$D_s^{\pm}$ was $F^{\pm}$

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

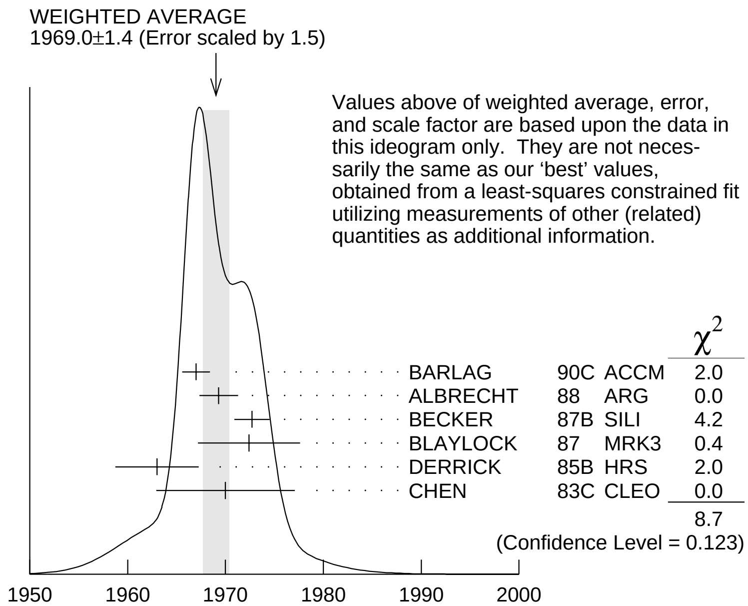
The angular distributions of the decays of the ϕ and $\overline{K}^*(892)^0$ in the $\phi\pi^+$ and $K^+\overline{K}^*(892)^0$ modes strongly indicate that the spin is zero. The parity given is that expected of a $c\overline{s}$ ground state.

$D_s^{\pm}$ 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*
1968.1± 0.5 OUR NEW UNCHECKED FIT Error includes scale factor of 1.1. [1968.5 ± 0.6 MeV OUR 2002 FIT Scale factor = 1.1]					
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).



$D_s^{\pm}$ mass (MeV)

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

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*
98.68±0.28 OUR NEW UNCHECKED FIT Error includes scale factor of 1.1. [99.2 ± 0.5 MeV OUR 2002 FIT Scale factor = 1.1]					
98.64±0.27 OUR NEW AVERAGE [99.2 ± 0.5 MeV OUR 2002 AVERAGE]					
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*
490 ± 9 OUR AVERAGE Error includes scale factor of 1.1.					
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
$486.3\pm15.0^{+4.9}_{-5.1}$	2167	[2] BONVICINI	99	CLE2	$e^+e^- \approx \Upsilon(4S)$

475	±20	± 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 ± 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	e^+ anything		$(8\ ^{+6}_{-5})$ %	
Γ_6	ϕ anything		$(18\ ^{+15}_{-10})$ %	
	Leptonic and semileptonic modes			
Γ_7	$\mu^+\nu_\mu$		$(5.0 \pm 1.9) \times 10^{-3}$	S=1.3
Γ_8	$\tau^+\nu_\tau$		(6.4 ± 1.5) %	
Γ_9	$\phi\ell^+\nu_\ell$	[a]	(2.0 ± 0.5) %	
Γ_{10}	$\eta\ell^+\nu_\ell$ + $\eta'(958)\ell^+\nu_\ell$	[a]	(3.4 ± 1.0) %	
Γ_{11}	$\eta\ell^+\nu_\ell$	[a]	(2.5 ± 0.7) %	
Γ_{12}	$\eta'(958)\ell^+\nu_\ell$	[a]	$(8.9 \pm 3.3) \times 10^{-3}$	
	Hadronic modes with a $K\overline{K}$ pair (including from a ϕ)			
Γ_{13}	$K^+\overline{K}^0$		(3.6 ± 1.1) %	
Γ_{14}	$K^+K^-\pi^+$	[b]	(4.4 ± 1.2) %	
Γ_{15}	$\phi\pi^+$	[c]	(3.6 ± 0.9) %	
Γ_{16}	$K^+\overline{K}^*(892)^0$	[c]	(3.3 ± 0.9) %	
Γ_{17}	$f_0(980)\pi^+ \times B(f_0 \to K^+K^-)$	[d]	$(4.9 \pm 2.3) \times 10^{-3}$	
Γ_{18}	$K^+\overline{K}_0^*(1430)^0$	[c]	$(7 \pm 4) \times 10^{-3}$	
Γ_{19}	$f_0(1710)\pi^+ \times B(f_0 \to K^+K^-)$			
Γ_{20}	$K^+K^-\pi^+$ nonresonant		$(9 \pm 4) \times 10^{-3}$	
Γ_{21}	$K^0\overline{K}^0\pi^+$		—	
Γ_{22}	$K^*(892)^+\overline{K}^0$	[c]	(4.3 ± 1.4) %	

Γ_{23}	$K^+ K^- \pi^+ \pi^0$		—	
Γ_{24}	$\phi \pi^+ \pi^0$	[c]	(9 ± 5) %	
Γ_{25}	$\phi \rho^+$	[c]	(6.7 ± 2.3) %	
Γ_{26}	$\phi \pi^+ \pi^0$ 3-body	[c]	< 2.6 %	CL=90%
Γ_{27}	$K^+ K^- \pi^+ \pi^0$ non-ϕ		< 9 %	CL=90%
Γ_{28}	$K^+ \overline{K}^0 \pi^+ \pi^-$		(2.5 ± 0.9) %	
Γ_{29}	$K^0 K^- \pi^+ \pi^+$		(4.3 ± 1.5) %	
Γ_{30}	$K^*(892)^+ \overline{K}^*(892)^0$	[c]	(5.8 ± 2.5) %	
Γ_{31}	$K^0 K^- \pi^+ \pi^+$ non-$K^{*+} \overline{K}^{*0}$		< 2.9 %	CL=90%
Γ_{32}	$K^+ K^- \pi^+ \pi^+ \pi^-$		$(8.4 \pm 3.3) \times 10^{-3}$	
Γ_{33}	$\phi \pi^+ \pi^+ \pi^-$	[c]	(1.18 ± 0.35) %	

Hadronic modes without K's

Γ_{34}	$\pi^+ \pi^+ \pi^-$		(1.01 ± 0.28) %	S=1.1
Γ_{35}	$\rho^0 \pi^+$		$< 7 \times 10^{-4}$	CL=90%
Γ_{36}	$f_0(980) \pi^+ \times$ B($f_0 \to \pi^+ \pi^-$)	[e]	$(5.7 \pm 1.7) \times 10^{-3}$	
Γ_{37}	$f_2(1270) \pi^+$	[c]	$(3.5 \pm 1.2) \times 10^{-3}$	
Γ_{38}	$f_0(1370) \pi^+ \times$ B($f_0 \to \pi^+ \pi^-$)	[e]	$(3.3 \pm 1.2) \times 10^{-3}$	
Γ_{39}	$\rho(1450)^0 \pi^+ \times$ B($\rho^0 \to \pi^+ \pi^-$)	[e]	$(4.4 \pm 2.5) \times 10^{-4}$	
Γ_{40}	$f_0(1500) \pi^+ \times$ B($f_0 \to \pi^+ \pi^-$)			
Γ_{41}	$\pi^+ \pi^+ \pi^-$ nonresonant		$(5 \pm 22) \times 10^{-5}$	
Γ_{42}	$\pi^+ \pi^+ \pi^- \pi^0$		< 12 %	CL=90%
Γ_{43}	$\eta \pi^+$	[c]	(1.7 ± 0.5) %	
Γ_{44}	$\omega \pi^+$	[c]	$(2.8 \pm 1.1) \times 10^{-3}$	
Γ_{45}	$\pi^+ \pi^+ \pi^+ \pi^- \pi^-$		$(7.0 \pm 3.0) \times 10^{-3}$	
Γ_{46}	$\pi^+ \pi^+ \pi^- \pi^0 \pi^0$		—	
Γ_{47}	$\eta \rho^+$	[c]	(10.8 ± 3.1) %	
Γ_{48}	$\eta \pi^+ \pi^0$ 3-body	[c]	< 4 %	CL=90%
Γ_{49}	$\pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^0$		(4.9 ± 3.2) %	
Γ_{50}	$\eta'(958) \pi^+$	[c]	(3.9 ± 1.0) %	
Γ_{51}	$\pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^0 \pi^0$		—	
Γ_{52}	$\eta'(958) \rho^+$	[c]	(10.1 ± 2.8) %	
Γ_{53}	$\eta'(958) \pi^+ \pi^0$ 3-body	[c]	< 1.4 %	CL=90%

Modes with one or three K's

Γ_{54}	$K^0 \pi^+$		$< 8 \times 10^{-3}$	CL=90%
Γ_{55}	$K^+ \pi^+ \pi^-$		(1.0 ± 0.4) %	
Γ_{56}	$K^+ \rho^0$		$< 2.9 \times 10^{-3}$	CL=90%
Γ_{57}	$K^*(892)^0 \pi^+$	[c]	$(6.5 \pm 2.8) \times 10^{-3}$	
Γ_{58}	$K^+ K^+ K^-$		$(4.0 \pm 1.7) \times 10^{-4}$	
Γ_{59}	ϕK^+	[c]	$< 5 \times 10^{-4}$	CL=90%

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

Γ_{60}	$\pi^+ e^+ e^-$		[f] $<$	2.7	$\times 10^{-4}$	CL=90%
Γ_{61}	$\pi^+ \mu^+ \mu^-$		[f] $<$	1.4	$\times 10^{-4}$	CL=90%
Γ_{62}	$K^+ e^+ e^-$	$C1$	$<$	1.6	$\times 10^{-3}$	CL=90%
Γ_{63}	$K^+ \mu^+ \mu^-$	$C1$	$<$	1.4	$\times 10^{-4}$	CL=90%
Γ_{64}	$K^*(892)^+ \mu^+ \mu^-$	$C1$	$<$	1.4	$\times 10^{-3}$	CL=90%
Γ_{65}	$\pi^+ e^\pm \mu^\mp$	LF	[g] $<$	6.1	$\times 10^{-4}$	CL=90%
Γ_{66}	$K^+ e^\pm \mu^\mp$	LF	[g] $<$	6.3	$\times 10^{-4}$	CL=90%
Γ_{67}	$\pi^- e^+ e^+$	L	$<$	6.9	$\times 10^{-4}$	CL=90%
Γ_{68}	$\pi^- \mu^+ \mu^+$	L	$<$	8.2	$\times 10^{-5}$	CL=90%
Γ_{69}	$\pi^- e^+ \mu^+$	L	$<$	7.3	$\times 10^{-4}$	CL=90%
Γ_{70}	$K^- e^+ e^+$	L	$<$	6.3	$\times 10^{-4}$	CL=90%
Γ_{71}	$K^- \mu^+ \mu^+$	L	$<$	1.8	$\times 10^{-4}$	CL=90%
Γ_{72}	$K^- e^+ \mu^+$	L	$<$	6.8	$\times 10^{-4}$	CL=90%
Γ_{73}	$K^*(892)^- \mu^+ \mu^+$	L	$<$	1.4	$\times 10^{-3}$	CL=90%

Γ_{74} A dummy mode used by the fit. (82 ± 5) %

[a] 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*.

[b] 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.

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

[d] This value includes only $K^+ K^-$ decays of the intermediate resonance, because branching fractions of this resonance are not known.

[e] This value includes only $\pi^+ \pi^-$ decays of the intermediate resonance, because branching fractions of this resonance are not known.

[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 12 branching ratios uses 24 measurements and one constraint to determine 9 parameters. The overall fit has a $\chi^2 = 13.0$ for 16 degrees of freedom.

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

x_9	70							
x_{11}	60	85						
x_{12}	45	64	54					
x_{14}	66	88	75	56				
x_{15}	72	96	81	61	92			
x_{16}	67	89	76	57	93	93		
x_{34}	63	84	72	54	86	88	84	
x_{74}	−73	−96	−86	−66	−96	−98	−96	−89
	x_7	x_9	x_{11}	x_{12}	x_{14}	x_{15}	x_{16}	x_{34}

D_s^+ BRANCHING RATIOS

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

Inclusive modes

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

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
$0.13^{+0.14}_{-0.12} \pm 0.02$	COFFMAN	91	MRK3	$e^+ e^-$ 4.14 GeV

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

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
$0.39^{+0.28}_{-0.27} \pm 0.04$	COFFMAN	91	MRK3	$e^+ e^-$ 4.14 GeV

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

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
$0.20^{+0.18}_{-0.13} \pm 0.04$	COFFMAN	91	MRK3	$e^+ e^-$ 4.14 GeV

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

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
0.64±0.17±0.03	[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.

$\Gamma(e^+ \text{anything})/\Gamma_{\text{total}}$ — Γ_5/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$\mathbf{0.077^{+0.057}_{-0.043}{}^{+0.024}_{-0.021}}$		BAI	97	BES	$e^+e^- \rightarrow D_s^+ D_s^-$
• • • 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 $\Gamma(e^+\text{anything})/\Gamma_{\text{total}} = 0.05 \pm 0.05 \pm 0.02$.

$\Gamma(\phi \text{ anything})/\Gamma_{\text{total}}$ — Γ_6/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{0.178^{+0.151}_{-0.072}{}^{+0.006}_{-0.063}}$	3	BAI	98	BES	$e^+e^- \rightarrow D_s^+ D_s^-$

Leptonic and semileptonic modes

$\Gamma(\mu^+\nu_\mu)/\Gamma_{\text{total}}$ — Γ_7/Γ

See the "Note on Pseudoscalar-Meson Decay Constants" in the Listings for the $\pi^{\pm}$.

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
$0.015\ {}^{+0.013}_{-0.006}\ {}^{+0.003}_{-0.002}$	3	[6] BAI	95	BES	$e^+e^- \rightarrow D_s^+ D_s^-$
$0.004\ {}^{+0.0018}_{-0.0014}\ {}^{+0.0020}_{-0.0019}$	8	[7] AOKI	93	WA75	π^- emulsion 350 GeV
<0.03	0	[8] AUBERT	83	SPEC	μ^+ Fe, 250 GeV

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

[6] BAI 95 uses one actual $D_s^+ \rightarrow \mu^+\nu_\mu$ event together with two $D_s^+ \rightarrow \tau^+\nu_\tau$ 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_7/Γ_{15}

See the "Note on Pseudoscalar-Meson Decay Constants" in the Listings for the $\pi^{\pm}$.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.14 ±0.04 OUR NEW UNCHECKED FIT Error includes scale factor of 1.4. [0.14 ± 0.04 OUR 2002 FIT Scale factor = 1.4]					
0.19 ±0.04 OUR AVERAGE					
$0.23 \pm 0.06 \pm 0.04$	18	[9] ALEXANDROV	00	BEAT	π^- nucleus, 350 GeV
$0.173 \pm 0.023 \pm 0.035$	182	[10] CHADA	98	CLE2	$e^+e^- \approx \Upsilon(4S)$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$0.245 \pm 0.052 \pm 0.074$	39	[11] ACOSTA	94	CLE2	See CHADA 98

[9] ALEXANDROV 00 uses $f^2_D/f^2_{D_s} = 0.82 \pm 0.09$ 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 $f_{D_s} = (323 \pm 44 \pm 36)$ MeV.

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

[11] ACOSTA 94 obtains $f_{D_s} = (344 \pm 37 \pm 52 \pm 42)$ 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_7/Γ_9

See the "Note on Pseudoscalar-Meson Decay Constants" in the Listings for the $\pi^\pm$.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.25±0.07 OUR NEW UNCHECKED FIT Error includes scale factor of 1.5. [0.25 ± 0.07 OUR 2002 FIT Scale factor = 1.4]					
0.16±0.06±0.03	23	[12] KODAMA	96	E653	π^- emulsion, 600 GeV

[12] KODAMA 96 obtains $f_{D_s} = (194 \pm 35 \pm 20 \pm 14)$ 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_8/Γ

See the "Note on Pseudoscalar-Meson Decay Constants" in the Listings for the $\pi^\pm$.

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 $f_{D_s} = (285 \pm 19 \pm 40)$ MeV.

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

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

$\Gamma(\phi\ell^+\nu_\ell)/\Gamma(\phi\pi^+)$ — Γ_9/Γ_{15}

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 NEW UNCHECKED FIT [0.56 ± 0.05 OUR 2002 FIT]					
0.54 ±0.04 OUR NEW AVERAGE [0.54 ± 0.05 OUR 2002 AVERAGE]					
0.540±0.033±0.048	793	[16] LINK	02J	FOCS	γ nucleus, $\approx$ 180 GeV
0.54 ±0.05 ±0.04	367	[17] BUTLER	94	CLE2	$e^+e^- \approx \Upsilon(4S)$
0.58 ±0.17 ±0.07	97	[18] FRABETTI	93G	E687	γBe $\overline{E}_\gamma$= 220 GeV
0.57 ±0.15 ±0.15	104	[19] ALBRECHT	91	ARG	$e^+e^- \approx$ 10.4 GeV
0.49 ±0.10 $^{+0.10}_{-0.14}$	54	[20] ALEXANDER	90B	CLEO	e^+e^- 10.5–11 GeV

[16] LINK 02J measures the $\Gamma(\phi\mu^+\nu_\mu)/\Gamma(\phi\pi^+)$ ratio.
[17] BUTLER 94 uses both $\phi e^+\nu_e$ and $\phi\mu^+\nu_\mu$ events, and makes a phase-space adjustment to the latter to use them as $\phi e^+\nu_e$ events.
[18] FRABETTI 93G measures the $\Gamma(\phi\mu^+\nu_\mu)/\Gamma(\phi\pi^+)$ ratio.
[19] ALBRECHT 91 measures the $\Gamma(\phi e^+\nu_e)/\Gamma(\phi\pi^+)$ ratio.
[20] ALEXANDER 90B measures an average of the $\Gamma(\phi e^+\nu_e)/\Gamma(\phi\pi^+)$ and $\Gamma(\phi\mu^+\nu_\mu)/\Gamma(\phi\pi^+)$ ratios.

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

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	[21] BRANDENB...	95	CLE2	$e^+e^- \approx \Upsilon(4S)$

[21] 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_{12}/Γ_9

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	[22] BRANDENB...	95	CLE2	$e^+e^- \approx \Upsilon(4S)$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<1.6	90		[23] KODAMA	93B	E653	π^- emulsion 600 GeV

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

$[\Gamma(\eta\ell^+\nu_\ell)+\Gamma(\eta'(958)\ell^+\nu_\ell)]/\Gamma(\phi\ell^+\nu_\ell)$ — $\Gamma_{10}/\Gamma_9=(\Gamma_{11}+\Gamma_{12})/\Gamma_9$

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	[24] 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		[25] BRANDENB...	95	CLE2	$e^+e^- \approx \Upsilon(4S)$

[24] KODAMA 93 uses μ^+ events.
[25] 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_{13}/Γ_{15}

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

$\Gamma(\phi\pi^+)/\Gamma_{total}$ — Γ_{15}/Γ

We now have model-independent measurements of this branching fraction, and so we no longer use the earlier, model-dependent results.

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.036 ±0.009 OUR FIT						
0.036 ±0.009 OUR AVERAGE						
0.0359±0.0077±0.0048			[26] ARTUSO	96	CLE2	e^+e^- at $\Upsilon(4S)$
$0.039\ ^{+0.051}_{-0.019}\ ^{+0.018}_{-0.011}$			[27] BAI	95C	BES	e^+e^- 4.03 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •						
0.051 ±0.004 ±0.008			[28] BUTLER	94	CLE2	$e^+e^- \approx \Upsilon(4S)$
<0.048	90		MUHEIM	94		
0.046 ±0.015			[29] MUHEIM	94		
0.031 ±0.009			[29] MUHEIM	94		
0.031 ±0.009 ±0.006			[28] FRABETTI	93G	E687	γ Be $\overline{E}_\gamma$= 220 GeV
0.024 ±0.010			[28] ALBRECHT	91	ARG	$e^+e^- \approx$ 10.4 GeV
<0.041	90	0	[27] ADLER	90B	MRK3	e^+e^- 4.14 GeV
$0.031 \pm0.006\ ^{+0.011}_{-0.009}$			[28] ALEXANDER	90B	CLEO	e^+e^- 10.5–11 GeV
0.048 ±0.017 ±0.019			[30] ALVAREZ	90C	NA14	Photoproduction
>0.034	90		[28] ANJOS	90B	E691	γ Be, $\overline{E}_\gamma \approx$ 145 GeV
0.02 ±0.01		405	[31] CHEN	89	CLEO	e^+e^- 10 GeV
0.033 ±0.016 ±0.010		9	[31] BRAUNSCH...	87	TASS	e^+e^- 35–44 GeV
0.033 ±0.011		30	[31] DERRICK	85B	HRS	e^+e^- 29 GeV

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

[27] BAI 95C uses $e^+e^- \rightarrow D_s^+ D_s^-$ events in which one or both of the $D_s^\pm$ are observed to obtain the first model-independent measurement of the $D_s^+ \rightarrow \phi\pi^+$ branching fraction, without assumptions about $\sigma(D_s^\pm)$. However, with only two "doubly-tagged" events, the statistical error is very large. ADLER 90B used the same method to set a limit.

[28] BUTLER 94, FRABETTI 93G, ALBRECHT 91, ALEXANDER 90B, and ANJOS 90B measure the ratio $\Gamma(D_s^+ \rightarrow \phi\ell^+\nu_\ell)/\Gamma(D_s^+ \rightarrow \phi\pi^+)$, where $\ell = e$ and/or μ, and then use a theoretical calculation of the ratio of widths $\Gamma(D_s^+ \rightarrow \phi\ell^+\nu_\ell)/\Gamma(D^+ \rightarrow \overline{K}^{*0}\ell^+\nu)$. Not everyone uses the same value for this ratio.

[29] The two MUHEIM 94 values here are model-dependent calculations based on distinct data sets. The first uses measurements of the $D_2^*(2460)^0$ and $D_{s1}(2536)^+$, the second uses B-decay factorization and $\Gamma(D_s^+ \rightarrow \mu^+\nu_\mu)/\Gamma(D_s^+ \rightarrow \phi\ell^+\nu_\ell)$. A third calculation using the semileptonic width of $D_s^+ \rightarrow \phi\ell^+\nu_\ell$ is not independent of other results listed here. Note also the upper limit, based on the sum of established D_s^+ branching ratios.

[30] ALVAREZ 90C relies on the Lund model to estimate the ratio of D_s^+ to D^+ cross sections.

[31] Values based on crude estimates of the $D_s^\pm$ production level. DERRICK 85B errors are statistical only.

$\Gamma(\phi\pi^+)/\Gamma(K^+K^-\pi^+)$ — Γ_{15}/Γ_{14}

Unseen decay modes of the ϕ are included.

VALUE	DOCUMENT ID		TECN	COMMENT
0.81 ±0.08 OUR FIT				
0.807±0.067±0.096	FRABETTI	95B	E687	Dalitz plot analysis

$\Gamma(K^+\overline{K}^*(892)^0)/\Gamma(K^+K^-\pi^+)$ — Γ_{16}/Γ_{14}

Unseen decay modes of the $\overline{K}^*(892)^0$ are included.

VALUE	DOCUMENT ID		TECN	COMMENT
0.75 ±0.07 OUR FIT				
0.717±0.069±0.060	FRABETTI	95B	E687	Dalitz plot analysis

$\Gamma(K^+\overline{K}^*(892)^0)/\Gamma(\phi\pi^+)$ — Γ_{16}/Γ_{15}

Unseen decay modes of the resonances are included.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.92±0.09 OUR FIT					
0.95±0.10 OUR AVERAGE					
0.85±0.34±0.20	9	ALVAREZ	90C	NA14	Photoproduction
0.84±0.30±0.22		ADLER	89B	MRK3	e^+e^- 4.14 GeV
1.05±0.17±0.12		CHEN	89	CLEO	e^+e^- 10 GeV
0.87±0.13±0.05	117	ANJOS	88	E691	Photoproduction
1.44±0.37	87	ALBRECHT	87F	ARG	e^+e^- 10 GeV

$\Gamma(f_0(980)\pi^+ \times B(f_0 \to K^+K^-))/\Gamma(K^+K^-\pi^+)$ — Γ_{17}/Γ_{14}

This includes only the K^+K^- decays of the $f_0(980)$, because branching fractions of this resonance are not known.

VALUE	DOCUMENT ID		TECN	COMMENT
0.11±0.035±0.026	FRABETTI	95B	E687	Dalitz plot analysis

$\Gamma(f_0(1710)\pi^+ \times B(f_0 \to K^+K^-))/\Gamma(K^+K^-\pi^+)$ — Γ_{19}/Γ_{14}

This includes only K^+K^- decays of the $f_0(1710)$, because branching fractions of this resonance are not known.

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.034±0.023±0.035	[32] FRABETTI	95B	E687	Dalitz plot analysis

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

$\Gamma(K^+\overline{K}^*_0(1430)^0)/\Gamma(K^+K^-\pi^+)$ — Γ_{18}/Γ_{14}

Unseen decay modes of the $\overline{K}^*_0(1430)^0$ are included.

VALUE	DOCUMENT ID		TECN	COMMENT
0.150±0.052±0.052	FRABETTI	95B	E687	Dalitz plot analysis

$\Gamma(K^+K^-\pi^+ \text{nonresonant})/\Gamma(\phi\pi^+)$ — Γ_{20}/Γ_{15}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.25±0.07±0.05	48	ANJOS	88	E691	Photoproduction

$\Gamma(K^*(892)^+\overline{K}^0)/\Gamma(\phi\pi^+)$ — Γ_{22}/Γ_{15}

Unseen decay modes of the resonances are included.

VALUE	DOCUMENT ID		TECN	COMMENT
1.20±0.21±0.13	CHEN	89	CLEO	e^+e^- 10 GeV

$\Gamma(K^*(892)^+ \overline{K}^0)/\Gamma(K^+ \overline{K}^0)$ — Γ_{22}/Γ_{13}

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	γ Be $\overline{E}_\gamma \approx$ 200 GeV

$\Gamma(\phi\pi^+\pi^0)/\Gamma(\phi\pi^+)$ — Γ_{24}/Γ_{15}

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
2.4±1.0±0.5		11	ANJOS	89E	E691	Photoproduction
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<2.6	90		ALVAREZ	90C	NA14	Photoproduction

$\Gamma(\phi\rho^+)/\Gamma(\phi\pi^+)$ — Γ_{25}/Γ_{15}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{1.86 \pm 0.26 ^{+0.29}_{-0.40}}$	253	AVERY	92	CLE2	$e^+e^- \simeq$ 10.5 GeV

$\Gamma(\phi\pi^+\pi^0$ 3-body$)/\Gamma(\phi\pi^+)$ — Γ_{26}/Γ_{15}

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_{27}/Γ_{15}

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

$\Gamma(K^+\overline{K}^0\pi^+\pi^-)/\Gamma(\phi\pi^+)$ — Γ_{28}/Γ_{15}

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.77	90	ALBRECHT	92B	ARG	$e^+e^- \simeq$ 10.4 GeV

$\Gamma(K^+\overline{K}^0\pi^+\pi^-)/\Gamma(K^0K^-\pi^+\pi^+)$ — Γ_{28}/Γ_{29}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.586±0.052±0.043	476	LINK	01C	FOCS	γ nucleus, $\overline{E}_\gamma \approx$ 180 GeV

$\Gamma(K^0K^-\pi^+\pi^+)/\Gamma(\phi\pi^+)$ — Γ_{29}/Γ_{15}

VALUE	DOCUMENT ID		TECN	COMMENT
1.2 ±0.2 ±0.2	ALBRECHT	92B	ARG	$e^+e^- \simeq$ 10.4 GeV

$\Gamma(K^*(892)^+\overline{K}^*(892)^0)/\Gamma(\phi\pi^+)$ — Γ_{30}/Γ_{15}

Unseen decay modes of the resonances are included.

VALUE	DOCUMENT ID		TECN	COMMENT
1.6±0.4±0.4	ALBRECHT	92B	ARG	$e^+e^- \simeq$ 10.4 GeV

$\Gamma(K^0K^-\pi^+\pi^+$ non-$K^{*+}\overline{K}^{*0})/\Gamma(\phi\pi^+)$ — Γ_{31}/Γ_{15}

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_{32}/Γ_{14}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.188±0.036±0.040	75	FRABETTI	97C	E687	γ Be, $\overline{E}_\gamma \approx$ 200 GeV

$\Gamma(\phi\pi^+\pi^+\pi^-)/\Gamma(\phi\pi^+)$ — Γ_{33}/Γ_{15}

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.33±0.06 OUR AVERAGE						
0.28±0.06±0.01		40	FRABETTI	97C	E687	γ Be, $\overline{E}_\gamma \approx$ 200 GeV
0.58±0.21±0.10		21	FRABETTI	92	E687	γ Be
0.42±0.13±0.07		19	ANJOS	88	E691	Photoproduction
1.11±0.37±0.28		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

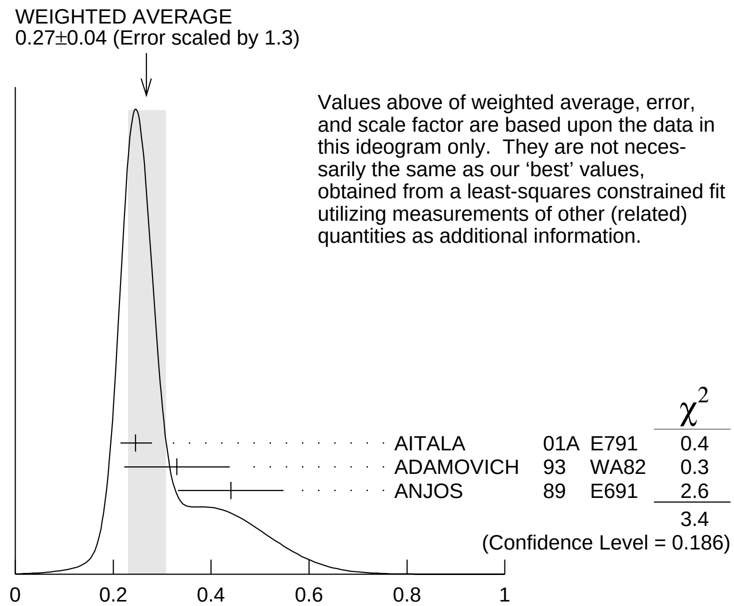
Pionic modes

$\Gamma(\pi^+\pi^+\pi^-)/\Gamma(K^+K^-\pi^+)$ — Γ_{34}/Γ_{14}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.227±0.033 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_{34}/Γ_{15}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.28 ±0.04 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.				
$0.245 \pm 0.028 ^{+0.019}_{-0.012}$	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



$\Gamma(\pi^+\pi^+\pi^-)/\Gamma(\phi\pi^+)$

$\Gamma(\rho^0\pi^+)/\Gamma(\pi^+\pi^+\pi^-)$ — Γ_{35}/Γ_{34}

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.073	90	FRABETTI	97D	E687	γ Be ≈ 200 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.058±0.023±0.037		[33] AITALA	01A	E791	π^- nucleus, 500 GeV

[33] This AITALA 01A result does not have enough statistical significance to prefer it to the FRABETTI 97D limit.

$\Gamma(\rho^0\pi^+)/\Gamma(\phi\pi^+)$ — Γ_{35}/Γ_{15}

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

$\Gamma(f_0(980)\pi^+ \times B(f_0 \to \pi^+\pi^-))/\Gamma(\pi^+\pi^+\pi^-)$ — Γ_{36}/Γ_{34}

This includes only the $\pi^+\pi^-$ decays of the $f_0(980)$, because branching fractions of this resonance are not known. In general, we favor the results of AITALA 01A over those of FRABETTI 97D (848 ± 44 events versus 98 ± 12).

VALUE	DOCUMENT ID		TECN	COMMENT
0.565±0.043±0.047	AITALA	01A	E791	π^- nucleus, 500 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1.074±0.140±0.043	FRABETTI	97D	E687	γ Be ≈ 200 GeV

$\Gamma(f_0(980)\pi^+ \times B(f_0 \to \pi^+\pi^-))/\Gamma(\phi\pi^+)$ — Γ_{36}/Γ_{15}

This includes only the $\pi^+\pi^-$ decays of the $f_0(980)$, because branching fractions of this resonance are not known.

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.28±0.10±0.03	ANJOS	89	E691	Photoproduction

$\Gamma(f_2(1270)\pi^+)/\Gamma(\pi^+\pi^+\pi^-)$ — Γ_{37}/Γ_{34}

Unseen decay modes of the $f_2(1270)$ are included.

In general, we favor the results of AITALA 01A over those of FRABETTI 97D (848 ± 44 events versus 98 ± 12).

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
0.349±0.059±0.011	[34] AITALA	01A	E791	π^- nucleus, 500 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.22 ±0.10 ±0.03	FRABETTI	97D	E687	γ Be ≈ 200 GeV

[34] See AITALA 01A for the magnitude and phase of this amplitude relative to the $f_0(980)\pi^+$ amplitude.

$\Gamma(f_0(1370)\pi^+ \times B(f_0 \to \pi^+\pi^-))/\Gamma(\pi^+\pi^+\pi^-)$ — Γ_{38}/Γ_{34}

This includes only the $\pi^+\pi^-$ decays of the $f_0(1370)$, because branching fractions of this resonance are not known.

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
0.324±0.077±0.017	[35] AITALA	01A	E791	π^- nucleus, 500 GeV

[35] See AITALA 01A for the magnitude and phase of this amplitude relative to the $f_0(980)\pi^+$ amplitude.

$\Gamma(\rho(1450)^0\pi^+ \times B(\rho^0 \to \pi^+\pi^-))/\Gamma(\pi^+\pi^+\pi^-)$ — Γ_{39}/Γ_{34}

This includes only the $\pi^+\pi^-$ decays of the $\rho(1450)^0$, because branching fractions of this resonance are not known.

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
0.044±0.021±0.002	[36] AITALA	01A	E791	π^- nucleus, 500 GeV

[36] See AITALA 01A for the magnitude and phase of this amplitude relative to the $f_0(980)\pi^+$ amplitude.

$\Gamma(f_0(1500)\pi^+ \times B(f_0 \to \pi^+\pi^-))/\Gamma(\pi^+\pi^+\pi^-)$ — Γ_{40}/Γ_{34}

This includes only $\pi^+\pi^-$ decays of the $f_0(1500)$, because branching fractions of this resonance are not known. In general, we favor the results of AITALA 01A over those of FRABETTI 97D (848 ± 44 events versus 98 ± 12).

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.274±0.114±0.019	[37] FRABETTI	97D	E687	γ Be ≈ 200 GeV

[37] 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 $f_0(1500)$.

$\Gamma(\pi^+\pi^+\pi^-$ nonresonant$)/\Gamma(\pi^+\pi^+\pi^-)$ — Γ_{41}/Γ_{34}

In general, we favor the results of AITALA 01A over those of FRABETTI 97D (848 ± 44 events versus 98 ± 12).

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
0.005±0.014±0.017		AITALA	01A	E791	π^- nucleus, 500 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.269	90	[38] FRABETTI	97D	E687	γ Be ≈ 200 GeV

[38] See FRABETTI 97D on the difficulty of disentangling the $f_0(1500)\pi^+$ and nonresonant modes.

$\Gamma(\pi^+\pi^+\pi^-$ nonresonant$)/\Gamma(\phi\pi^+)$ — Γ_{41}/Γ_{15}

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.29±0.09±0.03	ANJOS	89	E691	Photoproduction

$\Gamma(\pi^+\pi^+\pi^-\pi^0)/\Gamma(\phi\pi^+)$ — Γ_{42}/Γ_{15}

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

$\Gamma(\eta\pi^+)/\Gamma(\phi\pi^+)$ — Γ_{43}/Γ_{15}

Unseen decay modes of the resonances are included.

VALUE	CL%	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
<1.5	90		ANJOS	89E	E691	Photoproduction

$\Gamma(\omega\pi^+)/\Gamma(\phi\pi^+)$ — Γ_{44}/Γ_{15}

Unseen decay modes of the resonances are included.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.5	90	ANJOS	89E	E691	Photoproduction

$\Gamma(\omega\pi^+)/\Gamma(\eta\pi^+)$ — Γ_{44}/Γ_{43}

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

$\Gamma(\pi^+\pi^+\pi^+\pi^-\pi^-)/\Gamma(K^+K^-\pi^+)$ — Γ_{45}/Γ_{14}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.158±0.042±0.031	37	FRABETTI	97C	E687	γBe, $\overline{E}_\gamma \approx$ 200 GeV

$\Gamma(\pi^+\pi^+\pi^+\pi^-\pi^-)/\Gamma(\phi\pi^+)$ — Γ_{45}/Γ_{15}

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.29	90	ANJOS	89	E691	Photoproduction

$\Gamma(\eta\rho^+)/\Gamma(\phi\pi^+)$ — Γ_{47}/Γ_{15}

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_{48}/Γ_{15}

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	[39] DAOUDI	92	CLE2	See JESSOP 98

[39] 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.

$\Gamma(\pi^+\pi^+\pi^+\pi^-\pi^-\pi^0)/\Gamma_{\text{total}}$ — Γ_{49}/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_{50}/Γ_{15}

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	γ Be, $\overline{E}_\gamma \approx 145$ GeV

$\Gamma(\eta'(958)\rho^+)/\Gamma(\phi\pi^+)$ — Γ_{52}/Γ_{15}

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

$\Gamma(\eta'(958)\pi^+\pi^0\text{ 3-body})/\Gamma(\phi\pi^+)$ — Γ_{53}/Γ_{15}

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_{54}/Γ_{15}

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_{54}/Γ_{13}

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

$\Gamma(K^+\pi^+\pi^-)/\Gamma(\phi\pi^+)$ — Γ_{55}/Γ_{15}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.28±0.06±0.05	85	FRABETTI	95E	E687	γ Be, $\overline{E}_\gamma$= 220 GeV

$\Gamma(K^+\rho^0)/\Gamma(\phi\pi^+)$ — Γ_{56}/Γ_{15}

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.08	90	FRABETTI	95E	E687	γ Be, $\overline{E}_\gamma$= 220 GeV

$\Gamma(K^*(892)^0\pi^+)/\Gamma(\phi\pi^+)$ — Γ_{57}/Γ_{15}

Unseen decay modes of the resonances are included.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.18±0.05±0.04	25	FRABETTI	95E	E687	γ Be, $\overline{E}_\gamma$= 220 GeV

$\Gamma(K^+K^+K^-)/\Gamma(K^+K^-\pi^+)$ — Γ_{58}/Γ_{14}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
$0.00895\pm0.00212^{+0.00224}_{-0.00231}$	31	LINK	02I	FOCS	γ nucleus, $\approx$ 180 GeV

$\Gamma(K^+K^+K^-)/\Gamma(\phi\pi^+)$ — Γ_{58}/Γ_{15}

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.016	90	FRABETTI	95F	E687	γ Be, $\overline{E}_\gamma \approx$ 220 GeV

$\Gamma(\phi K^+)/\Gamma(\phi\pi^+)$ — Γ_{59}/Γ_{15}

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

Rare or forbidden modes

$\Gamma(\pi^+e^+e^-)/\Gamma_{total}$ — Γ_{60}/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
$<2.7\times10^{-4}$	90	AITALA	99G	E791	π^-N 500 GeV

$\Gamma(\pi^+ \mu^+ \mu^-)/\Gamma_{total}$ — Γ_{61}/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
$<1.4 \times 10^{-4}$	90		AITALA	99G	E791	$\pi^- N$ 500 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$<4.3 \times 10^{-4}$	90	0	KODAMA	95	E653	π^- emulsion 600 GeV

$\Gamma(K^+ e^+ e^-)/\Gamma_{total}$ — Γ_{62}/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	$\pi^- N$ 500 GeV

$\Gamma(K^+ \mu^+ \mu^-)/\Gamma_{total}$ — Γ_{63}/Γ

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

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$<1.4 \times 10^{-4}$	90		AITALA	99G	E791	$\pi^- N$ 500 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$<5.9 \times 10^{-4}$	90	0	KODAMA	95	E653	π^- emulsion 600 GeV

$\Gamma(K^*(892)^+ \mu^+ \mu^-)/\Gamma_{total}$ — Γ_{64}/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_{65}/Γ

A test of lepton-family-number conservation.

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

$\Gamma(K^+ e^\pm \mu^\mp)/\Gamma_{total}$ — Γ_{66}/Γ

A test of lepton-family-number conservation.

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

$\Gamma(\pi^- e^+ e^+)/\Gamma_{total}$ — Γ_{67}/Γ

A test of lepton-number conservation.

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

$\Gamma(\pi^- \mu^+ \mu^+)/\Gamma_{total}$ — Γ_{68}/Γ

A test of lepton-number conservation.

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$<8.2 \times 10^{-5}$	90		AITALA	99G	E791	$\pi^- N$ 500 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$<4.3 \times 10^{-4}$	90	0	KODAMA	95	E653	π^- emulsion 600 GeV

$\Gamma(\pi^- e^+ \mu^+)/\Gamma_{total}$ — Γ_{69}/Γ

A test of lepton-number conservation.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<7.3 × 10⁻⁴	90	AITALA	99G	E791	$\pi^- N$ 500 GeV

$\Gamma(K^- e^+ e^+)/\Gamma_{total}$ — Γ_{70}/Γ

A test of lepton-number conservation.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<6.3 × 10⁻⁴	90	AITALA	99G	E791	$\pi^- N$ 500 GeV

$\Gamma(K^- \mu^+ \mu^+)/\Gamma_{total}$ — Γ_{71}/Γ

A test of lepton-number conservation.

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<1.8 × 10⁻⁴	90		AITALA	99G	E791	$\pi^- N$ 500 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<5.9 × 10⁻⁴	90	0	KODAMA	95	E653	π^- emulsion 600 GeV

$\Gamma(K^- e^+ \mu^+)/\Gamma_{total}$ — Γ_{72}/Γ

A test of lepton-number conservation.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<6.8 × 10⁻⁴	90	AITALA	99G	E791	$\pi^- N$ 500 GeV

$\Gamma(K^*(892)^- \mu^+ \mu^+)/\Gamma_{total}$ — Γ_{73}/Γ

A test of lepton-number conservation.

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<1.4 × 10⁻³	90	0	KODAMA	95	E653	π^- emulsion 600 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
1.60±0.24 OUR AVERAGE					
1.57±0.25±0.19	271	AITALA	99D	E791	$\phi e^+ \nu_e$, $\phi \mu^+ \nu_\mu$
1.4 ±0.5 ±0.3	308	AVERY	94B	CLE2	$\phi e^+ \nu_e$
1.1 ±0.8 ±0.1	90	FRABETTI	94F	E687	$\phi \mu^+ \nu_\mu$
$2.1\ ^{+0.6}_{-0.5}$ ±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
1.92±0.32 OUR AVERAGE					
2.27±0.35±0.22	271	AITALA	99D	E791	$\phi e^+ \nu_e$, $\phi \mu^+ \nu_\mu$
0.9 ±0.6 ±0.3	308	AVERY	94B	CLE2	$\phi e^+ \nu_e$
1.8 ±0.9 ±0.2	90	FRABETTI	94F	E687	$\phi \mu^+ \nu_\mu$
$2.3\ ^{+1.1}_{-0.9}$ ±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 ±0.3 ±0.2	308	AVERY	94B	CLE2	$\phi e^+ \nu_e$
1.0 ±0.5 ±0.1	90	[40] FRABETTI	94F	E687	$\phi \mu^+ \nu_\mu$
0.54±0.21±0.10	19	[40] KODAMA	93	E653	$\phi \mu^+ \nu_\mu$

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

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