$$I(J^P) = \frac{3}{2}(\frac{3}{2}^+)$$
 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	$\pi N \rightarrow \pi N$	
1210.5	± 1.0	ANISOVICH	12A	DPWA	Multichannel	
1211		ARNDT	06	DPWA	$\pi N \rightarrow \pi N$, ηN	
1209		² HOEHLER	93	ARGD	$\pi N \rightarrow \pi N$	
1210	± 1	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$	
• • •	We do not use the follow	ving data for average	s, fits,	limits, e	etc. • • •	
1212		SHRESTHA	12A	DPWA	Multichannel	
1211	± 1	ANISOVICH	10	DPWA	Multichannel	
1210		ARNDT	04	DPWA	π N $ ightarrow$ π N, η N	
1217		VRANA	00	DPWA	Multichannel	
1211		ARNDT	95	DPWA	$\pi N \rightarrow N \pi$	
1210		ARNDT	91	DPWA	$\pi N \rightarrow \pi N \text{ Soln SM90}$	
-2×IMAGINARY PART, MIXED CHARGES						
VALUE	•	DOCUMENT ID		TECN	COMMENT	
98 to	102 (≈ 100) OUR EST	MATE				
00 0) 1	1 CVARC	1 /	L + D	_ ^/ ^/	

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT	
98 to 102 (≈ 100) OUR ESTIMA	98 to 102 (≈ 100) OUR ESTIMATE				
$98 \!\pm\! 2 \!\pm\! 1$	¹ SVARC	14	L+P	$\pi N \rightarrow \pi N$	
99±2	ANISOVICH	12A	DPWA	Multichannel	
99	ARNDT	06	DPWA	$\pi N \rightarrow \pi N$, ηN	
100	² HOEHLER	93	ARGD	$\pi N \rightarrow \pi N$	
100 ± 2	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$	
• • • We do not use the following	data for average	s, fits,	limits, e	etc. • • •	
98	SHRESTHA	12A	DPWA	Multichannel	
100 ± 2	ANISOVICH	10	DPWA	Multichannel	
100	ARNDT	04	DPWA	$\pi N \rightarrow \pi N$, ηN	
96	VRANA	00	DPWA	Multichannel	
100	ARNDT	95	DPWA	$\pi N \rightarrow N \pi$	
100	ARNDT	91	DPWA	$\pi N \rightarrow \pi N \text{ Soln SM90}$	

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

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

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

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

Created: 5/30/2017 17:20

HTTP://PDG.LBL.GOV Page 1

REAL PART, △(1232)+

VALUE (MeV)DOCUMENT IDTECNCOMMENT• • • We do not use the following data for averages, fits, limits, etc. • • •1211 ±1 to 1212 ± 1HANSTEIN 96DPWA $\gamma N \rightarrow \pi N$ 1206.9±0.9 to 1210.5 ± 1.8MIROSHNIC... 79Fit 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 ± 2
 3 HANSTEIN 96 DPWA $\gamma N \rightarrow \pi N$

 111.2±2.0 to 116.6 ± 2.2
 MIROSHNIC... 79 Fit photoproduction

REAL PART, $\triangle(1232)^0$

 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

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

 VALUE (MeV)
 DOCUMENT ID
 COMMENT

 • • • We do not use the following data for averages, fits, limits, etc. • • •
 104.10 ± 1.01
 BERNICHA 96
 Fit to PEDRONI 78

△(1232) ELASTIC POLE RESIDUES

ABSOLUTE VALUE, MIXED CHARGES

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
50 ± 1 ± 1	⁴ SVARC	14	L+P	$\pi N \rightarrow \pi N$
51.6 ± 0.6	ANISOVICH	12A	DPWA	Multichannel
52	ARNDT	06	DPWA	π N $ ightarrow$ π N, η N
50	HOEHLER	93	ARGD	$\pi N \rightarrow \pi N$
53 ±2	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
ullet $ullet$ We do not use the following	data for averages	s, fits,	limits, e	etc. • • •
53	ARNDT	04	DPWA	$\pi N \rightarrow \pi N$, ηN
38	⁵ ARNDT	95	DPWA	$\pi N \rightarrow N \pi$
52	ARNDT	91	DPWA	$\pi N \rightarrow \pi N \text{ Soln SM90}$

PHASE, MIXED CHARGES

VALUE (°)	DOCUMENT ID		TECN	COMMENT
$-46 \pm 1 \pm 1$	⁴ SVARC	14	L+P	$\pi N \rightarrow \pi N$
-46 ± 1	ANISOVICH	12A	DPWA	Multichannel
-47	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
-48	HOEHLER	93	ARGD	$\pi N \rightarrow \pi N$
-47 ± 1	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$

HTTP://PDG.LBL.GOV

Page 2

 $^{^{1}}$ 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 π N elastic partial-wave amplitudes and from plots of the speeds with which the amplitudes traverse the diagrams.

³ The second (lower) value of HANSTEIN 96 here goes with the second (higher) value of the real part in the preceding data block.

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

-47	ARNDT	04	DPWA $\pi N \rightarrow \pi N$, ηN
-22	⁵ ARNDT	95	DPWA $\pi N \rightarrow N \pi$
-31	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90

△(1232) BREIT-WIGNER MASSES

MIXED CHARGES

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1230 to 1234 (≈ 1232) OUR EST	IMATE			
1228 ± 2	ANISOVICH	12A	DPWA	Multichannel
1233.4 ± 0.4	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
1232 ± 3	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
1233 ± 2	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following of	data for averages	s, fits,	limits, e	etc. • • •
1231.1 ± 0.2	SHRESTHA	12A	DPWA	Multichannel
1230 ± 2	ANISOVICH	10	DPWA	Multichannel
1232.9 ± 1.2	ARNDT	04	DPWA	$\pi N o \pi N, \eta N$
1228 ± 1	PENNER	02C	DPWA	Multichannel
1234 ± 5	VRANA	00	DPWA	Multichannel
1233	ARNDT	95	DPWA	$\pi N \rightarrow N \pi$
1231 ± 1	MANLEY	92	IPWA	$\pi N \rightarrow \pi N \& N \pi \pi$

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

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following	ng data for avera	ges, fi	its, limit	s, etc. • • •
1230.55 ± 0.20	GRIDNEV	06	DPWA	$\pi N \rightarrow \pi N$
1231.88 ± 0.29	BERNICHA	96		Fit to PEDRONI 78
1230.5 ± 0.2	ABAEV	95	IPWA	$\pi N \rightarrow \pi N$
1230.9 ± 0.3	KOCH	80 B	IPWA	$\pi N \rightarrow \pi N$
1231.1 ± 0.2	PEDRONI	78		$\pi extsf{N} ightarrow ~\pi extsf{N}$ 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

Created: 5/30/2017 17:20

$\Delta(1232)^0$ MASS

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
ullet $ullet$ We do not use the following	g data for avera	ges, f	its, limit	s, etc. • • •
1231.3 ± 0.6	BREITSCHOP.	.06	CNTR	Using new CHEX data
1233.40 ± 0.22	GRIDNEV	06	DPWA	$\pi N \rightarrow \pi N$
1234.35 ± 0.75	BERNICHA	96		Fit to PEDRONI 78
1233.1 ± 0.3	ABAEV	95	IPWA	$\pi N \rightarrow \pi N$
1233.6 ± 0.5	KOCH	80 B	IPWA	$\pi N \rightarrow \pi N$
1233.8 ± 0.2	PEDRONI	78		$\pi\text{N} \rightarrow \pi\text{N} 70370 \text{MeV}$

 $^{^4\,\}text{Fit}$ to the amplitudes of HOEHLER 79. $^5\,\text{This}$ 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).

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

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the follow	ing data for average	es, fits,	limits, e	etc. • • •
2.86 ± 0.30	GRIDNEV	06	DPWA	$\pi N \rightarrow \pi N$
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	⁶ PEDRONI	78		See the masses
$^6 {\sf Using} \pi^{\pm} d $ as well, PEDR $4.6\pm0.2{\sf MeV}.$	ONI 78 determine	(M ⁻	- M ⁺⁺	$(M^0 - M^+)/3 =$

Δ (1232) BREIT-WIGNER WIDTHS

MIXED CHARGES

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
114 to 120 (≈ 117) OUR ESTIMA	TE			
110 ± 3	ANISOVICH	12A	DPWA	Multichannel
118.7 ± 0.6	ARNDT	06	DPWA	$\pi N \rightarrow \pi N$, ηN
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 d	lata for averages	, fits,	limits, e	etc. • • •
113.0± 0.5	SHRESTHA	12A	DPWA	Multichannel
112 ± 4	ANISOVICH	10	DPWA	Multichannel
118.0 ± 2.2	ARNDT	04	DPWA	$\pi N \rightarrow \pi N$, ηN
106 ± 1	PENNER	02C	DPWA	Multichannel
112 ± 18	VRANA	00	DPWA	Multichannel
114	ARNDT	95	DPWA	$\pi N \rightarrow N \pi$
118 ± 4	MANLEY	92	IPWA	$\pi N \rightarrow \pi N \& N \pi \pi$

Δ (1232)⁺⁺ WIDTH

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following	ig data for avera	iges, f	its, limit	s, etc. • • •
112.2 ± 0.7	GRIDNEV	06	DPWA	$\pi N \rightarrow \pi N$
109.07 ± 0.48	BERNICHA	96		Fit to PEDRONI 78
111.0 ± 1.0	KOCH	80 B	IPWA	$\pi N o \pi N$
111.3 ± 0.5	PEDRONI	78		$\pi extsf{N} ightarrow ~\pi extsf{N}$ 70–370 MeV

△(1232)⁺ WIDTH

VALUE (MeV)	DOCUMENT ID	COMMENT	

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

MIROSHNIC... 79 Fit photoproduction 131.1 ± 2.4

△(1232)⁰ WIDTH

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
• • • We do not use the follow	ing data for average	es, fits, limit	s, etc. • • •
112.5 ± 1.9	BREITSCHOP0	6 CNTR	Using new CHEX data
116.9 ± 0.7	GRIDNEV 0	6 DPWA	$\pi N \rightarrow \pi N$
117.58 ± 1.16	BERNICHA 9	6	Fit to PEDRONI 78
113.0 ± 1.5	KOCH 8	0B IPWA	$\pi N \rightarrow \pi N$
117.9 ± 0.9	PEDRONI 7	8	$\pi\text{N} \rightarrow \pi\text{N} 70370 \text{MeV}$
116.9 ± 0.7 117.58 ± 1.16 113.0 ± 1.5	GRIDNEV 00 BERNICHA 90 KOCH 80	6 DPWA 6 IPWA	$\pi N \rightarrow \pi N$ Fit to PEDRONI 78 $\pi N \rightarrow \pi N$

Δ^{0} - Δ^{++} WIDTH DIFFERENCE

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
ullet $ullet$ We do not use the followi	ng data for average	es, fits,	limits, e	etc. • • •
4.66 ± 1.0	GRIDNEV	06	DPWA	$\pi N \rightarrow \pi N$
8.45 ± 1.11	BERNICHA	96		Fit to PEDRONI 78
5.1 ± 1.0	ABAEV	95	IPWA	$\pi N \rightarrow \pi N$
$6.6\ \pm 1.0$	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)
$\overline{\Gamma_1}$	$N\pi$	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 %

△(1232) BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{total}$				Γ	1/Γ
VALUE	DOCUMENT ID		TECN	COMMENT	
0.994 OUR ESTIMATE					
1.00	ARNDT	06	DPWA	$\pi N \rightarrow \pi N$, ηN	
1.0	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$	
1.0	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$	
ullet $ullet$ We do not use the following of	data for averages	s, fits,	limits, e	etc. • • •	
0.994	SHRESTHA	12A	DPWA	Multichannel	
1.0	ANISOVICH	10	DPWA	Multichannel	
1.000	ARNDT	04	DPWA	$\pi N \rightarrow \pi N$, ηN	
1.00	PENNER	0 2C	DPWA	Multichannel	
1.00 ± 0.01	VRANA	00	DPWA	Multichannel	
1.0	ARNDT	95	DPWA	$\pi N \rightarrow N \pi$	
1.0	MANLEY	92	IPWA	$\pi N \rightarrow \pi N \& N\pi$	π

Δ (1232) PHOTON DECAY AMPLITUDES AT THE POLE

I

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

$MODULUS (GeV^{-1/2})$	PHASE (°)	DOCUMENT ID		TECN
$-0.114 ^{+0.010}_{-0.003}$	-9^{+4}_{-2}	ROENCHEN	14	DPWA

Δ (1232) \rightarrow N γ , helicity-3/2 amplitude A $_{3/2}$

$MODULUS (GeV^{-1/2})$	PHASE (°)	DOCUMENT ID	TECN
$-0.229^{+0.003}_{-0.004}$	$3^{+0.3}_{-0.4}$	ROENCHEN 14	DPWA

Δ (1232) BREIT-WIGNER PHOTON DECAY AMPLITUDES

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

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

, , , , , , , , , , , , , , , , , , , ,	/	_		
$VALUE$ (GeV $^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
-0.135 ± 0.006 OUR ESTIMATE				
-0.131 ± 0.004	ANISOVICH	12A	DPWA	Multichannel
-0.139 ± 0.002	WORKMAN	12A	DPWA	$\gamma N \rightarrow N \pi$
-0.139 ± 0.004	DUGGER	07	DPWA	$\gamma N \rightarrow \pi N$
-0.137 ± 0.005	AHRENS	04A	DPWA	$ec{\gamma} ec{p} ightarrow $
$-0.1357\!\pm\!0.0013\!\pm\!0.0037$	BLANPIED	01		$\gamma p \rightarrow p \gamma, p \pi^0, n \pi^+$
-0.131 ± 0.001	BECK	00	IPWA	$\vec{\gamma} p \rightarrow p \pi^0$, $n \pi^+$
$-0.140~\pm 0.005$	KAMALOV	99	DPWA	$\gamma N \rightarrow \pi N$
-0.1294 ± 0.0013	HANSTEIN	98	IPWA	$\gamma N \rightarrow \pi N$
-0.1278 ± 0.0012	DAVIDSON	97	DPWA	$\gamma {\sf N} ightarrow \pi {\sf N}$
-0.135 ± 0.016	DAVIDSON	91 B	FIT	$\gamma {\sf N} ightarrow \pi {\sf N}$
-0.145 ± 0.015	CRAWFORD	83	IPWA	$\gamma {\sf N} ightarrow \pi {\sf N}$
-0.138 ± 0.004	AWAJI	81	DPWA	$\gamma {\sf N} ightarrow \pi {\sf N}$
• • • We do not use the following d	lata for averages	, fits,	limits, e	etc. • • •
-0.137 ± 0.001	SHRESTHA	12A	DPWA	Multichannel
-0.136 ± 0.005	ANISOVICH	10	DPWA	Multichannel
-0.140	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$
-0.129 ± 0.001	ARNDT	02	DPWA	$\gamma p \rightarrow N \pi$
-0.128	PENNER	02 D	DPWA	Multichannel
-0.1312	HANSTEIN	98	DPWA	$\gamma N \rightarrow \pi N$
-0.135 ± 0.005	ARNDT	97	IPWA	$\gamma N \rightarrow \pi N$
-0.141 ± 0.005	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
-0.143 ± 0.004	LI	93	IPWA	$\gamma N \rightarrow \pi N$
-0.140 ± 0.007	DAVIDSON	90	FIT	See DAVIDSON 91B

Δ (1232) \rightarrow N γ , helicity-3/2 amplitude A $_{3/2}$

_(•			
VALUE (GeV $^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
-0.255 ± 0.005 OUR ESTIMATE				
-0.254 ± 0.005	ANISOVICH			Multichannel
-0.262 ± 0.003	WORKMAN			$\gamma N \rightarrow N \pi$
-0.258 ± 0.005	DUGGER	07		$\gamma N \rightarrow \pi N$
-0.256 ± 0.003	AHRENS	04A		$ec{\gamma} ec{p} ightarrow N \pi$
$-0.2669\pm0.0016\pm0.0078$	BLANPIED	01		$\gamma p \rightarrow p \gamma, p \pi^0, n \pi^+$
-0.251 ± 0.001	BECK	00		$\vec{\gamma} p \rightarrow p \pi^0$, $n \pi^+$
-0.258 ± 0.006	KAMALOV	99		$\gamma N \rightarrow \pi N$
-0.2466 ± 0.0013	HANSTEIN	98		$\gamma N \rightarrow \pi N$
-0.2524 ± 0.0013	DAVIDSON	97		$\gamma N \rightarrow \pi N$
-0.251 ± 0.033	DAVIDSON	91 B		$\gamma N \rightarrow \pi N$
-0.263 ± 0.026	CRAWFORD	83		$\gamma N \rightarrow \pi N$
-0.259 ± 0.006	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following	data for averages	s, fits,	limits, e	etc. • • •
-0.251 ± 0.001	SHRESTHA	12A	DPWA	Multichannel
-0.267 ± 0.008	ANISOVICH			Multichannel
-0.265	DRECHSEL			$\gamma N \rightarrow \pi N$
-0.243 ± 0.001	ARNDT	02		$\gamma p \rightarrow N \pi$
-0.247	PENNER	02D		Multichannel
-0.2522	HANSTEIN	98		$\gamma N \rightarrow \pi N$
-0.250 ± 0.008	ARNDT			$\gamma N \rightarrow \pi N$
-0.261 ± 0.005	ARNDT	96		$\gamma N \rightarrow \pi N$
-0.262 ± 0.004	LI	93		$\gamma N \rightarrow \pi N$
-0.254 ± 0.011	DAVIDSON	90		See DAVIDSON 91B
-0.234 ± 0.011	DAVIDOON	90	FII	See DAVIDSON 918
-0.234 ±0.011	DAVIDSON	90	FII	See DAVIDSON 918
Δ (1232) $\rightarrow N\gamma$, E_2/M_1 ratio		90	FII	See DAVIDSON 918
Δ (1232) $\rightarrow N\gamma$, E_2/M_1 ratio	DOCUMENT ID			
Δ (1232) $\rightarrow N\gamma$, E_2/M_1 ratio	DOCUMENT ID			
Δ (1232) $\rightarrow N\gamma$, E_2/M_1 ratio	DOCUMENT ID		TECN DPWA	$egin{array}{ll} {\it COMMENT} & & & & \ ec{\gamma} ec{p} ightarrow & {\it N} \pi & & & \end{array}$
Δ (1232) $\rightarrow N\gamma$, E_2/M_1 ratio $\frac{VALUE}{-0.025 \pm 0.005}$ OUR ESTIMATE	DOCUMENT ID		TECN DPWA DPWA	$\begin{array}{ccc} \underline{\textit{COMMENT}} \\ \vec{\gamma} \vec{p} \rightarrow & N \pi \\ \gamma p \rightarrow & N \pi \end{array}$
\triangle (1232) → $N\gamma$, E_2/M_1 ratio $\frac{VALUE}{-0.025 \pm 0.005}$ OUR ESTIMATE $-0.0274 \pm 0.0003 \pm 0.0030$	DOCUMENT ID AHRENS	04A	TECN DPWA DPWA	$egin{array}{ll} {\it COMMENT} & & & & \ ec{\gamma} ec{p} ightarrow & {\it N} \pi & & & \end{array}$
Δ (1232) → $N\gamma$, E_2/M_1 ratio $\frac{VALUE}{-0.025 \pm 0.005}$ OUR ESTIMATE $-0.0274 \pm 0.0003 \pm 0.0030$ -0.020 ± 0.002	DOCUMENT ID AHRENS ARNDT	04A 02	TECN DPWA DPWA LEGS	$\begin{array}{ccc} \underline{\textit{COMMENT}} \\ \vec{\gamma} \vec{p} \rightarrow & N \pi \\ \gamma p \rightarrow & N \pi \end{array}$
Δ (1232) → $N\gamma$, E_2/M_1 rationally rationally $N\gamma$, E_2/M_1 rationally $N\gamma$,	DOCUMENT ID AHRENS ARNDT BLANPIED	04A 02 01	TECN DPWA DPWA LEGS DPWA	$\begin{array}{l} \underline{\textit{COMMENT}} \\ \vec{\gamma} \vec{p} \rightarrow \ \ N\pi \\ \gamma p \rightarrow \ \ N\pi \\ \gamma p \rightarrow \ \ p\gamma, \ p\pi^0, \ n\pi^+ \end{array}$
Δ (1232) → N γ , E_2/M_1 ratio $VALUE$ -0.025 ±0.005 OUR ESTIMATE -0.0274±0.0003±0.0030 -0.020 ±0.002 -0.0307±0.0026±0.0024 -0.016 ±0.004 ±0.002 -0.025 ±0.001 ±0.002 -0.0233±0.0017	DOCUMENT ID AHRENS ARNDT BLANPIED GALLER BECK HANSTEIN	04A 02 01 01	DPWA DPWA LEGS DPWA IPWA	$\begin{array}{cccccccccccccccccccccccccccccccccccc$
Δ (1232) → N γ , E_2/M_1 ratio $VALUE$ -0.025 ±0.005 OUR ESTIMATE -0.0274±0.0003±0.0030 -0.020 ±0.002 -0.0307±0.0026±0.0024 -0.016 ±0.004 ±0.002 -0.025 ±0.001 ±0.002 -0.0233±0.0017	DOCUMENT ID AHRENS ARNDT BLANPIED GALLER BECK HANSTEIN	04A 02 01 01 00	DPWA DPWA LEGS DPWA IPWA IPWA	$\begin{array}{ll} \underline{\textit{COMMENT}} \\ \vec{\gamma} \vec{p} \rightarrow & \textit{N} \pi \\ \gamma \textit{p} \rightarrow & \textit{N} \pi \\ \gamma \textit{p} \rightarrow & \textit{p} \gamma, \textit{p} \pi^0, \textit{n} \pi^+ \\ \gamma \textit{p} \rightarrow & \gamma \textit{p} \\ \vec{\gamma} \textit{p} \rightarrow & \textit{p} \pi^0, \textit{n} \pi^+ \end{array}$
Δ (1232) → N γ , E_2/M_1 ratio $VALUE$ -0.025 ±0.005 OUR ESTIMATE -0.0274±0.0003±0.0030 -0.020 ±0.002 -0.0307±0.0026±0.0024 -0.016 ±0.004 ±0.002 -0.025 ±0.001 ±0.002 -0.0233±0.0017	DOCUMENT ID AHRENS ARNDT BLANPIED GALLER BECK	04A 02 01 01 00 98	TECN DPWA DPWA LEGS DPWA IPWA IPWA IPWA	$\begin{array}{ll} \underline{\textit{COMMENT}} \\ \vec{\gamma} \vec{p} \rightarrow & N\pi \\ \gamma p \rightarrow & N\pi \\ \gamma p \rightarrow & p\gamma, p\pi^0, n\pi^+ \\ \gamma p \rightarrow & \gamma p \\ \vec{\gamma} p \rightarrow & p\pi^0, n\pi^+ \\ \gamma N \rightarrow & \pi N \end{array}$
Δ (1232) → N γ , E ₂ /M ₁ rational value Δ (1232) → N γ , E ₂ /M ₁ rational value Δ (1232) → N γ , E ₂ /M ₁ rational value Δ (1232) → 0.025 ±0.005 OUR ESTIMATE Δ (1200) + 0.020 ±0.0030 −0.020 ±0.0024 −0.0307 ±0.0026 ±0.0024 −0.016 ±0.004 ±0.002 −0.025 ±0.001 ±0.002 −0.0233 ±0.0017 −0.015 ±0.005	DOCUMENT ID AHRENS ARNDT BLANPIED GALLER BECK HANSTEIN ARNDT DAVIDSON	04A 02 01 01 00 98 97 97	DPWA DPWA LEGS DPWA IPWA IPWA IPWA DPWA	$\begin{array}{l} \overrightarrow{COMMENT} \\ \overrightarrow{\gamma}\overrightarrow{p} \rightarrow N\pi \\ \gamma p \rightarrow N\pi \\ \gamma p \rightarrow p\gamma, p\pi^0, n\pi^+ \\ \gamma p \rightarrow \gamma p \\ \overrightarrow{\gamma}p \rightarrow p\pi^0, n\pi^+ \\ \gamma N \rightarrow \pi N \end{array}$
Δ (1232) → N γ , E_2/M_1 ratio $VALUE$ -0.025 ±0.005 OUR ESTIMATE -0.0274±0.0003±0.0030 -0.020 ±0.002 -0.0307±0.0026±0.0024 -0.016 ±0.004 ±0.002 -0.025 ±0.001 ±0.002 -0.0233±0.0017 -0.015 ±0.005 -0.0319±0.0024 • • • We do not use the following	DOCUMENT ID AHRENS ARNDT BLANPIED GALLER BECK HANSTEIN ARNDT DAVIDSON data for averages	04A 02 01 01 00 98 97 97 5, fits,	DPWA DPWA LEGS DPWA IPWA IPWA IPWA DPWA limits, e	$\begin{array}{ll} \overrightarrow{\nabla p} \rightarrow & N\pi \\ \gamma p \rightarrow & N\pi \\ \gamma p \rightarrow & N\pi \\ \gamma p \rightarrow & p\gamma, p\pi^0, n\pi^+ \\ \gamma p \rightarrow & \gamma p \\ \overrightarrow{\gamma} p \rightarrow & p\pi^0, n\pi^+ \\ \gamma N \rightarrow & \pi N \\ \text{etc.} \bullet \bullet \end{array}$
Δ (1232) → N γ , E_2/M_1 rationally rationally expression of the following -0.025 ± 0.005 OUR ESTIMATE $-0.0274 \pm 0.0003 \pm 0.0030$ -0.020 ± 0.002 $-0.0307 \pm 0.0026 \pm 0.0024$ $-0.016 \pm 0.004 \pm 0.002$ $-0.025 \pm 0.001 \pm 0.002$ -0.0233 ± 0.0017 -0.015 ± 0.005 -0.0319 ± 0.0024 • • • We do not use the following -0.022	DOCUMENT ID AHRENS ARNDT BLANPIED GALLER BECK HANSTEIN ARNDT DAVIDSON data for averages	04A 02 01 01 00 98 97 97 s, fits,	DPWA DPWA LEGS DPWA IPWA IPWA IPWA DPWA limits, e	$\begin{array}{cccccccccccccccccccccccccccccccccccc$
Δ (1232) → N γ , E_2/M_1 rationally rationally expression of the following Δ (1232) → N γ , E_2/M_1 rationally expression of the following Δ (1232) → N γ , E_2/M_1 rationally expression of the following Δ (1232) → N γ , E_2/M_1 rationally expression of the following Δ (1232) → N γ , E_2/M_1 rationally expression of the following Δ (1232) → N γ , E_2/M_1 rationally expression of the following Δ (1232) → N γ , Δ (1232) →	DOCUMENT ID AHRENS ARNDT BLANPIED GALLER BECK HANSTEIN ARNDT DAVIDSON data for averages DRECHSEL PENNER	04A 02 01 01 00 98 97 97 5, fits,	DPWA DPWA LEGS DPWA IPWA IPWA DPWA Limits, e DPWA DPWA	$\begin{array}{ll} \overrightarrow{\nabla p} \rightarrow & N\pi \\ \gamma p \rightarrow & N\pi \\ \gamma p \rightarrow & N\pi \\ \gamma p \rightarrow & p\gamma, p\pi^0, n\pi^+ \\ \gamma p \rightarrow & \gamma p \\ \overrightarrow{\gamma} p \rightarrow & p\pi^0, n\pi^+ \\ \gamma N \rightarrow & \pi N \\ \gamma N \rightarrow & \pi N \\ \gamma N \rightarrow & \pi N \\ \text{etc.} \bullet \bullet \\ \gamma N \rightarrow & \pi N \\ \text{Multichannel} \end{array}$
Δ (1232) → N γ , E_2/M_1 rational value $VALUE$ -0.025 ±0.005 OUR ESTIMATE -0.0274±0.0003±0.0030 -0.020 ±0.002 -0.0307±0.0026±0.0024 -0.016 ±0.004 ±0.002 -0.025 ±0.001 ±0.002 -0.0233±0.0017 -0.015 ±0.005 -0.0319±0.0024 • • • We do not use the following -0.022 -0.026 -0.0254±0.0010	DOCUMENT ID AHRENS ARNDT BLANPIED GALLER BECK HANSTEIN ARNDT DAVIDSON data for averages DRECHSEL PENNER HANSTEIN	04A 02 01 01 00 98 97 97 5, fits, 07 02D 98	DPWA DPWA IPWA IPWA IPWA DPWA Imits, e DPWA DPWA DPWA	$\begin{array}{l} \overrightarrow{\nabla p} \rightarrow N\pi \\ \gamma p \rightarrow N\pi \\ \gamma p \rightarrow p\gamma, p\pi^0, n\pi^+ \\ \gamma p \rightarrow \gamma p \\ \overrightarrow{\gamma} p \rightarrow p\pi^0, n\pi^+ \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi N \\ \text{etc.} \bullet \bullet \\ \gamma N \rightarrow \pi N \\ \text{Multichannel} \\ \gamma N \rightarrow \pi N \end{array}$
Δ (1232) → N γ , E_2/M_1 rational value	DOCUMENT ID AHRENS ARNDT BLANPIED GALLER BECK HANSTEIN ARNDT DAVIDSON data for averages DRECHSEL PENNER HANSTEIN BECK	04A 02 01 01 00 98 97 97 5, fits, 07 02D 98 97	DPWA DPWA IPWA IPWA IPWA DPWA DPWA DPWA DPWA DPWA DPWA DPWA D	$\begin{array}{l} \overrightarrow{\nabla p} \rightarrow N\pi \\ \gamma p \rightarrow N\pi \\ \gamma p \rightarrow p\gamma, p\pi^0, n\pi^+ \\ \gamma p \rightarrow p\gamma, p\pi^0, n\pi^+ \\ \gamma p \rightarrow p\pi^0, n\pi^+ \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi N \\ \text{etc.} \bullet \bullet \\ \gamma N \rightarrow \pi N \\ \text{Multichannel} \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi N \\ \end{array}$
Δ (1232) → N γ , E_2/M_1 ratio $VALUE$ -0.025 ±0.005 OUR ESTIMATE -0.0274±0.0003±0.0030 -0.020 ±0.002 -0.0307±0.0026±0.0024 -0.016 ±0.004 ±0.002 -0.025 ±0.001 ±0.002 -0.0233±0.0017 -0.015 ±0.005 -0.0319±0.0024 • • We do not use the following -0.022 -0.026 -0.025 ±0.001 -0.025 ±0.002 ±0.002 -0.030 ±0.003 ±0.002	DOCUMENT ID AHRENS ARNDT BLANPIED GALLER BECK HANSTEIN ARNDT DAVIDSON data for averages DRECHSEL PENNER HANSTEIN BECK BLANPIED	04A 02 01 01 00 98 97 97 5, fits, 07 02D 98 97 97	DPWA DPWA IPWA IPWA IPWA DPWA DPWA DPWA DPWA DPWA DPWA DPWA D	$\begin{array}{l} \overrightarrow{\nabla p} \rightarrow N\pi \\ \gamma p \rightarrow N\pi \\ \gamma p \rightarrow p\gamma, p\pi^0, n\pi^+ \\ \gamma p \rightarrow p\gamma p \\ \overrightarrow{\gamma} p \rightarrow p\pi^0, n\pi^+ \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi N \\ \text{etc.} \bullet \bullet \\ \gamma N \rightarrow \pi N \\ \text{Multichannel} \\ \gamma N \rightarrow \pi N \\ \gamma N $
Δ (1232) → N γ , E_2/M_1 rational value	DOCUMENT ID AHRENS ARNDT BLANPIED GALLER BECK HANSTEIN ARNDT DAVIDSON data for averages DRECHSEL PENNER HANSTEIN BECK BLANPIED KHANDAKER	04A 02 01 00 98 97 97 6, fits, 07 02D 98 97 97	DPWA DPWA LEGS DPWA IPWA IPWA DPWA DPWA DPWA DPWA DPWA DPWA DPWA D	$\begin{array}{l} \overrightarrow{\nabla p} \rightarrow N\pi \\ \gamma p \rightarrow N\pi \\ \gamma p \rightarrow p\gamma, p\pi^0, n\pi^+ \\ \gamma p \rightarrow p\pi^0, n\pi^+ \\ \gamma p \rightarrow p\pi^0, n\pi^+ \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi N \\ \text{etc.} \bullet \bullet \\ \gamma N \rightarrow \pi N \\ \text{Multichannel} \\ \gamma N \rightarrow \pi N \\ \gamma$
Δ (1232) → N γ , E_2/M_1 rational equations are superscript to the following of the following Δ (1232) → N γ , E_2/M_1 rational equations are superscript to Δ (1232) → N γ , E_2/M_1 rational equations are superscript to Δ (1232) → N γ , E_2/M_1 rational equations are superscript to Δ (1232) → N γ , E_2/M_1 rational equations are superscript to Δ (1232) → N γ , E_2/M_1 rational equation Δ (1232) → N γ , Δ (1232) → N γ	DOCUMENT ID AHRENS ARNDT BLANPIED GALLER BECK HANSTEIN ARNDT DAVIDSON data for averages DRECHSEL PENNER HANSTEIN BECK BLANPIED KHANDAKER WORKMAN	04A 02 01 01 00 98 97 97 6, fits, 02D 98 97 97 95 92	DPWA DPWA IPWA IPWA IPWA DPWA DPWA DPWA DPWA DPWA DPWA DPWA D	$\begin{array}{l} \overrightarrow{\nabla p} \rightarrow N\pi \\ \gamma p \rightarrow N\pi \\ \gamma p \rightarrow p\gamma, p\pi^0, n\pi^+ \\ \gamma p \rightarrow pp, p\pi^0, n\pi^+ \\ \gamma p \rightarrow p\pi^0, n\pi^+ \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi N \\ \text{etc.} \bullet \bullet \\ \gamma N \rightarrow \pi N \\ \text{Multichannel} \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi N$
Δ (1232) → N γ , E_2/M_1 rational equations are superscript to the following of the following Δ (1232) → N γ , E_2/M_1 rational equations are superscript to Δ (1232) → N γ , E_2/M_1 rational equations are superscript to Δ (1232) → N γ , E_2/M_1 rational equations are superscript to Δ (1232) → N γ , E_2/M_1 rational equations are superscript to Δ (1232) → N γ , E_2/M_1 rational equation Δ (1232) → N γ , Δ (1232) → N	DOCUMENT ID AHRENS ARNDT BLANPIED GALLER BECK HANSTEIN ARNDT DAVIDSON data for averages DRECHSEL PENNER HANSTEIN BECK BLANPIED KHANDAKER WORKMAN DAVIDSON	04A 02 01 01 00 98 97 97 6, fits, 07 02D 98 97 97 95 92 91B	DPWA DPWA IPWA IPWA IPWA DPWA DPWA DPWA DPWA DPWA DPWA DPWA D	$\begin{array}{l} \overrightarrow{\nabla p} \rightarrow N\pi \\ \gamma p \rightarrow N\pi \\ \gamma p \rightarrow p\gamma, p\pi^0, n\pi^+ \\ \gamma p \rightarrow pp, p\pi^0, n\pi^+ \\ \gamma p \rightarrow p\pi^0, n\pi^+ \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi N \\ \text{etc.} \bullet \bullet \\ \gamma N \rightarrow \pi N \\ \text{Multichannel} \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi N$
Δ (1232) → N γ , E_2/M_1 ratio $VALUE$ -0.025 ±0.005 OUR ESTIMATE -0.0274±0.0003±0.0030 -0.020 ±0.002 -0.0307±0.0026±0.0024 -0.016 ±0.004 ±0.002 -0.025 ±0.001 ±0.002 -0.0233±0.0017 -0.015 ±0.005 -0.0319±0.0024 • • • We do not use the following -0.022 -0.026 -0.0254±0.0010 -0.025 ±0.002 ±0.002 -0.030 ±0.003 ±0.002 -0.037 ±0.003 ±0.001 -0.015 ±0.005 -0.0157±0.0072 -0.0107±0.0037	DOCUMENT ID AHRENS ARNDT BLANPIED GALLER BECK HANSTEIN ARNDT DAVIDSON data for averages DRECHSEL PENNER HANSTEIN BECK BLANPIED KHANDAKER WORKMAN DAVIDSON	04A 02 01 01 00 98 97 97 5, fits, 02D 98 97 95 92 91B 90	DPWA DPWA IPWA IPWA IPWA DPWA DPWA DPWA DPWA DPWA DPWA IPWA DPWA TPWA DPWA TPWA TPWA TPWA TPWA TPWA TPWA TPWA T	$\begin{array}{l} \overrightarrow{COMMENT} \\ \overrightarrow{\gamma}\overrightarrow{p} \rightarrow N\pi \\ \gamma p \rightarrow N\pi \\ \gamma p \rightarrow p\gamma, p\pi^{0}, n\pi^{+} \\ \gamma p \rightarrow \gamma p \\ \overrightarrow{\gamma}p \rightarrow p\pi^{0}, n\pi^{+} \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi N \\ \text{etc.} \bullet \bullet \\ \gamma N \rightarrow \pi N \\ \text{Multichannel} \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi$
Δ (1232) → N γ , E_2/M_1 ratio $VALUE$ -0.025 ±0.005 OUR ESTIMATE -0.0274±0.0003±0.0030 -0.020 ±0.002 -0.0307±0.0026±0.0024 -0.016 ±0.004 ±0.002 -0.025 ±0.001 ±0.002 -0.0233±0.0017 -0.015 ±0.005 -0.0319±0.0024 • • We do not use the following -0.022 -0.026 -0.025 ±0.002 ±0.002 -0.025 ±0.003 ±0.002 -0.030 ±0.003 ±0.002 -0.037 ±0.003 -0.0157±0.0072 -0.0107±0.0037 -0.015 ±0.002	DOCUMENT ID AHRENS ARNDT BLANPIED GALLER BECK HANSTEIN ARNDT DAVIDSON data for averages DRECHSEL PENNER HANSTEIN BECK BLANPIED KHANDAKER WORKMAN DAVIDSON DAVIDSON	04A 02 01 01 00 98 97 97 5, fits, 07 02D 98 97 97 95 92 91B 90 86	DPWA DPWA IPWA IPWA IPWA DPWA DPWA DPWA DPWA DPWA DPWA IPWA DPWA FIT FIT	$\begin{array}{l} \overrightarrow{\nabla P} \rightarrow N\pi \\ \gamma p \rightarrow N\pi \\ \gamma p \rightarrow p\gamma, p\pi^0, n\pi^+ \\ \gamma p \rightarrow p\gamma p \\ \overrightarrow{\gamma} p \rightarrow p\pi^0, n\pi^+ \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi N \\ \text{etc.} \bullet \bullet \\ \gamma N \rightarrow \pi N \\ \text{Multichannel} \\ \gamma N \rightarrow \pi N \\ \gamma N $
Δ (1232) → N γ , E_2/M_1 ratio $VALUE$ -0.025 ±0.005 OUR ESTIMATE -0.0274±0.0003±0.0030 -0.020 ±0.002 -0.0307±0.0026±0.0024 -0.016 ±0.004 ±0.002 -0.025 ±0.001 ±0.002 -0.0233±0.0017 -0.015 ±0.005 -0.0319±0.0024 • • • We do not use the following -0.022 -0.026 -0.0254±0.0010 -0.025 ±0.002 ±0.002 -0.030 ±0.003 ±0.002 -0.037 ±0.003 ±0.001 -0.015 ±0.005 -0.0157±0.0072 -0.0107±0.0037	DOCUMENT ID AHRENS ARNDT BLANPIED GALLER BECK HANSTEIN ARNDT DAVIDSON data for averages DRECHSEL PENNER HANSTEIN BECK BLANPIED KHANDAKER WORKMAN DAVIDSON	04A 02 01 01 00 98 97 97 5, fits, 02D 98 97 95 92 91B 90	DPWA DPWA IPWA IPWA IPWA DPWA DPWA DPWA DPWA DPWA DPWA IPWA DPWA TPWA DPWA TPWA TPWA TPWA TPWA TPWA TPWA TPWA T	$\begin{array}{l} \overrightarrow{COMMENT} \\ \overrightarrow{\gamma}\overrightarrow{p} \rightarrow N\pi \\ \gamma p \rightarrow N\pi \\ \gamma p \rightarrow p\gamma, p\pi^{0}, n\pi^{+} \\ \gamma p \rightarrow \gamma p \\ \overrightarrow{\gamma}p \rightarrow p\pi^{0}, n\pi^{+} \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi N \\ \text{etc.} \bullet \bullet \\ \gamma N \rightarrow \pi N \\ \text{Multichannel} \\ \gamma N \rightarrow \pi N \\ \gamma N \rightarrow \pi$

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

VALUE	DOCUMENT ID		TECN COMMENT
• • • We do not use the following of	data for averages	s, 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	<u>DOCUMENT ID</u>		TECN COMMENT	
• • • We do not use the foll	owing data for average	s, fits	, limits, etc. • • •	
-122 ± 5	ARNDT	97	DPWA $\gamma N \rightarrow \pi N$	
-127.2	HANSTEIN	96	DPWA $\gamma N \rightarrow \pi N$	

⁷ 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.

△(1232) MAGNETIC MOMENTS

△(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	$\pi^+ \rho \rightarrow \pi^+ \rho \gamma$
$4.52\!\pm\!0.50\!\pm\!0.45$	BOSSHARD	91	$\pi^+ ho ightarrow \ \pi^+ ho \gamma$ (SIN data)
3.7 to 4.2	LIN	91 B	$\pi^+ p ightarrow \ \pi^+ p \gamma$ (from UCLA data)
4.6 to 4.9	LIN	91 B	$\pi^+ m m p ightarrow \pi^+ m p \gamma$ (from SIN data)
5.6 to 7.5	WITTMAN	88	$\pi^+ p ightarrow \ \pi^+ p \gamma$ (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	$\pi^+ ho ightarrow \pi^+ ho \gamma$ (UCLA data)

△(1232)⁺ MAGNETIC MOMENT

VALUE (μ_N)	DOCUMENT ID		COMMENT
• • • We do not use the following	g data for averages	, fits,	limits, etc. • •
$2.7^{+1.0}_{-1.2} \pm 1.5 \pm 3$	⁸ KOTULLA	02	$\gamma_p \rightarrow p \pi^0 \gamma'$

⁸ The second error is systematic, the third is an estimate of theoretical uncertainties.

△(1232) REFERENCES

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

PDG ROENCHEN Also	14 14	CP C38 070001 EPJ A50 101 EPJ A51 63 (errat.)	K. Olive <i>et al.</i> D. Roenchen <i>et al.</i> D. Roenchen <i>et al.</i>	(PDG Collab.)
SVARC	14	PR C89 045205	A. Svarc et al.	
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.	(ĠWU)
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.)

HTTP://PDG.LBL.GOV Page 8 Created: 5/30/2017 17:20

PENNER Q2D	ARNDT BREITSCHOP GRIDNEV PDG AHRENS ARNDT ARNDT KOTULLA PENNER	06 06 06 06 04A 04 02 02	PR C74 045205 PL B639 424 PAN 69 1542 JP G33 1 EPJ A21 323 PR C69 035213 PR C66 055213 PRL 89 272001 PR C66 055211	R.A. Arndt et al. J. Breitschopf et al. A.B. Gridnev et al. WM. Yao et al. J. Ahrens et al. R.A. Arndt et al. R. A. Arndt et al. M. Kotulla et al. G. Penner, U. Mosel	(GWU) (TUBIN, HEBR, CSUS) (PNPI, BONN, GWU) (PDG Collab.) Mainz GDH, A2 Collab.) (GWU, TRIU) (GWU) (MAMI TAPS Collab.) (GIES)
GALLER 01 PL B503 245 S (bohler G. Galler et al. (Mainz LARA Collab.) HOHLER DOPEZCAST 01 PL B517 339 S (bohler G. Lopez Castro, A. Mariano BECK DOPEZCAST 01 PL B517 339 S (bohler G. Lopez Castro, A. Mariano VRANA OD VRANA OD PRPL 328 181 T.P. Vrana, S.A. Dytman, TS.H. Lee (PITT, ANL) KAMALOV PRPL 328 181 T.P. Vrana, S.A. Dytman, TS.H. Lee (PITT, ANL) KAMALOV 99 PRL 38 34494 S.S. Kamalov, S.N. Yang (Taiwan U.) NP A632 561 O. Hanstein, D. Drechsel, L. Tiator ARNDT 97 PR C56 577 R.A. Arridt, I.I. Strakovsky, R.L. Workman (VPI) BECK 97 PRL 78 606 R. Beck et al. (MANZ, SACL, PAVI, GLAS) Also Also PRL 79 4512 R.L. Beck, H.P. Krahn (MANZ) PRL 79 4512 R.L. Beck, H.P. Krahn (MANZ, SACL, PAVI, GLAS) BLANPIED 97 PRL 79 4591 PRL 79 4593 R.M. Davidson, N.C.A. Mukhopadhyay (LEGS Collab.) R.M. Davidson, N.C.A. Mukhopadhyay (LEGS Collab.) BERNICHA 96 PR A597 623 A. Bernicha, G. Lopez Castro, J. Pestieau (LOUV+) A. Bernicha, G. Lopez Castro, J. Pestieau (LOUV+) ABAEV 95 ZPHY A352 85 V.V. Abaev, S.P. Kruglov (PIPI) ARNDT 96 PR C52 2120 R.A. Arndt et al. (KARL) KHANDAKER 95 PR D51 3966 M. Khandaker, A.M. Sandorfi (BNL, VPI) ASHON 97 PR D39 3094 D.M. Manley, E.M. Saleski (KSA) IJP Also PR D39 3094 D.M. Manley, E.M. Saleski (KSA) IJP Also PR D39 3094 D.M. Manley et al. (VPI) TELE) IJP CATT					(GIES)
HOHLER				•	
Also 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, TS.H. Lee (PITT, ANL.) 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 79 6510 R.L. Beck et al. (MANZ, SACL, PAVI, GLAS) Also PRL 79 4512 R.L. Beck, H.P. Krahn (MANZ) Also PRL 79 4513 (erratum) R.L. Beck, H.P. Krahn (MANZ) Also PR 179 4513 (erratum) R.L. Beck, H.P. Krahn (MANZ) ALSO PR 179 4513 (erratum) R.L. Beck, H.P. Krahn (MANZ) ALSO PR 179 4513 (erratum) R. Beck et al. (MANZ, SACL, PAVI, GLAS) BLAPIED 97 PRL 79 4530 R.A. Arndt, I.I. Strakovsky, R.L. Workman (VPI) BLADY <t< td=""><td></td><td></td><td></td><td></td><td></td></t<>					
BECK 00		01			
VRANALOV 99 PRL 83 4494 S.S. Kamalov, S.N. Yang (Taiwan U.) 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 PRC 56 577 R.A. Arndt, I.I. Strakovsky, R.L. Workman (VPI) BECK 97 PRL 79 4510 R.L. Beck, H.P. Krahn (MANZ, SACL, PAVI, GLAS) Also PRL 79 4512 R.L. Beck, H.P. Krahn (MANZ, SACL, PAVI, GLAS) Also PRL 79 4512 (erratum) R.L. Beck, H.P. Krahn (MANZ, SACL, PAVI, GLAS) BLANPIED PR PR 19 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+) ABAEV 95 PR C52 2120 R.A. Arndt et al. (VPI) KHANDAKER 95 PR C52 2120 R.		00			Microtron DAPHNE Col.)
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) Also PRL 79 4510 R.B. Beck et al. (MANZ, SACL, PAVI, GLAS) Also PRL 79 4512 R.L. Beck, H.P. Krahn (MANZ) Also PRL 79 4512 R.L. Beck, H.P. Krahn (MANZ, SACL, PAVI, GLAS) Also PRL 79 4515 (erratum) R.L. Beck et al. (MANZ, SACL, PAVI, GLAS) Also PRL 79 4515 (erratum) R.L. Beck et al. (MANZ, SACL, PAVI, GLAS) Also 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 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) (FNPI) ARNDT 95 PR C52 2120 R.A. Arndt et al. (VPI, BRCO) (FNPI) ARNDT 95 PR C51 3966 M. Khandaker, A.M. Sandorfi (BNL, VPI) HOEHLER 93 π N Newsletter 9 1 G. Hohler (KARL) LI 93 PR C47 2759 Z.J. Li et al. (VPI) Also PR C47 2759 Z.J. Li et al. (VPI) Also PR C49 2131 R.A. Arndt et al. (VPI) Also PR C44 1819 A. Bosshard et al. (VPI, ELE) IJP BOSSHARD 91 PR D44 1962 A. Bosshard et al. (VPI, ELE) IJP BOSSHARD 91 PR D44 1962 A. Bosshard et al. (VPI, ELE) IJP BOSSHARD 91 PR D44 1962 A. Bosshard et al. (CATH, LAUS, LBL+) LIN Also PR C43 8930 D. Lin, M.K. Liou Z.M. Ding (CUNY, CSOK) PR C43 8930 D. Lin, M.K. Liou, Z.M. Ding (CUNY, CSOK) PR C43 8930 D. Lin, M.K. Liou, Z.M. Ding (CUNY, CSOK) Also PR C35 718 L. Heller et al. (LAIL, MIT, ILL) DAVIDSON 83 PR C37 178 L. Heller et al. (LAIL, MIT, ILL) DAVIDSON 84 PR C37 178 L. Heller et al. (LAIL, MIT, ILL) DAVIDSON 90 PR D42 20 R.M. Davidson, N.C. Mukhopadhyay, R. Wittman (RPI) TANABE 85 PR C31 1876 H. Tanabe, K. Ohta (LAIL, MIT, ILL) DAVIDSON 90 PR D42 20 R.M. Davidson, N.C. Muk				`	Lee (PITT, ANL)
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 PRL 79 4510 R.L. Beck, H.P. Krahn (MANZ) Also PRL 79 4515 (erratum) R.L. Beck, H.P. Krahn (MANZ) 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) BRANPIED 96 PR C53 430 R.A. Arndt, I.I. Strakovsky, R.L. Workman (VPI) BERNICHA 96 PR D837 623 A. Bernicha, G. Lopez Castro, J. Pestieau (LOUV+) HANSTEIN 96 PL B385 45 O. Hanstein, D. Drechsel, L. Tiator (MANZ) VABADEV 95 PR D51 3966 M. Khandaker, A.M. Sandorfi (BNL, VPI) HOEHLER 93 7 N Newsletter 9 1 G. Hohler (VPI) LI 93 PR C47 2759 Z.J. Li et al. (VPI) MANLEY 92 PR C46 1546 R.L. Workman, R.A. Arndt					` ,
BECK 97 PRL 78 606 R. Beck et al. (MANZ, SACL, PAVI, GLAS) Also PRL 79 4510 R.L. Beck, H.P. Krahn (MANZ) Also PRL 79 4512 R.L. Beck, H.P. Krahn (MANZ, SACL, PAVI, GLAS) BLANPIED 97 PRL 79 4519 R.L. Beck et al. (MANZ, SACL, PAVI, GLAS) BLANPIED 97 PRL 79 4509 R.M. Davidson, N.C.A. Mukhopadhyay (RPI) ARNDT 96 PR 53 430 R.A. Arndt, I.I. Strakovsky, R.L. Workman (VPI) BERNICHA 96 PL B385 45 O. Hanstein, D. Drechsel, L. Tiator (MANZ) HANSTEIN 96 PL B385 45 O. Hanstein, D. Drechsel, L. Tiator (MANZ) ABAEV 95 PR PK 522 2120 R.A. Arndt et al. (VPI, BRCO) KHANDAKER 95 PR D51 3966 M. Khandaker, A.M. Sandorfi (BNL, VPI) HOEHLER 93 π N Newsletter 9 1 G. Hohler (KKARL) LI 93 π R N 42 4002 D.M. Manley, E.M. Saleski (KSA) JIP Also PR D30 3904 D.M. Manley, E.M. Saleski					
Also PRL 79 4510 R.L. Beck, H.P. Krahn (MANZ) Also PRL 79 4512 R.L. Beck, H.P. Krahn (MANZ) Also 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 PL B385 45 O. Hanstein, D. Drechsel, L. Tiator (MANZ) HANDTEIN 95 PPR D51 3966 M. Aknather, A.M. Sandorfi (PNPI) ARNDT 95 PR D51 3966 M. Khandaker, A.M. Sandorfi (KARL) LI 93 PR C47 2759 C. Hohler (KARL) LI 93 PR C47 2759 Z.J. Li et al. (VPI) MORKMAN 92 PR D43 2131 R.A. Arndt et al. (VPI) WORKMAN 92 PR C44 1819 A. Bosshard et al. (ZURI, LBL, VILL+) Also					
Also		31		,	,
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. Arrdt, 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 π N Newsletter 9 1 G. Hohler (KARL) LI 93 PR D45 4002 D.M. Manley et al. (VPI) WORKMAN 92 PR C46 1546 R.L. Workman, R.A. Arndt, Z.J. Li (VPI) Also PR D43 2131 R.A. Arndt et al. (VPI, TELE) JP BOSSHARD 91 PR D44 1962 A. Bosshar	Also		PRL 79 4512		• • • • • • • • • • • • • • • • • • • •
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 (PPIPI) KHANDAKER 95 PR D51 3966 M. Khandaker, A.M. Sandorfi (BNL, VPI) HOEHLER 93 π N Newsletter 9 1 G. Hohler (KRARL) LI 93 PR C47 2759 Z.J. Li et al. (VPI) MANLEY 92 PR D45 4002 D.M. Manley, E.M. Saleski (KSA) IJP Also PR D30 904 D.M. Walley, E.M. Saleski (VPI) WORKMAN 92 PR D43 2131 R.A. Arndt et al. (VPI) ASSSHARD 91 PR D44 1962 A. Bosshard et al. (ZURI, LBL, VILL+) ALIN PR C44 819 D.H. Lin, M.K. Liou (CATH, LAU			,		
ARNDT 96 PR C53 430 R.A. Arndt, I.I. Strakovsky, R.İ. Workman (VPI) BERNICHA 96 NP A597 623 A. Bernicha, G. Lopez Castro, J. Pestieau (LOUV+) HANSTEIN 96 PL 8385 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 π N 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 (KSA) IJP Also PR D43 2131 R.A. Arndt et al. (VPI) BOSSHARD 91 PR D43 2131 R.A. Arndt et al. (ZURI, LBL, VILL+) Also PR L 64 2619 A. Bosshard et al. (ZURI, LBL, VILL+) Also PR C43 R930 D. Lin, M.K. Liou, Z.M. Ding (CUNY, CSOK)					
BERNICHA 96 NP A597 623 A. Bernicha, G. Lopez Castro, J. Pestieau (LOÜV+) HANSTEIN 96 PL B385 45 O. Hanstein, D. Drechsel, L. Tiator (MANZ) ABAEV 95 ZPHY A352 85 V.V. Abaev, S.P. Kruglov (PPNPI) 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 31 7 N 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 (KSA) IJP Also PR D30 904 D.M. Workman, R.A. Arndt, Z.J. Li (VPI) WORKMAN 92 PR C44 1546 R.L. Workman, R.A. Arndt, Z.J. Li (VPI, TELE) IJP Also PR D43 2131 R.A. Arndt et al. (ZURI, LBL, VILL+) Also PR D44 1962 A. Bosshard et al. (CATH, LAUS, LBL+) DAVIDSON 91 PR D43 71 R.M. Davidson, N.C. Mukhopadhyay, R.S. Wittman					· ·
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 D51 3966 M. Khandaker, A.M. Sandorfi (BNL, VPI) HOEHLER 93 π N 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 (KSA) JJP Also PR D30 904 D.M. Manley, E.M. Saleski (VPI) WORKMAN 92 PR C46 1546 R.L. Workman, R.A. Arndt, Z.J. Li (VPI) BOSSHARD 91 PR D44 1962 A. Bosshard et al. (ZURI, LBL, VILL+) Also PR L64 2619 A. Bosshard et al. (ZURI, LBL, VILL+) Also PR C43 R930 D.H. Lin, M.K. Liou, Z.M. Ding (CUNY) Also PR C43 R930 D.L. Lin, M.K. Liou, Z.M. Ding (CUNY) DAVIDSON PR D42 20 R.M. Davidson, N.C. Mukhopadhyay, R.S. Wittman (TRIU) HELLER					
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 π N 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 (KSA) IJP Also PR D30 904 D.M. Manley, E.M. Saleski (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 PR L64 2619 A. Bosshard et al. (CATH, LAUS, LBL+) DAVIDSON 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) DAVIDSON 90 PR D42 20 R.M. Davidson, N.C. Mukhopadhyay (RPI) WITTMAN<					
KHANDAKER 95 PR D51 3966 M. Khandaker, A.M. Sandorfi (BNL, VPI) HOEHLER 93 π N Newsletter 9 1 G. Hohler (KARL) LI 93 π N Newsletter 9 1 G. Hohler (VPI) MANLEY 92 PR C47 2759 Z.J. Li et al. (VPI) MANLEY 92 PR D45 4002 D.M. Manley, E.M. Saleski (KSA) IJP Also PR D30 904 D.M. Manley, et al. (VPI) WORKMAN 92 PR C46 1546 R.L. Workman, R.A. Arndt, Z.J. Li (VPI, TELE) IJP BOSSHARD 91 PR D43 2131 R.A. Arndt et al. (ZURI, LBL, VILL+) Also PR L64 2619 A. Bosshard et al. (CATH, LAUS, LBL+) Also PR L64 2619 A. Bosshard et al. (CATH, LAUS, LBL+) Also PR C43 R930 D. Lin, M.K. Liou, Z.M. Ding (CUNY, CSOK) Also PR C43 R930 D. Lin, M.K. Liou, Z.M. Ding (CUNY, CSOK) DAVIDSON 90 PR D42 20 R.M. Davidson, N.C. Mukhopadhyay, R.S. Wittman (RPI) WITTMAN <t< td=""><td></td><td></td><td></td><td></td><td></td></t<>					
HOEHLER LI 93 π N Newsletter 9 1 G. Hohler (KARL) (VPI) LI 93 PR C47 2759 Z.J. Li et al. (VPI) MANLEY 92 PR D45 4002 D.M. Manley, E.M. Saleski (KSA) IJP Also PR D30 904 D.M. Manley, E.M. Saleski (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. (CATH, LAUS, LBL, VILL+) Also PRL 64 2619 A. Bosshard et al. (CATH, LAUS, LBL+) DAVIDSON 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, CSOK) Also PR D42 20 R.M. Davidson, N.C. Mukhopadhyay (RPI) WHTTMAN 88 PR C37 2075 R. Wittman (TRIU) HELLER 87 PR C35 718 L. Heller et al. (LANL, MIT, ILL) DAVIDSON 86<					
LI 93 PR C47 2759 Z.J. Li et al. (VPI) MANLEY 92 PR D45 4002 D.M. Manley, E.M. Saleski (KSA) IJP Also 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. (ZURI, LBL, VILL+) BOSSHARD 91 PR D44 1962 A. Bosshard et al. (ZURI, LBL, VILL+) Also PR L 64 2619 A. Bosshard et al. (CATH, LAUS, LBL+) DAVIDSON 91B PR D43 71 R.M. Davidson, N.C. Mukhopadhyay, R.S. Wittman LIN PR C43 R930 D. Lin, M.K. Liou, Z.M. Ding (CUNY, CSOK) Also PR C43 R930 D. Lin, M.K. Liou, Z.M. Wittman (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					`
MANLEY Also 92 PR D45 4002 PR D30 904 D.M. Manley, E.M. Saleski (KSA) IJP (VPI) WORKMANN 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+) (VPI, TELE) IJP Also 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) (CUNY, CSOK) Also PR C43 R930 D. Lin, M.K. Liou (CUNY) 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) AWAJI Also NP B197 365 K. Fujii et al. (NAGO) Also NP B197 365 K. Fujii et al. (CMU, LBL) IJP PR D20 2839 R.E. Cutkosky et al. (CMU, LBL) IJP PR D20 2839 R.E. Cutkosky et al. (CMU, LBL) IJP PR D20 2839 R.E. Cutkosky et al. (CMU, LBL) IJP PR D43 36 331 R. Koch, E. Pietarinen (KARLT) IJP Also Toronto Conf. 3 R. Koch (KARLT) IJP Toronto Conf					
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 PRL 64 2619 A. Bosshard et al. (CATH, LAUS, LBL+) DAVIDSON 91B PR C44 1819 D.H. Lin, M.K. Liou, Z.M. Ding (CUNY, CSOK) Also PR C43 R930 D. Lin, M.K. Liou, Z.M. Ding (CUNY, CSOK) Also 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)					
ARNDT 91 PR D43 2131 R.A. Arndt et al. (VPI, TELE) IJP BOSSHARD Also 91 PR D44 1962 A. Bosshard et al. (ZURI, LBL, VILL+) 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) PR C43 R930 D. Lin, M.K. Liou (CUNY, CSOK) 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) AWAJI 81 Bonn Conf. 352 N. Awaji, R. Kajikawa (NAGO) CUTKOSKY 80 Toronto Conf. 19 R.E. Cutkosky et al. (CMU, LBL) IJP			PR D30 904	D.M. Manley et al.	`(VPI)
BOSSHARD Also 91 PR D44 1962 PRL 64 2619 A. Bosshard et al. (ZURI, LBL, VILL+) 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 PR C43 R930 D. Lin, M.K. Liou, Z.M. Ding (CUNY, CSOK) 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) Also NP B197 365 K. Fujii et al. (NAGO) Also NP B197 365 K. Fujii et al. (CMU, LBL) IJP Also NP A336 331 R. E. Cutkosky et al. (CMU, LBL) KOCH					
Also 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 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 (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) AWAJI 81 Bonn Conf. 352 N. Awaji, R. Kajikawa (NAGO) Also NP B197 365 K. Fujii et al. (CMU, LBL) IJP Also Toronto Conf. 19 R.E. Cutkosky et al. (CMU, LBL) IJP Also PR D20 2839 R.E. Cutkosky et al. (CMU, LBL) KOCH 80B					
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 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) AWAJI 81 Bonn Conf. 352 N. Awaji, R. Kajikawa (NAGO) Also NP B197 365 K. Fujii et al. (CMU, LBL) IJP Also Toronto Conf. 19 R.E. Cutkosky et al. (CMU, LBL) IJP Also NP A336 331 R. Koch, E. Pietarinen (KARLT) IJP MIROSHNIC 79<		91			
Also 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) AWAJI 81 Bonn Conf. 352 N. Awaji, R. Kajikawa (NAGO) Also NP B197 365 K. Fujii et al. (NAGO) 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 Also Toronto Conf. 3 R. Koch (KARLT) IJP Also Toronto Conf. 3 R.		91B			`
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) AWAJI 81 Bonn Conf. 352 N. Awaji, R. Kajikawa (NAGO) Also NP B197 365 K. Fujii et al. (NAGO) 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 MIROSHNIC 79 SJNP 29 94 I.I. Miroshnichenko et al. (KFTI) IJP	LIN	91B	PR C44 1819	D.H. Lin, M.K. Liou, Z.M. Ding	(CUNY, CSOK)
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) AWAJI 81 Bonn Conf. 352 N. Awaji, R. Kajikawa (NAGO) Also NP B197 365 K. Fujii et al. (NAGO) 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 79 SJNP 29 94 I.I. Miroshnichenko et al. (KFTI) IJP NEFKENS 78 PR D18 3911 B.M.K. Nefkens et al. (UCLA, CATH) IJP		00			`
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) AWAJI 81 Bonn Conf. 352 N. Awaji, R. Kajikawa (NAGO) Also NP B197 365 K. Fujii et al. (NAGO) 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 NEFKENS 78 PR D18 3911 B.M.K. Nefkens et al. (UCLA, CATH) IJP					
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) AWAJI 81 Bonn Conf. 352 N. Awaji, R. Kajikawa (NAGO) Also NP B197 365 K. Fujii et al. (NAGO) 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 (KARLT) IJP Also Toronto Conf. 3 R. Koch (KARLT) IJP (KARLT) IJP MIROSHNIC 79 SJNP 29 94 I.I. Miroshnichenko et al. (KFTI) IJP NEFKENS 78 PR D18 3911 B.M.K. Nefkens et al. (UCLA, CATH) IJP					. ' '
CRAWFORD 83 NP B211 1 R.L. Crawford, W.T. Morton (GLAS) AWAJI 81 Bonn Conf. 352 N. Awaji, R. Kajikawa (NAGO) Also NP B197 365 K. Fujii et al. (NAGO) 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 NEFKENS 78 PR D18 3911 B.M.K. Nefkens et al. (UCLA, CATH) IJP					
AWAJI 81 Bonn Conf. 352 N. Awaji, R. Kajikawa (NAGO) Also NP B197 365 K. Fujii et al. (NAGO) 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 NEFKENS 78 PR D18 3911 B.M.K. Nefkens et al. (UCLA, CATH) IJP					(KOMAB)
Also NP B197 365 K. Fujii et al. (NAGO) 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 NEFKENS 78 PR D18 3911 B.M.K. Nefkens et al. (UCLA, CATH) IJP					
CUTKOSKY 80 Toronto Conf. 19 R.E. Čutkosky et al. (CMÙ, 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 NEFKENS 78 PR D18 3911 B.M.K. Nefkens et al. (UCLA, CATH) IJP		81			
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 NEFKENS 78 PR D18 3911 B.M.K. Nefkens et al. (UCLA, CATH) IJP		80			
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 NEFKENS 78 PR D18 3911 B.M.K. Nefkens et al. (UCLA, CATH) IJP		00			` -
Also Toronto Conf. 3 R. Koch (KARLT) IJP MIROSHNIC 79 SJNP 29 94 I.I. Miroshnichenko et al. Translated from YAF 29 188. (KFTI) IJP NEFKENS 78 PR D18 3911 B.M.K. Nefkens et al. (UCLA, CATH) IJP		80B	NP A336 331		` (KARLT) IJP
MIROSHNIC 79 SJNP 29 94 I.I. Miroshnichenko <i>et al.</i> (KFTI) IJP Translated from YAF 29 188. NEFKENS 78 PR D18 3911 B.M.K. Nefkens <i>et al.</i> (UCLA, CATH) IJP		79			
Translated from YAF 29 188. NEFKENS 78 PR D18 3911 B.M.K. Nefkens <i>et al.</i> (UCLA, CATH) IJP		70			
NEFKENS 78 PR D18 3911 B.M.K. Nefkens <i>et al.</i> (UCLA, CATH) IJP	IVIIROSHIVIC	19			(KFII) IJP
PEDRONI 78 NP A300 321 E. Pedroni <i>et al.</i> (SIN, ISNG, KARLE+) IJP	NEFKENS	78			(UCLA, CATH) IJP
	PEDRONI	78	NP A300 321	E. Pedroni <i>et al.</i>	(SIN, ISNG, KARLE+) IJP