$f_0(500)$

$I^G(J^{PC}) = 0^+(0^{++})$

also known as σ; was $f_0(600)$

See the related review(s):

Scalar Mesons below 2 GeV

$f_0(500)$ T-MATRIX POLE $\sqrt{s}$

Note that $\Gamma \approx 2\ \text{Im}(\sqrt{s_{\text{pole}}})$.

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
(400–550)−*i*(200–350) OUR ESTIMATE				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$(512 \pm 15)-i(188 \pm 12)$	[1] ABLIKIM	17	BES3	$J/\psi \rightarrow \gamma 3\pi$
$(440 \pm 10)-i(238 \pm 10)$	[2] ALBALADEJO	12	RVUE	Compilation
$(445 \pm 25)-i(278^{+22}_{-18})$	[3,4] GARCIA-MAR...	11	RVUE	Compilation
$(457^{+14}_{-13})-i(279^{+11}_{-7})$	[3,5] GARCIA-MAR...	11	RVUE	Compilation
$(442^{+5}_{-8})-i(274^{+6}_{-5})$	[6] MOUSSALLAM	11	RVUE	Compilation
$(452 \pm 13)-i(259 \pm 16)$	[7] MENNESSIER	10	RVUE	Compilation
$(448 \pm 43)-i(266 \pm 43)$	[8] MENNESSIER	10	RVUE	Compilation
$(455 \pm 6^{+31}_{-13})-i(278 \pm 6^{+34}_{-43})$	[9] CAPRINI	08	RVUE	Compilation
$(463 \pm 6^{+31}_{-17})-i(259 \pm 6^{+33}_{-34})$	[10] CAPRINI	08	RVUE	Compilation
$(552^{+84}_{-106})-i(232^{+81}_{-72})$	[11] ABLIKIM	07A	BES2	$\psi(2S) \rightarrow \pi^+\pi^- J/\psi$
$(466 \pm 18)-i(223 \pm 28)$	[12] BONVICINI	07	CLEO	$D^+ \rightarrow \pi^-\pi^+\pi^+$
$(472 \pm 30)-i(271 \pm 30)$	[13] BUGG	07A	RVUE	Compilation
$(484 \pm 17)-i(255 \pm 10)$	GARCIA-MAR...	07	RVUE	Compilation
$(430)-i(325)$	[14] ANISOVICH	06	RVUE	Compilation
$(441^{+16}_{-8})-i(272^{+9}_{-12.5})$	[15] CAPRINI	06	RVUE	$\pi\pi \rightarrow \pi\pi$
$(470 \pm 50)-i(285 \pm 25)$	[16] ZHOU	05	RVUE	
$(541 \pm 39)-i(252 \pm 42)$	[17] ABLIKIM	04A	BES2	$J/\psi \rightarrow \omega\pi^+\pi^-$
$(528 \pm 32)-i(207 \pm 23)$	[18] GALLEGOS	04	RVUE	Compilation
$(440 \pm 8)-i(212 \pm 15)$	[19] PELAEZ	04A	RVUE	$\pi\pi \rightarrow \pi\pi$
$(533 \pm 25)-i(249 \pm 25)$	[20] BUGG	03	RVUE	
$517 - i240$	BLACK	01	RVUE	$\pi^0\pi^0 \rightarrow \pi^0\pi^0$
$(470 \pm 30)-i(295 \pm 20)$	[15] COLANGELO	01	RVUE	$\pi\pi \rightarrow \pi\pi$
$(535^{+48}_{-36})-i(155^{+76}_{-53})$	[21] ISHIDA	01		$\Upsilon(3S) \rightarrow \Upsilon\pi\pi$
$610 \pm 14 - i620 \pm 26$	[22] SUROVTSEV	01	RVUE	$\pi\pi \rightarrow \pi\pi$, $K\overline{K}$
$(540^{+36}_{-29})-i(193^{+32}_{-40})$	ISHIDA	00B		$p\overline{p} \rightarrow \pi^0\pi^0\pi^0$
$445 - i235$	HANNAH	99	RVUE	π scalar form factor
$(523 \pm 12)-i(259 \pm 7)$	KAMINSKI	99	RVUE	$\pi\pi \rightarrow \pi\pi$, $K\overline{K}$, $\sigma\sigma$
$442 - i\ 227$	OLLER	99	RVUE	$\pi\pi \rightarrow \pi\pi$, $K\overline{K}$
$469 - i203$	OLLER	99B	RVUE	$\pi\pi \rightarrow \pi\pi$, $K\overline{K}$
$445 - i221$	OLLER	99C	RVUE	$\pi\pi \rightarrow \pi\pi$, $K\overline{K}$, $\eta\eta$
$(1530^{+90}_{-250})-i(560 \pm 40)$	ANISOVICH	98B	RVUE	Compilation
$420 - i\ 212$	LOCHER	98	RVUE	$\pi\pi \rightarrow \pi\pi$, $K\overline{K}$

$440 - i245$	[23] DOBADO	97	RVUE	Compilation
$(602 \pm 26)-i(196 \pm 27)$	[24] ISHIDA	97		$\pi\pi \rightarrow \pi\pi$
$(537 \pm 20)-i(250 \pm 17)$	[25] KAMINSKI	97B	RVUE	$\pi\pi \rightarrow \pi\pi$, $K\overline{K}$, 4π
$470 - i250$	[26,27] TORNQVIST	96	RVUE	$\pi\pi \rightarrow \pi\pi$, $K\overline{K}$, $K\pi$, $\eta\pi$
$387 - i305$	[27,28] JANSSEN	95	RVUE	$\pi\pi \rightarrow \pi\pi$, $K\overline{K}$
$420 - i370$	[29] ACHASOV	94	RVUE	$\pi\pi \rightarrow \pi\pi$
$(506 \pm 10)-i(247 \pm 3)$	KAMINSKI	94	RVUE	$\pi\pi \rightarrow \pi\pi$, $K\overline{K}$
$370 - i356$	[30] ZOU	94B	RVUE	$\pi\pi \rightarrow \pi\pi$, $K\overline{K}$
$408 - i342$	[27,30] ZOU	93	RVUE	$\pi\pi \rightarrow \pi\pi$, $K\overline{K}$
$470 - i208$	[31] VANBEVEREN	86	RVUE	$\pi\pi \rightarrow \pi\pi$, $K\overline{K}$, $\eta\eta$, ...
$(750 \pm 50)-i(450 \pm 50)$	[32] ESTABROOKS	79	RVUE	$\pi\pi \rightarrow \pi\pi$, $K\overline{K}$
$(660 \pm 100)-i(320 \pm 70)$	PROTOPOP...	73	HBC	$\pi\pi \rightarrow \pi\pi$, $K\overline{K}$
$650 - i370$	[33] BASDEVANT	72	RVUE	$\pi\pi \rightarrow \pi\pi$

[1] S-matrix pole; 8595 events.

[2] Applying the chiral unitary approach at NLO to the K_{e4} data of BATLEY 10 and $\pi N \rightarrow \pi\pi N$ data of HYAMS 73, GRAYER 74, and PROTOPOPESCU 73.

[3] Uses the K_{e4} data of BATLEY 10C and the $\pi N \rightarrow \pi\pi N$ data of HYAMS 73, GRAYER 74, and PROTOPOPESCU 73.

[4] Analytic continuation using Roy equations.

[5] Analytic continuation using GKPY equations.

[6] Using Roy equations.

[7] Average of three variants of the analytic K-matrix model. Uses the K_{e4} data of BATLEY 08A and the $\pi N \rightarrow \pi\pi N$ data of HYAMS 73 and GRAYER 74.

[8] Average of the analyses of three data sets in the K-matrix model. Uses the data of BATLEY 08A, HYAMS 73, and GRAYER 74, partially of COHEN 80 or ETKIN 82B.

[9] From the K_{e4} data of BATLEY 08A and $\pi N \rightarrow \pi\pi N$ data of HYAMS 73.

[10] From the K_{e4} data of BATLEY 08A and $\pi N \rightarrow \pi\pi N$ data of PROTOPOPESCU 73, GRAYER 74, and ESTABROOKS 74.

[11] From a mean of three different $f_0(500)$ parametrizations. Uses 40k events.

[12] From an isobar model using 2.6k events.

[13] Reanalysis of ABLIKIM 04A, PISLAK 01, and HYAMS 73 data.

[14] Using the N/D method.

[15] From the solution of the Roy equation (ROY 71) for the isoscalar S-wave and using a phase-shift analysis of HYAMS 73 and PROTOPOPESCU 73 data.

[16] Reanalysis of the data from PROTOPOPESCU 73, ESTABROOKS 74, GRAYER 74, ROSSELET 77, PISLAK 03, and AKHMETSHIN 04.

[17] From a mean of six different analyses and $f_0(500)$ parameterizations.

[18] Using data on $\psi(2S) \rightarrow J/\psi\pi\pi$ from BAI 00E and on $\Upsilon(nS) \rightarrow \Upsilon(mS)\pi\pi$ from BUTLER 94B and ALEXANDER 98.

[19] Reanalysis of data from PROTOPOPESCU 73, ESTABROOKS 74, GRAYER 74, and COHEN 80 in the unitarized ChPT model.

[20] From a combined analysis of HYAMS 73, AUGUSTIN 89, AITALA 01B, and PISLAK 01.

[21] A similar analysis (KOMADA 01) finds $(580^{+79}_{-30})-i(190^{+107}_{-49})$ MeV.

[22] Coupled channel reanalysis of BATON 70, BENSINGER 71, BAILLON 72, HYAMS 73, HYAMS 75, ROSSELET 77, COHEN 80, and ETKIN 82B using the uniformizing variable.

[23] Using the inverse amplitude method and data of ESTABROOKS 73, GRAYER 74, and PROTOPOPESCU 73.

[24] Reanalysis of data from HYAMS 73, GRAYER 74, SRINIVASAN 75, and ROSSELET 77 using the interfering amplitude method.

[25] Average and spread of 4 variants ("up" and "down") of KAMINSKI 97B 3-channel model.

[26] Uses data from BEIER 72B, OCHS 73, HYAMS 73, GRAYER 74, ROSSELET 77, CASON 83, ASTON 88, and ARMSTRONG 91B. Coupled channel analysis with flavor symmetry and all light two-pseudoscalars systems.
[27] Demonstrates explicitly that $f_0(500)$ and $f_0(1370)$ are two different poles.
[28] Analysis of data from FALVARD 88.
[29] Analysis of data from OCHS 73, ESTABROOKS 75, ROSSELET 77, and MUKHIN 80.
[30] Analysis of data from OCHS 73, GRAYER 74, and ROSSELET 77.
[31] Coupled-channel analysis using data from PROTOPOPESCU 73, HYAMS 73, HYAMS 75, GRAYER 74, ESTABROOKS 74, ESTABROOKS 75, FROGGATT 77, CORDEN 79, BISWAS 81.
[32] Analysis of data from APEL 72C, GRAYER 74, CASON 76, PAWLICKI 77. Includes spread and errors of 4 solutions.
[33] Analysis of data from BATON 70, BENSINGER 71, COLTON 71, BAILLON 72,PROTOPOPESCU 73, and WALKER 67.

$f_0(500)$ BREIT-WIGNER MASS OR K-MATRIX POLE PARAMETERS

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
(400–550) OUR ESTIMATE				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
513 ± 32	[34] MURAMATSU	02	CLEO	$e^+e^- \approx$ 10 GeV
$478^{+24}_{-23}\pm17$	AITALA	01B	E791	$D^+ \to \pi^-\pi^+\pi^+$
563^{+58}_{-29}	[35] ISHIDA	01		$\Upsilon(3S) \to \Upsilon\pi\pi$
555	[36] ASNER	00	CLE2	$\tau^- \to \pi^-\pi^0\pi^0\nu_\tau$
540 ± 36	ISHIDA	00B		$p\overline{p} \to \pi^0\pi^0\pi^0$
$750\pm\ 4$	ALEKSEEV	99	SPEC	1.78 $\pi^- p_{polar} \to \pi^-\pi^+ n$
$744\pm\ 5$	ALEKSEEV	98	SPEC	1.78 $\pi^- p_{polar} \to \pi^-\pi^+ n$
$759\pm\ 5$	[37] TROYAN	98		5.2 $np \to np\pi^+\pi^-$
780 ± 30	ALDE	97	GAM2	450 $pp \to pp\pi^0\pi^0$
585 ± 20	[38] ISHIDA	97		$\pi\pi \to \pi\pi$
761 ± 12	[39] SVEC	96	RVUE	6–17 $\pi N_{polar} \to \pi^+\pi^- N$
$\sim$ 860	[40,41] TORNQVIST	96	RVUE	$\pi\pi \to \pi\pi$, $K\overline{K}$, $K\pi$, $\eta\pi$
1165 ± 50	[42,43] ANISOVICH	95	RVUE	$\pi^- p \to \pi^0\pi^0 n$, $\overline{p}p \to \pi^0\pi^0\pi^0$, $\pi^0\pi^0\eta$, $\pi^0\eta\eta$
$\sim$ 1000	[44] ACHASOV	94	RVUE	$\pi\pi \to \pi\pi$
414 ± 20	[39] AUGUSTIN	89	DM2	

[34] Statistical uncertainty only.
[35] A similar analysis (KOMADA 01) finds 526^{+48}_{-37} MeV.
[36] From the best fit of the Dalitz plot.
[37] 6σ effect, no PWA.
[38] Reanalysis of data from HYAMS 73, GRAYER 74, SRINIVASAN 75, and ROSSELET 77 using the interfering amplitude method.
[39] Breit-Wigner fit to S-wave intensity measured in $\pi N \to \pi^-\pi^+ N$ on polarized targets. The fit does not include $f_0(980)$.
[40] Uses data from ASTON 88, OCHS 73, HYAMS 73, ARMSTRONG 91B, GRAYER 74, CASON 83, ROSSELET 77, and BEIER 72B. Coupled channel analysis with flavor symmetry and all light two-pseudoscalars systems.
[41] Also observed by ASNER 00 in $\tau^- \to \pi^-\pi^0\pi^0\nu_\tau$ decays.

[42] Uses $\pi^0\pi^0$ data from ANISOVICH 94, AMSLER 94D, and ALDE 95B, $\pi^+\pi^-$ data from OCHS 73, GRAYER 74 and ROSSELET 77, and $\eta\eta$ data from ANISOVICH 94.
[43] The pole is on Sheet III. Demonstrates explicitly that $f_0(500)$ and $f_0(1370)$ are two different poles.
[44] Analysis of data from OCHS 73, ESTABROOKS 75, ROSSELET 77, and MUKHIN 80.

$f_0(500)$ BREIT-WIGNER WIDTH

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
(400–700) OUR ESTIMATE				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
335 ± 67	[45] MURAMATSU	02	CLEO	$e^+e^- \approx$ 10 GeV
$324^{+42}_{-40} \pm 21$	AITALA	01B	E791	$D^+ \to \pi^-\pi^+\pi^+$
372^{+229}_{-95}	[46] ISHIDA	01		$\Upsilon(3S) \to \Upsilon\pi\pi$
540	[47] ASNER	00	CLE2	$\tau^- \to \pi^-\pi^0\pi^0\nu_\tau$
372 ± 80	ISHIDA	00B		$p\overline{p} \to \pi^0\pi^0\pi^0$
119 ± 13	ALEKSEEV	99	SPEC	$1.78\ \pi^- p_{polar} \to \pi^-\pi^+ n$
77 ± 22	ALEKSEEV	98	SPEC	$1.78\ \pi^- p_{polar} \to \pi^-\pi^+ n$
35 ± 12	[48] TROYAN	98		$5.2\ np \to np\pi^+\pi^-$
780 ± 60	ALDE	97	GAM2	$450\ pp \to pp\pi^0\pi^0$
385 ± 70	[49] ISHIDA	97		$\pi\pi \to \pi\pi$
290 ± 54	[50] SVEC	96	RVUE	6–17 $\pi N_{polar} \to \pi^+\pi^- N$
~ 880	[51,52] TORNQVIST	96	RVUE	$\pi\pi \to \pi\pi$, $K\overline{K}$, $K\pi$, $\eta\pi$
460 ± 40	[53,54] ANISOVICH	95	RVUE	$\pi^- p \to \pi^0\pi^0 n$, $\overline{p}p \to \pi^0\pi^0\pi^0$, $\pi^0\pi^0\eta$, $\pi^0\eta\eta$
~ 3200	[55] ACHASOV	94	RVUE	$\pi\pi \to \pi\pi$
494 ± 58	[50] AUGUSTIN	89	DM2	

[45] Statistical uncertainty only.
[46] A similar analysis (KOMADA 01) finds 301^{+145}_{-100} MeV.
[47] From the best fit of the Dalitz plot.
[48] 6σ effect, no PWA.
[49] Reanalysis of data from HYAMS 73, GRAYER 74, SRINIVASAN 75, and ROSSELET 77 using the interfering amplitude method.
[50] Breit-Wigner fit to S-wave intensity measured in $\pi N \to \pi^-\pi^+ N$ on polarized targets. The fit does not include $f_0(980)$.
[51] Uses data from ASTON 88, OCHS 73, HYAMS 73, ARMSTRONG 91B, GRAYER 74, CASON 83, ROSSELET 77, and BEIER 72B. Coupled channel analysis with flavor symmetry and all light two-pseudoscalars systems.
[52] Also observed by ASNER 00 in $\tau^- \to \pi^-\pi^0\pi^0\nu_\tau$ decays.
[53] Uses $\pi^0\pi^0$ data from ANISOVICH 94, AMSLER 94D, and ALDE 95B, $\pi^+\pi^-$ data from OCHS 73, GRAYER 74 and ROSSELET 77, and $\eta\eta$ data from ANISOVICH 94.
[54] The pole is on Sheet III. Demonstrates explicitly that $f_0(500)$ and $f_0(1370)$ are two different poles.
[55] Analysis of data from OCHS 73, ESTABROOKS 75, ROSSELET 77, and MUKHIN 80.

$f_0(500)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	$\pi\pi$	dominant
Γ_2	$\gamma\gamma$	seen

$f_0(500)$ PARTIAL WIDTHS

$\Gamma(\gamma\gamma)$ Γ_2

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
2.05 ± 0.21	[56] DAI	14A	RVUE	Compilation
1.7 ± 0.4	[57] HOFERICHTER	11	RVUE	Compilation
3.08 ± 0.82	[58] MENNESSIER	11	RVUE	Compilation
$2.08 \pm 0.2 {}^{+0.07}_{-0.04}$	[59] MOUSSALLAM	11	RVUE	Compilation
2.08	[60] MAO	09	RVUE	Compilation
1.2 ± 0.4	[61] BERNABEU	08	RVUE	
3.9 ± 0.6	[58] MENNESSIER	08	RVUE	$\gamma\gamma \to \pi^+\pi^-, \pi^0\pi^0$
1.8 ± 0.4	[62] OLLER	08	RVUE	Compilation
1.68 ± 0.15	[62,63] OLLER	08A	RVUE	Compilation
3.1 ± 0.5	[64,65] PENNINGTON	08	RVUE	Compilation
2.4 ± 0.4	[65,66] PENNINGTON	08	RVUE	Compilation
4.1 ± 0.3	[67] PENNINGTON	06	RVUE	$\gamma\gamma \to \pi^0\pi^0$
3.8 ± 1.5	[68,69] BOGLIONE	99	RVUE	$\gamma\gamma \to \pi^+\pi^-, \pi^0\pi^0$
5.4 ± 2.3	[68] MORGAN	90	RVUE	$\gamma\gamma \to \pi^+\pi^-, \pi^0\pi^0$
10 ± 6	COURAU	86	DM1	$e^+e^- \to \pi^+\pi^-e^+e^-$

[56] Using dispersive analysis with phases from GARCIA-MARTIN 11A and BUETTIKER 04 as input.

[57] Using Roy-Steiner equations with $\pi\pi$ phase shifts from an update of COLANGELO 01 and from GARCIA-MARTIN 11A.

[58] Using an analytic K-matrix model.

[59] Using dispersion integral with phase input from Roy equations and data from MARSISKE 90, BOYER 90, BEHREND 92, UEHARA 08A, and MORI 07.

[60] Used dispersion theory. The value quoted used the $f_0(500)$ pole position of $457 - i276$ MeV.

[61] Using p, n polarizabilities from PDG 06 and fitting to $\pi\pi$ phase motion from GARCIA-MARTIN 07 and σ-poles from GARCIA-MARTIN 07 and CAPRINI 06.

[62] Using twice-subtracted dispersion integrals.

[63] Supersedes OLLER 08.

[64] Solution A (preferred solution based on χ^2-analysis).

[65] Dispersion theory based amplitude analysis of BOYER 90, MARSISKE 90, BEHREND 92, and MORI 07.

[66] Solution B (worse than solution A; still acceptable when systematic uncertainties are included).

[67] Using unitarity and the σ pole position from CAPRINI 06.

[68] This width could equally well be assigned to the $f_0(1370)$. The authors analyse data from BOYER 90 and MARSISKE 90 and report strong correlation with $\gamma\gamma$ width of $f_2(1270)$.

[69] Supersedes MORGAN 90.

$f_0(500)$ REFERENCES

ABLIKIM	17	PRL 118 012001	M. Ablikim *et al.*	(BES III Collab.)
DAI	14A	PR D90 036004	L.-Y. Dai, M.R. Pennington	(CEBAF)
ALBALADEJO	12	PR D86 034003	M. Albaladejo, J.A. Oller	(MURC)
GARCIA-MAR...	11	PRL 107 072001	R. Garcia-Martin *et al.*	(MADR, CRAC)
GARCIA-MAR...	11A	PR D83 074004	R. Garcia-Martin *et al.*	(MADR, CRAC)
HOFERICHTER	11	EPJ C71 1743	M. Hoferichter, D.R. Phillips, C. Schat	(BONN+)
MENNESSIER	11	PL B696 40	G. Mennessier, S. Narison, X.-G. Wang	
MOUSSALLAM	11	EPJ C71 1814	B. Moussallam	
BATLEY	10	PL B686 101	J.R. Batley *et al.*	(CERN NA48/2 Collab.)
BATLEY	10C	EPJ C70 635	J.R. Batley *et al.*	(CERN NA48/2 Collab.)
MENNESSIER	10	PL B688 59	G. Mennessier, S. Narison, X.-G. Wang	
MAO	09	PR D79 116008	Y. Mao *et al.*	
BATLEY	08A	EPJ C54 411	J.R. Batley *et al.*	(CERN NA48/2 Collab.)
BERNABEU	08	PRL 100 241804	J. Bernabeu, J. Prades	(IFIC, GRAN)
CAPRINI	08	PR D77 114019	I. Caprini	
MENNESSIER	08	PL B665 205	G. Mennessier, S. Narison, W. Ochs	
OLLER	08	PL B659 201	J.A. Oller, L. Roca, C. Schat	(MURC, UBA)
OLLER	08A	EPJ A37 15	J.A. Oller, L. Roca	(MURC)
PENNINGTON	08	EPJ C56 1	M.R. Pennington *et al.*	
UEHARA	08A	PR D78 052004	S. Uehara *et al.*	(BELLE Collab.)
ABLIKIM	07A	PL B645 19	M. Ablikim *et al.*	(BES Collab.)
BONVICINI	07	PR D76 012001	G. Bonvicini *et al.*	(CLEO Collab.)
BUGG	07A	JP G34 151	D.V. Bugg *et al.*	
GARCIA-MAR...	07	PR D76 074034	R. Garcia-Martin, J.R. Pelaez, F.J. Yndurain	
MORI	07	PR D75 051101	T. Mori *et al.*	(BELLE Collab.)
ANISOVICH	06	IJMP A21 3615	V.V. Anisovich	
CAPRINI	06	PRL 96 132001	I. Caprini, G. Colangelo, H. Leutwyler	(BCIP+)
PDG	06	JP G33 1	W.-M. Yao *et al.*	(PDG Collab.)
PENNINGTON	06	PRL 97 011601	M.R. Pennington	
ZHOU	05	JHEP 0502 043	Z.Y. Zhou *et al.*	
ABLIKIM	04A	PL B598 149	M. Ablikim *et al.*	(BES Collab.)
AKHMETSHIN	04	PL B578 285	R.R. Akhmetshin *et al.*	(Novosibirsk CMD-2 Collab.)
BUETTIKER	04	EPJ C33 409	P. Buettiker, S. Descotes-Genon, B. Moussallam	
GALLEGOS	04	PR D69 074033	A. Gallegos *et al.*	
PELAEZ	04A	MPL A19 2879	J.R. Pelaez	
BUGG	03	PL B572 1	D.V. Bugg	
PISLAK	03	PR D67 072004	S. Pislak *et al.*	(BNL E865 Collab.)
Also		PR D81 119903E	S. Pislak *et al.*	(BNL E865 Collab.)
MURAMATSU	02	PRL 89 251802	H. Muramatsu *et al.*	(CLEO Collab.)
Also		PRL 90 059901 (errat.)	H. Muramatsu *et al.*	(CLEO Collab.)
AITALA	01B	PRL 86 770	E.M. Aitala *et al.*	(FNAL E791 Collab.)
BLACK	01	PR D64 014031	D. Black *et al.*	
COLANGELO	01	NP B603 125	G. Colangelo, J. Gasser, H. Leytwyler	
ISHIDA	01	PL B518 47	M. Ishida *et al.*	
KOMADA	01	PL B508 31	T. Komada *et al.*	
PISLAK	01	PRL 87 221801	S. Pislak *et al.*	(BNL E865 Collab.)
Also		PR D67 072004	S. Pislak *et al.*	(BNL E865 Collab.)
Also		PRL 105 019901E	S. Pislak *et al.*	(BNL E865 Collab.)
SUROVTSEV	01	PR D63 054024	Y.S. Surovtsev, D. Krupa, M. Nagy	
ASNER	00	PR D61 012002	D.M. Asner *et al.*	(CLEO Collab.)
BAI	00E	PR D62 032002	J. Bai *et al.*	(BES Collab.)
ISHIDA	00B	PTP 104 203	M. Ishida *et al.*	
ALEKSEEV	99	NP B541 3	I.G. Alekseev *et al.*	
BOGLIONE	99	EPJ C9 11	M. Boglione, M.R. Pennington	
HANNAH	99	PR D60 017502	T. Hannah	
KAMINSKI	99	EPJ C9 141	R. Kaminski, L. Lesniak, B. Loiseau	(CRAC, PARIN)
OLLER	99	PR D60 099906 (erratum)	J.A. Oller *et al.*	
OLLER	99B	NP A652 407 (erratum)	J.A. Oller, E. Oset	
OLLER	99C	PR D60 074023	J.A. Oller, E. Oset	
ALEKSEEV	98	PAN 61 174	I.G. Alekseev *et al.*	
ALEXANDER	98	PR D58 052004	J.P. Alexander *et al.*	(CLEO Collab.)
ANISOVICH	98B	SPU 41 419	V.V. Anisovich *et al.*	
		Translated from UFN 168 481.		
LOCHER	98	EPJ C4 317	M.P. Locher *et al.*	(PSI)
TROYAN	98	JINRRC 5-91 33	Yu. Troyan *et al.*	
ALDE	97	PL B397 350	D.M. Alde *et al.*	(GAMS Collab.)
DOBADO	97	PR D56 3057	A. Dobado, J.R. Pelaez	
ISHIDA	97	PTP 98 1005	S. Ishida *et al.*	(TOKY, MIYA, KEK)

KAMINSKI	97B	PL B413 130	R. Kaminski, L. Lesniak, B. Loiseau	(CRAC, IPN)
Also		PTP 95 745	S. Ishida *et al.*	(TOKY, MIYA, KEK)
SVEC	96	PR D53 2343	M. Svec	(MCGI)
TORNQVIST	96	PRL 76 1575	N.A. Tornqvist, M. Roos	(HELS)
ALDE	95B	ZPHY C66 375	D.M. Alde *et al.*	(GAMS Collab.)
ANISOVICH	95	PL B355 363	V.V. Anisovich *et al.*	(PNPI, SERP)
JANSSEN	95	PR D52 2690	G. Janssen *et al.*	(STON, ADLD, JULI)
ACHASOV	94	PR D49 5779	N.N. Achasov, G.N. Shestakov	(NOVM)
AMSLER	94D	PL B333 277	C. Amsler *et al.*	(Crystal Barrel Collab.)
ANISOVICH	94	PL B323 233	V.V. Anisovich *et al.*	(Crystal Barrel Collab.)
BUTLER	94B	PR D49 40	F. Butler *et al.*	(CLEO Collab.)
KAMINSKI	94	PR D50 3145	R. Kaminski, L. Lesniak, J.P. Maillet	(CRAC+)
ZOU	94B	PR D50 591	B.S. Zou, D.V. Bugg	(LOQM)
ZOU	93	PR D48 3948	B.S. Zou, D.V. Bugg	(LOQM)
BEHREND	92	ZPHY C56 381	H.J. Behrend	(CELLO Collab.)
ARMSTRONG	91B	ZPHY C52 389	T.A. Armstrong *et al.*	(ATHU, BARI, BIRM+)
BOYER	90	PR D42 1350	J. Boyer *et al.*	(Mark II Collab.)
MARSISKE	90	PR D41 3324	H. Marsiske *et al.*	(Crystal Ball Collab.)
MORGAN	90	ZPHY C48 623	D. Morgan, M.R. Pennington	(RAL, DURH)
AUGUSTIN	89	NP B320 1	J.E. Augustin, G. Cosme	(DM2 Collab.)
ASTON	88	NP B296 493	D. Aston *et al.*	(SLAC, NAGO, CINC, INUS)
FALVARD	88	PR D38 2706	A. Falvard *et al.*	(CLER, FRAS, LALO+)
COURAU	86	NP B271 1	A. Courau *et al.*	(CLER, LALO)
VANBEVEREN	86	ZPHY C30 615	E. van Beveren *et al.*	(NIJM, BIEL)
CASON	83	PR D28 1586	N.M. Cason *et al.*	(NDAM, ANL)
ETKIN	82B	PR D25 1786	A. Etkin *et al.*	(BNL, CUNY, TUFTS, VAND)
BISWAS	81	PRL 47 1378	N.N. Biswas *et al.*	(NDAM, ANL)
COHEN	80	PR D22 2595	D. Cohen *et al.*	(ANL) IJP
MUKHIN	80	JETPL 32 601	K.N. Mukhin *et al.*	(KIAE)
		Translated from ZETFP 32 616.		
CORDEN	79	NP B157 250	M.J. Corden *et al.*	(BIRM, RHEL, TELA+) JP
ESTABROOKS	79	PR D19 2678	P. Estabrooks	(CARL)
FROGGATT	77	NP B129 89	C.D. Froggatt, J.L. Petersen	(GLAS, NORD)
PAWLICKI	77	PR D15 3196	A.J. Pawlicki *et al.*	(ANL) IJ
ROSSELET	77	PR D15 574	L. Rosselet *et al.*	(GEVA, SACL)
CASON	76	PRL 36 1485	N.M. Cason *et al.*	(NDAM, ANL) IJ
ESTABROOKS	75	NP B95 322	P.G. Estabrooks, A.D. Martin	(DURH)
HYAMS	75	NP B100 205	B.D. Hyams *et al.*	(CERN, MPIM)
SRINIVASAN	75	PR D12 681	V. Srinivasan *et al.*	(NDAM, ANL)
ESTABROOKS	74	NP B79 301	P.G. Estabrooks, A.D. Martin	(DURH)
GRAYER	74	NP B75 189	G. Grayer *et al.*	(CERN, MPIM)
ESTABROOKS	73	Tallahassee	P.G. Estabrooks *et al.*	(CERN, MPIM)
HYAMS	73	NP B64 134	B.D. Hyams *et al.*	(CERN, MPIM)
OCHS	73	Thesis	W. Ochs	(MPIM, MUNI)
PROTOPOP...	73	PR D7 1279	S.D. Protopopescu *et al.*	(LBL)
APEL	72C	PL 41B 542	W.D. Apel *et al.*	(KARLK, KARLE, PISA)
BAILLON	72	PL 38B 555	P.H. Baillon *et al.*	(SLAC)
BASDEVANT	72	PL 41B 178	J.L. Basdevant, C.D. Froggatt, J.L. Petersen	(CERN)
BEIER	72B	PRL 29 511	E.W. Beier *et al.*	(PENN)
BENSINGER	71	PL 36B 134	J.R. Bensinger *et al.*	(WISC)
COLTON	71	PR D3 2028	E.P. Colton *et al.*	(LBL, FNAL, UCLA+)
ROY	71	PL 36B 353	S.M. Roy	
BATON	70	PL 33B 528	J.P. Baton, G. Laurens, J. Reignier	(SACL)
WALKER	67	RMP 39 695	W.D. Walker	(WISC)