$N(1720)\ P_{13}$

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

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).

N(1720) BREIT-WIGNER MASS

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1700 to 1750 (≈ 1720) OUR ESTIMATE				
1763.8± 4.6	ARNDT	06	DPWA	$\pi N \rightarrow \pi N$, ηN
1717 ± 31	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$
1700 ± 50	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
1710 ± 20	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1790 ±100	THOMA	08	DPWA	Multichannel
1749.6± 4.5	ARNDT	04	DPWA	$\pi N \rightarrow \pi N$, ηN
1705 ± 10	PENNER	02C	DPWA	Multichannel
1716 ±112	VRANA	00	DPWA	Multichannel
1713 ± 10	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
1820	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
1711 ± 26	BATINIC	95	DPWA	$\pi N \rightarrow N\pi$, $N\eta$
1720	LI	93	IPWA	$\gamma N \rightarrow \pi N$
1690	SAXON	80	DPWA	$\pi^- p \rightarrow \Lambda K^0$
1750	[1] LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$
1720	[2] LONGACRE	75	IPWA	$\pi N \rightarrow N\pi\pi$

N(1720) BREIT-WIGNER WIDTH

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
150 to 300 (≈ 200) OUR ESTIMATE				
210± 22	ARNDT	06	DPWA	$\pi N \rightarrow \pi N$, ηN
380±180	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$
125± 70	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
190± 30	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
690±100	THOMA	08	DPWA	Multichannel
256± 22	ARNDT	04	DPWA	$\pi N \rightarrow \pi N$, ηN
237± 73	PENNER	02C	DPWA	Multichannel
121± 39	VRANA	00	DPWA	Multichannel
153± 15	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
354	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
235± 51	BATINIC	95	DPWA	$\pi N \rightarrow N\pi$, $N\eta$
200	LI	93	IPWA	$\gamma N \rightarrow \pi N$
120	SAXON	80	DPWA	$\pi^- p \rightarrow \Lambda K^0$
130	[1] LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$
150	[2] LONGACRE	75	IPWA	$\pi N \rightarrow N\pi\pi$

N(1720) POLE POSITION

REAL PART

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1660 to 1690 (≈ 1675) OUR ESTIMATE				
1666	ARNDT	06	DPWA	$\pi N \rightarrow \pi N$, ηN
1686	[3] HOEHLER	93	SPED	$\pi N \rightarrow \pi N$
1680±30	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1630±90	THOMA	08	DPWA	Multichannel
1655	ARNDT	04	DPWA	$\pi N \rightarrow \pi N$, ηN
1692	VRANA	00	DPWA	Multichannel
1717	ARNDT	95	DPWA	$\pi N \rightarrow N \pi$
1675	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90
1716 or 1716	[4] LONGACRE	78	IPWA	$\pi N \rightarrow N \pi \pi$
1745 or 1748	[1] LONGACRE	77	IPWA	$\pi N \rightarrow N \pi \pi$

−2×IMAGINARY PART

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
115 to 275 OUR ESTIMATE				
355	ARNDT	06	DPWA	$\pi N \rightarrow \pi N$, ηN
187	[3] HOEHLER	93	SPED	$\pi N \rightarrow \pi N$
120±40	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
460±80	THOMA	08	DPWA	Multichannel
278	ARNDT	04	DPWA	$\pi N \rightarrow \pi N$, ηN
94	VRANA	00	DPWA	Multichannel
388	ARNDT	95	DPWA	$\pi N \rightarrow N \pi$
114	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90
124 or 126	[4] LONGACRE	78	IPWA	$\pi N \rightarrow N \pi \pi$
135 or 123	[1] LONGACRE	77	IPWA	$\pi N \rightarrow N \pi \pi$

N(1720) ELASTIC POLE RESIDUE

MODULUS |*r*|

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
25	ARNDT	06	DPWA	$\pi N \rightarrow \pi N$, ηN
15	HOEHLER	93	SPED	$\pi N \rightarrow \pi N$
8±2	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
20	ARNDT	04	DPWA	$\pi N \rightarrow \pi N$, ηN
39	ARNDT	95	DPWA	$\pi N \rightarrow N \pi$
11	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90

PHASE *θ*

VALUE (°)	*DOCUMENT ID*		*TECN*	*COMMENT*
− 94	ARNDT	06	DPWA	$\pi N \rightarrow \pi N$, ηN
−160±30	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$

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

− 88	ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
− 70	ARNDT	95	DPWA	$\pi N \to N\pi$
−130	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90

N(1720) DECAY MODES

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

	Mode	Fraction (Γ_i/Γ)
Γ_1	$N\pi$	10–20 %
Γ_2	$N\eta$	(4.0±1.0) %
Γ_3	ΛK	1–15 %
Γ_4	ΣK	
Γ_5	$N\pi\pi$	>70 %
Γ_6	$\Delta\pi$	
Γ_7	$\Delta(1232)\pi$, P-wave	
Γ_8	$N\rho$	70–85 %
Γ_9	$N\rho$, S=1/2, P-wave	
Γ_{10}	$N\rho$, S=3/2, P-wave	
Γ_{11}	$N(\pi\pi)^{I=0}_{S\text{-wave}}$	
Γ_{12}	$p\gamma$	0.003–0.10 %
Γ_{13}	$p\gamma$, helicity=1/2	0.003–0.08 %
Γ_{14}	$p\gamma$, helicity=3/2	0.001–0.03 %
Γ_{15}	$n\gamma$	0.002–0.39 %
Γ_{16}	$n\gamma$, helicity=1/2	0.0–0.002 %
Γ_{17}	$n\gamma$, helicity=3/2	0.001–0.39 %

N(1720) BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{total}$ — Γ_1/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.10 to 0.20 OUR ESTIMATE				
0.094±0.005	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
0.13 ±0.05	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
0.10 ±0.04	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
0.14 ±0.03	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.09 ±0.06	THOMA	08	DPWA	Multichannel
0.190±0.004	ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
0.17 ±0.02	PENNER	02C	DPWA	Multichannel
0.05 ±0.05	VRANA	00	DPWA	Multichannel
0.16	ARNDT	95	DPWA	$\pi N \to N\pi$
0.18 ±0.04	BATINIC	95	DPWA	$\pi N \to N\pi, N\eta$

$\Gamma(N\eta)/\Gamma_{total}$ — Γ_2/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.04 ±0.01	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.10 ±0.07	THOMA	08	DPWA	Multichannel
0.002±0.002	PENNER	02C	DPWA	Multichannel
0.002±0.01	BATINIC	95	DPWA	$\pi N \to N\pi$, $N\eta$

$\Gamma(\Lambda K)/\Gamma_{total}$ — Γ_3/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.044±0.004 OUR AVERAGE				
0.043±0.004	SHKLYAR	05	DPWA	Multichannel
0.09 ±0.03	PENNER	02C	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.12 ±0.09	THOMA	08	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1720) \to \Lambda K$ — $(\Gamma_1\Gamma_3)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
−0.14 to −0.06 OUR ESTIMATE				
−0.09	BELL	83	DPWA	$\pi^- p \to \Lambda K^0$
−0.11	SAXON	80	DPWA	$\pi^- p \to \Lambda K^0$

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 $\Delta(1232)\pi$.

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1720) \to \Delta(1232)\pi$, P-wave — $(\Gamma_1\Gamma_7)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
±0.27 to ±0.37 OUR ESTIMATE				
−0.17	[1] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1720) \to N\rho$, S=1/2, P-wave — $(\Gamma_1\Gamma_9)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
+0.34±0.05	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
−0.26	[1] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
+0.40	[2] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$

$\Gamma(N\rho$, S=1/2, P-wave$)/\Gamma_{total}$ — Γ_9/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.91±0.01	VRANA	00	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1720) \to N\rho$, S=3/2, P-wave — $(\Gamma_1\Gamma_{10})^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
+0.15	[1] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \rightarrow N(1720) \rightarrow N(\pi\pi)^{I=0}_{S\text{-wave}}$ — $(\Gamma_1\Gamma_{11})^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
−0.19	[1] LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$

N(1720) PHOTON DECAY AMPLITUDES

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

N(1720) → $p\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
+0.018±0.030 OUR ESTIMATE				
0.097±0.003	DUGGER	07	DPWA	$\gamma N \rightarrow \pi N$
−0.015±0.015	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
0.044±0.066	CRAWFORD	83	IPWA	$\gamma N \rightarrow \pi N$
−0.004±0.007	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.073	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$
−0.053	PENNER	02D	DPWA	Multichannel
0.012±0.003	LI	93	IPWA	$\gamma N \rightarrow \pi N$

N(1720) → $p\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.019±0.020 OUR ESTIMATE				
−0.039±0.003	DUGGER	07	DPWA	$\gamma N \rightarrow \pi N$
0.007±0.010	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
−0.024±0.006	CRAWFORD	83	IPWA	$\gamma N \rightarrow \pi N$
−0.040±0.016	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.011	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$
0.027	PENNER	02D	DPWA	Multichannel
−0.022±0.003	LI	93	IPWA	$\gamma N \rightarrow \pi N$

N(1720) → $n\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
+0.001±0.015 OUR ESTIMATE				
0.007±0.015	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
0.002±0.005	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.003	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$
−0.004	PENNER	02D	DPWA	Multichannel
0.050±0.004	LI	93	IPWA	$\gamma N \rightarrow \pi N$

N(1720) → $n\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.029±0.061 OUR ESTIMATE				
−0.005±0.025	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
−0.015±0.019	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$

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

−0.031	DRECHSEL	07	DPWA	$\gamma N \to \pi N$
0.003	PENNER	02D	DPWA	Multichannel
−0.017±0.004	LI	93	IPWA	$\gamma N \to \pi N$

$N(1720)$ $\gamma p \to \Lambda K^+$ AMPLITUDES

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $p\gamma \to N(1720) \to \Lambda K^+$ (E_{1+} amplitude)

VALUE (units 10^{-3})	DOCUMENT ID		TECN
• • • We do not use the following data for averages, fits, limits, etc. • • •			
10.2 ±0.2	WORKMAN	90	DPWA
9.52	TANABE	89	DPWA

$p\gamma \to N(1720) \to \Lambda K^+$ phase angle θ (E_{1+} amplitude)

VALUE (degrees)	DOCUMENT ID		TECN
• • • We do not use the following data for averages, fits, limits, etc. • • •			
−124 ±2	WORKMAN	90	DPWA
−103.4	TANABE	89	DPWA

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $p\gamma \to N(1720) \to \Lambda K^+$ (M_{1+} amplitude)

VALUE (units 10^{-3})	DOCUMENT ID		TECN
• • • We do not use the following data for averages, fits, limits, etc. • • •			
−4.5 ±0.2	WORKMAN	90	DPWA
3.18	TANABE	89	DPWA

$N(1720)$ FOOTNOTES

[1] 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.

[2] From method II of LONGACRE 75: eyeball fits with Breit-Wigner circles to the T-matrix amplitudes.

[3] 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.

[4] 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.

N(1720) REFERENCES

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

THOMA	08	PL B659 87	U. Thoma *et al.*	(CB-ELSA Collab.)
DRECHSEL	07	EPJ A34 69	D. Drechsel, S.S. Kamalov, L. Tiator	(MAINZ, JINR)
DUGGER	07	PR C76 025211	M. Dugger *et al.*	(Jefferson Lab CLAS Collab.)
ARNDT	06	PR C74 045205	R.A. Arndt *et al.*	(GWU)
PDG	06	JPG 33 1	W.-M. Yao *et al.*	(PDG Collab.)
SHKLYAR	05	PR C72 015210	V. Shklyar, H. Lenske, U. Mosel	(GIES)
ARNDT	04	PR C69 035213	R.A. Arndt *et al.*	(GWU, TRIU)
PENNER	02C	PR C66 055211	G. Penner, U. Mosel	(GIES)
PENNER	02D	PR C66 055212	G. Penner, U. Mosel	(GIES)
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman,, T.-S.H. Lee	(PITT+)
ARNDT	96	PR C53 430	R.A. Arndt, I.I. Strakovsky, R.L. Workman	(VPI)
ARNDT	95	PR C52 2120	R.A. Arndt *et al.*	(VPI, BRCO)
BATINIC	95	PR C51 2310	M. Batinic *et al.*	(BOSK, UCLA)
Also		PR C57 1004 (erratum)	M. Batinic *et al.*	
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)
LI	93	PR C47 2759	Z.J. Li *et al.*	(VPI)
MANLEY	92	PR D45 4002	D.M. Manley, E.M. Saleski	(KENT) IJP
Also		PR D30 904	D.M. Manley *et al.*	(VPI)
ARNDT	91	PR D43 2131	R.A. Arndt *et al.*	(VPI, TELE) IJP
WORKMAN	90	PR C42 781	R.L. Workman	(VPI)
TANABE	89	PR C39 741	H. Tanabe, M. Kohno, C. Bennhold	(MANZ)
Also		NC 102A 193	M. Kohno, H. Tanabe, C. Bennhold	(MANZ)
BELL	83	NP B222 389	K.W. Bell *et al.*	(RL) IJP
CRAWFORD	83	NP B211 1	R.L. Crawford, W.T. Morton	(GLAS)
PDG	82	PL 111B 1	M. Roos *et al.*	(HELS, CIT, CERN)
AWAJI	81	Bonn Conf. 352	N. Awaji, R. Kajikawa	(NAGO)
Also		NP B197 365	K. Fujii *et al.*	(NAGO)
CUTKOSKY	80	Toronto Conf. 19	R.E. Cutkosky *et al.*	(CMU, LBL) IJP
Also		PR D20 2839	R.E. Cutkosky *et al.*	(CMU, LBL) IJP
SAXON	80	NP B162 522	D.H. Saxon *et al.*	(RHEL, BRIS) IJP
HOEHLER	79	PDAT 12-1	G. Hohler *et al.*	(KARLT) IJP
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP
LONGACRE	78	PR D17 1795	R.S. Longacre *et al.*	(LBL, SLAC)
LONGACRE	77	NP B122 493	R.S. Longacre, J. Dolbeau	(SACL) IJP
Also		NP B108 365	J. Dolbeau *et al.*	(SACL) IJP
LONGACRE	75	PL 55B 415	R.S. Longacre *et al.*	(LBL, SLAC) IJP