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

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

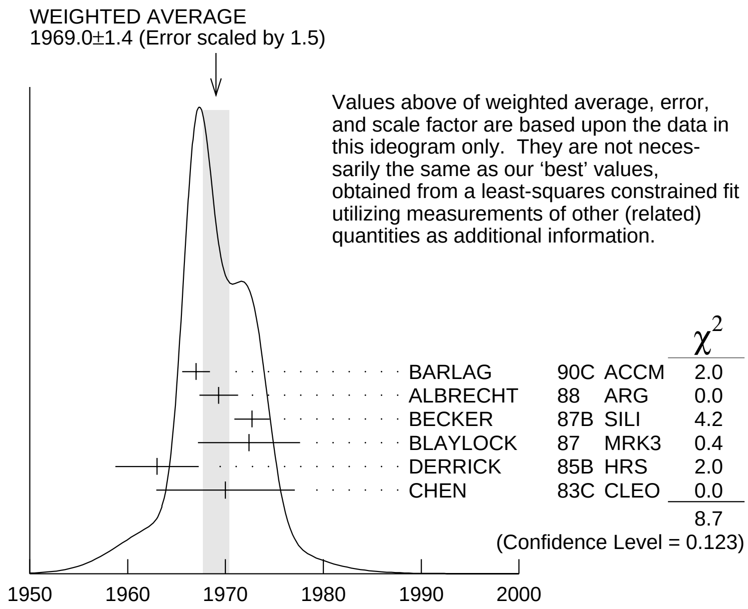
The angular distributions of the decays of the ϕ and $\overline{K}^*(892)^0$ in the $\phi\pi^+$ and $K^+\overline{K}^*(892)^0$ modes strongly indicate that the spin is zero. The parity given is that expected of a $c\overline{s}$ ground state.

$D_s^{\pm}$ 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*
1968.5± 0.6 OUR FIT Error includes scale factor of 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*
99.2±0.5 OUR FIT	Error includes scale factor of 1.1.				
99.2±0.5 OUR AVERAGE					
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 0.2×10^{-12} s are omitted from the average.

VALUE (10^{-12} s)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.495±0.013 OUR AVERAGE	Error includes scale factor of 1.1.				
0.518±0.014±0.007	1662	AITALA	99	E791	π^- nucleus, 500 GeV
0.475±0.020±0.007	900	FRABETTI	93F	E687	γ Be, $D_s^+ \rightarrow \phi\pi^+$
$0.33 \ {}^{+0.12}_{-0.08} \pm 0.03$	15	ALVAREZ	90	NA14	γ, $D_s^+ \rightarrow \phi\pi^+$
$0.469 {}^{+0.102}_{-0.086}$	54	[2] BARLAG	90C	ACCM	π^- Cu 230 GeV

0.50	±0.06	±0.03	104	FRABETTI	90	E687	γ Be, $\phi\pi^+$
0.56	$^{+0.13}_{-0.12}$	±0.08	144	ALBRECHT	88I	ARG	e^+e^- 10 GeV
0.47	±0.04	±0.02	228	RAAB	88	E691	Photoproduction
0.33	$^{+0.10}_{-0.06}$		21	[3] BECKER	87B	SILI	200 GeV π,K,p
0.26	$^{+0.16}_{-0.09}$		6	USHIDA	86	EMUL	ν wideband
• • • We do not use the following data for averages, fits, limits, etc. • • •							
0.31	$^{+0.24}_{-0.20}$	±0.05	18	AVERILL	89	HRS	e^+e^- 29 GeV
0.48	$^{+0.06}_{-0.05}$	±0.02	99	ANJOS	87B	E691	See RAAB 88
0.57	$^{+0.36}_{-0.26}$	±0.09	9	BRAUNSCH...	87	TASS	e^+e^- 35–44 GeV
0.47	±0.22	±0.05	141	CSORNA	87	CLEO	e^+e^- 10 GeV
0.35	$^{+0.24}_{-0.18}$	±0.09	17	JUNG	86	HRS	See AVERILL 89
0.32	$^{+0.30}_{-0.13}$		3	BAILEY	84	ACCM	hadron$^+$ Be $\rightarrow$ $\phi\pi^+$ X
0.19	$^{+0.13}_{-0.07}$		4	USHIDA	83	EMUL	See USHIDA 86

[2] BARLAG 90C estimates the systematic error to be negligible.
[3] BECKER 87B estimates the systematic error to be negligible.

D_s^+ DECAY MODES

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		$(39\ \pm28)$ %	
Γ_3	K^+ anything		$(20\ ^{+18}_{-14})$ %	
Γ_4	non-$K\overline{K}$ anything		$(64\ \pm17)$ %	
Γ_5	e^+ anything		$(8\ ^{+6}_{-5})$ %	
Γ_6	ϕ anything		$(18\ ^{+15}_{-10})$ %	
	Leptonic and semileptonic modes			
Γ_7	$\mu^+\nu_\mu$		$(4.6\ \pm\ 1.9)\times10^{-3}$	S=1.3
Γ_8	$\tau^+\nu_\tau$		$(7\ \pm\ 4)$ %	
Γ_9	$\phi\ell^+\nu_\ell$	[a]	$(2.0\ \pm\ 0.5)$ %	
Γ_{10}	$\eta\ell^+\nu_\ell$ + $\eta'(958)\ell^+\nu_\ell$	[a]	$(3.5\ \pm\ 1.0)$ %	
Γ_{11}	$\eta\ell^+\nu_\ell$		$(2.6\ \pm\ 0.7)$ %	
Γ_{12}	$\eta'(958)\ell^+\nu_\ell$		$(8.9\ \pm\ 3.4)\times10^{-3}$	

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) %	S=1.1
Γ_{15}	$\phi\pi^+$	[c]	(3.6 ± 0.9) %	
Γ_{16}	$K^+\overline{K}^*(892)^0$	[c]	(3.3 ± 0.9) %	
Γ_{17}	$f_0(980)\pi^+$	[c]	(1.8 ± 0.8) %	S=1.3
Γ_{18}	$K^+\overline{K}^*_0(1430)^0$	[c]	$(7 \pm 4) \times 10^{-3}$	
Γ_{19}	$f_J(1710)\pi^+ \rightarrow K^+K^-\pi^+$	[d]	$(1.5 \pm 1.9) \times 10^{-3}$	
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}	$K^+\overline{K}^0\pi^+\pi^-$		< 2.8 %	CL=90%
Γ_{29}	$K^0K^-\pi^+\pi^+$		(4.3 ± 1.5) %	
Γ_{30}	$K^*(892)^+\overline{K}^*(892)^0$	[c]	(5.8 ± 2.5) %	
Γ_{31}	$K^0K^-\pi^+\pi^+$ non-$K^{*+}\overline{K}^{*0}$		< 2.9 %	CL=90%
Γ_{32}	$K^+K^-\pi^+\pi^+\pi^-$		$(8.3 \pm 3.3) \times 10^{-3}$	
Γ_{33}	$\phi\pi^+\pi^+\pi^-$	[c]	(1.18 ± 0.35) %	
Γ_{34}	$K^+K^-\pi^+\pi^+\pi^-$ non-ϕ		$(3.0 {}^{+3.0}_{-2.0}) \times 10^{-3}$	

Hadronic modes without K's

Γ_{35}	$\pi^+\pi^+\pi^-$		(1.0 ± 0.4) %	S=1.2
Γ_{36}	$\rho^0\pi^+$		$< 8 \times 10^{-4}$	CL=90%
Γ_{37}	$f_0(980)\pi^+$	[c]	(1.8 ± 0.8) %	S=1.7
Γ_{38}	$f_2(1270)\pi^+$	[c]	$(2.3 \pm 1.3) \times 10^{-3}$	
Γ_{39}	$f_0(1500)\pi^+ \rightarrow \pi^+\pi^-\pi^+$	[e]	$(2.8 \pm 1.6) \times 10^{-3}$	
Γ_{40}	$\pi^+\pi^+\pi^-$ nonresonant		$< 2.8 \times 10^{-3}$	CL=90%
Γ_{41}	$\pi^+\pi^+\pi^-\pi^0$		< 12 %	CL=90%
Γ_{42}	$\eta\pi^+$	[c]	(1.7 ± 0.5) %	
Γ_{43}	$\omega\pi^+$	[c]	$(2.8 \pm 1.1) \times 10^{-3}$	
Γ_{44}	$\pi^+\pi^+\pi^+\pi^-\pi^-$		$(6.9 \pm 3.0) \times 10^{-3}$	
Γ_{45}	$\pi^+\pi^+\pi^-\pi^0\pi^0$		—	
Γ_{46}	$\eta\rho^+$	[c]	(10.8 ± 3.1) %	
Γ_{47}	$\eta\pi^+\pi^0$ 3-body	[c]	< 4 %	CL=90%
Γ_{48}	$\pi^+\pi^+\pi^+\pi^-\pi^-\pi^0$		(4.9 ± 3.2) %	
Γ_{49}	$\eta'(958)\pi^+$	[c]	(3.9 ± 1.0) %	
Γ_{50}	$\pi^+\pi^+\pi^+\pi^-\pi^-\pi^0\pi^0$		—	
Γ_{51}	$\eta'(958)\rho^+$	[c]	(10.1 ± 2.8) %	
Γ_{52}	$\eta'(958)\pi^+\pi^0$ 3-body	[c]	< 1.4 %	CL=90%

Modes with one or three K's

Γ_{53}	$K^0\pi^+$		< 8	$\times 10^{-3}$	CL=90%
Γ_{54}	$K^+\pi^+\pi^-$		(1.0 ± 0.4) %		
Γ_{55}	$K^+\rho^0$		< 2.9	$\times 10^{-3}$	CL=90%
Γ_{56}	$K^*(892)^0\pi^+$	[c]	(6.5 ± 2.8)	$\times 10^{-3}$	
Γ_{57}	$K^+K^+K^-$		< 6	$\times 10^{-4}$	CL=90%
Γ_{58}	ϕK^+	[c]	< 5	$\times 10^{-4}$	CL=90%

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

Γ_{59}	$\pi^+\mu^+\mu^-$		[f]	< 4.3	$\times 10^{-4}$	CL=90%
Γ_{60}	$K^+\mu^+\mu^-$	*C1*		< 5.9	$\times 10^{-4}$	CL=90%
Γ_{61}	$K^*(892)^+\mu^+\mu^-$	*C1*		< 1.4	$\times 10^{-3}$	CL=90%
Γ_{62}	$\pi^-\mu^+\mu^+$	*L*		< 4.3	$\times 10^{-4}$	CL=90%
Γ_{63}	$K^-\mu^+\mu^+$	*L*		< 5.9	$\times 10^{-4}$	CL=90%
Γ_{64}	$K^*(892)^-\mu^+\mu^+$	*L*		< 1.4	$\times 10^{-3}$	CL=90%

Γ_{65}	A dummy mode used by the fit.	(80 ± 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 $f_J(1710)$, because branching fractions of this resonance are not known.

[e] This value includes only $\pi^+\pi^-$ decays of the $f_0(1500)$, 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.

CONSTRAINED FIT INFORMATION

An overall fit to 15 branching ratios uses 24 measurements and one constraint to determine 10 parameters. The overall fit has a $\chi^2 = 17.5$ for 15 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_9	58								
x_{11}	50	86							
x_{12}	38	65	56						
x_{14}	52	85	73	55					
x_{15}	57	93	79	60	92				
x_{16}	53	86	74	56	92	93			
x_{35}	47	76	65	50	84	82	81		
x_{37}	30	48	42	32	51	52	50	54	
x_{65}	−59	−93	−84	−64	−95	−96	−94	−86	−64
	x_7	x_9	x_{11}	x_{12}	x_{14}	x_{15}	x_{16}	x_{35}	x_{37}

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*
$\mathbf{0.13^{+0.14}_{-0.12}\pm0.02}$	COFFMAN	91	MRK3	e^+e^- 4.14 GeV

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

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

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

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
$\mathbf{0.20^{+0.18}_{-0.13}\pm0.04}$	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±0.17±0.03	[4] COFFMAN	91	MRK3	e^+e^- 4.14 GeV

[4] 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	$e^+e^-\to D_s^+D_s^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.20	90	[5] BAI	90	MRK3	e^+e^- 4.14 GeV

[5] 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	$e^+e^-\to D_s^+D_s^-$

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

[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_7/Γ_{15}

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.13 ±0.04 OUR FIT	Error includes scale factor of 1.5.				
0.173±0.023±0.035	182	[9] CHADA	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	[10] ACOSTA	94	CLE2	See CHADA 98

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

[10] 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
0.23±0.08 OUR FIT	Error includes scale factor of 1.5.			
0.16±0.06±0.03	23	[11] KODAMA 96	E653	π^- emulsion, 600 GeV

[11] 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
0.074±0.028±0.024	16	[12] ACCIARRI 97F	L3	$D_s^{*+} \to \gamma D_s^+$

[12] 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
0.56±0.05 OUR FIT				
0.54±0.05 OUR AVERAGE				
0.54±0.05±0.04	367	[13] BUTLER 94	CLE2	$e^+e^- \approx \Upsilon(4S)$
0.58±0.17±0.07	97	[14] FRABETTI 93G	E687	γ Be $\overline{E}_\gamma$= 220 GeV
0.57±0.15±0.15	104	[15] ALBRECHT 91	ARG	$e^+e^- \approx$ 10.4 GeV
$0.49\pm0.10^{+0.10}_{-0.14}$	54	[16] ALEXANDER 90B	CLEO	e^+e^- 10.5–11 GeV

[13] 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.

[14] FRABETTI 93G measures the $\Gamma(\phi\mu^+\nu_\mu)/\Gamma(\phi\pi^+)$ ratio.

[15] ALBRECHT 91 measures the $\Gamma(\phi e^+\nu_e)/\Gamma(\phi\pi^+)$ ratio.

[16] 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	[17] BRANDENB... 95	CLE2	$e^+e^- \approx \Upsilon(4S)$

[17] 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	[18] BRANDENB...	95	CLE2	$e^+e^- \approx \Upsilon(4S)$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<1.6	90		[19] KODAMA	93B	E653	π^- emulsion 600 GeV

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

[19] 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	[20] 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		[21] BRANDENB...	95	CLE2	$e^+e^- \approx \Upsilon(4S)$

[20] KODAMA 93 uses μ^+ events.

[21] 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. See the "Note on D Mesons" in the D^+ Listings for a discussion.

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			[22] ARTUSO	96	CLE2	e^+e^- at $\Upsilon(4S)$
$0.039\ ^{+0.051}_{-0.019}\ ^{+0.018}_{-0.011}$			[23] 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		[24] BUTLER	94	CLE2	$e^+e^- \approx \Upsilon(4S)$
<0.048		90		MUHEIM	94		
0.046	±0.015			[25] MUHEIM	94		
0.031	±0.009			[25] MUHEIM	94		
0.031	±0.009	±0.006		[24] FRABETTI	93G	E687	γ Be $\overline{E}_\gamma$= 220 GeV
0.024	±0.010			[24] ALBRECHT	91	ARG	$e^+e^- \approx$ 10.4 GeV
<0.041		90	0	[23] ADLER	90B	MRK3	e^+e^- 4.14 GeV
0.031	±0.006	$^{+0.011}_{-0.009}$		[24] ALEXANDER	90B	CLEO	e^+e^- 10.5–11 GeV
0.048	±0.017	±0.019		[26] ALVAREZ	90C	NA14	Photoproduction
>0.034		90		[24] ANJOS	90B	E691	γ Be, $\overline{E}_\gamma \approx$ 145 GeV
0.02	±0.01		405	[27] CHEN	89	CLEO	e^+e^- 10 GeV
0.033	±0.016	±0.010	9	[27] BRAUNSCH...	87	TASS	e^+e^- 35–44 GeV
0.033	±0.011		30	[27] DERRICK	85B	HRS	e^+e^- 29 GeV

[22] 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.

[23] 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 too large for the result to be competitive with indirect measurements. ADLER 90B used the same method to set a limit.

[24] 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.

[25] 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.

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

[27] 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
0.82 ±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

$\Gamma(f_0(980)\pi^+)/\Gamma(K^+K^-\pi^+)$ — Γ_{37}/Γ_{14}

Unseen decay modes of the $f_0(980)$ are included.

VALUE	DOCUMENT ID		TECN	COMMENT
0.40±0.16 OUR FIT Error includes scale factor of 2.3.				
1.00±0.32±0.24	FRABETTI	95B	E687	Dalitz plot analysis

$\Gamma(f_J(1710)\pi^+ \rightarrow K^+K^-\pi^+)/\Gamma(K^+K^-\pi^+)$ — Γ_{19}/Γ_{14}

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

VALUE	DOCUMENT ID		TECN	COMMENT
0.034±0.023±0.035	FRABETTI	95B	E687	Dalitz plot analysis

$\Gamma(K^+\overline{K}_0^*(1430)^0)/\Gamma(K^+K^-\pi^+)$ — 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
$1.86\pm0.26^{+0.29}_{-0.40}$	253	AVERY	92	CLE2	$e^+e^- \simeq$ 10.5 GeV

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

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

$\Gamma(K^+K^-\pi^+\pi^0\ \text{non-}\phi)/\Gamma(\phi\pi^+)$ — Γ_{27}/Γ_{15}

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<2.4	90	[28] ANJOS	89E	E691	Photoproduction

[28] Total minus ϕ component.

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

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.77	90	ALBRECHT	92B	ARG	$e^+e^- \simeq$ 10.4 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

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

$\Gamma(K^+K^-\pi^+\pi^+\pi^-\ \text{non-}\phi)/\Gamma_{total}$ — Γ_{34}/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
$0.003^{+0.003}_{-0.002}$	BARLAG	92C	ACCM	π^- 230 GeV

$\Gamma(K^+K^-\pi^+\pi^+\pi^-\text{ non-}\phi)/\Gamma(\phi\pi^+)$ — Γ_{34}/Γ_{15}

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<0.32	90	10	ANJOS	88	E691	Photoproduction

Hadronic modes without K's

$\Gamma(\pi^+\pi^+\pi^-)/\Gamma(K^+K^-\pi^+)$ — Γ_{35}/Γ_{14}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.23 ±0.04 OUR FIT Error includes scale factor of 1.2.					
0.265±0.041±0.031	98	FRABETTI	97D	E687	γ Be ≈ 200 GeV

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.28±0.06 OUR FIT Error includes scale factor of 1.3.					
0.39±0.08 OUR AVERAGE					
0.33±0.10±0.04	29	ADAMOVICH	93	WA82	π^- 340 GeV
0.44±0.10±0.04		ANJOS	89	E691	Photoproduction

$\Gamma(\rho^0\pi^+)/\Gamma(\pi^+\pi^+\pi^-)$ — Γ_{36}/Γ_{35}

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.073	90	FRABETTI	97D	E687	γ Be ≈ 200 GeV

$\Gamma(\rho^0\pi^+)/\Gamma(\phi\pi^+)$ — Γ_{36}/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

$\Gamma(f_0(980)\pi^+)/\Gamma(\pi^+\pi^+\pi^-)$ — Γ_{37}/Γ_{35}

Unseen decay modes of the $f_0(980)$ are included.

VALUE	DOCUMENT ID		TECN	COMMENT
1.7 ±0.6 OUR FIT Error includes scale factor of 2.4.				
2.06±0.27±0.08	FRABETTI	97D	E687	γ Be ≈ 200 GeV

$\Gamma(f_0(980)\pi^+)/\Gamma(\phi\pi^+)$ — Γ_{37}/Γ_{15}

Unseen decay modes of the resonances are included.

VALUE	DOCUMENT ID		TECN	COMMENT
0.49±0.20 OUR FIT Error includes scale factor of 2.6.				
0.28±0.10±0.03	ANJOS	89	E691	Photoproduction

$\Gamma(f_2(1270)\pi^+)/\Gamma(\pi^+\pi^+\pi^-)$ — Γ_{38}/Γ_{35}

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

VALUE	DOCUMENT ID		TECN	COMMENT
0.22±0.10±0.03	FRABETTI	97D	E687	γ Be ≈ 200 GeV

$\Gamma(f_0(1500)\pi^+ \to \pi^+\pi^-\pi^+)/\Gamma(\pi^+\pi^+\pi^-)$ — Γ_{39}/Γ_{35}

This includes only $\pi^+\pi^-$ decays of the $f_0(1500)$, because branching fractions of this resonance are not known.

VALUE	DOCUMENT ID		TECN	COMMENT
0.274±0.114±0.019	[29] FRABETTI	97D	E687	γ Be ≈ 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 $f_0(1500)$.

$\Gamma(\pi^+\pi^+\pi^-$ nonresonant$)/\Gamma(\pi^+\pi^+\pi^-)$ — Γ_{40}/Γ_{35}

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.269	90	[30] FRABETTI	97D	E687	γ Be ≈ 200 GeV

[30] We rather arbitrarily use this FRABETTI 97D limit instead of the much large ANJOS 89 value given in the next entry. See, however, FRABETTI 97D on the difficulty of distengangling the $f_0(1500)\pi^+$ and nonresonant modes.

$\Gamma(\pi^+\pi^+\pi^-$ nonresonant$)/\Gamma(\phi\pi^+)$ — Γ_{40}/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_{41}/Γ_{15}

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

$\Gamma(\eta\pi^+)/\Gamma(\phi\pi^+)$ — Γ_{42}/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_{43}/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_{43}/Γ_{42}

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_{44}/Γ_{14}

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

$\Gamma(\pi^+\pi^+\pi^+\pi^-\pi^-)/\Gamma(\phi\pi^+)$ — Γ_{44}/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_{46}/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_{47}/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	[31] DAOUDI	92	CLE2	See JESSOP 98

[31] 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_{48}/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_{49}/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_{51}/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_{52}/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_{53}/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_{53}/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_{54}/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_{55}/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_{56}/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

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

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.016	90	FRABETTI	95F	E687	γ Be, $\overline{E}_\gamma \approx$ 220 GeV

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

$\Gamma(\pi^+\mu^+\mu^-)/\Gamma_{total}$ — Γ_{59}/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
<4.3 × 10^{-4}	90	0	KODAMA	95	E653	π^- emulsion 600 GeV

$\Gamma(K^+\mu^+\mu^-)/\Gamma_{total}$ — Γ_{60}/Γ

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

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<5.9 × 10^{-4}	90	0	KODAMA	95	E653	π^- emulsion 600 GeV

$\Gamma(K^*(892)^+ \mu^+ \mu^-)/\Gamma_{total}$ — Γ_{61}/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 × 10^{-3}	90	0	KODAMA	95	E653	π^- emulsion 600 GeV

$\Gamma(\pi^- \mu^+ \mu^+)/\Gamma_{total}$ — Γ_{62}/Γ

A test of lepton-number conservation.

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<4.3 × 10^{-4}	90	0	KODAMA	95	E653	π^- emulsion 600 GeV

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

A test of lepton-number conservation.

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<5.9 × 10^{-4}	90	0	KODAMA	95	E653	π^- emulsion 600 GeV

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

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

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
1.6±0.4 OUR AVERAGE					
1.4±0.5±0.3	308	[32] AVERY	94B	CLE2	$e^+ e^-$ 10 GeV
1.1±0.8±0.1	90	[33] FRABETTI	94F	E687	γ Be, $\overline{E}_\gamma$= 220 GeV
$2.1^{+0.6}_{-0.5}\pm0.2$	19	[33] KODAMA	93	E653	600 GeV $\pi^- N$

[32] AVERY 94B uses $D_s^+ \rightarrow \phi e^+ \nu_e$ decays.

[33] FRABETTI 94F and KODAMA 93 use $D_s^+ \rightarrow \phi \mu^+ \nu_\mu$ decays.

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
1.5±0.5 OUR AVERAGE					
0.9±0.6±0.3	308	[34] AVERY	94B	CLE2	$e^+ e^-$ 10 GeV
1.8±0.9±0.2	90	[35] FRABETTI	94F	E687	γ Be, $\overline{E}_\gamma$= 220 GeV
$2.3^{+1.1}_{-0.9}\pm0.4$	19	[35] KODAMA	93	E653	600 GeV $\pi^- N$

[34] AVERY 94B uses $D_s^+ \rightarrow \phi e^+ \nu_e$ decays.

[35] FRABETTI 94F and KODAMA 93 use $D_s^+ \rightarrow \phi \mu^+ \nu_\mu$ decays.

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

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
0.72±0.18 OUR AVERAGE				
1.0 ±0.3 ±0.2	308	[36] AVERY 94B	CLE2	$e^+ e^-$ 10 GeV
1.0 ±0.5 ±0.1	90	[37] FRABETTI 94F	E687	γBe, $\overline{E}_\gamma$= 220 GeV
0.54±0.21±0.10	19	[37] KODAMA 93	E653	600 GeV $\pi^- N$

[36] AVERY 94B uses $D_s^+ \rightarrow \phi e^+ \nu_e$ decays.

[37] FRABETTI 94F and KODAMA 93 use $D_s^+ \rightarrow \phi \mu^+ \nu_\mu$ decays. Γ_L/Γ_T is evaluated for a lepton mass of zero.

$D_s^\pm$ REFERENCES

AITALA	99	PL B445 449	E.M. Aitala+	(FNAL E791 Collab.)
BAI	98	PR D57 28	+Bardon, Blum+	(BEPC BES Collab.)
CHADA	98	PR D58 032002	M. Chada+	(CLEO Collab.)
JESSOP	98	PR D58 052002	C.P. Jessop+	(CLEO Collab.)
ACCIARRI	97F	PL B396 327	M. Acciarri+	(L3 Collab.)
BAI	97	PR D56 3779	+Bardon, Bian, Blum+	(BEPC BES Collab.)
BALEST	97	PRL 79 1436	+Behrens, Cho, Ford+	(CLEO Collab.)
FRABETTI	97C	PL B401 131	+Cheung, Cumalat+	(FNAL E687 Collab.)
FRABETTI	97D	PL B407 79	+Cheung, Cumalat+	(FNAL E687 Collab.)
ARTUSO	96	PL B378 364	+Efimov, Gao, Goldberg+	(CLEO Collab.)
KODAMA	96	PL B382 299	+Torikai, Ushida+	(FNAL E653 Collab.)
BAI	95	PRL 74 4599	+Bardon, Blum, Breakstone+	(BES Collab.)
BAI	95C	PR D52 3781	+Bardon, Blum, Breakstone+	(BES Collab.)
BRANDENB...	95	PRL 75 3804	Brandenburg, Cinabro, Liu+	(CLEO Collab.)
FRABETTI	95	PL B346 199	+Cheung, Cumalat+	(FNAL E687 Collab.)
FRABETTI	95B	PL B351 591	+Cheung, Cumalat+	(FNAL E687 Collab.)
FRABETTI	95E	PL B359 403	+Cheung, Cumalat+	(FNAL E687 Collab.)
FRABETTI	95F	PL B363 259	+Cheung, Cumalat+	(FNAL E687 Collab.)
KODAMA	95	PL B345 85	+Ushida, Mokhtarani+	(FNAL E653 Collab.)
ACOSTA	94	PR D49 5690	+Athanas, Masek, Paar+	(CLEO Collab.)
AVERY	94B	PL B337 405	+Freyberger, Rodriguez+	(CLEO Collab.)
BROWN	94	PR D50 1884	+Fast, McIlwain, Miao+	(CLEO Collab.)
BUTLER	94	PL B324 255	+Fu, Kalbfleisch, Ross+	(CLEO Collab.)
FRABETTI	94F	PL B328 187	+Cheung, Cumalat+	(FNAL E687 Collab.)
MUHEIM	94	PR D49 3767	+Stone	(SYRA)
ADAMOVICH	93	PL B305 177	+Alexandrov, Antinori+	(CERN WA82 Collab.)
AOKI	93	PTP 89 131	+Baroni, Bisi, Breslin+	(CERN WA75 Collab.)
FRABETTI	93F	PRL 71 827	+Cheung, Cumalat, Dallapiccola+	(FNAL E687 Collab.)
FRABETTI	93G	PL B313 253	+Cheung, Cumalat+	(FNAL E687 Collab.)
KODAMA	93	PL B309 483	+Ushida, Mokhtarani+	(FNAL E653 Collab.)
KODAMA	93B	PL B313 260	+Ushida, Mokhtarani+	(FNAL E653 Collab.)
ALBRECHT	92B	ZPHY C53 361	+Ehrlichmann, Hamacher, Krueger+	(ARGUS Collab.)
ALEXANDER	92	PRL 68 1275	+Bebek, Berkelman, Besson+	(CLEO Collab.)
ANJOS	92D	PRL 69 2892	+Appel, Bean, Bediaga+	(FNAL E691 Collab.)
AVERY	92	PRL 68 1279	+Freyberger, Rodriguez, Yelton+	(CLEO Collab.)
BARLAG	92C	ZPHY C55 383	+Becker, Bozek, Boehringer+	(ACCMOR Collab.)
Also	90D	ZPHY C48 29	Barlag, Becker, Boehringer, Bosman+	(ACCMOR Collab.)
DAOUDI	92	PR D45 3965	+Ford, Johnson, Lingel+	(CLEO Collab.)
FRABETTI	92	PL B281 167	+Bogart, Cheung, Culy+	(FNAL E687 Collab.)
ALBRECHT	91	PL B255 634	+Ehrlichmann, Hamacher, Krueger+	(ARGUS Collab.)
ALVAREZ	91	PL B255 639	+Barate, Bloch, Bonamy+	(CERN NA14/2 Collab.)
ANJOS	91B	PR D43 R2063	+Appel, Bean, Bracker+	(FNAL E691 Collab.)
COFFMAN	91	PL B263 135	+DeJongh, Dubois, Eigen, Hitlin+	(Mark III Collab.)
ADLER	90B	PRL 64 169	+Bai, Blaylock, Bolton+	(Mark III Collab.)
ALBRECHT	90D	PL B245 315	+Ehrlichmann, Glaeser, Harder+	(ARGUS Collab.)
ALEXANDER	90B	PRL 65 1531	+Artuso, Bebek, Berkelman+	(CLEO Collab.)
ALVAREZ	90	ZPHY C47 539	+Barate, Bloch, Bonamy+	(CERN NA14/2 Collab.)

ALVAREZ	90C	PL B246 261	+Barate, Bloch, Bonamy+	(CERN NA14/2 Collab.)
ANJOS	90B	PRL 64 2885	+Appel, Bean, Bracker+	(FNAL E691 Collab.)
ANJOS	90C	PR D41 2705	+Appel, Bean+	(FNAL E691 Collab.)
BAI	90	PRL 65 686	+Blaylock, Bolton, Brient+	(Mark III Collab.)
BARLAG	90C	ZPHY C46 563	+Becker, Boehringer, Bosman+	(ACCMOR Collab.)
FRABETTI	90	PL B251 639	+Bogart, Cheung, Coteus+	(FNAL E687 Collab.)
ADLER	89B	PRL 63 1211	+Bai, Becker, Blaylock, Bolton+	(Mark III Collab.)
Also	89D	PRL 63 2858 erratum		
ANJOS	89	PRL 62 125	+Appel, Bean, Bracker+	(FNAL E691 Collab.)
ANJOS	89E	PL B223 267	+Appel, Bean, Bracker+	(FNAL E691 Collab.)
AVERILL	89	PR D39 123	+Blockus, Brabson+	(HRS Collab.)
CHEN	89	PL B226 192	+McIlwain, Miller, Ng, Shibata+	(CLEO Collab.)
ALBRECHT	88	PL B207 349	+Binder, Boeckmann+	(ARGUS Collab.)
ALBRECHT	88I	PL B210 267	+Boeckmann, Glaeser+	(ARGUS Collab.)
ANJOS	88	PRL 60 897	+Appel+	(FNAL E691 Collab.)
RAAB	88	PR D37 2391	+Anjos, Appel, Bracker+	(FNAL E691 Collab.)
ALBRECHT	87F	PL B179 398	+Binder, Boeckmann, Glaeser+	(ARGUS Collab.)
ALBRECHT	87G	PL B195 102	+Andam, Binder, Boeckmann+	(ARGUS Collab.)
ANJOS	87B	PRL 58 1818	+Appel, Bracker, Browder+	(FNAL E691 Collab.)
BECKER	87B	PL B184 277	+Boehringer, Bosman+	(NA11 and NA32 Collab.)
BLAYLOCK	87	PRL 58 2171	+Bolton, Brown, Bunnell+	(Mark III Collab.)
BRAUNSCH...	87	ZPHY C35 317	Braunschweig, Gerhards+	(TASSO Collab.)
CSORNA	87	PL B191 318	+Mestayer, Panvini, Word+	(CLEO Collab.)
JUNG	86	PRL 56 1775	+Abachi+	(HRS Collab.)
USHIDA	86	PRL 56 1767	+Kondo, Tasaka, Park+	(FNAL E531 Collab.)
ALBRECHT	85D	PL 153B 343	+Drescher, Binder, Drews+	(ARGUS Collab.)
DERRICK	85B	PRL 54 2568	+Fernandez, Fries, Hyman+	(HRS Collab.)
AIHARA	84D	PRL 53 2465	+Alston-Garnjost, Badtke, Bakken+	(TPC Collab.)
ALTHOFF	84	PL 136B 130	+Braunschweig, Kirschfink+	(TASSO Collab.)
BAILEY	84	PL 139B 320	+Belau, Bohringer, Bosman+	(ACCMOR Collab.)
AUBERT	83	NP B213 31	+Bassompierre, Becks, Best+	(EMC Collab.)
CHEN	83C	PRL 51 634	+Alam, Giles, Kagan+	(CLEO Collab.)
USHIDA	83	PRL 51 2362	+Kondo, Fujioka, Fukushima+	(FNAL E653 Collab.)

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