$J/\psi(1S)$ – THIS IS PART 2 OF 2

To reduce the size of this section's PostScript file, we have divided it into two PostScript files. We present the following index:

PART 1

Page #	Section name
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1	Width
1	Decay modes
5	Partial widths
6	Branching ratios
7	Decays involving hadronic resonances

PART 2

Page #	Section name
	Branching ratios (continued)
15	Decays involving hadronic resonances (cont.)
15	Decays into stable hadrons
20	Radiative decays
27	References

<0.068	90	COFFMAN	88	MRK3	$e^+ e^- \to K^+ K^- \pi^0$

$\Gamma(2(\pi^+\pi^-)\pi^0)/\Gamma_{total}$ **Γ_{61}/Γ**

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.0337±0.0026 OUR AVERAGE					
0.0325±0.0049	46055	AUGUSTIN	89	DM2	$J/\psi \to 2(\pi^+\pi^-)\pi^0$
0.0317±0.0042	147	FRANKLIN	83	MRK2	$e^+e^- \to$ hadrons
0.0364±0.0052	1500	BURMESTER	77D	PLUT	e^+e^-
0.04 ±0.01	675	JEAN-MARIE	76	MRK1	e^+e^-

$\Gamma(3(\pi^+\pi^-)\pi^0)/\Gamma_{total}$ **Γ_{62}/Γ**

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.029±0.006 OUR AVERAGE					
0.028±0.009	11	FRANKLIN	83	MRK2	$e^+e^- \to$ hadrons
0.029±0.007	181	JEAN-MARIE	76	MRK1	e^+e^-

$\Gamma(\pi^+\pi^-\pi^0)/\Gamma_{total}$ **Γ_{63}/Γ**

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.015 ±0.002	168	FRANKLIN	83	MRK2	e^+e^-

$\Gamma(\pi^+\pi^-\pi^0 K^+ K^-)/\Gamma_{total}$ **Γ_{64}/Γ**

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.012 ±0.003	309	VANNUCCI	77	MRK1	e^+e^-

$\Gamma(4(\pi^+\pi^-)\pi^0)/\Gamma_{total}$ **Γ_{65}/Γ**

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
90±30	13	JEAN-MARIE	76	MRK1	e^+e^-

$\Gamma(\pi^+\pi^- K^+ K^-)/\Gamma_{total}$ **Γ_{66}/Γ**

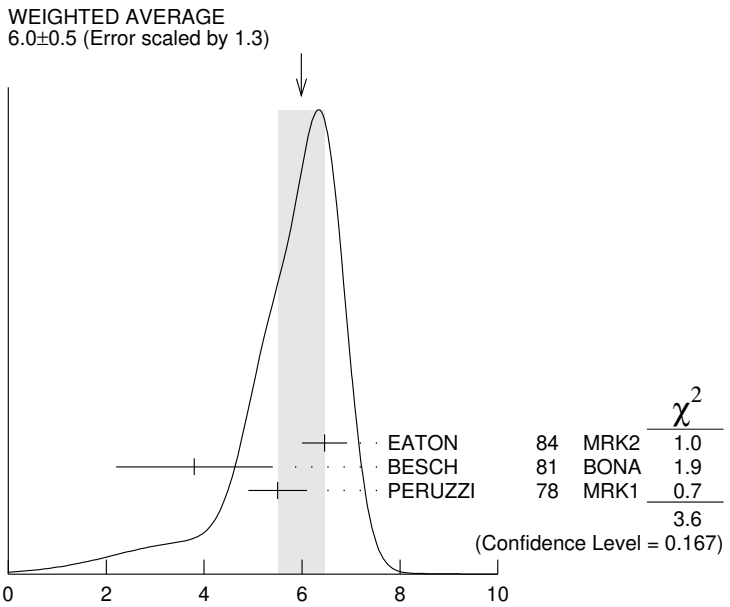
VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
72±23	205	VANNUCCI	77	MRK1	e^+e^-

$\Gamma(K\overline{K}\pi)/\Gamma_{total}$ **Γ_{67}/Γ**

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
61 ±10 OUR AVERAGE					
55.2±12.0	25	FRANKLIN	83	MRK2	$e^+e^- \to K^+K^-\pi^0$
78.0±21.0	126	VANNUCCI	77	MRK1	$e^+e^- \to K^0_S K^\pm \pi^\mp$

$\Gamma(p\overline{p}\pi^+\pi^-)/\Gamma_{total}$ **Γ_{68}/Γ**

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
6.0 ±0.5 OUR AVERAGE Error includes scale factor of 1.3. See the ideogram below.					
6.46±0.17±0.43	1435	EATON	84	MRK2	e^+e^-
3.8 ±1.6	48	BESCH	81	BONA	e^+e^-
5.5 ±0.6	533	PERUZZI	78	MRK1	e^+e^-



$\Gamma\left(p\overline{p}\pi^+\pi^-\right)/\Gamma_{\text{total}}$ (units 10^{-3})

$\Gamma\left(2(\pi^+\pi^-)\right)/\Gamma_{\text{total}}$ **Γ_{69}/Γ**

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.004 ±0.001	76	JEAN-MARIE	76	MRK1	e^+e^-

$\Gamma\left(3(\pi^+\pi^-)\right)/\Gamma_{\text{total}}$ **Γ_{70}/Γ**

VALUE (units 10^{-4})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
40±20	32	JEAN-MARIE	76	MRK1	e^+e^-

$\Gamma\left(n\overline{n}\pi^+\pi^-\right)/\Gamma_{\text{total}}$ **Γ_{71}/Γ**

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
3.8±3.6	5	BESCH	81	BONA	e^+e^-

$\Gamma\left(\Sigma^0\overline{\Sigma}^0\right)/\Gamma_{\text{total}}$ **Γ_{72}/Γ**

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1.27±0.17 OUR AVERAGE					
1.06±0.04±0.23	884±30	PALLIN	87	DM2	$e^+e^- \to \Sigma^0\overline{\Sigma}^0$
1.58±0.16±0.25	90	EATON	84	MRK2	$e^+e^- \to \Sigma^0\overline{\Sigma}^0$
1.3 ±0.4	52	PERUZZI	78	MRK1	$e^+e^- \to \Sigma^0\overline{\Sigma}^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.4 ±2.6	3	BESCH	81	BONA	$e^+e^- \to \Sigma^+\overline{\Sigma}^-$

$\Gamma\left(2(\pi^+\pi^-)K^+K^-\right)/\Gamma_{\text{total}}$ **Γ_{73}/Γ**

VALUE (units 10^{-4})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
31±13	30	VANNUCCI	77	MRK1	e^+e^-

$\Gamma(p\overline{p}\pi^+\pi^-\pi^0)/\Gamma_{total}$ Γ_{74}/Γ

Including $p\overline{p}\pi^+\pi^-\gamma$ and excluding ω, η, η'

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
2.3 ±0.9 OUR AVERAGE	Error includes scale factor of 1.9.				
3.36±0.65±0.28	364	EATON	84	MRK2	e^+e^-
1.6 ±0.6	39	PERUZZI	78	MRK1	e^+e^-

$\Gamma(p\overline{p})/\Gamma_{total}$ Γ_{75}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
2.14±0.10 OUR AVERAGE					
2.0 ±0.3	48	ANTONELLI	93	SPEC	e^+e^-
1.91±0.04±0.30		PALLIN	87	DM2	e^+e^-
2.16±0.07±0.15	1420	EATON	84	MRK2	e^+e^-
2.5 ±0.4	133	BRANDELIK	79C	DASP	e^+e^-
2.0 ±0.5		BESCH	78	BONA	e^+e^-
2.2 ±0.2	331	[23] PERUZZI	78	MRK1	e^+e^-

[23] Assuming angular distribution $(1+\cos^2\theta)$.

$\Gamma(p\overline{p}\eta)/\Gamma_{total}$ Γ_{76}/Γ

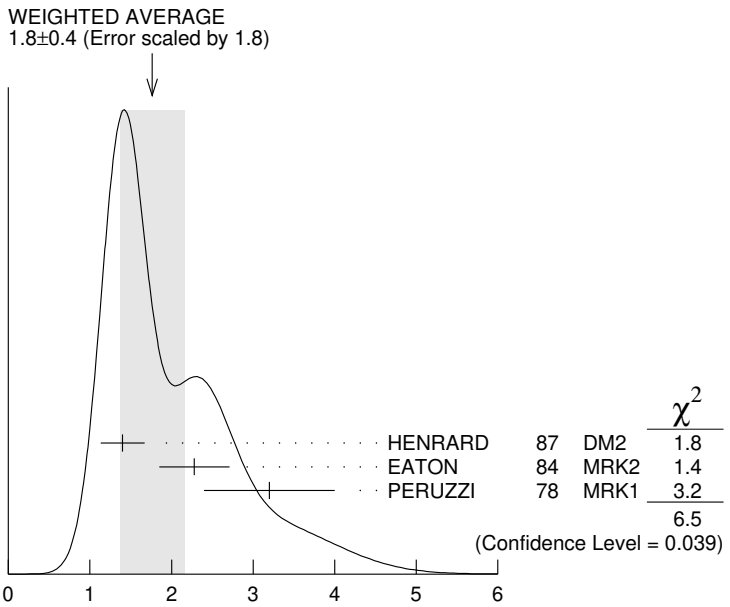
VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
2.09±0.18 OUR AVERAGE					
2.03±0.13±0.15	826	EATON	84	MRK2	e^+e^-
2.5 ±1.2		BRANDELIK	79C	DASP	e^+e^-
2.3 ±0.4	197	PERUZZI	78	MRK1	e^+e^-

$\Gamma(p\overline{n}\pi^-)/\Gamma_{total}$ Γ_{77}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
2.00±0.10 OUR AVERAGE					
2.02±0.07±0.16	1288	EATON	84	MRK2	$e^+e^- \to p\pi^-$
1.93±0.07±0.16	1191	EATON	84	MRK2	$e^+e^- \to \overline{p}\pi^+$
1.7 ±0.7	32	BESCH	81	BONA	$e^+e^- \to p\pi^-$
1.6 ±1.2	5	BESCH	81	BONA	$e^+e^- \to \overline{p}\pi^+$
2.16±0.29	194	PERUZZI	78	MRK1	$e^+e^- \to p\pi^-$
2.04±0.27	204	PERUZZI	78	MRK1	$e^+e^- \to \overline{p}\pi^+$

$\Gamma(\Xi\overline{\Xi})/\Gamma_{total}$ Γ_{79}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.8 ±0.4 OUR AVERAGE	Error includes scale factor of 1.8. See the ideogram below.				
1.40±0.12±0.24	132±11	HENRARD	87	DM2	$e^+e^- \to \Xi^-\overline{\Xi}^+$
2.28±0.16±0.40	194	EATON	84	MRK2	$e^+e^- \to \Xi^-\overline{\Xi}^+$
3.2 ±0.8	71	PERUZZI	78	MRK1	e^+e^-



$\Gamma\left(\Xi\overline{\Xi}\right)/\Gamma_{\text{total}}$ (units 10^{-3})

$\Gamma\left(n\overline{n}\right)/\Gamma_{\text{total}}$ **Γ_{78}/Γ**

VALUE (units 10^{-2})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.19 ±0.05 OUR AVERAGE					
0.190±0.055	40	ANTONELLI	93	SPEC	e^+e^-
0.18 ±0.09		BESCH	78	BONA	e^+e^-

$\Gamma\left(\Lambda\overline{\Lambda}\right)/\Gamma_{\text{total}}$ **Γ_{80}/Γ**

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1.35±0.14 OUR AVERAGE Error includes scale factor of 1.2.					
1.38±0.05±0.20	1847	PALLIN	87	DM2	e^+e^-
1.58±0.08±0.19	365	EATON	84	MRK2	e^+e^-
2.6 ±1.6	5	BESCH	81	BONA	e^+e^-
1.1 ±0.2	196	PERUZZI	78	MRK1	e^+e^-

$\Gamma\left(p\overline{p}\pi^0\right)/\Gamma_{\text{total}}$ **Γ_{81}/Γ**

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1.09±0.09 OUR AVERAGE					
1.13±0.09±0.09	685	EATON	84	MRK2	e^+e^-
1.4 ±0.4		BRANDELIK	79C	DASP	e^+e^-
1.00±0.15	109	PERUZZI	78	MRK1	e^+e^-

$\Gamma(\Lambda\overline{\Sigma}^-\pi^+ \text{(or c.c.)})/\Gamma_{total}$ Γ_{82}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.06±0.12 OUR AVERAGE					
0.90±0.06±0.16	225±15	HENRARD	87	DM2	$e^+e^- \to \Lambda\overline{\Sigma}^+\pi^-$
1.11±0.06±0.20	342±18	HENRARD	87	DM2	$e^+e^- \to \Lambda\overline{\Sigma}^-\pi^+$
1.53±0.17±0.38	135	EATON	84	MRK2	$e^+e^- \to \Lambda\overline{\Sigma}^+\pi^-$
1.38±0.21±0.35	118	EATON	84	MRK2	$e^+e^- \to \Lambda\overline{\Sigma}^-\pi^+$

$\Gamma(pK^-\overline{\Lambda})/\Gamma_{total}$ Γ_{83}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.89±0.07±0.14	307	EATON	84	MRK2	e^+e^-

$\Gamma(2(K^+K^-))/\Gamma_{total}$ Γ_{84}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
7 ±3	VANNUCCI	77	MRK1	e^+e^-

$\Gamma(pK^-\overline{\Sigma}^0)/\Gamma_{total}$ Γ_{85}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.29±0.06±0.05	90	EATON	84	MRK2	e^+e^-

$\Gamma(K^+K^-)/\Gamma_{total}$ Γ_{86}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
2.37±0.31 OUR AVERAGE					
2.39±0.24±0.22	107	BALTRUSAIT...85D		MRK3	e^+e^-
2.2 ±0.9	6	BRANDELIK	79C	DASP	e^+e^-

$\Gamma(\Lambda\overline{\Lambda}\pi^0)/\Gamma_{total}$ Γ_{87}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.22±0.05±0.05	19 ± 4	HENRARD	87	DM2	e^+e^-

$\Gamma(\pi^+\pi^-)/\Gamma_{total}$ Γ_{88}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
1.47±0.23 OUR AVERAGE					
1.58±0.20±0.15	84	BALTRUSAIT...85D		MRK3	e^+e^-
1.0 ±0.5	5	BRANDELIK	78B	DASP	e^+e^-
1.6 ±1.6	1	VANNUCCI	77	MRK1	e^+e^-

$\Gamma(K^0_S K^0_L)/\Gamma_{total}$ Γ_{89}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
1.08±0.14 OUR AVERAGE					
1.18±0.12±0.18		JOUSSET	90	DM2	$J/\psi \to$ hadrons
1.01±0.16±0.09	74	BALTRUSAIT...85D		MRK3	e^+e^-

$\Gamma(\Lambda\overline{\Sigma}+\text{c.c.})/\Gamma_{total}$ Γ_{90}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<0.15	90	PERUZZI	78	MRK1	$e^+e^- \to \Lambda X$

$\Gamma(K_S^0 K_S^0)/\Gamma_{total}$ Γ_{91}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<0.052	90	[24] BALTRUSAIT...85C		MRK3	$e^+ e^-$

[24] Forbidden by *CP*.

RADIATIVE DECAYS

$\Gamma(\gamma\eta_c(1S))/\Gamma_{total}$ Γ_{92}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.0127±0.0036		GAISER	86	CBAL	$J/\psi \to \gamma X$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
seen	16	BALTRUSAIT...84		MRK3	$J/\psi \to 2\phi\gamma$

$\Gamma(\gamma\pi^+\pi^- 2\pi^0)/\Gamma_{total}$ Γ_{93}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
8.3±0.2±3.1	[25] BALTRUSAIT...86B		MRK3	$J/\psi \to 4\pi\gamma$

[25] 4π mass less than 2.0 GeV.

$\Gamma(\gamma\eta\pi\pi)/\Gamma_{total}$ Γ_{94}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
6.1 ±1.0 OUR AVERAGE				
5.85±0.3±1.05	[26] EDWARDS	83B	CBAL	$J/\psi \to \eta\pi^+\pi^-$
7.8 ±1.2±2.4	[26] EDWARDS	83B	CBAL	$J/\psi \to \eta 2\pi^0$

[26] Broad enhancement at 1700 MeV.

$\Gamma(\gamma\eta(1440) \to \gamma K\overline{K}\pi)/\Gamma_{total}$ Γ_{95}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
0.91±0.18 OUR AVERAGE				
0.83±0.13±0.18	[27,28] AUGUSTIN	92	DM2	$J/\psi \to \gamma K\overline{K}\pi$
$1.03^{+0.21}_{-0.18}{}^{+0.26}_{-0.19}$	[27,29] BAI	90C	MRK3	$J/\psi \to \gamma K_S^0 K^\pm \pi^\mp$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1.78±0.21±0.33	[27,30] AUGUSTIN	92	DM2	$J/\psi \to \gamma K\overline{K}\pi$
3.8 ±0.3 ±0.6	[27] AUGUSTIN	90	DM2	$J/\psi \to \gamma K\overline{K}\pi$
$0.66^{+0.17}_{-0.16}{}^{+0.24}_{-0.15}$	[27,31] BAI	90C	MRK3	$J/\psi \to \gamma K_S^0 K^\pm \pi^\mp$
4.0 ±0.7 ±1.0	[27] EDWARDS	82E	CBAL	$J/\psi \to K^+ K^- \pi^0 \gamma$
4.3 ±1.7	[27,32] SCHARRE	80	MRK2	$e^+ e^-$

[27] Includes unknown branching fraction $\eta(1440) \to K\overline{K}\pi$.
[28] From fit to the $K^*(892)K$ 0^{-+} partial wave.
[29] From $K^*(890)K$ final state.
[30] From fit to the $a_0(980)\pi$ 0^{-+} partial wave.
[31] From $a_0(980)\pi$ final state.
[32] Corrected for spin-zero hypothesis for $\eta(1440)$.

$\Gamma(\gamma\eta(1440) \to \gamma\gamma\rho^0)/\Gamma_{total}$ Γ_{96}/Γ

VALUE (units 10^{-5})	DOCUMENT ID		TECN	COMMENT
6.4±1.2±0.7	[33] COFFMAN	90	MRK3	$J/\psi \to \gamma\gamma\pi^+\pi^-$

[33] Includes unknown branching fraction $\eta(1440) \to \gamma\rho^0$.

$\Gamma(\gamma\eta(1440) \to \gamma\eta\pi^+\pi^-)/\Gamma_{total}$ Γ_{97}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
3.38±0.33±0.64		[34] BOLTON	92B	MRK3	$J/\psi \to \gamma\eta\pi^+\pi^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
7.0 ±0.6 ±1.1	261	[35] AUGUSTIN	90	DM2	$J/\psi \to \gamma\eta\pi^+\pi^-$

[34] Via $a_0(980)\pi$.
[35] Includes unknown branching fraction to $\eta\pi^+\pi^-$.

$\Gamma(\gamma\rho\rho)/\Gamma_{total}$ Γ_{98}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
4.5 ±0.8 OUR AVERAGE					
4.7 ±0.3 ±0.9		[36] BALTRUSAIT...	86B	MRK3	$J/\psi \to 4\pi\gamma$
3.75±1.05±1.20		[37] BURKE	82	MRK2	$J/\psi \to 4\pi\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.09	90	[38] BISELLO	89B		$J/\psi \to 4\pi\gamma$

[36] 4π mass less than 2.0 GeV.
[37] 4π mass less than 2.0 GeV, $2\rho^0$ corrected to 2ρ by factor of 3.
[38] 4π mass in the range 2.0–25 GeV.

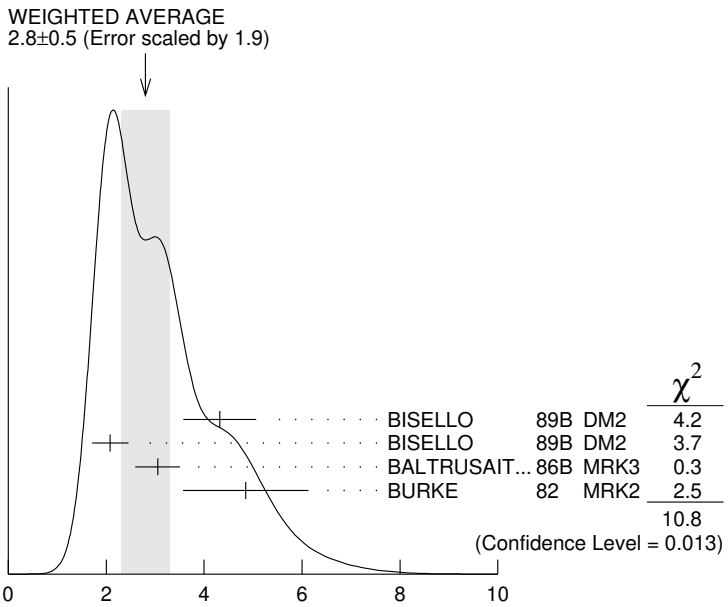
$\Gamma(\gamma\eta'(958))/\Gamma_{total}$ Γ_{99}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
4.31±0.30 OUR AVERAGE					
4.50±0.14±0.53		BOLTON	92B	MRK3	$J/\psi \to \gamma\pi^+\pi^-\eta$, $\eta \to \gamma\gamma$
4.30±0.31±0.71		BOLTON	92B	MRK3	$J/\psi \to \gamma\pi^+\pi^-\eta$, $\eta \to \pi^+\pi^-\pi^0$
4.04±0.16±0.85	622	AUGUSTIN	90	DM2	$J/\psi \to \gamma\eta\pi^+\pi^-$
4.39±0.09±0.66	2420	AUGUSTIN	90	DM2	$J/\psi \to \gamma\gamma\pi^+\pi^-$
4.1 ±0.3 ±0.6		BLOOM	83	CBAL	$e^+e^- \to 3\gamma +$ hadronsγ
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.9 ±1.1	6	BRANDELIK	79C	DASP	$e^+e^- \to 3\gamma$
2.4 ±0.7	57	BARTEL	76	CNTR	$e^+e^- \to 2\gamma\rho$

$\Gamma(\gamma 2\pi^+ 2\pi^-)/\Gamma_{total}$ Γ_{100}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
2.8 ±0.5 OUR AVERAGE Error includes scale factor of 1.9. See the ideogram below.				
4.32±0.14±0.73	[39] BISELLO	89B	DM2	$J/\psi \to 4\pi\gamma$
2.08±0.13±0.35	[40] BISELLO	89B	DM2	$J/\psi \to 4\pi\gamma$
3.05±0.08±0.45	[40] BALTRUSAIT...	86B	MRK3	$J/\psi \to 4\pi\gamma$
4.85±0.45±1.20	[41] BURKE	82	MRK2	e^+e^-

[39] 4π mass less than 3.0 GeV.
[40] 4π mass less than 2.0 GeV.
[41] 4π mass less than 2.5 GeV.



$\Gamma\left(\gamma 2\pi^+ 2\pi^-\right)/\Gamma_{\text{total}}$ (units 10^{-3})

$\Gamma(\gamma f_4(2050))/\Gamma_{\text{total}}$ Γ_{101}/Γ

VALUE (units 10^{-3})	*DOCUMENT ID*		*TECN*	*COMMENT*
2.7±0.5±0.5	[42] BALTRUSAIT...87		MRK3	$J/\psi \rightarrow \gamma\pi^+\pi^-$

[42] Assuming branching fraction $f_4(2050) \rightarrow \pi\pi/$ total = 0.167.

$\Gamma(\gamma\omega\omega)/\Gamma_{\text{total}}$ Γ_{102}/Γ

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1.59±0.33 OUR AVERAGE					
1.41±0.2 ±0.42	120±17	BISELLO	87	SPEC	e^+e^-, hadronsγ
1.76±0.09±0.45		BALTRUSAIT...85C		MRK3	$e^+e^- \rightarrow$ hadronsγ

$\Gamma(\gamma\eta(1440) \rightarrow \gamma\rho^0\rho^0)/\Gamma_{\text{total}}$ Γ_{103}/Γ

VALUE (units 10^{-3})	*DOCUMENT ID*		*TECN*	*COMMENT*
1.7 ±0.4 OUR AVERAGE Error includes scale factor of 1.3.				
2.1 ±0.4	BUGG	95	MRK3	$J/\psi \rightarrow \gamma\pi^+\pi^-\pi^+\pi^-$
1.36±0.38	[43,44] BISELLO	89B	DM2	$J/\psi \rightarrow 4\pi\gamma$

[43] Estimated by us from various fits.
[44] Includes unknown branching fraction to $\rho^0\rho^0$.

$\Gamma(\gamma f_2(1270))/\Gamma_{total}$ Γ_{104}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
1.38±0.14 OUR AVERAGE						
1.33±0.05±0.20		[45] AUGUSTIN	87	DM2		$J/\psi \to \gamma\pi^+\pi^-$
1.36±0.09±0.23		[45] BALTRUSAIT...	87	MRK3		$J/\psi \to \gamma\pi^+\pi^-$
1.48±0.25±0.30	178	EDWARDS	82B	CBAL		$e^+e^- \to 2\pi^0\gamma$
2.0 ±0.7	35	ALEXANDER	78	PLUT	0	e^+e^-
1.2 ±0.6	30	[46] BRANDELIK	78B	DASP		$e^+e^- \to \pi^+\pi^-\gamma$

[45] Estimated using B($f_2(1270) \to \pi\pi$)=0.843 ± 0.012. The errors do not contain the uncertainty in the $f_2(1270)$ decay.
[46] Restated by us to take account of spread of E1, M2, E3 transitions.

$\Gamma(\gamma f_J(1710) \to \gamma K\overline{K})/\Gamma_{total}$ Γ_{105}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
$8.5^{+1.2}_{-0.9}$ OUR AVERAGE Error includes scale factor of 1.2.					
$5.0\pm0.8^{+1.8}_{-0.4}$		[47,48] BAI	96C	BES	$J/\psi \to \gamma K^+K^-$
9.2±1.4±1.4		[48] AUGUSTIN	88	DM2	$J/\psi \to \gamma K^+K^-$
10.4±1.2±1.6		[48] AUGUSTIN	88	DM2	$J/\psi \to \gamma K^0_S K^0_S$
9.6±1.2±1.8		[48] BALTRUSAIT...	87	MRK3	$J/\psi \to \gamma K^+K^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$1.6\pm0.2^{+0.6}_{-0.2}$		[48,49] BAI	96C	BES	$J/\psi \to \gamma K^+K^-$
< 0.8	90	[50] BISELLO	89B		$J/\psi \to 4\pi\gamma$
1.6±0.4±0.3		[51] BALTRUSAIT...	87	MRK3	$J/\psi \to \gamma\pi^+\pi^-$
3.8±1.6		[52] EDWARDS	82D	CBAL	$e^+e^- \to \eta\eta\gamma$

[47] Assuming $J^P = 2^+$ for $f_J(1710)$.
[48] Includes unknown branching fraction to K^+K^- or $K^0_S K^0_S$. We have multiplied K^+K^- measurement by 2, and $K^0_S K^0_S$ by 4 to obtain $K\overline{K}$ result.
[49] Assuming $J^P = 0^+$ for $f_J(1710)$.
[50] Includes unknown branching fraction to $\rho^0\rho^0$.
[51] Includes unknown branching fraction to $\pi^+\pi^-$.
[52] Includes unknown branching fraction to $\eta\eta$.

$\Gamma(\gamma\eta)/\Gamma_{total}$ Γ_{106}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.86±0.08 OUR AVERAGE					
0.88±0.08±0.11		BLOOM	83	CBAL	e^+e^-
0.82±0.10		BRANDELIK	79C	DASP	e^+e^-
1.3 ±0.4	21	BARTEL	77	CNTR	e^+e^-

$\Gamma(\gamma f_1(1420) \to \gamma K\overline{K}\pi)/\Gamma_{total}$ Γ_{107}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
0.83±0.15 OUR AVERAGE				
0.76±0.15±0.21	[53,54] AUGUSTIN	92	DM2	$J/\psi \to \gamma K\overline{K}\pi$
$0.87\pm0.14^{+0.14}_{-0.11}$	[53] BAI	90C	MRK3	$J/\psi \to \gamma K^0_S K^\pm\pi^\mp$

[53] Included unknown branching fraction $f_1(1420) \to K\overline{K}\pi$.
[54] From fit to the $K^*(892)K$ 1^{++} partial wave.

$\Gamma(\gamma f_1(1285))/\Gamma_{total}$ Γ_{108}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
0.65 ±0.10 OUR AVERAGE				
0.625±0.063±0.103	[55] BOLTON	92	MRK3	$J/\psi \to \gamma f_1(1285)$
0.70 ±0.08 ±0.16	[56] BOLTON	92B	MRK3	$J/\psi \to \gamma \eta \pi^+ \pi^-$

[55] Obtained summing the sequential decay channels
$B(J/\psi \to \gamma f_1(1285), f_1(1285) \to \pi\pi\pi\pi) = (1.44 \pm 0.39 \pm 0.27) \times 10^{-4}$;
$B(J/\psi \to \gamma f_1(1285), f_1(1285) \to \delta\pi, \delta \to \eta\pi) = (3.90 \pm 0.42 \pm 0.87) \times 10^{-4}$;
$B(J/\psi \to \gamma f_1(1285), f_1(1285) \to \delta\pi, \delta \to K\overline{K}) = (0.66 \pm 0.26 \pm 0.29) \times 10^{-4}$;
$B(J/\psi \to \gamma f_1(1285), f_1(1285) \to \gamma\rho^0) = (0.25 \pm 0.07 \pm 0.03) \times 10^{-4}$.

[56] Using $B(f_1(1285) \to a_0(980)\pi) = 0.37$, and including unknown branching ratio for $a_0(980) \to \eta\pi$.

$\Gamma(\gamma f_2'(1525))/\Gamma_{total}$ Γ_{109}/Γ

VALUE (units 10^{-3})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$0.47^{+0.07}_{-0.05}$ OUR AVERAGE						
$0.36\pm0.04^{+0.14}_{-0.04}$			[57] BAI	96C	BES	$J/\psi \to \gamma K^+ K^-$
0.56±0.14±0.09			[57] AUGUSTIN	88	DM2	$J/\psi \to \gamma K^+ K^-$
0.45±0.04±0.09			[57] AUGUSTIN	88	DM2	$J/\psi \to \gamma K_S^0 K_S^0$
0.68±0.16±0.14			[57] BALTRUSAIT..	87	MRK3	$J/\psi \to \gamma K^+ K^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<0.34	90	4	[58] BRANDELIK	79C	DASP	$e^+ e^- \to \pi^+ \pi^- \gamma$
<0.23	90	3	ALEXANDER	78	PLUT	$e^+ e^- \to K^+ K^- \gamma$

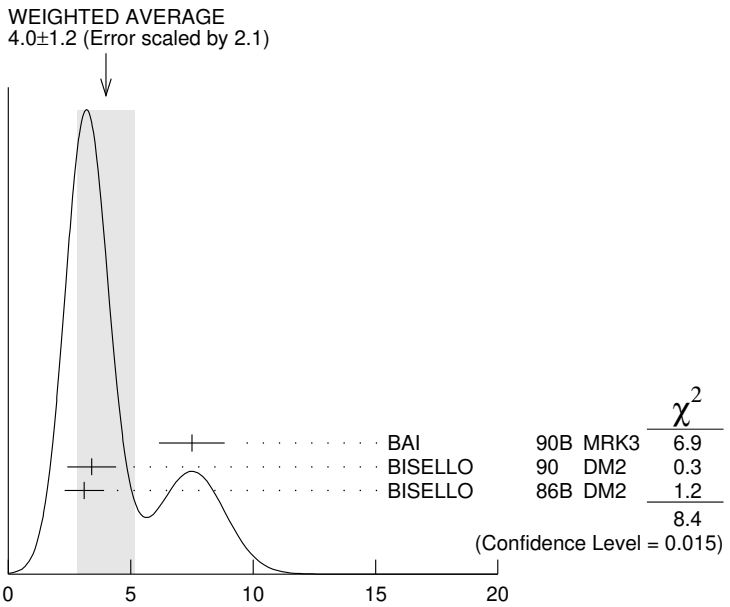
[57] Using $B(f_2'(1525) \to K\overline{K}) = 0.888$.

[58] Assuming isotropic production and decay of the $f_2'(1525)$ and isospin.

$\Gamma(\gamma\phi\phi)/\Gamma_{total}$ Γ_{110}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
4.0±1.2 OUR AVERAGE Error includes scale factor of 2.1. See the ideogram below.					
7.5±0.6±1.2	168	BAI	90B	MRK3	$J/\psi \to \gamma 4K$
3.4±0.8±0.6	33 ± 7	[59] BISELLO	90	DM2	$J/\psi \to \gamma K^+ K^- K_S^0 K_L^0$
3.1±0.7±0.4		[59] BISELLO	86B	DM2	$J/\psi \to \gamma K^+ K^- K^+ K^-$

[59] $\phi\phi$ mass less than 2.9 GeV, η_c excluded.



$\Gamma\left(\gamma\phi\phi\right)/\Gamma_{\text{total}}$ (units 10^{-4})

$\Gamma\left(\gamma p\overline{p}\right)/\Gamma_{\text{total}}$ Γ_{111}/Γ

VALUE (units 10^{-3})	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.38±0.07±0.07		49	EATON	84	MRK2	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<0.11	90		PERUZZI	78	MRK1	e^+e^-

$\Gamma\left(\gamma\eta(2225)\right)/\Gamma_{\text{total}}$ Γ_{112}/Γ

VALUE (units 10^{-3})		*DOCUMENT ID*		*TECN*	*COMMENT*
0.29±0.06 OUR AVERAGE					
0.33±0.08±0.05	[60]	BAI	90B	MRK3	$J/\psi \to \gamma K^+K^-K^+K^-$
0.27±0.06±0.06	[60]	BAI	90B	MRK3	$J/\psi \to \gamma K^+K^-K^0_SK^0_L$
$0.24^{+0.15}_{-0.10}$	[61,62]	BISELLO	89B	DM2	$J/\psi \to 4\pi\gamma$

[60] Includes unknown branching fraction to $\phi\phi$.
[61] Estimated by us from various fits.
[62] Includes unknown branching fraction to $\rho^0\rho^0$.

$\Gamma\left(\gamma\eta(1760) \to \gamma\rho^0\rho^0\right)/\Gamma_{\text{total}}$ Γ_{113}/Γ

VALUE (units 10^{-3})		*DOCUMENT ID*		*TECN*	*COMMENT*
0.13±0.09	[63,64]	BISELLO	89B	DM2	$J/\psi \to 4\pi\gamma$

[63] Estimated by us from various fits.
[64] Includes unknown branching fraction to $\rho^0\rho^0$.

$\Gamma(\gamma\pi^0)/\Gamma_{total}$ Γ_{114}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.039±0.013 OUR AVERAGE					
0.036±0.011±0.007		BLOOM	83	CBAL	e^+e^-
0.073±0.047	10	BRANDELIK	79C	DASP	e^+e^-

$\Gamma(\gamma p\overline{p}\pi^+\pi^-)/\Gamma_{total}$ Γ_{115}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<0.79	90	EATON	84	MRK2	e^+e^-

$\Gamma(\gamma\gamma)/\Gamma_{total}$ Γ_{116}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<0.5	90	BARTEL	77	CNTR	e^+e^-

$\Gamma(\gamma\Lambda\overline{\Lambda})/\Gamma_{total}$ Γ_{117}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<0.13	90	HENRARD	87	DM2	e^+e^-

$\Gamma(3\gamma)/\Gamma_{total}$ Γ_{118}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<0.055	90	PARTRIDGE	80	CBAL	e^+e^-

$\Gamma(\gamma f_0(2200))/\Gamma_{total}$ Γ_{119}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1.5	[65] AUGUSTIN	88	DM2	$J/\psi \to \gamma K^0_S K^0_S$

[65] Includes unknown branching fraction to $K^0_S K^0_S$.

$\Gamma(\gamma f_J(2220))/\Gamma_{total}$ Γ_{120}/Γ

VALUE (units 10^{-5})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
>250	99.9		[66] HASAN	96	SPEC	$\overline{p}p \to \pi^+\pi^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
>300			[67] BAI	96B	BES	$e^+e^- \to \gamma\overline{p}p,\ K\overline{K}$
< 2.3	95		[68] AUGUSTIN	88	DM2	$J/\psi \to \gamma K^+K^-$
< 1.6	95		[68] AUGUSTIN	88	DM2	$J/\psi \to \gamma K^0_S K^0_S$
$12.4^{+6.4}_{-5.2}\pm2.8$		23	[68] BALTRUSAIT..	86D	MRK3	$J/\psi \to \gamma K^0_S K^0_S$
$8.4^{+3.4}_{-2.8}\pm1.6$		93	[68] BALTRUSAIT..	86D	MRK3	$J/\psi \to \gamma K^+K^-$

[66] Using BAI 96B.
[67] Using BARNES 93.
[68] Includes unknown branching fraction to K^+K^- or $K^0_S K^0_S$.

$\Gamma(\gamma f_0(1500))/\Gamma_{total}$ Γ_{121}/Γ

VALUE (units 10^{-4})		*DOCUMENT ID*		*TECN*	*COMMENT*
5.7±0.8	[69,70]	BUGG	95	MRK3	$J/\psi \to \gamma\pi^+\pi^-\pi^+\pi^-$

[69] Including unknown branching ratio for $f_0(1500) \to \pi^+\pi^-\pi^+\pi^-$.
[70] Assuming that $f_0(1500)$ decays only to two S-wave dipions.

$\Gamma(\gamma e^+ e^-)/\Gamma_{total}$ Γ_{122}/Γ

VALUE (units 10^{-3})		*DOCUMENT ID*		*TECN*	*COMMENT*
8.8±1.3±0.4	[71]	ARMSTRONG	96	E760	$\overline{p}p \to e^+e^-\gamma$

[71] For $E_\gamma > 100$ MeV.

$J/\psi(1S)$ REFERENCES

ARMSTRONG	96	PR D54 7067	+Bettoni+(FNAL, FERR, GENO, UCI, NEAS, PENN, TORI)
BAI	96B	PRL 76 3502	+Chen, Chen+ (BES Collab.)
BAI	96C	PRL 77 3959	J.Z. Bai+ (BES Collab.)
BAI	96D	PR D54 1221	J.Z. Bai, Bardon+ (BES Collab.)
GRIBUSHIN	96	PR D53 4723	+Abramov, Antipov+ (E672 Collab., E706 Collab.)
HASAN	96	PL B388 376	+Bugg (BRUN, LOQM)
BAI	95B	PL B355 374	+Chen, Chen+ (BES Collab.)
BUGG	95	PL B353 378	+Scott, Zoli+ (LOQM, PNPI, WASH)
ANTONELLI	93	PL B301 317	+Baldini+ (FENICE Collab.)
ARMSTRONG	93B	PR D47 772	+Bettoni, Bharadwaj+ (FNAL E760 Collab.)
BARNES	93	PL B309 469	+Birien, Breunlich (PS185 Collab.)
AUGUSTIN	92	PR D46 1951	+Cosme (DM2 Collab.)
BOLTON	92	PL B278 495	+Brown, Bunnell+ (Mark III Collab.)
BOLTON	92B	PRL 69 1328	+Brown, Bunnell+ (Mark III Collab.)
COFFMAN	92	PRL 68 282	+DeJongh, Dubois, Hitlin+ (Mark III Collab.)
HSUEH	92	PR D45 R2181	+Palestini (FNAL, TORI)
AUGUSTIN	90	PR D42 10	+Cosme+ (DM2 Collab.)
BAI	90B	PRL 65 1309	+Blaylock+ (Mark III Collab.)
BAI	90C	PRL 65 2507	+Blaylock+ (Mark III Collab.)
BISELLO	90	PL B241 617	+Busetto+ (DM2 Collab.)
COFFMAN	90	PR D41 1410	+De Jongh+ (Mark III Collab.)
JOUSSET	90	PR D41 1389	+Ajaltouni+ (DM2 Collab.)
ALEXANDER	89	NP B320 45	+Bonvicini, Drell, Frey, Luth (LBL, MICH, SLAC)
AUGUSTIN	89	NP B320 1	+Cosme (DM2 Collab.)
BISELLO	89B	PR D39 701	Busetto+ (DM2 Collab.)
AUGUSTIN	88	PRL 60 2238	+Calcaterra+ (DM2 Collab.)
COFFMAN	88	PR D38 2695	+Dubois, Eigen, Hauser+ (Mark III Collab.)
FALVARD	88	PR D38 2706	+Ajaltouni+ (CLER, FRAS, LALO, PADO)
AUGUSTIN	87	ZPHY C36 369	+Cosme+ (LALO, CLER, FRAS, PADO)
BAGLIN	87	NP B286 592	+ (LAPP, CERN, GENO, LYON, OSLO, ROMA+)
BALTRUSAIT...	87	PR D35 2077	Baltrusaitis, Coffman, Dubois+ (Mark III Collab.)
BECKER	87	PRL 59 186	+Blaylock, Bolton, Brown+ (Mark III Collab.)
BISELLO	87	PL B192 239	+Ajaltouni, Baldini+ (PADO, CLER, FRAS, LALO)
HENRARD	87	NP B292 670	+Ajaltouni+ (CLER, FRAS, LALO, PADO)
PALLIN	87	NP B292 653	+Ajaltouni+ (CLER, FRAS, LALO, PADO)
BALTRUSAIT...	86B	PR D33 1222	Baltrusaitis, Coffman, Hauser+ (Mark III Collab.)
BALTRUSAIT...	86D	PRL 56 107	Baltrusaitis (CIT, UCSC, ILL, SLAC, WASH)
BISELLO	86B	PL B179 294	+Busetto, Castro, Limentani+ (DM2 Collab.)
GAISER	86	PR D34 711	+Bloom, Bulos, Godfrey+ (Crystal Ball Collab.)
BALTRUSAIT...	85C	PRL 55 1723	Baltrusaitis+ (CIT, UCSC, ILL, SLAC, WASH)
BALTRUSAIT...	85D	PR D32 566	Baltrusaitis, Coffman+ (CIT, UCSC, ILL, SLAC, WASH)
BALTRUSAIT...	84	PRL 52 2126	Baltrusaitis+ (CIT, UCSC, ILL, SLAC, WASH)
EATON	84	PR D29 804	+Goldhaber, Abrams, Alam, Boyarski+ (LBL, SLAC)
BLOOM	83	ARNS 33 143	+Peck (SLAC, CIT)
EDWARDS	83B	PRL 51 859	+Partridge, Peck+ (CIT, HARV, PRIN, STAN, SLAC)

FRANKLIN	83	PRL 51 963	+Franklin, Feldman, Abrams, Alam+	(LBL, SLAC)	
BURKE	82	PRL 49 632	+Trilling, Abrams, Alam, Blocker+	(LBL, SLAC)	
EDWARDS	82B	PR D25 3065	+Partridge, Peck+	(CIT, HARV, PRIN, STAN, SLAC)	
EDWARDS	82D	PRL 48 458	+Partridge, Peck+	(CIT, HARV, PRIN, STAN, SLAC)	
Also	83	ARNS 33 143	Bloom, Peck	(SLAC, CIT)	
EDWARDS	82E	PRL 49 259	+Partridge, Peck+	(CIT, HARV, PRIN, STAN, SLAC)	
LEMOIGNE	82	PL 113B 509	+Barate, Astbury+	(SACL, LOIC, SHMP, IND)	
BESCH	81	ZPHY C8 1	+Eisermann, Lohr, Kowalski+	(BONN, DESY, MANZ)	
GIDAL	81	PL 107B 153	+Goldhaber, Guy, Millikan, Abrams+	(SLAC, LBL)	
PARTRIDGE	80	PRL 44 712	+Peck+	(CIT, HARV, PRIN, SLAC, STAN)	
SCHARRE	80	PL 97B 329	+Trilling, Abrams, Alam, Blocker+	(SLAC, LBL)	
ZHOLENTZ	80	PL 96B 214	+Kurdadze, Lelchuk, Mishnev+	(NOVO)	
Also	81	SJNP 34 814	Zholentz, Kurdadze, Lelchuk+	(NOVO)	
		Translated from YAF 34 1471.			
BRANDELIK	79C	ZPHY C1 233	+Cords+	(DASP Collab.)	
ALEXANDER	78	PL 72B 493	+Criegee+	(DESY, HAMB, SIEG, WUPP)	
BESCH	78	PL 78B 347	+Eisermann, Kowalski, Eyss+	(BONN, DESY, MANZ)	
BRANDELIK	78B	PL 74B 292	+Cords+	(DASP Collab.)	
PERUZZI	78	PR D17 2901	+Piccolo, Alam, Boyarski, Goldhaber+	(SLAC, LBL)	
BARTEL	77	PL 66B 489	+Duinker, Olsson, Heintze+	(DESY, HEIDP)	
BURMESTER	77D	PL 72B 135	+Criegee+	(DESY, HAMB, SIEG, WUPP)	
FELDMAN	77	PRPL 33C 285	+Perl	(LBL, SLAC)	
VANNUCCI	77	PR D15 1814	+Abrams, Alam, Boyarski+	(SLAC, LBL)	
BARTEL	76	PL 64B 483	+Duinker, Olsson, Steffen, Heintze+	(DESY, HEIDP)	
BRAUNSCH...	76	PL 63B 487	Braunschweig+	(DASP Collab.)	
JEAN-MARIE	76	PRL 36 291	+Abrams, Boyarski, Breidenbach+	(SLAC, LBL)	IG
BALDINI-...	75	PL 58B 471	Baldini-Celio, Bozzo, Capon+	(FRAS, ROMA)	
BOYARSKI	75	PRL 34 1357	+Breidenbach, Bulos, Feldman+	(SLAC, LBL)	JPC
DASP	75	PL 56B 491	Braunschweig, Konigs+	(DASP Collab.)	
ESPOSITO	75B	LNC 14 73	+Bartoli, Bisello+	(FRAS, NAPL, PADO, ROMA)	
FORD	75	PRL 34 604	+Beron, Hilger, Hofstadter+	(SLAC, PENN)	

OTHER RELATED PAPERS

HOU	97	PR D55 6952	Wei-Shu Hou	
BARATE	83	PL 121B 449	+Bareyre, Bonamy+	(SACL, LOIC, SHMP, IND)
ABRAMS	74	PRL 33 1453	+Briggs, Augustin, Boyarski+	(LBL, SLAC)
ASH	74	LNC 11 705	+Zorn, Bartoli+	(FRAS, UMD, NAPL, PADO, ROMA)
AUBERT	74	PRL 33 1404	+Becker, Biggs, Burger, Chen, Everhart	(MIT, BNL)
AUGUSTIN	74	PRL 33 1406	+Boyarski, Abrams, Briggs+	(SLAC, LBL)
BACCI	74	PRL 33 1408	+Bartoli, Barbarino, Barbiellini+	(FRAS)
Also	74B	PRL 33 1649	Bacci	
BALDINI-...	74	LNC 11 711	Baldini-Celio, Bacci+	(FRAS, ROMA)
BARBIELLINI	74	LNC 11 718	+Bemporad+	(FRAS, NAPL, PISA, ROMA)
BRAUNSCH...	74	PL 53B 393	Braunschweig+	(DASP Collab.)
CHRISTENS...	70	PRL 25 1523	Christenson, Hicks, Lederman+	(COLU, BNL, CERN)