CITATION: R.M. Barnett *et al.* Physical Review D54, 1 (1996) and 1997 off-year partial update for the 1998 edition (URL: http://pdg.lbl.gov)

$f_4(2050)$

$I^G(J^{PC}) = 0^+(4^{++})$

f_4(2050) MASS

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
2044±11 OUR AVERAGE	Error includes scale factor of 1.4. See the ideogram below.				
1970±30		BELADIDZE	92B	VES	36 $\pi^- p \to \omega\omega n$
2060±20		ALDE	90	GAM2	38 $\pi^- p \to \omega\omega n$
2038±30		AUGUSTIN	87	DM2	$J/\psi \to \gamma\pi^+\pi^-$
2086±15		BALTRUSAIT...	87	MRK3	$J/\psi \to \gamma\pi^+\pi^-$
2000±60		ALDE	86D	GAM4	100 $\pi^- p \to n 2\eta$
2020±20	40k	[1] BINON	84B	GAM2	38 $\pi^- p \to n 2\pi^0$
2015±28		[2] CASON	82	STRC	8 $\pi^+ p \to \Delta^{++}\pi^0\pi^0$
2031^{+25}_{-36}		ETKIN	82B	MPS	23 $\pi^- p \to n 2K^0_S$
2020±30	700	APEL	75	NICE	40 $\pi^- p \to n 2\pi^0$
2050±25		BLUM	75	ASPK	18.4 $\pi^- p \to n K^+ K^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
~ 2040		[3] OAKDEN	94	RVUE	0.36-1.55 $\overline{p}p \to \pi^+\pi^-$
1978± 5		[4] ALPER	80	CNTR	62 $\pi^- p \to K^+ K^- n$
2040±10		[4] ROZANSKA	80	SPRK	18 $\pi^- p \to p\overline{p}n$
1935±13		[4] CORDEN	79	OMEG	12–15 $\pi^- p \to n 2\pi$
1988± 7		EVANGELISTA	79B	OMEG	10 $\pi^- p \to K^+ K^- n$
1922±14		[5] ANTIPOV	77	CIBS	25 $\pi^- p \to p 3\pi$

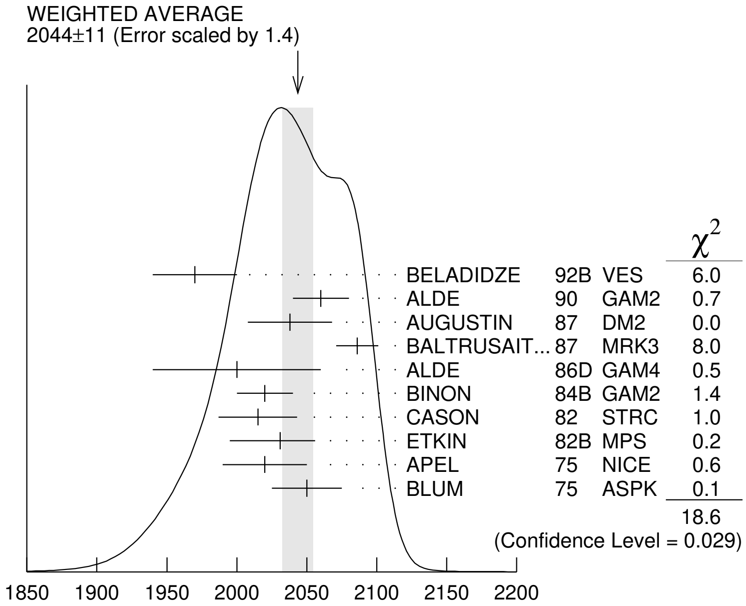
[1] From a partial-wave analysis of the data.

[2] From an amplitude analysis of the reaction $\pi^+\pi^- \to 2\pi^0$.

[3] From solution A of amplitude analysis of data on $\overline{p}p \to \pi\pi$ See however KLOET 96 who find waves only up to $J = 3$ to be important but not significantly resonant.

[4] $I(J^P) = 0(4^+)$ from amplitude analysis assuming one-pion exchange.

[5] Width errors enlarged by us to $4\Gamma/\sqrt{N}$; see the note with the $K^*(892)$ mass.



$f_4(2050)$ mass (MeV)

$f_4(2050)$ WIDTH

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
208± 13 OUR AVERAGE	Error includes scale factor of 1.2.				
300± 50		BELADIDZE	92B	VES	36 $\pi^- p \to \omega\omega n$
170± 60		ALDE	90	GAM2	38 $\pi^- p \to \omega\omega n$
304± 60		AUGUSTIN	87	DM2	$J/\psi \to \gamma\pi^+\pi^-$
210± 63		BALTRUSAIT...	87	MRK3	$J/\psi \to \gamma\pi^+\pi^-$
400±100		ALDE	86D	GAM4	100 $\pi^- p \to n 2\eta$
240± 40	40k	[6] BINON	84B	GAM2	38 $\pi^- p \to n 2\pi^0$
190± 14		DENNEY	83	LASS	10 $\pi^+ n/\pi^+ p$
186^{+103}_{-58}		[7] CASON	82	STRC	8 $\pi^+ p \to \Delta^{++}\pi^0\pi^0$
305^{+36}_{-119}		ETKIN	82B	MPS	23 $\pi^- p \to n 2K^0_S$
180± 60	700	APEL	75	NICE	40 $\pi^- p \to n 2\pi^0$
225^{+120}_{-70}		BLUM	75	ASPK	18.4 $\pi^- p \to n K^+ K^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
~ 60		[8] OAKDEN	94	RVUE	0.36-l.55 $\overline{p}p \to \pi^+\pi^-$
243± 16		[9] ALPER	80	CNTR	62 $\pi^- p \to K^+ K^- n$
140± 15		[9] ROZANSKA	80	SPRK	18 $\pi^- p \to p\overline{p}n$
263± 57		[9] CORDEN	79	OMEG	12–15 $\pi^- p \to n 2\pi$
100± 28		EVANGELISTA	79B	OMEG	10 $\pi^- p \to K^+ K^- n$
107± 56		[10] ANTIPOV	77	CIBS	25 $\pi^- p \to p 3\pi$

[6] From a partial-wave analysis of the data.

[7] From an amplitude analysis of the reaction $\pi^+\pi^- \rightarrow 2\pi^0$.
[8] From solution A of amplitude analysis of data on $\overline{p}p \rightarrow \pi\pi$ See however KLOET 96 who find waves only up to $J = 3$ to be important but not significantly resonant.
[9] $I(J^P) = 0(4^+)$ from amplitude analysis assuming one-pion exchange.
[10] Width errors enlarged by us to $4\Gamma/\sqrt{N}$; see the note with the $K^*(892)$ mass.

$f_4(2050)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	$\omega\omega$	(26 ± 6) %
Γ_2	$\pi\pi$	(17.0 ± 1.5) %
Γ_3	$K\overline{K}$	$(6.8^{+3.4}_{-1.8}) \times 10^{-3}$
Γ_4	$\eta\eta$	$(2.1\pm0.8) \times 10^{-3}$
Γ_5	$4\pi^0$	< 1.2 %
Γ_6	$\gamma\gamma$	

$f_4(2050)$ $\Gamma(i)\Gamma(\gamma\gamma)/\Gamma(\text{total})$

$\Gamma(K\overline{K}) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ — $\Gamma_3\Gamma_6/\Gamma$

VALUE (keV)	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.29	95	ALTHOFF	85B	TASS	$\gamma\gamma \rightarrow K\overline{K}\pi$

$\Gamma(\pi\pi) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ — $\Gamma_2\Gamma_6/\Gamma$

VALUE (keV)	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
<1.1	95	13 ± 4	OEST	90	JADE	$e^+e^- \rightarrow e^+e^-\pi^0\pi^0$

$f_4(2050)$ BRANCHING RATIOS

$\Gamma(\omega\omega)/\Gamma(\pi\pi)$ — Γ_1/Γ_2

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
1.5 ±0.3	ALDE	90	GAM2	$38\ \pi^- p \rightarrow \omega\omega n$

$\Gamma(\pi\pi)/\Gamma_{\text{total}}$ — Γ_2/Γ

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
0.170±0.015 OUR AVERAGE				
0.18 ± 0.03	[11] BINON	83C	GAM2	$38\ \pi^- p \rightarrow n4\gamma$
0.16 ± 0.03	[11] CASON	82	STRC	$8\ \pi^+ p \rightarrow \Delta^{++}\pi^0\pi^0$
0.17 ± 0.02	[11] CORDEN	79	OMEG	$12\text{–}15\ \pi^- p \rightarrow n2\pi$

[11] Assuming one pion exchange.

$\Gamma(K\overline{K})/\Gamma(\pi\pi)$ — Γ_3/Γ_2

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
$\mathbf{0.04\ ^{+0.02}_{-0.01}}$	ETKIN	82B	MPS	$23\ \pi^- p \rightarrow n2K^0_S$

$\Gamma(\eta\eta)/\Gamma_{total}$ Γ_4/Γ

VALUE (units 10^{-3})	*DOCUMENT ID*		*TECN*	*COMMENT*
2.1±0.8	ALDE	86D	GAM4	100 $\pi^- p \rightarrow n 4\gamma$

$\Gamma(4\pi^0)/\Gamma_{total}$ Γ_5/Γ

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
<0.012	ALDE	87	GAM4	100 $\pi^- p \rightarrow 4\pi^0 n$

$f_4(2050)$ REFERENCES

KLOET	96	PR D53 6120	+Myhrer	(RUTG, NORD)
OAKDEN	94	NPA 574 731	+Pennington	(DURH)
BELADIDZE	92B	ZPHY C54 367	+Bityukov, Borisov+	(VES Collab.)
ALDE	90	PL B241 600	+Binon+	(SERP, BELG, LANL, LAPP, PISA, KEK)
OEST	90	ZPHY C47 343	+Olsson+	(JADE Collab.)
ALDE	87	PL B198 286	+Binon, Bricman+	(LANL, BRUX, SERP, LAPP)
AUGUSTIN	87	ZPHY C36 369	+Cosme+	(LALO, CLER, FRAS, PADO)
BALTRUSAIT...	87	PR D35 2077	Baltrusaitis, Coffman, Dubois+	(Mark III Collab.)
ALDE	86D	NP B269 485	+Binon, Bricman+	(BELG, LAPP, SERP, CERN, LANL)
ALTHOFF	85B	ZPHY C29 189	+Braunschweig, Kirschfink+	(TASSO Collab.)
BINON	84B	LNC 39 41	+Donskov, Duteil, Gouanere+	(SERP, BELG, LAPP)
BINON	83C	SJNP 38 723	+Gouanere, Donskov, Duteil+	(SERP, BRUX+)
		Translated from YAF 38 1199.		
DENNEY	83	PR D28 2726	+Cranley, Firestone, Chapman+	(IOWA, MICH)
CASON	82	PRL 48 1316	+Biswas, Baumbaugh, Bishop+	(NDAM, ANL)
ETKIN	82B	PR D25 1786	+Foley, Lai+	(BNL, CUNY, TUFTS, VAND)
ALPER	80	PL 94B 422	+Becker+	(AMST, CERN, CRAC, MPIM, OXF+)
ROZANSKA	80	NP B162 505	+Blum, Dietl, Grayer, Lorenz+	(MPIM, CERN)
CORDEN	79	NP B157 250	+Dowell, Garvey+	(BIRM, RHEL, TELA, LOWC) JP
EVANGELISTA	79B	NP B154 381	+	(BARI, BONN, CERN, DARE, GLAS, LIVP+)
ANTIPOV	77	NP B119 45	+Busnello, Damgaard, Kienzle+	(SERP, GEVA)
APEL	75	PL 57B 398	+Augenstein+	(KARLK, KARLE, PISA, SERP, WIEN, CERN) JP
BLUM	75	PL 57B 403	+Chabaud, Dietl, Garelick, Grayer+	(CERN, MPIM) JP

OTHER RELATED PAPERS

PROKOSHKIN	97	SPD 42 117	+Kondashov, Sadovsky	(SERP)
		Translated from DANS 353 323.		
CASON	83	PR D28 1586	+Cannata, Baumbaugh, Bishop+	(NDAM, ANL)
GOTTESMAN	80	PR D22 1503	+Jacobs+	(SYRA, BRAN, BNL, CINC)
WAGNER	74	London Conf. 2 27		(MPIM)