

# $f_0(1500)$

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

See the review on "Spectroscopy of Light Meson Resonances."

## $f_0(1500)$ T-MATRIX POLE $\sqrt{s}$

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

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
<b>(1430–1530) – <math>i</math> (40–90) OUR ESTIMATE</b>			
$(1450 \pm 10) - i (53 \pm 8)$	<sup>1</sup> RODAS	22	RVUE $J/\psi(1S) \rightarrow \gamma (\pi\pi, K\bar{K})$
$(1483 \pm 15) - i (58 \pm 6)$	SARANTSEV	21	RVUE $J/\psi(1S) \rightarrow \gamma (\pi\pi, K\bar{K}, \eta\eta, \omega\phi)$
$(1496 \pm 1.2_{-26.4}^{+4.4}) - i (40.4 \pm 0.3_{-2.5}^{+10.0})$	<sup>2</sup> ALBRECHT	20	RVUE $0.9 \bar{p}p \rightarrow \pi^0\pi^0\eta, \pi^0\eta\eta, \pi^0K^+K^-$
$(1465 \pm 18) - i (50 \pm 9)$	<sup>3</sup> ROPERTZ	18	RVUE $\bar{B}_S^0 \rightarrow J/\psi(\pi^+\pi^-/K^+K^-)$
$(1486 \pm 10) - i (57 \pm 5)$	ANISOVICH	09	RVUE $0.0 \bar{p}p, \pi N$
$(1489_{-4}^{+8}) - i (51 \pm 5)$	<sup>4</sup> ANISOVICH	03	RVUE
$(1515 \pm 12) - i (55 \pm 12)$	BARBERIS	00A	$450 \bar{p}p \rightarrow p_f(\eta\eta', \eta'\eta')p_S$
$(1511 \pm 9) - i (51 \pm 9)$	<sup>5</sup> BARBERIS	00C	$450 \bar{p}p \rightarrow p_f 4\pi p_S$
$(1510 \pm 8) - i (55 \pm 8)$	BARBERIS	00E	$450 \bar{p}p \rightarrow p_f \eta\eta p_S$
$(1502 \pm 12 \pm 10) - i (49 \pm 9 \pm 8)$	<sup>6</sup> BARBERIS	99D	OMEG $450 \bar{p}p \rightarrow K^+K^-, \pi^+\pi^-$
$(1447 \pm 27) - i (54 \pm 23)$	<sup>7</sup> KAMINSKI	99	RVUE $\pi\pi \rightarrow \pi\pi, K\bar{K}, \sigma\sigma$
$(1499 \pm 8) - i (65 \pm 10)$	ANISOVICH	98B	RVUE Compilation.
$(1510 \pm 20) - i (60 \pm 18)$	BARBERIS	97B	OMEG $450 \bar{p}p \rightarrow p p 2(\pi^+\pi^-)$
$(1449 \pm 20) - i (57 \pm 15)$	BERTIN	97C	OBLX $0.0 \bar{p}p \rightarrow \pi^+\pi^-\pi^0$
$(1515 \pm 20) - i (53 \pm 8)$	ABELE	96B	CBAR $0.0 \bar{p}p \rightarrow \pi^0 K_L^0 K_L^0$
$(1500 \pm 8) - i (66 \pm 8)$	ABELE	96C	RVUE Compilation.
$(1500 \pm 10) - i (77 \pm 15)$	<sup>8</sup> AMSLER	95D	CBAR $0.0 \bar{p}p \rightarrow \pi^0\pi^0\pi^0, \pi^0\eta\eta, \pi^0\pi^0\eta$
$(1520 \pm 25) - i (74_{-13}^{+10})$	<sup>9</sup> ANISOVICH	94	CBAR $0.0 \bar{p}p \rightarrow 3\pi^0, \pi^0\eta\eta$
$(1505 \pm 20) - i (75 \pm 10)$	<sup>10</sup> BUGG	94	RVUE $\bar{p}p \rightarrow 3\pi^0, \eta\eta\pi^0, \eta\pi^0\pi^0$

<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, 5 poles, 5 channels, including scattering data from HYAMS 75 ( $\pi\pi$ ), LONGACRE 86 ( $K\bar{K}$ ), BINON 83 ( $\eta\eta$ ), and BINON 84C ( $\eta\eta'$ ).

<sup>3</sup> T-matrix pole of 3 channel unitary model fit to data from AAIJ 14BR and AAIJ 17V extracted using Pade approximants.

<sup>4</sup> Pole position from combined analysis of  $\pi^-\pi^0 n, \pi^-\pi^0 n, \pi^+\pi^-\pi^0, \pi^+\pi^-\pi^0, \pi^0\eta\eta, \pi^0\pi^0\eta, \pi^+\pi^-\pi^0, K^+K^-\pi^0, K_S^0 K_S^0 \pi^0, K^+K_S^0 \pi^-$  at rest,  $\bar{p}n \rightarrow \pi^-\pi^-\pi^+, K_S^0 K^-\pi^0, K_S^0 K_S^0 \pi^-$  at rest.

<sup>5</sup> Average between  $\pi^+\pi^-\pi^0$  and  $2(\pi^+\pi^-)$ .

<sup>6</sup> Supersedes BARBERIS 99 and BARBERIS 99B.

<sup>7</sup> T-matrix pole on sheet  $--+$ .

<sup>8</sup> Coupled-channel analysis of AMSLER 95B, AMSLER 95C, and AMSLER 94D.

<sup>9</sup> From a simultaneous analysis of the annihilations  $\bar{p}p \rightarrow 3\pi^0, \pi^0\eta\eta$ .

<sup>10</sup> Reanalysis of ANISOVICH 94 data.

### $f_0(1500)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
<b>1522 ± 25</b>		<sup>1</sup> BERTIN	98 OBLX	0.05–0.405 $\bar{p}p \rightarrow \pi^+\pi^+\pi^-$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
1492.5 ± 3.6 <sup>+</sup> <sub>–20.5</sub>		<sup>2</sup> ABLIKIM	22G BES3	$J/\psi \rightarrow \gamma\pi^+\pi^-\eta'$
1447 ± 16 ± 13	163	<sup>3,4</sup> DOBBS	15	$J/\psi \rightarrow \gamma\pi^+\pi^-$
1442 ± 9 ± 4	261	<sup>3,4</sup> DOBBS	15	$\psi(2S) \rightarrow \gamma\pi^+\pi^-$
1460.9 ± 2.9		<sup>5</sup> AAIJ	14BR LHCb	$\bar{B}_s^0 \rightarrow J/\psi\pi^+\pi^-$
1468 <sup>+</sup> <sub>–15</sub> + 23 <sup>+</sup> <sub>–74</sub>	5.5k	<sup>6</sup> ABLIKIM	13N BES3	$e^+e^- \rightarrow J/\psi \rightarrow \gamma\eta\eta$
1470 ± 60	568	<sup>7</sup> KLEMP	08 E791	$D_s^+ \rightarrow \pi^-\pi^+\pi^+$
1470 <sup>+</sup> <sub>–7</sub> + 72 <sup>+</sup> <sub>–255</sub>		<sup>8</sup> UEHARA	08A BELL	10.6 $e^+e^- \rightarrow e^+e^-\pi^0\pi^0$
1466 ± 6 ± 20		<sup>9</sup> ABLIKIM	06V BES2	$e^+e^- \rightarrow J/\psi \rightarrow \gamma\pi^+\pi^-$
1495 ± 4		AMSLER	06 CBAR	0.9 $\bar{p}p \rightarrow K^+K^-\pi^0$
1539 ± 20	9.9k	AUBERT	06O BABR	$B^+ \rightarrow K^+K^+K^-$
1473 ± 5	80k	<sup>9,10</sup> UMAN	06 E835	5.2 $\bar{p}p \rightarrow \eta\eta\pi^0$
1478 ± 6		VLADIMIRSK...	06 SPEC	40 $\pi^-p \rightarrow K_S^0K_S^0n$
1493 ± 7		<sup>9</sup> BINON	05 GAMS	33 $\pi^-p \rightarrow \eta\eta n$
1524 ± 14	1400	<sup>11</sup> GARMASH	05 BELL	$B^+ \rightarrow K^+K^+K^-$
1490 ± 30		<sup>9</sup> ABELE	01 CBAR	0.0 $\bar{p}d \rightarrow \pi^-4\pi^0p$
1497 ± 10		<sup>9</sup> BARBERIS	99 OMEG	450 $pp \rightarrow p_S p_f K^+K^-$
1502 ± 10		<sup>9</sup> BARBERIS	99B OMEG	450 $pp \rightarrow p_S p_f \pi^+\pi^-$
1530 ± 45		<sup>9</sup> BELLAZZINI	99 GAM4	450 $pp \rightarrow pp\pi^0\pi^0$
1505 ± 18		<sup>9</sup> FRENCH	99	300 $pp \rightarrow p_f(K^+K^-)p_S$
1580 ± 80		<sup>9</sup> ALDE	98 GAM4	100 $\pi^-p \rightarrow \pi^0\pi^0n$
~ 1520		REYES	98 SPEC	800 $pp \rightarrow p_S p_f K_S^0K_S^0$
~ 1475		FRABETTI	97D E687	$D_s^\pm \rightarrow \pi^\mp \pi^\pm \pi^\pm$
~ 1505		ABELE	96 CBAR	0.0 $\bar{p}p \rightarrow 5\pi^0$
1460 ± 20	120	<sup>9</sup> AMELIN	96B VES	37 $\pi^-A \rightarrow \eta\eta\pi^-A$
1500 ± 8		BUGG	96 RVUE	
1500 ± 15		<sup>12</sup> AMSLER	95B CBAR	0.0 $\bar{p}p \rightarrow 3\pi^0$
1505 ± 15		<sup>13</sup> AMSLER	95C CBAR	0.0 $\bar{p}p \rightarrow \eta\eta\pi^0$
1445 ± 5		<sup>14</sup> ANTINORI	95 OMEG	300,450 $pp \rightarrow pp2(\pi^+\pi^-)$
1497 ± 30		<sup>9</sup> ANTINORI	95 OMEG	300,450 $pp \rightarrow pp\pi^+\pi^-$
~ 1505		BUGG	95 MRK3	$J/\psi \rightarrow \gamma\pi^+\pi^-\pi^+\pi^-$

1446 ± 5		<sup>9</sup> ABATZIS	94	OMEG 450	$pp \rightarrow pp2(\pi^+ \pi^-)$
1545 ± 25		<sup>9</sup> AMSLER	94E	CBAR 0.0	$\bar{p}p \rightarrow \pi^0 \eta \eta'$
1560 ± 25		<sup>9</sup> AMSLER	92	CBAR 0.0	$\bar{p}p \rightarrow \pi^0 \eta \eta$
1550 ± 45 ± 30		<sup>9</sup> BELADIDZE	92C	VES 36	$\pi^- \text{Be} \rightarrow \pi^- \eta' \eta \text{Be}$
1449 ± 4		<sup>9</sup> ARMSTRONG	89E	OMEG 300	$pp \rightarrow pp2(\pi^+ \pi^-)$
1610 ± 20		<sup>9</sup> ALDE	88	GAM4 300	$\pi^- N \rightarrow \pi^- N 2\eta$
~ 1525		ASTON	88D	LASS 11	$K^- p \rightarrow K_S^0 K_S^0 \Lambda$
1570 ± 20	600	<sup>9</sup> ALDE	87	GAM4 100	$\pi^- p \rightarrow 4\pi^0 n$
1575 ± 45		<sup>15</sup> ALDE	86D	GAM4 100	$\pi^- p \rightarrow 2\eta n$
1568 ± 33		<sup>9</sup> BINON	84C	GAM2 38	$\pi^- p \rightarrow \eta \eta' n$
1592 ± 25		<sup>9</sup> BINON	83	GAM2 38	$\pi^- p \rightarrow 2\eta n$
1525 ± 5		<sup>9</sup> GRAY	83	DBC 0.0	$\bar{p}N \rightarrow 3\pi$

<sup>1</sup> Breit-Wigner mass.

<sup>2</sup> The  $\pi^+ \pi^-$  mass spectrum is described by a coherent sum of two Breit-Wigner resonances,  $f_0(1500)$  and a new  $X(1540)$  with mass  $1540.2 \pm 7.0^{+36.3}_{-6.1}$  MeV and width  $157 \pm 19^{+11}_{-77}$  MeV.

<sup>3</sup> Using CLEO-c data but not authored by the CLEO Collaboration.

<sup>4</sup> From a fit to a Breit-Wigner line shape with fixed  $\Gamma = 109$  MeV.

<sup>5</sup> Solution I, statistical error only.

<sup>6</sup> From partial wave analysis including all possible combinations of  $0^{++}$ ,  $2^{++}$ , and  $4^{++}$  resonances.

<sup>7</sup> Reanalysis of AITALA 01A data. This state could also be  $f_0(1370)$ .

<sup>8</sup> Breit-Wigner mass. May also be the  $f_0(1370)$ .

<sup>9</sup> Breit-Wigner mass.

<sup>10</sup> Statistical error only.

<sup>11</sup> Breit-Wigner, solution 1, PWA ambiguous.

<sup>12</sup> T-matrix pole, supersedes ANISOVICH 94.

<sup>13</sup> T-matrix pole, supersedes ANISOVICH 94 and AMSLER 92.

<sup>14</sup> Supersedes ABATZIS 94, ARMSTRONG 89E. Breit-Wigner mass.

<sup>15</sup> From central value and spread of two solutions. Breit-Wigner mass.

### $f_0(1500)$ WIDTH

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
<b>108 ± 33</b>		<sup>1</sup> BERTIN	98	OBLX 0.05–0.405 $\bar{p}p \rightarrow \pi^+ \pi^+ \pi^-$
• • •		We do not use the following data for averages, fits, limits, etc. • • •		
107 ± $9^{+21}_{-7}$		<sup>2</sup> ABLIKIM	22G	BES3 $J/\psi \rightarrow \gamma \pi^+ \pi^- \eta'$
124 ± 7		<sup>3</sup> AAIJ	14BR	LHCB $\bar{B}_s^0 \rightarrow J/\psi \pi^+ \pi^-$
$136^{+41+28}_{-26-100}$	5.5k	<sup>4</sup> ABLIKIM	13N	BES3 $e^+ e^- \rightarrow J/\psi \rightarrow \gamma \eta \eta$
$90^{+2+50}_{-1-22}$		<sup>5</sup> UEHARA	08A	BELL $10.6 e^+ e^- \rightarrow e^+ e^- \pi^0 \pi^0$
$108^{+14}_{-11} \pm 25$		<sup>6</sup> ABLIKIM	06V	BES2 $e^+ e^- \rightarrow J/\psi \rightarrow \gamma \pi^+ \pi^-$
121 ± 8		AMSLER	06	CBAR $0.9 \bar{p}p \rightarrow K^+ K^- \pi^0$
257 ± 33	9.9k	AUBERT	060	BABR $B^+ \rightarrow K^+ K^+ K^-$
108 ± 9	80k	<sup>6,7</sup> UMAN	06	E835 $5.2 \bar{p}p \rightarrow \eta \eta \pi^0$
119 ± 10		VLADIMIRSK...	06	SPEC 40 $\pi^- p \rightarrow K_S^0 K_S^0 n$

90 ± 15		<sup>6</sup> BINON	05	GAMS	33	$\pi^- p \rightarrow \eta \eta n$
136 ± 23	1400	<sup>8</sup> GARMASH	05	BELL		$B^+ \rightarrow K^+ K^+ K^-$
140 ± 40		<sup>6</sup> ABELE	01	CBAR	0.0	$\bar{p} d \rightarrow \pi^- 4\pi^0 p$
104 ± 25		<sup>6</sup> BARBERIS	99	OMEG	450	$pp \rightarrow p_s p_f K^+ K^-$
131 ± 15		<sup>6</sup> BARBERIS	99B	OMEG	450	$pp \rightarrow p_s p_f \pi^+ \pi^-$
160 ± 50		<sup>6</sup> BELLAZZINI	99	GAM4	450	$pp \rightarrow p p \pi^0 \pi^0$
100 ± 33		<sup>6</sup> FRENCH	99		300	$pp \rightarrow p_f (K^+ K^-) p_s$
280 ± 100		<sup>6</sup> ALDE	98	GAM4	100	$\pi^- p \rightarrow \pi^0 \pi^0 n$
~ 100		FRABETTI	97D	E687		$D_s^\pm \rightarrow \pi^\mp \pi^\pm \pi^\pm$
~ 169		ABELE	96	CBAR	0.0	$\bar{p} p \rightarrow 5\pi^0$
100 ± 30	120	<sup>6</sup> AMELIN	96B	VES	37	$\pi^- A \rightarrow \eta \eta \pi^- A$
132 ± 15		BUGG	96	RVUE		
120 ± 25		<sup>9</sup> AMSLER	95B	CBAR	0.0	$\bar{p} p \rightarrow 3\pi^0$
120 ± 30		<sup>10</sup> AMSLER	95C	CBAR	0.0	$\bar{p} p \rightarrow \eta \eta \pi^0$
65 ± 10		<sup>11</sup> ANTINORI	95	OMEG	300,450	$pp \rightarrow pp2(\pi^+ \pi^-)$
199 ± 30		<sup>6</sup> ANTINORI	95	OMEG	300,450	$pp \rightarrow pp\pi^+ \pi^-$
56 ± 12		<sup>6</sup> ABATZIS	94	OMEG	450	$pp \rightarrow pp2(\pi^+ \pi^-)$
100 ± 40		<sup>6</sup> AMSLER	94E	CBAR	0.0	$\bar{p} p \rightarrow \pi^0 \eta \eta'$
245 ± 50		<sup>6</sup> AMSLER	92	CBAR	0.0	$\bar{p} p \rightarrow \pi^0 \eta \eta$
153 ± 67 ± 50		<sup>6</sup> BELADIDZE	92C	VES	36	$\pi^- \text{Be} \rightarrow \pi^- \eta' \eta \text{Be}$
78 ± 18		<sup>6</sup> ARMSTRONG	89E	OMEG	300	$pp \rightarrow pp2(\pi^+ \pi^-)$
170 ± 40		<sup>6</sup> ALDE	88	GAM4	300	$\pi^- N \rightarrow \pi^- N 2\eta$
150 ± 20	600	<sup>6</sup> ALDE	87	GAM4	100	$\pi^- p \rightarrow 4\pi^0 n$
265 ± 65		<sup>12</sup> ALDE	86D	GAM4	100	$\pi^- p \rightarrow 2\eta n$
260 ± 60		<sup>6</sup> BINON	84C	GAM2	38	$\pi^- p \rightarrow \eta \eta' n$
210 ± 40		<sup>6</sup> BINON	83	GAM2	38	$\pi^- p \rightarrow 2\eta n$
101 ± 13		<sup>6</sup> GRAY	83	DBC	0.0	$\bar{p} N \rightarrow 3\pi$

<sup>1</sup> Breit-Wigner width.

<sup>2</sup> The  $\pi^+ \pi^-$  mass spectrum is described by a coherent sum of two Breit-Wigner resonances,  $f_0(1500)$  and a new  $X(1540)$  with mass  $1540.2 \pm 7.0^{+36.3}_{-6.1}$  MeV and width  $157 \pm 19^{+11}_{-77}$  MeV.

<sup>3</sup> Solution I, statistical error only.

<sup>4</sup> From partial wave analysis including all possible combinations of  $0^{++}$ ,  $2^{++}$ , and  $4^{++}$  resonances.

<sup>5</sup> Breit-Wigner width. May also be the  $f_0(1370)$ .

<sup>6</sup> Breit-Wigner width.

<sup>7</sup> Statistical error only.

<sup>8</sup> Breit-Wigner, solution 1, PWA ambiguous.

<sup>9</sup> T-matrix pole, supersedes ANISOVICH 94.

<sup>10</sup> T-matrix pole, supersedes ANISOVICH 94 and AMSLER 92.

<sup>11</sup> Supersedes ABATZIS 94, ARMSTRONG 89E. Breit-Wigner mass.

<sup>12</sup> From central value and spread of two solutions. Breit-Wigner mass.

### $f_0(1500)$ DECAY MODES

	Mode	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor
$\Gamma_1$	$\pi\pi$	$(34.5 \pm 2.2) \%$	1.2
$\Gamma_2$	$\pi^+\pi^-$	seen	
$\Gamma_3$	$2\pi^0$	seen	
$\Gamma_4$	$4\pi$	$(48.9 \pm 3.3) \%$	1.2
$\Gamma_5$	$4\pi^0$	seen	
$\Gamma_6$	$2\pi^+2\pi^-$	seen	
$\Gamma_7$	$2(\pi\pi)_{S\text{-wave}}$	seen	
$\Gamma_8$	$\rho\rho$	seen	
$\Gamma_9$	$\pi(1300)\pi$	seen	
$\Gamma_{10}$	$a_1(1260)\pi$	seen	
$\Gamma_{11}$	$\eta\eta$	$(6.0 \pm 0.9) \%$	1.1
$\Gamma_{12}$	$\eta\eta'(958)$	$(2.2 \pm 0.8) \%$	1.4
$\Gamma_{13}$	$K\bar{K}$	$(8.5 \pm 1.0) \%$	1.1
$\Gamma_{14}$	$\gamma\gamma$	not seen	

### CONSTRAINED FIT INFORMATION

An overall fit to 6 branching ratios uses 10 measurements and one constraint to determine 5 parameters. The overall fit has a  $\chi^2 = 5.6$  for 6 degrees of freedom.

The following *off-diagonal* array elements are the correlation coefficients  $\langle \delta x_i \delta x_j \rangle / (\delta x_i \delta x_j)$ , 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.

$x_4$	-88			
$x_{11}$	27	-56		
$x_{12}$	3	-32	26	
$x_{13}$	43	-64	20	2
	$x_1$	$x_4$	$x_{11}$	$x_{12}$

### $f_0(1500) \Gamma(i)\Gamma(\gamma\gamma)/\Gamma(\text{total})$

$\Gamma(\pi\pi) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$	CL%	DOCUMENT ID	TECN	COMMENT	$\Gamma_1\Gamma_{14}/\Gamma$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
$33^{+12}_{-6} + 1809_{-21}$		<sup>1</sup> UEHARA	08A BELL	$10.6 e^+e^- \rightarrow e^+e^-\pi^0\pi^0$	
not seen		ACCIARRI	01H L3	$\gamma\gamma \rightarrow K_S^0 K_S^0, E_{\text{cm}}^{ee} = 91, 183\text{--}209 \text{ GeV}$	
<460	95	BARATE	00E ALEP	$\gamma\gamma \rightarrow \pi^+\pi^-$	
<sup>1</sup> May also be the $f_0(1370)$ . Multiplied by us by 3 to obtain the $\pi\pi$ value.					

## $f_0(1500)$ BRANCHING RATIOS

### $\Gamma(\pi\pi)/\Gamma_{\text{total}}$ $\Gamma_1/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
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• • • We do not use the following data for averages, fits, limits, etc. • • •

0.454±0.104	BUGG	96	RVUE
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### $\Gamma(\pi^+\pi^-)/\Gamma_{\text{total}}$ $\Gamma_2/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
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**seen** BERTIN 98 OBLX 0.05–0.405  $\bar{p}p \rightarrow \pi^+\pi^+\pi^-$

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

possibly seen FRABETTI 97D E687  $D_S^\pm \rightarrow \pi^\mp \pi^\pm \pi^\pm$

### $\Gamma(4\pi)/\Gamma(\pi\pi)$ $\Gamma_4/\Gamma_1$

VALUE	DOCUMENT ID	TECN	COMMENT
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**1.42±0.18 OUR FIT** Error includes scale factor of 1.2.

**1.42±0.18 OUR AVERAGE** Error includes scale factor of 1.2.

1.37±0.16	BARBERIS	00D	450 $p\bar{p} \rightarrow p_f 4\pi p_S$
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2.1 ±0.6	1 AMSLER	98	RVUE
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• • • We do not use the following data for averages, fits, limits, etc. • • •

2.1 ±0.2	2 ANISOVICH	02D	SPEC Combined fit
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3.4 ±0.8	1 ABELE	96	CBAR 0.0 $\bar{p}p \rightarrow 5\pi^0$
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<sup>1</sup>Excluding  $\rho\rho$  contribution to  $4\pi$ .

<sup>2</sup>From a combined K-matrix analysis of Crystal Barrel (0.  $p\bar{p} \rightarrow \pi^0\pi^0\pi^0, \pi^0\eta\eta,$   
 $\pi^0\pi^0\eta$ ), GAMS ( $\pi p \rightarrow \pi^0\pi^0 n, \eta\eta n, \eta\eta' n$ ), and BNL ( $\pi p \rightarrow K\bar{K}n$ ) data.

### $\Gamma(2(\pi\pi)_{S\text{-wave}})/\Gamma(\pi\pi)$ $\Gamma_7/\Gamma_1$

VALUE	DOCUMENT ID	TECN	COMMENT
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• • • We do not use the following data for averages, fits, limits, etc. • • •

0.42±0.26	1 ABELE	01	CBAR 0.0 $\bar{p}d \rightarrow \pi^- 4\pi^0 p$
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<sup>1</sup>From the combined data of ABELE 96 and ABELE 96c.

### $\Gamma(2(\pi\pi)_{S\text{-wave}})/\Gamma(4\pi)$ $\Gamma_7/\Gamma_4$

VALUE	DOCUMENT ID	TECN	COMMENT
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• • • We do not use the following data for averages, fits, limits, etc. • • •

0.26±0.07	ABELE	01B	CBAR 0.0 $\bar{p}d \rightarrow 5\pi p$
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### $\Gamma(\rho\rho)/\Gamma(4\pi)$ $\Gamma_8/\Gamma_4$

VALUE	DOCUMENT ID	TECN	COMMENT
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• • • We do not use the following data for averages, fits, limits, etc. • • •

0.13±0.08	ABELE	01B	CBAR 0.0 $\bar{p}d \rightarrow 5\pi p$
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### $\Gamma(\rho\rho)/\Gamma(2(\pi\pi)_{S\text{-wave}})$ $\Gamma_8/\Gamma_7$

VALUE	DOCUMENT ID	COMMENT
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**2.87±0.34 OUR AVERAGE** Error includes scale factor of 1.1.

3.3 ±0.5	BARBERIS	00C	450 $p\bar{p} \rightarrow p_f \pi^+ \pi^- 2\pi^0 p_S$
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2.6 ±0.4	BARBERIS	00C	450 $p\bar{p} \rightarrow p_f 2(\pi^+ \pi^-) p_S$
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### $\Gamma(\pi(1300)\pi)/\Gamma(4\pi)$

$\Gamma_9/\Gamma_4$

VALUE	DOCUMENT ID	TECN	COMMENT
0.50±0.25	ABELE	01B	CBAR 0.0 $\bar{p}d \rightarrow 5\pi p$

### $\Gamma(a_1(1260)\pi)/\Gamma(4\pi)$

$\Gamma_{10}/\Gamma_4$

VALUE	DOCUMENT ID	TECN	COMMENT
0.12±0.05	ABELE	01B	CBAR 0.0 $\bar{p}d \rightarrow 5\pi p$

### $\Gamma(\eta\eta)/\Gamma_{\text{total}}$

$\Gamma_{11}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
large	ALDE	88	GAM4 300 $\pi^- N \rightarrow \eta\eta\pi^- N$
large	BINON	83	GAM2 38 $\pi^- p \rightarrow 2\eta n$

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

$\Gamma_{11}/\Gamma_1$

VALUE	DOCUMENT ID	TECN	COMMENT
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**0.173±0.024 OUR FIT** Error includes scale factor of 1.1.

**0.175±0.027 OUR AVERAGE**

0.18 ±0.03	BARBERIS	00E	450 $p p \rightarrow p_f \eta \eta p_s$
0.157±0.060	<sup>1</sup> AMSLER	95D	CBAR 0.0 $\bar{p}p \rightarrow \pi^0 \pi^0 \pi^0, \pi^0 \eta \eta, \pi^0 \pi^0 \eta$
0.080±0.033	AMSLER	02	CBAR 0.9 $\bar{p}p \rightarrow \pi^0 \eta \eta, \pi^0 \pi^0 \pi^0$
0.11 ±0.03	<sup>2</sup> ANISOVICH	02D	SPEC Combined fit
0.078±0.013	<sup>3</sup> ABELE	96C	RVUE Compilation
0.230±0.097	<sup>4</sup> AMSLER	95C	CBAR 0.0 $\bar{p}p \rightarrow \eta \eta \pi^0$

<sup>1</sup> Coupled-channel analysis of AMSLER 95B, AMSLER 95C, and AMSLER 94D.

<sup>2</sup> From a combined K-matrix analysis of Crystal Barrel (0.  $p\bar{p} \rightarrow \pi^0 \pi^0 \pi^0, \pi^0 \eta \eta, \pi^0 \pi^0 \eta$ ), GAMS ( $\pi p \rightarrow \pi^0 \pi^0 n, \eta \eta n, \eta \eta' n$ ), and BNL ( $\pi p \rightarrow K \bar{K} n$ ) data.

<sup>3</sup>  $2\pi$  width determined to be  $60 \pm 12$  MeV.

<sup>4</sup> Using AMSLER 95B ( $3\pi^0$ ).

### $\Gamma(4\pi^0)/\Gamma(\eta\eta)$

$\Gamma_5/\Gamma_{11}$

VALUE	DOCUMENT ID	TECN	COMMENT
0.8±0.3	ALDE	87	GAM4 100 $\pi^- p \rightarrow 4\pi^0 n$

### $\Gamma(\eta\eta'(958))/\Gamma(\pi\pi)$

$\Gamma_{12}/\Gamma_1$

VALUE (units $10^{-2}$ )	DOCUMENT ID	TECN	COMMENT
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**6.4±2.2 OUR FIT** Error includes scale factor of 1.4.

**9.5±2.6** BARBERIS 00A 450  $p p \rightarrow p_f \eta \eta p_s$

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

16.6 <sup>+4.2</sup> <sub>-4.0</sub>	<sup>1</sup> ABLIKIM	22AS	BES3 $J/\psi(1S) \rightarrow \gamma \eta \eta'$
0.5±0.3	<sup>2</sup> ANISOVICH	02D	SPEC Combined fit

<sup>1</sup> From a Breit-Wigner fit involving 9 resonances and a resonating exotic  $\eta_1(1855) \rightarrow \eta \eta'$  *P*-wave.

<sup>2</sup> From a combined K-matrix analysis of Crystal Barrel (0.  $p\bar{p} \rightarrow \pi^0 \pi^0 \pi^0, \pi^0 \eta \eta, \pi^0 \pi^0 \eta$ ), GAMS ( $\pi p \rightarrow \pi^0 \pi^0 n, \eta \eta n, \eta \eta' n$ ), and BNL ( $\pi p \rightarrow K \bar{K} n$ ) data.

### $\Gamma(\eta\eta'(958))/\Gamma(\eta\eta)$

$\Gamma_{12}/\Gamma_{11}$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.37±0.13 OUR FIT</b>	Error includes scale factor of 1.5.		
<b>0.29±0.10</b>	<sup>1</sup> AMSLER	95C	CBAR 0.0 $\bar{p}p \rightarrow \eta\eta\pi^0$
• • •	We do not use the following data for averages, fits, limits, etc. • • •		
0.05±0.03	<sup>2</sup> ANISOVICH	02D	SPEC Combined fit
0.84±0.23	ABELE	96C	RVUE Compilation
2.7 ±0.8	BINON	84C	GAM2 38 $\pi^- p \rightarrow \eta\eta' n$

<sup>1</sup> Using AMSLER 94E ( $\eta\eta'\pi^0$ ).

<sup>2</sup> From a combined K-matrix analysis of Crystal Barrel (0.  $p\bar{p} \rightarrow \pi^0\pi^0\pi^0$ ,  $\pi^0\eta\eta$ ,  $\pi^0\pi^0\eta$ ), GAMS ( $\pi p \rightarrow \pi^0\pi^0 n$ ,  $\eta\eta n$ ,  $\eta\eta' n$ ), and BNL ( $\pi p \rightarrow K\bar{K}n$ ) data.

### $\Gamma(K\bar{K})/\Gamma_{total}$

$\Gamma_{13}/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
• • •	We do not use the following data for averages, fits, limits, etc. • • •		
0.044±0.021	BUGG	96	RVUE

### $\Gamma(K\bar{K})/\Gamma(\pi\pi)$

$\Gamma_{13}/\Gamma_1$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.246±0.025 OUR FIT</b>			
<b>0.236±0.026 OUR AVERAGE</b>			
0.25 ±0.03	<sup>1</sup> BARGIOTTI	03	OBLX $\bar{p}p$
0.19 ±0.07	<sup>2</sup> ABELE	98	CBAR 0.0 $\bar{p}p \rightarrow K_L^0 K^\pm \pi^\mp$
0.20 ±0.08	<sup>3</sup> ABELE	96B	CBAR 0.0 $\bar{p}p \rightarrow \pi^0 K_L^0 K_L^0$
• • •	We do not use the following data for averages, fits, limits, etc. • • •		
0.16 ±0.05	<sup>4</sup> ANISOVICH	02D	SPEC Combined fit
0.33 ±0.03 ±0.07	BARBERIS	99D	OMEG 450 $pp \rightarrow K^+ K^-, \pi^+ \pi^-$

<sup>1</sup> Coupled channel analysis of  $\pi^+ \pi^- \pi^0$ ,  $K^+ K^- \pi^0$ , and  $K^\pm K_S^0 \pi^\mp$ .

<sup>2</sup> Using  $\pi^0\pi^0$  from AMSLER 95B.

<sup>3</sup> Using AMSLER 95B ( $3\pi^0$ ), AMSLER 94C ( $2\pi^0\eta$ ) and SU(3).

<sup>4</sup> From a combined K-matrix analysis of Crystal Barrel (0.  $p\bar{p} \rightarrow \pi^0\pi^0\pi^0$ ,  $\pi^0\eta\eta$ ,  $\pi^0\pi^0\eta$ ), GAMS ( $\pi p \rightarrow \pi^0\pi^0 n$ ,  $\eta\eta n$ ,  $\eta\eta' n$ ), and BNL ( $\pi p \rightarrow K\bar{K}n$ ) data.

### $\Gamma(K\bar{K})/\Gamma(\eta\eta)$

$\Gamma_{13}/\Gamma_{11}$

<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>1.43±0.24 OUR FIT</b>	Error includes scale factor of 1.1.			
<b>1.85±0.41</b>		BARBERIS	00E	450 $pp \rightarrow p_f \eta\eta p_S$
• • •	We do not use the following data for averages, fits, limits, etc. • • •			
1.5 ±0.6		<sup>1</sup> ANISOVICH	02D	SPEC Combined fit
<0.4	90	<sup>2</sup> PROKOSHKIN	91	GAM4 300 $\pi^- p \rightarrow \pi^- p \eta\eta$
<0.6		<sup>3</sup> BINON	83	GAM2 38 $\pi^- p \rightarrow 2\eta n$

<sup>1</sup> From a combined K-matrix analysis of Crystal Barrel (0.  $p\bar{p} \rightarrow \pi^0\pi^0\pi^0$ ,  $\pi^0\eta\eta$ ,  $\pi^0\pi^0\eta$ ), GAMS ( $\pi p \rightarrow \pi^0\pi^0 n$ ,  $\eta\eta n$ ,  $\eta\eta' n$ ), and BNL ( $\pi p \rightarrow K\bar{K}n$ ) data.

<sup>2</sup> Combining results of GAM4 with those of WA76 on  $K\bar{K}$  central production.

<sup>3</sup> Using ETKIN 82B and COHEN 80.



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