$c\bar{c}$ MESONS

MINIREVIEW GOES HERE

$\eta_c(1S)$ or $\eta_c(2980)$

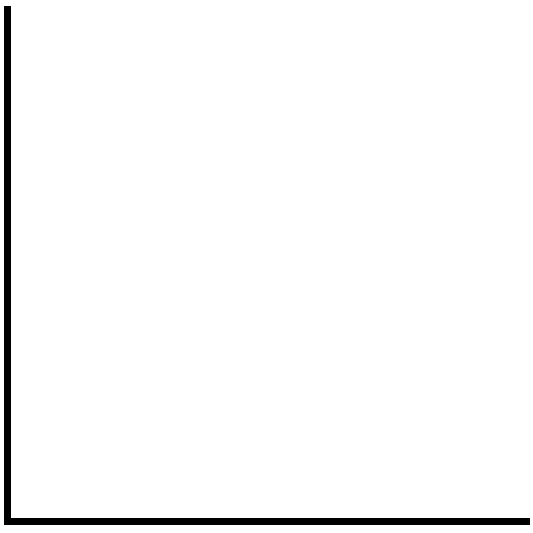
$I^G(J^{PC}) = 0^+(0^{-+})$

Observed in the inclusive γ spectrum generated from $\psi(2S)$ decay, therefore $C = +$. From the 4π decay $G = +$, therefore $I = 0$. From angular distribution in $J/\psi(1S) \to \eta_c\gamma$, $\eta_c \to \phi\phi$, $J^P = 0^-$ (BALTRUSAITIS 84).

$\eta_c(1S)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
2978.8± 1.9 OUR AVERAGE		Error includes scale factor of 1.8. See the ideogram below.			
2974.4± 1.9		[1] BISELLO	91	DM2	$J/\psi \to \eta_c\gamma$
2969 ± 4 ± 4	80	BAI	90B	MRK3	$J/\psi \to \gamma K^+K^-K^+K^-$
$2982.6^{+2.7}_{-2.3}$	12	BAGLIN	87B	SPEC	$\bar{p}p \to \gamma\gamma$
2980.2± 1.6		[1] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c\gamma$
2984 ± 2.3± 4.0		GAISER	86	CBAL	$J/\psi \to \gamma X$, $\psi(2S) \to \gamma X$
2982 ± 8	18	[2] HIMEL	80B	MRK2	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2956 ±12 ±12		BAI	90B	MRK3	$J/\psi \to \gamma K^+K^-K^0_SK^0_L$
2976 ± 8		[3] BALTRUSAIT...	84	MRK3	$J/\psi \to 2\phi\gamma$
2980 ± 9		[2] PARTRIDGE	80B	CBAL	e^+e^-

[1] Average of several decay modes.
[2] Mass adjusted by us to correspond to $J/\psi(1S)$ mass = 3097 MeV.
[3] $\eta_c \to \phi\phi$.



$\eta_c(1S)$ mass (MeV)

$\eta_c(1S)$ WIDTH

VALUE (MeV)	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$10.3^{+3.8}_{-3.4}$ OUR AVERAGE						
$7.0^{+7.5}_{-7.0}$		12	BAGLIN	87B	SPEC	$\overline{p}p \to \gamma\gamma$
$10.1^{+33.0}_{-8.2} \pm 11$		23	[4] BALTRUSAIT...	86	MRK3	$J/\psi \to \gamma p\overline{p}$
11.5 ± 4.5			GAISER	86	CBAL	$J/\psi \to \gamma X$, $\psi(2S) \to \gamma X$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<40	90	18	HIMEL	80B	MRK2	e^+e^-
<20	90		PARTRIDGE	80B	CBAL	e^+e^-

[4] Positive and negative errors correspond to 90% confidence level.

$\eta_c(1S)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Confidence level
	Decays involving hadronic resonances		
Γ_1	$\eta'(958)\pi\pi$	(4.1 ± 1.7) %	
Γ_2	$\rho\rho$	(2.6 ± 0.9) %	
Γ_3	$K^*(892)^0 K^-\pi^+ +$ c.c.	(2.0 ± 0.7) %	
Γ_4	$K^*(892)\overline{K}^*(892)$	$(8.5 \pm 3.1) \times 10^{-3}$	
Γ_5	$\phi\phi$	$(7.1 \pm 2.8) \times 10^{-3}$	
Γ_6	$a_0(980)\pi$	< 2 %	90%
Γ_7	$a_2(1320)\pi$	< 2 %	90%
Γ_8	$K^*(892)\overline{K} +$ c.c.	< 1.28 %	90%
Γ_9	$f_2(1270)\eta$	< 1.1 %	90%
Γ_{10}	$\omega\omega$	$< 3.1 \times 10^{-3}$	90%
	Decays into stable hadrons		
Γ_{11}	$K\overline{K}\pi$	(6.6 ± 1.8) %	
Γ_{12}	$\eta\pi\pi$	(4.9 ± 1.8) %	
Γ_{13}	$\pi^+\pi^- K^+K^-$	$(2.0\ ^{+0.7}_{-0.6})$ %	
Γ_{14}	$2(K^+K^-)$	(2.1 ± 1.2) %	
Γ_{15}	$2(\pi^+\pi^-)$	(1.2 ± 0.4) %	
Γ_{16}	$p\overline{p}$	$(1.2 \pm 0.4) \times 10^{-3}$	
Γ_{17}	$K\overline{K}\eta$	< 3.1 %	90%
Γ_{18}	$\pi^+\pi^- p\overline{p}$	< 1.2 %	90%
Γ_{19}	$\Lambda\overline{\Lambda}$	$< 2 \times 10^{-3}$	90%
	Radiative decays		
Γ_{20}	$\gamma\gamma$	$(6\ ^{+6}_{-5}) \times 10^{-4}$	

$\eta_c(1S)$ PARTIAL WIDTHS

$\Gamma(\gamma\gamma)$ Γ_{20}

VALUE (keV)	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
7.8 ± 1.7 OUR AVERAGE						
11.3 ± 4.2			ALBRECHT	94H	ARG	$\gamma\gamma$
$8.0 \pm 2.3 \pm 2.4$		17 ± 5	ADRIANI	93N	L3	$e^+e^- \to e^+e^-\eta_c$
$5.9^{+2.1}_{-1.8} \pm 1.9$			CHEN	90B	CLEO	$e^+e^- \to e^+e^-\eta_c$
$6.4^{+5.0}_{-3.4}$			AIHARA	88D	TPC	$e^+e^- \to e^+e^- X$
28 ± 15			[5] BERGER	86	PLUT	$\gamma\gamma \to K\overline{K}\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<11	90		BLINOV	86	MD1	$e^+e^- \to e^+e^- X$

[5] Re-evaluated by AIHARA 88D.

$\eta_c(1S)$ $\Gamma(i)\Gamma(\gamma\gamma)/\Gamma(total)$

$\Gamma(K\overline{K}\pi) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ $\Gamma_{11}\Gamma_{20}/\Gamma$

VALUE (keV)	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.94±0.18 OUR AVERAGE						
0.84±0.21			[6] ALBRECHT	94H	ARG	$\gamma\gamma \to K^{\pm}K^0_S\pi^{\mp}$
1.06±0.41±0.27		11 ± 4	BRAUNSCH...	89	TASS	$\gamma\gamma \to K\overline{K}\pi$
$1.5\ ^{+0.60}_{-0.45}\pm0.3$		7	[6] BERGER	86	PLUT	$\gamma\gamma \to K\overline{K}\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<0.63	95		[6] BEHREND	89	CELL	$\gamma\gamma \to K^0_S K^{\pm}\pi^{\mp}$
<4.4	95		ALTHOFF	85B	TASS	$\gamma\gamma \to K\overline{K}\pi$

[6] $K^{\pm}K^0_S\pi^{\mp}$ corrected to $K\overline{K}\pi$ by factor 3.

$\eta_c(1S)$ BRANCHING RATIOS

HADRONIC DECAYS

$\Gamma(\eta'(958)\pi\pi)/\Gamma_{total}$ Γ_1/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.041±0.017	14 ± 4	[7] BALTRUSAIT...86		MRK3	$J/\psi \to \eta_c\gamma$

$\Gamma(\rho\rho)/\Gamma_{total}$ Γ_2/Γ

VALUE (units 10^{-3})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
26 ± 9 OUR EVALUATION (Treating systematicerrors as correlated.)						
25 ± 8 OUR AVERAGE						
26.0± 2.4±8.8		113± 11	[7] BISELLO	91	DM2	$J/\psi \to \gamma\rho^0\rho^0$
23.6±10.6±8.2		32 ± 14	[7] BISELLO	91	DM2	$J/\psi \to \gamma\rho^+\rho^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<140	90		[7] BALTRUSAIT...86		MRK3	$J/\psi \to \eta_c\gamma$

$\Gamma(K^*(892)^0K^-\pi^+ + c.c.)/\Gamma_{total}$ Γ_3/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.02 ±0.007	63 ± 10	[7] BALTRUSAIT...86		MRK3	$J/\psi \to \eta_c\gamma$

$\Gamma(K^*(892)\overline{K}^*(892))/\Gamma_{total}$ Γ_4/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
85±31 OUR AVERAGE					
82±28±27	14 ± 5	[7] BISELLO	91	DM2	$e^+e^- \to \gamma K^+K^-\pi^+\pi^-$
90±50	9 ± 4	[7] BALTRUSAIT...86		MRK3	$J/\psi \to \eta_c\gamma$

$\Gamma(K^*(892)\overline{K} + c.c.)/\Gamma_{total}$ Γ_8/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.0128	90	BISELLO	91	DM2	$J/\psi \to \gamma K^0_S K^{\pm}\pi^{\mp}$
<0.0132	90	[7] BISELLO	91	DM2	$J/\psi \to \gamma K^+K^-\pi^0$

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

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
71±28 OUR EVALUATION (Treating systematic errors as correlated.)					
71±22 OUR AVERAGE					
74±18±24	80	[7] BAI	90B	MRK3	$J/\psi \to \gamma K^+K^-K^+K^-$
67±21±24		[7] BAI	90B	MRK3	$J/\psi \to \gamma K^+K^-K^0_S K^0_L$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
31± 7±10	19 ± 5	[7] BISELLO	91	DM2	$J/\psi \to \gamma K^+K^-K^+K^-$
$30^{+18}_{-12}\pm10$	5 ± 3	[7] BISELLO	91	DM2	$J/\psi \to \gamma K^+K^-K^0_S K^0_L$

$\Gamma(a_0(980)\pi)/\Gamma_{total}$ Γ_6/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.02	90	[7,8] BALTRUSAIT...86		MRK3	$J/\psi \to \eta_c\gamma$

$\Gamma(a_2(1320)\pi)/\Gamma_{total}$ Γ_7/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.02	90	[7] BALTRUSAIT...86		MRK3	$J/\psi \to \eta_c\gamma$

$\Gamma(f_2(1270)\eta)/\Gamma_{total}$ Γ_9/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.011	90	[7] BALTRUSAIT...86		MRK3	$J/\psi \to \eta_c\gamma$

$\Gamma(\omega\omega)/\Gamma_{total}$ Γ_{10}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.0031	90	[7] BALTRUSAIT...86		MRK3	$J/\psi \to \eta_c\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.0063		[7] BISELLO	91	DM2	$J/\psi \to \gamma\omega\omega$

$\Gamma(K\overline{K}\pi)/\Gamma_{total}$ Γ_{11}/Γ

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.066 ±0.018 OUR EVALUATION (Treating systematic errors as correlated.)						
0.063 ±0.013 OUR AVERAGE						
0.0690±0.0144±0.0234		33 ± 7	[7] BISELLO	91	DM2	$J/\psi \to \gamma K^+K^-\pi^0$
0.0543±0.0096±0.0180		68 ± 10	[7] BISELLO	91	DM2	$J/\psi \to \gamma K^\pm\pi^\mp K^0_S$
0.061 ±0.022		95 ± 18	[7,9] BALTRUSAIT...86		MRK3	$J/\psi \to \eta_c\gamma$
$0.161\ ^{+0.092}_{-0.073}$			[10] HIMEL	80B	MRK2	$\psi(2S) \to \eta_c\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<0.107	90		[7] PARTRIDGE	80B	CBAL	$J/\psi \to \eta_c\gamma$

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.049±0.018 OUR EVALUATION					
0.047±0.015 OUR AVERAGE					
0.054±0.020	75 ± 11	[7] BALTRUSAIT...86		MRK3	$J/\psi \to \eta_c\gamma$
0.037±0.013±0.020	18	[7] PARTRIDGE	80B	CBAL	$J/\psi \to \eta\pi^+\pi^-\gamma$

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{0.020\ ^{+0.007}_{-0.006}}$ **OUR AVERAGE**					
0.021±0.007	110± 17	[7] BALTRUSAIT...86		MRK3	$J/\psi \to \eta_c\gamma$
$0.014\ ^{+0.022}_{-0.009}$		[10] HIMEL	80B	MRK2	$\psi(2S) \to \eta_c\gamma$

$\Gamma(2(\pi^+\pi^-))/\Gamma_{total}$ Γ_{15}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.012 ±0.004 OUR EVALUATION					
0.0120±0.0031 OUR AVERAGE					
0.0105±0.0017±0.0034	137± 23	[7] BISELLO	91	DM2	$J/\psi \to \gamma 2\pi^+ 2\pi^-$
0.013 ±0.006	25 ± 9	[7] BALTRUSAIT...86		MRK3	$J/\psi \to \eta_c\gamma$
$0.020\ ^{+0.015}_{-0.010}$		[10] HIMEL	80B	MRK2	$\psi(2S) \to \eta_c\gamma$

$\Gamma(2(K^+K^-))/\Gamma_{total}$ Γ_{14}/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.021±0.010±0.006	ALBRECHT	94H	ARG	$\gamma\gamma \to K^+K^-K^+K^-$

$\Gamma(p\overline{p})/\Gamma_{total}$ Γ_{16}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
12± 4 OUR AVERAGE					
10± 3±4	18 ± 6	[7] BISELLO	91	DM2	$J/\psi \to \gamma p\overline{p}$
11± 6	23 ± 11	[7] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c\gamma$
29^{+29}_{-15}		[10] HIMEL	80B	MRK2	$\psi(2S) \to \eta_c\gamma$

$\Gamma(K\overline{K}\eta)/\Gamma_{total}$ Γ_{17}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.031	90	[7] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c\gamma$

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

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.012	90	HIMEL	80B	MRK2	$\psi(2S) \to \eta_c\gamma$

$\Gamma(\Lambda\overline{\Lambda})/\Gamma_{total}$ Γ_{19}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.002	90	[7] BISELLO	91	DM2	$e^+e^- \to \gamma\Lambda\overline{\Lambda}$

$\Gamma_i\Gamma_f/\Gamma^2_{total}$ in $p\overline{p} \to \eta_c(1S) \to \phi\phi$ $\Gamma_{16}\Gamma_5/\Gamma^2$

VALUE (units 10^{-5})	DOCUMENT ID		TECN	COMMENT
$\mathbf{4.0^{+3.5}_{-3.2}}$	BAGLIN	89	SPEC	$\overline{p}p \to K^+K^-K^+K^-$

[7] The quoted branching ratios use $B(J/\psi(1S) \to \gamma\eta_c(1S)) = 0.0127 \pm 0.0036$. Where relevant, the error in this branching ratio is treated as a common systematic in computing averages.
[8] We are assuming $B(a_0(980) \to \eta\pi) > 0.5$.
[9] Average from $K^+K^-\pi^0$ and $K^\pm K^0_S\pi^\mp$ decay channels.
[10] Estimated using $B(\psi(2S) \to \gamma\eta_c(1S)) = 0.0028 \pm 0.0006$.

RADIATIVE DECAYS

$\Gamma(\gamma\gamma)/\Gamma_{total}$ Γ_{20}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
$\mathbf{6^{+4}_{-3}\pm4}$		BAGLIN	87B	SPEC	$\overline{p}p \to \gamma\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
< 9	90	[7] BISELLO	91	DM2	$J/\psi \to \gamma\gamma\gamma$
<18	90	[11] BLOOM	83	CBAL	$J/\psi \to \eta_c\gamma$

[11] Using $B(J/\psi(1S) \to \gamma\eta_c(1S)) = 0.0127 \pm 0.0036$.

$\Gamma_i\Gamma_f/\Gamma^2_{total}$ in $p\overline{p} \to \eta_c(1S) \to \gamma\gamma$ $\Gamma_{16}\Gamma_{20}/\Gamma^2$

VALUE (units 10^{-6})	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{0.68^{+0.42}_{-0.31}}$	12	BAGLIN	87B	SPEC	$\overline{p}p \to \gamma\gamma$

$\eta_c(1S)$ REFERENCES

ALBRECHT 94H PL B338 390 +Hamacher, Hofmann+ (ARGUS Collab.)
ADRIANI 93N PL B318 575 +Aguilar-Benitez, Ahlen+ (L3 Collab.)
BISELLO 91 NP B350 1 +Busetto+ (DM2 Collab.)
BAI 90B PRL 65 1309 +Blaylock+ (Mark III Collab.)
CHEN 90B PL B243 169 +McIlwain+ (CLEO Collab.)
BAGLIN 89 PL B231 557 +Baird, Bassompierre (R704 Collab.)
BEHREND 89 ZPHY C42 367 +Criegee+ (CELLO Collab.)
BRAUNSCH... 89 ZPHY C41 533 Braunschweig, Bock+ (TASSO Collab.)
AIHARA 88D PRL 60 2355 +Alston-Garnjost+ (TPC Collab.)
BAGLIN 87B PL B187 191 +Baird, Bassompierre, Borreani+ (R704 Collab.)
BALTRUSAIT... 86 PR D33 629 Baltrusaitis, Coffman, Hauser+ (Mark III Collab.)
BERGER 86 PL 167B 120 +Genzel, Lackas, Pielorz+ (PLUTO Collab.)
BLINOV 86 +Blinov, Bondar, Bukin+ (NOVO)
Proc. XXIII Int. HEP Conf., Berkeley, CA (1986); World Scientific, Singapore, 1987, ed. S.C. Loken
GAISER 86 PR D34 711 +Bloom, Bulos, Godfrey+ (Crystal Ball Collab.)
ALTHOFF 85B ZPHY C29 189 +Braunschweig, Kirschfink+ (TASSO Collab.)
BALTRUSAIT... 84 PRL 52 2126 Baltrusaitis+ (CIT, UCSC, ILL, SLAC, WASH) JP
BLOOM 83 ARNS 33 143 +Peck (SLAC, CIT)
HIMEL 80B PRL 45 1146 +Trilling, Abrams, Alam+ (SLAC, LBL, UCB)
PARTRIDGE 80B PRL 45 1150 +Peck+ (CIT, HARV, PRIN, STAN, SLAC)

OTHER RELATED PAPERS

ARMSTRONG 89 PL B221 216 +Benayoun+(CERN, CDEF, BIRM, BARI, ATHU, CURIN+)
BLOOM 79 Fermilab Symp. 92 (CIT, HARV, PRIN, SLAC, STAN)

$J/\psi(1S)$ or $J/\psi(3097)$

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

$J/\psi(1S)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
3096.88±0.04 OUR AVERAGE					
3096.87±0.03±0.03		ARMSTRONG	93B	SPEC	$\overline{p}p \rightarrow e^+e^-$
3096.95±0.1 ±0.3	193	BAGLIN	87	SPEC	$\overline{p}p \rightarrow e^+e^-X$
3098.4 ±2.0	38k	LEMOIGNE	82	GOLI	190 GeV π^- Be $\rightarrow 2\mu$
3096.93±0.09	502	ZHOLENTZ	80	REDE	e^+e^-
3097.0 ±1		[1] BRANDELIK	79C	DASP	e^+e^-

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

$J/\psi(1S)$ WIDTH

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
88 ± 5 OUR AVERAGE				
99 ±12 ±6	ARMSTRONG	93B	SPEC	$\overline{p}p \rightarrow e^+e^-$
$85.5^{+\ 6.1}_{-\ 5.8}$	[2] HSUEH	92	RVUE	See Υ mini-review

[2] Using data from COFFMAN 92, BALDINI-CELIO 75, BOYARSKI 75, ESPOSITO 75B, BRANDELIK 79C.

$J/\psi(1S)$ DECAY MODES

	Mode		Fraction (Γ_i/Γ)	Scale factor/ Confidence level
Γ_1	hadrons		(86.0 ±2.0) %	
Γ_2	virtual $\gamma \rightarrow$ hadrons		(17.0 ±2.0) %	
Γ_3	e^+e^-		(5.99±0.25) %	
Γ_4	$\mu^+\mu^-$		(5.97±0.25) %	S=1.1
	Decays involving hadronic resonances			
Γ_5	$\rho\pi$		(1.28±0.10) %	
Γ_6	$\rho^0\pi^0$		(4.2 ±0.5) $\times 10^{-3}$	
Γ_7	$a_2(1320)\rho$		(1.09±0.22) %	
Γ_8	$\omega\pi^+\pi^+\pi^-\pi^-$		(8.5 ±3.4) $\times 10^{-3}$	
Γ_9	$\omega\pi^+\pi^-$		(7.2 ±1.0) $\times 10^{-3}$	
Γ_{10}	$K^*(892)^0\overline{K}_2^*(1430)^0$ + c.c.		(6.7 ±2.6) $\times 10^{-3}$	
Γ_{11}	$\omega K^*(892)\overline{K}$ + c.c.		(5.3 ±2.0) $\times 10^{-3}$	
Γ_{12}	$\omega f_2(1270)$		(4.3 ±0.6) $\times 10^{-3}$	
Γ_{13}	$K^+\overline{K}^*(892)^-$ + c.c.		(5.0 ±0.4) $\times 10^{-3}$	
Γ_{14}	$K^0\overline{K}^*(892)^0$ + c.c.		(4.2 ±0.4) $\times 10^{-3}$	
Γ_{15}	$\omega\pi^0\pi^0$		(3.4 ±0.8) $\times 10^{-3}$	
Γ_{16}	$b_1(1235)^\pm\pi^\mp$	[a]	(3.0 ±0.5) $\times 10^{-3}$	
Γ_{17}	$\omega K^\pm K_S^0\pi^\mp$	[a]	(3.0 ±0.7) $\times 10^{-3}$	
Γ_{18}	$b_1(1235)^0\pi^0$		(2.3 ±0.6) $\times 10^{-3}$	
Γ_{19}	$\phi K^*(892)\overline{K}$ + c.c.		(2.04±0.28) $\times 10^{-3}$	
Γ_{20}	$\omega K\overline{K}$		(1.9 ±0.4) $\times 10^{-3}$	
Γ_{21}	$\omega f_J(1710) \rightarrow \omega K\overline{K}$		(4.8 ±1.1) $\times 10^{-4}$	
Γ_{22}	$\phi 2(\pi^+\pi^-)$		(1.60±0.32) $\times 10^{-3}$	
Γ_{23}	$\Delta(1232)^{++}\overline{p}\pi^-$		(1.6 ±0.5) $\times 10^{-3}$	
Γ_{24}	$\omega\eta$		(1.58±0.16) $\times 10^{-3}$	
Γ_{25}	$\phi K\overline{K}$		(1.48±0.22) $\times 10^{-3}$	
Γ_{26}	$\phi f_J(1710) \rightarrow \phi K\overline{K}$		(3.6 ±0.6) $\times 10^{-4}$	
Γ_{27}	$p\overline{p}\omega$		(1.30±0.25) $\times 10^{-3}$	S=1.3
Γ_{28}	$\Delta(1232)^{++}\overline{\Delta}(1232)^{--}$		(1.10±0.29) $\times 10^{-3}$	
Γ_{29}	$\Sigma(1385)^-\overline{\Sigma}(1385)^+$ (or c.c.)	[a]	(1.03±0.13) $\times 10^{-3}$	
Γ_{30}	$p\overline{p}\eta'(958)$		(9 ±4) $\times 10^{-4}$	S=1.7

Γ_{31}	$\phi f_2'(1525)$		(8 ±4)	$\times 10^{-4}$	S=2.7
Γ_{32}	$\phi \pi^+ \pi^-$		(8.0 ±1.2)	$\times 10^{-4}$	
Γ_{33}	$\phi K^\pm K_S^0 \pi^\mp$	[a]	(7.2 ±0.9)	$\times 10^{-4}$	
Γ_{34}	$\omega f_1(1420)$		(6.8 ±2.4)	$\times 10^{-4}$	
Γ_{35}	$\phi \eta$		(6.5 ±0.7)	$\times 10^{-4}$	
Γ_{36}	$\Xi(1530)^- \overline{\Xi}^+$		(5.9 ±1.5)	$\times 10^{-4}$	
Γ_{37}	$p K^- \overline{\Sigma}(1385)^0$		(5.1 ±3.2)	$\times 10^{-4}$	
Γ_{38}	$\omega \pi^0$		(4.2 ±0.6)	$\times 10^{-4}$	S=1.4
Γ_{39}	$\phi \eta'(958)$		(3.3 ±0.4)	$\times 10^{-4}$	
Γ_{40}	$\phi f_0(980)$		(3.2 ±0.9)	$\times 10^{-4}$	S=1.9
Γ_{41}	$\Xi(1530)^0 \overline{\Xi}^0$		(3.2 ±1.4)	$\times 10^{-4}$	
Γ_{42}	$\Sigma(1385)^- \overline{\Sigma}^+$ (or c.c.)	[a]	(3.1 ±0.5)	$\times 10^{-4}$	
Γ_{43}	$\phi f_1(1285)$		(2.6 ±0.5)	$\times 10^{-4}$	S=1.1
Γ_{44}	$\rho \eta$		(1.93±0.23)	$\times 10^{-4}$	
Γ_{45}	$\omega \eta'(958)$		(1.67±0.25)	$\times 10^{-4}$	
Γ_{46}	$\omega f_0(980)$		(1.4 ±0.5)	$\times 10^{-4}$	
Γ_{47}	$\rho \eta'(958)$		(1.05±0.18)	$\times 10^{-4}$	
Γ_{48}	$p \overline{p} \phi$		(4.5 ±1.5)	$\times 10^{-5}$	
Γ_{49}	$a_2(1320)^\pm \pi^\mp$	[a]	< 4.3	$\times 10^{-3}$	CL=90%
Γ_{50}	$K \overline{K}_2^*(1430) +$ c.c.		< 4.0	$\times 10^{-3}$	CL=90%
Γ_{51}	$K_2^*(1430)^0 \overline{K}_2^*(1430)^0$		< 2.9	$\times 10^{-3}$	CL=90%
Γ_{52}	$K^*(892)^0 \overline{K}^*(892)^0$		< 5	$\times 10^{-4}$	CL=90%
Γ_{53}	$\phi f_2(1270)$		< 3.7	$\times 10^{-4}$	CL=90%
Γ_{54}	$p \overline{p} \rho$		< 3.1	$\times 10^{-4}$	CL=90%
Γ_{55}	$\phi \eta(1440) \rightarrow \phi \eta \pi \pi$		< 2.5	$\times 10^{-4}$	CL=90%
Γ_{56}	$\omega f_2'(1525)$		< 2.2	$\times 10^{-4}$	CL=90%
Γ_{57}	$\Sigma(1385)^0 \overline{\Lambda}$		< 2	$\times 10^{-4}$	CL=90%
Γ_{58}	$\Delta(1232)^+ \overline{p}$		< 1	$\times 10^{-4}$	CL=90%
Γ_{59}	$\Sigma^0 \overline{\Lambda}$		< 9	$\times 10^{-5}$	CL=90%
Γ_{60}	$\phi \pi^0$		< 6.8	$\times 10^{-6}$	CL=90%

Decays into stable hadrons

Γ_{61}	$2(\pi^+ \pi^-) \pi^0$		(3.37±0.26)	%	
Γ_{62}	$3(\pi^+ \pi^-) \pi^0$		(2.9 ±0.6)	%	
Γ_{63}	$\pi^+ \pi^- \pi^0$		(1.50±0.20)	%	
Γ_{64}	$\pi^+ \pi^- \pi^0 K^+ K^-$		(1.20±0.30)	%	
Γ_{65}	$4(\pi^+ \pi^-) \pi^0$		(9.0 ±3.0)	$\times 10^{-3}$	
Γ_{66}	$\pi^+ \pi^- K^+ K^-$		(7.2 ±2.3)	$\times 10^{-3}$	
Γ_{67}	$K \overline{K} \pi$		(6.1 ±1.0)	$\times 10^{-3}$	
Γ_{68}	$p \overline{p} \pi^+ \pi^-$		(6.0 ±0.5)	$\times 10^{-3}$	S=1.3
Γ_{69}	$2(\pi^+ \pi^-)$		(4.0 ±1.0)	$\times 10^{-3}$	
Γ_{70}	$3(\pi^+ \pi^-)$		(4.0 ±2.0)	$\times 10^{-3}$	
Γ_{71}	$n \overline{n} \pi^+ \pi^-$		(4 ±4)	$\times 10^{-3}$	
Γ_{72}	$\Sigma \overline{\Sigma}$		(3.8 ±0.5)	$\times 10^{-3}$	
Γ_{73}	$2(\pi^+ \pi^-) K^+ K^-$		(3.1 ±1.3)	$\times 10^{-3}$	
Γ_{74}	$p \overline{p} \pi^+ \pi^- \pi^0$	[b]	(2.3 ±0.9)	$\times 10^{-3}$	S=1.9
Γ_{75}	$p \overline{p}$		(2.14±0.10)	$\times 10^{-3}$	
Γ_{76}	$p \overline{p} \eta$		(2.09±0.18)	$\times 10^{-3}$	
Γ_{77}	$p \overline{n} \pi^-$		(2.00±0.10)	$\times 10^{-3}$	
Γ_{78}	$n \overline{n}$		(1.9 ±0.5)	$\times 10^{-3}$	
Γ_{79}	$\Xi \overline{\Xi}$		(1.8 ±0.4)	$\times 10^{-3}$	S=1.8
Γ_{80}	$\Lambda \overline{\Lambda}$		(1.35±0.14)	$\times 10^{-3}$	S=1.2
Γ_{81}	$p \overline{p} \pi^0$		(1.09±0.09)	$\times 10^{-3}$	
Γ_{82}	$\Lambda \overline{\Sigma}^- \pi^+$ (or c.c.)	[a]	(1.06±0.12)	$\times 10^{-3}$	
Γ_{83}	$p K^- \overline{\Lambda}$		(8.9 ±1.6)	$\times 10^{-4}$	
Γ_{84}	$2(K^+ K^-)$		(7.0 ±3.0)	$\times 10^{-4}$	

Γ_{85}	$p K^- \overline{\Sigma}^0$	(2.9 ±0.8) × 10^{-4}		
Γ_{86}	$K^+ K^-$	(2.37±0.31) × 10^{-4}		
Γ_{87}	$\Lambda\overline{\Lambda}\pi^0$	(2.2 ±0.7) × 10^{-4}		
Γ_{88}	$\pi^+ \pi^-$	(1.47±0.23) × 10^{-4}		
Γ_{89}	$K^0_S K^0_L$	(1.08±0.14) × 10^{-4}		
Γ_{90}	$\Lambda\overline{\Sigma}$ + c.c.	< 1.5	× 10^{-4}	CL=90%
Γ_{91}	$K^0_S K^0_S$	< 5.2	× 10^{-6}	CL=90%

Radiative decays

Γ_{92}	$\gamma\eta_c(1S)$		(1.3 ±0.4) %		
Γ_{93}	$\gamma\pi^+\pi^- 2\pi^0$		(8.3 ±3.1) × 10^{-3}		
Γ_{94}	$\gamma\eta\pi\pi$		(6.1 ±1.0) × 10^{-3}		
Γ_{95}	$\gamma\eta(1440) \to \gamma K\overline{K}\pi$	[c]	(9.1 ±1.8) × 10^{-4}		
Γ_{96}	$\gamma\eta(1440) \to \gamma\gamma\rho^0$		(6.4 ±1.4) × 10^{-5}		
Γ_{97}	$\gamma\rho\rho$		(4.5 ±0.8) × 10^{-3}		
Γ_{98}	$\gamma\eta'(958)$		(4.31±0.30) × 10^{-3}		
Γ_{99}	$\gamma 2\pi^+ 2\pi^-$		(2.8 ±0.5) × 10^{-3}		S=1.9
Γ_{100}	$\gamma f_4(2050)$		(2.7 ±0.7) × 10^{-3}		
Γ_{101}	$\gamma\omega\omega$		(1.59±0.33) × 10^{-3}		
Γ_{102}	$\gamma\eta(1440) \to \gamma\rho^0\rho^0$		(1.4 ±0.4) × 10^{-3}		
Γ_{103}	$\gamma f_2(1270)$		(1.38±0.14) × 10^{-3}		
Γ_{104}	$\gamma f_J(1710) \to \gamma K\overline{K}$		(9.7 ±1.2) × 10^{-4}		
Γ_{105}	$\gamma\eta$		(8.6 ±0.8) × 10^{-4}		
Γ_{106}	$\gamma f_1(1420) \to \gamma K\overline{K}\pi$		(8.3 ±1.5) × 10^{-4}		
Γ_{107}	$\gamma f_1(1285)$		(6.5 ±1.0) × 10^{-4}		
Γ_{108}	$\gamma f'_2(1525)$		(6.3 ±1.0) × 10^{-4}		
Γ_{109}	$\gamma\phi\phi$		(4.0 ±1.2) × 10^{-4}		S=2.1
Γ_{110}	$\gamma p\overline{p}$		(3.8 ±1.0) × 10^{-4}		
Γ_{111}	$\gamma\eta(2225)$		(2.9 ±0.6) × 10^{-4}		
Γ_{112}	$\gamma\eta(1760) \to \gamma\rho^0\rho^0$		(1.3 ±0.9) × 10^{-4}		
Γ_{113}	$\gamma\pi^0$		(3.9 ±1.3) × 10^{-5}		
Γ_{114}	$\gamma p\overline{p}\pi^+\pi^-$		< 7.9	× 10^{-4}	CL=90%
Γ_{115}	$\gamma\gamma$		< 5	× 10^{-4}	CL=90%
Γ_{116}	$\gamma\Lambda\overline{\Lambda}$		< 1.3	× 10^{-4}	CL=90%
Γ_{117}	3γ		< 5.5	× 10^{-5}	CL=90%
Γ_{118}	$\gamma f_0(2200)$				
Γ_{119}	$\gamma f_4(2220)$				
Γ_{120}	$\gamma X(1400)$				

[a] The value is for the sum of the charge states indicated.

[b] Includes $p\overline{p}\pi^+\pi^-\gamma$ and excludes $p\overline{p}\eta$, $p\overline{p}\omega$, $p\overline{p}\eta'$.

[c] See the "Note on the $\eta(1440)$" in the $\eta(1440)$ Full Listings.

$J/\psi(1S)$ PARTIAL WIDTHS

Γ(hadrons) — Γ_1

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
59±24	BALDINI-...	75	FRAG	e^+e^-
59±14	BOYARSKI	75	MRK1	e^+e^-
50±25	ESPOSITO	75B	FRAM	e^+e^-

Γ(virtual γ → hadrons) — Γ_2

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
12 ±2	[3] BOYARSKI	75	MRK1	e^+e^-

[3] Included in Γ(hadrons).

$\Gamma(e^+e^-)$ Γ_3

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
5.26±0.37 OUR EVALUATION				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$5.36^{+0.29}_{-0.28}$	[4] HSUEH	92	RVUE	See Υ mini-review
4.72±0.35	ALEXANDER	89	RVUE	See Υ mini-review
4.4 ±0.6	[4] BRANDELIK	79C	DASP	e^+e^-
4.6 ±0.8	[5] BALDINI-...	75	FRAG	e^+e^-
4.8 ±0.6	BOYARSKI	75	MRK1	e^+e^-
4.6 ±1.0	ESPOSITO	75B	FRAM	e^+e^-

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

[5] Assuming equal partial widths for e^+e^- and $\mu^+\mu^-$.

$\Gamma(\mu^+\mu^-)$ Γ_4

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
4.8±0.6	BOYARSKI	75	MRK1	e^+e^-
5.0±1.0	ESPOSITO	75B	FRAM	e^+e^-

$\Gamma(\gamma\gamma)$ Γ_{115}

VALUE (eV)	CL%	DOCUMENT ID		TECN	COMMENT
<5.4	90	BRANDELIK	79C	DASP	e^+e^-

$J/\psi(1S)$ $\Gamma(i)\Gamma(e^+e^-)/\Gamma(total)$

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.

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

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
4 ±0.8	[7] BALDINI-...	75	FRAG	e^+e^-
3.9±0.8	[7] ESPOSITO	75B	FRAM	e^+e^-

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

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.35±0.02	BRANDELIK	79C	DASP	e^+e^-
0.32±0.07	[7] BALDINI-...	75	FRAG	e^+e^-
0.34±0.14	BEMPORAD	75	FRAB	e^+e^-
0.34±0.09	[7] ESPOSITO	75B	FRAM	e^+e^-
0.36±0.10	[7] FORD	75	SPEC	e^+e^-

$\Gamma(\mu^+\mu^-) \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ $\Gamma_4\Gamma_3/\Gamma$

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.31±0.09	BEMPORAD	75	FRAB	e^+e^-
0.51±0.09	DASP	75	DASP	e^+e^-
0.38±0.05	[7] ESPOSITO	75B	FRAM	e^+e^-
0.46±0.10	[7] LIBERMAN	75	SPEC	e^+e^-

$\Gamma(p\overline{p}) \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ $\Gamma_{75}\Gamma_3/\Gamma$

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
9.7±1.7	[6] ARMSTRONG	93B	SPEC	$\overline{p}p \rightarrow e^+e^-$

[6] Using $\Gamma_{\text{total}} = 85.5^{+6.1}_{-5.8}$ MeV.

[7] Data redundant with branching ratios or partial widths above.

$J/\psi(1S)$ BRANCHING RATIOS

For the first four branching ratios, see also the partial widths, and (partial widths) $\times \Gamma(e^+e^-)/\Gamma_{total}$ above.

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

VALUE	DOCUMENT ID		TECN	COMMENT
0.86 ±0.02	BOYARSKI	75	MRK1	e^+e^-

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

VALUE	DOCUMENT ID		TECN	COMMENT
0.17 ±0.02	[8] BOYARSKI	75	MRK1	e^+e^-

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

$\Gamma(e^+e^-)/\Gamma_{total}$ Γ_3/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.0599±0.0025 OUR AVERAGE				
0.0592±0.0015±0.0020	COFFMAN	92	MRK3	$\psi(2S) \to J/\psi\pi^+\pi^-$
0.069 ±0.009	BOYARSKI	75	MRK1	e^+e^-

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

VALUE	DOCUMENT ID		TECN	COMMENT
0.0597±0.0025 OUR AVERAGE	Error includes scale factor of 1.1.			
0.0590±0.0015±0.0019	COFFMAN	92	MRK3	$\psi(2S) \to J/\psi\pi^+\pi^-$
0.069 ±0.009	BOYARSKI	75	MRK1	e^+e^-

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

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1.00±0.05	BOYARSKI	75	MRK1	e^+e^-
0.91±0.15	ESPOSITO	75B	FRAM	e^+e^-
0.93±0.10	FORD	75	SPEC	e^+e^-

HADRONIC DECAYS

$\Gamma(\rho\pi)/\Gamma_{total}$ Γ_5/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.0128±0.0010 OUR AVERAGE					
0.0142±0.0001±0.0019		COFFMAN	88	MRK3	e^+e^-
0.013 ±0.003	150	FRANKLIN	83	MRK2	e^+e^-
0.016 ±0.004	183	ALEXANDER	78	PLUT	e^+e^-
0.0133±0.0021		BRANDELIK	78B	DASP	e^+e^-
0.010 ±0.002	543	BARTEL	76	CNTR	e^+e^-
0.013 ±0.003	153	JEAN-MARIE	76	MRK1	e^+e^-

$\Gamma(\rho^0\pi^0)/\Gamma(\rho\pi)$ Γ_6/Γ_5

VALUE	DOCUMENT ID		TECN	COMMENT
0.328±0.005±0.027	COFFMAN	88	MRK3	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.36 ±0.03	SCHARRE	79B	MRK1	e^+e^-
0.35 ±0.08	ALEXANDER	78	PLUT	e^+e^-
0.32 ±0.08	BRANDELIK	78B	DASP	e^+e^-
0.39 ±0.11	BARTEL	76	CNTR	e^+e^-
0.37 ±0.09	JEAN-MARIE	76	MRK1	e^+e^-

$\Gamma(a_2(1320)\rho)/\Gamma_{total}$ Γ_7/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
10.9±2.2 OUR AVERAGE					
11.7±0.7±2.5	7584	AUGUSTIN	89	DM2	$J/\psi \to \rho^0\rho^\pm\pi^\mp$
8.4±4.5	36	VANNUCCI	77	MRK1	$e^+e^- \to 2(\pi^+\pi^-)\pi^0$

$\Gamma(\omega\pi^+\pi^+\pi^-\pi^-)/\Gamma_{total}$ Γ_8/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
85±34	140	VANNUCCI	77	MRK1	$e^+e^- \to 3(\pi^+\pi^-)\pi^0$

$\Gamma(\omega\pi^+\pi^-)/\Gamma_{total}$ Γ_9/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
7.2±1.0 OUR AVERAGE					
7.0±1.6	18058	AUGUSTIN	89	DM2	$J/\psi \to 2(\pi^+\pi^-)\pi^0$
7.8±1.6	215	BURMESTER	77D	PLUT	e^+e^-
6.8±1.9	348	VANNUCCI	77	MRK1	$e^+e^- \to 2(\pi^+\pi^-)\pi^0$

$\Gamma(\omega\pi^+\pi^-)/\Gamma(2(\pi^+\pi^-)\pi^0)$ Γ_9/Γ_{61}

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.3	[9] JEAN-MARIE	76	MRK1	e^+e^-

[9] Final state $(\pi^+\pi^-)\pi^0$ under the assumption that $\pi\pi$ is isospin 0.

$\Gamma(K^*(892)^0\overline{K}_2^*(1430)^0 + c.c.)/\Gamma_{total}$ Γ_{10}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
67±26	40	VANNUCCI	77	MRK1	$e^+e^- \to \pi^+\pi^- K^+K^-$

$\Gamma(\omega K^*(892)\overline{K} + c.c.)/\Gamma_{total}$ Γ_{11}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
53±14±14	530± 140	BECKER	87	MRK3	$e^+e^- \to$ hadrons

$\Gamma(\omega f_2(1270))/\Gamma_{total}$ Γ_{12}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
4.3±0.6 OUR AVERAGE					
4.3±0.2±0.6	5860	AUGUSTIN	89	DM2	e^+e^-
4.0±1.6	70	BURMESTER	77D	PLUT	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1.9±0.8	81	VANNUCCI	77	MRK1	$e^+e^- \to 2(\pi^+\pi^-)\pi^0$

$\Gamma(K^+\overline{K}^*(892)^- + c.c.)/\Gamma_{total}$ Γ_{13}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
5.0 ±0.4 OUR AVERAGE					
4.57±0.17±0.70	2285	JOUSSET	90	DM2	$J/\psi \to$ hadrons
5.26±0.13±0.53		COFFMAN	88	MRK3	$J/\psi \to K^\pm K^0_S \pi^\mp$, $K^+K^-\pi^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.6 ±0.6	24	FRANKLIN	83	MRK2	$J/\psi \to K^+K^-\pi^0$
3.2 ±0.6	48	VANNUCCI	77	MRK1	$J/\psi \to K^\pm K^0_S \pi^\mp$
4.1 ±1.2	39	BRAUNSCH...	76	DASP	$J/\psi \to K^\pm X$

$\Gamma(K^0\overline{K}^*(892)^0 + c.c.)/\Gamma_{total}$ Γ_{14}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
4.2 ±0.4 OUR AVERAGE					
3.96±0.15±0.60	1192	JOUSSET	90	DM2	$J/\psi \to$ hadrons
4.33±0.12±0.45		COFFMAN	88	MRK3	$J/\psi \to K^\pm K^0_S \pi^\mp$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.7 ±0.6	45	VANNUCCI	77	MRK1	$J/\psi \to K^\pm K^0_S \pi^\mp$

$\Gamma(K^0\overline{K}^*(892)^0 + c.c.)/\Gamma(K^+\overline{K}^*(892)^- + c.c.)$ Γ_{14}/Γ_{13}

VALUE	DOCUMENT ID		TECN	COMMENT
0.82±0.05±0.09	COFFMAN	88	MRK3	$J/\psi \to K\overline{K}^*(892)+c.c.$

$\Gamma(\omega\pi^0\pi^0)/\Gamma_{total}$ Γ_{15}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
3.4±0.3±0.7	509	AUGUSTIN	89	DM2	$J/\psi \to \pi^+\pi^- 3\pi^0$

$\Gamma(b_1(1235)^\pm\pi^\mp)/\Gamma_{total}$ Γ_{16}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
30±5 OUR AVERAGE					
31±6	4600	AUGUSTIN	89	DM2	$J/\psi \to 2(\pi^+\pi^-)\pi^0$
29±7	87	BURMESTER	77D	PLUT	e^+e^-

$\Gamma(\omega K^{\pm} K_S^0 \pi^{\mp})/\Gamma_{total}$ Γ_{17}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
29.5±1.4±7.0	879±41	BECKER	87	MRK3	$e^+e^- \rightarrow$ hadrons

$\Gamma(b_1(1235)^0\pi^0)/\Gamma_{total}$ Γ_{18}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
23±3±5	229	AUGUSTIN	89	DM2	e^+e^-

$\Gamma(\phi K^*(892)\overline{K}+\text{c.c.})/\Gamma_{total}$ Γ_{19}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
20.4±2.8 OUR AVERAGE					
20.7±2.4±3.0		FALVARD	88	DM2	$J/\psi \rightarrow$ hadrons
20 ±3 ±3	155±20	BECKER	87	MRK3	$e^+e^- \rightarrow$ hadrons

$\Gamma(\omega K\overline{K})/\Gamma_{total}$ Γ_{20}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
19 ± 4 OUR AVERAGE					
19.8± 2.1±3.9		[10] FALVARD	88	DM2	$J/\psi \rightarrow$ hadrons
16 ±10	22	FELDMAN	77	MRK1	e^+e^-

[10] Addition of ωK^+K^- and $\omega K^0\overline{K}^0$ branching ratios.

$\Gamma(\omega f_J(1710) \rightarrow \omega K\overline{K})/\Gamma_{total}$ Γ_{21}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
4.8±1.1±0.3	[11,12] FALVARD	88	DM2	$J/\psi \rightarrow$ hadrons

[11] Includes unknown branching fraction $f_J(1710) \rightarrow K\overline{K}$.
[12] Addition of $f_J(1710) \rightarrow K^+K^-$ and $f_J(1710) \rightarrow K^0\overline{K}^0$ branching ratios.

$\Gamma(\phi 2(\pi^+\pi^-))/\Gamma_{total}$ Γ_{22}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
16.0±1.0±3.0	FALVARD	88	DM2	$J/\psi \rightarrow$ hadrons

$\Gamma(\Delta(1232)^{++}\overline{p}\pi^-)/\Gamma_{total}$ Γ_{23}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.58±0.23±0.40	332	EATON	84	MRK2	e^+e^-

$\Gamma(\omega\eta)/\Gamma_{total}$ Γ_{24}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.58±0.16 OUR AVERAGE					
1.43±0.10±0.21	378	JOUSSET	90	DM2	$J/\psi \rightarrow$ hadrons
1.71±0.08±0.20		COFFMAN	88	MRK3	$e^+e^- \rightarrow 3\pi\eta$

$\Gamma(\phi K\overline{K})/\Gamma_{total}$ Γ_{25}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
14.8±2.2 OUR AVERAGE					
14.6±0.8±2.1		[13] FALVARD	88	DM2	$J/\psi \rightarrow$ hadrons
18 ±8	14	FELDMAN	77	MRK1	e^+e^-

[13] Addition of ϕK^+K^- and $\phi K^0\overline{K}^0$ branching ratios.

$\Gamma(\phi f_J(1710) \rightarrow \phi K\overline{K})/\Gamma_{total}$ Γ_{26}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
3.6± .2±0.6	[14,15] FALVARD	88	DM2	$J/\psi \rightarrow$ hadrons

[14] Including interference with $f_2'(1525)$.
[15] Includes unknown branching fraction $f_J(1710) \rightarrow K\overline{K}$.

$\Gamma(p\overline{p}\omega)/\Gamma_{total}$ Γ_{27}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.30±0.25 OUR AVERAGE Error includes scale factor of 1.3.					
1.10±0.17±0.18	486	EATON	84	MRK2	e^+e^-
1.6 ±0.3	77	PERUZZI	78	MRK1	e^+e^-

$\Gamma(\Delta(1232)^{++}\overline{\Delta}(1232)^{--})/\Gamma_{total}$ Γ_{28}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.10±0.09±0.28	233	EATON	84	MRK2	e^+e^-

$\Gamma(\Sigma(1385)^-\overline{\Sigma}(1385)^+ \text{(or c.c.)})/\Gamma_{total}$ Γ_{29}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.03±0.13 OUR AVERAGE					
1.00±0.04±0.21	631±25	HENRARD	87	DM2	$e^+e^- \to \Sigma^{*-}$
1.19±0.04±0.25	754±27	HENRARD	87	DM2	$e^+e^- \to \Sigma^{*+}$
0.86±0.18±0.22	56	EATON	84	MRK2	$e^+e^- \to \Sigma^{*-}$
1.03±0.24±0.25	68	EATON	84	MRK2	$e^+e^- \to \Sigma^{*+}$

$\Gamma(p\overline{p}\eta'(958))/\Gamma_{total}$ Γ_{30}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.9 ±0.4 OUR AVERAGE Error includes scale factor of 1.7.					
0.68±0.23±0.17	19	EATON	84	MRK2	e^+e^-
1.8 ±0.6	19	PERUZZI	78	MRK1	e^+e^-

$\Gamma(\phi f_2'(1525))/\Gamma_{total}$ Γ_{31}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
8 ±4 OUR AVERAGE Error includes scale factor of 2.7.					
12.3±0.6±2.0	[16,17]	FALVARD	88	DM2	$J/\psi \to$ hadrons
4.8±1.8	46	[16] GIDAL	81	MRK2	$J/\psi \to K^+K^-K^+K^-$

[16] Re-evaluated using $B(f_2'(1525) \to K\overline{K}) = 0.713$.

[17] Including interference with $f_J(1710)$.

$\Gamma(\phi\pi^+\pi^-)/\Gamma_{total}$ Γ_{32}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.80±0.12 OUR AVERAGE					
0.78±0.03±0.12		FALVARD	88	DM2	$J/\psi \to$ hadrons
2.1 ±0.9	23	FELDMAN	77	MRK1	e^+e^-

$\Gamma(\phi K^\pm K_S^0\pi^\mp)/\Gamma_{total}$ Γ_{33}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
7.2±0.9 OUR AVERAGE					
7.4±0.9±1.1		FALVARD	88	DM2	$J/\psi \to$ hadrons
7 ±0.6±1.0	163±15	BECKER	87	MRK3	$e^+e^- \to$ hadrons

$\Gamma(\omega f_1(1420))/\Gamma_{total}$ Γ_{34}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
$6.8^{+1.9}_{-1.6}\pm1.7$	111^{+31}_{-26}	BECKER	87	MRK3	$e^+e^- \to$ hadrons

$\Gamma(\phi\eta)/\Gamma_{total}$ Γ_{35}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.65 ±0.07 OUR AVERAGE					
0.64 ±0.04 ±0.11	346	JOUSSET	90	DM2	$J/\psi \to$ hadrons
0.661±0.045±0.078		COFFMAN	88	MRK3	$e^+e^- \to K^+K^-\eta$

$\Gamma(\Xi(1530)^-\overline{\Xi}^+)/\Gamma_{total}$ Γ_{36}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.59±0.09±0.12	75 ± 11	HENRARD	87	DM2	e^+e^-

$\Gamma(pK^-\overline{\Sigma}(1385)^0)/\Gamma_{total}$ Γ_{37}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.51±0.26±0.18	89	EATON	84	MRK2	e^+e^-

$\Gamma(\omega\pi^0)/\Gamma_{total}$ Γ_{38}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.42 ±0.06 OUR AVERAGE Error includes scale factor of 1.4.					
0.360±0.028±0.054	222	JOUSSET	90	DM2	$J/\psi \to$ hadrons
0.482±0.019±0.064		COFFMAN	88	MRK3	$e^+e^- \to \pi^0\pi^+\pi^-\pi^0$

$\Gamma(\phi\eta'(958))/\Gamma_{total}$ Γ_{39}/Γ

VALUE (units 10^{-3})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.33 ±0.04 OUR AVERAGE						
0.41 ±0.03 ±0.08		167	JOUSSET	90	DM2	$J/\psi \to$ hadrons
0.308±0.034±0.036			COFFMAN	88	MRK3	$e^+e^- \to K^+K^-\eta'$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<1.3	90		VANNUCCI	77	MRK1	e^+e^-

$\Gamma(\phi f_0(980))/\Gamma_{total}$ Γ_{40}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
3.2±0.9 OUR AVERAGE Error includes scale factor of 1.9.					
4.6±0.4±0.8		[18] FALVARD	88	DM2	$J/\psi \to$ hadrons
2.6±0.6	50	[18] GIDAL	81	MRK2	$J/\psi \to K^+K^-K^+K^-$

[18] Assuming B($f_0(980) \to \pi\pi$) = 0.78.

$\Gamma(\Xi(1530)^0\overline{\Xi}^0)/\Gamma_{total}$ Γ_{41}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.32±0.12±0.07	24 ± 9	HENRARD	87	DM2	e^+e^-

$\Gamma(\Sigma(1385)^-\overline{\Sigma}^+ (\text{or c.c.}))/\Gamma_{total}$ Γ_{42}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.31±0.05 OUR AVERAGE					
0.30±0.03±0.07	74 ± 8	HENRARD	87	DM2	$e^+e^- \to \Sigma^{*-}$
0.34±0.04±0.07	77 ± 9	HENRARD	87	DM2	$e^+e^- \to \Sigma^{*+}$
0.29±0.11±0.10	26	EATON	84	MRK2	$e^+e^- \to \Sigma^{*-}$
0.31±0.11±0.11	28	EATON	84	MRK2	$e^+e^- \to \Sigma^{*+}$

$\Gamma(\phi f_1(1285))/\Gamma_{total}$ Γ_{43}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
2.6±0.5 OUR AVERAGE Error includes scale factor of 1.1.					
3.2±0.6±0.4		JOUSSET	90	DM2	$J/\psi \to \phi 2(\pi^+\pi^-)$
2.1±0.5±0.4	25	[19] JOUSSET	90	DM2	$J/\psi \to \phi\eta\pi^+\pi^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.6±0.2±0.1	16 ± 6	BECKER	87	MRK3	$J/\psi \to \phi K\overline{K}\pi$

[19] We attrribute to the $f_1(1285)$ the signal observed in the $\pi^+\pi^-\eta$ invariant mass distribution at 1297 Mev.

$\Gamma(\rho\eta)/\Gamma_{total}$ Γ_{44}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.193±0.023 OUR AVERAGE					
0.194±0.017±0.029	299	JOUSSET	90	DM2	$J/\psi \to$ hadrons
0.193±0.013±0.029		COFFMAN	88	MRK3	$e^+e^- \to \pi^+\pi^-\eta$

$\Gamma(\omega\eta'(958))/\Gamma_{total}$ Γ_{45}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.167±0.025 OUR AVERAGE					
$0.18\ ^{+0.10}_{-0.08}\ \pm0.03$	6	JOUSSET	90	DM2	$J/\psi \to$ hadrons
0.166±0.017±0.019		COFFMAN	88	MRK3	$e^+e^- \to 3\pi\eta'$

$\Gamma(\omega f_0(980))/\Gamma_{total}$ Γ_{46}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
1.41±0.27±0.47	[20] AUGUSTIN	89	DM2	$J/\psi \to 2(\pi^+\pi^-)\pi^0$

[20] Assuming B($f_0(980) \to \pi\pi$) = 0.78.

$\Gamma(\rho\eta'(958))/\Gamma_{total}$ Γ_{47}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.105±0.018 OUR AVERAGE					
0.083±0.030±0.012	19	JOUSSET	90	DM2	$J/\psi \to$ hadrons
0.114±0.014±0.016		COFFMAN	88	MRK3	$J/\psi \to \pi^+\pi^-\eta'$

$\Gamma(p\overline{p}\phi)/\Gamma_{total}$ Γ_{48}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
0.45±0.13±0.07	FALVARD	88	DM2	$J/\psi \rightarrow$ hadrons

$\Gamma(a_2(1320)^{\pm}\pi^{\mp})/\Gamma_{total}$ Γ_{49}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<43	90	BRAUNSCH...	76	DASP	e^+e^-

$\Gamma(K\overline{K}_2^*(1430)+\text{c.c.})/\Gamma_{total}$ Γ_{50}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<40	90	VANNUCCI	77	MRK1	$e^+e^- \rightarrow K^0\overline{K}_2^{*0}$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<66	90	BRAUNSCH...	76	DASP	$e^+e^- \rightarrow K^{\pm}\overline{K}_2^{*\mp}$

$\Gamma(K_2^*(1430)^0\overline{K}_2^*(1430)^0)/\Gamma_{total}$ Γ_{51}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<29	90	VANNUCCI	77	MRK1	$e^+e^- \rightarrow \pi^+\pi^-K^+K^-$

$\Gamma(K^*(892)^0\overline{K}^*(892)^0)/\Gamma_{total}$ Γ_{52}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<5	90	VANNUCCI	77	MRK1	$e^+e^- \rightarrow \pi^+\pi^-K^+K^-$

$\Gamma(\phi f_2(1270))/\Gamma_{total}$ Γ_{53}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<3.7	90	VANNUCCI	77	MRK1	$e^+e^- \rightarrow \pi^+\pi^-K^+K^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<4.5	90	FALVARD	88	DM2	$J/\psi \rightarrow$ hadrons

$\Gamma(p\overline{p}\rho)/\Gamma_{total}$ Γ_{54}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<0.31	90	EATON	84	MRK2	$e^+e^- \rightarrow$ hadronsγ

$\Gamma(\phi\eta(1440) \rightarrow \phi\eta\pi\pi)/\Gamma_{total}$ Γ_{55}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<2.5	90	[21] FALVARD	88	DM2	$J/\psi \rightarrow$ hadrons

[21] Includes unknown branching fraction $\eta(1440) \rightarrow \eta\pi\pi$.

$\Gamma(\omega f_2'(1525))/\Gamma_{total}$ Γ_{56}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<2.2	90	[22] VANNUCCI	77	MRK1	$e^+e^- \rightarrow \pi^+\pi^-\pi^0K^+K^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<2.8	90	[22] FALVARD	88	DM2	$J/\psi \rightarrow$ hadrons

[22] Re-evaluated assuming $B(f_2'(1525) \rightarrow K\overline{K}) = 0.713$.

$\Gamma(\Sigma(1385)^0\overline{\Lambda})/\Gamma_{total}$ Γ_{57}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<0.2	90	HENRARD	87	DM2	e^+e^-

$\Gamma(\Delta(1232)^+\overline{p})/\Gamma_{total}$ Γ_{58}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<0.1	90	HENRARD	87	DM2	e^+e^-

$\Gamma(\Sigma^0\overline{\Lambda})/\Gamma_{total}$ Γ_{59}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<0.9	90	HENRARD	87	DM2	e^+e^-

$\Gamma(\phi\pi^0)/\Gamma_{total}$ Γ_{60}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<0.068	90	COFFMAN	88	MRK3	$e^+e^- \rightarrow K^+K^-\pi^0$

$\Gamma(2(\pi^+\pi^-)\pi^0)/\Gamma_{total}$ Γ_{61}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.0337±0.0026 OUR AVERAGE					
0.0325±0.0049	46055	AUGUSTIN	89	DM2	$J/\psi \rightarrow 2(\pi^+\pi^-)\pi^0$
0.0317±0.0042	147	FRANKLIN	83	MRK2	$e^+e^- \rightarrow$ hadrons
0.0364±0.0052	1500	BURMESTER	77D	PLUT	e^+e^-
0.04 ±0.01	675	JEAN-MARIE	76	MRK1	e^+e^-

$\Gamma(3(\pi^+\pi^-)\pi^0)/\Gamma_{total}$ Γ_{62}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.029±0.006 OUR AVERAGE					
0.028±0.009	11	FRANKLIN	83	MRK2	$e^+e^- \rightarrow$ hadrons
0.029±0.007	181	JEAN-MARIE	76	MRK1	e^+e^-

$\Gamma(\pi^+\pi^-\pi^0)/\Gamma_{total}$ Γ_{63}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.015 ±0.002	168	FRANKLIN	83	MRK2	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.0149±0.0022		EINSWEILER	83	MRK3	e^+e^-

$\Gamma(\pi^+\pi^-\pi^0K^+K^-)/\Gamma_{total}$ Γ_{64}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.012 ±0.003	309	VANNUCCI	77	MRK1	e^+e^-

$\Gamma(4(\pi^+\pi^-)\pi^0)/\Gamma_{total}$ Γ_{65}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
90±30	13	JEAN-MARIE	76	MRK1	e^+e^-

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

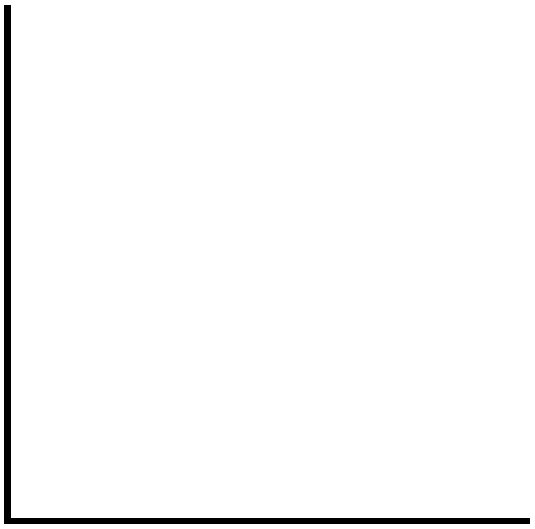
VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
72±23	205	VANNUCCI	77	MRK1	e^+e^-

$\Gamma(K\overline{K}\pi)/\Gamma_{total}$ Γ_{67}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
61 ±10 OUR AVERAGE					
55.2±12.0	25	FRANKLIN	83	MRK2	$e^+e^- \rightarrow K^+K^-\pi^0$
78.0±21.0	126	VANNUCCI	77	MRK1	$e^+e^- \rightarrow K^0_S K^\pm \pi^\mp$

$\Gamma(p\overline{p}\pi^+\pi^-)/\Gamma_{total}$ Γ_{68}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
6.0 ±0.5 OUR AVERAGE Error includes scale factor of 1.3. See the ideogram below.					
6.46±0.17±0.43	1435	EATON	84	MRK2	e^+e^-
3.8 ±1.6	48	BESCH	81	BONA	e^+e^-
5.5 ±0.6	533	PERUZZI	78	MRK1	e^+e^-



$\Gamma\left(p\overline{p}\pi^+\pi^-\right)/\Gamma_{\text{total}}$ (units 10^{-3})

$\Gamma(2(\pi^+\pi^-))/\Gamma_{\text{total}}$ **Γ_{69}/Γ**

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.004 ±0.001	76	JEAN-MARIE	76	MRK1	e^+e^-

$\Gamma(3(\pi^+\pi^-))/\Gamma_{\text{total}}$ **Γ_{70}/Γ**

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
40±20	32	JEAN-MARIE	76	MRK1	e^+e^-

$\Gamma(n\overline{n}\pi^+\pi^-)/\Gamma_{\text{total}}$ **Γ_{71}/Γ**

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
3.8±3.6	5	BESCH	81	BONA	e^+e^-

$\Gamma(\Sigma\overline{\Sigma})/\Gamma_{\text{total}}$ **Γ_{72}/Γ**

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
3.8 ±0.5 OUR AVERAGE					
3.18±0.12±0.69	884± 30	PALLIN	87	DM2	e^+e^-
4.74±0.48±0.75	90	EATON	84	MRK2	$e^+e^- \rightarrow \Sigma^0\overline{\Sigma}^0$
7.2 ±7.8	3	BESCH	81	BONA	$e^+e^- \rightarrow \Sigma^+\overline{\Sigma}^-$
3.9 ±1.2	52	PERUZZI	78	MRK1	$e^+e^- \rightarrow \Sigma^0\overline{\Sigma}^0$

$\Gamma(2(\pi^+\pi^-)K^+K^-)/\Gamma_{\text{total}}$ **Γ_{73}/Γ**

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
31±13	30	VANNUCCI	77	MRK1	e^+e^-

$\Gamma(p\overline{p}\pi^+\pi^-\pi^0)/\Gamma_{\text{total}}$ **Γ_{74}/Γ**

Including $p\overline{p}\pi^+\pi^-\gamma$ and excluding ω, η, η'

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
2.3 ±0.9 OUR AVERAGE Error includes scale factor of 1.9.					
3.36±0.65±0.28	364	EATON	84	MRK2	e^+e^-
1.6 ±0.6	39	PERUZZI	78	MRK1	e^+e^-

$\Gamma(p\overline{p})/\Gamma_{\text{total}}$ Γ_{75}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
2.14±0.10 OUR AVERAGE					
2.0 ±0.3	48	ANTONELLI	93	SPEC	e^+e^-
1.91±0.04±0.30		PALLIN	87	DM2	e^+e^-
2.16±0.07±0.15	1420	EATON	84	MRK2	e^+e^-
2.5 ±0.4	133	BRANDELIK	79C	DASP	e^+e^-
2.0 ±0.5		BESCH	78	BONA	e^+e^-
2.2 ±0.2	331	[23] PERUZZI	78	MRK1	e^+e^-

[23] Assuming angular distribution $(1+\cos^2\theta)$.

$\Gamma(p\overline{p})/\Gamma(\mu^+\mu^-)$ Γ_{75}/Γ_4

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.051±0.02	20	[24] WIIK	75	PLUT	e^+e^-

[24] Assuming angular distribution $(1+\cos^2\theta)$.

$\Gamma(p\overline{p}\eta)/\Gamma_{\text{total}}$ Γ_{76}/Γ

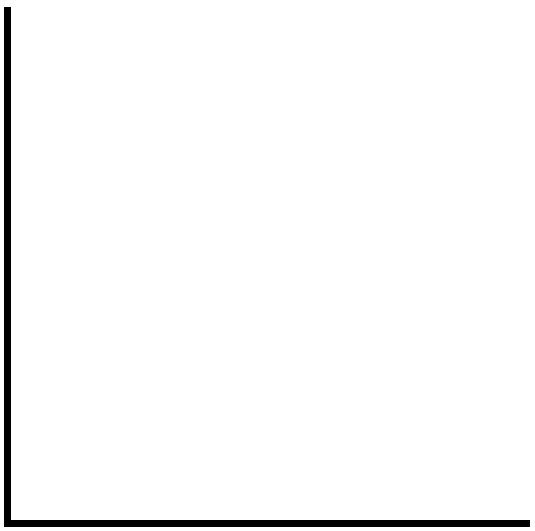
VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
2.09±0.18 OUR AVERAGE					
2.03±0.13±0.15	826	EATON	84	MRK2	e^+e^-
2.5 ±1.2		BRANDELIK	79C	DASP	e^+e^-
2.3 ±0.4	197	PERUZZI	78	MRK1	e^+e^-

$\Gamma(p\overline{n}\pi^-)/\Gamma_{\text{total}}$ Γ_{77}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
2.00±0.10 OUR AVERAGE					
2.02±0.07±0.16	1288	EATON	84	MRK2	$e^+e^- \to p\pi^-$
1.93±0.07±0.16	1191	EATON	84	MRK2	$e^+e^- \to \overline{p}\pi^+$
1.7 ±0.7	32	BESCH	81	BONA	$e^+e^- \to p\pi^-$
1.6 ±1.2	5	BESCH	81	BONA	$e^+e^- \to \overline{p}\pi^+$
2.16±0.29	194	PERUZZI	78	MRK1	$e^+e^- \to p\pi^-$
2.04±0.27	204	PERUZZI	78	MRK1	$e^+e^- \to \overline{p}\pi^+$

$\Gamma(\Xi\overline{\Xi})/\Gamma_{\text{total}}$ Γ_{79}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.8 ±0.4 OUR AVERAGE Error includes scale factor of 1.8. See the ideogram below.					
1.40±0.12±0.24	132±11	HENRARD	87	DM2	$e^+e^- \to \Xi^-\overline{\Xi}^+$
2.28±0.16±0.40	194	EATON	84	MRK2	$e^+e^- \to \Xi^-\overline{\Xi}^+$
3.2 ±0.8	71	PERUZZI	78	MRK1	e^+e^-



$\Gamma(\Xi\overline{\Xi})/\Gamma_{\text{total}}$ (units 10^{-3})

$\Gamma(n\overline{n})/\Gamma_{total}$ Γ_{78}/Γ

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
0.19 ±0.05 OUR AVERAGE					
0.190±0.055	40	ANTONELLI	93	SPEC	e^+e^-
0.18 ±0.09		BESCH	78	BONA	e^+e^-

$\Gamma(\Lambda\overline{\Lambda})/\Gamma_{total}$ Γ_{80}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.35±0.14 OUR AVERAGE Error includes scale factor of 1.2.					
1.38±0.05±0.20	1847	PALLIN	87	DM2	e^+e^-
1.58±0.08±0.19	365	EATON	84	MRK2	e^+e^-
2.6 ±1.6	5	BESCH	81	BONA	e^+e^-
1.1 ±0.2	196	PERUZZI	78	MRK1	e^+e^-

$\Gamma(p\overline{p}\pi^0)/\Gamma_{total}$ Γ_{81}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.09±0.09 OUR AVERAGE					
1.13±0.09±0.09	685	EATON	84	MRK2	e^+e^-
1.4 ±0.4		BRANDELIK	79C	DASP	e^+e^-
1.00±0.15	109	PERUZZI	78	MRK1	e^+e^-

$\Gamma(\Lambda\overline{\Sigma}^-\pi^+(\text{or c.c.}))/\Gamma_{total}$ Γ_{82}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.06±0.12 OUR AVERAGE					
0.90±0.06±0.16	225±15	HENRARD	87	DM2	$e^+e^- \to \Lambda\overline{\Sigma}^+\pi^-$
1.11±0.06±0.20	342±18	HENRARD	87	DM2	$e^+e^- \to \Lambda\overline{\Sigma}^-\pi^+$
1.53±0.17±0.38	135	EATON	84	MRK2	$e^+e^- \to \Lambda\overline{\Sigma}^+\pi^-$
1.38±0.21±0.35	118	EATON	84	MRK2	$e^+e^- \to \Lambda\overline{\Sigma}^-\pi^+$

$\Gamma(pK^-\overline{\Lambda})/\Gamma_{total}$ Γ_{83}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.89±0.07±0.14	307	EATON	84	MRK2	e^+e^-

$\Gamma(2(K^+K^-))/\Gamma_{total}$ Γ_{84}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
7 ±3	VANNUCCI	77	MRK1	e^+e^-

$\Gamma(pK^-\overline{\Sigma}^0)/\Gamma_{total}$ Γ_{85}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.29±0.06±0.05	90	EATON	84	MRK2	e^+e^-

$\Gamma(K^+K^-)/\Gamma_{total}$ Γ_{86}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
2.37±0.31 OUR AVERAGE					
2.39±0.24±0.22	107	BALTRUSAIT...	85D	MRK3	e^+e^-
2.2 ±0.9	6	BRANDELIK	79C	DASP	e^+e^-

$\Gamma(\Lambda\overline{\Lambda}\pi^0)/\Gamma_{total}$ Γ_{87}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.22±0.05±0.05	19 ± 4	HENRARD	87	DM2	e^+e^-

$\Gamma(\pi^+\pi^-)/\Gamma_{total}$ Γ_{88}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
1.47±0.23 OUR AVERAGE					
1.58±0.20±0.15	84	BALTRUSAIT...	85D	MRK3	e^+e^-
1.0 ±0.5	5	BRANDELIK	78B	DASP	e^+e^-
1.6 ±1.6	1	VANNUCCI	77	MRK1	e^+e^-

$\Gamma(K_S^0K_L^0)/\Gamma_{total}$ Γ_{89}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
1.08±0.14 OUR AVERAGE					
1.18±0.12±0.18		JOUSSET	90	DM2	$J/\psi \to$ hadrons
1.01±0.16±0.09	74	BALTRUSAIT...	85D	MRK3	e^+e^-

$\Gamma(\Lambda\overline{\Sigma}+\text{c.c.})/\Gamma_{\text{total}}$ Γ_{90}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<0.15	90	PERUZZI	78	MRK1	$e^+e^- \to \Lambda X$

$\Gamma(K^0_S K^0_S)/\Gamma_{\text{total}}$ Γ_{91}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<0.052	90	[25] BALTRUSAIT...	85C	MRK3	e^+e^-

[25] Forbidden by *CP*.

RADIATIVE DECAYS

$\Gamma(\gamma\eta_c(1S))/\Gamma_{\text{total}}$ Γ_{92}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.0127±0.0036		GAISER	86	CBAL	$J/\psi \to \gamma X$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
seen	16	BALTRUSAIT...	84	MRK3	$J/\psi \to 2\phi\gamma$

$\Gamma(\gamma\pi^+\pi^- 2\pi^0)/\Gamma_{\text{total}}$ Γ_{93}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
8.3±0.2±3.1	[26] BALTRUSAIT...	86B	MRK3	$J/\psi \to 4\pi\gamma$

[26] 4π mass less than 2.0 GeV.

$\Gamma(\gamma\eta\pi\pi)/\Gamma_{\text{total}}$ Γ_{94}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
6.1 ±1.0 OUR AVERAGE				
5.85±0.3±1.05	[27] EDWARDS	83B	CBAL	$J/\psi \to \eta\pi^+\pi^-$
7.8 ±1.2±2.4	[27] EDWARDS	83B	CBAL	$J/\psi \to \eta 2\pi^0$

[27] Broad enhancement at 1700 MeV.

$\Gamma(\gamma\eta(1440) \to \gamma K\overline{K}\pi)/\Gamma_{\text{total}}$ Γ_{95}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
0.91±0.18 OUR AVERAGE				
0.83±0.13±0.18	[28,29] AUGUSTIN	92	DM2	$J/\psi \to \gamma K\overline{K}\pi$
$1.03^{+0.21}_{-0.18}{}^{+0.26}_{-0.19}$	[28,30] BAI	90C	MRK3	$J/\psi \to \gamma K^0_S K^\pm\pi^\mp$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1.78±0.21±0.33	[28,31] AUGUSTIN	92	DM2	$J/\psi \to \gamma K\overline{K}\pi$
3.8 ±0.3 ±0.6	[28] AUGUSTIN	90	DM2	$J/\psi \to \gamma K\overline{K}\pi$
$0.66^{+0.17}_{-0.16}{}^{+0.24}_{-0.15}$	[28,32] BAI	90C	MRK3	$J/\psi \to \gamma K^0_S K^\pm\pi^\mp$
6.3 ±1.4	[28] WISNIEWSKI	87	MRK3	$J/\psi \to K\overline{K}\pi\gamma$
4.0 ±0.7 ±1.0	[28] EDWARDS	82E	CBAL	$J/\psi \to K^+K^-\pi^0\gamma$
4.3 ±1.7	[28,33] SCHARRE	80	MRK2	e^+e^-

[28] Includes unknown branching fraction $\eta(1440) \to K\overline{K}\pi$.
[29] From fit to the $K^*(892)K$ 0^{-+} partial wave.
[30] From $K^*(890)K$ final state.
[31] From fit to the $a_0(980)\pi$ 0^{-+} partial wave.
[32] From $a_0(980)\pi$ final state.
[33] Corrected for spin-zero hypothesis for $\eta(1440)$.

$\Gamma(\gamma\eta(1440) \to \gamma\gamma\rho^0)/\Gamma_{\text{total}}$ Γ_{96}/Γ

VALUE (units 10^{-5})	DOCUMENT ID		TECN	COMMENT
6.4±1.2±0.7	[34] COFFMAN	90	MRK3	$J/\psi \to \gamma\gamma\pi^+\pi^-$

[34] Includes unknown branching fraction $\eta(1440) \to \gamma\rho^0$.

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

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
4.5 ±0.8 OUR AVERAGE					
4.7 ±0.3 ±0.9		[35] BALTRUSAIT...	86B	MRK3	$J/\psi \to 4\pi\gamma$
3.75±1.05±1.20		[36] BURKE	82	MRK2	$J/\psi \to 4\pi\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.09	90	[37] BISELLO	89B		$J/\psi \to 4\pi\gamma$

[35] 4π mass less than 2.0 GeV.
[36] 4π mass less than 2.0 GeV, $2\rho^0$ corrected to 2ρ by factor of 3.
[37] 4π mass in the range 2.0–25 GeV.

$\Gamma(\gamma\eta'(958))/\Gamma_{total}$ Γ_{98}/Γ

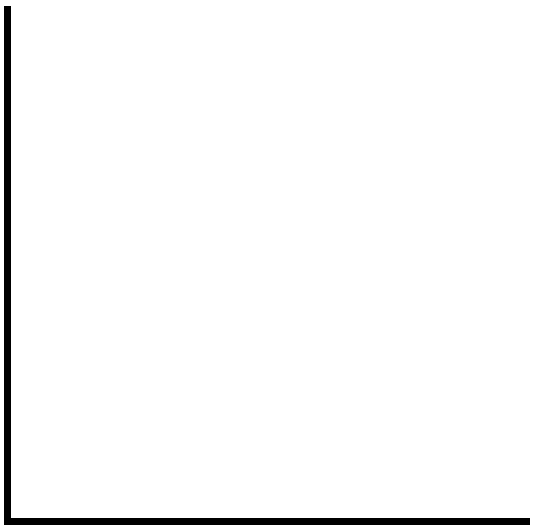
VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
4.31±0.30 OUR AVERAGE					
4.50±0.14±0.53		BOLTON	92B	MRK3	$J/\psi \to \gamma\pi^+\pi^-\eta,\ \eta \to \gamma\gamma$
4.30±0.31±0.71		BOLTON	92B	MRK3	$J/\psi \to \gamma\pi^+\pi^-\eta,\ \eta \to \pi^+\pi^-\pi^0$
4.04±0.16±0.85	622	AUGUSTIN	90	DM2	$J/\psi \to \gamma\eta\pi^+\pi^-$
4.39±0.09±0.66	2420	AUGUSTIN	90	DM2	$J/\psi \to \gamma\gamma\pi^+\pi^-$
4.1 ±0.3 ±0.6		BLOOM	83	CBAL	$e^+e^- \to 3\gamma$ + hadronsγ
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.9 ±1.1	6	BRANDELIK	79C	DASP	$e^+e^- \to 3\gamma$
3.8 ±1.3		[38] SCHARRE	79B	MRK1	$e^+e^- \to \gamma X$
3.4 ±0.7		SCHARRE	79B	MRK1	$e^+e^- \to 2\pi 2\gamma$
2.4 ±0.7	57	BARTEL	76	CNTR	$e^+e^- \to 2\gamma\rho$

[38] From the inclusive γ decay spectrum.

$\Gamma(\gamma 2\pi^+ 2\pi^-)/\Gamma_{total}$ Γ_{99}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
2.8 ±0.5 OUR AVERAGE	Error includes scale factor of 1.9. See the ideogram below.			
4.32±0.14±0.73	[39] BISELLO	89B	DM2	$J/\psi \to 4\pi\gamma$
2.08±0.13±0.35	[40] BISELLO	89B	DM2	$J/\psi \to 4\pi\gamma$
3.05±0.08±0.45	[40] BALTRUSAIT..	86B	MRK3	$J/\psi \to 4\pi\gamma$
4.85±0.45±1.20	[41] BURKE	82	MRK2	e^+e^-

[39] 4π mass less than 3.0 GeV.
[40] 4π mass less than 2.0 GeV.
[41] 4π mass less than 2.5 GeV.



$\Gamma\left(\gamma 2\pi^+ 2\pi^-\right)/\Gamma_{\text{total}}$ (units 10^{-3})

$\Gamma(\gamma f_4(2050))/\Gamma_{total}$ Γ_{100}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
2.7±0.5±0.5	[42] BALTRUSAIT..87		MRK3	$J/\psi \to \gamma\pi^+\pi^-$

[42] Assuming branching fraction $f_4(2050) \to \pi\pi/$ total = 0.167.

$\Gamma(\gamma\omega\omega)/\Gamma_{total}$ Γ_{101}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.59±0.33 OUR AVERAGE					
1.41±0.2 ±0.42	120±17	BISELLO	87	SPEC	e^+e^-, hadronsγ
1.76±0.09±0.45		BALTRUSAIT..	85C	MRK3	$e^+e^- \to$ hadronsγ

$\Gamma(\gamma\eta(1440)\to\gamma\rho^0\rho^0)/\Gamma_{\text{total}}$ Γ_{102}/Γ

VALUE (units 10^{-3})		DOCUMENT ID		TECN	COMMENT
1.36±0.38	[43,44]	BISELLO	89B	DM2	$J/\psi\to 4\pi\gamma$

[43] Estimated by us from various fits.
[44] Includes unknown branching fraction to $\rho^0\rho^0$.

$\Gamma(\gamma f_2(1270))/\Gamma_{\text{total}}$ Γ_{103}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
1.38±0.14 OUR AVERAGE						
1.33±0.05±0.20		[45] AUGUSTIN	87	DM2		$J/\psi\to\gamma\pi^+\pi^-$
1.36±0.09±0.23		[45] BALTRUSAIT...	87	MRK3		$J/\psi\to\gamma\pi^+\pi^-$
1.48±0.25±0.30	178	EDWARDS	82B	CBAL		$e^+e^-\to 2\pi^0\gamma$
2.0 ±0.7	35	ALEXANDER	78	PLUT	0	e^+e^-
1.2 ±0.6	30	[46] BRANDELIK	78B	DASP		$e^+e^-\to\pi^+\pi^-\gamma$

[45] Estimated using B($f_2(1270)\to\pi\pi$)=0.843 ± 0.012. The errors do not contain the uncertainty in the $f_2(1270)$ decay.
[46] Restated by us to take account of spread of E1, M2, E3 transitions.

$\Gamma(\gamma f_J(1710)\to\gamma K\overline{K})/\Gamma_{\text{total}}$ Γ_{104}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
9.7±1.2 OUR AVERAGE					
9.2±1.4±1.4		[47] AUGUSTIN	88	DM2	$J/\psi\to\gamma K^+K^-$
10.4±1.2±1.6		[47] AUGUSTIN	88	DM2	$J/\psi\to\gamma K^0_S K^0_S$
9.6±1.2±1.8		[47] BALTRUSAIT...	87	MRK3	$J/\psi\to\gamma K^+K^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
< 0.8	90	[48] BISELLO	89B		$J/\psi\to 4\pi\gamma$
1.6±0.4±0.3		[49] BALTRUSAIT...	87	MRK3	$J/\psi\to\gamma\pi^+\pi^-$
3.8±1.6		[50] EDWARDS	82D	CBAL	$e^+e^-\to\eta\eta\gamma$

[47] Includes unknown branching fraction to K^+K^- or $K^0_S K^0_S$. We have multiplied K^+K^- measurement by 2, and $K^0_S K^0_S$ by 4 to obtain $K\overline{K}$ result.
[48] Includes unknown branching fraction to $\rho^0\rho^0$.
[49] Includes unknown branching fraction to $\pi^+\pi^-$.
[50] Includes unknown branching fraction to $\eta\eta$.

$\Gamma(\gamma\eta)/\Gamma_{\text{total}}$ Γ_{105}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.86±0.08 OUR AVERAGE					
0.88±0.08±0.11		BLOOM	83	CBAL	e^+e^-
0.82±0.10		BRANDELIK	79C	DASP	e^+e^-
1.3 ±0.4	21	BARTEL	77	CNTR	e^+e^-

$\Gamma(\gamma f_1(1420)\to\gamma K\overline{K}\pi)/\Gamma_{\text{total}}$ Γ_{106}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
0.83±0.15 OUR AVERAGE				
0.76±0.15±0.21	[51,52] AUGUSTIN	92	DM2	$J/\psi\to\gamma K\overline{K}\pi$
$0.87\pm0.14^{+0.14}_{-0.11}$	[51] BAI	90C	MRK3	$J/\psi\to\gamma K^0_S K^\pm\pi^\mp$

[51] Included unknown branching fraction $f_1(1420)\to K\overline{K}\pi$.
[52] From fit to the $K^*(892)K$ 1^{++} partial wave.

$\Gamma(\gamma f_1(1285))/\Gamma_{\text{total}}$ Γ_{107}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
0.65 ±0.10 OUR AVERAGE					
0.625±0.063±0.103		[53] BOLTON	92	MRK3	$J/\psi\to\gamma f_1(1285)$
0.70 ±0.09 ±0.16		[54] BURCHELL	91	MRK3	$J/\psi\to\gamma\eta\pi^+\pi^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.025±0.007±0.003		[55] COFFMAN	90	MRK3	$J/\psi\to\gamma\gamma\pi^+\pi^-$
<6	90	[56] SCHARRE	80	MRK2	$J/\psi\to\gamma K\overline{K}\pi$

[53] Obtained summing the sequential decay channels
B($J/\psi\to\gamma f_1(1285), f_1(1285)\to\pi\pi\pi\pi$) = (1.44 ± 0.39 ± 0.27) × 10^{-4};
B($J/\psi\to\gamma f_1(1285), f_1(1285)\to\delta\pi,\delta\to\eta\pi$) = (3.90 ± 0.42 ± 0.87) × 10^{-4};
B($J/\psi\to\gamma f_1(1285), f_1(1285)\to\delta\pi,\delta\to K\overline{K}$) = (0.66 ± 0.26 ± 0.29) × 10^{-4};
B($J/\psi\to\gamma f_1(1285), f_1(1285)\to\gamma\rho^0$) = (0.25 ± 0.07 ± 0.03) × 10^{-4}.
[54] Using B($f_1(1285)\to a_0(980)\pi$) = 0.37, and including unknown branching ratio for $a_0(980)\to\eta\pi$.
[55] Includes unknown branching fraction $f_1(1285)\to\gamma\rho^0$.
[56] Using B($f_1(1285)\to K\overline{K}\pi$) = 0.12.

$\Gamma(\gamma f_2'(1525))/\Gamma_{\text{total}}$ Γ_{108}/Γ

VALUE (units 10^{-3})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.63±0.10 OUR AVERAGE						
0.70±0.17±0.11			[57] AUGUSTIN	88	DM2	$J/\psi \to \gamma K^+ K^-$
0.56±0.06±0.11			[57] AUGUSTIN	88	DM2	$J/\psi \to \gamma K_S^0 K_S^0$
0.84±0.20±0.17			[57] BALTRUSAIT...	87	MRK3	$J/\psi \to \gamma K^+ K^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
0.25±0.14			[57] FRANKLIN	83B	MRK2	$J/\psi \to \gamma K \overline{K}$
<0.34	90	4	[58] BRANDELIK	79C	DASP	$e^+ e^- \to \pi^+ \pi^- \gamma$
<0.23	90	3	ALEXANDER	78	PLUT	$e^+ e^- \to K^+ K^- \gamma$

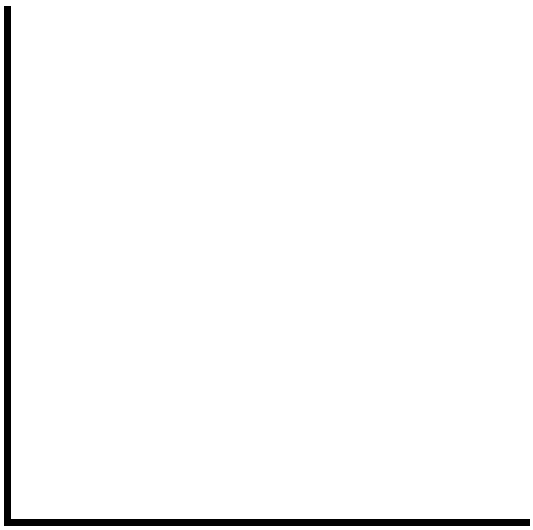
[57] Using $B(f_2'(1525) \to K\overline{K}) = 0.713$.

[58] Assuming isotropic production and decay of the $f_2'(1525)$ and isospin.

$\Gamma(\gamma\phi\phi)/\Gamma_{\text{total}}$ Γ_{109}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
4.0±1.2 OUR AVERAGE Error includes scale factor of 2.1. See the ideogram below.					
7.5±0.6±1.2	168	BAI	90B	MRK3	$J/\psi \to \gamma 4K$
3.4±0.8±0.6	33 ± 7	[59] BISELLO	90	DM2	$J/\psi \to \gamma K^+ K^- K_S^0 K_L^0$
3.1±0.7±0.4		[59] BISELLO	86B	DM2	$J/\psi \to \gamma K^+ K^- K^+ K^-$

[59] $\phi\phi$ mass less than 2.9 GeV, η_c excluded.



$\Gamma(\gamma\phi\phi)/\Gamma_{\text{total}}$ (units 10^{-4})

$\Gamma(\gamma p\overline{p})/\Gamma_{\text{total}}$ Γ_{110}/Γ

VALUE (units 10^{-3})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.38±0.07±0.07		49	EATON	84	MRK2	$e^+ e^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<0.11	90		PERUZZI	78	MRK1	$e^+ e^-$

$\Gamma(\gamma\eta(2225))/\Gamma_{total}$ Γ_{111}/Γ

VALUE (units 10^{-3})		DOCUMENT ID		TECN	COMMENT
0.29±0.06 OUR AVERAGE					
0.33±0.08±0.05	[60]	BAI	90B	MRK3	$J/\psi \to \gamma K^+ K^- K^+ K^-$
0.27±0.06±0.06	[60]	BAI	90B	MRK3	$J/\psi \to \gamma K^+ K^- K^0_S K^0_L$
$0.24^{+0.15}_{-0.10}$	[61,62]	BISELLO	89B	DM2	$J/\psi \to 4\pi\gamma$

[60] Includes unknown branching fraction to $\phi\phi$.
[61] Estimated by us from various fits.
[62] Includes unknown branching fraction to $\rho^0\rho^0$.

$\Gamma(\gamma\eta(1760) \to \gamma\rho^0\rho^0)/\Gamma_{total}$ Γ_{112}/Γ

VALUE (units 10^{-3})		DOCUMENT ID		TECN	COMMENT
0.13±0.09	[63,64]	BISELLO	89B	DM2	$J/\psi \to 4\pi\gamma$

[63] Estimated by us from various fits.
[64] Includes unknown branching fraction to $\rho^0\rho^0$.

$\Gamma(\gamma\pi^0)/\Gamma_{total}$ Γ_{113}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.039±0.013 OUR AVERAGE					
0.036±0.011±0.007		BLOOM	83	CBAL	e^+e^-
0.073±0.047	10	BRANDELIK	79C	DASP	e^+e^-

$\Gamma(\gamma p\bar{p}\pi^+\pi^-)/\Gamma_{total}$ Γ_{114}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<0.79	90	EATON	84	MRK2	e^+e^-

$\Gamma(\gamma\gamma)/\Gamma_{total}$ Γ_{115}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<0.5	90	BARTEL	77	CNTR	e^+e^-

$\Gamma(\gamma\Lambda\overline{\Lambda})/\Gamma_{total}$ Γ_{116}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<0.13	90	HENRARD	87	DM2	e^+e^-

$\Gamma(3\gamma)/\Gamma_{total}$ Γ_{117}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<0.055	90	PARTRIDGE	80	CBAL	e^+e^-

$\Gamma(\gamma f_0(2200))/\Gamma_{total}$ Γ_{118}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1.5	[65] AUGUSTIN	88	DM2	$J/\psi \to \gamma K^0_S K^0_S$

[65] Includes unknown branching fraction to $K^0_S K^0_S$.

$\Gamma(\gamma f_4(2220))/\Gamma_{total}$ Γ_{119}/Γ

VALUE (units 10^{-5})	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
< 2.3	95	[66] AUGUSTIN	88	DM2	$J/\psi \to \gamma K^+ K^-$
< 1.6	95	[66] AUGUSTIN	88	DM2	$J/\psi \to \gamma K^0_S K^0_S$
$12.4^{+6.4}_{-5.2}\pm2.8$	23	[66] BALTRUSAIT...86D		MRK3	$J/\psi \to \gamma K^0_S K^0_S$
$8.4^{+3.4}_{-2.8}\pm1.6$	93	[66] BALTRUSAIT...86D		MRK3	$J/\psi \to \gamma K^+ K^-$

[66] Includes unknown branching fraction to K^+K^- or $K^0_S K^0_S$.

$\Gamma(\gamma X(1400))/\Gamma_{total}$ Γ_{120}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
3.83±0.33±0.059		[67] BURCHELL	91	MRK3	$J/\psi \to \gamma\eta\pi^+\pi^-$
7.0 ±0.6 ±1.1	261	[67] AUGUSTIN	90	DM2	$J/\psi \to \gamma\eta\pi^+\pi^-$

[67] Includes unknown branching fraction to $\eta\pi^+\pi^-$.

$J/\psi(1S)$ REFERENCES

ANTONELLI	93	PL B301 317	+Baldini+	(FENICE Collab.)
ARMSTRONG	93B	PR D47 772	+Bettoni, Bharadwaj+	(FNAL E760 Collab.)
AUGUSTIN	92	PR D46 1951	+Cosme	(DM2 Collab.)
BOLTON	92	PL B278 495	+Brown, Bunnell+	(Mark III Collab.)
BOLTON	92B	PRL 69 1328	+Brown, Bunnell+	(Mark III Collab.)
COFFMAN	92	PRL 68 282	+DeJongh, Dubois, Hitlin+	(Mark III Collab.)
HSUEH	92	PR D45 R2181	+Palestini	(FNAL, TORI)
BURCHELL	91	NP B21 132 (suppl)		(Mark III Collab.)
AUGUSTIN	90	PR D42 10	+Cosme+	(DM2 Collab.)
BAI	90B	PRL 65 1309	+Blaylock+	(Mark III Collab.)
BAI	90C	PRL 65 2507	+Blaylock+	(Mark III Collab.)
BISELLO	90	PL B241 617	+Busetto+	(DM2 Collab.)
COFFMAN	90	PR D41 1410	+De Jongh+	(Mark III Collab.)
JOUSSET	90	PR D41 1389	+Ajaltouni+	(DM2 Collab.)
ALEXANDER	89	NP B320 45	+Bonvicini, Drell, Frey, Luth	(LBL, MICH, SLAC)
AUGUSTIN	89	NP B320 1	+Cosme	(DM2 Collab.)
BISELLO	89B	PR D39 701	Busetto+	(DM2 Collab.)
AUGUSTIN	88	PRL 60 2238	+Calcaterra+	(DM2 Collab.)
COFFMAN	88	PR D38 2695	+Dubois, Eigen, Hauser+	(Mark III Collab.)
FALVARD	88	PR D38 2706	+Ajaltouni+	(CLER, FRAS, LALO, PADO)
AUGUSTIN	87	ZPHY C36 369	+Cosme+	(LALO, CLER, FRAS, PADO)
BAGLIN	87	NP B286 592	+	(LAPP, CERN, GENO, LYON, OSLO, ROMA+)
BALTRUSAIT...	87	PR D35 2077	Baltrusaitis, Coffman, Dubois+	(Mark III Collab.)
BECKER	87	PRL 59 186	+Blaylock, Bolton, Brown+	(Mark III Collab.)
BISELLO	87	PL B192 239	+Ajaltouni, Baldini+	(PADO, CLER, FRAS, LALO)
HENRARD	87	NP B292 670	+Ajaltouni, et al	(CLER, FRAS, LALO, PADO)
PALLIN	87	NP B292 653	+Ajaltouni+	(CLER, FRAS, LALO, PADO)
WISNIEWSKI	87	Hadron 87 Conf.		(Mark III Collab.)
BALTRUSAIT...	86B	PR D33 1222	Baltrusaitis, Coffman, Hauser+	(Mark III Collab.)
BALTRUSAIT...	86D	PRL 56 107	Baltrusaitis	(CIT, UCSC, ILL, SLAC, WASH)
BISELLO	86B	PL B179 294	+Busetto, Castro, Limentani+	(DM2 Collab.)
GAISER	86	PR D34 711	+Bloom, Bulos, Godfrey+	(Crystal Ball Collab.)
BALTRUSAIT...	85C	PRL 55 1723	Baltrusaitis+	(CIT, UCSC, ILL, SLAC, WASH)
BALTRUSAIT...	85D	PR D32 566	Baltrusaitis, Coffman+	(CIT, UCSC, ILL, SLAC, WASH)
BALTRUSAIT...	84	PRL 52 2126	Baltrusaitis+	(CIT, UCSC, ILL, SLAC, WASH)
EATON	84	PR D29 804	+Goldhaber, Abrams, Alam, Boyarski+	(LBL, SLAC)
BLOOM	83	ARNS 33 143	+Peck	(SLAC, CIT)
EDWARDS	83B	PRL 51 859	+Partridge, Peck+	(CIT, HARV, PRIN, STAN, SLAC)
EINSWEILER	83	Brighton Conf. 348		(Mark III Collab.)
FRANKLIN	83	PRL 51 963	+Franklin, Feldman, Abrams, Alam+	(LBL, SLAC)
FRANKLIN	83B	Thesis SLAC-0254		(STAN)
BURKE	82	PRL 49 632	+Trilling, Abrams, Alam, Blocker+	(LBL, SLAC)
EDWARDS	82B	PR D25 3065	+Partridge, Peck+	(CIT, HARV, PRIN, STAN, SLAC)
EDWARDS	82D	PRL 48 458	+Partridge, Peck+	(CIT, HARV, PRIN, STAN, SLAC)
Also	83	ARNS 33 143	Bloom, Peck	(SLAC, CIT)
EDWARDS	82E	PRL 49 259	+Partridge, Peck+	(CIT, HARV, PRIN, STAN, SLAC)
LEMOIGNE	82	PL 113B 509	+Barate, Astbury+	(SACL, LOIC, SHMP, IND)
BESCH	81	ZPHY C8 1	+Eisermann, Lohr, Kowalski+	(BONN, DESY, MANZ)
GIDAL	81	PL 107B 153	+Goldhaber, Guy, Millikan, Abrams+	(SLAC, LBL)
PARTRIDGE	80	PRL 44 712	+Peck+	(CIT, HARV, PRIN, SLAC, 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	79C	ZPHY C1 233	+Cords+	(DASP Collab.)
SCHARRE	79B	SLAC-PUB-2321		(SLAC, LBL)
Also	79	LBL-9502	Abrams, Alam, Blocker, Boyarski+	(SLAC, LBL)
ALEXANDER	78	PL 72B 493	+Criegee+	(DESY, HAMB, SIEG, WUPP)
BESCH	78	PL 78B 347	+Eisermann, Kowalski, Eyss+	(BONN, DESY, MANZ)
BRANDELIK	78B	PL 74B 292	+Cords+	(DASP Collab.)
PERUZZI	78	PR D17 2901	+Piccolo, Alam, Boyarski, Goldhaber+	(SLAC, LBL)
BARTEL	77	PL 66B 489	+Duinker, Olsson, Heintze+	(DESY, HEIDP)
BURMESTER	77D	PL 72B 135	+Criegee+	(DESY, HAMB, SIEG, WUPP)
FELDMAN	77	PRPL 33C 285	+Perl	(LBL, SLAC)
VANNUCCI	77	PR D15 1814	+Abrams, Alam, Boyarski+	(SLAC, LBL)
BARTEL	76	PL 64B 483	+Duinker, Olsson, Steffen, Heintze+	(DESY, HEIDP)
BRAUNSCH...	76	PL 63B 487	Braunschweig+	(DASP Collab.)
JEAN-MARIE	76	PRL 36 291	+Abrams, Boyarski, Breidenbach+	(SLAC, LBL) IG
BALDINI-...	75	PL 58B 471	Baldini-Celio, Bozzo, Capon+	(FRAS, ROMA)
BEMPORAD	75	Stanford Symp. 113		(PISA, FRAS)
BOYARSKI	75	PRL 34 1357	+Breidenbach, Bulos, Feldman+	(SLAC, LBL) JPC
DASP	75	PL 56B 491	Braunschweig, Konigs+	(DASP Collab.)
ESPOSITO	75B	LNC 14 73	+Bartoli, Bisello+	(FRAS, NAPL, PADO, ROMA)
FORD	75	PRL 34 604	+Beron, Hilger, Hofstadter+	(SLAC, PENN)
LIBERMAN	75	Stanford Symp. 55		(STAN)
WIIK	75	Stanford Symp. 69		(DESY)

OTHER RELATED PAPERS

BAGLIN	85	SLAC Summer Inst. 609		(LAPP, CERN, GENO, LYON, OSLO, ROMA+)
LEE	85	SLAC 282		(SLAC)
BARATE	83	PL 121B 449	+Bareyre, Bonamy+	(SACL, LOIC, SHMP, IND)
ABRAMS	74	PRL 33 1453	+Briggs, Augustin, Boyarski+	(LBL, SLAC)
ASH	74	LNC 11 705	+Zorn, Bartoli+	(FRAS, UMD, NAPL, PADO, ROMA)
AUBERT	74	PRL 33 1404	+Becker, Biggs, Burger, Chen, Everhart	(MIT, BNL)
AUGUSTIN	74	PRL 33 1406	+Boyarski, Abrams, Briggs+	(SLAC, LBL)
BACCI	74	PRL 33 1408	+Bartoli, Barbarino, Barbiellini+	(FRAS)
Also	74B	PRL 33 1649	Bacci	
BALDINI-...	74	LNC 11 711	Baldini-Celio, Bacci+	(FRAS, ROMA)
BARBIELLINI	74	LNC 11 718	+Bemporad+	(FRAS, NAPL, PISA, ROMA)
BRAUNSCH...	74	PL 53B 393	Braunschweig+	(DASP Collab.)
CHRISTENS...	70	PRL 25 1523	Christenson, Hicks, Lederman+	(COLU, BNL, CERN)

$\chi_{c0}(1P)$ or $\chi_{c0}(3415)$

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

Observed in the radiative decay $\psi(2S) \to \chi_{c0}(1P)\gamma$. Therefore $C = +$. The observed decay into $\pi^+\pi^-$ or K^+K^- implies $G = +$, $J^P = 0^+, 2^+, \ldots$ The angular distribution is consistent with $J = 0$. J^P abnormal excluded by $\pi^+\pi^-$ and K^+K^- decays. $J^P = 0^+$ preferred (FELDMAN 77).

$\chi_{c0}(1P)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
3415.1± 1.0 OUR AVERAGE					
3417.8± 0.4±4		[1] GAISER	86	CBAL	$\psi(2S) \to \gamma X$
3414.8± 1.1		[2,3] HIMEL	79	MRK2	$e^+e^- \to$ hadrons
3422.0±10.0		[2] BARTEL	78B	CNTR	$e^+e^- \to J/\psi 2\gamma$
3416.0± 3 ±4		[2] TANENBAUM	78	MRK1	e^+e^-
3415.0± 9.0		[2] BIDDICK	77	CNTR	$e^+e^- \to \gamma X$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
3407.0± 8.0	2	[4] WIIK	75	DASP	$e^+e^- \to J/\psi 2\gamma$

[1] Using mass of $\psi(2S) = 3686.0$ MeV.
[2] Mass value shifted by us by amount appropriate for $\psi(2S)$ mass = 3686 MeV and $J/\psi(1S)$ mass = 3097 MeV.
[3] Systematic error added linearly by us.
[4] Only two events; this mass apparently never published.

$\chi_{c0}(1P)$ WIDTH

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
13.5±3.3±4.2	GAISER	86	CBAL	$\psi(2S) \to \gamma X, \gamma\pi^0\pi^0$

$\chi_{c0}(1P)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Confidence level
	Hadronic decays		
Γ_1	$2(\pi^+\pi^-)$	(3.7±0.7) %	
Γ_2	$\pi^+\pi^- K^+K^-$	(3.0±0.7) %	
Γ_3	$\rho^0\pi^+\pi^-$	(1.6±0.5) %	
Γ_4	$3(\pi^+\pi^-)$	(1.5±0.5) %	
Γ_5	$K^+\overline{K}^*(892)^0\pi^- +$ c.c.	(1.2±0.4) %	
Γ_6	$\pi^+\pi^-$	$(7.5\pm2.1)\times10^{-3}$	
Γ_7	K^+K^-	$(7.1\pm2.4)\times10^{-3}$	
Γ_8	$\pi^+\pi^- p\overline{p}$	$(5.0\pm2.0)\times10^{-3}$	
Γ_9	$\pi^0\pi^0$	$(3.1\pm0.6)\times10^{-3}$	
Γ_{10}	$\eta\eta$	$(2.5\pm1.1)\times10^{-3}$	
Γ_{11}	$p\overline{p}$	$< 9.0 \times10^{-4}$	90%
	Radiative decays		
Γ_{12}	$\gamma J/\psi(1S)$	$(6.6\pm1.8)\times10^{-3}$	
Γ_{13}	$\gamma\gamma$	$(4.0\pm2.3)\times10^{-4}$	

$\chi_{c0}(1P)$ PARTIAL WIDTHS

$\Gamma(\gamma\gamma)$ Γ_{13}

VALUE (keV)	CL%	DOCUMENT ID		TECN	COMMENT
< 6.2	95	CHEN	90B	CLEO	$e^+e^- \to e^+e^-\chi_{c0}$
4.0±2.8		LEE	85	CBAL	$\psi' \to$ photons
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<17	95	AIHARA	88D	TPC	$e^+e^- \to e^+e^- X$

$\chi_{c0}(1P)$ BRANCHING RATIOS

HADRONIC DECAYS

$\Gamma(2(\pi^+\pi^-))/\Gamma_{total}$ Γ_1/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.037±0.007	[5] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c0}$

$\Gamma(\pi^+\pi^- K^+ K^-)/\Gamma_{total}$ Γ_2/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.030±0.007	[5] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c0}$

$\Gamma(\rho^0\pi^+\pi^-)/\Gamma_{total}$ Γ_3/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.016±0.005	[5] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c0}$

$\Gamma(3(\pi^+\pi^-))/\Gamma_{total}$ Γ_4/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.015±0.005	[5] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c0}$

$\Gamma(K^+\overline{K}^*(892)^0\pi^- + \text{c.c.})/\Gamma_{total}$ Γ_5/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.012±0.004	[5] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c0}$

$\Gamma(\pi^+\pi^-)/\Gamma_{total}$ Γ_6/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
75±21 OUR AVERAGE				
70±30	[5] BRANDELIK	79B	DASP	$\psi(2S) \to \gamma\chi_{c0}$
80±30	[5] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c0}$

$\Gamma(K^+K^-)/\Gamma_{total}$ Γ_7/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
71±24 OUR AVERAGE				
60±30	[5] BRANDELIK	79B	DASP	$\psi(2S) \to \gamma\chi_{c0}$
90±40	[5] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c0}$

$\Gamma(\pi^+\pi^- p\overline{p})/\Gamma_{total}$ Γ_8/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.005 ±0.002	[5] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c0}$

$\Gamma(\pi^0\pi^0)/\Gamma_{total}$ Γ_9/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
3.1±0.4±0.5	[6] LEE	85	CBAL	$\psi' \to$ photons

$\Gamma(\eta\eta)/\Gamma_{total}$ Γ_{10}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
2.5±0.8±0.8	[6] LEE	85	CBAL	$\psi' \to$ photons

$\Gamma(p\overline{p})/\Gamma_{total}$ Γ_{11}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<9.0	90	[5] BRANDELIK	79B	DASP	$\psi(2S) \to \gamma\chi_{c0}$

[5] Calculated using $B(\psi(2S) \to \gamma\chi_{c0}(1P)) = 0.094$; the errors do not contain the uncertainty in the $\psi(2S)$ decay.

[6] Calculated using $B(\psi(2S) \to \gamma\chi_{c0}(1P)) = 0.093 \pm 0.008$.

RADIATIVE DECAYS

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

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
66± 18 OUR AVERAGE				
60± 18	GAISER	86	CBAL	$\psi(2S) \to \gamma\chi_{c0}$
320±210	[7] BRANDELIK	79B	DASP	$\psi(2S) \to \gamma\chi_{c0}$
150±100	[7] BARTEL	78B	CNTR	$\psi(2S) \to \gamma\chi_{c0}$
210±210	[7] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c0}$

$\Gamma(\gamma\gamma)/\Gamma_{total}$ Γ_{13}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
4.0±2.0±1.1		[6] LEE	85	CBAL	$\psi' \rightarrow$ photons
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<15	90	[7] YAMADA	77	DASP	$e^+e^- \rightarrow 3\gamma$

[7] Calculated using $B(\psi(2S) \rightarrow \gamma\chi_{c0}(1P)) = 0.094$; the errors do not contain the uncertainty in the $\psi(2S)$ decay.

$\chi_{c0}(1P)$ REFERENCES

CHEN	90B	PL B243 169	+McIlwain+	(CLEO Collab.)
AIHARA	88D	PRL 60 2355	+Alston-Garnjost+	(TPC Collab.)
GAISER	86	PR D34 711	+Bloom, Bulos, Godfrey+	(Crystal Ball Collab.)
LEE	85	SLAC 282		(SLAC)
BRANDELIK	79B	NP B160 426	+Cords+	(DASP Collab.)
HIMEL	79	Thesis SLAC-0223		(SLAC)
Also	82	Private Comm.	Trilling	(LBL, UCB)
BARTEL	78B	PL 79B 492	+Dittmann, Duinker, Olsson, O'Neill+	(DESY, HEIDP)
TANENBAUM	78	PR D17 1731	+Alam, Boyarski+	(SLAC, LBL)
Also	82	Private Comm.	Trilling	(LBL, UCB)
BIDDICK	77	PRL 38 1324	+Burnett+ (UCSD, UMD, PAVI, PRIN, SLAC, STAN)	
FELDMAN	77	PRPL 33C 285	+Perl	(LBL, SLAC)
YAMADA	77	Hamburg Conf. 69		(DASP Collab.)
WIIK	75	Stanford Symp. 69		(DESY)

OTHER RELATED PAPERS

OREGLIA	82	PR D25 2259	+Partridge+ (SLAC, CIT, HARV, PRIN, STAN)	
FELDMAN	75B	PRL 35 821	+Jean-Marie, Sadoulet, Vannucci+	(LBL, SLAC)
Also	75C	PRL 35 1189	Feldman	
Erratum.				
TANENBAUM	75	PRL 35 1323	+Whitaker, Abrams+	(LBL, SLAC)

$\chi_{c1}(1P)$ or $\chi_{c1}(3510)$

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

Observed in the radiative sequential decay $\psi(2S) \rightarrow \chi_{c1}(1P)\gamma$, $\chi_{c1}(1P) \rightarrow J/\psi(1S)\gamma$. Therefore, $C = +$. The lack of decays into $\pi^+\pi^-$ or K^+K^- is suggestive of J^P=abnormal. The decays into 4π and 6π imply $G = +$, thus $I = 0$. J=0,2 excluded by angular distribution in the $J/\psi(1S)\gamma$ decay. $J^P = 1^+$ preferred (FELDMAN 77, OREGLIA 82).

$\chi_{c1}(1P)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
3510.53± 0.12 OUR AVERAGE					
3510.53± 0.04±0.12	513	ARMSTRONG	92	SPEC	$\overline{p}p \rightarrow e^+e^-\gamma$
3511.3 ± 0.4 ±0.4	30	BAGLIN	86B	SPEC	$\overline{p}p \rightarrow e^+e^-$X
3512.3 ± 0.3 ±4.0		[1] GAISER	86	CBAL	$\psi(2S) \rightarrow \gamma$X
3507.4 ± 1.7	91	[2] LEMOIGNE	82	GOLI	190 GeV π^- Be $\rightarrow \gamma 2\mu$
3510.4 ± 0.6		OREGLIA	82	CBAL	$e^+e^- \rightarrow J/\psi 2\gamma$
3510.1 ± 1.1	254	[3] HIMEL	80	MRK2	$e^+e^- \rightarrow J/\psi 2\gamma$
3509.0 ±11.0	21	BRANDELIK	79B	DASP	$e^+e^- \rightarrow J/\psi 2\gamma$
3507.0 ± 3.0		[3] BARTEL	78B	CNTR	$e^+e^- \rightarrow J/\psi 2\gamma$
3505.0 ± 4 ±4		[3,4] TANENBAUM	78	MRK1	e^+e^-
3513.0 ± 7.0	367	[3] BIDDICK	77	CNTR	$\psi(2S) \rightarrow \gamma$X
• • • We do not use the following data for averages, fits, limits, etc. • • •					
3510.0 ±20.0		BARTEL	76B	CNTR	$e^+e^- \rightarrow J/\psi 2\gamma$
3500 ±10	40	TANENBAUM	75	MRK1	Hadrons γ
3507.0 ± 7.0	7	WIIK	75	DASP	$e^+e^- \rightarrow J/\psi 2\gamma$

[1] Using mass of $\psi(2S) = 3686.0$ MeV.

[2] $J/\psi(1S)$ mass constrained to 3097 MeV.

[3] Mass value shifted by us by amount appropriate for $\psi(2S)$ mass = 3686 MeV and $J/\psi(1S)$ mass = 3097 MeV.

[4] From a simultaneous fit to radiative and hadronic decay channels.

$\chi_{c1}(1P)$ WIDTH

VALUE (MeV)	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.88±0.11±0.08		513	ARMSTRONG	92	SPEC	$\overline{p}p \rightarrow e^+e^-\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<1.3	95		BAGLIN	86B	SPEC	$\overline{p}p \rightarrow e^+e^-X$
<3.8	90		GAISER	86	CBAL	$\psi(2S) \rightarrow \gamma X$

$\chi_{c1}(1P)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
	Hadronic decays	
Γ_1	$3(\pi^+\pi^-)$	(2.2±0.8) %
Γ_2	$2(\pi^+\pi^-)$	(1.6±0.5) %
Γ_3	$\pi^+\pi^- K^+K^-$	(9 ±4) × 10^{-3}
Γ_4	$\rho^0\pi^+\pi^-$	(3.9±3.5) × 10^{-3}
Γ_5	$K^+\overline{K}^*(892)^0\pi^- +$ c.c.	(3.2±2.1) × 10^{-3}
Γ_6	$\pi^+\pi^- p\overline{p}$	(1.4±0.9) × 10^{-3}
Γ_7	$p\overline{p}$	(8.6±1.2) × 10^{-5}
Γ_8	$\pi^+\pi^- + K^+K^-$	< 2.1 × 10^{-3}
	Radiative decays	
Γ_9	$\gamma J/\psi(1S)$	(27.3±1.6) %
Γ_{10}	$\gamma\gamma$	

$\chi_{c1}(1P)$ PARTIAL WIDTHS

$\Gamma(p\overline{p})$ Γ_7

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
74± 9 OUR AVERAGE					
76±10±5	513	[5] ARMSTRONG	92	SPEC	$\overline{p}p \rightarrow e^+e^-\gamma$
$69^{+16}_{-13}\pm4$		[5] BAGLIN	86B	SPEC	$\overline{p}p \rightarrow e^+e^-X$

[5] Restated by us using B($\chi_{c1}(1P) \rightarrow J/\psi(1S)\gamma$)B($J/\psi(1S) \rightarrow e^+e^-$) = 0.0171 ± 0.0011.

$\chi_{c1}(1P)$ BRANCHING RATIOS

HADRONIC DECAYS

$\Gamma(3(\pi^+\pi^-))/\Gamma_{total}$ Γ_1/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.022±0.008	[7] TANENBAUM	78	MRK1	$\psi(2S) \rightarrow \gamma\chi_{c1}$

$\Gamma(2(\pi^+\pi^-))/\Gamma_{total}$ Γ_2/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.016±0.005	[7] TANENBAUM	78	MRK1	$\psi(2S) \rightarrow \gamma\chi_{c1}$

$\Gamma(\pi^+\pi^- K^+K^-)/\Gamma_{total}$ Γ_3/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
90±40	[7] TANENBAUM	78	MRK1	$\psi(2S) \rightarrow \gamma\chi_{c1}$

$\Gamma(\rho^0\pi^+\pi^-)/\Gamma_{total}$ Γ_4/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
39±35	[7] TANENBAUM	78	MRK1	$\psi(2S) \rightarrow \gamma\chi_{c1}$

$\Gamma(K^+\overline{K}^*(892)^0\pi^- + \text{c.c.})/\Gamma_{total}$ Γ_5/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
32±21	[7] TANENBAUM	78	MRK1	$\psi(2S) \rightarrow \gamma\chi_{c1}$

$\Gamma(\pi^+\pi^- p\overline{p})/\Gamma_{total}$ Γ_6/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
14±9	[7] TANENBAUM	78	MRK1	$\psi(2S) \rightarrow \gamma\chi_{c1}$

$\Gamma(p\overline{p})/\Gamma_{total}$ Γ_7/Γ

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.86±0.12		513	[6] ARMSTRONG	92	SPEC	$\overline{p}p \rightarrow e^+e^-\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
> 0.54	95		BAGLIN	86B	SPEC	$\overline{p}p \rightarrow e^+e^-X$
<12.0	90		[7] BRANDELIK	79B	DASP	$\psi(2S) \rightarrow \gamma\chi_{c1}$

[6] Restated by us using $B(\chi_{c1}(1P) \rightarrow J/\psi(1S)\gamma)B(J/\psi(1S) \rightarrow e^+e^-) = 0.0171 \pm 0.0011$.

$[\Gamma(\pi^+\pi^-) + \Gamma(K^+K^-)]/\Gamma_{total}$ Γ_8/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<21		[7] FELDMAN	77	MRK1	$\psi(2S) \rightarrow \gamma\chi_{c1}$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<38	90	[7] BRANDELIK	79B	DASP	$\psi(2S) \rightarrow \gamma\chi_{c1}$

[7] Estimated using $B(\psi(2S) \rightarrow \gamma\chi_{c1}(1P)) = 0.087$. The errors do not contain the uncertainty in the $\psi(2S)$ decay.

RADIATIVE DECAYS

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.273±0.016 OUR AVERAGE					
0.284±0.021		GAISER	86	CBAL	$\psi(2S) \rightarrow \gamma X$
0.274±0.046	943	[8] OREGLIA	82	CBAL	$\psi(2S) \rightarrow \gamma\chi_{c1}$
0.28 ±0.07		[8] HIMEL	80	MRK2	$\psi(2S) \rightarrow \gamma\chi_{c1}$
0.19 ±0.05		[8] BRANDELIK	79B	DASP	$\psi(2S) \rightarrow \gamma\chi_{c1}$
0.29 ±0.05		[8] BARTEL	78B	CNTR	$\psi(2S) \rightarrow \gamma\chi_{c1}$
0.28 ±0.09		[8] TANENBAUM	78	MRK1	$\psi(2S) \rightarrow \gamma\chi_{c1}$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.57 ±0.17		[8] BIDDICK	77	CNTR	$\psi(2S) \rightarrow \gamma X$

$\Gamma(\gamma\gamma)/\Gamma_{total}$ Γ_{10}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.0015	90	[8] YAMADA	77	DASP	$e^+e^- \rightarrow 3\gamma$

[8] Estimated using $B(\psi(2S) \rightarrow \gamma\chi_{c1}(1P)) = 0.087$. The errors do not contain the uncertainty in the $\psi(2S)$ decay.

$\chi_{c1}(1P)$ REFERENCES

ARMSTRONG	92	NP B373 35	+Bettoni+	(FNAL, FERR, GENO, UCI, NWES+)
Also	92B	PRL 68 1468	Armstrong, Bettoni+	(FNAL, FERR, GENO, UCI, NWES+)
BAGLIN	86B	PL B172 455		(LAPP, CERN, GENO, LYON, OSLO, ROMA+)
GAISER	86	PR D34 711	+Bloom, Bulos, Godfrey+	(Crystal Ball Collab.)
LEMOIGNE	82	PL 113B 509	+Barate, Astbury+	(SACL, LOIC, SHMP, IND)
OREGLIA	82	PR D25 2259	+Partridge+	(SLAC, CIT, HARV, PRIN, STAN)
Also	82B	Private Comm.	Oreglia	(EFI)
HIMEL	80	PRL 44 920	+Abrams, Alam, Blocker+	(LBL, SLAC)
Also	82	Private Comm.	Trilling	(LBL, UCB)
BRANDELIK	79B	NP B160 426	+Cords+	(DASP Collab.)
BARTEL	78B	PL 79B 492	+Dittmann, Duinker, Olsson, O'Neill+	(DESY, HEIDP)
TANENBAUM	78	PR D17 1731	+Alam, Boyarski+	(SLAC, LBL)
Also	82	Private Comm.	Trilling	(LBL, UCB)
BIDDICK	77	PRL 38 1324	+Burnett+	(UCSD, UMD, PAVI, PRIN, SLAC, STAN)
FELDMAN	77	PRPL 33C 285	+Perl	(LBL, SLAC)
YAMADA	77	Hamburg Conf. 69		(DASP Collab.)
BARTEL	76B	Tbilisi Conf. N75	+Duinker, Olsson, Heintze+	(DESY, HEIDP)
TANENBAUM	75	PRL 35 1323	+Whitaker, Abrams+	(LBL, SLAC)
WIIK	75	Stanford Symp. 69		(DESY)

OTHER RELATED PAPERS

BARATE	83	PL 121B 449	+Bareyre, Bonamy+	(SACL, LOIC, SHMP, IND)
BRAUNSCH...	75B	PL 57B 407	Braunschweig, Konigs+	(DASP Collab.)
FELDMAN	75	Stanford Symp. 39		(SLAC)
HEINTZE	75	Stanford Symp. 97		(HEIDP)
SIMPSON	75	PRL 35 699	+Beron, Ford, Hilger, Hofstadter+	(STAN, PENN)

$h_c(1P)$

$I^G(J^{PC}) = ?^?(?^{??})$

OMITTED FROM SUMMARY TABLE

Observed in the reaction $\overline{p}p \rightarrow J/\psi(1S)\pi^0$ close to the center of gravity of the ^3P_J states and has characteristics consistent with what is expected for the $^1P_1$ state. First indications obtained by BAGLIN 86 in the reaction $\overline{p}p \rightarrow J/\psi(1S)X$. Needs confirmation.

$h_c(1P)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
3526.14±0.24 OUR AVERAGE					
3526.20±0.15±0.20	59	ARMSTRONG	92D	SPEC	$\overline{p}p \rightarrow J/\psi\pi^0$
3525.4 ±0.8 ±0.4	5	BAGLIN	86	SPEC	$\overline{p}p \rightarrow J/\psi X$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
3527 ±8	42	ANTONIAZZI	94	E705	300 $\pi^\pm$, pLi $\rightarrow$ $J/\psi\pi^0$X

$h_c(1P)$ WIDTH

VALUE (MeV)	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<1.1	90	59	ARMSTRONG	92D	SPEC	$\overline{p}p \rightarrow J/\psi\pi^0$

$h_c(1P)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	$J/\psi(1S)\pi^0$	seen
Γ_2	$J/\psi(1S)\pi\pi$	not seen
Γ_3	$p\overline{p}$	

$\Gamma(J/\psi(1S)\pi\pi)/\Gamma(J/\psi(1S)\pi^0)$ Γ_2/Γ_1

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.18	90	ARMSTRONG	92D	SPEC	$\overline{p}p \rightarrow J/\psi\pi^0$

$h_c(1P)$ REFERENCES

ANTONIAZZI	94	PR D50 4258	+Arenton+	(E705 Collab.)
ARMSTRONG	92D	PRL 69 2337	+Bettoni+	(FNAL, FERR, GENO, UCI, PENN, TORI)
BAGLIN	86	PL B171 135	+Baird+	(LAPP, CERN, TORI, STRB, OSLO, ROMA+)

$\chi_{c2}(1P)$ or $\chi_{c2}(3555)$

$I^G(J^{PC}) = 0^+(2^{++})$

Observed in the radiative decay $\psi(2S) \to \chi_{c2}(1P)\gamma$. Therefore $C = +$. The observed decay into 4π and 6π imply $G = +$, thus $I = 0$. $J = 0$ is excluded by the angular distribution in the hadronic decays. J^P abnormal excluded by $\pi^+\pi^-$ and K^+K^- decays. $J^P = 2^+$ preferred (FELDMAN 77, OREGLIA 82).

$\chi_{c2}(1P)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
3556.17± 0.13 OUR AVERAGE					
3556.15± 0.07±0.12	585	ARMSTRONG	92	SPEC	$\overline{p}p \to e^+e^-\gamma$
3556.9 ± 0.4 ±0.5	50	BAGLIN	86B	SPEC	$\overline{p}p \to e^+e^-$ X
3557.8 ± 0.2 ±4		[1] GAISER	86	CBAL	$\psi(2S) \to \gamma$ X
3553.4 ± 2.2	66	[2] LEMOIGNE	82	GOLI	190 GeV π^- Be $\to \gamma 2\mu$
3555.9 ± 0.7		[3] OREGLIA	82	CBAL	$e^+e^- \to J/\psi 2\gamma$
3557 ± 1.5	69	[4] HIMEL	80	MRK2	$e^+e^- \to J/\psi 2\gamma$
3551.0 ±11.0	15	BRANDELIK	79B	DASP	$e^+e^- \to J/\psi 2\gamma$
3553.0 ± 4.0		[4] BARTEL	78B	CNTR	$e^+e^- \to J/\psi 2\gamma$
3553.0 ± 4 ±4		[4,5] TANENBAUM	78	MRK1	e^+e^-
3563.0 ± 7.0	360	[4] BIDDICK	77	CNTR	$e^+e^- \to \gamma$ X
• • • We do not use the following data for averages, fits, limits, etc. • • •					
3550.0 ±10.0		TRILLING	76	MRK1	e^+e^- → hadronsγ
3543.0 ±10.0	4	WHITAKER	76	MRK1	$e^+e^- \to J/\psi 2\gamma$

[1] Using mass of $\psi(2S) = 3686.0$ MeV.
[2] $J/\psi(1S)$ mass constrained to 3097 MeV.
[3] Assuming $\psi(2S)$ mass = 3686 MeV and $J/\psi(1S)$ mass = 3097 MeV.
[4] Mass value shifted by us by amount appropriate for $\psi(2S)$ mass = 3686 MeV and $J/\psi(1S)$ mass = 3097 MeV.
[5] From a simultaneous fit to radiative and hadronic decay channels.

$\chi_{c2}(1P)$ WIDTH

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
2.00±0.18 OUR AVERAGE					
1.98±0.17±0.07	585	ARMSTRONG	92	SPEC	$\overline{p}p \to e^+e^-\gamma$
$2.6\ ^{+1.4}_{-1.0}$	50	BAGLIN	86B	SPEC	$\overline{p}p \to e^+e^-$ X
$2.8\ ^{+2.1}_{-2.0}$		[6] GAISER	86	CBAL	$\psi(2S) \to \gamma$ X

[6] Errors correspond to 90% confidence level; authors give only width range.

$\chi_{c2}(1P)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Confidence level
	Hadronic decays		
Γ_1	$2(\pi^+\pi^-)$	(2.2 ±0.5) %	
Γ_2	$\pi^+\pi^- K^+K^-$	(1.9 ±0.5) %	
Γ_3	$3(\pi^+\pi^-)$	(1.2 ±0.8) %	
Γ_4	$\rho^0\pi^+\pi^-$	(7 ±4) $\times 10^{-3}$	
Γ_5	$K^+\overline{K}^*(892)^0\pi^-$ + c.c.	(4.8 ±2.8) $\times 10^{-3}$	
Γ_6	$\pi^+\pi^- p\overline{p}$	(3.3 ±1.3) $\times 10^{-3}$	
Γ_7	$\pi^+\pi^-$	(1.9 ±1.0) $\times 10^{-3}$	
Γ_8	K^+K^-	(1.5 ±1.1) $\times 10^{-3}$	
Γ_9	$p\overline{p}$	(10.0 ±1.0) $\times 10^{-5}$	
Γ_{10}	$\pi^0\pi^0$	(1.10±0.28) $\times 10^{-3}$	
Γ_{11}	$\eta\eta$	(8 ±5) $\times 10^{-4}$	
Γ_{12}	$J/\psi(1S)\pi^+\pi^-\pi^0$	< 1.5 %	90%

Radiative decays

Γ_{13}	$\gamma J/\psi(1S)$	(13.5 ±1.1) %
Γ_{14}	$\gamma\gamma$	(1.6 ±0.5) × 10^{-4}

$\chi_{c2}(1P)$ PARTIAL WIDTHS

$\Gamma(p\overline{p})$ Γ_9

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
206±22 OUR AVERAGE					
197±18±16	585	[7] ARMSTRONG	92	SPEC	$\overline{p}p \to e^+e^-\gamma$
$252^{+55}_{-48}\pm21$		[7] BAGLIN	86B	SPEC	$\overline{p}p \to e^+e^-$ X

[7] Restated by us using B($\chi_{c2}(1P) \to J/\psi(1S)\gamma$)B($J/\psi(1S) \to e^+e^-$) = 0.0085 ± 0.0007.

$\Gamma(\gamma\gamma)$ Γ_{14}

VALUE (keV)	CL%	DOCUMENT ID		TECN	COMMENT
0.37 ±0.17 OUR AVERAGE		Error includes scale factor of 1.9.			
1.08 ±0.30 ±0.26		DOMINICK	94	CLE2	$e^+e^- \to e^+e^-\chi_{c2}$
0.321±0.078±0.054		[8] ARMSTRONG	93	SPEC	$\overline{p}p \to \gamma\gamma$
3.4 ±1.7 ±0.9		BAUER	93	TPC	$e^+e^- \to e^+e^-\chi_{c2}$
$2.9\ ^{+1.3}_{-1.0}$ ±1.7		BAGLIN	87B	SPEC	$\overline{p}p \to \gamma\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<4.2	95	UEHARA	91	VNS	$e^+e^- \to e^+e^-\chi_{c2}$
<1.0	95	CHEN	90B	CLEO	$e^+e^- \to e^+e^-\chi_{c2}$
<4.2	95	AIHARA	88D	TPC	$e^+e^- \to e^+e^-$ X
<1.6	90	YAMADA	77	DASP	$e^+e^- \to 3\gamma$

[8] Using B($\chi_{c2}(1P) \to p\overline{p}$) = (1.00 ± 0.23) × 10^{-4} and Γ_{total} = 2.00 ± 0.18 MeV.

$\chi_{c2}(1P)$ BRANCHING RATIOS

HADRONIC DECAYS

$\Gamma(2(\pi^+\pi^-))/\Gamma_{\text{total}}$ Γ_1/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.022±0.005	[10] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c2}$

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

VALUE	DOCUMENT ID		TECN	COMMENT
0.019±0.005	[10] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c2}$

$\Gamma(3(\pi^+\pi^-))/\Gamma_{\text{total}}$ Γ_3/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.012±0.008	[10] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c2}$

$\Gamma(\rho^0\pi^+\pi^-)/\Gamma_{\text{total}}$ Γ_4/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
68±40	[10] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c2}$

$\Gamma(K^+\overline{K}^*(892)^0\pi^- + \text{c.c.})/\Gamma_{\text{total}}$ Γ_5/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
48±28	[10] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c2}$

$\Gamma(\pi^+\pi^- p\overline{p})/\Gamma_{\text{total}}$ Γ_6/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
33±13	[10] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c2}$

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

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.9±1.0	4	[10] BRANDELIK	79C	DASP	$\psi(2S) \to \gamma\chi_{c2}$

$[\Gamma(\pi^+\pi^-) + \Gamma(K^+K^-)]/\Gamma_{\text{total}}$ $(\Gamma_7+\Gamma_8)/\Gamma$

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
24±10	[10] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c2}$

$\Gamma(K^+K^-)/\Gamma_{total}$ Γ_8/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.5±1.1	2	[10] BRANDELIK	79C	DASP	$\psi(2S) \to \gamma\chi_{c2}$

$\Gamma(p\overline{p})/\Gamma_{total}$ Γ_9/Γ

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
1.00±0.10 OUR AVERAGE						
1.00±0.11		585	[9] ARMSTRONG	92	SPEC	$\overline{p}p \to e^+e^-\gamma$
$0.97^{+0.44}_{-0.28}\pm0.08$			BAGLIN	86B	SPEC	$\overline{p}p \to e^+e^-X$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<9.5	90		[10] BRANDELIK	79B	DASP	$\psi(2S) \to \gamma\chi_{c2}$

[9] Restated by us using $B(\chi_{c2}(1P) \to J/\psi(1S)\gamma)B(J/\psi(1S) \to e^+e^-) = 0.0085 \pm 0.0007$.

$\Gamma_i\Gamma_f/\Gamma^2_{total}$ in $p\overline{p} \to \chi_{c2}(1P) \to \gamma\gamma$ $\Gamma_9\Gamma_{14}/\Gamma^2$

VALUE (units 10^{-7})	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.160±0.039±0.016		ARMSTRONG	93	SPEC	$\overline{p}p \to \gamma\gamma$
$0.99\ ^{+0.46}_{-0.35}$	6	[11] BAGLIN	87B	SPEC	$\overline{p}p \to \gamma\gamma$

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

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
1.1 ±0.2 ±0.2	[12] LEE	85	CBAL	$\psi' \to$ photons

$\Gamma(\eta\eta)/\Gamma_{total}$ Γ_{11}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
7.9±4.1±2.4	[12] LEE	85	CBAL	$\psi' \to$ photons

$\Gamma(J/\psi(1S)\pi^+\pi^-\pi^0)/\Gamma_{total}$ Γ_{12}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.015	90	BARATE	81	SPEC	190 GeV π^- Be $\to 2\pi 2\mu$

[10] Estimated using $B(\psi(2S) \to \gamma\chi_{c2}(1P)) = 0.078$; the errors do not contain the uncertainty in the $\psi(2S)$ decay.

[11] Assuming isotropic $\chi_{c2}(1P) \to \gamma\gamma$ distribution.

[12] LEE 85 result is calculated using $B(\psi(2S) \to \gamma\chi_{c2}(1P)) = 0.078 \pm 0.008$.

RADIATIVE DECAYS

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.135±0.011 OUR AVERAGE					
0.124±0.015		GAISER	86	CBAL	$\psi(2S) \to \gamma X$
0.162±0.028	479	[13] OREGLIA	82	CBAL	$\psi(2S) \to \gamma\chi_{c2}$
0.14 ±0.04		[13] HIMEL	80	MRK2	$\psi(2S) \to \gamma\chi_{c2}$
0.18 ±0.05		[13] BRANDELIK	79B	DASP	$\psi(2S) \to \gamma\chi_{c2}$
0.13 ±0.03		[13] BARTEL	78B	CNTR	$\psi(2S) \to \gamma\chi_{c2}$
$0.11\ ^{+0.13}_{-0.07}$		[13] SPITZER	78	PLUT	$\psi(2S) \to \gamma\chi_{c2}$
0.13 ±0.08		[13] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c2}$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.28 ±0.13		[13] BIDDICK	77	CNTR	$\psi(2S) \to \gamma X$

[13] Estimated using $B(\psi(2S) \to \gamma\chi_{c2}(1P)) = 0.078$; the errors do not contain the uncertainty in the $\psi(2S)$ decay.

$\Gamma(\gamma\gamma)/\Gamma_{total}$ Γ_{14}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
1.60±0.39±0.23	[14] ARMSTRONG	93	SPEC	$\overline{p}p \to \gamma\gamma$

[14] Using $B(\chi_{c2}(1P) \to p\overline{p}) = (1.00 \pm 0.23) \times 10^{-4}$.

$\chi_{c2}(1P)$ REFERENCES

DOMINICK	94	PR D50 4265	+Sanghera+	(CLEO Collab.)
ARMSTRONG	93	PRL 70 2988	+Bettoni, Bharadwaj+	(FNAL E760 Collab.)
BAUER	93	PL B302 345	+Belcinski+	(TPC Collab.)
ARMSTRONG	92	NP B373 35	+Bettoni+	(FNAL, FERR, GENO, UCI, NWES+)
Also	92B	PRL 68 1468	Armstrong, Bettoni+	(FNAL, FERR, GENO, UCI, NWES+)
UEHARA	91	PL B266 188	+Abe+	(VENUS Collab.)
CHEN	90B	PL B243 169	+McIlwain+	(CLEO Collab.)
AIHARA	88D	PRL 60 2355	+Alston-Garnjost+	(TPC Collab.)
BAGLIN	87B	PL B187 191	+Baird, Bassompierre, Borreani+	(R704 Collab.)
BAGLIN	86B	PL B172 455		(LAPP, CERN, GENO, LYON, OSLO, ROMA+)
GAISER	86	PR D34 711	+Bloom, Bulos, Godfrey+	(Crystal Ball Collab.)
LEE	85	SLAC 282		(SLAC)
LEMOIGNE	82	PL 113B 509	+Barate, Astbury+	(SACL, LOIC, SHMP, IND)
OREGLIA	82	PR D25 2259	+Partridge+	(SLAC, CIT, HARV, PRIN, STAN)
Also	82B	Private Comm.	Oreglia	(EFI)
BARATE	81	PR D24 2994	+Astbury+	(SACL, LOIC, SHMP, CERN, IND)
HIMEL	80	PRL 44 920	+Abrams, Alam, Blocker+	(LBL, SLAC)
Also	82	Private Comm.	Trilling	(LBL, UCB)
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)
SPITZER	78	Kyoto Sum. Inst. 47		(HAMB)
TANENBAUM	78	PR D17 1731	+Alam, Boyarski+	(SLAC, LBL)
Also	82	Private Comm.	Trilling	(LBL, UCB)
BIDDICK	77	PRL 38 1324	+Burnett+	(UCSD, UMD, PAVI, PRIN, SLAC, STAN)
FELDMAN	77	PRPL 33C 285	+Perl	(LBL, SLAC)
YAMADA	77	Hamburg Conf. 69		(DASP Collab.)
TRILLING	76	Stanford Symp. 437		(LBL)
WHITAKER	76	PRL 37 1596	+Tanenbaum, Abrams, Alam+	(SLAC, LBL)

OTHER RELATED PAPERS

BARATE	83	PL 121B 449	+Bareyre, Bonamy+	(SACL, LOIC, SHMP, IND)
FELDMAN	75B	PRL 35 821	+Jean-Marie, Sadoulet, Vannucci+	(LBL, SLAC)
Also	75C	PRL 35 1189	Feldman	
Erratum.				
TANENBAUM	75	PRL 35 1323	+Whitaker, Abrams+	(LBL, SLAC)

$\eta_c(2S)$ or $\eta_c(3590)$

$I^G(J^{PC}) = ?^?(?^{?+})$

OMITTED FROM SUMMARY TABLE

Our latest mini-review on this particle can be found in the 1984 edition. Needs confirmation.

$\eta_c(2S)$ MASS

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
3594.0±5.0	[1] EDWARDS	82C	CBAL	$e^+e^- \to \gamma X$

[1] Assuming mass of $\psi(2S) = 3686$ MeV.

$\eta_c(2S)$ WIDTH

VALUE (MeV)	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<8.0	95	EDWARDS	82C	CBAL	$e^+e^- \to \gamma X$

$\eta_c(2S)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	hadrons	seen
Γ_2	$\gamma\gamma$	

$\eta_c(2S)$ BRANCHING RATIOS

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

VALUE	DOCUMENT ID		TECN	COMMENT
seen	EDWARDS	82C	CBAL	$e^+e^- \to \gamma X$

$\Gamma(\gamma\gamma)/\Gamma_{total}$ Γ_2/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.01	90	LEE	85	CBAL	$\psi' \rightarrow$ photons

$\eta_c(2S)$ REFERENCES

LEE	85	SLAC 282		(SLAC)
EDWARDS	82C	PRL 48 70	+Partridge, Peck+	(CIT, HARV, PRIN, STAN, SLAC)

OTHER RELATED PAPERS

OREGLIA	82	PR D25 2259	+Partridge+	(SLAC, CIT, HARV, PRIN, STAN)
PORTER	81	SLAC Summer Inst. 355	+Edwards+	(CIT, HARV, PRIN, STAN, SLAC)
BARTEL	78B	PL 79B 492	+Dittmann, Duinker, Olsson, O'Neill+	(DESY, HEIDP)

$\psi(2S)$ or $\psi(3685)$

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

$\psi(2S)$ 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. • • •					
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 $\rightarrow 2\mu$
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^-	(8.8 ±1.3) $\times 10^{-3}$	
Γ_4	$\mu^+\mu^-$	(7.7 ±1.7) $\times 10^{-3}$	
	Decays into $J/\psi(1S)$ and anything		
Γ_5	$J/\psi(1S)$ anything	(57 ±4) %	
Γ_6	$J/\psi(1S)$ neutrals	(23.2 ±2.6) %	
Γ_7	$J/\psi(1S)\pi^+\pi^-$	(32.4 ±2.6) %	
Γ_8	$J/\psi(1S)\pi^0\pi^0$	(18.4 ±2.7) %	
Γ_9	$J/\psi(1S)\eta$	(2.7 ±0.4) %	S=1.7
Γ_{10}	$J/\psi(1S)\pi^0$	(9.7 ±2.1) $\times 10^{-4}$	

Hadronic decays

Γ_{11}	$3(\pi^+\pi^-)\pi^0$	(3.5	± 1.6)	$\times 10^{-3}$	
Γ_{12}	$2(\pi^+\pi^-)\pi^0$	(3.1	± 0.7)	$\times 10^{-3}$	
Γ_{13}	$\pi^+\pi^- K^+ K^-$	(1.6	± 0.4)	$\times 10^{-3}$	
Γ_{14}	$\pi^+\pi^- p\overline{p}$	(8.0	± 2.0)	$\times 10^{-4}$	
Γ_{15}	$K^+\overline{K}^*(892)^0\pi^-$ + c.c.	(6.7	± 2.5)	$\times 10^{-4}$	
Γ_{16}	$2(\pi^+\pi^-)$	(4.5	± 1.0)	$\times 10^{-4}$	
Γ_{17}	$\rho^0\pi^+\pi^-$	(4.2	± 1.5)	$\times 10^{-4}$	
Γ_{18}	$\overline{p}p$	(1.9	± 0.5)	$\times 10^{-4}$	
Γ_{19}	$3(\pi^+\pi^-)$	(1.5	± 1.0)	$\times 10^{-4}$	
Γ_{20}	$\overline{p}p\pi^0$	(1.4	± 0.5)	$\times 10^{-4}$	
Γ_{21}	K^+K^-	(1.0	± 0.7)	$\times 10^{-4}$	
Γ_{22}	$\pi^+\pi^-\pi^0$	(9	± 5)	$\times 10^{-5}$	
Γ_{23}	$\pi^+\pi^-$	(8	± 5)	$\times 10^{-5}$	
Γ_{24}	$\Lambda\overline{\Lambda}$	$<$ 4		$\times 10^{-4}$	CL=90%
Γ_{25}	$\Xi^-\overline{\Xi}^+$	$<$ 2		$\times 10^{-4}$	CL=90%
Γ_{26}	$\rho\pi$	$<$ 8.3		$\times 10^{-5}$	CL=90%
Γ_{27}	$K^+K^-\pi^0$	$<$ 2.96		$\times 10^{-5}$	CL=90%
Γ_{28}	$K^+\overline{K}^*(892)^-$ + c.c.	$<$ 5.4		$\times 10^{-5}$	CL=90%

Radiative decays

Γ_{29}	$\gamma\chi_{c0}(1P)$	(9.3	± 0.8)	%	
Γ_{30}	$\gamma\chi_{c1}(1P)$	(8.7	± 0.8)	%	
Γ_{31}	$\gamma\chi_{c2}(1P)$	(7.8	± 0.8)	%	
Γ_{32}	$\gamma\eta_c(1S)$	(2.8	± 0.6)	$\times 10^{-3}$	
Γ_{33}	$\gamma\eta_c(2S)$				
Γ_{34}	$\gamma\pi^0$	$<$ 5.4		$\times 10^{-3}$	CL=95%
Γ_{35}	$\gamma\eta'(958)$	$<$ 1.1		$\times 10^{-3}$	CL=90%
Γ_{36}	$\gamma\eta$				
Γ_{37}	$\gamma\gamma$	$<$ 1.6		$\times 10^{-4}$	CL=90%
Γ_{38}	$\gamma\eta(1440) \rightarrow \gamma K\overline{K}\pi$	[a] $<$ 1.2		$\times 10^{-4}$	CL=90%

Mode needed for fitting purposes

Γ_{39}	1. − other fit modes	(30	± 4)	%

[a] See the "Note on the $\eta(1440)$" in the $\eta(1440)$ Full Listings.

CONSTRAINED FIT INFORMATION

An overall fit to 7 branching ratios uses 13 measurements and one constraint to determine 6 parameters. The overall fit has a $\chi^2 = 6.9$ for 8 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	35				
x_9	0	−11			
x_{30}	1	−7	0		
x_{31}	0	−3	0	0	
x_{39}	−80	−78	−4	−14	−16
	x_7	x_8	x_9	x_{30}	x_{31}

$\psi(2S)$ 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_{37}

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

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

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 $\Gamma(i)/\text{total}$.

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

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	[4] 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	[5] LUTH	75	MRK1	e^+e^-

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

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
88±13	[6] FELDMAN	77	RVUE	e^+e^-

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

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
77±17	[7] 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^-

[4] Includes cascade decay into $J/\psi(1S)$.
[5] Included in $\Gamma(\text{hadrons})/\Gamma_{\text{total}}$.
[6] 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.
[7] Restated by us using $B(\psi(2S) \to J/\psi(1S)\text{anything}) = 0.55$.

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

$\Gamma(J/\psi(1S)\text{anything})/\Gamma_{\text{total}}$ $\Gamma_5/\Gamma \equiv (\Gamma_7+\Gamma_8+\Gamma_9+0.273\Gamma_{30}+0.135\Gamma_{31})/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
0.57±0.04 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

$\Gamma(J/\psi(1S)\text{neutrals})/\Gamma_{\text{total}}$ $\Gamma_6/\Gamma = (0.9761\Gamma_8+0.708\Gamma_9+0.273\Gamma_{30}+0.135\Gamma_{31})/\Gamma$

VALUE	DOCUMENT ID
0.232±0.026 OUR FIT	

$\Gamma(J/\psi(1S)\text{neutrals})/\Gamma(J/\psi(1S)\text{anything})$ $\Gamma_6/\Gamma_5 \equiv (0.9761\Gamma_8+0.708\Gamma_9+0.273\Gamma_{30}+0.135\Gamma_{31})/(\Gamma_7+\Gamma_8+\Gamma_9+0.273\Gamma_{30}+0.135\Gamma_{31})$

VALUE	DOCUMENT ID	TECN	COMMENT
0.409±0.026 OUR FIT			
• • • We do not use the following data for averages, fits, limits, etc. • • •			
0.44 ±0.03	[8] ABRAMS	75B MRK1	$e^+e^- \to J/\psi X$

$\Gamma(J/\psi(1S)\text{neutrals})/\Gamma(J/\psi(1S)\pi^+\pi^-)$ $\Gamma_6/\Gamma_7 \equiv (0.9761\Gamma_8+0.708\Gamma_9+0.273\Gamma_{30}+0.135\Gamma_{31})/\Gamma_7$

VALUE	DOCUMENT ID	TECN	COMMENT
0.72±0.08 OUR FIT			
0.73±0.09	[8] TANENBAUM 76	MRK1	e^+e^-

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

VALUE	DOCUMENT ID	TECN	COMMENT
0.324±0.026 OUR FIT			
0.332±0.033 OUR AVERAGE			
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

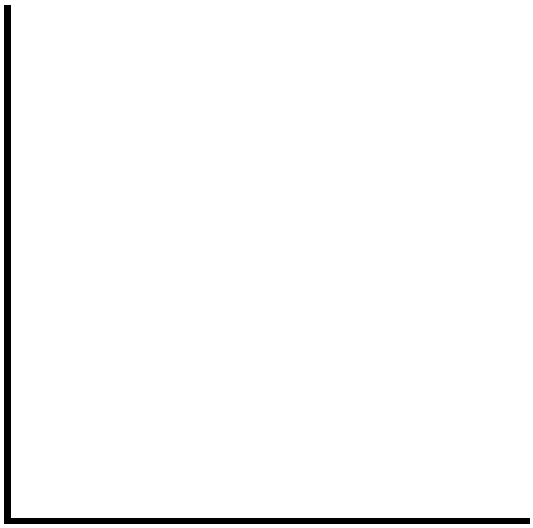
VALUE	DOCUMENT ID	TECN	COMMENT
0.184±0.027 OUR FIT			
0.18 ±0.06	WIIK 75	DASP	$e^+e^- \to J/\psi 2\pi^0$

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

VALUE	DOCUMENT ID	TECN	COMMENT
0.57±0.08 OUR FIT			
• • • We do not use the following data for averages, fits, limits, etc. • • •			
0.53±0.06	[9] TANENBAUM 76	MRK1	e^+e^-
0.64±0.15	[10] HILGER 75	SPEC	e^+e^-

$\Gamma(J/\psi(1S)\eta)/\Gamma_{\text{total}}$ 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	$e^+e^- \to J/\psi 2\gamma$
0.0218±0.0014±0.0035	386	OREGLIA 80	CBAL	$e^+e^- \to J/\psi 2\gamma$
0.036 ±0.005	164	BARTEL 78B	CNTR	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.035 ±0.009	17	[11] BRANDELIK 79B	DASP	$e^+e^- \to J/\psi 2\gamma$
0.043 ±0.008	44	[11] TANENBAUM 76	MRK1	e^+e^-



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

$\Gamma(J/\psi(1S)\pi^0)/\Gamma_{\rm total}$ **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	$\psi(2S) \to J/\psi 2\gamma$

[8] 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.

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

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

[11] Low statistics data removed from average.

HADRONIC DECAYS

$\Gamma(3(\pi^+\pi^-)\pi^0)/\Gamma_{\rm total}$ **Γ_{11}/Γ**

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

$\Gamma(2(\pi^+\pi^-)\pi^0)/\Gamma_{\rm total}$ **Γ_{12}/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^-

$\Gamma(\pi^+\pi^- K^+K^-)/\Gamma_{\rm total}$ **Γ_{13}/Γ**

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
16±4	[12] TANENBAUM	78	MRK1	e^+e^-

$\Gamma(\pi^+\pi^- p\bar{p})/\Gamma_{\rm total}$ **Γ_{14}/Γ**

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
8 ±2	[12] TANENBAUM	78	MRK1	e^+e^-

$\Gamma(K^+\overline{K}^*(892)^0\pi^- + \text{c.c.})/\Gamma_{\rm total}$ **Γ_{15}/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_{16}/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_{17}/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_{18}/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_{19}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
1.5±1.0	[12] TANENBAUM	78	MRK1	e^+e^-

$\Gamma(\bar{p}p\pi^0)/\Gamma_{total}$ Γ_{20}/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_{21}/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_{23}/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_{22}/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_{24}/Γ

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

$\Gamma(\Xi^-\bar{\Xi}^+)/\Gamma_{total}$ Γ_{25}/Γ

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

$\Gamma(\rho\pi)/\Gamma_{total}$ Γ_{26}/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		[13] ABRAMS	75	MRK1	e^+e^-

$\Gamma(K^+K^-\pi^0)/\Gamma_{total}$ Γ_{27}/Γ

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

$\Gamma(K^+\overline{K}^*(892)^- + \text{c.c.})/\Gamma_{total}$ Γ_{28}/Γ

VALUE (units 10^{-5})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<5.4	90	0	FRANKLIN	83	MRK2	$e^+e^- \rightarrow$ hadrons

[12] Assuming entirely strong decay.
[13] Final state $\rho^0\pi^0$.

RADIATIVE DECAYS

$\Gamma(\gamma\chi_{c0}(1P))/\Gamma_{total}$ Γ_{29}/Γ

VALUE (units 10^{-2})	DOCUMENT ID		TECN	COMMENT
9.3±0.8 OUR AVERAGE				
9.9±0.5±0.8	[14] GAISER	86	CBAL	$e^+e^- \to \gamma X$
7.2±2.3	[14] BIDDICK	77	CNTR	$e^+e^- \to \gamma X$
7.5±2.6	[14] WHITAKER	76	MRK1	e^+e^-

$\Gamma(\gamma\chi_{c1}(1P))/\Gamma_{total}$ Γ_{30}/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	[15] GAISER	86	CBAL	$e^+e^- \to \gamma X$
7.1±1.9	[16] BIDDICK	77	CNTR	$e^+e^- \to \gamma X$

$\Gamma(\gamma\chi_{c2}(1P))/\Gamma_{total}$ Γ_{31}/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	[17] GAISER	86	CBAL	$e^+e^- \to \gamma X$
7.0±2.0	[16] BIDDICK	77	CNTR	$e^+e^- \to \gamma X$

$\Gamma(\gamma\eta_c(1S))/\Gamma_{total}$ Γ_{32}/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_{33}/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_{34}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
< 54	95	[18] 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_{35}/Γ

VALUE (units 10^{-2})	CL%	DOCUMENT ID		TECN	COMMENT
<0.11	90	[19] BARTEL	76	CNTR	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.6	90	[20] BRAUNSCH...	77	DASP	e^+e^-

$\Gamma(\gamma\eta)/\Gamma_{total}$ Γ_{36}/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_{38}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<0.12	90	[21] SCHARRE	80	MRK1	e^+e^-

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

$\psi(2S)$ REFERENCES

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)

$\psi(3770)$

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

$\psi(3770)$ MASS

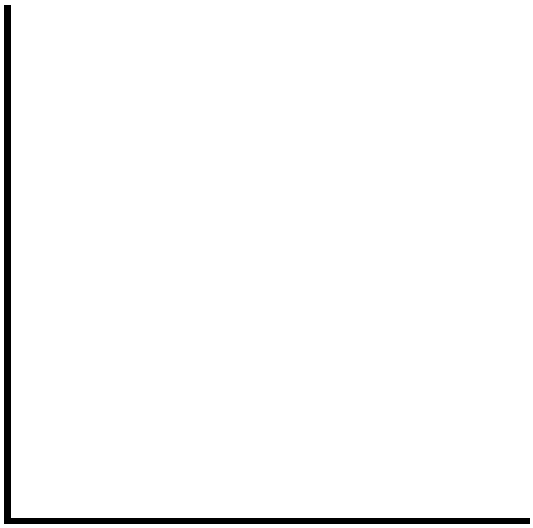
VALUE (MeV)	*DOCUMENT ID*	*TECN*	*COMMENT*
3769.9±2.5 OUR EVALUATION	Error includes scale factor of 1.8. From $m_{\psi(3685)}$ and mass difference below.		
• • • We do not use the following data for averages, fits, limits, etc. • • •			
3764.0±5.0	[1] SCHINDLER 80	MRK2	e^+e^-
3770 ±6.0	[1] BACINO 78	DLCO	e^+e^-
3772.0±6.0	[1] RAPIDIS 77	MRK1	e^+e^-

[1] Errors include systematic common to all experiments.

$m_{\psi(3770)} - m_{\psi(2S)}$

VALUE (MeV)	*DOCUMENT ID*	*TECN*	*COMMENT*
83.9±2.4 OUR AVERAGE	Error includes scale factor of 1.8. See the ideogram below.		
80.0±2.0	SCHINDLER 80	MRK2	e^+e^-
86.0±2.0	[2] BACINO 78	DLCO	e^+e^-
88.0±3.0	RAPIDIS 77	MRK1	e^+e^-

[2] SPEAR $\psi(2S)$ mass subtracted (see SCHINDLER 80).



$m_{\psi(3770)} - m_{\psi(2S)}$ (MeV)

$\psi(3770)$ WIDTH

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
23.6±2.7 OUR FIT Error includes scale factor of 1.1.				
25.3±2.9 OUR AVERAGE				
24.0±5.0	SCHINDLER	80	MRK2	e^+e^-
24.0±5.0	BACINO	78	DLCO	e^+e^-
28.0±5.0	RAPIDIS	77	MRK1	e^+e^-

$\psi(3770)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Scale factor
Γ_1	$D\overline{D}$	dominant	
Γ_2	e^+e^-	$(1.12\pm0.17)\times10^{-5}$	1.2

$\psi(3770)$ PARTIAL WIDTHS

$\Gamma(e^+e^-)$ Γ_2

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
0.26 ±0.04 OUR FIT Error includes scale factor of 1.2.				
0.24 ±0.05 OUR AVERAGE Error includes scale factor of 1.2.				
0.276±0.050	SCHINDLER	80	MRK2	e^+e^-
0.18 ±0.06	BACINO	78	DLCO	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.37 ±0.09	[3] RAPIDIS	77	MRK1	e^+e^-

[3] See also $\Gamma(e^+e^-)/\Gamma_{total}$ below.

$\psi(3770)$ BRANCHING RATIOS

$\Gamma(D\overline{D})/\Gamma_{total}$ Γ_1/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
dominant	PERUZZI	77	MRK1	$e^+e^- \rightarrow D\overline{D}$

$\Gamma(e^+e^-)/\Gamma_{total}$ Γ_2/Γ

VALUE (units 10^{-5})	DOCUMENT ID		TECN	COMMENT
1.12±0.17 OUR FIT Error includes scale factor of 1.2.				
1.3 ±0.2	RAPIDIS	77	MRK1	e^+e^-

$\psi(3770)$ REFERENCES

SCHINDLER	80	PR D21 2716	+Siegrist, Alam, Boyarski+	(Mark II Collab.)
BACINO	78	PRL 40 671	+Baumgarten, Birkwood+	(SLAC, UCLA, UCI)
PERUZZI	77	PRL 39 1301	+Piccolo, Feldman+	(SLAC, LBL, NWES, HAWA)
RAPIDIS	77	PRL 39 526	+Gobbi, Luke, Barbaro-Galtieri+	(Mark I Collab.)

$\psi(4040)$

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

J^{PC} for the $\psi(4040)$ is known by its production in e^+e^- collisions via single-photon annihilation. I^G is not known, and the interpretation of this state as a single resonance is unclear because of the expectation of substantial threshold effects in this energy region.

$\psi(4040)$ MASS

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
4040.0±10.0	BRANDELIK	78C	DASP	e^+e^-

$\psi(4040)$ WIDTH

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
52.0±10.0	BRANDELIK	78C	DASP	e^+e^-

$\psi(4040)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	e^+e^-	$(1.4\pm0.4)\times10^{-5}$
Γ_2	$D^0\overline{D}^0$	seen
Γ_3	$D^*(2007)^0\overline{D}^0$ + c.c.	seen
Γ_4	$D^*(2007)^0\overline{D}^*(2007)^0$	seen
Γ_5	$J/\psi(1S)$ hadrons	
Γ_6	$\mu^+\mu^-$	

$\psi(4040)$ PARTIAL WIDTHS

$\Gamma(e^+e^-)$ Γ_1

VALUE (keV)	*DOCUMENT ID*		*TECN*	*COMMENT*
0.75±0.15	BRANDELIK	78C	DASP	e^+e^-

$\psi(4040)$ BRANCHING RATIOS

$\Gamma(e^+e^-)/\Gamma_{total}$ Γ_1/Γ

VALUE (units 10^{-5})	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
~ 1.0	FELDMAN	77	MRK1	e^+e^-

$\Gamma(D^0\overline{D}^0)/\Gamma(D^*(2007)^0\overline{D}^0 + \text{c.c.})$ Γ_2/Γ_3

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
0.05 ±0.03	[1] GOLDHABER	77	MRK1	e^+e^-

[1] Phase-space factor (p^3) explicitly removed.

$\Gamma(D^*(2007)^0\overline{D}^*(2007)^0)/\Gamma(D^*(2007)^0\overline{D}^0 + \text{c.c.})$ Γ_4/Γ_3

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
32.0±12.0	[2] GOLDHABER	77	MRK1	e^+e^-

[2] Phase-space factor (p^3) explicitly removed.

$\psi(4040)$ REFERENCES

BRANDELIK	78C	PL 76B 361	+Cords+	(DASP Collab.)
Also	79C	ZPHY C1 233	Brandelik, Cords+	(DASP Collab.)
FELDMAN	77	PRPL 33C 285	+Perl	(LBL, SLAC)
GOLDHABER	77	PL 69B 503	+Wiss, Abrams, Alam+	(LBL, SLAC)

OTHER RELATED PAPERS

HEIKKILA	84	PR D29 110	+Tornqvist, Ono	(HELS, AACHT)
ONO	84	ZPHY C26 307		(ORSAY)
SIEGRIST	82	PR D26 969	+Schwitters, Alam, Chinowsky+	(SLAC, LBL)
AUGUSTIN	75	PRL 34 764	+Boyarski, Abrams, Briggs+	(SLAC, LBL)
BACCI	75	PL 58B 481	+Bidoli, Penso, Stella+	(ROMA, FRAS)
BOYARSKI	75B	PRL 34 762	+Breidenbach, Abrams, Briggs+	(SLAC, LBL)
ESPOSITO	75	PL 58B 478	+Felicetti, Peruzzi+	(FRAS, NAPL, PADO, ROMA)

$\psi(4160)$

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

J^{PC} for the $\psi(4160)$ is known by its production in e^+e^- collisions via single-photon annihilation. I^G is not known, and the interpretation of this state as a single resonance is unclear because of the expectation of substantial threshold effects in this energy region.

$\psi(4160)$ MASS

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
4159.0±20.0	BRANDELIK	78C	DASP	e^+e^-

$\psi(4160)$ WIDTH

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
78.0±20.0	BRANDELIK	78C	DASP	e^+e^-

$\psi(4160)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	e^+e^-	$(10\pm4)\times10^{-6}$

$\psi(4160)$ PARTIAL WIDTHS

$\Gamma(e^+e^-)$ Γ_1

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
0.77±0.23	BRANDELIK	78C	DASP	e^+e^-

$\psi(4160)$ REFERENCES

BRANDELIK	78C	PL 76B 361	+Cords+	(DASP Collab.)

OTHER RELATED PAPERS

ONO	84	ZPHY C26 307		(ORSAY)
KIRKBY	79B	Fermilab Symp. 107		(SLAC)
BURMESTER	77	PL 66B 395	+Criegee+	(DESY, HAMB, SIEG, WUPP)

$\psi(4415)$

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

J^{PC} for the $\psi(4415)$ is known by its production in e^+e^- collisions via single-photon annihilation. I^G is not known, and the interpretation of this state as a single resonance is unclear because of the expectation of substantial threshold effects in this energy region.

$\psi(4415)$ MASS

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
4415 ± 6 OUR AVERAGE				
4417.0±10.0	BRANDELIK	78C	DASP	e^+e^-
4414 ± 7	SIEGRIST	76	MRK1	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •				
~ 4400	KNIES	77	PLUT	$e^+e^- \to \mu^+\mu^-$

$\psi(4415)$ WIDTH

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
43 ±15 OUR AVERAGE Error includes scale factor of 1.8.				
66.0±15.0	BRANDELIK	78C	DASP	e^+e^-
33 ±10	SIEGRIST	76	MRK1	e^+e^-

$\psi(4415)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	hadrons	dominant
Γ_2	e^+e^-	$(1.1\pm0.4)\times10^{-5}$

$\psi(4415)$ PARTIAL WIDTHS

$\Gamma(e^+e^-)$ Γ_2

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
0.47±0.10 OUR AVERAGE				
0.49±0.13	BRANDELIK	78C	DASP	e^+e^-
0.44±0.14	SIEGRIST	76	MRK1	e^+e^-

$\psi(4415)$ BRANCHING RATIOS

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

VALUE	DOCUMENT ID		TECN	COMMENT
dominant	SIEGRIST	76	MRK1	e^+e^-

$\psi(4415)$ REFERENCES

BRANDELIK	78C	PL 76B 361	+Cords+	(DASP Collab.)
KNIES	77	Hamburg Symp. 93		(PLUTO Collab.)
SIEGRIST	76	PRL 36 700	+Abrams, Boyarski, Breidenbach+	(LBL, SLAC)

OTHER RELATED PAPERS

BURMESTER	77	PL 66B 395	+Criegee+	(DESY, HAMB, SIEG, WUPP)
LUTH	77	PL 70B 120	+Pierre, Abrams, Alam, Boyarski+	(LBL, SLAC)