K^0_L – THIS IS PART 4 OF 4

To reduce the size of this section's PostScript file, we have divided it into four PostScript files. We present the following index:

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1	Mean life
1	Decay modes
3	Decay rates
4	Branching ratios
8	Rare or forbidden modes

PART 2

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15	K^0_L form factors

PART 3

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PART 4

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CP-VIOLATION PARAMETERS IN K^0_L DECAYS

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

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

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

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

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

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

VALUE (%)	EVTS	DOCUMENT ID		TECN
The data in this block is included in the average printed for a previous datablock.				
0.304±0.025 OUR AVERAGE				
0.313±0.029	15M	GEWENIGER	74	ASPK
0.278±0.051	7.7M	PICCIONI	72	ASPK
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.60 ±0.14	4.1M	MCCARTHY	73	CNTR
0.57 ±0.17	1M	[93] PACIOTTI	69	OSPK
0.403±0.134	1M	[93] DORFAN	67	OSPK

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

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

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

VALUE (%)	EVTS	DOCUMENT ID		TECN
The data in this block is included in the average printed for a previous datablock.				
0.333±0.014 OUR AVERAGE				
0.341±0.018	34M	GEWENIGER	74	ASPK
0.318±0.038	40M	FITCH	73	ASPK
0.346±0.033	10M	MARX	70	CNTR
0.246±0.059	10M	[94] SAAL	69	CNTR
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.36 ±0.18	600k	ASHFORD	72	ASPK
0.224±0.036	10M	[94] BENNETT	67	CNTR

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

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

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

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 on *CP* Violation in K^0_L Decay" above for details.

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

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
2.275±0.019 OUR FIT	Error includes scale factor of 1.1.				
2.30 ±0.14 OUR AVERAGE					
2.25 ±0.22		[95] BRFIT	96		
2.33 ±0.18		CHRISTENS...	79	ASPK	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.71 ±0.37	56	[96] WOLFF	71	OSPK	Cu reg., 4γ's
2.95 ±0.63		[96] CHOLLET	70	OSPK	Cu reg., 4γ's

[95] This BRFIT value is computed from fitted values of the K^0_L and K^0_S lifetimes and branching fractions to $\pi\pi$. See the discussion in the "Note on *CP* violation in K^0_L decay."

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

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

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
2.285±0.019 OUR FIT					
2.284±0.018 OUR AVERAGE					
2.271±0.024		[97] BRFIT	96		
2.310±0.043±0.031		[98] ADLER	95B	CPLR	K^0-$\overline{K}^0$ asymmetry
2.32 ±0.14 ±0.03	10^5	ADLER	92B	SPEC	K^0-$\overline{K}^0$ asymm.
2.27 ±0.12		CHRISTENS...	79B	ASPK	
2.30 ±0.035		GEWENIGER	74B	ASPK	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.28 ±0.06	1687	[99] COUPAL	85	SPEC	P(K)=70 GeV/c
2.09 ±0.02		[100] ARONSON	82B	SPEC	E=30–110 GeV

[97] This BRFIT value is computed from fitted values of the K_L^0 and K_S^0 lifetimes and branching fractions to $\pi\pi$. See the discussion in the "Note on CP violation in K_L^0 decay."

[98] 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 $\Delta m = (0.5304 \pm 0.0014) \times 10^{-10}\ \hbar s^{-1}$ and $\tau_s = (0.8927 \pm 0.0009) \times 10^{-10}$ s.

[99] COUPAL 85 concludes: no energy dependence of $|\eta_{+-}|$, because their value is consistent with above values which occur at lower energies. Not independent of COUPAL 85 $\Gamma(\pi^+\pi^-)/\Gamma(\pi\ell\nu)$ measurement. Enters $|\eta_{+-}|$ via BRFIT value. In editions prior to 1990, this measurement was erroneously also included in our $|\eta_{+-}|$ average and fit. We thank H. Wahl (WAHL 89) for informing us.

[100] ARONSON 82B find that $|\eta_{+-}|$ may depend on the kaon energy.

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

VALUE	EVTS	DOCUMENT ID		TECN
0.9956±0.0023 OUR FIT Error includes scale factor of 1.8.				
0.9930±0.0020 OUR AVERAGE				
0.9931±0.0020		[101,102] BARR	93D	NA31
0.9904±0.0084±0.0036		[103] WOODS	88	E731
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.9939±0.0013±0.0015	1M	[101] BARR	93D	NA31
0.9899±0.0020±0.0025		[101] BURKHARDT	88	NA31
1.014 ±0.016 ±0.007	3152	BERNSTEIN	85B	SPEC
0.995 ±0.025	1122	BLACK	85	SPEC
1.00 ±0.09		[104] CHRISTENS...	79	ASPK
1.03 ±0.07	124	BANNER	72	OSPK
1.00 ±0.06	167	HOLDER	72	ASPK

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

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

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

[104] Not independent of $|\eta_{+-}|$ and $|\eta_{00}|$ values which are included in fit.

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

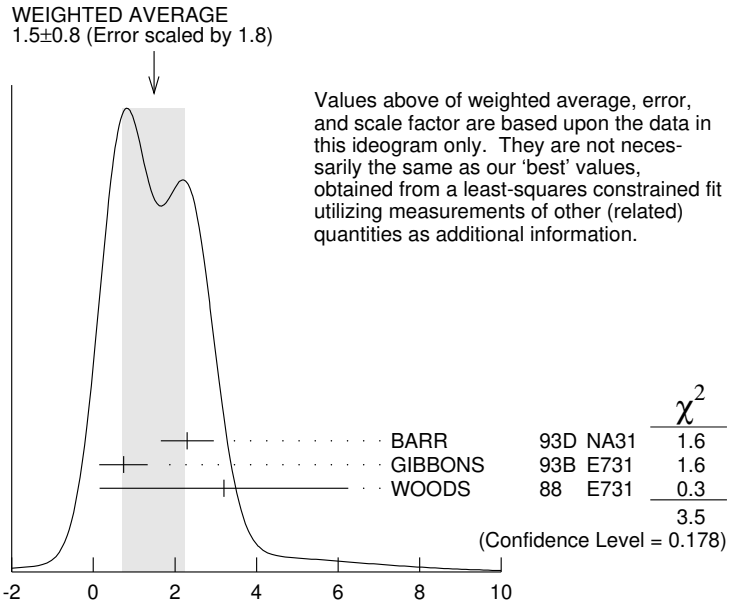
VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.5 ±0.8 OUR FIT Error includes scale factor of 1.8.					
1.5 ±0.8 OUR AVERAGE Error includes scale factor of 1.8. See the ideogram below.					
2.3 ±0.65		[105,106] BARR	93D	NA31	
0.74±0.52±0.29	>5E5	GIBBONS	93B	E731	
3.2 ±2.8 ±1.2		[105] WOODS	88	E731	

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

2.0 ±0.7	1M	[105] BARR	93D	NA31	
−0.4 ±1.4 ±0.6		PATTERSON	90	E731	in GIBBONS 93B
3.3 ±1.1		[105] BURKHARDT	88	NA31	

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

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



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

ϕ_{+-}, PHASE of η_{+-}

The dependence of the phase on Δm and τ_S is given for each experiment in the comments below, where Δm is the K_L^0-K_S^0 mass difference in units $10^{10}\ \hbar s^{-1}$ and τ_s is the K_S mean life in units 10^{-10} s. For the "used" data, we have evaluated these mass dependences using our 1996 values, $\Delta m = 0.5304 \pm 0.0014$, $\tau_s = 0.8927 \pm 0.0009$ to obtain the values quoted below. We also give the regeneration phase ϕ_f in the comments below.

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

VALUE (°)	*EVTS*	*DOCUMENT ID*	*TECN*	*COMMENT*
43.7± 0.6 OUR FIT				
43.6± 1.2		[107] ADLER	95B CPLR	K^0-$\overline{K}^0$ asymmetry
43.9± 0.8		[108,109] SCHWINGEN...	95 E773	$CH_{1.1}$ regenerator
42.9± 1.0		[109,110] GIBBONS	93 E731	$CH_{1.1}$ regenerator
44.3± 1.8		[111] CAROSI	90 NA31	Vacuum regen.
44.5± 2.8		[112] CARITHERS	75 SPEC	C regenerator
44.0± 1.3		[113] GEWENIGER	74B ASPK	Vacuum regen.
• • • We do not use the following data for averages, fits, limits, etc. • • •				
42.3± 4.4±1.4	10^5	[114] ADLER	92B SPEC	K^0-$\overline{K}^0$ asymm.
47.7± 2.0±0.9		[109,115] KARLSSON	90 E731	
35.3± 3.9		[116] ARONSON	82B SPEC	
41.7± 3.5		CHRISTENS...	79B ASPK	
36.2± 6.1		[117] CARNEGIE	72 ASPK	Cu regenerator
37 ±12		[118] BALATS	71 OSPK	Cu regenerator
40 ± 4		[119] JENSEN	70 ASPK	Vacuum regen.
34 ±10		[120] BENNETT	69 CNTR	Cu regenerator
44 ±12		[121] BOHM	69B OSPK	Vacuum regen.
45 ± 7		[122] FAISSNER	69 ASPK	Cu regenerator
51 ±11		[123] BENNETT	68B CNTR	Cu reg. uses
70 ±21		[124] BOTT-...	67B OSPK	C regenerator
25 ±35		[124] MISCHKE	67 OSPK	Cu regenerator
30 ±45		[124] FIRESTONE	66 HBC	
45 ±50		[124] FITCH	65 OSPK	Be regenerator

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

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

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

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

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

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

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

[114] 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.

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

[116] ARONSON 82 find that ϕ_{+-} may depend on the kaon energy.

[117] CARNEGIE 72 ϕ_{+-} is insensitive to Δm. $\phi_f = -56.2 \pm 5.2^\circ$.

[118] BALATS 71 $\phi_{+-} = (39.0 \pm 12.0) + 198\,[\Delta m - 0.544]^\circ$. $\phi_f = -43.0 \pm 4.0^\circ$.

[119] JENSEN 70 $\phi_{+-} = (42.4 \pm 4.0) + 576\,[\Delta m - 0.538]^\circ$.

[120] BENNETT 69 uses measurement of $(\phi_{+-}) - (\phi_f)$ of ALFF-STEINBERGER 66B. BENNETT 69 $\phi_{+-} = (34.9 \pm 10.0) + 69\,[\Delta m - 0.545]^\circ$. $\phi_f = -49.9 \pm 5.4^\circ$.

[121] BOHM 69B $\phi_{+-} = (41.0 \pm 12.0) + 479(\Delta m - 0.526)^\circ$.

[122] FAISSNER 69 error enlarged to include error in regenerator phase. FAISSNER 69 $\phi_{+-} = (49.3 \pm 7.4) + 205\,[\Delta m - 0.555]^\circ$. $\phi_f = -42.7 \pm 5.0^\circ$.

[123] BENNETT 69 is a re-evaluation of BENNETT 68B.

[124] Old experiments with large errors not included in average.

ϕ_{00}, PHASE OF η_{00}

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

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

VALUE (°)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
43.5± 1.0 OUR FIT					
44.5± 2.5		[125] CAROSI	90	NA31	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
47.4± 1.4±0.9		[126] KARLSSON	90	E731	
55.7± 5.8		CHRISTENS...	79	ASPK	
38.0±25.0	56	[127] WOLFF	71	OSPK	Cu reg., 4γ's
51.0±30.0		[128] CHOLLET	70	OSPK	Cu reg., 4γ's
first quadrant preferred		GOBBI	69B	OSPK	

[125] CAROSI 90 $\phi_{00} = 47.1 \pm 2.1 \pm 1.0 + 579\ [\Delta m - 0.5351] + 252\ [\tau_S - 0.8922]^\circ$.

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

[127] WOLFF 71 uses regenerator phase $\phi_f = -48.2 \pm 3.5^\circ$.

[128] CHOLLET 70 uses regenerator phase $\phi_f = -46.5 \pm 4.4^\circ$.

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

Test of *CPT*.

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

VALUE (°)	*DOCUMENT ID*		*TECN*	*COMMENT*
− 0.2 ± 0.8 OUR FIT				
− 0.3 ± 0.8 OUR AVERAGE				
− 0.30± 0.88	[129] SCHWINGEN...95			Combined E731, E773
0.2 ± 2.6 ±1.2	[130] CAROSI	90	NA31	

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

0.62± 0.71±0.75		SCHWINGEN...95	E773	
− 1.6 ± 1.2	[131]	GIBBONS 93	E731	
− 0.3 ± 2.4 ±1.2		KARLSSON 90	E731	
12.6 ± 6.2	[132]	CHRISTENS... 79	ASPK	
7.6 ±18.0	[133]	BARBIELLINI 73	ASPK	

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

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

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

[132] Not independent of ϕ_{+-} and ϕ_{00} values.

[133] Independent of regenerator mechanism, Δm, and lifetimes.

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

CHARGE ASYMMETRY j FOR $K^0_L \to \pi^+\pi^-\pi^0$

Defined at beginning of section "LINEAR COEFFICIENT g FOR $K^0_L \to \pi^+\pi^-\pi^0$ above. Such asymmetry violates *CP*. See also note on Daltitz plot parameters in $K^\pm$ section and note on *CP* violation in K^0_L decay above.

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*
0.0011±0.0008 OUR AVERAGE				
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	

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

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

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

$|\epsilon'_{+-\gamma}|/\epsilon$

VALUE	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*
<0.3	90	3671	[134] RAMBERG	93B	E731

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

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

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

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

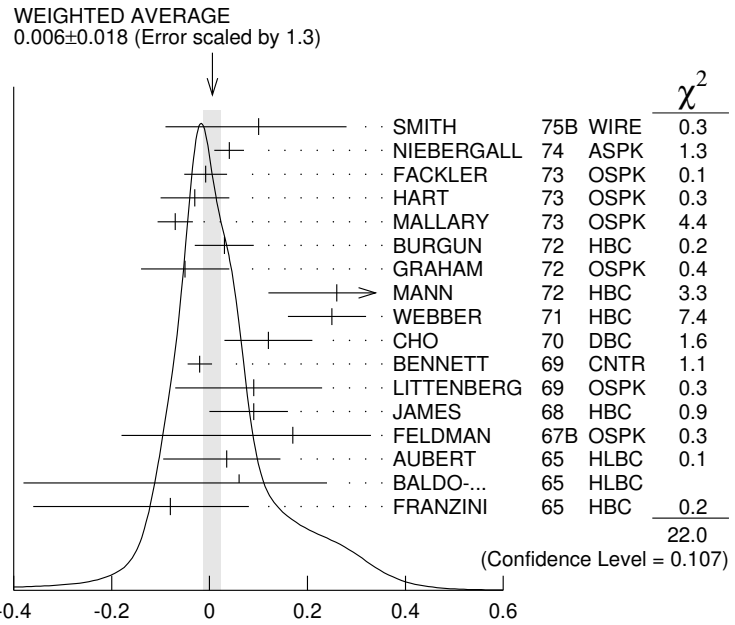
We list $\mathrm{Re}\{x\}$ and $\mathrm{Im}\{x\}$ for K_{e3} and $K_{\mu 3}$ combined.

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

REAL PART OF x

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.006±0.018 OUR AVERAGE		Error includes scale factor of 1.3. See the ideogram below.			
$0.10\ ^{+0.18}_{-0.19}$	79	SMITH	75B	WIRE	$\pi^- p \to K^0 \Lambda$
0.04 ±0.03	4724	NIEBERGALL	74	ASPK	$K^+ p \to K^0 p \pi^+$
−0.008±0.044	1757	FACKLER	73	OSPK	K_{e3} from K^0
−0.03 ±0.07	1367	HART	73	OSPK	K_{e3} from $K^0 \Lambda$
−0.070±0.036	1079	MALLARY	73	OSPK	K_{e3} from $K^0 \Lambda$X
0.03 ±0.06	410	[135] BURGUN	72	HBC	$K^+ p \to K^0 p \pi^+$
−0.05 ±0.09	442	[136] GRAHAM	72	OSPK	$\pi^- p \to K^0 \Lambda$
$0.26\ ^{+0.10}_{-0.14}$	126	MANN	72	HBC	$K^- p \to n \overline{K}^0$
$0.25\ ^{+0.07}_{-0.09}$	252	WEBBER	71	HBC	$K^- p \to n \overline{K}^0$
0.12 ±0.09	215	[137] CHO	70	DBC	$K^+ d \to K^0 pp$
−0.020±0.025		[138] BENNETT	69	CNTR	Charge asym+ Cu regen.
$0.09\ ^{+0.14}_{-0.16}$	686	LITTENBERG	69	OSPK	$K^+ n \to K^0 p$
$0.09\ ^{+0.07}_{-0.09}$	121	JAMES	68	HBC	$\overline{p} p$
$0.17\ ^{+0.16}_{-0.35}$	116	FELDMAN	67B	OSPK	$\pi^- p \to K^0 \Lambda$
$0.035^{+0.11}_{-0.13}$	196	AUBERT	65	HLBC	K^+ charge exchange
$0.06\ ^{+0.18}_{-0.44}$	152	[139] BALDO-...	65	HLBC	K^+ charge exchange
$-0.08\ ^{+0.16}_{-0.28}$	109	[140] FRANZINI	65	HBC	$\overline{p} p$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$0.04\ ^{+0.10}_{-0.13}$	100	[136] GRAHAM	72	OSPK	$K_{\mu 3}$ from $K^0 \Lambda$
−0.13 ±0.11	342	[136] MANTSCH	72	OSPK	K_{e3} from $K^0 \Lambda$
$0.04\ ^{+0.07}_{-0.08}$	222	[135] BURGUN	71	HBC	$K^+ p \to K^0 p \pi^+$
0.03 ±0.03		[138] BENNETT	68	CNTR	
0.17 ±0.10	335	[137] HILL	67	DBC	$K^+ d \to K^0 pp$

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



Re(x) ($\Delta S = -\Delta Q$ amplitude)

IMAGINARY PART OF x

Assumes $m_{K_L^0} - m_{K_S^0}$ positive. See Listings above.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
-0.003 ± 0.026 OUR AVERAGE		Error includes scale factor of 1.2.			
$-0.10\ ^{+0.16}_{-0.19}$	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	[141] BURGUN	72	HBC	$K^+ p \to K^0 p \pi^+$
0.05 ± 0.13	442	[142] GRAHAM	72	OSPK	$\pi^- p \to K^0 \Lambda$
$0.21\ ^{+0.15}_{-0.12}$	126	MANN	72	HBC	$K^- p \to n \overline{K}^0$
0.0 ± 0.08	252	WEBBER	71	HBC	$K^- p \to n \overline{K}^0$
-0.08 ± 0.07	215	[143] CHO	70	DBC	$K^+ d \to K^0 p p$
$-0.11\ ^{+0.10}_{-0.11}$	686	LITTENBERG	69	OSPK	$K^+ n \to K^0 p$
$+0.22\ ^{+0.37}_{-0.29}$	121	JAMES	68	HBC	$\overline{p} p$
0.0 ± 0.25	116	FELDMAN	67B	OSPK	$\pi^- p \to K^0 \Lambda$
$-0.21\ ^{+0.11}_{-0.15}$	196	AUBERT	65	HLBC	K^+ charge exchange
$-0.44\ ^{+0.32}_{-0.19}$	152	[144] BALDO-...	65	HLBC	K^+ charge exchange
$+0.24\ ^{+0.40}_{-0.30}$	109	[145] FRANZINI	65	HBC	$\overline{p} p$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$0.12\ ^{+0.17}_{-0.16}$	100	[142] GRAHAM	72	OSPK	$K_{\mu 3}$ from $K^0 \Lambda$
-0.04 ± 0.16	342	[142] MANTSCH	72	OSPK	K_{e3} from $K^0 \Lambda$
$0.12\ ^{+0.08}_{-0.09}$	222	[141] BURGUN	71	HBC	$K^+ p \to K^0 p \pi^+$
-0.20 ± 0.10	335	[143] HILL	67	DBC	$K^+ d \to K^0 p p$

[141] BURGUN 72 is a final result which includes BURGUN 71.
[142] First GRAHAM 72 value is second GRAHAM 72 value combined with MANTSCH 72.
[143] 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.
[144] BALDO-CEOLIN 65 gives x and θ converted by us to Re(x) and Im(x).
[145] FRANZINI 65 gives x and θ for Re(x) and Im(x). See SCHMIDT 67.

CPT-VIOLATION PARAMETERS IN K^0 DECAY

If *CP*-violating interactions include a T conserving part then

$$|K_S\rangle = [|K_1\rangle + (\epsilon + \Delta)|K_2\rangle]/\sqrt{1+|\epsilon+\Delta|^2}$$
$$|K_L\rangle = [|K_2\rangle + (\epsilon - \Delta)|K_1\rangle]/\sqrt{1+|\epsilon-\Delta|^2}$$

where

$$|K_1\rangle = [|K^0\rangle + |\overline{K}^0\rangle]/\sqrt{2}$$
$$|K_2\rangle = [|K^0\rangle - |\overline{K}^0\rangle]/\sqrt{2}$$

and

$$|\overline{K}^0\rangle = CP|K^0\rangle.$$

The parameter Δ specifies the *CPT*-violating part.

Estimates of Δ are given below. See also THOMSON 95 for a test of *CPT*-symmetry conservation in K^0 decays using the Bell-Steinberger relation.

REAL PART OF Δ

A nonzero value violates *CPT* invariance.

VALUE	EVTS	DOCUMENT ID			COMMENT
0.018 ± 0.020	6481	[146] DEMIDOV	95		$K_{\ell 3}$ reanalysis

[146] DEMIDOV 95 reanalyzes data from HART 73 and NIEBERGALL 74.

IMAGINARY PART OF Δ

A nonzero value violates *CPT* invariance.

VALUE	EVTS	DOCUMENT ID			COMMENT
0.021 ± 0.037	6481	[147] DEMIDOV	95		$K_{\ell 3}$ reanalysis

[147] DEMIDOV 95 reanalyzes data from HART 73 and NIEBERGALL 74.

K_L^0 REFERENCES

BRFIT 96 RPP
ETAFIT 96 RPP
ADLER 95 PL B363 237 +Alhalel, Angelopoulos, Apostolakis+ (CPLEAR Collab.)
ADLER 95B PL B363 243 +Alhalel, Angelopoulos, Apostolakis+ (CPLEAR Collab.)
AKAGI 95 PR D51 2061 +Fukuhisa, Hemmi+ (TOHOK, TOKY, KYOT, KEK)
BARR 95 ZPHY C65 361 +Buchholz+ (CERN, EDIN, MANZ, LALO, PISA, SIEG)
BARR 95C PL B358 399 +Buchholz+ (CERN, EDIN, MANZ, LALO, PISA, SIEG)
DEMIDOV 95 PAN 58 968 +Gusev, Shabalin (ITEP)
From YAF 58 1041.
HEINSON 95 PR D51 985 +Horvath, Knibbe, Mathiazhagan+ (BNL E791 Collab.)
KREUTZ 95 ZPHY C65 67 +Holder, Rost+ (SIEG, EDIN, MANZ, ORSAY, PISAI)
MATTHEWS 95 PRL 75 2803 +Gu, Haas, Hogan+ (RUTG, EFI, ELMT, FNAL, ILL)
SCHWINGEN... 95 PRL 74 4376 Schwingenheuer+ (EFI, CHIC, ELMT, FNAL, ILL, RUTG)
SPENCER 95 PRL 74 3323 + (UCLA, EFI, COLO, ELMT, FNAL, ILL, OSAK, RUTG)
THOMSON 95 PR D51 1412 +Zou (RUTG)
BARR 94 PL B328 528 +Buchholz+ (CERN, EDIN, MANZ, LALO, PISA, SIEG)
GU 94 PRL 72 3000 + (RUTG, UCLA, EFI, COLO, ELMT, FNAL, ILL, OSAK)
NAKAYA 94 PRL 73 2169 + (OSAK, UCLA, EFI, COLU, ELMT, FNAL, ILL, RUTG)
ROBERTS 94 PR D50 1874 + (UCLA, EFI, COLU, ELMT, FNAL, ILL, OSAK, RUTG)
WEAVER 94 PRL 72 3758 + (UCLA, EFI, COLU, ELMT, FNAL, ILL, OSAK, RUTG)
AKAGI 93 PR D47 R2644 +Fukuhisa, Hemmi+ (TOHOK, TOKY, KYOT, KEK)
ARISAKA 93 PRL 70 1049 +Auerbach, Axelrod, Belz, Biery+ (BNL E791 Collab.)
ARISAKA 93B PRL 71 3910 +Auerbach, Axelrod, Belz, Biery+ (BNL E791 Collab.)
BARR 93D PL B317 233 +Buchholz+ (CERN, EDIN, MANZ, LALO, PISA, SIEG)
GIBBONS 93 PRL 70 1199 +Barker, Briere, Makoff+ (FNAL E731 Collab.)
GIBBONS 93B PRL 70 1203 +Barker, Briere, Makoff+ (FNAL E731 Collab.)
GIBBONS 93C Thesis RX-1487 (CHIC)
HARRIS 93 PRL 71 3914 +Briere, Cheu, Makoff, McFarland+ (FNAL E799 Collab.)
HARRIS 93B PRL 71 3918 +Briere, Cheu, Makoff, McFarlane+ (FNAL E799 Collab.)
MAKOFF 93 PRL 70 1591 +Barker, Briere, Gibbons+ (FNAL E731 Collab.)
Also 95 PRL 75 2069 (erratum)
RAMBERG 93 PRL 70 2525 +Bock, Coleman, Enagonio, Hsiung+ (FNAL E731 Collab.)
RAMBERG 93B PRL 70 2529 +Bock, Coleman, Enagonio, Hsiung+ (FNAL E731 Collab.)
VAGINS 93 PRL 71 35 +Adair, Greenlee, Kasha, Mannelli+ (BNL E845 Collab.)
ADLER 92B PL B286 180 +Alhalel, Angelopoulos, Apostolakis+ (CPLEAR Collab.)
Also 92 SJNP 55 840 Adler, Alhalel, Angelopoulos+ (CPLEAR Collab.)
BARR 92 PL B284 440 +Buchholz+ (CERN, EDIN, MANZ, LALO, PISA, SIEG)
GRAHAM 92 PL B295 169 +Barker, Briere, Gibbons, Makoff+ (FNAL E731 Collab.)
MORSE 92 PR D45 36 +Leipuner, Larsen, Jastrzembski+ (BNL, YALE, VASS)
PDG 92 PR D45, 1 June, Part II Hikasa, Barnett, Stone+ (KEK, LBL, BOST+)
SOMALWAR 92 PRL 68 2580 +Barker, Briere, Gibbons+ (FNAL E731 Collab.)
AKAGI 91 PRL 67 2614 +Fukuhisa, Hemmi+ (TOHOK, TOKY, KYOT, KEK)
AKAGI 91B PRL 67 2618 +Fukuhisa, Hemmi+ (TOHOK, TOKY, KYOT, KEK)
BARR 91 PL B259 389 +Carosi+ (CERN, EDIN, MANZ, LALO, PISA, SIEG)
HEINSON 91 PR D44 R1 + (UCI, UCLA, LANL, PENN, STAN, TEMP, TEXA+)
PAPADIMITR... 91 PR D44 R573 Papadimitriou, Barker, Briere+ (FNAL E731 Collab.)
BARKER 90 PR D41 3546 +Briere, Gibbons, Makoff+ (FNAL E731 Collab.)
Also 88 PRL 61 2661 Gibbons, Papadimitriou+ (FNAL E731 Collab.)
BARR 90B PL B240 283 +Carosi+ (CERN, EDIN, MANZ, LALO, PISA, SIEG)
BARR 90C PL B242 523 +Carosi+ (CERN, EDIN, MANZ, LALO, PISA, SIEG)
CAROSI 90 PL B237 303 +Clarke+ (CERN, EDIN, MANZ, LALO, PISA, SIEG)
KARLSSON 90 PRL 64 2976 +Gollin, Okamitsu, Tschirhart, Barker+(FNAL E731 Collab.)
OHL 90 PRL 64 2755 +Adair, Greenlee, Kasha, Mannelli+ (BNL E845 Collab.)
OHL 90B PRL 65 1407 +Adair, Greenlee, Kasha, Mannelli+ (BNL E845 Collab.)
PATTERSON 90 PRL 64 1491 +Barker+ (FNAL E731 Collab.)
INAGAKI 89 PR D40 1712 +Kobayashi, Sato, Shinkawa+ (KEK, TOKY, KYOT)
LITTENBERG 89 PR D39 3322 (BNL)
MATHIAZHA... 89 PRL 63 2181 Mathiazhagan+ (UCI, UCLA, LANL, PENN, STAN+)
MATHIAZHA... 89B PRL 63 2185 Mathiazhagan+ (UCI, UCLA, LANL, PENN, STAN+)
PAPADIMITR... 89 PRL 63 28 Papadimitriou, Gibbons, Patterson+ (FNAL E731 Collab.)
SCHAFFNER 89 PR D39 990 +Greenlee, Kasha, Mannelli, Ohl+ (YALE, BNL)
WAHL 89 CERN-EP/89-86, H. Wahl — Rare Decay Symposium, Vancouver (CERN)
BARR 88 PL B214 303 +Clarke+ (CERN, EDIN, MANZ, LALO, PISA, SIEG)
BURKHARDT 88 PL B206 169 +Clarke+ (CERN, EDIN, MANZ, LALO, PISA, SIEG)
COUSINS 88 PR D38 2914 +Konigsberg+ (UCLA, LASL, PENN, STAN, TEMP, WILL)
GREENLEE 88 PRL 60 893 +Kasha, Mannelli, Mannelli+ (YALE, BNL)
JASTRZEM... 88 PRL 61 2300 Jastrzembski, Larsen, Leipuner, Morse+ (BNL, YALE)
WOODS 88 PRL 60 1695 +Nishikawa, Patterson, Wah, Winstein+(FNAL E731 Collab.)
BURKHARDT 87 PL B199 139 + (CERN, EDIN, MANZ, LALO, PISA, SIEG)
ARONSON 86 PR D33 3180 +Bernstein, Bock+ (BNL, CHIC, STAN, WISC)
Also 82 PRL 48 1078 Aronson, Bernstein+ (BNL, CHIC, STAN, WISC)
PDG 86C PL 170B 132 Aguilar-Benitez, Porter+ (CERN, CIT+)
BERNSTEIN 85B PRL 54 1631 +Bock, Carlsmith, Coupal+ (CHIC, SACL)
BLACK 85 PRL 54 1628 +Blatt, Campbell, Kasha, Mannelli+ (BNL, YALE)
COUPAL 85 PRL 55 566 +Bernstein, Bock, Carlsmith+ (CHIC, SACL)
BALATS 83 SJNP 38 556 +Berezin, Bogdanov, Vishnevsky+ (ITEP)
Translated from YAF 38 927.
BERGSTROM 83 PL 131B 229 +Masso, Singer (CERN)
ARONSON 82 PRL 48 1078 +Bernstein+ (BNL, CHIC, STAN, WISC)
ARONSON 82B PRL 48 1306 +Bock, Cheng, Fischbach (BNL, CHIC, PURD)
Also 82B PL 116B 73 Fischbach, Cheng+ (PURD, BNL, CHIC)
Also 83 PR D28 476 Aronson, Bock, Cheng+ (BNL, CHIC, PURD)
Also 83B PR D28 495 Aronson, Bock, Cheng+ (BNL, CHIC, PURD)
PDG 82B PL 111B 70 Roos, Porter, Aguilar-Benitez+ (HELS, CIT, CERN)
BIRULEV 81 NP B182 1 +Dzhordzhadze, Genchev, Grigalashvili+ (JINR)
Also 80 SJNP 31 622 Birulev, Vestergombi, Genchev+ (JINR)
Translated from YAF 31 1204.
CARROLL 80B PRL 44 529 +Chiang, Kycia, Li, Littenberg, Marx+ (BNL, ROCH)
CARROLL 80C PL 96B 407 +Chiang, Kycia, Li, Littenberg, Marx+ (BNL, ROCH)
CARROLL 80D PRL 44 525 +Chiang, Kycia, Li, Littenberg, Marx+ (BNL, ROCH)
CHO 80 PR D22 2688 +Derrick, Miller, Schlereth, Engler+ (ANL, CMU)
MORSE 80 PR D21 1750 +Leipuner, Larsen, Schmidt, Blatt+ (BNL, YALE)
BIRULEV 79 SJNP 29 778 +Vestergombi, Gvakhariya, Genchev+ (JINR)
Translated from YAF 29 1516.

CHRISTENS...	79	PRL 43 1209	Christenson, Goldman, Hummel, Roth+	(NYU)
CHRISTENS...	79B	PRL 43 1212	Christenson, Goldman, Hummel, Roth+	(NYU)
HILL	79	NP B153 39	+Sakitt, Snape, Stevens+	(BNL, SLAC, SBER)
SCHMIDT	79	PRL 43 556	+Blatt, Campbell, Grannan+	(YALE, BNL)
SHOCHET	79	PR D19 1965	+Linsay, Grosso-Pilcher, Frisch+	(EFI, ANL)
Also	77	PRL 39 59	Shochet, Linsay, Grosso-Pilcher+	(EFI, ANL)
ENGLER	78B	PR D18 623	+Keyes, Kraemer, Tanaka, Cho+	(CMU, ANL)
HILL	78	PL 73B 483	+Sakitt, Snape, Stevens+	(BNL, SLAC, SBER)
CHO	77	PR D15 587	+Derrick, Lissauer, Miller, Engler+	(ANL, CMU)
CLARK	77	PR D15 553	+Field, Holley, Johnson, Kerth, Sah, Shen	(LBL)
Also	75	Thesis LBL-4275	Shen	(LBL)
DEVOE	77	PR D16 565	+Cronin, Frisch, Grosso-Pilcher+	(EFI, ANL)
DZHORD...	77	SJNP 26 478	Dzhordzhadze, Kekelidze, Krivokhizhin+	(JINR)
		Translated from YAF 26 910.		
PEACH	77	NP B127 399	+Cameron+	(BGNA, EDIN, GLAS, PISA, RHEL)
BIRULEV	76	SJNP 24 178	+Vestergombi, Vovenko, Votruba+	(JINR)
		Translated from YAF 24 340.		
COOMBES	76	PRL 37 249	+Flexer, Hall, Kennelly, Kirkby+	(STAN, NYU)
DONALDSON	76	PR D14 2839	+Hitlin, Kennelly, Kirkby, Liu+	(SLAC)
Also	74	Thesis SLAC-0184	Donaldson	(SLAC)
FUKUSHIMA	76	PRL 36 348	+Jensen, Surko, Thaler+	(PRIN, MASA)
GJESDAL	76	NP B109 118	+Kamae, Presser, Steffen+	(CERN, HEIDH)
REY	76	PR D13 1161	+Cence, Jones, Parker+	(NDAM, HAWA, LBL)
Also	69	PRL 22 1210	Cence, Jones, Peterson, Stenger+	(HAWA, LRL)
BALDO-...	75	NC 25A 688	Baldo-Ceolin, Bobisut, Calimani+	(PADO, WISC)
BLUMENTHAL	75	PRL 34 164	+Frankel, Nagy+	(PENN, CHIC, TEMP)
BUCHANAN	75	PR D11 457	+Drickey, Pepper, Rudnick+	(UCLA, SLAC, JHU)
CARITHERS	75	PRL 34 1244	+Modis, Nygren, Pun+	(COLU, NYU)
SMITH	75B	Thesis UCSD unpub.		(UCSD)
ALBRECHT	74	PL 48B 393		(JINR, BERL, BUDA, PRAG, SERP, SOFI)
BISI	74	PL 50B 504	+Ferrero	(TORI)
DONALDSON	74	Thesis SLAC-0184		(SLAC)
Also	76	PR D14 2839	Donaldson, Hitlin, Kennelly, Kirkby, Liu+	(SLAC)
DONALDSON	74B	PR D9 2960	+Fryberger, Hitlin, Liu+	(SLAC, UCSC)
Also	73B	PRL 31 337	Donaldson, Fryberger, Hitlin, Liu+	(SLAC, UCSC)
DONALDSON	74C	PRL 33 554	+Hitlin, Kennelly, Kirkby+	(SLAC)
Also	74	Thesis SLAC-0184	Donaldson	(SLAC)
Also	76	PR D14 2839	Donaldson, Hitlin, Kennelly, Kirkby, Liu+	(SLAC)
FIELD	74	SLAC-PUB-1498 unpub.		(SLAC)
GEWENIGER	74	PL 48B 483	+Gjesdal, Kamae, Presser+	(CERN, HEIDH)
Also	74	Thesis CERN Int. 74-4	Luth	(CERN)
GEWENIGER	74B	PL 48B 487	+Gjesdal, Presser+	(CERN, HEIDH)
Also	74B	PL 52B 119	Gjesdal, Presser, Steffen+	(CERN, HEIDH)
GEWENIGER	74C	PL 52B 108	+Gjesdal, Presser+	(CERN, HEIDH)
GJESDAL	74	PL 52B 113	+Presser, Kamae, Steffen+	(CERN, HEIDH)
MESSNER	74	PRL 33 1458	+Franklin, Morse+	(COLO, SLAC, UCSC)
NIEBERGALL	74	PL 49B 103	+Regler, Stier+	(CERN, ORSAY, VIEN)
WANG	74	PR D9 540	+Smith, Whatley, Zorn, Hornbostel	(UMD, BNL)
WILLIAMS	74	PRL 33 240	+Larsen, Leipuner, Sapp, Sessoms+	(BNL, YALE)
ALBROW	73	NP B58 22	+Aston, Barber, Bird, Ellison+	(MCHS, DARE)
ALEXANDER	73B	NP B65 301	+Benary, Borowitz, Lande+	(TELA, HEID)
ANIKINA	73	JINR P1 7539	+Balashov, Bannik+	(JINR)
BARBIELLINI	73	PL 43B 529	+Darriulat, Fainberg+	(CERN)
BRANDENB...	73	PR D8 1978	Brandenburg, Johnson, Leith, Loos+	(SLAC)
CARITHERS	73	PRL 31 1025	+Nygren, Gordon+	(COLU, BNL, CERN)
Also	73B	PRL 30 1336	Carithers, Modis, Nygren+	(COLU, CERN, NYU)
EVANS	73	PR D7 36	+Muir, Peach, Budagov+	(EDIN, CERN)
Also	69	PRL 23 427	Evans, Golden, Muir, Peach+	(EDIN, CERN)
FACKLER	73	PRL 31 847	+Frisch, Martin, Smoot, Sompayrac	(MIT)
FITCH	73	PRL 31 1524	+Hepp, Jensen, Strovink, Webb	(PRIN)
Also	72	Thesis COO-3072-13	Webb	(PRIN)
GINSBERG	73	PR D8 3887	+Smith	(MIT, STON)
HART	73	NP B66 317	+Hutton, Field, Sharp, Blackmore+	(CAVE, RHEL)
MALLARY	73	PR D7 1953	+Binnie, Gallivan, Gomez, Peck, Sciulli+	(CIT)
Also	70	PRL 25 1214	Sciulli, Gallivan, Binnie, Gomez+	(CIT)
MCCARTHY	73	PR D7 687	+Brewer, Budnitz, Entis, Graven, Miller+	(LBL)
Also	72	PL 42B 291	McCarthy, Brewer, Budnitz, Entis, Graven+	(LBL)
Also	71	Thesis LBL-550	McCarthy	(LBL)
MESSNER	73	PRL 30 876	+Morse, Nauenberg, Hitlin+	(COLO, SLAC, UCSC)
PEACH	73	PL 43B 441	+Evans, Muir, Hopkins, Krenz	(EDIN, CERN, AACH)
SANDWEISS	73	PRL 30 1002	+Sunderland, Turner, Willis, Keller	(YALE, ANL)
WILLIAMS	73	PRL 31 1521	+Larsen, Leipuner, Sapp, Sessoms+	(BNL, YALE)
ALBROW	72	NP B44 1	+Aston, Barber, Bird, Ellison+	(MCHS, DARE)
ASHFORD	72	PL 38B 47	+Brown, Masek, Maung, Miller, Ruderman+	(UCSD)
BANNER	72	PRL 28 1597	+Cronin, Hoffman, Knapp, Shochet	(PRIN)
BANNER	72B	PRL 29 237	+Cronin, Hoffman, Knapp, Shochet	(PRIN)
BARMIN	72	SJNP 15 636	+Davidenko, Demidov, Dolgolenko+	(ITEP)
		Translated from YAF 15 1149.		
BARMIN	72B	SJNP 15 638	+Barylov, Davidenko, Demidov+	(ITEP)
		Translated from YAF 15 1152.		
BURGUN	72	NP B50 194	+Lesquoy, Muller, Pauli+	(SACL, CERN, OSLO)
CARNEGIE	72	PR D6 2335	+Cester, Fitch, Strovink, Sulak	(PRIN)
DALLY	72	PL 41B 647	+Innocenti, Seppi+	(SLAC, JHU, UCLA)
Also	70	PL 33B 627	Chien, Cox, Ettlinger+	(JHU, SLAC, UCLA)
Also	71	PL 35B 261	Chien, Cox, Ettlinger+	(JHU, SLAC, UCLA)
GRAHAM	72	NC 9A 166	+Abashian, Jones, Mantsch, Orr+	(ILL, NEAS)
HOLDER	72	PL 40B 141	+Radermacher, Staude+	(AACH, CERN, TORI)
JAMES	72	NP B49 1	+Montanet, Paul, Saetre+	(CERN, SACL, OSLO)
KRENZ	72	LNC 4 213	+Hopkins, Evans, Muir, Peach	(AACH, CERN, EDIN)
MANN	72	PR D6 137	+Kofler, Meisner, Hertzbach+	(MASA, BNL, YALE)
MANTSCH	72	NC 9A 160	+Abashian, Graham, Jones, Orr+	(ILL, NEAS)
MCCARTHY	72	PL 42B 291	+Brewer, Budnitz, Entis, Graven+	(LBL)
METCALF	72	PL 40B 703	+Neuhofer, Niebergall+	(CERN, IPN, WIEN)
NEUHOFER	72	PL 41B 642	+Niebergall, Regler, Stier+	(CERN, ORSAY, VIEN)
PICCIONI	72	PRL 29 1412	+Coombes, Donaldson, Dorfan, Fryberger+	(SLAC)
Also	74	PR D9 2939	Piccioni, Donaldson+	(SLAC, UCSC, COLO)

VOSBURGH	72	PR D6 1834	+Devlin, Esterling, Goz, Bryman+	(RUTG, MASA)
Also	71	PRL 26 866	Vosburgh, Devlin, Esterling, Goz+	(RUTG, MASA)
BALATS	71	SJNP 13 53	+Berezin, Vishnevsky, Galanina+	(ITEP)
		Translated from YAF 13 93.		
BARMIN	71	PL 35B 604	+Barylov, Veselovsky, Davidenko+	(ITEP)
BISI	71	PL 36B 533	+Darriulat, Ferrero, Rubbia+	(AACH, CERN, TORI)
BURGUN	71	LNC 2 1169	+Lesquoy, Muller, Pauli+	(SACL, CERN, OSLO)
CARNEGIE	71	PR D4 1	+Cester, Fitch, Strovink, Sulak	(PRIN)
CHAN	71	Thesis LBL-350		(LBL)
CHIEN	71	PL 35B 261	+Cox, Ettlinger+	(JHU, SLAC, UCLA)
Also	72	PL 41B 647	Dally, Innocenti, Seppi+	(SLAC, JHU, UCLA)
CHO	71	PR D3 1557	+Dralle, Canter, Engler, Fisk+	(CMU, BNL, CASE)
CLARK	71	PRL 26 1667	+Elioff, Field, Frisch, Johnson, Kerth+	(LRL)
Also	70	Thesis UCRL 19709	Johnson	(LRL)
Also	71	Thesis UCRL 20264	Frisch	(LRL)
Also	74	SLAC-PUB-1498 unpub.	Field	(SLAC)
ENSTROM	71	PR D4 2629	+Akavia, Coombes, Dorfan+	(SLAC, STAN)
Also	70	Thesis SLAC-0125	Enstrom	(STAN)
JAMES	71	PL 35B 265	+Montanet, Paul, Pauli+	(CERN, SACL, OSLO)
MEISNER	71	PR D3 59	+Mann, Hertzbach, Kofler+	(MASA, BNL, YALE)
PEACH	71	PL 35B 351	+Evans, Muir, Budagov, Hopkins+	(EDIN, CERN)
REPELLIN	71	PL 36B 603	+Wolff, Chollet, Gaillard, Jane+	(ORSAY, CERN)
WEBBER	71	PR D3 64	+Solmitz, Crawford, Alston-Garnjost	(LRL)
Also	68	PRL 21 498	Webber, Solmitz, Crawford, Alston-Garnjost	(LRL)
Also	69	Thesis UCRL 19226	Webber	(LRL)
WOLFF	71	PL 36B 517	+Chollet, Repellin, Gaillard+	(ORSAY, CERN)
ALBROW	70	PL 33B 516	+Aston, Barber, Bird, Ellison+	(MCHS, DARE)
ARONSON	70	PRL 25 1057	+Ehrlich, Hofer, Jensen+	(EFI, ILLC, SLAC)
BARMIN	70	PL 33B 377	+Barylov, Borisov, Bysheva+	(ITEP, JINR)
BASILE	70	PR D2 78	+Cronin, Thevent, Turlay, Zylberajch+	(SACL)
BECHERRAWY	70	PR D1 1452		(ROCH)
BUCHANAN	70	PL 33B 623	+Drickey, Rudnick, Shepard+	(SLAC, JHU, UCLA)
Also	71	Private Comm.	Cox	
BUDAGOV	70	PR D2 815	+Cundy, Myatt, Nezrick+	(CERN, ORSAY, EPOL)
Also	68B	PL 28B 215	Budagov, Cundy, Myatt+	(CERN, ORSAY, EPOL)
CHIEN	70	PL 33B 627	+Cox, Ettlinger+	(JHU, SLAC, UCLA)
Also	71	Private Comm.	Cox	
CHO	70	PR D1 3031	+Dralle, Canter, Engler, Fisk+	(CMU, BNL, CASE)
Also	67	PRL 19 668	Hill, Luers, Robinson, Sakitt+	(BNL, CMU)
CHOLLET	70	PL 31B 658	+Gaillard, Jane, Ratcliffe, Repellin+	(CERN)
CULLEN	70	PL 32B 523	+Darriulat, Deutsch, Foeth+	(AACH, CERN, TORI)
DARRIULAT	70	PL 33B 249	+Ferrero, Grosso, Holder+	(AACH, CERN, TORI)
FAISSNER	70	NC 70A 57	+Reithler, Thome, Gaillard+	(AACH3, CERN, RHEL)
GINSBERG	70	PR D1 229		(HAIF)
JENSEN	70	Thesis		(EFI)
Also	69	PRL 23 615	Jensen, Aronson, Ehrlich, Fryberger+	(EFI, ILL)
MARX	70	PL 32B 219	+Nygren, Peoples+	(COLU, HARV, CERN)
Also	70B	Thesis Nevis 179	Marx	(COLU)
SCRIBANO	70	PL 32B 224	+Mannelli, Pierazzini, Marx+	(PISA, COLU, HARV)
SMITH	70	PL 32B 133	+Wang, Whatley, Zorn, Hornbostel	(UMD, BNL)
WEBBER	70	PR D1 1967	+Solmitz, Crawford, Alston-Garnjost	(LRL)
Also	69	Thesis UCRL 19226	Webber	(LRL)
BANNER	69	PR 188 2033	+Cronin, Liu, Pilcher	(PRIN)
Also	68	PRL 21 1103	Banner, Cronin, Liu, Pilcher	(PRIN)
Also	68	PRL 21 1107	Cronin, Liu, Pilcher	(PRIN)
BEILLIERE	69	PL 30B 202	+Boutang, Limon	(EPOL)
BENNETT	69	PL 29B 317	+Nygren, Saal, Steinberger+	(COLU, BNL)
BOHM	69B	NP B9 605	+Darriulat, Grosso, Kaftanov+	(CERN)
Also	68	PL 27B 321	Bohm, Darriulat, Grosso, Kaftanov	(CERN)
CENCE	69	PRL 22 1210	+Jones, Peterson, Stenger+	(HAWA, LRL)
EVANS	69	PRL 23 427	+Golden, Muir, Peach+	(EDIN, CERN)
FAISSNER	69	PL 30B 204	+Foeth, Staude, Tittel+	(AACH3, CERN, TORI)
FOETH	69	PL 30B 282	+Holder, Radermacher+	(AACH, CERN, TORI)
GAILLARD	69	NC 59A 453	+Galbraith, Hussri, Jane+	(CERN, RHEL, AACH)
Also	67	PRL 18 20	Gaillard, Krienen, Galbraith+	(CERN, RHEL, AACH)
GOBBI	69B	PRL 22 685	+Green, Hakel, Moffett, Rosen, Goz+	(ROCH, RUTG)
LITTENBERG	69	PRL 22 654	+Field, Piccioni, Mehlhop+	(UCSD)
LONGO	69	PR 181 1808	+Young, Helland	(MICH, UCLA)
PACIOTTI	69	Thesis UCRL 19446		(LRL)
SAAL	69	Thesis		(COLU)
ABRAMS	68B	PR 176 1603	+Abashian, Mischke, Nefkens, Smith+	(ILL)
ARNOLD	68B	PL 28B 56	+Budagov, Cundy, Aubert+	(CERN, ORSAY)
ARONSON	68	PRL 20 287	+Chen	(PRIN)
Also	69	PR 175 1708	Aronson, Chen	(PRIN)
BARTLETT	68	PRL 21 558	+Carnegie, Fitch+	(PRIN)
BASILE	68	PL 26B 542	+Cronin, Thevenet, Turlay+	(SACL)
BASILE	68B	PL 28B 58	+Cronin, Thevenet, Turlay, Zylberajch+	(SACL)
BENNETT	68	PL 27B 244	+Nygren, Steinberger+	(COLU, CERN)
BENNETT	68B	PL 27B 248	+Nygren, Steinberger+	(COLU, CERN)
BLANPIED	68	PRL 21 1650	+Levit, Engels+	(CASE, HARV, MCGI)
BOHM	68B	PL 27B 594	+	
BUDAGOV	68	NC 57A 182	+Burmeister, Cundy+	(CERN, ORSAY, IPNP)
Also	68B	PL 28B 215	Budagov, Cundy, Myatt+	(CERN, ORSAY, EPOL)
JAMES	68	NP B8 365	+Briand	(IPNP, CERN)
Also	68	PRL 21 257	Helland, Longo, Young	(UCLA, MICH)
KULYUKINA	68	JETP 26 20	+Mestvirishvili, Nyagu+	(JINR)
		Translated from ZETF 53 29.		

KUNZ 68 Thesis PU-68-46 (PRIN)
BENNETT 67 PRL 19 993 +Nygren, Saal, Steinberger+ (COLU)
BOTT-... 67 PL 24B 194 Bott-Bodenhausen, DeBouard, Cassel+ (CERN)
BOTT-... 67B PL 24B 438 Bott-Bodenhausen, Debouard, Dekkers+ (CERN)
Also 66B PL 20 212 Bott-Bodenhausen, Debouard, Cassel+ (CERN)
Also 66 PL 23 277 Bott-Bodenhausen, DeBouard, Cassel+ (CERN)
CRONIN 67 PRL 18 25 +Kunz, Risk, Wheeler (PRIN)
Also 68 Thesis unpub. Wheeler (PRIN)
CRONIN 67B Princeton 11/67 +Kunz, Risk, Wheeler (PRIN)
DEBOUARD 67 NC 52A 662 +Dekkers, Jordan, Mermod+ (CERN)
Also 65 PL 15 58 DeBouard, Dekkers, Scharff+ (CERN, ORSAY, MPIM)
DEVLIN 67 PRL 18 54 +Solomon, Shepard, Beall+ (PRIN, UMD)
Also 68 PR 169 1045 Sayer, Beall, Devlin, Shephard+ (UMD, PPA, PRIN)
DORFAN 67 PRL 19 987 +Enstrom, Raymond, Schwartz+ (SLAC, LRL)
FELDMAN 67B PR 155 1611 +Frankel, Highland, Sloan (PENN)
FIRESTONE 67 PRL 18 176 +Kim, Lach, Sandweiss+ (YALE, BNL)
FITCH 67 PR 164 1711 +Roth, Russ, Vernon (PRIN)
GINSBERG 67 PR 162 1570 (MASB)
HAWKINS 67 PR 156 1444 (YALE)
HILL 67 PRL 19 668 +Luers, Robinson, Sakitt+ (BNL, CMU)
HOPKINS 67 PRL 19 185 +Bacon, Eisler (BNL)
KADYK 67 PRL 19 597 +Chan, Drijard, Oren, Sheldon (LRL)
KULYUKINA 67 Preprint +Mestvirishvili, Nyagu+ (JINR)
LOWYS 67 PL 24B 75 +Aubert, Chounet, Pascaud+ (EPOL, ORSAY)
MISCHKE 67 PRL 18 138 +Abashian, Abrams+ (ILL)
NEFKENS 67 PR 157 1233 +Abashian, Abrams, Carpenter, Fisher+ (ILL)
SCHMIDT 67 Thesis Nevis 160 (COLU)
TODOROFF 67 Thesis (ILL)
ALFF-... 66B PL 21 595 Alff-Steinberger, Heuer, Kleinknecht+ (CERN)
ANIKINA 66 SJNP 2 339 +Vardenga, Zhuravleva+ (JINR)
Translated from YAF 2 471.
AUERBACH 66B PRL 17 980 +Mann, McFarlane, Sciulli (PENN)
BASILE 66 Balaton Conf. +Cronin, Thevenet+ (SACL)
BEHR 66 PL 22 540 +Brisson, Petiau+ (EPOL, MILA, PADO, ORSAY)
BOTT-... 66 PL 23 277 Bott-Bodenhausen, DeBouard, Cassel+ (CERN)
CARPENTER 66 PR 142 871 +Abashian, Abrams, Fisher (ILL)
CRIEGEE 66 PRL 17 150 +Fox, Frauenfelder, Hanson, Moscat+ (ILL)
FIRESTONE 66 PRL 16 556 +Kim, Lach, Sandweiss+ (YALE, BNL)
HAWKINS 66 PL 21 238 (YALE)
Also 67 PR 156 1444 Hawkins (YALE)
ANDERSON 65 PRL 14 475 +Crawford, Golden, Stern, Binford+ (LRL, WISC)
ANIKINA 65 JINR P 2488 +Vardenga, Zhuravleva, Kotlya+ (JINR)
ASTBURY 65 PL 16 80 +Finocchiaro, Beusch+ (CERN, ZURI)
Also 65 HPA 39 523 Pepin
ASTBURY 65B PL 18 175 +Michelini, Beusch+ (CERN, ZURI)
ASTBURY 65C PL 18 178 +Michelini, Beusch+ (CERN, ZURI)
AUBERT 65 PL 17 59 +Behr, Canavan, Chounet+ (EPOL, ORSAY)
Also 67 PL 24B 75 Lowys, Aubert, Chounet, Pascaud+ (EPOL, ORSAY)
BALDO-... 65 NC 38 684 Baldo-Ceolin, Calimani, Ciampolillo+ (PADO)
FISHER 65 ANL 7130 83 +Abashian, Abrams, Carpenter+ (ILL)
FITCH 65 PRL 15 73 +Roth, Russ, Vernon (PRIN)
FRANZINI 65 PR 140B 127 +Kirsch, Plano+ (COLU, RUTG)
GALBRAITH 65 PRL 14 383 +Manning, Jones+ (AERE, BRIS, RHEL)
GUIDONI 65 Argonne Conf. 49 +Barnes, Foelsche, Ferbel, Firestone+ (BNL, YALE)
HOPKINS 65 Argonne Conf. 67 +Bacon, Eisler (VAND, RUTG)
ADAIR 64 PL 12 67 +Leipuner (YALE, BNL)
ALEKSANYAN 64B Dubna Conf. 2 102 +Alikhanyan, Vartazaryan+ (YERE)
Also 64 JETP 19 1019 Aleksanyan+ (LEBD, MPEI, YERE)
Translated from ZETF 46 1504.
ANIKINA 64 JETP 19 42 +Zhuravleva+ (GEOR, JINR)
Translated from ZETF 46 59.
CHRISTENS... 64 PRL 13 138 Christenson, Cronin, Fitch, Turlay (PRIN)
FUJII 64 Dubna Conf. 2 146 +Jovanovich, Turkot+ (BNL, UMD, MIT)
LUERS 64 PR 133B 1276 +Mittra, Willis, Yamamoto (BNL)
DARMON 62 PL 3 57 +Rousset, Six (EPOL)
ASTIER 61 Aix Conf. 1 227 +Blaskovic, Rivet, Siaud+ (EPOL)
FITCH 61 NC 22 1160 +Piroue, Perkins (PRIN, LASL)
GOOD 61 PR 124 1223 +Matsen, Muller, Piccioni+ (LRL)
NYAGU 61 PRL 6 552 +Okonov, Petrov, Rosanova, Rusakov (JINR)
Also 61B JETP 13 1138 Nyagu, Okonov, Petrov, Rozanova+ (JINR)
Translated from ZETF 40 1618.
BARDON 58 ANP 5 156 +Lande, Lederman (COLU, BNL)

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GINSBERG	73	PR D8 3887	+Smith	(MIT, STON)
GINSBERG	70	PR D1 229		(HAIF)
HEUSSE	70	LNC 3 449	+Aubert, Pascaud, Vialle	(ORSAY)
CRONIN	68C	Vienna Conf. 281		(PRIN)
RUBBIA	67	PL 24B 531	+Steinberger	(CERN, COLU)
Also	66C	PL 23 167	Rubbia, Steinberger	(CERN, COLU)
Also	66C	PL 20 207	Alff-Steinberger, Heuer, Kleinknecht+	(CERN)
Also	66B	PL 21 595	Alff-Steinberger, Heuer, Kleinknecht+	(CERN)
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MESTVIRISH...	65	JINR P 2449	Mestvirishvili, Nyagu, Petrov, Rusakov+	(JINR)
TRILLING	65B	UCRL 16473		(LRL)
Updated from 1965 Argonne Conference, page 115.				
JOVANOV...	63	BNL Conf. 42	Jovanovich, Fischer, Burris+	(BNL, UMD)