

$\chi_{c2}(1P)$

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

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

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

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	$\bar{p}p \rightarrow e^+ e^- \gamma$
2.6 ^{+1.4} _{-1.0}	50	BAGLIN	86B SPEC	$\bar{p}p \rightarrow e^+ e^- X$
2.8 ^{+2.1} _{-2.0}		⁶ GAISER	86 CBAL	$\psi(2S) \rightarrow \gamma X$

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 \pm 0.5) %	S=2.2
Γ_2 $\pi^+\pi^-K^+K^-$	(10 \pm 4) $\times 10^{-3}$	S=2.0
Γ_3 $3(\pi^+\pi^-)$	(9.2 \pm 2.2) $\times 10^{-3}$	
Γ_4 $\rho^0\pi^+\pi^-$	(7 \pm 4) $\times 10^{-3}$	
Γ_5 $K^+\overline{K}^*(892)^0\pi^- + c.c.$	(4.8 \pm 2.8) $\times 10^{-3}$	
Γ_6 $\pi^+\pi^-p\overline{p}$	(1.4 \pm 0.6) $\times 10^{-3}$	S=1.5
Γ_7 $\phi\phi$	(2.0 \pm 0.8) $\times 10^{-3}$	
Γ_8 $\pi^+\pi^-$	(1.52 \pm 0.25) $\times 10^{-3}$	
Γ_9 K^+K^-	(8.1 \pm 1.9) $\times 10^{-4}$	
Γ_{10} $K^+K^-K^+K^-$	(1.5 \pm 0.4) $\times 10^{-3}$	
Γ_{11} $K_S^0K_S^0$	(6.1 \pm 2.3) $\times 10^{-4}$	
Γ_{12} $p\overline{p}$	(9.8 \pm 1.0) $\times 10^{-5}$	
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} $K_S^0K^+\pi^-\pi^0 + c.c.$	< 1.06 $\times 10^{-3}$	CL=90%
Radiative decays		
Γ_{17} $\gamma J/\psi(1S)$	(13.5 \pm 1.1) %	
Γ_{18} $\gamma\gamma$	(1.6 \pm 0.5) $\times 10^{-4}$	

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

$\Gamma(p\overline{p})$					Γ_{12}
VALUE (eV)	EVTS	DOCUMENT ID	TECN	COMMENT	
206 \pm 22 OUR AVERAGE					
197 \pm 18 \pm 16	585	⁷ ARMSTRONG 92	E760	$\overline{p}p \rightarrow e^+e^-\gamma$	
252 $^{+55}_{-48}$ \pm 21		⁷ BAGLIN	86B SPEC	$\overline{p}p \rightarrow e^+e^-X$	
⁷ Restated by us using $B(\chi_{c2}(1P) \rightarrow J/\psi(1S)\gamma)B(J/\psi(1S) \rightarrow e^+e^-) = 0.0085 \pm 0.0007$.					
$\Gamma(\gamma\gamma)$					Γ_{18}
VALUE (keV)	CL%	DOCUMENT ID	TECN	COMMENT	
0.46 \pm 0.17 OUR AVERAGE					
Error includes scale factor of 1.9. See the ideogram below.					
1.02 \pm 0.40 \pm 0.17		⁸ ACCIARRI	99E L3	$e^+e^- \rightarrow e^+e^-\chi_{c2}$	
1.76 \pm 0.47 \pm 0.40		^{8,9} ACKER...,K...	98 OPAL	$e^+e^- \rightarrow e^+e^-\chi_{c2}$	
1.08 \pm 0.30 \pm 0.26		DOMINICK	94 CLE2	$e^+e^- \rightarrow e^+e^-\chi_{c2}$	
0.326 \pm 0.080 \pm 0.055		¹⁰ ARMSTRONG	93 E760	$\overline{p}p \rightarrow \gamma\gamma$	
3.4 \pm 1.7 \pm 0.9		BAUER	93 TPC	$e^+e^- \rightarrow e^+e^-\chi_{c2}$	
2.0 $^{+0.9}_{-0.7}$ \pm 0.3		¹⁰ BAGLIN	87B SPEC	$\overline{p}p \rightarrow \gamma\gamma$	

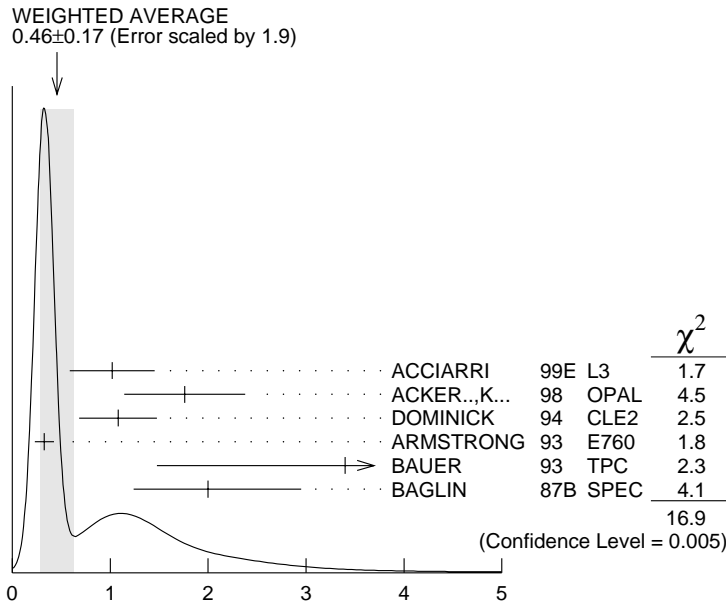
• • • We do not use the following data for averages, fits, limits, etc. • • •

<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 $B(\chi_{c2} \rightarrow J/\psi\gamma) = 13.5 \pm 1.1\%$ and $B(J/\psi \rightarrow \ell^+\ell^-) = 12.03 \pm 0.27\%$.

¹⁰ Using $B(\chi_{c2}(1P) \rightarrow p\bar{p}) = (0.98 \pm 0.10) \times 10^{-4}$ and $\Gamma_{\text{total}} = 2.00 \pm 0.18 \text{ MeV}$.



$\Gamma(\gamma\gamma)$

Γ_{18}

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

HADRONIC DECAYS

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

Γ_1/Γ

VALUE
0.012 ± 0.005 OUR AVERAGE

DOCUMENT ID TECN COMMENT
Error includes scale factor of 2.2.

0.0096 ± 0.0005 ± 0.0024
0.022 ± 0.005

¹¹ BAI 99B BES $\psi(2S) \rightarrow \gamma\chi_{c2}$
¹² TANENBAUM 78 MRK1 $\psi(2S) \rightarrow \gamma\chi_{c2}$

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

Γ_2/Γ

VALUE
0.010 ± 0.004 OUR AVERAGE

DOCUMENT ID TECN COMMENT
Error includes scale factor of 2.0.

0.0079 ± 0.0006 ± 0.0021
0.019 ± 0.005

¹¹ BAI 99B BES $\psi(2S) \rightarrow \gamma\chi_{c2}$
¹² TANENBAUM 78 MRK1 $\psi(2S) \rightarrow \gamma\chi_{c2}$

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

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

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

<u>VALUE (units 10⁻⁴)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
68 ± 40	12 TANENBAUM	78 MRK1	$\psi(2S) \rightarrow \gamma \chi_{c2}$

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

<u>VALUE (units 10⁻⁴)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
48 ± 28	12 TANENBAUM	78 MRK1	$\psi(2S) \rightarrow \gamma \chi_{c2}$

$\Gamma(\pi^+ \pi^- \rho \bar{\rho})/\Gamma_{\text{total}}$ Γ_6/Γ

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

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

<u>VALUE (units 10⁻³)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
2.00 ± 0.55 ± 0.61	11 BAI	99B BES	$\psi(2S) \rightarrow \gamma \chi_{c2}$

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

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

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

<u>VALUE (units 10⁻⁴)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
24 ± 10	12 TANENBAUM	78 MRK1	$\psi(2S) \rightarrow \gamma \chi_{c2}$

$\Gamma(K^+ K^-)/\Gamma_{\text{total}}$ Γ_9/Γ

<u>VALUE (units 10⁻³)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.81 ± 0.19 OUR AVERAGE				
0.79 ± 0.14 ± 0.13	115 ± 13	11 BAI	98I BES	$\psi(2S) \rightarrow \gamma \chi_{c2}$
1.5 ± 1.1	2	12 BRANDELIK	79C DASP	$\psi(2S) \rightarrow \gamma \chi_{c2}$

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

<u>VALUE (units 10⁻³)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1.48 ± 0.26 ± 0.32	11 BAI	99B BES	$\psi(2S) \rightarrow \gamma \chi_{c2}$

$\Gamma(K_S^0 K_S^0)/\Gamma_{\text{total}}$ Γ_{11}/Γ

<u>VALUE (units 10⁻³)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.61 ± 0.17 ± 0.16	11 BAI	99B BES	$\psi(2S) \rightarrow \gamma \chi_{c2}$

$\Gamma(\rho\bar{\rho})/\Gamma_{\text{total}}$ Γ_{12}/Γ

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
0.98 ± 0.10 OUR AVERAGE					
$0.58 \pm 0.31 \pm 0.32$		4.7 ± 2.5	¹¹ BAI	98I BES	$\psi(2S) \rightarrow \gamma\chi_{c2}$
1.00 ± 0.11		585	¹³ ARMSTRONG	92 E760	$\bar{p}p \rightarrow e^+e^-\gamma$
$0.97^{+0.44}_{-0.28} \pm 0.08$			BAGLIN	86B SPEC	$\bar{p}p \rightarrow e^+e^-X$

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

<9.5	90		¹² BRANDELIK	79B DASP	$\psi(2S) \rightarrow \gamma\chi_{c2}$
------	----	--	-------------------------	----------	--

$\Gamma_i\Gamma_f/\Gamma_{\text{total}}^2$ in $p\bar{p} \rightarrow \chi_{c2}(1P) \rightarrow \gamma\gamma$ $\Gamma_{12}\Gamma_{18}/\Gamma^2$

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

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

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

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

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

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

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<0.015	90	BARATE	81 SPEC	190 GeV $\pi^- \text{Be} \rightarrow 2\pi 2\mu$

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

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

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

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

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

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

RADIATIVE DECAYS

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

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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.

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

<u>VALUE (units 10^{-4})</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1.60 ± 0.39 ± 0.23			
	¹⁶ ARMSTRONG	93 E760	$\bar{p}p \rightarrow \gamma\gamma$

¹⁶ Using $B(\chi_{c2}(1P) \rightarrow p\bar{p}) = (1.00 \pm 0.23) \times 10^{-4}$.

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

ACCIARRI	99E PL B453 73	M. Acciarri <i>et al.</i>	(L3 Collab.)
ACCIARRI	99T PL B461 155	M. Acciarri <i>et al.</i>	(L3 Collab.)
BAI	99B PR D60 072001	J.Z. Bai <i>et al.</i>	(BES Collab.)
ACKER...K...	98 PL B439 197	K. Ackerstaff <i>et al.</i>	(OPAL Collab.)
BAI	98 PL B439 197	J.Z. Bai <i>et al.</i>	(BES Collab.)
DOMINICK	94 PR D50 4265	J. Dominick <i>et al.</i>	(CLEO Collab.)
ARMSTRONG	93 PRL 70 2988	T.A. Armstrong <i>et al.</i>	(FNAL E760 Collab.)
BAUER	93 PL B302 345	D.A. Bauer <i>et al.</i>	(TPC Collab.)
ARMSTRONG	92 NP B373 35	T.A. Armstrong <i>et al.</i>	(FNAL, FERR, GENO+)
Also	92B PRL 68 1468	T.A. Armstrong <i>et al.</i>	(FNAL, FERR, GENO+)
UEHARA	91 PL B266 188	S. Uehara <i>et al.</i>	(VENUS Collab.)
CHEN	90B PL B243 169	W.Y. Chen <i>et al.</i>	(CLEO Collab.)
AIHARA	88D PRL 60 2355	H. Aihara <i>et al.</i>	(TPC Collab.)
BAGLIN	87B PL B187 191	C. Baglin <i>et al.</i>	(R704 Collab.)
BAGLIN	86B PL B172 455	C. Baglin	(LAPP, CERN, GENO, LYON, OSLO+)
GAISER	86 PR D34 711	J. Gaiser <i>et al.</i>	(Crystal Ball Collab.)
LEE	85 SLAC 282	R.A. Lee	(SLAC)
LEMOIGNE	82 PL 113B 509	Y. Lemoigne <i>et al.</i>	(SACL, LOIC, SHMP+)
OREGLIA	82 PR D25 2259	M.J. Oreglia <i>et al.</i>	(SLAC, CIT, HARV+)
Also	82B Private Comm.	M.J. Oreglia	(EFI)
BARATE	81 PR D24 2994	R. Barate <i>et al.</i>	(SACL, LOIC, SHMP, CERN+)
HIMEL	80 PRL 44 920	T. Himel <i>et al.</i>	(LBL, SLAC)
Also	82 Private Comm.	G. Trilling	(LBL, UCB)
BRANDELIK	79B NP B160 426	R. Brandelik <i>et al.</i>	(DASP Collab.)
BRANDELIK	79C ZPHY C1 233	R. Brandelik <i>et al.</i>	(DASP Collab.)
BARTEL	78B PL 79B 492	W. Bartel <i>et al.</i>	(DESY, HEIDP)
TANENBAUM	78 PR D17 1731	W.M. Tanenbaum <i>et al.</i>	(SLAC, LBL)
Also	82 Private Comm.	G. Trilling	(LBL, UCB)
BIDDICK	77 PRL 38 1324	C.J. Biddick <i>et al.</i>	(UCSD, UMD, PAVI+)
WHITAKER	76 PRL 37 1596	J.S. Whitaker <i>et al.</i>	(SLAC, LBL)

————— **OTHER RELATED PAPERS** —————

BARATE	83	PL 121B 449	R. Barate <i>et al.</i>	(SACL, LOIC, SHMP, IND)
FELDMAN	75B	PRL 35 821	G.J. Feldman <i>et al.</i>	(LBL, SLAC)
Also	75C	PRL 35 1189	G.J. Feldman	
Erratum.				
TANENBAUM	75	PRL 35 1323	W.M. Tanenbaum <i>et al.</i>	(LBL, SLAC)
