$N(1440)\ 1/2^+$

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

Older and obsolete values are listed and referenced in the 2014 edition, Chinese Physics **C38** 070001 (2014).

N(1440) POLE POSITION

REAL PART

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1360 to 1385 (≈ 1370) OUR ESTIMATE				
1369± 3	SOKHOYAN	15A	DPWA	Multichannel
1363± 2±2	[1] SVARC	14	L+P	$\pi N \to \pi N$
1359	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
1385	HOEHLER	93	SPED	$\pi N \to \pi N$
1375±30	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1386	SHKLYAR	13	DPWA	Multichannel
1370± 4	ANISOVICH	12A	DPWA	Multichannel
1370	SHRESTHA	12A	DPWA	Multichannel
1363±11	BATINIC	10	DPWA	$\pi N \to N\pi, N\eta$
1383	VRANA	00	DPWA	Multichannel

−2×IMAGINARY PART

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
160 to 195 (≈ 180) OUR ESTIMATE				
189± 5	SOKHOYAN	15A	DPWA	Multichannel
180± 4±5	[1] SVARC	14	L+P	$\pi N \to \pi N$
162	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
164	HOEHLER	93	SPED	$\pi N \to \pi N$
180±40	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
277	SHKLYAR	13	DPWA	Multichannel
190± 7	ANISOVICH	12A	DPWA	Multichannel
214	SHRESTHA	12A	DPWA	Multichannel
151±13	BATINIC	10	DPWA	$\pi N \to N\pi, N\eta$
316	VRANA	00	DPWA	Multichannel

N(1440) ELASTIC POLE RESIDUE

MODULUS $|r|$

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
40 to 52 (≈ 46) OUR ESTIMATE				
49±3	SOKHOYAN	15A	DPWA	Multichannel
50±1±2	[1] SVARC	14	L+P	$\pi N \to \pi N$
38	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
40	HOEHLER	93	SPED	$\pi N \to \pi N$
52±5	CUTKOSKY	80	IPWA	$\pi N \to \pi N$

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

126	SHKLYAR	13	DPWA	Multichannel
48±3	ANISOVICH	12A	DPWA	Multichannel
44	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$

PHASE θ

VALUE (°)	DOCUMENT ID		TECN	COMMENT
− 80 to −100 (≈ − 90) OUR ESTIMATE				
− 82± 5	SOKHOYAN	15A	DPWA	Multichannel
− 88± 1±2	[1] SVARC	14	L+P	$\pi N \to \pi N$
− 98	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
−100±35	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
− 60	SHKLYAR	13	DPWA	Multichannel
− 78± 4	ANISOVICH	12A	DPWA	Multichannel
− 88	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$

N(1440) INELASTIC POLE RESIDUE

The "normalized residue" is the residue divided by $\Gamma_{pole}/2$.

Normalized residue in $N\pi \to N(1440) \to \Delta\pi$, P-wave

MODULUS (%)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
27±2	38 ± 5	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
27±2	40 ± 5	ANISOVICH	12A	DPWA	Multichannel

Normalized residue in $N\pi \to N(1440) \to N\,(\pi\pi)^{I=0}_{S-wave}$

MODULUS (%)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
21±4	−136 ± 4	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
21±5	−135 ± 7	ANISOVICH	12A	DPWA	Multichannel

N(1440) BREIT-WIGNER MASS

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1410 to 1450 (≈ 1430) OUR ESTIMATE				
1430 ±10	SOKHOYAN	15A	DPWA	Multichannel
1515 ±15	SHKLYAR	13	DPWA	Multichannel
1485.0± 1.2	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
1440 ±30	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
1410 ±12	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1430 ± 8	ANISOVICH	12A	DPWA	Multichannel
1412 ± 2	SHRESTHA	12A	DPWA	Multichannel
1439 ±19	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
1518 ± 5	PENNER	02C	DPWA	Multichannel
1479 ±80	VRANA	00	DPWA	Multichannel

N(1440) BREIT-WIGNER WIDTH

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
250 to 450 (≈ 350) OUR ESTIMATE				
360 ± 30	SOKHOYAN	15A	DPWA	Multichannel
605 ± 90	SHKLYAR	13	DPWA	Multichannel
284 ± 18	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
340 ± 70	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
135 ± 10	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
365 ± 35	ANISOVICH	12A	DPWA	Multichannel
248 ± 5	SHRESTHA	12A	DPWA	Multichannel
437 ± 141	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$
668 ± 41	PENNER	02C	DPWA	Multichannel
490 ± 120	VRANA	00	DPWA	Multichannel

N(1440) DECAY MODES

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

	Mode	Fraction (Γ_i/Γ)
Γ_1	$N\pi$	55–75 %
Γ_2	$N\eta$	<1 %
Γ_3	$N\pi\pi$	25–50 %
Γ_4	$\Delta(1232)\pi$	20–30 %
Γ_5	$\Delta(1232)\pi$, *P*-wave	13–27 %
Γ_6	$N\sigma$	11–23 %
Γ_7	$p\gamma$, helicity=1/2	0.035–0.048 %
Γ_8	$n\gamma$, helicity=1/2	0.02–0.04 %

N(1440) BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{\text{total}}$ Γ_1/Γ

VALUE (%)	*DOCUMENT ID*		*TECN*	*COMMENT*
55 to 75 (≈ 65) OUR ESTIMATE				
63 ±2	SOKHOYAN	15A	DPWA	Multichannel
56 ±2	SHKLYAR	13	DPWA	Multichannel
78.7 ±1.6	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
68 ±4	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
51 ±5	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
62 ±3	ANISOVICH	12A	DPWA	Multichannel
64.8 ±0.9	SHRESTHA	12A	DPWA	Multichannel
62 ±4	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$
57 ±1	PENNER	02C	DPWA	Multichannel
72 ±5	VRANA	00	DPWA	Multichannel

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

VALUE (%)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0 ± 1	VRANA	00	DPWA	Multichannel

$\Gamma(\Delta(1232)\pi, P\text{-wave})/\Gamma_{\text{total}}$ Γ_5/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
20 ±7	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
21 ±8	ANISOVICH	12A	DPWA	Multichannel
6.5 ± 0.8	SHRESTHA	12A	DPWA	Multichannel
16 ±1	VRANA	00	DPWA	Multichannel

$\Gamma(N\sigma)/\Gamma_{\text{total}}$ Γ_6/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
17 ± 6	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
17 ± 7	ANISOVICH	12A	DPWA	Multichannel
27 ± 1	SHRESTHA	12A	DPWA	Multichannel
12 ± 1	VRANA	00	DPWA	Multichannel

$N(1440)$ PHOTON DECAY AMPLITUDES AT THE POLE

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

MODULUS ($GeV^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
-0.044 ± 0.005	-40 ± 8	SOKHOYAN	15A	DPWA	Multichannel
$-0.054^{+0.004}_{-0.003}$	5^{+2}_{-5}	ROENCHEN	14	DPWA	

$N(1440)$ BREIT-WIGNER PHOTON DECAY AMPLITUDES

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

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
-0.060 ± 0.004 OUR ESTIMATE				
-0.061 ± 0.006	SOKHOYAN	15A	DPWA	Multichannel
-0.056 ± 0.001	WORKMAN	12A	DPWA	$\gamma N \rightarrow N\pi$
-0.051 ± 0.002	DUGGER	07	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
-0.085 ± 0.003	SHKLYAR	13	DPWA	Multichannel
-0.061 ± 0.008	ANISOVICH	12A	DPWA	Multichannel
-0.084 ± 0.003	SHRESTHA	12A	DPWA	Multichannel
-0.061	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$
-0.087	PENNER	02D	DPWA	Multichannel

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

VALUE ($GeV^{-1/2}$)	*DOCUMENT ID*		*TECN*	*COMMENT*
+0.040±0.010 OUR ESTIMATE				
0.043±0.012	ANISOVICH	13B	DPWA	Multichannel
0.048±0.004	CHEN	12A	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.040±0.005	SHRESTHA	12A	DPWA	Multichannel
0.054	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$
0.121	PENNER	02D	DPWA	Multichannel

N(1440) FOOTNOTES

[1] Fit to the amplitudes of HOEHLER 79.

N(1440) REFERENCES

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

SOKHOYAN	15A	EPJ A51 95	V. Sokhoyan *et al.*	(CBELSA/TAPS Collab.)
PDG	14	CP C38 070001	K. Olive *et al.*	(PDG Collab.)
ROENCHEN	14	EPJ A50 101	D. Roenchen *et al.*	
Also		EPJ A51 63 (errat.)	D. Roenchen *et al.*	
SVARC	14	PR C89 045205	A. Svarc *et al.*	
ANISOVICH	13B	EPJ A49 67	A.V. Anisovich *et al.*	
SHKLYAR	13	PR C87 015201	V. Shklyar, H. Lenske, U. Mosel	(GIES)
ANISOVICH	12A	EPJ A48 15	A.V. Anisovich *et al.*	(BONN, PNPI)
CHEN	12A	PR C86 015206	W. Chen *et al.*	(DUKE, GWU, MSST, ITEP+)
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)
WORKMAN	12A	PR C86 015202	R. Workman *et al.*	(GWU)
BATINIC	10	PR C82 038203	M. Batinic *et al.*	(ZAGR)
DRECHSEL	07	EPJ A34 69	D. Drechsel, S.S. Kamalov, L. Tiator	(MAINZ, JINR)
DUGGER	07	PR C76 025211	M. Dugger *et al.*	(JLab CLAS Collab.)
ARNDT	06	PR C74 045205	R.A. Arndt *et al.*	(GWU)
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, ANL)
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)
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
HOEHLER	79	PDAT 12-1	G. Hohler *et al.*	(KARLT) IJP
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP