$\phi(1020)$

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

$\phi(1020)$ MASS

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

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1019.413±0.008 OUR AVERAGE					
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	[1] 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	[2] 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	[3] ATKINSON	86	OMEG	20–70 γp
1019.7 ±1.0		BEBEK	86	CLEO	$e^+e^- \rightarrow \Upsilon(4S)$
1020.9 ±0.2		[3] FRAME	86	OMEG	13 $K^+p \rightarrow \phi K^+p$
1021.0 ±0.2		[3] ARMSTRONG	83B	OMEG	18.5 $K^-p \rightarrow K^-K^+\Lambda$
1020.0 ±0.5		[3] ARMSTRONG	83B	OMEG	18.5 $K^-p \rightarrow K^-K^+\Lambda$
1019.7 ±0.3		[3] 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	[3] 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 $\gamma p \rightarrow pK^+K^-$

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	[4] AGUILAR-...	72B	HBC	3.9,4.6 $K^- p \rightarrow \Lambda K^+ K^-$
1019.9 ±0.5	100	[4] 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] Weighted and scaled average of 12 measurements of DIJKSTRA 86.
[2] PELLINEN 82 review includes AKERLOF 77, DAUM 81, BALDI 77, AYRES 74, DEGROOT 74.
[3] Systematic errors not evaluated.
[4] Mass errors enlarged by us to $\Gamma/\sqrt{N}$; see the note with the $K^*(892)$ mass.

ϕ(1020) WIDTH

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

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
4.43±0.05 OUR AVERAGE					
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. $p p \rightarrow K K$
4.2 ±0.6	766	[5] IVANOV	81	OLYA	1–1.4 $e^+ e^- \rightarrow K^+ K^-$
4.3 ±0.6		[5] CORDIER	80	WIRE	$e^+ e^- \rightarrow \pi^+ \pi^- \pi^0$
4.36±0.29	3681	[5] BUKIN	78C	OLYA	$e^+ e^- \rightarrow$ hadrons
4.4 ±0.6	984	[5] BESCH	74	CNTR	2 $\gamma p \rightarrow p K^+ K^-$
4.67±0.72	681	[5] 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	[5] COOPER	78B	HBC	0.7–0.8 $\overline{p} p \rightarrow K^0_S K^0_L \pi^+ \pi^-$
4.5 ±0.50	1300	[5,6] AKERLOF	77	SPEC	400 pA $\rightarrow K^+ K^-$ X
4.5 ±0.8	500	[5,6] 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	[5] BORENSTEIN	72	HBC	2.18 $K^- p \rightarrow K \overline{K} n$

[5] Width errors enlarged by us to $4\Gamma/\sqrt{N}$; see the note with the $K^*(892)$ mass.
[6] Systematic errors not evaluated.

$\phi(1020)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Scale factor/ Confidence level
Γ_1	K^+K^-	(49.1 ± 0.8) %	S=1.3
Γ_2	$K^0_L K^0_S$	(34.1 ± 0.6) %	S=1.2
Γ_3	$\rho\pi + \pi^+\pi^-\pi^0$	(15.5 ± 0.7) %	S=1.5
Γ_4	$\rho\pi$		
Γ_5	$\pi^+\pi^-\pi^0$		
Γ_6	$\eta\gamma$	(1.26 ± 0.06) %	S=1.1
Γ_7	$\pi^0\gamma$	$(1.31\pm0.13) \times 10^{-3}$	
Γ_8	e^+e^-	$(2.99\pm0.08) \times 10^{-4}$	S=1.2
Γ_9	$\mu^+\mu^-$	$(2.5 \pm 0.4) \times 10^{-4}$	
Γ_{10}	ηe^+e^-	$(1.3 {}^{+0.8}_{-0.6}) \times 10^{-4}$	
Γ_{11}	$\pi^+\pi^-$	$(8 {}^{+5}_{-4}) \times 10^{-5}$	S=1.5
Γ_{12}	$\omega\gamma$	< 5 %	CL=84%
Γ_{13}	$\rho\gamma$	$< 7 \times 10^{-4}$	CL=90%
Γ_{14}	$\pi^+\pi^-\gamma$	$< 3 \times 10^{-5}$	CL=90%
Γ_{15}	$f_0(980)\gamma$	$< 1 \times 10^{-4}$	CL=90%
Γ_{16}	$\pi^0\pi^0\gamma$	$< 1 \times 10^{-3}$	CL=90%
Γ_{17}	$\pi^+\pi^-\pi^+\pi^-$	$< 8.7 \times 10^{-4}$	CL=90%
Γ_{18}	$\pi^+\pi^+\pi^-\pi^-\pi^0$	$< 1.5 \times 10^{-4}$	CL=95%
Γ_{19}	$\pi^0 e^+e^-$	$< 1.2 \times 10^{-4}$	CL=90%
Γ_{20}	$\pi^0\eta\gamma$	$< 2.5 \times 10^{-3}$	CL=90%
Γ_{21}	$a_0(980)\gamma$	$< 5 \times 10^{-3}$	CL=90%
Γ_{22}	$\eta'(958)\gamma$	$(1.2 {}^{+0.7}_{-0.5}) \times 10^{-4}$	
Γ_{23}	$\mu^+\mu^-\gamma$	$(2.3 \pm 1.0) \times 10^{-5}$	

CONSTRAINED FIT INFORMATION

An overall fit to 9 branching ratios uses 29 measurements and one constraint to determine 4 parameters. The overall fit has a $\chi^2 =$ 26.9 for 26 degrees of freedom.

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

x_2	−53		
x_3	−60	−36	
x_6	−3	−3	−2
	x_1	x_2	x_3

$\phi(1020)$ BRANCHING RATIOS

$\Gamma(K^+K^-)/\Gamma_{total}$ Γ_1/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.491±0.008 OUR FIT Error includes scale factor of 1.3.					
0.493±0.010 OUR AVERAGE					
0.492±0.012	2913	AKHMETSHIN	95	CMD2	$e^+e^- \to K^+K^-$
0.44 ±0.05	321	KALBFLEISCH	76	HBC	2.18 $K^-p \to \Lambda K^+K^-$
0.49 ±0.06	270	DEGROOT	74	HBC	4.2 $K^-p \to \Lambda\phi$
0.540±0.034	565	BALAKIN	71	OSPK	$e^+e^- \to K^+K^-$
0.48 ±0.04	252	LINDSEY	66	HBC	2.1–2.7 $K^-p \to \Lambda K^+K^-$

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.341±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	$e^+e^- \to K^0_L K^0_S$
0.326±0.035		DOLINSKY	91	ND	$e^+e^- \to K^0_L K^0_S$
0.310±0.024		DRUZHININ	84	ND	$e^+e^- \to K^0_L K^0_S$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.27 ±0.03	133	KALBFLEISCH	76	HBC	2.18 $K^-p \to \Lambda K^0_L K^0_S$
0.257±0.030	95	BALAKIN	71	OSPK	$e^+e^- \to K^0_L K^0_S$
0.40 ±0.04	167	LINDSEY	66	HBC	2.1–2.7 $K^-p \to \Lambda K^0_L K^0_S$

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.155±0.007 OUR FIT Error includes scale factor of 1.5.					
0.151±0.009 OUR AVERAGE Error includes scale factor of 1.7.					
0.161±0.008	11761	AKHMETSHIN	95	CMD2	$e^+e^- \to \pi^+\pi^-\pi^0$
0.143±0.007		DOLINSKY	91	ND	$e^+e^- \to \pi^+\pi^-\pi^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.139±0.007		[7] PARROUR	76B	OSPK	e^+e^-

[7] Using total width 4.1 MeV. The $\rho\pi$ to 3π mode is more than 80%. at the 90% confidence level.

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.410±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 $K^-p \to \Lambda K\overline{K}$
0.48 ±0.07	52	BADIER	65B	HBC	3 K^-p
0.40 ±0.10	34	SCHLEIN	63	HBC	1.95 $K^-p \to \Lambda K\overline{K}$

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

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
0.187±0.010 OUR FIT Error includes scale factor of 1.5.				
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 $K^- p \to \Lambda\pi^+\pi^-\pi^0$

$[\Gamma(\rho\pi) + \Gamma(\pi^+\pi^-\pi^0)]/\Gamma(K^0_L K^0_S)$ $\qquad\Gamma_3/\Gamma_2$

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.456±0.025 OUR FIT Error includes scale factor of 1.5.					
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	$e^+e^- \to \pi^+\pi^-\pi^0$

$\Gamma(\mu^+\mu^-)/\Gamma_{total}$ $\qquad\Gamma_9/\Gamma$

VALUE (units 10^{-4})	*DOCUMENT ID*		*TECN*	*COMMENT*
2.5 ±0.4 OUR AVERAGE				
2.69±0.46	[8] HAYES	71	CNTR	8.3,9.8 $\gamma C \to \mu^+\mu^- X$
2.17±0.60	[8] EARLES	70	CNTR	6.0 $\gamma C \to \mu^+\mu^- X$

[8] Neglecting interference between resonance and continuum.

$\Gamma(\eta\gamma)/\Gamma_{total}$ $\qquad\Gamma_6/\Gamma$

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.0126±0.0006 OUR FIT Error includes scale factor of 1.1.					
0.0126±0.0005 OUR AVERAGE Error includes scale factor of 1.1.					
0.0118±0.0011	279	[9] AKHMETSHIN	95	CMD2	$e^+e^- \to \pi^+\pi^- 3\gamma$
0.0130±0.0006		[10] DRUZHININ	84	ND	$e^+e^- \to 3\gamma$
0.014 ±0.002		[11] 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	[10] COSME	76	OSPK	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.0121±0.0007		[12] BENAYOUN	96	RVUE	0.54-1.04 $e^+e^- \to \eta\gamma$

[9] From $\pi^+\pi^-\pi^0$ decay mode of η.
[10] From 2γ decay mode of η.
[11] From $3\pi^0$ decay mode of η.
[12] Reanalysis of DRUZHININ 84, DOLINSKY 89, and DOLINSKY 91 taking into account a triangle anomaly contribution.

$\Gamma(\pi^+\pi^-\gamma)/\Gamma_{total}$ $\qquad\Gamma_{14}/\Gamma$

VALUE (units 10^{-4})	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
< 0.3	90	[13] AKHMETSHIN	97C	CMD2	$e^+e^- \to \pi^+\pi^-\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<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

[13] For $E_\gamma > 20$ MeV and assuming that B($\phi(1020) \to f_0(980)\gamma$) is negligible.

$\Gamma(\omega\gamma)/\Gamma_{total}$ — Γ_{12}/Γ

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

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

VALUE (units 10^{-4})	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
< 7	90	AKHMETSHIN	97C	CMD2	$e^+ e^- \rightarrow \pi^+ \pi^- \gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<200	84	LINDSEY	66	HBC	2.1–2.7 $K^- p \rightarrow \Lambda \pi^+ \pi^-$ 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	$e^+ e^- \rightarrow$ hadrons
3.00±0.21	3681	BUKIN	78C	OLYA	$e^+ e^- \rightarrow$ hadrons
3.10±0.14		[14] PARROUR	76	OSPK	$e^+ e^-$
3.3 ±0.3		COSME	74	OSPK	$e^+ e^- \rightarrow$ hadrons
2.81±0.25	681	BALAKIN	71	OSPK	$e^+ e^- \rightarrow$ hadrons
3.50±0.27		CHATELUS	71	OSPK	$e^+ e^-$

[14] 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.

$\Gamma(\pi^0\gamma)/\Gamma_{total}$ — 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	$e^+ e^- \rightarrow 3\gamma$
1.4 ±0.5	32	COSME	76	OSPK	$e^+ e^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1.26±0.17		[12] BENAYOUN	96	RVUE	0.54–1.04 $e^+ e^- \rightarrow \pi^0 \gamma$

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

VALUE (units 10^{-4})	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
$0.8^{+0.5}_{-0.4}$ OUR AVERAGE Error includes scale factor of 1.5.					
$0.63^{+0.37}_{-0.28}$		[15] GOLUBEV	86	ND	$e^+ e^- \rightarrow \pi^+ \pi^-$
$1.94^{+1.03}_{-0.81}$		[15] VASSERMAN	81	OLYA	$e^+ e^-$
<6.6	95	BUKIN	78B	OLYA	$e^+ e^- \rightarrow \pi^+ \pi^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<2.7	95	ALVENSLEB...	72	CNTR	6.7 $\gamma C \rightarrow C \pi^+ \pi^-$

[15] Using $\Gamma(e^+ e^-)/\Gamma_{total} = 3.1 \times 10^{-4}$.

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.695±0.021 OUR FIT	Error includes scale factor of 1.2.				
0.740±0.031 OUR AVERAGE					
0.70 ±0.06	2732	BUKIN	78C	OLYA	$e^+e^- \rightarrow K^0_L K^0_S$
0.82 ±0.08		LOSTY	78	HBC	4.2 $K^- p \rightarrow \phi$hyperon
0.71 ±0.05		LAVEN	77	HBC	10 $K^- p \rightarrow K^+K^-\Lambda$
0.71 ±0.08		LYONS	77	HBC	3–4 $K^- p \rightarrow \Lambda\phi$
0.89 ±0.10	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
0.317±0.017 OUR FIT	Error includes scale factor of 1.5.				
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	$e^+e^- \rightarrow \gamma\gamma e^+e^-$

$\Gamma(\eta'(958)\gamma)/\Gamma_{total}$ — Γ_{22}/Γ

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$1.2^{+0.7}_{-0.5}\pm0.2$		6	[16] AKHMETSHIN	97B	CMD2	$e^+e^- \rightarrow \pi^+\pi^- 3\gamma$
<4.1	90		DRUZHININ	87	ND	$e^+e^- \rightarrow \gamma\eta\pi^+\pi^-$

[16] Using the value $B(\phi \rightarrow \eta\gamma) = (1.26 \pm 0.06) \times 10^{-2}$

$\Gamma(\pi^0\pi^0\gamma)/\Gamma_{total}$ — Γ_{16}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<1	90	DRUZHININ	87	ND	$e^+e^- \rightarrow 5\gamma$

$\Gamma(\pi^+\pi^+\pi^-\pi^-\pi^0)/\Gamma_{total}$ — Γ_{18}/Γ

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

$\Gamma(\pi^+\pi^-\pi^+\pi^-)/\Gamma_{total}$ — Γ_{17}/Γ

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

$\Gamma(f_0(980)\gamma)/\Gamma_{total}$ — Γ_{15}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
< 1	90	[17] AKHMETSHIN	97C	CMD2	$e^+e^- \rightarrow \pi^+\pi^-\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
< 7	90	[18] AKHMETSHIN	97C	CMD2	$e^+e^- \rightarrow \pi^+\pi^-\gamma$
<20	90	DRUZHININ	87	ND	$e^+e^- \rightarrow \pi^0\pi^0\gamma$

[17] For destructive interference with the Bremsstrahlung process
[18] For constructive interference with the Bremsstrahlung process

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

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

$\Gamma(\pi^0 \eta\gamma)/\Gamma_{total}$ — Γ_{20}/Γ

VALUE (units 10^{-3})	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<2.5	90	DOLINSKY	91	ND	$e^+ e^- \rightarrow \pi^0 \eta\gamma$

$\Gamma(a_0(980)\gamma)/\Gamma_{total}$ — Γ_{21}/Γ

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

$\Gamma(\eta'(958)\gamma)/\Gamma(\eta\gamma)$ — Γ_{22}/Γ_6

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
$9.5^{+5.2}_{-4.0}\pm1.4$	6	AKHMETSHIN	97B	CMD2	$e^+ e^- \rightarrow \pi^+ \pi^- 3\gamma$

$\Gamma(\mu^+ \mu^- \gamma)/\Gamma_{total}$ — Γ_{23}/Γ

VALUE (units 10^{-5})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
2.3 ± 1.0	824 ± 33	[19] AKHMETSHIN	97C	CMD2	$e^+ e^- \rightarrow \mu^+ \mu^- \gamma$

[19] For $E_\gamma > 20$ MeV.

ϕ(1020) REFERENCES

AKHMETSHIN	97B	PL B415 445	R.R. Akhmetshin, Anashkin+	(NOVO, BOST, PITT, YALE)
AKHMETSHIN	97C	PL B415 452	+Aksenov+	(NOVO, BOST, PITT, YALE)
BENAYOUN	96	ZPHY C72 221	M. Benayoun+	(IPNP, NOVO)
AKHMETSHIN	95	PL B364 199	+Akesnov+	(NOVO, BOST, PITT, MINN, YALE)
DOLINSKY	91	PRPL 202 99	+Druzhinin, Dubrovin+	(NOVO)
DOLINSKY	89	ZPHY C42 511	+Druzhinin, Dubrovin, Golubev+	(NOVO)
BARKOV	88	SJNP 47 248	+Vasserman, Vorobyev, Ivanov+	(NOVO)
		Translated from YAF 47 393.		
DOLINSKY	88	SJNP 48 277	+Druzhinin, Dubrovin, Golubev+	(NOVO)
		Translated from YAF 48 442.		
DRUZHININ	87	ZPHY C37 1	+Dubrovin, Eidelman, Golubev+	(NOVO)
ARMSTRONG	86	PL 166B 245	+Bloodworth, Carney+	(ATHU, BARI, BIRM, CERN)
ATKINSON	86	ZPHY C30 521	+	(BONN, CERN, GLAS, LANC, MCHS, CURIN+)
BEBEK	86	PRL 56 1893	+Berkelman, Blucher, Cassel+	(CLEO Collab.)
DAVENPORT	86	PR 33 2519		(TUFTS, ARIZ, FNAL, FSU, NDAM, VAND)
DIJKSTRA	86	ZPHY C31 375	+Bailey+	(ANIK, BRIS, CERN, CRAC, MPIM, RAL)
FRAME	86	NP B276 667	+Hughes, Lynch, Minto, McFadzean+	(GLAS)
GOLUBEV	86	SJNP 44 409	+Druzhinin, Ivanchenko, Perevedentsev+	(NOVO)
		Translated from YAF 44 633.		
ALBRECHT	85D	PL 153B 343	+Drescher, Binder, Drews+	(ARGUS Collab.)
GOLUBEV	85	SJNP 41 756	+Druzhinin, Ivanchenko, Peryshkin+	(NOVO)
		Translated from YAF 41 1183.		
DRUZHININ	84	PL 144B 136	+Golubev, Ivanchenko, Peryshkin+	(NOVO)
ARMSTRONG	83B	NP B224 193	+	(BARI, BIRM, CERN, MILA, CURIN+)
BARATE	83	PL 121B 449	+Bareyre, Bonamy+	(SACL, LOIC, SHMP, IND)
KURDADZE	83C	JETPL 38 366	+Lelchuk, Root+	(NOVO)
		Translated from ZETFP 38 306.		

ARENTON	82	PR D25 2241	+Ayres, Diebold, May, Swallow+	(ANL, ILL)	
PELLINEN	82	PS 25 599	+Roos	(HELS)	
DAUM	81	PL 100B 439	+Bardsley+	(AMST, BRIS, CERN, CRAC, MPIM+)	
IVANOV	81	PL 107B 297	+Kurdadze, Lelchuk, Sidorov, Skrinsky+	(NOVO)	
Also	82	Private Comm.	Eidelman	(NOVO)	
VASSERMAN	81	PL 99B 62	+Kurdadze, Sidorov, Skrinsky+	(NOVO)	
CORDIER	80	NP B172 13	+Delcourt, Eschstruth, Fulda+	(LALO)	
CORDIER	79	PL 81B 389	+Delcourt, Eschstruth, Fulda+	(LALO)	
BUKIN	78B	SJNP 27 521	+Kurdadze, Sidorov, Skrinsky+	(NOVO)	
		Translated from YAF 27 985.			
BUKIN	78C	SJNP 27 516	+Kurdadze, Serednyakov, Sidorov+	(NOVO)	
		Translated from YAF 27 976.			
COOPER	78B	NP B146 1	+Ganguli+	(TATA, CERN, CDEF, MADR)	
LOSTY	78	NP B133 38	+Holmgren, Blokzijl+	(CERN, AMST, NIJM, OXF)	
AKERLOF	77	PRL 39 861	+Alley, Bintinger, Ditzler+	(FNAL, MICH, PURD)	
ANDREWS	77	PRL 38 198	+Fukushima, Harvey, Lobkowicz, May+	(ROCH)	
BALDI	77	PL 68B 381	+Bohringer, Dorsaz, Hungerbuhler+	(GEVA)	
CERRADA	77B	NP B126 241	+Blockzijl, Heinen+	(AMST, CERN, NIJM, OXF)	
COHEN	77	PRL 38 269	+Ayres, Diebold, Kramer, Pawlicki, Wicklund	(ANL)	
LAVEN	77	NP B127 43	+Otter, Klein+	(AACH3, BERL, CERN, LOIC, WIEN)	
LYONS	77	NP B125 207	+Cooper, Clark	(OXF)	
COSME	76	PL 63B 352	+Courau, Dudelzak, Grelaud, Jean-Marie+	(ORSAY)	
KALBFLEISCH	76	PR D13 22	+Strand, Chapman	(BNL, MICH)	
PARROUR	76	PL 63B 357	+Grelaud, Cosme, Courau, Dudelzak+	(ORSAY)	
PARROUR	76B	PL 63B 362	+Grelaud, Cosme, Courau, Dudelzak+	(ORSAY)	
KALBFLEISCH	75	PR D11 987	+Strand, Chapman	(BNL, MICH)	
AYRES	74	PRL 32 1463	+Diebold, Greene, Kramer, Levine+	(ANL)	
BESCH	74	NP B70 257	+Hartmann, Kose, Krautschneider, Paul+	(BONN)	
COSME	74	PL 48B 155	+Jean-Marie, Jullian, Laplanche+	(ORSAY)	
COSME	74B	PL 48B 159	+Jean-Marie, Jullian, Laplanche+	(ORSAY)	
DEGROOT	74	NP B74 77	+Hoogland, Jongejans, Metzger+	(AMST, NIJM)	
BALLAM	73	PR D7 3150	+Chadwick, Eisenberg, Bingham+	(SLAC, LBL)	
BINNIE	73B	PR D8 2789	+Carr, Debenham, Duane+	(LOIC, SHMP)	
AGUILAR-...	72B	PR D6 29	Aguilar-Benitez, Chung, Eisner, Samios	(BNL)	
ALVENSLEB...	72	PRL 28 66	Alvensleben, Becker, Biggs, Binkley+	(MIT, DESY)	
BORENSTEIN	72	PR D5 1559	+Danburg, Kalbfleisch+	(BNL, MICH)	
COLLEY	72	NP B50 1	+Jobes, Riddiford, Griffiths+	(BIRM, GLAS)	
BALAKIN	71	PL 34B 328	+Budker, Pakhtusova, Sidorov, Skrinsky+	(NOVO)	
CHATELUS	71	Thesis LAL 1247		(STRB)	
Also	70	PL 32 416	Bizot, Buon, Chatelus, Jeanjean+	(ORSAY)	
HAYES	71	PR D4 899	+Imlay, Joseph, Keizer, Stein	(CORN)	
STOTTLE...	71	Thesis ORO 2504 170	Stottlemyer	(UMD)	
BIZOT	70	PL 32 416	+Buon, Chatelus, Jeanjean+	(ORSAY)	
Also	69	Liverpool Sym. 69	Perez-y-Jorba		
EARLES	70	PRL 25 1312	+Faissler, Gettner, Lutz, Moy, Tang+	(NEAS)	
LINDSEY	66	PR 147 913	+Smith	(LRL)	
LONDON	66	PR 143 1034	+Rau, Goldberg, Lichtman+	(BNL, SYRA)	IGJPC
BADIER	65B	PL 17 337	+Demoulin, Barloutaud+	(EPOL, SACL, AMST)	
LINDSEY	65	PRL 15 221	+Smith	(LRL)	
LINDSEY 65 data included in LINDSEY 66.					
SCHLEIN	63	PRL 10 368	+Slater, Smith, Stork, Ticho	(UCLA)	IGJP

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ACHASOV	95	PLB 363 106	+Gubin	(NOVM)
KAMAL	92	PL B284 421	+Xu	(ALBE)
GEORGIO...	85	PL 152B 428	Georgiopoulos+	(TUFTS, ARIZ, FNAL, FSU, NDAM+)
GELFAND	63B	PRL 11 438	+Miller, Nussbaum, Kirsch+	(COLU, RUTG)
BERTANZA	62	PRL 9 180	+Brisson, Connolly, Hart+	(BNL, SYRA)