

$\Delta(1620) 1/2^-$ $I(J^P) = \frac{3}{2}(\frac{1}{2}^-)$ 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 (\approx 1600) OUR ESTIMATE			
1598 ± 7	SARANTSEV	25	DPWA Multichannel
1607 ± 2	ROENCHEN	22	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. ● ● ●			
1577	HUNT	19	DPWA Multichannel
1600	ROENCHEN	15A	DPWA Multichannel
1597 ± 5	SOKHOYAN	15A	DPWA Multichannel
1595	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
1607	VRANA	00	DPWA Multichannel
1608	HOEHLER	93	SPED $\pi N \rightarrow \pi N$

¹ Fit to the amplitudes of HOEHLER 79.

-2×IMAGINARY PART

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
80 to 140 (\approx 110) OUR ESTIMATE			
130 ± 10	SARANTSEV	25	DPWA Multichannel
85 ± 3	ROENCHEN	22	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. ● ● ●			
101	HUNT	19	DPWA Multichannel
65	ROENCHEN	15A	DPWA Multichannel
134 ± 8	SOKHOYAN	15A	DPWA Multichannel
135	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
148	VRANA	00	DPWA Multichannel
116	HOEHLER	93	SPED $\pi N \rightarrow \pi N$

¹ Fit to the amplitudes of HOEHLER 79.

 $\Delta(1620)$ ELASTIC POLE RESIDUE**MODULUS $|r|$**

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
10 to 20 (\approx 15) OUR ESTIMATE			
12 ± 1	ROENCHEN	22	DPWA Multichannel
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 (≈ -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 $N\pi \rightarrow \Delta(1620) \rightarrow \Delta\pi, D$ -wave

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

<u>MODULUS</u>	<u>PHASE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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0.11±0.01	–120 ± 3	ROENCHEN	22	DPWA Multichannel
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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 (≈ 1610) OUR ESTIMATE

1600 ± 8	SARANTSEV	25	DPWA	Multichannel
1635 ± 8	GOLOVATCH	19	DPWA	$\gamma p \rightarrow \pi^+ \pi^- p$
1589 ± 3	¹ HUNT	19	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. ● ● ●				
1595 ± 8	SOKHOYAN	15A	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			
135 ± 10	SARANTSEV	25	DPWA Multichannel
144 ± 16	GOLOVATCH	19	DPWA $\gamma p \rightarrow \pi^+ \pi^- p$
107 ± 7	¹ HUNT	19	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. ● ● ●			
135 ± 9	SOKHOYAN	15A	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_j/Γ)
Γ_1 $N\pi$	25–35 %
Γ_2 $N\pi\pi$	>67 %
Γ_3 $\Delta(1232)\pi$	44–72 %
Γ_4 $N\rho$	23–32%
Γ_5 $N\rho, S=1/2$	23–32%
Γ_6 $N\rho, S=3/2$	<0.04%
Γ_7 $N(1440)\pi$	<9 %
Γ_8 $N\gamma, \text{helicity}=1/2$	0.03–0.10 %

$\Delta(1620)$ BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{\text{total}}$ **Γ_1/Γ**
VALUE (%) DOCUMENT ID TECN COMMENT

25 to 35 (≈ 30) OUR ESTIMATE

30 ± 5	SEIFEN	25	DPWA	Multichannel
24 ± 2	¹ HUNT	19	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	SOKHOYAN	15A	DPWA	Multichannel
33 ± 2	¹ SHRESTHA	12A	DPWA	Multichannel
34 ± 1	PENNER	02C	DPWA	Multichannel
45 ± 5	VRANA	00	DPWA	Multichannel

¹Statistical error only.

$\Gamma(N\pi\pi)/\Gamma_{\text{total}}$ **Γ_2/Γ**
VALUE DOCUMENT ID TECN COMMENT

0.90 ± 0.10	GOLOVATCH	19	DPWA	$\gamma p \rightarrow \pi^+ \pi^- p$
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$\Gamma(\Delta(1232)\pi)/\Gamma_{\text{total}}$ **Γ_3/Γ**
VALUE (%) DOCUMENT ID TECN COMMENT

28 ± 11	SARANTSEV	25	DPWA	Multichannel
28 ± 15	SEIFEN	25	DPWA	Multichannel
48 ± 4	¹ HUNT	19	DPWA	Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
62 ± 10	SOKHOYAN	15A	DPWA	Multichannel
32 ± 2	¹ SHRESTHA	12A	DPWA	Multichannel
39 ± 2	VRANA	00	DPWA	Multichannel

¹Statistical error only.

$\Gamma(N\rho)/\Gamma_{\text{total}}$ **Γ_4/Γ**
VALUE (%) DOCUMENT ID TECN COMMENT

52 ± 17	SARANTSEV	25	DPWA	Multichannel
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$\Gamma(N\rho, S=1/2)/\Gamma_{\text{total}}$ **Γ_5/Γ**
VALUE (%) DOCUMENT ID TECN COMMENT

30 ± 12	SARANTSEV	25	DPWA	Multichannel
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.

$\Gamma(N\rho, S=3/2)/\Gamma_{\text{total}}$ Γ_6/Γ

VALUE (%)	DOCUMENT ID	TECN	COMMENT
22 ± 12	SARANTSEV 25	DPWA	Multichannel
< 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
¹ Statistical error only.			

$\Gamma(N(1440)\pi)/\Gamma_{\text{total}}$ Γ_7/Γ

VALUE (%)	DOCUMENT ID	TECN	COMMENT
15 ± 8	SEIFEN 25	DPWA	Multichannel
< 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
0.047 ± 0.007	10 ± 15	SARANTSEV 25	DPWA	Multichannel
0.011 ± 0.002	57 ± 12	ROENCHEN 22	DPWA	Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
0.014	26	ROENCHEN 15A	DPWA	Multichannel
0.054 ± 0.007	-6 ± 7	SOKHOYAN 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			
0.048 ± 0.007	SARANTSEV 25	DPWA	Multichannel
0.029 ± 0.0062	GOLOVATCH 19	DPWA	$\gamma p \rightarrow \pi^+ \pi^- p$
0.0124 ± 0.0007	¹ HUNT 19	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. ● ● ●			
0.055 ± 0.007	SOKHOYAN 15A	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.			

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

SARANTSEV	25	PR C112 015202	A.V. Sarantsev <i>et al.</i>	(Bonn-Gatchina Collab.)
SEIFEN	25	EPJ A61 173	T. Seifen <i>et al.</i>	(CBELSA/TAPS Collab.)
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
