

$\Delta(1620) \ 1/2^-$

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

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

$\Delta(1620)$ POLE POSITION

REAL PART

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
1590 to 1610 (≈ 1600) OUR ESTIMATE			
1607 $\pm$ 2	ROENCHEN	22	DPWA Multichannel
1597 $\pm$ 5	SOKHOYAN	15A	DPWA Multichannel
1603 $\pm$ 7 $\pm$ 2	¹ SVARC	14	L+P $\pi N \rightarrow \pi N$
1600 $\pm$ 15	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1577	HUNT	19	DPWA Multichannel
1600	ROENCHEN	15A	DPWA Multichannel
1597 $\pm$ 4	ANISOVICH	12A	DPWA Multichannel
1595	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
1607	VRANA	00	DPWA Multichannel
1608	HOEHLER	93	SPED $\pi N \rightarrow \pi N$

¹Fit to the amplitudes of HOEHLER 79.

−2×IMAGINARY PART

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
80 to 140 (≈ 110) OUR ESTIMATE			
85 $\pm$ 3	ROENCHEN	22	DPWA Multichannel
134 $\pm$ 8	SOKHOYAN	15A	DPWA Multichannel
114 $\pm$ 12 $\pm$ 4	¹ SVARC	14	L+P $\pi N \rightarrow \pi N$
120 $\pm$ 20	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
101	HUNT	19	DPWA Multichannel
65	ROENCHEN	15A	DPWA Multichannel
130 $\pm$ 9	ANISOVICH	12A	DPWA Multichannel
135	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
148	VRANA	00	DPWA Multichannel
116	HOEHLER	93	SPED $\pi N \rightarrow \pi N$

¹Fit to the amplitudes of HOEHLER 79.

$\Delta(1620)$ ELASTIC POLE RESIDUE

MODULUS $|r|$

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
10 to 20 (≈ 15) OUR ESTIMATE			
12 $\pm$ 1	ROENCHEN	22	DPWA Multichannel
20 $\pm$ 3	SOKHOYAN	15A	DPWA Multichannel
17 $\pm$ 2 $\pm$ 1	¹ SVARC	14	L+P $\pi N \rightarrow \pi N$
15 $\pm$ 2	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$

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

16	ROENCHEN	15A	DPWA	Multichannel
18±2	ANISOVICH	12A	DPWA	Multichannel
15	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
19	HOEHLER	93	SPED	$\pi N \rightarrow \pi N$

¹ Fit to the amplitudes of HOEHLER 79.

PHASE θ

VALUE (°)	DOCUMENT ID	TECN	COMMENT
−120 to −80 (≈ −100) OUR ESTIMATE			

126±2	ROENCHEN	22	DPWA	Multichannel
−90±15	SOKHOYAN	15A	DPWA	Multichannel
−106±10±4	¹ SVARC	14	L+P	$\pi N \rightarrow \pi N$
−110±20	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$

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

−104	ROENCHEN	15A	DPWA	Multichannel
−100±5	ANISOVICH	12A	DPWA	Multichannel
−92	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
−95	HOEHLER	93	SPED	$\pi N \rightarrow \pi N$

¹ Fit to the amplitudes of HOEHLER 79.

$\Delta(1620)$ INELASTIC POLE RESIDUE

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

Normalized residue in $N\pi \rightarrow \Delta(1620) \rightarrow \Delta\pi, D\text{-wave}$

MODULUS	PHASE (°)	DOCUMENT ID	TECN	COMMENT
0.32±0.01	81±1	ROENCHEN	22	DPWA Multichannel
0.42±0.06	−90±20	SOKHOYAN	15A	DPWA Multichannel

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

0.57	105	ROENCHEN	15A	DPWA Multichannel
0.38±0.09	−85±30	ANISOVICH	12A	DPWA Multichannel

Normalized residue in $N\pi \rightarrow \Delta(1620) \rightarrow \Sigma K$

MODULUS	PHASE (°)	DOCUMENT ID	TECN	COMMENT
0.11±0.01	−120±3	ROENCHEN	22	DPWA Multichannel

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

0.22	−105	ROENCHEN	15A	DPWA Multichannel
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Normalized residue in $N\pi \rightarrow \Delta(1620) \rightarrow N(1440)\pi$

MODULUS	PHASE (°)	DOCUMENT ID	TECN	COMMENT
0.10±0.06	−65±30	SOKHOYAN	15A	DPWA Multichannel

$\Delta(1620)$ BREIT-WIGNER MASS

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
1590 to 1630 (≈1610) OUR ESTIMATE			
1635 ± 8	GOLOVATCH	19	DPWA $\gamma p \rightarrow \pi^+ \pi^- p$
1589 ± 3	¹ HUNT	19	DPWA Multichannel
1595 ± 8	SOKHOYAN	15A	DPWA Multichannel

1615.2 ± 0.4	¹ ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
1620 ± 20	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
1610 ± 7	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1600 ± 8	ANISOVICH	12A	DPWA	Multichannel
1600 ± 1	¹ SHRESTHA	12A	DPWA	Multichannel
1612 ± 2	PENNER	02C	DPWA	Multichannel
1617 ± 15	VRANA	00	DPWA	Multichannel

¹Statistical error only.

$\Delta(1620)$ BREIT-WIGNER WIDTH

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
110 to 150 (≈ 130) OUR ESTIMATE			
144 ± 16	GOLOVATCH	19	DPWA $\gamma p \rightarrow \pi^+ \pi^- p$
107 ± 7	¹ HUNT	19	DPWA Multichannel
135 ± 9	SOKHOYAN	15A	DPWA Multichannel
146.9 ± 1.9	¹ ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
140 ± 20	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
139 ± 18	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
130 ± 11	ANISOVICH	12A	DPWA Multichannel
112 ± 2	¹ SHRESTHA	12A	DPWA Multichannel
202 ± 7	PENNER	02C	DPWA Multichannel
143 ± 42	VRANA	00	DPWA Multichannel

¹Statistical error only.

$\Delta(1620)$ DECAY MODES

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

Mode	Fraction (Γ_i/Γ)
Γ_1 $N\pi$	25–35 %
Γ_2 $N\pi\pi$	>67 %
Γ_3 $\Delta(1232)\pi$, D -wave	44–72 %
Γ_4 $N\rho$	23–32%
Γ_5 $N\rho$, $S=1/2$, S -wave	23–32%
Γ_6 $N\rho$, $S=3/2$, D -wave	<0.04%
Γ_7 $N(1440)\pi$	<9 %
Γ_8 $N\gamma$, helicity=1/2	0.03–0.10 %

$\Delta(1620)$ BRANCHING RATIOS **$\Gamma(N\pi)/\Gamma_{\text{total}}$** **$\Gamma_1/\Gamma$**

VALUE (%)	DOCUMENT ID	TECN	COMMENT
25 to 35 (≈ 30) OUR ESTIMATE			
24 ± 2	¹ HUNT	19	DPWA Multichannel
28 ± 3	SOKHOYAN	15A	DPWA Multichannel
31.5 ± 0.1	¹ ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
25 ± 3	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
35 ± 6	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
28 ± 3	ANISOVICH	12A	DPWA Multichannel
33 ± 2	¹ SHRESTHA	12A	DPWA Multichannel
34 ± 1	PENNER	02C	DPWA Multichannel
45 ± 5	VRANA	00	DPWA Multichannel

¹Statistical error only. **$\Gamma(N\pi\pi)/\Gamma_{\text{total}}$** **$\Gamma_2/\Gamma$**

VALUE	DOCUMENT ID	TECN	COMMENT
0.90 ± 0.10	GOLOVATCH	19	DPWA $\gamma p \rightarrow \pi^+ \pi^- p$

 $\Gamma(\Delta(1232)\pi, D\text{-wave})/\Gamma_{\text{total}}$ **Γ_3/Γ**

VALUE (%)	DOCUMENT ID	TECN	COMMENT
48 ± 4	¹ HUNT	19	DPWA Multichannel
62 ± 10	SOKHOYAN	15A	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
60 ± 17	ANISOVICH	12A	DPWA Multichannel
32 ± 2	¹ SHRESTHA	12A	DPWA Multichannel
39 ± 2	VRANA	00	DPWA Multichannel

¹Statistical error only. **$\Gamma(N\rho, S=1/2, S\text{-wave})/\Gamma_{\text{total}}$** **$\Gamma_5/\Gamma$**

VALUE (%)	DOCUMENT ID	TECN	COMMENT
27 ± 4	¹ HUNT	19	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
26 ± 2	¹ SHRESTHA	12A	DPWA Multichannel
14 ± 3	VRANA	00	DPWA Multichannel

¹Statistical error only. **$\Gamma(N\rho, S=3/2, D\text{-wave})/\Gamma_{\text{total}}$** **$\Gamma_6/\Gamma$**

VALUE (%)	DOCUMENT ID	TECN	COMMENT
<0.04	¹ HUNT	19	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
2 ± 1	VRANA	00	DPWA Multichannel

¹Statistical error only.

$\Gamma(N(1440)\pi)/\Gamma_{\text{total}}$					Γ_7/Γ
VALUE (%)		DOCUMENT ID	TECN	COMMENT	
<0.02		¹ HUNT	19	DPWA	Multichannel
6 ± 3		SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
9 ± 1		¹ SHRESTHA	12A	DPWA	Multichannel
0 ± 1		VRANA	00	DPWA	Multichannel
¹ Statistical error only.					

$\Delta(1620)$ PHOTON DECAY AMPLITUDES AT THE POLE

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

MODULUS ($\text{GeV}^{-1/2}$)	PHASE ($^\circ$)	DOCUMENT ID	TECN	COMMENT
0.011 ± 0.002	57 ± 12	ROENCHEN	22	DPWA Multichannel
0.054 ± 0.007	-6 ± 7	SOKHOYAN	15A	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.014	26	ROENCHEN	15A	DPWA Multichannel

$\Delta(1620)$ BREIT-WIGNER PHOTON DECAY AMPLITUDES

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

VALUE ($\text{GeV}^{-1/2}$)	DOCUMENT ID	TECN	COMMENT
0.030 to 0.060 (≈ 0.050) OUR ESTIMATE			
0.029 ± 0.0062	GOLOVATCH	19	DPWA $\gamma p \rightarrow \pi^+ \pi^- p$
0.0124 ± 0.0007	¹ HUNT	19	DPWA Multichannel
0.055 ± 0.007	SOKHOYAN	15A	DPWA Multichannel
0.029 ± 0.003	¹ WORKMAN	12A	DPWA $\gamma N \rightarrow N\pi$
0.050 ± 0.002	¹ DUGGER	07	DPWA $\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
0.052 ± 0.005	ANISOVICH	12A	DPWA Multichannel
-0.003 ± 0.003	¹ SHRESTHA	12A	DPWA Multichannel
0.066	DRECHSEL	07	DPWA $\gamma N \rightarrow \pi N$
-0.050	PENNER	02D	DPWA Multichannel
¹ Statistical error only.			

$\Delta(1620)$ REFERENCES

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

ROENCHEN	22	EPJ A58 229	D. Roenchen <i>et al.</i>	(JULI, GWU, BONN+)
GOLOVATCH	19	PL B788 371	E. Golovatch <i>et al.</i>	(CLAS Collab.)
HUNT	19	PR C99 055205	B.C. Hunt, D.M. Manley	
ROENCHEN	15A	EPJ A51 70	D. Roenchen <i>et al.</i>	
SOKHOYAN	15A	EPJ A51 95	V. Sokhoyan <i>et al.</i>	(CBELSA/TAPS Collab.)
PDG	14	CP C38 070001	K. Olive <i>et al.</i>	(PDG Collab.)
SVARC	14	PR C89 045205	A. Svarc <i>et al.</i>	(RBI Zagreb, UNI Tuzla)
ANISOVICH	12A	EPJ A48 15	A.V. Anisovich <i>et al.</i>	(BONN, PNPI)
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)
WORKMAN	12A	PR C86 015202	R. Workman <i>et al.</i>	(GWU)

DRECHSEL	07	EPJ A34 69	D. Drechsel, S.S. Kamalov, L. Tiator	(MAINZ, JINR)
DUGGER	07	PR C76 025211	M. Dugger <i>et al.</i>	(JLab CLAS Collab.)
ARNDT	06	PR C74 045205	R.A. Arndt <i>et al.</i>	(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 <i>et al.</i>	(CMU, LBL) IJP
Also		PR D20 2839	R.E. Cutkosky <i>et al.</i>	(CMU, LBL) IJP
HOEHLER	79	PDAT 12-1	G. Hohler <i>et al.</i>	(KARLT) IJP
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP
