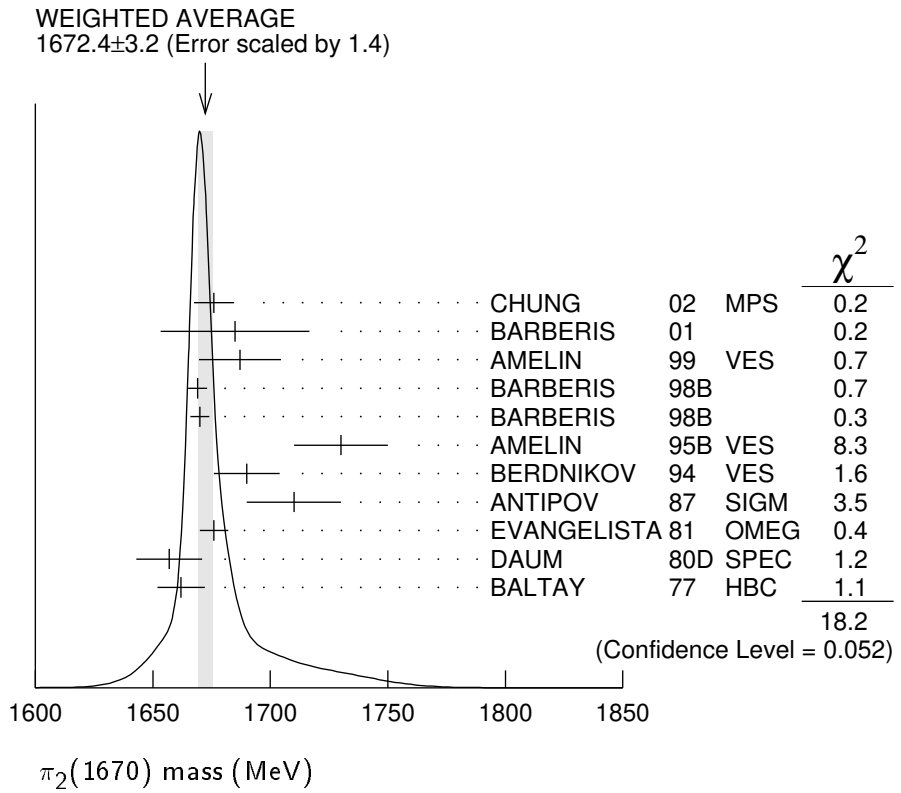
$\pi_2(1670)$

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

$\pi_2(1670)$ MASS

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*CHG*	*COMMENT*
1672.4± 3.2 OUR AVERAGE		Error includes scale factor of 1.4. See the ideogram below.				
1676 ± 3 ± 8		[1] CHUNG	02	MPS		18.3 $\pi^- p \to \pi^+ \pi^- \pi^- p$
1685 ±10 ±30		[2] BARBERIS	01			450 $pp \to p_f 3\pi^0 p_s$
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		[3] AMELIN	95B	VES		36 $\pi^- A \to \pi^+\pi^-\pi^- A$
1690 ±14		[4] 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		[4] EVANGELISTA	81	OMEG	–	12 $\pi^- p \to 3\pi p$
1657 ±14		[4,5] DAUM	80D	SPEC	–	63–94 $\pi p \to 3\pi$X
1662 ±10	2000	[4] 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		[1] BELLINI	85	SPEC		40 $\pi^- A \to \pi^-\pi^+\pi^- A$
1622 ±35		[6] BELLINI	85	SPEC		40 $\pi^- A \to \pi^-\pi^+\pi^- A$
1693 ±28		[7] BELLINI	85	SPEC		40 $\pi^- A \to \pi^-\pi^+\pi^- A$
1710 ±20		[8] DAUM	81B	SPEC	–	63,94 $\pi^- p$
1660 ±10		[4] ASCOLI	73	HBC	–	5–25 $\pi^- p \to p\pi_2$

[1] From $f_2(1270)\pi$ decay.
[2] From a fit to the invariant mass distribution.
[3] From a fit to $J^{PC} = 2^{-+}$ $f_2(1270)\pi$, $f_0(1370)\pi$ waves.
[4] From a fit to $J^P = 2^-$ S-wave $f_2(1270)\pi$ partial wave.
[5] 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.
[6] From $\rho\pi$ decay.
[7] From $\sigma\pi$ decay.
[8] From a two-resonance fit to four 2^-0^+ waves. This should not be averaged with all the single resonance fits.

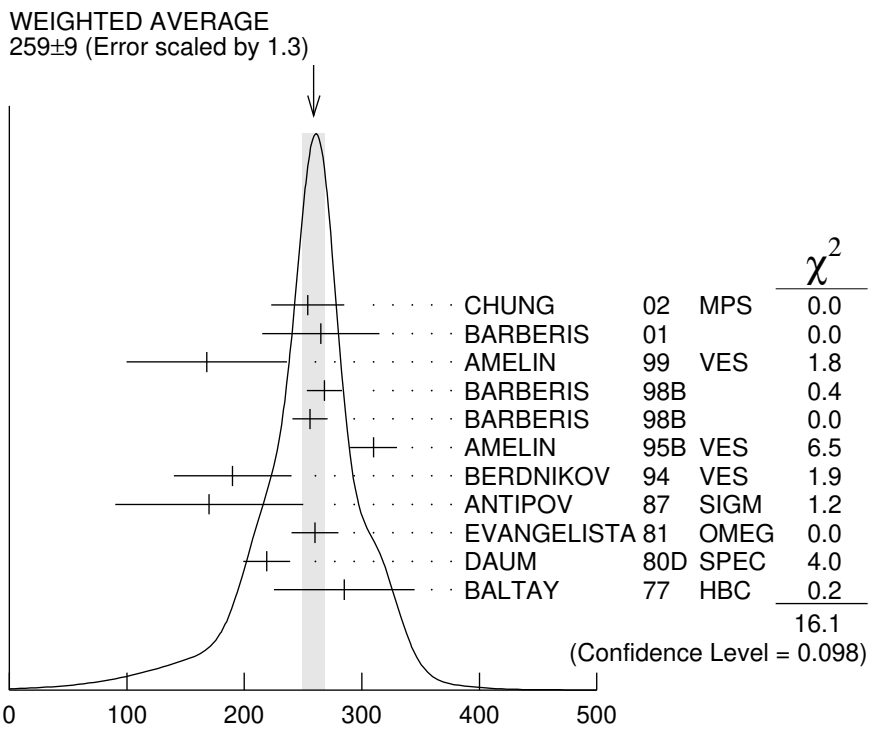


$\pi_2(1670)$ WIDTH

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*CHG*	*COMMENT*
259± 9 OUR AVERAGE		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 π^- 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	[15] BELLINI	85	SPEC		40 $\pi^- A \to \pi^- \pi^+ \pi^- A$
312± 50	[16] DAUM	81B	SPEC	–	63,94 $\pi^- p$
270± 60	[12] ASCOLI	73	HBC	–	5–25 $\pi^- p \to p \pi_2$

[9] From $f_2(1270)\pi$ decay.
[10] From a fit to the invariant mass distribution.
[11] From a fit to $J^{PC} = 2^{-+}$ $f_2(1270)\pi$, $f_0(1370)\pi$ waves.
[12] From a fit to $J^P = 2^-$ $f_2(1270)\pi$ partial wave.
[13] 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.
[14] From $\rho\pi$ decay.
[15] From $\sigma\pi$ decay.
[16] 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 (Γ_i/Γ)	Confidence level
Γ_1	3π	(95.8±1.4) %	
Γ_2	$\pi^+\pi^-\pi^0$		
Γ_3	$\pi^0\pi^0\pi^0$		
Γ_4	$f_2(1270)\pi$	(56.2±3.2) %	
Γ_5	$\rho\pi$	(31 ±4) %	
Γ_6	$\sigma\pi$	(10.9±3.4) %	
Γ_7	$(\pi\pi)_{S\text{-wave}}$	(8.7±3.4) %	

Γ_8	$K\overline{K}^*(892)+$ c.c.		(4.2±1.4) %		
Γ_9	$\omega\rho$		(2.7±1.1) %		
Γ_{10}	$\gamma\gamma$				
Γ_{11}	$\eta\pi$				
Γ_{12}	$\pi^\pm 2\pi^+ 2\pi^-$				
Γ_{13}	$\rho(1450)\pi$	<	3.6	$\times 10^{-3}$	97.7%
Γ_{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 $\left\langle \delta x_i \delta x_j \right\rangle / (\delta x_i \cdot \delta x_j)$, in percent, from the fit to the branching fractions, $x_i \equiv \Gamma_i/\Gamma_{\rm total}$. 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

$\Gamma(\gamma\gamma)$ Γ_{10}

VALUE (keV)	*CL%*	*DOCUMENT ID*		*TECN*	*CHG*	*COMMENT*
<0.072	90	[17] ACCIARRI	97T	L3		$e^+e^- \to e^+e^-\pi^+\pi^-\pi^0$
<0.19	90	[17] 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	[18]	BEHREND	90C	CELL	0	$e^+e^- \to e^+e^-\pi^+\pi^-\pi^0$
1.3 ±0.3 ±0.2	[19]	BEHREND	90C	CELL	0	$e^+e^- \to e^+e^-\pi^+\pi^-\pi^0$

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

$\pi_2(1670)$ BRANCHING RATIOS

$\Gamma(3\pi)/\Gamma_{\rm total}$ $\Gamma_1/\Gamma \equiv (\Gamma_4+\Gamma_5+\Gamma_7)/\Gamma$

VALUE	*DOCUMENT ID*
0.958±0.014 OUR FIT	

$\Gamma(\pi^0\pi^0\pi^0)/\Gamma(\pi^+\pi^-\pi^0)$ Γ_3/Γ_2

VALUE	DOCUMENT ID		COMMENT
0.29±0.03±0.05	[20] BARBERIS	01	450 $pp \rightarrow p_f 3\pi^0 p_s$

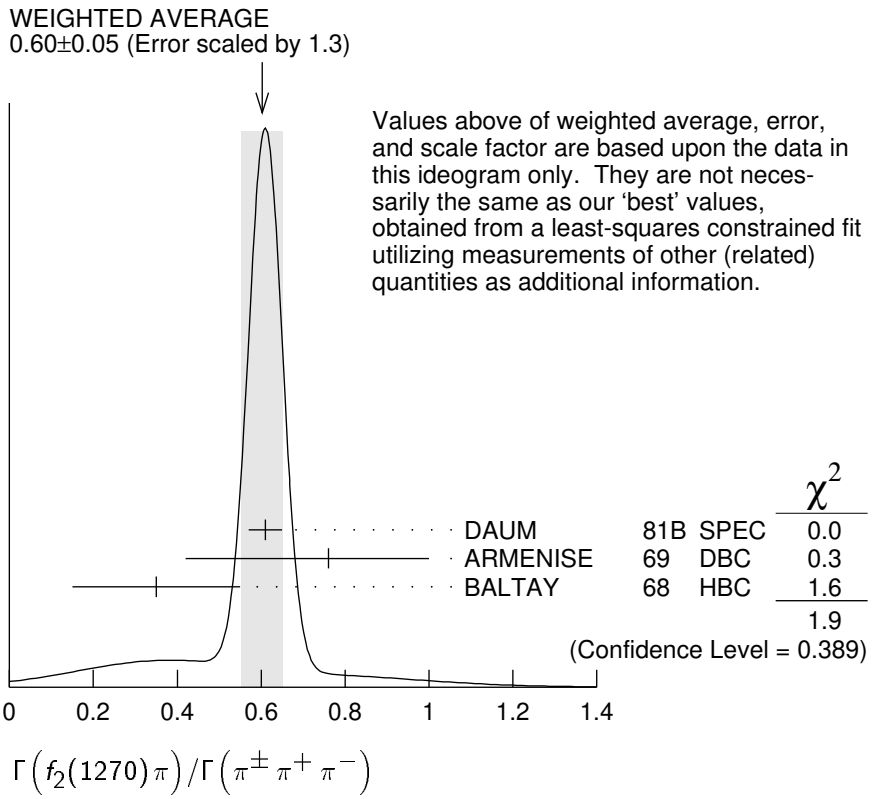
$\Gamma(\rho\pi)/\Gamma(\pi^\pm\pi^+\pi^-)$ $\frac{1}{2}\Gamma_5/(0.567\Gamma_4+\frac{1}{2}\Gamma_5+0.624\Gamma_7)$

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



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

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

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

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

(All 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 $\pi^- p \to f_2 \pi^- N$

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

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

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

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

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

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

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

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

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

$\Gamma(K\overline{K}^*(892)+\text{c.c.})/\Gamma(f_2(1270)\pi)$ Γ_8/Γ_4

VALUE		DOCUMENT ID		TECN	CHG	COMMENT
0.075±0.025 OUR FIT						
0.075±0.025	[22]	ARMSTRONG	82B	OMEG	−	16 $\pi^- p \to K^+ K^- \pi^- p$

$\Gamma(\omega\rho)/\Gamma_{total}$ Γ_9/Γ

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

$\Gamma(\sigma\pi)/\Gamma(f_2(1270)\pi)$ Γ_6/Γ_4

VALUE		DOCUMENT ID		TECN	COMMENT
0.19±0.06 OUR AVERAGE					
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 $\overline{p}p \rightarrow 4\pi^0$

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

VALUE		DOCUMENT ID		TECN	COMMENT
−0.18±0.06	[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	[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
−0.72±0.07±0.14	CHUNG	02	MPS	18.3 $\pi^- p \rightarrow \pi^+\pi^-\pi^- p$

[20] Using BARBERIS 98B.
[21] From a two-resonance fit to four 2^-0^+ waves.
[22] From a partial-wave analysis of $K^+K^-\pi^-$ system.
[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

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BARBERIS	01	PL B507 14	D. Barberis et al.	
AMELIN	99	PAN 62 445	D.V. Amelin et al.	(VES Collab.)
		Translated from YAF 62 487.		
BAKER	99	PL B449 114	C.A. Baker et al.	
BARBERIS	98B	PL B422 399	D. Barberis et al.	(WA 102 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	D. Bellini et al.	
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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+)
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DAUM	80D	PL 89B 285	C. Daum et al.	(AMST, CERN, CRAC, MPIM+) JP
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