

$\Upsilon(1S)$

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

$\Upsilon(1S)$ 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³ Superseded by ARTAMONOV 00.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)	Confidence level
$\Gamma_1 \quad \tau^+ \tau^-$	(2.60 ± 0.10) %	
$\Gamma_2 \quad e^+ e^-$	(2.38 ± 0.11) %	
$\Gamma_3 \quad \mu^+ \mu^-$	(2.48 ± 0.05) %	
Hadronic decays		
$\Gamma_4 \quad g g g$	(81.7 ± 0.7) %	
$\Gamma_5 \quad \gamma g g$	(2.2 ± 0.6) %	
$\Gamma_6 \quad \eta'(958)$ anything	(2.94 ± 0.24) %	
$\Gamma_7 \quad J/\psi(1S)$ anything	(6.5 ± 0.7) × 10 ⁻⁴	
$\Gamma_8 \quad \chi_{c0}$ anything	< 5 × 10 ⁻³	90%
$\Gamma_9 \quad \chi_{c1}$ anything	(2.3 ± 0.7) × 10 ⁻⁴	
$\Gamma_{10} \quad \chi_{c2}$ anything	(3.4 ± 1.0) × 10 ⁻⁴	
$\Gamma_{11} \quad \psi(2S)$ anything	(2.7 ± 0.9) × 10 ⁻⁴	
$\Gamma_{12} \quad \rho\pi$	< 2 × 10 ⁻⁴	90%
$\Gamma_{13} \quad \pi^+ \pi^-$	< 5 × 10 ⁻⁴	90%
$\Gamma_{14} \quad K^+ K^-$	< 5 × 10 ⁻⁴	90%

Γ_{15}	$p\bar{p}$	< 5	$\times 10^{-4}$	90%
Γ_{16}	$\pi^0\pi^+\pi^-$	< 1.84	$\times 10^{-5}$	90%
Γ_{17}	$D^*(2010)^\pm$ anything	$(2.52 \pm 0.20) \%$		
Γ_{18}	\bar{d} anything	$(2.86 \pm 0.28) \times 10^{-5}$		
Γ_{19}	Sum of 100 exclusive modes	$(1.200 \pm 0.017) \%$		

Radiative decays

Γ_{20}	$\gamma\pi^+\pi^-$	$(6.3 \pm 1.8) \times 10^{-5}$		
Γ_{21}	$\gamma\pi^0\pi^0$	$(1.7 \pm 0.7) \times 10^{-5}$		
Γ_{22}	$\gamma\pi^0\eta$	< 2.4	$\times 10^{-6}$	90%
Γ_{23}	$\gamma K^+ K^-$	[a]	$(1.14 \pm 0.13) \times 10^{-5}$	
Γ_{24}	$\gamma p\bar{p}$	[b]	< 6	$\times 10^{-6}$ 90%
Γ_{25}	$\gamma 2h^+ 2h^-$	$(7.0 \pm 1.5) \times 10^{-4}$		
Γ_{26}	$\gamma 3h^+ 3h^-$	$(5.4 \pm 2.0) \times 10^{-4}$		
Γ_{27}	$\gamma 4h^+ 4h^-$	$(7.4 \pm 3.5) \times 10^{-4}$		
Γ_{28}	$\gamma\pi^+\pi^- K^+ K^-$	$(2.9 \pm 0.9) \times 10^{-4}$		
Γ_{29}	$\gamma 2\pi^+ 2\pi^-$	$(2.5 \pm 0.9) \times 10^{-4}$		
Γ_{30}	$\gamma 3\pi^+ 3\pi^-$	$(2.5 \pm 1.2) \times 10^{-4}$		
Γ_{31}	$\gamma 2\pi^+ 2\pi^- K^+ K^-$	$(2.4 \pm 1.2) \times 10^{-4}$		
Γ_{32}	$\gamma\pi^+\pi^- p\bar{p}$	$(1.5 \pm 0.6) \times 10^{-4}$		
Γ_{33}	$\gamma 2\pi^+ 2\pi^- p\bar{p}$	$(4 \pm 6) \times 10^{-5}$		
Γ_{34}	$\gamma 2K^+ 2K^-$	$(2.0 \pm 2.0) \times 10^{-5}$		
Γ_{35}	$\gamma\eta'(958)$	< 1.9	$\times 10^{-6}$	90%
Γ_{36}	$\gamma\eta$	< 1.0	$\times 10^{-6}$	90%
Γ_{37}	$\gamma f_0(980)$	< 3	$\times 10^{-5}$	90%
Γ_{38}	$\gamma f_2'(1525)$	$(3.8 \pm 0.9) \times 10^{-5}$		
Γ_{39}	$\gamma f_2(1270)$	$(1.01 \pm 0.09) \times 10^{-4}$		
Γ_{40}	$\gamma\eta(1405)$	< 8.2	$\times 10^{-5}$	90%
Γ_{41}	$\gamma f_0(1500)$	< 1.5	$\times 10^{-5}$	90%
Γ_{42}	$\gamma f_0(1710)$	< 2.6	$\times 10^{-4}$	90%
Γ_{43}	$\gamma f_0(1710) \rightarrow \gamma K^+ K^-$	< 7	$\times 10^{-6}$	90%
Γ_{44}	$\gamma f_0(1710) \rightarrow \gamma\pi^0\pi^0$	< 1.4	$\times 10^{-6}$	90%
Γ_{45}	$\gamma f_0(1710) \rightarrow \gamma\eta\eta$	< 1.8	$\times 10^{-6}$	90%
Γ_{46}	$\gamma f_4(2050)$	< 5.3	$\times 10^{-5}$	90%
Γ_{47}	$\gamma f_0(2200) \rightarrow \gamma K^+ K^-$	< 2	$\times 10^{-4}$	90%
Γ_{48}	$\gamma f_J(2220) \rightarrow \gamma K^+ K^-$	< 8	$\times 10^{-7}$	90%
Γ_{49}	$\gamma f_J(2220) \rightarrow \gamma\pi^+\pi^-$	< 6	$\times 10^{-7}$	90%
Γ_{50}	$\gamma f_J(2220) \rightarrow \gamma p\bar{p}$	< 1.1	$\times 10^{-6}$	90%
Γ_{51}	$\gamma\eta(2225) \rightarrow \gamma\phi\phi$	< 3	$\times 10^{-3}$	90%
Γ_{52}	$\gamma\eta_c(1S)$	< 5.7	$\times 10^{-5}$	90%
Γ_{53}	$\gamma\chi_{c0}$	< 6.5	$\times 10^{-4}$	90%
Γ_{54}	$\gamma\chi_{c1}$	< 2.3	$\times 10^{-5}$	90%
Γ_{55}	$\gamma\chi_{c2}$	< 7.6	$\times 10^{-6}$	90%
Γ_{56}	$\gamma X(3872) \rightarrow \pi^+\pi^- J/\psi$	< 1.6	$\times 10^{-6}$	90%

Γ_{57}	$\gamma X(3872) \rightarrow \pi^+ \pi^- \pi^0 J/\psi$	< 2.8	$\times 10^{-6}$	90%
Γ_{58}	$\gamma X(3915) \rightarrow \omega J/\psi$	< 3.0	$\times 10^{-6}$	90%
Γ_{59}	$\gamma X(4140) \rightarrow \phi J/\psi$	< 2.2	$\times 10^{-6}$	90%
Γ_{60}	γX	[c] < 4.5	$\times 10^{-6}$	90%
Γ_{61}	$\gamma X \bar{X} (m_X < 3.1 \text{ GeV})$	[d] < 1	$\times 10^{-3}$	90%
Γ_{62}	$\gamma X \bar{X} (m_X < 4.5 \text{ GeV})$	[e] < 2.4	$\times 10^{-4}$	90%
Γ_{63}	$\gamma X \rightarrow \gamma + \geq 4 \text{ prongs}$	[f] < 1.78	$\times 10^{-4}$	95%
Γ_{64}	$\gamma a_1^0 \rightarrow \gamma \mu^+ \mu^-$	[g] < 9	$\times 10^{-6}$	90%
Γ_{65}	$\gamma a_1^0 \rightarrow \gamma \tau^+ \tau^-$	[a] < 5.0	$\times 10^{-5}$	90%

Lepton Family number (LF) violating modes

Γ_{66}	$\mu^\pm \tau^\mp$	LF < 6.0	$\times 10^{-6}$	95%
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Other decays

Γ_{67}	invisible	< 3.0	$\times 10^{-4}$	90%
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- [a] $2m_\tau < M(\tau^+ \tau^-) < 7500 \text{ MeV}$
- [b] $2 < m_{K^+ K^-} < 3 \text{ GeV}$
- [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] $201 < M(\mu^+ \mu^-) < 3565 \text{ MeV}$

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

$\Gamma(e^+ e^-) \times \Gamma(\mu^+ \mu^-)/\Gamma_{\text{total}}$				$\Gamma_2 \Gamma_3 / \Gamma$
<u>VALUE (eV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
$31.2 \pm 1.6 \pm 1.7$	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				
$1.252 \pm 0.004 \pm 0.019$	⁵ ROSNER	06	CLEO	$9.5 e^+ e^- \rightarrow \text{hadrons}$
$1.187 \pm 0.023 \pm 0.031$	⁵ BARU	92B	MD1	$e^+ e^- \rightarrow \text{hadrons}$
$1.23 \pm 0.02 \pm 0.05$	⁵ JAKUBOWSKI	88	CBAL	$e^+ e^- \rightarrow \text{hadrons}$
$1.37 \pm 0.06 \pm 0.09$	⁶ GILES	84B	CLEO	$e^+ e^- \rightarrow \text{hadrons}$
$1.23 \pm 0.08 \pm 0.04$	⁶ ALBRECHT	82	DASP	$e^+ e^- \rightarrow \text{hadrons}$
$1.13 \pm 0.07 \pm 0.11$	⁶ NICZYPORUK	82	LENA	$e^+ e^- \rightarrow \text{hadrons}$
1.09 ± 0.25	⁶ BOCK	80	CNTR	$e^+ e^- \rightarrow \text{hadrons}$
1.35 ± 0.14	⁷ BERGER	79	PLUT	$e^+ e^- \rightarrow \text{hadrons}$

⁵ Radiative corrections evaluated following KURAEV 85.

⁶ Radiative corrections reevaluated by BUCHMUELLER 88 following KURAEV 85.

⁷ Radiative corrections reevaluated by ALEXANDER 89 using $B(\mu\mu) = 0.026$.

$\Upsilon(1S)$ PARTIAL WIDTHS **$\Gamma(e^+e^-)$** **Γ_2**

VALUE (keV)

DOCUMENT ID

1.340±0.018 OUR EVALUATION **$\Upsilon(1S)$ BRANCHING RATIOS** **$\Gamma(\tau^+\tau^-)/\Gamma_{\text{total}}$** **$\Gamma_1/\Gamma$** VALUE (units 10^{-2})

EVTS

DOCUMENT ID

TECN

COMMENT

2.60±0.10 OUR AVERAGE2.53±0.13±0.05 60k ⁸ 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 ⁹ ALBRECHT 85C ARG $\Upsilon(2S) \rightarrow \pi^+\pi^-\tau^+\tau^-$ 3.4 ±0.4 ±0.4 GILES 83 CLEO $e^+e^- \rightarrow \tau^+\tau^-$

⁸ 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.

⁹ 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** VALUE (units 10^{-2})

EVTS

DOCUMENT ID

TECN

COMMENT

2.38±0.11 OUR AVERAGE2.29±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 $e^+e^- \rightarrow e^+e^-$ **$\Gamma(\mu^+\mu^-)/\Gamma_{\text{total}}$** **$\Gamma_3/\Gamma$**

VALUE

EVTS

DOCUMENT ID

TECN

COMMENT

0.0248±0.0005 OUR AVERAGE0.0249±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 ¹⁰ BARU 92 MD1 $e^+e^- \rightarrow \mu^+\mu^-$ 0.0231±0.0012±0.0010 ¹⁰ 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 $e^+e^- \rightarrow \mu^+\mu^-$

¹⁰ 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	¹¹ DEL-AMO-SA..10C	BABR	$\Upsilon(3S) \rightarrow \pi^+\pi^-\Upsilon(1S)$
1.02 ±0.02 ±0.05	60k	BESSON	07	CLEO $e^+e^- \rightarrow \Upsilon(1S)$

¹¹ 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	¹² BESSON	06A	CLEO $\Upsilon(1S) \rightarrow \text{hadrons}$

¹² 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 $R_{\text{hadrons}} = 3.51$. 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	¹³ BESSON	06A	CLEO $\Upsilon(1S) \rightarrow \gamma + \text{hadrons}$

¹³ 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 $\Upsilon(1S) \rightarrow (\gamma +) \text{hadrons}$

$\Gamma(\eta'(958) \text{ anything})/\Gamma_{total}$ 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 $\Upsilon(1S) \rightarrow \eta' \text{ anything}$
0.028 ±0.004 ±0.002	ARTUSO	03	CLE2 $\Upsilon(1S) \rightarrow \eta' \text{ anything}$

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

<u>VALUE (units 10⁻³)</u>	<u>CL%</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.65±0.07 OUR AVERAGE					
0.64±0.04±0.06		730 ± 40	BRIERE	04	CLEO $e^+e^- \rightarrow J/\psi X$
1.1 ±0.4 ±0.2			¹⁴ FULTON	89	CLEO $e^+e^- \rightarrow \mu^+\mu^- X$

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

<0.68	90	ALBRECHT	92J	ARG	$e^+e^- \rightarrow e^+e^- X, \mu^+\mu^- X$
<1.7	90	MASCHMANN	90	CBAL	$e^+e^- \rightarrow \text{hadrons}$
<20	90	NICZYPORUK	83	LENA	

¹⁴ Using $B((J/\psi) \rightarrow \mu^+\mu^-) = (6.9 \pm 0.9)\%$.

$\Gamma(\chi_{c0} \text{ anything})/\Gamma(J/\psi(1S) \text{ anything})$ Γ_8/Γ_7

<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<7.4	90	BRIERE	04	CLEO $e^+e^- \rightarrow J/\psi X$

$\Gamma(\chi_{c1} \text{ anything})/\Gamma(J/\psi(1S) \text{ anything})$ Γ_9/Γ_7

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.35±0.08±0.06	52 ± 12	BRIERE	04 CLEO	$e^+e^- \rightarrow J/\psi X$

$\Gamma(\chi_{c2} \text{ anything})/\Gamma(J/\psi(1S) \text{ anything})$ Γ_{10}/Γ_7

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.52±0.12±0.09	47 ± 11	BRIERE	04 CLEO	$e^+e^- \rightarrow J/\psi X$

$\Gamma(\psi(2S) \text{ anything})/\Gamma(J/\psi(1S) \text{ anything})$ Γ_{11}/Γ_7

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.41±0.11±0.08	42 ± 11	BRIERE	04 CLEO	$e^+e^- \rightarrow J/\psi \pi^+ \pi^- X$

$\Gamma(\rho\pi)/\Gamma_{\text{total}}$ Γ_{12}/Γ

<u>VALUE (units 10⁻⁴)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
< 2	90	FULTON	90B	$\Upsilon(1S) \rightarrow \rho^0 \pi^0$

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

<10	90	BLINOV	90 MD1	$\Upsilon(1S) \rightarrow \rho^0 \pi^0$
<21	90	NICZYPORUK	83 LENA	$\Upsilon(1S) \rightarrow \rho^0 \pi^0$

$\Gamma(\pi^+ \pi^-)/\Gamma_{\text{total}}$ Γ_{13}/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_{14}/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_{15}/Γ

<u>VALUE (units 10⁻⁴)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<5	90	¹⁵ BARU	96 MD1	$\Upsilon(1S) \rightarrow p\bar{p}$

¹⁵ Supersedes BARU 92 in this node.

$\Gamma(\pi^0 \pi^+ \pi^-)/\Gamma_{\text{total}}$ Γ_{16}/Γ

<u>VALUE (units 10⁻⁵)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<1.84	90	ANASTASSOV	99 CLE2	$e^+e^- \rightarrow \text{hadrons}$

$\Gamma(D^*(2010)^\pm \text{ anything})/\Gamma_{\text{total}}$ Γ_{17}/Γ

<u>VALUE (units 10⁻³)</u>	<u>CL%</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
25.2±1.3±1.5	≈ 2k	¹⁶	AUBERT	10c BABR	$\Upsilon(2S) \rightarrow \pi^+ \pi^- \Upsilon(1S)$

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

<19	90	¹⁷	ALBRECHT	92J ARG	$e^+e^- \rightarrow D^0 \pi^\pm X$
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¹⁶ For $x_p > 0.1$.

¹⁷ For $x_p > 0.2$.

$\Gamma(\bar{d} \text{ anything})/\Gamma_{\text{total}}$ Γ_{18}/Γ

<u>VALUE (units 10⁻⁵)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
2.86±0.19±0.21	455	ASNER	07 CLEO	$e^+e^- \rightarrow \bar{d} X$

$\Gamma(\text{Sum of 100 exclusive modes})/\Gamma_{\text{total}}$ **Γ_{19}/Γ**

<u>VALUE (units 10^{-2})</u>		<u>DOCUMENT ID</u>		<u>COMMENT</u>
1.200±0.017	18,19	DOBBS	12A	$\Upsilon(1S) \rightarrow \text{hadrons}$

¹⁸ DOBBS 12A presents individual exclusive branching fractions or upper limits for 100 modes of four to ten pions, kaons, or protons.

¹⁹ Obtained by analyzing CLEO III data but not authored by the CLEO Collaboration.

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

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

$\Gamma(\gamma\pi^+\pi^-)/\Gamma_{\text{total}}$ **Γ_{20}/Γ**

<u>VALUE (units 10^{-5})</u>		<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
6.3±1.2±1.3	²⁰	ANASTASSOV 99	CLE2	$e^+e^- \rightarrow \text{hadrons}$

²⁰ For $m_{\pi\pi} > 1$ GeV.

$\Gamma(\gamma\pi^0\pi^0)/\Gamma_{\text{total}}$ **Γ_{21}/Γ**

<u>VALUE (units 10^{-5})</u>		<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1.7±0.6±0.3	²¹	ANASTASSOV 99	CLE2	$e^+e^- \rightarrow \text{hadrons}$

²¹ For $m_{\pi\pi} > 1$ GeV.

$\Gamma(\gamma\pi^0\eta)/\Gamma_{\text{total}}$ **Γ_{22}/Γ**

<u>VALUE (units 10^{-6})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<2.4	90	²² BESSON	07A	CLEO $e^+e^- \rightarrow \Upsilon(1S)$

²² BESSON 07A obtained this limit for $0.7 < m_{\pi^0\eta} < 3$ GeV.

$\Gamma(\gamma K^+K^-)/\Gamma_{\text{total}}$ **Γ_{23}/Γ**

($2 < m_{K^+K^-} < 3$ GeV)

<u>VALUE (units 10^{-5})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1.14±0.08±0.10	90	ATHAR	06	CLE3 $\Upsilon(1S) \rightarrow \gamma K^+K^-$

$\Gamma(\gamma p\bar{p})/\Gamma_{\text{total}}$ **Γ_{24}/Γ**

($2 < m_{p\bar{p}} < 3$ GeV)

<u>VALUE (units 10^{-5})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<0.6	90	ATHAR	06	CLE3 $\Upsilon(1S) \rightarrow \gamma p\bar{p}$

$\Gamma(\gamma 2h^+2h^-)/\Gamma_{\text{total}}$ **Γ_{25}/Γ**

<u>VALUE (units 10^{-4})</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
7.0±1.1±1.0	80 ± 12	FULTON	90B	CLEO $e^+e^- \rightarrow \text{hadrons}$

$\Gamma(\gamma 3h^+3h^-)/\Gamma_{\text{total}}$ **Γ_{26}/Γ**

<u>VALUE (units 10^{-4})</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
5.4±1.5±1.3	39 ± 11	FULTON	90B	CLEO $e^+e^- \rightarrow \text{hadrons}$

$\Gamma(\gamma 4h^+ 4h^-)/\Gamma_{\text{total}}$ Γ_{27}/Γ

<u>VALUE (units 10^{-4})</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$7.4 \pm 2.5 \pm 2.5$	36 ± 12	FULTON	90B CLEO	$e^+ e^- \rightarrow$ hadrons

$\Gamma(\gamma \pi^+ \pi^- K^+ K^-)/\Gamma_{\text{total}}$ Γ_{28}/Γ

<u>VALUE (units 10^{-4})</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$2.9 \pm 0.7 \pm 0.6$	29 ± 8	FULTON	90B CLEO	$e^+ e^- \rightarrow$ hadrons

$\Gamma(\gamma 2\pi^+ 2\pi^-)/\Gamma_{\text{total}}$ Γ_{29}/Γ

<u>VALUE (units 10^{-4})</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$2.5 \pm 0.7 \pm 0.5$	26 ± 7	FULTON	90B CLEO	$e^+ e^- \rightarrow$ hadrons

$\Gamma(\gamma 3\pi^+ 3\pi^-)/\Gamma_{\text{total}}$ Γ_{30}/Γ

<u>VALUE (units 10^{-4})</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$2.5 \pm 0.9 \pm 0.8$	17 ± 5	FULTON	90B CLEO	$e^+ e^- \rightarrow$ hadrons

$\Gamma(\gamma 2\pi^+ 2\pi^- K^+ K^-)/\Gamma_{\text{total}}$ Γ_{31}/Γ

<u>VALUE (units 10^{-4})</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$2.4 \pm 0.9 \pm 0.8$	18 ± 7	FULTON	90B CLEO	$e^+ e^- \rightarrow$ hadrons

$\Gamma(\gamma \pi^+ \pi^- \rho \bar{\rho})/\Gamma_{\text{total}}$ Γ_{32}/Γ

<u>VALUE (units 10^{-4})</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$1.5 \pm 0.5 \pm 0.3$	22 ± 6	FULTON	90B CLEO	$e^+ e^- \rightarrow$ hadrons

$\Gamma(\gamma 2\pi^+ 2\pi^- \rho \bar{\rho})/\Gamma_{\text{total}}$ Γ_{33}/Γ

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

$\Gamma(\gamma 2K^+ 2K^-)/\Gamma_{\text{total}}$ Γ_{34}/Γ

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

$\Gamma(\gamma \eta'(958))/\Gamma_{\text{total}}$ Γ_{35}/Γ

<u>VALUE (units 10^{-6})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
< 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_{36}/Γ

<u>VALUE (units 10^{-6})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
< 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_{37}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID	TECN	COMMENT
<3	90	²³ ATHAR	06	CLE3 $\Upsilon(1S) \rightarrow \gamma \pi^+ \pi^-$
²³ Assuming $B(f_0(980) \rightarrow \pi\pi) = 1$.				

$\Gamma(\gamma f'_2(1525))/\Gamma_{\text{total}}$ Γ_{38}/Γ

VALUE (units 10^{-5})	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
3.8 ± 0.9 OUR AVERAGE					
$4.0 \pm 1.4 \pm 0.1$		17 ± 5	²⁴ BESSON	11	CLEO $\Upsilon(1S) \rightarrow K_S^0 K_S^0$
$3.7^{+0.9}_{-0.7} \pm 0.8$			ATHAR	06	CLE3 $\Upsilon(1S) \rightarrow \gamma K^+ K^-$

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

<14	90	²⁵ FULTON	90B	CLEO	$\Upsilon(1S) \rightarrow \gamma K^+ K^-$
<19.4	90	²⁵ ALBRECHT	89	ARG	$\Upsilon(1S) \rightarrow \gamma K^+ K^-$

²⁴ BESSON 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 $B(f'_2(1525) \rightarrow K\bar{K}) = 4 B(f'_2(1525) \rightarrow K_S^0 K_S^0)$.

²⁵ Assuming $B(f'_2(1525) \rightarrow K\bar{K}) = 0.71$.

$\Gamma(\gamma f_2(1270))/\Gamma_{\text{total}}$ Γ_{39}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID	TECN	COMMENT
10.1 ± 0.9 OUR AVERAGE				
$10.5 \pm 1.6^{+1.9}_{-1.8}$		²⁶ BESSON	07A	CLE3 $\Upsilon(1S) \rightarrow \gamma \pi^0 \pi^0$
$10.2 \pm 0.8 \pm 0.7$		ATHAR	06	CLE3 $\Upsilon(1S) \rightarrow \gamma \pi^+ \pi^-$
$8.1 \pm 2.3^{+2.9}_{-2.7}$		²⁷ ANASTASSOV	99	CLE2 $e^+ e^- \rightarrow \text{hadrons}$

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

<21	90	²⁷ FULTON	90B	CLEO	$\Upsilon(1S) \rightarrow \gamma \pi^+ \pi^-$
<13	90	²⁷ ALBRECHT	89	ARG	$\Upsilon(1S) \rightarrow \gamma \pi^+ \pi^-$
<81	90	SCHMITT	88	CBAL	$\Upsilon(1S) \rightarrow \gamma X$

²⁶ Using $B(f_2(1270) \rightarrow \pi^0 \pi^0) = B(f_2(1270) \rightarrow \pi\pi)/3$ and $B(f_2(1270) \rightarrow \pi\pi) = (0.845^{+0.025}_{-0.012})\%$.

²⁷ Using $B(f_2(1270) \rightarrow \pi\pi) = 0.84$.

$\Gamma(\gamma \eta(1405))/\Gamma_{\text{total}}$ Γ_{40}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID	TECN	COMMENT
<8.2	90	²⁸ FULTON	90B	CLEO $\Upsilon(1S) \rightarrow \gamma K^\pm \pi^\mp K_S^0$

²⁸ Includes unknown branching ratio of $\eta(1405) \rightarrow K^\pm \pi^\mp K_S^0$.

$\Gamma(\gamma f_0(1500))/\Gamma_{\text{total}}$ **Γ_{41}/Γ**

<u>VALUE (units 10^{-5})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<1.5	90	29 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	30 BESSON	07A CLEO	$e^+e^- \rightarrow \Upsilon(1S) \rightarrow \gamma\eta\eta$
29 Using $B(f_0(1500) \rightarrow \pi^0\pi^0) = B(f_0(1500) \rightarrow \pi\pi)/3$ and $B(f_0(1500) \rightarrow \pi\pi) = (0.349 \pm 0.023)\%$.				
30 Calculated by us using $B(f_0(1500) \rightarrow \eta\eta) = (5.1 \pm 0.9)\%$.				

$\Gamma(\gamma f_0(1710))/\Gamma_{\text{total}}$ **Γ_{42}/Γ**

<u>VALUE (units 10^{-4})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
< 2.6	90	31 ALBRECHT	89 ARG	$\Upsilon(1S) \rightarrow \gamma K^+ K^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
< 6.3	90	31 FULTON	90B CLEO	$\Upsilon(1S) \rightarrow \gamma K^+ K^-$
<19	90	31 FULTON	90B CLEO	$\Upsilon(1S) \rightarrow \gamma K_S^0 K_S^0$
< 8	90	32 ALBRECHT	89 ARG	$\Upsilon(1S) \rightarrow \gamma\pi^+\pi^-$
<24	90	33 SCHMITT	88 CBAL	$\Upsilon(1S) \rightarrow \gamma X$
31 Assuming $B(f_0(1710) \rightarrow K\bar{K}) = 0.38$.				
32 Assuming $B(f_0(1710) \rightarrow \pi\pi) = 0.04$.				
33 Assuming $B(f_0(1710) \rightarrow \eta\eta) = 0.18$.				

$\Gamma(\gamma f_0(1710) \rightarrow \gamma K^+ K^-)/\Gamma_{\text{total}}$ **Γ_{43}/Γ**

<u>VALUE (units 10^{-5})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<0.7	90	ATHAR	06 CLEO	$e^+e^- \rightarrow \Upsilon(1S) \rightarrow \gamma K^+ K^-$

$\Gamma(\gamma f_0(1710) \rightarrow \gamma\pi^0\pi^0)/\Gamma_{\text{total}}$ **Γ_{44}/Γ**

<u>VALUE (units 10^{-6})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<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_{45}/Γ**

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

$\Gamma(\gamma f_4(2050))/\Gamma_{\text{total}}$ **Γ_{46}/Γ**

<u>VALUE (units 10^{-5})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<5.3	90	34 ATHAR	06 CLE3	$\Upsilon(1S) \rightarrow \gamma\pi^+\pi^-$
34 Assuming $B(f_4(2050) \rightarrow \pi\pi) = 0.17$.				

$\Gamma(\gamma f_0(2200) \rightarrow \gamma K^+ K^-)/\Gamma_{\text{total}}$ **Γ_{47}/Γ**

<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<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_{48}/Γ**

<u>VALUE (units 10^{-7})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
< 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_{49}/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	$\Upsilon(1S) \rightarrow \gamma \pi^+ \pi^-$

$\Gamma(\gamma f_J(2220) \rightarrow \gamma p \bar{p})/\Gamma_{\text{total}}$ **Γ_{50}/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	$\Upsilon(1S) \rightarrow \gamma p \bar{p}$

$\Gamma(\gamma \eta(2225) \rightarrow \gamma \phi \phi)/\Gamma_{\text{total}}$ **Γ_{51}/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_{52}/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_{53}/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_{54}/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_{55}/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	$\Upsilon(1S) \rightarrow \gamma X$

$\Gamma(\gamma X(3872) \rightarrow \pi^+ \pi^- J/\psi)/\Gamma_{\text{total}}$ **Γ_{56}/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	$\Upsilon(1S) \rightarrow \gamma X$

$\Gamma(\gamma X(3872) \rightarrow \pi^+ \pi^- \pi^0 J/\psi) / \Gamma_{\text{total}}$ Γ_{57}/Γ

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

$\Gamma(\gamma X(3915) \rightarrow \omega J/\psi) / \Gamma_{\text{total}}$ Γ_{58}/Γ

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

$\Gamma(\gamma X(4140) \rightarrow \phi J/\psi) / \Gamma_{\text{total}}$ Γ_{59}/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_{60}/Γ
 ($X = \text{scalar with } m < 8.0 \text{ GeV}$)

VALUE (units 10^{-6})	CL%	DOCUMENT ID	TECN	COMMENT
< 4.5	90	³⁵ DEL-AMO-SA..11J	BABR	$e^+ e^- \rightarrow \gamma + X$

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

<30	90	³⁶ BALEST 95	CLEO	$e^+ e^- \rightarrow \gamma + X$
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³⁵ For a noninteracting scalar X with mass $m < 8.0 \text{ GeV}$.

³⁶ 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_{61}/Γ
 ($X \bar{X} = \text{vectors with } m < 3.1 \text{ GeV}$)

VALUE (units 10^{-3})	CL%	DOCUMENT ID	TECN	COMMENT
<1	90	³⁷ BALEST 95	CLEO	$e^+ e^- \rightarrow \gamma + X \bar{X}$

³⁷ 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_{62}/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	³⁸ DEL-AMO-SA..11J	BABR	$e^+ e^- \rightarrow \gamma + X \bar{X}$

³⁸ 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_{63}/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_{64}/Γ
 ($201 < M(\mu^+ \mu^-) < 3565 \text{ MeV}$)

VALUE (units 10^{-6})	CL%	DOCUMENT ID	TECN	COMMENT
<9	90	³⁹ 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	⁴⁰ LEES 13c	BABR	$e^+ e^- \rightarrow \gamma a_1^0 \rightarrow \gamma \mu^+ \mu^-$
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³⁹ For a narrow scalar or pseudoscalar a_1^0 with $201 < M(\mu^+ \mu^-) < 3565$ MeV, excluding J/ψ . Measured 90% CL limits as a function of $M(\mu^+ \mu^-)$ range from $1-9 \times 10^{-6}$.

⁴⁰ 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_{65} / Γ
 $(2m_\tau < M(\tau^+ \tau^-) < 7500 \text{ MeV})$

VALUE (units 10^{-6})	CL%	DOCUMENT ID	TECN	COMMENT
<50	90	⁴¹ LOVE	08	CLEO $e^+ e^- \rightarrow \gamma a_1^0 \rightarrow \gamma \tau^+ \tau^-$

⁴¹ For a narrow scalar or pseudoscalar a_1^0 with $2m_\tau < M(\tau^+ \tau^-) < 7500$ MeV. Measured 90% CL limits as a function of $M(\tau^+ \tau^-)$ range from $1-5 \times 10^{-5}$.

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

$\Gamma(\mu^\pm \tau^\mp) / \Gamma_{\text{total}}$ Γ_{66} / 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_{67} / Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID	TECN	COMMENT
< 3.0	90	AUBERT	09AX	BABR $\Upsilon(3S) \rightarrow \pi^+ \pi^- \Upsilon(1S)$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
<39	90	RUBIN	07	CLEO $\Upsilon(2S) \rightarrow \pi^+ \pi^- \Upsilon(1S)$
<25	90	TAJIMA	07	BELL $\Upsilon(3S) \rightarrow \pi^+ \pi^- \Upsilon(1S)$

$\Upsilon(1S)$ REFERENCES

LEES	13C	PR D87 031102	J.P. Lees <i>et al.</i>	(BABAR Collab.)
DOBBS	12A	PR D86 052003	S. Dobbs <i>et al.</i>	
BESSON	11	PR D83 037101	D. Besson <i>et al.</i>	(CLEO Collab.)
DEL-AMO-SA...	11J	PRL 107 021804	P. del Amo Sanchez <i>et al.</i>	(BABAR Collab.)
AUBERT	10C	PR D81 011102	B. Aubert <i>et al.</i>	(BABAR Collab.)
DEL-AMO-SA...	10C	PRL 104 191801	P. del Amo Sanchez <i>et al.</i>	(BABAR Collab.)
SHEN	10A	PR D82 051504	C.P. Shen <i>et al.</i>	(BELLE Collab.)
AUBERT	09AX	PRL 103 251801	B. Aubert <i>et al.</i>	(BABAR Collab.)
LOVE	08	PRL 101 151802	W. Love <i>et al.</i>	(CLEO Collab.)
LOVE	08A	PRL 101 201601	W. Love <i>et al.</i>	(CLEO Collab.)
PDG	08	PL B667 1	C. Amsler <i>et al.</i>	(PDG Collab.)
ASNER	07	PR D75 012009	D.M. Asner <i>et al.</i>	(CLEO Collab.)
ATHAR	07A	PR D76 072003	S.B. Athar <i>et al.</i>	(CLEO Collab.)
BESSON	07	PRL 98 052002	D. Besson <i>et al.</i>	(CLEO Collab.)
BESSON	07A	PR D75 072001	D. Besson <i>et al.</i>	(CLEO Collab.)
ROSNER	07A	PR D76 117102	J.L. Rosner <i>et al.</i>	(CLEO Collab.)
RUBIN	07	PR D75 031104	P. Rubin <i>et al.</i>	(CLEO Collab.)
TAJIMA	07	PRL 98 132001	O. Tajima <i>et al.</i>	(BELLE Collab.)
AQUINES	06A	PR D74 092006	O. Aquines <i>et al.</i>	(CLEO Collab.)
ATHAR	06	PR D73 032001	S.B. Athar <i>et al.</i>	(CLEO Collab.)
BESSON	06A	PR D74 012003	D. Besson <i>et al.</i>	(CLEO Collab.)
ROSNER	06	PRL 96 092003	J.L. Rosner <i>et al.</i>	(CLEO Collab.)
ADAMS	05	PRL 94 012001	G.S. Adams <i>et al.</i>	(CLEO Collab.)
BRIERE	04	PR D70 072001	R.A. Briere <i>et al.</i>	(CLEO Collab.)
ARTUSO	03	PR D67 052003	M. Artuso <i>et al.</i>	(CLEO Collab.)

MASEK	02	PR D65 072002	G. Masek <i>et al.</i>	(CLEO Collab.)
RICHICHI	01B	PRL 87 141801	S.J. Richichi <i>et al.</i>	(CLEO Collab.)
ARTAMONOV	00	PL B474 427	A.S. Artamonov <i>et al.</i>	
ANASTASSOV	99	PRL 82 286	A. Anastassov <i>et al.</i>	(CLEO Collab.)
ALEXANDER	98	PR D58 052004	J.P. Alexander <i>et al.</i>	(CLEO Collab.)
BARU	96	PRPL 267 71	S.E. Baru <i>et al.</i>	(NOVO)
BALEST	95	PR D51 2053	R. Balest <i>et al.</i>	(CLEO Collab.)
CINABRO	94B	PL B340 129	D. Cinabro <i>et al.</i>	(CLEO Collab.)
ALBRECHT	92J	ZPHY C55 25	H. Albrecht <i>et al.</i>	(ARGUS Collab.)
BARU	92	ZPHY C54 229	S.E. Baru <i>et al.</i>	(NOVO)
BARU	92B	ZPHY C56 547	S.E. Baru <i>et al.</i>	(NOVO)
KOBEL	92	ZPHY C53 193	M. Kobel <i>et al.</i>	(Crystal Ball Collab.)
BLINOV	90	PL B245 311	A.E. Blinov <i>et al.</i>	(NOVO)
FULTON	90B	PR D41 1401	R. Fulton <i>et al.</i>	(CLEO Collab.)
MASCHMANN	90	ZPHY C46 555	W.S. Maschmann <i>et al.</i>	(Crystal Ball Collab.)
ALBRECHT	89	ZPHY C42 349	H. Albrecht <i>et al.</i>	(ARGUS Collab.)
ALEXANDER	89	NP B320 45	J.P. Alexander <i>et al.</i>	(LBL, MICH, SLAC)
BARU	89	ZPHY C42 505	S.E. Baru <i>et al.</i>	(NOVO)
CHEN	89B	PR D39 3528	W.Y. Chen <i>et al.</i>	(CLEO Collab.)
FULTON	89	PL B224 445	R. Fulton <i>et al.</i>	(CLEO Collab.)
KAARSBERG	89	PRL 62 2077	T.M. Kaarsberg <i>et al.</i>	(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 <i>et al.</i>	(Crystal Ball Collab.) IGJPC
SCHMITT	88	ZPHY C40 199	P. Schmitt <i>et al.</i>	(Crystal Ball Collab.)
ALBRECHT	87	ZPHY C35 283	H. Albrecht <i>et al.</i>	(ARGUS Collab.)
COHEN	87	RMP 59 1121	E.R. Cohen, B.N. Taylor	(RISC, NBS)
BARU	86	ZPHY C30 551	S.E. Baru <i>et al.</i>	(NOVO)
ALBRECHT	85C	PL 154B 452	H. Albrecht <i>et al.</i>	(ARGUS Collab.)
KURAEV	85	SJNP 41 466	E.A. Kuraev, V.S. Fadin	(NOVO)
		Translated from YAF 41 733.		
ARTAMONOV	84	PL 137B 272	A.S. Artamonov <i>et al.</i>	(NOVO)
BESSON	84	PR D30 1433	D. Besson <i>et al.</i>	(CLEO Collab.)
GILES	84B	PR D29 1285	R. Giles <i>et al.</i>	(CLEO Collab.)
MACKAY	84	PR D29 2483	W.W. MacKay <i>et al.</i>	(CUSB Collab.)
ANDREWS	83	PRL 50 807	D.E. Andrews <i>et al.</i>	(CLEO Collab.)
GILES	83	PRL 50 877	R. Giles <i>et al.</i>	(HARV, OSU, ROCH, RUTG+)
NICZYPORUK	83	ZPHY C17 197	B. Niczyporuk <i>et al.</i>	(LENA Collab.)
ALBRECHT	82	PL 116B 383	H. Albrecht <i>et al.</i>	(DESY, DORT, HEIDH+)
ARTAMONOV	82	PL 118B 225	A.S. Artamonov <i>et al.</i>	(NOVO)
NICZYPORUK	82	ZPHY C15 299	B. Niczyporuk <i>et al.</i>	(LENA Collab.)
BERGER	80C	PL 93B 497	C. Berger <i>et al.</i>	(PLUTO Collab.)
BOCK	80	ZPHY C6 125	P. Bock <i>et al.</i>	(HEIDP, MPIM, DESY, HAMB)
BERGER	79	ZPHY C1 343	C. Berger <i>et al.</i>	(PLUTO Collab.)