

$\pi_2(1670)$

$$I^G(J^{PC}) = 1^-(2^-+)$$

$\pi_2(1670)$  MASS

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	CHG	COMMENT
<b>1672.4 ± 3.2 OUR AVERAGE</b>		Error includes scale factor of 1.4. See the ideogram below.			
1676 ± 3 ± 8		<sup>1</sup> CHUNG	02	MPS	18.3 $\pi^- p \rightarrow \pi^+ \pi^- \pi^- p$
1685 ± 10 ± 30		<sup>2</sup> BARBERIS	01		450 $p p \rightarrow p_f 3\pi^0 p_S$
1687 ± 9 ± 15		AMELIN	99	VES	37 $\pi^- A \rightarrow \omega \pi^- \pi^0 A^*$
1669 ± 4		BARBERIS	98B		450 $p p \rightarrow p_f \rho \pi p_S$
1670 ± 4		BARBERIS	98B		450 $p p \rightarrow p_f f_2(1270) \pi p_S$
1730 ± 20		<sup>3</sup> AMELIN	95B	VES	36 $\pi^- A \rightarrow \pi^+ \pi^- \pi^- A$
1690 ± 14		<sup>4</sup> BERDNIKOV	94	VES	37 $\pi^- A \rightarrow K^+ K^- \pi^- A$
1710 ± 20	700	ANTIPOV	87	SIGM	- 50 $\pi^- \text{Cu} \rightarrow \mu^+ \mu^- \pi^- \text{Cu}$
1676 ± 6		<sup>4</sup> EVANGELISTA	81	OMEG	- 12 $\pi^- p \rightarrow 3\pi p$
1657 ± 14		<sup>4,5</sup> DAUM	80D	SPEC	- 63-94 $\pi p \rightarrow 3\pi X$
1662 ± 10	2000	<sup>4</sup> BALTAY	77	HBC	+ 15 $\pi^+ p \rightarrow p 3\pi$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
1742 ± 31 ± 49		ANTREASYAN	90	CBAL	$e^+ e^- \rightarrow e^+ e^- \pi^0 \pi^0 \pi^0$
1624 ± 21		<sup>1</sup> BELLINI	85	SPEC	40 $\pi^- A \rightarrow \pi^- \pi^+ \pi^- A$
1622 ± 35		<sup>6</sup> BELLINI	85	SPEC	40 $\pi^- A \rightarrow \pi^- \pi^+ \pi^- A$
1693 ± 28		<sup>7</sup> BELLINI	85	SPEC	40 $\pi^- A \rightarrow \pi^- \pi^+ \pi^- A$
1710 ± 20		<sup>8</sup> DAUM	81B	SPEC	- 63,94 $\pi^- p$
1660 ± 10		<sup>4</sup> ASCOLI	73	HBC	- 5-25 $\pi^- p \rightarrow p \pi_2$

<sup>1</sup> From  $f_2(1270)\pi$  decay.

<sup>2</sup> From a fit to the invariant mass distribution.

<sup>3</sup> From a fit to  $J^{PC} = 2^-+ f_2(1270)\pi, f_0(1370)\pi$  waves.

<sup>4</sup> From a fit to  $J^P = 2^- S$ -wave  $f_2(1270)\pi$  partial wave.

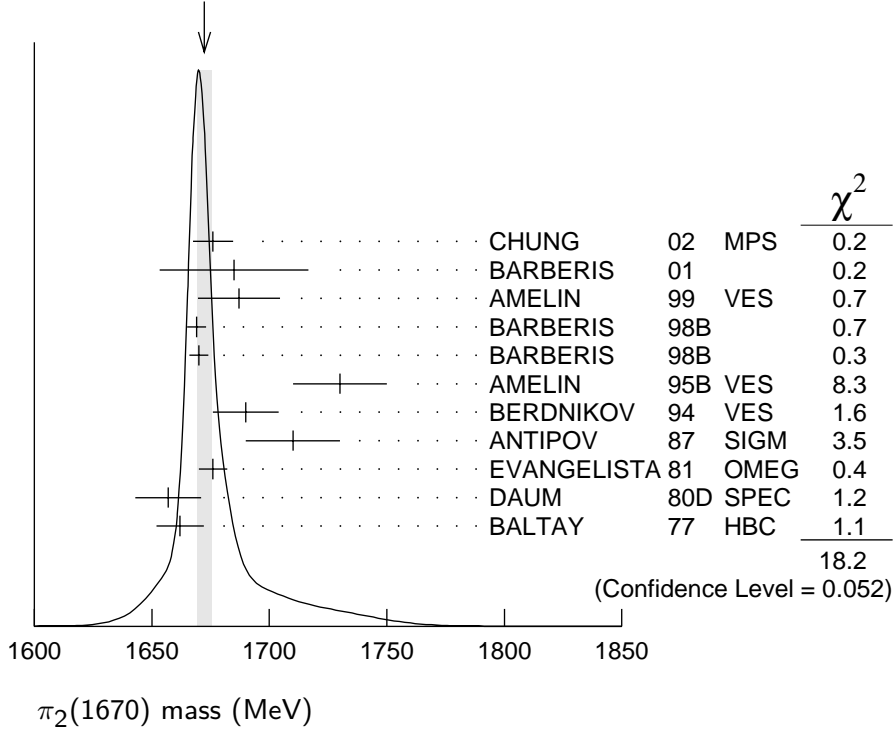
<sup>5</sup> Clear phase rotation seen in  $2^- S, 2^- P, 2^- D$  waves. We quote central value and spread of single-resonance fits to three channels.

<sup>6</sup> From  $\rho\pi$  decay.

<sup>7</sup> From  $\sigma\pi$  decay.

<sup>8</sup> From a two-resonance fit to four  $2^-0^+$  waves. This should not be averaged with all the single resonance fits.

WEIGHTED AVERAGE  
 $1672.4 \pm 3.2$  (Error scaled by 1.4)

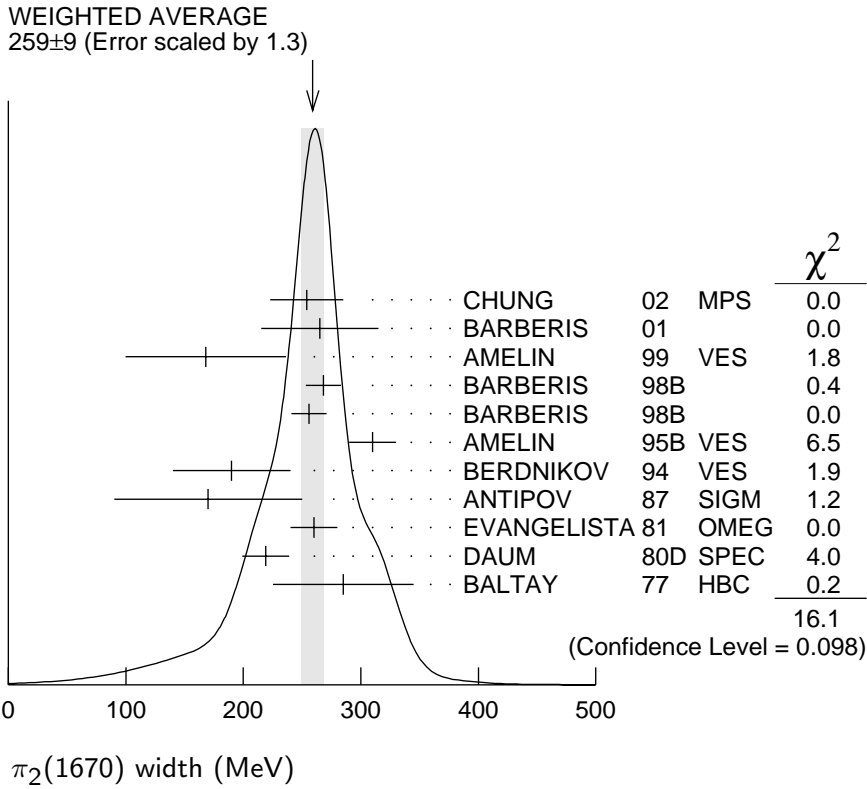


### $\pi_2(1670)$ WIDTH

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
<b>259 ± 9</b>	<b>OUR AVERAGE</b>	Error	includes scale factor of 1.3.	See the ideogram below.	
254 ± 3 ± 31	9	CHUNG	02	MPS	18.3 $\pi^- p \rightarrow \pi^+ \pi^- \pi^- p$
265 ± 30 ± 40	10	BARBERIS	01		450 $pp \rightarrow p_f 3\pi^0 p_S$
168 ± 43 ± 53		AMELIN	99	VES	37 $\pi^- A \rightarrow \omega \pi^- \pi^0 A^*$
268 ± 15		BARBERIS	98B		450 $pp \rightarrow p_f \rho \pi p_S$
256 ± 15		BARBERIS	98B		450 $pp \rightarrow p_f f_2(1270) \pi p_S$
310 ± 20		11 AMELIN	95B	VES	36 $\pi^- A \rightarrow \pi^+ \pi^- \pi^- A$
190 ± 50		12 BERDNIKOV	94	VES	37 $\pi^- A \rightarrow K^+ K^- \pi^- A$
170 ± 80	700	ANTIPOV	87	SIGM	- 50 $\pi^- Cu \rightarrow \mu^+ \mu^- \pi^- Cu$
260 ± 20		12 EVANGELISTA	81	OMEG	- 12 $\pi^- p \rightarrow 3\pi p$
219 ± 20		12,13 DAUM	80D	SPEC	- 63-94 $\pi p \rightarrow 3\pi X$
285 ± 60	2000	12 BALTAY	77	HBC	+ 15 $\pi^+ p \rightarrow p 3\pi$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
236 ± 49 ± 36		ANTREASYAN	90	CBAL	$e^+ e^- \rightarrow e^+ e^- \pi^0 \pi^0 \pi^0$
304 ± 22	9	BELLINI	85	SPEC	40 $\pi^- A \rightarrow \pi^- \pi^+ \pi^- A$
404 ± 108	14	BELLINI	85	SPEC	40 $\pi^- A \rightarrow \pi^- \pi^+ \pi^- A$

330 ± 90	<sup>15</sup> BELLINI	85 SPEC	40 $\pi^- A \rightarrow \pi^- \pi^+ \pi^- A$
312 ± 50	<sup>16</sup> DAUM	81B SPEC	— 63,94 $\pi^- p$
270 ± 60	<sup>12</sup> ASCOLI	73 HBC	— 5–25 $\pi^- p \rightarrow p \pi_2$

- <sup>9</sup> From  $f_2(1270)\pi$  decay.
- <sup>10</sup> From a fit to the invariant mass distribution.
- <sup>11</sup> From a fit to  $J^{PC} = 2^-+ f_2(1270)\pi, f_0(1370)\pi$  waves.
- <sup>12</sup> From a fit to  $J^P = 2^- f_2(1270)\pi$  partial wave.
- <sup>13</sup> Clear phase rotation seen in  $2^- S, 2^- P, 2^- D$  waves. We quote central value and spread of single-resonance fits to three channels.
- <sup>14</sup> From  $\rho\pi$  decay.
- <sup>15</sup> From  $\sigma\pi$  decay.
- <sup>16</sup> From a two-resonance fit to four  $2^-0^+$  waves. This should not be averaged with all the single resonance fits.



### $\pi_2(1670)$ DECAY MODES

Mode	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level
$\Gamma_1$ $3\pi$	(95.8 ± 1.4) %	
$\Gamma_2$ $\pi^+ \pi^- \pi^0$		
$\Gamma_3$ $\pi^0 \pi^0 \pi^0$		
$\Gamma_4$ $f_2(1270)\pi$	(56.2 ± 3.2) %	
$\Gamma_5$ $\rho\pi$	(31 ± 4) %	
$\Gamma_6$ $\sigma\pi$	(10.9 ± 3.4) %	
$\Gamma_7$ $(\pi\pi)_S$ -wave	( 8.7 ± 3.4) %	

$\Gamma_8$	$K \bar{K}^*(892) + \text{c.c.}$			$(4.2 \pm 1.4) \%$
$\Gamma_9$	$\omega \rho$			$(2.7 \pm 1.1) \%$
$\Gamma_{10}$	$\gamma \gamma$			
$\Gamma_{11}$	$\eta \pi$			
$\Gamma_{12}$	$\pi^\pm 2\pi^+ 2\pi^-$			
$\Gamma_{13}$	$\rho(1450)\pi$	$< 3.6$	$\times 10^{-3}$	97.7%
$\Gamma_{14}$	$b_1(1235)\pi$	$< 1.9$	$\times 10^{-3}$	97.7%

### CONSTRAINED FIT INFORMATION

An overall fit to 4 branching ratios uses 6 measurements and one constraint to determine 4 parameters. The overall fit has a  $\chi^2 = 1.9$  for 3 degrees of freedom.

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

$x_5$	-53		
$x_7$	-29	-59	
$x_8$	-8	-21	-9
	$x_4$	$x_5$	$x_7$

### $\pi_2(1670)$ PARTIAL WIDTHS

$\Gamma(\gamma\gamma)$						$\Gamma_{10}$
VALUE (keV)	CL%	DOCUMENT ID	TECN	CHG	COMMENT	
$< 0.072$	90	17 ACCIARRI	97T L3		$e^+ e^- \rightarrow e^+ e^- \pi^+ \pi^- \pi^0$	
$< 0.19$	90	17 ALBRECHT	97B ARG		$e^+ e^- \rightarrow e^+ e^- \pi^+ \pi^- \pi^0$	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
$1.41 \pm 0.23 \pm 0.28$		ANTREASYAN 90	CBAL	0	$e^+ e^- \rightarrow e^+ e^- \pi^0 \pi^0 \pi^0$	
$0.8 \pm 0.3 \pm 0.12$		18 BEHREND	90C CELL	0	$e^+ e^- \rightarrow e^+ e^- \pi^+ \pi^- \pi^0$	
$1.3 \pm 0.3 \pm 0.2$		19 BEHREND	90C CELL	0	$e^+ e^- \rightarrow e^+ e^- \pi^+ \pi^- \pi^0$	

<sup>17</sup> Decaying into  $f_2(1270)\pi$  and  $\rho\pi$ .

<sup>18</sup> Constructive interference between  $f_2(1270)\pi, \rho\pi$  and background.

<sup>19</sup> Incoherent Ansatz.

### $\pi_2(1670)$ BRANCHING RATIOS

$\Gamma(3\pi) / \Gamma_{\text{total}}$	$\Gamma_1 / \Gamma = (\Gamma_4 + \Gamma_5 + \Gamma_7) / \Gamma$
VALUE	DOCUMENT ID
<b>0.958 ± 0.014 OUR FIT</b>	

$$\Gamma(\pi^0\pi^0\pi^0)/\Gamma(\pi^+\pi^-\pi^0)$$

$$\Gamma_3/\Gamma_2$$

VALUE	DOCUMENT ID	COMMENT
<b>0.29±0.03±0.05</b>	20 BARBERIS 01	450 $p\bar{p} \rightarrow p_f 3\pi^0 p_s$

$$\Gamma(\rho\pi)/\Gamma(\pi^\pm\pi^+\pi^-)$$

$$\frac{1}{2}\Gamma_5/(0.567\Gamma_4+\frac{1}{2}\Gamma_5+0.624\Gamma_7)$$

VALUE	DOCUMENT ID	TECN	CHG	COMMENT
<b>0.29±0.04 OUR FIT</b>				
<b>0.29±0.05</b>	21 DAUM	81B	SPEC	63,94 $\pi^- p$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<0.3	BARTSCH 68	HBC	+	8 $\pi^+ p \rightarrow 3\pi p$

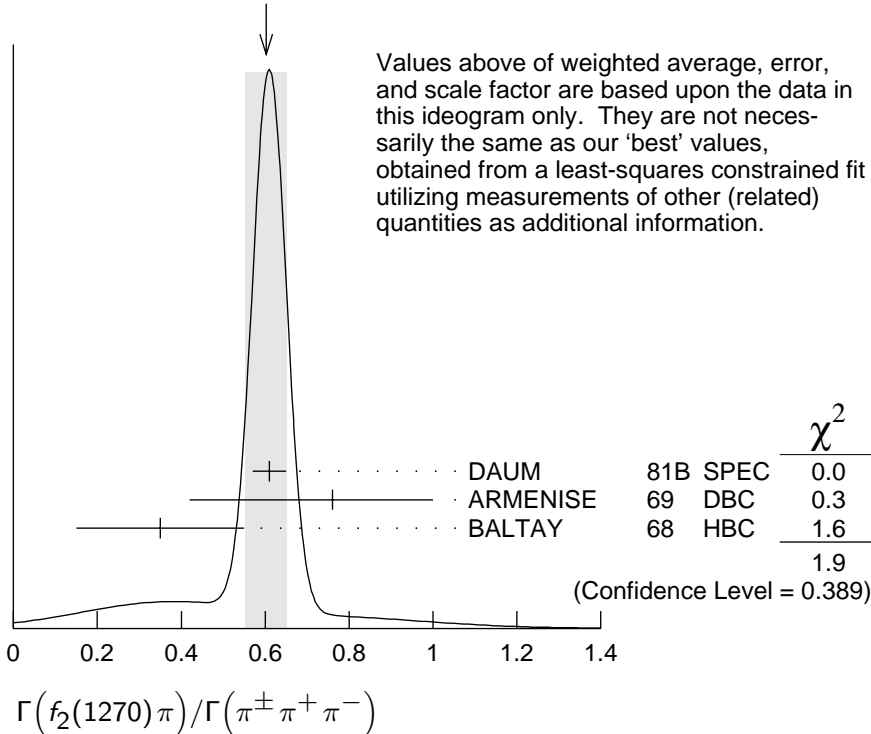
$$\Gamma(f_2(1270)\pi)/\Gamma(\pi^\pm\pi^+\pi^-)$$

$$0.567\Gamma_4/(0.567\Gamma_4+\frac{1}{2}\Gamma_5+0.624\Gamma_7)$$

(With  $f_2(1270) \rightarrow \pi^+\pi^-$ .)

VALUE	DOCUMENT ID	TECN	CHG	COMMENT	
<b>0.604±0.035 OUR FIT</b>					
<b>0.60 ±0.05 OUR AVERAGE</b>	Error includes scale factor of 1.3. See the ideogram below.				
0.61 ±0.04	21 DAUM	81B	SPEC	63,94 $\pi^- p$	
0.76 $\begin{smallmatrix} +0.24 \\ -0.34 \end{smallmatrix}$	ARMENISE	69	DBC	+	5.1 $\pi^+ d \rightarrow d3\pi$
0.35 ±0.20	BALTAY	68	HBC	+	7-8.5 $\pi^+ p$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.59	BARTSCH	68	HBC	+	8 $\pi^+ p \rightarrow 3\pi p$

WEIGHTED AVERAGE  
0.60±0.05 (Error scaled by 1.3)



$\Gamma(\rho\pi)/\Gamma(f_2(1270)\pi)$   $\Gamma_5/0.564\Gamma_4$

(With  $f_2(1270) \rightarrow \pi^+\pi^-$ .)

VALUE	DOCUMENT ID	TECN	COMMENT
<b>0.97±0.09 OUR AVERAGE</b>	Error includes scale factor of 1.9.		
0.76±0.07±0.10	CHUNG	02 MPS	18.3 $\pi^- p \rightarrow \pi^+\pi^-\pi^- p$
1.01±0.05	BARBERIS	98B	450 $p p \rightarrow p_f \pi^+\pi^-\pi^0 p_s$

$\Gamma(\eta\pi)/\Gamma(\pi^\pm\pi^+\pi^-)$   $\Gamma_{11}/(0.567\Gamma_4+\frac{1}{2}\Gamma_5+0.624\Gamma_7)$

(All  $\eta$  decays.)

VALUE	DOCUMENT ID	TECN	CHG	COMMENT
<b>&lt;0.09</b>	BALTAY	68 HBC	+	7-8.5 $\pi^+ p$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<0.10	CRENNELL	70 HBC	-	6 $\pi^- p \rightarrow f_2 \pi^- N$

$\Gamma(\pi^\pm 2\pi^+ 2\pi^-)/\Gamma(\pi^\pm\pi^+\pi^-)$   $\Gamma_{12}/(0.567\Gamma_4+\frac{1}{2}\Gamma_5+0.624\Gamma_7)$

VALUE	DOCUMENT ID	TECN	CHG	COMMENT
<b>&lt;0.10</b>	CRENNELL	70 HBC	-	6 $\pi^- p \rightarrow f_2 \pi^- N$
<0.1	BALTAY	68 HBC	+	7,8.5 $\pi^+ p$

$\Gamma(\rho(1450)\pi)/\Gamma_{total}$   $\Gamma_{13}/\Gamma$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<b>&lt;0.0036</b>	97.7	AMELIN	99 VES	37 $\pi^- A \rightarrow \omega\pi^-\pi^0 A^*$

$\Gamma(b_1(1235)\pi)/\Gamma_{total}$   $\Gamma_{14}/\Gamma$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<b>&lt;0.0019</b>	97.7	AMELIN	99 VES	37 $\pi^- A \rightarrow \omega\pi^-\pi^0 A^*$

$\Gamma((\pi\pi)_{S-wave})/\Gamma(\pi^\pm\pi^+\pi^-)$   $0.624\Gamma_7/(0.567\Gamma_4+\frac{1}{2}\Gamma_5+0.624\Gamma_7)$

(With  $(\pi\pi)_{S-wave} \rightarrow \pi^+\pi^-$ .)

VALUE	DOCUMENT ID	TECN	COMMENT
<b>0.10±0.04 OUR FIT</b>			
0.10±0.05	21 DAUM	81B SPEC	63,94 $\pi^- p$

$\Gamma(K\bar{K}^*(892)+c.c.)/\Gamma(f_2(1270)\pi)$   $\Gamma_8/\Gamma_4$

VALUE	DOCUMENT ID	TECN	CHG	COMMENT
<b>0.075±0.025 OUR FIT</b>				
0.075±0.025	22 ARMSTRONG	82B OMEG	-	16 $\pi^- p \rightarrow K^+ K^- \pi^- p$

$\Gamma(\omega\rho)/\Gamma_{total}$   $\Gamma_9/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
<b>0.027±0.004±0.010</b>	23 AMELIN	99 VES	37 $\pi^- A \rightarrow \omega\pi^-\pi^0 A^*$

### $\Gamma(\sigma\pi)/\Gamma(f_2(1270)\pi)$

$\Gamma_6/\Gamma_4$

VALUE	DOCUMENT ID	TECN	COMMENT
<b>0.19±0.06 OUR AVERAGE</b>			
0.17±0.02±0.07	CHUNG	02 MPS	18.3 $\pi^- p \rightarrow \pi^+ \pi^- \pi^- p$
0.24±0.10	24,25 BAKER	99 SPEC	1.94 $\bar{p} p \rightarrow 4\pi^0$

### D-wave/S-wave RATIO FOR $\pi_2(1670) \rightarrow f_2(1270)\pi$

VALUE	DOCUMENT ID	TECN	COMMENT
<b>-0.18±0.06</b>	24 BAKER	99 SPEC	1.94 $\bar{p} p \rightarrow 4\pi^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
0.22±0.10	21 DAUM	81B SPEC	63,94 $\pi^- p$

### F-wave/P-wave RATIO FOR $\pi_2(1670) \rightarrow \rho\pi$

VALUE	DOCUMENT ID	TECN	COMMENT
<b>-0.72±0.07±0.14</b>	CHUNG	02 MPS	18.3 $\pi^- p \rightarrow \pi^+ \pi^- \pi^- p$

<sup>20</sup> Using BARBERIS 98B.

<sup>21</sup> From a two-resonance fit to four  $2^-0^+$  waves.

<sup>22</sup> From a partial-wave analysis of  $K^+ K^- \pi^-$  system.

<sup>23</sup> Normalized to the  $B(\pi_2(1670) \rightarrow f_2\pi)$ .

<sup>24</sup> Using preliminary CBAR data.

<sup>25</sup> With the  $\sigma\pi$  in  $L=2$  and the  $f_2(1270)\pi$  in  $L=0$ .

## $\pi_2(1670)$ REFERENCES

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BARBERIS	01	PL B507 14	D. Barberis <i>et al.</i>	
AMELIN	99	PAN 62 445	D.V. Amelin <i>et al.</i>	(VES Collab.)
		Translated from YAF 62	487.	
BAKER	99	PL B449 114	C.A. Baker <i>et al.</i>	
BARBERIS	98B	PL B422 399	D. Barberis <i>et al.</i>	(WA 102 Collab.)
ACCIARRI	97T	PL B413 147	M. Acciarri <i>et al.</i>	(L3 Collab.)
ALBRECHT	97B	ZPHY C74 469	H. Albrecht <i>et al.</i>	(ARGUS Collab.)
AMELIN	95B	PL B356 595	D.V. Amelin <i>et al.</i>	(SERP, TBIL)
BERDNIKOV	94	PL B337 219	E.B. Berdnikov <i>et al.</i>	(SERP, TBIL)
ANTREASYAN	90	ZPHY C48 561	D. Antreasyan <i>et al.</i>	(Crystal Ball Collab.)
BEHREND	90C	ZPHY C46 583	H.J. Behrend <i>et al.</i>	(CELLO Collab.)
ANTIPOV	87	EPL 4 403	Y.M. Antipov <i>et al.</i>	(SERP, JINR, INRM+)
BELLINI	85	SJNP 41 781	D. Bellini <i>et al.</i>	
		Translated from YAF 41	1223.	
ARMSTRONG	82B	NP B202 1	T.A. Armstrong, B. Baccari	(AACH3, BARI, BONN+)
DAUM	81B	NP B182 269	C. Daum <i>et al.</i>	(AMST, CERN, CRAC, MPIM+)
EVANGELISTA	81	NP B178 197	C. Evangelista <i>et al.</i>	(BARI, BONN, CERN+)
Also	81B	NP B186 594	C. Evangelista	
DAUM	80D	PL 89B 285	C. Daum <i>et al.</i>	(AMST, CERN, CRAC, MPIM+) JP
BALTAY	77	PRL 39 591	C. Baltay, C.V. Cautis, M. Kalelkar	(COLU) JP
ASCOLI	73	PR D7 669	G. Ascoli	(ILL, TNTO, GENO, HAMB, MILA+) JP
CRENNELL	70	PRL 24 781	D.J. Crennell <i>et al.</i>	(BNL)
ARMENISE	69	LNC 2 501	N. Armenise <i>et al.</i>	(BARI, BGNA, FIRZ)
BALTAY	68	PRL 20 887	C. Baltay <i>et al.</i>	(COLU, ROCH, RUTG, YALE) I
BARTSCH	68	NP B7 345	J. Bartsch <i>et al.</i>	(AACH, BERL, CERN) JP

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		Translated from SJPN 30 5.		
CHEN	83B	PR D28 2304	T.Y. Chen <i>et al.</i>	(ARIZ, FNAL, FLOR, NDAM+)
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BELLINI	82B	NP B199 1	G. Bellini <i>et al.</i>	(CERN, MILA, JINR+)
DAUM	81B	NP B182 269	C. Daum <i>et al.</i>	(AMST, CERN, CRAC, MPIM+)
PERNEGR	78	NP B134 436	J. Pernegr <i>et al.</i>	(ETH, CERN, LOIC+)
FOCACCI	66	PRL 17 890	M.N. Focacci <i>et al.</i>	(CERN)
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VETLITSKY	66	PL 21 579	I.A. Vetlitsky <i>et al.</i>	(ITEP)
FORINO	65B	PL 19 68	A. Forino <i>et al.</i>	(BGNA, BARI, FIRZ, ORSAY+)

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