$D_s^\pm$

$I(J^P) = 0(0^-)$

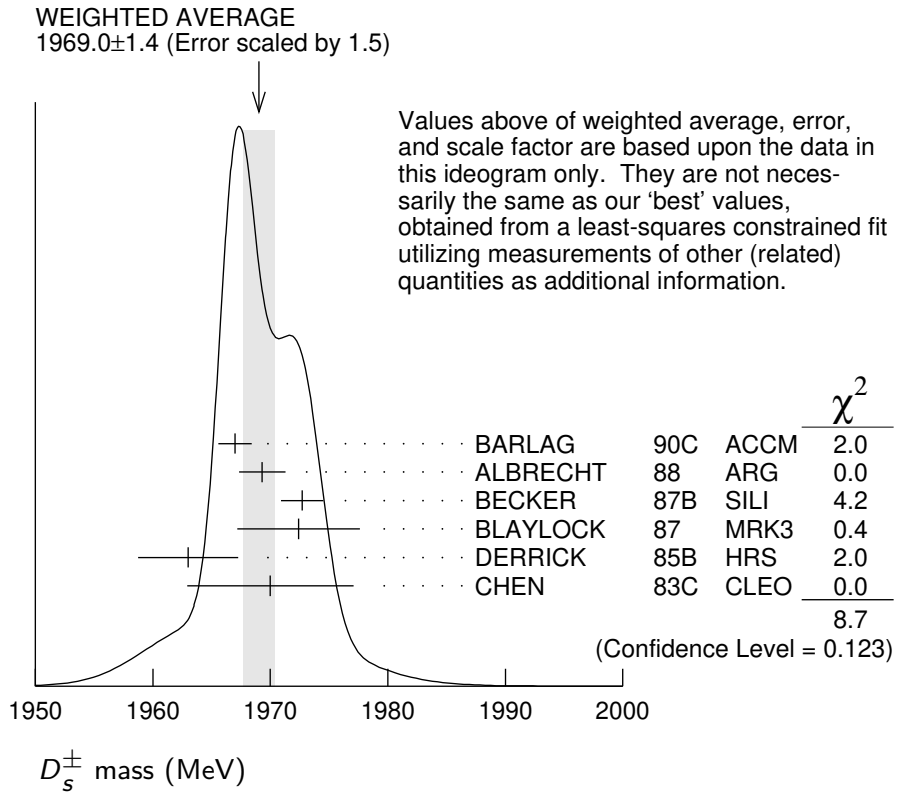
The angular distributions of the decays of the ϕ and $\overline{K}^*(892)^0$ in the $\phi\pi^+$ and $K^+\overline{K}^*(892)^0$ modes strongly indicate that the spin is zero. The parity given is that expected of a $c\overline{s}$ ground state.

$D_s^\pm$ MASS

The fit includes $D^\pm$, D^0, $D_s^\pm$, $D^{*\pm}$, D^{*0}, and $D_s^{*\pm}$ mass and mass difference measurements. Measurements of the $D_s^\pm$ mass with an error greater than 10 MeV are omitted from the fit and average. A number of early measurements have been omitted altogether.

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1968.49± 0.34 OUR FIT Error includes scale factor of 1.3.					
1969.0 ± 1.4 OUR AVERAGE Error includes scale factor of 1.5. See the ideogram below.					
1967.0 ± 1.0 ± 1.0	54	BARLAG	90C	ACCM	π^- Cu 230 GeV
1969.3 ± 1.4 ± 1.4		ALBRECHT	88	ARG	e^+e^- 9.4–10.6 GeV
1972.7 ± 1.5 ± 1.0	21	BECKER	87B	SILI	200 GeV π,K,p
1972.4 ± 3.7 ± 3.7	27	BLAYLOCK	87	MRK3	e^+e^- 4.14 GeV
1963 ± 3 ± 3	30	DERRICK	85B	HRS	e^+e^- 29 GeV
1970 ± 5 ± 5	104	CHEN	83C	CLEO	e^+e^- 10.5 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1968.3 ± 0.7 ± 0.7	290	[1] ANJOS	88	E691	Photoproduction
1980 ±15	6	USHIDA	86	EMUL	ν wideband
1973.6 ± 2.6 ± 3.0	163	ALBRECHT	85D	ARG	e^+e^- 10 GeV
1948 ±28 ±10	65	AIHARA	84D	TPC	e^+e^- 29 GeV
1975 ± 9 ±10	49	ALTHOFF	84	TASS	e^+e^- 14–25 GeV
1975 ± 4	3	BAILEY	84	ACCM	hadron$^+$ Be $\rightarrow$ $\phi\pi^+$ X

[1] ANJOS 88 enters the fit via $m_{D_s^\pm} - m_{D^\pm}$ (see below).



$m_{D_s^\pm} - m_{D^\pm}$

The fit includes $D^\pm$, D^0, $D_s^\pm$, $D^{*\pm}$, D^{*0}, and $D_s^{*\pm}$ mass and mass difference measurements.

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
98.87±0.30 OUR FIT	Error includes scale factor of 1.4.				
98.85±0.25 OUR AVERAGE	Error includes scale factor of 1.1.				
99.41±0.38±0.21		ACOSTA	03D	CDF2	$\overline{p}p$, $\sqrt{s}$= 1.96 TeV
98.4 ±0.1 ±0.3	48k	AUBERT	02G	BABR	$e^+e^- \approx \Upsilon(4S)$
99.5 ±0.6 ±0.3		BROWN	94	CLE2	$e^+e^- \approx \Upsilon(4S)$
98.5 ±1.5	555	CHEN	89	CLEO	e^+e^- 10.5 GeV
99.0 ±0.8	290	ANJOS	88	E691	Photoproduction

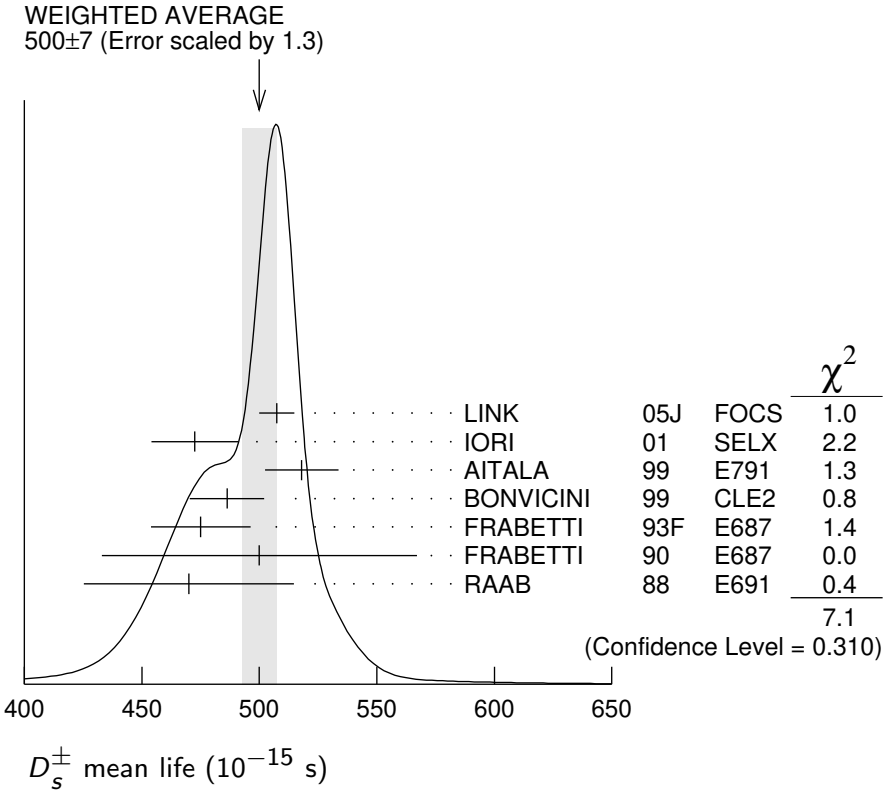
$D_s^\pm$ MEAN LIFE

Measurements with an error greater than 100×10^{-15} s or with fewer than 100 events have been omitted from the Listings.

VALUE (10^{-15} s)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
500 ± 7 OUR AVERAGE	Error includes scale factor of 1.3. See the ideogram below.				
507.4± 5.5± 5.1	13.6k	LINK	05J	FOCS	$\Phi\pi^+$ and $\overline{K}^{*0}K^+$
472.5±17.2± 6.6	760	IORI	01	SELX	600 GeV Σ^-, π^-, p
518 ±14 ± 7	1662	AITALA	99	E791	π^- nucleus, 500 GeV

$486.3 \pm 15.0^{+\ 4.9}_{-\ 5.1}$			2167	[2] BONVICINI	99	CLE2	$e^+e^- \approx \Upsilon(4S)$
475	± 20	$\pm\ 7$	900	FRABETTI	93F	E687	γBe, $\phi\pi^+$
500	± 60	± 30	104	FRABETTI	90	E687	γBe, $\phi\pi^+$
470	± 40	± 20	228	RAAB	88	E691	Photoproduction

[2] BONVICINI 99 obtains 1.19 $\pm$ 0.04 for the ratio of D_s^+ to D^0 lifetimes.



D_s^+ DECAY MODES

Unless otherwise noted, the branching fractions for modes with a resonance in the final state include all the decay modes of the resonance. D_s^- modes are charge conjugates of the modes below.

	Mode	Fraction (Γ_i/Γ)	Scale factor/ Confidence level
	Inclusive modes		
Γ_1	K^- anything	(13 $^{+14}_{-12}$) %	
Γ_2	$\overline{K}^0$ anything + K^0 anything	(39 ± 28) %	
Γ_3	K^+ anything	(20 $^{+18}_{-14}$) %	
Γ_4	(non-K $\overline{K}$) anything	(64 ± 17) %	

Γ_5	η anything	[a]	(24 $\pm$ 4) %	
Γ_6	η' anything		(8.7 $\pm$ 2.1) %	
Γ_7	ϕ anything		(16.1 $\pm$ 1.6) %	
Γ_8	e^+ anything		(8 $^{+\ 6}_{-\ 5}$) %	

Leptonic and semileptonic modes

Γ_9	$\mu^+\nu_\mu$		(6.3 $\pm$ 1.8) $\times 10^{-3}$	S=1.4
Γ_{10}	$\tau^+\nu_\tau$		(6.4 $\pm$ 1.5) %	
Γ_{11}	$\phi\ell^+\nu_\ell$	[b]	(2.49$\pm$ 0.28) %	
Γ_{12}	$\eta\ell^+\nu_\ell$ + $\eta'(958)\ell^+\nu_\ell$	[b]	(4.3 $\pm$ 0.8) %	
Γ_{13}	$\eta\ell^+\nu_\ell$	[b]	(3.2 $\pm$ 0.6) %	
Γ_{14}	$\eta'(958)\ell^+\nu_\ell$	[b]	(1.11$\pm$ 0.34) %	

Hadronic modes with a $K\overline{K}$ pair

Γ_{15}	$K^+\overline{K}^0$		(4.5 $\pm$ 0.8) %	
Γ_{16}	$K^+K^-\pi^+$	[c]	(5.3 $\pm$ 0.8) %	
Γ_{17}	$\phi\pi^+$	[d]	(4.5 $\pm$ 0.4) %	
Γ_{18}	$\phi\pi^+$, $\phi\to K^+K^-$		(2.20$\pm$ 0.20) %	
Γ_{19}	$K^+\overline{K}^*(892)^0$			
Γ_{20}	$K^+\overline{K}^*(892)^0$, $\overline{K}^{*0}\to K^-\pi^+$		(2.5 $\pm$ 0.5) %	
Γ_{21}	$f_0(980)\pi^+$, $f_0\to K^+K^-$		(5.8 $\pm$ 2.5) $\times 10^{-3}$	
Γ_{22}	$K^+\overline{K}_0^*(1430)^0$, $\overline{K}_0^*\to K^-\pi^+$		(4.9 $\pm$ 2.5) $\times 10^{-3}$	
Γ_{23}	$f_0(1710)\pi^+$, $f_0\to K^+K^-$			
Γ_{24}	$K^+K^-\pi^+$ nonresonant			
Γ_{25}	$K^0\overline{K}^0\pi^+$		—	
Γ_{26}	$K^*(892)^+\overline{K}^0$	[d]	(5.4 $\pm$ 1.2) %	
Γ_{27}	$K^+K^-\pi^+\pi^0$		—	
Γ_{28}	$\phi\pi^+\pi^0$, $\phi\to K^+K^-$		(5.3 $\pm$ 2.5) %	
Γ_{29}	$\phi\rho^+$, $\phi\to K^+K^-$		(4.1 $^{+\ 0.9}_{-\ 1.1}$) %	
Γ_{30}	$\phi\pi^+\pi^0$ 3-body, $\phi\to K^+K^-$		$<$ 1.6 %	CL=90%
Γ_{31}	$K^+K^-\pi^+\pi^0$ non-ϕ		$<$ 11 %	CL=90%
Γ_{32}	$K^+\overline{K}^0\pi^+\pi^-$		(3.2 $\pm$ 0.9) %	
Γ_{33}	$K^0K^-\pi^+\pi^+$		(5.4 $\pm$ 1.4) %	
Γ_{34}	$K^*(892)^+\overline{K}^*(892)^0$	[d]	(7.2 $\pm$ 2.6) %	
Γ_{35}	$K^0K^-\pi^+\pi^+$(non-$K^{*+}\overline{K}^{*0}$)		$<$ 4 %	CL=90%
Γ_{36}	$K^+K^-\pi^+\pi^+\pi^-$		(8.4 $\pm$ 1.9) $\times 10^{-3}$	
Γ_{37}	$\phi\pi^+\pi^+\pi^-$, $\phi\to K^+K^-$		(5.9 $\pm$ 0.8) $\times 10^{-3}$	
Γ_{38}	$K^+K^-\rho^0\pi^+$ non-ϕ		$<$ 2.5 $\times 10^{-4}$	CL=90%
Γ_{39}	$\phi\rho^0\pi^+$, $\phi\to K^+K^-$		(6.3 $\pm$ 1.6) $\times 10^{-3}$	

Γ_{40}	$\phi a_1(1260)^+$, $\phi \to K^+K^-$, $a_1^+ \to \rho^0\pi^+$		(7.2 ± 1.6) $\times 10^{-3}$	
Γ_{41}	$K^+K^-\pi^+\pi^+\pi^-$ nonresonant		(8 ± 7) $\times 10^{-4}$	
Γ_{42}	$K^0_S K^0_S \pi^+\pi^+\pi^-$		(2.7 ± 1.3) $\times 10^{-3}$	

Hadronic modes without K's

Γ_{43}	$\pi^+\pi^+\pi^-$		(1.24± 0.20) %	S=1.2
Γ_{44}	$\rho^0\pi^+$		not seen	
Γ_{45}	$\pi^+(\pi^+\pi^-)_{S-\text{wave}}$	[e]	(1.08± 0.19) %	
Γ_{46}	$f_0(980)\pi^+$, $f_0 \to \pi^+\pi^-$			
Γ_{47}	$f_0(1370)\pi^+$, $f_0 \to \pi^+\pi^-$			
Γ_{48}	$f_0(1500)\pi^+$, $f_0 \to \pi^+\pi^-$			
Γ_{49}	$f_2(1270)\pi^+$, $f_2 \to \pi^+\pi^-$		(1.2 ± 0.7) $\times 10^{-3}$	
Γ_{50}	$\rho(1450)^0\pi^+$, $\rho^0 \to \pi^+\pi^-$		(8 ± 7) $\times 10^{-4}$	
Γ_{51}	$\pi^+\pi^+\pi^-$ nonresonant			
Γ_{52}	$\pi^+\pi^+\pi^-\pi^0$		< 15 %	CL=90%
Γ_{53}	$\eta\pi^+$	[d]	(2.16± 0.30) %	
Γ_{54}	$\omega\pi^+$	[d]	(3.4 ± 1.2) $\times 10^{-3}$	
Γ_{55}	$3\pi^+2\pi^-$		(7.7 ± 1.4) $\times 10^{-3}$	
Γ_{56}	$\pi^+\pi^+\pi^-\pi^0\pi^0$		—	
Γ_{57}	$\eta\rho^+$	[d]	(13.4 ± 2.3) %	
Γ_{58}	$\eta\pi^+\pi^0$ 3-body	[d]	< 5 %	CL=90%
Γ_{59}	$3\pi^+2\pi^-\pi^0$		(4.9 ± 3.2) %	
Γ_{60}	$\eta'(958)\pi^+$	[d]	(4.8 ± 0.6) %	
Γ_{61}	$3\pi^+2\pi^-2\pi^0$		—	
Γ_{62}	$\eta'(958)\rho^+$	[d]	(12.5 ± 2.2) %	
Γ_{63}	$\eta'(958)\pi^+\pi^0$ 3-body	[d]	< 1.8 %	CL=90%

Modes with one or three K's

Γ_{64}	$K^0\pi^+$		< 9 $\times 10^{-3}$	CL=90%
Γ_{65}	$K^+\pi^+\pi^-$		(6.7 ± 1.3) $\times 10^{-3}$	
Γ_{66}	$K^+\rho^0$		(2.6 ± 0.6) $\times 10^{-3}$	
Γ_{67}	$K^+\rho(1450)^0$, $\rho^0 \to \pi^+\pi^-$		(7.1 ± 2.8) $\times 10^{-4}$	
Γ_{68}	$K^*(892)^0\pi^+$, $K^{*0} \to K^+\pi^-$		(1.5 ± 0.4) $\times 10^{-3}$	
Γ_{69}	$K^*(1410)^0\pi^+$, $K^{*0} \to K^+\pi^-$		(1.3 ± 0.4) $\times 10^{-3}$	
Γ_{70}	$K^*(1430)^0\pi^+$, $K^{*0} \to K^+\pi^-$		(5 ± 4) $\times 10^{-4}$	
Γ_{71}	$K^+\pi^+\pi^-$ nonresonant		(1.1 ± 0.4) $\times 10^{-3}$	
Γ_{72}	$K^+K^+K^-$		(4.7 ± 1.8) $\times 10^{-4}$	
Γ_{73}	ϕK^+, $\phi \to K^+K^-$		< 2.9 $\times 10^{-4}$	CL=90%

Doubly Cabibbo-suppressed modes

Γ_{74}	$K^+K^+\pi^-$		(2.7 ± 1.2) $\times 10^{-4}$	

$\Delta C = 1$ weak neutral current (*C1*) modes, Lepton family number (*LF*), or Lepton number (*L*) violating modes

Γ_{75}	$\pi^+ e^+ e^-$		[f]	< 2.7	$\times 10^{-4}$	CL=90%
Γ_{76}	$\pi^+ \mu^+ \mu^-$		[f]	< 2.6	$\times 10^{-5}$	CL=90%
Γ_{77}	$K^+ e^+ e^-$	*C1*		< 1.6	$\times 10^{-3}$	CL=90%
Γ_{78}	$K^+ \mu^+ \mu^-$	*C1*		< 3.6	$\times 10^{-5}$	CL=90%
Γ_{79}	$K^*(892)^+ \mu^+ \mu^-$	*C1*		< 1.4	$\times 10^{-3}$	CL=90%
Γ_{80}	$\pi^+ e^\pm \mu^\mp$	*LF*	[g]	< 6.1	$\times 10^{-4}$	CL=90%
Γ_{81}	$K^+ e^\pm \mu^\mp$	*LF*	[g]	< 6.3	$\times 10^{-4}$	CL=90%
Γ_{82}	$\pi^- e^+ e^+$	*L*		< 6.9	$\times 10^{-4}$	CL=90%
Γ_{83}	$\pi^- \mu^+ \mu^+$	*L*		< 2.9	$\times 10^{-5}$	CL=90%
Γ_{84}	$\pi^- e^+ \mu^+$	*L*		< 7.3	$\times 10^{-4}$	CL=90%
Γ_{85}	$K^- e^+ e^+$	*L*		< 6.3	$\times 10^{-4}$	CL=90%
Γ_{86}	$K^- \mu^+ \mu^+$	*L*		< 1.3	$\times 10^{-5}$	CL=90%
Γ_{87}	$K^- e^+ \mu^+$	*L*		< 6.8	$\times 10^{-4}$	CL=90%
Γ_{88}	$K^*(892)^- \mu^+ \mu^+$	*L*		< 1.4	$\times 10^{-3}$	CL=90%

Γ_{89} A dummy mode used by the fit. (79.4 ± 2.1) %

[a] This fraction includes η from η' decays.

[b] For now, we average together measurements of the $X e^+ \nu_e$ and $X \mu^+ \nu_\mu$ branching fractions. This is the *average*, not the *sum*.

[c] The branching fraction for this mode may differ from the sum of the submodes that contribute to it, due to interference effects. See the relevant papers.

[d] This branching fraction includes all the decay modes of the final-state resonance.

[e] This comes from a *K*-matrix parametrization of the $\pi^+\pi^-$ *S*-wave and is a sum over the $f_0(980)$, $f_0(1300)$, $f_0(1200–1600)$, $f_0(1500)$, and $f_0(1750)$. Not all of these correspond to particles in our Tables.

[f] This mode is not a useful test for a ΔC=1 weak neutral current because both quarks must change flavor in this decay.

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

CONSTRAINED FIT INFORMATION

An overall fit to 11 branching ratios uses 20 measurements and one constraint to determine 9 parameters. The overall fit has a $\chi^2 = 11.5$ for 12 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, $x_i \equiv \Gamma_i/\Gamma_{\text{total}}$. The fit constrains the x_i whose labels appear in this array to sum to one.

x_{11}	33							
x_{13}	20	60						
x_{14}	12	35	21					
x_{16}	21	46	27	16				
x_{17}	36	78	46	28	59			
x_{18}	35	77	46	27	59	99		
x_{43}	20	44	26	16	54	57	57	
x_{89}	−40	−82	−67	−43	−78	−87	−86	−64
	x_9	x_{11}	x_{13}	x_{14}	x_{16}	x_{17}	x_{18}	x_{43}

D_s^+ BRANCHING RATIOS

A few older, now obsolete results have been omitted. They may be found in earlier editions.

Inclusive modes

$\Gamma(K^-\text{ anything})/\Gamma_{\text{total}}$ **Γ_1/Γ**

VALUE	DOCUMENT ID		TECN	COMMENT
$0.13^{+0.14}_{-0.12}\pm0.02$	COFFMAN	91	MRK3	e^+e^- 4.14 GeV

$[\Gamma(\overline{K}^0\text{ anything}) + \Gamma(K^0\text{ anything})]/\Gamma_{\text{total}}$ **Γ_2/Γ**

VALUE	DOCUMENT ID		TECN	COMMENT
$0.39^{+0.28}_{-0.27}\pm0.04$	COFFMAN	91	MRK3	e^+e^- 4.14 GeV

$\Gamma(K^+\text{ anything})/\Gamma_{\text{total}}$ **Γ_3/Γ**

VALUE	DOCUMENT ID		TECN	COMMENT
$0.20^{+0.18}_{-0.13}\pm0.04$	COFFMAN	91	MRK3	e^+e^- 4.14 GeV

$\Gamma((\text{non-}K\overline{K})\text{ anything})/\Gamma_{\text{total}}$ **Γ_4/Γ**

VALUE	DOCUMENT ID		TECN	COMMENT
$0.64\pm0.17\pm0.03$	[3] COFFMAN	91	MRK3	e^+e^- 4.14 GeV

[3] COFFMAN 91 uses the direct measurements of the kaon content to determine this non-$K\overline{K}$ fraction. This number implies that a large fraction of D_s^+ decays involve η, η', and/or non-spectator decays.

$\Gamma(\eta \text{ anything})/\Gamma_{\text{total}}$ Γ_5/Γ

This ratio includes η particles from η' decays.

VALUE (units 10^{-2})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
23.5±3.1±2.0	674 ± 91	HUANG	06B	CLEO	e^+e^- at 4170 MeV

$\Gamma(\eta' \text{ anything})/\Gamma_{\text{total}}$ Γ_6/Γ

VALUE (units 10^{-2})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
8.7±1.9±0.8	68 ± 15	HUANG	06B	CLEO	e^+e^- at 4170 MeV

$\Gamma(\phi \text{ anything})/\Gamma_{\text{total}}$ Γ_7/Γ

VALUE (units 10^{-2})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
16.1± 1.2±1.1	398 ± 27	HUANG	06B	CLEO	e^+e^- at 4170 MeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$17.8^{+15.1+0.6}_{-\ 7.2-6.3}$	3	BAI	98	BES	$e^+e^- \to D_s^+ D_s^-$

$\Gamma(e^+ \text{ anything})/\Gamma_{\text{total}}$ Γ_8/Γ

VALUE	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
$\mathbf{0.077^{+0.057+0.024}_{-0.043-0.021}}$		BAI	97	BES	$e^+e^- \to D_s^+ D_s^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.20	90	[4] BAI	90	MRK3	e^+e^- 4.14 GeV

[4] Expressed as a value, the BAI 90 result is $\Gamma(e^+ \text{anything})/\Gamma_{\text{total}} = 0.05 \pm 0.05 \pm 0.02$.

Leptonic and semileptonic modes

A REVIEW GOES HERE – Check our WWW List of Reviews

$\Gamma(\mu^+\nu_\mu)/\Gamma_{\text{total}}$ Γ_9/Γ

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$0.0068 \pm 0.0011 \pm 0.0018$	553	[5] HEISTER	02I	ALEP	Z decays
$0.015\ ^{+0.013\ +0.003}_{-0.006\ -0.002}$	3	[6] BAI	95	BES	$e^+e^- \to D_s^+ D_s^-$
$0.004\ ^{+0.0018+0.0020}_{-0.0014-0.0019}$	8	[7] AOKI	93	WA75	π^- emulsion 350 GeV μ^+
<0.03	0	[8] AUBERT	83	SPEC	Fe, 250 GeV

[5] This HEISTER 02I result is not actually an independent measurement of the absolute $\mu^+\nu_\mu$ branching fraction, but is in fact based on our $\phi\pi^+$ branching fraction of 3.6 ± 0.9%, so it cannot be included in our overall fit. HEISTER 02I combines its $D_s^+ \to \tau^+\nu_\tau$ and $\mu^+\nu_\mu$ branching fractions to get $f_{D_s} = (285 \pm 19 \pm 40)$ MeV.

[6] BAI 95 uses one actual $D_s^+ \to \mu^+\nu_\mu$ event together with two $D_s^+ \to \tau^+\nu_\tau$ events and assumes μ-τ universality. This value of $\Gamma(\mu^+\nu_\mu)/\Gamma_{\text{total}}$ gives a pseudoscalar decay constant of $(430^{+150}_{-130} \pm 40)$ MeV.

[7] AOKI 93 assumes the ratio of production cross sections of the D_s^+ and D^0 is 0.27. The value of $\Gamma(\mu^+\nu_\mu)/\Gamma_{\text{total}}$ gives a pseudoscalar decay constant $f_{D_s} = (232 \pm 45 \pm 52)$ MeV.

[8] AUBERT 83 assume that the $D_s^\pm$ production rate is 20% of total charm production rate.

$\Gamma(\mu^+\nu_\mu)/\Gamma(\phi\pi^+)$ Γ_9/Γ_{17}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.14 ±0.04 OUR FIT Error includes scale factor of 1.4.					
0.19 ±0.04 OUR AVERAGE					
0.23 ±0.06 ±0.04	18	[9] ALEXANDROV	00	BEAT	π^- nucleus, 350 GeV
0.173±0.023±0.035	182	[10] CHADHA	98	CLE2	$e^+e^- \approx \Upsilon(4S)$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.245±0.052±0.074	39	[11] ACOSTA	94	CLE2	See CHADHA 98

[9] ALEXANDROV 00 uses $f_D^2/f_{D_s}^2 = 0.82 \pm 0.09$ from a lattice-gauge-theory calculation to get the relative numbers of $D^+ \to \mu^+\nu_\mu$ and $D_s^+ \to \mu^+\nu_\mu$ events. The present result leads to f_{D_s} = (323 ± 44 ± 36) MeV.

[10] CHADHA 98 obtains f_{D_s} = (280 ± 19 ± 28 ± 34) MeV from this measurement, using $\Gamma(D_s^+ \to \phi\pi^+)/\Gamma(\text{total}) = 0.036 \pm 0.009$.

[11] ACOSTA 94 obtains f_{D_s} = (344 ± 37 ± 52 ± 42) MeV from this measurement, using $\Gamma(D_s^+ \to \phi\pi^+)/\Gamma(\text{total}) = 0.037 \pm 0.009$.

$\Gamma(\mu^+\nu_\mu)/\Gamma(\phi\ell^+\nu_\ell)$ Γ_9/Γ_{11}

$\Gamma(\phi\ell^+\nu_\ell)$ is an average of $\Gamma(\phi e^+\nu_e)$ and $\Gamma(\phi\mu^+\nu_\mu)$

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.25±0.07 OUR FIT Error includes scale factor of 1.5.					
0.16±0.06±0.03	23	[12] KODAMA	96	E653	π^- emulsion, 600 GeV

[12] KODAMA 96 obtains f_{D_s} = (194 ± 35 ± 20 ± 14) MeV from this measurement, using $\Gamma(D_s^+ \to \phi\ell^+\nu)/\Gamma_{\text{total}} = 0.0188 \pm 0.0029$. The third error is from the uncertainty on $\phi\ell^+\nu_\ell$ branching fraction.

$\Gamma(\tau^+\nu_\tau)/\Gamma_{\text{total}}$ Γ_{10}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.064 ±0.015 OUR AVERAGE					
0.0579±0.0077±0.0184	881	[13] HEISTER	02I	ALEP	Z decays
0.070 ±0.021 ±0.020	22	[14] ABBIENDI	01L	OPAL	$D_s^{*+} \to \gamma D_s^+$ from Z's
0.074 ±0.028 ±0.024	16	[15] ACCIARRI	97F	L3	$D_s^{*+} \to \gamma D_s^+$ from Z's

[13] HEISTER 02I combines its $D_s^+ \to \tau^+\nu_\tau$ and $\mu^+\nu_\mu$ branching fractions to get f_{D_s} = (285 ± 19 ± 40) MeV.

[14] This ABBIENDI 01L value gives a decay constant f_{D_s} of (286 ± 44 ± 41) MeV.

[15] The second ACCIARRI 97F error here combines in quadrature systematic (0.016) and normalization (0.018) errors. The branching fraction gives f_{D_s} = (309 ± 58 ± 33 ± 38) MeV.

$\Gamma(\phi\ell^+\nu_\ell)/\Gamma(\phi\pi^+)$ Γ_{11}/Γ_{17}

For now, we average together measurements of the $\Gamma(\phi e^+\nu_e)/\Gamma(\phi\pi^+)$ and $\Gamma(\phi\mu^+\nu_\mu)/\Gamma(\phi\pi^+)$ ratios. See the end of the D_s^+ Listings for measurements of $D_s^+ \to \phi\ell^+\nu_\ell$ form-factor ratios.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.55 ±0.04 OUR FIT					
0.54 ±0.04 OUR AVERAGE					
0.540±0.033±0.048	793	LINK	02J	FOCS	Uses $\phi\mu^+\nu_\mu$
0.54 ±0.05 ±0.04	367	BUTLER	94	CLE2	Uses $\phi e^+\nu_e$ and $\phi\mu^+\nu_\mu$
0.58 ±0.17 ±0.07	97	FRABETTI	93G	E687	Uses $\phi\mu^+\nu_\mu$
0.57 ±0.15 ±0.15	104	ALBRECHT	91	ARG	Uses $\phi e^+\nu_e$
0.49 ±0.10 $^{+0.10}_{-0.14}$	54	ALEXANDER	90B	CLEO	Uses $\phi e^+\nu_e$ and $\phi\mu^+\nu_\mu$

$\Gamma(\eta\ell^+\nu_\ell)/\Gamma(\phi\ell^+\nu_\ell)$ Γ_{13}/Γ_{11}

Unseen decay modes of the η and the ϕ are included.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
1.27±0.19 OUR FIT					
1.24±0.12±0.15	440	[16] BRANDENB...	95	CLE2	$e^+e^- \approx \Upsilon(4S)$

[16] BRANDENBURG 95 uses both e^+ and μ^+ events and makes a phase-space adjustment to use the μ^+ events as e^+ events.

$\Gamma(\eta'(958)\ell^+\nu_\ell)/\Gamma(\phi\ell^+\nu_\ell)$ Γ_{14}/Γ_{11}

Unseen decay modes of the resonances are included.

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.44±0.13 OUR FIT						
0.43±0.11±0.07		29	[17] BRANDENB...	95	CLE2	$e^+e^- \approx \Upsilon(4S)$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<1.6	90		[18] KODAMA	93B	E653	π^- emulsion 600 GeV

[17] BRANDENBURG 95 uses both e^+ and μ^+ events and makes a phase-space adjustment to use the μ^+ events as e^+ events.
[18] KODAMA 93B uses μ^+ events.

$\left[\Gamma(\eta\ell^+\nu_\ell)+\Gamma(\eta'(958)\ell^+\nu_\ell)\right]/\Gamma(\phi\ell^+\nu_\ell)$ $\Gamma_{12}/\Gamma_{11}=(\Gamma_{13}+\Gamma_{14})/\Gamma_{11}$

Unseen decay modes of the resonances are included.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
1.72±0.23 OUR FIT					
3.9 ±1.6	13	[19] KODAMA	93	E653	π^- emulsion 600 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1.67±0.17±0.17		[20] BRANDENB...	95	CLE2	$e^+e^- \approx \Upsilon(4S)$

[19] KODAMA 93 uses μ^+ events.
[20] This BRANDENBURG 95 data is redundant with data in previous blocks.

Hadronic modes with a $K\overline{K}$ pair.

$\Gamma(K^+\overline{K}^0)/\Gamma(\phi\pi^+)$ Γ_{15}/Γ_{17}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
1.01±0.16 OUR AVERAGE					
1.15±0.31±0.19	68	ANJOS	90C	E691	γ Be
0.92±0.32±0.20		ADLER	89B	MRK3	e^+e^- 4.14 GeV
0.99±0.17±0.10		CHEN	89	CLEO	e^+e^- 10 GeV

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

The results here are model-independent. For earlier, model-dependent results, see our PDG 06 edition.

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
4.5 ±0.4 OUR FIT					
4.5 ±0.4 OUR AVERAGE					
4.62±0.36±0.51		[21] AUBERT	06N	BABR	e^+e^- at $\Upsilon(4S)$
4.81±0.52±0.38	212 ± 19	[22] AUBERT	05V	BABR	$e^+e^- \approx \Upsilon(4S)$
3.59±0.77±0.48		[23] ARTUSO	96	CLE2	e^+e^- at $\Upsilon(4S)$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$3.9\ ^{+5.1}_{-1.9}\ ^{+1.8}_{-1.1}$		[24] BAI	95C	BES	e^+e^- 4.03 GeV

[21] This AUBERT 06N measurement uses $\overline{B}^0 \to D_s^{(*)-} D^{(*)+}$ and $B^- \to D_s^{(*)-} D^{(*)0}$ decays, including some from other papers. However, the result is independent of AUBERT 05V.

[22] AUBERT 05V uses the ratio of $B^0 \to D^{*-} D_s^{*+}$ events seen in two different ways, in both of which the $D^{*-} \to \overline{D}^0\pi^-$ decay is fully reconstructed: (1) The $D_s^{*+} \to D_s^+\gamma$, $D_s^+ \to \phi\pi^+$ decay is fully reconstructed. (2) The number of events in the D_s^+ peak in the missing mass spectrum against the $D^{*-}\gamma$ is measured.

[23] ARTUSO 96 uses partially reconstructed $\overline{B}^0 \to D^{*+} D_s^{*-}$ decays to get a model-independent value for $\Gamma(D_s^- \to \phi\pi^-)/\Gamma(D^0 \to K^-\pi^+)$ of 0.92 ± 0.20 ± 0.11.

[24] BAI 95C uses $e^+e^- \to D_s^+ D_s^-$ events in which one or both of the $D_s^\pm$ are observed to obtain the first model-independent measurement of the $D_s^+ \to \phi\pi^+$ branching fraction, without assumptions about $\sigma(D_s^\pm)$. However, with only two "doubly-tagged" events, the statistical error is very large.

$\Gamma(\phi\pi^+, \phi \to K^+K^-)/\Gamma(\phi\pi^+)$ Γ_{18}/Γ_{17}

VALUE	DOCUMENT ID		
0.491±0.006 OUR FIT			
0.491±0.006	[25] PDG	06	

[25] This is, of course, just the $\phi \to K^+K^-$ branching fraction, but we need it to connect other modes in the fit.

$\Gamma(\phi\pi^+, \phi \to K^+K^-)/\Gamma(K^+K^-\pi^+)$ Γ_{18}/Γ_{16}

This is the "fit fraction" from the Dalitz-plot analysis.

VALUE	DOCUMENT ID		TECN	COMMENT
0.42 ±0.05 OUR FIT				
0.396±0.033±0.047	FRABETTI	95B	E687	Dalitz fit, 701 evts

$\Gamma(K^+\overline{K}^*(892)^0, \overline{K}^{*0} \to K^-\pi^+)/\Gamma(K^+K^-\pi^+)$ Γ_{20}/Γ_{16}

This is the "fit fraction" from the Dalitz-plot analysis.

VALUE	DOCUMENT ID		TECN	COMMENT
0.478±0.046±0.040	FRABETTI	95B	E687	Dalitz fit, 701 evts

$\Gamma(K^+\overline{K}^*(892)^0)/\Gamma(\phi\pi^+)$ Γ_{19}/Γ_{17}

Unseen decay modes of the resonances are included. However, we now get branching fractions for resonant submodes of 3-body decays from Dalitz-plot analyses.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$0.85\pm0.34\pm0.20$	9	ALVAREZ	90C	NA14	Photoproduction
$0.84\pm0.30\pm0.22$		ADLER	89B	MRK3	e^+e^- 4.14 GeV
$1.05\pm0.17\pm0.12$		CHEN	89	CLEO	e^+e^- 10 GeV
$0.87\pm0.13\pm0.05$	117	ANJOS	88	E691	Photoproduction
1.44 ± 0.37	87	ALBRECHT	87F	ARG	e^+e^- 10 GeV

$\Gamma(f_0(980)\pi^+, f_0\to K^+K^-)/\Gamma(K^+K^-\pi^+)$ Γ_{21}/Γ_{16}

This is the "fit fraction" from the Dalitz-plot analysis.

VALUE	DOCUMENT ID		TECN	COMMENT
$0.11\pm0.035\pm0.026$	FRABETTI	95B	E687	Dalitz fit, 701 evts

$\Gamma(f_0(1710)\pi^+, f_0\to K^+K^-)/\Gamma(K^+K^-\pi^+)$ Γ_{23}/Γ_{16}

This is the "fit fraction" from the Dalitz-plot analysis.

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$0.034\pm0.023\pm0.035$	[26] FRABETTI	95B	E687	Dalitz fit, 701 evts

[26] In other words, FRABETTI 95B doesn't see this resonance.

$\Gamma(K^+\overline{K}_0^*(1430)^0, \overline{K}_0^*\to K^-\pi^+)/\Gamma(K^+K^-\pi^+)$ Γ_{22}/Γ_{16}

This is the "fit fraction" from the Dalitz-plot analysis.

VALUE	DOCUMENT ID		TECN	COMMENT
$0.093\pm0.032\pm0.032$	FRABETTI	95B	E687	Dalitz fit, 701 evts

$\Gamma(K^+K^-\pi^+\text{nonresonant})/\Gamma(\phi\pi^+)$ Γ_{24}/Γ_{17}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$0.25\pm0.07\pm0.05$	48	ANJOS	88	E691	Photoproduction

$\Gamma(K^*(892)^+\overline{K}^0)/\Gamma(\phi\pi^+)$ Γ_{26}/Γ_{17}

Unseen decay modes of the resonances are included.

VALUE	DOCUMENT ID		TECN	COMMENT
$1.20\pm0.21\pm0.13$	CHEN	89	CLEO	e^+e^- 10 GeV

$\Gamma(K^*(892)^+\overline{K}^0)/\Gamma(K^+\overline{K}^0)$ Γ_{26}/Γ_{15}

Unseen decay modes of the $K^*(892)^+$ are included.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.9	90	FRABETTI	95	E687	γBe $\overline{E}_\gamma\approx 200$ GeV

$\Gamma(\phi\pi^+\pi^0, \phi\to K^+K^-)/\Gamma(\phi\pi^+, \phi\to K^+K^-)$ Γ_{28}/Γ_{18}

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$2.4\pm1.0\pm0.5$		11	ANJOS	89E	E691	Photoproduction
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<2.6	90		ALVAREZ	90C	NA14	Photoproduction

$\Gamma(\phi\rho^+,\ \phi\to K^+K^-)/\Gamma(\phi\pi^+,\phi\to K^+K^-)$ Γ_{29}/Γ_{18}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
$1.86\pm0.26^{+0.29}_{-0.40}$	253	AVERY	92	CLE2	$e^+e^-\simeq$ 10.5 GeV

$\Gamma(\phi\pi^+\pi^0$ 3-body, $\phi\to K^+K^-)/\Gamma(\phi\pi^+,\phi\to K^+K^-)$ Γ_{30}/Γ_{18}

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.71	90	DAOUDI	92	CLE2	$e^+e^-\approx$ 10.5 GeV

$\Gamma(K^+K^-\pi^+\pi^0$ non-$\phi)/\Gamma(\phi\pi^+)$ Γ_{31}/Γ_{17}

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<2.4	90	ANJOS	89E	E691	Photoproduction

$\Gamma(K^+\overline{K}{}^0\pi^+\pi^-)/\Gamma(K^0K^-\pi^+\pi^+)$ Γ_{32}/Γ_{33}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
$0.586\pm0.052\pm0.043$	476	LINK	01C	FOCS	γ nucleus, $\overline{E}_\gamma\approx$ 180 GeV

$\Gamma(K^0K^-\pi^+\pi^+)/\Gamma(\phi\pi^+)$ Γ_{33}/Γ_{17}

VALUE	DOCUMENT ID		TECN	COMMENT
$1.2\pm0.2\ \pm0.2$	ALBRECHT	92B	ARG	$e^+e^-\simeq$ 10.4 GeV

$\Gamma(K^*(892)^+\overline{K}{}^*(892)^0)/\Gamma(\phi\pi^+)$ Γ_{34}/Γ_{17}

Unseen decay modes of the resonances are included.

VALUE	DOCUMENT ID		TECN	COMMENT
$1.6\pm0.4\pm0.4$	ALBRECHT	92B	ARG	$e^+e^-\simeq$ 10.4 GeV

$\Gamma(K^0K^-\pi^+\pi^+$ (non-$K^{*+}\overline{K}{}^{*0}))/\Gamma(\phi\pi^+)$ Γ_{35}/Γ_{17}

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.80	90	ALBRECHT	92B	ARG	$e^+e^-\simeq$ 10.4 GeV

$\Gamma(K^+K^-\pi^+\pi^+\pi^-)/\Gamma(K^+K^-\pi^+)$ Γ_{36}/Γ_{16}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.160 ± 0.027 OUR AVERAGE					
$0.150\pm0.019\pm0.025$	240	LINK	03D	FOCS	γ A, $\overline{E}_\gamma\approx$ 180 GeV
$0.188\pm0.036\pm0.040$	75	FRABETTI	97C	E687	γBe, $\overline{E}_\gamma\approx$ 200 GeV

$\Gamma(\phi\pi^+\pi^+\pi^-,\ \phi\to K^+K^-)/\Gamma(\phi\pi^+,\phi\to K^+K^-)$ Γ_{37}/Γ_{18}

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.269 ± 0.027 OUR AVERAGE						
$0.249\pm0.024\pm0.021$		136	LINK	03D	FOCS	γ A, $\overline{E}_\gamma\approx$ 180 GeV
$0.28\ \pm0.06\ \pm0.01$		40	FRABETTI	97C	E687	γBe, $\overline{E}_\gamma\approx$ 200 GeV
$0.58\ \pm0.21\ \pm0.10$		21	FRABETTI	92	E687	γBe
$0.42\ \pm0.13\ \pm0.07$		19	ANJOS	88	E691	Photoproduction
$1.11\ \pm0.37\ \pm0.28$		62	ALBRECHT	85D	ARG	e^+e^- 10 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<0.24	90		ALVAREZ	90C	NA14	Photoproduction

$\Gamma(\phi\pi^+\pi^+\pi^-,\ \phi\to K^+K^-)/\Gamma(K^+K^-\pi^+\pi^+\pi^-)$ Γ_{37}/Γ_{36}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$0.21\pm0.05\pm0.06$	136	[27] LINK	03D	FOCS	γ A, $\overline{E}_\gamma\ \approx$ 180 GeV

[27] This LINK 03D result is redundant with its $\Gamma(\phi\pi^+\pi^+\pi^-)/\Gamma(\phi\pi^+)$ result above.

$\Gamma(K^+K^-\rho^0\pi^+\text{non-}\phi)/\Gamma(K^+K^-\pi^+\pi^+\pi^-)$ Γ_{38}/Γ_{36}

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.03	90	LINK	03D	FOCS	γ A, $\overline{E}_\gamma\ \approx$ 180 GeV

$\Gamma(\phi\rho^0\pi^+,\ \phi\to K^+K^-)/\Gamma(K^+K^-\pi^+\pi^+\pi^-)$ Γ_{39}/Γ_{36}

VALUE	DOCUMENT ID		TECN	COMMENT
0.75±0.06±0.04	LINK	03D	FOCS	γ A, $\overline{E}_\gamma\ \approx$ 180 GeV

$\Gamma(\phi a_1(1260)^+,\ \phi\to K^+K^-,\ a_1^+\to\rho^0\pi^+)/\Gamma(K^+K^-\pi^+)$ Γ_{40}/Γ_{16}

VALUE	DOCUMENT ID		TECN	COMMENT
0.137±0.019±0.011	LINK	03D	FOCS	γ A, $\overline{E}_\gamma\ \approx$ 180 GeV

$\Gamma(K^+K^-\pi^+\pi^+\pi^-\text{nonresonant})/\Gamma(K^+K^-\pi^+\pi^+\pi^-)$ Γ_{41}/Γ_{36}

VALUE	DOCUMENT ID		TECN	COMMENT
0.10±0.06±0.05	LINK	03D	FOCS	γ A, $\overline{E}_\gamma\ \approx$ 180 GeV

$\Gamma(K^0_S K^0_S\pi^+\pi^+\pi^-)/\Gamma(K^0K^-\pi^+\pi^+)$ Γ_{42}/Γ_{33}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.051±0.015±0.015	37 ± 10	LINK	04D	FOCS	γ A, $\overline{E}_\gamma\approx$ 180 GeV

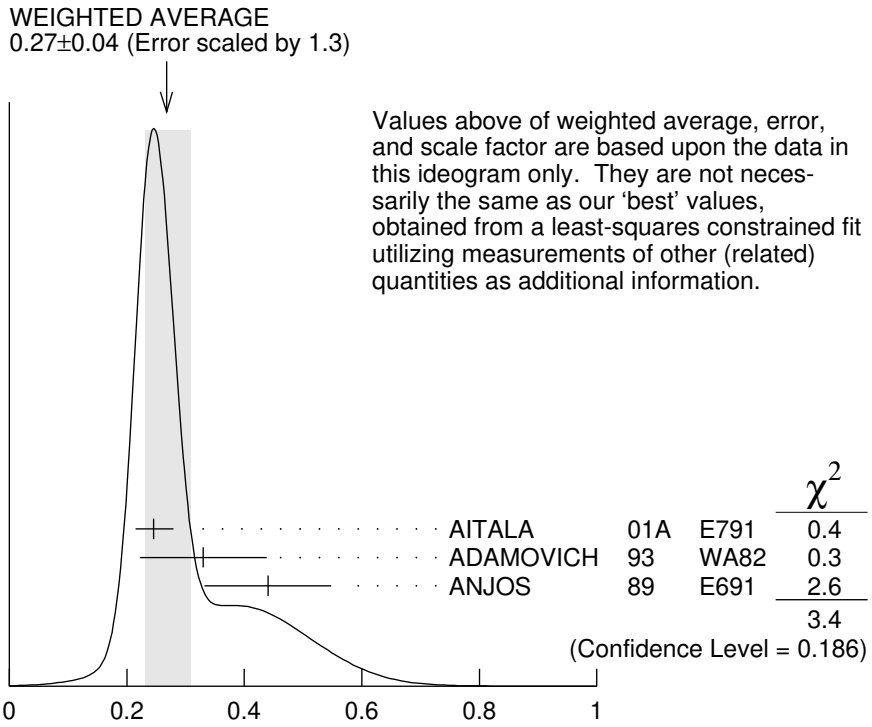
Pionic modes

$\Gamma(\pi^+\pi^+\pi^-)/\Gamma(K^+K^-\pi^+)$ Γ_{43}/Γ_{16}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.235±0.035 OUR FIT	Error includes scale factor of 1.1.				
0.265±0.041±0.031	98	FRABETTI	97D	E687	γ Be $\approx$ 200 GeV

$\Gamma(\pi^+\pi^+\pi^-)/\Gamma(\phi\pi^+)$ Γ_{43}/Γ_{17}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.277±0.035 OUR FIT	Error includes scale factor of 1.3.				
0.27 ±0.04 OUR AVERAGE	Error includes scale factor of 1.3. See the ideogram below.				
$0.245\pm0.028^{+0.019}_{-0.012}$	848	AITALA	01A	E791	π^- nucleus, 500 GeV
0.33 ±0.10 ±0.04	29	ADAMOVICH	93	WA82	π^- 340 GeV
0.44 ±0.10 ±0.04	68	ANJOS	89	E691	Photoproduction



$\Gamma(\rho^0\pi^+)/\Gamma(\pi^+\pi^+\pi^-)$ Γ_{44}/Γ_{43}

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
not seen		LINK	04	FOCS	Dalitz fit, 1475 ± 50 evts
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.058±0.023±0.037		AITALA	01A	E791	Dalitz fit, 848 evts
<0.073	90	FRABETTI	97D	E687	γ Be ≈ 200 GeV

$\Gamma(\rho^0\pi^+)/\Gamma(\phi\pi^+)$ Γ_{44}/Γ_{17}

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.08	90	ANJOS	89	E691	Photoproduction
<0.22	90	ALBRECHT	87G	ARG	e^+e^- 10 GeV

$\Gamma(\pi^+(\pi^+\pi^-)_{S-\text{wave}})/\Gamma(\pi^+\pi^+\pi^-)$ Γ_{45}/Γ_{43}

This is the "fit fraction" from the Dalitz-plot analysis.

VALUE	DOCUMENT ID		TECN	COMMENT
0.8704±0.0560±0.0438	[28] LINK	04	FOCS	Dalitz fit, 1475 ± 50 evts

[28] LINK 04 borrows a K-matrix parametrization from ANISOVICH 03 of the full π-π S-wave isoscalar scattering amplitude to describe the $\pi^+\pi^-$ S-wave component of the $\pi^+\pi^+\pi^-$ state. The fit fraction given above is a sum over five f_0 mesons, the $f_0(980)$, $f_0(1300)$, $f_0(1200–1600)$, $f_0(1500)$, and $f_0(1750)$. See LINK 04 for details and discussion.

$\Gamma(f_0(980)\pi^+, f_0 \to \pi^+\pi^-)/\Gamma(\pi^+\pi^+\pi^-)$ Γ_{46}/Γ_{43}

This is the "fit fraction" from the Dalitz-plot analysis.

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$0.565 \pm 0.043 \pm 0.047$	AITALA	01A	E791	Dalitz fit, 848 evts
$1.074 \pm 0.140 \pm 0.043$	FRABETTI	97D	E687	γ Be $\approx$ 200 GeV

$\Gamma(f_2(1270)\pi^+, f_2 \to \pi^+\pi^-)/\Gamma(\pi^+\pi^+\pi^-)$ Γ_{49}/Γ_{43}

This is the "fit fraction" from the Dalitz-plot analysis.

VALUE	DOCUMENT ID		TECN	COMMENT
$0.0974 \pm 0.0449 \pm 0.0294$	LINK	04	FOCS	Dalitz fit, 1475 ± 50 evts
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$0.197 \pm 0.033 \pm 0.006$	AITALA	01A	E791	Dalitz fit, 848 evts
$0.123 \pm 0.056 \pm 0.018$	FRABETTI	97D	E687	γ Be $\approx$ 200 GeV

$\Gamma(f_0(1370)\pi^+, f_0 \to \pi^+\pi^-)/\Gamma(\pi^+\pi^+\pi^-)$ Γ_{47}/Γ_{43}

This is the "fit fraction" from the Dalitz-plot analysis.

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$0.324 \pm 0.077 \pm 0.017$	AITALA	01A	E791	Dalitz fit, 848 evts

$\Gamma(\rho(1450)^0\pi^+, \rho^0 \to \pi^+\pi^-)/\Gamma(\pi^+\pi^+\pi^-)$ Γ_{50}/Γ_{43}

This is the "fit fraction" from the Dalitz-plot analysis.

VALUE	DOCUMENT ID		TECN	COMMENT
$0.0656 \pm 0.0343 \pm 0.0440$	LINK	04	FOCS	Dalitz fit, 1475 ± 50 evts
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$0.044 \pm 0.021 \pm 0.002$	AITALA	01A	E791	Dalitz fit, 848 evts

$\Gamma(f_0(1500)\pi^+, f_0 \to \pi^+\pi^-)/\Gamma(\pi^+\pi^+\pi^-)$ Γ_{48}/Γ_{43}

This is the "fit fraction" from the Dalitz-plot analysis.

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$0.274 \pm 0.114 \pm 0.019$	[29] FRABETTI	97D	E687	γ Be $\approx$ 200 GeV

[29] FRABETTI 97D calls this mode $S(1475)\,\pi^+$, but finds the mass and width of this $S(1475)$ to be in excellent agreement with those of the $f_0(1500)$.

$\Gamma(\pi^+\pi^+\pi^-\text{nonresonant})/\Gamma(\pi^+\pi^+\pi^-)$ Γ_{51}/Γ_{43}

This is the "fit fraction" from the Dalitz-plot analysis.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$0.005 \pm 0.014 \pm 0.017$		AITALA	01A	E791	π^- nucleus, 500 GeV
<0.269	90	FRABETTI	97D	E687	γ Be $\approx$ 200 GeV

$\Gamma(\pi^+\pi^+\pi^-\pi^0)/\Gamma(\phi\pi^+)$ Γ_{52}/Γ_{17}

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<3.3	90	ANJOS	89E	E691	Photoproduction

$\Gamma(\eta\pi^+)/\Gamma(\phi\pi^+)$ Γ_{53}/Γ_{17}

Unseen decay modes of the resonances are included.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.48±0.03±0.04	920	JESSOP	98	CLE2	$e^+e^- \approx \Upsilon(4S)$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.54±0.09±0.06	165	ALEXANDER	92	CLE2	See JESSOP 98

$\Gamma(\omega\pi^+)/\Gamma(\eta\pi^+)$ Γ_{54}/Γ_{53}

Unseen decay modes of the resonances are included.

VALUE	DOCUMENT ID		TECN	COMMENT
0.16±0.04±0.03	BALEST	97	CLE2	$e^+e^- \approx \Upsilon(4S)$

$\Gamma(3\pi^+2\pi^-)/\Gamma(K^+K^-\pi^+)$ Γ_{55}/Γ_{16}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.146±0.014 OUR AVERAGE					
0.145±0.011±0.010	671	LINK	03D	FOCS	γ A, $\overline{E}_\gamma \approx$ 180 GeV
0.158±0.042±0.031	37	FRABETTI	97C	E687	γBe, $\overline{E}_\gamma \approx$ 200 GeV

$\Gamma(\eta\rho^+)/\Gamma(\phi\pi^+)$ Γ_{57}/Γ_{17}

Unseen decay modes of the resonances are included.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
2.98±0.20±0.39	447	JESSOP	98	CLE2	$e^+e^- \approx \Upsilon(4S)$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$2.86\pm0.38^{+0.36}_{-0.38}$	217	AVERY	92	CLE2	See JESSOP 98

$\Gamma(\eta\pi^+\pi^0\text{3-body})/\Gamma(\phi\pi^+)$ Γ_{58}/Γ_{17}

Unseen decay modes of the resonances are included.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<1.1	90	JESSOP	98	CLE2	$e^+e^- \approx \Upsilon(4S)$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.82	90	[30] DAOUDI	92	CLE2	See JESSOP 98

[30] We use the JESSOP 98 limit, even though the DAOUDI 92 limit, from the same experiment but with a much smaller data sample, is more restrictive.

$\Gamma(3\pi^+2\pi^-\pi^0)/\Gamma_{\text{total}}$ Γ_{59}/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
$\mathbf{0.049^{+0.033}_{-0.030}}$	BARLAG	92C	ACCM	π^- 230 GeV

$\Gamma(\eta'(958)\pi^+)/\Gamma(\phi\pi^+)$ Γ_{60}/Γ_{17}

Unseen decay modes of the resonances are included.

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
1.08±0.09 OUR AVERAGE						
1.03±0.06±0.07		537	JESSOP	98	CLE2	$e^+e^- \approx \Upsilon(4S)$
$2.5 \pm1.0\ ^{+1.5}_{-0.4}$		22	ALVAREZ	91	NA14	Photoproduction
2.5 ±0.5 ±0.3		215	ALBRECHT	90D	ARG	$e^+e^- \approx$ 10.4 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •						
1.20±0.15±0.11		281	ALEXANDER	92	CLE2	See JESSOP 98
<1.3	90		ANJOS	91B	E691	γBe, $\overline{E}_\gamma \approx$ 145 GeV

$\Gamma(\eta'(958)\rho^+)/\Gamma(\phi\pi^+)$ Γ_{62}/Γ_{17}

Unseen decay modes of the resonances are included.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
2.78±0.28±0.30	137	JESSOP	98	CLE2	$e^+e^- \approx \Upsilon(4S)$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$3.44\pm0.62^{+0.44}_{-0.46}$	68	AVERY	92	CLE2	See JESSOP 98

$\Gamma(\eta'(958)\pi^+\pi^0$ 3-body$)/\Gamma(\phi\pi^+)$ Γ_{63}/Γ_{17}

Unseen decay modes of the resonances are included.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.4	90	JESSOP	98	CLE2	$e^+e^- \approx \Upsilon(4S)$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.85	90	DAOUDI	92	CLE2	See JESSOP 98

Modes with one or three K's

$\Gamma(K^0\pi^+)/\Gamma(\phi\pi^+)$ Γ_{64}/Γ_{17}

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.21	90	ADLER	89B	MRK3	e^+e^- 4.14 GeV

$\Gamma(K^0\pi^+)/\Gamma(K^+\overline{K}^0)$ Γ_{64}/Γ_{15}

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.53	90	FRABETTI	95	E687	γBe, $\overline{E}_\gamma \approx 200$ GeV

$\Gamma(K^+\pi^+\pi^-)/\Gamma(K^+K^-\pi^+)$ Γ_{65}/Γ_{16}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.127±0.007±0.014	567 ± 31	LINK	04F	FOCS	γ A, $\overline{E}_\gamma \approx 180$ GeV

$\Gamma(K^+\pi^+\pi^-)/\Gamma(\phi\pi^+)$ Γ_{65}/Γ_{17}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.28±0.06±0.05	85	FRABETTI	95E	E687	γBe, $\overline{E}_\gamma = 220$ GeV

$\Gamma(K^+\rho^0)/\Gamma(K^+\pi^+\pi^-)$ Γ_{66}/Γ_{65}

This is the "fit fraction" from the Dalitz-plot analysis.

VALUE	DOCUMENT ID		TECN	COMMENT
0.3883±0.0531±0.0261	LINK	04F	FOCS	Dalitz fit, 567 evts

$\Gamma(K^+\rho(1450)^0, \rho^0 \to \pi^+\pi^-)/\Gamma(K^+\pi^+\pi^-)$ Γ_{67}/Γ_{65}

This is the "fit fraction" from the Dalitz-plot analysis.

VALUE	DOCUMENT ID		TECN	COMMENT
0.1062±0.0351±0.0104	LINK	04F	FOCS	Dalitz fit, 567 evts

$\Gamma(K^*(892)^0\pi^+, K^{*0} \to K^+\pi^-)/\Gamma(K^+\pi^+\pi^-)$ Γ_{68}/Γ_{65}

This is the "fit fraction" from the Dalitz-plot analysis.

VALUE	DOCUMENT ID		TECN	COMMENT
0.2164±0.0321±0.0114	LINK	04F	FOCS	Dalitz fit, 567 evts

$\Gamma(K^*(1410)^0\pi^+, K^{*0} \to K^+\pi^-)/\Gamma(K^+\pi^+\pi^-)$ Γ_{69}/Γ_{65}

This is the "fit fraction" from the Dalitz-plot analysis.

VALUE	DOCUMENT ID		TECN	COMMENT
0.1882±0.0403±0.0122	LINK	04F	FOCS	Dalitz fit, 567 evts

$\Gamma(K^*(1430)^0\pi^+, K^{*0} \to K^+\pi^-)/\Gamma(K^+\pi^+\pi^-)$ Γ_{70}/Γ_{65}

This is the "fit fraction" from the Dalitz-plot analysis.

VALUE	DOCUMENT ID		TECN	COMMENT
0.0765±0.0500±0.0170	LINK	04F	FOCS	Dalitz fit, 567 evts

$\Gamma(K^+\pi^+\pi^-\text{nonresonant})/\Gamma(K^+\pi^+\pi^-)$ Γ_{71}/Γ_{65}

This is the "fit fraction" from the Dalitz-plot analysis.

VALUE	DOCUMENT ID		TECN	COMMENT
0.1588±0.0492±0.0153	LINK	04F	FOCS	Dalitz fit, 567 evts

$\Gamma(K^+K^+K^-)/\Gamma(K^+K^-\pi^+)$ Γ_{72}/Γ_{16}

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{8.95\pm2.12^{+2.24}_{-2.31}}$	31	LINK	02I	FOCS	γ nucleus, $\approx$ 180 GeV

$\Gamma(\phi K^+, \phi \to K^+K^-)/\Gamma(\phi\pi^+, \phi \to K^+K^-)$ Γ_{73}/Γ_{18}

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.013	90	FRABETTI	95F	E687	γBe, $\overline{E}_\gamma \approx$ 220 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.071	90	ANJOS	92D	E691	γBe, $\overline{E}_\gamma$ = 145 GeV

Doubly-Cabibbo-suppressed modes

$\Gamma(K^+K^+\pi^-)/\Gamma(K^+K^-\pi^+)$ Γ_{74}/Γ_{16}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.0052±0.0017±0.0011	27 ± 9	LINK	05K	FOCS	<0.78%, CL = 90%

Rare or forbidden modes

$\Gamma(\pi^+e^+e^-)/\Gamma_{\text{total}}$ Γ_{75}/Γ

This mode is not a useful test for a ΔC=1 weak neutral current because both quarks must change flavor in this decay.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$\mathbf{<2.7\times10^{-4}}$	90	AITALA	99G	E791	π^- N 500 GeV

$\Gamma(\pi^+\mu^+\mu^-)/\Gamma_{\text{total}}$ Γ_{76}/Γ

This mode is not a useful test for a ΔC=1 weak neutral current because both quarks must change flavor in this decay.

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{<2.6\times10^{-5}}$	90		LINK	03F	FOCS	γ nucleus, $\overline{E}_\gamma \approx$ 180 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$<1.4\times10^{-4}$	90		AITALA	99G	E791	π^- N 500 GeV
$<4.3\times10^{-4}$	90	0	KODAMA	95	E653	π^- emulsion 600 GeV

$\Gamma(K^+ e^+ e^-)/\Gamma_{total}$ Γ_{77}/Γ

A test for the ΔC=1 weak neutral current. Allowed by higher-order electroweak interactions.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<1.6 \times 10^{-3}$	90	AITALA	99G	E791	π^- *N* 500 GeV

$\Gamma(K^+ \mu^+ \mu^-)/\Gamma_{total}$ Γ_{78}/Γ

A test for the ΔC=1 weak neutral current. Allowed by higher-order electroweak interactions.

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$<3.6 \times 10^{-5}$	90		LINK	03F	FOCS	γ nucleus, $\overline{E}_\gamma \approx$ 180 GeV

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

$<1.4 \times 10^{-4}$	90		AITALA	99G	E791	π^- *N* 500 GeV
$<5.9 \times 10^{-4}$	90	0	KODAMA	95	E653	π^- emulsion 600 GeV

$\Gamma(K^*(892)^+ \mu^+ \mu^-)/\Gamma_{total}$ Γ_{79}/Γ

A test for the ΔC=1 weak neutral current. Allowed by higher-order electroweak interactions.

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$<1.4 \times 10^{-3}$	90	0	KODAMA	95	E653	π^- emulsion 600 GeV

$\Gamma(\pi^+ e^\pm \mu^\mp)/\Gamma_{total}$ Γ_{80}/Γ

A test of lepton-family-number conservation.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<6.1 \times 10^{-4}$	90	AITALA	99G	E791	π^- *N* 500 GeV

$\Gamma(K^+ e^\pm \mu^\mp)/\Gamma_{total}$ Γ_{81}/Γ

A test of lepton-family-number conservation.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<6.3 \times 10^{-4}$	90	AITALA	99G	E791	π^- *N* 500 GeV

$\Gamma(\pi^- e^+ e^+)/\Gamma_{total}$ Γ_{82}/Γ

A test of lepton-number conservation.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<6.9 \times 10^{-4}$	90	AITALA	99G	E791	π^- *N* 500 GeV

$\Gamma(\pi^- \mu^+ \mu^+)/\Gamma_{total}$ Γ_{83}/Γ

A test of lepton-number conservation.

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$<2.9 \times 10^{-5}$	90		LINK	03F	FOCS	γ nucleus, $\overline{E}_\gamma \approx$ 180 GeV

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

$<8.2 \times 10^{-5}$	90		AITALA	99G	E791	π^- *N* 500 GeV
$<4.3 \times 10^{-4}$	90	0	KODAMA	95	E653	π^- emulsion 600 GeV

$\Gamma(\pi^- e^+ \mu^+)/\Gamma_{total}$ Γ_{84}/Γ

A test of lepton-number conservation.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<7.3 \times 10^{-4}$	90	AITALA	99G	E791	π^- *N* 500 GeV

$\Gamma(K^- e^+ e^+)/\Gamma_{total}$ Γ_{85}/Γ

A test of lepton-number conservation.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<6.3 \times 10^{-4}$	90	AITALA	99G	E791	π^- *N* 500 GeV

$\Gamma(K^- \mu^+ \mu^+)/\Gamma_{total}$ Γ_{86}/Γ

A test of lepton-number conservation.

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$<1.3 \times 10^{-5}$	90		LINK	03F	FOCS	γ nucleus, $\overline{E}_\gamma \approx$ 180 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$<1.8 \times 10^{-4}$	90		AITALA	99G	E791	π^- *N* 500 GeV
$<5.9 \times 10^{-4}$	90	0	KODAMA	95	E653	π^- emulsion 600 GeV

$\Gamma(K^- e^+ \mu^+)/\Gamma_{total}$ Γ_{87}/Γ

A test of lepton-number conservation.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<6.8 \times 10^{-4}$	90	AITALA	99G	E791	π^- *N* 500 GeV

$\Gamma(K^*(892)^- \mu^+ \mu^+)/\Gamma_{total}$ Γ_{88}/Γ

A test of lepton-number conservation.

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$<1.4 \times 10^{-3}$	90	0	KODAMA	95	E653	π^- emulsion 600 GeV

$D_s^+ - D_s^-$ *T*-VIOLATING DECAY-RATE ASYMMETRIES

$A_{Tviol}(K_S^0 K^\pm \pi^+ \pi^-)$ in $D_s^\pm \to K_S^0 K^\pm \pi^+ \pi^-$

$C_T \equiv \vec{p}_{K^+} \cdot (\vec{p}_{\pi^+} \times \vec{p}_{\pi^-})$ is a *T*-odd correlation of the K^+, π^+, and π^- momenta for the D_s^+. $\overline{C}_T \equiv \vec{p}_{K^-} \cdot (\vec{p}_{\pi^-} \times \vec{p}_{\pi^+})$ is the corresponding quantity for the D_s^-. $A_T \equiv [\Gamma(C_T > 0) - \Gamma(C_T < 0)] / [\Gamma(C_T > 0) + \Gamma(C_T < 0)]$ would, in the absence of strong phases, test for *T* violation in D_s^+ decays (the Γ's are partial widths). With $\overline{A}_T \equiv [\Gamma(-\overline{C}_T > 0) - \Gamma(-\overline{C}_T < 0)] / [\Gamma(-\overline{C}_T > 0) + \Gamma(-\overline{C}_T < 0)]$, the asymmetry $A_{Tviol} \equiv \frac{1}{2}(A_T - \overline{A}_T)$ tests for *T* violation even with nonzero strong phases.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
$-0.036 \pm 0.067 \pm 0.023$	508 ± 34	LINK	05E	FOCS	γ A, $\overline{E}_\gamma \approx 180$ GeV

$D_s^+ \to \phi \ell^+ \nu_\ell$ FORM FACTORS

$r_2 \equiv A_2(0)/A_1(0)$ in $D_s^+ \to \phi \ell^+ \nu_\ell$

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
1.32 ±0.24 OUR AVERAGE	Error includes scale factor of 1.2.				
$0.713 \pm 0.202 \pm 0.284$	793	LINK	04C	FOCS	$\phi \mu^+ \nu_\mu$
$1.57 \pm 0.25 \pm 0.19$	271	AITALA	99D	E791	$\phi e^+ \nu_e$, $\phi \mu^+ \nu_\mu$
$1.4 \pm 0.5 \pm 0.3$	308	AVERY	94B	CLE2	$\phi e^+ \nu_e$
$1.1 \pm 0.8 \pm 0.1$	90	FRABETTI	94F	E687	$\phi \mu^+ \nu_\mu$
$2.1 \,^{+0.6}_{-0.5} \pm 0.2$	19	KODAMA	93	E653	$\phi \mu^+ \nu_\mu$

$r_v \equiv V(0)/A_1(0)$ in $D_s^+ \to \phi\ell^+\nu_\ell$

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
1.72 ±0.21 OUR AVERAGE					
$1.549 \pm 0.250 \pm 0.148$	793	LINK	04C	FOCS	$\phi\mu^+\nu_\mu$
$2.27 \pm 0.35 \pm 0.22$	271	AITALA	99D	E791	$\phi e^+\nu_e$, $\phi\mu^+\nu_\mu$
$0.9 \pm 0.6 \pm 0.3$	308	AVERY	94B	CLE2	$\phi e^+\nu_e$
$1.8 \pm 0.9 \pm 0.2$	90	FRABETTI	94F	E687	$\phi\mu^+\nu_\mu$
$2.3 \ ^{+1.1}_{-0.9} \pm 0.4$	19	KODAMA	93	E653	$\phi\mu^+\nu_\mu$

Γ_L/Γ_T in $D_s^+ \to \phi\ell^+\nu_\ell$

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.72±0.18 OUR AVERAGE					
$1.0 \pm 0.3 \pm 0.2$	308	AVERY	94B	CLE2	$\phi e^+\nu_e$
$1.0 \pm 0.5 \pm 0.1$	90	[31] FRABETTI	94F	E687	$\phi\mu^+\nu_\mu$
$0.54 \pm 0.21 \pm 0.10$	19	[31] KODAMA	93	E653	$\phi\mu^+\nu_\mu$

[31] FRABETTI 94F and KODAMA 93 evaluate Γ_L/Γ_T for a lepton mass of zero.

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