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 "*CP* violation in K_L decays" in the K^0_L Particle Listings. The result labeled "OUR FIT Assuming *CPT*" ["OUR FIT Not assuming *CPT*"] includes all measurements except those with the comment "Not assuming *CPT*" ["Assuming *CPT*"]. Measurements with neither comment do not assume *CPT* and enter both fits.

VALUE (10^{10} $\hbar$ s^{-1})		*DOCUMENT ID*		*TECN*	*COMMENT*
0.5292±0.0009	**OUR FIT**	Error includes scale factor of 1.2. Assuming *CPT*			
0.5290±0.0015	**OUR FIT**	Error includes scale factor of 1.1. Not assuming *CPT*			
0.5261±0.0015		[1,2] ALAVI-HARATI	03	KTEV	Assuming *CPT*
0.5288±0.0043		[2,3] ALAVI-HARATI	03	KTEV	Not assuming *CPT*
0.5240±0.0044	±0.0033	APOSTOLA...	99C	CPLR	K^0-$\overline{K}^0$ to $\pi^+\pi^-$
0.5297±0.0030	±0.0022	[4] SCHWINGEN...	95	E773	20–160 GeV *K* beams
0.5286±0.0028		[5] GIBBONS	93	E731	Assuming *CPT*
0.5257±0.0049	±0.0021	[4] GIBBONS	93C	E731	Not assuming *CPT*
0.5340±0.00255	±0.0015	[6] GEWENIGER	74C	SPEC	Gap method
0.5334±0.0040	±0.0015	[6,7] GJESDAL	74	SPEC	Assuming *CPT*
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.5343±0.0063	±0.0025	[8] ANGELOPO...	01	CPLR	
0.5295±0.0020	±0.0003	[9] ANGELOPO...	98D	CPLR	Assuming *CPT*
0.5307±0.0013		[10] ADLER	96C	RVUE	
0.5274±0.0029	±0.0005	[9] ADLER	95	CPLR	Sup. by ANGELOPOULOS 98D
0.482 ±0.014		[11] ARONSON	82B	SPEC	*E*=30–110 GeV
0.534 ±0.007		[12] CARNEGIE	71	ASPK	Gap method
0.542 ±0.006		[12] ARONSON	70	ASPK	Gap method
0.542 ±0.006		CULLEN	70	CNTR	

[1] ALAVI-HARATI 03 fit Δm and $\tau_{K^0_S}$ simultaneously. ϕ_{+-} is constrained to the Superweak value, i.e. *CPT* is assumed. See "K^0_S Mean Life" section for correlation information.

[2] The two ALAVI-HARATI 03 values use the same data. The first enters the "Assuming *CPT*" fit and the second enters the "Not assuming *CPT*" fit. They use 40–160 GeV *K* beams.

[3] ALAVI-HARATI 03 fit Δm, ϕ_{+-}, and τ_{K_S} simultaneously. See ϕ_{+-} in the "K_L *CP* violation" section for correlation information.

[4] Fits Δm and ϕ_{+-} simultaneously. GIBBONS 93C systematic error is from B. Winstein via private communication. 20–160 GeV *K* beams.

[5] GIBBONS 93 value assume $\phi_{+-} = \phi_{00} = \phi_{SW} = (43.7 \pm 0.2)^\circ$, i.e. assumes *CPT*. 20–160 GeV *K* beams.

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

[7] GJESDAL 74 uses charge asymmetry in $K^0_{\ell 3}$ decays.

[8] ANGELOPOULOS 01 uses strong interactions strangeness tagging at two different times.
[9] Uses $\overline{K}^0_{e3}$ and K^0_{e3} strangeness tagging at production and decay. Assumes CPT conservation on $\Delta S{=}-\Delta Q$ transitions.
[10] ADLER 96C is the result of a fit which includes nearly the same data as entered into the "OUR FIT" value above.
[11] ARONSON 82 find that Δm may depend on the kaon energy.
[12] 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	COMMENT
5.116±0.020 OUR FIT					
5.099±0.021 OUR AVERAGE					
5.072±0.011±0.035	13M	[13] AMBROSINO	06	KLOE	$\sum_i \mathrm{B}_i = 1$
5.092±0.017±0.025	15M	AMBROSINO	05C	KLOE	
5.154±0.044	0.4M	VOSBURGH	72	CNTR	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
5.15 ±0.14		DEVLIN	67	CNTR	

[13] AMBROSINO 06 uses $\phi \rightarrow K_L K_S$ with K_L tagged by $K_S \rightarrow \pi^+\pi^-$. The four major K_L BR's are measured, the small remainder ($\pi^+\pi^-$,$\pi^0\pi^0$,$\gamma\gamma$) is taken from PDG 04. This KLOE K_L lifetime is obtained by imposing $\sum_i \mathrm{B}_i = 1$. The correlation matrix among the four measured K_L BR's and this K_L lifetime is

	K_{e3}	$K_{\mu3}$	$3\pi^0$	$\pi^+\pi^-\pi^0$	τ_{K_L}
K_{e3}	1	−0.25	−0.56	−0.07	0.25
$K_{\mu3}$		1	−0.43	−0.20	0.33
$3\pi^0$			1	−0.39	−0.21
$\pi^+\pi^-\pi^0$				1	−0.39
τ_{K_L}					1

These correlations are taken into account in our fit. The average of this KLOE mean life measurement and the independent KLOE measurement in AMBROSINO 05C is $(5.084 \pm 0.023) \times 10^{-8}$ s.

K^0_L DECAY MODES

	Mode		Fraction (Γ_i/Γ)	Scale factor/ Confidence level
	Semileptonic modes			
Γ_1	$\pi^\pm e^\mp \nu_e$ Called K^0_{e3}.	[a]	(40.56 ± 0.12) %	S=1.8
Γ_2	$\pi^\pm \mu^\mp \nu_\mu$ Called $K^0_{\mu3}$.	[a]	(27.05 ± 0.07) %	S=1.1
Γ_3	$(\pi\,\mu\,\mathrm{atom})\nu$		$(1.05 \pm 0.11) \times 10^{-7}$	
Γ_4	$\pi^0\pi^\pm e^\mp \nu$	[a]	$(5.20 \pm 0.11) \times 10^{-5}$	

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

Γ_5	$3\pi^0$			(19.51 ± 0.12) %	S=1.6
Γ_6	$\pi^+\pi^-\pi^0$			(12.54 ± 0.05) %	
Γ_7	$\pi^+\pi^-$	*CPV*	[b]	$(1.966 \pm 0.010) \times 10^{-3}$	S=1.6
Γ_8	$\pi^0\pi^0$	*CPV*		$(8.64 \pm 0.06) \times 10^{-4}$	S=1.7

Semileptonic modes with photons

Γ_9	$\pi^\pm e^\mp \nu_e \gamma$		[a,c,d]	$(3.80 \pm 0.08) \times 10^{-3}$	
Γ_{10}	$\pi^\pm \mu^\mp \nu_\mu \gamma$			$(5.65 \pm 0.23) \times 10^{-4}$	

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

Γ_{11}	$\pi^0\pi^0\gamma$			$< 5.6 \times 10^{-6}$	
Γ_{12}	$\pi^+\pi^-\gamma$		[c,d]	$(4.15 \pm 0.15) \times 10^{-5}$	S=2.8
Γ_{13}	$\pi^+\pi^-\gamma$(DE)			$(2.84 \pm 0.11) \times 10^{-5}$	S=2.0
Γ_{14}	$\pi^0 2\gamma$		[d]	$(1.32 \pm 0.14) \times 10^{-6}$	S=3.6
Γ_{15}	$\pi^0\gamma e^+ e^-$			$(2.3 \pm 0.4) \times 10^{-8}$	

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

Γ_{16}	2γ			$(5.47 \pm 0.04) \times 10^{-4}$	S=1.1
Γ_{17}	3γ			$< 2.4 \times 10^{-7}$	CL=90%
Γ_{18}	$e^+e^-\gamma$			$(10.0 \pm 0.5) \times 10^{-6}$	S=1.5
Γ_{19}	$\mu^+\mu^-\gamma$			$(3.59 \pm 0.11) \times 10^{-7}$	S=1.3
Γ_{20}	$e^+e^-\gamma\gamma$		[d]	$(5.95 \pm 0.33) \times 10^{-7}$	
Γ_{21}	$\mu^+\mu^-\gamma\gamma$		[d]	$(1.0\ ^{+0.8}_{-0.6}) \times 10^{-8}$	

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

Γ_{22}	$\mu^+\mu^-$	*S1*		$(6.84 \pm 0.11) \times 10^{-9}$	
Γ_{23}	e^+e^-	*S1*		$(9\ ^{+6}_{-4}) \times 10^{-12}$	
Γ_{24}	$\pi^+\pi^-e^+e^-$	*S1*	[d]	$(3.11 \pm 0.19) \times 10^{-7}$	
Γ_{25}	$\pi^0\pi^0e^+e^-$	*S1*		$< 6.6 \times 10^{-9}$	CL=90%
Γ_{26}	$\mu^+\mu^-e^+e^-$	*S1*		$(2.69 \pm 0.27) \times 10^{-9}$	
Γ_{27}	$e^+e^-e^+e^-$	*S1*		$(3.56 \pm 0.21) \times 10^{-8}$	
Γ_{28}	$\pi^0\mu^+\mu^-$	*CP,S1*	[e]	$< 3.8 \times 10^{-10}$	CL=90%
Γ_{29}	$\pi^0e^+e^-$	*CP,S1*	[e]	$< 2.8 \times 10^{-10}$	CL=90%
Γ_{30}	$\pi^0\nu\overline{\nu}$	*CP,S1*	[f]	$< 2.1 \times 10^{-7}$	CL=90%
Γ_{31}	$e^\pm\mu^\mp$	*LF*	[a]	$< 4.7 \times 10^{-12}$	CL=90%
Γ_{32}	$e^\pm e^\pm \mu^\mp \mu^\mp$	*LF*	[a]	$< 4.12 \times 10^{-11}$	CL=90%
Γ_{33}	$\pi^0\mu^\pm e^\mp$	*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] This mode includes gammas from inner bremsstrahlung but not the direct emission mode $K^0_L \rightarrow \pi^+\pi^-\gamma$(DE).

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

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

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

[*f*] 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 and 13 branching ratios uses 23 measurements and one constraint to determine 10 parameters. The overall fit has a $\chi^2 = 28.0$ for 14 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	−23								
x_5	−78	−27							
x_6	−24	−20	−10						
x_7	57	−14	−49	−4					
x_8	33	−25	−12	−17	67				
x_{12}	7	−1	−6	−1	13	8			
x_{13}	6	−1	−6	−1	12	8	93		
x_{16}	−46	−21	63	−9	−22	6	−3	−3	
Γ	−17	−9	16	16	−9	−5	−1	−1	10
	x_1	x_2	x_5	x_6	x_7	x_8	x_{12}	x_{13}	x_{16}

	Mode		Rate (10^8 s^{-1})	Scale factor
Γ_1	$\pi^{\pm} e^{\mp} \nu_e$ Called K^0_{e3}.	[*a*]	0.07928 ± 0.00035	1.1
Γ_2	$\pi^{\pm} \mu^{\mp} \nu_\mu$ Called $K^0_{\mu3}$.	[*a*]	0.05287 ± 0.00024	
Γ_5	$3\pi^0$		0.03814 ± 0.00029	1.4
Γ_6	$\pi^+ \pi^- \pi^0$		0.02451 ± 0.00015	
Γ_7	$\pi^+ \pi^-$	[*b*]	$(3.843 \pm 0.023) \times 10^{-4}$	1.2
Γ_8	$\pi^0 \pi^0$		$(1.690 \pm 0.013) \times 10^{-4}$	1.3
Γ_{12}	$\pi^+ \pi^- \gamma$	[*c,d*]	$(8.11 \pm 0.29) \times 10^{-6}$	2.7
Γ_{13}	$\pi^+ \pi^- \gamma$(DE)		$(5.55 \pm 0.21) \times 10^{-6}$	2.0
Γ_{16}	2γ		$(1.069 \pm 0.009) \times 10^{-4}$	1.1

K^0_L DECAY RATES

$\Gamma(\pi^+\pi^-\pi^0)$ Γ_6

VALUE (10^6 s^{-1})	EVTS	DOCUMENT ID		TECN	COMMENT
2.451±0.015 OUR FIT					
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$2.32 \; ^{+0.13}_{-0.15}$	192	BALDO-...	75	HLBC	Assumes *CP*
2.35 ±0.20	180	[14] JAMES	72	HBC	Assumes *CP*
2.71 ±0.28	99	CHO	71	DBC	Assumes *CP*
2.5 ±0.3	98	[14] JAMES	71	HBC	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*
3.26 ±0.77	18	ANDERSON	65	HBC	
1.4 ±0.4	14	FRANZINI	65	HBC	

[14] 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
7.928±0.035 OUR FIT Error includes scale factor of 1.1.					
• • • We do not use the following data for averages, fits, limits, etc. • • •					
7.81 ±0.56	620	CHAN	71	HBC	
$7.52 \; ^{+0.85}_{-0.72}$		AUBERT	65	HLBC	$\Delta S=\Delta Q$, *CP* assumed

$\Gamma(\pi^\pm e^\mp \nu_e)+\Gamma(\pi^\pm \mu^\mp \nu_\mu)$ $(\Gamma_1+\Gamma_2)$

VALUE (10^6 s^{-1})	EVTS	DOCUMENT ID		TECN	COMMENT
13.21±0.05 OUR FIT					
• • • We do not use the following data for averages, fits, limits, etc. • • •					
12.4 ±0.7	410	[15] BURGUN	72	HBC	$K^+ p \to K^0 p \pi^+$
8.47±1.69	126	[15] MANN	72	HBC	$K^- p \to n \overline{K}^0$
13.1 ±1.3	252	[15] WEBBER	71	HBC	$K^- p \to n \overline{K}^0$
11.6 ±0.9	393	[15,16] CHO	70	DBC	$K^+ n \to K^0 p$
10.3 ±0.8	335	[16] HILL	67	DBC	$K^+ n \to K^0 p$
$9.85 \; ^{+1.15}_{-1.05}$	109	[15] FRANZINI	65	HBC	

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

K^0_L BRANCHING RATIOS

Semileptonic modes

$\Gamma(\pi^\pm e^\mp \nu_e)/\Gamma_{\rm total}$ Γ_1/Γ

VALUE	EVTS	DOCUMENT ID		TECN
0.4056±0.0012 OUR FIT Error includes scale factor of 1.8.				
0.4047±0.0028 OUR AVERAGE Error includes scale factor of 3.1.				
0.4007±0.0005±0.0015	13M	[17] AMBROSINO	06	KLOE
0.4067±0.0011		[18] ALEXOPOU...	04	KTEV

[17] There are correlations between these five KLOE measurements: B($K_L \to \pi e \nu$), B($K_L \to \pi \mu \nu$), B($K_L \to 3\pi^0$), B($K_L \to \pi^+\pi^-\pi^0$), and τ_{K_L} measured in AMBROSINO 06. See the footnote for the τ_{K_L} measurement for the correlation matrix.

[18] ALEXOPOULOS 04 constrains $\sum_i$ B$_i$ = 0.9993 for the six major K_L branching fractions. The correlations among these branching fractions are taken into account in our fit. The correlation matrix is

	K_{e3}	$K_{\mu 3}$	$3\pi^0$	$\pi^+\pi^-\pi^0$	$\pi^+\pi^-$	$\pi^0\pi^0$
K_{e3}	1					
$K_{\mu 3}$	0.15	1				
$3\pi^0$	−0.77	−0.62	1			
$\pi^+\pi^-\pi^0$	0.18	0.08	−0.54	1		
$\pi^+\pi^-$	0.28	0.22	−0.48	0.49	1	
$\pi^0\pi^0$	−0.72	−0.54	0.89	−0.46	−0.39	1

$\Gamma(\pi^\pm \mu^\mp \nu_\mu)/\Gamma_{total}$ Γ_2/Γ

VALUE	EVTS	DOCUMENT ID		TECN
0.2705±0.0007 OUR FIT Error includes scale factor of 1.1.				
0.2700±0.0008 OUR AVERAGE				
0.2698±0.0005±0.0015	13M	[19] AMBROSINO	06	KLOE
0.2701±0.0009		[20] ALEXOPOU...	04	KTEV

[19] There are correlations between these five KLOE measurements: B($K_L \to \pi e \nu$), B($K_L \to \pi \mu \nu$), B($K_L \to 3\pi^0$), B($K_L \to \pi^+\pi^-\pi^0$), and τ_{K_L} measured in AMBROSINO 06. See the footnote for the τ_{K_L} measurement for the correlation matrix.

[20] For correlations with other ALEXOPOULOS 04 measurements, see the footnote with their B($K_L \to \pi e \nu$) measurement.

$\left[\Gamma(\pi^\pm e^\mp \nu_e) + \Gamma(\pi^\pm \mu^\mp \nu_\mu)\right]/\Gamma_{total}$ $(\Gamma_1+\Gamma_2)/\Gamma$

VALUE	DOCUMENT ID
0.6760±0.0012 OUR FIT Error includes scale factor of 1.6.	

$\Gamma(\pi^\pm \mu^\mp \nu_\mu)/\Gamma(\pi^\pm e^\mp \nu_e)$ Γ_2/Γ_1

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.6669±0.0028 OUR FIT Error includes scale factor of 1.3.					
0.666 ±0.004 OUR AVERAGE Error includes scale factor of 1.6.					
0.6740±0.0059	13M	[21] AMBROSINO	06	KLOE	Not in fit
0.6640±0.0014±0.0022	394K	[22] ALEXOPOU...	04	KTEV	Not in fit
• • • We do not use the following data for averages, fits, limits, etc. • • •					
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	
0.68 ±0.08	3548	BASILE	70	OSPK	
0.71 ±0.05	770	BUDAGOV	68	HLBC	

[21] AMBROSINO 06 enters the fit via their separate measurements of these two modes.

[22] ALEXOPOULOS 04 enters the fit via their separate measurements of these two modes.

$\Gamma((\pi\mu\text{atom})\nu)/\Gamma(\pi^{\pm}\mu^{\mp}\nu_{\mu})$ — Γ_3/Γ_2

VALUE (units 10^{-7})	EVTS	DOCUMENT ID		TECN
3.90±0.39	155	[23] ARONSON	86	SPEC
• • • We do not use the following data for averages, fits, limits, etc. • • •				
seen	18	COOMBES	76	WIRE

[23] 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_4/Γ

VALUE (units 10^{-5})	CL%	EVTS	DOCUMENT ID		TECN
5.20±0.11 OUR AVERAGE					
5.21±0.07±0.09		5402	BATLEY	04	NA48
5.16±0.20±0.22		729	MAKOFF	93	E731
• • • We do not use the following data for averages, fits, limits, etc. • • •					
6.2 ±2.0		16	CARROLL	80C	SPEC
< 220	90		[24] DONALDSON	74	SPEC

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

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

$\Gamma(3\pi^0)/\Gamma_{\text{total}}$ — Γ_5/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.1951±0.0012 OUR FIT Error includes scale factor of 1.6.					
0.1969±0.0026 OUR AVERAGE Error includes scale factor of 2.0.					
0.1997±0.0003±0.0019	13M	[25] AMBROSINO	06	KLOE	Not fitted
0.1945±0.0018		[25] ALEXOPOU...	04	KTEV	Not fitted

[25] We exclude these B($K_L \to 3\pi^0$) measurements from our fit because the authors have constrained K_L branching fractions to sum to one. It enters our fit via the other measurements from the experiment and their correlations, along with our constraint that the fitted branching fractions sum to one.

$\Gamma(3\pi^0)/\Gamma(\pi^{\pm}e^{\mp}\nu_e)$ — Γ_5/Γ_1

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.481 ±0.004 OUR FIT Error includes scale factor of 1.8.					
0.4782±0.0014±0.0053	209K	[26] ALEXOPOU...	04	KTEV	Not in fit
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.545 ±0.004 ±0.009	38k	KREUTZ	95	NA31	

[26] This measurement enters the fit via their separate measurements of these two modes.

$\Gamma(3\pi^0)/[\Gamma(\pi^{\pm}e^{\mp}\nu_e)+\Gamma(\pi^{\pm}\mu^{\mp}\nu_{\mu})+\Gamma(\pi^+\pi^-\pi^0)]$ — $\Gamma_5/(\Gamma_1+\Gamma_2+\Gamma_6)$

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.2434±0.0018 OUR FIT Error includes scale factor of 1.6.					
• • • We do not use the following data for averages, fits, limits, etc. • • •					
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_5/Γ_6

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
1.556±0.012 OUR FIT	Error includes scale factor of 1.2.				
1.582±0.027	13M	[27] AMBROSINO	06	KLOE	Not in fit
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1.611±0.014±0.034	28k	KREUTZ	95	NA31	
1.65 ±0.07	883	BARMIN	72B	HLBC	Error statistical only
1.80 ±0.13	1010	BUDAGOV	68	HLBC	
2.0 ±0.6	188	ALEKSANYAN	64B	FBC	

[27] AMBROSINO 06 enters the fit via their separate measurements of these two modes.

$\Gamma(\pi^+\pi^-\pi^0)/\Gamma_{total}$ Γ_6/Γ

VALUE	EVTS	DOCUMENT ID		TECN
0.1254±0.0005 OUR FIT				
0.1255±0.0006 OUR AVERAGE				
0.1263±0.0004±0.0011	13M	[28] AMBROSINO	06	KLOE
0.1252±0.0007		[29] ALEXOPOU...	04	KTEV

[28] There are correlations between these five KLOE measurements: B($K_L \rightarrow \pi e \nu$), B($K_L \rightarrow \pi \mu \nu$), B($K_L \rightarrow 3\pi^0$), B($K_L \rightarrow \pi^+\pi^-\pi^0$), and τ_{K_L} measured in AMBROSINO 06. See the footnote for the τ_{K_L} measurement for the correlation matrix.

[29] For correlations with other ALEXOPOULOS 04 measurements, see the footnote with their B($K_L \rightarrow \pi e \nu$) measurement.

$\Gamma(\pi^+\pi^-\pi^0)/\Gamma(\pi^\pm e^\mp \nu_e)$ Γ_6/Γ_1

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.3092±0.0017 OUR FIT	Error includes scale factor of 1.2.				
0.3078±0.0005±0.0017	799K	[30] ALEXOPOU...	04	KTEV	Not in fit
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.336 ±0.003 ±0.007	28k	KREUTZ	95	NA31	

[30] This measurement enters the fit via their separate measurements for the two modes.

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.1565±0.0007 OUR FIT	Error includes scale factor of 1.1.				
• • • We do not use the following data for averages, fits, limits, etc. • • •					
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	
0.144 ±0.004	1729	HOPKINS	65	HBC	See HOPKINS 67

$\Gamma(\pi^+\pi^-)/\Gamma_{total}$ Γ_7/Γ

Violates *CP* conservation.

VALUE (units 10^{-3})	*DOCUMENT ID*	*TECN*
1.966±0.010 OUR FIT Error includes scale factor of 1.6.		
1.975±0.012	[31] ALEXOPOU... 04	KTEV

[31] For correlations with other ALEXOPOULOS 04 measurements, see the footnote with their B($K_L \to \pi e \nu$) measurement.

$\Gamma(\pi^+\pi^-)/\Gamma(\pi^\pm e^\mp \nu_e)$ Γ_7/Γ_1

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*	*TECN*	*COMMENT*
4.848±0.020 OUR FIT Error includes scale factor of 1.1.				
4.840±0.020 OUR AVERAGE				
4.826±0.022±0.016	47k	[32] LAI 07	NA48	
4.856±0.017±0.023	84k	[33] ALEXOPOU... 04	KTEV	Not in fit

[32] The LAI 07 central value of 4.835×10^{-3} has been reduced by 0.19% to 4.826×10^{-3} to subtract the contribution from the direct emission mode $K_L^0 \to \pi^+\pi^-\gamma$(DE).

[33] This measurement enters the fit via their separate measurements for the two modes.

$[\Gamma(\pi^+\pi^-)+\Gamma(\pi^+\pi^-\gamma(\mathrm{DE}))]/\Gamma(\pi^\pm \mu^\mp \nu_\mu)$ $(\Gamma_7+\Gamma_{13})/\Gamma_2$

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*	*TECN*
7.37 ±0.04 OUR FIT Error includes scale factor of 1.4.			
7.275±0.042±0.054	45k	[34] AMBROSINO 06F	KLOE

[34] Fully inclusive. Taking B($K_L^0 \to \pi \mu \nu$) from KLOE, AMBROSINO 06, B($K_L^0 \to \pi^+\pi^- + \pi^+\pi^-\gamma$(DE)) = $(1.963 \pm 0.012 \pm 0.017) \times 10^{-3}$ is obtained.

$\Gamma(\pi^+\pi^-)/[\Gamma(\pi^\pm e^\mp \nu_e)+\Gamma(\pi^\pm \mu^\mp \nu_\mu)]$ $\Gamma_7/(\Gamma_1+\Gamma_2)$

Violates *CP* conservation.

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*	*TECN*	*COMMENT*
2.908±0.013 OUR FIT Error includes scale factor of 1.3.				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
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
2.51 ±0.23	309	[35] DEBOUARD 67	OSPK	η_{+-}=2.00 ± 0.09
2.35 ±0.19	525	[35] FITCH 67	OSPK	η_{+-}=1.94 ± 0.08

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

$\Gamma(\pi^\pm e^\mp \nu_e)/\Gamma(2\,\mathrm{tracks})$ $\Gamma_1/(\Gamma_1+\Gamma_2+0.03508\Gamma_5+\Gamma_6+\Gamma_7)$

Γ(2 tracks) = $\Gamma(\pi^\pm e^\mp \nu_e)$ + $\Gamma(\pi^\pm \mu^\mp \nu_\mu)$ + 0.03508 $\Gamma(3\pi^0)$ + $\Gamma(\pi^+\pi^-\pi^0)$ + $\Gamma(\pi^+\pi^-)$ where 0.03508 is the fraction of $3\pi^0$ events with one Dalitz decay ($\pi^0 \to \gamma e^+ e^-$).

VALUE	*EVTS*	*DOCUMENT ID*	*TECN*
0.5005±0.0010 OUR FIT Error includes scale factor of 1.4.			
0.4978±0.0035	6.8M	LAI 04B	NA48

$\Gamma(\pi^+\pi^-)/[\Gamma(\pi^\pm e^\mp \nu_e)+\Gamma(\pi^\pm \mu^\mp \nu_\mu)+\Gamma(\pi^+\pi^-\pi^0)]$ $\Gamma_7/(\Gamma_1+\Gamma_2+\Gamma_6)$

Violates *CP* conservation.

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
2.453±0.011 OUR FIT	Error includes scale factor of 1.3.				
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.60 ±0.07	4200	[36] MESSNER	73	ASPK	$\eta_{+-} = 2.23 \pm 0.05$

[36] 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_7/Γ_6

Violates *CP* conservation.

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
1.568±0.010 OUR FIT	Error includes scale factor of 1.3.				
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1.64 ±0.04	4200	MESSNER	73	ASPK	$\eta_{+-} = 2.23$

$\Gamma(\pi^0\pi^0)/\Gamma_{total}$ Γ_8/Γ

Violates *CP* conservation.

VALUE (units 10^{-3})	DOCUMENT ID		TECN
0.864±0.006 OUR FIT	Error includes scale factor of 1.7.		
0.865±0.012	[37] ALEXOPOU...	04	KTEV

[37] For correlations with other ALEXOPOULOS 04 measurements, see the footnote with their B($K_L \to \pi e \nu$) measurement.

$\Gamma(\pi^0\pi^0)/\Gamma(\pi^+\pi^-)$ Γ_8/Γ_7

Violates *CP* conservation.

VALUE	DOCUMENT ID		COMMENT
0.4396±0.0022 OUR FIT	Error includes scale factor of 1.7.		
0.4391±0.0013	ETAFIT	07	S = 1.1

$\Gamma(\pi^0\pi^0)/\Gamma(3\pi^0)$ Γ_8/Γ_5

Violates *CP* conservation.

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
0.443 ±0.004 OUR FIT	Error includes scale factor of 2.1.				
0.4446±0.0016±0.0019	100K	[38] ALEXOPOU...	04	KTEV	Not in fit
• • • We do not use the following data for averages, fits, limits, etc. • • •					
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

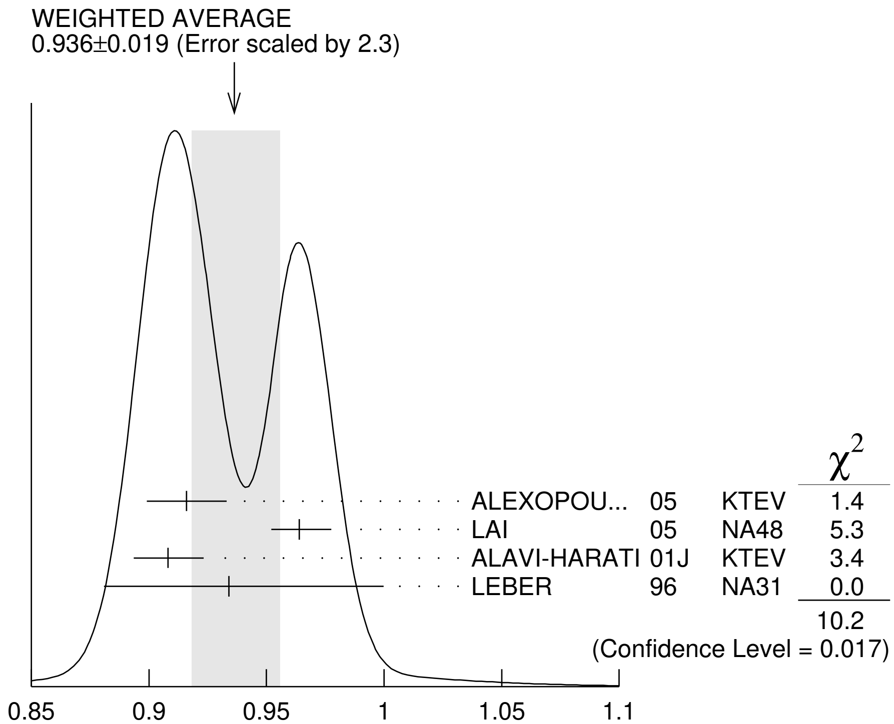
[38] This measurement enters the fit via their separate measurements for the two modes.

Semileptonic modes with photons

$\Gamma(\pi^\pm e^\mp \nu_e \gamma)/\Gamma(\pi^\pm e^\mp \nu_e)$ Γ_9/Γ_1

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
0.936±0.019 OUR AVERAGE	Error includes scale factor of 2.3. See the ideogram below.				
0.916±0.017	4309	[39] ALEXOPOU...	05	KTEV	E^*_γ >30 MeV, $\theta^*_{e\gamma}$ >20°
$0.964\pm0.008^{+0.011}_{-0.009}$	19K	LAI	05	NA48	E^*_γ >30 MeV, $\theta^*_{e\gamma}$ >20°
$0.908\pm0.008^{+0.013}_{-0.012}$	15k	ALAVI-HARATI	01J	KTEV	$E^*_\gamma \geq$ 30 MeV, $\theta^*_{e\gamma} \geq$ 20°
$0.934\pm0.036^{+0.055}_{-0.039}$	1384	LEBER	96	NA31	$E^*_\gamma \geq$ 30 MeV, $\theta^*_{e\gamma} \geq$ 20°

[39] Also measured cut E^*_γ >10 MeV, $\theta^*_{e\gamma}$ >0° 14221 evts: $\Gamma(\pi^\pm e^\mp \nu_e \gamma)$ / $\Gamma(\pi^\pm e^\mp \nu_e)$ = (4.942 ± 0.062)%.



$\Gamma(\pi^\pm e^\mp \nu_e \gamma)/\Gamma(\pi^\pm e^\mp \nu_e)$ Γ_9/Γ_1

$\Gamma(\pi^\pm \mu^\mp \nu_\mu \gamma)/\Gamma(\pi^\pm \mu^\mp \nu_\mu)$ Γ_{10}/Γ_2

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
2.09±0.08 OUR AVERAGE					
2.09±0.09		[40] ALEXOPOU...	05	KTEV	E^*_γ > 30 MeV
$2.08\pm0.17^{+0.16}_{-0.21}$	252	BENDER	98	NA48	$E^*_\gamma \geq$ 30 MeV

[40] Also measured cut E^*_γ >10 MeV, 1385 evts: $\Gamma(\pi^\pm \mu^\mp \nu_\mu \gamma)$ / $\Gamma(\pi^\pm \mu^\mp \nu_\mu)$ = (0.530 ± 0.014 ± 0.012)%.

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

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

$\Gamma(\pi^+\pi^-\gamma)/\Gamma(\pi^+\pi^-\pi^0)$ — Γ_{12}/Γ_6

For earlier limits see our 1992 edition Physical Review **D45** S1 (1992).

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1.23 ± 0.13	516	[41,42] CARROLL	80B	SPEC	$E^*_\gamma > 20$ MeV
2.33 ± 0.23	546	[41,43] CARROLL	80B	SPEC	
3.56 ± 0.26	1062	[41,44] CARROLL	80B	SPEC	$E^*_\gamma > 20$ MeV

[41] CARROLL 80B quotes B($\pi^+\pi^-\gamma$) using normalization B($\pi^+\pi^-\pi^0$) = 0.1239. We divide by this value to obtain their measured $\Gamma(\pi^+\pi^-\gamma)$ / $\Gamma(\pi^+\pi^-\pi^0)$.
[42] Internal Bremsstrahlung component only.
[43] Direct γ emission component only.
[44] Both IB and DE components.

$\Gamma(\pi^+\pi^-\gamma)/\Gamma(\pi^+\pi^-)$ — Γ_{12}/Γ_7

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
2.11±0.08 OUR FIT Error includes scale factor of 2.9.					
2.11±0.08 OUR AVERAGE Error includes scale factor of 2.9.					
$2.08\pm0.02\pm0.02$	8669	[45] ALAVI-HARATI	01B	KTEV	$E^*_\gamma > 20$ MeV
2.30 ± 0.07	3136	RAMBERG	93	E731	$E^*_\gamma > 20$ MeV

[45] ALAVI-HARATI 01B includes both Direct Emission (DE) and Inner Bremsstrahlung (IB) processes.

$\Gamma(\pi^+\pi^-\gamma(\mathrm{DE}))/\Gamma(\pi^+\pi^-\gamma)$ — Γ_{13}/Γ_{12}

These values assume that $\Gamma(K^0_L \to \pi^+\pi^-\gamma) = \Gamma(K^0_L \to \pi^+\pi^-\gamma(\mathrm{DE})) + \Gamma(K^0_L \to \pi^+\pi^-\gamma(\mathrm{IB}))$, the sum of widths for the direct emission (DE) and inner bremsstrahlung (IE) processes, with no IB-DE interference. DE assumes a form factor as described in RAMBERG 93.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.684±0.009 OUR FIT					
0.684±0.009 OUR AVERAGE					
0.689 ± 0.021	111k	ABOUZAID	06A	KTEV	$E^*_\gamma > 20$ MeV
0.683 ± 0.011	8669	ALAVI-HARATI	01B	KTEV	$E^*_\gamma > 20$ MeV
0.685 ± 0.041	3136	RAMBERG	93	E731	$E^*_\gamma > 20$ MeV

$\Gamma(\pi^0 2\gamma)/\Gamma_{\mathrm{total}}$ — Γ_{14}/Γ

VALUE (units 10^{-6})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
1.32±0.14 OUR AVERAGE Error includes scale factor of 3.6.						
$1.27\pm0.04\pm0.01$		2.5k	[46] LAI	02B	NA48	
$1.68\pm0.07\pm0.08$		884	[47] ALAVI-HARATI	99B	KTEV	
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$1.7\pm0.2\pm0.2$		63	[48] BARR	92	NA31	
$1.86\pm0.60\pm0.60$		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	[49] BARR	90C	NA31	$m_{\gamma\gamma} > 280$ MeV

[46] LAI 02B reports [B($K^0_L \to \pi^0 2\gamma$) / B($K^0_L \to \pi^0\pi^0$)] = $(1.467 \pm 0.032 \pm 0.032) \times 10^{-3}$. We multiply by our best value B($K^0_L \to \pi^0\pi^0$) = $(8.64 \pm 0.06) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. They also find that B($\pi^0 2\gamma$, $m_{\gamma\gamma}$ <110 MeV) < 0.6×10^{-8}(90% CL).

[47] ALAVI-HARATI 99B finds that $\Gamma(\pi^0 2\gamma$, $m_{\gamma\gamma}$ <240 MeV)) / $\Gamma(\pi^0 2\gamma)$ = (17.3 ± 1.3 ± 1.5)%.

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

[49] BARR 90C superseded by BARR 92.

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

VALUE (units 10^{-8})	CL%	EVTS	DOCUMENT ID		TECN
2.34±0.35±0.13		44	ALAVI-HARATI	01E	KTEV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<71	90	0	MURAKAMI	99	SPEC

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

$\Gamma(2\gamma)/\Gamma_{total}$ — Γ_{16}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
5.47±0.04 OUR FIT	Error includes scale factor of 1.1.				
• • • We do not use the following data for averages, fits, limits, etc. • • •					
4.54±0.84		[50] BANNER	72B	OSPK	
4.5 ±1.0	23	ENSTROM	71	OSPK	K^0_L 1.5–9 GeV/c
5.0 ±1.0		[51] REPELLIN	71	OSPK	
5.5 ±1.1	90	KUNZ	68	OSPK	Norm.to 3 π(C+N)

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

[51] 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_{16}/Γ_5

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
2.802±0.017 OUR FIT					
2.802±0.018 OUR AVERAGE					
2.79 ±0.02 ±0.02	27k	ADINOLFI	03	KLOE	
2.81 ±0.01 ±0.02		LAI	03	NA48	
• • • 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_{16}/Γ_8

VALUE	EVTS	DOCUMENT ID		TECN
0.632±0.006 OUR FIT	Error includes scale factor of 1.4.			
0.632±0.004±0.008	110k	BURKHARDT	87	NA31

$\Gamma(3\gamma)/\Gamma_{total}$ — Γ_{17}/Γ

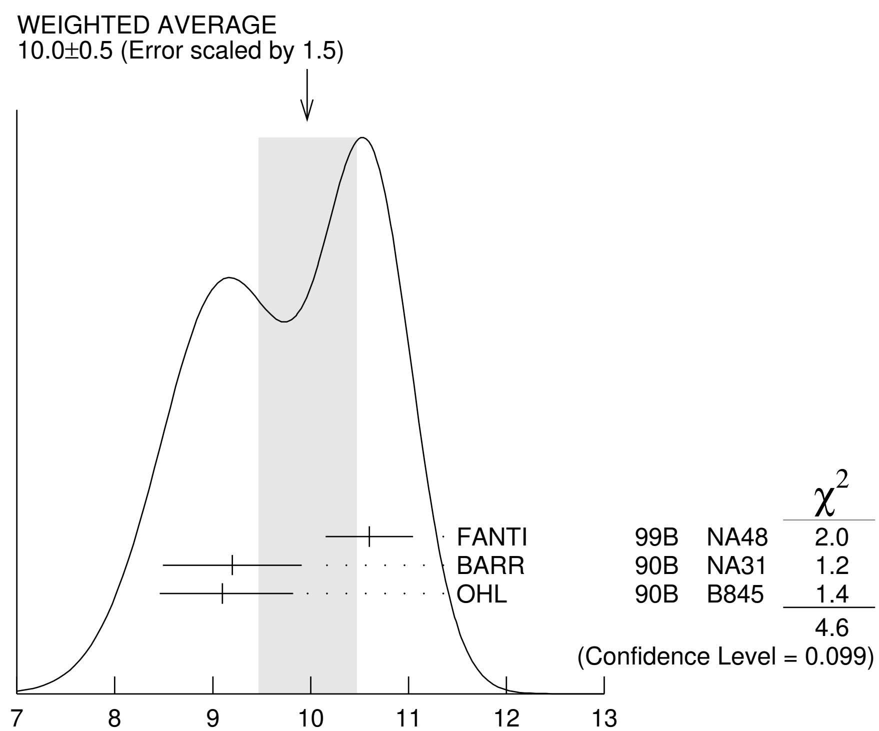
VALUE	CL%	DOCUMENT ID		TECN
$<2.4 \times 10^{-7}$	90	[52] BARR	95C	NA31

[52] Assumes a phase-space decay distribution.

$\Gamma(e^+e^-\gamma)/\Gamma_{total}$ — Γ_{18}/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	[53] 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

[53] 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.



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

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

VALUE (units 10^{-7})	EVTS	DOCUMENT ID		TECN
3.59±0.11 OUR AVERAGE Error includes scale factor of 1.3.				
3.62±0.04±0.08	9100	ALAVI-HARATI	01G	KTEV
3.4 ±0.6 ±0.4	45	FANTI	97	NA48
3.23±0.23±0.19	197	SPENCER	95	E799

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

VALUE (units 10^{-7})	EVTS	DOCUMENT ID		TECN	COMMENT
5.95±0.33 OUR AVERAGE					
5.84±0.15±0.32	1543	ALAVI-HARATI	01F	KTEV	$E^*_\gamma > 5$ MeV
8.0 ±1.5 $^{+1.4}_{-1.2}$	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

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

VALUE (units 10^{-9})	EVTS	DOCUMENT ID		TECN	COMMENT
$10.4^{+7.5}_{-5.9}$±0.7	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_{22}/Γ_7

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	[54] 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	[55] AKAGI	91B	SPEC	In AKAGI 95
3.45 ±0.18 ±0.13	368	[56] 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

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

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

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

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

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

VALUE (units 10^{-10})	CL%	EVTS	DOCUMENT ID		TECN
$0.087^{+0.057}_{-0.041}$		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	[57] ARISAKA	93B	B791

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

$\Gamma(\pi^+\pi^- e^+ e^-)/\Gamma_{\text{total}}$ — Γ_{24}/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
3.11±0.19 OUR AVERAGE						
3.08±0.09±0.18		1125	[58] LAI	03C	NA48	
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

[58] LAI 03C second error is 0.15(syst)±0.10(norm) combined in quadrature. The normalization uses BR($K_L \rightarrow \pi^+\pi^-\pi^0$) * BR($\pi^0 \rightarrow e^+e^-$) = (1.505 ± 0.047) × 10^{-3} from our 2000 Edition.

$\Gamma(\pi^0\pi^0 e^+ e^-)/\Gamma_{\text{total}}$ — Γ_{25}/Γ

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

VALUE (units 10^{-9})	CL%	EVTS	DOCUMENT ID		TECN
<6.6	90	1	ALAVI-HARATI	02C	E799

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

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

VALUE (units 10^{-9})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
2.69±0.27 OUR AVERAGE						
2.69±0.24±0.12		131	[59] ALAVI-HARATI	03B	KTEV	
$2.9\ ^{+6.7}_{-2.4}$		1	GU	96	E799	
• • • We do not use the following data for averages, fits, limits, etc. • • •						
2.62±0.40±0.17		43	ALAVI-HARATI	01H	KTEV	Sup. by ALAVI-HARATI 03B
<4900	90		BALATS	83	SPEC	

[59] ALAVI-HARATI 03B also measures the linear slope $\alpha = -1.59 \pm 0.37$.

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

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

VALUE (units 10^{-8})	EVTS	DOCUMENT ID		TECN	COMMENT
3.56±0.21 OUR AVERAGE					
3.30±0.24±0.25	200	[60] LAI	05B	NA48	
3.72±0.18±0.23	441	ALAVI-HARATI	01D	KTEV	
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. • • •					
6 ±2 ±1	18	[61] AKAGI	95	SPEC	m_{ee} >470 MeV
7 ±3 ±2	6	[61] AKAGI	95	SPEC	m_{ee} >470 MeV
10.4 ±3.7 ±1.1	8	[62] BARR	95	NA31	
6 ±2 ±1	18	AKAGI	93	CNTR	Sup. by AKAGI 95
4 ±3	2	BARR	91	NA31	Sup. by BARR 95

[60] LAI 05B uses 1998 and 1999 data. Data are normalized to the observed events of $K^0_L \rightarrow \pi^+\pi^-\pi^0$ (π^0 into Dalitz pair) and PDG 04 values are used for B($K^0_L \rightarrow \pi^+\pi^-\pi^0$) and B($\pi^0 \rightarrow e^+e^-\gamma$). The systematic error includes a normalization error of ±0.10.

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

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

$\Gamma(\pi^0\mu^+\mu^-)/\Gamma_{\text{total}}$ — Γ_{28}/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

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

Violates *CP* in leading order. Direct and indirect *CP*-violating contributions are expected to be comparable and to dominate the *CP*-conserving part. LAI 02B result suggests that *CP*-violation effects dominate. Test for $\Delta S = 1$ weak neutral current. Allowed by higher-order electroweak interaction.

VALUE (units 10^{-10})	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
< 2.8	90		[63] ALAVI-HARATI	04A	KTEV	combined result
• • • We do not use the following data for averages, fits, limits, etc. • • •						
< 3.5	90		ALAVI-HARATI	04A	KTEV	
$0.0047^{+0.0022}_{-0.0018}$			[64] LAI	02B	NA48	*CP*-conserving part
< 5.1	90	2	ALAVI-HARATI	01	KTEV	
0.01 to 0.02			ALAVI-HARATI	99B	KTEV	*CP*-conserving part
< 43	90	0	HARRIS	93B	E799	
< 75	90	0	BARKER	90	E731	
< 55	90	0	OHL	90	B845	
< 400	90		BARR	88	NA31	
<3200	90		JASTRZEM...	88	SPEC	

[63] Combined result of ALAVI-HARATI 04A 1999-2000 data set and ALAVI-HARATI 01 1997 data set.

[64] LAI 02B uses the absence of a signal in $K^0_L \rightarrow \pi^0\gamma\gamma$ with $m(\gamma\gamma) < m(\pi^0)$ and their a_V value to predict this value.

$\Gamma(\pi^0\nu\overline{\nu})/\Gamma_{\text{total}}$ — Γ_{30}/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^{-7})	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*
< 2.1	90	0	[65] AHN	06	K391
• • • We do not use the following data for averages, fits, limits, etc. • • •					
< 5.9	90	0	ALAVI-HARATI	00	KTEV
< 16	90	0	ADAMS	99	KTEV
< 580	90	0	WEAVER	94	E799
<2200	90	0	GRAHAM	92	CNTR

[65] Value obtained analyzing 10% of data of RUN 1 (performed in 2004).

$\Gamma(e^\pm\mu^\mp)/\Gamma_{\text{total}}$ — Γ_{31}/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	[66] ARISAKA	93	B791

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

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

Test of lepton family number conservation.

VALUE (units 10^{-11})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
< 4.12	90	0	ALAVI-HARATI	03B	KTEV	

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

< 12.3	90	0	[67] ALAVI-HARATI	01H	KTEV	Sup. by ALAVI-HARATI 03B
<610	90	0	[67] GU	96	E799	

[67] Assuming uniform phase space distribution.

$\Gamma(\pi^0 \mu^\pm e^\mp)/\Gamma_{\text{total}}$ Γ_{33}/Γ

Test of lepton family number conservation.

VALUE	CL%	DOCUMENT ID		TECN
$<6.2 \times 10^{-9}$	90	ARISAKA	98	E799

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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 $v = (s_2 - s_1) / m_\pi^2$

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. • • •

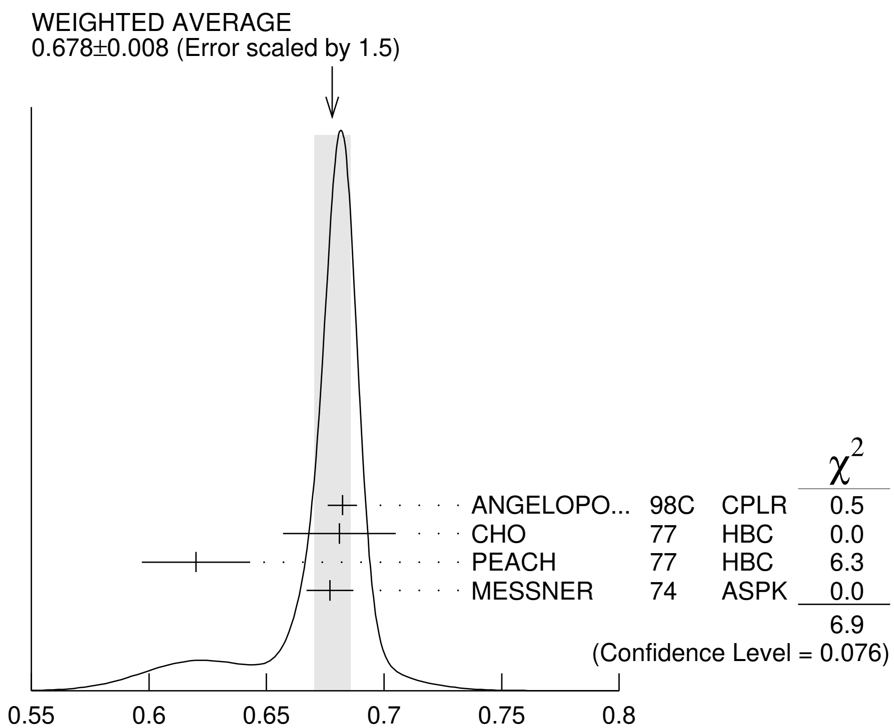
0.69 ±0.07	192	[68] BALDO-...	75	HLBC	
0.590 ±0.022	56k	[68] BUCHANAN	75	SPEC	$a_u = -0.277 \pm 0.010$
0.619 ±0.027	20k	[68,69] BISI	74	ASPK	$a_t = -0.282 \pm 0.011$
0.612 ±0.032		[68] ALEXANDER	73B	HBC	
0.73 ±0.04	3200	[68] BRANDENB...	73	HBC	
0.608 ±0.043	1486	[68] KRENZ	72	HLBC	$a_t = -0.277 \pm 0.018$

0.650 ±0.012	29k	[68] ALBROW	70	ASPK	$a_y = -0.858 \pm 0.015$
0.593 ±0.022	36k	[68,70] BUCHANAN	70	SPEC	$a_u = -0.278 \pm 0.010$
0.664 ±0.056	4400	[68] SMITH	70	OSPK	$a_t = -0.306 \pm 0.024$
0.400 ±0.045	2446	[68] BASILE	68B	OSPK	$a_t = -0.188 \pm 0.020$
0.649 ±0.044	1350	[68] HOPKINS	67	HBC	$a_t = -0.294 \pm 0.018$
0.428 ±0.055	1198	[68] NEFKENS	67	OSPK	$a_u = -0.204 \pm 0.025$

[68] 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.

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

[70] 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	[71] ALBROW	70	ASPK
0.043±0.052	4400	[71] SMITH	70	OSPK

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

[71] 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 $K_L^0 \rightarrow \pi^+\pi^-\pi^0$

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 $K_L^0 \rightarrow \pi^+\pi^-\pi^0$ (CP-VIOLATING TERM)

Listed in CP-violation section below.

QUADRATIC COEFFICIENT f FOR $K_L^0 \rightarrow \pi^+\pi^-\pi^0$ (CP-VIOLATING TERM)

Listed in CP-violation section below.

QUADRATIC COEFFICIENT h FOR $K_L^0 \rightarrow \pi^0\pi^0\pi^0$

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN
−5.0±1.4 OUR AVERAGE Error includes scale factor of 1.7.				
−6.1±0.9±0.5	14.7M	LAI	01B	NA48
−3.3±1.1±0.7	5M	[72] SOMALWAR	92	E731

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

K_L^0 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.

$f_0 = f_+ + f_-\ t/(m^2_{K^0} - m^2_{\pi^+})$.

t = momentum transfer to the π.

λ_+ and λ_0 are the linear expansion coefficients of f_+ and f_0:

$f_+(t) = f_+(0)\ (1 + \lambda_+ t\ /m^2_{\pi^+})$

For quadratic expansion

$f_+(t) = f_+(0)\ (1 + \lambda'_+ t\ /m^2_{\pi^+} + \frac{\lambda''_+}{2}\ t^2/m^4_{\pi^+}\ )$

as used by KTeV. If there is a non-vanishing quadratic term, then λ_+ represents an average slope, which is then different from λ'_+.

NA48 and ISTRA quadratic expansion coefficients are converted with

$\lambda'_+{}^{PDG} = \lambda_+{}^{NA48}$ and $\lambda''_+{}^{PDG} = 2\ \lambda'_+{}^{NA48}$

$\lambda'_+{}^{PDG} = (\frac{m_{\pi^\pm}}{m_{\pi^0}})^2\ \lambda_+{}^{ISTRA}$ and

$\lambda''_+{}^{PDG} = 2\,(\frac{m_{\pi^+}}{m_{\pi^0}})^4\ \lambda'_+{}^{ISTRA}$

ISTRA linear expansion coefficients are converted with
$\lambda_+{}^{PDG} = (\frac{m_{\pi^+}}{m_{\pi^0}})^2\ \lambda_+{}^{ISTRA}$ and $\lambda_0{}^{PDG} = (\frac{m_{\pi^+}}{m_{\pi^0}})^2\ \lambda_0{}^{ISTRA}$

The pole parametrization is

$$f_+(t) = f_+(0)\ (\frac{M_V^2}{M_V^2 - t})$$

$$f_0(t) = f_0(0)\ (\frac{M_S^2}{M_S^2 - t})$$

where M_V and M_S are the vector and scalar pole masses.

The following abbreviations are used:

DP = Dalitz plot analysis.

PI = π spectrum analysis.

MU = μ spectrum analysis.

POL= μ polarization analysis.

BR = $K^0_{\mu 3}/K^0_{e3}$ 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, BECHERRAWY 70, CIRIGLIANO 02, CIRIGLIANO 04, and ANDRE 04. Results labeled OUR FIT are discussed in the review "$K^{\pm}_{\ell 3}$ and $K^0_{\ell 3}$ Form Factors" in the $K^{\pm}$ Listings. For earlier, lower statistics results, see the 2004 edition of this review, Physics Letters **B592** 1 (2004).

VALUE (units 10^{-2})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
2.84 ±0.04 OUR FIT	Assuming μ-e universality				
2.85 ±0.04 OUR AVERAGE					
2.86 ±0.05 ±0.04	2M	AMBROSINO	06D	KLOE	
2.832±0.037±0.043	1.9M	ALEXOPOU...	04A	KTEV	PI, no $\mu = e$
2.88 ±0.04 ±0.11	5.6M	[73] LAI	04C	NA48	DP
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.84 ±0.07 ±0.13	5.6M	[74] LAI	04C	NA48	DP
2.45 ±0.12 ±0.22	366k	APOSTOLA...	00	CPLR	DP
3.06 ±0.34	74k	BIRULEV	81	SPEC	DP
3.12 ±0.25	500k	GJESDAL	76	SPEC	DP
2.70 ±0.28	25k	BLUMENTHAL	75	SPEC	DP

[73] Results from linear fit and assuming only vector and axial couplings.
[74] Results from linear fit with $|f_S/f_+|$ and $|f_T/f_+|$ free.

λ_+ (LINEAR ENERGY DEPENDENCE OF f_+ IN $K^0_{\mu 3}$ DECAY)

Results labeled OUR FIT are discussed in the review "$K^{\pm}_{\ell 3}$ and $K^0_{\ell 3}$ Form Factors" in the $K^{\pm}$ Listings. For earlier, lower statistics results, see the 2004 edition of this review, Physics Letters **B592** 1 (2004).

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
2.84 ±0.04 OUR FIT	Assuming μ-e universality				
2.78 ±0.10 OUR FIT	Not assuming μ-e universality				
2.745±0.088±0.063	1.5M	ALEXOPOU...	04A	KTEV	DP, no $\mu = e$
2.813±0.051	3.4M	ALEXOPOU...	04A	KTEV	PI, DP, $\mu = e$
3.0 ±0.3	1.6M	DONALDSON	74B	SPEC	DP
• • • We do not use the following data for averages, fits, limits, etc. • • •					
4.27 ±0.44	150k	BIRULEV	81	SPEC	DP

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 $d\xi(0)/d\lambda_+$. Results labeled OUR FIT are discussed in the review "$K^{\pm}_{\ell 3}$ and $K^0_{\ell 3}$ Form Factors" in the $K^{\pm}$ Listings. For earlier, lower statistics results, see the 2004 edition of this review, Physics Letters **B592** 1 (2004).

VALUE (units 10^{-2})	$d\lambda_0/d\lambda_+$	EVTS	DOCUMENT ID		TECN	COMMENT
1.64 ±0.11 OUR FIT	Correlation is $d\lambda_0/d\lambda_+ = -0.82$. Assumes μ-e universality.					
1.67 ±0.12 OUR FIT	Correlation is $d\lambda_0/d\lambda_+ = -0.44$.					
1.657±0.125	−0.44	1.5M	[75] ALEXOPOU...	04A	KTEV	DP, no $\mu = e$
1.635±0.121	−0.85	3.4M	[76] ALEXOPOU...	04A	KTEV	PI, DP, $\mu = e$
+1.9 ±0.4	−0.47	1.6M	[77] DONALDSON	74B	SPEC	DP
• • • We do not use the following data for averages, fits, limits, etc. • • •						
3.41 ±0.67	unknown	150k	[78] BIRULEV	81	SPEC	DP

[75] ALEXOPOULOS 04A gives a correlation −0.38 between their λ_0 and λ_+ measurements. From it we calculate $d\lambda_0/d\lambda_+$.

[76] ALEXOPOULOS 04A gives a correlation −0.36 between their λ_0 and λ_+ measurements. From it we calculate $d\lambda_0/d\lambda_+$.

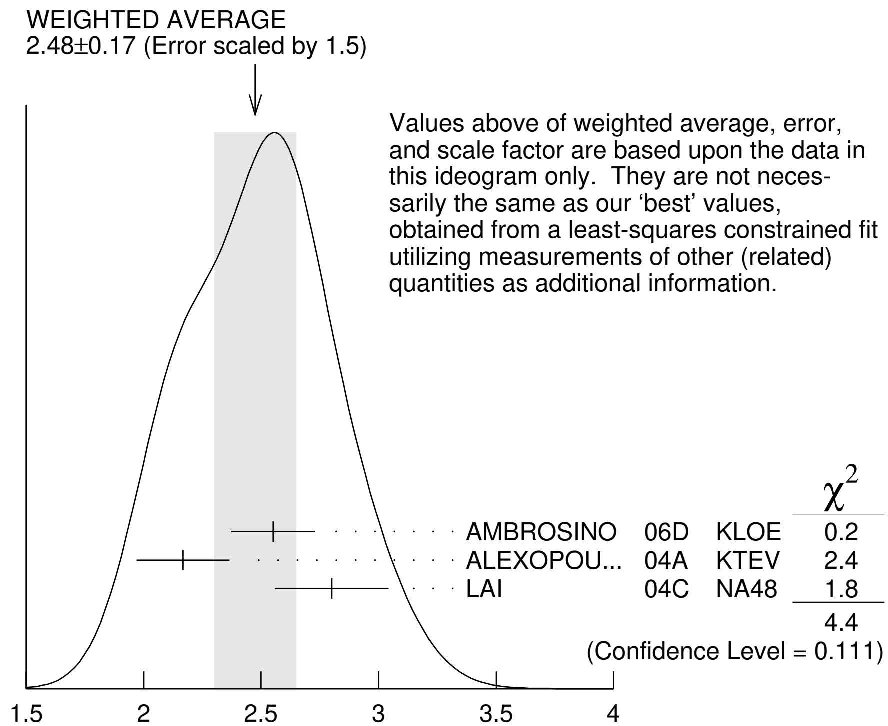
[77] DONALDSON 74B $d\lambda_0/d\lambda_+$ obtained from figure 18.

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

λ'_+(LINEAR K^0_{e3} FORM FACTOR FROM QUADRATIC FIT)

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
2.49 ±0.13 OUR FIT	Error includes scale factor of 1.1. Not assuming μ-e universality				
2.42 ±0.14 OUR FIT	Error includes scale factor of 1.3. Assuming μ-e universality				
2.48 ±0.17 OUR AVERAGE	Error includes scale factor of 1.5. See the ideogram below.				
2.55 ±0.15 ±0.10	2M	[79] AMBROSINO	06D	KLOE	
2.167±0.137±0.143	1.9M	[80] ALEXOPOU...	04A	KTEV	PI, no $\mu = e$
2.80 ±0.19 ±0.15	5.6M	[81] LAI	04C	NA48	DP

[79] AMBROSINO 06D gives a correlation -0.95 between their λ'_+ and λ''_+.
[80] ALEXOPOULOS 04A gives a correlation -0.97 between their λ'_+ and λ''_+.
[81] For LAI 04C we calculate a correlation -0.88 between their λ'_+ and λ''_+.

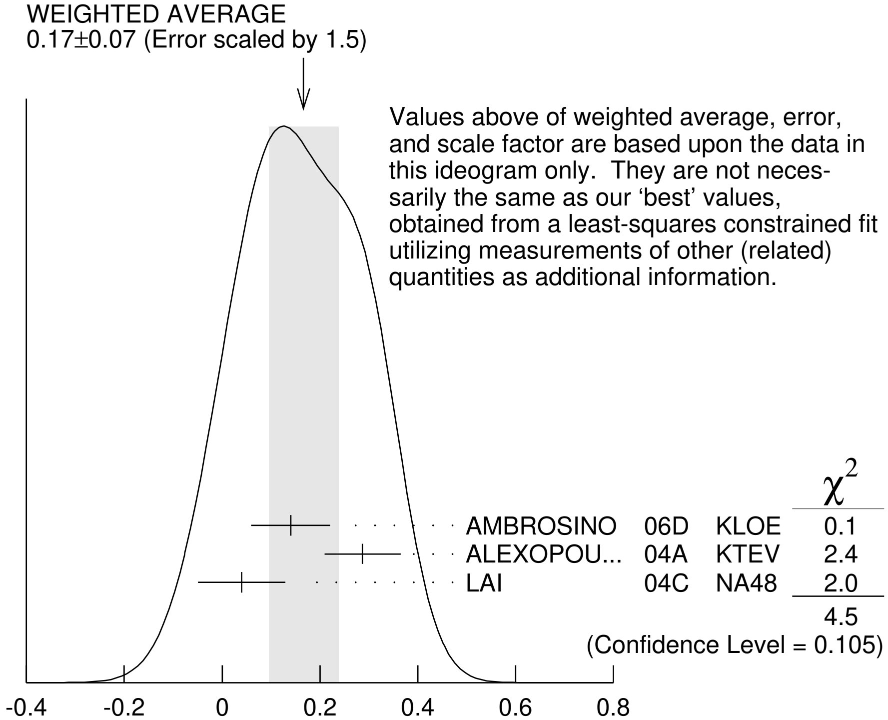


λ'_+(LINEAR K^0_{e3} FORM FACTOR FROM QUADRATIC FIT)

λ''_+(QUADRATIC K^0_{e3} FORM FACTOR)

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
0.18 ±0.05 OUR FIT Error includes scale factor of 1.1. Assuming μ-e universality					
0.16 ±0.05 OUR FIT Error includes scale factor of 1.1. Not assuming μ-e universality					
0.17 ±0.07 OUR AVERAGE Error includes scale factor of 1.5. See the ideogram below.					
0.14 ±0.07 ±0.04	2M	[82] AMBROSINO	06D	KLOE	
0.287±0.057±0.053	1.9M	[83] ALEXOPOU...	04A	KTEV	PI, no $\mu = e$
0.04 ±0.08 ±0.04	5.6M	[84,85] LAI	04C	NA48	DP

[82] AMBROSINO 06D gives a correlation -0.95 between their λ'_+ and λ''_+.
[83] ALEXOPOULOS 04A gives a correlation -0.97 between their λ'_+ and λ''_+.
[84] Values doubled to agree with PDG conventions described above.
[85] LAI 04C gives a correlation -0.88 between their λ'_+ and λ''_+.



λ''_+(QUADRATIC K^0_{e3} FORM FACTOR)

λ'_+(LINEAR $K^0_{\mu3}$ FORM FACTOR FROM QUADRATIC FIT)

VALUE (units 10^{-2})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
2.42 ±0.14 OUR FIT	Error includes scale factor of 1.3. Assuming μ-e universality				
1.7 ±0.4 OUR FIT	Not assuming μ-e universality				
1.703±0.319±0.177	1.5M	[86] ALEXOPOU...	04A	KTEV	DP, no $\mu = e$
2.064±0.175	3.4M	[86] ALEXOPOU...	04A	KTEV	PI, DP, $\mu = e$

[86] See section λ_0 below for correlations.

λ''_+(QUADRATIC $K^0_{\mu3}$ FORM FACTOR)

VALUE (units 10^{-2})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.18 ±0.05 OUR FIT	Error includes scale factor of 1.1. Assuming μ-e universality				
0.44 ±0.15 OUR FIT	Not assuming μ-e universality				
0.443±0.131±0.072	1.5M	[87] ALEXOPOU...	04A	KTEV	DP, no $\mu = e$
0.320±0.069	3.4M	[87] ALEXOPOU...	04A	KTEV	PI, DP, $\mu = e$

[87] See section λ_0 below for correlations.

λ_0(LINEAR f_0 $K^0_{\mu3}$ FORM FACTOR FROM QUADRATIC FIT)

VALUE (units 10^{-2})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1.46 ±0.13 OUR FIT	Assuming μ-e universality				
1.28 ±0.18 OUR FIT	Not assuming μ-e universality				
1.281±0.136±0.122	1.5M	[88] ALEXOPOU...	04A	KTEV	DP, no $\mu = e$
1.372±0.131	3.4M	[89] ALEXOPOU...	04A	KTEV	PI, DP, $\mu = e$

[88] ALEXOPOULOS 04A, not assuming μ-e universality, gives a correlation matrix

	λ'_+	λ''_+	λ_0
λ'_+	1		
λ''_+	-0.96	1	
λ_0	0.65	-0.75	1

[89] ALEXOPOULOS 04A, assuming μ-e universality, gives a correlation matrix

	λ'_+	λ''_+	λ_0
λ'_+	1		
λ''_+	-0.97	1	
λ_0	0.34	-0.44	1

M_V^e (POLE MASS FOR K^0_{e3} DECAY)

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
877 ± 5 OUR FIT Error includes scale factor of 1.1. Assuming μ-e universality					
875 ± 5 OUR AVERAGE					
870 ± 6 ±7	2M	AMBROSINO	06D	KLOE	
881.03± 5.12±4.94	1.9M	ALEXOPOU...	04A	KTEV	PI, no $\mu = e$
859 ±18	5.6M	LAI	04C	NA48	

M_V^μ (POLE MASS FOR $K^0_{\mu 3}$ DECAY)

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
877 ± 5 OUR FIT Error includes scale factor of 1.1. Assuming μ-e universality					
889 ±16 OUR FIT Not assuming μ-e universality					
889.19±12.81±9.92	1.5M	[90] ALEXOPOU...	04A	KTEV	DP, no $\mu = e$
882.32± 6.54	3.4M	[90] ALEXOPOU...	04A	KTEV	PI, DP, $\mu = e$

[90] See section M_S^μ below for correlations.

M_S^μ (POLE MASS FOR $K^0_{\mu 3}$ DECAY)

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
1167 ±40 OUR FIT Not assuming μ-e universality					
1187 ±50 OUR FIT Error includes scale factor of 1.4. Assuming μ-e universality					
1167.14±28.30±31.04	1.5M	[91] ALEXOPOU...	04A	KTEV	PI, no $\mu = e$
1173.80±39.47	3.4M	[92] ALEXOPOU...	04A	KTEV	PI, DP, $\mu = e$

[91] ALEXOPOULOS 04A gives a correlation -0.46 between their M_S^μ and M_V^μ and measurements, not assuming μ-e universality.

[92] ALEXOPOULOS 04A gives a correlation -0.40 between their M_S^μ and M_V^μ and measurements, assuming μ-e universality.

$a_1(t_0, Q^2)$ FORM FACTOR PARAMETER

See HILL 06 for a definition of this parameter.

VALUE	EVTS	DOCUMENT ID		TECN
1.023±0.028±0.029	2M	[93] ABOUZAID	06C	KTEV

[93] $Q^2 = 2$ GeV^2, $t_0 = 0.49\ (m_K - m_\pi)^2$. Correlation between a_1 and a_2: $\rho_{12} = -0.064$.

$a_2(t_0, Q^2)$ FORM FACTOR PARAMETER

See HILL 06 for a definition of this parameter.

VALUE	EVTS	DOCUMENT ID		TECN
0.75±1.58±1.47	2M	[94] ABOUZAID	06C	KTEV

[94] Q^2= 2 GeV^2, $t_0 = 0.49\ (m_K - m_\pi)^2$. Correlation between a_1 and a_2: $\rho_{12} = -0.064$.

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

Ratio of scalar to f_+ couplings.

VALUE (units 10^{-2})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{1.5^{+0.7}_{-1.0}\pm1.2}$		5.6M	[95] LAI	04C	NA48	
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<9.5	95	18k	HILL	78	STRC	
<7.	68	48k	BIRULEV	76	SPEC	See also BIRULEV 81
<4.	68	25k	BLUMENTHAL	75	SPEC	

[95] Results from linear fit with $\left|f_S/f_+\right|$ and $\left|f_T/f_+\right|$ free.

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

Ratio of tensor to f_+ couplings.

VALUE (units 10^{-2})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{5^{+3}_{-4}\pm3}$		5.6M	[96] LAI	04C	NA48	
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<40.	95	18k	HILL	78	STRC	
<34.	68	48k	BIRULEV	76	SPEC	See also BIRULEV 81
<23.	68	25k	BLUMENTHAL	75	SPEC	

[96] Results from linear fit with $\left|f_S/f_+\right|$ and $\left|f_T/f_+\right|$ free.

$\left|f_T/f_+\right|$ FOR $K^0_{\mu3}$ DECAY

Ratio of tensor to f_+ couplings.

VALUE (units 10^{-2})	DOCUMENT ID		TECN
12.±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

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

α_{K^*} is the constant in the model of BERGSTROM 83 described in the previous section.

VALUE	EVTS	DOCUMENT ID		TECN
-0.158 ± 0.027 OUR AVERAGE				
$-0.160^{+0.026}_{-0.028}$	9100	ALAVI-HARATI	01G	KTEV
$-0.04\ ^{+0.24}_{-0.21}$		FANTI	97	NA48

$\alpha^{\mathrm{eff}}_{K^*}$ DECAY FORM FACTOR FOR $K_L \to e^+ e^- e^+ e^-$

$\alpha^{\mathrm{eff}}_{K^*}$ is the parameter describing the relative strength of an intermediate pseudoscalar decay amplitude and a vector meson decay amplitude in the model of BERGSTROM 83. It takes into account both the radiative effects and the form factor. Since there are two $e^+ e^-$ pairs here compared with one in $e^+ e^- \gamma$ decays, a factorized expression is used for the $e^+ e^- e^+ e^-$ decay form factor.

VALUE	EVTS	DOCUMENT ID		TECN
$-0.14 \pm 0.16 \pm 0.15$	441	ALAVI-HARATI	01D	KTEV

a_1/a_2 FORM FACTOR FOR M1 DIRECT EMISSION AMPLITUDE

Form factor $= \tilde{g}_{M1} \left[1 + \frac{a_1/a_2}{(M^2_\rho - M^2_K) + 2 M_K E^*_\gamma}\right]$ as described in ALAVI-HARATI 00B.

VALUE (GeV^2)	EVTS	DOCUMENT ID		TECN	COMMENT
-0.737 ± 0.014 OUR AVERAGE					
$-0.744 \pm 0.027 \pm 0.032$	5241	[97] ABOUZAID	06	KTEV	$\pi^+ \pi^- e^+ e^-$
$-0.738 \pm 0.007 \pm 0.018$	111k	[98] ABOUZAID	06A	KTEV	$\pi^+ \pi^+ \gamma$
$-0.81\ ^{+0.07}_{-0.13} \pm 0.02$		[99] LAI	03C	NA48	$\pi^+ \pi^- e^+ e^-$
$-0.737 \pm 0.026 \pm 0.022$		[100] ALAVI-HARATI	01B		$\pi^+ \pi^- \gamma$
$-0.720 \pm 0.028 \pm 0.009$	1766	[101] ALAVI-HARATI	00B	KTEV	$\pi^+ \pi^- e^+ e^-$

[97] ABOUZAID 06 also measured $|\tilde{g}_{M1}| = 1.11 \pm 0.14$.
[98] ABOUZAID 06A also measured $|\tilde{g}_{M1}| = 1.198 \pm 0.035 \pm 0.086$.
[99] LAI 03C also measured $\tilde{g}_{M1} = 0.99^{+0.28}_{-0.27} \pm 0.07$.
[100] ALAVI-HARATI 01B fit gives χ^2/DOF = 38.8/27. Linear and quadratic fits give χ^2/DOF = 43.2/27 and 37.6/26 respectively.
[101] ALAVI-HARATI 00B also measured $|\tilde{g}_{M1}| = 1.35^{+0.20}_{-0.17} \pm 0.04$.

$\overline{f}_S$ DECAY FORM FACTOR FOR $K^0_L \to \pi^\pm \pi^0 e^\mp \nu_e$

VALUE	DOCUMENT ID		TECN
0.049 ± 0.011 OUR AVERAGE Error includes scale factor of 1.7.			
$0.052 \pm 0.006 \pm 0.002$	BATLEY	04	NA48
$0.010 \pm 0.016 \pm 0.017$	MAKOFF	93	E731

$\overline{f}_P$ DECAY FORM FACTOR FOR $K^0_L \to \pi^\pm \pi^0 e^\mp \nu_e$

VALUE	DOCUMENT ID		TECN
-0.052 ± 0.012 OUR AVERAGE			
$-0.051 \pm 0.011 \pm 0.005$	BATLEY	04	NA48
$-0.079 \pm 0.049 \pm 0.022$	MAKOFF	93	E731

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

VALUE	DOCUMENT ID		TECN
0.085±0.020 OUR AVERAGE			
0.087±0.019±0.006	BATLEY	04	NA48
0.014±0.087±0.070	MAKOFF	93	E731

$\overline{h}$ DECAY FORM FACTOR FOR $K^0_L \to \pi^\pm \pi^0 e^\mp \nu_e$

VALUE	DOCUMENT ID		TECN
−0.30±0.13 OUR AVERAGE			
−0.32±0.12±0.07	BATLEY	04	NA48
−0.07±0.31±0.31	MAKOFF	93	E731

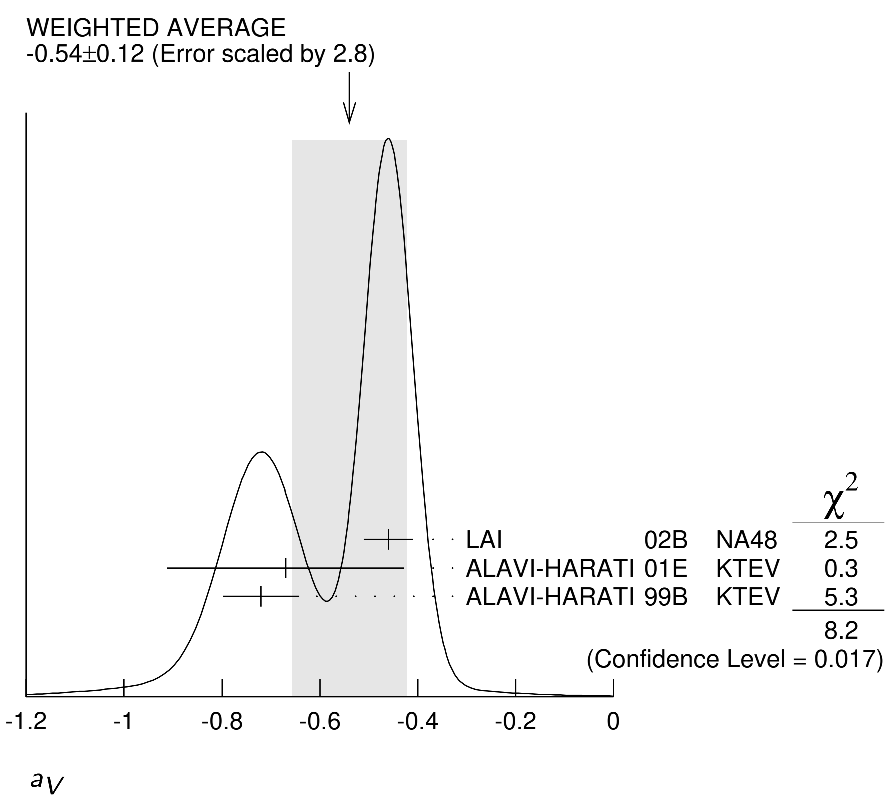
L_3 CHIRAL PERT. THEO. PARAM. FOR $K^0_L \to \pi^\pm \pi^0 e^\mp \nu_e$

VALUE (units 10^{-3})	DOCUMENT ID		TECN
−3.96±0.28 OUR AVERAGE	Error includes scale factor of 1.6.		
−4.1 ±0.2	BATLEY	04	NA48
−3.4 ±0.4	[102] MAKOFF	93	E731

[102] MAKOFF 93 sign has been changed to negative to agree with the sign convention used in BATLEY 04.

a_V, VECTOR MESON EXCHANGE CONTRIBUTION

VALUE	DOCUMENT ID		TECN	COMMENT
−0.54±0.12 OUR AVERAGE	Error includes scale factor of 2.8. See the ideogram below.			
−0.46±0.03±0.04	LAI	02B	NA48	$K^0_L \to \pi^0 2\gamma$
−0.67±0.21±0.12	ALAVI-HARATI	01E	KTEV	$K^0_L \to \pi^0 e^+ e^- \gamma$
−0.72±0.05±0.06	ALAVI-HARATI	99B	KTEV	$K^0_L \to \pi^0 2\gamma$



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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).

A_L = weighted average of $A_L(\mu)$ and $A_L(e)$

In previous editions and in the literature the symbol used for this asymmetry was δ_L or δ. We use A_L for consistency with B^0 asymmetry notation and with recent K_S^0 notation.

VALUE (%)	EVTS	DOCUMENT ID		TECN	COMMENT
0.332±0.006 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}

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

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

The data in this block is included in the average printed for a previous datablock.

VALUE (%)	EVTS	DOCUMENT ID		TECN
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	[103] PACIOTTI	69	OSPK
0.403±0.134	1M	[103] DORFAN	67	OSPK

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

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

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

The data in this block is included in the average printed for a previous datablock.

VALUE (%)	EVTS	DOCUMENT ID		TECN
0.334 ±0.007 OUR AVERAGE				
0.3322±0.0058±0.0047	298M	ALAVI-HARATI	02	
0.341 ±0.018	34M	GEWENIGER	74	ASPK
0.318 ±0.038	40M	FITCH	73	ASPK
0.346 ±0.033	10M	MARX	70	CNTR
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.36 ±0.18	600k	ASHFORD	72	ASPK
0.246 ±0.059	10M	[104] SAAL	69	CNTR
0.224 ±0.036	10M	[104] BENNETT	67	CNTR

[104] 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 "*CP* violation in K_L decays" 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*
2.222±0.010 OUR FIT Error includes scale factor of 1.5.				
2.240±0.014	BRFIT	07		S = 1.1
• • • We do not use the following data for averages, fits, limits, etc. • • •				
2.47 ±0.31 ±0.24	ANGELOPO...	98	CPLR	
2.49 ±0.40	[105] ADLER	96B	CPLR	Sup. by ANGELOPOULOS 98
2.33 ±0.18	CHRISTENS...	79	ASPK	
2.71 ±0.37	[106] WOLFF	71	OSPK	Cu reg., 4γ's
2.95 ±0.63	[106] CHOLLET	70	OSPK	Cu reg., 4γ's

[105] Error is statistical only.
[106] 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*
2.233±0.010 OUR FIT Error includes scale factor of 1.5.					
2.227±0.008		BRFIT	07		S = 1.2
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.223±0.012		[107] LAI	07	NA48	
2.219±0.013		[108] AMBROSINO	06F	KLOE	
2.228±0.010		[109] ALEXOPOU...	04	KTEV	
2.286±0.023±0.026	70M	[110] APOSTOLA...	99C	CPLR	K^0-$\overline{K}^0$ asymmetry
2.310±0.043±0.031		[111] 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
2.30 ±0.035		GEWENIGER	74B	ASPK	

[107] Value obtained from the NA48 measurements of $\Gamma(K^0_L \to \pi^+\pi^-)/\Gamma(K^0_L \to \pi e \nu_e)$ and $\tau_{K^0_S}$ and KLOE measurements of $B(K^0_S \to \pi^+\pi^-)$ and $\tau_{K^0_L}$. $\Gamma(K^0_L \to \pi^+\pi^-)$ is defined to include the inner bremsstrahlung component $\Gamma(K^0_L \to \pi^+\pi^-\gamma(\text{IB}))$ but exclude the direct emission component $B(K^0_S \to \pi^+\pi^-(\text{DE}))$. Their $|\eta^{+-}|$ value is not directly used in our fit, but enters the fit via their branching ratio and lifetime measurements.

[108] AMBROSINO 06F uses KLOE branching ratios and τ_L together with τ_S from PDG 04. Their $|\eta_{+-}|$ value is not directly used in our fit, but enters the fit via their branching ratio and lifetime measurements.

[109] ALEXOPOULOS 04 $|\eta_{+-}|$ uses their $K^0_L \to \pi\pi$ branching fractions, $\tau_S = (0.8963 \pm 0.0005) \times 10^{-10}$ s from the average of KTeV and NA48 τ_S measurements, and assumes that $\Gamma(K^0_S \to \pi \ell \nu_\ell) = \Gamma(K^0_L \to \pi \ell \nu_\ell)$ giving $B(K^0_S \to \pi \ell \nu_\ell) = 0.118\%$. Their η_{+-} is not directly used in our fit, but enters our fit via their branching ratio measurements.

[110] APOSTOLAKIS 99C report $(2.264 \pm 0.023 \pm 0.026 + 9.1[\tau_s - 0.8934]) \times 10^{-3}$. We evaluate for our 2006 best value $\tau_s = (0.8958 \pm 0.0005) \times 10^{-10}$ s.

[111] ADLER 95B report $(2.312 \pm 0.043 \pm 0.030 - 1[\Delta m - 0.5274] + 9.1[\tau_s - 0.8926]) \times 10^{-3}$. We evaluate for our 1996 best values $\Delta m = (0.5304 \pm 0.0014) \times 10^{-10}\ \hbar \text{s}^{-1}$ and $\tau_s = (0.8927 \pm 0.0009) \times 10^{-10}$ s. Superseded by APOSTOLAKIS 99C.

$|\epsilon| = (2|\eta_{+-}| + |\eta_{00}|)/3$

This expression is a very good approximation, good to about one part in 10^{-4} because of the small measured value of $\phi_{00} - \phi_{+-}$ and small theoretical ambiguities.

VALUE (units 10^{-3})	*DOCUMENT ID*
2.229±0.010 OUR FIT Error includes scale factor of 1.5.	

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

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*
0.9950±0.0008 OUR FIT Error includes scale factor of 1.6.				
0.9930±0.0020 OUR AVERAGE				
0.9931±0.0020		[112,113] BARR	93D	NA31
0.9904±0.0084±0.0036		[114] WOODS	88	E731
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.9939±0.0013±0.0015	1M	[112] BARR	93D	NA31
0.9899±0.0020±0.0025		[112] BURKHARDT	88	NA31

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

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

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

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

We have neglected terms of order $\omega \cdot \text{Re}(\epsilon'/\epsilon)$, where $\omega = \text{Re}(A_2)/\text{Re}(A_0) \simeq 1/22$. If included, this correction would lower $\text{Re}(\epsilon'/\epsilon)$ by about 0.04×10^{-3}. See SOZZI 04.

VALUE (units 10^{-3})	*DOCUMENT ID*		*TECN*	*COMMENT*
1.65±0.26 OUR FIT Error includes scale factor of 1.6.				
1.67±0.23 OUR AVERAGE Error includes scale factor of 1.4. See the ideogram below.				
2.07±0.28	ALAVI-HARATI	03	KTEV	
1.47±0.22	BATLEY	02	NA48	
2.3 ±0.65	[115,116] BARR	93D	NA31	
0.74±0.52±0.29	GIBBONS	93B	E731	

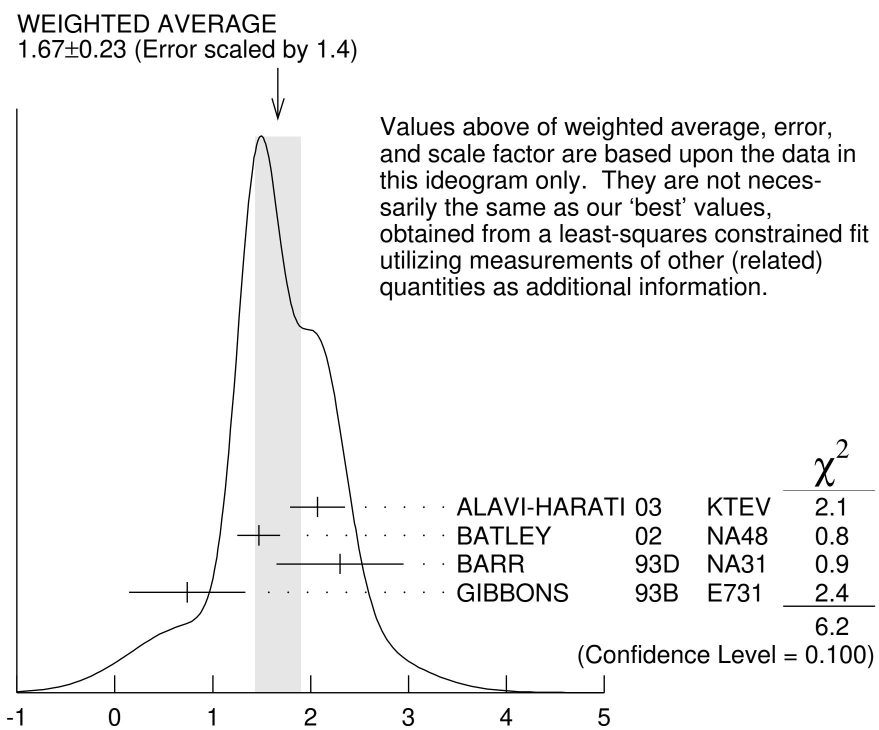
• • • We do not use the following data for averages, fits, limits, etc. • • •

1.53±0.26	LAI	01C	NA48	Incl. in BATLEY 02
2.80±0.30±0.28	ALAVI-HARATI	99D	KTEV	In ALAVI-HARATI 03
1.85±0.45±0.58	FANTI	99C	NA48	In LAI 01C
2.0 ±0.7	[117] BARR	93D	NA31	
−0.4 ±1.4 ±0.6	PATTERSON	90	E731	in GIBBONS 93B
3.3 ±1.1	[117] BURKHARDT	88	NA31	
3.2 ±2.8 ±1.2	[115] WOODS	88	E731	

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

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

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



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

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. We also give the regeneration phase ϕ_f in the comments below.

OUR FIT is described in the note on "*CP* violation in K_L decays" in the K_L^0 Particle Listings. Most experiments in this section are included in both the "Not Assuming *CPT*" and "Assuming *CPT*" fits. In the latter fit, they have little direct influence on ϕ_{+-} because their errors are large compared to that assuming *CPT*, but they influence Δm and τ_s through their dependencies on these parameters, which are given in the footnotes. Only ALAVI-HARATI 03 is excluded from the "Assuming *CPT*" fit because we explicitly include their Δm and τ_S measurements which assume *CPT*.

VALUE (°)	EVTS	DOCUMENT ID		TECN	COMMENT
43.52±0.05 OUR FIT	Error includes scale factor of 1.2. Assuming *CPT*				
43.4 ±0.7 OUR FIT	Error includes scale factor of 1.3. Not assuming *CPT*				
44.12±0.72±1.20		[118] ALAVI-HARATI	03	KTEV	Not assuming *CPT*
42.9 ±0.6 ±0.3	70M	[119] APOSTOLA...	99C	CPLR	K^0-$\overline{K}^0$ asymmetry
43.0 ±0.8 ±0.2		[120,121] SCHWINGEN...	95	E773	$CH_{1.1}$ regenerator
41.4 ±0.9 ±0.3		[121,122] GIBBONS	93	E731	B_4C regenerator
44.4 ±1.6 ±0.6		[123] CAROSI	90	NA31	Vacuum regen.
43.3 ±1.0 ±0.5		[124] GEWENIGER	74B	ASPK	Vacuum regen.
• • • We do not use the following data for averages, fits, limits, etc. • • •					
42.5 ±0.4 ±0.3		[125,126] ADLER	96C	RVUE	
43.4 ±1.1 ±0.3		[127] ADLER	95B	CPLR	K^0-$\overline{K}^0$ asymmetry
42.3 ±4.4 ±1.4	10^5	[128] ADLER	92B	CPLR	K^0-$\overline{K}^0$ asymmetry
47.7 ±2.0 ±0.9		[121,129] KARLSSON	90	E731	
44.3 ±2.8 ±0.2		[130] CARITHERS	75	SPEC	C regenerator

[118] ALAVI-HARATI 03 ϕ_{+-} is correlated with their $\Delta m = m_{K^0_L} - m_{K^0_S}$ and τ_{K_S} measurements in the K^0_L and K^0_S sections respectively. The correlation coefficients are $\rho(\phi_{+-},\Delta m)$=+0.955, $\rho(\phi_{+-},\tau_S)$=−0.871, and $\rho(\tau_S,\Delta m)$=−0.840. *CPT* is not assumed. Uses scintillator Pb regenerator.

[119] APOSTOLAKIS 99C measures $\phi_{+-} = (43.19 \pm 0.53 \pm 0.28)\ + 300\ [\Delta m - 0.5301]$ (°). We have adjusted the measurement to use our best values of ($\Delta m = 0.5292 \pm 0.0009$) ($10^{10}$ $\hbar$ s^{-1}). Our first error is their experiment's error and our second error is the systematic error from using our best values.

[120] SCHWINGENHEUER 95 measures $\phi_{+-} = (43.53 \pm 0.76)\ + 173\ [\Delta m - 0.5282] - 275\ [\tau_S - 0.8926]$ (°). We have adjusted the measurement to use our best values of ($\Delta m = 0.5292 \pm 0.0009$) ($10^{10}$ $\hbar$ s^{-1}), ($\tau_S = 0.8953 \pm 0.0005$) ($10^{-10}$ s). Our first error is their experiment's error and our second error is the systematic error from using our best values.

[121] 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.

[122] GIBBONS 93 measures $\phi_{+-} = (42.21 \pm 0.9)\ + 189\ [\Delta m - 0.5257] - 460\ [\tau_S - 0.8922]$ (°). We have adjusted the measurement to use our best values of ($\Delta m = 0.5292 \pm 0.0009$) ($10^{10}$ $\hbar$ s^{-1}), ($\tau_S = 0.8953 \pm 0.0005$) ($10^{-10}$ s). Our first error is their experiment's error and our second error is the systematic error from using our best values. This is actually reported in SCHWINGENHEUER 95, footnote 8. GIBBONS 93 reports ϕ_{+-} $(42.2 \pm 1.4)^\circ$. They measure ϕ_{+}−ϕ_f and calculate 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.

[123] CAROSI 90 measures $\phi_{+-} = (46.9 \pm 1.4 \pm 0.7)\ + 579\ [\Delta m - 0.5351] + 303\ [\tau_S - 0.8922]$ (°). We have adjusted the measurement to use our best values of ($\Delta m = 0.5292 \pm 0.0009$) ($10^{10}$ $\hbar$ s^{-1}), ($\tau_S = 0.8953 \pm 0.0005$) ($10^{-10}$ s). Our first error is their experiment's error and our second error is the systematic error from using our best values.

[124] GEWENIGER 74B measures $\phi_{+-} = (49.4 \pm 1.0)\ + 565\ [\Delta m - 0.540]$ (°). We have adjusted the measurement to use our best values of ($\Delta m = 0.5292 \pm 0.0009$) ($10^{10}$ $\hbar$

s^{-1}). Our first error is their experiment's error and our second error is the systematic error from using our best values.

[125] ADLER 96C measures ϕ_{+-} = (43.82 ± 0.41) + 339 [Δm − 0.5307] − 252 [τ_S − 0.8922] (°). We have adjusted the measurement to use our best values of (Δm = 0.5292 ± 0.0009) (10^{10} $\hbar$ s^{-1}), (τ_S = 0.8953 ± 0.0005) (10^{-10} s). Our first error is their experiment's error and our second error is the systematic error from using our best values.

[126] 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)).

[127] ADLER 95B measures ϕ_{+-} = (42.7 ± 0.9 ± 0.6) + 316 [Δm − 0.5274] + 30 [τ_S − 0.8926] (°). We have adjusted the measurement to use our best values of (Δm = 0.5292 ± 0.0009) (10^{10} $\hbar$ s^{-1}), (τ_S = 0.8953 ± 0.0005) (10^{-10} s). Our first error is their experiment's error and our second error is the systematic error from using our best values.

[128] 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.

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

[130] CARITHERS 75 measures ϕ_{+-} = (45.5 ± 2.8) + 224 [Δm − 0.5348] (°). We have adjusted the measurement to use our best values of (Δm = 0.5292 ± 0.0009) (10^{10} $\hbar$ s^{-1}). Our first error is their experiment's error and our second error is the systematic error from using our best values. ϕ_f = −40.9 ± 2.6°.

ϕ_{00}, PHASE OF η_{00}

See comment in ϕ_{+-} header above for treatment of Δm and τ_S dependence, as well as for the inclusion of data in both the "Assuming *CPT*" and "Not Assuming *CPT*" fits.

OUR FIT is described in the note on "*CP* violation in K_L decays" in the K_L^0 Particle Listings.

VALUE (°)	*DOCUMENT ID*		*TECN*	*COMMENT*
43.50±0.06 OUR FIT	Error includes scale factor of 1.2.		Assuming *CPT*	
43.7 ±0.8 OUR FIT	Error includes scale factor of 1.2.		Not assuming *CPT*	
44.5 ±2.3 ±0.6	[131] CAROSI	90	NA31	
• • • We do not use the following data for averages, fits, limits, etc. • • •				
41.6 ±5.9 ±0.2	[132] ANGELOPO...	98	CPLR	
50.8 ±7.1 ±1.7	[133] ADLER	96B	CPLR	Sup. by ANGELOPOULOS 98
47.4 ±1.4 ±0.9	[134] KARLSSON	90	E731	

[131] CAROSI 90 measures ϕ_{00} = (47.1 ± 2.1 ± 1.0) + 579 [Δm − 0.5351] + 252 [τ_S − 0.8922] (°). We have adjusted the measurement to use our best values of (Δm = 0.5292 ± 0.0009) (10^{10} $\hbar$ s^{-1}), (τ_S = 0.8953 ± 0.0005) (10^{-10} s). Our first error is their experiment's error and our second error is the systematic error from using our best values.

[132] ANGELOPOULOS 98 measures ϕ_{00} = (42.0 ± 5.6 ± 1.9) + 240 [Δm − 0.5307] (°). We have adjusted the measurement to use our best values of (Δm = 0.5292 ± 0.0009) (10^{10} $\hbar$ s^{-1}). Our first error is their experiment's error and our second error is the systematic error from using our best values. The τ_S dependence is negligible.

[133] 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.

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

$\phi_\epsilon = (2\phi_{+-} + \phi_{00})/3$

This expression is a very good approximation, good to about 10^{-3} degrees because of the small measured values of $\phi_{00} - \phi_{+-}$ and Re ϵ'/ϵ, and small theoretical ambiguities.

VALUE (°)	DOCUMENT ID	COMMENT
43.51 ±0.05 OUR FIT	Error includes scale factor of 1.1.	Assuming *CPT*
43.5 ±0.7 OUR FIT	Error includes scale factor of 1.3.	Not assuming *CPT*
43.5105±0.0004±0.0533	[135] SUPERWEAK 04	Assuming *CPT*

[135] SUPERWEAK 04 is a fake measurement used to impose the *CPT* or Superweak constraint $\phi_{+-}=\phi_{SW} = 2\,\frac{\Delta m}{\hbar}\,(\frac{\tau_S\tau_L}{\tau_L-\tau_S})$. This "measurement" is linearized using values near the RPP 2004 edition values of Δm, τ_S and τ_L, and then adjusted to our current values as described in the following "measurement". SUPERWEAK 04 measures $\phi_\epsilon =$ (43.5131 ± 0.0004) + 54 [$\Delta m -$ 0.5290] + 32 [$\tau_s -$ 0.8958] (°). We have adjusted the measurement to use our best values of ($\Delta m = 0.5292 \pm 0.0009$) ($10^{10}\ \hbar\ s^{-1}$), ($\tau_s = 0.8953 \pm 0.0005$) ($10^{-10}$ s). Our first error is their experiment's error and our second error is the systematic error from using our best values.

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

VALUE (%)	DOCUMENT ID		TECN
13.7±1.5 OUR AVERAGE			
13.6±1.4±1.5	ABOUZAID	06	KTEV
14.2±3.0±1.9	LAI	03C	NA48
13.6±2.5±1.2	ALAVI-HARATI	00B	KTEV

PARAMETERS FOR $e^+e^-e^+e^-$ DECAYS

These are the *CP*-violating parameters in the ϕ distribution, where ϕ is the angle between the planes of the two e^+e^- paris in the kaon rest frame:

$$d\Gamma/d\phi \ \propto\ 1 + \beta_{CP}\cos(2\phi) + \gamma_{CP}\sin(2\phi)$$

β_{CP} from $K^0_L \rightarrow e^+e^-e^+e^-$

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
−0.19±0.07 OUR AVERAGE					
−0.13±0.10±0.03	200	[136] LAI	05B	NA48	
−0.23±0.09±0.02	441	ALAVI-HARATI	01D	KTEV	$M_{ee} >8$ MeV/c^2

[136] LAI 05B obtains $\beta_{CP} = -0.13 \pm 0.10$ (stat) if $\gamma_{CP} = 0$ is assumed.

γ_{CP} from $K^0_L \rightarrow e^+e^-e^+e^-$

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.01±0.11 OUR AVERAGE	Error includes scale factor of 1.6.				
+0.13±0.10±0.03	200	LAI	05B	NA48	
−0.09±0.09±0.02	441	ALAVI-HARATI	01D	KTEV	$M_{ee} >8$ MeV/c^2

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

These are *CP*-violating charge-asymmetry parameters, defined at beginning of section "LINEAR COEFFICIENT g FOR $K^0_L \to \pi^+\pi^-\pi^0$ above.

See also note on Dalitz plot parameters in $K^\pm$ section and note on "*CP* violation in K_L decays" above.

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

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*
0.0012±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 $K^0_L \to \pi^+\pi^-\pi^0$

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

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

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

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

VALUE	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*
<0.3	90	3671	[137] RAMBERG	93B	E731

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

$|g_{E1}|$ for $K^0_L \to \pi^+\pi^-\gamma$

This parameter is the amplitude of the direct emission of a *CP* violating E1 electric dipole photon.

VALUE	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
<0.21	90	111k	ABOUZAID	06A	KTEV	$E^*_\gamma > 20$ MeV

T VIOLATION TESTS IN K^0_L DECAYS

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	[138]	CLARK	77	SPEC	POL, t=0
−0.085±0.064	2.2M	[139]	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

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

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

CPT-INVARIANCE TESTS IN K^0_L DECAYS

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

Test of CPT.

OUR FIT is described in the note on "CP violation in K_L decays" in the K^0_L Particle Listings.

VALUE (°)		DOCUMENT ID		TECN	COMMENT
−0.02 ±0.04 OUR FIT	Error includes scale factor of 2.1. Assuming CPT				
0.2 ±0.4 OUR FIT	Not assuming CPT				
−0.023±0.020	[140]	SUPERWEAK	04		Assuming CPT
0.39 ±0.22 ±0.45	[141]	ALAVI-HARATI	03	KTEV	
−0.30 ±0.88	[142]	SCHWINGEN...	95		Combined E731, E773
• • • 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	[143]	GIBBONS	93	E731	
0.2 ±2.6 ±1.2	[144]	CAROSI	90	NA31	
−0.3 ±2.4 ±1.2		KARLSSON	90	E731	

[140] SUPERWEAK 04 is a fake experiment to constrain ϕ_{00}-ϕ_{+-} to a small value as described in the note "CP violation in K_L decays."

[141] ALAVI-HARATI 03 fit Re(ϵ'/ϵ), Im(ϵ'/ϵ), Δm, τ_S, and ϕ_{+-} simultaneously, not assuming CPT. Phase difference is obtained from $\phi_{00} - \phi_{+-} \approx -3\mathrm{Im}(\epsilon'/\epsilon)$ for small $|\epsilon'/\epsilon|$.

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

[143] 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 $m_{K^0_L} - m_{K^0_S}$).

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

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

Test of CPT. The Superweak phase $\phi_{SW} \equiv \tan^{-1}(2\Delta m/\Delta\Gamma)$ where $\Delta m = m_{K_L^0} - m_{K_S^0}$ and $\Delta\Gamma = \hbar(\tau_L - \tau_S)/(\tau_L \tau_S)$.

VALUE (°)	DOCUMENT ID	TECN
0.61±0.62±1.01	[145] ALAVI-HARATI 03	KTEV

[145] ALAVI-HARATI 03 fit is the same as their ϕ_{+-}, τ_{K_S}, Δm fit, except that the parameter $\phi_{+-} - \phi_{SW}$ is used in place of ϕ.

$\mathrm{Re}(\frac{2}{3}\eta_{+-} + \frac{1}{3}\eta_{00}) - \frac{A_L}{2}$

Test of CPT

VALUE (units 10^{-6})	DOCUMENT ID	TECN	COMMENT
−3±35	[146] ALAVI-HARATI 02	E799	Uses A_L from K_{e3} decays

[146] ALAVI-HARATI 02 uses PDG 00 values of η_{+-} and η_{00}.

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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±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	[147] BURGUN 72	HBC	$K^+ p \to K^0 p \pi^+$
$0.04\ ^{+0.10}_{-0.13}$	100	[148] GRAHAM 72	OSPK	$K_{\mu 3}$ from $K^0 \Lambda$
$-0.05\ \pm0.09$	442	[148] 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	[148] MANTSCH 72	OSPK	K_{e3} from $K^0 \Lambda$
$0.04\ ^{+0.07}_{-0.08}$	222	[147] 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	[149] CHO 70	DBC	$K^+ d \to K^0 p p$
$-0.020\ \pm0.025$		[150] BENNETT 69	CNTR	Charge asym+ Cu regen.
$0.09\ ^{+0.14}_{-0.16}$	686	LITTENBERG 69	OSPK	$K^+ n \to K^0 p$
$0.03\ \pm0.03$		[150] 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	± 0.10	335	[149]	HILL	67	DBC	$K^+ d \to K^0 pp$
0.035	$^{+0.11}_{-0.13}$	196		AUBERT	65	HLBC	K^+ charge exchange
0.06	$^{+0.18}_{-0.44}$	152	[151]	BALDO-...	65	HLBC	K^+ charge exchange
-0.08	$^{+0.16}_{-0.28}$	109	[152]	FRANZINI	65	HBC	$\overline{p}p$

[147] BURGUN 72 is a final result which includes BURGUN 71.
[148] First GRAHAM 72 value is second GRAHAM 72 value combined with MANTSCH 72.
[149] CHO 70 is analysis of unambiguous events in new data and HILL 67.
[150] BENNETT 69 is a reanalysis of BENNETT 68.
[151] BALDO-CEOLIN 65 gives x and θ converted by us to Re(x) and Im(x).
[152] 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±0.0009		640k		ANGELOPO...	01B	CPLR	K_{e3} from K^0
• • • We do not use the following data for averages, fits, limits, etc. • • •							
0.0012	± 0.0019	640k	[153]	ANGELOPO...	98E	CPLR	K_{e3} from K^0
-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	[154]	BURGUN	72	HBC	$K^+ p \to K^0 p \pi^+$
0.12	$^{+0.17}_{-0.16}$	100	[155]	GRAHAM	72	OSPK	$K_{\mu 3}$ from $K^0 \Lambda$
0.05	± 0.13	442	[155]	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	[155]	MANTSCH	72	OSPK	K_{e3} from $K^0 \Lambda$
0.12	$^{+0.08}_{-0.09}$	222	[154]	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	[156]	CHO	70	DBC	$K^+ d \to K^0 pp$
-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	[156]	HILL	67	DBC	$K^+ d \to K^0 pp$

-0.21	$^{+0.11}_{-0.15}$	196	AUBERT	65	HLBC	K^+ charge exchange
-0.44	$^{+0.32}_{-0.19}$	152	[157] BALDO-...	65	HLBC	K^+ charge exchange
$+0.24$	$^{+0.40}_{-0.30}$	109	[158] FRANZINI	65	HBC	$\overline{p}p$

[153] Superseded by ANGELOPOULOS 01B.
[154] BURGUN 72 is a final result which includes BURGUN 71.
[155] First GRAHAM 72 value is second GRAHAM 72 value combined with MANTSCH 72.
[156] 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.
[157] BALDO-CEOLIN 65 gives x and θ converted by us to Re(x) and Im(x).
[158] FRANZINI 65 gives x and θ for Re(x) and Im(x). See SCHMIDT 67.

K^0_L REFERENCES

BRFIT	07	RPP 2007 WWW edition	T.G. Trippe	(PDG Collab.)
ETAFIT	07	RPP 2007 WWW edition	T.G. Trippe	(PDG Collab.)
LAI	07	PL B645 26	A. Lai *et al.*	(CERN NA48 Collab.)
ABOUZAID	06	PRL 96 101801	E. Abouzaid *et al.*	(KTeV Collab.)
ABOUZAID	06A	PR D74 032004	E. Abouzaid *et al.*	(KTeV Collab.)
Also		PR D74 039905 (Errat.)	E. Abouzaid *et al.*	(KTeV Collab.)
ABOUZAID	06C	PR D74 097101	E. Abouzaid *et al.*	(KTeV Collab.)
AHN	06	PR D74 051105R	J.K. Ahn *et al.*	(KEK E391a Collab.)
Also		PR D74 079901 (Errat.)	J.K. Ahn *et al.*	(KEK E391a Collab.)
AMBROSINO	06	PL B632 43	F. Ambrosino *et al.*	(KLOE Collab.)
AMBROSINO	06D	PL B636 166	F. Ambrosino *et al.*	(KLOE Collab.)
AMBROSINO	06F	PL B638 140	F. Ambrosino *et al.*	(KLOE Collab.)
HILL	06	PR D74 096006	R.J. Hill	(FNAL)
ALEXOPOU...	05	PR D71 012001	T. Alexopoulos *et al.*	(FNAL KTeV Collab.)
AMBROSINO	05C	PL B626 15	F. Ambrosino *et al.*	(KLOE Collab.)
LAI	05	PL B605 247	A. Lai *et al.*	(CERN NA48 Collab.)
LAI	05B	PL B615 31	A. Lai *et al.*	(CERN NA48 Collab.)
ALAVI-HARATI	04A	PRL 93 021805	A. Alavi-Harati *et al.*	(FNAL KTeV/E799 Collab.)
ALEXOPOU...	04	PR D70 092006	T. Alexopoulos *et al.*	(FNAL KTeV Collab.)
ALEXOPOU...	04A	PR D70 092007	T. Alexopoulos *et al.*	(FNAL KTeV Collab.)
ANDRE	04	hep-ph/0406006	T. Andre	(EFI)
BATLEY	04	PL B595 75	J.R. Batley *et al.*	(CERN NA48 Collab.)
CIRIGLIANO	04	EPJ C35 53	V. Cirigliano, H. Neufeld, H. Pichl	(CIT, VALE+)
LAI	04B	PL B602 41	A. Lai *et al.*	(CERN NA48 Collab.)
LAI	04C	PL B604 1	A. Lai *et al.*	(CERN NA48 Collab.)
PDG	04	PL B592 1	S. Eidelman *et al.*	
SOZZI	04	EPJ C36 37	M. Sozzi	(PISA)
SUPERWEAK	04	RPP 2004 edition	T.G. Trippe	(PDG Collab.)
CP violation in K_L decays				
ADINOLFI	03	PL B566 61	M. Adinolfi *et al.*	(KLOE Collab.)
ALAVI-HARATI	03	PR D67 012005	A. Alavi-Harati *et al.*	(FNAL KTeV Collab.)
Also		PR D70 079904 (Errat.)	A. Alavi-Harati *et al.*	(FNAL KTeV Collab.)
ALAVI-HARATI	03B	PRL 90 141801	A. ALavi-Harati *et al.*	(FNAL KTeV Collab.)
LAI	03	PL B551 7	A. Lai *et al.*	(CERN NA48 Collab.)
LAI	03C	EPJ C30 33	A. Lai *et al.*	(CERN NA48 Collab.)
ALAVI-HARATI	02	PRL 88 181601	A. Alavi-Harati *et al.*	(FNAL KTeV Collab.)
ALAVI-HARATI	02C	PRL 89 211801	A. Alavi-Harati *et al.*	(FNAL KTeV Collab.)
BATLEY	02	PL B544 97	J.R. Batley *et al.*	(CERN NA48 Collab.)
CIRIGLIANO	02	EPJ C23 121	V. Cirigliano *et al.*	(VIEN, VALE, MARS)
LAI	02B	PL B536 229	A. Lai *et al.*	(CERN NA48 Collab.)
ALAVI-HARATI	01	PRL 86 397	A. Alavi-Harati *et al.*	(FNAL KTeV Collab.)
ALAVI-HARATI	01B	PRL 86 761	A. Alavi-Harati *et al.*	(FNAL KTeV Collab.)
ALAVI-HARATI	01D	PRL 86 5425	A. Alavi-Harati *et al.*	(FNAL KTeV Collab.)
ALAVI-HARATI	01E	PRL 87 021801	A. Alavi-Harati *et al.*	(FNAL KTeV Collab.)
ALAVI-HARATI	01F	PR D64 012003	A. Alavi-Harati *et al.*	(FNAL KTeV Collab.)
ALAVI-HARATI	01G	PRL 87 071801	A. Alavi-Harati *et al.*	(FNAL KTeV Collab.)
ALAVI-HARATI	01H	PRL 87 111802	A. Alavi-Harati *et al.*	(FNAL KTeV Collab.)
ALAVI-HARATI	01J	PR D64 112004	A. Alavi-Harati *et al.*	(FNAL KTeV Collab.)
ANGELOPO...	01	PL B503 49	A. Angelopoulos *et al.*	(CPLEAR Collab.)

ANGELOPO...	01B	EPJ C22 55	A. Angelopoulos *et al.*	(CPLEAR Collab.)
LAI	01B	PL B515 261	A. Lai *et al.*	(CERN NA48 Collab.)
LAI	01C	EPJ C22 231	A. Lai *et al.*	(CERN NA48 Collab.)
ALAVI-HARATI	00	PR D61 072006	A. Alavi-Harati *et al.*	(FNAL KTeV Collab.)
ALAVI-HARATI	00B	PRL 84 408	A. Alavi-Harati *et al.*	(FNAL KTeV Collab.)
ALAVI-HARATI	00D	PRL 84 5279	A. Alavi-Harati *et al.*	(FNAL KTeV Collab.)
ALAVI-HARATI	00E	PR D62 112001	A. Alavi-Harati *et al.*	(FNAL 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.)
PDG	00	EPJ C15 1	D.E. Groom *et al.*	
ADAMS	99	PL B447 240	J. Adams *et al.*	(FNAL KTeV Collab.)
ALAVI-HARATI	99B	PRL 83 917	A. Alavi-Harati *et al.*	(FNAL KTeV Collab.)
ALAVI-HARATI	99D	PRL 83 22	A. Alavi-Harati *et al.*	(FNAL KTeV Collab.)
APOSTOLA...	99C	PL B458 545	A. Apostolakis *et al.*	(CPLEAR Collab.)
Also		EPJ C18 41	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.*	(FNAL 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.)
Also		EPJ C22 55	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		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		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		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		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 S1	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		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		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		PL 116B 73	E. Fischbach *et al.*	(PURD, BNL, CHIC)
Also		PR D28 476	S.H. Aronson *et al.*	(BNL, CHIC, PURD)
Also		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		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)
SCHMIDT	79	PRL 43 556	M.P. Schmidt *et al.*	(YALE, BNL)
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		Thesis LBL-4275	G. Shen	(LBL)
DEVOE	77	PR D16 565	R. Devoe *et al.*	(EFI, ANL)
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)
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)
BISI	74	PL 50B 504	V. Bisi, M.I. Ferrero	(TORI)
DONALDSON	74	Thesis SLAC-0184	G. Donaldson	(SLAC)
Also		PR D14 2839	G. Donaldson *et al.*	(SLAC)
DONALDSON	74B	PR D9 2960	G. Donaldson *et al.*	(SLAC, UCSC)
Also		PRL 31 337	G. Donaldson *et al.*	(SLAC, UCSC)
GEWENIGER	74	PL 48B 483	C. Geweniger *et al.*	(CERN, HEIDH)
Also		Thesis CERN Int. 74-4	V. Luth	(CERN)
GEWENIGER	74B	PL 48B 487	C. Geweniger *et al.*	(CERN, HEIDH)
Also		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)
WILLIAMS	74	PRL 33 240	H.H. Williams *et al.*	(BNL, YALE)
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		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		Thesis COO-3072-13	R.C. Webb	(PRIN)
HART	73	NP B66 317	J.C. Hart *et al.*	(CAVE, RHEL)
MALLARY	73	PR D7 1953	M.L. Mallary *et al.*	(CIT)
Also		PRL 25 1214	F.J. Sciulli *et al.*	(CIT)
MCCARTHY	73	PR D7 687	R.L. McCarthy *et al.*	(LBL)
Also		PL 42B 291	R.L. McCarthy *et al.*	(LBL)
Also		Thesis LBL-550	R.L. McCarthy	(LBL)
MESSNER	73	PRL 30 876	R. Messner *et al.*	(COLO, SLAC, UCSC)
SANDWEISS	73	PRL 30 1002	J. Sandweiss *et al.*	(YALE, ANL)
WILLIAMS	73	PRL 31 1521	H.H. Williams *et al.*	(BNL, YALE)
ASHFORD	72	PL 38B 47	V.A. Ashford *et al.*	(UCSD)
BANNER	72B	PRL 29 237	M. Banner *et al.*	(PRIN)
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)
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)
PICCIONI	72	PRL 29 1412	R. Piccioni *et al.*	(SLAC)
Also		PR D9 2939	R. Piccioni *et al.*	(SLAC, UCSC, COLO)
VOSBURGH	72	PR D6 1834	K.G. Vosburgh *et al.*	(RUTG, MASA)
Also		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)
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)
CHO	71	PR D3 1557	Y. Cho *et al.*	(CMU, BNL, CASE)
ENSTROM	71	PR D4 2629	J. Enstrom *et al.*	(SLAC, STAN)
Also		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		PRL 21 498	B.R. Webber *et al.*	(LRL)
Also		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		Private Comm.	A.J. Cox	
BUDAGOV	70	PR D2 815	I.A. Budagov *et al.*	(CERN, ORSAY, EPOL)
Also		PL 28B 215	I.A. Budagov *et al.*	(CERN, ORSAY, EPOL)
CHO	70	PR D1 3031	Y. Cho *et al.*	(CMU, BNL, CASE)
Also		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)
MARX	70	PL 32B 219	J. Marx *et al.*	(COLU, HARV, CERN)
Also		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		Thesis UCRL 19226	B.R. Webber	(LRL)

BANNER 69 PR 188 2033 M. Banner *et al.* (PRIN)
Also PRL 21 1103 M. Banner *et al.* (PRIN)
Also PRL 21 1107 J.W. Cronin, J.K. Liu, J.E. Pilcher (PRIN)
BENNETT 69 PL 29B 317 S. Bennett *et al.* (COLU, BNL)
FAISSNER 69 PL 30B 204 H. Faissner *et al.* (AACH3, CERN, TORI)
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)
BASILE 68B PL 28B 58 P. Basile *et al.* (SACL)
BENNETT 68 PL 27B 244 S. Bennett *et al.* (COLU, CERN)
BLANPIED 68 PRL 21 1650 W.A. Blanpied *et al.* (CASE, HARV, MCGI)
BOHM 68B PL 27B 594 A. Bohm *et al.*
BUDAGOV 68 NC 57A 182 I.A. Budagov *et al.* (CERN, ORSAY, IPNP)
Also PL 28B 215 I.A. Budagov *et al.* (CERN, ORSAY, EPOL)
JAMES 68 NP B8 365 F. James, H. Briand (IPNP, CERN)
Also 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)
DEBOUARD 67 NC 52A 662 X. de Bouard *et al.* (CERN)
Also PL 15 58 X. de Bouard *et al.* (CERN, ORSAY, MPIM)
DEVLIN 67 PRL 18 54 T.J. Devlin *et al.* (PRIN, UMD)
Also 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)
FITCH 67 PR 164 1711 V.L. Fitch *et al.* (PRIN)
GINSBERG 67 PR 162 1570 E.S. Ginsberg (MASB)
HILL 67 PRL 19 668 D.G. Hill *et al.* (BNL, CMU)
HOPKINS 67 PRL 19 185 H.W.K. Hopkins, T.C. Bacon, F.R. Eisler (BNL)
NEFKENS 67 PR 157 1233 B.M.K. Nefkens *et al.* (ILL)
SCHMIDT 67 Thesis Nevis 160 P. Schmidt (COLU)
BEHR 66 PL 22 540 L. Behr *et al.* (EPOL, MILA, PADO, ORSAY)
HAWKINS 66 PL 21 238 C.J.B. Hawkins (YALE)
Also PR 156 1444 C.J.B. Hawkins (YALE)
ANDERSON 65 PRL 14 475 J.A. Anderson *et al.* (LRL, WISC)
ASTBURY 65B PL 18 175 P. Astbury *et al.* (CERN, ZURI)
AUBERT 65 PL 17 59 B. Aubert *et al.* (EPOL, ORSAY)
Also PL 24B 75 J.P. Lowys *et al.* (EPOL, ORSAY)
BALDO-... 65 NC 38 684 M. Baldo-Ceolin *et al.* (PADO)
FRANZINI 65 PR 140B 127 P. Franzini *et al.* (COLU, RUTG)
GUIDONI 65 Argonne Conf. 49 P. Guidoni *et al.* (BNL, YALE)
HOPKINS 65 Argonne Conf. 67 H.W.K. Hopkins, T.C. Bacon, F. Eisler (VAND+)
ALEKSANYAN 64B Dubna Conf. 2 102 A.S. Aleksanyan *et al.* (YERE)
Also 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)
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