$f_0(400\text{–}1200)$ or σ

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

See "Note on scalar mesons" under $f_0(1370)$.

$f_0(400\text{–}1200)$ T-MATRIX POLE $\sqrt{s}$

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

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
(400–1200)–i(300–500) OUR ESTIMATE				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$470 - i250$	[1,2] TORNQVIST	96	RVUE	$\pi\pi \to \pi\pi$, $K\overline{K}$, $K\pi$, $\eta\pi$
$\sim (1100 - i300)$	AMSLER	95B	CBAR	$\overline{p}p \to 3\pi^0$
$400 - i500$	[2,3] AMSLER	95D	CBAR	$\overline{p}p \to 3\pi^0$
$1100 - i137$	[2,4] AMSLER	95D	CBAR	$\overline{p}p \to 3\pi^0$
$387 - i305$	[2,5] JANSSEN	95	RVUE	$\pi\pi \to \pi\pi$, $K\overline{K}$
$525 - i269$	[6] ACHASOV	94	RVUE	$\pi\pi \to \pi\pi$
$370 - i356$	[7] ZOU	94B	RVUE	$\pi\pi \to \pi\pi$, $K\overline{K}$
$408 - i342$	[2,7] ZOU	93	RVUE	$\pi\pi \to \pi\pi$, $K\overline{K}$
$870 - i370$	[2,8] AU	87	RVUE	$\pi\pi \to \pi\pi$, $K\overline{K}$
$750 \pm 50 - i(450 \pm 50)$	[9] ESTABROOKS	79	RVUE	$\pi\pi \to \pi\pi$, $K\overline{K}$
$660 \pm 100 - i(320 \pm 70)$	PROTOPOP...	73	HBC	$\pi\pi \to \pi\pi$, $K\overline{K}$
$650 - i370$	[10] BASDEVANT	72	RVUE	$\pi\pi \to \pi\pi$

[1] 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.

[2] Demonstrates explicitly that $f_0(400\text{–}1200)$ and $f_0(1370)$ are two different poles.

[3] Coupled channel analysis of $\overline{p}p \to 3\pi^0$, $\pi^0\eta\eta$ and $\pi^0\pi^0\eta$ on sheet II.

[4] Coupled channel analysis of $\overline{p}p \to 3\pi^0$, $\pi^0\eta\eta$ and $\pi^0\pi^0\eta$ on sheet III.

[5] Analysis of data from FALVARD 88.

[6] Analysis of data from OCHS 73, ESTABROOKS 75, ROSSELET 77, and MUKHIN 80.

[7] Analysis of data from OCHS 73, GRAYER 74, and ROSSELET 77.

[8] Analysis of data from OCHS 73, GRAYER 74, BECKER 79, and CASON 83.

[9] Analysis of data from APEL 73, GRAYER 74, CASON 76, PAWLICKI 77. Includes spread and errors of 4 solutions.

[10] Analysis of data from BATON 70, BENSINGER 71, COLTON 71, BAILLON 72, PROTOPOPESCU 73, and WALKER 67.

$f_0(400\text{–}1200)$ BREIT-WIGNER MASS OR K-MATRIX POLE PARAMETERS

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
(400–1200) OUR ESTIMATE				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
761 ± 12	[11] SVEC	96	RVUE	6–17 $\pi N_{\mathrm{polar}} \to \pi^+\pi^- N$
~ 860	[12] TORNQVIST	96	RVUE	$\pi\pi \to \pi\pi$, $K\overline{K}$, $K\pi$, $\eta\pi$
1165 ± 50	[13,14] ANISOVICH	95	RVUE	$\pi^- p \to \pi^0\pi^0 n$, $\overline{p}p \to \pi^0\pi^0\pi^0$, $\pi^0\pi^0\eta$, $\pi^0\eta\eta$
~ 1000	[15] ACHASOV	94	RVUE	$\pi\pi \to \pi\pi$
414 ± 20	[11] AUGUSTIN	89	DM2	

[11] Breit-Wigner fit to S-wave intensity measured in $\pi N \to \pi^-\pi^+ N$ on polarized targets. The fit does not include $f_0(980)$.

[12] 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.

[13] 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 fromANISOVICH 94.

[14] The pole is on Sheet III. Demonstrates explicitly that $f_0(400\text{–}1200)$ and $f_0(1370)$ are two different poles.

[15] Analysis of data from OCHS 73, ESTABROOKS 75, ROSSELET 77, and MUKHIN 80.

f_0(400–1200) BREIT-WIGNER WIDTH

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
(600–1000) OUR ESTIMATE				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
290±54	[16] SVEC	96	RVUE	6–17 $\pi N_{\text{polar}} \rightarrow \pi^+\pi^- N$
∼ 880	[17] TORNQVIST	96	RVUE	$\pi\pi \rightarrow \pi\pi$, $K\overline{K}$, $K\pi$, $\eta\pi$
460±40	[18,19] ANISOVICH	95	RVUE	$\pi^- p \rightarrow \pi^0\pi^0 n$, $\overline{p}p \rightarrow \pi^0\pi^0\pi^0$, $\pi^0\pi^0\eta$, $\pi^0\eta\eta$
∼ 3200	[20] ACHASOV	94	RVUE	$\pi\pi \rightarrow \pi\pi$
494±58	[16] AUGUSTIN	89	DM2	

[16] Breit-Wigner fit to S-wave intensity measured in $\pi N \rightarrow \pi^- \pi^+ N$ on polarized targets. The fit does not include $f_0(980)$.
[17] 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.
[18] 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 fromANISOVICH 94.
[19] The pole is on Sheet III. Demonstrates explicitly that f_0(400–1200) and f_0(1370) are two different poles.
[20] Analysis of data from OCHS 73, ESTABROOKS 75, ROSSELET 77, and MUKHIN 80.

f_0(400–1200) DECAY MODES

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

f_0(400–1200) PARTIAL WIDTHS

$\Gamma(\gamma\gamma)$ Γ_2

VALUE (keV)	*DOCUMENT ID*		*TECN*	*COMMENT*
seen	[21] MORGAN	90	RVUE	$\gamma\gamma \rightarrow \pi^+\pi^-$, $\pi^0\pi^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
10±6	COURAU	86	DM1	$e^+e^- \rightarrow \pi^+\pi^- e^+e^-$

[21] Analysis of data from BOYER 90 and MARSISKE 90.

f_0(400–1200) REFERENCES

SVEC	96	PR D53 2343		(MCGI)
TORNQVIST	96	PRL 76 1575	+Roos	(HELS)
ALDE	95B	ZPHY C66 375	+Binon, Boutemeur+	(GAMS Collab.)
AMSLER	95B	PL B342 433	+Armstrong, Brose+	(Crystal Barrel Collab.)
AMSLER	95D	PL B355 425	+Armstrong, Spanier+	(Crystal Barrel Collab.)
ANISOVICH	95	PL B355 363	+Kondashov+	(PNPI, SERP)
JANSSEN	95	PR D52 2690	+Pearce, Holinde, Speth	(STON, ADLD, JULI)
ACHASOV	94	PR D49 5779	+Shestakov	(NOVM)
AMSLER	94D	PL B333 277	+Anisovich, Spanier+	(Crystal Barrel Collab.)
ANISOVICH	94	PL B323 233	+Armstrong+	(Crystal Barrel Collab.)
ZOU	94B	PR D50 591	+Bugg	(LOQM)
ZOU	93	PR D48 R3948	+Bugg	(LOQM)
ARMSTRONG	91B	ZPHY C52 389	+Barnes+	(ATHU, BARI, BIRM, CERN, CDEF)
BOYER	90	PR D42 1350	+Butler+	(Mark II Collab.)
MARSISKE	90	PR D41 3324	+Antreasyan+	(Crystal Ball Collab.)
MORGAN	90	ZPHY C48 623	+Pennington	(RAL, DURH)
AUGUSTIN	89	NP B320 1	+Cosme	(DM2 Collab.)
ASTON	88	NP B296 493	+Awaji, Bienz, Bird+	(SLAC, NAGO, CINC, INUS)
FALVARD	88	PR D38 2706	+Ajaltouni+	(CLER, FRAS, LALO, PADO)
AU	87	PR D35 1633	+Morgan, Pennington	(DURH, RAL)
COURAU	86	NP B271 1	+Falvard, Haissinski, Jousset, Michel+	(CLER, LALO)
CASON	83	PR D28 1586	+Cannata, Baumbaugh, Bishop+	(NDAM, ANL)
MUKHIN	80	JETPL 32 601	+Patarakin+	
BECKER	79	NP B151 46	+Blanar, Blum+	(MPIM, CERN, ZEEM, CRAC)
ESTABROOKS	79	PR D19 2678		(CARL)
PAWLICKI	77	PR D15 3196	+Ayres, Cohen, Diebold, Kramer, Wicklund	(ANL) IJ
ROSSELET	77	PR D15 574	+Extermann, Fischer, Guisan+	(GEVA, SACL)
CASON	76	PRL 36 1485	+Polychronakos, Bishop, Biswas+	(NDAM, ANL) IJ
ESTABROOKS	75	NP B95 322	+Martin	(DURH)
GRAYER	74	NP B75 189	+Hyams, Blum, Dietl+	(CERN, MPIM)
APEL	73	PL 41B 542	+Auslander, Muller+	(KARL, PISA)
HYAMS	73	NP B64 134	+Jones, Weilhammer, Blum, Dietl+	(CERN, MPIM)
OCHS	73	Thesis		(MPIM, MUNI)
PROTOPOP...	73	PR D7 1279	Protopopescu, Alston-Garnjost, Galtieri, Flatte+	(LBL)
BAILLON	72	PL 38B 555	+Carnegie, Kluge, Leith, Lynch, Ratcliff+	(SLAC)
BASDEVANT	72	PL 41B 178	+Froggatt, Petersen	(CERN)
BEIER	72B	PRL 29 511	+Buchholtz, Mann+	(PENN)
BENSINGER	71	PL 36B 134	+Erwin, Thompson, Walker	(WISC)
COLTON	71	PR D3 2028	+Malamud, Schlein+	(LBL, FNAL, UCLA, HAWA)
BATON	70	PL 33B 528	+Laurens, Reignier	(SACL)
WALKER	67	RMP 39 695		(WISC)

OTHER RELATED PAPERS

AMSLER	96	PR D53 295	+Close	(ZURI, RAL)	
AMSLER	95C	PL B353 571	+Armstrong, Hackman+	(Crystal Barrel Collab.)	
ANTINORI	95	PL B353 589	+Barberis, Bayes+	(ATHU, BARI, BIRM, CERN, JINR)	
TORNQVIST	95	ZPHY C68 647		(HELS)	
AMSLER	94	PL B322 431	+Armstrong, Meyer+	(Crystal Barrel Collab.)	
ADAMO	93	NP A558 13C	+Agnello+	(OBELIX Collab.)	
GASPERO	93	NP A562 407		(ROMAI)	
MORGAN	93	PR D48 1185	+Pennington	(RAL, DURH)	
Also	93C	NC A Conf. Suppl.	Morgan	(RAL)	
SVEC	92	PR D45 55	+de Lesquen, van Rossum	(MCGI, SACL)	
SVEC	92B	PR D45 1518	+de Lesquen, van Rossum	(MCGI, SACL)	
SVEC	92C	PR D46 949	+de Lesquen, van Rossum	(MCGI, SACL)	
WEINSTEIN	89	UTPT 89 03	+Isgur	(TNTO)	
ASTON	88D	NP B301 525	+Awaji, Bienz+	(SLAC, NAGO, CINC, INUS)	
ACHASOV	84	ZPHY C22 53	+Devyanin, Shestakov	(NOVM)	
BINON	83	NC 78A 313	+Donskov, Duteil+	(BELG, LAPP, SERP, CERN)	
ETKIN	82B	PR D25 1786	+Foley, Lai+	(BNL, CUNY, TUFTS, VAND)	
TORNQVIST	82	PRL 49 624		(HELS)	
COHEN	80	PR D22 2595	+Ayres, Diebold, Kramer, Pawlicki+	(ANL)	IJP
BECKER	79B	NP B150 301	+Blanar, Blum+	(MPIM, CERN, ZEEM, CRAC)	
POLYCHRO...	79	PR D19 1317	Polychronakos, Cason, Bishop+	(NDAM, ANL)	IJP
WETZEL	76	NP B115 208	+Freudenreich, Beusch+	(ETH, CERN, LOIC)	