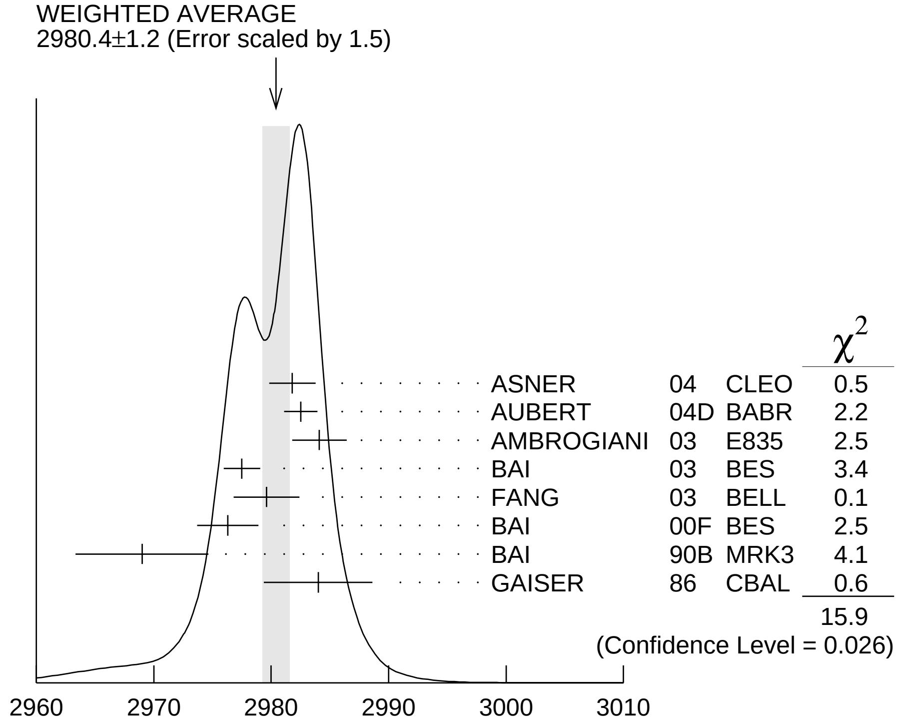
$\eta_c(1S)$

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

$\eta_c(1S)$ MASS

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
2980.4± 1.2 OUR AVERAGE	Error includes scale factor of 1.5. See the ideogram below.				
2981.8± 1.3± 1.5	592	ASNER	04	CLEO	$\gamma\gamma \to \eta_c \to K^0_S K^\pm \pi^\mp$
2982.5± 1.1± 0.9	2547 ± 90	AUBERT	04D	BABR	$\gamma\gamma \to \eta_c(1S) \to K\overline{K}\pi$
2984.1± 2.1± 1.0	190	[6] AMBROGIANI	03	E835	$\overline{p}p \to \eta_c \to \gamma\gamma$
2977.5± 1.0± 1.2		[1] BAI	03	BES	$J/\psi \to \gamma\eta_c$
2979.6± 2.3± 1.6	182 ± 25	FANG	03	BELL	$B \to \eta_c K$
2976.3± 2.3± 1.2		[7,8,9] BAI	00F	BES	$J/\psi \to \gamma\eta_c$ and $\psi(2S) \to \gamma\eta_c$
2969 ± 4 ± 4	80	BAI	90B	MRK3	$J/\psi \to \gamma K^+ K^- K^+ K^-$
2984 ± 2.3± 4.0		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. • • •					
2972 ± 7	235	[2] ABE	04G	BELL	10.6 $e^+e^- \to J/\psi(c\overline{c})$
2976.6± 2.9± 1.3	140	[7,8] BAI	00F	BES	$J/\psi \to \gamma\eta_c$
2980.4± 2.3± 0.6		[3] BRANDENB...	00B	CLE2	$\gamma\gamma \to \eta_c \to K^\pm K^0_S \pi^\mp$
2975.8± 3.9± 1.2		[7,8] BAI	99B	BES	Sup. by BAI 00F
2999 ± 8	25	ABREU	98O	DLPH	$e^+e^- \to e^+e^-$ +hadrons
$2988.3^{+3.3}_{-3.1}$		ARMSTRONG	95F	E760	$\overline{p}p \to \gamma\gamma$
2974.4± 1.9		[7] BISELLO	91	DM2	$J/\psi \to \eta_c\gamma$
2956 ±12 ±12		BAI	90B	MRK3	$J/\psi \to \gamma K^+ K^- K^0_S K^0_L$
$2982.6^{+2.7}_{-2.3}$	12	BAGLIN	87B	SPEC	$\overline{p}p \to \gamma\gamma$
2980.2± 1.6		[7] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c\gamma$
2976 ± 8		[4] BALTRUSAIT...	84	MRK3	$J/\psi \to 2\phi\gamma$
2982 ± 8	18	[5] HIMEL	80B	MRK2	e^+e^-
2980 ± 9		[5] PARTRIDGE	80B	CBAL	e^+e^-

[1] From a simultaneous fit of five decay modes of the η_c.
[2] From a fit of the J/ψ recoil mass spectrum. Systematic errors not estimated.
[3] Superseded by ASNER 04.
[4] $\eta_c \to \phi\phi$.
[5] Mass adjusted by us to correspond to $J/\psi(1S)$ mass = 3097 MeV.



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

[6] Using mass of $\psi(2S)$ = 3686.00 MeV.
[7] Average of several decay modes.
[8] Using an η_c width of 13.2 MeV.
[9] Weighted average of the $\psi(2S)$ and $J/\psi(1S)$ samples.

$\eta_c(1S)$ WIDTH

VALUE (MeV)	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
25.5± 3.4 OUR AVERAGE			Error includes scale factor of 2.0. See the ideogram below.			
24.8± 3.4±3.5		592	ASNER	04	CLEO	$\gamma\gamma \to \eta_c \to K^0_S K^{\pm}\pi^{\mp}$
34.3± 2.3±0.9		2547± 90	AUBERT	04D	BABR	$\gamma\gamma \to \eta_c(1S) \to K\overline{K}\pi$
$20.4^{+7.7}_{-6.7}$±2.0		190	AMBROGIANI	03	E835	$\overline{p}p \to \eta_c \to \gamma\gamma$
17.0± 3.7±7.4			[10] BAI	03	BES	$J/\psi \to \gamma\eta_c$
29 ± 8 ±6		182± 25	FANG	03	BELL	$B \to \eta_c K$
11.0± 8.1±4.1			[13] BAI	00F	BES	$J/\psi \to \gamma\eta_c$ and $\psi(2S) \to \gamma\eta_c$
$23.9^{+12.6}_{-7.1}$			ARMSTRONG	95F	E760	$\overline{p}p \to \gamma\gamma$
$7.0^{+7.5}_{-7.0}$		12	BAGLIN	87B	SPEC	$\overline{p}p \to \gamma\gamma$
$10.1^{+33.0}_{-8.2}$		23	[11] BALTRUSAIT...	86	MRK3	$J/\psi \to \gamma p\overline{p}$
11.5± 4.5			GAISER	86	CBAL	$J/\psi \to \gamma X$, $\psi(2S) \to \gamma X$

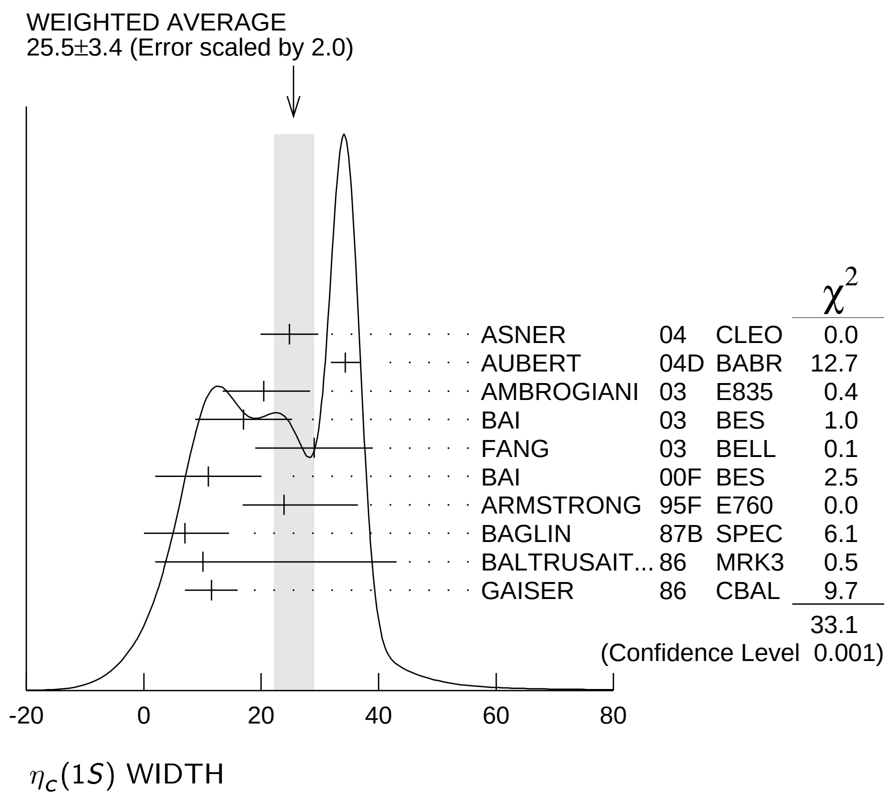
• • • We do not use the following data for averages, fits, limits, etc. • • •

$27.0\pm\ 5.8\pm1.4$			12 BRANDENB...	00B CLE2	$\gamma\gamma\to\ \eta_c\to K^{\pm}K^0_S\pi^{\mp}$
<40	90	18	HIMEL	80B MRK2	e^+e^-
<20	90		PARTRIDGE	80B CBAL	e^+e^-

[10] From a simultaneous fit of five decay modes of the η_c.

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

[12] Superseded by ASNER 04.



[13] From a fit to the 4-prong invariant mass in $\psi(2S)\to\ \gamma\eta_c$ and $J/\psi(1S)\to\ \gamma\eta_c$ decays.

$\eta_c(1S)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Confidence level
	Decays involving hadronic resonances		
Γ_1	$\eta'(958)\pi\pi$	$(4.1\ \pm1.7\ )\ \%$	
Γ_2	$\rho\rho$	$(2.6\ \pm0.9\ )\ \%$	
Γ_3	$K^*(892)^0K^-\pi^+ +$ c.c.	$(2.0\ \pm0.7\ )\ \%$	
Γ_4	$K^*(892)\overline{K}^*(892)$	$(8.5\ \pm3.1\ )\times10^{-3}$	
Γ_5	ϕK^+K^-	$(2.9\ \pm1.4\ )\times10^{-3}$	
Γ_6	$\phi\phi$	$(2.6\ \pm0.9\ )\times10^{-3}$	

Γ_7	$a_0(980)\pi$	< 2	%	90%
Γ_8	$a_2(1320)\pi$	< 2	%	90%
Γ_9	$K^*(892)\overline{K}$ + c.c.	< 1.28	%	90%
Γ_{10}	$f_2(1270)\eta$	< 1.1	%	90%
Γ_{11}	$\omega\omega$	< 3.1	$\times 10^{-3}$	90%
Γ_{12}	$f_2(1270)f_2(1270)$	$(1.0\ {}^{+0.4}_{-0.5})$ %		

Decays into stable hadrons

Γ_{13}	$K\overline{K}\pi$	$(5.7\ \pm1.6)$ %		
Γ_{14}	$\eta\pi\pi$	$(4.9\ \pm1.8)$ %		
Γ_{15}	$\pi^+\pi^-K^+K^-$	$(1.5\ \pm0.6)$ %		
Γ_{16}	$2(K^+K^-)$	$(1.5\ \pm0.7)\times10^{-3}$		
Γ_{17}	$2(\pi^+\pi^-)$	(1.20 ± 0.30) %		
Γ_{18}	$p\overline{p}$	$(1.3\ \pm0.4)\times10^{-3}$		
Γ_{19}	$K\overline{K}\eta$	< 3.1	%	90%
Γ_{20}	$\pi^+\pi^-p\overline{p}$	< 1.2	%	90%
Γ_{21}	$\Lambda\overline{\Lambda}$	< 2	$\times 10^{-3}$	90%

Radiative decays

Γ_{22}	$\gamma\gamma$	$(2.9\ \pm1.0)\times10^{-4}$		

$\eta_c(1S)$ PARTIAL WIDTHS

$\Gamma(\gamma\gamma)$ Γ_{22}

VALUE (keV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
7.4± 0.9± 2.1 OUR EVALUATION					Treating systematic errors as correlated.
$7.0^{+1.0}_{-0.9}$ OUR AVERAGE					
7.4± 0.4± 2.3		[14] ASNER	04	CLEO	$\gamma\gamma \to \eta_c \to K^0_S K^\pm\pi^\mp$
13.9± 2.0± 3.0	41	[23] ABDALLAH	03J	DLPH	$\gamma\gamma \to \eta_c$
$3.8^{+1.1}_{-1.0}{}^{+1.9}_{-1.0}$	190	[15] AMBROGIANI	03	E835	$\overline{p}p \to \eta_c \to \gamma\gamma$
6.9± 1.7± 2.1	76	[16] ACCIARRI	99T	L3	$e^+e^- \to e^+e^-\eta_c$
27 ±16 ±10	5	[14] SHIRAI	98	AMY	58 e^+e^-
$6.7^{+2.4}_{-1.7}\pm 2.3$		[17] ARMSTRONG	95F	E760	$\overline{p}p \to \gamma\gamma$
11.3± 4.2		[18] ALBRECHT	94H	ARG	$e^+e^- \to e^+e^-\eta_c$
$5.9^{+2.1}_{-1.8}\pm 1.9$		[15] CHEN	90B	CLEO	$e^+e^- \to e^+e^-\eta_c$
$6.4^{+5.0}_{-3.4}$		[19] AIHARA	88D	TPC	$e^+e^- \to e^+e^-X$
$4.3^{+3.4}_{-3.7}\pm 2.4$		[17] BAGLIN	87B	SPEC	$\overline{p}p \to \gamma\gamma$
28 ±15		[14,20] BERGER	86	PLUT	$\gamma\gamma \to K\overline{K}\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
7.6± 0.8± 2.3		[14,21] BRANDENB...	00B	CLE2	$\gamma\gamma \to \eta_c \to K^\pm K^0_S\pi^\mp$
8.0± 2.3± 2.4	17	[22] ADRIANI	93N	L3	$e^+e^- \to e^+e^-\eta_c$

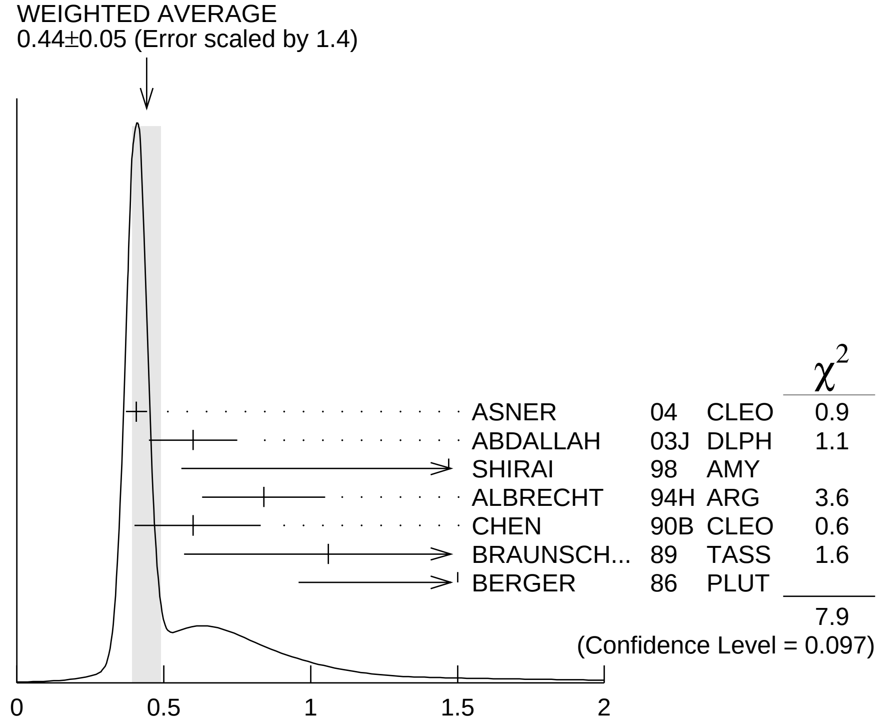
[14] Normalized to B($\eta_c \to K^\pm K^0_S \pi^\mp$).
[15] Normalized to the sum of B($\eta_c \to K^\pm K^0_S \pi^\mp$), B($\eta_c \to K^+ K^- \pi^+ \pi^-$), and B($\eta_c \to 2\pi^+ 2\pi^-$).
[16] Normalized to the sum of 9 branching ratios.
[17] Normalized to B($\eta_c \to p\overline{p}$)= $(1.2 \pm 0.4) \times 10^{-3}$.
[18] Normalized to the sum of B($\eta_c \to K^\pm K^0_S \pi^\mp$), B($\eta_c \to \phi\phi$), B($\eta_c \to K^+ K^- \pi^+ \pi^-$), and B($\eta_c \to 2\pi^+ 2\pi^-$).
[19] Normalized to the sum of B($\eta_c \to K^\pm K^0_S \pi^\mp$), B($\eta_c \to 2K^+ 2K^-$), B($\eta_c \to K^+ K^- \pi^+ \pi^-$), and B($\eta_c \to 2\pi^+ 2\pi^-$).
[20] Re-evaluated by AIHARA 88D.
[21] Superseded by ASNER 04.
[22] Superseded by ACCIARRI 99T.
[23] Average of $K^0_S K^\pm \pi^\mp$, $\pi^+ \pi^- K^+ K^-$, and $2(K^+ K^-)$ decay modes.

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

$\Gamma(K\overline{K}\pi) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ — $\Gamma_{13}\Gamma_{22}/\Gamma$

VALUE (keV)	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.44 ±0.05 OUR AVERAGE			Error includes scale factor of 1.4. See the ideogram below.			
0.407±0.022±0.028			[24,25] ASNER	04	CLEO	$\gamma\gamma \to \eta_c \to K^0_S K^\pm \pi^\mp$
0.60 ±0.12 ±0.09		41	[25,26] ABDALLAH	03J	DLPH	$\gamma\gamma \to K^0_S K^\pm \pi^\mp$
1.47 ±0.87 ±0.27			[25] SHIRAI	98	AMY	$\gamma\gamma \to \eta_c \to K^\pm K^0_S \pi^\mp$
0.84 ±0.21			[25] ALBRECHT	94H	ARG	$\gamma\gamma \to K^\pm K^0_S \pi^\mp$
0.60 $^{+0.23}_{-0.20}$			[25] CHEN	90B	CLEO	$\gamma\gamma \to \eta_c K^\pm K^0_S \pi^\mp$
1.06 ±0.41 ±0.27		11	[25] BRAUNSCH...	89	TASS	$\gamma\gamma \to K\overline{K}\pi$
1.5 $^{+0.60}_{-0.45}$ ±0.3		7	[25] BERGER	86	PLUT	$\gamma\gamma \to K\overline{K}\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
0.418±0.044±0.022			[25,27] BRANDENB...	00B	CLE2	$\gamma\gamma \to \eta_c \to K^\pm K^0_S \pi^\mp$
<0.63	95		[25] BEHREND	89	CELL	$\gamma\gamma \to K^0_S K^\pm \pi^\mp$
<4.4	95		ALTHOFF	85B	TASS	$\gamma\gamma \to K\overline{K}\pi$

[24] Calculated by us from the value reported in ASNER 04 that assumes B($\eta_c \to K\overline{K}\pi$) = 5.5 ± 1.7%



$\Gamma\left(K\overline{K}\pi\right) \times \Gamma\left(\gamma\gamma\right)/\Gamma_{total}$ $\Gamma_{13}\Gamma_{22}/\Gamma$

$\Gamma(\pi^+\pi^-K^+K^-) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ $\Gamma_{15}\Gamma_{22}/\Gamma$

VALUE (keV)	EVTS	DOCUMENT ID		TECN	COMMENT
0.21±0.07 OUR AVERAGE					
0.28±0.10±0.06	42	[28] ABDALLAH	03J	DLPH	$\gamma\gamma \rightarrow \pi^+\pi^-K^+K^-$
0.17±0.08±0.02	13.9±6.6	ALBRECHT	94H	ARG	$\gamma\gamma \rightarrow \pi^+\pi^-K^+K^-$

$\Gamma(2(K^+K^-)) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ $\Gamma_{16}\Gamma_{22}/\Gamma$

VALUE (keV)	EVTS	DOCUMENT ID		TECN	COMMENT
0.28 ±0.07 OUR AVERAGE					
0.35 ±0.09 ±0.06	46	[29] ABDALLAH	03J	DLPH	$\gamma\gamma \rightarrow 2(K^+K^-)$
0.231±0.090±0.023	9.1 ±3.3	[30] ALBRECHT	94H	ARG	$\gamma\gamma \rightarrow 2(K^+K^-)$

$\Gamma(2(\pi^+\pi^-)) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ $\Gamma_{17}\Gamma_{22}/\Gamma$

VALUE (keV)	EVTS	DOCUMENT ID		TECN	COMMENT
0.18±0.07±0.02	21.4±8.6	ALBRECHT	94H	ARG	$\gamma\gamma \rightarrow 2(\pi^+\pi^-)$

[25] We have multiplied $K^\pm K^0_S\pi^\mp$ measurement by 3 to obtain $K\overline{K}\pi$.
[26] Calculated by us from the value reported in ABDALLAH 03J, which uses B($\eta_c \rightarrow K^0_S K^\pm\pi^\mp$) = (1.5 ± 0.4)%.
[27] Superseded by ASNER 04.
[28] Calculated by us from the value reported in ABDALLAH 03J, which uses B($\eta_c \rightarrow \pi^+\pi^-K^+K^-$) = (2.0 ± 0.7)%.
[29] Calculated by us from the value reported in ABDALLAH 03J, which uses B($\eta_c \rightarrow$) $2(K^+K^-)$ = (2.1 ± 1.2)%.
[30] Incudes all topological modes except $\eta_c \rightarrow \phi\phi$.

$\eta_c(1S)$ 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	[32] 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	[32] BISELLO	91	DM2	$J/\psi \to \gamma\rho^0\rho^0$
23.6±10.6±8.2		32	[32] BISELLO	91	DM2	$J/\psi \to \gamma\rho^+\rho^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<14	90		[32] BALTRUSAIT...86		MRK3	$J/\psi \to \eta_c\gamma$

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

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
0.02 ±0.007	63	[32] 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	[32] BISELLO	91	DM2	$e^+e^- \to \gamma K^+K^-\pi^+\pi^-$
90±50	9	[32] BALTRUSAIT...86		MRK3	$J/\psi \to \eta_c\gamma$

$\Gamma(K^*(892)\overline{K} + c.c.)/\Gamma_{total}$ — Γ_9/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	[32] BISELLO	91	DM2	$J/\psi \to \gamma K^+K^-\pi^0$

$\Gamma(\phi K^+K^-)/\Gamma_{total}$ — Γ_5/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{2.9^{+0.9}_{-0.8}\pm1.1}$	$14.1^{+4.4}_{-3.7}$	[33] HUANG	03	BELL	$B^+ \to (\phi K^+K^-)\ K^+$

$\Gamma(\phi\phi)/\Gamma_{total}$ — Γ_6/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
26± 9 OUR EVALUATION (Treating systematic errors as correlated.)					
28± 5 OUR AVERAGE					
26± 9	357 ± 64	[32] BAI	04	BES	$J/\psi \to \gamma K^+K^-K^+K^-$
$18^{+8}_{-6}\pm 7$	$7.0^{+3.0}_{-2.3}$	[33] HUANG	03	BELL	$B^+ \to (\phi\phi)\ K^+$
31± 7±10	19	[32] BISELLO	91	DM2	$J/\psi \to \gamma K^+K^-K^+K^-$

$30^{+18}_{-12}\pm10$	5	[32] BISELLO	91	DM2	$J/\psi \to \gamma K^+ K^- K^0_S K^0_L$
$74\pm18\pm24$	80	[32] BAI	90B	MRK3	$J/\psi \to \gamma K^+ K^- K^+ K^-$
$67\pm21\pm24$		[32] BAI	90B	MRK3	$J/\psi \to \gamma K^+ K^- K^0_S K^0_L$

$\Gamma(a_0(980)\pi)/\Gamma_{total}$ — Γ_7/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<0.02	90	[32,34] BALTRUSAIT...86	MRK3	$J/\psi \to \eta_c \gamma$

$\Gamma(a_2(1320)\pi)/\Gamma_{total}$ — Γ_8/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<0.02	90	[32] BALTRUSAIT...86	MRK3	$J/\psi \to \eta_c \gamma$

$\Gamma(f_2(1270)\eta)/\Gamma_{total}$ — Γ_{10}/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<0.011	90	[32] BALTRUSAIT...86	MRK3	$J/\psi \to \eta_c \gamma$

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

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<0.0031	90	[32] BALTRUSAIT...86	MRK3	$J/\psi \to \eta_c \gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<0.0063		[32] BISELLO 91	DM2	$J/\psi \to \gamma\omega\omega$

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

VALUE (units 10^{-2})	EVTS	DOCUMENT ID	TECN	COMMENT
$\mathbf{1.02^{+0.33}_{-0.39}\pm0.29}$	91.2 ± 19.8	[31] ABLIKIM 04M	BES	$J/\psi \to \gamma 2\pi^+ 2\pi^-$

[31] ABLIKIM 04M reports $[B(\eta_c(1S) \to f_2(1270) f_2(1270)) \times B(J/\psi(1S) \to \gamma\eta_c(1S))] = (1.3 \pm 0.3^{+0.3}_{-0.4}) \times 10^{-4}$. We divide by our best value $B(J/\psi(1S) \to \gamma\eta_c(1S)) = (1.3 \pm 0.4) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(K\overline{K}\pi)/\Gamma_{total}$ — Γ_{13}/Γ

VALUE	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
0.057 ±0.016 OUR EVALUATION			(Treating systematic errors as correlated.)		
0.056 ±0.008 OUR AVERAGE					
0.051 ±0.021		609±71	[32] BAI 04	BES	$J/\psi \to \gamma K^\pm \pi^\mp K^0_S$
0.0690±0.0142±0.0132		33	[32] BISELLO 91	DM2	$J/\psi \to \gamma K^+ K^- \pi^0$
0.0543±0.0094±0.0094		68	[32] BISELLO 91	DM2	$J/\psi \to \gamma K^\pm \pi^\mp K^0_S$
0.048 ±0.017		95	[32,35] BALTRUSAIT...86	MRK3	$J/\psi \to \eta_c \gamma$
$0.161\ ^{+0.092}_{-0.073}$			[36] HIMEL 80B	MRK2	$\psi(2S) \to \eta_c \gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.107	90		[32] PARTRIDGE 80B	CBAL	$J/\psi \to \eta_c \gamma$

$\Gamma(\eta\pi\pi)/\Gamma_{total}$ — Γ_{14}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.049±0.018 OUR EVALUATION					
0.047±0.015 OUR AVERAGE					
0.054±0.020	75	[32] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c \gamma$
0.037±0.013±0.020	18	[32] PARTRIDGE	80B	CBAL	$J/\psi \to \eta\pi^+\pi^-\gamma$

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.015 ±0.006 OUR EVALUATION					
0.0142±0.0033 OUR AVERAGE					
0.012 ±0.004	413 ± 54	[32] BAI	04	BES	$J/\psi \to \gamma K^+K^-\pi^+\pi^-$
0.021 ±0.007	110	[32] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c \gamma$
0.014 $^{+0.022}_{-0.009}$		[36] HIMEL	80B	MRK2	$\psi(2S) \to \eta_c \gamma$

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.012 ±0.003 OUR EVALUATION					
0.0115±0.0026 OUR AVERAGE					
0.010 ±0.005	542 ± 75	[32] BAI	04	BES	$J/\psi \to \gamma 2(\pi^+\pi^-)$
0.0105±0.0017±0.0034	137	[32] BISELLO	91	DM2	$J/\psi \to \gamma 2\pi^+ 2\pi^-$
0.013 ±0.006	25	[32] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c \gamma$
0.020 $^{+0.015}_{-0.010}$		[36] HIMEL	80B	MRK2	$\psi(2S) \to \eta_c \gamma$

$\Gamma(2(K^+K^-))/\Gamma_{total}$ — Γ_{16}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.0015±0.0007 OUR AVERAGE					
0.0014$^{+0.0005}_{-0.0004}$±0.0006	14.5$^{+4.6}_{-3.0}$	[33] HUANG	03	BELL	$B^+ \to 2(K^+K^-) K^+$
0.021 ±0.010 ±0.006		[37] ALBRECHT	94H	ARG	$\gamma\gamma \to K^+K^-K^+K^-$

$\Gamma(p\overline{p})/\Gamma_{total}$ — Γ_{18}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
13 ± 4 OUR EVALUATION		(Treating systematic errors as correlated.)			
12.5± 3.2 OUR AVERAGE					
15 ± 6	213 ± 33	[32] BAI	04	BES	$J/\psi \to \gamma p\overline{p}$
10 ± 3 ±4	18	[32] BISELLO	91	DM2	$J/\psi \to \gamma p\overline{p}$
11 ± 6	23	[32] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c \gamma$
29 $^{+29}_{-15}$		[36] HIMEL	80B	MRK2	$\psi(2S) \to \eta_c \gamma$

$\Gamma(K\overline{K}\eta)/\Gamma_{total}$ — Γ_{19}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.031	90	[32] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c \gamma$

$\Gamma(\pi^+\pi^- p\overline{p})/\Gamma_{total}$ — Γ_{20}/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_{21}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.002	90	[32] BISELLO	91	DM2	$e^+e^- \to \gamma\Lambda\overline{\Lambda}$

$\Gamma_i\Gamma_f/\Gamma^2_{total}$ in $p\overline{p} \to \eta_c(1S) \to \phi\phi$ — $\Gamma_{18}\Gamma_6/\Gamma^2$

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

[32] The quoted branching ratios use B($J/\psi(1S) \to \gamma\eta_c(1S)$) = 0.0127 ± 0.0036. Where relevant, the error in this branching ratio is treated as a common systematic in computing averages.

[33] Using B($B^+ \to \eta_c K^+$) = $(1.25 \pm 0.12^{+0.10}_{-0.12}) \times 10^{-3}$ from FANG 03 and B($\eta_c \to K\overline{K}\pi$) = $(5.5 \pm 1.7) \times 10^{-2}$.

[34] We are assuming B($a_0(980) \to \eta\pi$) >0.5.

[35] Average from $K^+K^-\pi^0$ and $K^\pm K^0_S\pi^\mp$ decay channels.

[36] Estimated using B($\psi(2S) \to \gamma\eta_c(1S)$) = 0.0028 ± 0.0006.

[37] Normalized to the sum of B($\eta_c \to K^\pm K^0_S\pi^\mp$), B($\eta_c \to \phi\phi$), B($\eta_c \to K^+K^-\pi^+\pi^-$), and B($\eta_c \to 2\pi^+2\pi^-$).

RADIATIVE DECAYS

$\Gamma(\gamma\gamma)/\Gamma_{total}$ — Γ_{22}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$2.80^{+0.67}_{-0.58} \pm 1.0$		[38] ARMSTRONG	95F	E760	$\overline{p}p \to \gamma\gamma$
< 9	90	[32] BISELLO	91	DM2	$J/\psi \to \gamma\gamma\gamma$
$6 \; ^{+4}_{-3} \; \pm 4$		[38] BAGLIN	87B	SPEC	$\overline{p}p \to \gamma\gamma$
<18	90	[39] BLOOM	83	CBAL	$J/\psi \to \eta_c\gamma$

[38] Not independent from the values of the total and two-photon width quoted by the same experiment.

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

$\Gamma_i\Gamma_f/\Gamma^2_{total}$ in $p\overline{p} \to \eta_c(1S) \to \gamma\gamma$ — $\Gamma_{18}\Gamma_{22}/\Gamma^2$

VALUE (units 10^{-6})	EVTS	DOCUMENT ID		TECN	COMMENT
0.26 ±0.05 OUR AVERAGE	Error includes scale factor of 1.4.				
$0.224^{+0.038}_{-0.037} \pm 0.020$	190	AMBROGIANI	03	E835	$\overline{p}p \to \eta_c \to \gamma\gamma$
$0.336^{+0.080}_{-0.070}$		ARMSTRONG	95F	E760	$\overline{p}p \to \gamma\gamma$
$0.68 \; ^{+0.42}_{-0.31}$	12	BAGLIN	87B	SPEC	$\overline{p}p \to \gamma\gamma$

$\eta_c(1S)$ REFERENCES

ABE	04G	PR D70 071102	K. Abe *et al.*	(BELLE Collab.)
ABLIKIM	04M	PR D70 112008	M. Ablikim *et al.*	(BES Collab.)
ASNER	04	PRL 92 142001	D.M. Asner *et al.*	(CLEO Collab.)
AUBERT	04D	PRL 92 142002	B. Aubert *et al.*	(BABAR Collab.)
BAI	04	PL B578 16	J.Z. Bai *et al.*	(BES Collab.)
ABDALLAH	03J	EPJ C31 481	J. Abdallah *et al.*	(DELPHI Collab.)
AMBROGIANI	03	PL B566 45	M. Ambrogiani *et al.*	(FNAL E835 Collab.)
BAI	03	PL B555 174	J.Z. Bai *et al.*	(BES Collab.)
FANG	03	PRL 90 071801	F. Fang *et al.*	(BELLE Collab.)
HUANG	03	PRL 91 241802	H.-C. Huang *et al.*	(BELLE Collab.)
BAI	00F	PR D62 072001	J.Z. Bai *et al.*	(BES Collab.)
BRANDENB...	00B	PRL 85 3095	G. Brandenburg *et al.*	(CLEO Collab.)
ACCIARRI	99T	PL B461 155	M. Acciarri *et al.*	(L3 Collab.)
BAI	99B	PR D60 072001	J.Z. Bai *et al.*	(BES Collab.)
ABREU	98O	PL B441 479	P. Abreu *et al.*	(DELPHI Collab.)
SHIRAI	98	PL B424 405	M. Shirai *et al.*	(AMY Collab.)
ARMSTRONG	95F	PR D52 4839	T.A. Armstrong *et al.*	(FNAL, FERR, GENO+)
ALBRECHT	94H	PL B338 390	H. Albrecht *et al.*	(ARGUS Collab.)
ADRIANI	93N	PL B318 575	O. Adriani *et al.*	(L3 Collab.)
BISELLO	91	NP B350 1	D. Bisello *et al.*	(DM2 Collab.)
BAI	90B	PRL 65 1309	Z. Bai *et al.*	(Mark III Collab.)
CHEN	90B	PL B243 169	W.Y. Chen *et al.*	(CLEO Collab.)
BAGLIN	89	PL B231 557	C. Baglin, S. Baird, G. Bassompierre	(R704 Collab.)
BEHREND	89	ZPHY C42 367	H.J. Behrend *et al.*	(CELLO Collab.)
BRAUNSCH...	89	ZPHY C41 533	W. Braunschweig *et al.*	(TASSO Collab.)
AIHARA	88D	PRL 60 2355	H. Aihara *et al.*	(TPC Collab.)
BAGLIN	87B	PL B187 191	C. Baglin *et al.*	(R704 Collab.)
BALTRUSAIT...	86	PR D33 629	R.M. Baltrusaitis *et al.*	(Mark III Collab.)
BERGER	86	PL 167B 120	C. Berger *et al.*	(PLUTO Collab.)
GAISER	86	PR D34 711	J. Gaiser *et al.*	(Crystal Ball Collab.)
ALTHOFF	85B	ZPHY C29 189	M. Althoff *et al.*	(TASSO Collab.)
BALTRUSAIT...	84	PRL 52 2126	R.M. Baltrusaitis *et al.*	(CIT, UCSC+) JP
BLOOM	83	ARNS 33 143	E.D. Bloom, C. Peck	(SLAC, CIT)
HIMEL	80B	PRL 45 1146	T.M. Himel *et al.*	(SLAC, LBL, UCB)
PARTRIDGE	80B	PRL 45 1150	R. Partridge *et al.*	(CIT, HARV, PRIN+)

OTHER RELATED PAPERS

ARMSTRONG	89	PL B221 216	T.A. Armstrong *et al.*	(CERN, CDEF, BIRM+)