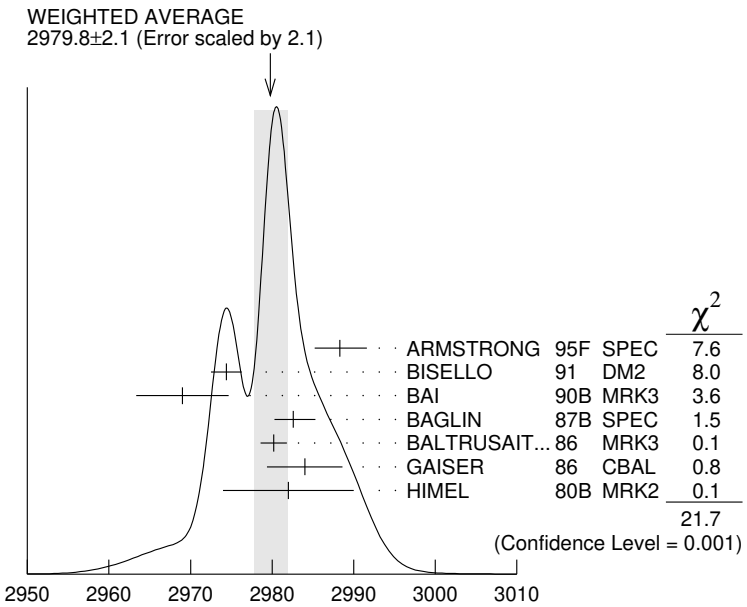
# $\eta_c(1S)$

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

## $\eta_c(1S)$ MASS

| *VALUE* (MeV) | *EVTS* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|---|
| **2979.8± 2.1 OUR AVERAGE** | | Error includes scale factor of 2.1. See the ideogram below. | | | |
| $2988.3^{+3.3}_{-3.1}$ | | ARMSTRONG | 95F | SPEC | $\overline{p}p \to \gamma\gamma$ |
| 2974.4± 1.9 | | [1] BISELLO | 91 | DM2 | $J/\psi \to \eta_c\gamma$ |
| 2969 ± 4 ± 4 | 80 | BAI | 90B | MRK3 | $J/\psi \to \gamma K^+K^-K^+K^-$ |
| $2982.6^{+2.7}_{-2.3}$ | 12 | BAGLIN | 87B | SPEC | $\overline{p}p \to \gamma\gamma$ |
| 2980.2± 1.6 | | [1] BALTRUSAIT...86 | | MRK3 | $J/\psi \to \eta_c\gamma$ |
| 2984 ± 2.3± 4.0 | | GAISER | 86 | CBAL | $J/\psi \to \gamma$X, $\psi(2S) \to \gamma$X |
| 2982 ± 8 | 18 | [2] HIMEL | 80B | MRK2 | $e^+e^-$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 2956 ±12 ±12 | | BAI | 90B | MRK3 | $J/\psi \to \gamma K^+K^-K^0_SK^0_L$ |
| 2976 ± 8 | | [3] BALTRUSAIT...84 | | MRK3 | $J/\psi \to 2\phi\gamma$ |
| 2980 ± 9 | | [2] PARTRIDGE | 80B | CBAL | $e^+e^-$ |

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




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

## $\eta_c(1S)$ WIDTH

| *VALUE* (MeV) | *CL%* | *EVTS* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|---|---|
| **$13.2^{+3.8}_{-3.2}$ OUR AVERAGE** | | | | | | |
| $23.9^{+12.6}_{-7.1}$ | | | ARMSTRONG | 95F | SPEC | $\overline{p}p \rightarrow \gamma\gamma$ |
| $7.0^{+7.5}_{-7.0}$ | | 12 | BAGLIN | 87B | SPEC | $\overline{p}p \rightarrow \gamma\gamma$ |
| $10.1^{+33.0}_{-8.2}$ | | 23 | [4] BALTRUSAIT... | 86 | MRK3 | $J/\psi \rightarrow \gamma p\overline{p}$ |
| $11.5 \pm 4.5$ | | | GAISER | 86 | CBAL | $J/\psi \rightarrow \gamma X$, $\psi(2S) \rightarrow \gamma X$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | | |
| $<40$ | 90 | 18 | HIMEL | 80B | MRK2 | $e^+e^-$ |
| $<20$ | 90 | | PARTRIDGE | 80B | CBAL | $e^+e^-$ |

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

## $\eta_c(1S)$ DECAY MODES

| | Mode | Fraction ($\Gamma_i/\Gamma$) | Confidence level |
|---|---|---|---|
| | **Decays involving hadronic resonances** | | |
| $\Gamma_1$ | $\eta'(958)\pi\pi$ | $(4.1 \pm 1.7)\,\%$ | |
| $\Gamma_2$ | $\rho\rho$ | $(2.6 \pm 0.9)\,\%$ | |
| $\Gamma_3$ | $K^*(892)^0 K^- \pi^+ +$ c.c. | $(2.0 \pm 0.7)\,\%$ | |
| $\Gamma_4$ | $K^*(892)\overline{K}^*(892)$ | $(8.5 \pm 3.1) \times 10^{-3}$ | |
| $\Gamma_5$ | $\phi\phi$ | $(7.1 \pm 2.8) \times 10^{-3}$ | |
| $\Gamma_6$ | $a_0(980)\pi$ | $< 2$ % | 90% |
| $\Gamma_7$ | $a_2(1320)\pi$ | $< 2$ % | 90% |
| $\Gamma_8$ | $K^*(892)\overline{K} +$ c.c. | $< 1.28$ % | 90% |
| $\Gamma_9$ | $f_2(1270)\eta$ | $< 1.1$ % | 90% |
| $\Gamma_{10}$ | $\omega\omega$ | $< 3.1 \times 10^{-3}$ | 90% |
| | **Decays into stable hadrons** | | |
| $\Gamma_{11}$ | $K\overline{K}\pi$ | $(5.5 \pm 1.7)\,\%$ | |
| $\Gamma_{12}$ | $\eta\pi\pi$ | $(4.9 \pm 1.8)\,\%$ | |
| $\Gamma_{13}$ | $\pi^+\pi^- K^+ K^-$ | $(2.0\ ^{+0.7}_{-0.6})\,\%$ | |
| $\Gamma_{14}$ | $2(K^+K^-)$ | $(2.1 \pm 1.2)\,\%$ | |
| $\Gamma_{15}$ | $2(\pi^+\pi^-)$ | $(1.2 \pm 0.4)\,\%$ | |
| $\Gamma_{16}$ | $p\overline{p}$ | $(1.2 \pm 0.4) \times 10^{-3}$ | |
| $\Gamma_{17}$ | $K\overline{K}\eta$ | $< 3.1$ % | 90% |
| $\Gamma_{18}$ | $\pi^+\pi^- p\overline{p}$ | $< 1.2$ % | 90% |
| $\Gamma_{19}$ | $\Lambda\overline{\Lambda}$ | $< 2 \times 10^{-3}$ | 90% |
| | **Radiative decays** | | |
| $\Gamma_{20}$ | $\gamma\gamma$ | $(3.0 \pm 1.2) \times 10^{-4}$ | |

## $\eta_c(1S)$ PARTIAL WIDTHS

### $\Gamma(\gamma\gamma)$ $\Gamma_{20}$

| *VALUE* (keV) | *CL%* | *EVTS* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|---|---|
| **$7.5^{+1.6}_{-1.4}$ OUR AVERAGE** | | | | | | |
| $6.7^{+2.4}_{-1.7} \pm 2.3$ | | | ARMSTRONG | 95F | SPEC | $\overline{p}p \to \gamma\gamma$ |
| $11.3 \pm 4.2$ | | | ALBRECHT | 94H | ARG | $\gamma\gamma$ |
| $8.0 \pm 2.3 \pm 2.4$ | | 17 | ADRIANI | 93N | L3 | $e^+e^- \to e^+e^-\eta_c$ |
| $5.9^{+2.1}_{-1.8} \pm 1.9$ | | | CHEN | 90B | CLEO | $e^+e^- \to e^+e^-\eta_c$ |
| $6.4^{+5.0}_{-3.4}$ | | | AIHARA | 88D | TPC | $e^+e^- \to e^+e^-X$ |
| $28 \pm 15$ | | | [5] BERGER | 86 | PLUT | $\gamma\gamma \to K\overline{K}\pi$ |

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

| | | | | | |
|---|---|---|---|---|---|
| <11 | 90 | BLINOV | 86 | MD1 | $e^+ e^- \to e^+ e^- X$ |

[5] Re-evaluated by AIHARA 88D.

## $\eta_c(1S)$ Γ(i)Γ($\gamma\gamma$)/Γ(total)

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

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

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

## $\eta_c(1S)$ BRANCHING RATIOS

### HADRONIC DECAYS

### $\Gamma(\eta'(958)\pi\pi)/\Gamma_{total}$ — $\Gamma_1/\Gamma$

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

### $\Gamma(\rho\rho)/\Gamma_{total}$ — $\Gamma_2/\Gamma$

| 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 | [7] BISELLO | 91 | DM2 | $J/\psi \to \gamma\rho^0\rho^0$ |
| 23.6±10.6±8.2 | | 32 | [7] BISELLO | 91 | DM2 | $J/\psi \to \gamma\rho^+\rho^-$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | | |
| <140 | 90 | | [7] BALTRUSAIT...86 | | MRK3 | $J/\psi \to \eta_c\gamma$ |

### $\Gamma(K^*(892)^0 K^-\pi^+ + \text{c.c.})/\Gamma_{total}$ — $\Gamma_3/\Gamma$

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

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

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

### $\Gamma(K^*(892)\overline{K} + \text{c.c.})/\Gamma_{total}$ — $\Gamma_8/\Gamma$

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

### $\Gamma(\phi\phi)/\Gamma_{total}$ $\Gamma_5/\Gamma$

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

### $\Gamma(a_0(980)\pi)/\Gamma_{total}$ $\Gamma_6/\Gamma$

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

### $\Gamma(a_2(1320)\pi)/\Gamma_{total}$ $\Gamma_7/\Gamma$

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

### $\Gamma(f_2(1270)\eta)/\Gamma_{total}$ $\Gamma_9/\Gamma$

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

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

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

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

| VALUE | CL% | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|---|
| **0.055 ±0.017 OUR EVALUATION** (Treating systematic errors as correlated.) | | | | | | |
| **0.055 ±0.008 OUR AVERAGE** | | | | | | |
| 0.0690±0.0142±0.0132 | | 33 | [7] BISELLO | 91 | DM2 | $J/\psi \to \gamma K^+ K^- \pi^0$ |
| 0.0543±0.0094±0.0094 | | 68 | [7] BISELLO | 91 | DM2 | $J/\psi \to \gamma K^\pm \pi^\mp K^0_S$ |
| 0.048 ±0.011 | | 95 | [7,9] BALTRUSAIT...86 | | MRK3 | $J/\psi \to \eta_c \gamma$ |
| $0.161\ ^{+0.092}_{-0.073}$ | | | [10] HIMEL | 80B | MRK2 | $\psi(2S) \to \eta_c \gamma$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | | |
| <0.107 | 90 | | [7] PARTRIDGE | 80B | CBAL | $J/\psi \to \eta_c \gamma$ |

### $\Gamma(\eta\pi\pi)/\Gamma_{total}$ — $\Gamma_{12}/\Gamma$

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

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

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

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

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

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

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

### $\Gamma(p\overline{p})/\Gamma_{total}$ — $\Gamma_{16}/\Gamma$

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

### $\Gamma(K\overline{K}\eta)/\Gamma_{total}$ — $\Gamma_{17}/\Gamma$

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

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

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

### $\Gamma(\Lambda\overline{\Lambda})/\Gamma_{total}$ — $\Gamma_{19}/\Gamma$

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

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

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

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

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

[9] Average from $K^+K^-\pi^0$ and $K^\pm K^0$'s$\pi^\mp$ decay channels.

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

## RADIATIVE DECAYS

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

| *VALUE* (units $10^{-4}$) | *CL%* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|---|
| **3.0 ±1.2 OUR AVERAGE** | | | | | |
| $2.80^{+0.67}_{-0.58} \pm 1.0$ | | ARMSTRONG | 95F | SPEC | $\overline{p}p \to \gamma\gamma$ |
| $6\ ^{+4}_{-3} \pm 4$ | | BAGLIN | 87B | SPEC | $\overline{p}p \to \gamma\gamma$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| < 9 | 90 | [7] BISELLO | 91 | DM2 | $J/\psi \to \gamma\gamma\gamma$ |
| <18 | 90 | [11] BLOOM | 83 | CBAL | $J/\psi \to \eta_c\gamma$ |

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

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

| *VALUE* (units $10^{-6}$) | *EVTS* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|---|
| $\mathbf{0.36\ ^{+0.08}_{-0.07}}$ **OUR AVERAGE** | Error includes scale factor of 1.1. | | | | |
| $0.336^{+0.080}_{-0.070}$ | | ARMSTRONG | 95F | SPEC | $\overline{p}p \to \gamma\gamma$ |
| $0.68\ ^{+0.42}_{-0.31}$ | 12 | BAGLIN | 87B | SPEC | $\overline{p}p \to \gamma\gamma$ |

## $\eta_c(1S)$ REFERENCES


| | | | | |
|---|---|---|---|---|
| ARMSTRONG | 95F | PR D52 4839 | +Bettoni+ | (FNAL, FERR, GENO, UCI, NWES+) |
| ALBRECHT | 94H | PL B338 390 | +Hamacher, Hofmann+ | (ARGUS Collab.) |
| ADRIANI | 93N | PL B318 575 | +Aguilar-Benitez, Ahlen+ | (L3 Collab.) |
| BISELLO | 91 | NP B350 1 | +Busetto+ | (DM2 Collab.) |
| BAI | 90B | PRL 65 1309 | +Blaylock+ | (Mark III Collab.) |
| CHEN | 90B | PL B243 169 | +McIlwain+ | (CLEO Collab.) |
| BAGLIN | 89 | PL B231 557 | +Baird, Bassompierre | (R704 Collab.) |
| BEHREND | 89 | ZPHY C42 367 | +Criegee+ | (CELLO Collab.) |
| BRAUNSCH... | 89 | ZPHY C41 533 | Braunschweig, Bock+ | (TASSO Collab.) |
| AIHARA | 88D | PRL 60 2355 | +Alston-Garnjost+ | (TPC Collab.) |
| BAGLIN | 87B | PL B187 191 | +Baird, Bassompierre, Borreani+ | (R704 Collab.) |
| BALTRUSAIT... | 86 | PR D33 629 | Baltrusaitis, Coffman, Hauser+ | (Mark III Collab.) |
| BERGER | 86 | PL 167B 120 | +Genzel, Lackas, Pielorz+ | (PLUTO Collab.) |
| BLINOV | 86 | | +Blinov, Bondar, Bukin+ | (NOVO) |
| Proc. XXIII Int. HEP Conf., Berkeley, CA (1986); World Scientific, Singapore, 1987, ed. S.C. Loken | | | | |
| GAISER | 86 | PR D34 711 | +Bloom, Bulos, Godfrey+ | (Crystal Ball Collab.) |
| ALTHOFF | 85B | ZPHY C29 189 | +Braunschweig, Kirschfink+ | (TASSO Collab.) |
| BALTRUSAIT... | 84 | PRL 52 2126 | Baltrusaitis+ | (CIT, UCSC, ILL, SLAC, WASH) JP |
| BLOOM | 83 | ARNS 33 143 | +Peck | (SLAC, CIT) |
| HIMEL | 80B | PRL 45 1146 | +Trilling, Abrams, Alam+ | (SLAC, LBL, UCB) |
| PARTRIDGE | 80B | PRL 45 1150 | +Peck+ | (CIT, HARV, PRIN, STAN, SLAC) |

## OTHER RELATED PAPERS

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