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
	Semileptonic modes				
Γ_1	$\pi^\pm e^\mp \nu_e$		[a]	(38.79 ±0.28) %	S=1.1
	Called K^0_{e3}.				
Γ_2	$\pi^- e^+ \nu_e$				
Γ_3	$\pi^+ e^- \overline{\nu}_e$				
Γ_4	$\pi^\pm \mu^\mp \nu_\mu$		[a]	(27.18 ±0.25) %	S=1.1
	Called $K^0_{\mu3}$.				
Γ_5	$\pi^- \mu^+ \nu_\mu$				
Γ_6	$\pi^+ \mu^- \overline{\nu}_\mu$				
Γ_7	$(\pi\,\mu\,\text{atom})\nu$			(1.06 ±0.11) × 10^{-7}	
Γ_8	$\pi^0 \pi^\pm e^\mp \nu$		[a]	(5.18 ±0.29) × 10^{-5}	
	Hadronic modes, including Charge conjugation×Parity Violating (*CPV*) modes				
Γ_9	$3\pi^0$			(21.11 ±0.27) %	S=1.1
Γ_{10}	$\pi^+\pi^-\pi^0$			(12.56 ±0.20) %	S=1.7
Γ_{11}	$\pi^+\pi^-$	*CPV*		(2.056±0.033) × 10^{-3}	
Γ_{12}	$\pi^0\pi^0$	*CPV*		(9.28 ±0.19) × 10^{-4}	
	Semileptonic modes with photons				
Γ_{13}	$\pi^\pm e^\mp \nu_e \gamma$		[a,b,c]	(3.62 $^{+0.26}_{-0.21}$) × 10^{-3}	
Γ_{14}	$\pi^\pm \mu^\mp \nu_\mu \gamma$			(5.7 $^{+0.6}_{-0.7}$) × 10^{-4}	

Hadronic modes with photons or $\ell\overline{\ell}$ pairs

Γ_{15}	$\pi^0\pi^0\gamma$			$<$ 5.6	$\times 10^{-6}$	
Γ_{16}	$\pi^+\pi^-\gamma$		[b,c]	(4.61 $\pm$0.14)	$\times 10^{-5}$	
Γ_{17}	$\pi^0 2\gamma$		[c]	(1.68 $\pm$0.10)	$\times 10^{-6}$	
Γ_{18}	$\pi^0\gamma e^+e^-$			$<$ 7.1	$\times 10^{-7}$	CL=90%

Other modes with photons or $\ell\overline{\ell}$ pairs

Γ_{19}	2γ			(5.86 $\pm$0.15)	$\times 10^{-4}$	
Γ_{20}	3γ			$<$ 2.4	$\times 10^{-7}$	CL=90%
Γ_{21}	$e^+e^-\gamma$			(10.0 $\pm$0.5)	$\times 10^{-6}$	S=1.5
Γ_{22}	$\mu^+\mu^-\gamma$			(3.25 $\pm$0.28)	$\times 10^{-7}$	
Γ_{23}	$e^+e^-\gamma\gamma$		[c]	(6.9 $\pm$1.0)	$\times 10^{-7}$	
Γ_{24}	$\mu^+\mu^-\gamma\gamma$		[c]	(1.0 $^{+0.8}_{-0.6}$)	$\times 10^{-8}$	

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

Γ_{25}	$\mu^+\mu^-$	*S1*		(7.15 $\pm$0.16)	$\times 10^{-9}$	
Γ_{26}	e^+e^-	*S1*		(9 $^{+6}_{-4}$)	$\times 10^{-12}$	
Γ_{27}	$\pi^+\pi^-e^+e^-$	*S1*	[c]	(3.5 $\pm$0.6)	$\times 10^{-7}$	
Γ_{28}	$\mu^+\mu^-e^+e^-$	*S1*		(2.9 $^{+6.7}_{-2.4}$)	$\times 10^{-9}$	
Γ_{29}	$e^+e^-e^+e^-$	*S1*		(4.1 $\pm$0.8)	$\times 10^{-8}$	S=1.2
Γ_{30}	$\pi^0\mu^+\mu^-$	*CP,S1*	[d]	$<$ 3.8	$\times 10^{-10}$	CL=90%
Γ_{31}	$\pi^0 e^+e^-$	*CP,S1*	[d]	$<$ 4.3	$\times 10^{-9}$	CL=90%
Γ_{32}	$\pi^0\nu\overline{\nu}$	*CP,S1*	[e]	$<$ 5.9	$\times 10^{-7}$	CL=90%
Γ_{33}	$e^\pm\mu^\mp$	*LF*	[a]	$<$ 4.7	$\times 10^{-12}$	CL=90%
Γ_{34}	$e^\pm e^\pm\mu^\mp\mu^\mp$	*LF*	[a]	$<$ 6.1	$\times 10^{-9}$	CL=90%
Γ_{35}	$\pi^0\mu^\pm e^\mp$	*LF*	[a]	$<$ 6.2	$\times 10^{-9}$	CL=90%

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

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

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

[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, 3 decay rate, and 12 branching ratios uses 45 measurements and one constraint to determine 8 parameters. The overall fit has a χ^2 = 38.7 for 38 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_4	−36						
x_9	−49	−37					
x_{10}	−28	−28	−19				
x_{11}	−7	−8	−12	34			
x_{12}	−6	−6	−9	26	77		
x_{19}	−5	−5	−7	21	63	83	
Γ	0	0	0	0	0	0	0
	x_1	x_4	x_9	x_{10}	x_{11}	x_{12}	x_{19}

	Mode		Rate (10^8 s^{-1})	Scale factor
Γ_1	$\pi^{\pm} e^{\mp} \nu_e$ Called K^0_{e3}.	[a]	0.0750 ± 0.0008	1.1
Γ_4	$\pi^{\pm} \mu^{\mp} \nu_\mu$ Called $K^0_{\mu3}$.	[a]	0.0525 ± 0.0007	1.1
Γ_9	$3\pi^0$		0.0408 ± 0.0006	
Γ_{10}	$\pi^+ \pi^- \pi^0$		0.0243 ± 0.0004	1.5
Γ_{11}	$\pi^+ \pi^-$		$(3.97 \pm 0.07) \times 10^{-4}$	1.1
Γ_{12}	$\pi^0 \pi^0$		$(1.79 \pm 0.04) \times 10^{-4}$	
Γ_{19}	2γ		$(1.133 \pm 0.030) \times 10^{-4}$	

K^0_L DECAY RATES

$\Gamma(\pi^+ \pi^- \pi^0)$ — Γ_{10}

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	

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

$\Gamma(\pi^{\pm} e^{\mp} \nu_e)$ Γ_1

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

$\Gamma(\pi^{\pm} e^{\mp} \nu_e) + \Gamma(\pi^{\pm} \mu^{\mp} \nu_{\mu})$ $(\Gamma_1+\Gamma_4)$

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

Semileptonic modes

$\left[\Gamma(\pi^{\pm} e^{\mp} \nu_e) + \Gamma(\pi^{\pm} \mu^{\mp} \nu_{\mu})\right]/\Gamma_{total}$ $(\Gamma_1+\Gamma_4)/\Gamma$

VALUE	DOCUMENT ID
0.6598±0.0030 OUR FIT	Error includes scale factor of 1.2.

$\Gamma(\pi^{\pm} \mu^{\mp} \nu_{\mu})/\Gamma(\pi^{\pm} e^{\mp} \nu_e)$ Γ_4/Γ_1

VALUE	EVTS	DOCUMENT ID		TECN
0.701±0.009 OUR FIT				
$\mathbf{0.697^{+0.010}_{-0.009}}$ **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

$\Gamma((\pi\mu\text{atom})\nu)/\Gamma(\pi^{\pm}\mu^{\mp}\nu_\mu)$ Γ_7/Γ_4

VALUE (units 10^{-7})	EVTS	DOCUMENT ID		TECN
3.90±0.39	155	[12] ARONSON	86	SPEC
• • • We do not use the following data for averages, fits, limits, etc. • • •				
seen	18	COOMBES	76	WIRE

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

$\Gamma(\pi^0\pi^{\pm}e^{\mp}\nu)/\Gamma_{\text{total}}$ Γ_8/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		[13] DONALDSON	74	SPEC

[13] DONALDSON 74 uses $K^0_L \rightarrow \pi^+\pi^-\pi^0/(\text{all } K^0_L)$ decays = 0.126.

Hadronic modes, including Charge conjugation×Parity Violating (*CPV*) modes

$\Gamma(3\pi^0)/\Gamma_{\text{total}}$ Γ_9/Γ

VALUE	EVTS	DOCUMENT ID		TECN
0.2111±0.0027 OUR FIT Error includes scale factor of 1.1.				
0.2105±0.0028	38k	[14] KREUTZ	95	NA31

[14] 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.

$\Gamma(3\pi^0)/\Gamma(\pi^{\pm}e^{\mp}\nu_e)$ Γ_9/Γ_1

VALUE	EVTS	DOCUMENT ID		TECN
0.544±0.009 OUR FIT Error includes scale factor of 1.1.				
0.545±0.004±0.009	38k	[15] KREUTZ	95	NA31

[15] 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.

$\Gamma(3\pi^0)/[\Gamma(\pi^{\pm}e^{\mp}\nu_e)+\Gamma(\pi^{\pm}\mu^{\mp}\nu_\mu)+\Gamma(\pi^+\pi^-\pi^0)]$ $\Gamma_9/(\Gamma_1+\Gamma_4+\Gamma_{10})$

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	

$\Gamma(3\pi^0)/\Gamma(\pi^+\pi^-\pi^0)$ — Γ_9/Γ_{10}

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	[16] 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

[16] 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.

$\Gamma(\pi^+\pi^-\pi^0)/\Gamma_{\text{total}}$ — Γ_{10}/Γ

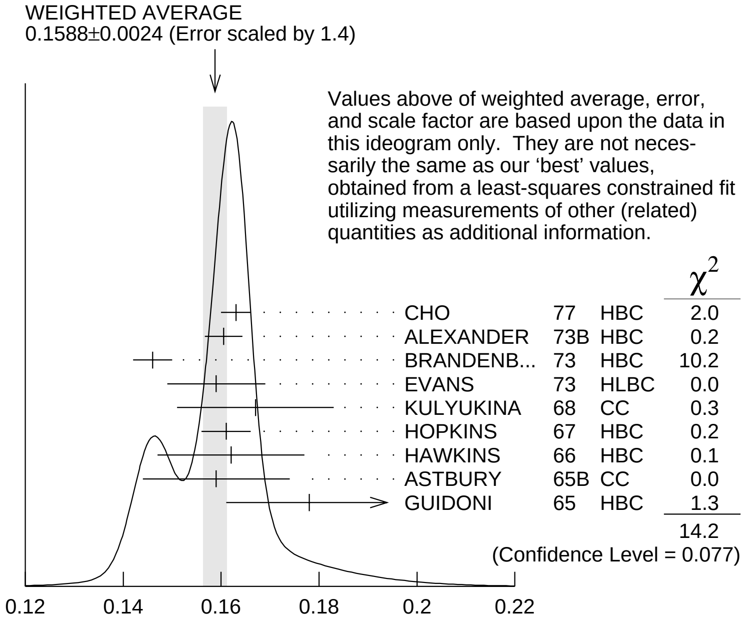
VALUE	DOCUMENT ID
0.1256±0.0020 OUR FIT Error includes scale factor of 1.7.	

$\Gamma(\pi^+\pi^-\pi^0)/\Gamma(\pi^\pm e^\mp \nu_e)$ — Γ_{10}/Γ_1

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

$\Gamma(\pi^+\pi^-\pi^0)/[\Gamma(\pi^\pm e^\mp \nu_e)+\Gamma(\pi^\pm \mu^\mp \nu_\mu)+\Gamma(\pi^+\pi^-\pi^0)]$ — $\Gamma_{10}/(\Gamma_1+\Gamma_4+\Gamma_{10})$

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. • • •				
0.144 ±0.004	1729	HOPKINS 65	HBC	See HOPKINS 67



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

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

Violates *CP* conservation.

VALUE (units 10^{-3})	*DOCUMENT ID*	
2.056±0.033 OUR FIT		
2.071±0.049	[17] ETAFIT	00

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

$\Gamma(\pi^+\pi^-)/\left[\Gamma(\pi^\pm e^\mp \nu_e)+\Gamma(\pi^\pm \mu^\mp \nu_\mu)\right]$ $\qquad$ $\Gamma_{11}/(\Gamma_1+\Gamma_4)$

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	[18] DEBOUARD	67	OSPK	η_{+-}=2.00 ± 0.09
2.35±0.19	525	[18] FITCH	67	OSPK	η_{+-}=1.94 ± 0.08

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

$\Gamma(\pi^+\pi^-)/[\Gamma(\pi^\pm e^\mp \nu_e)+\Gamma(\pi^\pm \mu^\mp \nu_\mu)+\Gamma(\pi^+\pi^-\pi^0)]$ — $\Gamma_{11}/(\Gamma_1+\Gamma_4+\Gamma_{10})$

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	[19] MESSNER	73	ASPK	$\eta_{+-} = 2.23 \pm 0.05$

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

$\Gamma(\pi^+\pi^-)/\Gamma(\pi^+\pi^-\pi^0)$ — Γ_{11}/Γ_{10}

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	$\eta_{+-} = 2.23$

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

Violates *CP* conservation.

VALUE (units 10^{-3})	*DOCUMENT ID*
0.928±0.019 OUR FIT	

$\Gamma(\pi^0\pi^0)/\Gamma(\pi^+\pi^-)$ — Γ_{12}/Γ_{11}

Violates *CP* conservation.

VALUE	*DOCUMENT ID*	
0.451 ±0.006 OUR FIT		
0.4517±0.0060	[20] ETAFIT	00

[20] 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."

$\Gamma(\pi^0\pi^0)/\Gamma(3\pi^0)$ — Γ_{12}/Γ_9

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	$\eta_{00}=2.02 \pm 0.23$
0.32 ±0.15	30	BUDAGOV	70	HLBC	$\eta_{00}=1.9 \pm 0.5$
0.46 ±0.11	57	BANNER	69	OSPK	$\eta_{00}=2.2 \pm 0.3$

Semileptonic modes with photons

$\Gamma(\pi^\pm e^\mp \nu_e \gamma)/\Gamma(\pi^\pm e^\mp \nu_e)$ — Γ_{13}/Γ_1

VALUE (units 10^{-2})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
$0.934\pm0.036^{+0.055}_{-0.039}$	1384	LEBER	96	NA31	$E^*_\gamma \geq$ 30 MeV, $\theta^*_{e\gamma} \geq 20^\circ$

$\Gamma(\pi^\pm \mu^\mp \nu_\mu \gamma)/\Gamma(\pi^\pm \mu^\mp \nu_\mu)$ — Γ_{14}/Γ_4

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
$2.08\pm0.17^{+0.16}_{-0.21}$	4261	BENDER	98	NA48	$E^*_\gamma \geq 30$ MeV

Hadronic modes with photons or $\ell\overline{\ell}$ pairs

$\Gamma(\pi^0\pi^0\gamma)/\Gamma_{total}$ — Γ_{15}/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

$\Gamma(\pi^+\pi^-\gamma)/\Gamma_{total}$ — 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	[21] RAMBERG	93	E731	E_γ >20 MeV
4.41±0.32	1062	[22] CARROLL	80B	SPEC	E_γ >20 MeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1.52±0.16	516	[23] CARROLL	80B	SPEC	E_γ >20 MeV
2.89±0.28	546	[24] CARROLL	80B	SPEC	

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

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

[23] Internal Bremsstrahlung component only.

[24] Direct γ emission component only.

$\Gamma(\pi^0 2\gamma)/\Gamma_{total}$ — Γ_{17}/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	[25] 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	[26] BARR	90C	NA31	$m_{\gamma\gamma}$ > 280 MeV

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

[26] BARR 90C superseded by BARR 92.

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

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

Other modes with photons or $\ell\overline{\ell}$ pairs

$\Gamma(2\gamma)/\Gamma_{total}$ — Γ_{19}/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		[27] BANNER	72B	OSPK	
4.5 ±1.0	23	ENSTROM	71	OSPK	K^0_L 1.5–9 GeV/c
5.0 ±1.0		[28] REPELLIN	71	OSPK	
5.5 ±1.1	90	KUNZ	68	OSPK	Norm.to 3 π(C+N)

[27] This value uses $(\eta_{00}/\eta_{+-})^2 = 1.05 \pm 0.14$. In general, $\Gamma(2\gamma)/\Gamma_{total} = [(4.32 \pm 0.55) \times 10^{-4}]\,[(\eta_{00}/\eta_{+-})^2]$.

[28] 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.

$\Gamma(2\gamma)/\Gamma(3\pi^0)$ — Γ_{19}/Γ_9

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
2.78±0.08 OUR FIT					
• • • 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_{19}/Γ_{12}

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_{20}/Γ

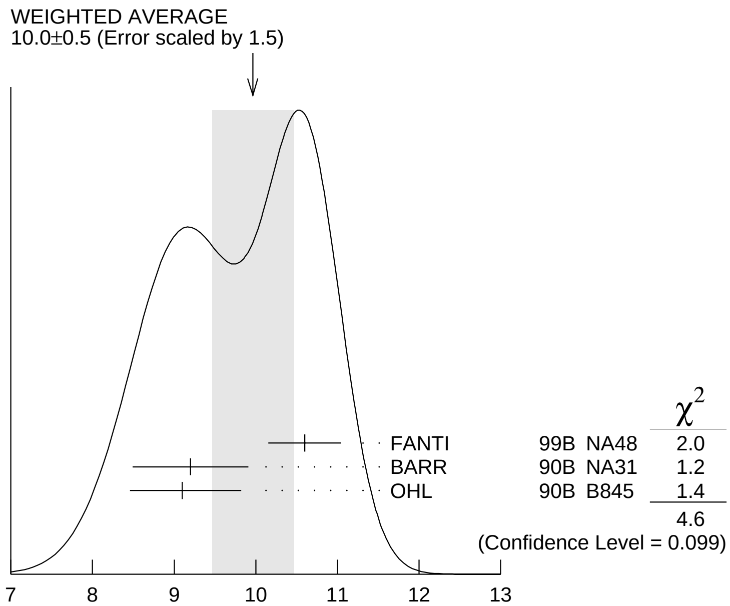
VALUE	CL%	DOCUMENT ID		TECN
$<2.4 \times 10^{-7}$	90	[29] BARR	95C	NA31

[29] Assumes a phase-space decay distribution.

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

VALUE (units 10^{-6})	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	[30] FANTI	99B	NA48
9.2±0.5±0.5	1053	BARR	90B	NA31
$9.1 \pm 0.4^{+0.6}_{-0.5}$	919	OHL	90B	B845

[30] 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.



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

$\Gamma(\mu^+ \mu^- \gamma)/\Gamma_{\text{total}}$ Γ_{22}/Γ

VALUE (units 10^{-7})	*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

$\Gamma(e^+ e^- \gamma\gamma)/\Gamma_{\text{total}}$ Γ_{23}/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±1.2±0.6	58	NAKAYA	94	E799	$E_\gamma > 5$ MeV
6.6±3.2		MORSE	92	B845	$E_\gamma > 5$ MeV

$\Gamma(\mu^+ \mu^- \gamma\gamma)/\Gamma_{\text{total}}$ Γ_{24}/Γ

VALUE (units 10^{-9})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
$\mathbf{10.4^{+7.5}_{-5.9}\pm0.7}$	4	ALAVI-HARATI	00E	KTEV	$m_{\gamma\gamma} \geq 1$ MeV/c^2

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

$\Gamma(\mu^+\mu^-)/\Gamma(\pi^+\pi^-)$ — Γ_{25}/Γ_{11}

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

VALUE (units 10^{-6})	EVTS	DOCUMENT ID		TECN	COMMENT
3.48 ±0.05 OUR AVERAGE					
3.474±0.057	6210	AMBROSE	00	B871	
3.87 ±0.30	179	[31] 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	[32] AKAGI	91B	SPEC	In AKAGI 95
3.45 ±0.18 ±0.13	368	[33] 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

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

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

[33] 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.

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

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

VALUE (units 10^{-10})	CL%	EVTS	DOCUMENT ID		TECN
$\mathbf{0.087^{+0.057}_{-0.041}}$		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	[34] ARISAKA	93B	B791

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

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

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

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

VALUE (units 10^{-9})	CL%	EVTS	DOCUMENT ID		TECN
$\mathbf{2.9^{+6.7}_{-2.4}}$		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_{29}/Γ

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

VALUE (units 10^{-8})	EVTS	DOCUMENT ID		TECN	COMMENT
4.1 ±0.8 OUR AVERAGE		Error includes scale factor of 1.2.			
6 ±2 ±1	18	[35] AKAGI	95	SPEC	m_{ee} >470 MeV
10.4 ±3.7 ±1.1	8	[36] 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	[35] 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

[35] Values are for the total branching fraction, acceptance-corrected for the m_{ee} cuts shown.

[36] Distribution of angles between two e^+e^- pair planes favors $CP=-1$ for K^0_L.

$\Gamma(\pi^0\mu^+\mu^-)/\Gamma_{total}$ — Γ_{30}/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
<0.38	90		ALAVI-HARATI	00D	KTEV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<5.1	90	0	HARRIS	93	E799

$\Gamma(\pi^0e^+e^-)/\Gamma_{total}$ — Γ_{31}/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

$\Gamma(\pi^0\nu\overline{\nu})/\Gamma_{total}$ — Γ_{32}/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	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

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

Test of lepton family number conservation.

VALUE (units 10^{-11})	CL%	EVTS	DOCUMENT ID		TECN
<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	[37] ARISAKA	93	B791

[37] This is the combined result of ARISAKA 93 and MATHIAZHAGAN 89.

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

Test of lepton family number conservation.

VALUE (units 10^{-9})	CL%	EVTS	DOCUMENT ID		TECN
<6.1	90	0	[38] GU	96	E799

[38] Assuming uniform phase space distribution.

$\Gamma(\pi^0\mu^{\pm}e^{\mp})/\Gamma_{total}$ Γ_{35}/Γ

Test of lepton family number conservation.

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

ENERGY DEPENDENCE OF K_L^0 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 $v = (s_1 - s_2)\ /\ m_\pi^2$

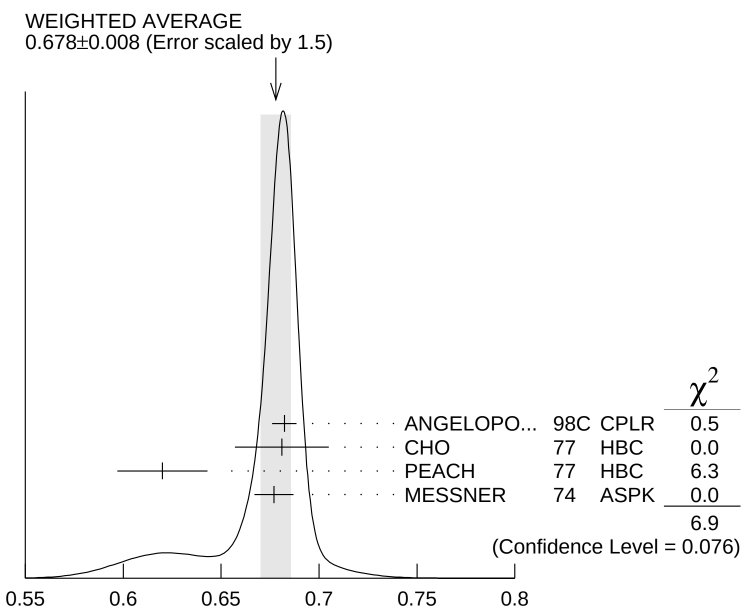
LINEAR COEFFICIENT g FOR $K_L^0 \to \pi^+\pi^-\pi^0$

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	[39] BALDO-...	75	HLBC	
0.590 ±0.022	56k	[39] BUCHANAN	75	SPEC	$a_u = -0.277 \pm 0.010$
0.619 ±0.027	20k	[39,40] BISI	74	ASPK	$a_t = -0.282 \pm 0.011$
0.612 ±0.032		[39] ALEXANDER	73B	HBC	
0.73 ±0.04	3200	[39] BRANDENB...	73	HBC	
0.608 ±0.043	1486	[39] KRENZ	72	HLBC	$a_t = -0.277 \pm 0.018$
0.650 ±0.012	29k	[39] ALBROW	70	ASPK	$a_y = -0.858 \pm 0.015$
0.593 ±0.022	36k	[39,41] BUCHANAN	70	SPEC	$a_u = -0.278 \pm 0.010$
0.664 ±0.056	4400	[39] SMITH	70	OSPK	$a_t = -0.306 \pm 0.024$
0.400 ±0.045	2446	[39] BASILE	68B	OSPK	$a_t = -0.188 \pm 0.020$
0.649 ±0.044	1350	[39] HOPKINS	67	HBC	$a_t = -0.294 \pm 0.018$
0.428 ±0.055	1198	[39] NEFKENS	67	OSPK	$a_u = -0.204 \pm 0.025$

[39] 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.

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

[41] 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 $K^0_L \to \pi^+\pi^-\pi^0$ matrix element squared

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

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	[42] ALBROW	70	ASPK
0.043±0.052	4400	[42] SMITH	70	OSPK

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

[42] 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 $K^0_L \to \pi^+\pi^-\pi^0$

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 $K^0_L \to \pi^+\pi^-\pi^0$ (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	[43] SOMALWAR	92	E731

[43] 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.

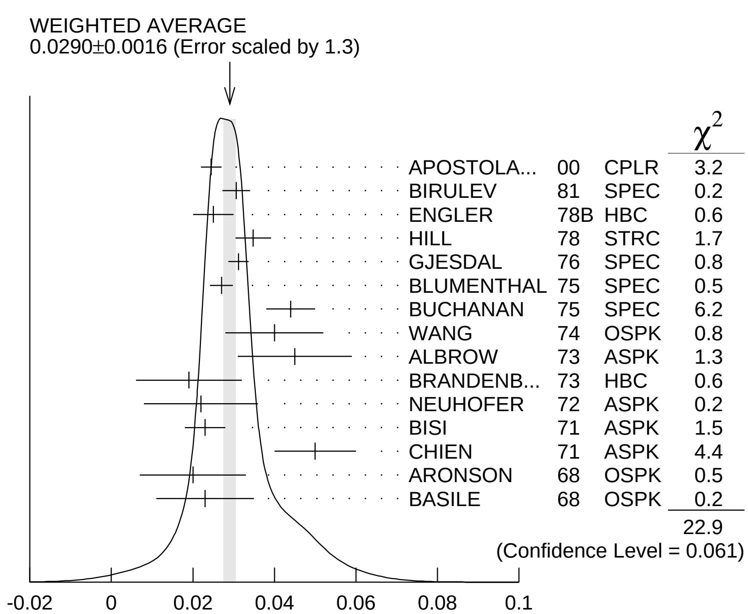
RC = radiative corrections.

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
0.0290±0.0016 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	[44] 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
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.029 ±0.005	19k	[44] CHO	80	HBC	DP

[44] 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	[45] BIRULEV	81	SPEC	DP
+0.26±0.16	−13	14k	[46] CHO	80	HBC	DP
+0.13±0.23	−20	16k	[46] HILL	79	STRC	DP
−0.25±0.22	−5.9	32k	[47] BUCHANAN	75	SPEC	DP
−0.11±0.07	−17	1.6M	[48] DONALDSON	74B	SPEC	DP
−1.00±0.45	−20	1385	[49] PEACH	73	HLBC	DP
−1.5 ±0.7	−28	9086	[50] ALBROW	72	ASPK	DP
+1.2 ±0.8	−18	1341	[51] CARPENTER	66	OSPK	DP
• • • We do not use the following data for averages, fits, limits, etc. • • •						
+0.50±0.61	unknown	16k	[52] DALLY	72	ASPK	DP
−3.9 ±0.4		3140	[53] BASILE	70	OSPK	DP, indep of λ_+
$-0.68^{+0.12}_{-0.20}$	−26	16k	[52] CHIEN	70	ASPK	DP

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

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

[47] 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. $\lambda_- = \lambda_+$.

[48] 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 $d\lambda_0/d\lambda_+$.

[49] 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).

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

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

[52] 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.

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

$\xi_b = f_-/f_+$ (determined from $K^0_{\mu 3}/K^0_{e3}$)

The $K^0_{\mu 3}/K^0_{e3}$ 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 $K^0_{\mu 3}/K^0_{e3}$ branching ratio via the fitted $K^0_{\mu 3}/K^0_{e3}$ 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, $\lambda_+=0.019 \pm 0.013$
−0.08±0.25	1309	[54] EVANS	73	HLBC	BR, $\lambda_+=0.02$
−0.5 ±0.5	3548	BASILE	70	OSPK	BR, $\lambda_+=0.02$
+0.45±0.28	569	BEILLIERE	69	HLBC	BR, $\lambda_+=0$
−0.22±0.30	1309	[54] EVANS	69	HLBC	
$+0.2\ ^{+0.8}_{-1.2}$		KULYUKINA	68	CC	BR, $\lambda_+=0$
+1.1 ±1.1	389	ADAIR	64	HBC	BR, $\lambda_+=0$
$+0.66^{+0.9}_{-1.3}$		LUERS	64	HBC	BR, $\lambda_+=0$

[54] EVANS 73 replaces EVANS 69.

$\xi_c = f_-/f_+$ (determined from μ polarization in $K^0_{\mu 3}$)

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 $K^0_{\mu 3}$, 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	[55] CLARK	77	SPEC	POL, $d\xi(0)/d\lambda_+ = +0.68$
−0.385±0.105	2.2M	[56] SANDWEISS	73	CNTR	POL, $d\xi(0)/d\lambda_+ = -6$
$-1.81\ ^{+0.50}_{-0.26}$		[57] LONGO	69	CNTR	POL, t=3.3
• • • We do not use the following data for averages, fits, limits, etc. • • •					
−1.6 ±0.5	638	[58] ABRAMS	68B	OSPK	Polarization
−1.2 ±0.5	2608	[58] AUERBACH	66B	OSPK	Polarization

[55] CLARK 77 $t = +3.80$, $d\xi(0)/d\lambda_+ = \xi(t)t = 0.178\times3.80 = +0.68$.

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

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

[58] t value not given.

Im(ξ) in $K^0_{\mu 3}$ 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	[59] CLARK	77	SPEC	POL, t=0
−0.085±0.064	2.2M	[60] 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

[59] CLARK 77 value has additional $\xi(0)$ dependence $+0.21\text{Re}\left[\xi(0)\right]$.

[60] 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 $K^0_{\mu 3}$ 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 $K^0_{\mu 3}$ DECAY)" below. For radiative correction of $K^0_{\mu 3}$ 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 $K_{\ell 3}$ 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	[61] 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	[62] CLARK	77	SPEC	POL
+0.025 ±0.019	+0.5	32k	[63] BUCHANAN	75	SPEC	DP
+0.019 ±0.004	−0.47	1.6M	[64] DONALDSON	74B	SPEC	DP
−0.060 ±0.038	−0.71	1385	[65] PEACH	73	HLBC	DP
−0.018 ±0.009	+0.49	2.2M	[62] SANDWEISS	73	CNTR	POL
−0.043 ±0.052	−1.39	9086	[66] ALBROW	72	ASPK	DP
$-0.140\ ^{+0.043}_{-0.022}$	+0.49		[62] LONGO	69	CNTR	POL
+0.08 ±0.07	−0.54	1371	[62] CARPENTER	66	OSPK	DP
• • • We do not use the following data for averages, fits, limits, etc. • • •						
0.041 ±0.008		14k	[67] 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	[68] BRANDENB...	73	HBC	BR, λ_+=0.019 ± 0.013
−0.067 ±0.227	unknown	16k	[69] DALLY	72	ASPK	DP
−0.333 ±0.034	+1.	3140	[70] BASILE	70	OSPK	DP

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

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

[63] 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.

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

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

[66] 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.

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

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

[69] 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.

[70] 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 $K^0_{\mu3}$ DECAY

Ratio of tensor to f_+ couplings.

VALUE	DOCUMENT ID		TECN
0.12±0.12	BIRULEV	81	SPEC

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

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

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 $K^0_L \rightarrow \pi^\pm\pi^0e^\mp\nu_e$

Given in MAKOFF 93.

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CP-VIOLATION PARAMETERS IN K^0_L DECAYS

——— CHARGE ASYMMETRY IN $K^0_{\ell3}$ 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	$K_{\mu3} + K_{e3}$

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

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	[71] PACIOTTI 69	OSPK
0.403±0.134	1M	[71] DORFAN 67	OSPK

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

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

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	[72] 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	[72] BENNETT 67	CNTR

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

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

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

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 $K^0_L \rightarrow \pi\pi$ and $K^0_S \rightarrow \pi\pi$ 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.

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

VALUE (units 10^{-3})	DOCUMENT ID	TECN	COMMENT
2.262±0.017 OUR FIT			
2.23 ±0.11 OUR AVERAGE			
2.12 ±0.16	[73] 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	[74] ADLER	96B	CPLR	Sup. by ANGELOPOULOS 98
2.71 ±0.37	[75] WOLFF	71	OSPK	Cu reg., 4γ's
2.95 ±0.63	[75] CHOLLET	70	OSPK	Cu reg., 4γ's

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

[74] Error is statistical only.

[75] 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).

$|\eta_{+-}| = |A(K_L^0 \to \pi^+\pi^-) / A(K_S^0 \to \pi^+\pi^-)|$

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		[76] BRFIT	00		
2.264±0.023±0.027	70M	[77] 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		[78] 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

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

[77] 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.

[78] 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		[79,80] BARR	93D	NA31
0.9904±0.0084±0.0036		[81] WOODS	88	E731
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.9939±0.0013±0.0015	1M	[79] BARR	93D	NA31
0.9899±0.0020±0.0025		[79] BURKHARDT	88	NA31

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

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

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

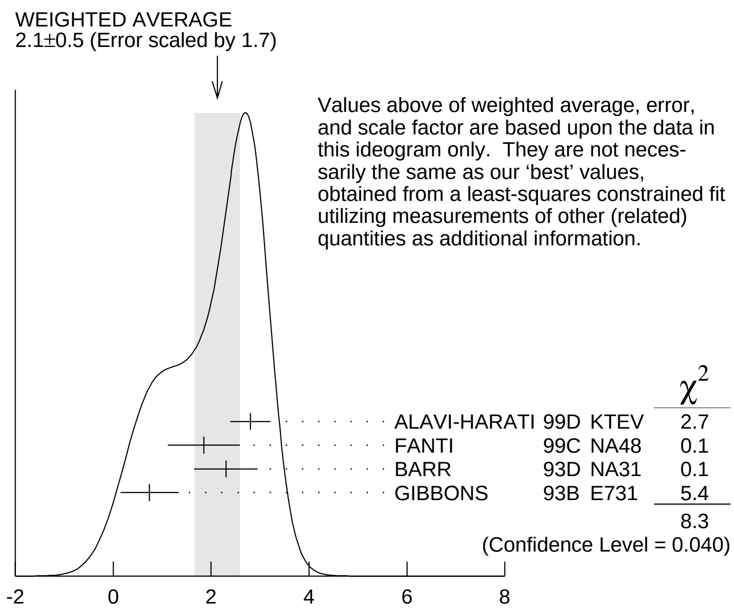
$\epsilon'/\epsilon \approx \mathrm{Re}(\epsilon'/\epsilon) = (1-|\eta_{00}/\eta_{+-}|)/3$

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	82,83	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	84	BARR	93D	NA31	
−0.4 ±1.4 ±0.6		PATTERSON	90	E731	in GIBBONS 93B
3.3 ±1.1	84	BURKHARDT	88	NA31	
3.2 ±2.8 ±1.2	82	WOODS	88	E731	

[82] 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.

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

[84] 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 $K^0_L - K^0_S$ 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				
43.2 ±0.7	70M	[85] APOSTOLA... 99C	CPLR	K^0-$\overline{K}^0$ asymmetry
43.6 ±0.8		[86,87] SCHWINGEN...95	E773	$CH_{1.1}$ regenerator
42.4 ±1.0		[87,88] GIBBONS 93	E731	B_4C regenerator
44.4 ±1.7		[89] CAROSI 90	NA31	Vacuum regen.
44.4 ±2.8		[90] CARITHERS 75	SPEC	C regenerator
43.8 ±1.2		[91] GEWENIGER 74B	ASPK	Vacuum regen.
• • • We do not use the following data for averages, fits, limits, etc. • • •				
43.82±0.63		[92,93] ADLER 96C	RVUE	
43.6 ±1.2		[94] ADLER 95B	CPLR	K^0-$\overline{K}^0$ asymmetry
42.3 ±4.4 ±1.4	10^5	[95] ADLER 92B	CPLR	K^0-$\overline{K}^0$ asymmetry
47.7 ±2.0 ±0.9		[87,96] KARLSSON 90	E731	

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

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

[87] 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."

[88] 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_{+-} $(42.2 \pm 1.4)^\circ$

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

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

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

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

[93] 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)).

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

[95] 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.

[96] 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				
41.9±5.6±1.9	[97] ANGELOPO...	98	CPLR	
44.5±2.5	[98] CAROSI	90	NA31	
• • • We do not use the following data for averages, fits, limits, etc. • • •				
50.8±7.1±1.7	[99] ADLER	96B	CPLR	Sup. by ANGELOPOULOS 98
47.4±1.4±0.9	[100] KARLSSON	90	E731	

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

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

[99] 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.

[100] 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	[101] SCHWINGEN...	95		Combined E731, E773
0.2 ±2.6 ±1.2	[102] 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	[103] GIBBONS	93	E731	
−0.3 ±2.4 ±1.2	KARLSSON	90	E731	

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

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

[103] 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 $K^0_L \rightarrow \pi^+\pi^-\pi^0$ above.

See also note on Dalitz plot parameters in $K^{\pm}$ section and note on *CP* violation in K^0_L decay above.

LINEAR COEFFICIENT *j* FOR $K^0_L \rightarrow \pi^+\pi^-\pi^0$

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 $K^0_L \rightarrow \pi^+\pi^-\pi^0$

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

PARAMETERS for $K^0_L \rightarrow \pi^+\pi^-\gamma$ DECAY

$|\eta_{+-\gamma}| = |A(K^0_L \rightarrow \pi^+\pi^-\gamma$, *CP* violating$)/A(K^0_S \rightarrow \pi^+\pi^-\gamma)|$

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 $K^0_L \rightarrow \pi^+\pi^-\gamma$

VALUE	CL%	EVTS	DOCUMENT ID		TECN
<0.3	90	3671	[104] RAMBERG	93B	E731

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

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

REAL PART OF x

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
$-0.0018 \pm 0.0041 \pm 0.0045$		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	$\pi^- p \to K^0 \Lambda$
$0.04\ \pm 0.03$	4724	NIEBERGALL	74	ASPK	$K^+ p \to K^0 p \pi^+$
$-0.008\ \pm 0.044$	1757	FACKLER	73	OSPK	K_{e3} from K^0
$-0.03\ \pm 0.07$	1367	HART	73	OSPK	K_{e3} from $K^0 \Lambda$
$-0.070\ \pm 0.036$	1079	MALLARY	73	OSPK	K_{e3} from $K^0 \Lambda X$
$0.03\ \pm 0.06$	410	[105] BURGUN	72	HBC	$K^+ p \to K^0 p \pi^+$
$0.04\ {}^{+0.10}_{-0.13}$	100	[106] GRAHAM	72	OSPK	$K_{\mu 3}$ from $K^0 \Lambda$
$-0.05\ \pm 0.09$	442	[106] GRAHAM	72	OSPK	$\pi^- p \to K^0 \Lambda$
$0.26\ {}^{+0.10}_{-0.14}$	126	MANN	72	HBC	$K^- p \to n \overline{K}^0$
$-0.13\ \pm 0.11$	342	[106] MANTSCH	72	OSPK	K_{e3} from $K^0 \Lambda$
$0.04\ {}^{+0.07}_{-0.08}$	222	[105] BURGUN	71	HBC	$K^+ p \to K^0 p \pi^+$
$0.25\ {}^{+0.07}_{-0.09}$	252	WEBBER	71	HBC	$K^- p \to n \overline{K}^0$
$0.12\ \pm 0.09$	215	[107] CHO	70	DBC	$K^+ d \to K^0 p p$
$-0.020\ \pm 0.025$		[108] BENNETT	69	CNTR	Charge asym+ Cu regen.
$0.09\ {}^{+0.14}_{-0.16}$	686	LITTENBERG	69	OSPK	$K^+ n \to K^0 p$
$0.03\ \pm 0.03$		[108] 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	$\pi^- p \to K^0 \Lambda$
$0.17\ \pm 0.10$	335	[107] 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	[109] BALDO-...	65	HLBC	K^+ charge exchange
$-0.08\ {}^{+0.16}_{-0.28}$	109	[110] FRANZINI	65	HBC	$\overline{p} p$

[105] BURGUN 72 is a final result which includes BURGUN 71.
[106] First GRAHAM 72 value is second GRAHAM 72 value combined with MANTSCH 72.
[107] CHO 70 is analysis of unambiguous events in new data and HILL 67.
[108] BENNETT 69 is a reanalysis of BENNETT 68.
[109] BALDO-CEOLIN 65 gives x and θ converted by us to Re(x) and Im(x).
[110] 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	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	$\pi^- p \rightarrow K^0 \Lambda$
$-0.06\ \pm0.05$	4724	NIEBERGALL	74	ASPK	$K^+ p \rightarrow K^0 p \pi^+$
$-0.017\ \pm0.060$	1757	FACKLER	73	OSPK	K_{e3} from K^0
$0.09\ \pm0.07$	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	[111] BURGUN	72	HBC	$K^+ p \rightarrow K^0 p \pi^+$
$0.12\ ^{+0.17}_{-0.16}$	100	[112] GRAHAM	72	OSPK	$K_{\mu 3}$ from $K^0 \Lambda$
$0.05\ \pm0.13$	442	[112] GRAHAM	72	OSPK	$\pi^- p \rightarrow K^0 \Lambda$
$0.21\ ^{+0.15}_{-0.12}$	126	MANN	72	HBC	$K^- p \rightarrow n \overline{K}^0$
$-0.04\ \pm0.16$	342	[112] MANTSCH	72	OSPK	K_{e3} from $K^0 \Lambda$
$0.12\ ^{+0.08}_{-0.09}$	222	[111] BURGUN	71	HBC	$K^+ p \rightarrow K^0 p \pi^+$
$0.0\ \pm0.08$	252	WEBBER	71	HBC	$K^- p \rightarrow n \overline{K}^0$
$-0.08\ \pm0.07$	215	[113] CHO	70	DBC	$K^+ d \rightarrow K^0 p p$
$-0.11\ ^{+0.10}_{-0.11}$	686	LITTENBERG	69	OSPK	$K^+ n \rightarrow K^0 p$
$+0.22\ ^{+0.37}_{-0.29}$	121	JAMES	68	HBC	$\overline{p} p$
$0.0\ \pm0.25$	116	FELDMAN	67B	OSPK	$\pi^- p \rightarrow K^0 \Lambda$
$-0.20\ \pm0.10$	335	[113] HILL	67	DBC	$K^+ d \rightarrow K^0 p p$
$-0.21\ ^{+0.11}_{-0.15}$	196	AUBERT	65	HLBC	K^+ charge exchange
$-0.44\ ^{+0.32}_{-0.19}$	152	[114] BALDO-...	65	HLBC	K^+ charge exchange
$+0.24\ ^{+0.40}_{-0.30}$	109	[115] FRANZINI	65	HBC	$\overline{p} p$

[111] BURGUN 72 is a final result which includes BURGUN 71.
[112] First GRAHAM 72 value is second GRAHAM 72 value combined with MANTSCH 72.
[113] 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.
[114] BALDO-CEOLIN 65 gives x and θ converted by us to Re(x) and Im(x).
[115] 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.)
ALAVI-HARATI	00D	PRL 84 5279	A. Alavi-Harati *et al.*	(KTeV Collab.)
ALAVI-HARATI	00E	PR D62 112001	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 2000 edition	T.G. Trippe	
Fits for K^0_L *CP*-Violation Parameters				
ETAFIT	00	RPP 2000 edition	T.G. Trippe	
Fits for K^0_L *CP*-Violation Parameters				
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	R. M. Barnett *et al.*	
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)	G. Makoff *et al.*	
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	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)
MATHIAZHA...	89	PRL 63 2181	C. Mathiazhagan *et al.*	(UCI, UCLA, LANL+)
MATHIAZHA...	89B	PRL 63 2185	C. Mathiazhagan *et al.*	(UCI, UCLA, LANL+)
WAHL	89	CERN-EP/89-86	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+)
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)
CHO	80	PR D22 2688	Y. Cho *et al.*	(ANL, CMU)
MORSE	80	PR D21 1750	W.M. Morse *et al.*	(BNL, YALE)
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)
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)
GJESDAL	76	NP B109 118	G. Gjesdal *et al.*	(CERN, HEIDH)
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)
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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+)
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Also	76	PR D14 2839	G. Donaldson *et al.*	(SLAC)

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Also	73B	PRL 31 337	G. Donaldson *et al.*	(SLAC, UCSC)
GEWENIGER	74	PL 48B 483	C. Geweniger *et al.*	(CERN, HEIDH)
Also	74	Thesis CERN Int. 74-4	V. Luth	(CERN)
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Also	74B	PL 52B 119	S. Gjesdal *et al.*	(CERN, HEIDH)
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WANG	74	PR D9 540	L. Wang *et al.*	(UMD, BNL)
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ALBROW	73	NP B58 22	M.G. Albrow *et al.*	(MCHS, DARE)
ALEXANDER	73B	NP B65 301	G. Alexander *et al.*	(TELA, HEID)
BRANDENB...	73	PR D8 1978	G.W. Brandenburg *et al.*	(SLAC)
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)
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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)
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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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BARMIN	72B	SJNP 15 638	V.V. Barmin *et al.*	(ITEP)
		Translated from YAF 15 1152.		
BURGUN	72	NP B50 194	G. Burgun *et al.*	(SACL, CERN, OSLO)
DALLY	72	PL 41B 647	E.B. Dally *et al.*	(SLAC, JHU, UCLA)
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)
GRAHAM	72	NC 9A 166	M.F. Graham *et al.*	(ILL, NEAS)
JAMES	72	NP B49 1	F. James *et al.*	(CERN, SACL, OSLO)
KRENZ	72	LNC 4 213	W. Krenz *et al.*	(AACH, CERN, EDIN)
MANN	72	PR D6 137	W.A. Mann *et al.*	(MASA, BNL, YALE)
MANTSCH	72	NC 9A 160	P.M. Mantsch *et al.*	(ILL, NEAS)
MCCARTHY	72	PL 42B 291	R.L. McCarthy *et al.*	(LBL)
NEUHOFER	72	PL 41B 642	G. Neuhofer *et al.*	(CERN, ORSAY, VIEN)
PICCIONI	72	PRL 29 1412	R. Piccioni *et al.*	(SLAC)
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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)
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)
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.	A.J. 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)
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PACIOTTI	69	Thesis UCRL 19446	M.A. Paciotti	(LRL)
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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)
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BASILE	68	PL 26B 542	P. Basile *et al.*	(SACL)
BASILE	68B	PL 28B 58	P. Basile *et al.*	(SACL)
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JAMES	68	NP B8 365	F. James, H. Briand	(IPNP, CERN)
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KUNZ	68	Thesis PU-68-46	P.F. Kunz	(PRIN)
BENNETT	67	PRL 19 993	S. Bennett *et al.*	(COLU)
DEBOUARD	67	NC 52A 662	X. de Bouard *et al.*	(CERN)
Also	65	PL 15 58	X. de Bouard *et al.*	(CERN, ORSAY, MPIM)
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