K^0_S

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

K^0_S MEAN LIFE

For earlier measurements, beginning with BOLDT 58B, see our our 1986 edition, Physics Letters **170B** 130 (1986).

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

VALUE (10^{-10} s)	EVTS	DOCUMENT ID		TECN	COMMENT
0.8935±0.0008 OUR FIT					
0.8940±0.0009 OUR AVERAGE					
0.8971±0.0021		BERTANZA	97	NA31	
0.8941±0.0014±0.0009		SCHWINGEN...	95	E773	Δm free, $\phi_{+-}=\phi_{SW}$
0.8929±0.0016		GIBBONS	93	E731	
0.8920±0.0044	214k	GROSSMAN	87	SPEC	
0.881 ±0.009	26k	ARONSON	76	SPEC	
0.8924±0.0032		[1] CARITHERS	75	SPEC	
0.8937±0.0048	6M	GEWENIGER	74B	ASPK	
0.8958±0.0045	50k	[2] SKJEGGEST...	72	HBC	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.905 ±0.007		[3] ARONSON	82B	SPEC	
0.867 ±0.024	2173	[4] FACKLER	73	OSPK	
0.856 ±0.008	19994	[5] DONALD	68B	HBC	
0.872 ±0.009	20000	[5,6] HILL	68	DBC	
0.866 ±0.016		[5] ALFF-...	66B	OSPK	
0.843 ±0.013	5000	[5] KIRSCH	66	HBC	

[1] CARITHERS 75 value is for $m_{K^0_L} - m_{K^0_S}$ $\Delta m = 0.5301 \pm 0.0013$. The Δm dependence of the total decay rate (inverse mean life) is $\Gamma(K^0_S) = \left[(1.122 \pm 0.004) + 0.16(\Delta m - 0.5348)/\Delta m\right]10^{10}$/s, or, in terms of meanlife $\tau_s = 0.8913 \pm 0.0032 - 0.238(\Delta m - 0.5348)$ where Δm and τ_s are in units of $10^{10}\hbar s^{-1}$ and 10^{-10}s respectively.

[2] HILL 68 has been changed by the authors from the published value (0.865 ± 0.009) because of a correction in the shift due to η_{+-}. SKJEGGESTAD 72 and HILL 68 give detailed discussions of systematics encountered in this type of experiment.

[3] ARONSON 82 find that K^0_S mean life may depend on the kaon energy.

[4] FACKLER 73 does not include systematic errors.

[5] Pre-1971 experiments are excluded from the average because of disagreement with later more precise experiments.

[6] HILL 68 has been changed by the authors from the published value (0.865 ± 0.009) because of a correction in the shift due to η_{+-}. SKJEGGESTAD 72 and HILL 68 give detailed discussions of systematics encountered in this type of experiment.

K^0_S DECAY MODES

	Mode		Fraction (Γ_i/Γ)	Scale factor/ Confidence level
Γ_1	$\pi^+\pi^-$		(68.61 ± 0.28) %	S=1.2
Γ_2	$\pi^0\pi^0$		(31.39 ± 0.28) %	S=1.2
Γ_3	$\pi^+\pi^-\gamma$	[a,b]	$(1.78\pm0.05)\times10^{-3}$	
Γ_4	$\gamma\gamma$		$(2.4\pm0.9)\times10^{-6}$	
Γ_5	$\pi^+\pi^-\pi^0$		$(3.2\ ^{+1.2}_{-1.0})\times10^{-7}$	
Γ_6	$3\pi^0$		$<1.4\times10^{-5}$	CL=90%
Γ_7	$\pi^\pm e^\mp\nu_e$	[c]	$(7.2\pm1.4)\times10^{-4}$	
Γ_8	$\pi^\pm\mu^\mp\nu_\mu$	[c]		
	$\Delta S = 1$ weak neutral current (*S1*) modes			
Γ_9	$\mu^+\mu^-$	*S1*	$<3.2\times10^{-7}$	CL=90%
Γ_{10}	e^+e^-	*S1*	$<1.4\times10^{-7}$	CL=90%
Γ_{11}	$\pi^0e^+e^-$	*S1*	$<1.1\times10^{-6}$	CL=90%

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

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

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

CONSTRAINED FIT INFORMATION

An overall fit to 3 branching ratios uses 17 measurements and one constraint to determine 2 parameters. The overall fit has a $\chi^2 =$ 16.5 for 16 degrees of freedom.

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

	x_1
x_2	−100

K^0_S DECAY RATES

$\Gamma(\pi^\pm e^\mp\nu_e)$ — Γ_7

VALUE (10^6 s^{-1})	EVTS	DOCUMENT ID	TECN	COMMENT
8.1 ±1.6	75	[7] AKHMETSHIN 99	CMD2	Tagged K^0_S using $\phi\to K^0_L K^0_S$

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

7.50±0.08	[8] PDG	98		
seen	BURGUN	72	HBC	$K^+ p \to K^0 p \pi^+$
9.3 ±2.5	AUBERT	65	HLBC	$\Delta S = \Delta Q$, CP cons. not assumed

[7] AKHMETSHIN 99 is from a measured branching ratio $B(K^0_S \to \pi e \nu_e) = (7.2 \pm 1.4) \times 10^{-4}$ and $\tau_{K^0_S} = (0.8934 \pm 0.0008) \times 10^{-10}$ s.

[8] PDG 98 from K^0_L measurements, assuming that $\Delta S = \Delta Q$ in K^0 decay so that $\Gamma(K^0_S \to \pi^\pm e^\mp \nu_e) = \Gamma(K^0_L \to \pi^\pm e^\mp \nu_e)$.

$\Gamma(\pi^\pm \mu^\mp \nu_\mu)$ — Γ_8

VALUE (10^6 s^{-1})	DOCUMENT ID	
• • • We do not use the following data for averages, fits, limits, etc. • • •		
5.25±0.07	[9] PDG	98

[9] PDG 98 from K^0_L measurements, assuming that $\Delta S = \Delta Q$ in K^0 decay so that $\Gamma(K^0_S \to \pi^\pm \mu^\mp \nu_\mu) = \Gamma(K^0_L \to \pi^\pm \mu^\mp \nu_\mu)$.

K^0_S BRANCHING RATIOS

$\Gamma(\pi^+\pi^-)/\Gamma_{\text{total}}$ — Γ_1/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.6861±0.0028 OUR FIT Error includes scale factor of 1.2.					
0.671 ±0.010 OUR AVERAGE					
0.670 ±0.010	3447	[10] DOYLE	69	HBC	$\pi^- p \to \Lambda K^0$
0.70 ±0.08		COLUMBIA	60B	HBC	
0.68 ±0.04		CRAWFORD	59B	HBC	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.740 ±0.024		[10] ANDERSON	62B	HBC	

[10] Anderson result not published, events added to Doyle sample.

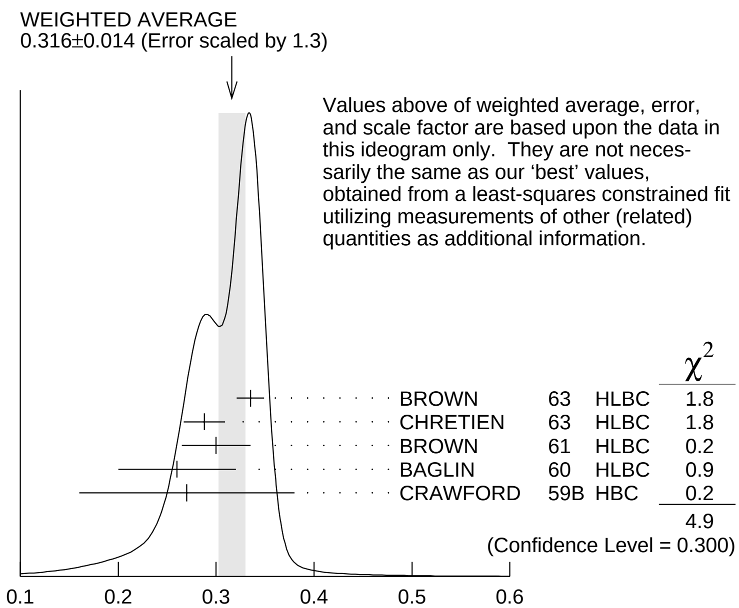
$\Gamma(\pi^+\pi^-)/\Gamma(\pi^0\pi^0)$ — Γ_1/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
2.186±0.028 OUR FIT Error includes scale factor of 1.2.					
2.197±0.026 OUR AVERAGE					
2.11 ±0.09	1315	EVERHART	76	WIRE	$\pi^- p \to \Lambda K^0$
2.169±0.094	16k	COWELL	74	OSPK	$\pi^- p \to \Lambda K^0$
2.16 ±0.08	4799	HILL	73	DBC	$K^+ d \to K^0 p p$
2.22 ±0.10	3068	[11] ALITTI	72	HBC	$K^+ p \to \pi^+ p K^0$
2.22 ±0.08	6380	MORSE	72B	DBC	$K^+ n \to K^0 p$
2.10 ±0.11	701	[12] NAGY	72	HLBC	$K^+ n \to K^0 p$
2.22 ±0.095	6150	[13] BALTAY	71	HBC	$K p \to K^0$ neutrals
2.282±0.043	7944	[14] MOFFETT	70	OSPK	$K^+ n \to K^0 p$
2.10 ±0.06	3700	MORFIN	69	HLBC	$K^+ n \to K^0 p$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.12 ±0.17	267	[12] BOZOKI	69	HLBC	
2.285±0.055	3016	[14] GOBBI	69	OSPK	$K^+ n \to K^0 p$

[11] The directly measured quantity is $K^0_S \to \pi^+\pi^-$/all $K^0 = 0.345 \pm 0.005$.
[12] NAGY 72 is a final result which includes BOZOKI 69.
[13] The directly measured quantity is $K^0_S \to \pi^+\pi^-$/all $\overline{K}^0 = 0.345 \pm 0.005$.
[14] MOFFETT 70 is a final result which includes GOBBI 69.

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

VALUE	EVTS	DOCUMENT ID		TECN
0.3139±0.0028 OUR FIT Error includes scale factor of 1.2.				
0.316 ±0.014 OUR AVERAGE Error includes scale factor of 1.3. See the ideogram below.				
0.335 ±0.014	1066	BROWN	63	HLBC
0.288 ±0.021	198	CHRETIEN	63	HLBC
0.30 ±0.035		BROWN	61	HLBC
0.26 ±0.06		BAGLIN	60	HLBC
0.27 ±0.11		CRAWFORD	59B	HBC



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

$\Gamma(\pi^+\pi^-\gamma)/\Gamma(\pi^+\pi^-)$ — Γ_3/Γ_1

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
2.60±0.08 OUR AVERAGE					
2.56±0.09	1286	RAMBERG	93	E731	p_γ >50 MeV/c
2.68±0.15		[15] TAUREG	76	SPEC	p_γ >50 MeV/c
2.8 ±0.6		[16] BURGUN	73	HBC	p_γ >50 MeV/c
3.3 ±1.2	10	WEBBER	70	HBC	p_γ >50 MeV/c
no ratio given	27	BELLOTTI	66	HBC	p_γ >50 MeV/c

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

7.10±0.22	3723		RAMBERG	93	E731	p_γ >20 MeV/c
3.0 ±0.6	29	[17]	BOBISUT	74	HLBC	p_γ >40 MeV/c

[15] TAUREG 76 find direct emission contribution <0.06, CL = 90%.
[16] BURGUN 73 estimates that direct emission contribution is 0.3 ± 0.6.
[17] BOBISUT 74 not included in average because p_γ cut differs. Estimates direct emission contribution to be 0.5 or less, CL = 95%.

$\Gamma(\gamma\gamma)/\Gamma_{total}$ Γ_4/Γ

VALUE (units 10^{-6})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
2.4±0.9		35	[18] BARR	95B	NA31	
• • • We do not use the following data for averages, fits, limits, etc. • • •						
2.2±1.1		16	[19] BARR	95B	NA31	
< 13	90		BALATS	89	SPEC	
2.4±1.2		19	BURKHARDT	87	NA31	
< 133	90		BARMIN	86B	XEBC	
< 200	90		VASSERMAN	86	CALO	$\phi \to K^0_S K^0_L$
< 400	90	0	BARMIN	73B	HLBC	
< 710	90	0	[20] BANNER	72B	OSPK	
< 2000	90	0	MORSE	72B	DBC	
< 2200	90	0	[20] REPELLIN	71	OSPK	
<21000	90	0	[20] BANNER	69	OSPK	

[18] BARR 95B quotes this as the combined BARR 95B + BURKHARDT 87 result after rescaling BURKHARDT 87 to use same branching ratios and lifetimes as BARR 95B.
[19] BARR 95B result is calculated using B($K_L \to \gamma\gamma$) = (5.86 ± 0.17) × 10^{-4}.
[20] These limits are for maximum interference in K^0_S-K^0_L to 2γ's.

$\Gamma(\pi^+\pi^-\pi^0)/\Gamma_{total}$ Γ_5/Γ

VALUE (units 10^{-7})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$3.2^{+1.2}_{-1.0}$ OUR AVERAGE						
$2.5^{+1.3}_{-1.0}{}^{+0.5}_{-0.6}$		500k	[21] ADLER	97B	CPLR	
$4.8^{+2.2}_{-1.6}\pm1.1$			[22] ZOU	96	E621	
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$4.1^{+2.5}_{-1.9}{}^{+0.5}_{-0.6}$			[23] ADLER	96E	CPLR	Sup. by ADLER 97B
$3.9^{+5.4}_{-1.8}{}^{+0.9}_{-0.7}$			[24] THOMSON	94	E621	Sup. by ZOU 96
<490	90		[25] BARMIN	85	HLBC	
<850	90		METCALF	72	ASPK	

[21] ADLER 97B find the *CP*-conserving parameters Re(λ) = (28 ± 7 ± 3) × 10^{-3}, Im(λ) = (−10 ± 8 ± 2) × 10^{-3}. They estimate B($K^0_S \to \pi^+\pi^-\pi^0$) from Re($\lambda$) and the K^0_L decay parameters. See also ANGELOPOULOS 98C.
[22] ZOU 96 is from the the measured quantities $|\rho_{+-0}| = 0.039^{+0.009}_{-0.006} \pm 0.005$ and $\phi_\rho = (-9 \pm 18)^\circ$.
[23] ADLER 96E is from the measured quantities Re(λ) = $0.036 \pm 0.010^{+0.002}_{-0.003}$ and Im(λ) consistent with zero. Note that the quantity λ is the same as ρ_{+-0} used in other footnotes.

[24] THOMSON 94 calculates this branching ratio from their measurements $|\rho_{+-0}| = 0.035^{+0.019}_{-0.011} \pm 0.004$ and $\phi_\rho = (-59 \pm 48)^\circ$ where $|\rho_{+-0}| e^{i\phi_\rho} = A(K^0_S \to \pi^+\pi^-\pi^0, I=2)/A(K^0_L \to \pi^+\pi^-\pi^0)$.

[25] BARMIN 85 assumes that *CP*-allowed and *CP*-violating amplitudes are equally suppressed.

$\Gamma(3\pi^0)/\Gamma_{total}$ — Γ_6/Γ

Violates *CP* conservation.

VALUE (units 10^{-5})	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*
< 1.4	90	7M	ACHASOV	99D	SND
• • • We do not use the following data for averages, fits, limits, etc. • • •					
< 1.9	90	17300	[26] ANGELOPO...	98B	CPLR
< 3.7	90		BARMIN	83	HLBC
<43	90		BARMIN	73	HLBC

[26] ANGELOPOULOS 98B is from $\text{Im}(\eta_{000}) = -0.05 \pm 0.12 \pm 0.05$, assuming $\text{Re}(\eta_{000}) = \text{Re}(\epsilon) = 1.635 \times 10^{-3}$ and using the value $B(K^0_L \to \pi^0\pi^0\pi^0) = 0.2112 \pm 0.0027$.

$\Gamma(\pi^\pm e^\mp \nu_e)/\Gamma_{total}$ — Γ_7/Γ

VALUE (units 10^{-4})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
7.2±1.4	75	AKHMETSHIN	99	CMD2	Tagged K^0_S using $\phi \to K^0_L K^0_S$

$\Gamma(\mu^+\mu^-)/\Gamma_{total}$ — Γ_9/Γ

Test for $\Delta S = 1$ weak neutral current. Allowed by first-order weak interaction combined with electromagnetic interaction.

VALUE (units 10^{-5})	*CL%*	*DOCUMENT ID*		*TECN*
< 0.032	90	GJESDAL	73	ASPK
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<14	90	BOHM	69	OSPK
< 0.7	90	HYAMS	69B	OSPK
<22	90	[27] STUTZKE	69	OSPK
< 7	90	BOTT-...	67	OSPK

[27] Value calculated by us, using 2.3 instead of 1 event, 90% CL.

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

Test for $\Delta S = 1$ weak neutral current. Allowed by first-order weak interaction combined with electromagnetic interaction.

VALUE (units 10^{-7})	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
< 1.4	90		ANGELOPO...	97	CPLR	
• • • We do not use the following data for averages, fits, limits, etc. • • •						
< 28	90	0	BLICK	94	CNTR	Hyperon facility
< 100	90		BARMIN	86	XEBC	
<1100	90		BITSADZE	86	CALO	
<3400	90		BOHM	69	OSPK	

$\Gamma(\pi^0 e^+ e^-)/\Gamma_{\text{total}}$ **Γ_{11}/Γ**

Test for $\Delta S = 1$ weak neutral current. Allowed by first-order weak interaction combined with electromagnetic interaction.

VALUE (units 10^{-6})	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*
< 1.1	90	0	BARR	93B	NA31
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<45	90		GIBBONS	88	E731

CP VIOLATION IN $K_S \to 3\pi$

Written 1996 by T. Nakada (Paul Scherrer Institute) and L. Wolfenstein (Carnegie-Mellon University).

The possible final states for the decay $K^0 \to \pi^+\pi^-\pi^0$ have isospin $I = 0$, 1, 2, and 3. The $I = 0$ and $I = 2$ states have $CP = +1$ and K_S can decay into them without violating CP symmetry, but they are expected to be strongly suppressed by centrifugal barrier effects. The $I = 1$ and $I = 3$ states, which have no centrifugal barrier, have $CP = -1$ so that the K_S decay to these requires CP violation.

In order to see CP violation in $K_S \to \pi^+\pi^-\pi^0$, it is necessary to observe the interference between K_S and K_L decay, which determines the amplitude ratio

$$\eta_{+-0} = \frac{A(K_S \to \pi^+\pi^-\pi^0)}{A(K_L \to \pi^+\pi^-\pi^0)} \ . \tag{1}$$

If η_{+-0} is obtained from an integration over the whole Dalitz plot, there is no contribution from the $I = 0$ and $I = 2$ final states and a nonzero value of η_{+-0} is entirely due to CP violation.

Only $I = 1$ and $I = 3$ states, which are $CP = -1$, are allowed for $K^0 \to \pi^0\pi^0\pi^0$ decays and the decay of K_S into $3\pi^0$ is an unambiguous sign of CP violation. Similarly to η_{+-0}, η_{000} is defined as

$$\eta_{000} = \frac{A(K_S \to \pi^0\pi^0\pi^0)}{A(K_L \to \pi^0\pi^0\pi^0)} \ . \tag{2}$$

If one assumes that CPT invariance holds and that there are no transitions to $I = 3$ (or to nonsymmetric $I = 1$ states), it can be shown that

$$\eta_{+-0} = \eta_{000} = \epsilon + i\frac{\text{Im } a_1}{\text{Re } a_1} \ . \tag{3}$$

With the Wu-Yang phase convention, a_1 is the weak decay amplitude for K^0 into $I = 1$ final states; ϵ is determined from CP violation in $K_L \rightarrow 2\pi$ decays. The real parts of η_{+-0} and η_{000} are equal to Re(ϵ). Since currently-known upper limits on $|\eta_{+-0}|$ and $|\eta_{000}|$ are much larger than $|\epsilon|$, they can be interpreted as upper limits on Im(η_{+-0}) and Im(η_{000}) and so as limits on the CP-violating phase of the decay amplitude a_1.

CP-VIOLATION PARAMETERS IN K^0_S DECAY

$\text{Im}(\eta_{+-0})^2 = \Gamma(K^0_S \rightarrow \pi^+\pi^-\pi^0$, *CP*-violating) / $\Gamma(K^0_L \rightarrow \pi^+\pi^-\pi^0)$

CPT assumed valid (i.e. Re(η_{+-0}) $\simeq$ 0).

VALUE	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<0.23	90	601	[28] BARMIN	85	HLBC	
<1.2	90	192	BALDO-...	75	HLBC	
<0.71	90	148	MALLARY	73	OSPK	Re(A)=−0.05 ± 0.17
<0.66	90	180	JAMES	72	HBC	
<1.2	90	99	JONES	72	OSPK	
<0.12	90	384	METCALF	72	ASPK	
<1.2	90	99	CHO	71	DBC	
<1.0	90	98	JAMES	71	HBC	Incl. in JAMES 72
<1.2	95	50	[29] MEISNER	71	HBC	CL=90% not avail.
<0.8	90	71	WEBBER	70	HBC	
<0.45	90		BEHR	66	HLBC	
<3.8	90	18	ANDERSON	65	HBC	Incl. in WEBBER 70

[28] BARMIN 85 find Re(η_{+-0}) = (0.05 ± 0.17) and Im(η_{+-0}) = (0.15 ± 0.33). Includes events of BALDO-CEOLIN 75.

[29] These authors find Re(A) = 2.75 ± 0.65, above value at Re(A) = 0.

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

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
$\mathbf{-0.002\pm0.009^{+0.002}_{-0.001}}$	500k	[30] ADLER 97B	CPLR	
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$-0.002\pm0.018\pm0.003$	137k	[31] ADLER 96D	CPLR	Sup. by ADLER 97B
$-0.015\pm0.017\pm0.025$	272k	[32] ZOU 94	SPEC	

[30] ADLER 97B also find $\mathrm{Re}(\eta_{+-0}) = -0.002 \pm 0.007^{+0.004}_{-0.001}$. See also ANGELOPOULOS 98C.

[31] The ADLER 96D fit also yields $\mathrm{Re}(\eta_{+-0}) = 0.006 \pm 0.013 \pm 0.001$ with a correlation $+0.66$ between real and imaginary parts. Their results correspond to $|\eta_{+-0}| < 0.037$ with 90% CL.

[32] ZOU 94 use theoretical constraint $\mathrm{Re}(\eta_{+-0}) = \mathrm{Re}(\epsilon) = 0.0016$. Without this constraint they find $\mathrm{Im}(\eta_{+-0}) = 0.019 \pm 0.061$ and $\mathrm{Re}(\eta_{+-0}) = 0.019 \pm 0.027$.

$\mathrm{Im}(\eta_{000})^2 = \Gamma(K^0_S \to 3\pi^0) / \Gamma(K^0_L \to 3\pi^0)$

CPT assumed valid (i.e. $\mathrm{Re}(\eta_{000}) \simeq 0$). This limit determines branching ratio $\Gamma(3\pi^0)/\Gamma_{\mathrm{total}}$ above.

VALUE	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.1	90	632	[33] BARMIN 83	HLBC	
<0.28	90		[34] GJESDAL 74B	SPEC	Indirect meas.
<1.2	90	22	BARMIN 73	HLBC	

[33] BARMIN 83 find $\mathrm{Re}(\eta_{000}) = (-0.08\pm0.18)$ and $\mathrm{Im}(\eta_{000}) = (-0.05\pm0.27)$. Assuming *CPT* invariance they obtain the limit quoted above.

[34] GJESDAL 74B uses $K2\pi$, $K_{\mu3}$, and K_{e3} decay results, unitarity, and *CPT*. Calculates $|(\eta_{000})| = 0.26 \pm 0.20$. We convert to upper limit.

$\mathrm{Im}(\eta_{000}) = \mathrm{Im}(A(K^0_S \to \pi^0\pi^0\pi^0)/A(K^0_L \to \pi^0\pi^0\pi^0))$

$K^0_S \to \pi^0\pi^0\pi^0$ violates *CP* conservation, in contrast to $K^0_S \to \pi^+\pi^-\pi^0$ which has a *CP*-conserving part.

VALUE	EVTS	DOCUMENT ID	TECN
$\mathbf{-0.05\pm0.12\pm0.05}$	17300	[35] ANGELOPO... 98B	CPLR

[35] ANGELOPOULOS 98B assumes $\mathrm{Re}(\eta_{000}) = \mathrm{Re}(\epsilon) = 1.635 \times 10^{-3}$. Without assuming *CPT* invariance, they obtain $\mathrm{Re}(\eta_{000}) = 0.18 \pm 0.14 \pm 0.06$ and $\mathrm{Im}(\eta_{000}) = 0.15 \pm 0.20 \pm 0.03$.

K^0_S REFERENCES

ACHASOV	99D	PL B459 674	M.N. Achasov *et al.*	
AKHMETSHIN	99	PL B456 90	R.R. Akhmetshin *et al.*	(CMD-2 Collab.)
ANGELOPO...	98B	PL B425 391	A. Angelopoulos *et al.*	(CPLEAR Collab.)
ANGELOPO...	98C	EPJ C5 389	A. Angelopoulos *et al.*	(CPLEAR Collab.)
PDG	98	EPJ C3 1	C. Caso *et al.*	
ADLER	97B	PL B407 193	R. Adler *et al.*	(CPLEAR Collab.)
ANGELOPO...	97	PL B413 232	A. Angelopoulos *et al.*	(CPLEAR Collab.)
BERTANZA	97	ZPHY C73 629	L. Bertanza	(PISA, CERN, EDIN, MANZ, ORSAY+)
ADLER	96D	PL B370 167	R. Adler *et al.*	(CPLEAR Collab.)
ADLER	96E	PL B374 313	R. Adler *et al.*	(CPLEAR Collab.)
ZOU	96	PL B369 362	Y. Zou *et al.*	(RUTG, MINN, MICH)
BARR	95B	PL B351 579	G.D. Barr *et al.*	(CERN, EDIN, MANZ, LALO+)
SCHWINGEN...	95	PRL 74 4376	B. Schwingenheuer *et al.*	(EFI, CHIC+)
BLICK	94	PL B334 234	A.M. Blick *et al.*	(SERP, JINR)
THOMSON	94	PL B337 411	G.B. Thomson *et al.*	(RUTG, MINN, MICH)
ZOU	94	PL B329 519	Y. Zou *et al.*	(RUTG, MINN, MICH)
BARR	93B	PL B304 381	G.D. Barr *et al.*	(CERN, EDIN, MANZ, LALO+)
GIBBONS	93	PRL 70 1199	L.K. Gibbons *et al.*	(FNAL E731 Collab.)
Also	97	PR D55 6625	L.K. Gibbons *et al.*	(FNAL E731 Collab.)
RAMBERG	93	PRL 70 2525	E. Ramberg *et al.*	(FNAL E731 Collab.)
BALATS	89	SJNP 49 828 Translated from YAF 49 1332.	M.Y. Balats *et al.*	(ITEP)
GIBBONS	88	PRL 61 2661	L.K. Gibbons *et al.*	(FNAL E731 Collab.)
BURKHARDT	87	PL B199 139	H. Burkhardt *et al.*	(CERN, EDIN, MANZ+)
GROSSMAN	87	PRL 59 18	N. Grossman *et al.*	(MINN, MICH, RUTG)
BARMIN	86	SJNP 44 622 Translated from YAF 44 965.	V.V. Barmin *et al.*	(ITEP)
BARMIN	86B	NC 96A 159	V.V. Barmin *et al.*	(ITEP, PADO)
BITSADZE	86	PL 167B 138	G.S. Bitsadze, Y.A. Budagov	(CMNS, SOFI, SERP+)
PDG	86B	PL 170B 130	M. Aguilar-Benitez *et al.*	(CERN, CIT+)
VASSERMAN	86	JETPL 43 588 Translated from ZETFP 43 457.	I.B. Vasserman *et al.*	(NOVO)
BARMIN	85	NC 85A 67	V.V. Barmin *et al.*	(ITEP, PADO)
Also	85B	SJNP 41 759 Translated from YAF 41 1187.	V.V. Barmin *et al.*	(ITEP)
BARMIN	83	PL 128B 129	V.V. Barmin *et al.*	(ITEP, PADO)
Also	84	SJNP 39 269 Translated from YAF 39 428.	V.V. Barmin *et al.*	(ITEP, PADO)
ARONSON	82	PRL 48 1078	S.H. Aronson *et al.*	(BNL, CHIC, STAN+)
ARONSON	82B	PRL 48 1306	S.H. Aronson *et al.*	(BNL, CHIC, PURD)
Also	82B	PL 116B 73	E. Fischbach *et al.*	(PURD, BNL, CHIC)
Also	83	PR D28 476	S.H. Aronson *et al.*	(BNL, CHIC, PURD)
Also	83B	PR D28 495	S.H. Aronson *et al.*	(BNL, CHIC, PURD)
ARONSON	76	NC 32A 236	S.H. Aronson *et al.*	(WISC, EFI, UCSD+)
EVERHART	76	PR D14 661	G.C. Everhart *et al.*	(PENN)
TAUREG	76	PL 65B 92	H. Taureg *et al.*	(HEIDH, CERN, DORT)
BALDO-...	75	NC 25A 688	M. Baldo-Ceolin *et al.*	(PADO, WISC)
CARITHERS	75	PRL 34 1244	W.C.J. Carithers *et al.*	(COLU, NYU)
BOBISUT	74	LNC 11 646	F. Bobisut *et al.*	(PADO)
COWELL	74	PR D10 2083	P.L. Cowell *et al.*	(STON, COLU)
GEWENIGER	74B	PL 48B 487	C. Geweniger *et al.*	(CERN, HEIDH)
GJESDAL	74B	PL 52B 119	S. Gjesdal *et al.*	(CERN, HEIDH)
BARMIN	73	PL 46B 465	V.V. Barmin *et al.*	(ITEP)
BARMIN	73B	PL 47B 463	V.V. Barmin *et al.*	(ITEP)
BURGUN	73	PL 46B 481	G. Burgun *et al.*	(SACL, CERN)
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MALLARY	73	PR D7 1953	M.L. Mallary *et al.*	(CIT)
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BANNER	72B	PRL 29 237	M. Banner *et al.*	(PRIN)
BURGUN	72	NP B50 194	G. Burgun *et al.*	(SACL, CERN, OSLO)
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JONES	72	NC 9A 151	L.H. Jones *et al.*	(ILL)
METCALF	72	PL 40B 703	M. Metcalf *et al.*	(CERN, IPN, WIEN)

MORSE	72B	PRL 28 388	R. Morse *et al.*	(COLO, PRIN, UMD)
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