$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\rm total}$ in $N\pi \to N(1440) \to N(\pi\pi)^{I=0}_{S\text{-wave}}$ $(\Gamma_1\Gamma_9)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
±0.17 to ±0.25 OUR ESTIMATE				
$+0.24\pm0.03$	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
-0.18	[2,8] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
-0.23	[3] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$

$N(1440)$ PHOTON DECAY AMPLITUDES

$N(1440) \to p\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($\mathrm{GeV}^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
-0.072 ± 0.009 OUR ESTIMATE				
-0.085 ± 0.003	LI	93	IPWA	$\gamma N \to \pi N$
-0.069 ± 0.018	CRAWFORD	83	IPWA	$\gamma N \to \pi N$
-0.063 ± 0.008	AWAJI	81	DPWA	$\gamma N \to \pi N$
-0.069 ± 0.004	ARAI	80	DPWA	$\gamma N \to \pi N$ (fit 1)
-0.066 ± 0.004	ARAI	80	DPWA	$\gamma N \to \pi N$ (fit 2)
-0.079 ± 0.009	BRATASHEV...	80	DPWA	$\gamma N \to \pi N$
-0.068 ± 0.015	CRAWFORD	80	DPWA	$\gamma N \to \pi N$
-0.0584 ± 0.0148	ISHII	80	DPWA	Compton scattering
• • • We do not use the following data for averages, fits, limits, etc. • • •				
-0.066 ± 0.017	ARNDT	90B	IPWA	See LI 93
-0.064	ARNDT	90B	FIT	See LI 93
-0.129	[9] WADA	84	DPWA	Compton scattering
-0.075 ± 0.015	BARBOUR	78	DPWA	$\gamma N \to \pi N$
-0.125	[10] NOELLE	78		$\gamma N \to \pi N$
-0.076	BERENDS	77	IPWA	$\gamma N \to \pi N$
-0.087 ± 0.006	FELLER	76	DPWA	$\gamma N \to \pi N$

$N(1440) \to n\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($\mathrm{GeV}^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
$+0.052\pm0.025$ OUR ESTIMATE				
0.085 ± 0.006	LI	93	IPWA	$\gamma N \to \pi N$
0.037 ± 0.010	AWAJI	81	DPWA	$\gamma N \to \pi N$
0.030 ± 0.003	FUJII	81	DPWA	$\gamma N \to \pi N$
0.023 ± 0.009	ARAI	80	DPWA	$\gamma N \to \pi N$ (fit 1)
0.019 ± 0.012	ARAI	80	DPWA	$\gamma N \to \pi N$ (fit 2)
0.056 ± 0.015	CRAWFORD	80	DPWA	$\gamma N \to \pi N$
-0.029 ± 0.035	TAKEDA	80	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.050 ± 0.019	ARNDT	90B	IPWA	See LI 93
0.045	ARNDT	90B	FIT	See LI 93
$+0.059\pm0.016$	BARBOUR	78	DPWA	$\gamma N \to \pi N$
0.062	[10] NOELLE	78		$\gamma N \to \pi N$

$N(1440)$ FOOTNOTES

1 BAKER 79 finds a coupling of the $N(1440)$ to the $N\eta$ channel near (but slightly below) threshold.

2 LONGACRE 77 pole positions are from a search for poles in the unitarized T-matrix; the first (second) value uses, in addition to $\pi N \to N\pi\pi$ 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 and HOEHLER 94 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 ARNDT 91 (Soln SM90) also finds a second-sheet pole with real part = 1413 MeV, $-2\times$ imaginary part = 256 MeV, and residue = $(78-153i)$ MeV.

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

7 An alternative which cannot be distinguished from this is to have a P_{13} resonance with M = 1530 MeV, Γ = 79 MeV, and elasticity = +0.271.

8 LONGACRE 77 considers this coupling to be well determined.

9 WADA 84 is inconsistent with other analyses; see the Note on N and Δ Resonances.

10 Converted to our conventions using M = 1486 MeV, Γ = 613 MeV from NOELLE 78.

$N(1440)$ REFERENCES

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

HOEHLER	94	πN Newsletter 10 (to be pub.)		(KARL)
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
ARNDT	90B	PR C42 1864	+Workman, Li, Roper	(VPI)
CUTKOSKY	90	PR D42 235	+Wang	(CMU)
ARNDT	85	PR D32 1085	+Ford, Roper	(VPI)
WADA	84	NP B247 313	+Egawa, Imanishi, Ishii, Kato, Ukai+	(INUS)
CRAWFORD	83	NP B211 1	+Morton	(GLAS)
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)
FUJII	81	NP B187 53	+Hayashii, Iwata, Kajikawa+	(NAGO, OSAK)
ARAI	80	Toronto Conf. 93		(INUS)
Also	82	NP B194 251	Arai, Fujii	(INUS)
BRATASHEV...	80	NP B166 525	Bratashevskij, Gorbenko, Derebchinskij+	(KFTI)
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
ISHII	80	NP B165 189	+Egawa, Kato, Miyachi+	(KYOT, INUS)
TAKEDA	80	NP B168 17	+Arai, Fujii, Ikeda, Iwasaki+	(TOKY, INUS)
BAKER	79	NP B156 93	+Brown, Clark, Davies, Depagter, Evans+	(RHEL) IJP
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)
NOELLE	78	PTP 60 778		(NAGO)
BERENDS	77	NP B136 317	+Donnachie	(LEID, MCHS) IJP
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
FELTESSE	75	NP B93 242	+Ayed, Bareyre, Borgeaud, David+	(SACL) IJP
LONGACRE	75	PL 55B 415	+Rosenfeld, Lasinski, Smadja+	(LBL, SLAC) IJP

$N(1520)$ D_{13}

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

$N(1520)$ MASS

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1515 to 1530 (≈ 1520) OUR ESTIMATE				
1524 ± 4	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
1525 ± 10	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
1519 ± 4	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1510	LI	93	IPWA	$\gamma N \to \pi N$
1504	CRAWFORD	80	DPWA	$\gamma N \to \pi N$
1503	BARBOUR	78	DPWA	$\gamma N \to \pi N$
1510	BERENDS	77	IPWA	$\gamma N \to \pi N$
1510	[1] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
1520	[2] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$

$N(1520)$ WIDTH

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
110 to 135 (≈ 120) OUR ESTIMATE				
124 ± 8	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
120 ± 15	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
114 ± 7	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
120	LI	93	IPWA	$\gamma N \to \pi N$
124	CRAWFORD	80	DPWA	$\gamma N \to \pi N$
183	BAKER	79	DPWA	$\pi^- p \to n\eta$
135	BARBOUR	78	DPWA	$\gamma N \to \pi N$
105	BERENDS	77	IPWA	$\gamma N \to \pi N$
110	[1] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
150	[2] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$

$N(1520)$ POLE POSITION

REAL PART

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1510	[3] HOEHLER	93	ARGD	$\pi N \to \pi N$
1511	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90
1510 ± 5	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1510	ARNDT	85	DPWA	See ARNDT 91
1514 or 1511	[4] LONGACRE	78	IPWA	$\pi N \to N\pi\pi$
1508 or 1505	[1] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$

−2×IMAGINARY PART

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
120	[3] HOEHLER	93	ARGD	$\pi N \to \pi N$
108	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90
114 ± 10	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
122	ARNDT	85	DPWA	See ARNDT 91
146 or 137	[4] LONGACRE	78	IPWA	$\pi N \to N\pi\pi$
109 or 107	[1] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$

$N(1520)$ ELASTIC POLE RESIDUE

MODULUS $|r|$

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
32	HOEHLER	93	ARGD	$\pi N \to \pi N$
33	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90
35 ± 2	CUTKOSKY	80	IPWA	$\pi N \to \pi N$