

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

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

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 π N → π N
1210.5±1.0	ANISOVICH	12A	DPWA Multichannel
1210 ±1	CUTKOSKY	80	IPWA π N → π 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 π N → π N, η N
1210	ARNDT	04	DPWA π N → π N, η N
1209	² HOEHLER	93	ARGD π N → π N

¹Fit to the amplitudes of HOEHLER 79.

²See 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.

−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 π N → π N
99 ±2	ANISOVICH	12A	DPWA Multichannel
100 ±2	CUTKOSKY	80	IPWA π N → π 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 π N → π N, η N
100	ARNDT	04	DPWA π N → π N, η N
100	² HOEHLER	93	ARGD π N → π N

¹Fit to the amplitudes of HOEHLER 79.

²See 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.

REAL PART, Δ(1232)⁺⁺

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

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

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

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

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

–2×IMAGINARY PART, $\Delta(1232)^{+}$

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

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

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

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
• • • 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, $\Delta(1232)^0$

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

$\Delta(1232)$ ELASTIC POLE RESIDUES

ABSOLUTE VALUE, MIXED CHARGES

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

PHASE, MIXED CHARGES

<u>VALUE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
–48 to –45 (≈ –46) OUR ESTIMATE			
–39±1	ROENCHEN 22	DPWA	Multichannel
–46±1±1	¹ SVARC 14	L+P	$\pi N \rightarrow \pi N$
–46±1	ANISOVICH 12A	DPWA	Multichannel
–47±1	CUTKOSKY 80	IPWA	$\pi N \rightarrow \pi N$

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

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

¹ Fit to the amplitudes of HOEHLER 79.

$\Delta(1232)$ BREIT-WIGNER MASSES

MIXED CHARGES

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
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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	$\pi N \rightarrow \pi N, \eta N$
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 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	$\pi N \rightarrow \pi N, \eta N$
1228 ± 1	PENNER	02C	DPWA	Multichannel

¹ Statistical error only.

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

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
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• • • We do not use the following data for averages, fits, limits, etc. • • •

1230.55 ± 0.20	GRIDNEV	06	DPWA	$\pi N \rightarrow \pi N$
1231.88 ± 0.29	BERNICH	96		Fit to PEDRONI 78
1230.5 ± 0.2	ABAEV	95	IPWA	$\pi N \rightarrow \pi N$
1230.9 ± 0.3	KOCH	80B	IPWA	$\pi N \rightarrow \pi N$
1231.1 ± 0.2	PEDRONI	78		$\pi N \rightarrow \pi N$ 70–370 MeV

$\Delta(1232)^+$ MASS

VALUE (MeV)	DOCUMENT ID	COMMENT
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• • • We do not use the following data for averages, fits, limits, etc. • • •

1234.9 ± 1.4	MIROSHNIC...	79	Fit photoproduction
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$\Delta(1232)^0$ MASS

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
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• • • 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	$\pi N \rightarrow \pi N$
1234.35 ± 0.75	BERNICH	96		Fit to PEDRONI 78
1233.1 ± 0.3	ABAEV	95	IPWA	$\pi N \rightarrow \pi N$
1233.6 ± 0.5	KOCH	80B	IPWA	$\pi N \rightarrow \pi N$
1233.8 ± 0.2	PEDRONI	78		$\pi N \rightarrow \pi N$ 70–370 MeV

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

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
2.86 ± 0.30	GRIDNEV	06	DPWA $\pi N \rightarrow \pi N$
2.25 ± 0.68	BERNICHIA	96	Fit to PEDRONI 78
2.6 ± 0.4	ABAEV	95	IPWA $\pi N \rightarrow \pi N$
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.			

$\Delta(1232)$ BREIT-WIGNER WIDTHS

MIXED CHARGES

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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 $\pi N \rightarrow \pi N, \eta N$
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. ● ● ●			
113.0 ± 0.5	¹ SHRESTHA	12A	DPWA Multichannel
112 ± 4	ANISOVICH	10	DPWA Multichannel
118.0 ± 2.2	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$
106 ± 1	PENNER	02C	DPWA Multichannel

¹ Statistical error only.

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

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
112.2 ± 0.7	GRIDNEV	06	DPWA $\pi N \rightarrow \pi N$
109.07 ± 0.48	BERNICHIA	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

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

$\Delta(1232)^0$ WIDTH

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
● ● ● 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 $\pi N \rightarrow \pi N$
117.58 ± 1.16	BERNICHIA	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

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
● ● ● We do not use the following data for averages, fits, limits, 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 ±1.0	PEDRONI	78	See the widths

$\Delta(1232)$ DECAY MODES

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

Mode	Fraction (Γ_i/Γ)
Γ_1 $N\pi$	99.4 %
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 $p e^+ e^-$	$(4.2 \pm 0.7) \times 10^{-5}$

$\Delta(1232)$ BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{\text{total}}$					Γ_1/Γ
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>		
0.994 OUR ESTIMATE					
0.9939±0.0001	¹ HUNT	19	DPWA	Multichannel	
1.00	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$	
1.0	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$	
1.0	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$	
● ● ● 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	$\pi N \rightarrow \pi N, \eta N$	
1.00	PENNER	02C	DPWA	Multichannel	

¹Statistical error only.

$\Gamma(p e^+ e^-)/\Gamma_{\text{total}}$					Γ_5/Γ
<u>VALUE (units 10^{-5})</u>	<u>DOCUMENT ID</u>				
4.19±0.34±0.62	¹ ADAMCZEW... 17				

¹The systematic uncertainty includes the model dependence.

$\Delta(1232)$ PHOTON DECAY AMPLITUDES AT THE POLE

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

<u>MODULUS ($\text{GeV}^{-1/2}$)</u>	<u>PHASE ($^\circ$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-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

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

<u>MODULUS ($\text{GeV}^{-1/2}$)</u>	<u>PHASE ($^\circ$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-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

$\Delta(1232)$ BREIT-WIGNER PHOTON DECAY AMPLITUDES

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

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

<u>VALUE ($\text{GeV}^{-1/2}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-0.142 to -0.129 (\approx - 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 $\gamma N \rightarrow N\pi$
-0.139 ± 0.004	¹ DUGGER	07	DPWA $\gamma N \rightarrow \pi N$
-0.137 ± 0.005	AHRENS	04A	DPWA $\vec{\gamma}\vec{p} \rightarrow N\pi$
$-0.1357 \pm 0.0013 \pm 0.0037$	BLANPIED	01	LEGS $\gamma p \rightarrow p\gamma, p\pi^0, n\pi^+$
-0.131 ± 0.001	¹ BECK	00	IPWA $\vec{\gamma}p \rightarrow p\pi^0, n\pi^+$
-0.140 ± 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 $\gamma N \rightarrow \pi N$
● ● ● 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 $\gamma N \rightarrow \pi N$
-0.129 ± 0.001	ARNDT	02	DPWA $\gamma p \rightarrow N\pi$
-0.128	PENNER	02D	DPWA Multichannel
-0.1312	HANSTEIN	98	DPWA $\gamma N \rightarrow \pi N$

¹Statistical error only.

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

<u>VALUE ($\text{GeV}^{-1/2}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-0.262 to -0.248 (\approx - 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 $\gamma N \rightarrow N\pi$
-0.258 ± 0.005	DUGGER	07	DPWA $\gamma N \rightarrow \pi N$
-0.256 ± 0.003	AHRENS	04A	DPWA $\vec{\gamma}\vec{p} \rightarrow N\pi$
$-0.2669 \pm 0.0016 \pm 0.0078$	BLANPIED	01	LEGS $\gamma p \rightarrow p\gamma, p\pi^0, n\pi^+$
-0.251 ± 0.001	BECK	00	IPWA $\vec{\gamma}p \rightarrow p\pi^0, n\pi^+$
-0.258 ± 0.006	KAMALOV	99	DPWA $\gamma N \rightarrow \pi N$
-0.2466 ± 0.0013	HANSTEIN	98	IPWA $\gamma N \rightarrow \pi N$
-0.2524 ± 0.0013	DAVIDSON	97	DPWA $\gamma N \rightarrow \pi N$

• • • 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	$\gamma N \rightarrow \pi N$
-0.243 ± 0.001	ARNDT	02	DPWA	$\gamma p \rightarrow N\pi$
-0.247	PENNER	02D	DPWA	Multichannel
-0.2522	HANSTEIN	98	DPWA	$\gamma N \rightarrow \pi N$

¹Statistical error only.

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

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-0.030 to -0.020 (≈ -0.025) OUR ESTIMATE			
$-0.0274 \pm 0.0003 \pm 0.0030$	AHRENS	04A	DPWA $\vec{\gamma}\vec{p} \rightarrow N\pi$
-0.020 ± 0.002	ARNDT	02	DPWA $\gamma p \rightarrow N\pi$
$-0.0307 \pm 0.0026 \pm 0.0024$	BLANPIED	01	LEGS $\gamma p \rightarrow p\gamma, p\pi^0, n\pi^+$
$-0.016 \pm 0.004 \pm 0.002$	GALLER	01	DPWA $\gamma p \rightarrow \gamma p$
$-0.025 \pm 0.001 \pm 0.002$	BECK	00	IPWA $\vec{\gamma}p \rightarrow p\pi^0, n\pi^+$
-0.0233 ± 0.0017	HANSTEIN	98	IPWA $\gamma N \rightarrow \pi N$
-0.015 ± 0.005	¹ 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. • • •

-0.022	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$
-0.026	PENNER	02D	DPWA	Multichannel
-0.0254 ± 0.0010	HANSTEIN	98	DPWA	$\gamma N \rightarrow \pi N$
$-0.025 \pm 0.002 \pm 0.002$	BECK	97	IPWA	$\gamma N \rightarrow \pi N$
$-0.030 \pm 0.003 \pm 0.002$	BLANPIED	97	DPWA	$\gamma N \rightarrow \pi N, \gamma N$

¹This 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.

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

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
• • • We do not use the following data for averages, fits, limits, etc. • • •			
0.065 ± 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

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
• • • We do not use the following data for averages, fits, limits, etc. • • •			
-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
● ● ● 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} ± 1.5 ± 3	¹ KOTULLA 02	$\gamma p \rightarrow p \pi^0 \gamma'$

¹The 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 <i>et al.</i>	(JULI, GWU, BONN+)
HUNT 19	PR C99 055205	B.C. Hunt, D.M. Manley	
ADAMCZEW... 17	PR C95 065205	J. Adamczewski-Musch <i>et al.</i>	(HADES Collab.)
ROENCHEN 15A	EPJ A51 70	D. Roenchen <i>et al.</i>	
PDG 14	CP C38 070001	K. Olive <i>et al.</i>	(PDG Collab.)
SVARC 14	PR C89 045205	A. Svarc <i>et al.</i>	(RBI Zagreb, UNI Tuzla)
ANISOVICH 12A	EPJ A48 15	A.V. Anisovich <i>et al.</i>	(BONN, PNPI)
SHRESTHA 12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)
WORKMAN 12A	PR C86 015202	R. Workman <i>et al.</i>	(GWU)
ANISOVICH 10	EPJ A44 203	A.V. Anisovich <i>et al.</i>	(BONN, PNPI)
DRECHSEL 07	EPJ A34 69	D. Drechsel, S.S. Kamalov, L. Tiator	(MAINZ, JINR)
DUGGER 07	PR C76 025211	M. Dugger <i>et al.</i>	(JLab CLAS Collab.)
ARNDT 06	PR C74 045205	R.A. Arndt <i>et al.</i>	(GWU)
BREITSCHOP... 06	PL B639 424	J. Breitschopf <i>et al.</i>	(TUBIN, HEBR, CSUS)
GRIDNEV 06	PAN 69 1542	A.B. Gridnev <i>et al.</i>	(PNPI, BONN, GWU)
PDG 06	JP G33 1	W.-M. Yao <i>et al.</i>	(PDG Collab.)
AHRENS 04A	EPJ A21 323	J. Ahrens <i>et al.</i>	(A2 Collab.)
ARNDT 04	PR C69 035213	R.A. Arndt <i>et al.</i>	(GWU, TRIU)
ARNDT 02	PR C66 055213	R. A. Arndt <i>et al.</i>	(GWU)
KOTULLA 02	PRL 89 272001	M. Kotulla <i>et al.</i>	(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 <i>et al.</i>	(BNL LEGS Collab.)
GALLER 01	PL B503 245	G. Galler <i>et al.</i>	(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 <i>et al.</i>	(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 <i>et al.</i>	(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 (erratum)	R.L. Beck <i>et al.</i>	(MAINZ, SACL, PAVI, GLAS)
BLANPIED	97	PRL 79 4337	G.S. Blanpied <i>et al.</i>	(LEGS Collab.)
DAVIDSON	97	PRL 79 4509	R.M. Davidson, N.C.A. Mukhopadhyay	(RPI)
BERNICHIA	96	NP A597 623	A. Bernichia, 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 <i>et al.</i>	(ZURI, LBL, VILL+)
Also		PRL 64 2619	A. Bosshard <i>et al.</i>	(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 <i>et al.</i>	(LANL, MIT, ILL)
CUTKOSKY	80	Toronto Conf. 19	R.E. Cutkosky <i>et al.</i>	(CMU, LBL) IJP
Also		PR D20 2839	R.E. Cutkosky <i>et al.</i>	(CMU, LBL)
KOCH	80B	NP A336 331	R. Koch, E. Pietarinen	(KARLT) IJP
HOEHLER	79	PDAT 12-1	G. Hohler <i>et al.</i>	(KARLT) IJP
Also		Toronto Conf. 3	R. Koch	(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
PEDRONI	78	NP A300 321	E. Pedroni <i>et al.</i>	(SIN, ISNG, KARLE+) IJP