$\psi(2S)$

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

$\psi(2S)$ MASS

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
3686.00±0.09 OUR AVERAGE					
3686.02±0.09±0.27		ARMSTRONG	93B	SPEC	$\overline{p}p \rightarrow e^+e^-$
3686.00±0.10	413	ZHOLENTZ	80	OLYA	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •					
3684 ±2		GRIBUSHIN	96	FMWS	π^- Be $\rightarrow$ $J/\psi\pi^+\pi^-$, $2\mu X$
3683 ±5	77	ANTONIAZZI	94	E705	300 $\pi^\pm$, pLi $\rightarrow$ $J/\psi\pi^+\pi^-$X

$m_{\psi(2S)} - m_{J/\psi(1S)}$

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
589.07±0.13 OUR AVERAGE				
589.7 ±1.2	LEMOIGNE	82	GOLI	190 GeV π^- Be $\rightarrow$ 2μ
589.07±0.13	[1] ZHOLENTZ	80	OLYA	e^+e^-
588.7 ±0.8	LUTH	75	MRK1	

[1] Redundant with data in mass above.

$\psi(2S)$ WIDTH

VALUE (keV)	*DOCUMENT ID*		*TECN*	*COMMENT*
277±31 OUR AVERAGE Error includes scale factor of 1.1.				
306±36±16	ARMSTRONG	93B	SPEC	$\overline{p}p \rightarrow e^+e^-$
243±43	[2] PDG	92	RVUE	

[2] Uses $\Gamma(ee)$ from ALEXANDER 89 and $B(ee) = (88 \pm 13) \times 10^{-4}$ from FELDMAN 77.

$\psi(2S)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Scale factor/ Confidence level
Γ_1	hadrons	(98.10±0.30) %	
Γ_2	virtual $\gamma \rightarrow$ hadrons	(2.9 ±0.4) %	
Γ_3	e^+e^-	(8.5 ±0.7) $\times 10^{-3}$	
Γ_4	$\mu^+\mu^-$	(7.7 ±1.7) $\times 10^{-3}$	
	Decays into $J/\psi(1S)$ and anything		
Γ_5	$J/\psi(1S)$anything	(54.9 ±2.9) %	
Γ_6	$J/\psi(1S)$neutrals	(22.9 ±1.7) %	
Γ_7	$J/\psi(1S)\pi^+\pi^-$	(30.7 ±1.9) %	
Γ_8	$J/\psi(1S)\pi^0\pi^0$	(18.1 ±1.7) %	
Γ_9	$J/\psi(1S)\eta$	(2.7 ±0.4) %	S=1.7
Γ_{10}	$J/\psi(1S)\pi^0$	(9.7 ±2.1) $\times 10^{-4}$	
Γ_{11}	$J/\psi(1S)\mu^+\mu^-$	(1.02±0.34) %	

Hadronic decays

Γ_{12}	$3(\pi^+\pi^-)\pi^0$	$(\ 3.5\ \pm 1.6\ )\times 10^{-3}$		
Γ_{13}	$2(\pi^+\pi^-)\pi^0$	$(\ 3.1\ \pm 0.7\ )\times 10^{-3}$		
Γ_{14}	$\pi^+\pi^- K^+ K^-$	$(\ 1.6\ \pm 0.4\ )\times 10^{-3}$		
Γ_{15}	$\pi^+\pi^- p\overline{p}$	$(\ 8.0\ \pm 2.0\ )\times 10^{-4}$		
Γ_{16}	$K^+\overline{K}^*(892)^0\pi^- +$ c.c.	$(\ 6.7\ \pm 2.5\ )\times 10^{-4}$		
Γ_{17}	$2(\pi^+\pi^-)$	$(\ 4.5\ \pm 1.0\ )\times 10^{-4}$		
Γ_{18}	$\rho^0\pi^+\pi^-$	$(\ 4.2\ \pm 1.5\ )\times 10^{-4}$		
Γ_{19}	$\overline{p}p$	$(\ 1.9\ \pm 0.5\ )\times 10^{-4}$		
Γ_{20}	$3(\pi^+\pi^-)$	$(\ 1.5\ \pm 1.0\ )\times 10^{-4}$		
Γ_{21}	$\overline{p}p\pi^0$	$(\ 1.4\ \pm 0.5\ )\times 10^{-4}$		
Γ_{22}	K^+K^-	$(\ 1.0\ \pm 0.7\ )\times 10^{-4}$		
Γ_{23}	$\pi^+\pi^-\pi^0$	$(\ 9\ \pm 5\ )\times 10^{-5}$		
Γ_{24}	$\pi^+\pi^-$	$(\ 8\ \pm 5\ )\times 10^{-5}$		
Γ_{25}	$\Lambda\overline{\Lambda}$	$<\ 4$	$\times 10^{-4}$	CL=90%
Γ_{26}	$\Xi^-\overline{\Xi}^+$	$<\ 2$	$\times 10^{-4}$	CL=90%
Γ_{27}	$\rho\pi$	$<\ 8.3$	$\times 10^{-5}$	CL=90%
Γ_{28}	$K^+K^-\pi^0$	$<\ 2.96$	$\times 10^{-5}$	CL=90%
Γ_{29}	$K^+\overline{K}^*(892)^- +$ c.c.	$<\ 5.4$	$\times 10^{-5}$	CL=90%

Radiative decays

Γ_{30}	$\gamma\chi_{c0}(1P)$	$(\ 9.3\ \pm 0.8\ )\ \%$		
Γ_{31}	$\gamma\chi_{c1}(1P)$	$(\ 8.7\ \pm 0.8\ )\ \%$		
Γ_{32}	$\gamma\chi_{c2}(1P)$	$(\ 7.8\ \pm 0.8\ )\ \%$		
Γ_{33}	$\gamma\eta_c(1S)$	$(\ 2.8\ \pm 0.6\ )\times 10^{-3}$		
Γ_{34}	$\gamma\eta_c(2S)$			
Γ_{35}	$\gamma\pi^0$	$<\ 5.4$	$\times 10^{-3}$	CL=95%
Γ_{36}	$\gamma\eta'(958)$	$<\ 1.1$	$\times 10^{-3}$	CL=90%
Γ_{37}	$\gamma\eta$			
Γ_{38}	$\gamma\gamma$	$<\ 1.6$	$\times 10^{-4}$	CL=90%
Γ_{39}	$\gamma\eta(1440)\rightarrow\ \gamma K\overline{K}\pi$	$<\ 1.2$	$\times 10^{-4}$	CL=90%

Mode needed for fitting purposes

Γ_{40}	1. — other fit modes	$(31.0\ \pm 3.1\ )\ \%$		

CONSTRAINED FIT INFORMATION

An overall fit to 8 branching ratios uses 16 measurements and one constraint to determine 7 parameters. The overall fit has a $\chi^2 = 8.1$ for 10 degrees of freedom.

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

x_8	24					
x_9	2	−7				
x_{11}	19	4	0			
x_{31}	2	−4	−1	0		
x_{32}	1	−2	0	0	0	
x_{40}	−77	−68	−12	−25	−24	−25
	x_7	x_8	x_9	x_{11}	x_{31}	x_{32}

$\psi(2S)$ PARTIAL WIDTHS

Γ(hadrons) Γ_1

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
224 ± 56	LUTH	75	MRK1	$e^+ e^-$

$\Gamma(e^+ e^-)$ Γ_3

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
2.14 ± 0.21	ALEXANDER	89	RVUE	See Υ mini-review
• • • We do not use the following data for averages, fits, limits, etc. • • •				
2.0 ± 0.3	BRANDELIK	79C	DASP	$e^+ e^-$
2.1 ± 0.3	[3] LUTH	75	MRK1	$e^+ e^-$

[3] From a simultaneous fit to $e^+ e^-$, $\mu^+ \mu^-$, and hadronic channels assuming $\Gamma(e^+ e^-) = \Gamma(\mu^+ \mu^-)$.

$\Gamma(\gamma\gamma)$ Γ_{38}

VALUE (eV)	CL%	DOCUMENT ID		TECN	COMMENT
<43	90	BRANDELIK	79C	DASP	$e^+ e^-$

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

This combination of a partial width with the partial width into e^+e^- and with the total width is obtained from the integrated cross section into channel$_i$ in the e^+e^- annihilation. We list only data that have not been used to determine the partial width $\Gamma(I)$ or the branching ratio $\Gamma(I)$/total.

$\Gamma(\text{hadrons}) \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ $\Gamma_1\Gamma_3/\Gamma$

VALUE (keV)	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
2.2 ± 0.4	ABRAMS	75	MRK1	e^+e^-

$\psi(2S)$ BRANCHING RATIOS

$\Gamma(\text{hadrons})/\Gamma_{\text{total}}$ Γ_1/Γ

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
0.981 ±0.003	[5] LUTH	75	MRK1	e^+e^-

$\Gamma(\text{virtual}\,\gamma \to \text{hadrons})/\Gamma_{\text{total}}$ Γ_2/Γ

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
0.029±0.004	[6] LUTH	75	MRK1	e^+e^-

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

VALUE (units 10^{-4})	*DOCUMENT ID*		*TECN*	*COMMENT*
85± 7 OUR AVERAGE				
83± 5±7	[4] ARMSTRONG	97	E760	$\overline{p}p \to \psi(2S)X$
88±13	[7] FELDMAN	77	RVUE	e^+e^-

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

VALUE (units 10^{-4})	*DOCUMENT ID*		*TECN*	*COMMENT*
77±17	[8] HILGER	75	SPEC	e^+e^-

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

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.89 ± 0.16	BOYARSKI	75C	MRK1	e^+e^-

[5] Includes cascade decay into $J/\psi(1S)$.

[6] Included in $\Gamma(\text{hadrons})/\Gamma_{\text{total}}$.

[7] From an overall fit assuming equal partial widths for e^+e^- and $\mu^+\mu^-$. For a measurement of the ratio see the entry $\Gamma(\mu^+\mu^-)/\Gamma(e^+e^-)$ below. Includes LUTH 75, HILGER 75, BURMESTER 77.

[8] Restated by us using $B(\psi(2S) \to J/\psi(1S)\text{anything}) = 0.55$.

DECAYS INTO $J/\psi(1S)$ AND ANYTHING

$\Gamma(J/\psi(1S)\text{anything})/\Gamma_{\text{total}}$ $\Gamma_5/\Gamma = (\Gamma_7+\Gamma_8+\Gamma_9+0.273\Gamma_{31}+0.135\Gamma_{32})/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
0.549±0.029 OUR FIT				
0.55 ±0.07 OUR AVERAGE				
0.51 ±0.12	BRANDELIK	79C	DASP	$e^+e^- \to \mu^+\mu^- X$
0.57 ±0.08	ABRAMS	75B	MRK1	$e^+e^- \to \mu^+\mu^- X$

$\Gamma(J/\psi(1S)\text{neutrals})/\Gamma_{\text{total}}$ $\Gamma_6/\Gamma = (0.9761\Gamma_8+0.708\Gamma_9+0.273\Gamma_{31}+0.135\Gamma_{32})/\Gamma$

VALUE	DOCUMENT ID
0.229±0.017 OUR FIT	

$\Gamma(J/\psi(1S)\text{neutrals})/\Gamma(J/\psi(1S)\text{anything})$ $\Gamma_6/\Gamma_5 = (0.9761\Gamma_8+0.708\Gamma_9+0.273\Gamma_{31}+0.135\Gamma_{32})/(\Gamma_7+\Gamma_8+\Gamma_9+0.273\Gamma_{31}+0.135\Gamma_{32})$

VALUE	DOCUMENT ID		TECN	COMMENT
0.418±0.020 OUR FIT				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.44 ±0.03	[10] ABRAMS	75B	MRK1	$e^+e^- \to J/\psi X$

$\Gamma(J/\psi(1S)\text{neutrals})/\Gamma(J/\psi(1S)\pi^+\pi^-)$ $\Gamma_6/\Gamma_7 = (0.9761\Gamma_8+0.708\Gamma_9+0.273\Gamma_{31}+0.135\Gamma_{32})/\Gamma_7$

VALUE	DOCUMENT ID		TECN	COMMENT
0.75±0.06 OUR FIT				
0.73±0.09	[10] TANENBAUM	76	MRK1	e^+e^-

$\Gamma(J/\psi(1S)\pi^+\pi^-)/\Gamma_{\text{total}}$ Γ_7/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.307±0.019 OUR FIT					
0.304±0.022 OUR AVERAGE					
0.283±0.021±0.020	363	[4] ARMSTRONG	97	E760	$\overline{p}p \to \psi(2S)X$
0.32 ±0.04		ABRAMS	75B	MRK1	$e^+e^- \to J/\psi\pi^+\pi^-$
0.36 ±0.06		WIIK	75	DASP	$e^+e^- \to J/\psi\pi^+\pi^-$

$\Gamma(J/\psi(1S)\pi^0\pi^0)/\Gamma_{\text{total}}$ Γ_8/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.181±0.017 OUR FIT					
0.183±0.021 OUR AVERAGE					
0.184±0.019±0.013	157	[4] ARMSTRONG	97	E760	$\overline{p}p \to \psi(2S)$
0.18 ±0.06		WIIK	75	DASP	$e^+e^- \to J/\psi 2\pi^0$

$\Gamma(J/\psi(1S)\pi^0\pi^0)/\Gamma(J/\psi(1S)\pi^+\pi^-)$ Γ_8/Γ_7

VALUE	DOCUMENT ID		TECN	COMMENT
0.59±0.06 OUR FIT				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.53±0.06	[11] TANENBAUM	76	MRK1	e^+e^-
0.64±0.15	[12] HILGER	75	SPEC	e^+e^-

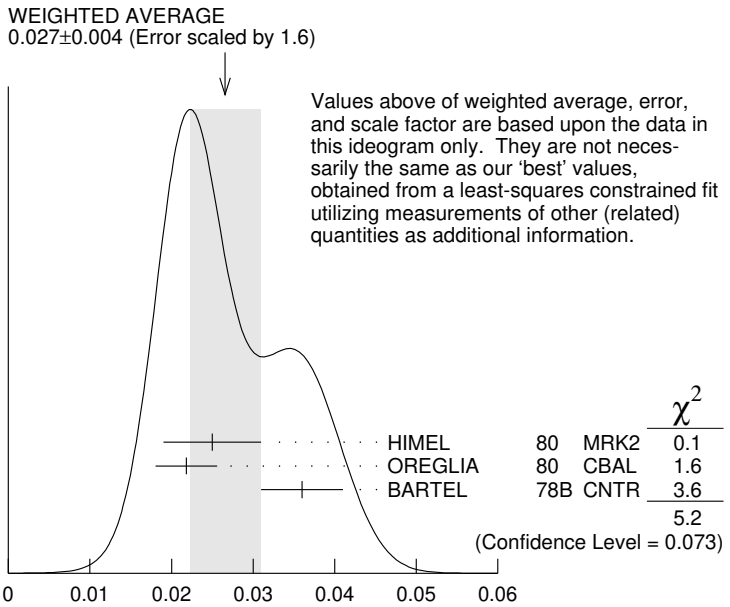
$\Gamma(J/\psi(1S)\pi^+\pi^-)/\Gamma(J/\psi(1S)\mu^+\mu^-)$ Γ_7/Γ_{11}

VALUE	DOCUMENT ID		TECN	COMMENT
30 ±10 OUR FIT				
30.2± 7.1±6.8	[9] GRIBUSHIN	96	FMWS	π^- Be $\rightarrow$ $J/\psi\pi^+\pi^-$, $2\mu X$

[9] Using B($J/\psi(1S) \rightarrow \mu^+\mu^-$) = 0.0597 ± 0.0025.

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.027 ±0.004 OUR FIT Error includes scale factor of 1.7.					
0.027 ±0.004 OUR AVERAGE Error includes scale factor of 1.6. See the ideogram below.					
0.025 ±0.006	166	HIMEL	80	MRK2	e^+e^-
0.0218±0.0014±0.0035	386	OREGLIA	80	CBAL	$e^+e^- \rightarrow J/\psi 2\gamma$
0.036 ±0.005	164	BARTEL	78B	CNTR	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.032 ±0.010 ±0.002	36	[4] ARMSTRONG	97	E760	$\overline{p}p \rightarrow \psi(2S)$
0.035 ±0.009	17	[13] BRANDELIK	79B	DASP	$e^+e^- \rightarrow J/\psi 2\gamma$
0.043 ±0.008	44	[13] TANENBAUM	76	MRK1	e^+e^-



$\Gamma(J/\psi(1S)\eta)/\Gamma_{total}$

$\Gamma(J/\psi(1S)\pi^0)/\Gamma_{total}$ Γ_{10}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
9.7±2.1 OUR AVERAGE					
15 ±6	7	HIMEL	80	MRK2	e^+e^-
9 ±2 ±1	23	OREGLIA	80	CBAL	$\psi(2S) \rightarrow J/\psi 2\gamma$

[10] The ABRAMS 75B measurement of Γ_6/Γ_5 and the TANENBAUM 76 result for Γ_6/Γ_7 are not independent. The TANENBAUM 76 result is used in the fit because it includes more accurate corrections for angular distributions.

[11] Not independent of the TANENBAUM 76 result for Γ_6/Γ_7.

[12] Ignoring the $J/\psi(1S)\eta$ and $J/\psi(1S)\gamma\gamma$ decays.

[13] Low statistics data removed from average.

HADRONIC DECAYS

$\Gamma(3(\pi^+\pi^-)\pi^0)/\Gamma_{total}$ Γ_{12}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
35±16	6	FRANKLIN	83	MRK2	$e^+e^- \rightarrow$ hadrons

$\Gamma(2(\pi^+\pi^-)\pi^0)/\Gamma_{total}$ Γ_{13}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
31± 7 OUR AVERAGE					
30± 8	42	FRANKLIN	83	MRK2	e^+e^-
35±15		ABRAMS	75	MRK1	e^+e^-

$\Gamma(\pi^+\pi^- K^+K^-)/\Gamma_{total}$ Γ_{14}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
16±4	[14] TANENBAUM	78	MRK1	e^+e^-

$\Gamma(\pi^+\pi^- p\overline{p})/\Gamma_{total}$ Γ_{15}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
8 ±2	[14] TANENBAUM	78	MRK1	e^+e^-

$\Gamma(K^+\overline{K}^*(892)^0\pi^- + \text{c.c.})/\Gamma_{total}$ Γ_{16}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
6.7±2.5	TANENBAUM	78	MRK1	e^+e^-

$\Gamma(2(\pi^+\pi^-))/\Gamma_{total}$ Γ_{17}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
4.5±1.0	TANENBAUM	78	MRK1	e^+e^-

$\Gamma(\rho^0\pi^+\pi^-)/\Gamma_{total}$ Γ_{18}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
4.2±1.5	TANENBAUM	78	MRK1	e^+e^-

$\Gamma(\bar{p}p)/\Gamma_{total}$ Γ_{19}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
1.9±0.5 OUR AVERAGE					
1.4±0.8	4	BRANDELIK	79C	DASP	e^+e^-
2.3±0.7		FELDMAN	77	MRK1	e^+e^-

$\Gamma(3(\pi^+\pi^-))/\Gamma_{total}$ Γ_{20}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
1.5±1.0	[14] TANENBAUM	78	MRK1	e^+e^-

$\Gamma(\bar{p}p\pi^0)/\Gamma_{total}$ Γ_{21}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
1.4±0.5	9	FRANKLIN	83	MRK2	e^+e^-

$\Gamma(K^+K^-)/\Gamma_{total}$ Γ_{22}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
1.0±0.7		BRANDELIK	79C	DASP	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.5	90	FELDMAN	77	MRK1	e^+e^-

$\Gamma(\pi^+\pi^-)/\Gamma_{total}$ Γ_{24}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
0.8±0.5		BRANDELIK	79C	DASP	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.5	90	FELDMAN	77	MRK1	e^+e^-

$\Gamma(\pi^+\pi^-\pi^0)/\Gamma_{total}$ Γ_{23}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
0.85±0.46	4	FRANKLIN	83	MRK2	$e^+e^- \rightarrow$ hadrons

$\Gamma(\Lambda\bar{\Lambda})/\Gamma_{total}$ Γ_{25}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<4	90	FELDMAN	77	MRK1	e^+e^-

$\Gamma(\Xi^-\bar{\Xi}^+)/\Gamma_{total}$ Γ_{26}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<2	90	FELDMAN	77	MRK1	e^+e^-

$\Gamma(\rho\pi)/\Gamma_{total}$ Γ_{27}/Γ

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
< 0.83	90	1	FRANKLIN	83	MRK2	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<10	90		BARTEL	76	CNTR	e^+e^-
<10	90		[15] ABRAMS	75	MRK1	e^+e^-

$\Gamma(K^+K^-\pi^0)/\Gamma_{total}$ Γ_{28}/Γ

VALUE (units 10^{-5})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<2.96	90	1	FRANKLIN	83	MRK2	$e^+e^- \to$ hadrons

$\Gamma(K^+\overline{K}^*(892)^- + \text{c.c.})/\Gamma_{total}$ Γ_{29}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID		TECN	COMMENT
<5.4	90	FRANKLIN	83	MRK2	$e^+e^- \to$ hadrons

[14] Assuming entirely strong decay.
[15] Final state $\rho^0\pi^0$.

RADIATIVE DECAYS

$\Gamma(\gamma\chi_{c0}(1P))/\Gamma_{total}$ Γ_{30}/Γ

VALUE (units 10^{-2})		DOCUMENT ID		TECN	COMMENT
9.3±0.8 OUR AVERAGE					
9.9±0.5±0.8	[16]	GAISER	86	CBAL	$e^+e^- \to \gamma X$
7.2±2.3	[16]	BIDDICK	77	CNTR	$e^+e^- \to \gamma X$
7.5±2.6	[16]	WHITAKER	76	MRK1	e^+e^-

$\Gamma(\gamma\chi_{c1}(1P))/\Gamma_{total}$ Γ_{31}/Γ

VALUE (units 10^{-2})		DOCUMENT ID		TECN	COMMENT
8.7±0.8 OUR FIT					
8.7±0.8 OUR AVERAGE					
9.0±0.5±0.7	[17]	GAISER	86	CBAL	$e^+e^- \to \gamma X$
7.1±1.9	[18]	BIDDICK	77	CNTR	$e^+e^- \to \gamma X$

$\Gamma(\gamma\chi_{c2}(1P))/\Gamma_{total}$ Γ_{32}/Γ

VALUE (units 10^{-2})		DOCUMENT ID		TECN	COMMENT
7.8±0.8 OUR FIT					
7.8±0.8 OUR AVERAGE					
8.0±0.5±0.7	[19]	GAISER	86	CBAL	$e^+e^- \to \gamma X$
7.0±2.0	[18]	BIDDICK	77	CNTR	$e^+e^- \to \gamma X$

$\Gamma(\gamma\eta_c(1S))/\Gamma_{total}$ Γ_{33}/Γ

VALUE (units 10^{-2})	DOCUMENT ID		TECN	COMMENT
0.28±0.06	GAISER	86	CBAL	$e^+e^- \to \gamma X$

$\Gamma(\gamma\eta_c(2S))/\Gamma_{total}$ Γ_{34}/Γ

VALUE (units 10^{-2})	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.2 to 1.3	95	EDWARDS	82C	CBAL	$e^+e^- \to \gamma X$

$\Gamma(\gamma\pi^0)/\Gamma_{total}$ Γ_{35}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
< 54	95	[20] LIBERMAN	75	SPEC	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<100	90	WIIK	75	DASP	e^+e^-

$\Gamma(\gamma\eta'(958))/\Gamma_{total}$ Γ_{36}/Γ

VALUE (units 10^{-2})	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<0.11	90	[21] BARTEL	76	CNTR	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.6	90	[22] BRAUNSCH...	77	DASP	e^+e^-

$\Gamma(\gamma\eta)/\Gamma_{total}$ Γ_{37}/Γ

VALUE (units 10^{-2})	*CL%*	*DOCUMENT ID*	*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<0.02	90	YAMADA 77	DASP	$e^+e^- \to 3\gamma$

$\Gamma(\gamma\eta(1440) \to \gamma K\overline{K}\pi)/\Gamma_{total}$ Γ_{39}/Γ

VALUE (units 10^{-3})	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<0.12	90	[23] SCHARRE	80	MRK1	e^+e^-

[16] Angular distribution $(1+\cos^2\theta)$ assumed.
[17] Angular distribution $(1-0.189\ \cos^2\theta)$ assumed.
[18] Valid for isotropic distribution of the photon.
[19] Angular distribution $(1-0.052\ \cos^2\theta)$ assumed.
[20] Restated by us using $B(\psi(2S) \to \mu^+\mu^-) = 0.0077$.
[21] The value is normalized to the branching ratio for $\Gamma(J/\psi(1S)\eta)/\Gamma_{total}$.
[22] Restated by us using total decay width 228 keV.
[23] Includes unknown branching fraction $\eta(1440) \to K\overline{K}\pi$.

$\psi(2S)$ REFERENCES

ARMSTRONG	97	PR D55 1153	+Bettoni, Bharadwaj+	(E760 Collaboration)
GRIBUSHIN	96	PR D53 4723	+Abramov, Antipov+	(E672 Collab., E706 Collab.)
ANTONIAZZI	94	PR D50 4258	+Arenton+	(E705 Collab.)
ARMSTRONG	93B	PR D47 772	+Bettoni, Bharadwaj+	(FNAL E760 Collab.)
PDG	92	PR D45, 1 June, Part II	Hikasa, Barnett, Stone+	(KEK, LBL, BOST+)
ALEXANDER	89	NP B320 45	+Bonvicini, Drell, Frey, Luth	(LBL, MICH, SLAC)
GAISER	86	PR D34 711	+Bloom, Bulos, Godfrey+	(Crystal Ball Collab.)
FRANKLIN	83	PRL 51 963	+Franklin, Feldman, Abrams, Alam+	(LBL, SLAC)
EDWARDS	82C	PRL 48 70	+Partridge, Peck+	(CIT, HARV, PRIN, STAN, SLAC)
LEMOIGNE	82	PL 113B 509	+Barate, Astbury+	(SACL, LOIC, SHMP, IND)
HIMEL	80	PRL 44 920	+Abrams, Alam, Blocker+	(LBL, SLAC)
OREGLIA	80	PRL 45 959	+Partridge+	(SLAC, CIT, HARV, PRIN, STAN)
SCHARRE	80	PL 97B 329	+Trilling, Abrams, Alam, Blocker+	(SLAC, LBL)
ZHOLENTZ	80	PL 96B 214	+Kurdadze, Lelchuk, Mishnev+	(NOVO)
Also	81	SJNP 34 814	Zholentz, Kurdadze, Lelchuk+	(NOVO)
		Translated from YAF 34 1471.		
BRANDELIK	79B	NP B160 426	+Cords+	(DASP Collab.)
BRANDELIK	79C	ZPHY C1 233	+Cords+	(DASP Collab.)
BARTEL	78B	PL 79B 492	+Dittmann, Duinker, Olsson, O'Neill+	(DESY, HEIDP)
TANENBAUM	78	PR D17 1731	+Alam, Boyarski+	(SLAC, LBL)
BIDDICK	77	PRL 38 1324	+Burnett+	(UCSD, UMD, PAVI, PRIN, SLAC, STAN)
BRAUNSCH...	77	PL 67B 249	Braunschweig+	(DASP Collab.)
BURMESTER	77	PL 66B 395	+Criegee+	(DESY, HAMB, SIEG, WUPP)
FELDMAN	77	PRPL 33C 285	+Perl	(LBL, SLAC)
YAMADA	77	Hamburg Conf. 69		(DASP Collab.)
BARTEL	76	PL 64B 483	+Duinker, Olsson, Steffen, Heintze+	(DESY, HEIDP)
TANENBAUM	76	PRL 36 402	+Abrams, Boyarski, Bulos+	(SLAC, LBL) IG
WHITAKER	76	PRL 37 1596	+Tanenbaum, Abrams, Alam+	(SLAC, LBL)
ABRAMS	75	Stanford Symp. 25		(LBL)
ABRAMS	75B	PRL 34 1181	+Briggs, Chinowsky, Friedberg+	(LBL, SLAC)
BOYARSKI	75C	Palermo Conf. 54	+Breidenbach, Bulos, Abrams, Briggs+	(SLAC, LBL)
HILGER	75	PRL 35 625	+Beron, Ford, Hofstadter, Howell+	(STAN, PENN)
LIBERMAN	75	Stanford Symp. 55		(STAN)
LUTH	75	PRL 35 1124	+Boyarski, Lynch, Breidenbach+	(SLAC, LBL) JPC
WIIK	75	Stanford Symp. 69		(DESY)

OTHER RELATED PAPERS

LEE	85	SLAC 282		(SLAC)
BARATE	83	PL 121B 449	+Bareyre, Bonamy+	(SACL, LOIC, SHMP, IND)
FRANKLIN	83B	Thesis SLAC-0254		(STAN)
AUBERT	75B	PRL 33 1624	+Becker, Biggs, Burger, Glenn+	(MIT, BNL)
BRAUNSCH...	75B	PL 57B 407	Braunschweig, Konigs+	(DASP Collab.)
CAMERINI	75	PRL 35 483	+Learned, Prepost, Ash, Anderson+	(WISC, SLAC)
FELDMAN	75B	PRL 35 821	+Jean-Marie, Sadoulet, Vannucci+	(LBL, SLAC)
GRECO	75	PL 56B 367	+Pancheri-Srivastava, Srivastava	(FRAS)
JACKSON	75	NIM 128 13	+Scharre	(LBL)
SIMPSON	75	PRL 35 699	+Beron, Ford, Hilger, Hofstadter+	(STAN, PENN)
ABRAMS	74	PRL 33 1453	+Briggs, Augustin, Boyarski+	(LBL, SLAC)