# $f_0(980)$

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

**See the related review(s):**
Scalar Mesons below 1 GeV

## $f_0(980)$ T-MATRIX POLE $\sqrt{s}$

Note that $\Gamma = -2\ \mathrm{Im}(\sqrt{s})$.

| VALUE (MeV) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **(980–1010) − *i* (20–35) OUR ESTIMATE** | (see Fig. 64.4 in the review) | | | |
| $(993 \pm 2^{+2}_{-1}) - i(21 \pm 3^{+2}_{-4})$ | [1] DANILKIN | 21 | RVUE | Compilation |
| $(1014 \pm 8) - i(35 \pm 5)$ | SARANTSEV | 21 | RVUE | $J/\psi(1S) \to \gamma\ (\pi\pi,\ K\overline{K},\ \eta\eta,\ \omega\phi)$ |
| $(992.8 \pm 1.3) - i(30.7 \pm 2.3)$ | [2] ALBRECHT | 20 | RVUE | 0.9 $\overline{p}p \to \pi^0\pi^0\eta,\ \pi^0\eta\eta,\ \pi^0 K^+ K^-$ |
| $(1003^{+5}_{-27}) - i(21^{+10}_{-8})$ | [3] GARCIA-MAR..11 | | RVUE | Compilation |
| $(996 \pm 7) - i(25^{+10}_{-6})$ | [4] GARCIA-MAR..11 | | RVUE | Compilation |
| $(996^{+4}_{-14}) - i(24^{+11}_{-3})$ | [5] MOUSSALLAM11 | | RVUE | Compilation |
| $(981 \pm 43) - i(18 \pm 11)$ | [6] MENNESSIER | 10 | RVUE | Compilation |
| $(1030^{+30}_{-10}) - i(35^{+10}_{-16})$ | [7] ANISOVICH | 09 | RVUE | 0.0 $\overline{p}p,\ \pi N$ |
| $(973^{+39}_{-127}) - i(11^{+189}_{-11})$ | [8] PELAEZ | 04A | RVUE | $\pi\pi \to \pi\pi$ |

[1] Data driven analysis using partial-wave dispersion relations .
[2] 5 poles, 5 channels, including scattering data from HYAMS 75 ($\pi\pi$), LONGACRE 86 ($K\overline{K}$), BINON 83 ($\eta\eta$), and BINON 84C ($\eta\eta'$). Based on 18.5k events. Second solution 977.8 ± 1.7 MeV.
[3] Reanalysis of the $K_{e4}$ data of BATLEY 10C and the $\pi N \to \pi\pi N$ data of HYAMS 73, GRAYER 74, and PROTOPOPESCU 73 using Roy equations.
[4] Reanalysis of the $K_{e4}$ data of BATLEY 10C and the $\pi N \to \pi\pi N$ data of HYAMS 73, GRAYER 74, and PROTOPOPESCU 73 using GKPY equations.
[5] Uses Roy equations.
[6] 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.
[7] On sheet II in a 2-pole solution. The other pole is found on sheet III at $(850 - i\ 100)$ MeV.
[8] Reanalysis of data from PROTOPOPESCU 73, ESTABROOKS 74, GRAYER 74, and COHEN 80 in the unitarized ChPT model.

## $f_0(980)$ MASS

| VALUE (MeV) | EVTS | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|---|
| **990 ±20 OUR ESTIMATE** | | | | |

• • • We do not use the following data for averages, fits, limits, etc. • • •

| | | | | | |
|---|---|---|---|---|---|
| $992.0^{+8.5}_{-7.5}\pm 8.6$ | | [1] AAIJ | 19H | LHCB | $p p \to D^{\pm} X$ |
| $989.4\pm 1.3$ | 424 | ABLIKIM | 15P | BES3 | $J/\psi \to K^+ K^- 3\pi$ |
| $989.9\pm 0.4$ | 706 | ABLIKIM | 12E | BES3 | $J/\psi \to \gamma 3\pi$ |
| $977 ^{+11}_{-9} \pm 1$ | 44 | [2] ECKLUND | 09 | CLEO | 4.17 $e^+ e^- \to D_s^- D_s^{*+}$ + c.c. |
| $982.2\pm 1.0^{+8.1}_{-8.0}$ | | [3] UEHARA | 08A | BELL | 10.6 $e^+ e^- \to e^+ e^- \pi^0 \pi^0$ |
| $976.8\pm 0.3^{+10.1}_{-0.6}$ | 64k | [4] AMBROSINO | 07 | KLOE | 1.02 $e^+ e^- \to \pi^0 \pi^0 \gamma$ |
| $984.7\pm 0.4^{+2.4}_{-3.7}$ | 64k | [5] AMBROSINO | 07 | KLOE | 1.02 $e^+ e^- \to \pi^0 \pi^0 \gamma$ |
| $973 \pm 3$ | $262\pm 30$ | [6] AUBERT | 07AK | BABR | 10.6 $e^+ e^- \to \phi \pi^+ \pi^- \gamma$ |
| $970 \pm 7$ | $54 \pm 9$ | [6] AUBERT | 07AK | BABR | 10.6 $e^+ e^- \to \phi \pi^0 \pi^0 \gamma$ |
| $953 \pm 20$ | 2.6k | [7] BONVICINI | 07 | CLEO | $D^+ \to \pi^- \pi^+ \pi^+$ |
| $985.6^{+1.2}_{-1.5}{}^{+1.1}_{-1.6}$ | | [8] MORI | 07 | BELL | 10.6 $e^+ e^- \to e^+ e^- \pi^+ \pi^-$ |
| $983.0\pm 0.6^{+4.0}_{-3.0}$ | | [9] AMBROSINO | 06B | KLOE | 1.02 $e^+ e^- \to \pi^+ \pi^- \gamma$ |
| $977.3\pm 0.9^{+3.7}_{-4.3}$ | | [10] AMBROSINO | 06B | KLOE | 1.02 $e^+ e^- \to \pi^+ \pi^- \gamma$ |
| $950 \pm 9$ | 4286 | [11] GARMASH | 06 | BELL | $B^+ \to K^+ \pi^+ \pi^-$ |
| $965 \pm 10$ | | [12] ABLIKIM | 05 | BES2 | $J/\psi \to \phi \pi^+ \pi^-$, $\phi K^+ K^-$ |
| $1031 \pm 8$ | | [13] ANISOVICH | 03 | RVUE | |
| $1037 \pm 31$ | | TIKHOMIROV | 03 | SPEC | 40.0 $\pi^- C \to K_S^0 K_S^0 K_L^0 X$ |
| $973 \pm 1$ | 2438 | [14] ALOISIO | 02D | KLOE | $e^+ e^- \to \pi^0 \pi^0 \gamma$ |
| $977 \pm 3 \pm 2$ | 848 | [15] AITALA | 01A | E791 | $D_s^+ \to \pi^- \pi^+ \pi^+$ |
| $969.8\pm 4.5$ | 419 | [16] ACHASOV | 00H | SND | $e^+ e^- \to \pi^0 \pi^0 \gamma$ |
| $985 ^{+16}_{-12}$ | 419 | [17,18] ACHASOV | 00H | SND | $e^+ e^- \to \pi^0 \pi^0 \gamma$ |
| $976 \pm 5 \pm 6$ | | [19] AKHMETSHIN | 99B | CMD2 | $e^+ e^- \to \pi^+ \pi^- \gamma$ |
| $977 \pm 3 \pm 6$ | 268 | [19] AKHMETSHIN | 99C | CMD2 | $e^+ e^- \to \pi^0 \pi^0 \gamma$ |
| $975 \pm 4 \pm 6$ | | [20] AKHMETSHIN | 99C | CMD2 | $e^+ e^- \to \pi^0 \pi^0 \gamma$ |
| $975 \pm 4 \pm 6$ | | [21] AKHMETSHIN | 99C | CMD2 | $e^+ e^- \to \pi^+ \pi^- \gamma$, $\pi^0 \pi^0 \gamma$ |
| $985 \pm 10$ | | BARBERIS | 99 | OMEG | 450 $p p \to p_s p_f K^+ K^-$ |
| $982 \pm 3$ | | BARBERIS | 99B | OMEG | 450 $p p \to p_s p_f \pi^+ \pi^-$ |
| $982 \pm 3$ | | BARBERIS | 99C | OMEG | 450 $p p \to p_s p_f \pi^0 \pi^0$ |
| $987 \pm 6 \pm 6$ | | [22] BARBERIS | 99D | OMEG | 450 $p p \to K^+ K^-$, $\pi^+ \pi^-$ |
| $989 \pm 15$ | | BELLAZZINI | 99 | GAM4 | 450 $p p \to p p \pi^0 \pi^0$ |
| $991 \pm 3$ | | [23] KAMINSKI | 99 | RVUE | $\pi\pi \to \pi\pi$, $K\overline{K}$, $\sigma\sigma$ |
| $\sim 980$ | | [23] OLLER | 99 | RVUE | $\pi\pi \to \pi\pi$, $K\overline{K}$ |
| $\sim 993.5$ | | OLLER | 99B | RVUE | $\pi\pi \to \pi\pi$, $K\overline{K}$ |
| $\sim 987$ | | [23] OLLER | 99C | RVUE | $\pi\pi \to \pi\pi$, $K\overline{K}$, $\eta\eta$ |
| $957 \pm 6$ | | [24] ACKERSTAFF | 98Q | OPAL | $Z \to f_0$ X |
| $960 \pm 10$ | | ALDE | 98 | GAM4 | |

| | | | | | |
|---|---|---|---|---|---|
| 1015 ±15 | | [23] ANISOVICH | 98B | RVUE | Compilation |
| 1008 | | [25] LOCHER | 98 | RVUE | $\pi\pi \to \pi\pi$ , $K\overline{K}$ |
| 955 ±10 | | [24] ALDE | 97 | GAM2 | 450 $pp \to pp\pi^0\pi^0$ |
| 994 ± 9 | | [26] BERTIN | 97C | OBLX | 0.0 $\overline{p}p \to \pi^+\pi^-\pi^0$ |
| 993.2± 6.5± 6.9 | | [27] ISHIDA | 96 | RVUE | $\pi\pi \to \pi\pi$, $K\overline{K}$ |
| 1006 | | TORNQVIST | 96 | RVUE | $\pi\pi \to \pi\pi$, $K\overline{K}$, $K\pi$, $\eta\pi$ |
| 997 ± 5 | 3k | [28] ALDE | 95B | GAM2 | 38 $\pi^- p \to \pi^0\pi^0 n$ |
| 960 ±10 | 10k | [29] 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 | | [30] 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 | | [31] ANISOVICH | 95 | RVUE | |
| 1015 | | JANSSEN | 95 | RVUE | $\pi\pi \to \pi\pi$, $K\overline{K}$ |
| 983 | | [32] BUGG | 94 | RVUE | $\overline{p}p \to \eta 2\pi^0$ |
| 973 ± 2 | | [33] KAMINSKI | 94 | RVUE | $\pi\pi \to \pi\pi$, $K\overline{K}$ |
| 988 | | [34] ZOU | 94B | RVUE | |
| 988 ±10 | | [35] 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 | | [24] AGUILAR-... | 91 | EHS | 400 $pp$ |
| 979 ± 4 | | [36] 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 | | [24] AUGUSTIN | 89 | DM2 | $J/\psi \to \omega\pi^+\pi^-$ |
| 978 ± 9 | | [24] 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 | | [36] GIDAL | 81 | MRK2 | $J/\psi \to \pi^+\pi^- X$ |
| 975 | | [37] ACHASOV | 80 | RVUE | |
| 986 ±10 | | [36] AGUILAR-... | 78 | HBC | 0.7 $\overline{p}p \to K^0_S K^0_S$ |
| 969 ± 5 | | [36] LEEPER | 77 | ASPK | 2–2.4 $\pi^- p \to \pi^+\pi^- n$, $K^+K^- n$ |
| 987 ± 7 | | [36] BINNIE | 73 | CNTR | $\pi^- p \to n$MM |
| 1012 ± 6 | | [38] GRAYER | 73 | ASPK | 17 $\pi^- p \to \pi^+\pi^- n$ |
| 1007 ±20 | | [38] HYAMS | 73 | ASPK | 17 $\pi^- p \to \pi^+\pi^- n$ |
| 997 ± 6 | | [38] PROTOPOP... | 73 | HBC | 7 $\pi^+ p \to \pi^+ p\pi^+\pi^-$ |

[1] From the $D^\pm \to K^\pm K^+ K^-$ Dalitz plot fit with the Triple-M amplitude in the multi-meson model of AOUDE 18.

[2] Using a relativistic Breit-Wigner function and taking into account the finite $D_s$ mass.

[3] Breit-Wigner mass. Using finite width corrections according to FLATTE 76 and ACHASOV 05, and the ratio $g_{f_0 KK}/g_{f_0 \pi\pi} = 0$.

[4] In the kaon-loop fit.

[5] In the no-structure fit.

[6] Systematic errors not estimated.

[7] FLATTE 76 parameterization. $g_{f_0\pi\pi} = 329 \pm 96$ MeV/c$^2$ assuming $g_{f_0 K\overline{K}}/g_{f_0\pi\pi}=2$.

[8] Breit-Wigner mass. Using finite width corrections according to FLATTE 76 and ACHASOV 05, and the ratio $g_{f_0 KK}/g_{f_0\pi\pi} = 4.21 \pm 0.25 \pm 0.21$ from ABLIKIM 05.

[9] In the kaon-loop fit following formalism of ACHASOV 89.

[10] In the no-structure fit assuming a direct coupling of $\phi$ to $f_0\gamma$.

[11] FLATTE 76 parameterization. Supersedes GARMASH 05.

[12] FLATTE 76 parameterization, $g_{f_0 K\overline{K}}/g_{f_0 \pi\pi}$ = 4.21 ± 0.25 ± 0.21.

[13] K-matrix pole from combined analysis of $\pi^- p \to \pi^0 \pi^0 n$, $\pi^- p \to K\overline{K} n$, $\pi^+\pi^- \to \pi^+\pi^-$, $\overline{p}p \to \pi^0\pi^0\pi^0$, $\pi^0\eta\eta$, $\pi^0\pi^0\eta$, $\pi^+\pi^-\pi^0$, $K^+K^-\pi^0$, $K^0_S K^0_S \pi^0$, $K^+ K^0_S \pi^-$ at rest, $\overline{p}n \to \pi^-\pi^-\pi^+$, $K^0_S K^- \pi^0$, $K^0_S K^0_S \pi^-$ at rest.

[14] From the negative interference with the $f_0$(500) meson of AITALA 01B using the ACHASOV 89 parameterization for the $f_0$(980), a Breit-Wigner for the $f_0$(500), and ACHASOV 01F for the $\rho\pi$ contribution.

[15] Coupled-channel Breit-Wigner, couplings $g_\pi$=0.09±0.01±0.01, $g_K$=0.02±0.04±0.03.

[16] Supersedes ACHASOV 98I. Using the model of ACHASOV 89.

[17] Supersedes ACHASOV 98I.

[18] In the "narrow resonance" approximation.

[19] Assuming $\Gamma(f_0)$= 40 MeV.

[20] From a narrow pole fit taking into account $f_0$(980) and $f_0$(1200) intermediate mechanisms.

[21] From the combined fit of the photon spectra in the reactions $e^+e^- \to \pi^+\pi^-\gamma$, $\pi^0\pi^0\gamma$.

[22] Supersedes BARBERIS 99 and BARBERIS 99B

[23] T-matrix pole.

[24] From invariant mass fit.

[25] On sheet II in a 2 pole solution. The other pole is found on sheet III at (1039−93$i$) MeV.

[26] On sheet II in a 2 pole solution. The other pole is found on sheet III at (963-29i) MeV.

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

[28] At high $|t|$.

[29] At low $|t|$.

[30] 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.

[31] Combined fit of ALDE 95B, ANISOVICH 94, AMSLER 94D.

[32] On sheet II in a 2 pole solution. The other pole is found on sheet III at (996−103$i$) MeV.

[33] From sheet II pole position.

[34] 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.

[35] On sheet II in a 2 pole solution. The other pole is found on sheet III at (978−28$i$) MeV.

[36] From coupled channel analysis.

[37] Coupled channel analysis with finite width corrections.

[38] Included in AGUILAR-BENITEZ 78 fit.

## $f_0$(980) WIDTH

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

| VALUE (MeV) | EVTS | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|---|
| **10 to 100 OUR ESTIMATE** | | | | |

• • • We do not use the following data for averages, fits, limits, etc. • • •

| | | | | | | |
|---|---|---|---|---|---|---|
| $15.3 \pm 4.7$ | 424 | | ABLIKIM | 15P | BES3 | $J/\psi \to K^+ K^- 3\pi$ |
| $9.5 \pm 1.1$ | 706 | | ABLIKIM | 12E | BES3 | $J/\psi \to \gamma 3\pi$ |
| $91 {}^{+30}_{-22} \pm 3$ | 44 | 1 | ECKLUND | 09 | CLEO | $4.17\ e^+ e^- \to D_s^- D_s^{*+}$ + c.c. |
| $66.9 \pm 2.2 {}^{+17.6}_{-12.5}$ | | 2 | UEHARA | 08A | BELL | $10.6\ e^+ e^- \to e^+ e^- \pi^0 \pi^0$ |
| $65 \pm 13$ | $262 \pm 30$ | 3 | AUBERT | 07AK | BABR | $10.6\ e^+ e^- \to \phi \pi^+ \pi^- \gamma$ |
| $81 \pm 21$ | $54 \pm 9$ | 3 | AUBERT | 07AK | BABR | $10.6\ e^+ e^- \to \phi \pi^0 \pi^0 \gamma$ |
| $51.3 {}^{+20.8}_{-17.7} {}^{+13.2}_{-3.8}$ | | 4 | MORI | 07 | BELL | $10.6\ e^+ e^- \to e^+ e^- \pi^+ \pi^-$ |
| $61 \pm 9 {}^{+14}_{-8}$ | 2584 | 5 | GARMASH | 05 | BELL | $B^+ \to K^+ \pi^+ \pi^-$ |
| $64 \pm 16$ | | 6 | ANISOVICH | 03 | RVUE | |
| $121 \pm 23$ | | | TIKHOMIROV | 03 | SPEC | $40.0\ \pi^- C \to K^0_S K^0_S K^0_L X$ |
| $\sim 70$ | | 7 | BRAMON | 02 | RVUE | $1.02\ e^+ e^- \to \pi^0 \pi^0 \gamma$ |
| $44 \pm 2 \pm 2$ | 848 | 8 | AITALA | 01A | E791 | $D_s^+ \to \pi^- \pi^+ \pi^+$ |
| $201 \pm 28$ | 419 | 9 | ACHASOV | 00H | SND | $e^+ e^- \to \pi^0 \pi^0 \gamma$ |
| $122 \pm 13$ | 419 | 10,11 | ACHASOV | 00H | SND | $e^+ e^- \to \pi^0 \pi^0 \gamma$ |
| $56 \pm 20$ | | 12 | AKHMETSHIN | 99C | CMD2 | $e^+ e^- \to \pi^0 \pi^0 \gamma$ |
| $65 \pm 20$ | | | BARBERIS | 99 | OMEG | $450\ p p \to p_s p_f K^+ K^-$ |
| $80 \pm 10$ | | | BARBERIS | 99B | OMEG | $450\ p p \to p_s p_f \pi^+ \pi^-$ |
| $80 \pm 10$ | | | BARBERIS | 99C | OMEG | $450\ p p \to p_s p_f \pi^0 \pi^0$ |
| $48 \pm 12 \pm 8$ | | 13 | BARBERIS | 99D | OMEG | $450\ p p \to K^+ K^-$, $\pi^+ \pi^-$ |
| $65 \pm 25$ | | | BELLAZZINI | 99 | GAM4 | $450\ p p \to p p \pi^0 \pi^0$ |
| $71 \pm 14$ | | 14 | KAMINSKI | 99 | RVUE | $\pi\pi \to \pi\pi$, $K\overline{K}$, $\sigma\sigma$ |
| $\sim 28$ | | 14 | OLLER | 99 | RVUE | $\pi\pi \to \pi\pi$, $K\overline{K}$ |
| $\sim 25$ | | | OLLER | 99B | RVUE | $\pi\pi \to \pi\pi$, $K\overline{K}$ |
| $\sim 14$ | | 14 | OLLER | 99C | RVUE | $\pi\pi \to \pi\pi$, $K\overline{K}$, $\eta\eta$ |
| $70 \pm 20$ | | | ALDE | 98 | GAM4 | |
| $86 \pm 16$ | | 14 | ANISOVICH | 98B | RVUE | Compilation |
| 54 | | 15 | LOCHER | 98 | RVUE | $\pi\pi \to \pi\pi$ , $K\overline{K}$ |
| $69 \pm 15$ | | 16 | ALDE | 97 | GAM2 | $450\ p p \to p p \pi^0 \pi^0$ |
| $38 \pm 20$ | | 17 | BERTIN | 97C | OBLX | $0.0\ \overline{p} p \to \pi^+ \pi^- \pi^0$ |
| $\sim 100$ | | 18 | ISHIDA | 96 | RVUE | $\pi\pi \to \pi\pi$, $K\overline{K}$ |
| 34 | | | TORNQVIST | 96 | RVUE | $\pi\pi \to \pi\pi$, $K\overline{K}$, $K\pi$, $\eta\pi$ |
| $48 \pm 10$ | 3k | 19 | ALDE | 95B | GAM2 | $38\ \pi^- p \to \pi^0 \pi^0 n$ |
| $95 \pm 20$ | 10k | 20 | ALDE | 95B | GAM2 | $38\ \pi^- p \to \pi^0 \pi^0 n$ |
| $26 \pm 10$ | | | AMSLER | 95B | CBAR | $0.0\ \overline{p} p \to 3\pi^0$ |
| $\sim 112$ | | 21 | AMSLER | 95D | CBAR | $0.0\ \overline{p} p \to \pi^0 \pi^0 \pi^0$, $\pi^0 \eta\eta$, $\pi^0 \pi^0 \eta$ |
| $80 \pm 12$ | | 22 | ANISOVICH | 95 | RVUE | |
| 30 | | | JANSSEN | 95 | RVUE | $\pi\pi \to \pi\pi$, $K\overline{K}$ |

| | | | | |
|---|---|---|---|---|
| 74 | [23] BUGG | 94 | RVUE | $\overline{p}p \to \eta 2\pi^0$ |
| 29 ± 2 | [24] KAMINSKI | 94 | RVUE | $\pi\pi \to \pi\pi$, $K\overline{K}$ |
| 46 | [25] ZOU | 94B | RVUE | |
| 48 ± 12 | [26] 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 | [16] AGUILAR-... | 91 | EHS | 400 $pp$ |
| 72 ± 8 | [27] ARMSTRONG | 91 | OMEG | 300 $pp \to pp\pi\pi$, $ppK\overline{K}$ |
| 110 ± 30 | BREAKSTONE | 90 | SFM | $pp \to pp\pi^+\pi^-$ |
| 29 ± 13 | [16] 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 | [27] GIDAL | 81 | MRK2 | $J/\psi \to \pi^+\pi^- X$ |
| 70 to 300 | [28] ACHASOV | 80 | RVUE | |
| 100 ± 80 | [29] AGUILAR-... | 78 | HBC | 0.7 $\overline{p}p \to K^0_S K^0_S$ |
| 30 ± 8 | [27] LEEPER | 77 | ASPK | 2–2.4 $\pi^- p \to \pi^+\pi^- n$, $K^+K^- n$ |
| 48 ± 14 | [27] BINNIE | 73 | CNTR | $\pi^- p \to n$MM |
| 32 ± 10 | [30] GRAYER | 73 | ASPK | 17 $\pi^- p \to \pi^+\pi^- n$ |
| 30 ± 10 | [30] HYAMS | 73 | ASPK | 17 $\pi^- p \to \pi^+\pi^- n$ |
| 54 ± 16 | [30] PROTOPOP... | 73 | HBC | 7 $\pi^+ p \to \pi^+ p \pi^+\pi^-$ |

[1] Using a relativistic Breit-Wigner function and taking into account the finite $D_s$ mass.

[2] Breit-Wigner $\pi\pi$ width. Using finite width corrections according to FLATTE 76 and ACHASOV 05, and the ratio $g_{f_0 KK}/g_{f_0\pi\pi} = 0$.

[3] Systematic errors not estimated.

[4] Breit-Wigner $\pi\pi$ width. Using finite width corrections according to FLATTE 76 and ACHASOV 05, and the ratio $g_{f_0 KK}/g_{f_0\pi\pi} = 4.21 \pm 0.25 \pm 0.21$ from ABLIKIM 05.

[5] Breit-Wigner, solution 1, PWA ambiguous.

[6] K-matrix pole from combined analysis of $\pi^- p \to \pi^0\pi^0 n$, $\pi^- p \to K\overline{K}n$, $\pi^+\pi^- \to \pi^+\pi^-$, $\overline{p}p \to \pi^0\pi^0\pi^0$, $\pi^0\eta\eta$, $\pi^0\pi^0\eta$, $\pi^+\pi^-\pi^0$, $K^+K^-\pi^0$, $K^0_S K^0_S \pi^0$, $K^+K^0_S\pi^-$ at rest, $\overline{p}n \to \pi^-\pi^-\pi^+$, $K^0_S K^-\pi^0$, $K^0_S K^0_S \pi^-$ at rest.

[7] Using the data of AKHMETSHIN 99C, ACHASOV 00H, and ALOISIO 02D.

[8] Breit-Wigner width.

[9] Supersedes ACHASOV 98I. Using the model of ACHASOV 89.

[10] Supersedes ACHASOV 98I.

[11] In the "narrow resonance" approximation.

[12] From the combined fit of the photon spectra in the reactions $e^+e^- \to \pi^+\pi^-\gamma$, $\pi^0\pi^0\gamma$.

[13] Supersedes BARBERIS 99 and BARBERIS 99B

[14] T-matrix pole.

[15] On sheet II in a 2 pole solution. The other pole is found on sheet III at $(1039-93i)$ MeV.

[16] From invariant mass fit.

[17] On sheet II in a 2 pole solution. The other pole is found on sheet III at (963-29i) MeV.

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

[19] At high $|t|$.

[20] At low $|t|$.

[21] 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.
[22] Combined fit of ALDE 95B, ANISOVICH 94,
[23] On sheet II in a 2 pole solution. The other pole is found on sheet III at (996−103$i$) MeV.
[24] From sheet II pole position.
[25] 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.
[26] On sheet II in a 2 pole solution. The other pole is found on sheet III at (978−28$i$) MeV.
[27] From coupled channel analysis.
[28] Coupled channel analysis with finite width corrections.
[29] 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.
[30] Included in AGUILAR-BENITEZ 78 fit.

## $f_0(980)$ DECAY MODES

| | Mode | Fraction ($\Gamma_i/\Gamma$) |
|---|---|---|
| $\Gamma_1$ | $\pi\pi$ | seen |
| $\Gamma_2$ | $K\overline{K}$ | seen |
| $\Gamma_3$ | $\gamma\gamma$ | seen |
| $\Gamma_4$ | $e^+e^-$ | |

## $f_0(980)$ PARTIAL WIDTHS

### $\Gamma(\gamma\gamma)$ $\Gamma_3$

| VALUE (keV) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **0.29 $^{+0.11}_{-0.06}$ OUR AVERAGE** | | | | |
| 0.286±0.017$^{+0.211}_{-0.070}$ | [1] UEHARA | 08A | BELL | 10.6 $e^+e^- \to e^+e^-\pi^0\pi^0$ |
| 0.205$^{+0.095}_{-0.083}$$^{+0.147}_{-0.117}$ | [2] MORI | 07 | BELL | 10.6 $e^+e^- \to e^+e^-\pi^+\pi^-$ |
| 0.42 ±0.06 ±0.18 | [3] OEST | 90 | JADE | $e^+e^- \to e^+e^-\pi^0\pi^0$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 0.32 ±0.05 | [4] DAI | 14A | RVUE | Compilation |
| 0.16 ±0.01 | [5] MENNESSIER | 11 | RVUE | |
| 0.29 ±0.21 $^{+0.02}_{-0.07}$ | [6] MOUSSALLAM | 11 | RVUE | Compilation |
| 0.42 | [7,8] PENNINGTON | 08 | RVUE | Compilation |
| 0.10 | [8,9] PENNINGTON | 08 | RVUE | Compilation |
| 0.28 $^{+0.09}_{-0.13}$ | [10] BOGLIONE | 99 | RVUE | $\gamma\gamma \to \pi^+\pi^-, \pi^0\pi^0$ |
| 0.29 ±0.07 ±0.12 | [11,12] BOYER | 90 | MRK2 | $e^+e^- \to e^+e^-\pi^+\pi^-$ |
| 0.31 ±0.14 ±0.09 | [11,12] MARSISKE | 90 | CBAL | $e^+e^- \to e^+e^-\pi^0\pi^0$ |
| 0.63 ±0.14 | [13] MORGAN | 90 | RVUE | $\gamma\gamma \to \pi^+\pi^-, \pi^0\pi^0$ |

[1] Using finite width corrections according to FLATTE 76 and ACHASOV 05, and the ratio $g_{f_0 K K}/g_{f_0 \pi\pi} = 0$.
[2] Using finite width corrections according to FLATTE 76 and ACHASOV 05, and the ratio $g_{f_0 K K}/g_{f_0 \pi\pi} = 4.21 \pm 0.25 \pm 0.21$ from ABLIKIM 05.
[3] OEST 90 quote systematic errors $^{+0.08}_{-0.18}$. We use $\pm 0.18$. Observed 60 events.
[4] Using dispersive analysis with phases from GARCIA-MARTIN 11A and BUETTIKER 04 as input.
[5] Uses an analytic K-matrix model. Compilation.
[6] Using dispersion integral with phase input from Roy equations and data from MARSISKE 90, BOYER 90, BEHREND 92, UEHARA 08A, and MORI 07.
[7] Solution A (preferred solution based on $\chi^2$-analysis).
[8] Dispersion theory based amplitude analysis of BOYER 90, MARSISKE 90, BEHREND 92, and MORI 07.
[9] Solution B (worse than solution A; still acceptable when systematic uncertainties are included).
[10] Supersedes MORGAN 90.
[11] From analysis allowing arbitrary background unconstrained by unitarity.
[12] Data included in MORGAN 90, BOGLIONE 99 analyses.
[13] From amplitude analysis of BOYER 90 and MARSISKE 90, data corresponds to resonance parameters $m = 989$ MeV, $\Gamma = 61$ MeV.

### $\Gamma(e^+ e^-)$ $\Gamma_4$

| 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 | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| $0.52 \pm 0.12$ | 9.9k | [1] AUBERT | 06O | BABR | $B^\pm \to K^\pm \pi^\pm \pi^\mp$ |
| $0.75^{+0.11}_{-0.13}$ | | [2] ABLIKIM | 05Q | BES2 | $\chi_{c0} \to 2\pi^+ 2\pi^-$, $\pi^+\pi^- K^+ K^-$ |
| $0.84 \pm 0.02$ | | [3] ANISOVICH | 02D | SPEC | Combined fit |
| $\sim 0.68$ | | OLLER | 99B | RVUE | $\pi\pi \to \pi\pi$, $K\overline{K}$ |
| $0.67 \pm 0.09$ | | [4] LOVERRE | 80 | HBC | $4\ \pi^- p \to n 2K^0_S$ |
| $0.81^{+0.09}_{-0.04}$ | | [4] CASON | 78 | STRC | $7\ \pi^- p \to n 2K^0_S$ |
| $0.78 \pm 0.03$ | | [4] WETZEL | 76 | OSPK | $8.9\ \pi^- p \to n 2K^0_S$ |

[1] Recalculated by us using $\Gamma(K^+ K^-)\ /\ \Gamma(\pi^+ \pi^-) = 0.69 \pm 0.32$ from AUBERT 06O and isospin relations.
[2] Using data from ABLIKIM 04G.
[3] From a combined K-matrix analysis of Crystal Barrel ($p\overline{p} \to \pi^0\pi^0\pi^0$, $\pi^0\eta\eta$, $\pi^0\pi^0\eta$), GAMS ($\pi p \to \pi^0\pi^0 n$, $\eta\eta n$, $\eta\eta' n$), and BNL ($\pi p \to K\overline{K} n$) data.
[4] Measure $\pi\pi$ elasticity assuming two resonances coupled to the $\pi\pi$ and $K\overline{K}$ channels only.

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