

$\Delta(1620) 1/2^-$ $I(J^P) = \frac{3}{2}(\frac{1}{2}^-)$ 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			
1597 ± 5	SOKHOYAN	15A	DPWA Multichannel
$1603 \pm 7 \pm 2$	¹ SVARC	14	L+P $\pi N \rightarrow \pi N$
1600 ± 15	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1600	ROENCHEN	15A	DPWA Multichannel
1597 ± 4	ANISOVICH	12A	DPWA Multichannel
1587	SHRESTHA	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.**-2xIMAGINARY PART**

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
100 to 140 (≈ 120) OUR ESTIMATE			
134 ± 8	SOKHOYAN	15A	DPWA Multichannel
$114 \pm 12 \pm 4$	¹ SVARC	14	L+P $\pi N \rightarrow \pi N$
120 ± 20	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
65	ROENCHEN	15A	DPWA Multichannel
130 ± 9	ANISOVICH	12A	DPWA Multichannel
107	SHRESTHA	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
15 to 20 (≈ 17) OUR ESTIMATE			
20 ± 3	SOKHOYAN	15A	DPWA Multichannel
$17 \pm 2 \pm 1$	¹ SVARC	14	L+P $\pi N \rightarrow \pi N$
15 ± 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

<u>VALUE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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–120 to –80 (\approx –100) OUR ESTIMATE

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

<u>MODULUS</u>	<u>PHASE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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0.42±0.06	–90 ± 20	SOKHOYAN	15A	DPWA	Multichannel
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• • • 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 $N\pi \rightarrow \Delta(1620) \rightarrow \Sigma K$

<u>MODULUS</u>	<u>PHASE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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• • • 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 $N\pi \rightarrow \Delta(1620) \rightarrow N(1440)\pi$

<u>MODULUS</u>	<u>PHASE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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0.10±0.06	–65 ± 30	SOKHOYAN	15A	DPWA	Multichannel
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$\Delta(1620)$ BREIT-WIGNER MASS

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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1590 to 1630 (\approx 1610) OUR ESTIMATE

1635 ± 8	GOLOVATCH	19	DPWA	$\gamma p \rightarrow \pi^+ \pi^- p$
1595 ± 8	SOKHOYAN	15A	DPWA	Multichannel
1600 ± 1	¹ SHRESTHA	12A	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
1612 ± 2	PENNER	02C	DPWA	Multichannel
1617 ± 15	VRANA	00	DPWA	Multichannel

¹Statistical error only.

Δ(1620) BREIT-WIGNER WIDTH

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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110 to 150 (≈ 130) OUR ESTIMATE

144 ± 16	GOLOVATCH	19	DPWA	$\gamma p \rightarrow \pi^+ \pi^- p$
135 ± 9	SOKHOYAN	15A	DPWA	Multichannel
112 ± 2	¹ SHRESTHA	12A	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
202 ± 7	PENNER	02C	DPWA	Multichannel
143 ± 42	VRANA	00	DPWA	Multichannel

¹Statistical error only.

Δ(1620) DECAY MODES

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

Mode	Fraction (Γ_j/Γ)
Γ_1 $N\pi$	25–35 %
Γ_2 $N\pi\pi$	55–80 %
Γ_3 $\Delta(1232)\pi$	
Γ_4 $\Delta(1232)\pi, D\text{-wave}$	52–72 %
Γ_5 $N\rho$	
Γ_6 $N\rho, S=1/2, S\text{-wave}$	seen
Γ_7 $N\rho, S=3/2, D\text{-wave}$	seen
Γ_8 $N(1440)\pi$	3–9 %
Γ_9 $N\gamma, \text{helicity}=1/2$	0.03–0.10 %

Δ(1620) BRANCHING RATIOS

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	Γ_1/Γ
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Γ(Nπ)/Γ_{total}

25 to 35 (≈ 30) OUR ESTIMATE

28 ± 3	SOKHOYAN	15A	DPWA	Multichannel
33 ± 2	¹ SHRESTHA	12A	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
34 ± 1	PENNER	02C	DPWA	Multichannel
45 ± 5	VRANA	00	DPWA	Multichannel

¹Statistical error only.

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

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

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

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
62 ± 10	SOKHOYAN 15A	DPWA	Multichannel
32 ± 2	¹ SHRESTHA 12A	DPWA	Multichannel

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

60 ± 17	ANISOVICH 12A	DPWA	Multichannel
39 ± 2	VRANA 00	DPWA	Multichannel

¹Statistical error only.

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

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
26 ± 2	¹ SHRESTHA 12A	DPWA	Multichannel

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

14 ± 3	VRANA 00	DPWA	Multichannel
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¹Statistical error only.

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

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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• • • We do not use the following data for averages, fits, limits, etc. • • •

2 ± 1	VRANA 00	DPWA	Multichannel
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$\Gamma(N(1440)\pi)/\Gamma_{\text{total}}$ Γ_8/Γ

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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6 ± 3	SOKHOYAN 15A	DPWA	Multichannel
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9 ± 1	¹ SHRESTHA 12A	DPWA	Multichannel
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• • • We do not use the following data for averages, fits, limits, etc. • • •

0 ± 1	VRANA 00	DPWA	Multichannel
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¹Statistical error only.

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

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

<u>MODULUS ($\text{GeV}^{-1/2}$)</u>	<u>PHASE ($^\circ$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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0.054 ± 0.007	-6 ± 7	SOKHOYAN 15A	DPWA	Multichannel
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-0.028 $\begin{smallmatrix} +0.006 \\ -0.002 \end{smallmatrix}$	-166 $\begin{smallmatrix} +1 \\ -4 \end{smallmatrix}$	ROENCHEN 14	DPWA	
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• • • We do not use the following data for averages, fits, limits, etc. • • •

0.014	26	ROENCHEN 15A	DPWA	Multichannel
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$\Delta(1620)$ BREIT-WIGNER PHOTON DECAY AMPLITUDES **$\Delta(1620) \rightarrow N\gamma$, helicity-1/2 amplitude $A_{1/2}$**

VALUE (GeV ^{-1/2})	DOCUMENT ID	TECN	COMMENT
0.030 to 0.060 (≈ 0.050) OUR ESTIMATE			
0.029 \pm 0.0062	GOLOVATCH 19	DPWA	$\gamma p \rightarrow \pi^+ \pi^- p$
0.055 \pm 0.007	SOKHOYAN 15A	DPWA	Multichannel
0.029 \pm 0.003	¹ WORKMAN 12A	DPWA	$\gamma N \rightarrow N\pi$
0.050 \pm 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 \pm 0.005	ANISOVICH 12A	DPWA	Multichannel
-0.003 \pm 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.			

 $\Delta(1620)$ REFERENCESFor early references, see Physics Letters **111B** 1 (1982).

GOLOVATCH 19	PL B788 371	E. Golovatch <i>et al.</i>	(CLAS Collab.)
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.)
ROENCHEN 14	EPJ A50 101	D. Roenchen <i>et al.</i>	
Also	EPJ A51 63 (errat.)	D. Roenchen <i>et al.</i>	
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