

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

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

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

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
<b>1209 to 1211 (<math>\approx 1210</math>) OUR ESTIMATE</b>			
1211 $\pm 1 \pm 1$	<sup>1</sup> SVARC	14	L+P $\pi N \rightarrow \pi N$
1210.5 $\pm 1.0$	ANISOVICH	12A	DPWA Multichannel
1210 $\pm 1$	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
1211 $\pm 1$	ANISOVICH	10	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	<sup>2</sup> HOEHLER	93	ARGD $\pi N \rightarrow \pi N$

<sup>1</sup> Fit to the amplitudes of HOEHLER 79.

<sup>2</sup> See HOEHLER 93 for a detailed discussion of the evidence for and the pole parameters of  $N$  and  $\Delta$  resonances as determined from Argand diagrams of  $\pi N$  elastic partial-wave amplitudes and from plots of the speeds with which the amplitudes traverse the diagrams.

### –2xIMAGINARY PART, MIXED CHARGES

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
<b>98 to 102 (<math>\approx 100</math>) OUR ESTIMATE</b>			
98 $\pm 2 \pm 1$	<sup>1</sup> SVARC	14	L+P $\pi N \rightarrow \pi N$
99 $\pm 2$	ANISOVICH	12A	DPWA Multichannel
100 $\pm 2$	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
100 $\pm 2$	ANISOVICH	10	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	<sup>2</sup> HOEHLER	93	ARGD $\pi N \rightarrow \pi N$

<sup>1</sup> Fit to the amplitudes of HOEHLER 79.

<sup>2</sup> See HOEHLER 93 for a detailed discussion of the evidence for and the pole parameters of  $N$  and  $\Delta$  resonances as determined from Argand diagrams of  $\pi N$  elastic partial-wave amplitudes and from plots of the speeds with which the amplitudes traverse the diagrams.

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

VALUE (MeV)	DOCUMENT ID	COMMENT
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●		
1212.50 $\pm 0.24$	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	<sup>1</sup> HANSTEIN 96	DPWA	$\gamma N \rightarrow \pi N$
111.2±2.0 to 116.6 ± 2.2	MIROSHNIC... 79		Fit photoproduction

<sup>1</sup>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>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>
<b>49 to 52 (<math>\approx</math> 50) OUR ESTIMATE</b>			
50 ±1 ±1	<sup>1</sup> 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>
<b>–48 to –45 (<math>\approx</math> –46) OUR ESTIMATE</b>			
–46±1±1	<sup>1</sup> SVARC 14	L+P	$\pi N \rightarrow \pi N$
–46±1	ANISOVICH 12A	DPWA	Multichannel

$-47 \pm 1$	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	$\pi N \rightarrow \pi N$

<sup>1</sup>Fit 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>
<b>1230 to 1234 (<math>\approx 1232</math>) OUR ESTIMATE</b>			
$1230.8 \pm 0.4$	<sup>1</sup> HUNT	19	DPWA Multichannel
$1228 \pm 2$	ANISOVICH	12A	DPWA Multichannel
$1233.4 \pm 0.4$	<sup>1</sup> ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
$1232 \pm 3$	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
$1233 \pm 2$	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
$1231.1 \pm 0.2$	<sup>1</sup> SHRESTHA	12A	DPWA Multichannel
$1230 \pm 2$	ANISOVICH	10	DPWA Multichannel
$1232.9 \pm 1.2$	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$
$1228 \pm 1$	PENNER	02C	DPWA Multichannel

<sup>1</sup>Statistical 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. ● ● ●			
$1230.55 \pm 0.20$	GRIDNEV	06	DPWA $\pi N \rightarrow \pi N$
$1231.88 \pm 0.29$	BERNICH	96	Fit to PEDRONI 78
$1230.5 \pm 0.2$	ABAEV	95	IPWA $\pi N \rightarrow \pi N$
$1230.9 \pm 0.3$	KOCH	80B	IPWA $\pi N \rightarrow \pi N$
$1231.1 \pm 0.2$	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. ● ● ●		
$1234.9 \pm 1.4$	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 $\pi N \rightarrow \pi N$
$1234.35 \pm 0.75$	BERNICH	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

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

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
$2.86 \pm 0.30$	GRIDNEV	06	DPWA $\pi N \rightarrow \pi N$
$2.25 \pm 0.68$	BERNICHIA	96	Fit to PEDRONI 78
$2.6 \pm 0.4$	ABAEV	95	IPWA $\pi N \rightarrow \pi N$
$2.7 \pm 0.3$	<sup>1</sup> PEDRONI	78	See the masses
<sup>1</sup> 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

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
<b>114 to 120 (<math>\approx 117</math>) OUR ESTIMATE</b>			
$110.9 \pm 0.8$	<sup>1</sup> HUNT	19	DPWA Multichannel
$110 \pm 3$	ANISOVICH	12A	DPWA Multichannel
$118.7 \pm 0.6$	<sup>1</sup> 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. ● ● ●			
$113.0 \pm 0.5$	<sup>1</sup> SHRESTHA	12A	DPWA Multichannel
$112 \pm 4$	ANISOVICH	10	DPWA Multichannel
$118.0 \pm 2.2$	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$
$106 \pm 1$	PENNER	02C	DPWA Multichannel

<sup>1</sup> Statistical error only. $\Delta(1232)^{++}$  WIDTH

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

VALUE (MeV)	DOCUMENT ID	COMMENT
● ● ● 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

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

**$\Delta^0$ - $\Delta^{++}$  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. ● ● ●			
$4.66 \pm 1.0$	GRIDNEV	06	DPWA $\pi N \rightarrow \pi N$
$8.45 \pm 1.11$	BERNICHIA	96	Fit to PEDRONI 78
$5.1 \pm 1.0$	ABAEV	95	IPWA $\pi N \rightarrow \pi N$
$6.6 \pm 1.0$	PEDRONI	78	See the widths

 **$\Delta(1232)$  DECAY MODES**

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

Mode	Fraction ( $\Gamma_i/\Gamma$ )
$\Gamma_1$ $N\pi$	99.4 %
$\Gamma_2$ $N\gamma$	0.55–0.65 %
$\Gamma_3$ $N\gamma$ , helicity=1/2	0.11–0.13 %
$\Gamma_4$ $N\gamma$ , helicity=3/2	0.44–0.52 %
$\Gamma_5$ $p e^+ e^-$	$(4.2 \pm 0.7) \times 10^{-5}$

 **$\Delta(1232)$  BRANCHING RATIOS**

<u><math>\Gamma(N\pi)/\Gamma_{\text{total}}</math></u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	$\Gamma_1/\Gamma$
<b>0.994 OUR ESTIMATE</b>				
$0.9939 \pm 0.0001$	<sup>1</sup> 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	

<sup>1</sup>Statistical error only.

<u><math>\Gamma(p e^+ e^-)/\Gamma_{\text{total}}</math></u>	<u>DOCUMENT ID</u>	$\Gamma_5/\Gamma$
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<u>VALUE (units <math>10^{-5}</math>)</u>	<u>DOCUMENT ID</u>
<b><math>4.19 \pm 0.34 \pm 0.62</math></b>	<sup>1</sup> ADAMCZEW... 17

<sup>1</sup>The systematic uncertainty includes the model dependence.

 **$\Delta(1232)$  PHOTON DECAY AMPLITUDES AT THE POLE** **$\Delta(1232) \rightarrow N\gamma$ , helicity-1/2 amplitude  $A_{1/2}$** 

<u>MODULUS (<math>\text{GeV}^{-1/2}</math>)</u>	<u>PHASE (<math>^\circ</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$-0.114^{+0.010}_{-0.003}$	$-9^{+4}_{-2}$	ROENCHEN	14	DPWA
● ● ● 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 (<math>\text{GeV}^{-1/2}</math>)</u>	<u>PHASE (<math>^\circ</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$-0.229^{+0.003}_{-0.004}$	$3^{+0.3}_{-0.4}$	ROENCHEN	14	DPWA
● ● ● 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  $\gamma N$  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  $A_{1/2}$** 

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

<sup>1</sup>Statistical error only.

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

<u>VALUE (<math>\text{GeV}^{-1/2}</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>-0.262 to -0.248 (<math>\approx</math> -0.255) OUR ESTIMATE</b>			
$-0.250 \pm 0.002$	<sup>1</sup> HUNT	19	DPWA Multichannel
$-0.254 \pm 0.005$	ANISOVICH	12A	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. • • •

$-0.251 \pm 0.001$	<sup>1</sup> SHRESTHA	12A	DPWA	Multichannel
$-0.267 \pm 0.008$	ANISOVICH	10	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	$\gamma N \rightarrow \pi N$

<sup>1</sup>Statistical 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>
<b>−0.030 to −0.020 (<math>\approx</math> −0.025) OUR ESTIMATE</b>			
$-0.0274 \pm 0.0003 \pm 0.0030$	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 $\gamma N \rightarrow \pi N$
$-0.015 \pm 0.005$	<sup>1</sup> 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	$\gamma N \rightarrow \pi N, \gamma N$

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

### $\Delta(1232) \rightarrow N\gamma$ , 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

<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. • • •			
$-122 \pm 5$	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 ( $\mu_N$ )	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 ( $\mu_N$ )	DOCUMENT ID	COMMENT
• • •	We do not use the following data for averages, fits, limits, etc. • • •	
$2.7^{+1.0}_{-1.3} \pm 1.5 \pm 3$	<sup>1</sup> KOTULLA 02	$\gamma p \rightarrow p \pi^0 \gamma'$

<sup>1</sup>The second error is systematic, the third is an estimate of theoretical uncertainties.

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