

$\Upsilon(2S)$ 

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

### $\Upsilon(2S)$ MASS

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
<b>10023.4 ± 0.5</b>	<sup>1</sup> SHAMOV	23	RVUE $e^+e^- \rightarrow$ hadrons
• • • We do not use the following data for averages, fits, limits, etc. • • •			
10022.7 ± 0.4	<sup>2</sup> SHAMOV	23	RVUE $e^+e^- \rightarrow$ hadrons
10023.5 ± 0.5	<sup>3,4</sup> ARTAMONOV	00	MD1 $e^+e^- \rightarrow$ hadrons
10023.6 ± 0.5	<sup>5,6</sup> BARU	86B	MD1 $e^+e^- \rightarrow$ hadrons
10023.1 ± 0.4	<sup>7</sup> BARBER	84	ARG $e^+e^- \rightarrow$ hadrons

<sup>1</sup> Reanalysis of MD1 data using the electron mass from COHEN 87, the radiative corrections from KURAEV 85 and interference effects.

<sup>2</sup> Obtained by reanalysing ARGUS and Crystal Ball data (BARBER 84), but not authored by the ARGUS and Crystal Ball collaboration.

<sup>3</sup> Reanalysis of BARU 86B using new electron mass (COHEN 87).

<sup>4</sup> Superseded by SHAMOV 23.

<sup>5</sup> Reanalysis of ARTAMONOV 84.

<sup>6</sup> Superseded by ARTAMONOV 00.

<sup>7</sup> Reanalysed by SHAMOV 23.

### $m_{\Upsilon(2S)} - m_{\Upsilon(1S)}$

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
<b>562.81 ± 0.11 OUR AVERAGE</b>				
562.71 ± 0.04 ± 0.20	3.7M	<sup>1</sup> AAIJ	24AC LHCb	$\Upsilon \rightarrow \mu^+\mu^-$
562.85 ± 0.03 ± 0.12	89k	<sup>1</sup> AAIJ	24AC LHCb	$\Upsilon(2S) \rightarrow \Upsilon(1S)\pi^+\pi^-$

<sup>1</sup> Observed in prompt  $p\bar{p}$  production.

### $\Upsilon(2S)$ WIDTH

VALUE (keV)	DOCUMENT ID
<b>31.98 ± 2.63 OUR EVALUATION</b>	See the Note on "Width Determinations of the $\Upsilon$ States"

### $\Upsilon(2S)$ DECAY MODES

Mode	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level
$\Gamma_1$ $\Upsilon(1S)\pi^+\pi^-$	(17.85 ± 0.26) %	
$\Gamma_2$ $\Upsilon(1S)\pi^0\pi^0$	( 8.6 ± 0.4 ) %	
$\Gamma_3$ $\tau^+\tau^-$	( 2.00 ± 0.21 ) %	
$\Gamma_4$ $\mu^+\mu^-$	( 1.93 ± 0.17 ) %	S=2.2
$\Gamma_5$ $e^+e^-$	( 1.91 ± 0.16 ) %	
$\Gamma_6$ $\Upsilon(1S)\pi^0$	< 4 × 10 <sup>-5</sup>	CL=90%
$\Gamma_7$ $\Upsilon(1S)\eta$	( 2.9 ± 0.4 ) × 10 <sup>-4</sup>	S=2.0
$\Gamma_8$ $J/\psi(1S)$ anything	< 6 × 10 <sup>-3</sup>	CL=90%

$\Gamma_9$	$J/\psi(1S)\eta_c$	$< 5.4$	$\times 10^{-6}$	CL=90%
$\Gamma_{10}$	$J/\psi(1S)\chi_{c0}$	$< 3.4$	$\times 10^{-6}$	CL=90%
$\Gamma_{11}$	$J/\psi(1S)\chi_{c1}$	$< 1.2$	$\times 10^{-6}$	CL=90%
$\Gamma_{12}$	$J/\psi(1S)\chi_{c2}$	$< 2.0$	$\times 10^{-6}$	CL=90%
$\Gamma_{13}$	$J/\psi(1S)\eta_c(2S)$	$< 2.5$	$\times 10^{-6}$	CL=90%
$\Gamma_{14}$	$J/\psi(1S)X(3940)$	$< 2.0$	$\times 10^{-6}$	CL=90%
$\Gamma_{15}$	$J/\psi(1S)X(4160)$	$< 2.0$	$\times 10^{-6}$	CL=90%
$\Gamma_{16}$	$\chi_{c1}$ anything	$(2.2 \pm 0.5)$	$\times 10^{-4}$	
$\Gamma_{17}$	$\chi_{c1}(1P)^0 X_{tetra}$	$< 3.67$	$\times 10^{-5}$	CL=90%
$\Gamma_{18}$	$\chi_{c2}$ anything	$(2.3 \pm 0.8)$	$\times 10^{-4}$	
$\Gamma_{19}$	$\psi(2S)\eta_c$	$< 5.1$	$\times 10^{-6}$	CL=90%
$\Gamma_{20}$	$\psi(2S)\chi_{c0}$	$< 4.7$	$\times 10^{-6}$	CL=90%
$\Gamma_{21}$	$\psi(2S)\chi_{c1}$	$< 2.5$	$\times 10^{-6}$	CL=90%
$\Gamma_{22}$	$\psi(2S)\chi_{c2}$	$< 1.9$	$\times 10^{-6}$	CL=90%
$\Gamma_{23}$	$\psi(2S)\eta_c(2S)$	$< 3.3$	$\times 10^{-6}$	CL=90%
$\Gamma_{24}$	$\psi(2S)X(3940)$	$< 3.9$	$\times 10^{-6}$	CL=90%
$\Gamma_{25}$	$\psi(2S)X(4160)$	$< 3.9$	$\times 10^{-6}$	CL=90%
$\Gamma_{26}$	$T_{c\bar{c}1}(3900)^+ T_{c\bar{c}1}(3900)^-$	$< 1.0$	$\times 10^{-6}$	CL=90%
$\Gamma_{27}$	$T_{c\bar{c}1}(4200)^+ T_{c\bar{c}1}(4200)^-$	$< 1.67$	$\times 10^{-5}$	CL=90%
$\Gamma_{28}$	$T_{c\bar{c}1}(3900)^\pm T_{c\bar{c}1}(4200)^\mp$	$< 7.3$	$\times 10^{-6}$	CL=90%
$\Gamma_{29}$	$T_{c\bar{c}}(4050)^+ T_{c\bar{c}}(4050)^-$	$< 1.35$	$\times 10^{-5}$	CL=90%
$\Gamma_{30}$	$T_{c\bar{c}}(4250)^+ T_{c\bar{c}}(4250)^-$	$< 2.67$	$\times 10^{-5}$	CL=90%
$\Gamma_{31}$	$T_{c\bar{c}}(4050)^\pm T_{c\bar{c}}(4250)^\mp$	$< 2.72$	$\times 10^{-5}$	CL=90%
$\Gamma_{32}$	$T_{c\bar{c}1}(4430)^+ T_{c\bar{c}1}(4430)^-$	$< 2.03$	$\times 10^{-5}$	CL=90%
$\Gamma_{33}$	$T_{c\bar{c}}(4055)^\pm T_{c\bar{c}}(4055)^\mp$	$< 1.11$	$\times 10^{-5}$	CL=90%
$\Gamma_{34}$	$T_{c\bar{c}}(4055)^\pm T_{c\bar{c}1}(4430)^\mp$	$< 2.11$	$\times 10^{-5}$	CL=90%
$\Gamma_{35}$	$P_{c\bar{c}s}(4459)/\bar{P}_{c\bar{c}s}(4459)$ anything	$(2.9 \pm 1.7)$	$\times 10^{-6}$	
$\Gamma_{36}$	$P_{c\bar{c}s}(4338)/\bar{P}_{c\bar{c}s}(4338)$ anything	$< 1.6$	$\times 10^{-6}$	CL=90%
$\Gamma_{37}$	$P_c(4457)$ anything, $P_c(4457) \rightarrow pJ/\psi(1S)$	$< 4.6$	$\times 10^{-6}$	CL=90%
$\Gamma_{38}$	$P_c(4440)$ anything, $P_c(4440) \rightarrow pJ/\psi(1S)$	$< 1.18$	$\times 10^{-5}$	CL=90%
$\Gamma_{39}$	$P_c(4312)$ anything, $P_c(4312) \rightarrow pJ/\psi(1S)$	$< 7.2$	$\times 10^{-6}$	CL=90%
$\Gamma_{40}$	$p/\bar{p}J/\psi(1S)$ anything	$(4.3 \pm 0.6)$	$\times 10^{-5}$	
$\Gamma_{41}$	$J/\psi(1S)\Lambda/\bar{\Lambda}$ anything	$(2.2 \pm 0.6)$	$\times 10^{-5}$	
$\Gamma_{42}$	${}^2H$ anything	$(2.78_{-0.26}^{+0.30})$	$\times 10^{-5}$	S=1.2
$\Gamma_{43}$	hadrons	$(94 \pm 11)$	%	
$\Gamma_{44}$	$ggg$	$(58.8 \pm 1.2)$	%	
$\Gamma_{45}$	$\gamma gg$	$(1.87 \pm 0.28)$	%	
$\Gamma_{46}$	$\phi K^+ K^-$	$(1.6 \pm 0.4)$	$\times 10^{-6}$	
$\Gamma_{47}$	$\omega \pi^+ \pi^-$	$< 2.58$	$\times 10^{-6}$	CL=90%
$\Gamma_{48}$	$K^*(892)^0 K^- \pi^+ + c.c.$	$(2.3 \pm 0.7)$	$\times 10^{-6}$	

$\Gamma_{49}$	$\phi f_2'(1525)$	$< 1.33 \times 10^{-6}$	CL=90%
$\Gamma_{50}$	$\omega f_2(1270)$	$< 5.7 \times 10^{-7}$	CL=90%
$\Gamma_{51}$	$\rho(770) a_2(1320)$	$< 8.8 \times 10^{-7}$	CL=90%
$\Gamma_{52}$	$K^*(892)^0 \bar{K}_2^*(1430)^0 + \text{c.c.}$	$(1.5 \pm 0.6) \times 10^{-6}$	
$\Gamma_{53}$	$K_1(1270)^\pm K^\mp$	$< 3.22 \times 10^{-6}$	CL=90%
$\Gamma_{54}$	$K_1(1400)^\pm K^\mp$	$< 8.3 \times 10^{-7}$	CL=90%
$\Gamma_{55}$	$b_1(1235)^\pm \pi^\mp$	$< 4.0 \times 10^{-7}$	CL=90%
$\Gamma_{56}$	$\rho \pi$	$< 1.16 \times 10^{-6}$	CL=90%
$\Gamma_{57}$	$\pi^+ \pi^- \pi^0$	$< 8.0 \times 10^{-7}$	CL=90%
$\Gamma_{58}$	$\omega \pi^0$	$< 1.63 \times 10^{-6}$	CL=90%
$\Gamma_{59}$	$\pi^+ \pi^- \pi^0 \pi^0$	$(1.30 \pm 0.28) \times 10^{-5}$	
$\Gamma_{60}$	$K_S^0 K^+ \pi^- + \text{c.c.}$	$(1.14 \pm 0.33) \times 10^{-6}$	
$\Gamma_{61}$	$K^*(892)^0 \bar{K}^0 + \text{c.c.}$	$< 4.22 \times 10^{-6}$	CL=90%
$\Gamma_{62}$	$K^*(892)^- K^+ + \text{c.c.}$	$< 1.45 \times 10^{-6}$	CL=90%
$\Gamma_{63}$	$f_1(1285) \text{ anything}$	$(2.2 \pm 1.6) \times 10^{-3}$	
$\Gamma_{64}$	$f_1(1285) X_{tetra}$	$< 6.47 \times 10^{-5}$	CL=90%
$\Gamma_{65}$	$D_s^+ D_{s1}(2536)^-$		
$\Gamma_{66}$	$D_s^+ D_{s1}(2536)^-, D_{s1}^- \rightarrow K^- D^*(2007)^0$	$(1.6 \pm 0.4) \times 10^{-5}$	
$\Gamma_{67}$	$D_s^+ D_{s1}(2536)^-, D_{s1}^- \rightarrow K_S^0 D^*(2010)^-$	$(8.4 \pm 2.3) \times 10^{-6}$	
$\Gamma_{68}$	$D_s^{*+} D_{s1}(2536)^-$		
$\Gamma_{69}$	$D_s^{*+} D_{s1}(2536)^-, D_{s1}^- \rightarrow K^- D^*(2007)^0$	$(1.4 \pm 0.4) \times 10^{-5}$	
$\Gamma_{70}$	$D_s^{*+} D_{s1}(2536)^-, D_{s1}^- \rightarrow K_S^0 D^*(2010)^-$	$(8.2 \pm 3.1) \times 10^{-6}$	
$\Gamma_{71}$	$D_s^+ D_{s2}^*(2573)^-$		
$\Gamma_{72}$	$D_s^+ D_{s2}^*(2573)^-, D_{s2}^{*-} \rightarrow K^- D^0$	$(1.4 \pm 0.4) \times 10^{-5}$	
$\Gamma_{73}$	$D_s^+ D_{s2}^*(2573)^-, D_{s2}^{*-} \rightarrow K_S^0 D^-$	$(6.9 \pm 3.0) \times 10^{-6}$	
$\Gamma_{74}$	$D_s^{*+} D_{s2}^*(2573)^-$		
$\Gamma_{75}$	$D_s^{*+} D_{s2}^*(2573)^-, D_{s2}^{*-} \rightarrow K^- D^0$	$(9 \pm 5) \times 10^{-6}$	
$\Gamma_{76}$	$D_s^{*+} D_{s2}^*(2573)^-, D_{s2}^{*-} \rightarrow K_S^0 D^-$	$(5 \pm 6) \times 10^{-6}$	
$\Gamma_{77}$	Sum of 100 exclusive modes	$(2.90 \pm 0.30) \times 10^{-3}$	

### Radiative decays

$\Gamma_{78}$	$\gamma \chi_{b1}(1P)$	$(6.9 \pm 0.4) \%$
$\Gamma_{79}$	$\gamma \chi_{b2}(1P)$	$(7.15 \pm 0.35) \%$
$\Gamma_{80}$	$\gamma \chi_{b0}(1P)$	$(3.8 \pm 0.4) \%$

$\Gamma_{81}$	$\gamma f_0(1710)$	$< 5.9$	$\times 10^{-4}$	CL=90%
$\Gamma_{82}$	$\gamma f_2'(1525)$	$< 5.3$	$\times 10^{-4}$	CL=90%
$\Gamma_{83}$	$\gamma f_2(1270)$	$< 2.41$	$\times 10^{-4}$	CL=90%
$\Gamma_{84}$	$\gamma f_J(2220)$			
$\Gamma_{85}$	$\gamma \eta_c(1S)$	$< 2.7$	$\times 10^{-5}$	CL=90%
$\Gamma_{86}$	$\gamma \chi_{c0}$	$< 1.0$	$\times 10^{-4}$	CL=90%
$\Gamma_{87}$	$\gamma \chi_{c1}$	$< 3.6$	$\times 10^{-6}$	CL=90%
$\Gamma_{88}$	$\gamma \chi_{c2}$	$< 1.5$	$\times 10^{-5}$	CL=90%
$\Gamma_{89}$	$\gamma \chi_{c1}(3872)$	$< 1.8$	$\times 10^{-5}$	CL=90%
$\Gamma_{90}$	$\gamma \chi_{c1}(3872), \chi_{c1} \rightarrow \pi^+ \pi^- \pi^0 J/\psi$	$< 2.4$	$\times 10^{-6}$	CL=90%
$\Gamma_{91}$	$\gamma \chi_{c0}(3915) \rightarrow \omega J/\psi$	$< 2.8$	$\times 10^{-6}$	CL=90%
$\Gamma_{92}$	$\gamma \chi_{c1}(4140) \rightarrow \phi J/\psi$	$< 1.2$	$\times 10^{-6}$	CL=90%
$\Gamma_{93}$	$\gamma X(4350) \rightarrow \phi J/\psi$	$< 1.3$	$\times 10^{-6}$	CL=90%
$\Gamma_{94}$	$\gamma \eta_b(1S)$	$(5.5 \pm_{-0.9}^{+1.1}) \times 10^{-4}$		S=1.2
$\Gamma_{95}$	$\gamma \eta_b(1S) \rightarrow \gamma$ Sum of 26 exclusive modes	$< 3.7$	$\times 10^{-6}$	CL=90%
$\Gamma_{96}$	$\gamma X_{b\bar{b}} \rightarrow \gamma$ Sum of 26 exclusive modes	$< 4.9$	$\times 10^{-6}$	CL=90%
$\Gamma_{97}$	$\gamma X \rightarrow \gamma + \geq 4$ prongs	[a] $< 1.95$	$\times 10^{-4}$	CL=95%
$\Gamma_{98}$	$\gamma A^0 \rightarrow \gamma$ hadrons	$< 8$	$\times 10^{-5}$	CL=90%
$\Gamma_{99}$	$\gamma A^0 \rightarrow \gamma \mu^+ \mu^-$	$< 8.3$	$\times 10^{-6}$	CL=90%

### Lepton Family number (LF) violating modes

$\Gamma_{100}$	$e^\pm \tau^\mp$	LF	$< 1.12$	$\times 10^{-6}$	CL=90%
$\Gamma_{101}$	$\mu^\pm \tau^\mp$	LF	$< 2.3$	$\times 10^{-7}$	CL=90%

[a]  $1.5 \text{ GeV} < m_X < 5.0 \text{ GeV}$

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## FIT INFORMATION

An overall fit to 3 branching ratios uses 13 measurements to determine 2 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  $\langle \delta x_i \delta x_j \rangle / (\delta x_i \delta x_j)$ , in percent, from the fit to the branching fractions,  $x_i \equiv \Gamma_i / \Gamma_{\text{total}}$ .

$$x_7 \begin{vmatrix} & & 2 \\ & & \\ & & \end{vmatrix} x_1$$


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

$\Gamma(\mu^+\mu^-) \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$					$\Gamma_4\Gamma_5/\Gamma$
<u>VALUE (eV)</u>		<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>6.5±1.5±1.0</b>		KOBEL	92	CBAL	$e^+e^- \rightarrow \mu^+\mu^-$

$\Gamma(\Upsilon(1S)\pi^+\pi^-) \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$					$\Gamma_1\Gamma_5/\Gamma$
<u>VALUE (eV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>105.4±1.0±4.2</b>	11.8k	<sup>1</sup> AUBERT	08BP	BABR	$10.58 e^+e^- \rightarrow \gamma\pi^+\pi^-\ell^+\ell^-$
<sup>1</sup> Using $B(\Upsilon(1S) \rightarrow e^+e^-) = (2.38 \pm 0.11)\%$ and $B(\Upsilon(1S) \rightarrow \mu^+\mu^-) = (2.48 \pm 0.05)\%$ .					

$\Gamma(\text{hadrons}) \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$					$\Gamma_{43}\Gamma_5/\Gamma$
<u>VALUE (keV)</u>		<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>0.577±0.009 OUR AVERAGE</b>					
0.581±0.004±0.009		<sup>1</sup> ROSNER	06	CLEO	$10.0 e^+e^- \rightarrow \text{hadrons}$
0.552±0.031±0.017		<sup>1</sup> BARU	96	MD1	$e^+e^- \rightarrow \text{hadrons}$
0.54 ±0.04 ±0.02		<sup>1</sup> JAKUBOWSKI	88	CBAL	$e^+e^- \rightarrow \text{hadrons}$
0.58 ±0.03 ±0.04		<sup>2</sup> GILES	84B	CLEO	$e^+e^- \rightarrow \text{hadrons}$
0.60 ±0.12 ±0.07		<sup>2</sup> ALBRECHT	82	DASP	$e^+e^- \rightarrow \text{hadrons}$
0.54 ±0.07 <sup>+0.09</sup> <sub>-0.05</sub>		<sup>2</sup> NICZYPORUK	81C	LENA	$e^+e^- \rightarrow \text{hadrons}$
0.41 ±0.18		<sup>2</sup> BOCK	80	CNTR	$e^+e^- \rightarrow \text{hadrons}$

<sup>1</sup>Radiative corrections evaluated following KURAEV 85.<sup>2</sup>Radiative corrections reevaluated by BUCHMUELLER 88 following KURAEV 85. $\Upsilon(2S)$  PARTIAL WIDTHS

$\Gamma(e^+e^-)$		$\Gamma_5$
<u>VALUE (keV)</u>	<u>DOCUMENT ID</u>	
<b>0.612±0.011 OUR EVALUATION</b>		

 $\Upsilon(2S)$  BRANCHING RATIOS

$\Gamma(\Upsilon(1S)\pi^+\pi^-)/\Gamma_{\text{total}}$					$\Gamma_1/\Gamma$
Abbreviation MM in the COMMENT field below stands for missing mass.					
<u>VALUE (units 10<sup>-2</sup>)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>17.85±0.26 OUR FIT</b>					
<b>17.92±0.26 OUR AVERAGE</b>					
16.8 ±1.1 ±1.3	906k	<sup>1</sup> LEES	11C	BABR	$e^+e^- \rightarrow \pi^+\pi^-X$
17.80±0.05±0.37	170k	<sup>2</sup> LEES	11L	BABR	$\Upsilon(2S) \rightarrow \pi^+\pi^-\mu^+\mu^-$
18.02±0.02±0.61	851k	<sup>3</sup> BHARI	09	CLEO	$e^+e^- \rightarrow \pi^+\pi^- \text{MM}$
17.22±0.17±0.75	11.8k	<sup>4</sup> AUBERT	08BP	BABR	$e^+e^- \rightarrow \gamma\pi^+\pi^-\ell^+\ell^-$
19.2 ±0.2 ±1.0	52.6k	<sup>5</sup> ALEXANDER	98	CLE2	$\pi^+\pi^-\ell^+\ell^-, \pi^+\pi^- \text{MM}$
18.1 ±0.5 ±1.0	11.6k	ALBRECHT	87	ARG	$e^+e^- \rightarrow \pi^+\pi^- \text{MM}$
16.9 ±4.0		GELPHMAN	85	CBAL	$e^+e^- \rightarrow e^+e^-\pi^+\pi^-$
19.1 ±1.2 ±0.6		BESSON	84	CLEO	$\pi^+\pi^- \text{MM}$
18.9 ±2.6		FONSECA	84	CUSB	$e^+e^- \rightarrow \ell^+\ell^-\pi^+\pi^-$
21 ±7	7	NICZYPORUK	81B	LENA	$e^+e^- \rightarrow \ell^+\ell^-\pi^+\pi^-$

<sup>1</sup> 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 (shown rounded) 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 (shown rounded) value.

<sup>2</sup> Using  $B(\Upsilon(1S) \rightarrow \mu^+\mu^-) = (2.48 \pm 0.05)\%$ .

<sup>3</sup> A weighted average of the inclusive and exclusive results.

<sup>4</sup> 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.

<sup>5</sup> Using  $B(\Upsilon(1S) \rightarrow e^+e^-) = (2.52 \pm 0.17)\%$  and  $B(\Upsilon(1S) \rightarrow \mu^+\mu^-) = (2.48 \pm 0.07)\%$ .

### $\Gamma(\Upsilon(1S)\pi^0\pi^0)/\Gamma_{\text{total}}$ $\Gamma_2/\Gamma$

<u>VALUE (units <math>10^{-2}</math>)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>8.6 ± 0.4 OUR AVERAGE</b>				
8.43 ± 0.16 ± 0.42	38k	<sup>1</sup> BHARI 09	CLEO	$e^+e^- \rightarrow \pi^0\pi^0\ell^+\ell^-$
9.2 ± 0.6 ± 0.8	275	<sup>2</sup> 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	$e^+e^- \rightarrow \pi^0\pi^0\ell^+\ell^-$

<sup>1</sup> Authors assume  $B(\Upsilon(1S) \rightarrow e^+e^-) + B(\Upsilon(1S) \rightarrow \mu^+\mu^-) = 4.96\%$ .

<sup>2</sup> Using  $B(\Upsilon(1S) \rightarrow e^+e^-) = (2.52 \pm 0.17)\%$  and  $B(\Upsilon(1S) \rightarrow \mu^+\mu^-) = (2.48 \pm 0.07)\%$ .

### $\Gamma(\Upsilon(1S)\pi^0\pi^0)/\Gamma(\Upsilon(1S)\pi^+\pi^-)$ $\Gamma_2/\Gamma_1$

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

<sup>1</sup> Not independent of other values reported by BHARI 09.

### $\Gamma(\tau^+\tau^-)/\Gamma_{\text{total}}$ $\Gamma_3/\Gamma$

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

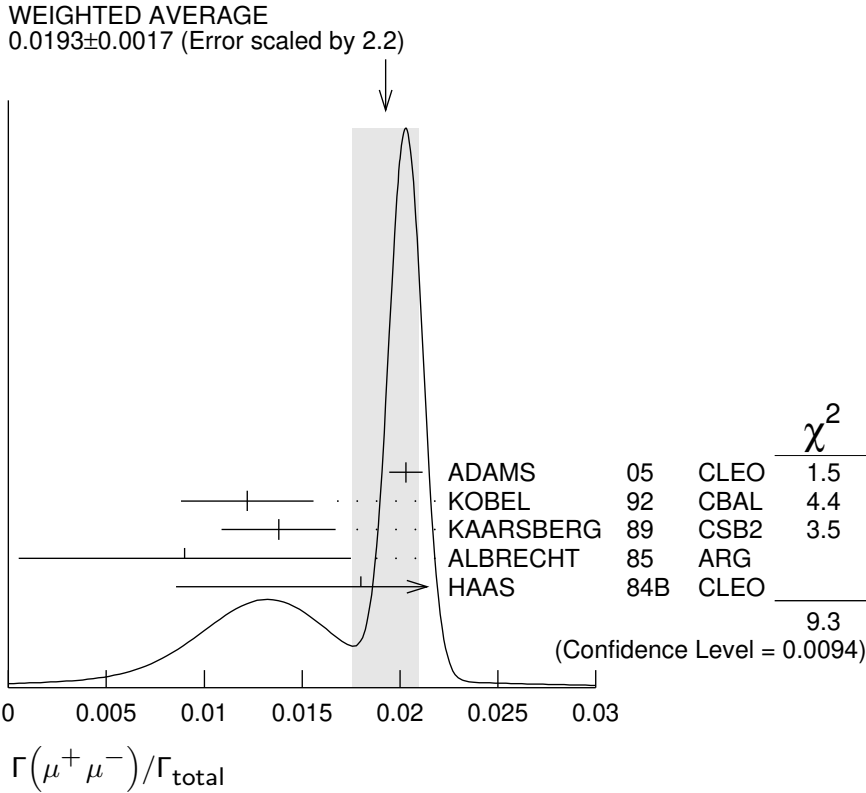
<sup>1</sup> BESSON 07 reports  $[\Gamma(\Upsilon(2S) \rightarrow \tau^+\tau^-)/\Gamma_{\text{total}}] / [B(\Upsilon(2S) \rightarrow \mu^+\mu^-)] = 1.04 \pm 0.04 \pm 0.05$  which we multiply by our best (shown rounded) value  $B(\Upsilon(2S) \rightarrow \mu^+\mu^-) = (1.93 \pm 0.17) \times 10^{-2}$ .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

### $\Gamma(\mu^+\mu^-)/\Gamma_{\text{total}}$ $\Gamma_4/\Gamma$

<u>VALUE</u>	<u>CL%</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.0193 ± 0.0017 OUR AVERAGE</b> 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			<sup>1</sup> 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			<sup>2</sup> 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	$e^+e^- \rightarrow \mu^+\mu^-$

<sup>1</sup> Taking into account interference between the resonance and continuum.

<sup>2</sup> Re-evaluated using  $B(\Upsilon(1S) \rightarrow \mu^+ \mu^-) = 0.026$ .



$\Gamma(\tau^+ \tau^-) / \Gamma(\mu^+ \mu^-)$   $\Gamma_3 / \Gamma_4$

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
<b><math>1.04 \pm 0.04 \pm 0.05</math></b>	22k	BESSION 07	CLEO	$e^+ e^- \rightarrow \Upsilon(2S)$

$\Gamma(\Upsilon(1S)\pi^0) / \Gamma_{\text{total}}$   $\Gamma_6 / \Gamma$

VALUE (units $10^{-5}$ )	CL%	DOCUMENT ID	TECN	COMMENT
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• • • We do not use the following data for averages, fits, limits, etc. • • •

< 4	90	<sup>1</sup> TAMPONI 13	BELL	$e^+ e^- \rightarrow \Upsilon(1S)\pi^0$
< 18	90	<sup>2</sup> HE 08A	CLEO	$e^+ e^- \rightarrow \ell^+ \ell^- \gamma \gamma$
< 110	90	ALEXANDER 98	CLE2	$e^+ e^- \rightarrow \ell^+ \ell^- \gamma \gamma$
< 800	90	LURZ 87	CBAL	$e^+ e^- \rightarrow \ell^+ \ell^- \gamma \gamma$

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

<sup>2</sup> Authors assume  $B(\Upsilon(1S) \rightarrow e^+ e^-) + B(\Upsilon(1S) \rightarrow \mu^+ \mu^-) = 4.96\%$ .

$\Gamma(\Upsilon(1S)\pi^0) / \Gamma(\Upsilon(1S)\pi^+ \pi^-)$   $\Gamma_6 / \Gamma_1$

VALUE (units $10^{-4}$ )	CL%	DOCUMENT ID	TECN	COMMENT
<b>&lt; 2.3</b>	90	TAMPONI 13	BELL	$e^+ e^- \rightarrow \Upsilon(1S)\pi^0$

$\Gamma(\Upsilon(1S)\eta)/\Gamma_{\text{total}}$

$\Gamma_7/\Gamma$

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 ± 0.31 ± 0.14	112	<sup>1</sup> LEES	11L	BABR	$\Upsilon(2S) \rightarrow \ell^+ \ell^- \eta$
2.1 <sup>+0.7</sup> <sub>-0.6</sub> ± 0.3	14	<sup>2</sup> HE	08A	CLEO	$e^+ e^- \rightarrow \ell^+ \ell^- \eta$

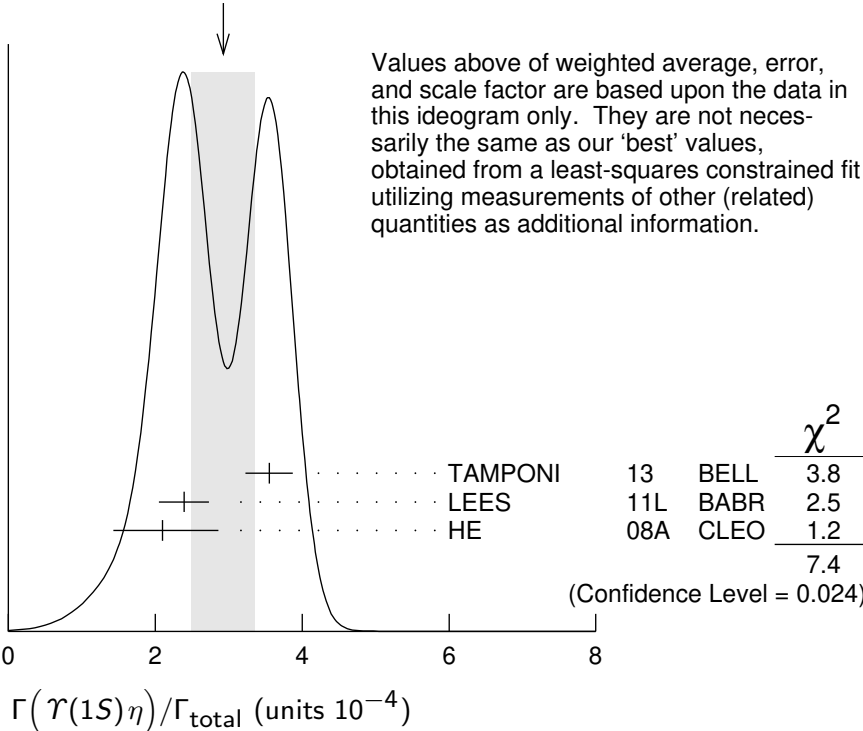
• • • We use the following data for averages but not for fits. • • •  
 3.55 ± 0.32 ± 0.05 241 <sup>3</sup> TAMPONI 13 BELL  $e^+ e^- \rightarrow \Upsilon(1S)\eta$

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

< 9	90	<sup>1,4</sup> AUBERT	08BP	BABR	$e^+ e^- \rightarrow \gamma \pi^+ \pi^- \pi^0 \ell^+ \ell^-$
< 28	90	ALEXANDER98	CLE2		$e^+ e^- \rightarrow \ell^+ \ell^- \eta$
< 50	90	ALBRECHT	87	ARG	$e^+ e^- \rightarrow \pi^+ \pi^- \ell^+ \ell^-$ MM
< 70	90	LURZ	87	CBAL	$e^+ e^- \rightarrow \ell^+ \ell^- (\gamma\gamma, 3\pi^0)$
< 100	90	BESSION	84	CLEO	$e^+ e^- \rightarrow \pi^+ \pi^- \ell^+ \ell^-$ MM
< 20	90	FONSECA	84	CUSB	$e^+ e^- \rightarrow \ell^+ \ell^- (\gamma\gamma, \pi^+ \pi^- \pi^0)$

<sup>1</sup> Using  $B(\Upsilon(1S) \rightarrow e^+ e^-) = (2.38 \pm 0.11)\%$  and  $B(\Upsilon(1S) \rightarrow \mu^+ \mu^-) = (2.48 \pm 0.05)\%$ .  
<sup>2</sup> Authors assume  $B(\Upsilon(1S) \rightarrow e^+ e^-) + B(\Upsilon(1S) \rightarrow \mu^+ \mu^-) = 4.96\%$ .  
<sup>3</sup> TAMPONI 13 reports  $[\Gamma(\Upsilon(2S) \rightarrow \Upsilon(1S)\eta)/\Gamma_{\text{total}}] / [B(\Upsilon(2S) \rightarrow \Upsilon(1S)\pi^+ \pi^-)] = (1.99 \pm 0.14 \pm 0.11) \times 10^{-3}$  which we multiply by our best (shown rounded) value  $B(\Upsilon(2S) \rightarrow \Upsilon(1S)\pi^+ \pi^-) = (17.85 \pm 0.26) \times 10^{-2}$ . Our first error is their experiment's error and our second error is the systematic error from using our best (shown rounded) value.  
<sup>4</sup> Using  $\Gamma_{ee}(\Upsilon(2S)) = 0.612 \pm 0.011$  keV.

WEIGHTED AVERAGE  
 2.9±0.4 (Error scaled by 1.9)



$\Gamma(\Upsilon(1S)\eta)/\Gamma(\Upsilon(1S)\pi^+\pi^-)$   $\Gamma_7/\Gamma_1$

VALUE (units $10^{-3}$ )	CL% EVTS	DOCUMENT ID	TECN	COMMENT
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**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		<sup>1</sup> LEES	11L BABR	$\Upsilon(2S) \rightarrow (\pi^+\pi^-)(\gamma\gamma)\mu^+\mu^-$
< 5.2	90	<sup>2</sup> AUBERT	08BP BABR	$e^+e^- \rightarrow \gamma\pi^+\pi^-(\pi^0)\ell^+\ell^-$

<sup>1</sup> Not independent of other values reported by LEES 11L.

<sup>2</sup> Not independent of other values reported by AUBERT 08BP.

$\Gamma(\Upsilon(1S)\pi^0)/\Gamma(\Upsilon(1S)\eta)$   $\Gamma_6/\Gamma_7$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
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• • • We do not use the following data for averages, fits, limits, etc. • • •

<0.13	90	TAMPONI	13 BELL	$e^+e^- \rightarrow \Upsilon(1S)\pi^0$
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$\Gamma(J/\psi(1S) \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_8/\Gamma$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
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<0.006	90	MASCHMANN	90 CBAL	$e^+e^- \rightarrow \text{hadrons}$
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$\Gamma(J/\psi(1S)\eta_c)/\Gamma_{\text{total}}$   $\Gamma_9/\Gamma$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
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<5.4 × 10 <sup>-6</sup>	90	YANG	14 BELL	$e^+e^- \rightarrow J/\psi X$
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$\Gamma(J/\psi(1S)\chi_{c0})/\Gamma_{\text{total}}$   $\Gamma_{10}/\Gamma$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
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<3.4 × 10 <sup>-6</sup>	90	YANG	14 BELL	$e^+e^- \rightarrow J/\psi X$
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$\Gamma(J/\psi(1S)\chi_{c1})/\Gamma_{\text{total}}$   $\Gamma_{11}/\Gamma$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
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<1.2 × 10 <sup>-6</sup>	90	YANG	14 BELL	$e^+e^- \rightarrow J/\psi X$
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$\Gamma(J/\psi(1S)\chi_{c2})/\Gamma_{\text{total}}$   $\Gamma_{12}/\Gamma$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
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<2.0 × 10 <sup>-6</sup>	90	YANG	14 BELL	$e^+e^- \rightarrow J/\psi X$
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$\Gamma(J/\psi(1S)\eta_c(2S))/\Gamma_{\text{total}}$   $\Gamma_{13}/\Gamma$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
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<2.5 × 10 <sup>-6</sup>	90	YANG	14 BELL	$e^+e^- \rightarrow J/\psi X$
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$\Gamma(J/\psi(1S)X(3940))/\Gamma_{\text{total}}$   $\Gamma_{14}/\Gamma$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
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<2.0 × 10 <sup>-6</sup>	90	YANG	14 BELL	$e^+e^- \rightarrow J/\psi X$
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$\Gamma(J/\psi(1S)X(4160))/\Gamma_{\text{total}}$   $\Gamma_{15}/\Gamma$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
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<2.0 × 10 <sup>-6</sup>	90	YANG	14 BELL	$e^+e^- \rightarrow J/\psi X$
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$\Gamma(\chi_{c1} \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{16}/\Gamma$ 

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

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

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<b><math>&lt; 36.7 \times 10^{-6}</math></b>	90	<sup>1</sup> JIA	17A	BELL $e^+e^- \rightarrow \text{hadrons}$

<sup>1</sup> 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  $4.4 \times 10^{-6}$  to  $36.7 \times 10^{-6}$ .

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

VALUE (units $10^{-4}$ )	DOCUMENT ID	TECN	COMMENT
<b><math>2.28 \pm 0.73 \pm 0.34</math></b>	JIA	17	BELL $\Upsilon(2S) \rightarrow \gamma J/\psi(1S)$

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

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<b><math>&lt; 5.1 \times 10^{-6}</math></b>	90	YANG	14	BELL $e^+e^- \rightarrow \psi(2S)X$

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

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<b><math>&lt; 4.7 \times 10^{-6}</math></b>	90	YANG	14	BELL $e^+e^- \rightarrow \psi(2S)X$

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

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<b><math>&lt; 2.5 \times 10^{-6}</math></b>	90	YANG	14	BELL $e^+e^- \rightarrow \psi(2S)X$

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

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<b><math>&lt; 1.9 \times 10^{-6}</math></b>	90	YANG	14	BELL $e^+e^- \rightarrow \psi(2S)X$

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

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<b><math>&lt; 3.3 \times 10^{-6}</math></b>	90	YANG	14	BELL $e^+e^- \rightarrow \psi(2S)X$

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

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<b><math>&lt; 3.9 \times 10^{-6}</math></b>	90	YANG	14	BELL $e^+e^- \rightarrow \psi(2S)X$

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

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<b><math>&lt; 3.9 \times 10^{-6}</math></b>	90	YANG	14	BELL $e^+e^- \rightarrow \psi(2S)X$

 $\Gamma(T_{c\bar{c}1}(3900)^+ T_{c\bar{c}1}(3900)^-)/\Gamma_{\text{total}}$   $\Gamma_{26}/\Gamma$ 

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<b><math>&lt; 1.0 \times 10^{-6}</math></b>	90	<sup>1</sup> JIA	18	BELL $\Upsilon(2S) \rightarrow J/\psi \pi^\pm X$

<sup>1</sup> Assuming  $B(T_{c\bar{c}1}(3900)^\pm \rightarrow J/\psi \pi^\pm) = 1$ .

$\Gamma(T_{c\bar{c}1}(4200)^+ T_{c\bar{c}1}(4200)^-)/\Gamma_{\text{total}}$   $\Gamma_{27}/\Gamma$ 

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<16.7 \times 10^{-6}$	90	<sup>1</sup> JIA	18	BELL $\Upsilon(1S) \rightarrow J/\psi \pi^\pm X$

<sup>1</sup> Assuming  $B(T_{c\bar{c}1}(4200)^\pm \rightarrow J/\psi \pi^\pm) = 1$

 $\Gamma(T_{c\bar{c}1}(3900)^\pm T_{c\bar{c}1}(4200)^\mp)/\Gamma_{\text{total}}$   $\Gamma_{28}/\Gamma$ 

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<7.3 \times 10^{-6}$	90	<sup>1</sup> JIA	18	BELL $\Upsilon(2S) \rightarrow J/\psi \pi^\pm X$

<sup>1</sup> Assuming  $B(T_{c\bar{c}1}(4200)^\pm \rightarrow J/\psi \pi^\pm) = 1 = B(T_{c\bar{c}1}(3900)^\pm \rightarrow J/\psi \pi^\pm)$ .

 $\Gamma(T_{c\bar{c}}(4050)^+ T_{c\bar{c}}(4050)^-)/\Gamma_{\text{total}}$   $\Gamma_{29}/\Gamma$ 

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<13.5 \times 10^{-6}$	90	<sup>1</sup> JIA	18	BELL $\Upsilon(2S) \rightarrow \chi_{c1}(1P) \pi^\pm X$

<sup>1</sup> Assuming  $B(T_{c\bar{c}}(4050)^\pm \rightarrow \chi_{c1}(1P) \pi^\pm)$

 $\Gamma(T_{c\bar{c}}(4250)^+ T_{c\bar{c}}(4250)^-)/\Gamma_{\text{total}}$   $\Gamma_{30}/\Gamma$ 

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<26.7 \times 10^{-6}$	90	<sup>1</sup> JIA	18	BELL $\Upsilon(2S) \rightarrow \chi_{c1}(1P) \pi^\pm X$

<sup>1</sup> Assuming  $B(T_{c\bar{c}}(4250)^\pm \rightarrow \chi_{c1}(1P) \pi^\pm) = 1$

 $\Gamma(T_{c\bar{c}}(4050)^\pm T_{c\bar{c}}(4250)^\mp)/\Gamma_{\text{total}}$   $\Gamma_{31}/\Gamma$ 

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<27.2 \times 10^{-6}$	90	<sup>1</sup> JIA	18	BELL $\Upsilon(2S) \rightarrow \chi_{c1}(1P) \pi^\pm X$

<sup>1</sup> Assuming  $B(T_{c\bar{c}}(4050)^\pm \rightarrow \chi_{c1}(1P) \pi^\pm) = 1 = B(T_{c\bar{c}}(4250)^\pm \rightarrow \chi_{c1}(1P) \pi^\pm)$

 $\Gamma(T_{c\bar{c}1}(4430)^+ T_{c\bar{c}1}(4430)^-)/\Gamma_{\text{total}}$   $\Gamma_{32}/\Gamma$ 

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

<sup>1</sup> Assuming  $B(T_{c\bar{c}1}(4430)^\pm \rightarrow \psi(2P) \pi^\pm) = 1$

 $\Gamma(T_{c\bar{c}}(4055)^\pm T_{c\bar{c}}(4055)^\mp)/\Gamma_{\text{total}}$   $\Gamma_{33}/\Gamma$ 

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<11.1 \times 10^{-6}$	90	<sup>1</sup> JIA	18	BELL $\Upsilon(2S) \rightarrow \psi(2S) \pi^\pm X$

<sup>1</sup> Assuming  $B(T_{c\bar{c}}(4055)^\pm \rightarrow \psi(2S) \pi^\pm) = 1$

 $\Gamma(T_{c\bar{c}}(4055)^\pm T_{c\bar{c}1}(4430)^\mp)/\Gamma_{\text{total}}$   $\Gamma_{34}/\Gamma$ 

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<21.1 \times 10^{-6}$	90	<sup>1</sup> JIA	18	BELL $\Upsilon(2S) \rightarrow \psi(2S) \pi^\pm X$

<sup>1</sup> Assuming  $B(T_{c\bar{c}}(4055)^\pm \rightarrow \psi(2S) \pi^\pm) = 1 = B(T_{c\bar{c}1}(4430)^\pm \rightarrow \psi(2S) \pi^\pm)$

 $\Gamma(P_{c\bar{c}s}(4459)/\bar{P}_{c\bar{c}s}(4459)\text{anything})/\Gamma_{\text{total}}$   $\Gamma_{35}/\Gamma$ 

VALUE (units $10^{-6}$ )	EVTS	DOCUMENT ID	TECN	COMMENT
$2.9 \pm 1.7 \pm 0.4$	21	<sup>1</sup> ADACHI	25A	BELL $e^+ e^- \rightarrow \Upsilon(2S)$

<sup>1</sup>  $21 \pm 5$  corresponds to the number of  $P_{c\bar{c}s}(4459)$  events in the combined  $\Upsilon(1S)$  and  $\Upsilon(2S)$  samples.

$\Gamma(P_{c\bar{c}s}(4338)/\bar{P}_{c\bar{c}s}(4338)\text{anything})/\Gamma_{\text{total}}$   $\Gamma_{36}/\Gamma$ 

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<1.6 \times 10^{-6}$	90	ADACHI	25A	BELL $e^+e^- \rightarrow \Upsilon(2S)$

 $\Gamma(P_c(4457)\text{anything}, P_c(4457) \rightarrow pJ/\psi(1S))/\Gamma_{\text{total}}$   $\Gamma_{37}/\Gamma$ 

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<4.6 \times 10^{-6}$	90	DONG	25	BELL $e^+e^- \rightarrow \Upsilon(2S)$

 $\Gamma(P_c(4440)\text{anything}, P_c(4440) \rightarrow pJ/\psi(1S))/\Gamma_{\text{total}}$   $\Gamma_{38}/\Gamma$ 

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<11.8 \times 10^{-6}$	90	DONG	25	BELL $e^+e^- \rightarrow \Upsilon(2S)$

 $\Gamma(P_c(4312)\text{anything}, P_c(4312) \rightarrow pJ/\psi(1S))/\Gamma_{\text{total}}$   $\Gamma_{39}/\Gamma$ 

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<7.2 \times 10^{-6}$	90	DONG	25	BELL $e^+e^- \rightarrow \Upsilon(2S)$

 $\Gamma(p/\bar{p}J/\psi(1S)\text{anything})/\Gamma_{\text{total}}$   $\Gamma_{40}/\Gamma$ 

VALUE (units $10^{-5}$ )	EVTS	DOCUMENT ID	TECN	COMMENT
$4.3 \pm 0.5 \pm 0.4$	564	<sup>1</sup> DONG	25	BELL $e^+e^- \rightarrow \Upsilon(2S)$

<sup>1</sup> The contribution from cascade  $\Upsilon(1S)$  decays has been removed.

 $\Gamma(J/\psi(1S)\Lambda/\bar{\Lambda}\text{anything})/\Gamma_{\text{total}}$   $\Gamma_{41}/\Gamma$ 

VALUE (units $10^{-6}$ )	EVTS	DOCUMENT ID	TECN	COMMENT
$22.3 \pm 5.7 \pm 3.1$	140	ADACHI	25A	BELL $e^+e^- \rightarrow \Upsilon(2S)$

 $\Gamma(\bar{2}H\text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{42}/\Gamma$ 

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  $e^+e^- \rightarrow \bar{2}H X$

$3.37 \pm 0.50 \pm 0.25$  58 ASNER 07 CLEO  $e^+e^- \rightarrow \bar{2}H X$

 $\Gamma(ggg)/\Gamma_{\text{total}}$   $\Gamma_{44}/\Gamma$ 

VALUE (units $10^{-2}$ )	EVTS	DOCUMENT ID	TECN	COMMENT
$58.8 \pm 1.2$	6M	<sup>1</sup> BESSION	06A	CLEO $\Upsilon(2S) \rightarrow \text{hadrons}$

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

 $\Gamma(\gamma g g)/\Gamma(g g g)$   $\Gamma_{45}/\Gamma_{44}$ 

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

 $\Gamma(\phi K^+ K^-)/\Gamma_{\text{total}}$   $\Gamma_{46}/\Gamma$ 

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

$\Gamma(\omega\pi^+\pi^-)/\Gamma_{\text{total}}$					$\Gamma_{47}/\Gamma$
<u>VALUE (units <math>10^{-6}</math>)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>&lt;2.58</b>	90	SHEN	12A BELL	$\Upsilon(1S) \rightarrow 2(\pi^+\pi^-)\pi^0$	
$\Gamma(K^*(892)^0 K^- \pi^+ + \text{c.c.})/\Gamma_{\text{total}}$					$\Gamma_{48}/\Gamma$
<u>VALUE (units <math>10^{-6}</math>)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b><math>2.32 \pm 0.40 \pm 0.54</math></b>	135	SHEN	12A BELL	$\Upsilon(1S) \rightarrow K^+ K^- \pi^+ \pi^-$	
$\Gamma(\phi f'_2(1525))/\Gamma_{\text{total}}$					$\Gamma_{49}/\Gamma$
<u>VALUE (units <math>10^{-6}</math>)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>&lt;1.33</b>	90	SHEN	12A BELL	$\Upsilon(1S) \rightarrow 2(K^+ K^-)$	
$\Gamma(\omega f_2(1270))/\Gamma_{\text{total}}$					$\Gamma_{50}/\Gamma$
<u>VALUE (units <math>10^{-6}</math>)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>&lt;0.57</b>	90	SHEN	12A BELL	$\Upsilon(1S) \rightarrow 2(\pi^+\pi^-)\pi^0$	
$\Gamma(\rho(770) a_2(1320))/\Gamma_{\text{total}}$					$\Gamma_{51}/\Gamma$
<u>VALUE (units <math>10^{-6}</math>)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>&lt;0.88</b>	90	SHEN	12A BELL	$\Upsilon(1S) \rightarrow 2(\pi^+\pi^-)\pi^0$	
$\Gamma(K^*(892)^0 \bar{K}_2^*(1430)^0 + \text{c.c.})/\Gamma_{\text{total}}$					$\Gamma_{52}/\Gamma$
<u>VALUE (units <math>10^{-6}</math>)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b><math>1.53 \pm 0.52 \pm 0.19</math></b>	32	SHEN	12A BELL	$\Upsilon(1S) \rightarrow K^+ K^- \pi^+ \pi^-$	
$\Gamma(K_1(1270)^\pm K^\mp)/\Gamma_{\text{total}}$					$\Gamma_{53}/\Gamma$
<u>VALUE (units <math>10^{-6}</math>)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>&lt;3.22</b>	90	SHEN	12A BELL	$\Upsilon(1S) \rightarrow K^+ K^- \pi^+ \pi^-$	
$\Gamma(K_1(1400)^\pm K^\mp)/\Gamma_{\text{total}}$					$\Gamma_{54}/\Gamma$
<u>VALUE (units <math>10^{-6}</math>)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>&lt;0.83</b>	90	SHEN	12A BELL	$\Upsilon(1S) \rightarrow K^+ K^- \pi^+ \pi^-$	
$\Gamma(b_1(1235)^\pm \pi^\mp)/\Gamma_{\text{total}}$					$\Gamma_{55}/\Gamma$
<u>VALUE (units <math>10^{-6}</math>)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>&lt;0.40</b>	90	SHEN	12A BELL	$\Upsilon(1S) \rightarrow 2(\pi^+\pi^-)\pi^0$	
$\Gamma(\rho\pi)/\Gamma_{\text{total}}$					$\Gamma_{56}/\Gamma$
<u>VALUE (units <math>10^{-6}</math>)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>&lt;1.16</b>	90	SHEN	13 BELL	$\Upsilon(2S) \rightarrow \pi^+ \pi^- \pi^0$	
$\Gamma(\pi^+ \pi^- \pi^0)/\Gamma_{\text{total}}$					$\Gamma_{57}/\Gamma$
<u>VALUE (units <math>10^{-6}</math>)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>&lt;0.80</b>	90	SHEN	13 BELL	$\Upsilon(2S) \rightarrow \pi^+ \pi^- \pi^0$	
$\Gamma(\omega\pi^0)/\Gamma_{\text{total}}$					$\Gamma_{58}/\Gamma$
<u>VALUE (units <math>10^{-6}</math>)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>&lt;1.63</b>	90	SHEN	13 BELL	$\Upsilon(2S) \rightarrow \pi^+ \pi^- \pi^0 \pi^0$	

$$\Gamma(\pi^+\pi^-\pi^0\pi^0)/\Gamma_{\text{total}} \quad \Gamma_{59}/\Gamma$$

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

$$\Gamma(K_S^0 K^+ \pi^- + \text{c.c.})/\Gamma_{\text{total}} \quad \Gamma_{60}/\Gamma$$

VALUE (units $10^{-6}$ )	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
<b>1.14±0.30±0.13</b>		40 ± 10	SHEN	13	BELL $\Upsilon(2S) \rightarrow K_S^0 K^- \pi^+$

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

<3.2	90	<sup>1</sup> DOBBS	12A	$\Upsilon(2S) \rightarrow K_S^0 K^- \pi^+$
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<sup>1</sup> Obtained by analyzing CLEO III data but not authored by the CLEO Collaboration.

$$\Gamma(K^*(892)^0 \bar{K}^0 + \text{c.c.})/\Gamma_{\text{total}} \quad \Gamma_{61}/\Gamma$$

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

$$\Gamma(K^*(892)^- K^+ + \text{c.c.})/\Gamma_{\text{total}} \quad \Gamma_{62}/\Gamma$$

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

$$\Gamma(f_1(1285) \text{ anything})/\Gamma_{\text{total}} \quad \Gamma_{63}/\Gamma$$

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

$$\Gamma(f_1(1285) X_{\text{tetra}})/\Gamma_{\text{total}} \quad \Gamma_{64}/\Gamma$$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<b>&lt;64.7 × 10<sup>-6</sup></b>	90	<sup>1</sup> JIA	17A	BELL $e^+e^- \rightarrow \text{hadrons}$

<sup>1</sup> For a tetraquark state  $X_{\text{tetra}}$ , 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  $X_{\text{tetra}}$  mass and width range from  $7.8 \times 10^{-6}$  to  $64.7 \times 10^{-6}$ .

$$\Gamma(D_s^+ D_{s1}(2536)^-, D_{s1}^- \rightarrow K^- D^*(2007)^0)/\Gamma_{\text{total}} \quad \Gamma_{66}/\Gamma$$

VALUE (units $10^{-5}$ )	DOCUMENT ID	TECN	COMMENT
<b>1.6±0.3±0.2</b>	GAO	23	BELL $e^+e^-$ at 10.52 GeV

$$\Gamma(D_s^+ D_{s1}(2536)^-, D_{s1}^- \rightarrow K_S^0 D^*(2010)^-)/\Gamma_{\text{total}} \quad \Gamma_{67}/\Gamma$$

VALUE (units $10^{-5}$ )	DOCUMENT ID	TECN	COMMENT
<b>0.84±0.18±0.15</b>	GAO	23	BELL $e^+e^-$ at 10.52 GeV

$$\Gamma(D_s^{*+} D_{s1}(2536)^-, D_{s1}^- \rightarrow K^- D^*(2007)^0)/\Gamma_{\text{total}} \quad \Gamma_{69}/\Gamma$$

VALUE (units $10^{-5}$ )	DOCUMENT ID	TECN	COMMENT
<b>1.4±0.4±0.2</b>	GAO	23	BELL $e^+e^-$ at 10.52 GeV

$$\Gamma(D_s^{*+} D_{s1}(2536)^-, D_{s1}^- \rightarrow K_S^0 D^*(2010)^-)/\Gamma_{\text{total}} \quad \Gamma_{70}/\Gamma$$

VALUE (units $10^{-5}$ )	DOCUMENT ID	TECN	COMMENT
<b>0.82±0.25±0.19</b>	GAO	23	BELL $e^+e^-$ at 10.52 GeV

$\Gamma(D_s^+ D_{s2}^*(2573)^-, D_{s2}^{*-} \rightarrow K^- D^0)/\Gamma_{\text{total}}$   $\Gamma_{72}/\Gamma$

<u>VALUE (units 10<sup>-5</sup>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>1.4±0.4±0.2</b>	GAO	23	BELL e <sup>+</sup> e <sup>-</sup> at 10.52 GeV

$\Gamma(D_s^+ D_{s2}^*(2573)^-, D_{s2}^{*-} \rightarrow K_S^0 D^-)/\Gamma_{\text{total}}$   $\Gamma_{73}/\Gamma$

<u>VALUE (units 10<sup>-5</sup>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.69±0.20±0.22</b>	GAO	23	BELL e <sup>+</sup> e <sup>-</sup> at 10.52 GeV

$\Gamma(D_s^{*+} D_{s2}^*(2573)^-, D_{s2}^{*-} \rightarrow K^- D^0)/\Gamma_{\text{total}}$   $\Gamma_{75}/\Gamma$

<u>VALUE (units 10<sup>-5</sup>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.9±0.5±0.2</b>	GAO	23	BELL e <sup>+</sup> e <sup>-</sup> at 10.52 GeV

$\Gamma(D_s^{*+} D_{s2}^*(2573)^-, D_{s2}^{*-} \rightarrow K_S^0 D^-)/\Gamma_{\text{total}}$   $\Gamma_{76}/\Gamma$

<u>VALUE (units 10<sup>-5</sup>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.54±0.31±0.47</b>	GAO	23	BELL e <sup>+</sup> e <sup>-</sup> at 10.52 GeV

$\Gamma(\text{Sum of 100 exclusive modes})/\Gamma_{\text{total}}$   $\Gamma_{77}/\Gamma$

<u>VALUE (units 10<sup>-2</sup>)</u>	<u>DOCUMENT ID</u>	<u>COMMENT</u>
<b>0.29±0.03</b>	<sup>1,2</sup> DOBBS 12A	$\Upsilon(2S) \rightarrow \text{hadrons}$

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

<sup>2</sup> Obtained by analyzing CLEO III data but not authored by the CLEO Collaboration.

$\Gamma(\gamma\chi_{b1}(1P))/\Gamma_{\text{total}}$   $\Gamma_{78}/\Gamma$

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

$\Gamma(\gamma\chi_{b2}(1P))/\Gamma_{\text{total}}$   $\Gamma_{79}/\Gamma$

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

$\Gamma(\gamma\chi_{b0}(1P))/\Gamma_{\text{total}}$   $\Gamma_{80}/\Gamma$

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.038 ±0.004 OUR AVERAGE</b>				
0.0375±0.0012±0.0047	198k	ARTUSO	05	CLEO e <sup>+</sup> e <sup>-</sup> → $\gamma X$
0.034 ±0.005 ±0.006		EDWARDS	99	CLE2 $\Upsilon(2S) \rightarrow \gamma\chi(1P)$

0.064 ±0.014 ±0.016	ALBRECHT	85E	ARG	$e^+e^- \rightarrow \gamma \text{conv. } X$
0.036 ±0.008 ±0.009	NERNST	85	CBAL	$e^+e^- \rightarrow \gamma X$
0.044 ±0.023 ±0.009	HAAS	84	CLEO	$e^+e^- \rightarrow \gamma \text{conv. } X$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.035 ±0.014	KLOPFEN...	83	CUSB	$e^+e^- \rightarrow \gamma X$

### $\Gamma(\gamma f_0(1710))/\Gamma_{\text{total}}$ $\Gamma_{81}/\Gamma$

<u>VALUE (units <math>10^{-5}</math>)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>&lt;59</b>	90	<sup>1</sup> ALBRECHT 89	ARG	$\Upsilon(2S) \rightarrow \gamma K^+ K^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
< 5.9	90	<sup>2</sup> ALBRECHT 89	ARG	$\Upsilon(2S) \rightarrow \gamma \pi^+ \pi^-$

<sup>1</sup> Re-evaluated assuming  $B(f_0(1710) \rightarrow K^+ K^-) = 0.19$ .

<sup>2</sup> Includes unknown branching ratio of  $f_0(1710) \rightarrow \pi^+ \pi^-$ .

### $\Gamma(\gamma f'_2(1525))/\Gamma_{\text{total}}$ $\Gamma_{82}/\Gamma$

<u>VALUE (units <math>10^{-5}</math>)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>&lt;53</b>	90	<sup>1</sup> ALBRECHT 89	ARG	$\Upsilon(2S) \rightarrow \gamma K^+ K^-$

<sup>1</sup> Re-evaluated assuming  $B(f'_2(1525) \rightarrow K \bar{K}) = 0.71$ .

### $\Gamma(\gamma f_2(1270))/\Gamma_{\text{total}}$ $\Gamma_{83}/\Gamma$

<u>VALUE (units <math>10^{-5}</math>)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>&lt;24.1</b>	90	<sup>1</sup> ALBRECHT 89	ARG	$\Upsilon(2S) \rightarrow \gamma \pi^+ \pi^-$

<sup>1</sup> Using  $B(f_2(1270) \rightarrow \pi \pi) = 0.84$ .

### $\Gamma(\gamma f_J(2220))/\Gamma_{\text{total}}$ $\Gamma_{84}/\Gamma$

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

<sup>1</sup> Includes unknown branching ratio of  $f_J(2220) \rightarrow K^+ K^-$ .

### $\Gamma(\gamma \eta_c(1S))/\Gamma_{\text{total}}$ $\Gamma_{85}/\Gamma$

<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>&lt;2.7 × 10<sup>-5</sup></b>	90	WANG 11B	BELL	$\Upsilon(2S) \rightarrow \gamma X$

### $\Gamma(\gamma \chi_{c0})/\Gamma_{\text{total}}$ $\Gamma_{86}/\Gamma$

<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>&lt;1.0 × 10<sup>-4</sup></b>	90	WANG 11B	BELL	$\Upsilon(2S) \rightarrow \gamma X$

### $\Gamma(\gamma \chi_{c1})/\Gamma_{\text{total}}$ $\Gamma_{87}/\Gamma$

<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>&lt;3.6 × 10<sup>-6</sup></b>	90	WANG 11B	BELL	$\Upsilon(2S) \rightarrow \gamma X$

### $\Gamma(\gamma \chi_{c2})/\Gamma_{\text{total}}$ $\Gamma_{88}/\Gamma$

<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>&lt;1.5 × 10<sup>-5</sup></b>	90	WANG 11B	BELL	$\Upsilon(2S) \rightarrow \gamma X$

$\Gamma(\gamma\chi_{c1}(3872))/\Gamma_{\text{total}}$   $\Gamma_{89}/\Gamma$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
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$<1.8 \times 10^{-5}$	90	<sup>1</sup> WANG	11B BELL	$\Upsilon(2S) \rightarrow \gamma X$
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<sup>1</sup> WANG 11B reports  $[\Gamma(\Upsilon(2S) \rightarrow \gamma\chi_{c1}(3872))/\Gamma_{\text{total}}] \times [B(\chi_{c1}(3872) \rightarrow \pi^+\pi^- J/\psi(1S))] < 0.8 \times 10^{-6}$  which we divide by our best (shown rounded) value  $B(\chi_{c1}(3872) \rightarrow \pi^+\pi^- J/\psi(1S)) = 4.3 \times 10^{-2}$ .

$\Gamma(\gamma\chi_{c1}(3872), \chi_{c1} \rightarrow \pi^+\pi^-\pi^0 J/\psi)/\Gamma_{\text{total}}$   $\Gamma_{90}/\Gamma$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
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$<2.4 \times 10^{-6}$	90	WANG	11B BELL	$\Upsilon(2S) \rightarrow \gamma X$
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$\Gamma(\gamma\chi_{c0}(3915) \rightarrow \omega J/\psi)/\Gamma_{\text{total}}$   $\Gamma_{91}/\Gamma$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
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$<2.8 \times 10^{-6}$	90	WANG	11B BELL	$\Upsilon(2S) \rightarrow \gamma X$
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$\Gamma(\gamma\chi_{c1}(4140) \rightarrow \phi J/\psi)/\Gamma_{\text{total}}$   $\Gamma_{92}/\Gamma$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
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$<1.2 \times 10^{-6}$	90	WANG	11B BELL	$\Upsilon(2S) \rightarrow \gamma X$
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$\Gamma(\gamma X(4350) \rightarrow \phi J/\psi)/\Gamma_{\text{total}}$   $\Gamma_{93}/\Gamma$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
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$<1.3 \times 10^{-6}$	90	WANG	11B BELL	$\Upsilon(2S) \rightarrow \gamma X$
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$\Gamma(\gamma\eta_b(1S))/\Gamma_{\text{total}}$   $\Gamma_{94}/\Gamma$

VALUE (units $10^{-4}$ )	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
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$5.5^{+1.1}_{-0.9}$  OUR AVERAGE Error includes scale factor of 1.2.

$6.1^{+0.6+0.9}_{-0.7-0.6}$		29k	FULSOM	18 BELL	$\Upsilon(2S) \rightarrow \gamma X$
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$3.9 \pm 1.1^{+1.1}_{-0.9}$		$13 \pm 5k$	<sup>1</sup> AUBERT	09AQ BABR	$\Upsilon(2S) \rightarrow \gamma X$
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• • • We do not use the following data for averages, fits, limits, etc. • • •

$<21$	90	LEES	11J BABR	$\Upsilon(2S) \rightarrow X\gamma$
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$< 8.4$	90	<sup>1</sup> BONVICINI	10 CLEO	$\Upsilon(2S) \rightarrow \gamma X$
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$< 5.1$	90	<sup>2</sup> ARTUSO	05 CLEO	$e^+e^- \rightarrow \gamma X$
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<sup>1</sup> Assuming  $\Gamma_{\eta_b(1S)} = 10$  MeV.

<sup>2</sup> Superseded by BONVICINI 10.

$\Gamma(\gamma\eta_b(1S) \rightarrow \gamma \text{Sum of 26 exclusive modes})/\Gamma_{\text{total}}$   $\Gamma_{95}/\Gamma$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
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$<3.7 \times 10^{-6}$	90	SANDILYA	13 BELL	$\Upsilon(2S) \rightarrow \gamma$ hadrons
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$\Gamma(\gamma X_{b\bar{b}} \rightarrow \gamma \text{Sum of 26 exclusive modes})/\Gamma_{\text{total}}$   $\Gamma_{96}/\Gamma$

VALUE (units $10^{-6}$ )	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
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$< 4.9$	90		SANDILYA	13 BELL	$\Upsilon(2S) \rightarrow \gamma$ hadrons
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• • • We do not use the following data for averages, fits, limits, etc. • • •

$46.2^{+29.7}_{-14.2} \pm 10.6$		10	<sup>1</sup> DOBBS	12	$\Upsilon(2S) \rightarrow \gamma$ hadrons
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<sup>1</sup> Obtained by analyzing CLEO III data but not authored by the CLEO Collaboration.

$\Gamma(\gamma X \rightarrow \gamma + \geq 4 \text{ prongs})/\Gamma_{\text{total}}$   $\Gamma_{97}/\Gamma$   
 (1.5 GeV <  $m_X$  < 5.0 GeV)

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

$\Gamma(\gamma A^0 \rightarrow \gamma \text{ hadrons})/\Gamma_{\text{total}}$   $\Gamma_{98}/\Gamma$   
 (0.3 GeV <  $m_{A^0}$  < 7 GeV)

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<8 × 10 <sup>-5</sup>	90	<sup>1</sup> LEES	11H	BABR $\Upsilon(2S) \rightarrow \gamma \text{ hadrons}$

<sup>1</sup> 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  $1 \times 10^{-6}$  to  $8 \times 10^{-5}$ .

$\Gamma(\gamma A^0 \rightarrow \gamma \mu^+ \mu^-)/\Gamma_{\text{total}}$   $\Gamma_{99}/\Gamma$

VALUE (units $10^{-6}$ )	CL%	DOCUMENT ID	TECN	COMMENT
<8.3	90	<sup>1</sup> AUBERT	09Z	BABR $e^+e^- \rightarrow A^0 \rightarrow \gamma \mu^+ \mu^-$

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

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

$\Gamma(e^\pm \tau^\mp)/\Gamma_{\text{total}}$   $\Gamma_{100}/\Gamma$

VALUE (units $10^{-6}$ )	CL%	DOCUMENT ID	TECN	COMMENT
<1.12	90	DHAMIJA	24	BELL $e^+e^- \rightarrow e^\pm \tau^\mp$

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

<3.2	90	LEES	10B	BABR $e^+e^- \rightarrow e^\pm \tau^\mp$
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$\Gamma(\mu^\pm \tau^\mp)/\Gamma_{\text{total}}$   $\Gamma_{101}/\Gamma$

VALUE (units $10^{-6}$ )	CL%	DOCUMENT ID	TECN	COMMENT
< 0.23	90	DHAMIJA	24	BELL $e^+e^- \rightarrow \mu^\pm \tau^\mp$

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

< 3.3	90	LEES	10B	BABR $e^+e^- \rightarrow \mu^\pm \tau^\mp$
<14.4	95	LOVE	08A	CLEO $e^+e^- \rightarrow \mu^\pm \tau^\mp$

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

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

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

**$\Upsilon(2S)$  REFERENCES**

ADACHI	25A	PRL 135 041901	I. Adachi <i>et al.</i>	(BELLE and BELLE II Collab.)
DONG	25	JHEP 2509 048	X. Dong <i>et al.</i>	(BELLE Collab.)
AAIJ	24AC	JHEP 2410 122	R. Aaij <i>et al.</i>	(LHCb Collab.)
DHAMIJA	24	JHEP 2402 187	R. Dhamija <i>et al.</i>	(BELLE Collab.)
GAO	23	PR D108 112015	B.S. Gao <i>et al.</i>	(BELLE Collab.)
SHAMOV	23	PL B839 137766	A.G. Shamov, O.L. Rezanova	(NOVO, NOVOU)
FULSOM	18	PRL 121 232001	B.G. Fulsom <i>et al.</i>	(BELLE Collab.)
JIA	18	PR D97 112004	S. Jia <i>et al.</i>	(BELLE Collab.)
JIA	17	PR D95 012001	S. Jia <i>et al.</i>	(BELLE Collab.)
JIA	17A	PR D96 112002	S. Jia <i>et al.</i>	(BELLE Collab.)
LEES	14G	PR D89 111102	J.P. Lees <i>et al.</i>	(BABAR Collab.)
YANG	14	PR D90 112008	S.D. Yang <i>et al.</i>	(BELLE Collab.)
SANDILYA	13	PRL 111 112001	S. Sandilya <i>et al.</i>	(BELLE Collab.)
SHEN	13	PR D88 011102	C.P. Shen <i>et al.</i>	(BELLE Collab.)
TAMPONI	13	PR D87 011104	U. Tamponi <i>et al.</i>	(BELLE Collab.)
DOBBS	12	PRL 109 082001	S. Dobbs <i>et al.</i>	
DOBBS	12A	PR D86 052003	S. Dobbs <i>et al.</i>	
SHEN	12A	PR D86 031102	C.P. Shen <i>et al.</i>	(BELLE Collab.)
LEES	11C	PR D84 011104	J.P. Lees <i>et al.</i>	(BABAR Collab.)
LEES	11H	PRL 107 221803	J.P. Lees <i>et al.</i>	(BABAR Collab.)
LEES	11J	PR D84 072002	J.P. Lees <i>et al.</i>	(BABAR Collab.)
LEES	11L	PR D84 092003	J.P. Lees <i>et al.</i>	(BABAR Collab.)
WANG	11B	PR D84 071107	X.L. Wang <i>et al.</i>	(BELLE Collab.)
BONVICINI	10	PR D81 031104	G. Bonvicini <i>et al.</i>	(CLEO Collab.)
LEES	10B	PRL 104 151802	J.P. Lees <i>et al.</i>	(BABAR Collab.)
AUBERT	09AQ	PRL 103 161801	B. Aubert <i>et al.</i>	(BABAR Collab.)
AUBERT	09Z	PRL 103 081803	B. Aubert <i>et al.</i>	(BABAR Collab.)
BHARI	09	PR D79 011103	S.R. Bhari <i>et al.</i>	(CLEO Collab.)
AUBERT	08BP	PR D78 112002	B. Aubert <i>et al.</i>	(BABAR Collab.)
HE	08A	PRL 101 192001	Q. He <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.)
BESSON	07	PRL 98 052002	D. Besson <i>et al.</i>	(CLEO Collab.)
ROSNER	07A	PR D76 117102	J.L. Rosner <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.)
ARTUSO	05	PRL 94 032001	M. Artuso <i>et al.</i>	(CLEO Collab.)
ARTAMONOV	00	PL B474 427	A.S. Artamonov <i>et al.</i>	
EDWARDS	99	PR D59 032003	K.W. Edwards <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)
KOBEL	92	ZPHY C53 193	M. Kobel <i>et al.</i>	(Crystal Ball 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.)
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)
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JAKUBOWSKI	88	ZPHY C40 49	Z. Jakubowski <i>et al.</i>	(Crystal Ball Collab.) IGJPC
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)
LURZ	87	ZPHY C36 383	B. Lurz <i>et al.</i>	(Crystal Ball Collab.)
BARU	86B	ZPHY C32 622 (errat.)	S.E. Baru <i>et al.</i>	(NOVO)
ALBRECHT	85	ZPHY C28 45	H. Albrecht <i>et al.</i>	(ARGUS Collab.)
ALBRECHT	85E	PL 160B 331	H. Albrecht <i>et al.</i>	(ARGUS Collab.)
GELPHMAN	85	PR D32 2893	D. Gelpman <i>et al.</i>	(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 <i>et al.</i>	(Crystal Ball Collab.)
ARTAMONOV	84	PL 137B 272	A.S. Artamonov <i>et al.</i>	(NOVO)
BARBER	84	PL 135B 498	D.P. Barber <i>et al.</i>	
BESSON	84	PR D30 1433	D. Besson <i>et al.</i>	(CLEO Collab.)
FONSECA	84	NP B242 31	V. Fonseca <i>et al.</i>	(CUSB Collab.)
GILES	84B	PR D29 1285	R. Giles <i>et al.</i>	(CLEO Collab.)
HAAS	84	PRL 52 799	J. Haas <i>et al.</i>	(CLEO Collab.)
HAAS	84B	PR D30 1996	J. Haas <i>et al.</i>	(CLEO Collab.)
KLOPFEN...	83	PRL 51 160	C. Klopfenstein <i>et al.</i>	(CUSB Collab.)

ALBRECHT	82	PL 116B 383	H. Albrecht <i>et al.</i>	(DESY, DORT, HEIDH+)
NICZYPORUK	81B	PL 100B 95	B. Niczyporuk <i>et al.</i>	(LENA Collab.)
NICZYPORUK	81C	PL 99B 169	B. Niczyporuk <i>et al.</i>	(LENA Collab.)
BOCK	80	ZPHY C6 125	P. Bock <i>et al.</i>	(HEIDP, MPIM, DESY, HAMB)

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