$\Delta(1232)\ 3/2^+$

$I(J^P) = \frac{3}{2}(\frac{3}{2}^+)$ Status: ∗∗∗∗

Older and obsolete values are listed and referenced in the 2014 edition, Chinese Physics **C38** 070001 (2014).

Δ(1232) POLE POSITIONS

REAL PART, MIXED CHARGES

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1209 to 1211 (≈ 1210) OUR ESTIMATE				
1211 ±1 ±1	[1] SVARC	14	L+P	$\pi N \to \pi N$
1210.5±1.0	ANISOVICH	12A	DPWA	Multichannel
1210 ±1	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1215 ±1	ROENCHEN	22	DPWA	Multichannel
1212.4	HUNT	19	DPWA	Multichannel
1218	ROENCHEN	15A	DPWA	Multichannel
1211 ±1	ANISOVICH	10	DPWA	Multichannel
1211	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
1210	ARNDT	04	DPWA	$\pi N \to \pi N$, ηN
1209	[2] HOEHLER	93	ARGD	$\pi N \to \pi N$

[1] Fit to the amplitudes of HOEHLER 79.

[2] 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.

−2×IMAGINARY PART, MIXED CHARGES

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
98 to 102 (≈ 100) OUR ESTIMATE				
93 ±1	ROENCHEN	22	DPWA	Multichannel
98 ±2±1	[1] SVARC	14	L+P	$\pi N \to \pi N$
99 ±2	ANISOVICH	12A	DPWA	Multichannel
100 ±2	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
96.8	HUNT	19	DPWA	Multichannel
92	ROENCHEN	15A	DPWA	Multichannel
100 ±2	ANISOVICH	10	DPWA	Multichannel
99	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
100	ARNDT	04	DPWA	$\pi N \to \pi N$, ηN
100	[2] HOEHLER	93	ARGD	$\pi N \to \pi N$

[1] Fit to the amplitudes of HOEHLER 79.

[2] 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.

REAL PART, $\Delta(1232)^{++}$

VALUE (MeV)	DOCUMENT ID		COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
1212.50±0.24	BERNICHA	96	Fit to PEDRONI 78

−2×IMAGINARY PART, $\Delta(1232)^{++}$

VALUE (MeV)	*DOCUMENT ID*		*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •			
97.37±0.42	BERNICHA	96	Fit to PEDRONI 78

REAL PART, $\Delta(1232)^{+}$

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1211 ±1 to 1212 ± 1	HANSTEIN	96	DPWA	$\gamma N \to \pi N$
1206.9±0.9 to 1210.5 ± 1.8	MIROSHNIC...	79		Fit photoproduction

−2×IMAGINARY PART, $\Delta(1232)^{+}$

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
102 ±2 to 99 ± 2	[1] HANSTEIN	96	DPWA	$\gamma N \to \pi N$
111.2±2.0 to 116.6 ± 2.2	MIROSHNIC...	79		Fit photoproduction

[1] The second (lower) value of HANSTEIN 96 here goes with the second (higher) value of the real part in the preceding data block.

REAL PART, $\Delta(1232)^{0}$

VALUE (MeV)	*DOCUMENT ID*		*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •			
1213.20±0.66	BERNICHA	96	Fit to PEDRONI 78

−2×IMAGINARY PART, $\Delta(1232)^{0}$

VALUE (MeV)	*DOCUMENT ID*		*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •			
104.10±1.01	BERNICHA	96	Fit to PEDRONI 78

Δ(1232) ELASTIC POLE RESIDUES

ABSOLUTE VALUE, MIXED CHARGES

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
49 to 52 (≈ 50) OUR ESTIMATE				
50 ±1	ROENCHEN	22	DPWA	Multichannel
50 ±1 ±1	[1] SVARC	14	L+P	$\pi N \to \pi N$
51.6±0.6	ANISOVICH	12A	DPWA	Multichannel
53 ±2	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
46	ROENCHEN	15A	DPWA	Multichannel
52	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
53	ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
50	HOEHLER	93	ARGD	$\pi N \to \pi N$

PHASE, MIXED CHARGES

VALUE (°)	*DOCUMENT ID*		*TECN*	*COMMENT*
−48 to −45 (≈ − 46) OUR ESTIMATE				
−39±1	ROENCHEN	22	DPWA	Multichannel
−46±1±1	[1] SVARC	14	L+P	$\pi N \to \pi N$
−46±1	ANISOVICH	12A	DPWA	Multichannel
−47±1	CUTKOSKY	80	IPWA	$\pi N \to \pi N$

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

−36	ROENCHEN	15A	DPWA	Multichannel
−47	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
−47	ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
−48	HOEHLER	93	ARGD	$\pi N \to \pi N$

[1] Fit to the amplitudes of HOEHLER 79.

Δ(1232) BREIT-WIGNER MASSES

MIXED CHARGES

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1230 to 1234 (≈ 1232) OUR ESTIMATE				
1230.8±0.4	[1] HUNT	19	DPWA	Multichannel
1228 ±2	ANISOVICH	12A	DPWA	Multichannel
1233.4±0.4	[1] ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
1232 ±3	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
1233 ±2	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1231.1±0.2	[1] SHRESTHA	12A	DPWA	Multichannel
1230 ±2	ANISOVICH	10	DPWA	Multichannel
1232.9±1.2	ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
1228 ±1	PENNER	02C	DPWA	Multichannel

[1] Statistical error only.

$\Delta(1232)^{++}$ MASS

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1230.55±0.20	GRIDNEV	06	DPWA	$\pi N \to \pi N$
1231.88±0.29	BERNICHA	96		Fit to PEDRONI 78
1230.5 ±0.2	ABAEV	95	IPWA	$\pi N \to \pi N$
1230.9 ±0.3	KOCH	80B	IPWA	$\pi N \to \pi N$
1231.1 ±0.2	PEDRONI	78		$\pi N \to \pi N$ 70–370 MeV

$\Delta(1232)^{+}$ MASS

VALUE (MeV)	DOCUMENT ID		COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
1234.9±1.4	MIROSHNIC...	79	Fit photoproduction

$\Delta(1232)^{0}$ MASS

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1231.3 ±0.6	BREITSCHOP...	06	CNTR	Using new CHEX data
1233.40±0.22	GRIDNEV	06	DPWA	$\pi N \to \pi N$
1234.35±0.75	BERNICHA	96		Fit to PEDRONI 78
1233.1 ±0.3	ABAEV	95	IPWA	$\pi N \to \pi N$
1233.6 ±0.5	KOCH	80B	IPWA	$\pi N \to \pi N$
1233.8 ±0.2	PEDRONI	78		$\pi N \to \pi N$ 70–370 MeV

$m_{\Delta^0} - m_{\Delta^{++}}$

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
2.86±0.30	GRIDNEV	06	DPWA	$\pi N \to \pi N$
2.25±0.68	BERNICHA	96		Fit to PEDRONI 78
2.6 ±0.4	ABAEV	95	IPWA	$\pi N \to \pi N$
2.7 ±0.3	[1] PEDRONI	78		See the masses

[1] Using $\pi^{\pm} d$ as well, PEDRONI 78 determine $(M^- - M^{++}) + (M^0 - M^+)/3 = 4.6 \pm 0.2$ MeV.

Δ(1232) BREIT-WIGNER WIDTHS

MIXED CHARGES

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
114 to 120 (≈ 117) OUR ESTIMATE				
110.9±0.8	[1] HUNT	19	DPWA	Multichannel
110 ±3	ANISOVICH	12A	DPWA	Multichannel
118.7±0.6	[1] ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
120 ±5	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
116 ±5	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
113.0±0.5	[1] SHRESTHA	12A	DPWA	Multichannel
112 ±4	ANISOVICH	10	DPWA	Multichannel
118.0±2.2	ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
106 ±1	PENNER	02C	DPWA	Multichannel

[1] Statistical error only.

Δ(1232)$^{++}$ WIDTH

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
112.2 ±0.7	GRIDNEV	06	DPWA	$\pi N \to \pi N$
109.07±0.48	BERNICHA	96		Fit to PEDRONI 78
111.0 ±1.0	KOCH	80B	IPWA	$\pi N \to \pi N$
111.3 ±0.5	PEDRONI	78		$\pi N \to \pi N$ 70–370 MeV

Δ(1232)$^+$ WIDTH

VALUE (MeV)	DOCUMENT ID		COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
131.1±2.4	MIROSHNIC...	79	Fit photoproduction

Δ(1232)^0 WIDTH

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
112.5 ±1.9	BREITSCHOP...	06	CNTR	Using new CHEX data
116.9 ±0.7	GRIDNEV	06	DPWA	$\pi N \to \pi N$
117.58±1.16	BERNICHA	96		Fit to PEDRONI 78
113.0 ±1.5	KOCH	80B	IPWA	$\pi N \to \pi N$
117.9 ±0.9	PEDRONI	78		$\pi N \to \pi N$ 70–370 MeV

Δ^0-Δ^{++} WIDTH DIFFERENCE

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
4.66±1.0	GRIDNEV	06	DPWA	$\pi N \to \pi N$
8.45±1.11	BERNICHA	96		Fit to PEDRONI 78
5.1 ±1.0	ABAEV	95	IPWA	$\pi N \to \pi N$
6.6 ±1.0	PEDRONI	78		See the widths

Δ(1232) DECAY MODES

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

	Mode	Fraction (Γ_i/Γ)
Γ_1	$N\pi$	99.4 %
Γ_2	$N\gamma$	0.55–0.65 %
Γ_3	$N\gamma$, helicity=1/2	0.11–0.13 %
Γ_4	$N\gamma$, helicity=3/2	0.44–0.52 %
Γ_5	$p e^+ e^-$	$(4.2\pm0.7)\times10^{-5}$

Δ(1232) BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{total}$ — Γ_1/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.994 OUR ESTIMATE				
0.9939±0.0001	[1] HUNT	19	DPWA	Multichannel
1.00	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
1.0	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
1.0	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.994	SHRESTHA	12A	DPWA	Multichannel
1.0	ANISOVICH	10	DPWA	Multichannel
1.000	ARNDT	04	DPWA	$\pi N \to \pi N$, ηN
1.00	PENNER	02C	DPWA	Multichannel

[1] Statistical error only.

$\Gamma(pe^+e^-)/\Gamma_{total}$ — Γ_5/Γ

VALUE (units 10^{-5})	DOCUMENT ID	
4.19±0.34±0.62	[1] ADAMCZEW...	17

[1] The systematic uncertainty includes the model dependence.

Δ(1232) PHOTON DECAY AMPLITUDES AT THE POLE

$\Delta(1232) \to N\gamma$, helicity-1/2 amplitude $A_{1/2}$

MODULUS (GeV$^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
−0.126±0.002	−18 ± 2	ROENCHEN	22	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
−0.117	−6.6	ROENCHEN	15A	DPWA	Multichannel

Δ(1232) → $N\gamma$, helicity-3/2 amplitude $A_{3/2}$

MODULUS ($GeV^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
−0.245±0.004	−0.7 ± 0.9	ROENCHEN	22	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
−0.226	2.8	ROENCHEN	15A	DPWA	Multichannel

Δ(1232) BREIT-WIGNER PHOTON DECAY AMPLITUDES

Papers on γN amplitudes predating 1981 may be found in our 2006 edition, Journal of Physics **G33** 1 (2006).

Δ(1232) → $N\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.142 to −0.129 (≈ − 0.135) OUR ESTIMATE				
−0.146 ±0.002	[1] HUNT	19	DPWA	Multichannel
−0.131 ±0.004	ANISOVICH	12A	DPWA	Multichannel
−0.139 ±0.002	[1] WORKMAN	12A	DPWA	$\gamma N \to N\pi$
−0.139 ±0.004	[1] DUGGER	07	DPWA	$\gamma N \to \pi N$
−0.137 ±0.005	AHRENS	04A	DPWA	$\vec{\gamma}\vec{p} \to N\pi$
−0.1357±0.0013±0.0037	BLANPIED	01	LEGS	$\gamma p \to p\gamma$, $p\pi^0$, $n\pi^+$
−0.131 ±0.001	[1] BECK	00	IPWA	$\vec{\gamma} p \to p\pi^0$, $n\pi^+$
−0.140 ±0.005	KAMALOV	99	DPWA	$\gamma N \to \pi N$
−0.1294±0.0013	HANSTEIN	98	IPWA	$\gamma N \to \pi N$
−0.1278±0.0012	DAVIDSON	97	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.137 ±0.001	[1] SHRESTHA	12A	DPWA	Multichannel
−0.136 ±0.005	ANISOVICH	10	DPWA	Multichannel
−0.140	DRECHSEL	07	DPWA	$\gamma N \to \pi N$
−0.129 ±0.001	ARNDT	02	DPWA	$\gamma p \to N\pi$
−0.128	PENNER	02D	DPWA	Multichannel
−0.1312	HANSTEIN	98	DPWA	$\gamma N \to \pi N$

[1] Statistical error only.

Δ(1232) → $N\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.262 to −0.248 (≈ − 0.255) OUR ESTIMATE				
−0.250 ±0.002	[1] HUNT	19	DPWA	Multichannel
−0.254 ±0.005	ANISOVICH	12A	DPWA	Multichannel
−0.262 ±0.003	WORKMAN	12A	DPWA	$\gamma N \to N\pi$
−0.258 ±0.005	DUGGER	07	DPWA	$\gamma N \to \pi N$
−0.256 ±0.003	AHRENS	04A	DPWA	$\vec{\gamma}\vec{p} \to N\pi$
−0.2669±0.0016±0.0078	BLANPIED	01	LEGS	$\gamma p \to p\gamma$, $p\pi^0$, $n\pi^+$
−0.251 ±0.001	BECK	00	IPWA	$\vec{\gamma} p \to p\pi^0$, $n\pi^+$
−0.258 ±0.006	KAMALOV	99	DPWA	$\gamma N \to \pi N$
−0.2466±0.0013	HANSTEIN	98	IPWA	$\gamma N \to \pi N$
−0.2524±0.0013	DAVIDSON	97	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.251 ±0.001	[1] SHRESTHA	12A	DPWA	Multichannel
−0.267 ±0.008	ANISOVICH	10	DPWA	Multichannel

−0.265	DRECHSEL 07	DPWA	$\gamma N \to \pi N$
−0.243 ±0.001	ARNDT 02	DPWA	$\gamma p \to N\pi$
−0.247	PENNER 02D	DPWA	Multichannel
−0.2522	HANSTEIN 98	DPWA	$\gamma N \to \pi N$

[1] Statistical error only.

$\Delta(1232) \to N\gamma$, E_2/M_1 ratio

VALUE	DOCUMENT ID	TECN	COMMENT
−0.030 to −0.020 (≈ − 0.025) OUR ESTIMATE			
−0.0274±0.0003±0.0030	AHRENS 04A	DPWA	$\vec{\gamma}\vec{p} \to N\pi$
−0.020 ±0.002	ARNDT 02	DPWA	$\gamma p \to N\pi$
−0.0307±0.0026±0.0024	BLANPIED 01	LEGS	$\gamma p \to p\gamma$, $p\pi^0$, $n\pi^+$
−0.016 ±0.004 ±0.002	GALLER 01	DPWA	$\gamma p \to \gamma p$
−0.025 ±0.001 ±0.002	BECK 00	IPWA	$\vec{\gamma} p \to p\pi^0$, $n\pi^+$
−0.0233±0.0017	HANSTEIN 98	IPWA	$\gamma N \to \pi N$
−0.015 ±0.005	[1] ARNDT 97	IPWA	$\gamma N \to \pi N$
−0.0319±0.0024	DAVIDSON 97	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
−0.022	DRECHSEL 07	DPWA	$\gamma N \to \pi N$
−0.026	PENNER 02D	DPWA	Multichannel
−0.0254±0.0010	HANSTEIN 98	DPWA	$\gamma N \to \pi N$
−0.025 ±0.002 ±0.002	BECK 97	IPWA	$\gamma N \to \pi N$
−0.030 ±0.003 ±0.002	BLANPIED 97	DPWA	$\gamma N \to \pi N$, γN

[1] This ARNDT 97 value is very sensitive to the database being fitted. The result is from a fit to the full pion photoproduction database, apart from the BLANPIED 97 cross-section measurements.

$\Delta(1232) \to N\gamma$, absolute value of E_2/M_1 ratio at pole

VALUE	DOCUMENT ID	TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
0.065±0.007	ARNDT 97	DPWA	$\gamma N \to \pi N$
0.058	HANSTEIN 96	DPWA	$\gamma N \to \pi N$

$\Delta(1232) \to N\gamma$, phase of E_2/M_1 ratio at pole

VALUE	DOCUMENT ID	TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
−122 ±5	ARNDT 97	DPWA	$\gamma N \to \pi N$
−127.2	HANSTEIN 96	DPWA	$\gamma N \to \pi N$

$\Delta(1232)$ MAGNETIC MOMENTS

$\Delta(1232)^{++}$ MAGNETIC MOMENT

The values are extracted from UCLA and SIN data on $\pi^+ p$ bremsstrahlung using a variety of different theoretical approximations and methods. Our estimate is *only* a rough guess of the range we expect the moment to lie within.

VALUE (μ_N)	DOCUMENT ID	TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
6.14±0.51	LOPEZCAST... 01	DPWA	$\pi^+ p \to \pi^+ p\gamma$
4.52±0.50±0.45	BOSSHARD 91		$\pi^+ p \to \pi^+ p\gamma$ (SIN data)

3.7 to 4.2	LIN	91B	$\pi^+ p \to \pi^+ p \gamma$ (from UCLA data)
4.6 to 4.9	LIN	91B	$\pi^+ p \to \pi^+ p \gamma$ (from SIN data)
5.6 to 7.5	WITTMAN	88	$\pi^+ p \to \pi^+ p \gamma$ (from UCLA data)
6.9 to 9.8	HELLER	87	$\pi^+ p \to \pi^+ p \gamma$ (from UCLA data)
4.7 to 6.7	NEFKENS	78	$\pi^+ p \to \pi^+ p \gamma$ (UCLA data)

$\Delta(1232)^+$ MAGNETIC MOMENT

VALUE (μ_N)	DOCUMENT ID		COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$2.7^{+1.0}_{-1.3} \pm 1.5 \pm 3$	[1] KOTULLA	02	$\gamma p \to p \pi^0 \gamma'$

[1] The second error is systematic, the third is an estimate of theoretical uncertainties.

$\Delta(1232)$ REFERENCES

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

ROENCHEN	22	EPJ A58 229	D. Roenchen *et al.*	(JULI, GWU, BONN+)
HUNT	19	PR C99 055205	B.C. Hunt, D.M. Manley	
ADAMCZEW...	17	PR C95 065205	J. Adamczewski-Musch *et al.*	(HADES Collab.)
ROENCHEN	15A	EPJ A51 70	D. Roenchen *et al.*	
PDG	14	CP C38 070001	K. Olive *et al.*	(PDG Collab.)
SVARC	14	PR C89 045205	A. Svarc *et al.*	(RBI Zagreb, UNI Tuzla)
ANISOVICH	12A	EPJ A48 15	A.V. Anisovich *et al.*	(BONN, PNPI)
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)
WORKMAN	12A	PR C86 015202	R. Workman *et al.*	(GWU)
ANISOVICH	10	EPJ A44 203	A.V. Anisovich *et al.*	(BONN, PNPI)
DRECHSEL	07	EPJ A34 69	D. Drechsel, S.S. Kamalov, L. Tiator	(MAINZ, JINR)
DUGGER	07	PR C76 025211	M. Dugger *et al.*	(JLab CLAS Collab.)
ARNDT	06	PR C74 045205	R.A. Arndt *et al.*	(GWU)
BREITSCHOP...	06	PL B639 424	J. Breitschopf *et al.*	(TUBIN, HEBR, CSUS)
GRIDNEV	06	PAN 69 1542	A.B. Gridnev *et al.*	(PNPI, BONN, GWU)
PDG	06	JP G33 1	W.-M. Yao *et al.*	(PDG Collab.)
AHRENS	04A	EPJ A21 323	J. Ahrens *et al.*	(A2 Collab.)
ARNDT	04	PR C69 035213	R.A. Arndt *et al.*	(GWU, TRIU)
ARNDT	02	PR C66 055213	R. A. Arndt *et al.*	(GWU)
KOTULLA	02	PRL 89 272001	M. Kotulla *et al.*	(MAMI TAPS Collab.)
PENNER	02C	PR C66 055211	G. Penner, U. Mosel	(GIES)
PENNER	02D	PR C66 055212	G. Penner, U. Mosel	(GIES)
BLANPIED	01	PR C64 025203	G. Blanpied *et al.*	(BNL LEGS Collab.)
GALLER	01	PL B503 245	G. Galler *et al.*	(Mainz LARA Collab.)
LOPEZCAST...	01	PL B517 339	G. Lopez Castro, A. Mariano	
Also		NP A697 440	G. Lopez Castro, A. Mariano	
BECK	00	PR C61 035204	R. Beck *et al.*	(Mainz Microtron DAPHNE Col.)
KAMALOV	99	PRL 83 4494	S.S. Kamalov, S.N. Yang	(Taiwan U.)
HANSTEIN	98	NP A632 561	O. Hanstein, D. Drechsel, L. Tiator	
ARNDT	97	PR C56 577	R.A. Arndt, I.I. Strakovsky, R.L. Workman	(VPI)
BECK	97	PRL 78 606	R. Beck *et al.*	(MAINZ, SACL, PAVI, GLAS)
Also		PRL 79 4510	R.L. Beck, H.P. Krahn	(MAINZ)
Also		PRL 79 4512	R.L. Beck, H.P. Krahn	(MAINZ)
Also		PRL 79 4515 (errat.)	R.L. Beck *et al.*	(MAINZ, SACL, PAVI, GLAS)
BLANPIED	97	PRL 79 4337	G.S. Blanpied *et al.*	(LEGS Collab.)
DAVIDSON	97	PRL 79 4509	R.M. Davidson, N.C.A. Mukhopadhyay	(RPI)
BERNICHA	96	NP A597 623	A. Bernicha, G. Lopez Castro, J. Pestieau	(LOUV+)
HANSTEIN	96	PL B385 45	O. Hanstein, D. Drechsel, L. Tiator	(MAINZ)
ABAEV	95	ZPHY A352 85	V.V. Abaev, S.P. Kruglov	(PNPI)
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)
BOSSHARD	91	PR D44 1962	A. Bosshard *et al.*	(ZURI, LBL, VILL+)
Also		PRL 64 2619	A. Bosshard *et al.*	(CATH, LAUS, LBL+)
LIN	91B	PR C44 1819	D.H. Lin, M.K. Liou, Z.M. Ding	(CUNY, CSOK)
Also		PR C43 R930	D. Lin, M.K. Liou	(CUNY)
WITTMAN	88	PR C37 2075	R. Wittman	(TRIU)
HELLER	87	PR C35 718	L. Heller *et al.*	(LANL, MIT, ILL)
CUTKOSKY	80	Toronto Conf. 19	R.E. Cutkosky *et al.*	(CMU, LBL) IJP
Also		PR D20 2839	R.E. Cutkosky *et al.*	(CMU, LBL)

KOCH	80B	NP A336 331	R. Koch, E. Pietarinen	(KARLT) IJP
HOEHLER	79	PDAT 12-1	G. Hohler *et al.*	(KARLT) IJP
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP
MIROSHNIC...	79	SJNP 29 94	I.I. Miroshnichenko *et al.*	(KFTI) IJP
		Translated from YAF 29 188.		
NEFKENS	78	PR D18 3911	B.M.K. Nefkens *et al.*	(UCLA, CATH) IJP
PEDRONI	78	NP A300 321	E. Pedroni *et al.*	(SIN, ISNG, KARLE+) IJP