$\chi_{c2}(1P)$

$I^G(J^{PC}) = 0^+(2^{++})$

$\chi_{c2}(1P)$ MASS

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
3556.18± 0.13 OUR AVERAGE					
3556.4 ± 0.7		BAI	99B	BES	$\psi(2S) \to \gamma X$
3556.15± 0.07±0.12	585	ARMSTRONG	92	E760	$\overline{p}p \to e^+e^-\gamma$
3556.9 ± 0.4 ±0.5	50	BAGLIN	86B	SPEC	$\overline{p}p \to e^+e^-X$
3557.8 ± 0.2 ±4		[1] GAISER	86	CBAL	$\psi(2S) \to \gamma X$
3553.4 ± 2.2	66	[2] LEMOIGNE	82	GOLI	190 π^- Be $\to \gamma 2\mu$
3555.9 ± 0.7		[3] OREGLIA	82	CBAL	$e^+e^- \to J/\psi 2\gamma$
3557 ± 1.5	69	[4] HIMEL	80	MRK2	$e^+e^- \to J/\psi 2\gamma$
3551 ±11	15	BRANDELIK	79B	DASP	$e^+e^- \to J/\psi 2\gamma$
3553 ± 4		[4] BARTEL	78B	CNTR	$e^+e^- \to J/\psi 2\gamma$
3553 ± 4 ±4		[4,5] TANENBAUM	78	MRK1	e^+e^-
3563 ± 7	360	[4] BIDDICK	77	CNTR	$e^+e^- \to \gamma X$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
3543 ±10	4	WHITAKER	76	MRK1	$e^+e^- \to J/\psi 2\gamma$

[1] Using mass of $\psi(2S) = 3686.0$ MeV.
[2] $J/\psi(1S)$ mass constrained to 3097 MeV.
[3] Assuming $\psi(2S)$ mass = 3686 MeV and $J/\psi(1S)$ mass = 3097 MeV.
[4] Mass value shifted by us by amount appropriate for $\psi(2S)$ mass = 3686 MeV and $J/\psi(1S)$ mass = 3097 MeV.
[5] From a simultaneous fit to radiative and hadronic decay channels.

$\chi_{c2}(1P)$ WIDTH

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
2.00±0.18 OUR AVERAGE					
1.98±0.17±0.07	585	ARMSTRONG	92	E760	$\overline{p}p \to e^+e^-\gamma$
$2.6\ ^{+1.4}_{-1.0}$	50	BAGLIN	86B	SPEC	$\overline{p}p \to e^+e^-X$
$2.8\ ^{+2.1}_{-2.0}$		[6] GAISER	86	CBAL	$\psi(2S) \to \gamma X$

[6] Errors correspond to 90% confidence level; authors give only width range.

$\chi_{c2}(1P)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Scale factor/ Confidence level
	Hadronic decays		
Γ_1	$2(\pi^+\pi^-)$	(1.2 ±0.5) %	S=2.2
Γ_2	$\pi^+\pi^- K^+K^-$	(10 ±4) × 10^{-3}	S=2.0
Γ_3	$3(\pi^+\pi^-)$	(9.2 ±2.2) × 10^{-3}	
Γ_4	$\rho^0\pi^+\pi^-$	(7 ±4) × 10^{-3}	
Γ_5	$K^+\overline{K}^*(892)^0\pi^-$ + c.c.	(4.8 ±2.8) × 10^{-3}	
Γ_6	$\pi^+\pi^- p\overline{p}$	(1.4 ±0.6) × 10^{-3}	S=1.5
Γ_7	$\phi\phi$	(2.0 ±0.8) × 10^{-3}	
Γ_8	$\pi^+\pi^-$	(1.52±0.25) × 10^{-3}	
Γ_9	K^+K^-	(8.1 ±1.9) × 10^{-4}	
Γ_{10}	$K^+K^-K^+K^-$	(1.5 ±0.4) × 10^{-3}	
Γ_{11}	$K^0_S K^0_S$	(6.1 ±2.3) × 10^{-4}	
Γ_{12}	$p\overline{p}$	(9.8 ±1.0) × 10^{-5}	
Γ_{13}	$\pi^0\pi^0$		
Γ_{14}	$\eta\eta$		
Γ_{15}	$J/\psi(1S)\pi^+\pi^-\pi^0$	< 1.5 %	CL=90%
Γ_{16}	$K^0_S K^+\pi^-$ + c.c.	< 1.06 × 10^{-3}	CL=90%
	Radiative decays		
Γ_{17}	$\gamma J/\psi(1S)$	(13.5 ±1.1) %	
Γ_{18}	$\gamma\gamma$	(1.42±0.24) × 10^{-4}	

$\chi_{c2}(1P)$ PARTIAL WIDTHS

$\Gamma(p\overline{p})$ Γ_{12}

VALUE (eV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
206±22 OUR AVERAGE					
197±18±16	585	[7] ARMSTRONG	92	E760	$\overline{p}p \to e^+e^-\gamma$
$252^{+55}_{-48}\pm21$		[7] BAGLIN	86B	SPEC	$\overline{p}p \to e^+e^-$X

[7] Restated by us using B($\chi_{c2}(1P) \to J/\psi(1S)\gamma$)B($J/\psi(1S) \to e^+e^-$) = 0.0085 ± 0.0007.

$\Gamma(\gamma\gamma)$ Γ_{18}

VALUE (keV)	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.46 ±0.17 OUR AVERAGE		Error includes scale factor of 1.9. See the ideogram below.			
1.02 ±0.40 ±0.17		[8] ACCIARRI	99E	L3	$e^+e^- \to e^+e^-\chi_{c2}$
1.76 ±0.47 ±0.40		[8,9] ACKER..,K...	98	OPAL	$e^+e^- \to e^+e^-\chi_{c2}$
1.08 ±0.30 ±0.26		DOMINICK	94	CLE2	$e^+e^- \to e^+e^-\chi_{c2}$
0.326±0.080±0.055		[10] ARMSTRONG	93	E760	$\overline{p}p \to \gamma\gamma$
3.4 ±1.7 ±0.9		BAUER	93	TPC	$e^+e^- \to e^+e^-\chi_{c2}$
$2.0\ ^{+0.9}_{-0.7}$ ±0.3		[10] BAGLIN	87B	SPEC	$\overline{p}p \to \gamma\gamma$

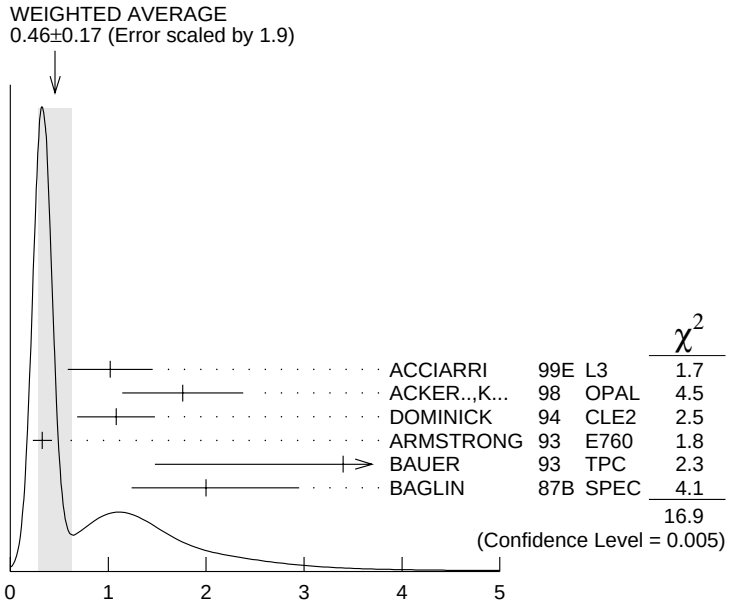
• • • We do not use the following data for averages, fits, limits, etc. • • •

<1.4	95	ACCIARRI	99T	L3	$\gamma\gamma$
<4.2	95	UEHARA	91	VNS	$e^+e^- \rightarrow e^+e^-\chi_{c2}$
<1.0	95	CHEN	90B	CLEO	$e^+e^- \rightarrow e^+e^-\chi_{c2}$
<4.2	95	AIHARA	88D	TPC	$e^+e^- \rightarrow e^+e^-$X

[8] Systematic error includes, added in quadrature, error due to B($\chi_{c2} \rightarrow J/\psi\gamma$) and B($J/\psi \rightarrow \ell^+\ell^-$) uncertainties.

[9] Using B($\chi_{c2} \rightarrow J/\psi\gamma$) = 13.5 ± 1.1% and B($J/\psi \rightarrow \ell^+\ell^-$) = 12.03 ± 0.27%.

[10] Using B($\chi_{c2}(1P) \rightarrow p\overline{p}$) = (0.98 ± 0.10) × 10^{-4} and Γ_{total} = 2.00 ± 0.18 MeV.



$\Gamma(\gamma\gamma)$ Γ_{18}

$\chi_{c2}(1P)$ BRANCHING RATIOS

HADRONIC DECAYS

$\Gamma(2(\pi^+\pi^-))/\Gamma_{\text{total}}$ **Γ_1/Γ**

VALUE	DOCUMENT ID		TECN	COMMENT
0.012 ±0.005 OUR AVERAGE	Error includes scale factor of 2.2.			
0.0096±0.0005±0.0024	[11] BAI	99B	BES	$\psi(2S) \rightarrow \gamma\chi_{c2}$
0.022 ±0.005	[12] TANENBAUM	78	MRK1	$\psi(2S) \rightarrow \gamma\chi_{c2}$

$\Gamma(\pi^+\pi^- K^+K^-)/\Gamma_{\text{total}}$ **Γ_2/Γ**

VALUE	DOCUMENT ID		TECN	COMMENT
0.010 ±0.004 OUR AVERAGE	Error includes scale factor of 2.0.			
0.0079±0.0006±0.0021	[11] BAI	99B	BES	$\psi(2S) \rightarrow \gamma\chi_{c2}$
0.019 ±0.005	[12] TANENBAUM	78	MRK1	$\psi(2S) \rightarrow \gamma\chi_{c2}$

$\Gamma(3(\pi^+\pi^-))/\Gamma_{total}$ Γ_3/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.0092±0.0022 OUR AVERAGE				
0.009 ±0.001 ±0.002	[11] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c2}$
0.012 ±0.008	[12] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c2}$

$\Gamma(\rho^0\pi^+\pi^-)/\Gamma_{total}$ Γ_4/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
68±40	[12] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c2}$

$\Gamma(K^+\overline{K}^*(892)^0\pi^- + \text{c.c.})/\Gamma_{total}$ Γ_5/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
48±28	[12] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c2}$

$\Gamma(\pi^+\pi^- p\overline{p})/\Gamma_{total}$ Γ_6/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
14 ± 6 OUR AVERAGE Error includes scale factor of 1.5.				
12.3± 2.0±3.5	[11] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c2}$
33 ±13	[12] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c2}$

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

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
2.00±0.55±0.61	[11] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c2}$

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

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.52±0.25 OUR AVERAGE					
1.49±0.14±0.22	185±16	[11] BAI	98I	BES	$\psi(2S) \to \gamma\chi_{c2}$
1.9 ±1.0	4	[12] BRANDELIK	79C	DASP	$\psi(2S) \to \gamma\chi_{c2}$

$[\Gamma(\pi^+\pi^-) + \Gamma(K^+K^-)]/\Gamma_{total}$ $(\Gamma_8+\Gamma_9)/\Gamma$

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
24±10	[12] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c2}$

$\Gamma(K^+K^-)/\Gamma_{total}$ Γ_9/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.81±0.19 OUR AVERAGE					
0.79±0.14±0.13	115±13	[11] BAI	98I	BES	$\psi(2S) \to \gamma\chi_{c2}$
1.5 ±1.1	2	[12] BRANDELIK	79C	DASP	$\psi(2S) \to \gamma\chi_{c2}$

$\Gamma(K^+K^-K^+K^-)/\Gamma_{total}$ Γ_{10}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
1.48±0.26±0.32	[11] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c2}$

$\Gamma(K^0_S K^0_S)/\Gamma_{total}$ Γ_{11}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
0.61±0.17±0.16	[11] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c2}$

$\Gamma(p\overline{p})/\Gamma_{total}$ — Γ_{12}/Γ

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.98±0.10 OUR AVERAGE						
0.58±0.31±0.32		4.7 ± 2.5	[11] BAI	98I	BES	$\psi(2S) \to \gamma\chi_{c2}$
1.00±0.11		585	[13] ARMSTRONG	92	E760	$\overline{p}p \to e^+e^-\gamma$
$0.97^{+0.44}_{-0.28}\pm0.08$			BAGLIN	86B	SPEC	$\overline{p}p \to e^+e^-X$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<9.5	90		[12] BRANDELIK	79B	DASP	$\psi(2S) \to \gamma\chi_{c2}$

$\Gamma_i\Gamma_f/\Gamma^2_{total}$ in $p\overline{p} \to \chi_{c2}(1P) \to \gamma\gamma$ — $\Gamma_{12}\Gamma_{18}/\Gamma^2$

VALUE (units 10^{-7})	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.160±0.039±0.016		ARMSTRONG	93	E760	$\overline{p}p \to \gamma\gamma$
$0.99\ ^{+0.46}_{-0.35}$	6	[14] BAGLIN	87B	SPEC	$\overline{p}p \to \gamma\gamma$

$\Gamma(\pi^0\pi^0)/\Gamma_{total}$ — Γ_{13}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1.1±0.2±0.2	[11] LEE	85	CBAL	$\psi' \to$ photons

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

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
7.9±4.1±2.4	[11] LEE	85	CBAL	$\psi' \to$ photons

$\Gamma(J/\psi(1S)\pi^+\pi^-\pi^0)/\Gamma_{total}$ — Γ_{15}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.015	90	BARATE	81	SPEC	190 GeV π^- Be → $2\pi 2\mu$

$\Gamma(K^0_S K^+\pi^- + \text{c.c.})/\Gamma_{total}$ — Γ_{16}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<1.06	90	[11] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c2}$

[11] Calculated using $B(\psi(2S) \to \gamma\chi_{c2}(1P)) = 0.078 \pm 0.008$.

[12] Estimated using $B(\psi(2S) \to \gamma\chi_{c2}(1P)) = 0.078$; the errors do not contain the uncertainty in the $\psi(2S)$ decay.

[13] Restated by us using $B(\chi_{c2}(1P) \to J/\psi(1S)\gamma)B(J/\psi(1S) \to e^+e^-) = 0.0085 \pm 0.0007$.

[14] Assuming isotropic $\chi_{c2}(1P) \to \gamma\gamma$ distribution.

RADIATIVE DECAYS

$\Gamma(\gamma J/\psi(1S))/\Gamma_{total}$ Γ_{17}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.135±0.011 OUR AVERAGE					
0.124±0.015		GAISER	86	CBAL	$\psi(2S) \rightarrow \gamma X$
0.162±0.028	479	[15] OREGLIA	82	CBAL	$\psi(2S) \rightarrow \gamma\chi_{c2}$
0.14 ±0.04		[15] HIMEL	80	MRK2	$\psi(2S) \rightarrow \gamma\chi_{c2}$
0.18 ±0.05		[15] BRANDELIK	79B	DASP	$\psi(2S) \rightarrow \gamma\chi_{c2}$
0.13 ±0.03		[15] BARTEL	78B	CNTR	$\psi(2S) \rightarrow \gamma\chi_{c2}$
0.13 ±0.08		[15] TANENBAUM	78	MRK1	$\psi(2S) \rightarrow \gamma\chi_{c2}$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.28 ±0.13		[15] BIDDICK	77	CNTR	$\psi(2S) \rightarrow \gamma X$

[15] Estimated using $B(\psi(2S) \rightarrow \gamma\chi_{c2}(1P)) = 0.078$; the errors do not contain the uncertainty in the $\psi(2S)$ decay.

$\Gamma(\gamma\gamma)/\Gamma_{total}$ Γ_{18}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
1.42±0.24 OUR AVERAGE				
1.35±0.25±0.12	[16] AMBROGIANI	00B	E835	$\overline{p}p \rightarrow \gamma\gamma$
1.60±0.39±0.23	[17] ARMSTRONG	93	E760	$\overline{p}p \rightarrow \gamma\gamma$

[16] Estimated using $B(\chi_{c2} \rightarrow \gamma J/\psi \rightarrow \gamma e^+ e^-) = (0.81 \pm 0.07) \times 10^{-2}$.

[17] Using $B(\chi_{c2}(1P) \rightarrow p\overline{p}) = (1.00 \pm 0.23) \times 10^{-4}$.

$\chi_{c2}(1P)$ REFERENCES

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ACCIARRI	99E	PL B453 73	M. Acciarri *et al.*	(L3 Collab.)
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BAI	99B	PR D60 072001	J.Z. Bai *et al.*	(BES Collab.)
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ARMSTRONG	93	PRL 70 2988	T.A. Armstrong *et al.*	(FNAL E760 Collab.)
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ARMSTRONG	92	NP B373 35	T.A. Armstrong *et al.*	(FNAL, FERR, GENO+)
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UEHARA	91	PL B266 188	S. Uehara *et al.*	(VENUS Collab.)
CHEN	90B	PL B243 169	W.Y. Chen *et al.*	(CLEO Collab.)
AIHARA	88D	PRL 60 2355	H. Aihara *et al.*	(TPC Collab.)
BAGLIN	87B	PL B187 191	C. Baglin *et al.*	(R704 Collab.)
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LEE	85	SLAC 282	R.A. Lee	(SLAC)
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OREGLIA	82	PR D25 2259	M.J. Oreglia *et al.*	(SLAC, CIT, HARV+)
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BARATE	81	PR D24 2994	R. Barate *et al.*	(SACL, LOIC, SHMP, CERN+)
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