NODE=B082

$\Delta(1620)\ S_{31}$

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

NODE=B082

Most of the results published before 1975 were last included in our 1982 edition, Physics Letters **111B** 1 (1982). Some further obsolete results published before 1984 were last included in our 2006 edition, Journal of Physics, G **33** 1 (2006).

$\Delta(1620)$ BREIT-WIGNER MASS

NODE=B082205

NODE=B082M

→ NOT CHECKED ←

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1600 to 1660 (≈ 1630) OUR ESTIMATE				
1615.2± 0.4	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
1672 ± 7	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
1620 ±20	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
1610 ± 7	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1650 ±25	THOMA	08	DPWA	Multichannel
1614.1± 1.1	ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
1612 ± 2	PENNER	02C	DPWA	Multichannel
1617 ±15	VRANA	00	DPWA	Multichannel
1672 ± 5	ARNDT	96	IPWA	$\gamma N \to \pi N$
1617	ARNDT	95	DPWA	$\pi N \to N\pi$
1669	LI	93	IPWA	$\gamma N \to \pi N$
1620	BARNHAM	80	IPWA	$\pi N \to N\pi\pi$
1712.8± 6.0	[1] CHEW	80	BPWA	$\pi^+ p \to \pi^+ p$
1786.7± 2.0	[1] CHEW	80	BPWA	$\pi^+ p \to \pi^+ p$
1580	[2] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
1600	[3] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$

OCCUR=2

$\Delta(1620)$ BREIT-WIGNER WIDTH

NODE=B082210

NODE=B082W

→ NOT CHECKED ←

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
135 to 150 (≈ 145) OUR ESTIMATE				
146.9± 1.9	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
154 ±37	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
140 ±20	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
139 ±18	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
250 ±60	THOMA	08	DPWA	Multichannel
141.0± 6.0	ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
202 ± 7	PENNER	02C	DPWA	Multichannel
143 ±42	VRANA	00	DPWA	Multichannel
147 ± 8	ARNDT	96	IPWA	$\gamma N \to \pi N$
108	ARNDT	95	DPWA	$\pi N \to N\pi$
184	LI	93	IPWA	$\gamma N \to \pi N$
120	BARNHAM	80	IPWA	$\pi N \to N\pi\pi$
228.3±18.0	[1] CHEW	80	BPWA	$\pi^+ p \to \pi^+ p$ (lower mass)
30.0± 6.4	[1] CHEW	80	BPWA	$\pi^+ p \to \pi^+ p$ (higher mass)
120	[2] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
150	[3] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$

OCCUR=2

$\Delta(1620)$ POLE POSITION

NODE=B082215

REAL PART

NODE=B082RE

NODE=B082RE

→ NOT CHECKED ←

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1590 to 1610 (≈ 1600) OUR ESTIMATE				
1595	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
1608	[4] HOEHLER	93	SPED	$\pi N \to \pi N$
1600±15	CUTKOSKY	80	IPWA	$\pi N \to \pi N$

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

1615±25	THOMA	08	DPWA	Multichannel
1594	ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
1607	VRANA	00	DPWA	Multichannel
1585	ARNDT	95	DPWA	$\pi N \to N\pi$
1587	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90
1583 or 1583	[5] LONGACRE	78	IPWA	$\pi N \to N\pi\pi$
1575 or 1572	[2] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$

−2×IMAGINARY PART

NODE=B082IM
NODE=B082IM

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
115 to 120 (≈ 118) OUR ESTIMATE				
135	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
116	[4] HOEHLER	93	SPED	$\pi N \to \pi N$
120±20	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
180±35	THOMA	08	DPWA	Multichannel
118	ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
148	VRANA	00	DPWA	Multichannel
104	ARNDT	95	DPWA	$\pi N \to N\pi$
120	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90
143 or 149	[5] LONGACRE	78	IPWA	$\pi N \to N\pi\pi$
119 or 128	[2] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$

→ NOT CHECKED ←

$\Delta(1620)$ ELASTIC POLE RESIDUE

NODE=B082220

MODULUS $|r|$

NODE=B082RER
NODE=B082RER

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
15	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
19	HOEHLER	93	SPED	$\pi N \to \pi N$
15±2	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
17	ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
14	ARNDT	95	DPWA	$\pi N \to N\pi$
15	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90

PHASE θ

NODE=B082IMR
NODE=B082IMR

VALUE (°)	DOCUMENT ID		TECN	COMMENT
− 92	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
− 95	HOEHLER	93	SPED	$\pi N \to \pi N$
−110±20	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−104	ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
−121	ARNDT	95	DPWA	$\pi N \to N\pi$
−125	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90

$\Delta(1620)$ DECAY MODES

NODE=B082225;NODE=B082

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

NODE=B082

	Mode	Fraction (Γ_i/Γ)	
Γ_1	$N\pi$	20–30 %	DESIG=1;OUR EST
Γ_2	$N\pi\pi$	70–80 %	DESIG=2;OUR EST
Γ_3	$\Delta\pi$	30–60 %	DESIG=181;OUR EST
Γ_4	$\Delta(1232)\pi$, D-wave		DESIG=3
Γ_5	$N\rho$	7–25 %	DESIG=182;OUR EST
Γ_6	$N\rho$, S=1/2, S-wave		DESIG=4
Γ_7	$N\rho$, S=3/2, D-wave		DESIG=5
Γ_8	$N(1440)\pi$		DESIG=6
Γ_9	$N\gamma$	0.004–0.044 %	DESIG=185;OUR EST
Γ_{10}	$N\gamma$, helicity=1/2	0.004–0.044 %	DESIG=7;OUR EST

$\Delta(1620)$ BRANCHING RATIOS

NODE=B082230

$\Gamma(N\pi)/\Gamma_{total}$ — Γ_1/Γ

NODE=B082R1
NODE=B082R1
→ NOT CHECKED ←

VALUE	DOCUMENT ID		TECN	COMMENT
0.2 to 0.3 OUR ESTIMATE				
0.315±0.001	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
0.09 ±0.02	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
0.25 ±0.03	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
0.35 ±0.06	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.22 ±0.12	THOMA	08	DPWA	Multichannel
0.310±0.004	ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
0.34 ±0.01	PENNER	02C	DPWA	Multichannel
0.45 ±0.05	VRANA	00	DPWA	Multichannel
0.29	ARNDT	95	DPWA	$\pi N \to N\pi$
0.60	[1] CHEW	80	BPWA	$\pi^+ p \to \pi^+ p$ (lower mass)
0.36	[1] CHEW	80	BPWA	$\pi^+ p \to \pi^+ p$ (higher mass)

OCCUR=2

Note: Signs of couplings from $\pi N \to N\pi\pi$ 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 $\Delta(1232)\pi$.

NODE=B082310

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to \Delta(1620) \to \Delta(1232)\pi$, D-wave — $(\Gamma_1\Gamma_4)^{1/2}/\Gamma$

NODE=B082R2
NODE=B082R2
→ NOT CHECKED ←

VALUE	DOCUMENT ID		TECN	COMMENT
−0.36 to −0.28 OUR ESTIMATE				
−0.24±0.03	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
−0.33±0.06	BARNHAM	80	IPWA	$\pi N \to N\pi\pi$
−0.39	[2,6] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
−0.40	[3] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$

$\Gamma(\Delta(1232)\pi$, D-wave$)/\Gamma_{total}$ — Γ_4/Γ

NODE=B082R8
NODE=B082R8

VALUE	DOCUMENT ID		TECN	COMMENT
0.39±0.02	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.48±0.25	THOMA	08	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to \Delta(1620) \to N\rho$, S=1/2, S-wave — $(\Gamma_1\Gamma_6)^{1/2}/\Gamma$

NODE=B082R3
NODE=B082R3
→ NOT CHECKED ←

VALUE	DOCUMENT ID		TECN	COMMENT
+0.12 to +0.22 OUR ESTIMATE				
+0.15±0.02	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
+0.40±0.10	BARNHAM	80	IPWA	$\pi N \to N\pi\pi$
+0.08	[2,6] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
+0.28	[3] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$

$\Gamma(N\rho$, S=1/2, S-wave$)/\Gamma_{total}$ — Γ_6/Γ

NODE=B082R6
NODE=B082R6

VALUE	DOCUMENT ID		TECN	COMMENT
0.14±0.03	VRANA	00	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to \Delta(1620) \to N\rho$, S=3/2, D-wave — $(\Gamma_1\Gamma_7)^{1/2}/\Gamma$

NODE=B082R4
NODE=B082R4
→ NOT CHECKED ←

VALUE	DOCUMENT ID		TECN	COMMENT
−0.15 to −0.03 OUR ESTIMATE				
−0.06±0.02	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
−0.13	[2,6] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$

$\Gamma(N\rho$, S=3/2, D-wave$)/\Gamma_{total}$ — Γ_7/Γ

NODE=B082R7
NODE=B082R7

VALUE	DOCUMENT ID		TECN	COMMENT
0.02±0.01	VRANA	00	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to \Delta(1620) \to N(1440)\pi$ — $(\Gamma_1\Gamma_8)^{1/2}/\Gamma$

NODE=B082R5
NODE=B082R5

VALUE	DOCUMENT ID		TECN	COMMENT
0.11±0.05	BARNHAM	80	IPWA	$\pi N \to N\pi\pi$

$\Gamma(N(1440)\pi)/\Gamma_{total}$ — Γ_8/Γ

NODE=B082R9
NODE=B082R9

VALUE	DOCUMENT ID		TECN	COMMENT
0.00±0.01	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.19±0.12	THOMA	08	DPWA	Multichannel

Δ(1620) PHOTON DECAY AMPLITUDES

NODE=B082235

Papers on γN amplitudes predating 1981 may be found in our 2006 edition, Journal of Physics, G **33** 1 (2006).

NODE=B082235

$\Delta(1620) \rightarrow N\gamma$, helicity-1/2 amplitude $A_{1/2}$

NODE=B082A1
NODE=B082A1

→ NOT CHECKED ←

VALUE (GeV$^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
+0.027±0.011 OUR ESTIMATE				
0.050±0.002	DUGGER	07	DPWA	$\gamma N \rightarrow \pi N$
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	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.066	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$
−0.050	PENNER	02D	DPWA	Multichannel
0.042±0.003	LI	93	IPWA	$\gamma N \rightarrow \pi N$
0.066	WADA	84	DPWA	Compton scattering

Δ(1620) FOOTNOTES

NODE=B082

[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. NODE=B082;LINKAGE=C

[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. NODE=B082;LINKAGE=L7

[3] From method II of LONGACRE 75: eyeball fits with Breit-Wigner circles to the T-matrix amplitudes. NODE=B082;LINKAGE=L5

[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. NODE=B010;LINKAGE=H9

[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. NODE=B082;LINKAGE=L8

[6] LONGACRE 77 considers this coupling to be well determined. NODE=B082;LINKAGE=X

Δ(1620) REFERENCES

NODE=B082

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

NODE=B082

THOMA	08	PL B659 87	U. Thoma *et al.*	(CB-ELSA Collab.)		REFID=52087
DRECHSEL	07	EPJ A34 69	D. Drechsel, S.S. Kamalov, L. Tiator	(MAINZ, JINR)		REFID=52105
DUGGER	07	PR C76 025211	M. Dugger *et al.*	(Jefferson Lab CLAS Collab.)		REFID=52039
ARNDT	06	PR C74 045205	R.A. Arndt *et al.*	(GWU)		REFID=51535
PDG	06	JPG 33 1	W.-M. Yao *et al.*	(PDG Collab.)		REFID=51004
ARNDT	04	PR C69 035213	R.A. Arndt *et al.*	(GWU, TRIU)		REFID=49947
PENNER	02C	PR C66 055211	G. Penner, U. Mosel	(GIES)		REFID=49129
PENNER	02D	PR C66 055212	G. Penner, U. Mosel	(GIES)		REFID=49130
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman,, T.-S.H. Lee	(PITT+)		REFID=47593
ARNDT	96	PR C53 430	R.A. Arndt, I.I. Strakovsky, R.L. Workman	(VPI)		REFID=44675
ARNDT	95	PR C52 2120	R.A. Arndt *et al.*	(VPI, BRCO)		REFID=44535
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)		REFID=43821
LI	93	PR C47 2759	Z.J. Li *et al.*	(VPI)		REFID=43327
MANLEY	92	PR D45 4002	D.M. Manley, E.M. Saleski	(KENT)	IJP	REFID=41535
Also		PR D30 904	D.M. Manley *et al.*	(VPI)		REFID=30071
ARNDT	91	PR D43 2131	R.A. Arndt *et al.*	(VPI, TELE)	IJP	REFID=41467
WADA	84	NP B247 313	Y. Wada *et al.*	(INUS)		REFID=30072
CRAWFORD	83	NP B211 1	R.L. Crawford, W.T. Morton	(GLAS)		REFID=30070
HOEHLER	83	Landolt-Boernstein 1/9B2	G. Hohler	(KARLT)		REFID=31158
PDG	82	PL 111B 1	M. Roos *et al.*	(HELS, CIT, CERN)		REFID=41167
AWAJI	81	Bonn Conf. 352	N. Awaji, R. Kajikawa	(NAGO)		REFID=30067
Also		NP B197 365	K. Fujii *et al.*	(NAGO)		REFID=30068
BARNHAM	80	NP B168 243	K.W.J. Barnham *et al.*	(LOIC)		REFID=31072
CHEW	80	Toronto Conf. 123	D.M. Chew	(LBL)	IJP	REFID=31151
CUTKOSKY	80	Toronto Conf. 19	R.E. Cutkosky *et al.*	(CMU, LBL)	IJP	REFID=30064
Also		PR D20 2839	R.E. Cutkosky *et al.*	(CMU, LBL)	IJP	REFID=40096
HOEHLER	79	PDAT 12-1	G. Hohler *et al.*	(KARLT)	IJP	REFID=30058
Also		Toronto Conf. 3	R. Koch	(KARLT)	IJP	REFID=30859
LONGACRE	78	PR D17 1795	R.S. Longacre *et al.*	(LBL, SLAC)		REFID=30054
LONGACRE	77	NP B122 493	R.S. Longacre, J. Dolbeau	(SACL)	IJP	REFID=30051
Also		NP B108 365	J. Dolbeau *et al.*	(SACL)	IJP	REFID=30052
LONGACRE	75	PL 55B 415	R.S. Longacre *et al.*	(LBL, SLAC)	IJP	REFID=30047