$\phi(1020)$

$I^G(J^{PC}) = 0^-(1^{--})$

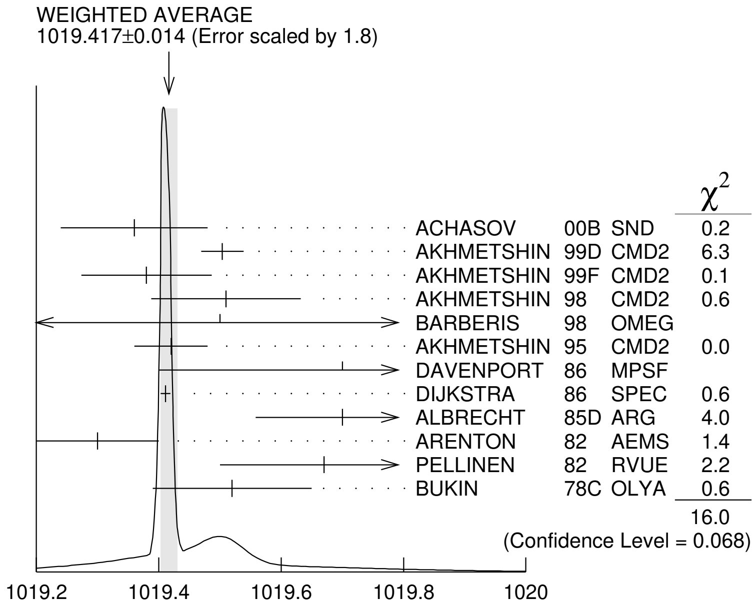
ϕ(1020) MASS

We average mass and width values only when the systematic errors have been evaluated.

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1019.417±0.014 OUR AVERAGE		Error includes scale factor of 1.8. See the ideogram below.			
1019.36 ±0.12		[1] ACHASOV	00B	SND	$e^+e^- \rightarrow \eta\gamma$
1019.504±0.011±0.033	314k	AKHMETSHIN	99D	CMD2	$e^+e^- \rightarrow K^0_L K^0_S$
1019.38 ±0.07 ±0.08	2200	[2] AKHMETSHIN	99F	CMD2	$e^+e^- \rightarrow \pi^+\pi^- \geq 2\gamma$
1019.51 ±0.07 ±0.10	11169	AKHMETSHIN	98	CMD2	$e^+e^- \rightarrow \pi^+\pi^-\pi^0$
1019.5 ±0.4		BARBERIS	98	OMEG	450 $pp \rightarrow pp2K^+2K^-$
1019.42 ±0.06	55600	AKHMETSHIN	95	CMD2	$e^+e^- \rightarrow$ hadrons
1019.7 ±0.3	2012	DAVENPORT	86	MPSF	400 pA $\rightarrow$ 4KX
1019.411±0.008	642k	[3] DIJKSTRA	86	SPEC	100–200 $\pi^\pm$, $\overline{p}$, p, $K^\pm$, on Be
1019.7 ±0.1 ±0.1	5079	ALBRECHT	85D	ARG	10 $e^+e^- \rightarrow K^+K^-$X
1019.3 ±0.1	1500	ARENTON	82	AEMS	11.8 polar. $pp \rightarrow KK$
1019.67 ±0.17	25080	[4] PELLINEN	82	RVUE	
1019.52 ±0.13	3681	BUKIN	78C	OLYA	$e^+e^- \rightarrow$ hadrons
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1019.8 ±0.7		ARMSTRONG	86	OMEG	85 $\pi^+/pp \rightarrow \pi^+/p4Kp$
1020.1 ±0.11	5526	[5] ATKINSON	86	OMEG	20–70 γp
1019.7 ±1.0		BEBEK	86	CLEO	$e^+e^- \rightarrow \Upsilon(4S)$
1020.9 ±0.2		[5] FRAME	86	OMEG	13 $K^+p \rightarrow \phi K^+p$
1021.0 ±0.2		[5] ARMSTRONG	83B	OMEG	18.5 $K^-p \rightarrow K^-K^+\Lambda$
1020.0 ±0.5		[5] ARMSTRONG	83B	OMEG	18.5 $K^-p \rightarrow K^-K^+\Lambda$
1019.7 ±0.3		[5] BARATE	83	GOLI	190 π^-Be $\rightarrow 2\mu$X
1019.8 ±0.2 ±0.5	766	IVANOV	81	OLYA	1–1.4 $e^+e^- \rightarrow K^+K^-$
1019.4 ±0.5	337	COOPER	78B	HBC	0.7–0.8 $\overline{p}p \rightarrow K^0_S K^0_L \pi^+\pi^-$
1020 ±1	383	[5] BALDI	77	CNTR	10 $\pi^-p \rightarrow \pi^-\phi p$

1018.9	±0.6	800	COHEN	77	ASPK	6 $\pi^{\pm} N \rightarrow K^+ K^- N$
1019.7	±0.5	454	KALBFLEISCH	76	HBC	2.18 $K^- p \rightarrow \Lambda K \overline{K}$
1019.4	±0.8	984	BESCH	74	CNTR	2 $\gamma p \rightarrow p K^+ K^-$
1020.3	±0.4	100	BALLAM	73	HBC	2.8–9.3 γp
1019.4	±0.7		BINNIE	73B	CNTR	$\pi^- p \rightarrow \phi n$
1019.6	±0.5	120	[6] AGUILAR-...	72B	HBC	3.9,4.6 $K^- p \rightarrow \Lambda K^+ K^-$
1019.9	±0.5	100	[6] AGUILAR-...	72B	HBC	3.9,4.6 $K^- p \rightarrow K^- p K^+ K^-$
1020.4	±0.5	131	COLLEY	72	HBC	10 $K^+ p \rightarrow K^+ p \phi$
1019.9	±0.3	410	STOTTLE...	71	HBC	2.9 $K^- p \rightarrow \Sigma / \Lambda K \overline{K}$

[1] Using a total width of 4.43 ± 0.05 MeV. Systematic uncertainty included.
[2] Using a total width of 4.43 ± 0.05 MeV.
[3] Weighted and scaled average of 12 measurements of DIJKSTRA 86.
[4] PELLINEN 82 review includes AKERLOF 77, DAUM 81, BALDI 77, AYRES 74, DEGROOT 74.
[5] Systematic errors not evaluated.
[6] Mass errors enlarged by us to $\Gamma/\sqrt{N}$; see the note with the $K^*(892)$ mass.



$\phi(1020)$ mass (MeV)

$\phi(1020)$ WIDTH

We average mass and width values only when the systematic errors have been evalutated.

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
4.458±0.032 OUR AVERAGE					
4.477±0.036±0.022	314k	AKHMETSHIN	99D	CMD2	$e^+e^- \rightarrow K^0_L K^0_S$
4.44 ±0.09	55600	AKHMETSHIN	95	CMD2	$e^+e^- \rightarrow$ hadrons
4.45 ±0.06	271k	DIJKSTRA	86	SPEC	100 π^- Be
4.5 ±0.7	1500	ARENTON	82	AEMS	11.8 polar. $pp \rightarrow KK$
4.2 ±0.6	766	[7] IVANOV	81	OLYA	1–1.4 $e^+e^- \rightarrow K^+K^-$
4.3 ±0.6		[7] CORDIER	80	WIRE	$e^+e^- \rightarrow \pi^+\pi^-\pi^0$
4.36 ±0.29	3681	[7] BUKIN	78C	OLYA	$e^+e^- \rightarrow$ hadrons
4.4 ±0.6	984	[7] BESCH	74	CNTR	2 $\gamma p \rightarrow pK^+K^-$
4.67 ±0.72	681	[7] BALAKIN	71	OSPK	$e^+e^- \rightarrow$ hadrons
4.09 ±0.29		BIZOT	70	OSPK	$e^+e^- \rightarrow$ hadrons
• • • We do not use the following data for averages, fits, limits, etc. • • •					
3.6 ±0.8	337	[7] COOPER	78B	HBC	0.7–0.8 $\overline{p}p \rightarrow K^0_S K^0_L \pi^+\pi^-$
4.5 ±0.50	1300	[7,8] AKERLOF	77	SPEC	400 pA $\rightarrow K^+K^-$X
4.5 ±0.8	500	[7,8] AYRES	74	ASPK	3–6 $\pi^- p \rightarrow K^+K^- n$, $K^- p \rightarrow K^+K^- \Lambda/\Sigma^0$
3.81 ±0.37		COSME	74B	OSPK	$e^+e^- \rightarrow K^0_L K^0_S$
3.8 ±0.7	454	[7] BORENSTEIN	72	HBC	2.18 $K^- p \rightarrow K\overline{K}n$

[7] Width errors enlarged by us to $4\Gamma/\sqrt{N}$; see the note with the $K^*(892)$ mass.

[8] Systematic errors not evaluated.

$\phi(1020)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Scale factor/ Confidence level
Γ_1	K^+K^-	(49.2 ±0.7) %	S=1.2
Γ_2	$K^0_L K^0_S$	(33.8 ±0.6) %	S=1.2
Γ_3	$\rho\pi + \pi^+\pi^-\pi^0$	(15.5 ±0.6) %	S=1.4
Γ_4	$\rho\pi$		
Γ_5	$\pi^+\pi^-\pi^0$		
Γ_6	$\eta\gamma$	(1.297±0.033) %	S=1.2
Γ_7	$\pi^0\gamma$	(1.26 ±0.10) $\times 10^{-3}$	
Γ_8	e^+e^-	(2.91 ±0.07) $\times 10^{-4}$	S=1.2
Γ_9	$\mu^+\mu^-$	(3.7 ±0.5) $\times 10^{-4}$	
Γ_{10}	ηe^+e^-	(1.3 $^{+0.8}_{-0.6}$) $\times 10^{-4}$	
Γ_{11}	$\pi^+\pi^-$	(7.5 ±1.4) $\times 10^{-5}$	
Γ_{12}	$\omega\pi^0$	(4.8 ±2.0) $\times 10^{-5}$	
Γ_{13}	$\omega\gamma$	< 5 %	CL=84%

Γ_{14}	$\rho\gamma$	$< 1.2 \times 10^{-5}$	CL=90%
Γ_{15}	$\pi^+\pi^-\gamma$	$(4.1 \pm 1.3) \times 10^{-5}$	
Γ_{16}	$f_0(980)\gamma$	$(3.4 \pm 0.4) \times 10^{-4}$	
Γ_{17}	$\pi^0\pi^0\gamma$	$(1.08 \pm 0.19) \times 10^{-4}$	
Γ_{18}	$\pi^+\pi^-\pi^+\pi^-$	$< 8.7 \times 10^{-4}$	CL=90%
Γ_{19}	$\pi^+\pi^+\pi^-\pi^-\pi^0$	$< 1.5 \times 10^{-4}$	CL=95%
Γ_{20}	$\pi^0 e^+ e^-$	$< 1.2 \times 10^{-4}$	CL=90%
Γ_{21}	$\pi^0\eta\gamma$	$(8.6 \pm 1.8) \times 10^{-5}$	
Γ_{22}	$a_0(980)\gamma$	$< 5 \times 10^{-3}$	CL=90%
Γ_{23}	$\eta'(958)\gamma$	$(6.7 {}^{+3.5}_{-3.1}) \times 10^{-5}$	
Γ_{24}	$\eta\pi^0\pi^0\gamma$	$< 2 \times 10^{-5}$	CL=90%
Γ_{25}	$\mu^+\mu^-\gamma$	$(1.4 \pm 0.5) \times 10^{-5}$	
Γ_{26}	$\rho\gamma\gamma$	$< 5 \times 10^{-4}$	CL=90%
Γ_{27}	$\eta\pi^+\pi^-$	$< 3 \times 10^{-4}$	CL=90%

CONSTRAINED FIT INFORMATION

An overall fit to 15 branching ratios uses 42 measurements and one constraint to determine 8 parameters. The overall fit has a $\chi^2 = 38.2$ for 35 degrees of freedom.

The following *off-diagonal* array elements are the correlation coefficients $\langle\delta x_i \delta x_j\rangle/(\delta x_i \cdot \delta x_j)$, in percent, from the fit to the branching fractions, $x_i \equiv \Gamma_i/\Gamma_{total}$. The fit constrains the x_i whose labels appear in this array to sum to one.

x_2	−66						
x_3	−58	−22					
x_6	−19	16	1				
x_7	−14	14	1	11			
x_8	44	−47	−4	−37	−30		
x_9	−8	8	1	6	5	−18	
x_{11}	−6	6	1	5	4	−13	2
	x_1	x_2	x_3	x_6	x_7	x_8	x_9

ϕ(1020) PARTIAL WIDTHS

$\Gamma(\eta\gamma)$ — Γ_6

VALUE (keV)	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
58.9±0.5±2.4	ACHASOV	00	SND	$e^+e^- \rightarrow \eta\gamma$

$\Gamma(\pi^0\gamma)$ Γ_7

VALUE (keV)	*DOCUMENT ID*	*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$5.40 \pm 0.16^{+0.43}_{-0.40}$	ACHASOV 00	SND	$e^+e^- \to \pi^0\gamma$

$\Gamma(e^+e^-)$ Γ_8

VALUE (keV)	*EVTS*	*DOCUMENT ID*	*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$1.32 \pm 0.02 \pm 0.04$	314k	[9] AKHMETSHIN 99D	CMD2	$e^+e^- \to K^0_L K^0_S$

[9] Using B($\phi \to K^0_L K^0_S$)= 0.331 ± 0.009.

$\phi(1020)$ $\Gamma(i)\Gamma(e^+e^-)/\Gamma^2(\text{total})$

$\Gamma(e^+e^-) \times \Gamma(K^0_L K^0_S)/\Gamma^2_{\text{total}}$ $\Gamma_8\Gamma_2/\Gamma^2$

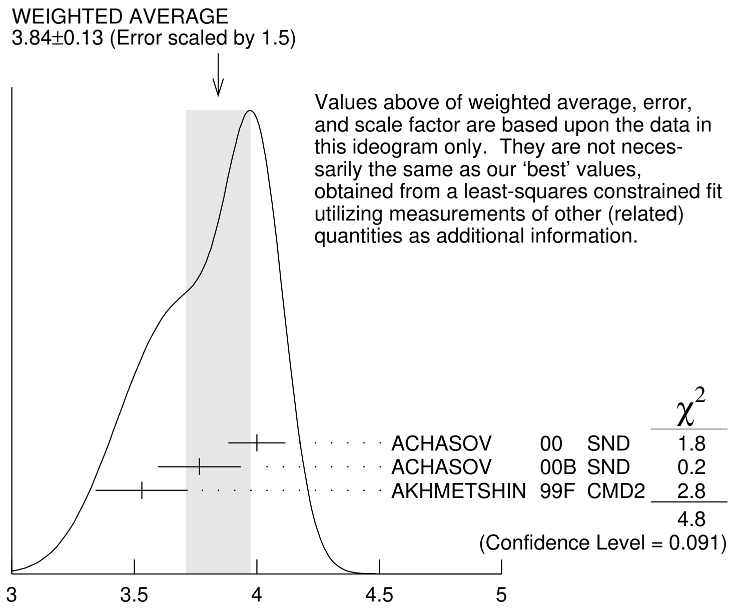
VALUE (units 10^{-5})	*EVTS*	*DOCUMENT ID*	*TECN*	*COMMENT*
9.85 ±0.22 OUR FIT Error includes scale factor of 1.3.				
9.756±0.114±0.146	314k	[10] AKHMETSHIN 99D	CMD2	$e^+e^- \to K^0_L K^0_S$

$\Gamma(e^+e^-) \times [\Gamma(\rho\pi) + \Gamma(\pi^+\pi^-\pi^0)]/\Gamma^2_{\text{total}}$ $\Gamma_8\Gamma_3/\Gamma^2$

VALUE (units 10^{-5})	*EVTS*	*DOCUMENT ID*	*TECN*	*COMMENT*
4.50±0.19 OUR FIT Error includes scale factor of 1.3.				
4.35±0.27±0.08	11169	[10] AKHMETSHIN 98	CMD2	$e^+e^- \to \pi^+\pi^-\pi^0$

$\Gamma(e^+e^-) \times \Gamma(\eta\gamma)/\Gamma^2_{\text{total}}$ $\Gamma_8\Gamma_6/\Gamma^2$

VALUE (units 10^{-6})	*EVTS*	*DOCUMENT ID*	*TECN*	*COMMENT*
3.77 ±0.11 OUR FIT Error includes scale factor of 1.4.				
3.84 ±0.13 OUR AVERAGE Error includes scale factor of 1.5. See the ideogram below.				
4.00 ±0.04 ±0.11		[11] ACHASOV 00	SND	$e^+e^- \to \eta\gamma$
3.765±0.092±0.143		[12] ACHASOV 00B	SND	$e^+e^- \to \eta\gamma$
3.53 ±0.08 ±0.17	2200	[12,13] AKHMETSHIN 99F	CMD2	$e^+e^- \to \eta\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
3.848±0.036±0.070		[14] ACHASOV 00B	SND	$e^+e^- \to \eta\gamma$



$\Gamma(e^+e^-) \times \Gamma(\eta\gamma)/\Gamma^2_{total}$ $\Gamma_8\Gamma_6/\Gamma^2$

$\Gamma(e^+e^-) \times \Gamma(\pi^0\gamma)/\Gamma^2_{total}$ $\Gamma_8\Gamma_7/\Gamma^2$

VALUE (units 10^{-7})	*DOCUMENT ID*		*TECN*	*COMMENT*
3.67±0.28 OUR FIT				
$3.67\pm0.10^{+0.27}_{-0.25}$	[15] ACHASOV	00	SND	$e^+e^- \rightarrow \pi^0\gamma$

$\Gamma(e^+e^-) \times \Gamma(\mu^+\mu^-)/\Gamma^2_{total}$ $\Gamma_8\Gamma_9/\Gamma^2$

VALUE (units 10^{-8})	*DOCUMENT ID*		*TECN*	*COMMENT*
10.8±1.4 OUR FIT				
10.8±1.4 OUR AVERAGE				
9.9±1.4±0.9	[13] ACHASOV	99C	SND	$e^+e^- \rightarrow \mu^+\mu^-$
14.4±3.0	[10] VASSERMAN	81	OLYA	$e^+e^- \rightarrow \mu^+\mu^-$
8.6±5.9	[10] AUGUSTIN	73	OSPK	$e^+e^- \rightarrow \mu^+\mu^-$

$\Gamma(e^+e^-) \times \Gamma(\pi^+\pi^-)/\Gamma^2_{total}$ $\Gamma_8\Gamma_{11}/\Gamma^2$

VALUE (units 10^{-8})	*DOCUMENT ID*		*TECN*	*COMMENT*
2.2 ±0.4 OUR FIT				
2.2 ±0.4 OUR AVERAGE				
2.1 ±0.3 ±0.3	[13] ACHASOV	00C	SND	$e^+e^- \rightarrow \pi^+\pi^-$
$1.95^{+1.15}_{-0.87}$	[10] GOLUBEV	86	ND	$e^+e^- \rightarrow \pi^+\pi^-$
$6.01^{+3.19}_{-2.51}$	[10] VASSERMAN	81	OLYA	$e^+e^- \rightarrow \pi^+\pi^-$

[10] Recalculated by us from the cross section in the peak.
[11] From the $\eta \rightarrow 2\gamma$ decay and using $B(\eta \rightarrow 2\gamma) = (39.21 \pm 0.34) \times 10^{-2}$.
[12] From the $\eta \rightarrow \pi^+\pi^-\pi^0$ decay and using $B(\eta \rightarrow \pi^+\pi^-\pi^0) = (23.1 \pm 0.5) \times 10^{-2}$.

[13] Recalculated by the authors from the cross section in the peak.
[14] Using various decay modes of the η from ACHASOV 98F, ACHASOV 00, and ACHASOV 00B.
[15] From the $\pi^0 \rightarrow 2\gamma$ decay and using B($\pi^0 \rightarrow 2\gamma$) =(98.798 ± 0.032) × 10^{-2}.

$\phi(1020)$ BRANCHING RATIOS

$\Gamma(K^+K^-)/\Gamma_{total}$ — Γ_1/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.492±0.007 OUR FIT Error includes scale factor of 1.2.					
0.493±0.010 OUR AVERAGE					
0.492±0.012	2913	AKHMETSHIN	95	CMD2	$e^+e^- \rightarrow K^+K^-$
0.44 ±0.05	321	KALBFLEISCH	76	HBC	2.18 $K^-p \rightarrow \Lambda K^+K^-$
0.49 ±0.06	270	DEGROOT	74	HBC	4.2 $K^-p \rightarrow \Lambda\phi$
0.540±0.034	565	BALAKIN	71	OSPK	$e^+e^- \rightarrow K^+K^-$
0.48 ±0.04	252	LINDSEY	66	HBC	2.1–2.7 $K^-p \rightarrow \Lambda K^+K^-$

$\Gamma(K^0_L K^0_S)/\Gamma_{total}$ — Γ_2/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.338±0.006 OUR FIT Error includes scale factor of 1.2.					
0.331±0.009 OUR AVERAGE					
0.335±0.010	40644	AKHMETSHIN	95	CMD2	$e^+e^- \rightarrow K^0_L K^0_S$
0.326±0.035		DOLINSKY	91	ND	$e^+e^- \rightarrow K^0_L K^0_S$
0.310±0.024		DRUZHININ	84	ND	$e^+e^- \rightarrow K^0_L K^0_S$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.329±0.006±0.010	314k	[16] AKHMETSHIN	99D	CMD2	$e^+e^- \rightarrow K^0_L K^0_S$
0.27 ±0.03	133	KALBFLEISCH	76	HBC	2.18 $K^-p \rightarrow \Lambda K^0_L K^0_S$
0.257±0.030	95	BALAKIN	71	OSPK	$e^+e^- \rightarrow K^0_L K^0_S$
0.40 ±0.04	167	LINDSEY	66	HBC	2.1–2.7 $K^-p \rightarrow \Lambda K^0_L K^0_S$

$[\Gamma(\rho\pi) + \Gamma(\pi^+\pi^-\pi^0)]/\Gamma_{total}$ — Γ_3/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.155±0.006 OUR FIT Error includes scale factor of 1.4.					
0.151±0.009 OUR AVERAGE Error includes scale factor of 1.7.					
0.161±0.008	11761	AKHMETSHIN	95	CMD2	$e^+e^- \rightarrow \pi^+\pi^-\pi^0$
0.143±0.007		DOLINSKY	91	ND	$e^+e^- \rightarrow \pi^+\pi^-\pi^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.145±0.009±0.003	11169	[17] AKHMETSHIN	98	CMD2	$e^+e^- \rightarrow \pi^+\pi^-\pi^0$
0.139±0.007		[18] PARROUR	76B	OSPK	e^+e^-

$\Gamma(K^0_L K^0_S)/\Gamma(K\overline{K})$ — $\Gamma_2/(\Gamma_1+\Gamma_2)$

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
$0.407^{+0.008}_{-0.007}$ OUR FIT Error includes scale factor of 1.2.					
0.45 ±0.04 OUR AVERAGE					
0.44 ±0.07		LONDON	66	HBC	2.24 $K^-p \rightarrow \Lambda K\overline{K}$
0.48 ±0.07	52	BADIER	65B	HBC	3 K^-p
0.40 ±0.10	34	SCHLEIN	63	HBC	1.95 $K^-p \rightarrow \Lambda K\overline{K}$

$\left[\Gamma(\rho\pi)+\Gamma(\pi^+\pi^-\pi^0)\right]/\Gamma(K\overline{K})$ — $\Gamma_3/(\Gamma_1+\Gamma_2)$

VALUE	DOCUMENT ID		TECN	COMMENT
0.186±0.008 OUR FIT Error includes scale factor of 1.4.				
0.24 ±0.04 OUR AVERAGE				
0.237±0.039	CERRADA	77B	HBC	4.2 $K^- p \to \Lambda 3\pi$
0.30 ±0.15	LONDON	66	HBC	2.24 $K^- p \to \Lambda\pi^+\pi^-\pi^0$

$\left[\Gamma(\rho\pi)+\Gamma(\pi^+\pi^-\pi^0)\right]/\Gamma(K^0_L K^0_S)$ — Γ_3/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.457±0.020 OUR FIT Error includes scale factor of 1.3.					
0.51 ±0.05 OUR AVERAGE					
0.56 ±0.07	3681	BUKIN	78C	OLYA	$e^+e^- \to K^0_L K^0_S$, $\pi^+\pi^-\pi^0$
0.47 ±0.06	516	COSME	74	OSPK	$e^+e^- \to \pi^+\pi^-\pi^0$

$\Gamma(\eta\gamma)/\Gamma(\pi^0\gamma)$ — Γ_6/Γ_7

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$10.9\pm0.3^{+0.7}_{-0.8}$	ACHASOV	00	SND	$e^+e^- \to \eta\gamma$, $\pi^0\gamma$

$\Gamma(\mu^+\mu^-)/\Gamma_{total}$ — Γ_9/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
2.5 ±0.4 OUR AVERAGE				
2.69±0.46	[19] HAYES	71	CNTR	8.3,9.8 $\gamma C \to \mu^+\mu^- X$
2.17±0.60	[19] EARLES	70	CNTR	6.0 $\gamma C \to \mu^+\mu^- X$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
3.30±0.45±0.32	[17] ACHASOV	99C	SND	$e^+e^- \to \mu^+\mu^-$
4.83±1.02	[20] VASSERMAN	81	OLYA	$e^+e^- \to \mu^+\mu^-$
2.87±1.98	[20] AUGUSTIN	73	OSPK	$e^+e^- \to \mu^+\mu^-$

$\Gamma(\eta\gamma)/\Gamma_{total}$ — Γ_6/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.01297±0.00033 OUR FIT Error includes scale factor of 1.2.					
0.0126 ±0.0004 OUR AVERAGE					
0.01246±0.00025±0.00057	10k	[21] ACHASOV	98F	SND	$e^+e^- \to 7\gamma$
0.0118 ±0.0011	279	[22] AKHMETSHIN	95	CMD2	$e^+e^- \to \pi^+\pi^- 3\gamma$
0.0130 ±0.0006		[23] DRUZHININ	84	ND	$e^+e^- \to 3\gamma$
0.014 ±0.002		[24] DRUZHININ	84	ND	$e^+e^- \to 6\gamma$
0.0088 ±0.0020	290	KURDADZE	83C	OLYA	$e^+e^- \to 3\gamma$
0.0135 ±0.0029		ANDREWS	77	CNTR	6.7–10 γCu
0.015 ±0.004	54	[23] COSME	76	OSPK	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.01338±0.00012±0.00052		[25] ACHASOV	00	SND	$e^+e^- \to \eta\gamma$
0.01287±0.00012±0.00042		[26] ACHASOV	00B	SND	$e^+e^- \to \eta\gamma$
0.01259±0.00030±0.00059		[27] ACHASOV	00B	SND	$e^+e^- \to \eta\gamma$
0.0118 ±0.0003 ±0.0006	2200	[28] AKHMETSHIN	99F	CMD2	$e^+e^- \to \eta\gamma$
0.0121 ±0.0007		[29] BENAYOUN	96	RVUE	0.54-1.04 $e^+e^- \to \eta\gamma$

$\Gamma(\pi^+\pi^-\gamma)/\Gamma_{total}$ — Γ_{15}/Γ

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.41±0.12±0.04		30175	[30] AKHMETSHIN	99B	CMD2	$e^+e^- \to \pi^+\pi^-\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
< 0.3	90		[31] AKHMETSHIN	97C	CMD2	$e^+e^- \to \pi^+\pi^-\gamma$
<600	90		KALBFLEISCH	75	HBC	2.18 $K^-p \to \Lambda\pi^+\pi^-\gamma$
< 70	90		COSME	74	OSPK	$e^+e^- \to \pi^+\pi^-\gamma$
<400	90		LINDSEY	65	HBC	2.1–2.7 $K^-p \to \Lambda\pi^+\pi^-$ neutrals

$\Gamma(\omega\gamma)/\Gamma_{total}$ — Γ_{13}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.05	84	LINDSEY	66	HBC	2.1–2.7 $K^-p \to \Lambda\pi^+\pi^-$ neutrals

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

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
< 0.12	90	[32] AKHMETSHIN	99B	CMD2	$e^+e^- \to \pi^+\pi^-\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
< 7	90	AKHMETSHIN	97C	CMD2	$e^+e^- \to \pi^+\pi^-\gamma$
<200	84	LINDSEY	66	HBC	2.1–2.7 $K^-p \to \Lambda\pi^+\pi^-$ neutrals

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

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
2.99±0.08 OUR AVERAGE Error includes scale factor of 1.2.					
2.88±0.09	55600	AKHMETSHIN	95	CMD2	$e^+e^- \to$ hadrons
3.00±0.21	3681	BUKIN	78C	OLYA	$e^+e^- \to$ hadrons
3.10±0.14		[33] PARROUR	76	OSPK	e^+e^-
3.3 ±0.3		COSME	74	OSPK	$e^+e^- \to$ hadrons
2.81±0.25	681	BALAKIN	71	OSPK	$e^+e^- \to$ hadrons
3.50±0.27		CHATELUS	71	OSPK	e^+e^-

$\Gamma(\pi^0\gamma)/\Gamma_{total}$ — Γ_7/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.31 ±0.13 OUR AVERAGE					
1.30 ±0.13		DRUZHININ	84	ND	$e^+e^- \to 3\gamma$
1.4 ±0.5	32	COSME	76	OSPK	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$1.226\pm0.036^{+0.096}_{-0.089}$		[34] ACHASOV	00	SND	$e^+e^- \to \pi^0\gamma$
1.26 ±0.17		[29] BENAYOUN	96	RVUE	0.54–1.04 $e^+e^- \to \pi^0\gamma$

$\Gamma(\pi^+\pi^-)/\Gamma_{total}$ — Γ_{11}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$0.71\pm0.11\pm0.09$		[17] ACHASOV	00C	SND	$e^+e^-\to\pi^+\pi^-$
$0.65^{+0.38}_{-0.29}$		[17] GOLUBEV	86	ND	$e^+e^-\to\pi^+\pi^-$
$2.01^{+1.07}_{-0.84}$		[17] VASSERMAN	81	OLYA	$e^+e^-\to\pi^+\pi^-$
<6.6	95	BUKIN	78B	OLYA	$e^+e^-\to\pi^+\pi^-$
<2.7	95	ALVENSLEB...	72	CNTR	$6.7\ \gamma C\to C\pi^+\pi^-$

$\Gamma(\omega\pi^0)/\Gamma_{total}$ — Γ_{12}/Γ

VALUE (units 10^{-5})	DOCUMENT ID		TECN	COMMENT
$\mathbf{4.8^{+1.9}_{-1.7}\pm0.8}$	ACHASOV	99	SND	$e^+e^-\to\pi^+\pi^-\pi^0\pi^0$

$\Gamma(K^0_L K^0_S)/\Gamma(K^+K^-)$ — Γ_2/Γ_1

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{0.688^{+0.022}_{-0.019}}$ **OUR FIT**	Error includes scale factor of 1.2.				
0.740±0.031 OUR AVERAGE					
$0.70\ \pm0.06$	2732	BUKIN	78C	OLYA	$e^+e^-\to K^0_L K^0_S$
$0.82\ \pm0.08$		LOSTY	78	HBC	$4.2\ K^-p\to\phi$hyperon
$0.71\ \pm0.05$		LAVEN	77	HBC	$10\ K^-p\to K^+K^-\Lambda$
$0.71\ \pm0.08$		LYONS	77	HBC	$3–4\ K^-p\to\Lambda\phi$
$0.89\ \pm0.10$	144	AGUILAR-...	72B	HBC	$3.9,4.6\ K^-p$

$[\Gamma(\rho\pi)+\Gamma(\pi^+\pi^-\pi^0)]/\Gamma(K^+K^-)$ — Γ_3/Γ_1

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.314±0.014 OUR FIT	Error includes scale factor of 1.4.				
0.28 ±0.09	34	AGUILAR-...	72B	HBC	$3.9,4.6\ K^-p$

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

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{1.3^{+0.8}_{-0.6}}$	7	GOLUBEV	85	ND	$e^+e^-\to\gamma\gamma e^+e^-$

$\Gamma(\eta'(958)\gamma)/\Gamma_{total}$ — Γ_{23}/Γ

VALUE (units 10^{-5})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{6.7^{+3.4}_{-2.9}\pm1.0}$		5	[35] AULCHENKO	99	SND	$e^+e^-\to\pi^+\pi^-3\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$8.2^{+2.1}_{-1.9}\pm1.1$		21	[36] AKHMETSHIN	00B	CMD2	$e^+e^-\to\pi^+\pi^-3\gamma$
<11	90		AULCHENKO	98	SND	$e^+e^-\to7\gamma$
$12\ ^{+7}_{-5}\ \pm2$		6	[36] AKHMETSHIN	97B	CMD2	$e^+e^-\to\pi^+\pi^-3\gamma$
<41	90		DRUZHININ	87	ND	$e^+e^-\to\gamma\eta\pi^+\pi^-$

$\Gamma(\eta\pi^0\pi^0\gamma)/\Gamma_{\rm total}$ — Γ_{24}/Γ

VALUE (units 10^{-5})	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<2	90	AULCHENKO	98	SND	$e^+e^- \to 7\gamma$

$\Gamma(\pi^0\pi^0\gamma)/\Gamma_{\rm total}$ — Γ_{17}/Γ

VALUE (units 10^{-4})	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1.08±0.17±0.09		268	AKHMETSHIN	99C	CMD2	$e^+e^- \to \pi^0\pi^0\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
1.14±0.10±0.12		164	ACHASOV	98I	SND	$e^+e^- \to 5\gamma$
<10	90		DRUZHININ	87	ND	$e^+e^- \to 5\gamma$

$\Gamma(\pi^0\pi^0\gamma)/\Gamma(\eta\gamma)$ — Γ_{17}/Γ_6

VALUE (units 10^{-2})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.90±0.08±0.07	164	ACHASOV	98I	SND	$e^+e^- \to 5\gamma$

$\Gamma(\pi^+\pi^+\pi^-\pi^-\pi^0)/\Gamma_{\rm total}$ — Γ_{19}/Γ

VALUE (units 10^{-4})	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<1.5	95	BARKOV	88	CMD	$e^+e^- \to \pi^+\pi^-\pi^+\pi^-\pi^0$

$\Gamma(\pi^+\pi^-\pi^+\pi^-)/\Gamma_{\rm total}$ — Γ_{18}/Γ

VALUE (units 10^{-4})	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<8.7	90	CORDIER	79	WIRE	$e^+e^- \to 4\pi$

$\Gamma(f_0(980)\gamma)/\Gamma_{\rm total}$ — Γ_{16}/Γ

VALUE (units 10^{-4})	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
3.4 ±0.4 OUR AVERAGE						
2.90±0.21±1.54			[37] AKHMETSHIN	99C	CMD2	$e^+e^- \to \pi^+\pi^-\gamma$, $\pi^0\pi^0\gamma$
3.42±0.30±0.36		164	[38] ACHASOV	98I	SND	$e^+e^- \to 5\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
1.93±0.46±0.50		27188	[39] AKHMETSHIN	99B	CMD2	$e^+e^- \to \pi^+\pi^-\gamma$
3.05±0.25±0.72		268	[40] AKHMETSHIN	99C	CMD2	$e^+e^- \to \pi^0\pi^0\gamma$
1.5 ±0.5		268	[41] AKHMETSHIN	99C	CMD2	$e^+e^- \to \pi^0\pi^0\gamma$
< 1	90		[42] AKHMETSHIN	97C	CMD2	$e^+e^- \to \pi^+\pi^-\gamma$
< 7	90		[43] AKHMETSHIN	97C	CMD2	$e^+e^- \to \pi^+\pi^-\gamma$
<20	90		DRUZHININ	87	ND	$e^+e^- \to \pi^0\pi^0\gamma$

$\Gamma(\pi^0e^+e^-)/\Gamma_{\rm total}$ — Γ_{20}/Γ

VALUE	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<1.2 × 10^{-4}	90	DOLINSKY	88	ND	$e^+e^- \to \pi^0e^+e^-$

$\Gamma(\pi^0 \eta\gamma)/\Gamma_{\text{total}}$ — Γ_{21}/Γ

VALUE (units 10^{-4})	*CL%*	*EVTS*	*DOCUMENT ID*	*TECN*	*COMMENT*
0.86±0.18 OUR AVERAGE					
0.90±0.24±0.10		80	AKHMETSHIN 99C	CMD2	$e^+e^- \to \eta\pi^0\gamma$
0.83±0.23±0.12		20	ACHASOV 98B	SND	$e^+e^- \to 5\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<25	90		DOLINSKY 91	ND	$e^+e^- \to \pi^0\eta\gamma$

$\Gamma(a_0(980)\gamma)/\Gamma_{\text{total}}$ — Γ_{22}/Γ

VALUE (units 10^{-3})	*CL%*	*DOCUMENT ID*	*TECN*	*COMMENT*
<5	90	DOLINSKY 91	ND	$e^+e^- \to \pi^0\eta\gamma$

$\Gamma(\eta'(958)\gamma)/\Gamma(\eta\gamma)$ — Γ_{23}/Γ_6

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*	*TECN*	*COMMENT*
$\mathbf{6.5^{+1.7}_{-1.5}\pm0.8}$	21	AKHMETSHIN 00B	CMD2	$e^+e^- \to \pi^+\pi^-3\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$9.5^{+5.2}_{-4.0}\pm1.4$	6	[44] AKHMETSHIN 97B	CMD2	$e^+e^- \to \pi^+\pi^-3\gamma$

$\Gamma(\mu^+\mu^-\gamma)/\Gamma_{\text{total}}$ — Γ_{25}/Γ

VALUE (units 10^{-5})	*EVTS*	*DOCUMENT ID*	*TECN*	*COMMENT*
1.43±0.45±0.14	27188	[39] AKHMETSHIN 99B	CMD2	$e^+e^- \to \mu^+\mu^-\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
2.3 ±1.0	824±33	[45] AKHMETSHIN 97C	CMD2	$e^+e^- \to \mu^+\mu^-\gamma$

$\Gamma(\rho\gamma\gamma)/\Gamma_{\text{total}}$ — Γ_{26}/Γ

VALUE (units 10^{-4})	*CL%*	*DOCUMENT ID*	*TECN*	*COMMENT*
<5	90	AKHMETSHIN 98	CMD2	$e^+e^- \to \pi^+\pi^-\gamma\gamma$

$\Gamma(\eta\pi^+\pi^-)/\Gamma_{\text{total}}$ — Γ_{27}/Γ

VALUE (units 10^{-4})	*CL%*	*DOCUMENT ID*	*TECN*	*COMMENT*
<3	90	AKHMETSHIN 98	CMD2	$e^+e^- \to \pi^+\pi^-\gamma\gamma$

[16] Using $\Gamma_{e^+e^-}$= 1.32 ± 0.04 keV.

[17] Using B($\phi \to e^+e^-$)=(2.99 ± 0.08) × 10^{-4}.

[18] Using Γ(ϕ)= 4.1 Mev. If interference between the $\rho\pi$ and 3π modes is neglected, the fraction of the $\rho\pi$ is more than 80% at the 90% confidence level.

[19] Neglecting interference between resonance and continuum.

[20] Recalculated by us using B($\phi \to e^+e^-$)= (2.99 ± 0.08) × 10^{-4}.

[21] Using B($\phi \to e^+e^-$) = (2.99 ± 0.08)×10^{-4} and B($\eta \to 3\pi^0$)= (32.2 ± 0.4)×10^{-2}.

[22] From $\pi^+\pi^-\pi^0$ decay mode of η.

[23] From 2γ decay mode of η.

[24] From $3\pi^0$ decay mode of η.

[25] From the $\eta \to 2\gamma$ decay and using B($\phi \to e^+e^-$) =(2.99 ± 0.08) × 10^{-4}.

[26] Using various decay modes of the η from ACHASOV 98F, ACHASOV 00, and ACHASOV 00B and B($\phi \to e^+e^-$) = (2.99 ± 0.08) × 10^{-4}.

[27] From the $\eta \to \pi^+\pi^-\pi^0$ decay and B($\phi \to e^+e^-$) = (2.99 ± 0.08) × 10^{-4}.

[28] From $\pi^+\pi^-\pi^0$ decay mode of η and using B($\phi \to e^+e^-$)= $(2.99 \pm 0.08) \times 10^{-4}$.
[29] Reanalysis of DRUZHININ 84, DOLINSKY 89, and DOLINSKY 91 taking into account a triangle anomaly contribution.
[30] For $E_\gamma > 20$ MeV and assuming that B($\phi(1020) \to f_0(980)\gamma$) is neglibible. Supersedes AKHMETSHIN 97C.
[31] For $E_\gamma > 20$ MeV and assuming that B($\phi(1020) \to f_0(980)\gamma$) is negligible.
[32] Supersedes AKHMETSHIN 97C.
[33] Using total width 4.2 MeV. They detect 3π mode and observe significant interference with ω tail. This is accounted for in the result quoted above.
[34] From the $\pi^0 \to 2\gamma$ decay and using B($\phi \to e^+e^-$) = $(2.99 \pm 0.08) \times 10^{-4}$.
[35] Using the value B($\eta' \to \eta\pi^+\pi^-$)= $(43.7 \pm 1.5) \times 10^{-2}$ and B($\eta \to \gamma\gamma$)= $(39.25 \pm 0.31) \times 10^{-2}$.
[36] Using the value B($\phi \to \eta\gamma$) = $(1.26 \pm 0.06) \times 10^{-2}$.
[37] From the combined fit of the photon spectra in the reactions $e^+e^- \to \pi^+\pi^-\gamma$, $\pi^0\pi^0\gamma$.
[38] Assuming that the $\pi^0\pi^0\gamma$ final state is completely determined by the $f_0\gamma$ mechanism, neglecting the decay B($\phi \to K\overline{K}\gamma$) and using B($f_0 \to \pi^+\pi^-$)= 2B($f_0 \to \pi^0\pi^0$).
[39] For $E_\gamma > 20$ MeV. Supersedes AKHMETSHIN 97C.
[40] Neglecting other intermediate mechanisms ($\rho\pi$, $\sigma\gamma$).
[41] A narrow pole fit taking into account $f_0(980)$ and $f_0(1200)$ intermediate mechanisms.
[42] For destructive interference with the Bremsstrahlung process
[43] For constructive interference with the Bremsstrahlung process
[44] Superseded by AKHMETSHIN 00B.
[45] For $E_\gamma > 20$ MeV.

$\pi^+\pi^-\pi^0$ / $\rho\pi$ AMPLITUDE RATIO a_1 IN DECAY OF $\phi \to \pi^+\pi^-\pi^0$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$-0.16 < a_1 < 0.11$	90	[46] AKHMETSHIN 98	CMD2	$e^+e^- \to \pi^+\pi^-\gamma\gamma$

[46] Dalitz plot analysis of 9735 events taking into account interference between the contact and $\rho\pi$ terms and assuming zero phase for the contact term.

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		Translated from ZHETF 117 22.		
ACHASOV	00C	PL B474 188	M.N. Achasov *et al.*	(Novosibirsk SND Collab.)
AKHMETSHIN	00B	PL B473 337	R.R. Akhmetshin *et al.*	(CMD-2 Collab.)
ACHASOV	99	PL B449 122	M.N. Achasov *et al.*	
ACHASOV	99C	PL B456 304	M.N. Achasov *et al.*	
AKHMETSHIN	99B	PL B462 371	R.R. Akhmetshin *et al.*	(CMD-2 Collab.)
AKHMETSHIN	99C	PL B462 380	R.R. Akhmetshin *et al.*	(CMD-2 Collab.)
AKHMETSHIN	99D	PL B466 385	R.R. Akhmetshin *et al.*	
AKHMETSHIN	99F	PL B460 242	R.R. Akhmetshin *et al.*	(CMD-2 Collab.)
AULCHENKO	99	JETPL 69 97	V.M. Aulchenko *et al.*	
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ACHASOV	98F	JETPL 68 573	M.N. Achasov *et al.*	(Novosibirsk SND Collab.)
ACHASOV	98I	PL B440 442	M.N. Achasov *et al.*	
AKHMETSHIN	98	PL B434 426	R.R. Akhmetshin *et al.*	
AULCHENKO	98	PL B436 199	V.M. Aulchenko *et al.*	
BARBERIS	98	PL B432 436	D. Barberis *et al.*	(Omega expt.)
AKHMETSHIN	97B	PL B415 445	R.R. Akhmetshin *et al.*	(NOVO, BOST, PITT+)
AKHMETSHIN	97C	PL B415 452	R.R. Akhmetshin *et al.*	(CMD-2 Collab.)
BENAYOUN	96	ZPHY C72 221	M. Benayoun *et al.*	(IPNP, NOVO)
AKHMETSHIN	95	PL B364 199	R.R. Akhmetshin *et al.*	(CMD-2 Collab.)
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		Translated from YAF 47 393.		
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ATKINSON	86	ZPHY C30 521	M. Atkinson *et al.*	(BONN, CERN, GLAS+)
BEBEK	86	PRL 56 1893	C. Bebek *et al.*	(CLEO Collab.)
DAVENPORT	86	PR 33 2519	T.F. Davenport	(TUFTS, ARIZ, FNAL, FSU, NDAM+)
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KURDADZE	83C	JETPL 38 366	L.M. Kurdadze *et al.*	(NOVO)
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DAUM	81	PL 100B 439	C. Daum *et al.*	(AMST, BRIS, CERN, CRAC+)
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Also	70	PL 32 416	J.C. Bizot *et al.*	(ORSAY)
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		Translated from YAF 62 484.		
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ACHASOV	98C	PR D57 1987	N.N. Achasov *et al.*	
OLLER	98B	PL B426 7	J.A. Oller	
ACHASOV	97C	PR D56 4084	N.N. Achasov *et al.*	
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ACHASOV	95	PLB 363 106	N.N. Achasov, V.V. Gubin	(NOVM)
KAMAL	92	PL B284 421	A.N. Kamal, Q.P. Xu	(ALBE)
GEORGIO...	85	PL 152B 428	C. Georgiopoulos *et al.*	(TUFTS, ARIZ, FNAL+)
GELFAND	63B	PRL 11 438	N. Gelfand *et al.*	(COLU, RUTG)
BERTANZA	62	PRL 9 180	L. Bertanza *et al.*	(BNL, SYRA)