$\eta_c(1S)$

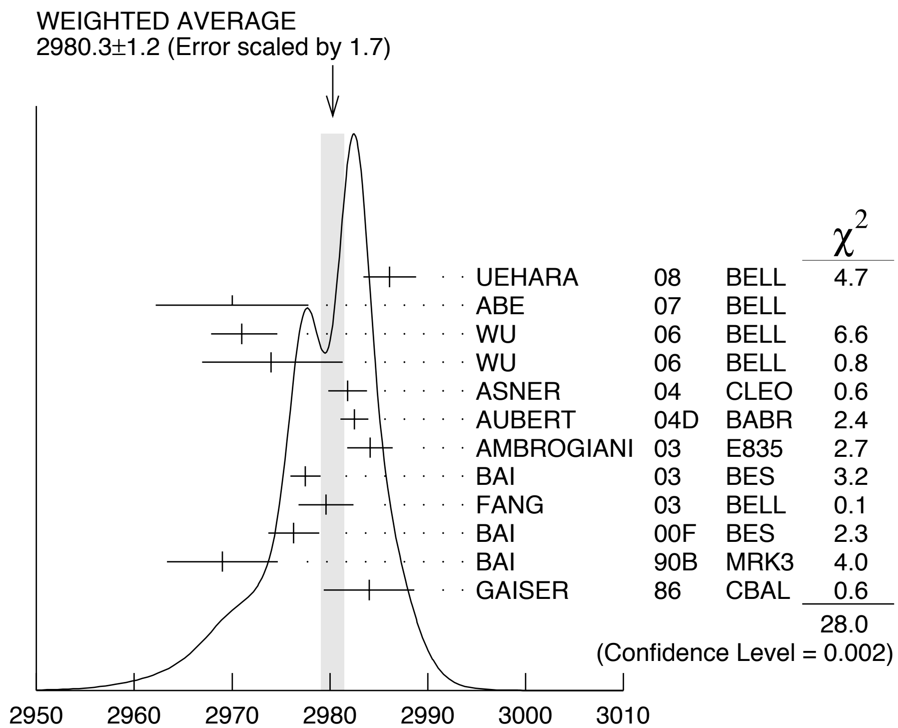
$I^G(J^{PC}) = 0^+(0^{-+})$

$\eta_c(1S)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
2980.3± 1.2 OUR AVERAGE		Error includes scale factor of 1.7. See the ideogram below.			
2986.1± 1.0± 2.5	7.5k	UEHARA	08	BELL	$\gamma\gamma \to \eta_c \to$ hadrons
2970 ± 5 ± 6	501	[1] ABE	07	BELL	$e^+e^- \to J/\psi(c\overline{c})$
2971 ± 3 $^{+2}_{-1}$	195	WU	06	BELL	$B^+ \to p\overline{p}K^+$
2974 ± 7 $^{+2}_{-1}$	20	WU	06	BELL	$B^+ \to \Lambda\overline{\Lambda}K^+$
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	[2] AMBROGIANI	03	E835	$\overline{p}p \to \eta_c \to \gamma\gamma$
2977.5± 1.0± 1.2		[3] 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		[4,5,6] 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. • • •					
2982 ± 5	273 ± 43	[7] AUBERT	06E	BABR	$B^\pm \to K^\pm X_{c\overline{c}}$
2976.6± 2.9± 1.3	140	[4,5] BAI	00F	BES	$J/\psi \to \gamma\eta_c$
2980.4± 2.3± 0.6		[8] BRANDENB...	00B	CLE2	$\gamma\gamma \to \eta_c \to K^\pm K^0_S\pi^\mp$
2975.8± 3.9± 1.2		[4,5] 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		[4] 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		[4] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c\gamma$
2976 ± 8		[9] BALTRUSAIT...	84	MRK3	$J/\psi \to 2\phi\gamma$
2982 ± 8	18	[10] HIMEL	80B	MRK2	e^+e^-
2980 ± 9		[10] PARTRIDGE	80B	CBAL	e^+e^-

[1] From a fit of the J/ψ recoil mass spectrum. Supersedes ABE,K 02 and ABE 04G.
[2] Using mass of $\psi(2S)$ = 3686.00 MeV.
[3] From a simultaneous fit of five decay modes of the η_c.
[4] Average of several decay modes.
[5] Using an η_c width of 13.2 MeV.

[6] Weighted average of the $\psi(2S)$ and $J/\psi(1S)$ samples.
[7] From the fit of the kaon momentum spectrum. Systematic errors not evaluated.
[8] Superseded by ASNER 04.
[9] $\eta_c \rightarrow \phi\phi$.
[10] Mass adjusted by us to correspond to $J/\psi(1S)$ mass = 3097 MeV.



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

$\eta_c(1S)$ WIDTH

VALUE (MeV)	*CL%*	*EVTS*	*DOCUMENT ID*	*TECN*	*COMMENT*
26.7± 3.0 OUR AVERAGE			Error includes scale factor of 2.0. See the ideogram below.		
28.1± 3.2±2.2		7.5k	UEHARA 08	BELL	$\gamma\gamma \rightarrow \eta_c \rightarrow$ hadrons
48 $^{+8}_{-7}$ ±5		195	WU 06	BELL	$B^+ \rightarrow p\overline{p}K^+$
40 ±19 ±5		20	WU 06	BELL	$B^+ \rightarrow \Lambda\overline{\Lambda}K^+$
24.8± 3.4±3.5		592	ASNER 04	CLEO	$\gamma\gamma \rightarrow \eta_c \rightarrow K^0_S K^\pm \pi^\mp$
34.3± 2.3±0.9		2547 ± 90	AUBERT 04D	BABR	$\gamma\gamma \rightarrow \eta_c(1S) \rightarrow K\overline{K}\pi$
20.4$^{+7.7}_{-6.7}$±2.0		190	AMBROGIANI 03	E835	$\overline{p}p \rightarrow \eta_c \rightarrow \gamma\gamma$
17.0± 3.7±7.4			[11] BAI 03	BES	$J/\psi \rightarrow \gamma\eta_c$
29 ± 8 ±6		182 ± 25	FANG 03	BELL	$B \rightarrow \eta_c K$
11.0± 8.1±4.1			[12] BAI 00F	BES	$J/\psi \rightarrow \gamma\eta_c$ and $\psi(2S) \rightarrow \gamma\eta_c$

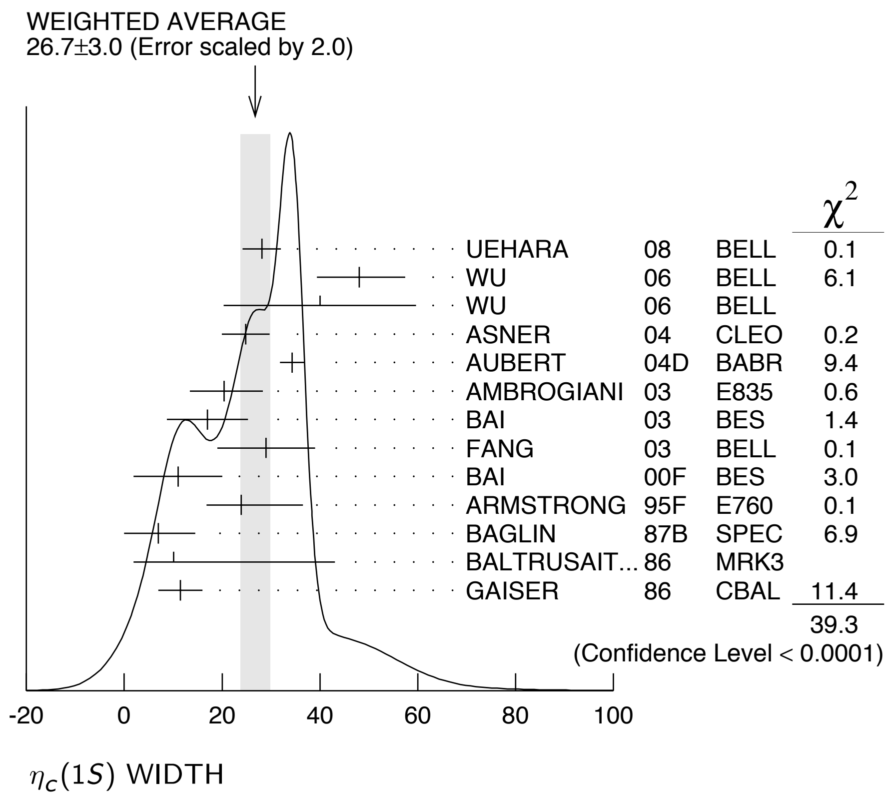
$23.9^{+12.6}_{-\ 7.1}$			ARMSTRONG	95F	E760	$\overline{p}p \to \gamma\gamma$
$7.0^{+\ 7.5}_{-\ 7.0}$		12	BAGLIN	87B	SPEC	$\overline{p}p \to \gamma\gamma$
$10.1^{+33.0}_{-\ 8.2}$		23	[13] BALTRUSAIT...86		MRK3	$J/\psi \to \gamma p\overline{p}$
11.5 ± 4.5			GAISER	86	CBAL	$J/\psi \to \gamma X$, $\psi(2S) \to \gamma X$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$27.0 \pm 5.8 \pm 1.4$			[14] 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	$e^+ e^-$

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

[12] 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.

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

[14] Superseded by ASNER 04.



$\eta_c(1S)$ 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	$\rho\rho$		(2.0 ±0.7) %	
Γ_3	$K^*(892)^0 K^- \pi^+ +$ c.c.		(2.0 ±0.7) %	
Γ_4	$K^*(892)\overline{K}^*(892)$		(9.2 ±3.4) $\times 10^{-3}$	
Γ_5	$K^{*0}\overline{K}^{*0}\pi^+\pi^-$		(1.5 ±0.8) %	
Γ_6	$\phi K^+ K^-$		(2.9 ±1.4) $\times 10^{-3}$	
Γ_7	$\phi\phi$		(2.7 ±0.9) $\times 10^{-3}$	
Γ_8	$\phi 2(\pi^+\pi^-)$		< 4.7 $\times 10^{-3}$	90%
Γ_9	$a_0(980)\pi$		< 2 %	90%
Γ_{10}	$a_2(1320)\pi$		< 2 %	90%
Γ_{11}	$K^*(892)\overline{K} +$ c.c.		< 1.28 %	90%
Γ_{12}	$f_2(1270)\eta$		< 1.1 %	90%
Γ_{13}	$\omega\omega$		< 3.1 $\times 10^{-3}$	90%
Γ_{14}	$\omega\phi$		< 1.7 $\times 10^{-3}$	90%
Γ_{15}	$f_2(1270) f_2(1270)$		(1.0 $^{+0.4}_{-0.5}$) %	
Γ_{16}	$f_2(1270) f'_2(1525)$		(8 ±4) $\times 10^{-3}$	

Decays into stable hadrons

Γ_{17}	$K\overline{K}\pi$		(7.0 ±1.2) %	
Γ_{18}	$\eta\pi\pi$		(4.9 ±1.8) %	
Γ_{19}	$\pi^+\pi^- K^+ K^-$		(1.5 ±0.6) %	
Γ_{20}	$K^+ K^- 2(\pi^+\pi^-)$		(10 ±4) $\times 10^{-3}$	
Γ_{21}	$2(K^+ K^-)$		(1.5 ±0.7) $\times 10^{-3}$	
Γ_{22}	$2(\pi^+\pi^-)$		(1.20±0.30) %	
Γ_{23}	$3(\pi^+\pi^-)$		(2.0 ±0.7) %	
Γ_{24}	$p\overline{p}$		(1.3 ±0.4) $\times 10^{-3}$	
Γ_{25}	$\Lambda\overline{\Lambda}$		(1.04±0.31) $\times 10^{-3}$	
Γ_{26}	$K\overline{K}\eta$		< 3.1 %	90%
Γ_{27}	$\pi^+\pi^- p\overline{p}$		< 1.2 %	90%

Radiative decays

Γ_{28}	$\gamma\gamma$		(2.4 $^{+1.1}_{-0.9}$) $\times 10^{-4}$	

Charge conjugation (C), Parity (P), Lepton family number (LF) violating modes

Γ_{29}	$\pi^+\pi^-$	P,CP	< 8.7 $\times 10^{-4}$	90%
Γ_{30}	$\pi^0\pi^0$	P,CP	< 5.6 $\times 10^{-4}$	90%
Γ_{31}	$K^+ K^-$	P,CP	< 7.6 $\times 10^{-4}$	90%
Γ_{32}	$K^0_S K^0_S$	P,CP	< 4.2 $\times 10^{-4}$	90%

$\eta_c(1S)$ PARTIAL WIDTHS

$\Gamma(\gamma\gamma)$ — Γ_{28}

7.2± 0.7± 2.0 OUR EVALUATION Error includes scale factor of 1.3. Treating systematic errors as correlated.

VALUE (keV)	EVTS	DOCUMENT ID	TECN	COMMENT
$6.7^{+0.9}_{-0.8}$ OUR AVERAGE				
5.5± 1.2± 1.8	157 ± 33	[15] KUO 05	BELL	$\gamma\gamma \to p\overline{p}$
7.4± 0.4± 2.3		[16] ASNER 04	CLEO	$\gamma\gamma \to \eta_c \to K^0_S K^\pm \pi^\mp$
13.9± 2.0± 3.0	41	[17] ABDALLAH 03J	DLPH	$\gamma\gamma \to \eta_c$
$3.8^{+1.1}_{-1.0}{}^{+1.9}_{-1.0}$	190	[18] AMBROGIANI 03	E835	$\overline{p}p \to \eta_c \to \gamma\gamma$
6.9± 1.7± 2.1	76	[19] ACCIARRI 99T	L3	$e^+e^- \to e^+e^-\eta_c$
27 ±16 ±10	5	[16] SHIRAI 98	AMY	58 e^+e^-
$6.7^{+2.4}_{-1.7}$± 2.3		[15] ARMSTRONG 95F	E760	$\overline{p}p \to \gamma\gamma$
11.3± 4.2		[20] ALBRECHT 94H	ARG	$e^+e^- \to e^+e^-\eta_c$
$5.9^{+2.1}_{-1.8}$± 1.9		[18] CHEN 90B	CLEO	$e^+e^- \to e^+e^-\eta_c$
$6.4^{+5.0}_{-3.4}$		[21] AIHARA 88D	TPC	$e^+e^- \to e^+e^- X$
$4.3^{+3.4}_{-3.7}$± 2.4		[15] BAGLIN 87B	SPEC	$\overline{p}p \to \gamma\gamma$
28 ±15		[16,22] BERGER 86	PLUT	$\gamma\gamma \to K\overline{K}\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
5.2± 1.2	273 ± 43	[23,24] AUBERT 06E	BABR	$B^\pm \to K^\pm X_{c\overline{c}}$
7.6± 0.8± 2.3		[16,25] BRANDENB... 00B	CLE2	$\gamma\gamma \to \eta_c \to K^\pm K^0_S \pi^\mp$
8.0± 2.3± 2.4	17	[26] ADRIANI 93N	L3	$e^+e^- \to e^+e^-\eta_c$

[15] Normalized to B($\eta_c \to p\overline{p}$)= (1.3 ± 0.4) × 10^{-3}.

[16] Normalized to B($\eta_c \to K^\pm K^0_S \pi^\mp$).

[17] Average of $K^0_S K^\pm \pi^\mp$, $\pi^+\pi^- K^+ K^-$, and $2(K^+K^-)$ decay modes.

[18] 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($\eta_c \to 2\pi^+ 2\pi^-$).

[19] Normalized to the sum of 9 branching ratios.

[20] 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($\eta_c \to 2\pi^+ 2\pi^-$).

[21] 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($\eta_c \to 2\pi^+ 2\pi^-$).

[22] Re-evaluated by AIHARA 88D.

[23] Calculated by us using $\Gamma(\eta_c \to K\overline{K}\pi) \times \Gamma(\eta_c \to \gamma\gamma) / \Gamma$ = 0.44 ± 0.05 keV from PDG 06 and B($\eta_c \to K\overline{K}\pi$) = (8.5 ± 1.8)% from AUBERT 06E.

[24] Systematic errors not evaluated.

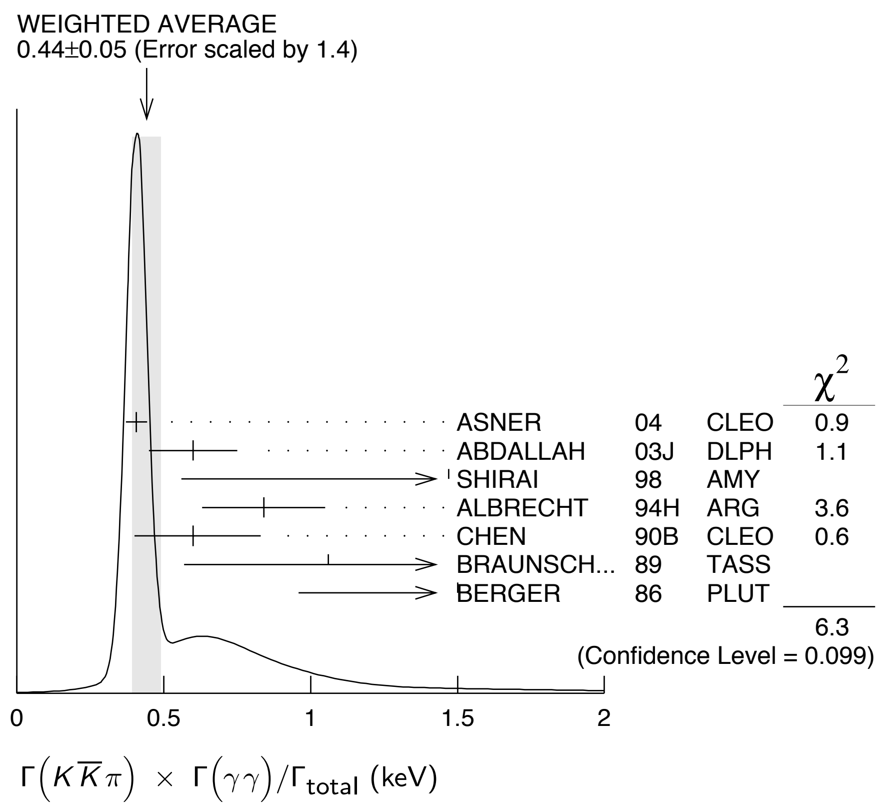
[25] Superseded by ASNER 04.

[26] Superseded by ACCIARRI 99T.

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

$\Gamma(K\overline{K}\pi) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ — $\Gamma_{17}\Gamma_{28}/\Gamma$

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			[27,28] ASNER	04	CLEO	$\gamma\gamma \to \eta_c \to K^0_S K^\pm \pi^\mp$
0.60 ±0.12 ±0.09		41	[28,29] ABDALLAH	03J	DLPH	$\gamma\gamma \to K^0_S K^\pm \pi^\mp$
1.47 ±0.87 ±0.27			[28] SHIRAI	98	AMY	$\gamma\gamma \to \eta_c \to K^\pm K^0_S \pi^\mp$
0.84 ±0.21			[28] ALBRECHT	94H	ARG	$\gamma\gamma \to K^\pm K^0_S \pi^\mp$
0.60 $^{+0.23}_{-0.20}$			[28] CHEN	90B	CLEO	$\gamma\gamma \to \eta_c K^\pm K^0_S \pi^\mp$
1.06 ±0.41 ±0.27		11	[28] BRAUNSCH...	89	TASS	$\gamma\gamma \to K\overline{K}\pi$
1.5 $^{+0.60}_{-0.45}$ ±0.3		7	[28] 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			[28,30] BRANDENB...	00B	CLE2	$\gamma\gamma \to \eta_c \to K^\pm K^0_S \pi^\mp$
<0.63	95		[28] BEHREND	89	CELL	$\gamma\gamma \to K^0_S K^\pm \pi^\mp$
<4.4	95		ALTHOFF	85B	TASS	$\gamma\gamma \to K\overline{K}\pi$



$\Gamma(\pi^+\pi^- K^+ K^-) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_{19}\Gamma_{28}/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
27 ± 6 OUR AVERAGE					
25.7 ± 3.2 ± 4.9	2019 ± 248	UEHARA	08	BELL	$\gamma\gamma \to \pi^+\pi^- K^+ K^-$
280 ± 100 ± 60	42	[31] ABDALLAH	03J	DLPH	$\gamma\gamma \to \pi^+\pi^- K^+ K^-$
170 ± 80 ± 20	13.9 ± 6.6	ALBRECHT	94H	ARG	$\gamma\gamma \to \pi^+\pi^- K^+ K^-$

$\Gamma(K^*(892)\overline{K}^*(892)) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_4\Gamma_{28}/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
32.4±4.2±5.8	882 ± 115	UEHARA	08	BELL	$\gamma\gamma \to \pi^+\pi^- K^+ K^-$

$\Gamma(f_2(1270) f'_2(1525)) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_{16}\Gamma_{28}/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
49± 9±13	1128 ± 206	UEHARA	08	BELL	$\gamma\gamma \to \pi^+\pi^- K^+ K^-$

$\Gamma(2(K^+K^-)) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_{21}\Gamma_{28}/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
5.8± 1.9 OUR AVERAGE					
5.6 ± 1.1 ± 1.6	216 ± 42	UEHARA	08	BELL	$\gamma\gamma \to 2(K^+K^-)$
350 ± 90 ± 60	46	[32] ABDALLAH	03J	DLPH	$\gamma\gamma \to 2(K^+K^-)$
231 ± 90 ± 23	9.1 ± 3.3	[33] ALBRECHT	94H	ARG	$\gamma\gamma \to 2(K^+K^-)$

$\Gamma(\phi\phi) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_7\Gamma_{28}/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
6.8±1.2±1.3	132 ± 23	UEHARA	08	BELL	$\gamma\gamma \to 2(K^+K^-)$

$\Gamma(2(\pi^+\pi^-)) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_{22}\Gamma_{28}/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
42 ± 6 OUR AVERAGE					
40.7 ± 3.7 ± 5.3	5381 ± 492	UEHARA	08	BELL	$\gamma\gamma \to 2(\pi^+\pi^-)$
180 ± 70 ± 20	21.4 ± 8.6	ALBRECHT	94H	ARG	$\gamma\gamma \to 2(\pi^+\pi^-)$

$\Gamma(\rho\rho) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_2\Gamma_{28}/\Gamma$

VALUE (eV)	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<39	90	< 1556	UEHARA	08	BELL	$\gamma\gamma \to 2(\pi^+\pi^-)$

$\Gamma(f_2(1270) f_2(1270)) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_{15}\Gamma_{28}/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
69±17±12	3182 ± 766	UEHARA	08	BELL	$\gamma\gamma \to 2(\pi^+\pi^-)$

$\Gamma(p\overline{p}) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_{24}\Gamma_{28}/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
$6.2^{+1.1}_{-1.0}$ OUR AVERAGE Error includes scale factor of 1.1.					
$7.20 \pm 1.53^{+0.67}_{-0.75}$	157 ± 33	[34] KUO	05	BELL	$\gamma\gamma \to p\overline{p}$
$4.6^{+1.3}_{-1.1} \pm 0.4$	190	[34] AMBROGIANI	03	E835	$\overline{p}p \to \gamma\gamma$
$8.1^{+2.9}_{-2.0}$		[34] ARMSTRONG	95F	E760	$\overline{p}p \to \gamma\gamma$

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

[28] We have multiplied $K^\pm K^0_S \pi^\mp$ measurement by 3 to obtain $K\overline{K}\pi$.

[29] Calculated by us from the value reported in ABDALLAH 03J, which uses B($\eta_c \to K^0_S K^\pm \pi^\mp$) = (1.5 ± 0.4)%.

[30] Superseded by ASNER 04.

[31] Calculated by us from the value reported in ABDALLAH 03J, which uses B($\eta_c \to \pi^+\pi^- K^+ K^-$) = (2.0 ± 0.7)%.

[32] Calculated by us from the value reported in ABDALLAH 03J, which uses B($\eta_c \to$) $2(K^+K^-)$ = (2.1 ± 1.2)%.

[33] Incudes all topological modes except $\eta_c \to \phi\phi$.

[34] Not independent from the $\Gamma_{\gamma\gamma}$ reported by the same experiment.

$\eta_c(1S)$ 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	[35] 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
20 ± 7 OUR EVALUATION			(Treating systematicerrors as correlated.)		
18 ± 5 OUR AVERAGE					
12.6± 3.8±5.1		72	[35] ABLIKIM 05L	BES2	$J/\psi \to \pi^+\pi^-\pi^+\pi^-\gamma$
26.0± 2.4±8.8		113	[35] BISELLO 91	DM2	$J/\psi \to \gamma\rho^0\rho^0$
23.6±10.6±8.2		32	[35] BISELLO 91	DM2	$J/\psi \to \gamma\rho^+\rho^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<14	90		[35] BALTRUSAIT...86	MRK3	$J/\psi \to \eta_c\gamma$

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

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
0.02±0.007	63	[35] 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
92±34 OUR EVALUATION		(Treating systematicerrors as correlated.)		
91±26 OUR AVERAGE				
108±25±44	60	[35] ABLIKIM 05L	BES2	$J/\psi \to K^+K^-\pi^+\pi^-\gamma$
82±28±27	14	[35] BISELLO 91	DM2	$e^+e^- \to \gamma K^+K^-\pi^+\pi^-$
90±50	9	[35] BALTRUSAIT...86	MRK3	$J/\psi \to \eta_c\gamma$

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

VALUE (units 10^{-4})	EVTS	DOCUMENT ID	TECN	COMMENT
150±63±43	45	[36] ABLIKIM 06A	BES2	$J/\psi \to K^{*0}\overline{K}^{*0}\pi^+\pi^-\gamma$

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

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{2.9^{+0.9}_{-0.8}\pm1.1}$	$14.1^{+4.4}_{-3.7}$	[37] HUANG	03	BELL	$B^+ \to (\phi K^+ K^-) K^+$

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

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
27 ± 9 OUR EVALUATION	(Treating systematic errors as correlated.)				
27 ± 5 OUR AVERAGE					
25.3± 5.1± 9.1	72	[35] ABLIKIM	05L	BES2	$J/\psi \to K^+ K^- K^+ K^- \gamma$
26 ± 9	357 ± 64	[35] BAI	04	BES	$J/\psi \to \gamma K^+ K^- K^+ K^-$
$18\ ^{+\ 8}_{-\ 6}\ \pm\ 7$	$7.0^{+3.0}_{-2.3}$	[37] HUANG	03	BELL	$B^+ \to (\phi\phi) K^+$
31 ± 7 ±10	19	[35] BISELLO	91	DM2	$J/\psi \to \gamma K^+ K^- K^+ K^-$
$30\ ^{+18}_{-12}\ \pm10$	5	[35] BISELLO	91	DM2	$J/\psi \to \gamma K^+ K^- K^0_S K^0_L$
74 ±18 ±24	80	[35] BAI	90B	MRK3	$J/\psi \to \gamma K^+ K^- K^+ K^-$
67 ±21 ±24		[35] BAI	90B	MRK3	$J/\psi \to \gamma K^+ K^- K^0_S K^0_L$

$\Gamma(\phi 2(\pi^+\pi^-))/\Gamma_{total}$ Γ_8/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<50	90	[38] ABLIKIM	06A	BES2	$J/\psi \to \phi 2(\pi^+\pi^-)\gamma$

$\Gamma(a_0(980)\pi)/\Gamma_{total}$ Γ_9/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.02	90	[35,39] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c \gamma$

$\Gamma(a_2(1320)\pi)/\Gamma_{total}$ Γ_{10}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.02	90	[35] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c \gamma$

$\Gamma(K^*(892)\overline{K}+\text{c.c.})/\Gamma_{total}$ Γ_{11}/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	[35] BISELLO	91	DM2	$J/\psi \to \gamma K^+ K^- \pi^0$

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

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.011	90	[35] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c \gamma$

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

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.0031	90	[35] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c \gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.0063	90	[35] ABLIKIM	05L	BES2	$J/\psi \to \pi^+ \pi^- \pi^0 \pi^+ \pi^- \pi^0 \gamma$
<0.0063		[35] BISELLO	91	DM2	$J/\psi \to \gamma \omega \omega$

$\Gamma(\omega\phi)/\Gamma_{total}$ — Γ_{14}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.0017	90	[35] ABLIKIM	05L	BES2	$J/\psi \to \pi^+\pi^-\pi^0 K^+K^-\gamma$

$\Gamma(f_2(1270)f_2(1270))/\Gamma_{total}$ — Γ_{15}/Γ

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{1.02^{+0.33}_{-0.39}\pm0.29}$	91.2 ± 19.8	[40] ABLIKIM	04M	BES	$J/\psi \to \gamma 2\pi^+ 2\pi^-$

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

VALUE (units 10^{-2})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
7.0 ±1.2 OUR EVALUATION (Treating systematic errors as correlated.)						
6.1 ±0.8 OUR AVERAGE						
8.5 ± 1.8			[41] AUBERT	06E	BABR	$B^\pm \to K^\pm X_{c\overline{c}}$
5.1 ± 2.1		609 ± 71	[35] BAI	04	BES	$J/\psi \to \gamma K^\pm \pi^\mp K^0_S$
$6.90\pm1.42\pm1.32$		33	[35] BISELLO	91	DM2	$J/\psi \to \gamma K^+K^-\pi^0$
$5.43\pm0.94\pm0.94$		68	[35] BISELLO	91	DM2	$J/\psi \to \gamma K^\pm \pi^\mp K^0_S$
4.8 ± 1.7		95	[35,42] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c\gamma$
$16.1 \ ^{+9.2}_{-7.3}$			[43] HIMEL	80B	MRK2	$\psi(2S) \to \eta_c\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
< 10.7	90		[35] PARTRIDGE	80B	CBAL	$J/\psi \to \eta_c\gamma$

$\Gamma(\phi\phi)/\Gamma(K\overline{K}\pi)$ — Γ_7/Γ_{17}

VALUE	DOCUMENT ID		TECN	COMMENT
0.055±0.014±0.005	AUBERT,B	04B	BABR	$B^\pm \to K^\pm \eta_c$

$\Gamma(\eta\pi\pi)/\Gamma_{total}$ — Γ_{18}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.049±0.018 OUR EVALUATION					
0.047±0.015 OUR AVERAGE					
0.054 ± 0.020	75	[35] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c\gamma$
$0.037\pm0.013\pm0.020$	18	[35] PARTRIDGE	80B	CBAL	$J/\psi \to \eta\pi^+\pi^-\gamma$

$\Gamma(\pi^+\pi^-K^+K^-)/\Gamma_{total}$ — Γ_{19}/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	[35] BAI	04	BES	$J/\psi \to \gamma K^+K^-\pi^+\pi^-$
0.021 ± 0.007	110	[35] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c\gamma$
$0.014 \ ^{+0.022}_{-0.009}$		[43] HIMEL	80B	MRK2	$\psi(2S) \to \eta_c\gamma$

$\Gamma(K^+K^-2(\pi^+\pi^-))/\Gamma_{total}$ — Γ_{20}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
95±31±27	100	[44] ABLIKIM	06A	BES2	$J/\psi \to K^+K^-2(\pi^+\pi^-)\gamma$

$\Gamma(2(K^+K^-))/\Gamma_{total}$ — Γ_{21}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.0015±0.0007 OUR AVERAGE					
$0.0014^{+0.0005}_{-0.0004}\pm0.0006$	$14.5^{+4.6}_{-3.0}$	[37] HUANG	03	BELL	$B^+ \to 2(K^+K^-)K^+$
$0.021 \pm0.010 \pm0.006$		[45] ALBRECHT	94H	ARG	$\gamma\gamma \to K^+K^-K^+K^-$

$\Gamma(2(K^+K^-))/\Gamma(K\overline{K}\pi)$ — Γ_{21}/Γ_{17}

VALUE	DOCUMENT ID		TECN	COMMENT
0.023±0.007±0.006	AUBERT,B	04B	BABR	$B^\pm \to K^\pm \eta_c$

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

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
1.2 ±0.3 OUR EVALUATION					
1.15±0.26 OUR AVERAGE					
1.0 ±0.5	542 ± 75	[35] BAI	04	BES	$J/\psi \to \gamma\, 2(\pi^+\pi^-)$
1.05±0.17±0.34	137	[35] BISELLO	91	DM2	$J/\psi \to \gamma 2\pi^+ 2\pi^-$
1.3 ±0.6	25	[35] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c \gamma$
$2.0\ ^{+1.5}_{-1.0}$		[43] HIMEL	80B	MRK2	$\psi(2S) \to \eta_c \gamma$

$\Gamma(3(\pi^+\pi^-))/\Gamma_{total}$ — Γ_{23}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
204±45±58	479	[46] ABLIKIM	06A	BES2	$J/\psi \to 3(\pi^+\pi^-)\gamma$

$\Gamma(p\overline{p})/\Gamma_{total}$ — Γ_{24}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
13 ± 4 OUR EVALUATION		(Treating systematic errors as correlated.)			
14.0± 2.2 OUR AVERAGE					
$15.5^{+2.1}_{-2.5}\pm2.1$	195	[47] WU	06	BELL	$B^+ \to p\overline{p}K^+$
15 ± 6	213 ± 33	[35] BAI	04	BES	$J/\psi \to \gamma p\overline{p}$
10 ± 3 ±4	18	[35] BISELLO	91	DM2	$J/\psi \to \gamma p\overline{p}$
11 ± 6	23	[35] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c \gamma$
$29\ ^{+29}_{-15}$		[43] HIMEL	80B	MRK2	$\psi(2S) \to \eta_c \gamma$

$\Gamma(p\overline{p}) \times \Gamma(\phi\phi)/\Gamma^2_{total}$ — $\Gamma_{24}\Gamma_7/\Gamma^2$

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

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

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{10.4^{+2.9}_{-2.7}\pm1.4}$		20	[48] WU	06	BELL	$B^+ \to \Lambda\overline{\Lambda}K^+$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<20	90		[35] BISELLO	91	DM2	$e^+e^- \to \gamma\Lambda\overline{\Lambda}$

$\Gamma(\Lambda\overline{\Lambda})/\Gamma(p\overline{p})$ — Γ_{25}/Γ_{24}

VALUE	DOCUMENT ID		TECN	COMMENT
$\mathbf{0.67^{+0.19}_{-0.16}\pm0.12}$	[49] WU	06	BELL	$B^+ \to p\overline{p}K^+$, $\Lambda\overline{\Lambda}K^+$

$\Gamma(K\overline{K}\eta)/\Gamma_{\text{total}}$ — Γ_{26}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.031	90	[35] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c\gamma$

$\Gamma(\pi^+\pi^- p\overline{p})/\Gamma_{\text{total}}$ — Γ_{27}/Γ

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

[35] 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.

[36] ABLIKIM 06A reports [B($\eta_c(1S) \to K^{*0}\overline{K}^{*0}\pi^+\pi^-$)] × [B($J/\psi(1S) \to \gamma\eta_c(1S)$)] = $(1.91 \pm 0.64 \pm 0.48) \times 10^{-4}$. 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.

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

[38] ABLIKIM 06A reports [B($\eta_c(1S) \to \phi 2(\pi^+\pi^-)$)] × [B($J/\psi(1S) \to \gamma\eta_c(1S)$)] < 0.603×10^{-4}. We divide by our best value B($J/\psi(1S) \to \gamma\eta_c(1S)$) = 0.013.

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

[40] ABLIKIM 04M reports [B($\eta_c(1S) \to f_2(1270) f_2(1270)$)] × [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.

[41] Determined from the ratio of B($B^\pm \to K^\pm\eta_c$) B($\eta_c \to K\overline{K}\pi$) = $(7.4 \pm 0.5 \pm 0.7) \times 10^{-5}$ reported in AUBERT,B 04B and B($B^\pm \to K^\pm\eta_c$) = $(8.7 \pm 1.5) \times 10^{-3}$ reported in AUBERT 06E.

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

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

[44] ABLIKIM 06A reports [B($\eta_c(1S) \to K^+K^- 2(\pi^+\pi^-)$)] × [B($J/\psi(1S) \to \gamma\eta_c(1S)$)] = $(1.21 \pm 0.32 \pm 0.24) \times 10^{-4}$. 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.

[45] 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($\eta_c \to 2\pi^+2\pi^-$).

[46] ABLIKIM 06A reports [B($\eta_c(1S) \to 3(\pi^+\pi^-)$)] × [B($J/\psi(1S) \to \gamma\eta_c(1S)$)] = $(2.59 \pm 0.32 \pm 0.47) \times 10^{-4}$. 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.

[47] WU 06 reports [B($\eta_c(1S) \to p\overline{p}$)] × [B($B^+ \to \eta_c K^+$)] = $(1.42 \pm 0.11^{+0.16}_{-0.20}) \times 10^{-6}$. We divide by our best value B($B^+ \to \eta_c K^+$) = $(9.1 \pm 1.3) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[48] WU 06 reports $[B(\eta_c(1S) \to \Lambda\overline{\Lambda})] \times [B(B^+ \to \eta_c K^+)] = (0.95^{+0.25}_{-0.22}{}^{+0.08}_{-0.11}) \times 10^{-6}$. We divide by our best value $B(B^+ \to \eta_c K^+) = (9.1 \pm 1.3) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[49] Not independent from other $\eta_c \to \Lambda\overline{\Lambda}$, $p\overline{p}$ branching ratios reported by WU 06.

RADIATIVE DECAYS

$\Gamma(\gamma\gamma)/\Gamma_{total}$ — Γ_{28}/Γ

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$2.4^{+1.1}_{-0.8} \pm 0.3$		13	[50] WICHT	08	BELL	$B^\pm \to K^\pm \gamma\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$2.80^{+0.67}_{-0.58} \pm 1.0$			[51] ARMSTRONG	95F	E760	$\overline{p}p \to \gamma\gamma$
< 9	90		[52] BISELLO	91	DM2	$J/\psi \to \gamma\gamma\gamma$
$6^{+4}_{-3} \pm 4$			[51] BAGLIN	87B	SPEC	$\overline{p}p \to \gamma\gamma$
<18	90		[53] BLOOM	83	CBAL	$J/\psi \to \eta_c\gamma$

[50] WICHT 08 reports $[B(\eta_c(1S) \to \gamma\gamma)] \times [B(B^+ \to \eta_c K^+)] = (2.2^{+0.9}_{-0.7}{}^{+0.4}_{-0.2}) \times 10^{-7}$. We divide by our best value $B(B^+ \to \eta_c K^+) = (9.1 \pm 1.3) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

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

[52] 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.

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

$\Gamma(p\overline{p}) \times \Gamma(\gamma\gamma)/\Gamma^2_{total}$ — $\Gamma_{24}\Gamma_{28}/\Gamma^2$

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	$\overline{p}p \to \gamma\gamma$

Charge conjugation (C), Parity (P), Lepton family number (LF) violating modes

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

VALUE (units 10^{-5})	CL%	DOCUMENT ID		TECN	COMMENT
<90	90	[54] ABLIKIM	06B	BES2	$J/\psi \to \pi^+\pi^-\gamma$

[54] ABLIKIM 06B reports $[B(\eta_c(1S) \to \pi^+\pi^-)] \times [B(J/\psi(1S) \to \gamma\eta_c(1S))] < 1.1 \times 10^{-5}$. We divide by our best value $B(J/\psi(1S) \to \gamma\eta_c(1S)) = 0.013$.

$\Gamma(\pi^0\pi^0)/\Gamma_{total}$ — Γ_{30}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID		TECN	COMMENT
<60	90	[55] ABLIKIM	06B	BES2	$J/\psi \rightarrow \pi^0\pi^0\gamma$

[55] ABLIKIM 06B reports $[B(\eta_c(1S) \rightarrow \pi^0\pi^0)] \times [B(J/\psi(1S) \rightarrow \gamma\eta_c(1S))] < 0.71 \times 10^{-5}$. We divide by our best value $B(J/\psi(1S) \rightarrow \gamma\eta_c(1S)) = 0.013$.

$\Gamma(K^+K^-)/\Gamma_{total}$ — Γ_{31}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID		TECN	COMMENT
<80	90	[56] ABLIKIM	06B	BES2	$J/\psi \rightarrow K^+K^-\gamma$

[56] ABLIKIM 06B reports $[B(\eta_c(1S) \rightarrow K^+K^-)] \times [B(J/\psi(1S) \rightarrow \gamma\eta_c(1S))] < 0.96 \times 10^{-5}$. We divide by our best value $B(J/\psi(1S) \rightarrow \gamma\eta_c(1S)) = 0.013$.

$\Gamma(K^0_S K^0_S)/\Gamma_{total}$ — Γ_{32}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID		TECN	COMMENT
<40	90	[57] ABLIKIM	06B	BES2	$J/\psi \rightarrow K^0_S K^0_S\gamma$

[57] ABLIKIM 06B reports $[B(\eta_c(1S) \rightarrow K^0_S K^0_S)] \times [B(J/\psi(1S) \rightarrow \gamma\eta_c(1S))] < 0.53 \times 10^{-5}$. We divide by our best value $B(J/\psi(1S) \rightarrow \gamma\eta_c(1S)) = 0.013$.

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