

$\eta_c(2S)$

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

Quantum numbers are quark model predictions.

$\eta_c(2S)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
3639.2 ± 1.2 OUR AVERAGE				
3637.0 ± 5.7 ± 3.4	178	^{1,2} LEES	14E BABR	$\gamma\gamma \rightarrow K^+ K^- \pi^0$
3635.1 ± 5.8 ± 2.1	47	^{1,3} LEES	14E BABR	$\gamma\gamma \rightarrow K^+ K^- \eta$
3646.9 ± 1.6 ± 3.6	57 ± 17	ABLIKIM	13K BES3	$\psi(2S) \rightarrow$ $\gamma K_S^0 K^\pm \pi^\mp \pi^+ \pi^-$
3637.6 ± 2.9 ± 1.6	127 ± 18	⁴ ABLIKIM	12G BES3	$\psi(2S) \rightarrow \gamma K^0 K \pi,$ $K K \pi^0$
3638.5 ± 1.5 ± 0.8	624	¹ DEL-AMO-SA..11M	BABR	$\gamma\gamma \rightarrow K_S^0 K^\pm \pi^\mp$
3640.5 ± 3.2 ± 2.5	1201	¹ DEL-AMO-SA..11M	BABR	$\gamma\gamma \rightarrow K^+ K^- \pi^+ \pi^- \pi^0$
3636.1 ^{+3.9+0.7} _{-4.2-2.0}	128	⁵ VINOKUROVA 11	BELL	$B^\pm \rightarrow K^\pm (K_S^0 K^\pm \pi^\mp)$
3626 ± 5 ± 6	311	⁶ ABE	07 BELL	$e^+ e^- \rightarrow J/\psi(c\bar{c})$
3645.0 ± 5.5 ^{+4.9} _{-7.8}	121 ± 27	AUBERT	05C BABR	$e^+ e^- \rightarrow J/\psi c\bar{c}$
3642.9 ± 3.1 ± 1.5	61	ASNER	04 CLEO	$\gamma\gamma \rightarrow \eta_c \rightarrow K_S^0 K^\pm \pi^\mp$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
3639 ± 7	98 ± 52	⁷ AUBERT	06E BABR	$B^\pm \rightarrow K^\pm X_{c\bar{c}}$
3630.8 ± 3.4 ± 1.0	112 ± 24	⁸ AUBERT	04D BABR	$\gamma\gamma \rightarrow \eta_c(2S) \rightarrow K\bar{K}\pi$
3654 ± 6 ± 8	39 ± 11	⁹ CHOI	02 BELL	$B \rightarrow K K_S K^- \pi^+$
3594 ± 5		¹⁰ EDWARDS	82C CBAL	$e^+ e^- \rightarrow \gamma X$

- ¹ Ignoring possible interference with continuum.
- ² With a width fixed to 11.3 MeV.
- ³ With a width fixed to 11.3 MeV. Using both $\eta \rightarrow \gamma\gamma$ and $\eta \rightarrow \pi^+ \pi^- \pi^0$ decays.
- ⁴ From a simultaneous fit to $K_S^0 K^\pm \pi^\mp$ and $K^+ K^- \pi^0$ decay modes.
- ⁵ Accounts for interference with non-resonant continuum.
- ⁶ From a fit of the J/ψ recoil mass spectrum. Supersedes ABE,K 02 and ABE 04G.
- ⁷ From the fit of the kaon momentum spectrum. Systematic errors not evaluated.
- ⁸ Superseded by DEL-AMO-SANCHEZ 11M.
- ⁹ Superseded by VINOKUROVA 11.
- ¹⁰ Assuming mass of $\psi(2S) = 3686$ MeV.

$\eta_c(2S)$ WIDTH

VALUE (MeV)	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
11.3⁺₋ 3.2 2.9 OUR AVERAGE					
9.9 ± 4.8 ± 2.9		57 ± 17	ABLIKIM	13K BES3	$\psi(2S) \rightarrow$ $\gamma K_S^0 K^\pm \pi^\mp \pi^+ \pi^-$
16.9 ± 6.4 ± 4.8		127 ± 18	¹¹ ABLIKIM	12G BES3	$\psi(2S) \rightarrow \gamma K^0 K \pi,$ $K K \pi^0$
13.4 ± 4.6 ± 3.2		624	¹² DEL-AMO-SA..11M	BABR	$\gamma\gamma \rightarrow K_S^0 K^\pm \pi^\mp$

$6.6^{+8.4+2.6}_{-5.1-0.9}$	128	¹³ VINOKUROVA	11	BELL	$B^{\pm} \rightarrow K^{\pm}(K_S^0 K^{\pm} \pi^{\mp})$
$6.3 \pm 12.4 \pm 4.0$	61	ASNER	04	CLEO	$\gamma\gamma \rightarrow \eta_c \rightarrow K_S^0 K^{\pm} \pi^{\mp}$

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

< 23	90	98 ± 52	¹⁴ AUBERT	06E BABR	$B^{\pm} \rightarrow K^{\pm} X_{c\bar{c}}$
22 ± 14		121 ± 27	AUBERT	05C BABR	$e^+ e^- \rightarrow J/\psi c\bar{c}$
$17.0 \pm 8.3 \pm 2.5$		112 ± 24	¹⁵ AUBERT	04D BABR	$\gamma\gamma \rightarrow \eta_c(2S) \rightarrow K\bar{K}\pi$
<55	90	39 ± 11	¹⁶ CHOI	02 BELL	$B \rightarrow K K_S K^- \pi^+$
<8.0	95		¹⁷ EDWARDS	82C CBAL	$e^+ e^- \rightarrow \gamma X$

¹¹ From a simultaneous fit to $K_S^0 K^{\pm} \pi^{\mp}$ and $K^+ K^- \pi^0$ decay modes.

¹² Ignoring possible interference with continuum.

¹³ Accounts for interference with non-resonant continuum.

¹⁴ From the fit of the kaon momentum spectrum. Systematic errors not evaluated.

¹⁵ Superseded by DEL-AMO-SANCHEZ 11M.

¹⁶ For a mass value of 3654 ± 6 MeV. Superseded by VINOKUROVA 11.

¹⁷ For a mass value of 3594 ± 5 MeV

$\eta_c(2S)$ DECAY MODES

Mode	Fraction (Γ_i/Γ)	Confidence level
Γ_1 hadrons	not seen	
Γ_2 $K\bar{K}\pi$	(1.9 ± 1.2) %	
Γ_3 $K\bar{K}\eta$	(5 ± 4) $\times 10^{-3}$	
Γ_4 $2\pi^+ 2\pi^-$	not seen	
Γ_5 $\rho^0 \rho^0$	not seen	
Γ_6 $3\pi^+ 3\pi^-$	not seen	
Γ_7 $K^+ K^- \pi^+ \pi^-$	not seen	
Γ_8 $K^{*0} \bar{K}^{*0}$	not seen	
Γ_9 $K^+ K^- \pi^+ \pi^- \pi^0$	(1.4 ± 1.0) %	
Γ_{10} $K^+ K^- 2\pi^+ 2\pi^-$	not seen	
Γ_{11} $K_S^0 K^- 2\pi^+ \pi^- + c.c.$	seen	
Γ_{12} $2K^+ 2K^-$	not seen	
Γ_{13} $\phi\phi$	not seen	
Γ_{14} $\rho\bar{\rho}$	< 2.0 $\times 10^{-3}$	90%
Γ_{15} $\gamma\gamma$	(1.9 ± 1.3) $\times 10^{-4}$	
Γ_{16} $\pi^+ \pi^- \eta$	not seen	
Γ_{17} $\pi^+ \pi^- \eta'$	not seen	
Γ_{18} $\pi^+ \pi^- \eta_c(1S)$	< 25 %	90%

$\eta_c(2S)$ PARTIAL WIDTHS

$\Gamma(\gamma\gamma)$ Γ_{15}

VALUE (keV)	DOCUMENT ID	TECN	COMMENT
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• • • We do not use the following data for averages, fits, limits, etc. • • •

1.3±0.6	¹⁸ ASNER	04	CLEO $\gamma\gamma \rightarrow \eta_c \rightarrow K_S^0 K^\pm \pi^\mp$
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¹⁸ They measure $\Gamma(\eta_c(2S)\gamma\gamma) B(\eta_c(2S) \rightarrow K\bar{K}\pi) = (0.18 \pm 0.05 \pm 0.02) \Gamma(\eta_c(1S)\gamma\gamma) B(\eta_c(1S) \rightarrow K\bar{K}\pi)$. The value for $\Gamma(\eta_c(2S) \rightarrow \gamma\gamma)$ is derived assuming that the branching fractions for $\eta_c(2S)$ and $\eta_c(1S)$ decays to $K_S K\pi$ are equal and using $\Gamma(\eta_c(1S) \rightarrow \gamma\gamma) = 7.4 \pm 0.4 \pm 2.3$ keV.

$\eta_c(2S) \Gamma(i)\Gamma(\gamma\gamma)/\Gamma(\text{total})$

$\Gamma(2\pi^+2\pi^-) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ $\Gamma_4\Gamma_{15}/\Gamma$

VALUE (eV)	CL%	DOCUMENT ID	TECN	COMMENT
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<6.5	90	UEHARA	08	BELL $\gamma\gamma \rightarrow \eta_c(2S) \rightarrow 2(\pi^+\pi^-)$
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$\Gamma(K\bar{K}\pi) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ $\Gamma_2\Gamma_{15}/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID	TECN	COMMENT
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41±4±6	624	¹⁹ DEL-AMO-SA..11M	BABR	$\gamma\gamma \rightarrow K_S^0 K^\pm \pi^\mp$
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¹⁹ Not independent from other measurements reported in DEL-AMO-SANCHEZ 11M.

$\Gamma(K^+K^-\pi^+\pi^-) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ $\Gamma_7\Gamma_{15}/\Gamma$

VALUE (eV)	CL%	DOCUMENT ID	TECN	COMMENT
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<5.0	90	UEHARA	08	BELL $\gamma\gamma \rightarrow \eta_c(2S) \rightarrow K^+K^-\pi^+\pi^-$
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$\Gamma(K^+K^-\pi^+\pi^-\pi^0) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ $\Gamma_9\Gamma_{15}/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID	TECN	COMMENT
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30±6±5	1201	²⁰ DEL-AMO-SA..11M	BABR	$\gamma\gamma \rightarrow K^+K^-\pi^+\pi^-\pi^0$
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²⁰ Not independent from other measurements reported in DEL-AMO-SANCHEZ 11M.

$\Gamma(2K^+2K^-) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ $\Gamma_{12}\Gamma_{15}/\Gamma$

VALUE (eV)	CL%	DOCUMENT ID	TECN	COMMENT
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<2.9	90	UEHARA	08	BELL $\gamma\gamma \rightarrow \eta_c(2S) \rightarrow 2(K^+K^-)$
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$\Gamma(\pi^+\pi^-\eta_c(1S)) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ $\Gamma_{18}\Gamma_{15}/\Gamma$

VALUE (eV)	CL%	DOCUMENT ID	TECN	COMMENT
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<133	90	LEES	12AE	BABR $e^+e^- \rightarrow e^+e^-\pi^+\pi^-\eta_c$
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$\eta_c(2S) \Gamma(i)\Gamma(\gamma\gamma)/\Gamma^2(\text{total})$

$\Gamma(p\bar{p})/\Gamma_{\text{total}} \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ $\Gamma_{14}/\Gamma \times \Gamma_{15}/\Gamma$

VALUE (units 10^{-8})	CL%	DOCUMENT ID	TECN	COMMENT
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< 5.6	90 ^{21,22,23}	AMBROGIANI	01	E835 $\bar{p}p \rightarrow \gamma\gamma$
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• • • We do not use the following data for averages, fits, limits, etc. • • •

< 8.0	90 ^{21,22,24}	AMBROGIANI	01	E835 $\bar{p}p \rightarrow \gamma\gamma$
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<12.0	90	22,24	AMBROGIANI	01 E835 $\bar{p}p \rightarrow \gamma\gamma$
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²¹Including the measurements of of ARMSTRONG 95F in the AMBROGIANI 01 analysis.

²²For a total width $\Gamma=5$ MeV.

²³For the resonance mass region 3589–3599 MeV/ c^2 .

²⁴For the resonance mass region 3575–3660 MeV/ c^2 .

$\eta_c(2S)$ BRANCHING RATIOS

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

VALUE	DOCUMENT ID	TECN	COMMENT
not seen	ABREU	98O	DLPH $e^+e^- \rightarrow e^+e^- + \text{hadrons}$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
seen	²⁵ EDWARDS	82C	CBAL $e^+e^- \rightarrow \gamma X$
²⁵ For a mass value of 3594 ± 5 MeV			

$\Gamma(K\bar{K}\pi)/\Gamma_{\text{total}}$ Γ_2/Γ

VALUE (units 10^{-2})	EVTS	DOCUMENT ID	TECN	COMMENT
$1.9 \pm 0.4 \pm 1.1$	59 ± 12	²⁶ AUBERT	08AB	BABR $B \rightarrow \eta_c(2S) K \rightarrow K\bar{K}\pi K$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
seen	127 ± 18	ABLIKIM	13K	BES3 $\psi(2S) \rightarrow \gamma K\bar{K}\pi$
seen	39 ± 11	²⁷ CHOI	02	BELL $B \rightarrow K K_S K^- \pi^+$

²⁶ Derived from a measurement of $[B(B^+ \rightarrow \eta_c(2S) K^+) \times B(\eta_c(2S) \rightarrow K\bar{K}\pi)] / [B(B^+ \rightarrow \eta_c K^+) \times B(\eta_c \rightarrow K\bar{K}\pi)] = (9.6^{+2.0}_{-1.9} \pm 2.5)\%$ and using $B(B^+ \rightarrow \eta_c(2S) K^+) = (3.4 \pm 1.8) \times 10^{-4}$, and $[B(B^+ \rightarrow \eta_c K^+) \times B(\eta_c \rightarrow K\bar{K}\pi)] = (6.88 \pm 0.77^{+0.55}_{-0.66}) \times 10^{-5}$.

²⁷ For a mass value of 3654 ± 6 MeV

$\Gamma(K\bar{K}\eta)/\Gamma(K\bar{K}\pi)$ Γ_3/Γ_2

VALUE (units 10^{-2})	EVTS	DOCUMENT ID	TECN	COMMENT
$27.3 \pm 7.0 \pm 5.7$	225	²⁸ LEES	14E	BABR $\gamma\gamma \rightarrow K^+ K^- \gamma\gamma$

²⁸ LEES 14E reports $B(\eta_c(2S) \rightarrow K^+ K^- \eta)/B(\eta_c(2S) \rightarrow K^+ K^- \pi^0) = 0.82 \pm 0.21 \pm 0.17$, which we divide by 3 to account for isospin symmetry.

$\Gamma(2\pi^+ 2\pi^-)/\Gamma_{\text{total}}$ Γ_4/Γ

VALUE	DOCUMENT ID	TECN	COMMENT
not seen	UEHARA	08	BELL $\gamma\gamma \rightarrow \eta_c(2S)$

$\Gamma(\rho^0 \rho^0)/\Gamma_{\text{total}}$ Γ_5/Γ

VALUE	DOCUMENT ID	TECN	COMMENT
not seen	ABLIKIM	11H	BES3 $\psi(2S) \rightarrow \gamma 2\pi^+ 2\pi^-$

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

VALUE	DOCUMENT ID	TECN	COMMENT
not seen	UEHARA	08	BELL $\gamma\gamma \rightarrow \eta_c(2S)$

$\Gamma(K^+ K^- \pi^+ \pi^- \pi^0)/\Gamma(K \bar{K} \pi)$ Γ_9/Γ_2

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
0.73±0.17±0.17	1201	²⁹ DEL-AMO-SA..11M	BABR	$\gamma\gamma \rightarrow K^+ K^- \pi^+ \pi^- \pi^0$

²⁹ We have multiplied the value of $\Gamma(K^+ K^- \pi^+ \pi^- \pi^0)/\Gamma(K_S^0 K^\pm \pi^\mp)$ reported in DEL-AMO-SANCHEZ 11M by a factor 1/3 to obtain $\Gamma(K^+ K^- \pi^+ \pi^- \pi^0)/\Gamma(K \bar{K} \pi)$. Not independent from other measurements reported in DEL-AMO-SANCHEZ 11M.

$\Gamma(K^*0 \bar{K}^*0)/\Gamma_{total}$ Γ_8/Γ

VALUE	DOCUMENT ID	TECN	COMMENT
not seen	ABLIKIM	11H BES3	$\psi(2S) \rightarrow \gamma K^+ K^- \pi^+ \pi^-$

$\Gamma(K_S^0 K^- 2\pi^+ \pi^- + c.c.)/\Gamma_{total}$ Γ_{11}/Γ

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
seen	57±17	ABLIKIM	13K BES3	$\psi(2S) \rightarrow \gamma K_S^0 K^\pm \pi^\mp \pi^+ \pi^-$

$\Gamma(2K^+ 2K^-)/\Gamma_{total}$ Γ_{12}/Γ

VALUE	DOCUMENT ID	TECN	COMMENT
not seen	UEHARA	08 BELL	$\gamma\gamma \rightarrow \eta_c(2S)$

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

VALUE	DOCUMENT ID	TECN	COMMENT
not seen	ABLIKIM	11H BES3	$\psi(2S) \rightarrow \gamma K^+ K^- K^+ K^-$

$\Gamma(\gamma\gamma)/\Gamma_{total}$ Γ_{15}/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
• • •				We do not use the following data for averages, fits, limits, etc. • • •
<5 × 10 ⁻⁴	90	³⁰ WICHT	08 BELL	$B^\pm \rightarrow K^\pm \gamma\gamma$
not seen		AMBROGIANI	01 E835	$\bar{p}p \rightarrow \gamma\gamma$
<0.01	90	LEE	85 CBAL	$\psi' \rightarrow \text{photons}$

³⁰ WICHT 08 reports $[\Gamma(\eta_c(2S) \rightarrow \gamma\gamma)/\Gamma_{total}] \times [B(B^+ \rightarrow \eta_c(2S) K^+)] < 0.18 \times 10^{-6}$ which we divide by our best value $B(B^+ \rightarrow \eta_c(2S) K^+) = 3.4 \times 10^{-4}$.

$\Gamma(\pi^+ \pi^- \eta_c(1S))/\Gamma(K \bar{K} \pi)$ Γ_{18}/Γ_2

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<3.33	90	³¹ LEES	12AE BABR	$e^+ e^- \rightarrow e^+ e^- \pi^+ \pi^- \eta_c$

³¹ We divided the reported limit by 3 to take into account isospin relations.

$\eta_c(2S)$ CROSS-PARTICLE BRANCHING RATIOS

$\Gamma(\eta_c(2S) \rightarrow 2\pi^+ 2\pi^-)/\Gamma_{total} \times \Gamma(\psi(2S) \rightarrow \gamma\eta_c(2S))/\Gamma_{total}$
 $\Gamma_4/\Gamma \times \Gamma_{132}^{\psi(2S)}/\Gamma\psi(2S)$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<14.6 × 10⁻⁶	90	³² CRONIN-HEN..10	CLEO	$\psi(2S) \rightarrow \gamma 2\pi^+ 2\pi^-$

³² Assuming $\Gamma(\eta_c(2S)) = 14$ MeV. CRONIN-HENNESSY 10 gives the analytic dependence of limits on width.

$$\Gamma(\eta_c(2S) \rightarrow \rho^0 \rho^0) / \Gamma_{\text{total}} \times \Gamma(\psi(2S) \rightarrow \gamma \eta_c(2S)) / \Gamma_{\text{total}}$$

$$\Gamma_5 / \Gamma \times \Gamma_{132}^{\psi(2S)} / \Gamma_{\psi(2S)}$$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<12.7 \times 10^{-7}$	90	ABLIKIM	11H BES3	$\psi(2S) \rightarrow \gamma 2\pi^+ 2\pi^-$

$$\Gamma(\eta_c(2S) \rightarrow 3\pi^+ 3\pi^-) / \Gamma_{\text{total}} \times \Gamma(\psi(2S) \rightarrow \gamma \eta_c(2S)) / \Gamma_{\text{total}}$$

$$\Gamma_6 / \Gamma \times \Gamma_{132}^{\psi(2S)} / \Gamma_{\psi(2S)}$$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<13.2 \times 10^{-6}$	90	33 CRONIN-HEN..10	CLEO	$\psi(2S) \rightarrow \gamma 3\pi^+ 3\pi^-$

³³ Assuming $\Gamma(\eta_c(2S)) = 14$ MeV. CRONIN-HENNESSY 10 gives the analytic dependence of limits on width.

$$\Gamma(\eta_c(2S) \rightarrow K^+ K^- \pi^+ \pi^-) / \Gamma_{\text{total}} \times \Gamma(\psi(2S) \rightarrow \gamma \eta_c(2S)) / \Gamma_{\text{total}}$$

$$\Gamma_7 / \Gamma \times \Gamma_{132}^{\psi(2S)} / \Gamma_{\psi(2S)}$$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<9.6 \times 10^{-6}$	90	34 CRONIN-HEN..10	CLEO	$\psi(2S) \rightarrow \gamma K^+ K^- \pi^+ \pi^-$

³⁴ Assuming $\Gamma(\eta_c(2S)) = 14$ MeV. CRONIN-HENNESSY 10 gives the analytic dependence of limits on width.

$$\Gamma(\eta_c(2S) \rightarrow K^{*0} \bar{K}^{*0}) / \Gamma_{\text{total}} \times \Gamma(\psi(2S) \rightarrow \gamma \eta_c(2S)) / \Gamma_{\text{total}}$$

$$\Gamma_8 / \Gamma \times \Gamma_{132}^{\psi(2S)} / \Gamma_{\psi(2S)}$$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<19.6 \times 10^{-7}$	90	ABLIKIM	11H BES3	$\psi(2S) \rightarrow \gamma K^+ K^- \pi^+ \pi^-$

$$\Gamma(\eta_c(2S) \rightarrow K^+ K^- \pi^+ \pi^- \pi^0) / \Gamma_{\text{total}} \times \Gamma(\psi(2S) \rightarrow \gamma \eta_c(2S)) / \Gamma_{\text{total}}$$

$$\Gamma_9 / \Gamma \times \Gamma_{132}^{\psi(2S)} / \Gamma_{\psi(2S)}$$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<43.0 \times 10^{-6}$	90	35 CRONIN-HEN..10	CLEO	$\psi(2S) \rightarrow \gamma K^+ K^- \pi^+ \pi^- \pi^0$

³⁵ Assuming $\Gamma(\eta_c(2S)) = 14$ MeV. CRONIN-HENNESSY 10 gives the analytic dependence of limits on width.

$$\Gamma(\eta_c(2S) \rightarrow K^+ K^- 2\pi^+ 2\pi^-) / \Gamma_{\text{total}} \times \Gamma(\psi(2S) \rightarrow \gamma \eta_c(2S)) / \Gamma_{\text{total}}$$

$$\Gamma_{10} / \Gamma \times \Gamma_{132}^{\psi(2S)} / \Gamma_{\psi(2S)}$$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<9.7 \times 10^{-6}$	90	36 CRONIN-HEN..10	CLEO	$\psi(2S) \rightarrow \gamma K^+ K^- 2\pi^+ 2\pi^-$

³⁶ Assuming $\Gamma(\eta_c(2S)) = 14$ MeV. CRONIN-HENNESSY 10 gives the analytic dependence of limits on width.

$$\Gamma(\eta_c(2S) \rightarrow K_S^0 K^- 2\pi^+ \pi^- + \text{c.c.}) / \Gamma_{\text{total}} \times \Gamma(\psi(2S) \rightarrow \gamma \eta_c(2S)) / \Gamma_{\text{total}}$$

$$\Gamma_{11} / \Gamma \times \Gamma_{132}^{\psi(2S)} / \Gamma_{\psi(2S)}$$

VALUE (units 10^{-6})	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
$7.03 \pm 2.10 \pm 0.7$	60		ABLIKIM	13K BES3	$\psi(2S) \rightarrow \gamma K_S^0 K^- 2\pi^+ \pi^- + \text{c.c.}$

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

< 15.2	90	37 CRONIN-HEN..10	CLEO	$\psi(2S) \rightarrow \gamma K_S^0 K^- 2\pi^+ \pi^- + \text{c.c.}$
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³⁷ Assuming $\Gamma(\eta_c(2S)) = 14$ MeV. CRONIN-HENNESSY 10 gives the analytic dependence of limits on width.

$$\Gamma(\eta_c(2S) \rightarrow \phi\phi)/\Gamma_{\text{total}} \times \Gamma(\psi(2S) \rightarrow \gamma\eta_c(2S))/\Gamma_{\text{total}} \quad \Gamma_{13}/\Gamma \times \Gamma_{132}^{\psi(2S)}/\Gamma\psi(2S)$$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<7.8 \times 10^{-7}$	90	ABLIKIM	11H BES3	$\psi(2S) \rightarrow \gamma K^+ K^- K^+ K^-$

$$\Gamma(\eta_c(2S) \rightarrow \pi^+\pi^-\eta)/\Gamma_{\text{total}} \times \Gamma(\psi(2S) \rightarrow \gamma\eta_c(2S))/\Gamma_{\text{total}} \quad \Gamma_{16}/\Gamma \times \Gamma_{132}^{\psi(2S)}/\Gamma\psi(2S)$$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<4.3 \times 10^{-6}$	90	³⁸ CRONIN-HEN..10	CLEO	$\psi(2S) \rightarrow \gamma\pi^+\pi^-\eta$

³⁸ Assuming $\Gamma(\eta_c(2S)) = 14$ MeV. CRONIN-HENNESSY 10 gives the analytic dependence of limits on width.

$$\Gamma(\eta_c(2S) \rightarrow \pi^+\pi^-\eta')/\Gamma_{\text{total}} \times \Gamma(\psi(2S) \rightarrow \gamma\eta_c(2S))/\Gamma_{\text{total}} \quad \Gamma_{17}/\Gamma \times \Gamma_{132}^{\psi(2S)}/\Gamma\psi(2S)$$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<14.2 \times 10^{-6}$	90	³⁹ CRONIN-HEN..10	CLEO	$\psi(2S) \rightarrow \gamma\pi^+\pi^-\eta'$

³⁹ Assuming $\Gamma(\eta_c(2S)) = 14$ MeV. CRONIN-HENNESSY 10 gives the analytic dependence of limits on width.

$$\Gamma(\eta_c(2S) \rightarrow K\bar{K}\eta)/\Gamma_{\text{total}} \times \Gamma(\psi(2S) \rightarrow \gamma\eta_c(2S))/\Gamma_{\text{total}} \quad \Gamma_3/\Gamma \times \Gamma_{132}^{\psi(2S)}/\Gamma\psi(2S)$$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<11.8 \times 10^{-6}$	90	⁴⁰ CRONIN-HEN..10	CLEO	$\psi(2S) \rightarrow \gamma K^+ K^- \eta$

• • • We do not use the following data for averages, fits, limits, etc. • • •
⁴⁰ CRONIN-HENNESSY 10 reports a limit of $< 5.9 \times 10^{-6}$ for the decay $\eta_c(2S) \rightarrow K^+ K^- \eta$ which we multiply by 2 account for isospin symmetry. It assumes $\Gamma(\eta_c(2S)) = 14$ MeV. It also gives the analytic dependence of limits on width.

$$\Gamma(\eta_c(2S) \rightarrow \pi^+\pi^-\eta_c(1S))/\Gamma_{\text{total}} \times \Gamma(\psi(2S) \rightarrow \gamma\eta_c(2S))/\Gamma_{\text{total}} \quad \Gamma_{18}/\Gamma \times \Gamma_{132}^{\psi(2S)}/\Gamma\psi(2S)$$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<1.7 \times 10^{-4}$	90	⁴¹ CRONIN-HEN..10	CLEO	$\psi(2S) \rightarrow \gamma\pi^+\pi^-\eta_c(1S)$

⁴¹ Assuming $\Gamma(\eta_c(2S)) = 14$ MeV. CRONIN-HENNESSY 10 gives the analytic dependence of limits on width.

$$\Gamma(\eta_c(2S) \rightarrow p\bar{p})/\Gamma_{\text{total}} \times \Gamma(\psi(2S) \rightarrow \gamma\eta_c(2S))/\Gamma_{\text{total}} \quad \Gamma_{14}/\Gamma \times \Gamma_{132}^{\psi(2S)}/\Gamma\psi(2S)$$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<1.4 \times 10^{-6}$	90	ABLIKIM	13V BES3	$\psi(2S) \rightarrow \gamma p\bar{p}$

$\eta_c(2S)$ REFERENCES

LEES	14E	PR D89 112004	J.P. Lees <i>et al.</i>	(BABAR Collab.)
ABLIKIM	13K	PR D87 052005	M. Ablikim <i>et al.</i>	(BES III Collab.)
ABLIKIM	13V	PR D88 112001	M. Ablikim <i>et al.</i>	(BES III Collab.)
ABLIKIM	12G	PRL 109 042003	M. Ablikim <i>et al.</i>	(BES III Collab.)
LEES	12AE	PR D86 092005	J.P. Lees <i>et al.</i>	(BABAR Collab.)
ABLIKIM	11H	PR D84 091102	M. Ablikim <i>et al.</i>	(BES III Collab.)
DEL-AMO-SA...	11M	PR D84 012004	P. del Amo Sanchez <i>et al.</i>	(BABAR Collab.)
VINOKUROVA	11	PL B706 139	A. Vinokurova <i>et al.</i>	(BELLE Collab.)
CRONIN-HEN...	10	PR D81 052002	D. Cronin-Hennessey <i>et al.</i>	(CLEO Collab.)
AUBERT	08AB	PR D78 012006	B. Aubert <i>et al.</i>	(BABAR Collab.)
UEHARA	08	EPJ C53 1	S. Uehara <i>et al.</i>	(BELLE Collab.)
WICHT	08	PL B662 323	J. Wicht <i>et al.</i>	(BELLE Collab.)
ABE	07	PRL 98 082001	K. Abe <i>et al.</i>	(BELLE Collab.)
AUBERT	06E	PRL 96 052002	B. Aubert <i>et al.</i>	(BABAR Collab.)
AUBERT	05C	PR D72 031101	B. Aubert <i>et al.</i>	(BABAR Collab.)
ABE	04G	PR D70 071102	K. Abe <i>et al.</i>	(BELLE Collab.)
ASNER	04	PRL 92 142001	D.M. Asner <i>et al.</i>	(CLEO Collab.)
AUBERT	04D	PRL 92 142002	B. Aubert <i>et al.</i>	(BABAR Collab.)
ABE,K	02	PRL 89 142001	K. Abe <i>et al.</i>	(BELLE Collab.)
CHOI	02	PRL 89 102001	S.-K. Choi <i>et al.</i>	(BELLE Collab.)
AMBROGIANI	01	PR D64 052003	M. Ambrogiani <i>et al.</i>	(FNAL E835 Collab.)
ABREU	98O	PL B441 479	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ARMSTRONG	95F	PR D52 4839	T.A. Armstrong <i>et al.</i>	(FNAL, FERR, GENO+)
LEE	85	SLAC 282	R.A. Lee	(SLAC)
EDWARDS	82C	PRL 48 70	C. Edwards <i>et al.</i>	(CIT, HARV, PRIN+)
