

$\Delta(1700) \ 3/2^-$ $I(J^P) = \frac{3}{2}(\frac{3}{2}^-)$ Status: ****

Most of the results published before 1975 were last included in our 1982 edition, *Physics Letters* **111B** 1 (1982). Some further obsolete results published before 1984 were last included in our 2006 edition, *Journal of Physics* (generic for all A,B,E,G) **G33** 1 (2006).

 $\Delta(1700)$ BREIT-WIGNER MASS

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1670 to 1750 (≈ 1700) OUR ESTIMATE			
1715 $\begin{smallmatrix} +30 \\ -15 \end{smallmatrix}$	ANISOVICH	12A	DPWA Multichannel
1695.0 \pm 1.3	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
1710 \pm 30	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
1680 \pm 70	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1691 \pm 4	SHRESTHA	12A	DPWA Multichannel
1780 \pm 40	ANISOVICH	10	DPWA Multichannel
1790 \pm 30	HORN	08A	DPWA Multichannel
1770 \pm 40	THOMA	08	DPWA Multichannel
1687.9 \pm 2.5	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$
1678 \pm 1	PENNER	02C	DPWA Multichannel
1732 \pm 23	VRANA	00	DPWA Multichannel
1690 \pm 15	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
1680	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
1655	LI	93	IPWA $\gamma N \rightarrow \pi N$
1762 \pm 44	MANLEY	92	IPWA $\pi N \rightarrow \pi N \ \& \ N\pi\pi$
1650	BARNHAM	80	IPWA $\pi N \rightarrow N\pi\pi$
1718.4 $\begin{smallmatrix} +13.1 \\ -13.0 \end{smallmatrix}$	¹ CHEW	80	BPWA $\pi^+ p \rightarrow \pi^+ p$
1600	² LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$
1680	³ LONGACRE	75	IPWA $\pi N \rightarrow N\pi\pi$

 $\Delta(1700)$ BREIT-WIGNER WIDTH

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
200 to 400 (≈ 300) OUR ESTIMATE			
310 $\begin{smallmatrix} +40 \\ -15 \end{smallmatrix}$	ANISOVICH	12A	DPWA Multichannel
375.5 \pm 7.0	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
280 \pm 80	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
230 \pm 80	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$

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

248 ± 9	SHRESTHA	12A	DPWA	Multichannel
580 ± 120	ANISOVICH	10	DPWA	Multichannel
580 ± 60	HORN	08A	DPWA	Multichannel
630 ± 150	THOMA	08	DPWA	Multichannel
364.8 ± 16.6	ARNDT	04	DPWA	$\pi N \rightarrow \pi N, \eta N$
606 ± 15	PENNER	02C	DPWA	Multichannel
119 ± 70	VRANA	00	DPWA	Multichannel
285 ± 20	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
272	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
348	LI	93	IPWA	$\gamma N \rightarrow \pi N$
600 ± 250	MANLEY	92	IPWA	$\pi N \rightarrow \pi N \& N\pi\pi$
160	BARNHAM	80	IPWA	$\pi N \rightarrow N\pi\pi$
193.3 ± 26.0	¹ CHEW	80	BPWA	$\pi^+ p \rightarrow \pi^+ p$
200	² LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$
240	³ LONGACRE	75	IPWA	$\pi N \rightarrow N\pi\pi$

$\Delta(1700)$ POLE POSITION

REAL PART

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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1620 to 1680 (≈ 1650) OUR ESTIMATE

1680 ± 10	ANISOVICH	12A	DPWA	Multichannel
1632	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
1651	⁴ HOEHLER	93	SPED	$\pi N \rightarrow \pi N$
1675 ± 25	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$

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

1656	SHRESTHA	12A	DPWA	Multichannel
1650 ± 30	ANISOVICH	10	DPWA	Multichannel
1640 ± 25	HORN	08A	DPWA	Multichannel
1610 ± 35	THOMA	08	DPWA	Multichannel
1617	ARNDT	04	DPWA	$\pi N \rightarrow \pi N, \eta N$
1726	VRANA	00	DPWA	Multichannel
1655	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
1646	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90
1681 or 1672	⁵ LONGACRE	78	IPWA	$\pi N \rightarrow N\pi\pi$
1600 or 1594	² LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$

− 2×IMAGINARY PART

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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160 to 300 (≈ 230) OUR ESTIMATE

305 ± 15	ANISOVICH	12A	DPWA	Multichannel
253	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
159	⁴ HOEHLER	93	SPED	$\pi N \rightarrow \pi N$
220 ± 40	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$

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

226	SHRESTHA	12A	DPWA	Multichannel
275 ± 35	ANISOVICH	10	DPWA	Multichannel
325 ± 35	HORN	08A	DPWA	Multichannel
320 ± 60	THOMA	08	DPWA	Multichannel
226	ARNDT	04	DPWA	$\pi N \rightarrow \pi N, \eta N$
118	VRANA	00	DPWA	Multichannel
242	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
208	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90
245 or 241	⁵ LONGACRE	78	IPWA	$\pi N \rightarrow N\pi\pi$
208 or 201	² LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$

$\Delta(1700)$ ELASTIC POLE RESIDUE

MODULUS $|r|$

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
42 ± 7	ANISOVICH	12A	DPWA Multichannel
18	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
10	HOEHLER	93	SPED $\pi N \rightarrow \pi N$
13 ± 3	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$

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

16	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$
16	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
13	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90

PHASE θ

<u>VALUE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
− 3 ± 15	ANISOVICH	12A	DPWA Multichannel
− 40	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
− 20 ± 25	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$

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

− 47	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$
− 12	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
− 22	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90

$\Delta(1700)$ INELASTIC POLE RESIDUE

The “normalized residue” is the residue divided by $\Gamma_{pole}/2$.

Normalized residue in $N\pi \rightarrow \Delta(1700) \rightarrow \Delta\eta$

<u>MODULUS (%)</u>	<u>PHASE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
12 ± 3	− 60 ± 15	ANISOVICH	12A	DPWA Multichannel

$\Delta(1700)$ DECAY MODES

The following branching fractions are our estimates, not fits or averages.

Mode	Fraction (Γ_i/Γ)
Γ_1 $N\pi$	10–20 %
Γ_2 ΣK	
Γ_3 $N\pi\pi$	80–90 %
Γ_4 $\Delta\pi$	30–60 %
Γ_5 $\Delta(1232)\pi$, <i>S</i> -wave	25–50 %
Γ_6 $\Delta(1232)\pi$, <i>D</i> -wave	5–15 %
Γ_7 $N\rho$	30–55 %
Γ_8 $N\rho$, $S=1/2$, <i>D</i> -wave	
Γ_9 $N\rho$, $S=3/2$, <i>S</i> -wave	5–20 %
Γ_{10} $N\rho$, $S=3/2$, <i>D</i> -wave	
Γ_{11} $N(1535)\pi$	
Γ_{12} $\Delta(1232)\eta$	(5.0±2.0) %
Γ_{13} $N\gamma$	0.22–0.60 %
Γ_{14} $N\gamma$, helicity=1/2	0.12–0.30 %
Γ_{15} $N\gamma$, helicity=3/2	0.10–0.30 %

$\Delta(1700)$ BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{\text{total}}$				Γ_1/Γ
VALUE (%)	DOCUMENT ID	TECN	COMMENT	
10 to 20 OUR ESTIMATE				
22 ±4	ANISOVICH	12A	DPWA	Multichannel
15.6±0.1	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
12 ±3	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
20 ±3	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
14 ±1	SHRESTHA	12A	DPWA	Multichannel
16 ±7	ANISOVICH	10	DPWA	Multichannel
20 ±7	HORN	08A	DPWA	Multichannel
15 ±8	THOMA	08	DPWA	Multichannel
15.0±0.1	ARNDT	04	DPWA	$\pi N \rightarrow \pi N, \eta N$
14 ±1	PENNER	02C	DPWA	Multichannel
5 ±1	VRANA	00	DPWA	Multichannel
16	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
14 ±6	MANLEY	92	IPWA	$\pi N \rightarrow \pi N \& N\pi\pi$
16	¹ CHEW	80	BPWA	$\pi^+ p \rightarrow \pi^+ p$

Note: Signs of couplings from $\pi N \rightarrow N\pi\pi$ analyses were changed in the 1986 edition to agree with the baryon-first convention; the overall phase

ambiguity is resolved by choosing a negative sign for the $\Delta(1620) S_{31}$ coupling to $\Delta(1232)\pi$.

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1700) \rightarrow \Delta(1232)\pi$, **S-wave** $(\Gamma_1 \Gamma_5)^{1/2} / \Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
+0.21 to +0.29 OUR ESTIMATE			
+0.18 ± 0.04	BARNHAM	80	IPWA $\pi N \rightarrow N\pi\pi$
+0.30	^{2,6} LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$
+0.24	³ LONGACRE	75	IPWA $\pi N \rightarrow N\pi\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
+0.32 ± 0.06	MANLEY	92	IPWA $\pi N \rightarrow \pi N \& N\pi\pi$

$\Gamma(\Delta(1232)\pi, S\text{-wave}) / \Gamma_{\text{total}}$ Γ_5 / Γ

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
20 ⁺²⁵ ₋₁₃	ANISOVICH	12A	DPWA Multichannel
90 ± 2	VRANA	00	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
54 ± 3	SHRESTHA	12A	DPWA Multichannel

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1700) \rightarrow \Delta(1232)\pi$, **D-wave** $(\Gamma_1 \Gamma_6)^{1/2} / \Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
+0.05 to +0.11 OUR ESTIMATE			
0.14 ± 0.04	BARNHAM	80	IPWA $\pi N \rightarrow N\pi\pi$
+0.05	^{2,6} LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$
+0.10	³ LONGACRE	75	IPWA $\pi N \rightarrow N\pi\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
+0.08 ± 0.03	MANLEY	92	IPWA $\pi N \rightarrow \pi N \& N\pi\pi$

$\Gamma(\Delta(1232)\pi, D\text{-wave}) / \Gamma_{\text{total}}$ Γ_6 / Γ

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
5 to 15 OUR ESTIMATE			
12 ⁺¹⁴ ₋₇	ANISOVICH	12A	DPWA Multichannel
4 ± 1	VRANA	00	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
1 ± 1	SHRESTHA	12A	DPWA Multichannel

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1700) \rightarrow N\rho, S=1/2$, **D-wave** $(\Gamma_1 \Gamma_8)^{1/2} / \Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
+0.17 ± 0.05	BARNHAM	80	IPWA $\pi N \rightarrow N\pi\pi$

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1700) \rightarrow N\rho, S=3/2$, **S-wave** $(\Gamma_1 \Gamma_9)^{1/2} / \Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
±0.11 to ±0.19 OUR ESTIMATE			
+0.04	^{2,6} LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$
-0.30	³ LONGACRE	75	IPWA $\pi N \rightarrow N\pi\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
+0.10 ± 0.03	MANLEY	92	IPWA $\pi N \rightarrow \pi N \& N\pi\pi$

$\Gamma(N\rho, S=3/2, S\text{-wave})/\Gamma_{\text{total}}$ Γ_9/Γ

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1 ± 1	VRANA	00	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
30 ± 3	SHRESTHA	12A	DPWA Multichannel

$(\Gamma_i \Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1700) \rightarrow N\rho, S=3/2, D\text{-wave}$ $(\Gamma_1 \Gamma_{10})^{1/2}/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.18 ± 0.07	BARNHAM	80	IPWA $\pi N \rightarrow N\pi\pi$

$\Gamma(N(1535)\pi)/\Gamma_{\text{total}}$ Γ_{11}/Γ

<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. • • •			
4 ± 2	HORN	08A	DPWA Multichannel

$\Gamma(\Delta(1232)\eta)/\Gamma_{\text{total}}$ Γ_{12}/Γ

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
5 ± 2	ANISOVICH	12A	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
2 ± 1	HORN	08A	DPWA Multichannel

$\Gamma(N(1535)\pi)/\Gamma(\Delta(1232)\eta)$ Γ_{11}/Γ_{12}

<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. • • •			
0.67	KASHEVAROV 09	CBAL	$\gamma p \rightarrow p\pi^0\eta$

$\Delta(1700)$ PHOTON DECAY AMPLITUDES

Papers on γN amplitudes predating 1981 may be found in our 2006 edition, *Journal of Physics* (generic for all A,B,E,G) **G33** 1 (2006).

$\Delta(1700) \rightarrow N\gamma$, helicity-1/2 amplitude $A_{1/2}$

<u>VALUE ($\text{GeV}^{-1/2}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.140 ± 0.030 OUR ESTIMATE			
0.132 ± 0.005	DUGGER	13	DPWA $\gamma N \rightarrow \pi N$
0.160 ± 0.020	ANISOVICH	12A	DPWA Multichannel
0.105 ± 0.005	WORKMAN	12A	DPWA $\gamma N \rightarrow \pi N$
0.125 ± 0.003	DUGGER	07	DPWA $\gamma N \rightarrow \pi N$
0.111 ± 0.017	CRAWFORD	83	IPWA $\gamma N \rightarrow \pi N$
0.089 ± 0.033	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
0.058 ± 0.010	SHRESTHA	12A	DPWA Multichannel
0.160 ± 0.045	ANISOVICH	10	DPWA Multichannel
0.160 ± 0.040	HORN	08A	DPWA Multichannel
0.226	DRECHSEL	07	DPWA $\gamma N \rightarrow \pi N$
0.096	PENNER	02D	DPWA Multichannel
0.090 ± 0.025	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
0.121 ± 0.004	LI	93	IPWA $\gamma N \rightarrow \pi N$

$\Delta(1700) \rightarrow N\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE (GeV ^{-1/2})	DOCUMENT ID	TECN	COMMENT
0.140±0.030 OUR ESTIMATE			
0.108±0.005	DUGGER	13	DPWA $\gamma N \rightarrow \pi N$
0.165±0.025	ANISOVICH	12A	DPWA Multichannel
0.092±0.004	WORKMAN	12A	DPWA $\gamma N \rightarrow \pi N$
0.105±0.003	DUGGER	07	DPWA $\gamma N \rightarrow \pi N$
0.107±0.015	CRAWFORD	83	IPWA $\gamma N \rightarrow \pi N$
0.060±0.015	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.097±0.008	SHRESTHA	12A	DPWA Multichannel
0.160±0.040	ANISOVICH	10	DPWA Multichannel
0.150±0.030	HORN	08A	DPWA Multichannel
0.210	DRECHSEL	07	DPWA $\gamma N \rightarrow \pi N$
0.154	PENNER	02D	DPWA Multichannel
0.097±0.020	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
0.115±0.004	LI	93	IPWA $\gamma N \rightarrow \pi N$

 $\Delta(1700)$ FOOTNOTES

- ¹ Problems with CHEW 80 are discussed in section 2.1.11 of HOEHLER 83.
- ² LONGACRE 77 pole positions are from a search for poles in the unitarized T-matrix; the first (second) value uses, in addition to $\pi N \rightarrow N\pi\pi$ data, elastic amplitudes from a Saclay (CERN) partial-wave analysis. The other LONGACRE 77 values are from eyeball fits with Breit-Wigner circles to the T-matrix amplitudes.
- ³ From method II of LONGACRE 75: eyeball fits with Breit-Wigner circles to the T-matrix amplitudes.
- ⁴ See HOEHLER 93 for a detailed discussion of the evidence for and the pole parameters of N and Δ resonances as determined from Argand diagrams of πN elastic partial-wave amplitudes and from plots of the speeds with which the amplitudes traverse the diagrams.
- ⁵ LONGACRE 78 values are from a search for poles in the unitarized T-matrix. The first (second) value uses, in addition to $\pi N \rightarrow N\pi\pi$ data, elastic amplitudes from a Saclay (CERN) partial-wave analysis.
- ⁶ LONGACRE 77 considers this coupling to be well determined.

 $\Delta(1700)$ REFERENCES

For early references, see Physics Letters **111B** 1 (1982).

DUGGER	13	PR C88 065203	M. Dugger <i>et al.</i>	(CLAS Collab.)
ANISOVICH	12A	EPJ A48 15	A.V. Anisovich <i>et al.</i>	(BONN, PNPI)
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)
WORKMAN	12A	PR C86 015202	R. Workman <i>et al.</i>	(GWU)
ANISOVICH	10	EPJ A44 203	A.V. Anisovich <i>et al.</i>	(BONN, PNPI)
KASHEVAROV	09	EPJ A42 141	V.L. Kashevarov <i>et al.</i>	(MAMI Crystal Ball/TAPS)
HORN	08A	EPJ A38 173	I. Horn <i>et al.</i>	(CB-ELSA Collab.)
Also		PRL 101 202002	I. Horn <i>et al.</i>	(CB-ELSA Collab.)
THOMA	08	PL B659 87	U. Thoma <i>et al.</i>	(CB-ELSA Collab.)
DRECHSEL	07	EPJ A34 69	D. Drechsel, S.S. Kamalov, L. Tiator	(MAINZ, JINR)
DUGGER	07	PR C76 025211	M. Dugger <i>et al.</i>	(Jefferson Lab CLAS Collab.)
ARNDT	06	PR C74 045205	R.A. Arndt <i>et al.</i>	(GWU)
PDG	06	JP G33 1	W.-M. Yao <i>et al.</i>	(PDG Collab.)
ARNDT	04	PR C69 035213	R.A. Arndt <i>et al.</i>	(GWU, TRIU)
PENNER	02C	PR C66 055211	G. Penner, U. Mosel	(GIES)
PENNER	02D	PR C66 055212	G. Penner, U. Mosel	(GIES)
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman, T.-S.H. Lee	(PITT+)
ARNDT	96	PR C53 430	R.A. Arndt, I.I. Strakovsky, R.L. Workman	(VPI)

ARNDT	95	PR C52 2120	R.A. Arndt <i>et al.</i>	(VPI, BRCO)
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)
LI	93	PR C47 2759	Z.J. Li <i>et al.</i>	(VPI)
MANLEY	92	PR D45 4002	D.M. Manley, E.M. Saleski	(KSA) IJP
Also		PR D30 904	D.M. Manley <i>et al.</i>	(VPI)
ARNDT	91	PR D43 2131	R.A. Arndt <i>et al.</i>	(VPI, TELE) IJP
CRAWFORD	83	NP B211 1	R.L. Crawford, W.T. Morton	(GLAS)
HOEHLER	83	Landolt-Boernstein 1/9B2	G. Hohler	(KARLT)
PDG	82	PL 111B 1	M. Roos <i>et al.</i>	(HELS, CIT, CERN)
AWAJI	81	Bonn Conf. 352	N. Awaji, R. Kajikawa	(NAGO)
Also		NP B197 365	K. Fujii <i>et al.</i>	(NAGO)
BARNHAM	80	NP B168 243	K.W.J. Barnham <i>et al.</i>	(LOIC)
CHEW	80	Toronto Conf. 123	D.M. Chew	(LBL) IJP
CUTKOSKY	80	Toronto Conf. 19	R.E. Cutkosky <i>et al.</i>	(CMU, LBL) IJP
Also		PR D20 2839	R.E. Cutkosky <i>et al.</i>	(CMU, LBL) IJP
HOEHLER	79	PDAT 12-1	G. Hohler <i>et al.</i>	(KARLT) IJP
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP
LONGACRE	78	PR D17 1795	R.S. Longacre <i>et al.</i>	(LBL, SLAC)
LONGACRE	77	NP B122 493	R.S. Longacre, J. Dolbeau	(SACL) IJP
Also		NP B108 365	J. Dolbeau <i>et al.</i>	(SACL) IJP
LONGACRE	75	PL 55B 415	R.S. Longacre <i>et al.</i>	(LBL, SLAC) IJP