$f_4(2050)$

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

$f_4(2050)$ MASS

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
2025± 8 OUR AVERAGE	Error includes scale factor of 1.7. See the ideogram below.				
2018± 6		ANISOVICH	00J	SPEC	
1998±15		ALDE	98	GAM4	$100\ \pi^- p \to \pi^0 \pi^0 n$
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. • • •					
∼ 2000		[3] MARTIN	98	RVUE	$N\overline{N} \to \pi\pi$
∼ 2010		[4] MARTIN	97	RVUE	$\overline{N}N \to \pi\pi$
∼ 2040		[5] OAKDEN	94	RVUE	0.36–1.55 $\overline{p}p \to \pi\pi$
∼ 1990		[6] OAKDEN	94	RVUE	0.36–1.55 $\overline{p}p \to \pi\pi$
1978± 5		[7] ALPER	80	CNTR	$62\ \pi^- p \to K^+ K^- n$
2040±10		[7] ROZANSKA	80	SPRK	$18\ \pi^- p \to p\overline{p}n$
1935±13		[7] 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		[8] 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] Energy-dependent analysis.

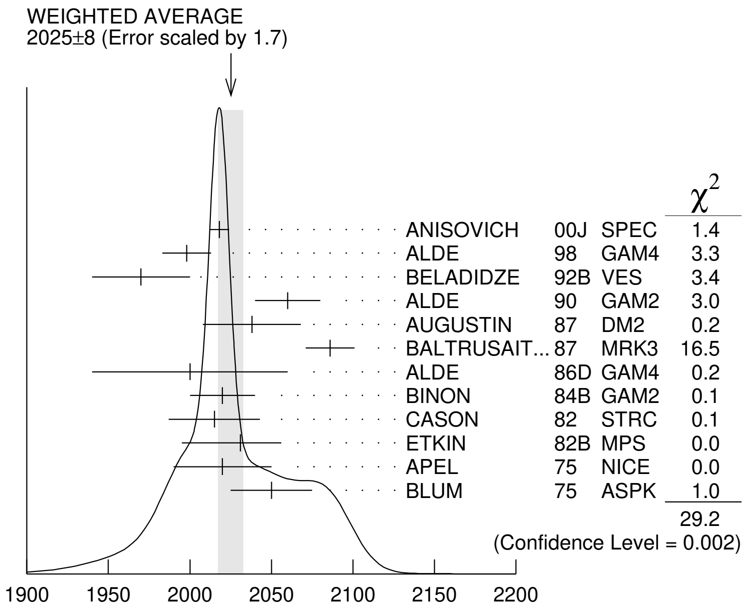
[4] Single energy analysis.

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

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

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

[8] 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*
194± 13 OUR AVERAGE	Error includes scale factor of 2.2. See the ideogram below.				
182± 7		ANISOVICH	00J	SPEC	
395± 40		ALDE	98	GAM4	100 $\pi^- p \rightarrow \pi^0 \pi^0 n$
300± 50		BELADIDZE	92B	VES	36 $\pi^- p \rightarrow \omega \omega n$
170± 60		ALDE	90	GAM2	38 $\pi^- p \rightarrow \omega \omega n$
304± 60		AUGUSTIN	87	DM2	$J/\psi \rightarrow \gamma \pi^+ \pi^-$
210± 63		BALTRUSAIT...	87	MRK3	$J/\psi \rightarrow \gamma \pi^+ \pi^-$
400±100		ALDE	86D	GAM4	100 $\pi^- p \rightarrow n 2\eta$
240± 40	40k	[9] BINON	84B	GAM2	38 $\pi^- p \rightarrow n 2\pi^0$
190± 14		DENNEY	83	LASS	10 $\pi^+ n / \pi^+ p$
186^{+103}_{-58}		[10] CASON	82	STRC	8 $\pi^+ p \rightarrow \Delta^{++} \pi^0 \pi^0$
305^{+36}_{-119}		ETKIN	82B	MPS	23 $\pi^- p \rightarrow n 2K^0_S$
180± 60	700	APEL	75	NICE	40 $\pi^- p \rightarrow n 2\pi^0$
225^{+120}_{-70}		BLUM	75	ASPK	18.4 $\pi^- p \rightarrow n K^+ K^-$

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

~ 170	[11] MARTIN	98	RVUE	$N\overline{N} \rightarrow \pi\pi$
~ 200	[12] MARTIN	97	RVUE	$\overline{N}N \rightarrow \pi\pi$
~ 60	[13] OAKDEN	94	RVUE	0.36–1.55 $\overline{p}p \rightarrow \pi\pi$
~ 80	[14] OAKDEN	94	RVUE	0.36–1.55 $\overline{p}p \rightarrow \pi\pi$
243± 16	[15] ALPER	80	CNTR	62 $\pi^- p \rightarrow K^+ K^- n$
140± 15	[15] ROZANSKA	80	SPRK	18 $\pi^- p \rightarrow p\overline{p}n$
263± 57	[15] CORDEN	79	OMEG	12–15 $\pi^- p \rightarrow n 2\pi$
100± 28	EVANGELISTA	79B	OMEG	10 $\pi^- p \rightarrow K^+ K^- n$
107± 56	[16] ANTIPOV	77	CIBS	25 $\pi^- p \rightarrow p 3\pi$

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

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

[11] Energy-dependent analysis.

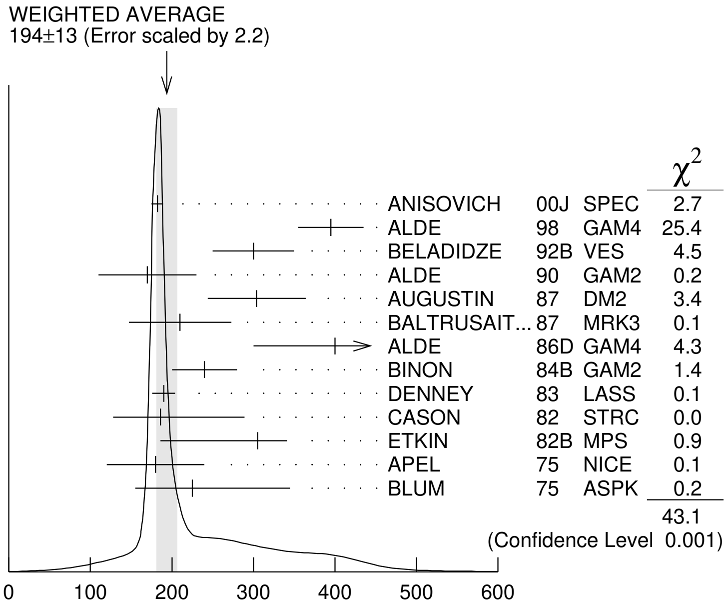
[12] Single energy analysis.

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

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

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

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



$f_4(2050)$ WIDTH

$f_4(2050)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	$\omega\omega$	not seen
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	$\gamma\gamma$	
Γ_7	$a_2(1320)\pi$	seen

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

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

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

$\Gamma(\omega\omega)/\Gamma_{\text{total}}$ Γ_1/Γ

VALUE	*DOCUMENT ID*		*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •			
not seen	BARBERIS	00F	450 $pp \rightarrow p_f\omega\omega p_s$

$\Gamma(\omega\omega)/\Gamma(\pi\pi)$ 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	[17] BINON	83C	GAM2	38 $\pi^- p \rightarrow n4\gamma$
0.16 ±0.03	[17] CASON	82	STRC	8 $\pi^+ p \rightarrow \Delta^{++}\pi^0\pi^0$
0.17 ±0.02	[17] CORDEN	79	OMEG	12–15 $\pi^- p \rightarrow n2\pi$

[17] 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 $\pi^- p \to n 4\gamma$

$\Gamma(4\pi^0)/\Gamma_{total}$ Γ_5/Γ

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

$\Gamma(a_2(1320)\pi)/\Gamma_{total}$ Γ_7/Γ

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
seen	AMELIN	00	VES	37 $\pi^- p \to \eta\pi^+\pi^- n$

$f_4(2050)$ REFERENCES

AMELIN	00	NP B668 83	D. Amelin *et al.*	(VES Collab.)
ANISOVICH	00J	PL B491 47	A.V. Anisovich *et al.*	
BARBERIS	00F	PL B484 198	D. Barberis *et al.*	(WA 102 Collab.)
ALDE	98	EPJ A3 361	D. Alde *et al.*	(GAM4 Collab.)
Also	99	PAN 62 405	D. Alde *et al.*	(GAMS Collab.)
MARTIN	98	PR C57 3492	B.R. Martin *et al.*	
MARTIN	97	PR C56 1114	B.R. Martin, G.C. Oades	(LOUC, AARH)
KLOET	96	PR D53 6120	W.M. Kloet, F. Myhrer	(RUTG, NORD)
OAKDEN	94	NPA 574 731	M.N. Oakden, M.R. Pennington	(DURH)
BELADIDZE	92B	ZPHY C54 367	G.M. Beladidze *et al.*	(VES Collab.)
ALDE	90	PL B241 600	D.M. Alde *et al.*	(SERP, BELG, LANL, LAPP+)
OEST	90	ZPHY C47 343	T. Oest *et al.*	(JADE Collab.)
ALDE	87	PL B198 286	D.M. Alde *et al.*	(LANL, BRUX, SERP, LAPP)
AUGUSTIN	87	ZPHY C36 369	J.E. Augustin *et al.*	(LALO, CLER, FRAS+)
BALTRUSAIT...	87	PR D35 2077	R.M. Baltrusaitis *et al.*	(Mark III Collab.)
ALDE	86D	NP B269 485	D.M. Alde *et al.*	(BELG, LAPP, SERP, CERN+)
ALTHOFF	85B	ZPHY C29 189	M. Althoff *et al.*	(TASSO Collab.)
BINON	84B	LNC 39 41	F.G. Binon *et al.*	(SERP, BELG, LAPP)
BINON	83C	SJNP 38 723 Translated from YAF 38 1199.	F.G. Binon *et al.*	(SERP, BRUX+)
DENNEY	83	PR D28 2726	D.L. Denney *et al.*	(IOWA, MICH)
CASON	82	PRL 48 1316	N.M. Cason *et al.*	(NDAM, ANL)
ETKIN	82B	PR D25 1786	A. Etkin *et al.*	(BNL, CUNY, TUFTS, VAND)
ALPER	80	PL 94B 422	B. Alper *et al.*	(AMST, CERN, CRAC, MPIM+)
ROZANSKA	80	NP B162 505	M. Rozanska *et al.*	(MPIM, CERN)
CORDEN	79	NP B157 250	M.J. Corden *et al.*	(BIRM, RHEL, TELA+) JP
EVANGELISTA	79B	NP B154 381	C. Evangelista *et al.*	(BARI, BONN, CERN+)
ANTIPOV	77	NP B119 45	Y.M. Antipov *et al.*	(SERP, GEVA)
APEL	75	PL 57B 398	W.D. Apel *et al.*	(KARLK, KARLE, PISA, SERP+) JP
BLUM	75	PL 57B 403	W. Blum *et al.*	(CERN, MPIM) JP

OTHER RELATED PAPERS

ANISOVICH	99D	PL B452 180	A.V. Anisovich *et al.*	
Also	99F	NP A651 253	A.V. Anisovich *et al.*	
ANISOVICH	99F	NP A651 253	A.V. Anisovich *et al.*	
PROKOSHKIN	97	SPD 42 117 Translated from DANS 353 323.	Y.D. Prokoshkin *et al.*	(SERP)
CASON	83	PR D28 1586	N.M. Cason *et al.*	(NDAM, ANL)
GOTTESMAN	80	PR D22 1503	S.R. Gottesman *et al.*	(SYRA, BRAN, BNL+)
EISENHAND...	75	NP B96 109	E. Eisenhandler *et al.*	(LOQM, LIVP, DARE+)
WAGNER	74	London Conf. 2 27	F. Wagner	(MPIM)