

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

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

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

$\Delta(1232)$ POLE POSITIONS

REAL PART, MIXED CHARGES

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1209 to 1211 (≈ 1210) OUR ESTIMATE			
1210 ± 1	SARANTSEV 25	DPWA	Multichannel
1209.5 ± 1.1	¹ HOFERICHT... 24	RVUE	$\pi N \rightarrow \pi N$
1215 ± 1	ROENCHEN 22	DPWA	Multichannel
1211 $\pm 1 \pm 1$	² SVARC 14	L+P	$\pi N \rightarrow \pi N$
1210 ± 1	CUTKOSKY 80	IPWA	$\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1212.4	HUNT 19	DPWA	Multichannel
1218	ROENCHEN 15A	DPWA	Multichannel
1210.5 ± 1.0	ANISOVICH 12A	DPWA	Multichannel
1211	ARNDT 06	DPWA	$\pi N \rightarrow \pi N, \eta N$
1210	ARNDT 04	DPWA	$\pi N \rightarrow \pi N, \eta N$
1209	³ HOEHLER 93	ARGD	$\pi N \rightarrow \pi N$

¹Roy-Steiner equations applied to πN scattering amplitudes and pionic atom data

²Fit to the amplitudes of HOEHLER 79.

³See HOEHLER 93 for a detailed discussion of the evidence for and the pole parameters of N and Δ resonances as determined from Argand diagrams of πN elastic partial-wave amplitudes and from plots of the speeds with which the amplitudes traverse the diagrams.

–2×IMAGINARY PART, MIXED CHARGES

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
98 to 102 (≈ 100) OUR ESTIMATE			
101 ± 2	SARANTSEV 25	DPWA	Multichannel
98.5 ± 1.2	¹ HOFERICHT... 24	RVUE	$\pi N \rightarrow \pi N$
93 ± 1	ROENCHEN 22	DPWA	Multichannel
98 $\pm 2 \pm 1$	² SVARC 14	L+P	$\pi N \rightarrow \pi N$
100 ± 2	CUTKOSKY 80	IPWA	$\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
96.8	HUNT 19	DPWA	Multichannel
92	ROENCHEN 15A	DPWA	Multichannel
99 ± 2	ANISOVICH 12A	DPWA	Multichannel
99	ARNDT 06	DPWA	$\pi N \rightarrow \pi N, \eta N$
100	ARNDT 04	DPWA	$\pi N \rightarrow \pi N, \eta N$
100	³ HOEHLER 93	ARGD	$\pi N \rightarrow \pi N$

¹Roy-Steiner equations applied to πN scattering amplitudes and pionic atom data.

²Fit to the amplitudes of HOEHLER 79.

³See HOEHLER 93 for a detailed discussion of the evidence for and the pole parameters of N and Δ resonances as determined from Argand diagrams of πN elastic partial-wave amplitudes and from plots of the speeds with which the amplitudes traverse the diagrams.

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

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

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

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>COMMENT</u>
• • • We do not use the following data for averages, fits, limits, etc. • • •		
97.37±0.42	BERNICH A 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

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, $\Delta(1232)^0$

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>COMMENT</u>
• • • We do not use the following data for averages, fits, limits, etc. • • •		
1213.20±0.66	BERNICH A 96	Fit to PEDRONI 78

−2×IMAGINARY PART, $\Delta(1232)^0$

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>COMMENT</u>
• • • We do not use the following data for averages, fits, limits, etc. • • •		
104.10±1.01	BERNICH A 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			
51.3±0.9	¹ HOFERICH T... 24	RVUE	$\pi N \rightarrow \pi N$
50 ±1	ROENCHEN 22	DPWA	Multichannel
50 ±1 ±1	² 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	$\pi N \rightarrow \pi N$

¹Roy-Steiner equations applied to πN scattering amplitudes and pionic atom data.²Fit to the amplitudes of HOEHLER 79.**PHASE, MIXED CHARGES**

<u>VALUE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
−48 to −45 (≈ −46) OUR ESTIMATE			
−47.4±0.4	¹ HOFERICH... 24	RVUE	$\pi N \rightarrow \pi N$
−39 ±1	ROENCHEN 22	DPWA	Multichannel
−46 ±1 ±1	² 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	$\pi N \rightarrow \pi N$

¹Roy-Steiner equations applied to πN scattering amplitudes and pionic atom data.²Fit to the amplitudes of HOEHLER 79. **$\Delta(1232)$ BREIT-WIGNER MASSES****MIXED CHARGES**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1230 to 1234 (≈ 1232) OUR ESTIMATE			
1230 ±1	SARANTSEV 25	DPWA	Multichannel
1230.8±0.4	¹ HUNT 19	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. ● ● ●			
1228 ±2	ANISOVICH 12A	DPWA	Multichannel
1231.1±0.2	¹ SHRESTHA 12A	DPWA	Multichannel
1232.9±1.2	ARNDT 04	DPWA	$\pi N \rightarrow \pi N, \eta N$
1228 ±1	PENNER 02C	DPWA	Multichannel

¹Statistical error only. **$\Delta(1232)^{++}$ MASS**

<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. ● ● ●			
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

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

$\Delta(1232)^0$ MASS

<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. ● ● ●			
1231.3 \pm 0.6	BREITSCHOP..06	CNTR	Using new CHEX data
1233.40 \pm 0.22	GRIDNEV 06	DPWA	$\pi N \rightarrow \pi N$
1234.35 \pm 0.75	BERNICHA 96		Fit to PEDRONI 78
1233.1 \pm 0.3	ABAEV 95	IPWA	$\pi N \rightarrow \pi N$
1233.6 \pm 0.5	KOCH 80B	IPWA	$\pi N \rightarrow \pi N$
1233.8 \pm 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 \pm 0.30	GRIDNEV 06	DPWA	$\pi N \rightarrow \pi N$
2.25 \pm 0.68	BERNICHA 96		Fit to PEDRONI 78
2.6 \pm 0.4	ABAEV 95	IPWA	$\pi N \rightarrow \pi N$
2.7 \pm 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 (\approx 117) OUR ESTIMATE			
116 \pm 2	SARANTSEV 25	DPWA	Multichannel
110.9 \pm 0.8	¹ HUNT 19	DPWA	Multichannel
118.7 \pm 0.6	¹ ARNDT 06	DPWA	$\pi N \rightarrow \pi N, \eta N$
120 \pm 5	CUTKOSKY 80	IPWA	$\pi N \rightarrow \pi N$
116 \pm 5	HOEHLER 79	IPWA	$\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
110 \pm 3	ANISOVICH 12A	DPWA	Multichannel
113.0 \pm 0.5	¹ SHRESTHA 12A	DPWA	Multichannel
118.0 \pm 2.2	ARNDT 04	DPWA	$\pi N \rightarrow \pi N, \eta N$
106 \pm 1	PENNER 02C	DPWA	Multichannel

¹Statistical 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 \pm 0.7	GRIDNEV 06	DPWA	$\pi N \rightarrow \pi N$
109.07 \pm 0.48	BERNICHA 96		Fit to PEDRONI 78
111.0 \pm 1.0	KOCH 80B	IPWA	$\pi N \rightarrow \pi N$
111.3 \pm 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 \pm 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	BERNICHIA	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 $\rho e^+ e^-$	$(4.2 \pm 0.7) \times 10^{-5}$

$\Delta(1232)$ 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.

$\Gamma(pe^+e^-)/\Gamma_{\text{total}}$ Γ_5/Γ VALUE (units 10^{-5})

DOCUMENT ID

4.19±0.34±0.62¹ ADAMCZEW... 17¹ The systematic uncertainty includes the model dependence. **$\Delta(1232)$ PHOTON DECAY AMPLITUDES AT THE POLE** **$\Delta(1232) \rightarrow N\gamma$, helicity-1/2 amplitude $A_{1/2}$**

MODULUS ($\text{GeV}^{-1/2}$)	PHASE ($^\circ$)	DOCUMENT ID	TECN	COMMENT
-0.133 ± 0.003	-17 ± 2	SARANTSEV	25	DPWA Multichannel
-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 $A_{3/2}$

MODULUS ($\text{GeV}^{-1/2}$)	PHASE ($^\circ$)	DOCUMENT ID	TECN	COMMENT
-0.255 ± 0.005	-10 ± 2	SARANTSEV	25	DPWA Multichannel
-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 $A_{1/2}$

VALUE ($\text{GeV}^{-1/2}$)	DOCUMENT ID	TECN	COMMENT
-0.142 to -0.129 (≈ -0.135) OUR ESTIMATE			
-0.135 ± 0.003	SARANTSEV	25	DPWA Multichannel
-0.146 ± 0.002	¹ HUNT	19	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. ● ● ●			
-0.131 ± 0.004	ANISOVICH	12A	DPWA Multichannel
-0.137 ± 0.001	¹ SHRESTHA	12A	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 $\gamma N \rightarrow \pi N$

¹ Statistical error only.

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

<u>VALUE (GeV^{-1/2})</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-0.262 to -0.248 (\approx -0.255) OUR ESTIMATE			
-0.259 \pm 0.005	SARANTSEV	25	DPWA Multichannel
-0.250 \pm 0.002	¹ HUNT	19	DPWA Multichannel
-0.262 \pm 0.003	WORKMAN	12A	DPWA $\gamma N \rightarrow N\pi$
-0.258 \pm 0.005	DUGGER	07	DPWA $\gamma N \rightarrow \pi N$
-0.256 \pm 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 \pm 0.001	BECK	00	IPWA $\vec{\gamma}p \rightarrow p\pi^0, n\pi^+$
-0.258 \pm 0.006	KAMALOV	99	DPWA $\gamma N \rightarrow \pi N$
-0.2466 \pm 0.0013	HANSTEIN	98	IPWA $\gamma N \rightarrow \pi N$
-0.2524 \pm 0.0013	DAVIDSON	97	DPWA $\gamma N \rightarrow \pi N$

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

-0.254 \pm 0.005	ANISOVICH	12A	DPWA Multichannel
-0.251 \pm 0.001	¹ SHRESTHA	12A	DPWA Multichannel
-0.265	DRECHSEL	07	DPWA $\gamma N \rightarrow \pi N$
-0.243 \pm 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>
-0.028 to -0.022 (\approx -0.025) OUR ESTIMATE			
-0.0238 \pm 0.0016 \pm 0.0010	MORNACCHI	24	DPWA $\vec{\gamma}\vec{p} \rightarrow N\pi$
-0.0274 \pm 0.0003 \pm 0.0030	AHRENS	04A	DPWA $\vec{\gamma}\vec{p} \rightarrow N\pi$
-0.020 \pm 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 \pm 0.0017	HANSTEIN	98	IPWA $\gamma N \rightarrow \pi N$
-0.015 \pm 0.005	¹ ARNDT	97	IPWA $\gamma N \rightarrow \pi N$
-0.0319 \pm 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 \pm 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 \pm 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
• • • We do not use the following data for averages, fits, limits, etc. • • •			
6.14 ± 0.51	LOPEZCAST...01	DPWA	$\pi^+ p \rightarrow \pi^+ p \gamma$
$4.52 \pm 0.50 \pm 0.45$	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. • • •		
$2.7^{+1.0}_{-1.3} \pm 1.5 \pm 3$	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).

SARANTSEV	25	PR C112 015202	A.V. Sarantsev <i>et al.</i>	(Bonn-Gatchina Collab.)
HOFERICHT...	24	PL B853 138698	M. Hoferichter <i>et al.</i>	(BERN, MADU, BONN+)
MORNACCHI	24	PR C109 055201	E. Mornacchi <i>et al.</i>	(A2 Collab. at MAMI)
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 (errat.)	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