$\Delta(1232)$ P_{33}

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

Most of the results published before 1977 are now obsolete and have been omitted. They may be found in our 1982 edition, Physics Letters **111B** (1982).

$\Delta(1232)$ BREIT-WIGNER MASSES

MIXED CHARGES

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1230 to 1234 (≈ 1232) OUR ESTIMATE				
1231±1	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
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. • • •				
1228±1	PENNER	02C	DPWA	Multichannel
1234±5	VRANA	00	DPWA	Multichannel
1233	ARNDT	95	DPWA	$\pi N \to N\pi$

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

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
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*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1231.6	CRAWFORD	80	DPWA	$\gamma N \to \pi N$
1234.9±1.4	MIROSHNIC...	79		Fit photoproduction
1231.2	BARBOUR	78	DPWA	$\gamma N \to \pi N$
1231.8	BERENDS	75	IPWA	$\gamma p \to \pi N$

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

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
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. • • •				
2.25±0.68	BERNICHA	96		Fit to PEDRONI 78
2.6 ±0.4	ABAEV	95	IPWA	$\pi N \rightarrow \pi N$
2.7 ±0.3	[3] PEDRONI	78		See the masses

Δ(1232) BREIT-WIGNER WIDTHS

MIXED CHARGES

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
115 to 125 (≈ 120) OUR ESTIMATE				
118± 4	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$
120± 5	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
116± 5	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
106± 1	PENNER	02C	DPWA	Multichannel
112±18	VRANA	00	DPWA	Multichannel
114	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$

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

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

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

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
111.2	CRAWFORD	80	DPWA	$\gamma N \rightarrow \pi N$
131.1±2.4	MIROSHNIC...	79		Fit photoproduction
111.0	BARBOUR	78	DPWA	$\gamma N \rightarrow \pi N$

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

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
117.58±1.16	BERNICHA	96		Fit to PEDRONI 78
113.0 ±1.5	KOCH	80B	IPWA	$\pi N \rightarrow \pi N$
117.9 ±0.9	PEDRONI	78		$\pi N \rightarrow \pi N$ 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. • • •				
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) POLE POSITIONS

REAL PART, MIXED CHARGES

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1209 to 1211 (≈ 1210) OUR ESTIMATE				
1211	ARNDT	95	DPWA	$\pi N \to N\pi$
1209	[4] HOEHLER	93	ARGD	$\pi N \to \pi N$
1210±1	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1217	VRANA	00	DPWA	Multichannel
1210	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90

−2×IMAGINARY PART, MIXED CHARGES

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
98 to 102 (≈ 100) OUR ESTIMATE				
100	ARNDT	95	DPWA	$\pi N \to N\pi$
100	[4] HOEHLER	93	ARGD	$\pi N \to \pi N$
100±2	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
96	VRANA	00	DPWA	Multichannel
100	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90

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
1209.6 ±0.5	[5] VASAN	76B	Fit to CARTER 73
1210.5 to 1210.8	[6] VASAN	76B	Fit to CARTER 73

−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
100.8 ±1.0	[5] VASAN	76B	Fit to CARTER 73
99.8 to 100	[6] VASAN	76B	Fit to CARTER 73

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
1208.0±2.0	CAMPBELL	76		Fit photoproduction

$-2\times$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 $\pm$ 2	[1] HANSTEIN	96	DPWA	$\gamma N \rightarrow \pi N$
111.2$\pm$2.0 to 116.6 $\pm$ 2.2	MIROSHNIC...	79		Fit photoproduction
106 ± 4	CAMPBELL	76		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$\pm$0.66	BERNICHA	96	Fit to PEDRONI 78
1210.75$\pm$0.6	[5] VASAN	76B	Fit to CARTER 73
1210.2	[6] VASAN	76B	Fit to CARTER 73

$-2\times$IMAGINARY PART, $\Delta(1232)^{0}$

VALUE (MeV)	DOCUMENT ID		COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
104.10$\pm$1.01	BERNICHA	96	Fit to PEDRONI 78
105.6 $\pm$1.2	[5] VASAN	76B	Fit to CARTER 73
105.8 to 106.2	[6] VASAN	76B	Fit to CARTER 73

$\Delta(1232)$ ELASTIC POLE RESIDUES

ABSOLUTE VALUE, MIXED CHARGES

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
50	HOEHLER	93	ARGD	$\pi N \rightarrow \pi N$
53$\pm$2	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
38	[7] ARNDT	95	DPWA	$\pi N \rightarrow N \pi$
52	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90

PHASE, MIXED CHARGES

VALUE (°)	DOCUMENT ID		TECN	COMMENT
-48	HOEHLER	93	ARGD	$\pi N \rightarrow \pi N$
-47 ± 1	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
-22	[7] ARNDT	95	DPWA	$\pi N \rightarrow N \pi$
-31	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90

ABSOLUTE VALUE, $\Delta(1232)^{++}$

VALUE (MeV)	DOCUMENT ID		COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
52.4 to 53.2	[5] VASAN	76B	Fit to CARTER 73
52.1 to 52.4	[6] VASAN	76B	Fit to CARTER 73

PHASE, $\Delta(1232)^{++}$

VALUE (rad)	DOCUMENT ID		COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
-0.822 to -0.833	[5] VASAN	76B	Fit to CARTER 73
-0.823 to -0.830	[6] VASAN	76B	Fit to CARTER 73

ABSOLUTE VALUE, $\Delta(1232)^{0}$

VALUE (MeV)	DOCUMENT ID		COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
54.8 to 55.0	[5] VASAN	76B	Fit to CARTER 73
55.2 to 55.3	[6] VASAN	76B	Fit to CARTER 73

PHASE, $\Delta(1232)^{0}$

VALUE (rad)	DOCUMENT ID		COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
-0.840 to -0.847	[5] VASAN	76B	Fit to CARTER 73
-0.848 to -0.856	[6] VASAN	76B	Fit to CARTER 73

$\Delta(1232)$ DECAY MODES

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

	Mode	Fraction (Γ_i/Γ)
Γ_1	$N\pi$	>99 %
Γ_2	$N\gamma$	0.52–0.60 %
Γ_3	$N\gamma$, helicity=1/2	0.11–0.13 %
Γ_4	$N\gamma$, helicity=3/2	0.41–0.47 %

$\Delta(1232)$ BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{total}$ — Γ_1/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.993 to 0.995 OUR ESTIMATE				
1.0	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
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. • • •				
1.00	PENNER	02C	DPWA	Multichannel
1.00 $\pm$0.01	VRANA	00	DPWA	Multichannel
1.0	ARNDT	95	DPWA	$\pi N \to N\pi$

$\Delta(1232)$ PHOTON DECAY AMPLITUDES

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

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.135 ±0.006 OUR ESTIMATE				
−0.129 ±0.001	ARNDT	02	DPWA	$\gamma p \rightarrow N\pi$
−0.1357±0.0013±0.0037	BLANPIED	01	LEGS	$\gamma p \rightarrow p\gamma$, $p\pi^0$, $n\pi^+$
−0.131 ±0.001	BECK	00	IPWA	$\vec{\gamma} p \rightarrow p\pi^0$, $n\pi^+$
−0.1294±0.0013	HANSTEIN	98	IPWA	$\gamma N \rightarrow \pi N$
−0.135 ±0.005	ARNDT	97	IPWA	$\gamma N \rightarrow \pi N$
−0.1278±0.0012	DAVIDSON	97	DPWA	$\gamma N \rightarrow \pi N$
−0.141 ±0.005	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
−0.135 ±0.016	DAVIDSON	91B	FIT	$\gamma N \rightarrow \pi N$
−0.145 ±0.015	CRAWFORD	83	IPWA	$\gamma N \rightarrow \pi N$
−0.138 ±0.004	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
−0.147 ±0.001	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 1)
−0.145 ±0.001	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 2)
−0.136 ±0.006	CRAWFORD	80	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.128	PENNER	02D	DPWA	Multichannel
−0.1312	HANSTEIN	98	DPWA	$\gamma N \rightarrow \pi N$
−0.143 ±0.004	LI	93	IPWA	$\gamma N \rightarrow \pi N$
−0.140 ±0.007	DAVIDSON	90	FIT	See DAVIDSON 91B
−0.142 ±0.007	BARBOUR	78	DPWA	$\gamma N \rightarrow \pi N$
−0.140	[8] NOELLE	78		$\gamma N \rightarrow \pi N$
−0.141 ±0.004	FELLER	76	DPWA	$\gamma N \rightarrow \pi N$

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

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.250 ±0.008 OUR ESTIMATE				
−0.243 ±0.001	ARNDT	02	DPWA	$\gamma p \rightarrow N\pi$
−0.2669±0.0016±0.0078	BLANPIED	01	LEGS	$\gamma p \rightarrow p\gamma$, $p\pi^0$, $n\pi^+$
−0.251 ±0.001	BECK	00	IPWA	$\vec{\gamma} p \rightarrow p\pi^0$, $n\pi^+$
−0.2466±0.0013	HANSTEIN	98	IPWA	$\gamma N \rightarrow \pi N$
−0.250 ±0.008	ARNDT	97	IPWA	$\gamma N \rightarrow \pi N$
−0.2524±0.0013	DAVIDSON	97	DPWA	$\gamma N \rightarrow \pi N$
−0.261 ±0.005	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
−0.251 ±0.033	DAVIDSON	91B	FIT	$\gamma N \rightarrow \pi N$
−0.263 ±0.026	CRAWFORD	83	IPWA	$\gamma N \rightarrow \pi N$
−0.259 ±0.006	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
−0.264 ±0.002	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 1)
−0.261 ±0.002	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 2)
−0.247 ±0.010	CRAWFORD	80	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.247	PENNER	02D	DPWA	Multichannel
−0.2522	HANSTEIN	98	DPWA	$\gamma N \rightarrow \pi N$
−0.262 ±0.004	LI	93	IPWA	$\gamma N \rightarrow \pi N$
−0.254 ±0.011	DAVIDSON	90	FIT	See DAVIDSON 91B
−0.271 ±0.010	BARBOUR	78	DPWA	$\gamma N \rightarrow \pi N$
−0.247	[8] NOELLE	78		$\gamma N \rightarrow \pi N$
−0.256 ±0.003	FELLER	76	DPWA	$\gamma N \rightarrow \pi N$

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

VALUE	DOCUMENT ID		TECN	COMMENT
−0.025 ±0.005 OUR ESTIMATE				
−0.020 ±0.002	ARNDT	02	DPWA	$\gamma p \rightarrow N\pi$
−0.0307±0.0026±0.0024	BLANPIED	01	LEGS	$\gamma p \rightarrow p\gamma$, $p\pi^0$, $n\pi^+$
−0.016 ±0.004 ±0.002	GALLER	01	DPWA	$\gamma p \rightarrow \gamma p$
−0.025 ±0.001 ±0.002	BECK	00	IPWA	$\vec{\gamma} p \rightarrow p\pi^0$, $n\pi^+$
−0.0254±0.0010	HANSTEIN	98	DPWA	$\gamma N \rightarrow \pi N$
−0.015 ±0.005	[9] ARNDT	97	IPWA	$\gamma N \rightarrow \pi N$
−0.0319±0.0024	DAVIDSON	97	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.026	PENNER	02D	DPWA	Multichannel
−0.0233±0.0017	HANSTEIN	98	IPWA	$\gamma N \rightarrow \pi N$
−0.025 ±0.002 ±0.002	BECK	97	IPWA	$\gamma N \rightarrow \pi N$
−0.030 ±0.003 ±0.002	BLANPIED	97	DPWA	$\gamma N \rightarrow \pi N$, γN
−0.027 ±0.003 ±0.001	KHANDAKER	95	DPWA	$\gamma N \rightarrow \pi N$
−0.015 ±0.005	WORKMAN	92	IPWA	$\gamma N \rightarrow \pi N$
−0.0157±0.0072	DAVIDSON	91B	FIT	$\gamma N \rightarrow \pi N$
−0.0107±0.0037	DAVIDSON	90	FIT	$\gamma N \rightarrow \pi N$
−0.015 ±0.002	DAVIDSON	86	FIT	$\gamma N \rightarrow \pi N$
+0.037 ±0.004	TANABE	85	FIT	$\gamma N \rightarrow \pi N$

$\Delta(1232) \rightarrow N\gamma$, 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	$\gamma N \rightarrow \pi N$
0.058	HANSTEIN	96	DPWA	$\gamma N \rightarrow \pi N$

$\Delta(1232) \rightarrow N\gamma$, 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	$\gamma N \rightarrow \pi N$
−127.2	HANSTEIN	96	DPWA	$\gamma N \rightarrow \pi N$

$\Delta(1232)$ 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
3.7 to 7.5 OUR ESTIMATE				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
6.14±0.51	LOPEZCAST...	01	DPWA	$\pi^+ p \rightarrow \pi^+ p\gamma$
4.52±0.50±0.45	BOSSHARD	91		$\pi^+ p \rightarrow \pi^+ p\gamma$ (SIN data)
3.7 to 4.2	LIN	91B		$\pi^+ p \rightarrow \pi^+ p\gamma$ (from UCLA data)
4.6 to 4.9	LIN	91B		$\pi^+ p \rightarrow \pi^+ p\gamma$ (from SIN data)
5.6 to 7.5	WITTMAN	88		$\pi^+ p \rightarrow \pi^+ p\gamma$ (from UCLA data)
6.9 to 9.8	HELLER	87		$\pi^+ p \rightarrow \pi^+ p\gamma$ (from UCLA data)
4.7 to 6.7	NEFKENS	78		$\pi^+ p \rightarrow \pi^+ p\gamma$ (UCLA data)

$\Delta(1232)^+$ MAGNETIC MOMENT

VALUE (μ_N)	*DOCUMENT ID*		*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$2.7^{+1.0}_{-1.3} \pm 1.5 \pm 3$	[2] KOTULLA	02	$\gamma p \to p \pi^0 \gamma'$

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

$\Delta(1232)$ FOOTNOTES

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

[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] This VASAN 76B value is from fits to the coulomb-barrier-corrected CARTER 73 phase shift.

[6] This VASAN 76B value is from fits to the CARTER 73 nuclear phase shift without coulomb barrier corrections.

[7] This ARNDT 95 value is in error, as pointed out by HOHLER 01. The corrected value is in line with the ARNDT 91 value (R.A. Arndt, private communication).

[8] Converted to our conventions using $M = 1232$ MeV, $\Gamma = 110$ MeV from NOELLE 78.

[9] 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.

$\Delta(1232)$ REFERENCES

For early references, see Physics Letters **111B** 70 (1982).

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.)
HOHLER	01	NSTAR 2001 185	G. Hohler	(KARL)
LOPEZCAST...	01	PL B517 339	G. Lopez Castro, A. Mariano	
Also	02	NP A697 440	G. Lopez Castro, A. Mariano	
BECK	00	PR C61 035204	R. Beck *et al.*	(Mainz Microtron DAPHNE Col.)
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman,, T.-S.H. Lee	(PITT+)
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.*	(MANZ, SACL, PAVI, GLAS)
Also	97B	PRL 79 4510	R.L. Beck, H.P. Krahn	(MANZ)
Also	97C	PRL 79 4512	R.L. Beck, H.P. Krahn	(MANZ)
Also	97D	PRL 79 4515 (erratum)	R.L. Beck *et al.*	(MANZ, 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)
ARNDT	96	PR C53 430	R.A. Arndt, I.I. Strakovsky, R.L. Workman	(VPI)
BERNICHA	96	NP A597 623	A. Bernicha, G. Lopez Castro, J. Pestieau	(LOUV+)
HANSTEIN	96	PL B385 45	O. Hanstein, D. Drechsel, L. Tiator	(MANZ)
ABAEV	95	ZPHY A352 85	V.V. Abaev, S.P. Kruglov	(PNPI)
ARNDT	95	PR C52 2120	R.A. Arndt *et al.*	(VPI, BRCO)
KHANDAKER	95	PR D51 3966	M. Khandaker, A.M. Sandorfi	(BNL, VPI)
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)
LI	93	PR C47 2759	Z.J. Li *et al.*	(VPI)
MANLEY	92	PR D45 4002	D.M. Manley, E.M. Saleski	(KENT) IJP
Also	84	PR D30 904	D.M. Manley *et al.*	(VPI)
WORKMAN	92	PR C46 1546	R.L. Workman, R.A. Arndt, Z.J. Li	(VPI)
ARNDT	91	PR D43 2131	R.A. Arndt *et al.*	(VPI, TELE) IJP
BOSSHARD	91	PR D44 1962	A. Bosshard *et al.*	(ZURI, LBL, VILL+)
Also	90	PRL 64 2619	A. Bosshard *et al.*	(CATH, LAUS, LBL+)

DAVIDSON	91B	PR D43 71	R.M. Davidson, N.C. Mukhopadhyay, R.S. Wittman		
LIN	91B	PR C44 1819	D.H. Lin, M.K. Liou, Z.M. Ding	(CUNY, CSOK)	
Also	91	PR C43 R930	D. Lin, M.K. Liou	(CUNY)	
DAVIDSON	90	PR D42 20	R.M. Davidson, N.C. Mukhopadhyay	(RPI)	
WITTMAN	88	PR C37 2075	R. Wittman	(TRIU)	
HELLER	87	PR C35 718	L. Heller *et al.*	(LANL, MIT, ILL)	
DAVIDSON	86	PRL 56 804	R.M. Davidson, N.C. Mukhopadhyay, R. Wittman	(RPI)	
TANABE	85	PR C31 1876	H. Tanabe, K. Ohta	(KOMAB)	
CRAWFORD	83	NP B211 1	R.L. Crawford, W.T. Morton	(GLAS)	
PDG	82	PL 111B	M. Roos *et al.*	(HELS, CIT, CERN)	
AWAJI	81	Bonn Conf. 352	N. Awaji, R. Kajikawa	(NAGO)	
Also	82	NP B197 365	K. Fujii *et al.*	(NAGO)	
ARAI	80	Toronto Conf. 93	I. Arai	(INUS)	
Also	82	NP B194 251	I. Arai, H. Fujii	(INUS)	
CRAWFORD	80	Toronto Conf. 107	R.L. Crawford	(GLAS)	
CUTKOSKY	80	Toronto Conf. 19	R.E. Cutkosky *et al.*	(CMU, LBL)	IJP
Also	79	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	80	Toronto Conf. 3	R. Koch	(KARLT)	IJP
MIROSHNIC...	79	SJNP 29 94	I.I. Miroshnichenko *et al.*	(KFTI)	IJP
		Translated from YAF 29 188.			
BARBOUR	78	NP B141 253	I.M. Barbour, R.L. Crawford, N.H. Parsons	(GLAS)	
NEFKENS	78	PR D18 3911	B.M.K. Nefkens *et al.*	(UCLA, CATH)	IJP
NOELLE	78	PTP 60 778	P. Noelle	(NAGO)	
PEDRONI	78	NP A300 321	E. Pedroni *et al.*	(SIN, ISNG, KARLE+)	IJP
CAMPBELL	76	PR D14 2431	R.R. Campbell, G.L. Shaw, J.S. Ball	(BOIS, UCI+)	IJP
FELLER	76	NP B104 219	P. Feller *et al.*	(NAGO, OSAK)	IJP
VASAN	76B	NP B106 535	S.S. Vasan	(CMU)	IJP
Also	76	NP B106 526	S.S Vasan	(CMU)	IJP
BERENDS	75	NP B84 342	F.A. Berends, A. Donnachie	(LEID, MCHS)	
CARTER	73	NP B58 378	J.R. Carter, D.V. Bugg, J.R. Carter	(CAVE, LOQM)	IJP