$\pi_2(1670)$

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

$\pi_2(1670)$ MASS

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*CHG*	*COMMENT*
1670 ±20 OUR ESTIMATE		This is only an educated guess; the error given is larger than the error on the average of the published values.				
1672.0± 3.5 OUR AVERAGE		Error includes scale factor of 1.5. See the ideogram below.				
1687 ± 9 ±15		AMELIN	99	VES		37 $\pi^- A \to \omega\pi^-\pi^0 A^*$
1669 ± 4		BARBERIS	98B			450 $pp \to p_f \rho\pi p_s$
1670 ± 4		BARBERIS	98B			450 $pp \to p_f f_2(1270)\pi p_s$
1730 ±20		[1] AMELIN	95B	VES		36 $\pi^- A \to \pi^+\pi^-\pi^- A$
1690 ±14		[2] BERDNIKOV	94	VES		37 $\pi^- A \to K^+K^-\pi^- A$
1710 ±20	700	ANTIPOV	87	SIGM	–	50 π^- Cu $\to \mu^+\mu^-\pi^-$ Cu
1676 ± 6		[2] EVANGELISTA	81	OMEG	–	12 $\pi^- p \to 3\pi p$
1657 ±14		[2,3] DAUM	80D	SPEC	–	63–94 $\pi p \to 3\pi$X
1662 ±10	2000	[2] BALTAY	77	HBC	+	15 $\pi^+ p \to p3\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
1742 ±31 ±49		ANTREASYAN	90	CBAL		$e^+e^- \to e^+e^-\pi^0\pi^0\pi^0$
1624 ±21		[4] BELLINI	85	SPEC		40 $\pi^- A \to \pi^-\pi^+\pi^- A$
1622 ±35		[5] BELLINI	85	SPEC		40 $\pi^- A \to \pi^-\pi^+\pi^- A$
1693 ±28		[6] BELLINI	85	SPEC		40 $\pi^- A \to \pi^-\pi^+\pi^- A$
1710 ±20		[7] DAUM	81B	SPEC	–	63,94 $\pi^- p$
1660 ±10		[2] ASCOLI	73	HBC	–	5–25 $\pi^- p \to p\pi_2$

[1] From a fit to $J^{PC} = 2^{-+}$ $f_2(1270)\pi$, $f_0(1370)\pi$ waves.

[2] From a fit to $J^P = 2^-$ S-wave $f_2(1270)\pi$ partial wave.

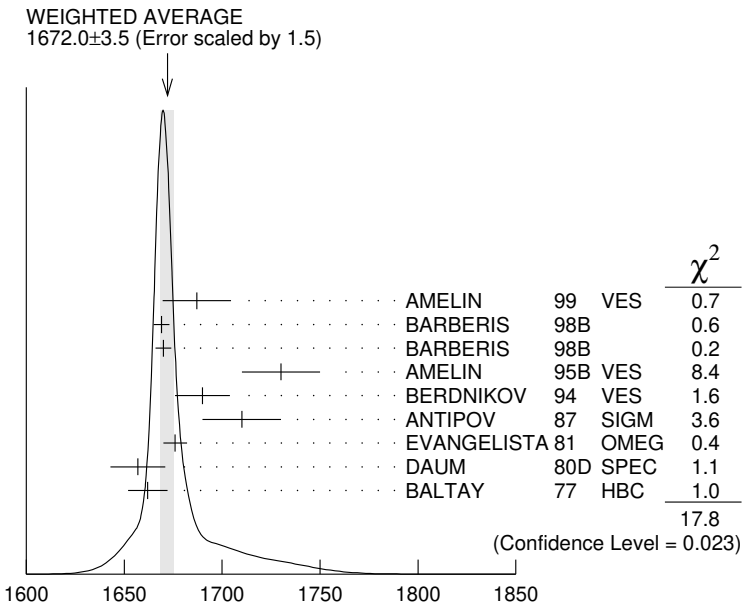
[3] Clear phase rotation seen in 2^-S, 2^-P, 2^-D waves. We quote central value and spread of single-resonance fits to three channels.

[4] From $f_2(1270)\pi$ decay.

[5] From $\rho\pi$ decay.

[6] From $\sigma\pi$ decay.

[7] From a two-resonance fit to four 2^-0^+ waves. This should not be averaged with all the single resonance fits.

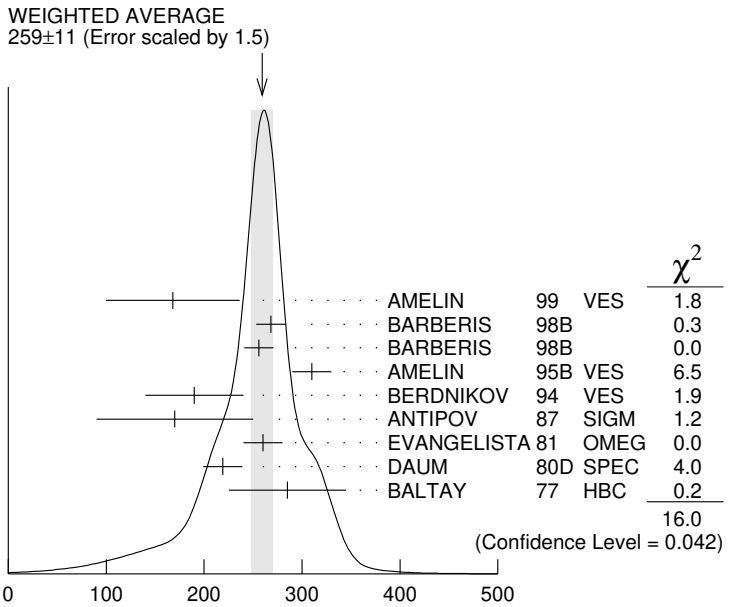


$\pi_2(1670)$ mass (MeV)

$\pi_2(1670)$ WIDTH

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*CHG*	*COMMENT*
259± 11 OUR AVERAGE		Error includes scale factor of 1.5. See the ideogram below.				
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	[8]	AMELIN	95B	VES		36 $\pi^- A \rightarrow \pi^+\pi^-\pi^- A$
190± 50	[9]	BERDNIKOV	94	VES		37 $\pi^- A \rightarrow K^+ K^-\pi^- A$
170± 80	700	ANTIPOV	87	SIGM	–	50 π^- Cu $\rightarrow \mu^+\mu^-\pi^-$ Cu
260± 20	[9]	EVANGELISTA	81	OMEG	–	12 $\pi^- p \rightarrow 3\pi p$
219± 20	[9,10]	DAUM	80D	SPEC	–	63–94 $\pi p \rightarrow 3\pi X$
285± 60	2000 [9]	BALTAY	77	HBC	+	15 $\pi^+ p \rightarrow p3\pi$
• • • 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	[11]	BELLINI	85	SPEC		40 $\pi^- A \rightarrow \pi^-\pi^+\pi^- A$
404±108	[12]	BELLINI	85	SPEC		40 $\pi^- A \rightarrow \pi^-\pi^+\pi^- A$
330± 90	[13]	BELLINI	85	SPEC		40 $\pi^- A \rightarrow \pi^-\pi^+\pi^- A$
312± 50	[14]	DAUM	81B	SPEC	–	63,94 $\pi^- p$
270± 60	[9]	ASCOLI	73	HBC	–	5–25 $\pi^- p \rightarrow p\pi_2$

[8] From a fit to $J^{PC} = 2^{-+}$ $f_2(1270)\pi$, $f_0(1370)\pi$ waves.
[9] From a fit to $J^P = 2^-$ $f_2(1270)\pi$ partial wave.
[10] 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.
[11] From $f_2(1270)\pi$ decay.
[12] From $\rho\pi$ decay.
[13] From $\sigma\pi$ decay.
[14] From a two-resonance fit to four 2^-0^+ waves. This should not be averaged with all the single resonance fits.



$\pi_2(1670)$ width (MeV)

$\pi_2(1670)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Confidence level
Γ_1	3π	(95.8±1.4) %	
Γ_2	$f_2(1270)\pi$	(56.2±3.2) %	
Γ_3	$\rho\pi$	(31 ±4) %	
Γ_4	$\sigma\pi$	(13 ±6) %	
Γ_5	$f_0(1370)\pi$	(8.7±3.4) %	
Γ_6	$K\overline{K}^*(892)+$ c.c.	(4.2±1.4) %	

Γ_7	$\omega\rho$		(2.7 ± 1.1) %		
Γ_8	$\gamma\gamma$				
Γ_9	$\eta\pi$				
Γ_{10}	$\pi^\pm 2\pi^+ 2\pi^-$				
Γ_{11}	$\rho(1450)\pi$	<	3.6	$\times 10^{-3}$	97.7%
Γ_{12}	$b_1(1235)\pi$	<	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_3	−53		
x_5	−29	−59	
x_6	−8	−21	−9
	x_2	x_3	x_5

$\pi_2(1670)$ PARTIAL WIDTHS

$\Gamma(\gamma\gamma)$ Γ_8

VALUE (keV)	CL%	DOCUMENT ID		TECN	CHG	COMMENT
<0.072	90	[15] ACCIARRI	97T	L3		$e^+e^- \to e^+e^-\pi^+\pi^-\pi^0$
<0.19	90	[15] ALBRECHT	97B	ARG		$e^+e^- \to e^+e^-\pi^+\pi^-\pi^0$

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

1.41 ±0.23±0.28		ANTREASYAN	90	CBAL	0	$e^+e^- \to e^+e^-\pi^0\pi^0\pi^0$
0.8 ±0.3 ±0.12	[16]	BEHREND	90C	CELL	0	$e^+e^- \to e^+e^-\pi^+\pi^-\pi^0$
1.3 ±0.3 ±0.2	[17]	BEHREND	90C	CELL	0	$e^+e^- \to e^+e^-\pi^+\pi^-\pi^0$

[15] Decaying into $f_2(1270)\pi$ and $\rho\pi$.
[16] Constructive interference between $f_2(1270)\pi$, $\rho\pi$ and background.
[17] Incoherent Ansatz.

$\pi_2(1670)$ BRANCHING RATIOS

$\Gamma(3\pi)/\Gamma_{\text{total}}$ $\Gamma_1/\Gamma = (\Gamma_2+\Gamma_3+\Gamma_5)/\Gamma$

VALUE	DOCUMENT ID
0.958±0.014 OUR FIT	

$\Gamma(\rho\pi)/\Gamma(\pi^{\pm}\pi^{+}\pi^{-})$ $\frac{1}{2}\Gamma_3/(0.567\Gamma_2+\frac{1}{2}\Gamma_3+0.624\Gamma_5)$

VALUE	DOCUMENT ID		TECN	CHG	COMMENT
0.29±0.04 OUR FIT					
0.29±0.05	[18] 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 $\pi^+ p \rightarrow 3\pi p$

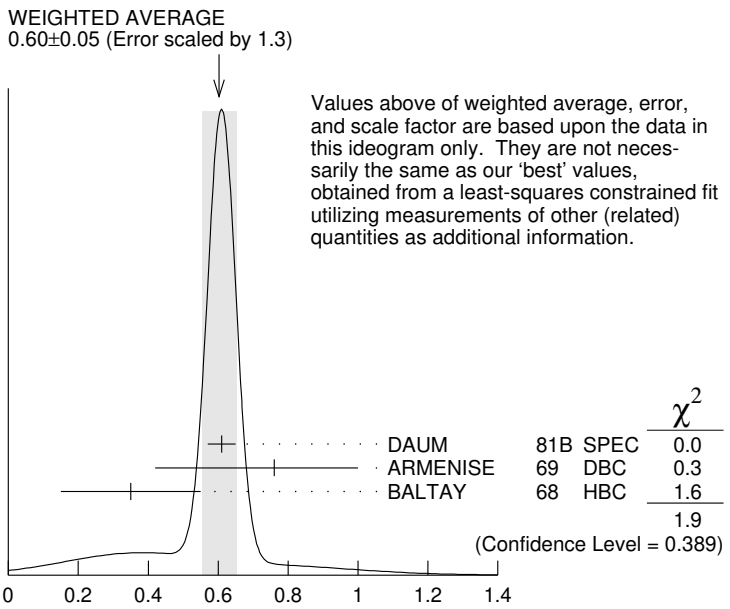
[18] From a two-resonance fit to four 2^-0^+ waves.

$\Gamma(f_2(1270)\pi)/\Gamma(\pi^{\pm}\pi^{+}\pi^{-})$ $0.567\Gamma_2/(0.567\Gamma_2+\frac{1}{2}\Gamma_3+0.624\Gamma_5)$

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

VALUE	DOCUMENT ID		TECN	CHG	COMMENT
0.604±0.035 OUR FIT					
0.60 ±0.05 OUR AVERAGE Error includes scale factor of 1.3. See the ideogram below.					
0.61 ±0.04	[19] DAUM	81B	SPEC		63,94 $\pi^- p$
$0.76\ ^{+0.24}_{-0.34}$	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 $\pi^+ p \rightarrow 3\pi p$

[19] From a two-resonance fit to four 2^-0^+ waves.



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

$\Gamma(\rho\pi)/\Gamma(f_2(1270)\pi)$ $\Gamma_3/0.564\Gamma_2$

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

VALUE	DOCUMENT ID		COMMENT
1.01±0.05	BARBERIS	98B	450 $pp \rightarrow p_f \pi^+\pi^-\pi^0 p_s$

$\Gamma(\eta\pi)/\Gamma(\pi^\pm\pi^+\pi^-)$ $\Gamma_9/(0.567\Gamma_2+\frac{1}{2}\Gamma_3+0.624\Gamma_5)$

(All η decays.)

VALUE	DOCUMENT ID		TECN	CHG	COMMENT
<0.09	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 $\pi^- p \rightarrow f_2 \pi^- N$

$\Gamma(\pi^\pm 2\pi^+ 2\pi^-)/\Gamma(\pi^\pm\pi^+\pi^-)$ $\Gamma_{10}/(0.567\Gamma_2+\frac{1}{2}\Gamma_3+0.624\Gamma_5)$

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

$\Gamma(\rho(1450)\pi)/\Gamma_{\text{total}}$ Γ_{11}/Γ

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

$\Gamma(b_1(1235)\pi)/\Gamma_{\text{total}}$ Γ_{12}/Γ

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

$\Gamma(f_0(1370)\pi)/\Gamma(\pi^\pm\pi^+\pi^-)$ $0.624\Gamma_5/(0.567\Gamma_2+\frac{1}{2}\Gamma_3+0.624\Gamma_5)$

(With $f_0(1370) \rightarrow \pi^+\pi^-$.)

VALUE		DOCUMENT ID		TECN	COMMENT
0.10±0.04 OUR FIT					
0.10±0.05	[20]	DAUM	81B	SPEC	63,94 $\pi^- p$

[20] From a two-resonance fit to four 2^-0^+ waves.

$\Gamma(K\overline{K}^*(892)+\text{c.c.})/\Gamma(f_2(1270)\pi)$ Γ_6/Γ_2

VALUE		DOCUMENT ID		TECN	CHG	COMMENT
0.075±0.025 OUR FIT						
0.075±0.025	[21]	ARMSTRONG	82B	OMEG	−	16 $\pi^- p \rightarrow K^+ K^- \pi^- p$

[21] From a partial-wave analysis of $K^+ K^- \pi^-$ system.

$\Gamma(\omega\rho)/\Gamma_{\text{total}}$ Γ_7/Γ

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

$\Gamma(\sigma\pi)/\Gamma(f_2(1270)\pi)$ Γ_4/Γ_2

VALUE		DOCUMENT ID		TECN	COMMENT
0.24±0.10	[24,25]	BAKER	99	SPEC	1.94 $\overline{p}p \rightarrow 4\pi^0$

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

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
$=0.18\pm0.06$	[24] BAKER	99	SPEC	1.94 $\overline{p}p \rightarrow 4\pi^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.22 ± 0.10	[22] DAUM	81B	SPEC	63,94 $\pi^- p$

[22] From a two-resonance fit to four 2^-0^+ waves.
[23] Normalized to the B($\pi_2(1670) \rightarrow f_2\pi$).
[24] Using preliminary CBAR data.
[25] With the $\sigma\pi$ in L=2 and the $f_2(1270)\pi$ in L=0.

$\pi_2(1670)$ REFERENCES

AMELIN	99	PAN 62 445 Translated from YAF 62 487.	D.V. Amelin *et al.*	(VES Collab.)
BAKER	99	PL B449 114	C.A. Baker *et al.*	
BARBERIS	98B	PL B422 399	D. Barberis *et al.*	(WA102 Collab.)
ACCIARRI	97T	PL B413 147	M. Acciarri *et al.*	(L3 Collab.)
ALBRECHT	97B	ZPHY C74 469	H. Albrecht *et al.*	(ARGUS Collab.)
AMELIN	95B	PL B356 595	D.V. Amelin *et al.*	(SERP, TBIL)
BERDNIKOV	94	PL B337 219	E.B. Berdnikov *et al.*	(SERP, TBIL)
ANTREASYAN	90	ZPHY C48 561	D. Antreasyan *et al.*	(Crystal Ball Collab.)
BEHREND	90C	ZPHY C46 583	H.J. Behrend *et al.*	(CELLO Collab.)
ANTIPOV	87	EPL 4 403	Y.M. Antipov *et al.*	(SERP, JINR, INRM+)
BELLINI	85	SJNP 41 781 Translated from YAF 41 1223.	D. Bellini *et al.*	
ARMSTRONG	82B	NP B202 1	T.A. Armstrong, B. Baccari	(AACH3, BARI, BONN+)
DAUM	81B	NP B182 269	C. Daum *et al.*	(AMST, CERN, CRAC, MPIM+)
EVANGELISTA	81	NP B178 197	C. Evangelista *et al.*	(BARI, BONN, CERN+)
Also	81B	NP B186 594	C. Evangelista	
DAUM	80D	PL 89B 285	C. Daum *et al.*	(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
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ARMENISE	69	LNC 2 501	N. Armenise *et al.*	(BARI, BGNA, FIRZ)
BALTAY	68	PRL 20 887	C. Baltay *et al.*	(COLU, ROCH, RUTG, YALE) I
BARTSCH	68	NP B7 345	J. Bartsch *et al.*	(AACH, BERL, CERN) JP

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ABELE	96	PL B380 453	A. Abele *et al.*	(Crystal Barrel Collab.)
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LEEDOM	83	PR D27 1426	I.D. Leedom *et al.*	(PURD, TNTO)
BELLINI	82B	NP B199 1	G. Bellini *et al.*	(CERN, MILA, JINR+)
DAUM	81B	NP B182 269	C. Daum *et al.*	(AMST, CERN, CRAC, MPIM+)
PERNEGR	78	NP B134 436	J. Pernegr *et al.*	(ETH, CERN, LOIC+)
FOCACCI	66	PRL 17 890	M.N. Focacci *et al.*	(CERN)
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VETLITSKY	66	PL 21 579	I.A. Vetlitsky *et al.*	(ITEP)
FORINO	65B	PL 19 68	A. Forino *et al.*	(BGNA, BARI, FIRZ, ORSAY+)