

Δ(1620) S₃₁

$$I(J^P) = \frac{3}{2}(\frac{1}{2}^-) \text{ Status: } ****$$

Most of the results published before 1975 are now obsolete and have been omitted. They may be found in our 1982 edition, Physics Letters **111B** (1982).

Δ(1620) BREIT-WIGNER MASS

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
1615 to 1675 (≈ 1620) OUR ESTIMATE			
1672 ± 7	MANLEY	92	IPWA π N → π N & N π π
1620 ± 20	CUTKOSKY	80	IPWA π N → π N
1610 ± 7	HOEHLER	79	IPWA π N → π N
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1672 ± 5	ARNDT	96	IPWA γ N → π N
1617	ARNDT	95	DPWA π N → N π
1669	LI	93	IPWA γ N → π N
1620	BARNHAM	80	IPWA π N → N π π
1712.8 ± 6.0	¹ CHEW	80	BPWA π ⁺ p → π ⁺ p
1786.7 ± 2.0	¹ CHEW	80	BPWA π ⁺ p → π ⁺ p
1657	CRAWFORD	80	DPWA γ N → π N
1662	BARBOUR	78	DPWA γ N → π N
1580	² LONGACRE	77	IPWA π N → N π π
1600	³ LONGACRE	75	IPWA π N → N π π

Δ(1620) BREIT-WIGNER WIDTH

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
120 to 180 (≈ 150) OUR ESTIMATE			
154 ± 37	MANLEY	92	IPWA π N → π N & N π π
140 ± 20	CUTKOSKY	80	IPWA π N → π N
139 ± 18	HOEHLER	79	IPWA π N → π N
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
147 ± 8	ARNDT	96	IPWA γ N → π N
108	ARNDT	95	DPWA π N → N π
184	LI	93	IPWA γ N → π N
120	BARNHAM	80	IPWA π N → N π π
228.3 ± 18.0	¹ CHEW	80	BPWA π ⁺ p → π ⁺ p (lower mass)
30.0 ± 6.4	¹ CHEW	80	BPWA π ⁺ p → π ⁺ p (higher mass)
161	CRAWFORD	80	DPWA γ N → π N
180	BARBOUR	78	DPWA γ N → π N
120	² LONGACRE	77	IPWA π N → N π π
150	³ LONGACRE	75	IPWA π N → N π π

$\Delta(1620)$ POLE POSITION

REAL PART

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1580 to 1620 (≈ 1600) OUR ESTIMATE			
1585	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
1608	⁴ HOEHLER	93	SPED $\pi N \rightarrow \pi N$
1600 \pm 15	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1587	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90
1583 or 1583	⁵ LONGACRE	78	IPWA $\pi N \rightarrow N\pi\pi$
1575 or 1572	² LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$

– 2×IMAGINARY PART

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
100 to 130 (≈ 115) OUR ESTIMATE			
104	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
116	⁴ HOEHLER	93	SPED $\pi N \rightarrow \pi N$
120 \pm 20	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
120	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90
143 or 149	⁵ LONGACRE	78	IPWA $\pi N \rightarrow N\pi\pi$
119 or 128	² LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$

$\Delta(1620)$ ELASTIC POLE RESIDUE

MODULUS $|r|$

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
14	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
19	HOEHLER	93	SPED $\pi N \rightarrow \pi N$
15 \pm 2	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
15	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90

PHASE θ

<u>VALUE ($^\circ$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
– 121	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
– 95	HOEHLER	93	SPED $\pi N \rightarrow \pi N$
– 110 \pm 20	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
– 125	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90

$\Delta(1620)$ DECAY MODES

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

Mode	Fraction (Γ_i/Γ)
Γ_1 $N\pi$	20–30 %
Γ_2 $N\pi\pi$	70–80 %
Γ_3 $\Delta\pi$	30–60 %
Γ_4 $\Delta(1232)\pi$, <i>D-wave</i>	
Γ_5 $N\rho$	7–25 %
Γ_6 $N\rho$, $S=1/2$, <i>S-wave</i>	
Γ_7 $N\rho$, $S=3/2$, <i>D-wave</i>	
Γ_8 $N(1440)\pi$	
Γ_9 $N\gamma$	0.004–0.044 %
Γ_{10} $N\gamma$, helicity=1/2	0.004–0.044 %

$\Delta(1620)$ BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{\text{total}}$				Γ_1/Γ
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
0.2 to 0.3 OUR ESTIMATE				
0.09±0.02	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$
0.25±0.03	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
0.35±0.06	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
0.29	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
0.60	¹ CHEW	80	BPWA	$\pi^+ p \rightarrow \pi^+ p$ (lower mass)
0.36	¹ CHEW	80	BPWA	$\pi^+ p \rightarrow \pi^+ p$ (higher mass)

Note: Signs of couplings from $\pi N \rightarrow N\pi\pi$ analyses were changed in the 1986 edition to agree with the baryon-first convention; the overall phase ambiguity is resolved by choosing a negative sign for the $\Delta(1620)$ S_{31} coupling to $\Delta(1232)\pi$.

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1620) \rightarrow \Delta(1232)\pi$, <i>D-wave</i>				$(\Gamma_1\Gamma_4)^{1/2}/\Gamma$
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
–0.36 to –0.28 OUR ESTIMATE				
–0.24±0.03	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$
–0.33±0.06	BARNHAM	80	IPWA	$\pi N \rightarrow N\pi\pi$
–0.39	^{2,6} LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$
–0.40	³ LONGACRE	75	IPWA	$\pi N \rightarrow N\pi\pi$

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1620) \rightarrow N\rho, S=1/2, S\text{-wave}$				$(\Gamma_1 \Gamma_6)^{1/2} / \Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
+0.12 to +0.22 OUR ESTIMATE				
+0.15±0.02	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$
+0.40±0.10	BARNHAM	80	IPWA	$\pi N \rightarrow N\pi\pi$
+0.08	^{2,6} LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$
+0.28	³ LONGACRE	75	IPWA	$\pi N \rightarrow N\pi\pi$

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1620) \rightarrow N\rho, S=3/2, D\text{-wave}$				$(\Gamma_1 \Gamma_7)^{1/2} / \Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
-0.15 to -0.03 OUR ESTIMATE				
-0.06±0.02	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$
-0.13	^{2,6} LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1620) \rightarrow N(1440)\pi$				$(\Gamma_1 \Gamma_8)^{1/2} / \Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
0.11±0.05	BARNHAM	80	IPWA	$\pi N \rightarrow N\pi\pi$

Δ(1620) PHOTON DECAY AMPLITUDES

Δ(1620) → Nγ, helicity-1/2 amplitude A_{1/2}

VALUE (GeV ^{-1/2})	DOCUMENT ID	TECN	COMMENT	
+0.027±0.011 OUR ESTIMATE				
0.035±0.020	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
0.035±0.010	CRAWFORD	83	IPWA	$\gamma N \rightarrow \pi N$
0.010±0.015	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
-0.022±0.007	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 1)
-0.026±0.008	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 2)
0.021±0.020	CRAWFORD	80	DPWA	$\gamma N \rightarrow \pi N$
0.126±0.021	TAKEDA	80	DPWA	$\gamma N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
0.042±0.003	LI	93	IPWA	$\gamma N \rightarrow \pi N$
0.066	WADA	84	DPWA	Compton scattering
+0.034±0.028	BARBOUR	78	DPWA	$\gamma N \rightarrow \pi N$
-0.005±0.016	FELLER	76	DPWA	$\gamma N \rightarrow \pi N$

Δ(1620) FOOTNOTES

- ¹ CHEW 80 reports two S_{31} resonances at somewhat higher masses than other analyses. Problems with this analysis are discussed in section 2.1.11 of HOEHLER 83.
- ² LONGACRE 77 pole positions are from a search for poles in the unitarized T-matrix; the first (second) value uses, in addition to $\pi N \rightarrow N\pi\pi$ data, elastic amplitudes from a Saclay (CERN) partial-wave analysis. The other LONGACRE 77 values are from eyeball fits with Breit-Wigner circles to the T-matrix amplitudes.
- ³ From method II of LONGACRE 75: eyeball fits with Breit-Wigner circles to the T-matrix amplitudes.
- ⁴ See HOEHLER 93 for a detailed discussion of the evidence for and the pole parameters of N and Δ resonances as determined from Argand diagrams of πN elastic partial-wave amplitudes and from plots of the speeds with which the amplitudes traverse the diagrams.

⁵ LONGACRE 78 values are from a search for poles in the unitarized T-matrix. The first (second) value uses, in addition to $\pi N \rightarrow N\pi\pi$ data, elastic amplitudes from a Saclay (CERN) partial-wave analysis.

⁶ LONGACRE 77 considers this coupling to be well determined.

$\Delta(1620)$ REFERENCES

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

ARNDT	96	PR C53 430	+Strakovsky, Workman	(VPI)
ARNDT	95	PR C52 2120	+Strakovsky, Workman, Pavan	(VPI, BRCO)
HOEHLER	93	πN Newsletter 9 1		(KARL)
LI	93	PR C47 2759	+Arndt, Roper, Workman	(VPI)
MANLEY	92	PR D45 4002	+Saleski	(KENT) IJP
Also	84	PR D30 904	Manley, Arndt, Goradia, Teplitz	(VPI)
ARNDT	91	PR D43 2131	+Li, Roper, Workman, Ford	(VPI, TELE) IJP
WADA	84	NP B247 313	+Egawa, Imanishi, Ishii, Kato, Ukai+	(INUS)
CRAWFORD	83	NP B211 1	+Morton	(GLAS)
HOEHLER	83	Landolt-Boernstein 1/9B2		(KARLT)
PDG	82	PL 111B	Roos, Porter, Aguilar-Benitez+	(HELS, CIT, CERN)
AWAJI	81	Bonn Conf. 352	+Kajikawa	(NAGO)
Also	82	NP B197 365	Fujii, Hayashii, Iwata, Kajikawa+	(NAGO)
ARAI	80	Toronto Conf. 93		(INUS)
Also	82	NP B194 251	Arai, Fujii	(INUS)
BARNHAM	80	NP B168 243	+Glickman, Mier-Jedrzejowicz+	(LOIC)
CHEW	80	Toronto Conf. 123		(LBL) IJP
CRAWFORD	80	Toronto Conf. 107		(GLAS)
CUTKOSKY	80	Toronto Conf. 19	+Forsyth, Babcock, Kelly, Hendrick	(CMU, LBL) IJP
Also	79	PR D20 2839	Cutkosky, Forsyth, Hendrick, Kelly	(CMU, LBL) IJP
TAKEDA	80	NP B168 17	+Arai, Fujii, Ikeda, Iwasaki+	(TOKY, INUS)
HOEHLER	79	PDAT 12-1	+Kaiser, Koch, Pietarinen	(KARLT) IJP
Also	80	Toronto Conf. 3	Koch	(KARLT) IJP
BARBOUR	78	NP B141 253	+Crawford, Parsons	(GLAS)
LONGACRE	78	PR D17 1795	+Lasinski, Rosenfeld, Smadja+	(LBL, SLAC)
LONGACRE	77	NP B122 493	+Dolbeau	(SACL) IJP
Also	76	NP B108 365	Dolbeau, Triantis, Neveu, Cadiet	(SACL) IJP
FELLER	76	NP B104 219	+Fukushima, Horikawa, Kajikawa+	(NAGO, OSAK) IJP
LONGACRE	75	PL 55B 415	+Rosenfeld, Lasinski, Smadja+	(LBL, SLAC) IJP
