

$f_2(1950)$ 

$$I^G(J^{PC}) = 0^+(2^{++})$$

## $f_2(1950)$ T-MATRIX POLE $\sqrt{s}$

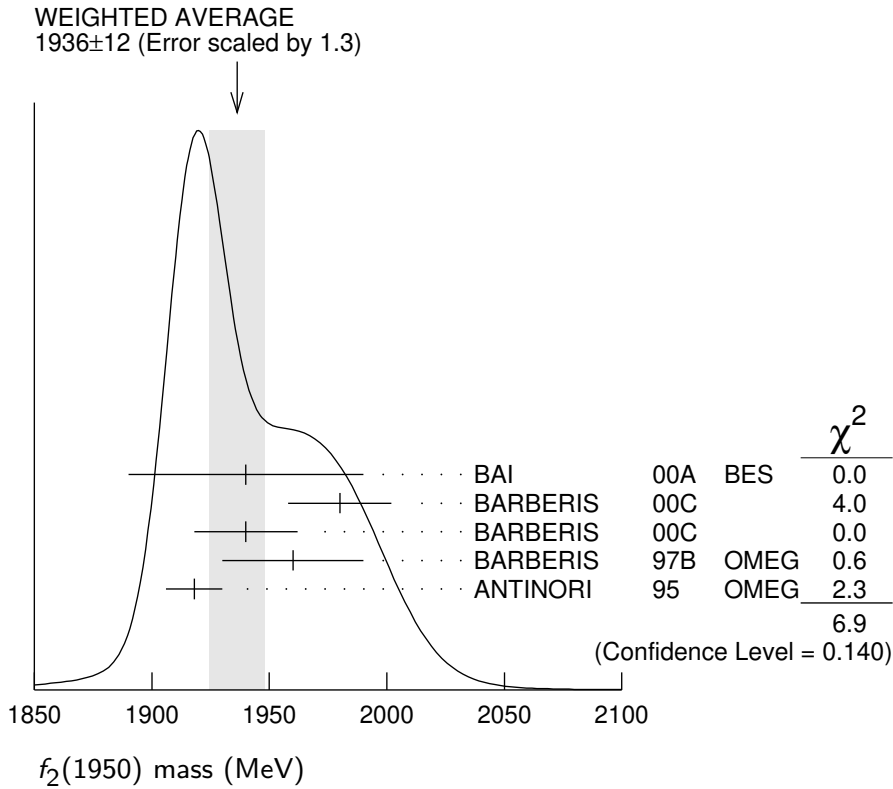
Note that  $\Gamma = -2 \text{Im}(\sqrt{s})$ .

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
<b>(1830–2020) – <math>i</math> (110–220) OUR ESTIMATE</b>			
$(2069.9 \pm 22.2 \pm 17.6)$ – $i$ $(130.0 \pm 26.0 \pm 19.3)$	ABLIKIM	25CD BES3	$e^+e^- \rightarrow \psi(2S)$
$(1955 \pm 75)$ – $i$ $(175 \pm 57)$	<sup>1</sup> RODAS	22 RVUE	$J/\psi(1S) \rightarrow \gamma(\pi\pi, K\bar{K})$
$(1978.2 \pm 1.8^{+28.4}_{-16.9})$ – $i$ $(118.8 \pm 0.8^{+20.8}_{-7.8})$	<sup>2</sup> ALBRECHT	20 RVUE	$0.9 \bar{p}p \rightarrow \pi^0\pi^0\eta, \pi^0\eta\eta,$ $\pi^0K^+K^-$
$(1867 \pm 46)$ – $i$ $(193 \pm 29)$	AMSLER	02 CBAR	$0.9 \bar{p}p \rightarrow \pi^0\eta\eta, \pi^0\pi^0\pi^0$
<sup>1</sup> T-matrix pole from coupled channel K-matrix fit to data on $J/\psi \rightarrow \gamma\pi^0\pi^0$ (ABLIKIM 15AE) and $J/\psi \rightarrow \gamma K_S^0 K_S^0$ (ABLIKIM 18AA).			
<sup>2</sup> T-matrix pole, 4 poles, 4 channels, including scattering data from HYAMS 75 ( $\pi\pi$ ), LONGACRE 86 ( $K\bar{K}$ ), BINON 83 ( $\eta\eta$ ).			

## $f_2(1950)$ MASS

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
<b>1936 ± 12 OUR AVERAGE</b> Error includes scale factor of 1.3. See the ideogram below.			
1940 ± 50	BAI	00A BES	$J/\psi \rightarrow \gamma(\pi^+\pi^-\pi^+\pi^-)$
1980 ± 22	<sup>1</sup> BARBERIS	00C	450 $pp \rightarrow pp4\pi$
1940 ± 22	<sup>2</sup> BARBERIS	00C	450 $pp \rightarrow pp2\pi2\pi^0$
1960 ± 30	BARBERIS	97B OMEG	450 $pp \rightarrow pp2(\pi^+\pi^-)$
1918 ± 12	ANTINORI	95 OMEG	300,450 $pp \rightarrow pp2(\pi^+\pi^-)$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
$2038^{+13+12}_{-11-73}$	<sup>3</sup> UEHARA	09 BELL	10.6 $e^+e^- \rightarrow e^+e^-\pi^0\pi^0$
1930 ± 25	<sup>4</sup> BINON	05 GAMS	33 $\pi^-p \rightarrow \eta\eta n$
1980 ± 2 ± 14	ABE	04 BELL	10.6 $e^+e^- \rightarrow e^+e^-K^+K^-$
2010 ± 25	ANISOVICH	00J SPEC	
1980 ± 50	ANISOVICH	99B SPEC	1.35–1.94 $p\bar{p} \rightarrow \eta\eta\pi^0$
~ 1990	<sup>5</sup> OAKDEN	94 RVUE	0.36–1.55 $\bar{p}p \rightarrow \pi\pi$
1950 ± 15	<sup>6</sup> ASTON	91 LASS	11 $K^-p \rightarrow \Lambda K\bar{K}\pi\pi$

<sup>1</sup> Decaying into  $\pi^+\pi^-2\pi^0$ .<sup>2</sup> Decaying into  $2(\pi^+\pi^-)$ .<sup>3</sup> Taking into account  $f_4(2050)$ .<sup>4</sup> First solution, PWA is ambiguous.<sup>5</sup> From solution B of amplitude analysis of data on  $\bar{p}p \rightarrow \pi\pi$ . See however KLOET 96 who fit  $\pi^+\pi^-$  only and find waves only up to  $J = 3$  to be important but not significantly resonant.<sup>6</sup> Cannot determine spin to be 2.



### $f_2(1950)$ WIDTH

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
<b><math>464 \pm 24</math> OUR AVERAGE</b>			
$380^{+120}_{-90}$	BAI	00A	BES $J/\psi \rightarrow \gamma(\pi^+\pi^-\pi^+\pi^-)$
$520 \pm 50$	<sup>1</sup> BARBERIS	00C	450 $pp \rightarrow pp4\pi$
$485 \pm 55$	<sup>2</sup> BARBERIS	00C	450 $pp \rightarrow pp4\pi$
$460 \pm 40$	BARBERIS	97B	OMEG 450 $pp \rightarrow pp2(\pi^+\pi^-)$
$390 \pm 60$	ANTINORI	95	OMEG 300,450 $pp \rightarrow pp2(\pi^+\pi^-)$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
$441^{+27+28}_{-25-192}$	<sup>3</sup> UEHARA	09	BELL 10.6 $e^+e^- \rightarrow e^+e^-\pi^0\pi^0$
$450 \pm 50$	<sup>4</sup> BINON	05	GAMS 33 $\pi^-p \rightarrow \eta\eta n$
$297 \pm 12 \pm 6$	ABE	04	BELL 10.6 $e^+e^- \rightarrow e^+e^-K^+K^-$
$495 \pm 35$	ANISOVICH	00J	SPEC
$500 \pm 100$	ANISOVICH	99B	SPEC 1.35–1.94 $p\bar{p} \rightarrow \eta\eta\pi^0$
$\sim 100$	<sup>5</sup> OAKDEN	94	RVUE 0.36–1.55 $\bar{p}p \rightarrow \pi\pi$
$250 \pm 50$	<sup>6</sup> ASTON	91	LASS 11 $K^-p \rightarrow \Lambda K\bar{K}\pi\pi$

<sup>1</sup> Decaying into  $\pi^+\pi^-2\pi^0$ .

<sup>2</sup> Decaying into  $2(\pi^+\pi^-)$ .

<sup>3</sup> Taking into account  $f_4(2050)$ .

<sup>4</sup> First solution, PWA is ambiguous.

<sup>5</sup> From solution B of amplitude analysis of data on  $\bar{p}p \rightarrow \pi\pi$ . See however KLOET 96 who fit  $\pi^+\pi^-$  only and find waves only up to  $J = 3$  to be important but not significantly resonant.

<sup>6</sup> Cannot determine spin to be 2.

## $f_2(1950)$ DECAY MODES

	Mode	Fraction ( $\Gamma_i/\Gamma$ )
$\Gamma_1$	$K^*(892)\bar{K}^*(892)$	seen
$\Gamma_2$	$\pi\pi$	
$\Gamma_3$	$\pi^+\pi^-$	seen
$\Gamma_4$	$\pi^0\pi^0$	seen
$\Gamma_5$	$4\pi$	seen
$\Gamma_6$	$\pi^+\pi^-\pi^+\pi^-$	
$\Gamma_7$	$a_2(1320)\pi$	
$\Gamma_8$	$\eta\eta$	seen
$\Gamma_9$	$K\bar{K}$	seen
$\Gamma_{10}$	$\gamma\gamma$	seen
$\Gamma_{11}$	$\gamma\phi$	seen
$\Gamma_{12}$	$\rho\bar{\rho}$	seen

## $f_2(1950)$ $\Gamma(i)\Gamma(\gamma\gamma)/\Gamma(\text{total})$

$\Gamma(K\bar{K}) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$   $\Gamma_9\Gamma_{10}/\Gamma$

VALUE (eV)      DOCUMENT ID      TECN      COMMENT

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

$122 \pm 4 \pm 26$       <sup>1</sup> ABE      04      BELL       $10.6 e^+e^- \rightarrow e^+e^-K^+K^-$

<sup>1</sup> Assuming spin 2.

$\Gamma(\pi\pi) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$   $\Gamma_2\Gamma_{10}/\Gamma$

VALUE      DOCUMENT ID      TECN      COMMENT

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

$162^{+69+1137}_{-42-204}$       <sup>1</sup> UEHARA      09      BELL       $10.6 e^+e^- \rightarrow e^+e^-\pi^0\pi^0$

<sup>1</sup> Taking into account  $f_4(2050)$ .

## $f_2(1950)$ BRANCHING RATIOS

$\Gamma(K^*(892)\bar{K}^*(892))/\Gamma_{\text{total}}$   $\Gamma_1/\Gamma$

VALUE      DOCUMENT ID      TECN      CHG      COMMENT

seen      ASTON      91      LASS      0       $11 K^-p \rightarrow \Lambda K\bar{K}\pi\pi$

$\Gamma(a_2(1320)\pi)/\Gamma_{\text{total}}$   $\Gamma_7/\Gamma$

VALUE      DOCUMENT ID      TECN      COMMENT

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

not seen      BARBERIS      00B      450  $pp \rightarrow p_f \eta \pi^+ \pi^- p_s$

not seen      BARBERIS      00C      450  $pp \rightarrow p_f 4\pi p_s$

possibly seen      BARBERIS      97B      OMEG      450  $pp \rightarrow p\rho 2(\pi^+\pi^-)$

$\Gamma(\eta\eta)/\Gamma(4\pi)$

$\Gamma_8/\Gamma_5$

VALUE	CL%	DOCUMENT ID	COMMENT
$<5.0 \times 10^{-3}$	90	BARBERIS 00E	450 $pp \rightarrow p_f \eta \eta p_s$

$\Gamma(\eta\eta)/\Gamma(\pi^+\pi^-)$

$\Gamma_8/\Gamma_3$

VALUE	DOCUMENT ID	TECN	COMMENT
<b>0.14 ± 0.05</b>	AMSLER 02	CBAR	0.9 $\bar{p}p \rightarrow \pi^0 \eta \eta, \pi^0 \pi^0 \pi^0$

$\Gamma(\gamma\phi)/\Gamma_{\text{total}}$

$\Gamma_{11}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
<b>seen</b>	<sup>1</sup> ABLIKIM	25P	BES3 $J/\psi \rightarrow \gamma\gamma\phi$

<sup>1</sup> From a partial wave analysis of  $J/\psi \rightarrow \gamma\gamma\phi$  with significance  $13.1\sigma$ .

$\Gamma(p\bar{p})/\Gamma_{\text{total}}$

$\Gamma_{12}/\Gamma$

VALUE	EVTs	DOCUMENT ID	TECN	COMMENT
<b>seen</b>	111	ALEXANDER 10	CLEO	$\psi(2S) \rightarrow \gamma p \bar{p}$

**$f_2(1950)$  REFERENCES**

ABLIKIM 25CD	JHEP 2510 081	M. Ablikim <i>et al.</i>	(BESIII Collab.)
ABLIKIM 25P	PR D111 052011	M. Ablikim <i>et al.</i>	(BESIII Collab.)
RODAS 22	EPJ C82 80	A. Rodas <i>et al.</i>	(JPAC Collab.)
ALBRECHT 20	EPJ C80 453	M. Albrecht <i>et al.</i>	(Crystal Barrel Collab.)
ABLIKIM 18AA	PR D98 072003	M. Ablikim <i>et al.</i>	(BESIII Collab.)
ABLIKIM 15AE	PR D92 052003	M. Ablikim <i>et al.</i>	(BESIII Collab.)
ALEXANDER 10	PR D82 092002	J.P. Alexander <i>et al.</i>	(CLEO Collab.)
UEHARA 09	PR D79 052009	S. Uehara <i>et al.</i>	(BELLE Collab.)
BINON 05	PAN 68 960	F. Binon <i>et al.</i>	
	Translated from YAF 68 998.		
ABE 04	EPJ C32 323	K. Abe <i>et al.</i>	(BELLE Collab.)
AMSLER 02	EPJ C23 29	C. Amsler <i>et al.</i>	(Crystal Barrel Collab.)
ANISOVICH 00J	PL B491 47	A.V. Anisovich <i>et al.</i>	(RAL, LOQM, PNPI+)
BAI 00A	PL B472 207	J.Z. Bai <i>et al.</i>	(BES Collab.)
BARBERIS 00B	PL B471 435	D. Barberis <i>et al.</i>	(WA 102 Collab.)
BARBERIS 00C	PL B471 440	D. Barberis <i>et al.</i>	(WA 102 Collab.)
BARBERIS 00E	PL B479 59	D. Barberis <i>et al.</i>	(WA 102 Collab.)
ANISOVICH 99B	PL B449 154	A.V. Anisovich <i>et al.</i>	
BARBERIS 97B	PL B413 217	D. Barberis <i>et al.</i>	(WA 102 Collab.)
KLOET 96	PR D53 6120	W.M. Kloet, F. Myhrer	(RUTG, NORD)
ANTINORI 95	PL B353 589	F. Antinori <i>et al.</i>	(ATHU, BARI, BIRM+) JP
OAKDEN 94	NP A574 731	M.N. Oakden, M.R. Pennington	(DURH)
ASTON 91	NPBPS B21 5	D. Aston <i>et al.</i>	(LASS Collab.)
LONGACRE 86	PL B177 223	R.S. Longacre <i>et al.</i>	(BNL, BRAN, CUNY+)
BINON 83	NC 78A 313	F.G. Binon <i>et al.</i>	(BELG, LAPP, SERP+)
HYAMS 75	NP B100 205	B.D. Hyams <i>et al.</i>	(CERN, MPIM)