K^0_L

$I(J^P) = \frac{1}{2}(0^-)$

$m_{K^0_L} - m_{K^0_S}$

For earlier measurements, beginning with GOOD 61 and FITCH 61, see our 1986 edition, Physics Letters **170B** 132 (1986).

OUR FIT is described in the note on "Fits for K^0_L *CP*-Violation Parameters" in the K^0_L Particle Listings.

VALUE ($10^{10}\ \hbar\ s^{-1}$)		*DOCUMENT ID*		*TECN*	*COMMENT*
0.5300±0.0012 OUR FIT					
0.5307±0.0015 OUR AVERAGE		Error includes scale factor of 1.1.			
0.5240±0.0044	±0.0033	APOSTOLA...	99C	CPLR	K^0-$\overline{K}^0$ to $\pi^+\pi^-$
0.5295±0.0020	±0.0003	[1] ANGELOPO...	98D	CPLR	
0.5297±0.0030	±0.0022	[2] SCHWINGEN...	95	E773	20–160 GeV K beams
0.5257±0.0049	±0.0021	[2] GIBBONS	93C	E731	20–160 GeV K beams
0.5340±0.00255	±0.0015	[3] GEWENIGER	74C	SPEC	Gap method
0.5334±0.0040	±0.0015	[3] GJESDAL	74	SPEC	Charge asymmetry in $K^0_{\ell 3}$
0.542 ±0.006		CULLEN	70	CNTR	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.5307±0.0013		[4] ADLER	96C	RVUE	
0.5274±0.0029	±0.0005	[1] ADLER	95	CPLR	Sup. by ANGELOPOULOS 98D
0.5286±0.0028		[5] GIBBONS	93	E731	20–160 GeV K beams
0.482 ±0.014		[6] ARONSON	82B	SPEC	E=30–110 GeV
0.534 ±0.007		[7] CARNEGIE	71	ASPK	Gap method
0.542 ±0.006		[7] ARONSON	70	ASPK	Gap method

[1] Uses $\overline{K}^0_{e3}$ and K^0_{e3} strangeness tagging at production and decay.

[2] Fits Δm and ϕ_{+-} simultaneously. GIBBONS 93C systematic error is from B. Winstein via private communtication.

[3] These two experiments have a common systematic error due to the uncertainty in the momentum scale, as pointed out in WAHL 89.

[4] ADLER 96C is the result of a fit which includes nearly the same data as entered into the "OUR FIT" value above.

[5] GIBBONS 93 value assume $\phi_{+-} = \phi_{00} = \phi_{SW} = (43.7 \pm 0.2)^\circ$.

[6] ARONSON 82 find that Δm may depend on the kaon energy.

[7] ARONSON 70 and CARNEGIE 71 use K^0_S mean life = $(0.862 \pm 0.006) \times 10^{-10}$ s. We have not attempted to adjust these values for the subsequent change in the K^0_S mean life or in η_{+-}.

K^0_L MEAN LIFE

VALUE (10^{-8} s)	*EVTS*	*DOCUMENT ID*		*TECN*
5.17 ±0.04 OUR FIT	Error includes scale factor of 1.1.			
5.15 ±0.04 OUR AVERAGE				
5.154±0.044	0.4M	VOSBURGH	72	CNTR
5.15 ±0.14		DEVLIN	67	CNTR

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

5.0	± 0.5		[8] LOWYS	67	HLBC
6.1	$^{+1.5}_{-1.2}$	1700	ASTBURY	65C	CNTR
5.3	± 0.6		FUJII	64	OSPK
5.1	$^{+2.4}_{-1.3}$	15	DARMON	62	FBC
8.1	$^{+3.2}_{-2.4}$	34	BARDON	58	CNTR

[8] Sum of partial decay rates.

K^0_L DECAY MODES

	Mode		Fraction (Γ_i/Γ)	Scale factor/ Confidence level
Γ_1	$3\pi^0$		(21.13 ± 0.27) %	S=1.1
Γ_2	$\pi^+\pi^-\pi^0$		(12.55 ± 0.20) %	S=1.7
Γ_3	$\pi^\pm\mu^\mp\nu_\mu$	[a]	(27.18 ± 0.25) %	S=1.1
	Called $K^0_{\mu3}$.			
Γ_4	$\pi^-\mu^+\nu_\mu$			
Γ_5	$\pi^+\mu^-\overline{\nu}_\mu$			
Γ_6	$\pi^\pm e^\mp\nu_e$	[a]	(38.78 ± 0.28) %	S=1.1
	Called K^0_{e3}.			
Γ_7	$\pi^- e^+\nu_e$			
Γ_8	$\pi^+ e^-\overline{\nu}_e$			
Γ_9	2γ		$(5.86 \pm 0.15) \times 10^{-4}$	
Γ_{10}	3γ		$< 2.4 \times 10^{-7}$	CL=90%
Γ_{11}	$\pi^0 2\gamma$	[b]	$(1.68 \pm 0.10) \times 10^{-6}$	
Γ_{12}	$\pi^0\pi^\pm e^\mp\nu$	[a]	$(5.18 \pm 0.29) \times 10^{-5}$	
Γ_{13}	$(\pi\mu\,\text{atom})\nu$		$(1.06 \pm 0.11) \times 10^{-7}$	
Γ_{14}	$\pi^\pm e^\mp\nu_e\gamma$	[a,b,c]	$(3.62 {}^{+0.26}_{-0.21}) \times 10^{-3}$	
Γ_{15}	$\pi^\pm\mu^\mp\nu_\mu\gamma$		$(5.7 {}^{+0.6}_{-0.7}) \times 10^{-4}$	
Γ_{16}	$\pi^+\pi^-\gamma$	[b,c]	$(4.61 \pm 0.14) \times 10^{-5}$	
Γ_{17}	$\pi^0\pi^0\gamma$		$< 5.6 \times 10^{-6}$	
Γ_{18}	$\mu^+\mu^-\gamma$		$(3.25 \pm 0.28) \times 10^{-7}$	
Γ_{19}	$e^+e^-\gamma$		$(10.0 \pm 0.5) \times 10^{-6}$	S=1.5
Γ_{20}	$e^+e^-\gamma\gamma$	[b]	$(6.9 \pm 1.0) \times 10^{-7}$	
Γ_{21}	$\pi^0\gamma e^+e^-$		$< 7.1 \times 10^{-7}$	CL=90%

Charge conjugation × Parity (*CP*, *CPV*) or Lepton Family number (*LF*) violating modes, or $\Delta S = 1$ weak neutral current (*S1*) modes

Γ_{22}	$\pi^+\pi^-$	*CPV*		(2.056±0.033) × 10^{-3}		
Γ_{23}	$\pi^0\pi^0$	*CPV*		(9.27 ±0.19) × 10^{-4}		
Γ_{24}	$\mu^+\mu^-$	*S1*		(7.15 ±0.16) × 10^{-9}		
Γ_{25}	e^+e^-	*S1*		(9 $^{+6}_{-4}$) × 10^{-12}		
Γ_{26}	$\pi^+\pi^-e^+e^-$	*S1*	[*b*]	(3.5 ±0.6) × 10^{-7}		
Γ_{27}	$\mu^+\mu^-e^+e^-$	*S1*		(2.9 $^{+6.7}_{-2.4}$) × 10^{-9}		
Γ_{28}	$e^+e^-e^+e^-$	*S1*		(4.1 ±0.8) × 10^{-8}	S=1.2	
Γ_{29}	$\pi^0\mu^+\mu^-$	*CP,S1*	[*d*]	< 5.1 × 10^{-9}	CL=90%	
Γ_{30}	$\pi^0e^+e^-$	*CP,S1*	[*d*]	< 4.3 × 10^{-9}	CL=90%	
Γ_{31}	$\pi^0\nu\overline{\nu}$	*CP,S1*	[*e*]	< 5.9 × 10^{-7}	CL=90%	
Γ_{32}	$e^\pm\mu^\mp$	*LF*	[*a*]	< 4.7 × 10^{-12}	CL=90%	
Γ_{33}	$e^\pm e^\pm\mu^\mp\mu^\mp$	*LF*	[*a*]	< 6.1 × 10^{-9}	CL=90%	
Γ_{34}	$\pi^0\mu^\pm e^\mp$	*LF*	[*a*]	< 6.2 × 10^{-9}	CL=90%	

[*a*] The value is for the sum of the charge states or particle/antiparticle states indicated.

[*b*] See the Particle Listings below for the energy limits used in this measurement.

[*c*] Most of this radiative mode, the low-momentum γ part, is also included in the parent mode listed without γ's.

[*d*] Allowed by higher-order electroweak interactions.

[*e*] Violates *CP* in leading order. Test of direct *CP* violation since the indirect *CP*-violating and *CP*-conserving contributions are expected to be suppressed.

CONSTRAINED FIT INFORMATION

An overall fit to the mean life, 4 decay rate, and 12 branching ratios uses 46 measurements and one constraint to determine 8 parameters. The overall fit has a $\chi^2 = 40.5$ for 39 degrees of freedom.

The following *off-diagonal* array elements are the correlation coefficients $\left\langle\delta p_i \delta p_j\right\rangle/(\delta p_i \cdot \delta p_j)$, in percent, from the fit to parameters p_i, including 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	−19						
x_3	−37	−28					
x_6	−49	−28	−36				
x_9	−7	21	−5	−5			
x_{22}	−12	34	−8	−7	63		
x_{23}	−9	26	−6	−6	83	77	
Γ	0	0	0	0	0	0	0
	x_1	x_2	x_3	x_6	x_9	x_{22}	x_{23}

	Mode		Rate (10^8 s^{-1})	Scale factor
Γ_1	$3\pi^0$		0.0408±0.0006	
Γ_2	$\pi^+\pi^-\pi^0$		0.0243±0.0004	1.5
Γ_3	$\pi^\pm\mu^\mp\nu_\mu$ Called $K^0_{\mu3}$.	[a]	0.0525±0.0007	1.1
Γ_6	$\pi^\pm e^\mp\nu_e$ Called K^0_{e3}.	[a]	0.0750±0.0008	1.1
Γ_9	2γ		$(1.133 \pm 0.030) \times 10^{-4}$	
Γ_{22}	$\pi^+\pi^-$		$(3.97 \pm 0.07) \times 10^{-4}$	1.1
Γ_{23}	$\pi^0\pi^0$		$(1.79 \pm 0.04) \times 10^{-4}$	

K^0_L DECAY RATES

$\Gamma(3\pi^0)$ — Γ_1

VALUE (10^6 s^{-1})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
4.08±0.06 OUR FIT					
$5.22^{+1.03}_{-0.84}$	54	BEHR	66	HLBC	Assumes *CP*

$\Gamma(\pi^+\pi^-\pi^0)$ Γ_2

VALUE (10^6 s^{-1})	EVTS	DOCUMENT ID		TECN	COMMENT
2.43±0.04 OUR FIT Error includes scale factor of 1.5.					
2.38±0.09 OUR AVERAGE					
$2.32^{+0.13}_{-0.15}$	192	BALDO-...	75	HLBC	Assumes *CP*
2.35±0.20	180	[9] JAMES	72	HBC	Assumes *CP*
2.71±0.28	99	CHO	71	DBC	Assumes *CP*
2.12±0.33	50	MEISNER	71	HBC	Assumes *CP*
2.20±0.35	53	WEBBER	70	HBC	Assumes *CP*
$2.62^{+0.28}_{-0.27}$	136	BEHR	66	HLBC	Assumes *CP*
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.5 ±0.3	98	[9] JAMES	71	HBC	Assumes *CP*
3.26±0.77	18	ANDERSON	65	HBC	
1.4 ±0.4	14	FRANZINI	65	HBC	

In the fit this rate is well determined by the mean life and the branching ratio $\Gamma(\pi^+\pi^-\pi^0)/\left[\Gamma(\pi^+\pi^-\pi^0)+\Gamma(\pi^\pm\mu^\mp\nu_\mu)+\Gamma(\pi^\pm e^\mp\nu_e)\right]$. For this reason the discrepancy between the $\Gamma(\pi^+\pi^-\pi^0)$ measurements does not affect the scale factor of the overall fit.

[9] JAMES 72 is a final measurement and includes JAMES 71.

$\Gamma(\pi^\pm\mu^\mp\nu_\mu)$ Γ_3

VALUE (10^6 s^{-1})	EVTS	DOCUMENT ID		TECN
5.25±0.07 OUR FIT Error includes scale factor of 1.1.				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$4.54^{+1.24}_{-1.08}$	19	LOWYS	67	HLBC

$\Gamma(\pi^\pm e^\mp\nu_e)$ Γ_6

VALUE (10^6 s^{-1})	EVTS	DOCUMENT ID		TECN	COMMENT
7.50±0.08 OUR FIT Error includes scale factor of 1.1.					
7.7 ±0.5 OUR AVERAGE					
7.81±0.56	620	CHAN	71	HBC	
$7.52^{+0.85}_{-0.72}$		AUBERT	65	HLBC	ΔS=ΔQ,*CP* assumed

$\Gamma(\pi^+\pi^-\pi^0)+\Gamma(\pi^\pm\mu^\mp\nu_\mu)+\Gamma(\pi^\pm e^\mp\nu_e)$ $(\Gamma_2+\Gamma_3+\Gamma_6)$

$K^0_L \rightarrow$ charged.

VALUE (10^6 s^{-1})	EVTS	DOCUMENT ID		TECN
15.18±0.14 OUR FIT Error includes scale factor of 1.1.				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
15.1 ±1.9	98	AUERBACH	66B	OSPK

$\Gamma(\pi^{\pm}\mu^{\mp}\nu_{\mu})+\Gamma(\pi^{\pm}e^{\mp}\nu_{e})$ (Γ_3+Γ_6)

VALUE (10^6 s^{-1})	EVTS	DOCUMENT ID		TECN	COMMENT
12.75±0.12 OUR FIT Error includes scale factor of 1.1.					
11.9 ±0.6 OUR AVERAGE Error includes scale factor of 1.2.					
12.4 ±0.7	410	[10] BURGUN	72	HBC	$K^+ p \to K^0 p \pi^+$
13.1 ±1.3	252	[10] WEBBER	71	HBC	$K^- p \to n \overline{K}^0$
11.6 ±0.9	393	[10,11] CHO	70	DBC	$K^+ n \to K^0 p$
$9.85^{+1.15}_{-1.05}$	109	[10] FRANZINI	65	HBC	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
8.47±1.69	126	[10] MANN	72	HBC	$K^- p \to n \overline{K}^0$
10.3 ±0.8	335	[11] HILL	67	DBC	$K^+ n \to K^0 p$

[10] Assumes $\Delta S = \Delta Q$ rule.
[11] CHO 70 includes events of HILL 67.

K^0_L BRANCHING RATIOS

$\Gamma(3\pi^0)/\Gamma_{\text{total}}$ Γ_1/Γ

VALUE	EVTS	DOCUMENT ID		TECN
0.2113±0.0027 OUR FIT Error includes scale factor of 1.1.				
0.2105±0.0028	38k	[12] KREUTZ	95	NA31

[12] KREUTZ 95 measure $3\pi^0$, $\pi^+\pi^-\pi^0$, and $\pi e \nu_e$ modes. They assume PDG 1992 values for $\pi\mu\nu_{\mu}$, 2π, and 2γ modes.

$\Gamma(3\pi^0)/\Gamma(\pi^+\pi^-\pi^0)$ Γ_1/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
1.68 ±0.04 OUR FIT Error includes scale factor of 1.3.					
1.63 ±0.05 OUR AVERAGE Error includes scale factor of 1.4.					
1.611±0.014±0.034	38k	[13] KREUTZ	95	NA31	
1.80 ±0.13	1010	BUDAGOV	68	HLBC	
2.0 ±0.6	188	ALEKSANYAN	64B	FBC	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1.65 ±0.07	883	BARMIN	72B	HLBC	Error statistical only

[13] KREUTZ 95 excluded from fit because it is not independent of their $\Gamma(3\pi^0)/\Gamma_{\text{total}}$ measurement, which is in the fit.

$\Gamma(3\pi^0)/\Gamma(\pi^{\pm}e^{\mp}\nu_e)$ Γ_1/Γ_6

VALUE	EVTS	DOCUMENT ID		TECN
0.545±0.009 OUR FIT Error includes scale factor of 1.1.				
0.545±0.004±0.009	38k	[14] KREUTZ	95	NA31

[14] KREUTZ 95 measurement excluded from fit because it is not independent of their $\Gamma(3\pi^0)/\Gamma_{\text{total}}$ measurement, which is in the fit.

$\Gamma(3\pi^0)/[\Gamma(\pi^+\pi^-\pi^0)+\Gamma(\pi^\pm\mu^\mp\nu_\mu)+\Gamma(\pi^\pm e^\mp\nu_e)]$ $\Gamma_1/(\Gamma_2+\Gamma_3+\Gamma_6)$

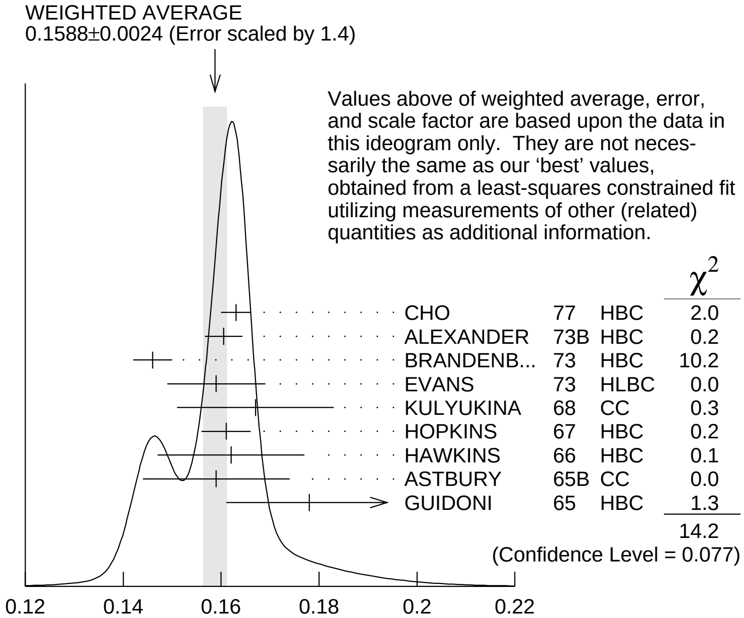
VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.269±0.004 OUR FIT Error includes scale factor of 1.1.					
0.260±0.011 OUR AVERAGE					
0.251±0.014	549	BUDAGOV	68	HLBC	ORSAY measur.
0.277±0.021	444	BUDAGOV	68	HLBC	Ecole polytec.meas
$0.31\ ^{+0.07}_{-0.06}$	29	KULYUKINA	68	CC	
0.24 ±0.08	24	ANIKINA	64	CC	

$\Gamma(\pi^+\pi^-\pi^0)/\Gamma_{total}$ Γ_2/Γ

VALUE	DOCUMENT ID
0.1255±0.0020 OUR FIT Error includes scale factor of 1.7.	

$\Gamma(\pi^+\pi^-\pi^0)/[\Gamma(\pi^+\pi^-\pi^0)+\Gamma(\pi^\pm\mu^\mp\nu_\mu)+\Gamma(\pi^\pm e^\mp\nu_e)]$ $\Gamma_2/(\Gamma_2+\Gamma_3+\Gamma_6)$

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.1599±0.0025 OUR FIT Error includes scale factor of 1.7.					
0.1588±0.0024 OUR AVERAGE Error includes scale factor of 1.4. See the ideogram below.					
0.163 ±0.003	6499	CHO	77	HBC	
0.1605±0.0038	1590	ALEXANDER	73B	HBC	
0.146 ±0.004	3200	BRANDENB...	73	HBC	
0.159 ±0.010	558	EVANS	73	HLBC	
0.167 ±0.016	1402	KULYUKINA	68	CC	
0.161 ±0.005		HOPKINS	67	HBC	
0.162 ±0.015	126	HAWKINS	66	HBC	
0.159 ±0.015	326	ASTBURY	65B	CC	
0.178 ±0.017	566	GUIDONI	65	HBC	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$0.15\ ^{+0.03}_{-0.04}$	66	ASTBURY	65	CC	
0.144 ±0.004	1729	HOPKINS	65	HBC	See HOPKINS 67
0.151 ±0.020	79	ADAIR	64	HBC	
$0.157\ ^{+0.03}_{-0.04}$	75	LUERS	64	HBC	
0.185 ±0.038	59	ASTIER	61	CC	



$\Gamma(\pi^+\pi^-\pi^0)/[\Gamma(\pi^+\pi^-\pi^0)+\Gamma(\pi^\pm\mu^\mp\nu_\mu)+\Gamma(\pi^\pm e^\mp\nu_e)]$

$\Gamma(\pi^+\pi^-\pi^0)/\Gamma(\pi^\pm e^\mp\nu_e)$ — Γ_2/Γ_6

VALUE	EVTS	DOCUMENT ID		TECN
0.324±0.006 OUR FIT	Error includes scale factor of 1.6.			
0.336±0.003±0.007	28k	KREUTZ	95	NA31

$\Gamma(\pi^\pm\mu^\mp\nu_\mu)/\Gamma(\pi^\pm e^\mp\nu_e)$ — Γ_3/Γ_6

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.701±0.009 OUR FIT					
$0.697^{+0.010}_{-0.009}$ OUR AVERAGE					
0.702±0.011	33k	CHO	80	HBC	
0.662±0.037	10k	WILLIAMS	74	ASPK	
0.741±0.044	6700	BRANDENB...	73	HBC	
0.662±0.030	1309	EVANS	73	HLBC	
0.71 ±0.05	770	BUDAGOV	68	HLBC	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.68 ±0.08	3548	BASILE	70	OSPK	
0.71 ±0.04	569	[15] BEILLIERE	69	HLBC	
0.648±0.030	1309	EVANS	69	HLBC	Repl. by EVANS 73
0.67 ±0.13		[16] KULYUKINA	68	CC	
0.82 ±0.10		DEBOUARD	67	OSPK	
0.7 ±0.2	273	HAWKINS	67	HBC	
0.81 ±0.08		HOPKINS	67	HBC	
0.81 ±0.19		ADAIR	64	HBC	

[15] BEILLIERE 69 is a scanning experiment using same exposure as BUDAGOV 68.

[16] KULYUKINA 68 $\Gamma(\pi^{\pm}\mu^{\mp}\nu_{\mu})/\Gamma(\pi^{\pm}e^{\mp}\nu_{e})$ is not measured independently from $\Gamma(\pi^{+}\pi^{-}\pi^{0})/\left[\Gamma(\pi^{+}\pi^{-}\pi^{0}) + \Gamma(\pi^{\pm}\mu^{\mp}\nu_{\mu}) + \Gamma(\pi^{\pm}e^{\mp}\nu_{e})\right]$ and $\Gamma(\pi^{\pm}e^{\mp}\nu_{e})/\left[\Gamma(\pi^{+}\pi^{-}\pi^{0}) + \Gamma(\pi^{\pm}\mu^{\mp}\nu_{\mu}) + \Gamma(\pi^{\pm}e^{\mp}\nu_{e})\right]$.

$\Gamma(\pi^{\pm}\mu^{\mp}\nu_{\mu})/\left[\Gamma(\pi^{+}\pi^{-}\pi^{0})+\Gamma(\pi^{\pm}\mu^{\mp}\nu_{\mu})+\Gamma(\pi^{\pm}e^{\mp}\nu_{e})\right]$ — $\Gamma_3/(\Gamma_2+\Gamma_3+\Gamma_6)$

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*
0.3461±0.0030 OUR FIT Error includes scale factor of 1.1.				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.335 ±0.055	330	[17] KULYUKINA	68	CC
0.39 $^{+0.08}_{-0.10}$	172	[17] ASTBURY	65	CC
0.356 ±0.07	251	[17] LUERS	64	HBC

[17] This mode not measured independently from $\Gamma(\pi^{+}\pi^{-}\pi^{0})/\left[\Gamma(\pi^{+}\pi^{-}\pi^{0}) + \Gamma(\pi^{\pm}\mu^{\mp}\nu_{\mu}) + \Gamma(\pi^{\pm}e^{\mp}\nu_{e})\right]$ and $\Gamma(\pi^{\pm}e^{\mp}\nu_{e})/\left[\Gamma(\pi^{+}\pi^{-}\pi^{0}) + \Gamma(\pi^{\pm}\mu^{\mp}\nu_{\mu}) + \Gamma(\pi^{\pm}e^{\mp}\nu_{e})\right]$.

$\Gamma(\pi^{\pm}e^{\mp}\nu_{e})/\left[\Gamma(\pi^{+}\pi^{-}\pi^{0})+\Gamma(\pi^{\pm}\mu^{\mp}\nu_{\mu})+\Gamma(\pi^{\pm}e^{\mp}\nu_{e})\right]$ — $\Gamma_6/(\Gamma_2+\Gamma_3+\Gamma_6)$

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*
0.4940±0.0030 OUR FIT Error includes scale factor of 1.1.				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.498 ±0.052	500	KULYUKINA	68	CC
0.46 $^{+0.08}_{-0.10}$	202	ASTBURY	65	CC
0.487 ±0.05	153	LUERS	64	HBC
0.46 ±0.11	24	NYAGU	61	CC

$\Gamma(\pi^{\pm}e^{\mp}\nu_{e})/\left[\Gamma(\pi^{\pm}\mu^{\mp}\nu_{\mu})+\Gamma(\pi^{\pm}e^{\mp}\nu_{e})\right]$ — $\Gamma_6/(\Gamma_3+\Gamma_6)$

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*
0.5880±0.0033 OUR FIT				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.415 ±0.120	320	ASTIER	61	CC

$\left[\Gamma(\pi^{\pm}\mu^{\mp}\nu_{\mu})+\Gamma(\pi^{\pm}e^{\mp}\nu_{e})\right]/\Gamma_{total}$ — $(\Gamma_3+\Gamma_6)/\Gamma$

VALUE	*DOCUMENT ID*
0.6596±0.0030 OUR FIT Error includes scale factor of 1.2.	

$\Gamma(2\gamma)/\Gamma_{total}$ — Γ_9/Γ

VALUE (units 10^{-4})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
5.86±0.15 OUR FIT					
• • • We do not use the following data for averages, fits, limits, etc. • • •					
4.54±0.84		[18] BANNER	72B	OSPK	
4.5 ±1.0	23	ENSTROM	71	OSPK	K^0_L 1.5–9 GeV/c
5.0 ±1.0		[19] REPELLIN	71	OSPK	
5.5 ±1.1	90	KUNZ	68	OSPK	Norm.to 3 π(C+N)
7.4 ±1.6	33	[20] CRONIN	67	OSPK	
6.7 ±2.2	32	TODOROFF	67	OSPK	Repl. CRIEGEE 66
1.3 ±0.6		[21] CRIEGEE	66	OSPK	

[18] This value uses $(\eta_{00}/\eta_{+-})^2 = 1.05 \pm 0.14$. In general, $\Gamma(2\gamma)/\Gamma_{total} = [(4.32 \pm 0.55) \times 10^{-4}][(\eta_{00}/\eta_{+-})^2]$.
[19] Assumes regeneration amplitude in copper at 2 GeV is 22 mb. To evaluate for a given regeneration amplitude and error, multiply by (regeneration amplitude/22mb)^2.
[20] CRONIN 67 replaced by KUNZ 68.
[21] CRIEGEE 66 replaced by TODOROFF 67.

$\Gamma(2\gamma)/\Gamma(3\pi^0)$ — Γ_9/Γ_1

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
2.77±0.08 OUR FIT	Error includes scale factor of 1.1.				
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.13±0.43	28	BARMIN	71	HLBC	
2.24±0.28	115	BANNER	69	OSPK	
2.5 ±0.7	16	ARNOLD	68B	HLBC	Vacuum decay

$\Gamma(2\gamma)/\Gamma(\pi^0\pi^0)$ — Γ_9/Γ_{23}

VALUE	EVTS	DOCUMENT ID		TECN
0.632±0.009 OUR FIT				
0.632±0.004±0.008	110k	BURKHARDT	87	NA31

$\Gamma(3\gamma)/\Gamma_{total}$ — Γ_{10}/Γ

VALUE	CL%	DOCUMENT ID		TECN
$<2.4 \times 10^{-7}$	90	[22] BARR	95C	NA31

[22] Assumes a phase-space decay distribution.

$\Gamma(\pi^0 2\gamma)/\Gamma_{total}$ — Γ_{11}/Γ

VALUE (units 10^{-6})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
1.68±0.10 OUR AVERAGE						
1.68±0.07±0.08		884	ALAVI-HARATI	99B	KTEV	
1.7 ±0.2 ±0.2		63	[23] BARR	92	SPEC	
• • • We do not use the following data for averages, fits, limits, etc. • • •						
1.86±0.60±0.60		60	PAPADIMITR...	91	E731	$m_{\gamma\gamma} > 280$ MeV
$<$ 5.1	90		PAPADIMITR...	91	E731	$m_{\gamma\gamma} < 264$ MeV
2.1 ±0.6		14	[24] BARR	90C	NA31	$m_{\gamma\gamma} > 280$ MeV
$<$ 2.7	90		PAPADIMITR...	89	E731	In PAPADI...91
$<$230	90	0	BANNER	69	OSPK	

[23] BARR 92 find that $\Gamma(\pi^0 2\gamma, m_{\gamma\gamma} < 240 \text{ MeV})/\Gamma(\pi^0 2\gamma) < 0.09$ (90% CL).
[24] BARR 90C superseded by BARR 92.

$\Gamma(\pi^0\pi^\pm e^\mp\nu)/\Gamma_{total}$ — Γ_{12}/Γ

VALUE (units 10^{-5})	CL%	EVTS	DOCUMENT ID		TECN
5.18±0.29 OUR AVERAGE					
5.16±0.20±0.22		729	MAKOFF	93	E731
6.2 ±2.0		16	CARROLL	80C	SPEC
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<$220	90		[25] DONALDSON	74	SPEC

[25] DONALDSON 74 uses $K^0_L \to \pi^+\pi^-\pi^0$/(all K^0_L) decays = 0.126.

$\Gamma((\pi\mu\text{atom})\nu)/\Gamma(\pi^{\pm}\mu^{\mp}\nu_{\mu})$ Γ_{13}/Γ_{3}

VALUE (units 10^{-7})	EVTS	DOCUMENT ID		TECN
3.90±0.39	155	[26] ARONSON	86	SPEC
• • • We do not use the following data for averages, fits, limits, etc. • • •				
seen	18	COOMBES	76	WIRE

[26] ARONSON 86 quote theoretical value of $(4.31 \pm 0.08) \times 10^{-7}$.

$\Gamma(\pi^{\pm}e^{\mp}\nu_e\gamma)/\Gamma(\pi^{\pm}e^{\mp}\nu_e)$ Γ_{14}/Γ_{6}

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
$0.934 \pm 0.036 ^{+0.055}_{-0.039}$	1384	LEBER	96	NA31	$E^*_\gamma \geq$ 30 MeV, $\theta^*_{e\gamma} \geq 20^\circ$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
3.3 ±2.0	10	PEACH	71	HLBC	γ KE >15 MeV

$\Gamma(\pi^{\pm}\mu^{\mp}\nu_{\mu}\gamma)/\Gamma(\pi^{\pm}\mu^{\mp}\nu_{\mu})$ Γ_{15}/Γ_{3}

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
$2.08 \pm 0.17 ^{+0.16}_{-0.21}$	4261	BENDER	98	NA48	$E^*_\gamma \geq 30$ MeV

$\Gamma(\pi^+\pi^-\gamma)/\Gamma_{\text{total}}$ Γ_{16}/Γ

For earlier limits see our 1992 edition Physical Review **D45,** 1 June, Part II (1992).

VALUE (units 10^{-5})	EVTS	DOCUMENT ID		TECN	COMMENT
4.61±0.14 OUR AVERAGE					
4.66±0.15	3136	[27] RAMBERG	93	E731	E_γ >20 MeV
4.41±0.32	1062	[28] CARROLL	80B	SPEC	E_γ >20 MeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1.52±0.16	516	[29] CARROLL	80B	SPEC	E_γ >20 MeV
2.89±0.28	546	[30] CARROLL	80B	SPEC	
6.2 ±2.1	24	[31] DONALDSON	74C	SPEC	

[27] RAMBERG 93 finds that fraction of Direct Emission (DE) decays with E_γ >20 MeV is 0.685 ± 0.041.

[28] Both components. Uses $K^0_L \to \pi^+\pi^-\pi^0$/(all K^0_L) decays = 0.1239.

[29] Internal Bremsstrahlung component only.

[30] Direct γ emission component only.

[31] Uses $K^0_L \to \pi^+\pi^-\pi^0$/(all K^0_L) decays = 0.126.

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

VALUE (units 10^{-6})	CL%	EVTS	DOCUMENT ID		TECN
< 5.6			BARR	94	NA31
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<230	90	0	ROBERTS	94	E799

$\Gamma(\mu^+\mu^-\gamma)/\Gamma_{total}$ Γ_{18}/Γ

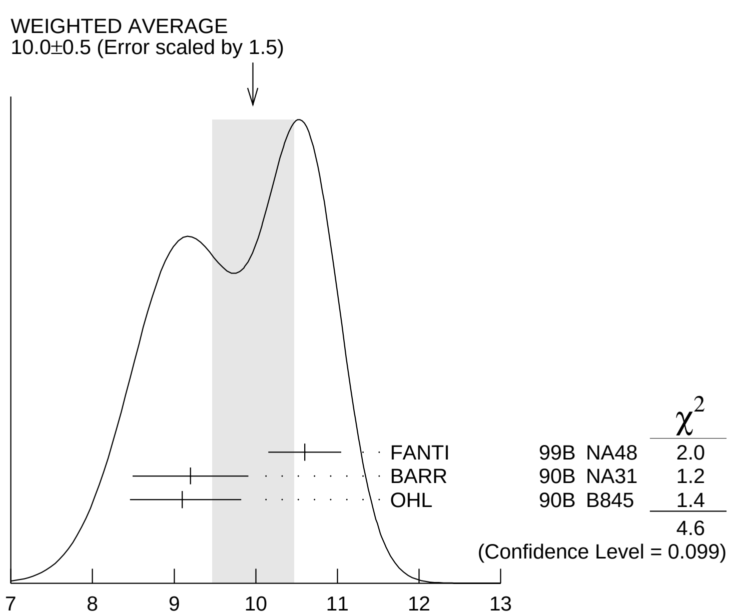
VALUE (units 10^{-7})	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*
3.25±0.28 OUR AVERAGE					
3.4 ±0.6 ±0.4		45	FANTI	97	NA48
3.23±0.23±0.19		197	SPENCER	95	E799
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.8 ±2.8		1	[32] CARROLL	80D	SPEC
<78.1	90		[33] DONALDSON	74	SPEC

[32] Uses $K^0_L \to \pi^+\pi^-\pi^0$/(all K^0_L) decays = 0.1239.
[33] Uses $K^0_L \to \pi^+\pi^-\pi^0$/(all K^0_L) decays = 0.126.

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

VALUE (units 10^{-6})	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*
10.0±0.5 OUR AVERAGE Error includes scale factor of 1.5. See the ideogram below.					
10.6±0.2±0.4		6864	[34] FANTI	99B	NA48
9.2±0.5±0.5		1053	BARR	90B	NA31
$9.1\pm0.4^{+0.6}_{-0.5}$		919	OHL	90B	B845
• • • We do not use the following data for averages, fits, limits, etc. • • •					
17.4±8.7		4	[35] CARROLL	80D	SPEC
<27	90	0	[36] BARMIN	72	HLBC

[34] For FANTI 99B, the ±0.4 systematic error includes for uncertainties in the calculation, primarily uncertainties in the $\pi^0 \to e^+e^-\gamma$ and $K^0_L \to \pi^0\pi^0$ branching ratios, evaluated using our 1999 Web edition values.
[35] Uses $K^0_L \to \pi^+\pi^-\pi^0$/(all K^0_L) decays = 0.1239.
[36] Uses $K^0_L \to 3\pi^0$/total = 0.214.



$\Gamma(e^+e^-\gamma)/\Gamma_{total}$ (units 10^{-6})

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

VALUE (units 10^{-7})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
6.9±1.0 OUR AVERAGE					
$8.0\pm1.5^{+1.4}_{-1.2}$	40	SETZU	98	NA31	$E_\gamma > 5$ MeV
$6.5\pm1.2\pm0.6$	58	NAKAYA	94	E799	$E_\gamma > 5$ MeV
6.6 ± 3.2		MORSE	92	B845	$E_\gamma > 5$ MeV

$\Gamma(\pi^0\gamma e^+e^-)/\Gamma_{total}$ — Γ_{21}/Γ

VALUE (units 10^{-7})	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*
<7.1	90	0	MURAKAMI	99	SPEC

$\Gamma(\pi^+\pi^-)/\Gamma_{total}$ — Γ_{22}/Γ

Violates *CP* conservation.

VALUE (units 10^{-3})	*DOCUMENT ID*	
2.056±0.033 OUR FIT		
2.07 ±0.05 OUR AVERAGE		
2.071±0.049	[37] ETAFIT	00

[37] This ETAFIT value is computed from fitted values of $|\eta_{+-}|$, the K^0_L and K^0_S lifetimes, and the $K^0_S \to \pi^+\pi^-$ branching fraction. See the discussion in the note "Fits for K^0_L *CP*-Violation Parameters."

$\Gamma(\pi^+\pi^-)/\Gamma(\pi^+\pi^-\pi^0)$ — Γ_{22}/Γ_2

Violates *CP* conservation.

VALUE (units 10^{-2})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1.637±0.030 OUR FIT Error includes scale factor of 1.1.					
1.64 ±0.04	4200	MESSNER	73	ASPK	$\eta_{+-} = 2.23$

$\Gamma(\pi^+\pi^-)/[\Gamma(\pi^\pm\mu^\mp\nu_\mu)+\Gamma(\pi^\pm e^\mp\nu_e)]$ — $\Gamma_{22}/(\Gamma_3+\Gamma_6)$

Violates *CP* conservation.

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
3.12±0.05 OUR FIT Error includes scale factor of 1.1.					
3.08±0.10 OUR AVERAGE					
3.13±0.14	1687	COUPAL	85	SPEC	η_{+-}=2.28 ± 0.06
3.04±0.14	2703	DEVOE	77	SPEC	η_{+-}=2.25 ± 0.05
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.51±0.23	309	[38] DEBOUARD	67	OSPK	η_{+-}=2.00 ± 0.09
2.35±0.19	525	[38] FITCH	67	OSPK	η_{+-}=1.94 ± 0.08

[38] Old experiments excluded from fit. See subsection on η_{+-} in section on "PARAMETERS FOR $K^0_L \to 2\pi$ DECAY" below for average η_{+-} of these experiments and for note on discrepancy.

$\Gamma(\pi^+\pi^-)/\left[\Gamma(\pi^+\pi^-\pi^0)+\Gamma(\pi^\pm\mu^\mp\nu_\mu)+\Gamma(\pi^\pm e^\mp\nu_e)\right]$ $\Gamma_{22}/(\Gamma_2+\Gamma_3+\Gamma_6)$

Violates *CP* conservation.

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
2.62 ±0.04 OUR FIT					
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.60 ±0.07	4200	[39] MESSNER	73	ASPK	η_{+-} = 2.23 ± 0.05
1.93 ±0.26		[40] BASILE	66	OSPK	η_{+-} = 1.92 ± 0.13
1.993±0.080		[40] BOTT-...	66	OSPK	η_{+-} = 1.95 ± 0.04
2.08 ±0.35	54	[40] GALBRAITH	65	OSPK	η_{+-} = 1.99 ± 0.16
2.0 ±0.4	45	[40] CHRISTENS...	64	OSPK	η_{+-} = 1.95 ± 0.20

[39] From same data as $\Gamma(\pi^+\pi^-)/\Gamma(\pi^+\pi^-\pi^0)$ MESSNER 73, but with different normalization.

[40] Old experiments excluded from fit. See subsection on η_{+-} in section on "PARAMETERS FOR $K^0_L \rightarrow 2\pi$ DECAY" below for average η_{+-}.

$\Gamma(\pi^0\pi^0)/\Gamma_{\text{total}}$ Γ_{23}/Γ

Violates *CP* conservation.

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.927±0.019 OUR FIT					
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.5 ±0.8	189	[41] GAILLARD	69	OSPK	η_{00}=3.6 ± 0.6
1.2 $^{+1.5}_{-1.2}$	7	[42] CRIEGEE	66	OSPK	

[41] Latest result of this experiment given by FAISSNER 70 $\Gamma(\pi^0\pi^0)/\Gamma(3\pi^0)$.

[42] CRIEGEE 66 experiment not designed to measure $2\pi^0$ decay mode.

$\Gamma(\pi^0\pi^0)/\Gamma(3\pi^0)$ Γ_{23}/Γ_1

Violates *CP* conservation.

VALUE (units 10^{-2})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.439±0.011 OUR FIT Error includes scale factor of 1.1.					
0.39 ±0.06 OUR AVERAGE					
0.37 ±0.08	29	BARMIN	70	HLBC	η_{00}=2.02 ± 0.23
0.32 ±0.15	30	BUDAGOV	70	HLBC	η_{00}=1.9 ± 0.5
0.46 ±0.11	57	BANNER	69	OSPK	η_{00}=2.2 ± 0.3
not seen		BARTLETT	68	OSPK	See η_{00} below
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1.21 ±0.30	150	[43] REY	76	OSPK	η_{00}=3.8 ± 0.5
0.90 ±0.30	172	[44] FAISSNER	70	OSPK	η_{00}=3.2 ± 0.5
1.31 ±0.31	133	[43] CENCE	69	OSPK	η_{00}=3.7 ± 0.5
1.89 ±0.31	109	[45] CRONIN	67	OSPK	η_{00}=4.9 ± 0.5
1.36 ±0.18		[45] CRONIN	67B	OSPK	η_{00}=3.92 ± 0.3

[43] CENCE 69 events are included in REY 76.

[44] FAISSNER 70 contains same $2\pi^0$ events as GAILLARD 69 $\Gamma(\pi^0\pi^0)/\Gamma_{\text{total}}$.

[45] CRONIN 67B is further analysis of CRONIN 67, now both withdrawn.

$\Gamma(\pi^0\pi^0)/\Gamma(\pi^+\pi^-)$ Γ_{23}/Γ_{22}

Violates *CP* conservation.

VALUE	DOCUMENT ID	
0.451 ±0.006 OUR FIT		
0.452 ±0.006 OUR AVERAGE		
0.4517±0.0060	[46] ETAFIT	00

[46] This ETAFIT value is computed from fitted values of $|\eta_{00} / \eta_{+-}|$ and the $\Gamma(K^0_S \to \pi^+\pi^-)$ / $\Gamma(K^0_S \to \pi^0\pi^0)$ branching fraction. See the discussion in the note "Fits for K^0_L *CP*-Violation Parameters."

$\Gamma(\mu^+\mu^-)/[\Gamma(\pi^+\pi^-\pi^0)+\Gamma(\pi^\pm\mu^\mp\nu_\mu)+\Gamma(\pi^\pm e^\mp\nu_e)]$ $\Gamma_{24}/(\Gamma_2+\Gamma_3+\Gamma_6)$

Test for $\Delta S = 1$ weak neutral current. Allowed by higher-order electroweak interaction.

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN
• • • We do not use the following data for averages, fits, limits, etc. • • •				
< 2.0	90	BOTT-...	67	OSPK
< 35.0	90	FITCH	67	OSPK
<250.0	90	ALFF-...	66B	OSPK
<100.0		ANIKINA	65	CC

$\Gamma(\mu^+\mu^-)/\Gamma(\pi^+\pi^-)$ Γ_{24}/Γ_{22}

Test for $\Delta S = 1$ weak neutral current. Allowed by higher-order electroweak interaction.

VALUE (units 10^{-6})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
3.48 ±0.05 OUR AVERAGE						
3.474±0.057		6210	AMBROSE	00	B871	
3.87 ±0.30		179	[47] AKAGI	95	SPEC	
3.38 ±0.17		707	HEINSON	95	B791	
• • • We do not use the following data for averages, fits, limits, etc. • • •						
3.9 ±0.3 ±0.1		178	[48] AKAGI	91B	SPEC	In AKAGI 95
3.45 ±0.18 ±0.13		368	[49] HEINSON	91	SPEC	In HEINSON 95
4.1 ±0.5		54	INAGAKI	89	SPEC	In AKAGI 91B
2.8 ±0.3 ±0.2		87	MATHIAZHA...	89B	SPEC	In HEINSON 91
$4.0\ {}^{+1.4}_{-0.9}$		15	SHOCHET	79	SPEC	
$4.2\ {}^{+5.1}_{-2.6}$		3	[50] FUKUSHIMA	76	SPEC	
$5.8\ {}^{+2.3}_{-1.5}$		9	[51] CARITHERS	73	SPEC	
< 1.53	90	0	[52] CLARK	71	SPEC	
< 18.	90	0	DARRIULAT	70	SPEC	
<140.	90	0	FOETH	69	SPEC	

[47] AKAGI 95 gives this number multiplied by the PDG 1992 average for $\Gamma(K^0_L \to \pi^+\pi^-)/\Gamma(\text{total})$.

[48] AKAGI 91B give this number multiplied by the 1990 PDG average for $\Gamma(K^0_L \to \pi^+\pi^-)/\Gamma(\text{total})$.

[49] HEINSON 91 give $\Gamma(K^0_L \to \mu\mu)/\Gamma_{\text{total}}$. We divide out the $\Gamma(K^0_L \to \pi^+\pi^-)/\Gamma_{\text{total}}$ PDG average which they used.

[50] FUKUSHIMA 76 errors are at CL = 90%.

[51] CARITHERS 73 errors are at CL = 68%, W.Carithers, (private communication 79).

[52] CLARK 71 limit raised from 1.2×10^{-6} by FIELD 74 reanalysis. Not in agreement with subsequent experiments. So not averaged.

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

Test for $\Delta S = 1$ weak neutral current. Allowed by higher-order electroweak interaction.

VALUE (units 10^{-10})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$0.087^{+0.057}_{-0.041}$		4	AMBROSE	98	B871	
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$<$ 1.6	90	1	AKAGI	95	SPEC	
$<$ 0.41	90	0	[53] ARISAKA	93B	B791	
$<$ 1.6	90	1	AKAGI	91	SPEC	Sup. by AKAGI 95
$<$ 5.6	90		INAGAKI	89	SPEC	In AKAGI 91
$<$ 3.2	90		MATHIAZHA...	89	SPEC	In ARISAKA 93B
$<$ 110	90		COUSINS	88	SPEC	
$<$ 45	90		GREENLEE	88	SPEC	Repl. by JASTRZEMBSKI 88
$<$ 12	90		JASTRZEM...	88	SPEC	
$<$ 15.7	90		[54] CLARK	71	ASPK	
$<$1500	90	0	FOETH	69	ASPK	

[53] ARISAKA 93B includes all events with $<$6 MeV radiated energy.

[54] Possible (but unknown) systematic errors. See note on CLARK 71 $\Gamma(\mu^+\mu^-)/\Gamma(\pi^+\pi^-)$ entry.

$\Gamma(e^+e^-)/[\Gamma(\pi^+\pi^-\pi^0)+\Gamma(\pi^\pm\mu^\mp\nu_\mu)+\Gamma(\pi^\pm e^\mp\nu_e)]$ — $\Gamma_{25}/(\Gamma_2+\Gamma_3+\Gamma_6)$

Test for $\Delta S = 1$ weak neutral current. Allowed by higher-order electroweak interaction.

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$<$ 23.0	90	BOTT-...	67	OSPK
$<$ 200.0	90	ALFF-...	66B	OSPK
$<$1000.0		ANIKINA	65	CC

$\Gamma(\pi^+\pi^-e^+e^-)/\Gamma_{total}$ — Γ_{26}/Γ

Test for $\Delta S = 1$ weak neutral current. Allowed by higher-order electroweak interaction.

VALUE (units 10^{-7})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
3.5±0.6 OUR AVERAGE						
3.2±0.6±0.4		37	ADAMS	98	KTEV	
4.4±1.3±0.5		13	TAKEUCHI	98	SPEC	
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$<$ 4.6	90		NOMURA	97	SPEC	$m_{ee} > 4$ MeV
$<$ 25	90	0	BALATS	83	SPEC	
$<$ 88.1	90		[55] DONALDSON	76	SPEC	
$<$300			ANIKINA	73	STRC	

[55] Uses $K^0_L \rightarrow \pi^+\pi^-\pi^0$/(all K^0_L) decays = 0.126.

$\Gamma(\mu^+\mu^-e^+e^-)/\Gamma_{total}$ — Γ_{27}/Γ

Test for $\Delta S = 1$ weak neutral current. Allowed by higher-order electroweak interaction.

VALUE (units 10^{-9})	CL%	EVTS	DOCUMENT ID		TECN
$2.9^{+6.7}_{-2.4}$		1	GU	96	E799
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<$4900	90		BALATS	83	SPEC

$\Gamma(e^+e^-e^+e^-)/\Gamma_{total}$ — Γ_{28}/Γ

Test for $\Delta S=1$ weak neutral current. Allowed by higher-order electroweak interaction.

VALUE (units 10^{-8})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
4.1 ±0.8 OUR AVERAGE			Error includes scale factor of 1.2.			
6 ±2 ±1		18	[56] AKAGI	95	SPEC	m_{ee} >470 MeV
10.4 ±3.7 ±1.1		8	[57] BARR	95	NA31	
3.96±0.78±0.32		27	GU	94	E799	
3.07±1.25±0.26		6	VAGINS	93	B845	
• • • We do not use the following data for averages, fits, limits, etc. • • •						
7 ±3 ±2		6	[56] AKAGI	95	SPEC	m_{ee} >470 MeV
6 ±2 ±1		18	AKAGI	93	CNTR	Sup. by AKAGI 95
4 ±3		2	BARR	91	NA31	Sup. by BARR 95
<260	90		BALATS	83	SPEC	

[56] Values are for the total branching fraction, acceptance-corrected for the m_{ee} cuts shown.
[57] Distribution of angles between two e^+e^- pair planes favors $CP=-1$ for K^0_L.

$\Gamma(\pi^0\mu^+\mu^-)/\Gamma_{total}$ — Γ_{29}/Γ

Violates *CP* in leading order. Test for $\Delta S = 1$ weak neutral current. Allowed by higher-order electroweak interaction.

VALUE (units 10^{-9})	CL%	EVTS	DOCUMENT ID		TECN
< 5.1	90	0	HARRIS	93	E799
• • • We do not use the following data for averages, fits, limits, etc. • • •					
< 1200	90	0	[58] CARROLL	80D	SPEC
<56600	90		[59] DONALDSON	74	SPEC

[58] Uses $K^0_L \rightarrow \pi^+\pi^-\pi^0$/(all K^0_L) decays = 0.1239.
[59] Uses $K^0_L \rightarrow \pi^+\pi^-\pi^0$/(all K^0_L) decays = 0.126.

$\Gamma(\pi^0 e^+e^-)/\Gamma_{total}$ — Γ_{30}/Γ

Violates *CP* in leading order. Direct and indirect *CP*-violating contributions are expected to be comparable and to dominate the *CP*-conserving part. Test for $\Delta S = 1$ weak neutral current. Allowed by higher-order electroweak interaction.

VALUE (units 10^{-9})	CL%	EVTS	DOCUMENT ID		TECN
< 4.3	90	0	HARRIS	93B	E799
< 7.5	90	0	BARKER	90	E731
< 5.5	90	0	OHL	90	B845
• • • We do not use the following data for averages, fits, limits, etc. • • •					
< 40	90		BARR	88	NA31
< 320	90		JASTRZEM...	88	SPEC
<2300	90	0	[60] CARROLL	80D	SPEC

[60] Uses $K^0_L \rightarrow \pi^+\pi^-\pi^0$/(all K^0_L) decays = 0.1239.

$\Gamma(\pi^0\nu\overline{\nu})/\Gamma_{total}$ — Γ_{31}/Γ

Violates *CP* in leading order. Test of direct *CP* violation since the indirect *CP*-violating and *CP*-conserving contributions are expected to be suppressed. Test of $\Delta S = 1$ weak neutral current.

VALUE (units 10^{-5})	CL%	EVTS	DOCUMENT ID		TECN
< 0.059 (CL = 90%)					
< 0.059	90	0	ALAVI-HARATI	00	KTEV

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

$<$ 0.16	90	0	ADAMS	99	KTEV
$<$ 5.8	90	0	WEAVER	94	E799
$<$ 22	90	0	GRAHAM	92	CNTR
$<$760	90		[61] LITTENBERG	89	RVUE

[61] LITTENBERG 89 is from retroactive data analysis of CRONIN 67.

$\Gamma(e^{\pm}\mu^{\mp})/\Gamma_{total}$ Γ_{32}/Γ

Test of lepton family number conservation.

VALUE (units 10^{-11})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
< 0.47 (CL = 90%)						
< 0.47	90		AMBROSE	98B	B871	
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$<$ 9.4	90	0	AKAGI	95	SPEC	
$<$ 3.9	90	0	ARISAKA	93	B791	
$<$ 3.3	90	0	[62] ARISAKA	93	B791	
$<$ 9.4	90	0	AKAGI	91	SPEC	Sup. by AKAGI 95
$<$ 43	90		INAGAKI	89	SPEC	In AKAGI 91
$<$ 22	90		MATHIAZHA...	89	SPEC	
$<$ 190	90		SCHAFFNER	89	SPEC	
$<$1100	90		COUSINS	88	SPEC	
$<$ 670	90		GREENLEE	88	SPEC	Repl. by SCHAFFNER 89
$<$ 157	90		[63] CLARK	71	ASPK	

[62] This is the combined result of ARISAKA 93 and MATHIAZHAGAN 89.
[63] Possible (but unknown) systematic errors. See note on CLARK 71 $\Gamma(\mu^+\mu^-)/\Gamma(\pi^+\pi^-)$ entry.

$\Gamma(e^{\pm}e^{\pm}\mu^{\mp}\mu^{\mp})/\Gamma_{total}$ Γ_{33}/Γ

Test of lepton family number conservation.

VALUE (units 10^{-9})	CL%	EVTS	DOCUMENT ID		TECN
<6.1	90	0	[64] GU	96	E799

[64] Assuming uniform phase space distribution.

$\Gamma(e^{\pm}\mu^{\mp})/\left[\Gamma(\pi^+\pi^-\pi^0)+\Gamma(\pi^{\pm}\mu^{\mp}\nu_{\mu})+\Gamma(\pi^{\pm}e^{\mp}\nu_e)\right]$ $\Gamma_{32}/(\Gamma_2+\Gamma_3+\Gamma_6)$

Test of lepton family number conservation.

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$<$ 0.1	90	BOTT-...	67	OSPK
$<$ 0.08	90	FITCH	67	OSPK
$<$ 1.0	90	CARPENTER	66	OSPK
$<$10.0		ANIKINA	65	CC

$\Gamma(\pi^0\mu^{\pm}e^{\mp})/\Gamma_{total}$ Γ_{34}/Γ

Test of lepton family number conservation.

VALUE	CL%	DOCUMENT ID		TECN
$<6.2\times10^{-9}$	90	ARISAKA	98	E799

ENERGY DEPENDENCE OF K^0_L DALITZ PLOT

For discussion, see note on Dalitz plot parameters in the $K^{\pm}$ section of the Particle Listings above. For definitions of a_v, a_t, a_u, and a_y, see the earlier version of the same note in the 1982 edition of this *Review* published in Physics Letters **111B** 70 (1982).

$|\text{matrix element}|^2 = 1 + gu + hu^2 + jv + kv^2 + fuv$
where $u = (s_3 - s_0) / m_\pi^2$ and $v = (s_1 - s_2) / m_\pi^2$

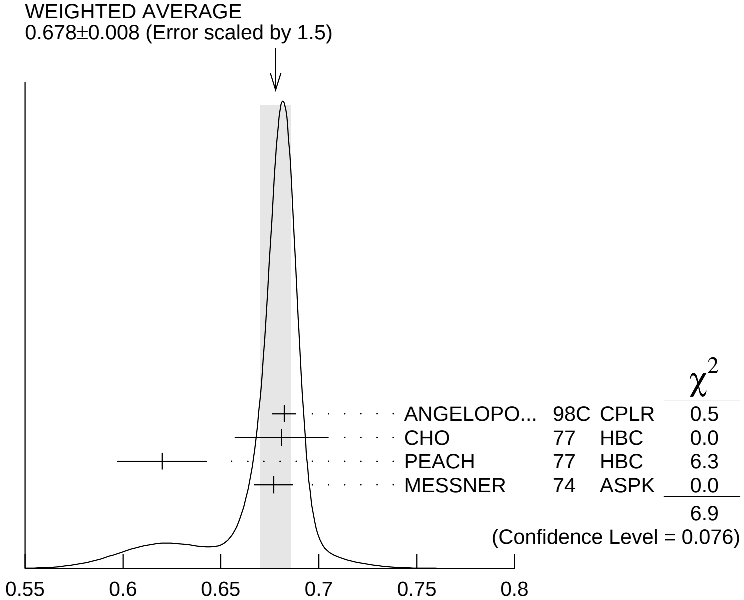
LINEAR COEFFICIENT g FOR $K^0_L \to \pi^+\pi^-\pi^0$

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.678 ±0.008 OUR AVERAGE		Error includes scale factor of 1.5. See the ideogram below.			
0.6823±0.0044±0.0044	500k	ANGELOPO...	98C	CPLR	
0.681 ±0.024	6499	CHO	77	HBC	
0.620 ±0.023	4709	PEACH	77	HBC	
0.677 ±0.010	509k	MESSNER	74	ASPK	$a_y = -0.917 \pm 0.013$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.69 ±0.07	192	[65] BALDO-...	75	HLBC	
0.590 ±0.022	56k	[65] BUCHANAN	75	SPEC	$a_u = -0.277 \pm 0.010$
0.619 ±0.027	20k	[65,66] BISI	74	ASPK	$a_t = -0.282 \pm 0.011$
0.612 ±0.032		[65] ALEXANDER	73B	HBC	
0.73 ±0.04	3200	[65] BRANDENB...	73	HBC	
0.50 ±0.11	180	[65] JAMES	72	HBC	
0.608 ±0.043	1486	[65] KRENZ	72	HLBC	$a_t = -0.277 \pm 0.018$
0.688 ±0.074	384	[65] METCALF	72	ASPK	$a_t = -0.31 \pm 0.03$
0.650 ±0.012	29k	[65] ALBROW	70	ASPK	$a_y = -0.858 \pm 0.015$
0.593 ±0.022	36k	[65,67] BUCHANAN	70	SPEC	$a_u = -0.278 \pm 0.010$
0.664 ±0.056	4400	[65] SMITH	70	OSPK	$a_t = -0.306 \pm 0.024$
0.400 ±0.045	2446	[65] BASILE	68B	OSPK	$a_t = -0.188 \pm 0.020$
0.649 ±0.044	1350	[65] HOPKINS	67	HBC	$a_t = -0.294 \pm 0.018$
0.428 ±0.055	1198	[65] NEFKENS	67	OSPK	$a_u = -0.204 \pm 0.025$
0.64 ±0.17	280	[65] ANIKINA	66	CC	$a_v = -8.2^{+0.9}_{-1.3}$
0.70 ±0.12	126	[65] HAWKINS	66	HBC	$a_v = -8.6 \pm 0.7$
0.32 ±0.13	66	[65] ASTBURY	65	CC	$a_v = -5.5 \pm 1.5$
0.51 ±0.09	310	[65] ASTBURY	65B	CC	$a_v = -7.3^{+0.6}_{-0.8}$
0.55 ±0.23	79	[65] ADAIR	64	HBC	$a_v = -7.6 \pm 1.7$
0.51 ±0.20	77	[65] LUERS	64	HBC	$a_v = -7.3 \pm 1.6$

[65] Quadratic dependence required by some experiments. (See sections on "QUADRATIC COEFFICIENT h" and "QUADRATIC COEFFICIENT k" below.) Correlations prevent us from averaging results of fits not including g, h, and k terms.

[66] BISI 74 value comes from quadratic fit with quad. term consistent with zero. g error is thus larger than if linear fit were used.

[67] BUCHANAN 70 result revised by BUCHANAN 75 to include radiative correlations and to use more reliable K^0_L momentum spectrum of second experiment (had same beam).



Linear coeff. g for $K^0_L \rightarrow \pi^+\pi^-\pi^0$ matrix element squared

QUADRATIC COEFFICIENT h FOR $K^0_L \rightarrow \pi^+\pi^-\pi^0$

VALUE	EVTS	DOCUMENT ID		TECN
0.076±0.006 OUR AVERAGE				
0.061±0.004±0.015	500k	ANGELOPO...	98C	CPLR
0.095±0.032	6499	CHO	77	HBC
0.048±0.036	4709	PEACH	77	HBC
0.079±0.007	509k	MESSNER	74	ASPK
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.011±0.018	29k	[68] ALBROW	70	ASPK
0.043±0.052	4400	[68] SMITH	70	OSPK

See notes in section "LINEAR COEFFICIENT g FOR $K^0_L \rightarrow \pi^+\pi^-\pi^0$ $|$MATRIX ELEMENT$|^2$" above.

[68] Quadratic coefficients h and k required by some experiments. (See section on "QUADRATIC COEFFICIENT k" below.) Correlations prevent us from averaging results of fits not including g, h, and k terms.

QUADRATIC COEFFICIENT k FOR $K^0_L \rightarrow \pi^+\pi^-\pi^0$

VALUE	EVTS	DOCUMENT ID		TECN
0.0099±0.0015 OUR AVERAGE				
0.0104±0.0017±0.0024	500k	ANGELOPO...	98C	CPLR
0.024 ±0.010	6499	CHO	77	HBC
−0.008 ±0.012	4709	PEACH	77	HBC
0.0097±0.0018	509k	MESSNER	74	ASPK

LINEAR COEFFICIENT j FOR $K^0_L \rightarrow \pi^+\pi^-\pi^0$ (CP-VIOLATING TERM)

Listed in CP-violation section below.

QUADRATIC COEFFICIENT f FOR $K^0_L \to \pi^+\pi^-\pi^0$ (CP-VIOLATING TERM)

Listed in CP-violation section below.

QUADRATIC COEFFICIENT h FOR $K^0_L \to \pi^0\pi^0\pi^0$

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*		*TECN*
−3.3±1.1±0.7	5M	[69] SOMALWAR	92	E731

[69] SOMALWAR 92 chose m_{π^+} as normalization to make it compatible with the Particle Data Group $K^0_L \to \pi^+\pi^-\pi^0$ definitions.

K^0_L FORM FACTORS

For discussion, see note on form factors in the $K^{\pm}$ section of the Particle Listings above.

In the form factor comments, the following symbols are used.

f_+ and f_- are form factors for the vector matrix element.

f_S and f_T refer to the scalar and tensor term.

$f_0 = f_+ + f_- t/(m^2_K - m^2_\pi)$.

λ_+, λ_-, and λ_0 are the linear expansion coefficients of f_+, f_-, and f_0.

λ_+ refers to the $K^0_{\mu3}$ value except in the K^0_{e3} sections.

$d\xi(0)/d\lambda_+$ is the correlation between $\xi(0)$ and λ_+ in $K^0_{\mu3}$.

$d\lambda_0/d\lambda_+$ is the correlation between λ_0 and λ_+ in $K^0_{\mu3}$.

t = momentum transfer to the π in units of m^2_π.

DP = Dalitz plot analysis.

PI = π spectrum analysis.

MU = μ spectrum analysis.

POL= μ polarization analysis.

BR = $K^0_{\mu3}/K^0_{e3}$ branching ratio analysis.

E = positron or electron spectrum analysis.

RC = radiative corrections.

λ_+ (LINEAR ENERGY DEPENDENCE OF f_+ IN K^0_{e3} DECAY)

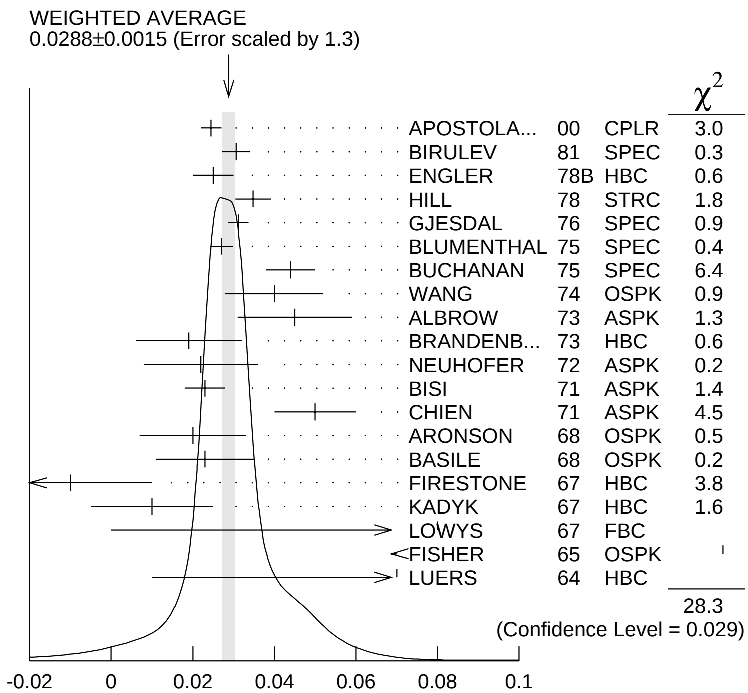
For radiative correction of K^0_{e3} DP, see GINSBERG 67 and BECHERRAWY 70.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.0288±0.0015 OUR AVERAGE		Error includes scale factor of 1.3. See the ideogram below.			
0.0245±0.0012±0.0022	366k	APOSTOLA...	00	CPLR	DP
0.0306±0.0034	74k	BIRULEV	81	SPEC	DP
0.025 ±0.005	12k	[70] ENGLER	78B	HBC	DP
0.0348±0.0044	18k	HILL	78	STRC	DP
0.0312±0.0025	500k	GJESDAL	76	SPEC	DP
0.0270±0.0028	25k	BLUMENTHAL	75	SPEC	DP
0.044 ±0.006	24k	BUCHANAN	75	SPEC	DP
0.040 ±0.012	2171	WANG	74	OSPK	DP
0.045 ±0.014	5600	ALBROW	73	ASPK	DP
0.019 ±0.013	1871	BRANDENB...	73	HBC	PI transv.
0.022 ±0.014	1910	NEUHOFER	72	ASPK	PI
0.023 ±0.005	42k	BISI	71	ASPK	DP
0.05 ±0.01	16k	CHIEN	71	ASPK	DP, no RC
0.02 ±0.013	1000	ARONSON	68	OSPK	PI
+0.023 ±0.012	4800	BASILE	68	OSPK	DP, no RC
−0.01 ±0.02	762	FIRESTONE	67	HBC	DP, no RC
+0.01 ±0.015	531	KADYK	67	HBC	*e*,PI, no RC
+0.08 $^{+0.10}_{-0.08}$	240	LOWYS	67	FBC	PI
+0.15 ±0.08	577	FISHER	65	OSPK	DP, no RC
+0.07 ±0.06	153	LUERS	64	HBC	DP, no RC

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

0.029 ±0.005	19k	[70] CHO	80	HBC	DP
0.0286±0.0049	26k	BIRULEV	79	SPEC	Repl. by BIRULEV 81
0.032 ±0.0042	48k	BIRULEV	76	SPEC	Repl. by BIRULEV 81

[70] ENGLER 78B uses an unique K_{e3} subset of CHO 80 events and is less subject to systematic effects.



λ_+ (Linear energy dependence of f_+, K_{e3} decay)

$\xi_a = f_-/f_+$ (determined from $K^0_{\mu 3}$ spectra)

The parameter ξ is redundant with λ_0 below and is not put into the Meson Summary Table.

VALUE	$d\xi(0)/d\lambda_+$	EVTS	DOCUMENT ID		TECN	COMMENT
−0.11±0.09 OUR EVALUATION			Error includes scale factor of 2.3. Correlation is $d\xi(0)/d\lambda_+ = -14$. From a fit discussed in note on $K_{\ell 3}$ form factors in 1982 edition, PL **111B** (April 1982).			
−0.10±0.09	−12	150k	[71] BIRULEV	81	SPEC	DP
+0.26±0.16	−13	14k	[72] CHO	80	HBC	DP
+0.13±0.23	−20	16k	[72] HILL	79	STRC	DP
−0.25±0.22	−5.9	32k	[73] BUCHANAN	75	SPEC	DP
−0.11±0.07	−17	1.6M	[74] DONALDSON	74B	SPEC	DP
−1.00±0.45	−20	1385	[75] PEACH	73	HLBC	DP
−1.5 ±0.7	−28	9086	[76] ALBROW	72	ASPK	DP
+1.2 ±0.8	−18	1341	[77] CARPENTER	66	OSPK	DP
• • • We do not use the following data for averages, fits, limits, etc. • • •						
+0.50±0.61	unknown	16k	[78] DALLY	72	ASPK	DP
−3.9 ±0.4		3140	[79] BASILE	70	OSPK	DP, indep of λ_+
$-0.68^{+0.12}_{-0.20}$	−26	16k	[78] CHIEN	70	ASPK	DP

[71] BIRULEV 81 error, $d\xi(0)/d\lambda_+$ calculated by us from λ_0, λ_+. $d\lambda_0/d\lambda_+ = 0$ used.

[72] HILL 79 and CHO 80 calculated by us from λ_0, λ_+, and $d\lambda_0/d\lambda_+$.

[73] BUCHANAN 75 is calculated by us from λ_0, λ_+ and $d\lambda_0/d\lambda_+$ because their appendix A value -0.20 ± 22 assumes $\xi(t)$ constant, i.e. $\lambda_- = \lambda_+$.

[74] DONALDSON 74B gives $\xi = -0.11 \pm 0.02$ not including systematics. Above error and $d\xi(0)/d\lambda_+$ were calculated by us from λ_0 and λ_+ errors (which include systematics) and $d\lambda_0/d\lambda_+$.

[75] PEACH 73 gives $\xi(0) = -0.95 \pm 0.45$ for $\lambda_+ = \lambda_- = 0.025$. The above value is for $\lambda_- = 0$. K.Peach, private communication (1974).

[76] ALBROW 72 fit has λ_- free, gets $\lambda_- = -0.030 \pm 0.060$ or $\Lambda = +0.15^{+0.17}_{-0.11}$.

[77] CARPENTER 66 $\xi(0)$ is for $\lambda_+ = 0$. $d\xi(0)/d\lambda_+$ is from figure 9.

[78] CHIEN 70 errors are statistical only. $d\xi(0)/d\lambda_+$ from figure 4. DALLY 72 is a reanalysis of CHIEN 70. The DALLY 72 result is not compatible with assumption $\lambda_- = 0$ so not included in our fit. The nonzero λ_- value and the relatively large λ_+ value found by DALLY 72 come mainly from a single low t bin (figures 1,2). The (f_+,ξ) correlation was ignored. We estimate from figure 2 that fixing $\lambda_- = 0$ would give $\xi(0) = -1.4 \pm 0.3$ and would add 10 to χ^2. $d\xi(0)/d\lambda_+$ is not given.

[79] BASILE 70 is incompatible with all other results. Authors suggest that efficiency estimates might be responsible.

$\xi_b = f_-/f_+$ (determined from $K^0_{\mu3}/K^0_{e3}$)

The $K^0_{\mu3}/K^0_{e3}$ branching ratio fixes a relationship between $\xi(0)$ and λ_+. We quote the author's $\xi(0)$ and associated λ_+ but do not average because the λ_+ values differ. The fit result and scale factor given below are not obtained from these ξ_b values. Instead they are obtained directly from the authors $K^0_{\mu3}/K^0_{e3}$ branching ratio via the fitted $K^0_{\mu3}/K^0_{e3}$ ratio $(\Gamma(\pi^\pm \mu^\mp \nu_\mu)/\Gamma(\pi^\pm e^\mp \nu_e))$. The parameter ξ is redundant with λ_0 below and is not put into the Meson Summary Table.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
−0.11±0.09 OUR EVALUATION		Error includes scale factor of 2.3. Correlation is $d\xi(0)/d\lambda_+ = -14$. From a fit discussed in note on $K_{\ell 3}$ form factors in 1982 edition, PL **111B** (April 1982).			
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.5 ±0.4	6700	BRANDENB...	73	HBC	BR, λ_+=0.019 ± 0.013
−0.08±0.25	1309	[80] EVANS	73	HLBC	BR, λ_+=0.02
−0.5 ±0.5	3548	BASILE	70	OSPK	BR, λ_+=0.02
+0.45±0.28	569	BEILLIERE	69	HLBC	BR, λ_+=0
−0.22±0.30	1309	[80] EVANS	69	HLBC	
$+0.2\ ^{+0.8}_{-1.2}$		KULYUKINA	68	CC	BR, λ_+=0
+1.1 ±1.1	389	ADAIR	64	HBC	BR, λ_+=0
$+0.66^{+0.9}_{-1.3}$		LUERS	64	HBC	BR, λ_+=0

[80] EVANS 73 replaces EVANS 69.

$\xi_c = f_-/f_+$ (determined from μ polarization in $K^0_{\mu3}$)

The μ polarization is a measure of $\xi(t)$. No assumptions on λ_{+-} necessary, t (weighted by sensitivity to $\xi(t)$) should be specified. In λ_+, $\xi(0)$ parametrization this is $\xi(0)$ for $\lambda_+ = 0$. $d\xi/d\lambda = \xi t$. For radiative correction to μ polarization in $K^0_{\mu3}$, see GINSBERG 73. The parameter ξ is redundant with λ_0 below and is not put into the Meson Summary Table.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
−0.11 ±0.09 OUR EVALUATION		Error includes scale factor of 2.3. Correlation is $d\xi(0)/d\lambda_+ = -14$. From a fit discussed in note on $K_{\ell 3}$ form factors in 1982 edition, PL **111B** (April 1982).			
+0.178±0.105	207k	[81] CLARK	77	SPEC	POL, $d\xi(0)/d\lambda_+ = +0.68$
−0.385±0.105	2.2M	[82] SANDWEISS	73	CNTR	POL, $d\xi(0)/d\lambda_+ = -6$
$-1.81\ ^{+0.50}_{-0.26}$		[83] LONGO	69	CNTR	POL, t=3.3
• • • We do not use the following data for averages, fits, limits, etc. • • •					
−1.6 ±0.5	638	[84] ABRAMS	68B	OSPK	Polarization
−1.2 ±0.5	2608	[84] AUERBACH	66B	OSPK	Polarization

[81] CLARK 77 $t = +3.80$, $d\xi(0)/d\lambda_+ = \xi(t)t = 0.178 \times 3.80 = +0.68$.

[82] SANDWEISS 73 is for $\lambda_+ = 0$ and $t = 0$.

[83] LONGO 69 $t = 3.3$ calculated from $d\xi(0)/d\lambda_+ = -6.0$ (table 1) divided by $\xi = -1.81$.

[84] t value not given.

Im(ξ) in $K^0_{\mu3}$ DECAY (from transverse μ pol.)

Test of T reversal invariance.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
−0.007±0.026 OUR AVERAGE					
0.009±0.030	12M	MORSE	80	CNTR	Polarization
0.35 ±0.30	207k	[85] CLARK	77	SPEC	POL, t=0
−0.085±0.064	2.2M	[86] SANDWEISS	73	CNTR	POL, t=0
−0.02 ±0.08		LONGO	69	CNTR	POL, t=3.3
−0.2 ±0.6		ABRAMS	68B	OSPK	Polarization
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.012±0.026		SCHMIDT	79	CNTR	Repl. by MORSE 80

[85] CLARK 77 value has additional $\xi(0)$ dependence $+0.21\mathrm{Re}\big[\xi(0)\big]$.

[86] SANDWEISS 73 value corrected from value quoted in their paper due to new value of Re(ξ). See footnote 4 of SCHMIDT 79.

λ_+ (LINEAR ENERGY DEPENDENCE OF f_+ IN $K^0_{\mu3}$ DECAY)

See also the corresponding entries and notes in section "$\xi_A = f_-/f_+$" above and section "λ_0 (LINEAR ENERGY DEPENDENCE OF f_0 IN $K^0_{\mu3}$ DECAY)" below. For radiative correction of $K^0_{\mu3}$ Dalitz plot see GINSBERG 70 and BECHERRAWY 70.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.034 ±0.005 OUR EVALUATION		From a fit discussed in note on $K_{\ell3}$ form factors in 1982 edition, PL **111B** (April 1982).			
0.0427±0.0044	150k	BIRULEV	81	SPEC	DP
0.028 ±0.010	14k	CHO	80	HBC	DP
0.028 ±0.011	16k	HILL	79	STRC	DP
0.046 ±0.030	32k	BUCHANAN	75	SPEC	DP
0.030 ±0.003	1.6M	DONALDSON	74B	SPEC	DP
0.085 ±0.015	9086	ALBROW	72	ASPK	DP
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.0337±0.0033	129k	DZHORD...	77	SPEC	Repl. by BIRULEV 81
0.046 ±0.008	82k	ALBRECHT	74	WIRE	Repl. by BIRULEV 81
0.11 ±0.04	16k	DALLY	72	ASPK	DP
0.07 ±0.02	16k	CHIEN	70	ASPK	Repl. by DALLY 72

λ_0 (LINEAR ENERGY DEPENDENCE OF f_0 IN $K^0_{\mu 3}$ DECAY)

Wherever possible, we have converted the above values of $\xi(0)$ into values of λ_0 using the associated λ_+^{μ} and $d\xi(0)/d\lambda_+$.

VALUE	$d\lambda_0/d\lambda_+$	EVTS	DOCUMENT ID		TECN	COMMENT
0.025 ±0.006	**OUR EVALUATION**					Error includes scale factor of 2.3. Correlation is $d\lambda_0/d\lambda_+$=−0.16. From a fit discussed in note on $K_{\ell 3}$ form factors in 1982 edition, PL **111B** (April 1982).
0.0341±0.0067	unknown	150k	[87] BIRULEV	81	SPEC	DP
+0.050 ±0.008	−0.11	14k	CHO	80	HBC	DP
+0.039 ±0.010	−0.67	16k	HILL	79	STRC	DP
+0.047 ±0.009	1.06	207k	[88] CLARK	77	SPEC	POL
+0.025 ±0.019	+0.5	32k	[89] BUCHANAN	75	SPEC	DP
+0.019 ±0.004	−0.47	1.6M	[90] DONALDSON	74B	SPEC	DP
−0.060 ±0.038	−0.71	1385	[91] PEACH	73	HLBC	DP
−0.018 ±0.009	+0.49	2.2M	[88] SANDWEISS	73	CNTR	POL
−0.043 ±0.052	−1.39	9086	[92] ALBROW	72	ASPK	DP
−0.140 $^{+0.043}_{-0.022}$	+0.49		[88] LONGO	69	CNTR	POL
+0.08 ±0.07	−0.54	1371	[88] CARPENTER	66	OSPK	DP
• • • We do not use the following data for averages, fits, limits, etc. • • •						
0.041 ±0.008		14k	[93] CHO	80	HBC	BR, λ_+=0.028
+0.0485±0.0076		47k	DZHORD...	77	SPEC	In BIRULEV 81
+0.024 ±0.011		82k	ALBRECHT	74	WIRE	In BIRULEV 81
+0.06 ±0.03		6700	[94] BRANDENB...	73	HBC	BR, λ_+=0.019 ± 0.013
−0.067 ±0.227	unknown	16k	[95] DALLY	72	ASPK	DP
−0.333 ±0.034	+1.	3140	[96] BASILE	70	OSPK	DP

[87] BIRULEV 81 gives $d\lambda_0/d\lambda_+ = -1.5$, giving an unreasonably narrow error ellipse which dominates all other results. We use $d\lambda_0/d\lambda_+ = 0$.

[88] λ_0 value is for $\lambda_+ = 0.03$ calculated by us from $\xi(0)$ and $d\xi(0)/d\lambda_+$.

[89] BUCHANAN 75 value is from their appendix A and uses only $K_{\mu 3}$ data. $d\lambda_0/d\lambda_+$ was obtained by private communication, C.Buchanan, 1976.

[90] DONALDSON 74B $d\lambda_0/d\lambda_+$ obtained from figure 18.

[91] PEACH 73 assumes $\lambda_+ = 0.025$. Calculated by us from $\xi(0)$ and $d\xi(0)/d\lambda_+$.

[92] ALBROW 72 λ_0 is calculated by us from ξ_A, λ_+ and $d\xi(0)/d\lambda_+$. They give $\lambda_0 = -0.043 \pm 0.039$ for $\lambda_- = 0$. We use our larger calculated error.

[93] CHO 80 BR result not independent of their Dalitz plot result.

[94] Fit for λ_0 does not include this value but instead includes the $K_{\mu 3}/K_{e3}$ result from this experiment.

[95] DALLY 72 gives $f_0 = 1.20 \pm 0.35$, $\lambda_0 = -0.080 \pm 0.272$, $\lambda_0{}' = -0.006 \pm 0.045$, but with a different definition of λ_0. Our quoted λ_0 is his λ_0/f_0. We cannot calculate true λ_0 error without his (λ_0,f_0) correlations. See also note on DALLY 72 in section ξ_A.

[96] BASILE 70 λ_0 is for $\lambda_+ = 0$. Calculated by us from ξ_A with $d\xi(0)/d\lambda_+ = 0$. BASILE 70 is incompatible with all other results. Authors suggest that efficiency estimates might be responsible.

$|f_S/f_+|$ FOR K^0_{e3} DECAY

Ratio of scalar to f_+ couplings.

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<0.04	68	25k	BLUMENTHAL	75	SPEC	
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<0.095	95	18k	HILL	78	STRC	
<0.07	68	48k	BIRULEV	76	SPEC	See also BIRULEV 81
<0.19	95	5600	ALBROW	73	ASPK	
<0.15	68		KULYUKINA	67	CC	

$|f_T/f_+|$ FOR K^0_{e3} DECAY

Ratio of tensor to f_+ couplings.

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<0.23	68	25k	BLUMENTHAL	75	SPEC	
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<0.40	95	18k	HILL	78	STRC	
<0.34	68	48k	BIRULEV	76	SPEC	See also BIRULEV 81
<1.0	95	5600	ALBROW	73	ASPK	
<1.0	68		KULYUKINA	67	CC	

$|f_T/f_+|$ FOR $K^0_{\mu 3}$ DECAY

Ratio of tensor to f_+ couplings.

VALUE	DOCUMENT ID		TECN
0.12±0.12	BIRULEV	81	SPEC

α_{K^*} DECAY FORM FACTOR FOR $K_L \to e^+ e^- \gamma$

α_{K^*} is the constant in the model of BERGSTROM 83 which measures the relative strength of the vector-vector transition $K_L \to K^* \gamma$ with $K^* \to \rho, \omega, \phi \to \gamma^*$ and the pseudoscalar-pseudoscalar transition $K_L \to \pi, \eta, \eta' \to \gamma\gamma^*$.

VALUE	EVTS	DOCUMENT ID		TECN
−0.33 ±0.05 OUR AVERAGE				
−0.36 ±0.06 ±0.02	6864	FANTI	99B	NA48
−0.28 ±0.13		BARR	90B	NA31
$-0.280^{+0.099}_{-0.090}$		OHL	90B	B845

DECAY FORM FACTORS FOR $K^0_L \to \pi^\pm \pi^0 e^\mp \nu_e$

Given in MAKOFF 93.

FITS FOR K^0_L CP-VIOLATION PARAMETERS

Revised April 2000 by T.G. Trippe (LBNL).

In recent years, K^0_L CP-violation experiments have improved our knowledge of CP-violation parameters and their consistency with the expectations of CPT invariance and unitarity. For definitions of K_L^0 CP-violation parameters and a brief discussion of the theory, see the article "CP Violation" by L. Wolfenstein in Section 12 of this *Review*.

This note describes our two fits for the CP-violation parameters in $K_L^0 \to \pi^+\pi^-$ and $\pi^0\pi^0$ decay, one for the phases ϕ_{+-} and ϕ_{00}, and another for the amplitudes $|\eta_{+-}|$ and $|\eta_{00}|$.

Fit to $\boldsymbol{\phi_{+-}}$***,*** $\boldsymbol{\phi_{00}}$***,*** $\boldsymbol{\Delta\phi}$***,*** $\boldsymbol{\Delta m}$***, and*** $\boldsymbol{\tau_S}$ ***data***: We perform a joint fit to the data on ϕ_{+-}, ϕ_{00}, the phase difference $\Delta\phi = \phi_{00} - \phi_{+-}$, the $K_L^0 - K_S^0$ mass difference Δm, and the K_S^0 mean life τ_S, including the effects of correlations. Measurements of ϕ_{+-} and ϕ_{00} are highly correlated with Δm and τ_S. Some measurements of τ_S are correlated with Δm. The correlations are given in the footnotes of the ϕ_{+-} and ϕ_{00} sections of the K_L^0 Particle Listings and the τ_S section of the K_S^0 Particle listings. In editions of the Review prior to 1996, we adjusted the experimental values of ϕ_{+-} and ϕ_{00} to account for correlations with Δm and τ_S but did not include the effects of these correlations when evaluating Δm and τ_S. In 1996, we introduced a joint fit including these correlations. In this fit, the ϕ_{+-} measurements have a strong influence on the fitted value of Δm. This is because the CERN NA31 vacuum regeneration experiments (CAROSI 90 [1] and GEWENIGER 74B [2]), the Fermilab E773/E731 regenerator experiments (SCHWINGENHEUER 95 [3] and GIBBONS 93 [4]), and the CPLEAR $K^0 - \overline{K}^0$ asymmetry experiment (APOSTOLAKIS 99C [5]) have very different dependences of ϕ_{+-} on Δm, as can be seen from their diagonal bands in Fig. 1.

The region where the ϕ_{+-} bands from these experiments cross gives a powerful measurement of Δm which decreases the fitted Δm value relative to our pre-1996 average Δm and earlier measurements such as CULLEN 70 [6], GEWENIGER 74C [7], and GJESDAL 74 [8].

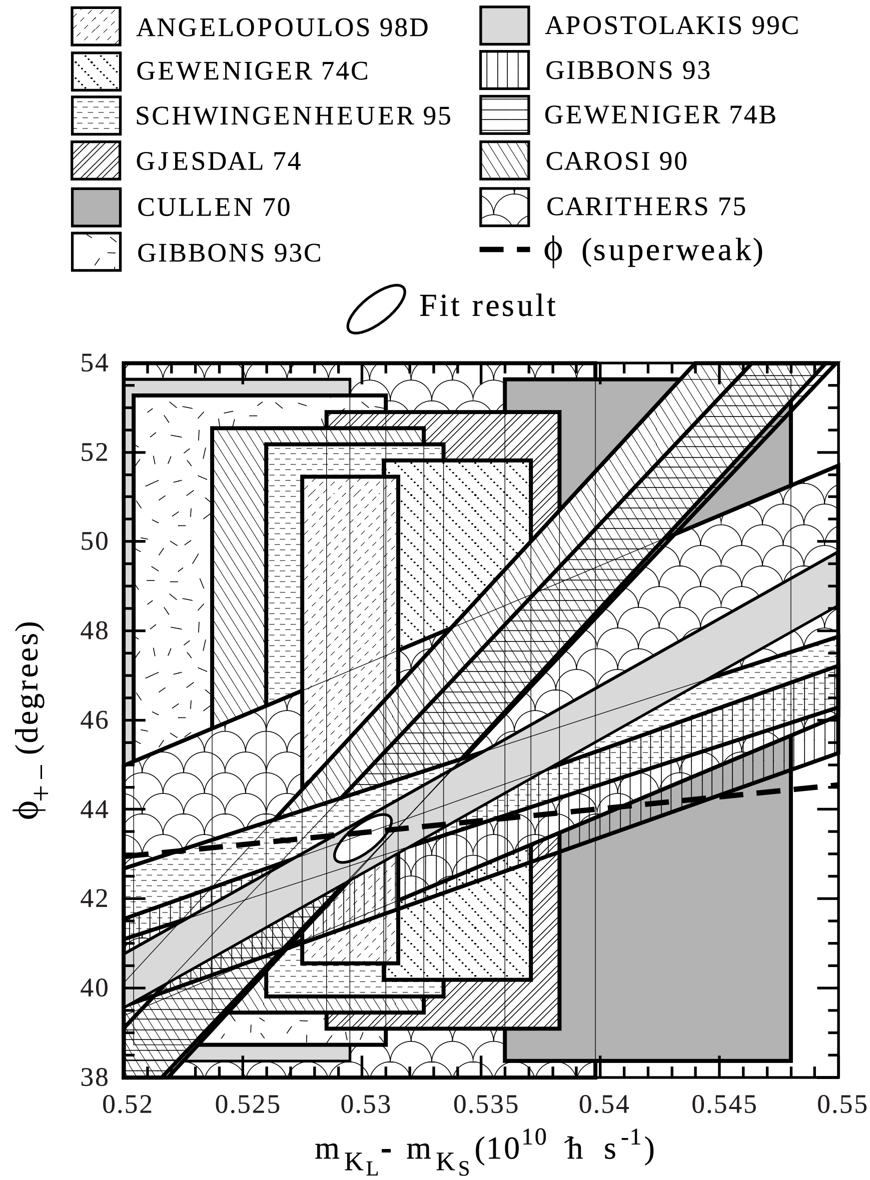


Figure 1: ϕ_{+-} vs Δm. Δm measurements appear as vertical bands spanning $\Delta m \pm 1\sigma$, some of which are cut near the top to aid the eye. The ϕ_{+-} measurements appear as diagonal bands spanning $\phi_{+-} \pm \sigma_\phi$. The dashed line shows ϕ(superweak). The ellipse shows the 1σ contour of the fit result. See Table 1 for data references.

Table 1: References and location of input data for Fig. 1 and Fig. 2. Unless otherwise indicated by a footnote, a check (✓) indicates that the data can be found in the ϕ_{+-} or Δm sections of the K_L Particle Listings, or the τ_S section of the K_S Particle Listings, according to the column headers.

Location of input data					
Fig. 1		Fig. 2			
ϕ_{+-}	Δm	ϕ_{+-}	τ_S	PDG Document ID	Ref.
✓	✓	✓		APOSTOLAKIS 99C	[5]
✓		✓	✓	GIBBONS 93	[4]
✓	✓	✓	✓	SCHWINGENHEUER 95	[3]
✓		✓	✓	GEWENIGER 74B	[2]
✓	✓*	✓	✓*	CAROSI 90	[1]
✓	✓†	✓	✓	CARITHERS 75	[10]
	✓			ANGELOPOULOS 98D	[11]
	✓			GEWENIGER 74C	[7]
	✓			GJESDAL 74	[8]
	✓			CULLEN 70	[6]
	✓			GIBBONS 93C	[12]
			✓	BERTANZA 97	[9]
			✓	GROSSMAN 87	[13]
			✓	SKJEGGESTAD 72	[14]
			✓	ARONSON 76	[15]

* from $\phi_{00}(\Delta m, \tau_S)$ in ϕ_{00} Particle Listings.

† from $\tau_S(\Delta m)$ in τ_S Particle Listings.

This decrease brings the Δm-dependent ϕ_{+-} measurements into good agreement with each other and with ϕ(superweak), where

$$\phi(\text{superweak}) = \tan^{-1}\left(\frac{2\Delta m}{\Delta\Gamma}\right) = \tan^{-1}\left(\frac{2\Delta m \tau_S \tau_L}{\hbar(\tau_L - \tau_S)}\right) \ . \qquad (1)$$

The (ϕ_{+-}, τ_S) correlations influence the τ_S fit result in a similar manner, as can be seen in Fig. 2. The influence of the ϕ_{+-} experiments is not as great on τ_S as it is on Δm because the indirect measurements of τ_S derived from the diagonal crossing bands in Fig. 2 are not as precise as the direct measurements of τ_S from E773 (SCHWINGENHEUER 95 [3]), E731 (GIBBONS 93 [4]), and NA31 (BERTANZA 97 [9]).

In Fig. 1 [Fig. 2] the slope of the diagonal ϕ_{+-} bands shows the Δm [τ_S] dependence; the unseen τ_S [Δm] dependent term is evaluated using the fitted τ_S [Δm]. The vertical half-width σ_ϕ of each band is the ϕ_{+-} error for fixed Δm [τ_S] and includes the systematic error due to the error in the fitted τ_S [Δm].

Table 2 gives the resulting fit values for the parameters and Table 3 gives the correlation matrix. The resulting ϕ_{+-} is in good agreement with ϕ(superweak) $= 43.49 \pm 0.07°$ obtained from Eq. (1) using Δm and τ_S from Table 2.

Table 2: Results of the fit for ϕ_{+-}, ϕ_{00}, $\phi_{00} - \phi_{+-}$, Δm, and τ_S. The fit has $\chi^2 = 16.0$ for 20 degrees of freedom (24 measurements -5 parameters $+1$ constraint).

Quantity	Fit Result
ϕ_{+-}	$43.3 \pm 0.5°$
Δm	$(0.5300 \pm 0.0012) \times 10^{10}\hbar\ \mathrm{s}^{-1}$
τ_S	$(0.8935 \pm 0.0008) \times 10^{-10}\mathrm{s}$
ϕ_{00}	$43.2 \pm 1.0°$
$\Delta\phi$	$-0.1 \pm 0.8°$

The χ^2 is 16.0 for 20 degrees of freedom, indicating good agreement of the input data. Nevertheless, there has been criticism that Fermilab E773 (SCHWINGENHEUER 95 [3]) and E731 (GIBBONS 93 [4]) measure $\phi_{+-} - \phi_f$ and calculate the regeneration phase ϕ_f from the power law momentum dependence of the regeneration amplitude using analyticity

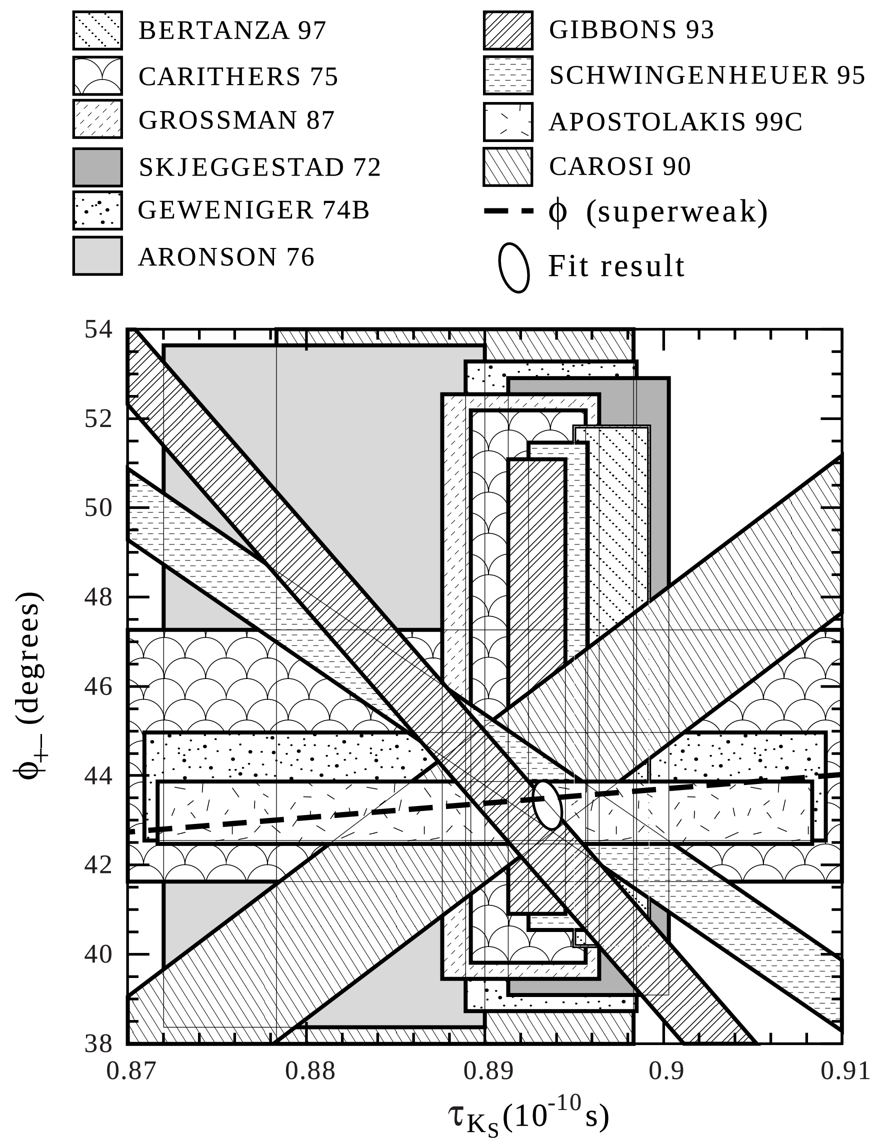


Figure 2: ϕ_{+-} vs τ_S. τ_S measurements appear as vertical bands spanning $\tau_S \pm 1\sigma$, some of which are cut near the top to aid the eye. The ϕ_{+-} measurements appear as diagonal bands spanning $\phi_{+-} \pm \sigma_\phi$. The dashed line shows ϕ(superweak). The ellipse shows the fit result's 1σ contour. See Table 1 for data references.

Table 3: Correlation matrix for the fitted parameters.

	ϕ_{+-}	Δm	τ_S	ϕ_{00}	$\Delta\phi$
ϕ_{+-}	1.00	0.71	−0.30	0.54	−0.02
Δm	0.71	1.00	−0.19	0.43	0.04
τ_S	−0.30	−0.19	1.00	−0.14	0.04
ϕ_{00}	0.54	0.43	−0.14	1.00	0.83
$\Delta\phi$	−0.02	0.04	0.04	0.83	1.00

and dispersion relations. In the E731 result, a systematic error of ± 0.5 degrees for departures from a pure power-law is included. For the E773 result, they modeled a variety of effects that do distort the amplitude from a pure power law and ascribed a $\pm 0.35°$ systematic error from uncertainties in these effects. Even so, the E731 result remains valid within its quoted errors. KLEINKNECHT 94 [16] and KLEINKNECHT 95 [17] argue that these systematic errors should be around 3°, primarily because of the absence of data on the momentum dependence of the regeneration amplitude above 160 GeV/c. BRIERE 95 [18] and BRIERE 95C [19] reply that the current understanding of regeneration is sufficient to allow a precise and reliable correction for the region above 160 GeV/c. The question is one of judgement about the reliability of the assumptions used. In the absence of any contradictory evidence, we choose to accept the judgement of the E731/E773 experimenters in setting their systematic errors.

Fit for ϵ'/ϵ, $|\eta_{+-}|$, $|\eta_{00}|$, and B($K_L \to \pi\pi$)

We list measurements of $|\eta_{+-}|$, $|\eta_{00}|$, $|\eta_{00}/\eta_{+-}|$ and ϵ'/ϵ. Independent information on $|\eta_{+-}|$ and $|\eta_{00}|$ can be obtained from measurements of the

K^0_L and K^0_S lifetimes (τ_L, τ_S) and branching ratios (B) to $\pi\pi$, using the relations

$$|\eta_{+-}| = \left[\frac{\mathrm{B}(K^0_L \to \pi^+\pi^-)}{\tau_L}\;\frac{\tau_S}{\mathrm{B}(K^0_S \to \pi^+\pi^-)}\right]^{1/2} , \qquad (2a)$$

$$|\eta_{00}| = \left[\frac{\mathrm{B}(K^0_L \to \pi^0\pi^0)}{\tau_L}\;\frac{\tau_S}{\mathrm{B}(K^0_S \to \pi^0\pi^0)}\right]^{1/2} . \qquad (2b)$$

For historical reasons the branching ratio fits and the CP-violation fits are done separately, but we want to include the influence of $|\eta_{+-}|$, $|\eta_{00}|$, $|\eta_{00}/\eta_{+-}|$, and ϵ'/ϵ measurements on $\mathrm{B}(K^0_L \to \pi^+\pi^-)$ and $\mathrm{B}(K^0_L \to \pi^0\pi^0)$ and vice versa. We approximate a global fit to all of these measurements by first performing two independent fits: 1) BRFIT, a fit to the K^0_L branching ratios, rates, and mean life, and 2) ETAFIT, a fit to the $|\eta_{+-}|$, $|\eta_{00}|$, $|\eta_{+-}/\eta_{00}|$, and ϵ'/ϵ measurements. The results from fit 1, along with the K^0_S values from this edition are used to compute values of $|\eta_{+-}|$ and $|\eta_{00}|$ which are included as measurements in the $|\eta_{00}|$ and $|\eta_{+-}|$ sections with a document ID of BRFIT 00. Thus the fit values of $|\eta_{+-}|$ and $|\eta_{00}|$ given in this edition include both the direct measurements and the results from the branching ratio fit.

The process is reversed in order to include the direct $|\,\eta\,|$ measurements in the branching ratio fit. The results from fit 2 above (before including BRFIT 00 values) are used along with the K^0_L and K^0_S mean lives and the $K^0_S \to \pi\pi$ branching fractions to compute the K^0_L branching ratios $\Gamma(K^0_L \to \pi^+\pi^-)/\Gamma(\mathrm{total})$ and $\Gamma(K^0_L \to \pi^0\pi^0)/\Gamma(K^0_L \to \pi^+\pi^-)$. These branching ratio values are included as measurements in the branching ratio section with a document ID of ETAFIT 00. Thus the K^0_L branching ratio fit values in this edition include the results of direct measurements of $|\eta_{+-}|$, $|\eta_{00}|$, $|\eta_{00}/\eta_{+-}|$, and ϵ'/ϵ. A more detailed discussion of these fits is given in the 1990 edition of this *Review* [20].

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CP-VIOLATION PARAMETERS IN K_L^0 DECAYS

CHARGE ASYMMETRY IN $K_{\ell 3}^0$ DECAYS

Such asymmetry violates *CP*. It is related to Re(ϵ).

δ = weighted average of $\delta(\mu)$ and $\delta(e)$

VALUE (%)	EVTS	DOCUMENT ID		TECN	COMMENT
0.327±0.012 OUR AVERAGE	Includes data from the 2 datablocks that follow this one.				
0.333±0.050	33M	WILLIAMS	73	ASPK	$K_{\mu 3}$ + K_{e3}

$\delta(\mu) = [\Gamma(\pi^- \mu^+ \nu_\mu) - \Gamma(\pi^+ \mu^- \overline{\nu}_\mu)]$/SUM

Only the combined value below is put into the Meson Summary Table.

VALUE (%)	*EVTS*	*DOCUMENT ID*		*TECN*
The data in this block is included in the average printed for a previous datablock.				
0.304±0.025 OUR AVERAGE				
0.313±0.029	15M	GEWENIGER	74	ASPK
0.278±0.051	7.7M	PICCIONI	72	ASPK
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.60 ±0.14	4.1M	MCCARTHY	73	CNTR
0.57 ±0.17	1M	[97] PACIOTTI	69	OSPK
0.403±0.134	1M	[97] DORFAN	67	OSPK

[97] PACIOTTI 69 is a reanalysis of DORFAN 67 and is corrected for $\mu^+ \mu^-$ range difference in MCCARTHY 72.

$\delta(e) = [\Gamma(\pi^- e^+ \nu_e) - \Gamma(\pi^+ e^- \overline{\nu}_e)]$/SUM

Only the combined value below is put into the Meson Summary Table.

VALUE (%)	*EVTS*	*DOCUMENT ID*		*TECN*
The data in this block is included in the average printed for a previous datablock.				
0.333±0.014 OUR AVERAGE				
0.341±0.018	34M	GEWENIGER	74	ASPK
0.318±0.038	40M	FITCH	73	ASPK
0.346±0.033	10M	MARX	70	CNTR
0.246±0.059	10M	[98] SAAL	69	CNTR
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.36 ±0.18	600k	ASHFORD	72	ASPK
0.224±0.036	10M	[98] BENNETT	67	CNTR

[98] SAAL 69 is a reanalysis of BENNETT 67.

PARAMETERS FOR $K^0_L \to 2\pi$ DECAY

η_{+-} = A($K^0_L \to \pi^+\pi^-$) / A($K^0_S \to \pi^+\pi^-$)
η_{00} = A($K^0_L \to \pi^0\pi^0$) / A($K^0_S \to \pi^0\pi^0$)

The fitted values of $|\eta_{+-}|$ and $|\eta_{00}|$ given below are the results of a fit to $|\eta_{+-}|$, $|\eta_{00}|$, $|\eta_{00}/\eta_{+-}|$, and Re(ϵ'/ϵ). Independent information on $|\eta_{+-}|$ and $|\eta_{00}|$ can be obtained from the fitted values of the $K^0_L \to \pi\pi$ and $K^0_S \to \pi\pi$ branching ratios and the K^0_L and K^0_S lifetimes. This information is included as data in the $|\eta_{+-}|$ and $|\eta_{00}|$ sections with a Document ID "BRFIT." See the note "Fits for K^0_L *CP*-Violation Parameters" above for details.

$|\eta_{00}| = |A(K^0_L \to 2\pi^0) / A(K^0_S \to 2\pi^0)|$

VALUE (units 10^{-3})	*DOCUMENT ID*		*TECN*	*COMMENT*
2.262±0.017 OUR FIT				
2.23 ±0.11 OUR AVERAGE				
2.12 ±0.16	[99] BRFIT	00		
2.47 ±0.31 ±0.24	ANGELOPO...	98	CPLR	
2.33 ±0.18	CHRISTENS...	79	ASPK	

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

2.49 ±0.40	[100] ADLER	96B	CPLR	Sup. by ANGELOPOULOS 98
2.71 ±0.37	[101] WOLFF	71	OSPK	Cu reg., 4γ's
2.95 ±0.63	[101] CHOLLET	70	OSPK	Cu reg., 4γ's

[99] This BRFIT value is computed from fitted values of the K^0_L and K^0_S lifetimes and branching fractions to $\pi\pi$. See the discussion in the note "Fits for K^0_L *CP*-Violation Parameters."

[100] Error is statistical only.

[101] CHOLLET 70 gives $|\eta_{00}|$ = (1.23 ± 0.24)×(regeneration amplitude, 2 GeV/c Cu)/10000mb. WOLFF 71 gives $|\eta_{00}|$ = (1.13 ± 0.12)×(regeneration amplitude, 2 GeV/c Cu)/10000mb. We compute both $|\eta_{00}|$ values for (regeneration amplitude, 2 GeV/c Cu) = 24 ± 2mb. This regeneration amplitude results from averaging over FAISSNER 69, extrapolated using optical-model calculations of Bohm et al., Physics Letters **27B** 594 (1968) and the data of BALATS 71. (From H. Faissner, private communication).

$|\eta_{+-}| = |A(K^0_L \to \pi^+\pi^-) / A(K^0_S \to \pi^+\pi^-)|$

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
2.276±0.017 OUR FIT					
2.277±0.017 OUR AVERAGE					
2.272±0.024		[102] BRFIT	00		
2.264±0.023±0.027	70M	[103] APOSTOLA...	99C	CPLR	K^0-$\overline{K}^0$ asymmetry
2.30 ±0.035		GEWENIGER	74B	ASPK	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.310±0.043±0.031		[104] ADLER	95B	CPLR	K^0-$\overline{K}^0$ asymmetry
2.32 ±0.14 ±0.03	10^5	ADLER	92B	CPLR	K^0-$\overline{K}^0$ asymmetry

[102] This BRFIT value is computed from fitted values of the K^0_L and K^0_S lifetimes and branching fractions to $\pi\pi$. See the discussion in the note "Fits for K^0_L *CP*-Violation Parameters."

[103] APOSTOLAKIS 99C report (2.264 ± 0.023 ± 0.026 + 9.1[τ_S − 0.8934]) × 10^{-3}. We evaluate for our 1998 best value τ_S= (0.8934 ± 0.0008) × 10^{-10} s.

[104] ADLER 95B report (2.312 ± 0.043 ± 0.030 − 1[Δm− 0.5274] + 9.1[τ_S − 0.8926]) × 10^{-3}. We evaluate for our 1996 best values Δm = (0.5304 ± 0.0014) × 10^{-10} $\hbar$s^{-1} and τ_S = (0.8927 ± 0.0009) × 10^{-10} s. Superseded by APOSTOLAKIS 99C.

$|\eta_{00}/\eta_{+-}|$

VALUE	EVTS	DOCUMENT ID		TECN
0.9936±0.0014 OUR FIT Error includes scale factor of 1.6.				
0.9930±0.0020 OUR AVERAGE				
0.9931±0.0020		[105,106] BARR	93D	NA31
0.9904±0.0084±0.0036		[107] WOODS	88	E731
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.9939±0.0013±0.0015	1M	[105] BARR	93D	NA31
0.9899±0.0020±0.0025		[105] BURKHARDT	88	NA31

[105] This is the square root of the ratio R given by BURKHARDT 88 and BARR 93D.

[106] This is the combined results from BARR 93D and BURKHARDT 88, taking into account a common systematic uncertainty of 0.0014.

[107] We calculate $|\eta_{00}/\eta_{+-}| = 1-3(\epsilon'/\epsilon)$ from WOODS 88 (ϵ'/ϵ) value.

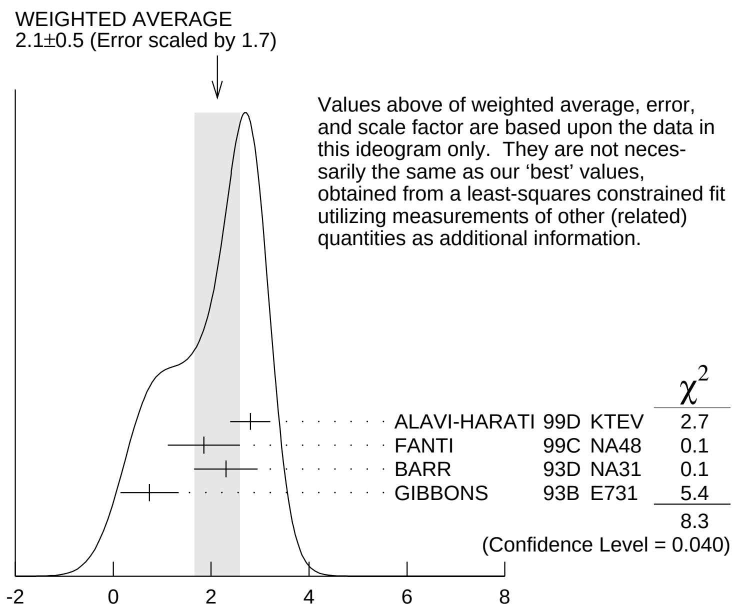
$\epsilon'/\epsilon \approx \mathrm{Re}(\epsilon'/\epsilon) = (1-|\eta_{00}/\eta_{+-}|)/3$

VALUE (units 10^{-3})	*DOCUMENT ID*	*TECN*	*COMMENT*
2.1 ±0.5 OUR FIT Error includes scale factor of 1.6.			
2.1 ±0.5 OUR AVERAGE Error includes scale factor of 1.7. See the ideogram below.			
2.80±0.30±0.28	ALAVI-HARATI 99D	KTEV	
1.85±0.45±0.58	FANTI 99C	NA48	
2.3 ±0.65	[108,109] BARR 93D	NA31	
0.74±0.52±0.29	GIBBONS 93B	E731	
• • • We do not use the following data for averages, fits, limits, etc. • • •			
2.0 ±0.7	[110] BARR 93D	NA31	
−0.4 ±1.4 ±0.6	PATTERSON 90	E731	in GIBBONS 93B
3.3 ±1.1	[110] BURKHARDT 88	NA31	
3.2 ±2.8 ±1.2	[108] WOODS 88	E731	

[108] These values are derived from $|\eta_{00}/\eta_{+-}|$ measurements. They enter the average in this section but enter the fit via the $|\eta_{00}/\eta_{+-}|$ section only.

[109] This is the combined results from BARR 93D and BURKHARDT 88, taking into account their common systematic uncertainty.

[110] These values are derived from $|\eta_{00}/\eta_{+-}|$ measurements.



$\epsilon'/\epsilon \approx \mathrm{Re}(\epsilon'/\epsilon) = (1-|\eta_{00}/\eta_{+-}|)/3$

ϕ_{+-}, PHASE of η_{+-}

The dependence of the phase on Δm and τ_S is given for each experiment in the comments below, where Δm is the $K_L^0 - K_S^0$ mass difference in units $10^{10}\ \hbar s^{-1}$ and τ_s is the K_S mean life in units 10^{-10} s. For the "used" data, we have evaluated these mass dependences using our 2000 values, $\Delta m = 0.5300 \pm 0.0012$, $\tau_s = 0.8935 \pm 0.0008$

to obtain the values quoted below. We also give the regeneration phase ϕ_f in the comments below.

OUR FIT is described in the note on "Fits for K^0_L *CP*-Violation Parameters" in the K^0_L Particle Listings.

VALUE (°)	*EVTS*	*DOCUMENT ID*	*TECN*	*COMMENT*
43.3 ±0.5 OUR FIT				
Average is meaningless.				
43.2 ±0.7	70M	[111] APOSTOLA... 99C	CPLR	K^0-$\overline{K}^0$ asymmetry
43.6 ±0.8		[112,113] SCHWINGEN...95	E773	$CH_{1.1}$ regenerator
42.4 ±1.0		[113,114] GIBBONS 93	E731	B_4C regenerator
44.4 ±1.7		[115] CAROSI 90	NA31	Vacuum regen.
44.4 ±2.8		[116] CARITHERS 75	SPEC	C regenerator
43.8 ±1.2		[117] GEWENIGER 74B	ASPK	Vacuum regen.
• • • We do not use the following data for averages, fits, limits, etc. • • •				
43.82±0.63		[118,119] ADLER 96C	RVUE	
43.6 ±1.2		[120] ADLER 95B	CPLR	K^0-$\overline{K}^0$ asymmetry
42.3 ±4.4 ±1.4	10^5	[121] ADLER 92B	CPLR	K^0-$\overline{K}^0$ asymmetry
47.7 ±2.0 ±0.9		[113,122] KARLSSON 90	E731	

[111] APOSTOLAKIS 99C report $(43.19 \pm 0.53 \pm 0.28)^\circ + 300\ [\Delta m - 0.5301]^\circ$.

[112] SCHWINGENHEUER 95 reports $\phi_{+-} = 43.53 \pm 0.76 + 173[\Delta m - 0.5282] - 275[\tau_S - 0.8926]$.

[113] These experiments measure ϕ_{+-}–ϕ_f and calculate the regeneration phase from the power law momentum dependence of the regeneration amplitude using analyticity and dispersion relations. SCHWINGENHEUER 95 [GIBBONS 93] includes a systematic error of 0.35° [0.5°] for uncertainties in their modeling of the regeneration amplitude. See the discussion of these systematic errors, including criticism that they could be underestimated, in the note on "*C* violation in K^0_L decay."

[114] GIBBONS 93 measures ϕ_{+}–ϕ_f and calculates the regeneration phase ϕ_f from the power law momentum dependence of the regeneration amplitude using analyticity. An error of 0.6° is included for possible uncertainties in the regeneration phase. They find $\phi_{+-} = 42.21 \pm 0.9 + 189\ [\Delta m - 0.5257] - 460\ [\tau_S - 0.8922]^\circ$, as given in SCHWINGENHEUER 95, footnote 8. GIBBONS 93 reports ϕ_{+-} $(42.2 \pm 1.4)^\circ$

[115] CAROSI 90 $\phi_{+-} = 46.9 \pm 1.4 \pm 0.7 + 579\ [\Delta m - 0.5351] + 303\ [\tau_S - 0.8922]^\circ$.

[116] CARITHERS 75 $\phi_{+-} = (45.5 \pm 2.8) + 224[\Delta m - 0.5348]^\circ$. $\phi_f = -40.9 \pm 2.6^\circ$.

[117] GEWENIGER 74B $\phi_{+-} = (49.4 \pm 1.0) + 565[\Delta m - 0.540]^\circ$.

[118] ADLER 96C fit gives $(43.82 \pm 0.41)^\circ + 339(\Delta m - 0.5307)^\circ - 252(\tau_S - 0.8922)^\circ$.

[119] ADLER 96C is the result of a fit which includes nearly the same data as entered into the "OUR FIT" value in the 1996 edition of this Review (Physical Review **D54** 1 (1996)).

[120] ADLER 95B report $42.7^\circ \pm 0.9^\circ \pm 0.6^\circ + 316[\Delta m - 0.5274]^\circ + 30[\tau_S - 0.8926]^\circ$.

[121] ADLER 92B quote separately two systematic errors: ±0.4 from their experiment and ±1.0 degrees due to the uncertainty in the value of Δm.

[122] KARLSSON 90 systematic error does not include regeneration phase uncertainty.

ϕ_{00}, PHASE OF η_{00}

See comment in ϕ_{+-} header above for treatment of Δm and τ_s dependence.

OUR FIT is described in the note on "Fits for K^0_L *CP*-Violation Parameters" in the K^0_L Particle Listings.

VALUE (°)	DOCUMENT ID		TECN	COMMENT
43.2±1.0 OUR FIT				
Average is meaningless.				
41.9±5.6±1.9	[123] ANGELOPO...	98	CPLR	
44.5±2.5	[124] CAROSI	90	NA31	
• • • We do not use the following data for averages, fits, limits, etc. • • •				
50.8±7.1±1.7	[125] ADLER	96B	CPLR	Sup. by ANGELOPOULOS 98
47.4±1.4±0.9	[126] KARLSSON	90	E731	

[123] ANGELOPOULOS 98 ϕ_{00}= 42.0 ± 5.6 ± 1.9 + 240[Δm−0.5307] with negligible τ_s dependence.

[124] CAROSI 90 ϕ_{00} = 47.1 ± 2.1 ± 1.0 +579 [Δm − 0.5351] +252 [τ_s − 0.8922]°.

[125] ADLER 96B identified initial neutral kaon individually as being a K^0 or a $\overline{K}^0$. The systematic uncertainty is ±1.5° combined in quadrature with ±0.8° due to Δm.

[126] KARLSSON 90 systematic error does not include regeneration phase uncertainty.

PHASE DIFFERENCE $\phi_{00} - \phi_{+-}$

Test of *CPT*.

OUR FIT is described in the note on "Fits for K^0_L *CP*-Violation Parameters" in the K^0_L Particle Listings.

VALUE (°)	DOCUMENT ID		TECN	COMMENT
−0.1 ±0.8 OUR FIT				
−0.3 ±0.8 OUR AVERAGE				
−0.30±0.88	[127] SCHWINGEN...	95		Combined E731, E773
0.2 ±2.6 ±1.2	[128] CAROSI	90	NA31	
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.62±0.71±0.75	SCHWINGEN...	95	E773	
−1.6 ±1.2	[129] GIBBONS	93	E731	
−0.3 ±2.4 ±1.2	KARLSSON	90	E731	

[127] This SCHWINGENHEUER 95 values is the combined result of SCHWINGENHEUER 95 and GIBBONS 93, accounting for correlated systematic errors.

[128] CAROSI 90 is excluded from the fit because it it is not independent of ϕ_{+-} and ϕ_{00} values.

[129] GIBBONS 93 give detailed dependence of systematic error on lifetime (see the section on the K^0_S mean life) and mass difference (see the section on $m_{K^0_L} - m_{K^0_S}$).

DECAY-PLANE ASYMMETRY IN $\pi^+\pi^-e^+e^-$ DECAYS

This is the *CP*-violating asymmetry

$$A = \frac{N_{\sin\phi\cos\phi>0.0} - N_{\sin\phi\cos\phi<0.0}}{N_{\sin\phi\cos\phi>0.0} + N_{\sin\phi\cos\phi<0.0}}$$

where ϕ is the angle between the e^+e^- and $\pi^+\pi^-$ planes in the K^0_L rest frame.

CP ASYMMETRY *A* in $K^0_L \to \pi^+\pi^-e^+e^-$

VALUE (%)	DOCUMENT ID		TECN
13.6±2.5±1.2	ALAVI-HARATI	00B	KTEV

CHARGE ASYMMETRY IN $\pi^+\pi^-\pi^0$ DECAYS

These are *CP*-violating charge-asymmetry parameters, defined at beginning of section "LINEAR COEFFICIENT *g* FOR $K_L^0 \to \pi^+\pi^-\pi^0$ above. See also note on Dalitz plot parameters in $K^\pm$ section and note on *CP* violation in K_L^0 decay above.

LINEAR COEFFICIENT *j* FOR $K_L^0 \to \pi^+\pi^-\pi^0$

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*
0.0011±0.0008 OUR AVERAGE				
0.0010±0.0024±0.0030	500k	ANGELOPO...	98C	CPLR
0.001 ±0.011	6499	CHO	77	
−0.001 ±0.003	4709	PEACH	77	
0.0013±0.0009	3M	SCRIBANO	70	
0.0 ±0.017	4400	SMITH	70	OSPK
0.001 ±0.004	238k	BLANPIED	68	

QUADRATIC COEFFICIENT *f* FOR $K_L^0 \to \pi^+\pi^-\pi^0$

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*
0.0045±0.0024±0.0059	500k	ANGELOPO...	98C	CPLR

PARAMETERS for $K_L^0 \to \pi^+\pi^-\gamma$ DECAY

$|\eta_{+-\gamma}| = |A(K_L^0 \to \pi^+\pi^-\gamma$, *CP* violating)$/A(K_S^0 \to \pi^+\pi^-\gamma)|$

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*		*TECN*
2.35 ±0.07 OUR AVERAGE				
2.359±0.062±0.040	9045	MATTHEWS	95	E773
2.15 ±0.26 ±0.20	3671	RAMBERG	93B	E731

$\phi_{+-\gamma}$ = phase of $\eta_{+-\gamma}$

VALUE (°)	*EVTS*	*DOCUMENT ID*		*TECN*
44 ± 4 OUR AVERAGE				
43.8± 3.5± 1.9	9045	MATTHEWS	95	E773
72 ±23 ±17	3671	RAMBERG	93B	E731

$|\epsilon'_{+-\gamma}|/\epsilon$ for $K_L^0 \to \pi^+\pi^-\gamma$

VALUE	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*
<0.3	90	3671	[130] RAMBERG	93B	E731

[130] RAMBERG 93B limit on $|\epsilon'_{+-\gamma}|/\epsilon$ assumes than any difference between η_{+-} and $\eta_{+-\gamma}$ is due to direct *CP* violation.

$\Delta S = \Delta Q$ IN K^0 DECAYS

The relative amount of $\Delta S \neq \Delta Q$ component present is measured by the parameter x, defined as

$$x = A(\overline{K}^0 \to \pi^-\ell^+\nu)/A(K^0 \to \pi^-\ell^+\nu) .$$

We list Re$\{x\}$ and Im$\{x\}$ for K_{e3} and $K_{\mu3}$ combined.

$x = A(\overline{K}^0 \to \pi^- \ell^+ \nu)/A(K^0 \to \pi^- \ell^+ \nu) = A(\Delta S{=}-\Delta Q)/A(\Delta S{=}\Delta Q)$

REAL PART OF x

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
−0.002 ±0.006 OUR AVERAGE					
−0.0018±0.0041±0.0045		ANGELOPO...	98D	CPLR	K_{e3} from K^0
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$0.10\ ^{+0.18}_{-0.19}$	79	SMITH	75B	WIRE	$\pi^- p \to K^0 \Lambda$
$0.04\ \pm0.03$	4724	NIEBERGALL	74	ASPK	$K^+ p \to K^0 p \pi^+$
$-0.008\ \pm0.044$	1757	FACKLER	73	OSPK	K_{e3} from K^0
$-0.03\ \pm0.07$	1367	HART	73	OSPK	K_{e3} from $K^0 \Lambda$
$-0.070\ \pm0.036$	1079	MALLARY	73	OSPK	K_{e3} from $K^0 \Lambda X$
$0.03\ \pm0.06$	410	[131] BURGUN	72	HBC	$K^+ p \to K^0 p \pi^+$
$0.04\ ^{+0.10}_{-0.13}$	100	[132] GRAHAM	72	OSPK	$K_{\mu3}$ from $K^0 \Lambda$
$-0.05\ \pm0.09$	442	[132] GRAHAM	72	OSPK	$\pi^- p \to K^0 \Lambda$
$0.26\ ^{+0.10}_{-0.14}$	126	MANN	72	HBC	$K^- p \to n \overline{K}^0$
$-0.13\ \pm0.11$	342	[132] MANTSCH	72	OSPK	K_{e3} from $K^0 \Lambda$
$0.04\ ^{+0.07}_{-0.08}$	222	[131] BURGUN	71	HBC	$K^+ p \to K^0 p \pi^+$
$0.25\ ^{+0.07}_{-0.09}$	252	WEBBER	71	HBC	$K^- p \to n \overline{K}^0$
$0.12\ \pm0.09$	215	[133] CHO	70	DBC	$K^+ d \to K^0 p p$
$-0.020\ \pm0.025$		[134] BENNETT	69	CNTR	Charge asym+ Cu regen.
$0.09\ ^{+0.14}_{-0.16}$	686	LITTENBERG	69	OSPK	$K^+ n \to K^0 p$
$0.03\ \pm0.03$		[134] BENNETT	68	CNTR	
$0.09\ ^{+0.07}_{-0.09}$	121	JAMES	68	HBC	$\overline{p} p$
$0.17\ ^{+0.16}_{-0.35}$	116	FELDMAN	67B	OSPK	$\pi^- p \to K^0 \Lambda$
$0.17\ \pm0.10$	335	[133] HILL	67	DBC	$K^+ d \to K^0 p p$
$0.035\ ^{+0.11}_{-0.13}$	196	AUBERT	65	HLBC	K^+ charge exchange
$0.06\ ^{+0.18}_{-0.44}$	152	[135] BALDO-...	65	HLBC	K^+ charge exchange
$-0.08\ ^{+0.16}_{-0.28}$	109	[136] FRANZINI	65	HBC	$\overline{p} p$

[131] BURGUN 72 is a final result which includes BURGUN 71.
[132] First GRAHAM 72 value is second GRAHAM 72 value combined with MANTSCH 72.
[133] CHO 70 is analysis of unambiguous events in new data and HILL 67.
[134] BENNETT 69 is a reanalysis of BENNETT 68.
[135] BALDO-CEOLIN 65 gives x and θ converted by us to Re(x) and Im(x).
[136] FRANZINI 65 gives x and θ for Re(x) and Im(x). See SCHMIDT 67.

IMAGINARY PART OF x

Assumes $m_{K^0_L} - m_{K^0_S}$ positive. See Listings above.

VALUE		EVTS	DOCUMENT ID		TECN	COMMENT
0.0012±0.0019 OUR AVERAGE						
0.0012±0.0019		640k	ANGELOPO...	98E	CPLR	K_{e3} from K^0
• • • We do not use the following data for averages, fits, limits, etc. • • •						
-0.10	$^{+0.16}_{-0.19}$	79	SMITH	75B	WIRE	$\pi^- p \to K^0 \Lambda$
-0.06	± 0.05	4724	NIEBERGALL	74	ASPK	$K^+ p \to K^0 p \pi^+$
-0.017	± 0.060	1757	FACKLER	73	OSPK	K_{e3} from K^0
0.09	± 0.07	1367	HART	73	OSPK	K_{e3} from $K^0 \Lambda$
0.107	$^{+0.092}_{-0.074}$	1079	MALLARY	73	OSPK	K_{e3} from $K^0 \Lambda X$
0.07	$^{+0.06}_{-0.07}$	410	[137] BURGUN	72	HBC	$K^+ p \to K^0 p \pi^+$
0.12	$^{+0.17}_{-0.16}$	100	[138] GRAHAM	72	OSPK	$K_{\mu 3}$ from $K^0 \Lambda$
0.05	± 0.13	442	[138] GRAHAM	72	OSPK	$\pi^- p \to K^0 \Lambda$
0.21	$^{+0.15}_{-0.12}$	126	MANN	72	HBC	$K^- p \to n \overline{K}^0$
-0.04	± 0.16	342	[138] MANTSCH	72	OSPK	K_{e3} from $K^0 \Lambda$
0.12	$^{+0.08}_{-0.09}$	222	[137] BURGUN	71	HBC	$K^+ p \to K^0 p \pi^+$
0.0	± 0.08	252	WEBBER	71	HBC	$K^- p \to n \overline{K}^0$
-0.08	± 0.07	215	[139] CHO	70	DBC	$K^+ d \to K^0 p p$
-0.11	$^{+0.10}_{-0.11}$	686	LITTENBERG	69	OSPK	$K^+ n \to K^0 p$
$+0.22$	$^{+0.37}_{-0.29}$	121	JAMES	68	HBC	$\overline{p} p$
0.0	± 0.25	116	FELDMAN	67B	OSPK	$\pi^- p \to K^0 \Lambda$
-0.20	± 0.10	335	[139] HILL	67	DBC	$K^+ d \to K^0 p p$
-0.21	$^{+0.11}_{-0.15}$	196	AUBERT	65	HLBC	K^+ charge exchange
-0.44	$^{+0.32}_{-0.19}$	152	[140] BALDO-...	65	HLBC	K^+ charge exchange
$+0.24$	$^{+0.40}_{-0.30}$	109	[141] FRANZINI	65	HBC	$\overline{p} p$

[137] BURGUN 72 is a final result which includes BURGUN 71.

[138] First GRAHAM 72 value is second GRAHAM 72 value combined with MANTSCH 72.

[139] Footnote 10 of HILL 67 should read +0.58, not −0.58 (private communication) CHO 70 is analysis of unambiguous events in new data and HILL 67.

[140] BALDO-CEOLIN 65 gives x and θ converted by us to Re(x) and Im(x).

[141] FRANZINI 65 gives x and θ for Re(x) and Im(x). See SCHMIDT 67.

K^0_L REFERENCES

ALAVI-HARATI	00	PR D61 072006	A. Alavi-Harati *et al.*	(KTeV Collab.)
ALAVI-HARATI	00B	PRL 84 408	A. Alavi-Harati *et al.*	(KTeV Collab.)
AMBROSE	00	PRL 84 1389	D. Ambrose *et al.*	(BNL E871 Collab.)
APOSTOLA...	00	PL B473 186	A. Apostolakis *et al.*	(CPLEAR Collab.)
BRFIT	00	RPP		
ETAFIT	00	RPP		
ADAMS	99	PL B447 240	J. Adams *et al.*	(KTeV Collab.)
ALAVI-HARATI	99B	PRL 83 917	A. Alavi-Harati *et al.*	(KTeV Collab.)
ALAVI-HARATI	99D	PRL 83 22	A. Alavi-Harati *et al.*	(KTeV Collab.)
APOSTOLA...	99C	PL B458 545	A. Apostolakis *et al.*	(CPLEAR Collab.)
FANTI	99B	PL B458 553	V. Fanti *et al.*	(CERN NA48 Collab.)
FANTI	99C	PL B465 335	V. Fanti *et al.*	(CERN NA48 Collab.)
MURAKAMI	99	PL B463 333	K. Murakami *et al.*	(KEK E162 Collab.)
ADAMS	98	PRL 80 4123	J. Adams *et al.*	(KTeV Collab.)
AMBROSE	98	PRL 81 4309	D. Ambrose *et al.*	(BNL E871 Collab.)
AMBROSE	98B	PRL 81 5734	D. Ambrose *et al.*	(BNL E871 Collab.)
ANGELOPO...	98	PL B420 191	A. Angelopoulos *et al.*	(CPLEAR Collab.)
ANGELOPO...	98C	EPJ C5 389	A. Angelopoulos *et al.*	(CPLEAR Collab.)
ANGELOPO...	98D	PL B444 38	A. Angelopoulos *et al.*	(CPLEAR Collab.)
ANGELOPO...	98E	PL B444 43	A. Angelopoulos *et al.*	(CPLEAR Collab.)
ARISAKA	98	PL B432 230	K. Arisaka *et al.*	(FNAL E799 Collab.)
BENDER	98	PL B418 411	M. Bender *et al.*	(CERN NA48 Collab.)
SETZU	98	PL B420 205	M.G. Setzu *et al.*	
TAKEUCHI	98	PL B443 409	Y. Takeuchi *et al.*	(KYOT, KEK, HIRO)
FANTI	97	ZPHY C76 653	V. Fanti *et al.*	(CERN NA48 Collab.)
NOMURA	97	PL B408 445	T. Nomura *et al.*	(KYOT, KEK, HIRO)
ADLER	96B	ZPHY C70 211	R. Adler *et al.*	(CPLEAR Collab.)
ADLER	96C	PL B369 367	R. Adler *et al.*	(CPLEAR Collab.)
GU	96	PRL 76 4312	P. Gu *et al.*	(RUTG, UCLA, EFI, COLO+)
LEBER	96	PL B369 69	F. Leber *et al.*	(MANZ, CERN, EDIN, ORSAY+)
PDG	96	PR D54 1		
ADLER	95	PL B363 237	R. Adler *et al.*	(CPLEAR Collab.)
ADLER	95B	PL B363 243	R. Adler *et al.*	(CPLEAR Collab.)
AKAGI	95	PR D51 2061	T. Akagi *et al.*	(TOHOK, TOKY, KYOT, KEK)
BARR	95	ZPHY C65 361	G.D. Barr *et al.*	(CERN, EDIN, MANZ, LALO+)
BARR	95C	PL B358 399	G.D. Barr *et al.*	(CERN, EDIN, MANZ, LALO+)
HEINSON	95	PR D51 985	A.P. Heinson *et al.*	(BNL E791 Collab.)
KREUTZ	95	ZPHY C65 67	A. Kreutz *et al.*	(SIEG, EDIN, MANZ, ORSAY+)
MATTHEWS	95	PRL 75 2803	J.N. Matthews *et al.*	(RUTG, EFI, ELMT+)
SCHWINGEN...	95	PRL 74 4376	B. Schwingenheuer *et al.*	(EFI, CHIC+)
SPENCER	95	PRL 74 3323	M.B. Spencer *et al.*	(UCLA, EFI, COLO+)
BARR	94	PL B328 528	G.D. Barr *et al.*	(CERN, EDIN, MANZ, LALO+)
GU	94	PRL 72 3000	P. Gu *et al.*	(RUTG, UCLA, EFI, COLO+)
NAKAYA	94	PRL 73 2169	T. Nakaya *et al.*	(OSAK, UCLA, EFI, COLU+)
ROBERTS	94	PR D50 1874	D. Roberts *et al.*	(UCLA, EFI, COLU+)
WEAVER	94	PRL 72 3758	M. Weaver *et al.*	(UCLA, EFI, COLU, ELMT+)
AKAGI	93	PR D47 R2644	T. Akagi *et al.*	(TOHOK, TOKY, KYOT, KEK)
ARISAKA	93	PRL 70 1049	K. Arisaka *et al.*	(BNL E791 Collab.)
ARISAKA	93B	PRL 71 3910	K. Arisaka *et al.*	(BNL E791 Collab.)
BARR	93D	PL B317 233	G.D. Barr *et al.*	(CERN, EDIN, MANZ, LALO+)
GIBBONS	93	PRL 70 1199	L.K. Gibbons *et al.*	(FNAL E731 Collab.)
Also	97	PR D55 6625	L.K. Gibbons *et al.*	(FNAL E731 Collab.)
GIBBONS	93B	PRL 70 1203	L.K. Gibbons *et al.*	(FNAL E731 Collab.)
GIBBONS	93C	Thesis RX-1487	L.K. Gibbons	(CHIC)
Also	97	PR D55 6625	L.K. Gibbons *et al.*	(FNAL E731 Collab.)
HARRIS	93	PRL 71 3914	D.A. Harris *et al.*	(EFI, UCLA, COLO+)
HARRIS	93B	PRL 71 3918	D.A. Harris *et al.*	(EFI, UCLA, COLO+)
MAKOFF	93	PRL 70 1591	G. Makoff *et al.*	(FNAL E731 Collab.)
Also	95	PRL 75 2069 (erratum)		
RAMBERG	93	PRL 70 2525	E. Ramberg *et al.*	(FNAL E731 Collab.)
RAMBERG	93B	PRL 70 2529	E.J. Ramberg *et al.*	(FNAL E731 Collab.)
VAGINS	93	PRL 71 35	M.R. Vagins *et al.*	(BNL E845 Collab.)
ADLER	92B	PL B286 180	R. Adler *et al.*	(CPLEAR Collab.)
Also	92	SJNP 55 840	R. Adler *et al.*	(CPLEAR Collab.)
BARR	92	PL B284 440	G.D. Barr *et al.*	(CERN, EDIN, MANZ, LALO+)
GRAHAM	92	PL B295 169	G.E. Graham *et al.*	(FNAL E731 Collab.)
MORSE	92	PR D45 36	W.M. Morse *et al.*	(BNL, YALE, VASS)
PDG	92	PR D45, 1 June, Part II	K. Hikasa *et al.*	(KEK, LBL, BOST+)

SOMALWAR	92	PRL 68 2580	S.V. Somalwar *et al.*	(FNAL E731 Collab.)
AKAGI	91	PRL 67 2614	T. Akagi *et al.*	(TOHOK, TOKY, KYOT, KEK)
AKAGI	91B	PRL 67 2618	T. Akagi *et al.*	(TOHOK, TOKY, KYOT, KEK)
BARR	91	PL B259 389	G.D. Barr *et al.*	(CERN, EDIN, MANZ, LALO+)
HEINSON	91	PR D44 R1	A.P. Heinson *et al.*	(UCI, UCLA, LANL+)
PAPADIMITR...	91	PR D44 R573	V. Papadimitriou *et al.*	(FNAL E731 Collab.)
BARKER	90	PR D41 3546	A.R. Barker *et al.*	(FNAL E731 Collab.)
Also	88	PRL 61 2661	L.K. Gibbons *et al.*	(FNAL E731 Collab.)
BARR	90B	PL B240 283	G.D. Barr *et al.*	(CERN, EDIN, MANZ, LALO+)
BARR	90C	PL B242 523	G.D. Barr *et al.*	(CERN, EDIN, MANZ, LALO+)
CAROSI	90	PL B237 303	R. Carosi *et al.*	(CERN, EDIN, MANZ, LALO+)
KARLSSON	90	PRL 64 2976	M. Karlsson *et al.*	(FNAL E731 Collab.)
OHL	90	PRL 64 2755	K.E. Ohl *et al.*	(BNL E845 Collab.)
OHL	90B	PRL 65 1407	K.E. Ohl *et al.*	(BNL E845 Collab.)
PATTERSON	90	PRL 64 1491	J.R. Patterson *et al.*	(FNAL E731 Collab.)
INAGAKI	89	PR D40 1712	T. Inagaki *et al.*	(KEK, TOKY, KYOT)
LITTENBERG	89	PR D39 3322	L.S. Littenberg	(BNL)
MATHIAZHA...	89	PRL 63 2181	C. Mathiazhagan *et al.*	(UCI, UCLA, LANL+)
MATHIAZHA...	89B	PRL 63 2185	C. Mathiazhagan *et al.*	(UCI, UCLA, LANL+)
PAPADIMITR...	89	PRL 63 28	V. Papadimitriou *et al.*	(FNAL E731 Collab.)
SCHAFFNER	89	PR D39 990	S.F. Schaffner *et al.*	(YALE, BNL)
WAHL	89	CERN-EP/89-86, H. Wahl—Rare Decay Symposium, Vancouver	H. Wahl	(CERN)
BARR	88	PL B214 303	G.D. Barr *et al.*	(CERN, EDIN, MANZ, LALO+)
BURKHARDT	88	PL B206 169	H. Burkhardt *et al.*	(CERN, EDIN, MANZ+)
COUSINS	88	PR D38 2914	R.D. Cousins *et al.*	(UCLA, LASL, PENN+)
GREENLEE	88	PRL 60 893	H.B. Greenlee *et al.*	(YALE, BNL)
JASTRZEM...	88	PRL 61 2300	E. Jastrzembski *et al.*	(BNL, YALE)
WOODS	88	PRL 60 1695	M. Woods *et al.*	(FNAL E731 Collab.)
BURKHARDT	87	PL B199 139	H. Burkhardt *et al.*	(CERN, EDIN, MANZ+)
ARONSON	86	PR D33 3180	S.H. Aronson *et al.*	(BNL, CHIC, STAN+)
Also	82	PRL 48 1078	S.H. Aronson *et al.*	(BNL, CHIC, STAN+)
PDG	86C	PL 170B 132	M. Aguilar-Benitez *et al.*	(CERN, CIT+)
COUPAL	85	PRL 55 566	D.P. Coupal *et al.*	(CHIC, SACL)
BALATS	83	SJNP 38 556	M.Y. Balats *et al.*	(ITEP)
		Translated from YAF 38 927.		
BERGSTROM	83	PL 131B 229	L. Bergstrom, E. Masso, P. Singer	(CERN)
ARONSON	82	PRL 48 1078	S.H. Aronson *et al.*	(BNL, CHIC, STAN+)
ARONSON	82B	PRL 48 1306	S.H. Aronson *et al.*	(BNL, CHIC, PURD)
Also	82B	PL 116B 73	E. Fischbach *et al.*	(PURD, BNL, CHIC)
Also	83	PR D28 476	S.H. Aronson *et al.*	(BNL, CHIC, PURD)
Also	83B	PR D28 495	S.H. Aronson *et al.*	(BNL, CHIC, PURD)
PDG	82B	PL 111B 70	M. Roos *et al.*	(HELS, CIT, CERN)
BIRULEV	81	NP B182 1	V.K. Birulev *et al.*	(JINR)
Also	80	SJNP 31 622	V.K. Birulev *et al.*	(JINR)
		Translated from YAF 31 1204.		
CARROLL	80B	PRL 44 529	A.S. Carroll *et al.*	(BNL, ROCH)
CARROLL	80C	PL 96B 407	A.S. Carroll *et al.*	(BNL, ROCH)
CARROLL	80D	PRL 44 525	A.S. Carroll *et al.*	(BNL, ROCH)
CHO	80	PR D22 2688	Y. Cho *et al.*	(ANL, CMU)
MORSE	80	PR D21 1750	W.M. Morse *et al.*	(BNL, YALE)
BIRULEV	79	SJNP 29 778	V.K. Birulev *et al.*	(JINR)
		Translated from YAF 29 1516.		
CHRISTENS...	79	PRL 43 1209	J.H. Christenson *et al.*	(NYU)
HILL	79	NP B153 39	D.G. Hill *et al.*	(BNL, SLAC, SBER)
SCHMIDT	79	PRL 43 556	M.P. Schmidt *et al.*	(YALE, BNL)
SHOCHET	79	PR D19 1965	M.J. Shochet *et al.*	(EFI, ANL)
Also	77	PRL 39 59	M.J. Shochet *et al.*	(EFI, ANL)
ENGLER	78B	PR D18 623	A. Engler *et al.*	(CMU, ANL)
HILL	78	PL 73B 483	D.G. Hill *et al.*	(BNL, SLAC, SBER)
CHO	77	PR D15 587	Y. Cho *et al.*	(ANL, CMU)
CLARK	77	PR D15 553	A.R. Clark *et al.*	(LBL)
Also	75	Thesis LBL-4275	G. Shen	(LBL)
DEVOE	77	PR D16 565	R. Devoe *et al.*	(EFI, ANL)
DZHORD...	77	SJNP 26 478	V.P. Dzhordzhadze *et al.*	(JINR)
		Translated from YAF 26 910.		
PEACH	77	NP B127 399	K.J. Peach *et al.*	(BGNA, EDIN, GLAS+)
BIRULEV	76	SJNP 24 178	V.K. Birulev *et al.*	(JINR)
		Translated from YAF 24 340.		

COOMBES	76	PRL 37 249	R.W. Coombes *et al.*	(STAN, NYU)
DONALDSON	76	PR D14 2839	G. Donaldson *et al.*	(SLAC)
Also	74	Thesis SLAC-0184	G. Donaldson	(SLAC)
FUKUSHIMA	76	PRL 36 348	Y. Fukushima *et al.*	(PRIN, MASA)
GJESDAL	76	NP B109 118	G. Gjesdal *et al.*	(CERN, HEIDH)
REY	76	PR D13 1161	C.A. Rey *et al.*	(NDAM, HAWA, LBL)
Also	69	PRL 22 1210	R.J. Cence *et al.*	(HAWA, LRL)
BALDO-...	75	NC 25A 688	M. Baldo-Ceolin *et al.*	(PADO, WISC)
BLUMENTHAL	75	PRL 34 164	R.B. Blumenthal *et al.*	(PENN, CHIC, TEMP)
BUCHANAN	75	PR D11 457	C.D. Buchanan *et al.*	(UCLA, SLAC, JHU)
CARITHERS	75	PRL 34 1244	W.C.J. Carithers *et al.*	(COLU, NYU)
SMITH	75B	Thesis UCSD unpub.	J.G. Smith	(UCSD)
ALBRECHT	74	PL 48B 393	K.F. Albrecht	(JINR, BERL, BUDA, PRAG, SERP+)
BISI	74	PL 50B 504	V. Bisi, M.I. Ferrero	(TORI)
DONALDSON	74	Thesis SLAC-0184	G. Donaldson	(SLAC)
Also	76	PR D14 2839	G. Donaldson *et al.*	(SLAC)
DONALDSON	74B	PR D9 2960	G. Donaldson *et al.*	(SLAC, UCSC)
Also	73B	PRL 31 337	G. Donaldson *et al.*	(SLAC, UCSC)
DONALDSON	74C	PRL 33 554	G. Donaldson *et al.*	(SLAC)
Also	74	Thesis SLAC-0184	G. Donaldson	(SLAC)
Also	76	PR D14 2839	G. Donaldson *et al.*	(SLAC)
FIELD	74	SLAC-PUB-1498 unpub.	R.C. Field	(SLAC)
GEWENIGER	74	PL 48B 483	C. Geweniger *et al.*	(CERN, HEIDH)
Also	74	Thesis CERN Int. 74-4	V. Luth	(CERN)
GEWENIGER	74B	PL 48B 487	C. Geweniger *et al.*	(CERN, HEIDH)
Also	74B	PL 52B 119	S. Gjesdal *et al.*	(CERN, HEIDH)
GEWENIGER	74C	PL 52B 108	C. Geweniger *et al.*	(CERN, HEIDH)
GJESDAL	74	PL 52B 113	S. Gjesdal *et al.*	(CERN, HEIDH)
MESSNER	74	PRL 33 1458	R. Messner *et al.*	(COLO, SLAC, UCSC)
NIEBERGALL	74	PL 49B 103	F. Niebergall *et al.*	(CERN, ORSAY, VIEN)
WANG	74	PR D9 540	L. Wang *et al.*	(UMD, BNL)
WILLIAMS	74	PRL 33 240	H.H. Williams *et al.*	(BNL, YALE)
ALBROW	73	NP B58 22	M.G. Albrow *et al.*	(MCHS, DARE)
ALEXANDER	73B	NP B65 301	G. Alexander *et al.*	(TELA, HEID)
ANIKINA	73	JINR P1 7539	M.K. Anikina *et al.*	(JINR)
BRANDENB...	73	PR D8 1978	G.W. Brandenburg *et al.*	(SLAC)
CARITHERS	73	PRL 31 1025	W.C.J. Carithers *et al.*	(COLU, BNL, CERN)
Also	73B	PRL 30 1336	W.C.J. Carithers *et al.*	(COLU, CERN, NYU)
EVANS	73	PR D7 36	G.R. Evans *et al.*	(EDIN, CERN)
Also	69	PRL 23 427	G.R. Evans *et al.*	(EDIN, CERN)
FACKLER	73	PRL 31 847	O. Fackler *et al.*	(MIT)
FITCH	73	PRL 31 1524	V.L. Fitch *et al.*	(PRIN)
Also	72	Thesis COO-3072-13	R.C. Webb	(PRIN)
GINSBERG	73	PR D8 3887	E.S. Ginsberg, J. Smith	(MIT, STON)
HART	73	NP B66 317	J.C. Hart *et al.*	(CAVE, RHEL)
MALLARY	73	PR D7 1953	M.L. Mallary *et al.*	(CIT)
Also	70	PRL 25 1214	F.J. Sciulli *et al.*	(CIT)
MCCARTHY	73	PR D7 687	R.L. McCarthy *et al.*	(LBL)
Also	72	PL 42B 291	R.L. McCarthy *et al.*	(LBL)
Also	71	Thesis LBL-550	R.L. McCarthy	(LBL)
MESSNER	73	PRL 30 876	R. Messner *et al.*	(COLO, SLAC, UCSC)
PEACH	73	PL 43B 441	K.J. Peach *et al.*	(EDIN, CERN, AACH)
SANDWEISS	73	PRL 30 1002	J. Sandweiss *et al.*	(YALE, ANL)
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ASHFORD	72	PL 38B 47	V.A. Ashford *et al.*	(UCSD)
BANNER	72B	PRL 29 237	M. Banner *et al.*	(PRIN)
BARMIN	72	SJNP 15 636	V.V. Barmin *et al.*	(ITEP)
		Translated from YAF 15 1149.		
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		Translated from YAF 15 1152.		
BURGUN	72	NP B50 194	G. Burgun *et al.*	(SACL, CERN, OSLO)
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Also	70	PL 33B 627	C.Y. Chien *et al.*	(JHU, SLAC, UCLA)
Also	71	PL 35B 261	C.Y. Chien *et al.*	(JHU, SLAC, UCLA)
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MCCARTHY	72	PL 42B 291	R.L. McCarthy *et al.*	(LBL)
METCALF	72	PL 40B 703	M. Metcalf *et al.*	(CERN, IPN, WIEN)
NEUHOFER	72	PL 41B 642	G. Neuhofer *et al.*	(CERN, ORSAY, VIEN)
PICCIONI	72	PRL 29 1412	R. Piccioni *et al.*	(SLAC)
Also	74	PR D9 2939	R. Piccioni *et al.*	(SLAC, UCSC, COLO)
VOSBURGH	72	PR D6 1834	K.G. Vosburgh *et al.*	(RUTG, MASA)
Also	71	PRL 26 866	K.G. Vosburgh *et al.*	(RUTG, MASA)
BALATS	71	SJNP 13 53	M.Y. Balats *et al.*	(ITEP)
		Translated from YAF 13 93.		
BARMIN	71	PL 35B 604	V.V. Barmin *et al.*	(ITEP)
BISI	71	PL 36B 533	V. Bisi *et al.*	(AACH, CERN, TORI)
BURGUN	71	LNC 2 1169	G. Burgun *et al.*	(SACL, CERN, OSLO)
CARNEGIE	71	PR D4 1	R.K. Carnegie *et al.*	(PRIN)
CHAN	71	Thesis LBL-350	J.H.S. Chan	(LBL)
CHIEN	71	PL 35B 261	C.Y. Chien *et al.*	(JHU, SLAC, UCLA)
Also	72	PL 41B 647	E.B. Dally *et al.*	(SLAC, JHU, UCLA)
CHO	71	PR D3 1557	Y. Cho *et al.*	(CMU, BNL, CASE)
CLARK	71	PRL 26 1667	A.R. Clark *et al.*	(LRL)
Also	70	Thesis UCRL 19709	R.P. Johnson	(LRL)
Also	71	Thesis UCRL 20264	H.J. Frisch	(LRL)
Also	74	SLAC-PUB-1498 unpub.	R.C. Field	(SLAC)
ENSTROM	71	PR D4 2629	J. Enstrom *et al.*	(SLAC, STAN)
Also	70	Thesis SLAC-0125	J.E. Enstrom	(STAN)
JAMES	71	PL 35B 265	F. James *et al.*	(CERN, SACL, OSLO)
MEISNER	71	PR D3 59	G.W. Meisner *et al.*	(MASA, BNL, YALE)
PEACH	71	PL 35B 351	K.J. Peach *et al.*	(EDIN, CERN)
REPELLIN	71	PL 36B 603	J.P. Repellin *et al.*	(ORSAY, CERN)
WEBBER	71	PR D3 64	B.R. Webber *et al.*	(LRL)
Also	68	PRL 21 498	B.R. Webber *et al.*	(LRL)
Also	69	Thesis UCRL 19226	B.R. Webber	(LRL)
WOLFF	71	PL 36B 517	B. Wolff *et al.*	(ORSAY, CERN)
ALBROW	70	PL 33B 516	M.G. Albrow *et al.*	(MCHS, DARE)
ARONSON	70	PRL 25 1057	S.H. Aronson *et al.*	(EFI, ILLC, SLAC)
BARMIN	70	PL 33B 377	V.V. Barmin *et al.*	(ITEP, JINR)
BASILE	70	PR D2 78	P. Basile *et al.*	(SACL)
BECHERRAWY	70	PR D1 1452	T. Becherrawy	(ROCH)
BUCHANAN	70	PL 33B 623	C.D. Buchanan *et al.*	(SLAC, JHU, UCLA)
Also	71	Private Comm.	Cox	
BUDAGOV	70	PR D2 815	I.A. Budagov *et al.*	(CERN, ORSAY, EPOL)
Also	68B	PL 28B 215	I.A. Budagov *et al.*	(CERN, ORSAY, EPOL)
CHIEN	70	PL 33B 627	C.Y. Chien *et al.*	(JHU, SLAC, UCLA)
Also	71	Private Comm.	Cox	
CHO	70	PR D1 3031	Y. Cho *et al.*	(CMU, BNL, CASE)
Also	67	PRL 19 668	D.G. Hill *et al.*	(BNL, CMU)
CHOLLET	70	PL 31B 658	J.C. Chollet *et al.*	(CERN)
CULLEN	70	PL 32B 523	M. Cullen *et al.*	(AACH, CERN, TORI)
DARRIULAT	70	PL 33B 249	P. Darriulat *et al.*	(AACH, CERN, TORI)
FAISSNER	70	NC 70A 57	H. Faissner *et al.*	(AACH3, CERN, RHEL)
GINSBERG	70	PR D1 229	E.S. Ginsberg	(HAIF)
MARX	70	PL 32B 219	J. Marx *et al.*	(COLU, HARV, CERN)
Also	70B	Thesis Nevis 179	J. Marx	(COLU)
SCRIBANO	70	PL 32B 224	A. Scribano *et al.*	(PISA, COLU, HARV)
SMITH	70	PL 32B 133	R.C. Smith *et al.*	(UMD, BNL)
WEBBER	70	PR D1 1967	B.R. Webber *et al.*	(LRL)
Also	69	Thesis UCRL 19226	B.R. Webber	(LRL)
BANNER	69	PR 188 2033	M. Banner *et al.*	(PRIN)
Also	68	PRL 21 1103	M. Banner *et al.*	(PRIN)
Also	68	PRL 21 1107	J.W. Cronin, J.K. Liu, J.E. Pilcher	(PRIN)
BEILLIERE	69	PL 30B 202	P. Beilliere, G. Boutang, J. Limon	(EPOL)
BENNETT	69	PL 29B 317	S. Bennett *et al.*	(COLU, BNL)
CENCE	69	PRL 22 1210	R.J. Cence *et al.*	(HAWA, LRL)
EVANS	69	PRL 23 427	G.R. Evans *et al.*	(EDIN, CERN)
FAISSNER	69	PL 30B 204	H. Faissner *et al.*	(AACH3, CERN, TORI)
FOETH	69	PL 30B 282	H. Foeth *et al.*	(AACH, CERN, TORI)
GAILLARD	69	NC 59A 453	J.M. Gaillard *et al.*	(CERN, RHEL, AACH)
Also	67	PRL 18 20	J.M. Gaillard *et al.*	(CERN, RHEL, AACH)
LITTENBERG	69	PRL 22 654	L.S. Littenberg *et al.*	(UCSD)
LONGO	69	PR 181 1808	M.J. Longo, K.K. Young, J.A. Helland	(MICH, UCLA)
PACIOTTI	69	Thesis UCRL 19446	M.A. Paciotti	(LRL)

SAAL	69	Thesis	H.J. Saal	(COLU)
ABRAMS	68B	PR 176 1603	R.J. Abrams *et al.*	(ILL)
ARNOLD	68B	PL 28B 56	R.G. Arnold *et al.*	(CERN, ORSAY)
ARONSON	68	PRL 20 287	S.H. Aronson, K.W. Chen	(PRIN)
Also	69	PR 175 1708	S.H. Aronson, K.W. Chen	(PRIN)
BARTLETT	68	PRL 21 558	D.F. Bartlett *et al.*	(PRIN)
BASILE	68	PL 26B 542	P. Basile *et al.*	(SACL)
BASILE	68B	PL 28B 58	P. Basile *et al.*	(SACL)
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BOHM	68B	PL 27B 594	A. Bohm *et al.*	
BUDAGOV	68	NC 57A 182	I.A. Budagov *et al.*	(CERN, ORSAY, IPNP)
Also	68B	PL 28B 215	I.A. Budagov *et al.*	(CERN, ORSAY, EPOL)
JAMES	68	NP B8 365	F. James, H. Briand	(IPNP, CERN)
Also	68	PRL 21 257	J.A. Helland, M.J. Longo, K.K. Young	(UCLA, MICH)
KULYUKINA	68	JETP 26 20	L.A. Kulyukina *et al.*	(JINR)
		Translated from ZETF 53 29.		
KUNZ	68	Thesis PU-68-46	P.F. Kunz	(PRIN)
BENNETT	67	PRL 19 993	S. Bennett *et al.*	(COLU)
BOTT-...	67	PL 24B 194	M. Bott-Bodenhausen *et al.*	(CERN)
CRONIN	67	PRL 18 25	J.W. Cronin *et al.*	(PRIN)
Also	68	Thesis unpub.	Wheeler	(PRIN)
CRONIN	67B	Princeton 11/67	J.W. Cronin *et al.*	(PRIN)
DEBOUARD	67	NC 52A 662	X. de Bouard *et al.*	(CERN)
Also	65	PL 15 58	X. de Bouard *et al.*	(CERN, ORSAY, MPIM)
DEVLIN	67	PRL 18 54	T.J. Devlin *et al.*	(PRIN, UMD)
Also	68	PR 169 1045	G.A. Sayer *et al.*	(UMD, PPA, PRIN)
DORFAN	67	PRL 19 987	D.E. Dorfan *et al.*	(SLAC, LRL)
FELDMAN	67B	PR 155 1611	L. Feldman *et al.*	(PENN)
FIRESTONE	67	PRL 18 176	A. Firestone *et al.*	(YALE, BNL)
FITCH	67	PR 164 1711	V.L. Fitch *et al.*	(PRIN)
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KULYUKINA	67	Preprint	L.A. Kulyukina *et al.*	(JINR)
LOWYS	67	PL 24B 75	J.P. Lowys *et al.*	(EPOL, ORSAY)
NEFKENS	67	PR 157 1233	B.M.K. Nefkens *et al.*	(ILL)
SCHMIDT	67	Thesis Nevis 160	Schmidt	(COLU)
TODOROFF	67	Thesis	Todoroff	(ILL)
ALFF-...	66B	PL 21 595	C. Alff-Steinberger *et al.*	(CERN)
ANIKINA	66	SJNP 2 339	M.K. Anikina *et al.*	(JINR)
		Translated from YAF 2 471.		
AUERBACH	66B	PRL 17 980	L.B. Auerbach *et al.*	(PENN)
BASILE	66	Balaton Conf.	P. Basile *et al.*	(SACL)
BEHR	66	PL 22 540	L. Behr *et al.*	(EPOL, MILA, PADO, ORSAY)
BOTT-...	66	PL 23 277	M. Bott-Bodenhausen *et al.*	(CERN)
CARPENTER	66	PR 142 871	D.W. Carpenter *et al.*	(ILL)
CRIEGEE	66	PRL 17 150	L. Criegee *et al.*	(ILL)
HAWKINS	66	PL 21 238	C.J.B. Hawkins	(YALE)
Also	67	PR 156 1444	C.J.B. Hawkins	(YALE)
ANDERSON	65	PRL 14 475	J.A. Anderson *et al.*	(LRL, WISC)
ANIKINA	65	JINR P 2488	M.K. Anikina *et al.*	(JINR)
ASTBURY	65	PL 16 80	P. Astbury *et al.*	(CERN, ZURI)
Also	65	HPA 39 523	M. Pepin	
ASTBURY	65B	PL 18 175	P. Astbury *et al.*	(CERN, ZURI)
ASTBURY	65C	PL 18 178	P. Astbury *et al.*	(CERN, ZURI)
AUBERT	65	PL 17 59	B. Aubert *et al.*	(EPOL, ORSAY)
Also	67	PL 24B 75	J.P. Lowys *et al.*	(EPOL, ORSAY)
BALDO-...	65	NC 38 684	M. Baldo-Ceolin *et al.*	(PADO)
FISHER	65	ANL 7130 83	G.P. Fisher *et al.*	(ILL)
FRANZINI	65	PR 140B 127	P. Franzini *et al.*	(COLU, RUTG)
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ADAIR	64	PL 12 67	R.K. Adair, L.B. Leipuner	(YALE, BNL)
ALEKSANYAN	64B	Dubna Conf. 2 102	A.S. Aleksanyan *et al.*	(YERE)
Also	64	JETP 19 1019	A.S. Aleksanyan *et al.*	(LEBD, MPEI, YERE)
		Translated from ZETF 46 1504.		
ANIKINA	64	JETP 19 42	M.K. Anikina *et al.*	(GEOR, JINR)
		Translated from ZETF 46 59.		

CHRISTENS... 64 PRL 13 138 J.H. Christenson *et al.* (PRIN)
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GOOD 61 PR 124 1223 R.H. Good *et al.* (LRL)
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Also 61B JETP 13 1138 D.V. Nyagu *et al.* (JINR)
Translated from ZETF 40 1618.
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