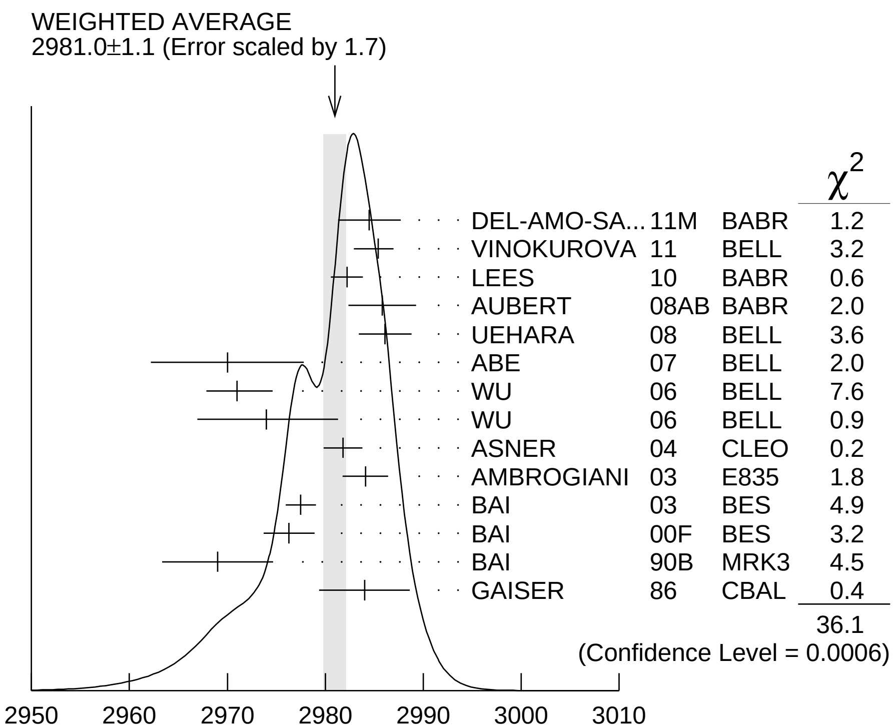
$\eta_c(1S)$

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

$\eta_c(1S)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
2981.0± 1.1 OUR AVERAGE		Error includes scale factor of 1.7. See the ideogram below.			
2984.5± 0.8± 3.1	11k	DEL-AMO-SA...	11M	BABR	$\gamma\gamma \to K^+K^-\pi^+\pi^-\pi^0$
2985.4± $1.5^{+0.5}_{-2.0}$	920	[1] VINOKUROVA	11	BELL	$B^\pm \to K^\pm(K^0_S K^\pm \pi^\mp)$
2982.2± 0.4± 1.6	14k	[2] LEES	10	BABR	10.6 $e^+e^- \to e^+e^- K^0_S K^\pm \pi^\mp$
2985.8± 1.5± 3.1	0.9k	AUBERT	08AB	BABR	$B \to \eta_c(1S) K^{(*)} \to K\overline{K}\pi K^{(*)}$
2986.1± 1.0± 2.5	7.5k	UEHARA	08	BELL	$\gamma\gamma \to \eta_c \to$ hadrons
2970 ± 5 ± 6	501	[3] 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	$\gamma\gamma \to \eta_c \to K^0_S K^\pm \pi^\mp$
2984.1± 2.1± 1.0	190	[4] AMBROGIANI	03	E835	$\overline{p}p \to \eta_c \to \gamma\gamma$
2977.5± 1.0± 1.2		[5,6] BAI	03	BES	$J/\psi \to \gamma\eta_c$
2976.3± 2.3± 1.2		[6,7,8] BAI	00F	BES	$J/\psi \to \gamma\eta_c$ and $\psi(2S) \to \gamma\eta_c$
2969 ± 4 ± 4	80	[6] BAI	90B	MRK3	$J/\psi \to \gamma K^+K^-K^+K^-$
2984 ± 2.3± 4.0		[6] 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± 0.4± 1.4	12k	[9] DEL-AMO-SA...	11M	BABR	$\gamma\gamma \to K^0_S K^\pm \pi^\mp$
2982.2± 0.6		[6] MITCHELL	09	CLEO	$e^+e^- \to \gamma X$
2982 ± 5	270	[10] AUBERT	06E	BABR	$B^\pm \to K^\pm X_{c\overline{c}}$
2982.5± 1.1± 0.9	2.5k	[11] AUBERT	04D	BABR	$\gamma\gamma \to \eta_c(1S) \to K\overline{K}\pi$
2979.6± 2.3± 1.6	180	[12] FANG	03	BELL	$B \to \eta_c K$
2976.6± 2.9± 1.3	140	[6,7,13] BAI	00F	BES	$J/\psi \to \gamma\eta_c$
2980.4± 2.3± 0.6		[14] BRANDENB...	00B	CLE2	$\gamma\gamma \to \eta_c \to K^\pm K^0_S \pi^\mp$
2975.8± 3.9± 1.2		[7,13] 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		[6,13] BISELLO	91	DM2	$J/\psi \to \eta_c\gamma$
2956 ±12 ±12		[6] 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		[6,13] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c\gamma$
2976 ± 8		[6,15] BALTRUSAIT...	84	MRK3	$J/\psi \to 2\phi\gamma$
2982 ± 8	18	[16] HIMEL	80B	MRK2	e^+e^-
2980 ± 9		[16] PARTRIDGE	80B	CBAL	e^+e^-

[1] Accounts for interference with non-resonant continuum.
[2] Taking into account interference with the non-resonant $J^P = 0^-$ amplitude.
[3] From a fit of the J/ψ recoil mass spectrum. Supersedes ABE,K 02 and ABE 04G.
[4] Using mass of $\psi(2S) = 3686.00$ MeV.
[5] From a simultaneous fit of five decay modes of the η_c.
[6] MITCHELL 09 observes a significant asymmetry in the lineshapes of $\psi(2S) \rightarrow \gamma\eta_c$ and $J/\psi \rightarrow \gamma\eta_c$ transitions. If ignored, this asymmetry could lead to significant bias whenever the mass and width are measured in $\psi(2S)$ or J/ψ radiative decays.
[7] Using an η_c width of 13.2 MeV.
[8] Weighted average of the $\psi(2S)$ and $J/\psi(1S)$ samples.
[9] Not independent from the measurements reported by LEES 10.
[10] From the fit of the kaon momentum spectrum. Systematic errors not evaluated.
[11] Superseded by LEES 10.
[12] Superseded by VINOKUROVA 11.
[13] Average of several decay modes.
[14] Superseded by ASNER 04.
[15] $\eta_c \rightarrow \phi\phi$.
[16] Mass adjusted by us to correspond to $J/\psi(1S)$ mass = 3097 MeV.



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

$\eta_c(1S)$ WIDTH

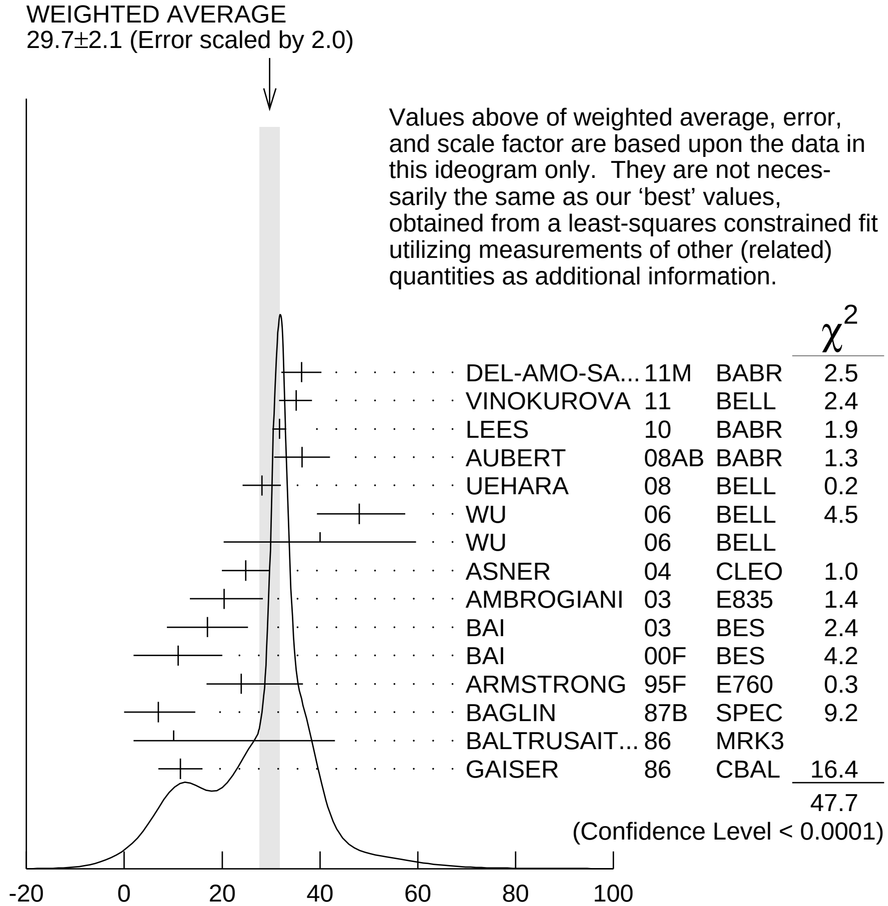
VALUE (MeV)	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
29.7± 1.0 OUR FIT					
29.7± 2.1 OUR AVERAGE Error includes scale factor of 2.0. See the ideogram below.					
36.2± 2.8±3.0		11k	DEL-AMO-SA...11M	BABR	$\gamma\gamma \rightarrow K^+K^-\pi^+\pi^-\pi^0$

$35.1 \pm 3.1^{+1.0}_{-1.6}$	920	[17] VINOKUROVA	11	BELL	$B^{\pm} \to K^{\pm}(K^0_S K^{\pm} \pi^{\mp})$
$31.7 \pm 1.2 \pm 0.8$	14k	[18] LEES	10	BABR	$10.6\ e^+e^- \to e^+e^- K^0_S K^{\pm}\pi^{\mp}$
$36.3^{+3.7}_{-3.6} \pm 4.4$	921 ± 32	AUBERT	08AB	BABR	$B \to \eta_c(1S) K^{(*)} \to K\overline{K}\pi K^{(*)}$
$28.1 \pm 3.2 \pm 2.2$	7.5k	UEHARA	08	BELL	$\gamma\gamma \to \eta_c \to$ hadrons
$48\ ^{+8}_{-7}\ \pm 5$	195	WU	06	BELL	$B^+ \to p\overline{p}K^+$
$40\ \pm 19\ \pm 5$	20	WU	06	BELL	$B^+ \to \Lambda\overline{\Lambda}K^+$
$24.8 \pm 3.4 \pm 3.5$	592	ASNER	04	CLEO	$\gamma\gamma \to \eta_c \to K^0_S K^{\pm}\pi^{\mp}$
$20.4^{+7.7}_{-6.7} \pm 2.0$	190	AMBROGIANI	03	E835	$\overline{p}p \to \eta_c \to \gamma\gamma$
$17.0 \pm 3.7 \pm 7.4$		[19] BAI	03	BES	$J/\psi \to \gamma\eta_c$
$11.0 \pm 8.1 \pm 4.1$		[20] 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	[21] 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. • • •

$32.1 \pm 1.1 \pm 1.3$		12k	[22] DEL-AMO-SA...	11M	BABR	$\gamma\gamma \to K^0_S K^{\pm}\pi^{\mp}$
$34.3 \pm 2.3 \pm 0.9$		2547 ± 90	[23] AUBERT	04D	BABR	$\gamma\gamma \to \eta_c(1S) \to K\overline{K}\pi$
$29\ \pm 8\ \pm 6$		182 ± 25	[24] FANG	03	BELL	$B \to \eta_c K$
$27.0 \pm 5.8 \pm 1.4$			[25] 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^-

[17] Accounts for interference with non-resonant continuum.
[18] Taking into account interference with the non-resonant $J^P = 0^-$ amplitude.
[19] From a simultaneous fit of five decay modes of the η_c.
[20] 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.
[21] Positive and negative errors correspond to 90% confidence level.
[22] Not independent from the measurements reported by LEES 10.
[23] Superseded by LEES 10.
[24] Superseded by VINOKUROVA 11.
[25] Superseded by ASNER 04.



$\eta_c(1S)$ WIDTH

$\eta_c(1S)$ 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	$\rho\rho$	(1.8 ± 0.5) %	
Γ_3	$K^*(892)^0 K^- \pi^+ +$ c.c.	(2.0 ± 0.7) %	
Γ_4	$K^*(892)\overline{K}^*(892)$	$(6.8 \pm 1.3) \times 10^{-3}$	
Γ_5	$K^{*0}\overline{K}^{*0}\pi^+\pi^-$	(1.1 ± 0.5) %	
Γ_6	$\phi K^+ K^-$	$(2.9 \pm 1.4) \times 10^{-3}$	
Γ_7	$\phi\phi$	$(1.94 \pm 0.30) \times 10^{-3}$	
Γ_8	$\phi 2(\pi^+\pi^-)$	$< 3.5 \times 10^{-3}$	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}	$f_2(1270)f_2(1270)$		$(9.7\ \pm 2.5\ ) \times 10^{-3}$		
Γ_{16}	$f_2(1270)f'_2(1525)$		$(9.3\ \pm 3.1\ ) \times 10^{-3}$		
	Decays into stable hadrons				
Γ_{17}	$K\overline{K}\pi$		$(7.2\ \pm 0.6\ )$ %		
Γ_{18}	$\eta\pi^+\pi^-$		$(4.9\ \pm 1.8\ )$ %		
Γ_{19}	$K^+K^-\pi^+\pi^-$		$(6.1\ \pm 1.2\ ) \times 10^{-3}$		
Γ_{20}	$K^+K^-\pi^+\pi^-\pi^0$		$(3.4\ \pm 0.6\ )$ %		
Γ_{21}	$K^+K^-2(\pi^+\pi^-)$		$(7.1\ \pm 2.9\ ) \times 10^{-3}$		
Γ_{22}	$2(K^+K^-)$		$(1.34 \pm 0.32) \times 10^{-3}$		
Γ_{23}	$2(\pi^+\pi^-)$		$(8.6\ \pm 1.3\ ) \times 10^{-3}$		
Γ_{24}	$3(\pi^+\pi^-)$		$(1.5\ \pm 0.5\ )$ %		
Γ_{25}	$p\overline{p}$		$(1.41 \pm 0.17) \times 10^{-3}$		
Γ_{26}	$\Lambda\overline{\Lambda}$		$(9.4\ \pm 3.2\ ) \times 10^{-4}$		
Γ_{27}	$K\overline{K}\eta$		<3.1	%	90%
Γ_{28}	$\pi^+\pi^-p\overline{p}$		<1.2	%	90%
	Radiative decays				
Γ_{29}	$\gamma\gamma$		$(1.78 \pm 0.16) \times 10^{-4}$		
	Charge conjugation (C), Parity (P), Lepton family number (LF) violating modes				
Γ_{30}	$\pi^+\pi^-$	P,CP	<1.1	$\times 10^{-4}$	90%
Γ_{31}	$\pi^0\pi^0$	P,CP	<3.5	$\times 10^{-5}$	90%
Γ_{32}	K^+K^-	P,CP	<6	$\times 10^{-4}$	90%
Γ_{33}	$K^0_S K^0_S$	P,CP	<3.1	$\times 10^{-4}$	90%

CONSTRAINED FIT INFORMATION

An overall fit to the total width, 8 combinations of partial widths obtained from integrated cross section, and 14 branching ratios uses 73 measurements and one constraint to determine 11 parameters. The overall fit has a $\chi^2 = 136.4$ for 63 degrees of freedom.

The following *off-diagonal* array elements are the correlation coefficients $\left\langle \delta p_i \delta p_j \right\rangle / (\delta p_i \cdot \delta p_j)$, in percent, from the fit to parameters p_i, including 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_7	15								
x_{15}	5	6							
x_{17}	28	35	10						
x_{19}	15	17	5	32					
x_{22}	12	14	4	31	14				
x_{23}	18	20	6	38	20	16			
x_{25}	20	23	7	46	23	19	26		
x_{29}	−33	−39	−12	−72	−38	−31	−45	−56	
Γ	−3	−3	−1	−6	−3	−3	−4	10	−31
	x_4	x_7	x_{15}	x_{17}	x_{19}	x_{22}	x_{23}	x_{25}	x_{29}

	Mode	Rate (MeV)
Γ_4	$K^*(892)\overline{K}^*(892)$	0.20 ±0.04
Γ_7	$\phi\phi$	0.058 ±0.009
Γ_{15}	$f_2(1270) f_2(1270)$	0.29 ±0.07
Γ_{17}	$K\overline{K}\pi$	2.12 ±0.19
Γ_{19}	$K^+K^-\pi^+\pi^-$	0.180 ±0.035
Γ_{22}	$2(K^+K^-)$	0.040 ±0.009
Γ_{23}	$2(\pi^+\pi^-)$	0.25 ±0.04
Γ_{25}	$p\overline{p}$	0.042 ±0.005
Γ_{29}	$\gamma\gamma$	0.0053±0.0005

$\eta_c(1S)$ PARTIAL WIDTHS

$\Gamma(\gamma\gamma)$ Γ_{29}

VALUE (keV)	EVTS	DOCUMENT ID		TECN	COMMENT
5.3± 0.5 OUR FIT					
• • • We do not use the following data for averages, fits, limits, etc. • • •					
5.2± 1.2	273 ± 43	[26,27] AUBERT	06E	BABR	$B^\pm \to K^\pm X_{c\overline{c}}$
5.5± 1.2± 1.8	157 ± 33	[28] KUO	05	BELL	$\gamma\gamma \to p\overline{p}$
7.4± 0.4± 2.3		[29] ASNER	04	CLEO	$\gamma\gamma \to \eta_c \to K^0_S K^\pm \pi^\mp$
13.9± 2.0± 3.0	41	[30] ABDALLAH	03J	DLPH	$\gamma\gamma \to \eta_c$
$3.8^{+1.1}_{-1.0}{}^{+1.9}_{-1.0}$	190	[31] AMBROGIANI	03	E835	$\overline{p}p \to \eta_c \to \gamma\gamma$
7.6± 0.8± 2.3		[29,32] BRANDENB...	00B	CLE2	$\gamma\gamma \to \eta_c \to K^\pm K^0_S \pi^\mp$
6.9± 1.7± 2.1	76	[33] ACCIARRI	99T	L3	$e^+e^- \to e^+e^-\eta_c$
27 ±16 ±10	5	[29] SHIRAI	98	AMY	58 e^+e^-
$6.7^{+2.4}_{-1.7}$± 2.3		[28] ARMSTRONG	95F	E760	$\overline{p}p \to \gamma\gamma$
11.3± 4.2		[34] ALBRECHT	94H	ARG	$e^+e^- \to e^+e^-\eta_c$
8.0± 2.3± 2.4	17	[35] ADRIANI	93N	L3	$e^+e^- \to e^+e^-\eta_c$
$5.9^{+2.1}_{-1.8}$± 1.9		[31] CHEN	90B	CLEO	$e^+e^- \to e^+e^-\eta_c$
$6.4^{+5.0}_{-3.4}$		[36] AIHARA	88D	TPC	$e^+e^- \to e^+e^-X$

$4.3^{+3.4}_{-3.7}\pm 2.4$	[28] BAGLIN	87B	SPEC	$\overline{p}p \to \gamma\gamma$
28 ± 15	[29,37] BERGER	86	PLUT	$\gamma\gamma \to K\overline{K}\pi$

[26] Calculated by us using $\Gamma(\eta_c \to K\overline{K}\pi) \times \Gamma(\eta_c \to \gamma\gamma) / \Gamma = 0.44 \pm 0.05$ keV from PDG 06 and $B(\eta_c \to K\overline{K}\pi) = (8.5 \pm 1.8)\%$ from AUBERT 06E.
[27] Systematic errors not evaluated.
[28] Normalized to $B(\eta_c \to p\overline{p}) = (1.3 \pm 0.4) \times 10^{-3}$.
[29] Normalized to $B(\eta_c \to K^\pm K^0_S \pi^\mp)$.
[30] Average of $K^0_S K^\pm \pi^\mp$, $\pi^+\pi^- K^+ K^-$, and $2(K^+K^-)$ decay modes.
[31] 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 $B(\eta_c \to 2\pi^+ 2\pi^-)$.
[32] Superseded by ASNER 04.
[33] Normalized to the sum of 9 branching ratios.
[34] 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 $B(\eta_c \to 2\pi^+ 2\pi^-)$.
[35] Superseded by ACCIARRI 99T.
[36] 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 $B(\eta_c \to 2\pi^+ 2\pi^-)$.
[37] Re-evaluated by AIHARA 88D.

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

$\Gamma(K\overline{K}\pi) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ — $\Gamma_{17}\Gamma_{29}/\Gamma$

VALUE (keV)	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.377±0.021 OUR FIT						
0.407±0.027 OUR AVERAGE			Error includes scale factor of 1.2.			
0.374±0.009±0.031		14k	[38] LEES	10	BABR	$10.6\ e^+e^- \to e^+e^- K^0_S K^\pm \pi^\mp$
0.407±0.022±0.028			[39,40] ASNER	04	CLEO	$\gamma\gamma \to \eta_c \to K^0_S K^\pm \pi^\mp$
0.60 ±0.12 ±0.09		41	[40,41] ABDALLAH	03J	DLPH	$\gamma\gamma \to K^0_S K^\pm \pi^\mp$
1.47 ±0.87 ±0.27			[40] SHIRAI	98	AMY	$\gamma\gamma \to \eta_c \to K^\pm K^0_S \pi^\mp$
0.84 ±0.21			[40] ALBRECHT	94H	ARG	$\gamma\gamma \to K^\pm K^0_S \pi^\mp$
$0.60\ ^{+0.23}_{-0.20}$			[40] CHEN	90B	CLEO	$\gamma\gamma \to \eta_c K^\pm K^0_S \pi^\mp$
1.06 ±0.41 ±0.27		11	[40] BRAUNSCH...	89	TASS	$\gamma\gamma \to K\overline{K}\pi$
$1.5\ ^{+0.60}_{-0.45} \pm 0.3$		7	[40] BERGER	86	PLUT	$\gamma\gamma \to K\overline{K}\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
0.386±0.008±0.021		12k	[42] DEL-AMO-SA...	11M	BABR	$\gamma\gamma \to K^0_S K^\pm \pi^\mp$
0.418±0.044±0.022			[40,43] BRANDENB...	00B	CLE2	$\gamma\gamma \to \eta_c \to K^\pm K^0_S \pi^\mp$
<0.63	95		[40] BEHREND	89	CELL	$\gamma\gamma \to K^0_S K^\pm \pi^\mp$
<4.4	95		ALTHOFF	85B	TASS	$\gamma\gamma \to K\overline{K}\pi$

[38] From the corrected and unfolded mass spectrum.
[39] Calculated by us from the value reported in ASNER 04 that assumes B($\eta_c \rightarrow K\overline{K}\pi$) = 5.5 ± 1.7%
[40] We have multiplied $K^{\pm} K^0_S \pi^{\mp}$ measurement by 3 to obtain $K\overline{K}\pi$.
[41] 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)%.
[42] Not independent from the measurements reported by LEES 10.
[43] Superseded by ASNER 04.

$\Gamma(K^+K^-\pi^+\pi^-) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_{19}\Gamma_{29}/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
32 ± 6 OUR FIT					
27 ± 6 OUR AVERAGE					
25.7 ± 3.2 ± 4.9	2019 ± 248	UEHARA	08	BELL	$\gamma\gamma \rightarrow \pi^+\pi^-K^+K^-$
280 ± 100 ± 60	42	[44] ABDALLAH	03J	DLPH	$\gamma\gamma \rightarrow \pi^+\pi^-K^+K^-$
170 ± 80 ± 20	13.9 ± 6.6	ALBRECHT	94H	ARG	$\gamma\gamma \rightarrow \pi^+\pi^-K^+K^-$

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

$\Gamma(K^+K^-\pi^+\pi^-\pi^0) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_{20}\Gamma_{29}/\Gamma$

VALUE (keV)	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.190 ± 0.006 ± 0.028	11k	[45] DEL-AMO-SA..11M		BABR	$\gamma\gamma \rightarrow K^+K^-\pi^+\pi^-\pi^0$

[45] Not independent from other measurements reported in DEL-AMO-SANCHEZ 11M.

$\Gamma(K^*(892)\overline{K}^*(892)) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_4\Gamma_{29}/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
36 ± 6 OUR FIT					
32.4 ± 4.2 ± 5.8	882 ± 115	UEHARA	08	BELL	$\gamma\gamma \rightarrow \pi^+\pi^-K^+K^-$

$\Gamma(f_2(1270)f'_2(1525)) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_{16}\Gamma_{29}/\Gamma$

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

$\Gamma(2(K^+K^-)) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_{22}\Gamma_{29}/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
7.0 ± 1.6 OUR FIT					
5.8 ± 1.9 OUR AVERAGE					
5.6 ± 1.1 ± 1.6	216 ± 42	UEHARA	08	BELL	$\gamma\gamma \rightarrow 2(K^+K^-)$
350 ± 90 ± 60	46	[46] ABDALLAH	03J	DLPH	$\gamma\gamma \rightarrow 2(K^+K^-)$
231 ± 90 ± 23	9.1 ± 3.3	[47] ALBRECHT	94H	ARG	$\gamma\gamma \rightarrow 2(K^+K^-)$

[46] Calculated by us from the value reported in ABDALLAH 03J, which uses B($\eta_c \rightarrow$) $2(K^+K^-)$ = (2.1 ± 1.2)%.
[47] Includes all topological modes except $\eta_c \rightarrow \phi\phi$.

$\Gamma(\phi\phi) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_7\Gamma_{29}/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
10.2±1.4 OUR FIT					
6.8±1.2±1.3	132 ± 23	UEHARA	08	BELL	$\gamma\gamma \to 2(K^+K^-)$

$\Gamma(2(\pi^+\pi^-)) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_{23}\Gamma_{29}/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
45 ± 6 OUR FIT					
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	$\gamma\gamma \to 2(\pi^+\pi^-)$

$\Gamma(\rho\rho) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_2\Gamma_{29}/\Gamma$

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	$\gamma\gamma \to 2(\pi^+\pi^-)$

$\Gamma(f_2(1270)f_2(1270)) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_{15}\Gamma_{29}/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
51±13 OUR FIT					
69±17±12	3182±766	UEHARA	08	BELL	$\gamma\gamma \to 2(\pi^+\pi^-)$

$\Gamma(p\overline{p}) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_{25}\Gamma_{29}/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
7.4 ±0.8 OUR FIT					
$7.20\pm1.53^{+0.67}_{-0.75}$	157 ± 33	[48] KUO	05	BELL	$\gamma\gamma \to p\overline{p}$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$4.6\ ^{+1.3}_{-1.1}\ \pm0.4$	190	[48] AMBROGIANI	03	E835	$\overline{p}p \to \gamma\gamma$
$8.1\ ^{+2.9}_{-2.0}$		[48] ARMSTRONG	95F	E760	$\overline{p}p \to \gamma\gamma$

[48] 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	[49] 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
18 ± 5 OUR AVERAGE						
12.6± 3.8±5.1		72	[49] ABLIKIM	05L	BES2	$J/\psi \to \pi^+\pi^-\pi^+\pi^-\gamma$
26.0± 2.4±8.8		113	[49] BISELLO	91	DM2	$J/\psi \to \gamma\rho^0\rho^0$
23.6±10.6±8.2		32	[49] BISELLO	91	DM2	$J/\psi \to \gamma\rho^+\rho^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<14	90		[49] BALTRUSAIT...86		MRK3	$J/\psi \to \eta_c\gamma$

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.02±0.007	63	[49] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c \gamma$

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

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
68±13 OUR FIT					
91±26 OUR AVERAGE					
108±25±44	60	[49] ABLIKIM	05L	BES2	$J/\psi \to K^+ K^- \pi^+ \pi^- \gamma$
82±28±27	14	[49] BISELLO	91	DM2	$e^+ e^- \to \gamma K^+ K^- \pi^+ \pi^-$
90±50	9	[49] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c \gamma$

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

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
112±47±26	45	[50] ABLIKIM	06A	BES2	$J/\psi \to K^{*0}\overline{K}^{*0}\pi^+\pi^-\gamma$

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

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{2.9^{+0.9}_{-0.8}\pm1.1}$	$14.1^{+4.4}_{-3.7}$	[51] HUANG	03	BELL	$B^+ \to (\phi K^+ K^-) K^+$

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

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
19.4± 3.0 OUR FIT					
30 ± 5 OUR AVERAGE					
25.3± 5.1± 9.1	72	[49] ABLIKIM	05L	BES2	$J/\psi \to K^+ K^- K^+ K^- \gamma$
26 ± 9	357 ± 64	[49] BAI	04	BES	$J/\psi \to \gamma K^+ K^- K^+ K^-$
31 ± 7 ±10	19	[49] BISELLO	91	DM2	$J/\psi \to \gamma K^+ K^- K^+ K^-$
$30\ ^{+18}_{-12}\ \pm10$	5	[49] BISELLO	91	DM2	$J/\psi \to \gamma K^+ K^- K^0_S K^0_L$
74 ±18 ±24	80	[49] BAI	90B	MRK3	$J/\psi \to \gamma K^+ K^- K^+ K^-$
67 ±21 ±24		[49] 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. • • •					
$18\ ^{+\ 8}_{-\ 6}\ \pm\ 7$	$7.0^{+3.0}_{-2.3}$	[51] HUANG	03	BELL	$B^+ \to (\phi\phi) K^+$

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.027±0.004 OUR FIT					
$\mathbf{0.044^{+0.012}_{-0.010}}$ **OUR AVERAGE**					
0.055±0.014±0.005		AUBERT,B	04B	BABR	$B^\pm \to K^\pm \eta_c$
$0.032^{+0.014}_{-0.010}\pm0.009$	7	[51] HUANG	03	BELL	$B^\pm \to K^\pm \phi\phi$

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

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<35	90	[52] 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	[49,53] 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	[49] 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	[49] 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	[49] 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	[49] BALTRUSAIT...86	MRK3	$J/\psi \to \eta_c \gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<0.0063	90	[49] ABLIKIM 05L	BES2	$J/\psi \to \pi^+\pi^-\pi^0\pi^+\pi^-\pi^0\gamma$
<0.0063		[49] 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	[49] 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
0.97±0.25 OUR FIT				
$\mathbf{0.76^{+0.25}_{-0.29}\pm0.18}$	91.2 ± 19.8	[54] 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
7.2 ±0.6 OUR FIT					
6.1 ±0.8 OUR AVERAGE					
8.5 ±1.8			[55] AUBERT 06E	BABR	$B^\pm \to K^\pm X_{c\overline{c}}$
5.1 ±2.1		609 ± 71	[49] BAI 04	BES	$J/\psi \to \gamma K^\pm \pi^\mp K^0_S$
6.90±1.42±1.32		33	[49] BISELLO 91	DM2	$J/\psi \to \gamma K^+ K^- \pi^0$
5.43±0.94±0.94		68	[49] BISELLO 91	DM2	$J/\psi \to \gamma K^\pm \pi^\mp K^0_S$
4.8 ±1.7		95	[49,56] BALTRUSAIT...86	MRK3	$J/\psi \to \eta_c \gamma$
$16.1\ ^{+9.2}_{-7.3}$			[57] HIMEL 80B	MRK2	$\psi(2S) \to \eta_c \gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
< 10.7	90		[49] PARTRIDGE 80B	CBAL	$J/\psi \to \eta_c \gamma$

$\Gamma(\eta\pi^+\pi^-)/\Gamma_{total}$ — 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	[49] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c\gamma$
0.037±0.013±0.020	18	[49] PARTRIDGE	80B	CBAL	$J/\psi \to \eta\pi^+\pi^-\gamma$

$\Gamma(K^+K^-\pi^+\pi^-)/\Gamma_{total}$ — Γ_{19}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.0061±0.0012 OUR FIT					
0.0142±0.0033 OUR AVERAGE					
0.012 ±0.004	413 ± 54	[49] BAI	04	BES	$J/\psi \to \gamma K^+K^-\pi^+\pi^-$
0.021 ±0.007	110	[49] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c\gamma$
$0.014\ ^{+0.022}_{-0.009}$		[57] HIMEL	80B	MRK2	$\psi(2S) \to \eta_c\gamma$

$\Gamma(K^+K^-\pi^+\pi^-\pi^0)/\Gamma(K\overline{K}\pi)$ — Γ_{20}/Γ_{17}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.477±0.017±0.070	11k	[58] DEL-AMO-SA...	11M	BABR	$\gamma\gamma \to K^+K^-\pi^+\pi^-\pi^0$

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

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
71±23±16	100	[59] ABLIKIM	06A	BES2	$J/\psi \to K^+K^-2(\pi^+\pi^-)\gamma$

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

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.34± 0.32 OUR FIT					
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$1.4\ ^{+0.5}_{-0.4}$ ±0.6	$14.5^{+4.6}_{-3.0}$	[51] HUANG	03	BELL	$B^+ \to 2(K^+K^-)\ K^+$
21 ±10 ±6		[60] ALBRECHT	94H	ARG	$\gamma\gamma \to K^+K^-K^+K^-$

$\Gamma(2(K^+K^-))/\Gamma(K\overline{K}\pi)$ — Γ_{22}/Γ_{17}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.019±0.004 OUR FIT					
0.024±0.007 OUR AVERAGE					
0.023±0.007±0.006		AUBERT,B	04B	BABR	$B^\pm \to K^\pm\eta_c$
$0.026^{+0.009}_{-0.007}$±0.007	15	[51] HUANG	03	BELL	$B^\pm \to K^\pm(2K^+2K^-)$

$\Gamma(2(\pi^+\pi^-))/\Gamma_{total}$ — Γ_{23}/Γ

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
0.86±0.13 OUR FIT					
1.15±0.26 OUR AVERAGE					
1.0 ±0.5	542 ± 75	[49] BAI	04	BES	$J/\psi \to \gamma\ 2(\pi^+\pi^-)$
1.05±0.17±0.34	137	[49] BISELLO	91	DM2	$J/\psi \to \gamma 2\pi^+2\pi^-$
1.3 ±0.6	25	[49] BALTRUSAIT...	86	MRK3	$J/\psi \to \eta_c\gamma$
$2.0\ ^{+1.5}_{-1.0}$		[57] HIMEL	80B	MRK2	$\psi(2S) \to \eta_c\gamma$

$\Gamma(\phi K^+ K^-)/\Gamma(K\overline{K}\pi)$ — Γ_6/Γ_{17}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
$0.052^{+0.016}_{-0.014}\pm0.014$	7	[51] HUANG	03	BELL	$B^\pm \to K^\pm \phi\phi$

$\Gamma(3(\pi^+\pi^-))/\Gamma_{total}$ — Γ_{24}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
152±33±35	479	[61] ABLIKIM	06A	BES2	$J/\psi \to 3(\pi^+\pi^-)\gamma$

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

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
14.1± 1.7 OUR FIT					
12.5± 3.2 OUR AVERAGE					
15 ± 6	213 ± 33	[49] BAI	04	BES	$J/\psi \to \gamma p\overline{p}$
10 ± 3 ±4	18	[49] BISELLO	91	DM2	$J/\psi \to \gamma p\overline{p}$
11 ± 6	23	[49] BALTRUSAIT...86		MRK3	$J/\psi \to \eta_c\gamma$
$29\ ^{+29}_{-15}$		[57] HIMEL	80B	MRK2	$\psi(2S) \to \eta_c\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$14.8^{+\ 2.0}_{-\ 2.4}\pm1.8$	195	[62] WU	06	BELL	$B^+ \to p\overline{p}K^+$

$\Gamma(p\overline{p})/\Gamma(K\overline{K}\pi)$ — Γ_{25}/Γ_{17}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.0197±0.0022 OUR FIT					
$0.021\ \pm0.002\ ^{+0.004}_{-0.006}$	195	[51] WU	06	BELL	$B^\pm \to K^\pm p\overline{p}$

$\Gamma(p\overline{p})/\Gamma_{total} \times \Gamma(\phi\phi)/\Gamma_{total}$ — $\Gamma_{25}/\Gamma \times \Gamma_7/\Gamma$

VALUE (units 10^{-5})	DOCUMENT ID		TECN	COMMENT
0.27±0.06 OUR FIT				
$4.0\ ^{+3.5}_{-3.2}$	BAGLIN	89	SPEC	$\overline{p}p \to K^+K^-K^+K^-$

$\Gamma(\Lambda\overline{\Lambda})/\Gamma_{total}$ — Γ_{26}/Γ

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$9.9^{+2.7}_{-2.6}\pm1.2$		20	[63] WU	06	BELL	$B^+ \to \Lambda\overline{\Lambda}K^+$
<20	90		[49] BISELLO	91	DM2	$e^+e^- \to \gamma\Lambda\overline{\Lambda}$

$\Gamma(\Lambda\overline{\Lambda})/\Gamma(p\overline{p})$ — Γ_{26}/Γ_{25}

VALUE	DOCUMENT ID		TECN	COMMENT
$0.67^{+0.19}_{-0.16}\pm0.12$	[64] WU	06	BELL	$B^+ \to p\overline{p}K^+$, $\Lambda\overline{\Lambda}K^+$

$\Gamma(K\overline{K}\eta)/\Gamma_{total}$ — Γ_{27}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.031	90	[49] BALTRUSAIT...86		MRK3	$J/\psi \to \eta_c\gamma$

$\Gamma(\pi^+\pi^- p\overline{p})/\Gamma_{\rm total}$ — Γ_{28}/Γ

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

[49] 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.

[50] ABLIKIM 06A reports $[\Gamma(\eta_c(1S) \to K^{*0}\overline{K}^{*0}\pi^+\pi^-)/\Gamma_{\rm total}] \times [B(J/\psi(1S) \to \gamma\eta_c(1S))] = (1.91\pm0.64\pm0.48)\times10^{-4}$ which we divide by our best value $B(J/\psi(1S) \to \gamma\eta_c(1S)) = (1.7\pm0.4)\times10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

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

[52] ABLIKIM 06A reports $[\Gamma(\eta_c(1S) \to \phi 2(\pi^+\pi^-))/\Gamma_{\rm total}] \times [B(J/\psi(1S) \to \gamma\eta_c(1S))] < 0.603 \times 10^{-4}$ which we divide by our best value $B(J/\psi(1S) \to \gamma\eta_c(1S)) = 1.7 \times 10^{-2}$.

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

[54] ABLIKIM 04M reports $[\Gamma(\eta_c(1S) \to f_2(1270) f_2(1270))/\Gamma_{\rm total}] \times [B(J/\psi(1S) \to \gamma\eta_c(1S))] = (1.3 \pm 0.3^{+0.3}_{-0.4}) \times 10^{-4}$ which we divide by our best value $B(J/\psi(1S) \to \gamma\eta_c(1S)) = (1.7 \pm 0.4) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[55] 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.

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

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

[58] We have multiplied the value of $\Gamma(K^+K^-\pi^+\pi^-\pi^0)/\Gamma(K^0_S K^\pm\pi^\mp)$ reported in DEL-AMO-SANCHEZ 11M by a factor 1/3 to obtain $\Gamma(K^+K^-\pi^+\pi^-\pi^0)/\Gamma(K\overline{K}\pi)$. Not independent from other measurements reported in DEL-AMO-SANCHEZ 11M.

[59] ABLIKIM 06A reports $[\Gamma(\eta_c(1S) \to K^+K^- 2(\pi^+\pi^-))/\Gamma_{\rm total}] \times [B(J/\psi(1S) \to \gamma\eta_c(1S))] = (1.21\pm0.32\pm0.24)\times10^{-4}$ which we divide by our best value $B(J/\psi(1S) \to \gamma\eta_c(1S)) = (1.7\pm0.4)\times10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

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

[61] ABLIKIM 06A reports $[\Gamma(\eta_c(1S) \to 3(\pi^+\pi^-))/\Gamma_{\rm total}] \times [B(J/\psi(1S) \to \gamma\eta_c(1S))] = (2.59 \pm 0.32 \pm 0.47) \times 10^{-4}$ which we divide by our best value $B(J/\psi(1S) \to \gamma\eta_c(1S)) = (1.7 \pm 0.4) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[62] WU 06 reports $[\Gamma(\eta_c(1S) \to p\overline{p})/\Gamma_{\rm total}] \times [B(B^+ \to \eta_c K^+)] = (1.42\pm0.11^{+0.16}_{-0.20})\times 10^{-6}$ which we divide by our best value $B(B^+ \to \eta_c K^+) = (9.6 \pm 1.2) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[63] WU 06 reports $[\Gamma(\eta_c(1S) \to \Lambda\overline{\Lambda})/\Gamma_{\rm total}] \times [B(B^+ \to \eta_c K^+)] = (0.95^{+0.25}_{-0.22}{}^{+0.08}_{-0.11}) \times 10^{-6}$ which we divide by our best value $B(B^+ \to \eta_c K^+) = (9.6 \pm 1.2) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[64] 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_{29}/Γ

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
1.78±0.16 OUR FIT						
$1.4\ ^{+0.7}_{-0.5}\ \pm0.3$		$1.2^{+2.8}_{-1.1}$	[65] ADAMS	08	CLEO	$\psi(2S) \to \pi^+\pi^- J/\psi$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$2.3\ ^{+1.0}_{-0.8}\ \pm0.3$		13	[66] WICHT	08	BELL	$B^\pm \to K^\pm\gamma\gamma$
$2.80^{+0.67}_{-0.58}\pm1.0$			[67] ARMSTRONG	95F	E760	$\overline{p}p \to \gamma\gamma$
<9	90		[68] BISELLO	91	DM2	$J/\psi \to \gamma\gamma\gamma$
$6\ ^{+4}_{-3}\ \pm4$			[67] BAGLIN	87B	SPEC	$\overline{p}p \to \gamma\gamma$
<18	90		[69] BLOOM	83	CBAL	$J/\psi \to \eta_c\gamma$

[65] ADAMS 08 reports $[\Gamma(\eta_c(1S) \to \gamma\gamma)/\Gamma_{total}] \times [B(J/\psi(1S) \to \gamma\eta_c(1S))] = (2.4^{+1.1}_{-0.8} \pm 0.3) \times 10^{-6}$ which we divide by our best value $B(J/\psi(1S) \to \gamma\eta_c(1S)) = (1.7 \pm 0.4) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[66] WICHT 08 reports $[\Gamma(\eta_c(1S) \to \gamma\gamma)/\Gamma_{total}] \times [B(B^+ \to \eta_c K^+)] = (2.2^{+0.9}_{-0.7}{}^{+0.4}_{-0.2}) \times 10^{-7}$ which we divide by our best value $B(B^+ \to \eta_c K^+) = (9.6 \pm 1.2) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

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

[68] 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.

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

$\Gamma(\gamma\gamma)/\Gamma(K\overline{K}\pi)$ — Γ_{29}/Γ_{17}

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
2.5±0.4 OUR FIT					
$3.2^{+1.3}_{-1.0}{}^{+0.8}_{-0.6}$	13	[70] WICHT	08	BELL	$B^\pm \to K^\pm\gamma\gamma$

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

$\Gamma(p\overline{p})/\Gamma_{total} \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_{25}/\Gamma \times \Gamma_{29}/\Gamma$

VALUE (units 10^{-6})	EVTS	DOCUMENT ID		TECN	COMMENT
0.250±0.026 OUR FIT					
0.26 ±0.05 OUR AVERAGE	Error includes scale factor of 1.4.				
$0.224^{+0.038}_{-0.037}\pm0.020$	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_{30}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID		TECN	COMMENT
<11	90	[71] ABLIKIM	11G	BES3	$J/\psi \to \gamma\pi^+\pi^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<60	90	[72] ABLIKIM	06B	BES2	$J/\psi \to \pi^+\pi^-\gamma$

[71] ABLIKIM 11G reports $[\Gamma(\eta_c(1S) \to \pi^+\pi^-)/\Gamma_{total}] \times [B(J/\psi(1S) \to \gamma\eta_c(1S))] < 1.82\times10^{-6}$ which we divide by our best value $B(J/\psi(1S) \to \gamma\eta_c(1S)) = 1.7\times10^{-2}$.

[72] ABLIKIM 06B reports $[\Gamma(\eta_c(1S) \to \pi^+\pi^-)/\Gamma_{total}] \times [B(J/\psi(1S) \to \gamma\eta_c(1S))] < 1.1\times10^{-5}$ which we divide by our best value $B(J/\psi(1S) \to \gamma\eta_c(1S)) = 1.7\times10^{-2}$.

$\Gamma(\pi^0\pi^0)/\Gamma_{total}$ — Γ_{31}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID		TECN	COMMENT
< 3.5	90	[73] ABLIKIM	11G	BES3	$J/\psi \to \gamma\pi^0\pi^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<40	90	[74] ABLIKIM	06B	BES2	$J/\psi \to \pi^0\pi^0\gamma$

[73] ABLIKIM 11G reports $[\Gamma(\eta_c(1S) \to \pi^0\pi^0)/\Gamma_{total}] \times [B(J/\psi(1S) \to \gamma\eta_c(1S))] < 6.0\times10^{-7}$ which we divide by our best value $B(J/\psi(1S) \to \gamma\eta_c(1S)) = 1.7\times10^{-2}$.

[74] ABLIKIM 06B reports $[\Gamma(\eta_c(1S) \to \pi^0\pi^0)/\Gamma_{total}] \times [B(J/\psi(1S) \to \gamma\eta_c(1S))] < 0.71\times10^{-5}$ which we divide by our best value $B(J/\psi(1S) \to \gamma\eta_c(1S)) = 1.7\times10^{-2}$.

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

VALUE (units 10^{-5})	CL%	DOCUMENT ID		TECN	COMMENT
<60	90	[75] ABLIKIM	06B	BES2	$J/\psi \to K^+K^-\gamma$

[75] ABLIKIM 06B reports $[\Gamma(\eta_c(1S) \to K^+K^-)/\Gamma_{total}] \times [B(J/\psi(1S) \to \gamma\eta_c(1S))] < 0.96\times10^{-5}$ which we divide by our best value $B(J/\psi(1S) \to \gamma\eta_c(1S)) = 1.7\times10^{-2}$.

$\Gamma(K^0_S K^0_S)/\Gamma_{total}$ — Γ_{33}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID		TECN	COMMENT
<31	90	[76] ABLIKIM	06B	BES2	$J/\psi \to K^0_S K^0_S\gamma$

[76] ABLIKIM 06B reports $[\Gamma(\eta_c(1S) \to K^0_S K^0_S)/\Gamma_{total}] \times [B(J/\psi(1S) \to \gamma\eta_c(1S))] < 0.53\times10^{-5}$ which we divide by our best value $B(J/\psi(1S) \to \gamma\eta_c(1S)) = 1.7\times10^{-2}$.

$\eta_c(1S)$ REFERENCES

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DEL-AMO-SA...	11M	PR D84 012004	P. del Amo Sanchez *et al.*	(BABAR Collab.)
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MITCHELL	09	PRL 102 011801	R.E. Mitchell *et al.*	(CLEO Collab.)
ADAMS	08	PRL 101 101801	G.S. Adams *et al.*	(CLEO Collab.)
AUBERT	08AB	PR D78 012006	B. Aubert *et al.*	(BABAR Collab.)
UEHARA	08	EPJ C53 1	S. Uehara *et al.*	(BELLE Collab.)
WICHT	08	PL B662 323	J. Wicht *et al.*	(BELLE Collab.)
ABE	07	PRL 98 082001	K. Abe *et al.*	(BELLE Collab.)
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PDG	06	JPG 33 1	W.-M. Yao *et al.*	(PDG Collab.)
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KUO	05	PL B621 41	C.C. Kuo *et al.*	(BELLE Collab.)
ABE	04G	PR D70 071102	K. Abe *et al.*	(BELLE Collab.)
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BAI	00F	PR D62 072001	J.Z. Bai *et al.*	(BES Collab.)
BRANDENB...	00B	PRL 85 3095	G. Brandenburg *et al.*	(CLEO Collab.)
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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.)
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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.)
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AIHARA	88D	PRL 60 2355	H. Aihara *et al.*	(TPC Collab.)
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