$f_0(980)$

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

See also the minireview on scalar mesons under $f_0(1370)$ and on the non-$q\overline{q}$ candidates. (See the index for the page number.)

$f_0(980)$ MASS

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
980 ±10 OUR ESTIMATE					
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1006		TORNQVIST	96	RVUE	$\pi\pi \to \pi\pi, K\overline{K}, K\pi, \eta\pi$
997 ± 5	3k	[1] ALDE	95B	GAM2	$38\ \pi^- p \to \pi^0\pi^0 n$
960 ±10	10k	[2] ALDE	95B	GAM2	$38\ \pi^- p \to \pi^0\pi^0 n$
994 ± 5		AMSLER	95B	CBAR	$0.0\ \overline{p}p \to 3\pi^0$
∼ 996		[3] AMSLER	95D	CBAR	$0.0\ \overline{p}p \to \pi^0\pi^0\pi^0, \pi^0\eta\eta, \pi^0\pi^0\eta$
987 ± 6		[4] ANISOVICH	95	RVUE	
1015		JANSSEN	95	RVUE	$\pi\pi \to \pi\pi, K\overline{K}$
983		[5] BUGG	94	RVUE	$\overline{p}p \to \eta 2\pi^0$
988		[6] ZOU	94B	RVUE	
988 ±10		[7] MORGAN	93	RVUE	$\pi\pi(K\overline{K}) \to \pi\pi(K\overline{K}), J/\psi \to \phi\pi\pi(K\overline{K}), D_s \to \pi(\pi\pi)$
971.1± 4.0		[8] AGUILAR-...	91	EHS	$400\ pp$
979 ± 4		[9] ARMSTRONG	91	OMEG	$300\ pp \to pp\pi\pi, ppK\overline{K}$
956 ±12		BREAKSTONE	90	SFM	$pp \to pp\pi^+\pi^-$
959.4± 6.5		[8] AUGUSTIN	89	DM2	$J/\psi \to \omega\pi^+\pi^-$
978 ± 9		[8] ABACHI	86B	HRS	$e^+e^- \to \pi^+\pi^- X$
$985.0^{+9.0}_{-39.0}$		ETKIN	82B	MPS	$23\ \pi^- p \to n 2K^0_S$
974 ± 4		[9] GIDAL	81	MRK2	$J/\psi \to \pi^+\pi^- X$
975		[10] ACHASOV	80	RVUE	
986 ±10		[9] AGUILAR-...	78	HBC	$0.7\ \overline{p}p \to K^0_S K^0_S$
969 ± 5		[9] LEEPER	77	ASPK	$2–2.4\ \pi^- p \to \pi^+\pi^- n, K^+K^- n$
987 ± 7		[9] BINNIE	73	CNTR	$\pi^- p \to n MM$
1012 ± 6		[11] GRAYER	73	ASPK	$17\ \pi^- p \to \pi^+\pi^- n$
1007 ±20		[11] HYAMS	73	ASPK	$17\ \pi^- p \to \pi^+\pi^- n$
997 ± 6		[11] PROTOPOP...	73	HBC	$7\ \pi^+ p \to \pi^+ p \pi^+\pi^-$

[1] At high $|t|$.
[2] At low $|t|$.
[3] On sheet II in a 4-pole solution, the other poles are found on sheet III at $(953-55i)$ MeV and on sheet IV at $(938-35i)$ MeV.
[4] Combined fit of ALDE 95B, ANISOVICH 94, AMSLER 94D.
[5] On sheet II in a 2 pole solution. The other pole is found on sheet III at $(996-103i)$ MeV.
[6] On sheet II in a 2 pole solution. The other pole is found on sheet III at $(797-185i)$ MeV and can be interpreted as a shadow pole.
[7] On sheet II in a 2 pole solution. The other pole is found on sheet III at $(978-28i)$ MeV.
[8] From invariant mass fit.
[9] From coupled channel analysis.
[10] Coupled channel analysis with finite width corrections.
[11] Included in AGUILAR-BENITEZ 78 fit.

$f_0(980)$ WIDTH

Width determination very model dependent. Peak width is about 50 MeV, but decay width can be much larger.

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
40 to 100 OUR ESTIMATE					
• • • We do not use the following data for averages, fits, limits, etc. • • •					
34		TORNQVIST	96	RVUE	$\pi\pi \to \pi\pi, K\overline{K}, K\pi, \eta\pi$
48 ± 10	3k	[12] ALDE	95B	GAM2	$38\ \pi^- p \to \pi^0\pi^0 n$
95 ± 20	10k	[13] ALDE	95B	GAM2	$38\ \pi^- p \to \pi^0\pi^0 n$

26 ± 10		AMSLER	95B	CBAR	0.0 $\overline{p}p \to 3\pi^0$
~ 112	[14]	AMSLER	95D	CBAR	0.0 $\overline{p}p \to \pi^0\pi^0\pi^0$, $\pi^0\eta\eta$, $\pi^0\pi^0\eta$
80 ± 12	[15]	ANISOVICH	95	RVUE	
30		JANSSEN	95	RVUE	$\pi\pi \to \pi\pi$, $K\overline{K}$
74	[16]	BUGG	94	RVUE	$\overline{p}p \to \eta 2\pi^0$
46	[17]	ZOU	94B	RVUE	
48 ± 12	[18]	MORGAN	93	RVUE	$\pi\pi(K\overline{K}) \to \pi\pi(K\overline{K})$, $J/\psi \to \phi\pi\pi(K\overline{K})$, $D_s \to \pi(\pi\pi)$
37.4 ± 10.6	[19]	AGUILAR-...	91	EHS	400 pp
72 ± 8	[20]	ARMSTRONG	91	OMEG	300 $pp \to pp\pi\pi$, $ppK\overline{K}$
110 ± 30		BREAKSTONE	90	SFM	$pp \to pp\pi^+\pi^-$
29 ± 13	[19]	ABACHI	86B	HRS	$e^+e^- \to \pi^+\pi^- X$
120 ±281 ±20		ETKIN	82B	MPS	23 $\pi^- p \to n 2K^0_S$
28 ± 10	[20]	GIDAL	81	MRK2	$J/\psi \to \pi^+\pi^- X$
70 to 300	[21]	ACHASOV	80	RVUE	
100 ± 80	[22]	AGUILAR-...	78	HBC	0.7 $\overline{p}p \to K^0_S K^0_S$
30 ± 8	[20]	LEEPER	77	ASPK	2–2.4 $\pi^- p \to \pi^+\pi^- n$, $K^+K^- n$
48 ± 14	[20]	BINNIE	73	CNTR	$\pi^- p \to n$MM
32 ± 10	[23]	GRAYER	73	ASPK	17 $\pi^- p \to \pi^+\pi^- n$
30 ± 10	[23]	HYAMS	73	ASPK	17 $\pi^- p \to \pi^+\pi^- n$
54 ± 16	[23]	PROTOPOP...	73	HBC	7 $\pi^+ p \to \pi^+ p \pi^+\pi^-$

[12] At high $|t|$.
[13] At low $|t|$.
[14] On sheet II in a 4-pole solution, the other poles are found on sheet III at (953−55*i*) MeV and on sheet IV at (938−35*i*) MeV.
[15] Combined fit of ALDE 95B, ANISOVICH 94,
[16] On sheet II in a 2 pole solution. The other pole is found on sheet III at (996−103*i*) MeV.
[17] On sheet II in a 2 pole solution. The other pole is found on sheet III at (797−185*i*) MeV and can be interpreted as a shadow pole.
[18] On sheet II in a 2 pole solution. The other pole is found on sheet III at (978−28*i*) MeV.
[19] From invariant mass fit.
[20] From coupled channel analysis.
[21] Coupled channel analysis with finite width corrections.
[22] From coupled channel fit to the HYAMS 73 and PROTOPOPESCU 73 data. With a simultaneous fit to the $\pi\pi$ phase-shifts, inelasticity and to the $K^0_S K^0_S$ invariant mass.
[23] Included in AGUILAR-BENITEZ 78 fit.

$f_0(980)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Confidence level
Γ_1	$\pi\pi$	(78.1 ±2.4) %	
Γ_2	$K\overline{K}$	(21.9 ±2.4) %	
Γ_3	$\gamma\gamma$	(1.19±0.33) × 10^{-5}	
Γ_4	e^+e^-	< 3 × 10^{-7}	90%

CONSTRAINED FIT INFORMATION

An overall fit to a branching ratio uses 3 measurements and one constraint to determine 2 parameters. The overall fit has a χ^2 = 2.0 for 2 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_2	−100
	x_1

$f_0(980)$ PARTIAL WIDTHS

$\Gamma(\gamma\gamma)$ — Γ_3

VALUE (keV)	EVTS	DOCUMENT ID		TECN	COMMENT
0.56±0.11 OUR AVERAGE					
0.63±0.14		[24] MORGAN	90	RVUE	$\gamma\gamma \to \pi^+\pi^-$, $\pi^0\pi^0$
0.42±0.06±0.18	60	[25] OEST	90	JADE	$e^+e^- \to e^+e^-\pi^0\pi^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.29±0.07±0.12		[26,27] BOYER	90	MRK2	$e^+e^- \to e^+e^-\pi^+\pi^-$
0.31±0.14±0.09		[26,27] MARSISKE	90	CBAL	$e^+e^- \to e^+e^-\pi^0\pi^0$

[24] From amplitude analysis of BOYER 90 and MARSISKE 90, data corresponds to resonance parameters $m = 989$ MeV, $\Gamma = 61$ MeV.
[25] OEST 90 quote systematic errors $^{+0.08}_{-0.18}$. We use ±0.18.
[26] From analysis allowing arbitrary background unconstrained by unitarity.
[27] Data included in MORGAN 90 analysis.

$\Gamma(e^+e^-)$ — Γ_4

VALUE (eV)	CL%	DOCUMENT ID		TECN	COMMENT
<8.4	90	VOROBYEV	88	ND	$e^+e^- \to \pi^0\pi^0$

$f_0(980)$ BRANCHING RATIOS

$\Gamma(\pi\pi)/[\Gamma(\pi\pi)+\Gamma(K\overline{K})]$ — $\Gamma_1/(\Gamma_1+\Gamma_2)$

VALUE	DOCUMENT ID		TECN	COMMENT
0.781±0.024 OUR FIT				
$0.781^{+0.027}_{-0.023}$ OUR AVERAGE				
0.67 ±0.09	[28] LOVERRE	80	HBC	$4\ \pi^- p \to n2K^0_S$
$0.81\ ^{+0.09}_{-0.04}$	[28] CASON	78	STRC	$7\ \pi^- p \to n2K^0_S$
0.78 ±0.03	[28] WETZEL	76	OSPK	$8.9\ \pi^- p \to n2K^0_S$

[28] Measure $\pi\pi$ elasticity assuming two resonances coupled to the $\pi\pi$ and $K\overline{K}$ channels only.

$f_0(980)$ REFERENCES

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)
AMSLER	94D	PL B333 277	+Anisovich, Spanier+	(Crystal Barrel Collab.)
ANISOVICH	94	PL B323 233	+Armstrong+	(Crystal Barrel Collab.)
BUGG	94	PR D50 4412	+Anisovich+	(LOQM)
ZOU	94B	PR D50 591	+Bugg	(LOQM)
MORGAN	93	PR D48 1185	+Pennington	(RAL, DURH)
AGUILAR-...	91	ZPHY C50 405	Aguilar-Benitez, Allison, Batalor+	(LEBC-EHS Collab.)
ARMSTRONG	91	ZPHY C51 351	+Benayoun+	(ATHU, BARI, BIRM, CERN, CDEF)
BOYER	90	PR D42 1350	+Butler+	(Mark II Collab.)
BREAKSTONE	90	ZPHY C48 569	+	(ISU, BGNA, CERN, DORT, HEIDH, WARS)
MARSISKE	90	PR D41 3324	+Antreasyan+	(Crystal Ball Collab.)
MORGAN	90	ZPHY C48 623	+Pennington	(RAL, DURH)
OEST	90	ZPHY C47 343	+Olsson+	(JADE Collab.)
AUGUSTIN	89	NP B320 1	+Cosme	(DM2 Collab.)
VOROBYEV	88	SJNP 48 273	+Golubev, Dolinsky, Druzhinin+	(NOVO)
		Translated from YAF 48 436.		
ABACHI	86B	PRL 57 1990	+Derrick, Blockus+	(PURD, ANL, IND, MICH, LBL)
ETKIN	82B	PR D25 1786	+Foley, Lai+	(BNL, CUNY, TUFTS, VAND)
GIDAL	81	PL 107B 153	+Goldhaber, Guy, Millikan, Abrams+	(SLAC, LBL)
ACHASOV	80	SJNP 32 566	+Devyanin, Shestakov	(NOVM)
		Translated from YAF 32 1098.		
LOVERRE	80	ZPHY C6 187	+Armenteros, Dionisi+	(CERN, CDEF, MADR, STOH) IJP
AGUILAR-...	78	NP B140 73	Aguilar-Benitez, Cerrada+	(MADR, BOMB, CERN+)
CASON	78	PRL 41 271	+Baumbaugh, Bishop, Biswas+	(NDAM, ANL)
LEEPER	77	PR D16 2054	+Buttram, Crawley, Duke, Lamb, Peterson	(ISU)
WETZEL	76	NP B115 208	+Freudenreich, Beusch+	(ETH, CERN, LOIC)
BINNIE	73	PRL 31 1534	+Carr, Debenham, Duane, Garbutt+	(LOIC, SHMP)
GRAYER	73	Tallahassee	+Hyams, Jones, Blum, Dietl, Koch+	(CERN, MPIM)
HYAMS	73	NP B64 134	+Jones, Weilhammer, Blum, Dietl+	(CERN, MPIM)
PROTOPOP...	73	PR D7 1279	Protopopescu, Alston-Garnjost, Galtieri, Flatte+	(LBL)

OTHER RELATED PAPERS

AU	87	PR D35 1633	+Morgan, Pennington	(DURH, RAL)
AKESSON	86	NP B264 154	+Albrow, Almehed+	(Axial Field Spec. Collab.)
MENNESSIER	83	ZPHY C16 241		(MONP)
BARBER	82	ZPHY C12 1	+Dainton, Brodbeck, Brookes+	(DARE, LANC, SHEF)
ETKIN	82C	PR D25 2446	+Foley, Lai+	(BNL, CUNY, TUFTS, VAND)
BIGI	62	CERN Conf. 247	+Brandt, Carrara+	(CERN)
BINGHAM	62	CERN Conf. 240	+Bloch+	(EPOL, CERN)
ERWIN	62	PRL 9 34	+Hoyer, March, Walker, Wangler	(WISC, BNL)
WANG	61	JETP 13 323	+Veksler, Vrana+	(JINR)
		Translated from ZETF 40 464.		