Upsilon(1S) \rightarrow \gamma\pi^+\pi^-$
¹ Assuming $B(f_0(980) \rightarrow \pi\pi) = 1$.				

$\Gamma(\gamma f'_2(1525))/\Gamma_{\text{total}}$ Γ_{94}/Γ

VALUE (units 10^{-5})	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
2.9 ± 0.6	OUR AVERAGE				
$2.13 \pm 0.28 \pm 0.72$			¹ LEES	18A	BABR $\Upsilon(1S) \rightarrow \gamma K^+ K^-$
$4.0 \pm 1.4 \pm 0.1$		17	² BESSION	11	CLEO $\Upsilon(1S) \rightarrow K_S^0 K_S^0$
$3.7 \begin{smallmatrix} +0.9 \\ -0.7 \end{smallmatrix} \pm 0.8$			ATHAR	06	CLE3 $\Upsilon(1S) \rightarrow \gamma K^+ K^-$

• • • We do not use the following data for averages, fits, limits, etc. • • •

< 14	90	³ FULTON	90B	CLEO $\Upsilon(1S) \rightarrow \gamma K^+ K^-$
< 19.4	90	³ ALBRECHT	89	ARG $\Upsilon(1S) \rightarrow \gamma K^+ K^-$

¹ Using $B(f'_2(1525) \rightarrow K\bar{K}) = 0.887 \pm 0.022$ and $B(K^0\bar{K}^0) = 1/2 B(K\bar{K})$.

² BESSION 11 reports $(4.0 \pm 1.3 \pm 0.6) \times 10^{-5}$ from a measurement of $[\Gamma(\Upsilon(1S) \rightarrow \gamma f'_2(1525))/\Gamma_{\text{total}}] \times [B(f'_2(1525) \rightarrow K\bar{K})]$ assuming $B(f'_2(1525) \rightarrow K\bar{K}) = (88.8 \pm 3.1) \times 10^{-2}$, which we rescale to our best value $B(f'_2(1525) \rightarrow K\bar{K}) = (88.7 \pm 2.2) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. The result also assumes $B(K_S^0 \rightarrow \pi^+\pi^-) = (69.20 \pm 0.05)\%$ and $B(f'_2(1525) \rightarrow K\bar{K}) = 4 B(f'_2(1525) \rightarrow K_S^0 K_S^0)$.

³ Assuming $B(f'_2(1525) \rightarrow K\bar{K}) = 0.71$.

$\Gamma(\gamma f_2(1270))/\Gamma_{\text{total}}$ Γ_{95}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID	TECN	COMMENT
10.1 ± 0.6	OUR AVERAGE			
10.15 ± 0.59 ^{+0.54} _{-0.43}		¹ LEES	18A BABR	$\Upsilon(1S) \rightarrow \gamma \pi^+ \pi^-$
10.5 ± 1.6 ^{+1.9} _{-1.8}		² BESSON	07A CLE3	$\Upsilon(1S) \rightarrow \gamma \pi^0 \pi^0$
10.2 ± 0.8 ± 0.7		ATHAR	06 CLE3	$\Upsilon(1S) \rightarrow \gamma \pi^+ \pi^-$
8.1 ± 2.3 ^{+2.9} _{-2.7}		³ ANASTASSOV	99 CLE2	$e^+ e^- \rightarrow \text{hadrons}$

• • • We do not use the following data for averages, fits, limits, etc. • • •

<21	90	³ FULTON	90B CLEO	$\Upsilon(1S) \rightarrow \gamma \pi^+ \pi^-$
<13	90	³ ALBRECHT	89 ARG	$\Upsilon(1S) \rightarrow \gamma \pi^+ \pi^-$
<81	90	SCHMITT	88 CBAL	$\Upsilon(1S) \rightarrow \gamma X$

¹ Using $B(f_2(1270) \rightarrow \pi^0 \pi^0) = 1/3 B(f_2(1270) \rightarrow \pi \pi)$ and $B(f_2(1270) \rightarrow \pi \pi) = (84.2^{+2.9}_{-0.9})\%$.

² Using $B(f_2(1270) \rightarrow \pi^0 \pi^0) = B(f_2(1270) \rightarrow \pi \pi)/3$ and $B(f_2(1270) \rightarrow \pi \pi) = (84.7^{+2.5}_{-1.2})\%$.

³ Using $B(f_2(1270) \rightarrow \pi \pi) = 0.84$.

 $\Gamma(\gamma \eta(1405))/\Gamma_{\text{total}}$ Γ_{96}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID	TECN	COMMENT
<8.2	90	¹ FULTON	90B CLEO	$\Upsilon(1S) \rightarrow \gamma K^\pm \pi^\mp K_S^0$

¹ Includes unknown branching ratio of $\eta(1405) \rightarrow K^\pm \pi^\mp K_S^0$.

 $\Gamma(\gamma f_0(1500))/\Gamma_{\text{total}}$ Γ_{97}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID	TECN	COMMENT
<1.5	90	¹ BESSON	07A CLEO	$e^+ e^- \rightarrow \Upsilon(1S) \rightarrow \gamma \pi^0 \pi^0$

• • • We do not use the following data for averages, fits, limits, etc. • • •

<6.1	90	² BESSON	07A CLEO	$e^+ e^- \rightarrow \Upsilon(1S) \rightarrow \gamma \eta \eta$
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¹ Using $B(f_0(1500) \rightarrow \pi^0 \pi^0) = B(f_0(1500) \rightarrow \pi \pi)/3$ and $B(f_0(1500) \rightarrow \pi \pi) = (0.349 \pm 0.023)\%$.

² Calculated by us using $B(f_0(1500) \rightarrow \eta \eta) = (5.1 \pm 0.9)\%$.

 $\Gamma(\gamma f_0(1500) \rightarrow \gamma K^+ K^-)/\Gamma_{\text{total}}$ Γ_{98}/Γ

VALUE (units 10^{-5})	DOCUMENT ID	TECN	COMMENT
1.04 ± 0.14 ± 0.33	¹ LEES	18A BABR	$e^+ e^- \rightarrow \Upsilon(1S) \rightarrow \gamma K^+ K^-$

¹ LEES 18A quotes $B(\Upsilon(1S) \rightarrow \gamma f_0(1500) \rightarrow \gamma K \bar{K}) = (2.08 \pm 0.27 \pm 0.65) \times 10^{-5}$ assuming $B(K^0 \bar{K}^0) = 1/2 B(K \bar{K})$.

 $\Gamma(\gamma f_0(1710))/\Gamma_{\text{total}}$ Γ_{99}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID	TECN	COMMENT
< 2.6	90	¹ ALBRECHT	89 ARG	$\Upsilon(1S) \rightarrow \gamma K^+ K^-$

• • • We do not use the following data for averages, fits, limits, etc. • • •

< 6.3	90	¹ FULTON	90B	CLEO	$\Upsilon(1S) \rightarrow \gamma K^+ K^-$
< 19	90	¹ FULTON	90B	CLEO	$\Upsilon(1S) \rightarrow \gamma K_S^0 K_S^0$
< 8	90	² ALBRECHT	89	ARG	$\Upsilon(1S) \rightarrow \gamma \pi^+ \pi^-$
< 24	90	³ SCHMITT	88	CBAL	$\Upsilon(1S) \rightarrow \gamma X$

¹ Assuming $B(f_0(1710) \rightarrow K\bar{K}) = 0.38$.

² Assuming $B(f_0(1710) \rightarrow \pi\pi) = 0.04$.

³ Assuming $B(f_0(1710) \rightarrow \eta\eta) = 0.18$.

$\Gamma(\gamma f_0(1710) \rightarrow \gamma K^+ K^-) / \Gamma_{\text{total}}$ Γ_{100} / Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID	TECN	COMMENT
1.01 ± 0.26 ± 0.18		¹ LEES	18A	BABR $e^+ e^- \rightarrow \Upsilon(1S) \rightarrow \gamma K^+ K^-$

• • • We do not use the following data for averages, fits, limits, etc. • • •

< 0.7	90	ATHAR	06	CLEO	$e^+ e^- \rightarrow \Upsilon(1S) \rightarrow \gamma K^+ K^-$
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¹ LEES 18A quotes $B(\Upsilon(1S) \rightarrow \gamma f_0(1710) \rightarrow \gamma K\bar{K}) = (2.02 \pm 0.51 \pm 0.35) \times 10^{-5}$ assuming $B(K^0 \bar{K}^0) = 1/2 B(K\bar{K})$.

$\Gamma(\gamma f_0(1710) \rightarrow \gamma \pi^+ \pi^-) / \Gamma_{\text{total}}$ Γ_{101} / Γ

VALUE (units 10^{-5})	DOCUMENT ID	TECN	COMMENT
0.53 ± 0.17 ± 0.11	¹ LEES	18A	BABR $\Upsilon(1S) \rightarrow \gamma \pi^+ \pi^-$

¹ LEES 18A quotes $B(\Upsilon(1S) \rightarrow \gamma f_0(1710) \rightarrow \gamma \pi\pi) = (0.79 \pm 0.26 \pm 0.17) \times 10^{-5}$ assuming $B(\pi^0 \pi^0) = 1/3 B(\pi\pi)$.

$\Gamma(\gamma f_0(1710) \rightarrow \gamma \pi^0 \pi^0) / \Gamma_{\text{total}}$ Γ_{102} / Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID	TECN	COMMENT
< 1.4	90	BESSON	07A	CLEO $e^+ e^- \rightarrow \Upsilon(1S) \rightarrow \gamma \pi^0 \pi^0$

$\Gamma(\gamma f_0(1710) \rightarrow \gamma \eta \eta) / \Gamma_{\text{total}}$ Γ_{103} / Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID	TECN	COMMENT
< 1.8	90	BESSON	07A	CLEO $e^+ e^- \rightarrow \Upsilon(1S) \rightarrow \gamma \eta \eta$

$\Gamma(\gamma f_4(2050)) / \Gamma_{\text{total}}$ Γ_{104} / Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID	TECN	COMMENT
< 5.3	90	¹ ATHAR	06	CLE3 $\Upsilon(1S) \rightarrow \gamma \pi^+ \pi^-$

¹ Assuming $B(f_4(2050) \rightarrow \pi\pi) = 0.17$.

$\Gamma(\gamma f_0(2200) \rightarrow \gamma K^+ K^-) / \Gamma_{\text{total}}$ Γ_{105} / Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
< 0.0002	90	BARU	89	MD1 $\Upsilon(1S) \rightarrow \gamma K^+ K^-$

$\Gamma(\gamma f_J(2220) \rightarrow \gamma K^+ K^-) / \Gamma_{\text{total}}$ Γ_{106} / Γ

VALUE (units 10^{-7})	CL%	DOCUMENT ID	TECN	COMMENT
< 8	90	ATHAR	06	CLE3 $\Upsilon(1S) \rightarrow \gamma K^+ K^-$

• • • We do not use the following data for averages, fits, limits, etc. • • •

< 160	90	MASEK	02	CLEO	$\Upsilon(1S) \rightarrow \gamma K^+ K^-$
< 150	90	FULTON	90B	CLEO	$\Upsilon(1S) \rightarrow \gamma K^+ K^-$
< 290	90	ALBRECHT	89	ARG	$\Upsilon(1S) \rightarrow \gamma K^+ K^-$
<2000	90	BARU	89	MD1	$\Upsilon(1S) \rightarrow \gamma K^+ K^-$

$\Gamma(\gamma f_J(2220) \rightarrow \gamma \pi^+ \pi^-) / \Gamma_{\text{total}}$ Γ_{107} / Γ

<u>VALUE (units 10^{-7})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
< 6	90	ATHAR	06	CLE3 $\Upsilon(1S) \rightarrow \gamma \pi^+ \pi^-$

• • • We do not use the following data for averages, fits, limits, etc. • • •

<120	90	MASEK	02	CLEO	$\Upsilon(1S) \rightarrow \gamma \pi^+ \pi^-$
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$\Gamma(\gamma f_J(2220) \rightarrow \gamma p \bar{p}) / \Gamma_{\text{total}}$ Γ_{108} / Γ

<u>VALUE (units 10^{-7})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
< 11	90	ATHAR	06	CLE3 $\Upsilon(1S) \rightarrow \gamma p \bar{p}$

• • • We do not use the following data for averages, fits, limits, etc. • • •

<160	90	MASEK	02	CLEO	$\Upsilon(1S) \rightarrow \gamma p \bar{p}$
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$\Gamma(\gamma \eta(2225) \rightarrow \gamma \phi \phi) / \Gamma_{\text{total}}$ Γ_{109} / Γ

<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<0.003	90	BARU	89	MD1 $\Upsilon(1S) \rightarrow \gamma K^+ K^- K^+ K^-$

$\Gamma(\gamma \eta_c(1S)) / \Gamma_{\text{total}}$ Γ_{110} / Γ

<u>VALUE (units 10^{-5})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<5.7	90	SHEN	10A	BELL $\Upsilon(1S) \rightarrow \gamma X$

$\Gamma(\gamma \chi_{c0}) / \Gamma_{\text{total}}$ Γ_{111} / Γ

<u>VALUE (units 10^{-4})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<6.5	90	SHEN	10A	BELL $\Upsilon(1S) \rightarrow \gamma X$

$\Gamma(\gamma \chi_{c1}) / \Gamma_{\text{total}}$ Γ_{112} / Γ

<u>VALUE (units 10^{-5})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<2.3	90	SHEN	10A	BELL $\Upsilon(1S) \rightarrow \gamma X$

$\Gamma(\gamma \chi_{c2}) / \Gamma_{\text{total}}$ Γ_{113} / Γ

<u>VALUE (units 10^{-6})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<7.6	90	SHEN	10A	BELL $\Upsilon(1S) \rightarrow \gamma X$

$\Gamma(\gamma \chi_{c1}(3872) \rightarrow \pi^+ \pi^- J/\psi) / \Gamma_{\text{total}}$ Γ_{114} / Γ

<u>VALUE (units 10^{-6})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<1.6	90	SHEN	10A	BELL $\Upsilon(1S) \rightarrow \gamma X$

$\Gamma(\gamma \chi_{c1}(3872) \rightarrow \pi^+ \pi^- \pi^0 J/\psi) / \Gamma_{\text{total}}$ Γ_{115} / Γ

<u>VALUE (units 10^{-6})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<2.8	90	SHEN	10A	BELL $\Upsilon(1S) \rightarrow \gamma X$

$\Gamma(\gamma X(3915) \rightarrow \omega J/\psi)/\Gamma_{\text{total}}$ Γ_{116}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID	TECN	COMMENT
<3.0	90	SHEN	10A	BELL $\Upsilon(1S) \rightarrow \gamma X$

$\Gamma(\gamma \chi_{c1}(4140) \rightarrow \phi J/\psi)/\Gamma_{\text{total}}$ Γ_{117}/Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID	TECN	COMMENT
<2.2	90	SHEN	10A	BELL $\Upsilon(1S) \rightarrow \gamma X$

$\Gamma(\gamma X)/\Gamma_{\text{total}}$ Γ_{118}/Γ
($X = \text{scalar with } m < 8.0 \text{ GeV}$)

VALUE (units 10^{-6})	CL%	DOCUMENT ID	TECN	COMMENT
< 4.5	90	¹ DEL-AMO-SA...11J	BABR	$e^+e^- \rightarrow \gamma + X$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<30	90	² BALEST	95	CLEO $e^+e^- \rightarrow \gamma + X$

¹ For a noninteracting scalar X with mass $m < 8.0 \text{ GeV}$.

² For a noninteracting pseudoscalar X with mass $< 7.2 \text{ GeV}$.

$\Gamma(\gamma X \bar{X}(m_X < 3.1 \text{ GeV}))/\Gamma_{\text{total}}$ Γ_{119}/Γ
($X \bar{X} = \text{vectors with } m < 3.1 \text{ GeV}$)

VALUE (units 10^{-3})	CL%	DOCUMENT ID	TECN	COMMENT
<1	90	¹ BALEST	95	CLEO $e^+e^- \rightarrow \gamma + X \bar{X}$

¹ For a noninteracting vector X with mass $< 3.1 \text{ GeV}$.

$\Gamma(\gamma X \bar{X}(m_X < 4.5 \text{ GeV}))/\Gamma_{\text{total}}$ Γ_{120}/Γ
 X and $\bar{X} = \text{zero spin with } m < 4.5 \text{ GeV}$

VALUE (units 10^{-5})	CL%	DOCUMENT ID	TECN	COMMENT
<24	90	¹ DEL-AMO-SA...11J	BABR	$e^+e^- \rightarrow \gamma + X \bar{X}$

¹ For a noninteracting scalar X with mass $m < 4.5 \text{ GeV}$.

$\Gamma(\gamma X \rightarrow \gamma + \geq 4 \text{ prongs})/\Gamma_{\text{total}}$ Γ_{121}/Γ
($1.5 \text{ GeV} < m_X < 5.0 \text{ GeV}$)

VALUE (units 10^{-4})	CL%	DOCUMENT ID	TECN	COMMENT
<1.78	95	ROSNER	07A	CLEO $e^+e^- \rightarrow \gamma X$

$\Gamma(\gamma a_1^0 \rightarrow \gamma \mu^+ \mu^-)/\Gamma_{\text{total}}$ Γ_{122}/Γ
($201 < M(\mu^+ \mu^-) < 3565 \text{ MeV}$)

VALUE (units 10^{-6})	CL%	DOCUMENT ID	TECN	COMMENT
<9	90	¹ LOVE	08	CLEO $e^+e^- \rightarrow \gamma a_1^0 \rightarrow \gamma \mu^+ \mu^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<9.7	90	² LEES	13C	BABR $e^+e^- \rightarrow \gamma a_1^0 \rightarrow \gamma \mu^+ \mu^-$

¹ For a narrow scalar or pseudoscalar a_1^0 with $201 < M(\mu^+ \mu^-) < 3565 \text{ MeV}$, excluding J/ψ . Measured 90% CL limits as a function of $M(\mu^+ \mu^-)$ range from $1-9 \times 10^{-6}$.

² For a narrow scalar or pseudoscalar a_1^0 with mass in the range 212–9200 MeV, excluding J/ψ and $\psi(2S)$. Measured 90% CL limits as a function of $m_{a_1^0}$ range from $0.28-9.7 \times 10^{-6}$.

$\Gamma(\gamma a_1^0 \rightarrow \gamma \tau^+ \tau^-) / \Gamma_{\text{total}}$ Γ_{123} / Γ
 $(2m_\tau < M(a_1^0) < 9.2 \text{ GeV})$

VALUE (units 10^{-6})	CL%	DOCUMENT ID	TECN	COMMENT
<130	90	¹ LEES	13R	BABR $\gamma(2S) \rightarrow \gamma \tau^+ \tau^- \pi^+ \pi^-$

• • • We do not use the following data for averages, fits, limits, etc. • • •

< 50	90	² LOVE	08	CLEO $e^+ e^- \rightarrow \gamma a_1^0 \rightarrow \gamma \tau^+ \tau^-$
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¹ For a narrow scalar a_1^0 with $2m_\tau < M(a_1^0) < 9.2 \text{ GeV}$, which result in a 90% CL upper limits of 0.9×10^{-5} at $M(a_1^0) = 2m_\tau$, $\approx 1.5 \times 10^{-5}$ at $M(a_1^0) = 7.5 \text{ GeV}$, and 13×10^{-5} at $M(a_1^0) = 9.2 \text{ GeV}$.

² For a narrow scalar or pseudoscalar a_1^0 with $2m_\tau < M(a_1^0) < 7.5 \text{ GeV}$, which result in a 90% CL limits ranging from 1×10^{-5} at $M(a_1^0) = 2m_\tau$ to 5×10^{-5} at $M(a_1^0) = 7.5 \text{ GeV}$.

$\Gamma(\gamma a_1^0 \rightarrow \gamma g g) / \Gamma_{\text{total}}$ Γ_{124} / Γ
 $(0.5 \text{ GeV} < m < 9.0 \text{ GeV})$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<1 × 10⁻²	90	¹ LEES	13L	BABR $\gamma(1S) \rightarrow \gamma X$

¹ For a narrow, *CP*-odd pseudoscalar a_1^0 searched for in 26 hadronic decay modes with invariant mass $0.5 \text{ GeV} < m_X < 9.0 \text{ GeV}$. Measured 90% CL limit as a function of m_X range from 10^{-6} to 10^{-2} .

$\Gamma(\gamma a_1^0 \rightarrow \gamma s \bar{s}) / \Gamma_{\text{total}}$ Γ_{125} / Γ
 $(0.5 \text{ GeV} < m < 9.0 \text{ GeV})$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<1 × 10⁻³	90	¹ LEES	13L	BABR $\gamma(1S) \rightarrow \gamma X$

¹ For a narrow, *CP*-odd pseudoscalar a_1^0 searched for in 14 hadronic decay modes with invariant mass $1.5 \text{ GeV} < m_X < 9.0 \text{ GeV}$. Measured 90% CL limit as a function of m_X range from 10^{-5} to 10^{-3} .

———— LEPTON FAMILY NUMBER (*LF*) VIOLATING MODES ————

$\Gamma(\mu^\pm \tau^\mp) / \Gamma_{\text{total}}$ Γ_{126} / Γ

VALUE (units 10^{-6})	CL%	DOCUMENT ID	TECN	COMMENT
<6.0	95	LOVE	08A	CLEO $e^+ e^- \rightarrow \mu^\pm \tau^\mp$

———— OTHER DECAYS ————

$\Gamma(\text{invisible}) / \Gamma_{\text{total}}$ Γ_{127} / Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID	TECN	COMMENT
< 3.0	90	AUBERT	09AX	BABR $\gamma(3S) \rightarrow \pi^+ \pi^- \gamma(1S)$

• • • We do not use the following data for averages, fits, limits, etc. • • •

<39	90	RUBIN	07	CLEO $\gamma(2S) \rightarrow \pi^+ \pi^- \gamma(1S)$
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<25	90	TAJIMA	07	BELL $\gamma(3S) \rightarrow \pi^+ \pi^- \gamma(1S)$
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JIA	17A	PR D96 112002	S. Jia <i>et al.</i>	(BELLE Collab.)
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LEES	13C	PR D87 031102	J.P. Lees <i>et al.</i>	(BABAR Collab.)
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