

$\Delta(1620) 1/2^-$  $I(J^P) = \frac{3}{2}(\frac{1}{2}^-)$  Status: \*\*\*\*

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

 **$\Delta(1620)$  POLE POSITION****REAL PART**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>1590 to 1610 (<math>\approx 1600</math>) OUR ESTIMATE</b>			
1597 $\pm$ 5	SOKHOYAN	15A	DPWA Multichannel
1603 $\pm$ 7 $\pm$ 2	<sup>1</sup> 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 $\pi N \rightarrow \pi N$

<sup>1</sup> Fit to the amplitudes of HOEHLER 79.

**-2xIMAGINARY PART**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>100 to 140 (<math>\approx 120</math>) OUR ESTIMATE</b>			
134 $\pm$ 8	SOKHOYAN	15A	DPWA Multichannel
114 $\pm$ 12 $\pm$ 4	<sup>1</sup> 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 $\pi N \rightarrow \pi N$

<sup>1</sup> Fit to the amplitudes of HOEHLER 79.

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

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>15 to 20 (<math>\approx 17</math>) OUR ESTIMATE</b>			
20 $\pm$ 3	SOKHOYAN	15A	DPWA Multichannel
17 $\pm$ 2 $\pm$ 1	<sup>1</sup> 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 $\pm$ 2	ANISOVICH	12A	DPWA Multichannel

15	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
19	HOEHLER	93	SPED	$\pi N \rightarrow \pi N$

<sup>1</sup> Fit to the amplitudes of HOEHLER 79.

### PHASE $\theta$

VALUE ( $^\circ$ )	DOCUMENT ID	TECN	COMMENT
<b>–120 to –80 (<math>\approx</math> –100) OUR ESTIMATE</b>			
–90 $\pm$ 15	SOKHOYAN	15A	DPWA Multichannel
–106 $\pm$ 10 $\pm$ 4	<sup>1</sup> SVARC	14	L+P $\pi N \rightarrow \pi N$
–110 $\pm$ 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 $\pm$ 5	ANISOVICH	12A	DPWA Multichannel
–92	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
–95	HOEHLER	93	SPED $\pi N \rightarrow \pi N$

<sup>1</sup> 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 ( $^\circ$ )	DOCUMENT ID	TECN	COMMENT
0.42 $\pm$ 0.06	–90 $\pm$ 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 $\pm$ 0.09	–85 $\pm$ 30	ANISOVICH	12A	DPWA Multichannel

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

MODULUS	PHASE ( $^\circ$ )	DOCUMENT ID	TECN	COMMENT
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
0.22	–105	ROENCHEN	15A	DPWA Multichannel

#### Normalized residue in $N\pi \rightarrow \Delta(1620) \rightarrow N(1440)\pi$

MODULUS	PHASE ( $^\circ$ )	DOCUMENT ID	TECN	COMMENT
0.10 $\pm$ 0.06	–65 $\pm$ 30	SOKHOYAN	15A	DPWA Multichannel

### $\Delta(1620)$ BREIT-WIGNER MASS

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
<b>1590 to 1630 (<math>\approx</math> 1610) OUR ESTIMATE</b>			
1635 $\pm$ 8	GOLOVATCH	19	DPWA $\gamma p \rightarrow \pi^+ \pi^- p$
1589 $\pm$ 3	<sup>1</sup> HUNT	19	DPWA Multichannel
1595 $\pm$ 8	SOKHOYAN	15A	DPWA Multichannel
1615.2 $\pm$ 0.4	<sup>1</sup> ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
1620 $\pm$ 20	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
1610 $\pm$ 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	<sup>1</sup> SHRESTHA	12A	DPWA	Multichannel
1612 ± 2	PENNER	02C	DPWA	Multichannel
1617 ± 15	VRANA	00	DPWA	Multichannel

<sup>1</sup>Statistical error only.

### Δ(1620) BREIT-WIGNER WIDTH

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
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#### 110 to 150 (≈ 130) OUR ESTIMATE

144 ± 16	GOLOVATCH	19	DPWA	$\gamma p \rightarrow \pi^+ \pi^- p$
107 ± 7	<sup>1</sup> HUNT	19	DPWA	Multichannel
135 ± 9	SOKHOYAN	15A	DPWA	Multichannel
146.9 ± 1.9	<sup>1</sup> 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	<sup>1</sup> SHRESTHA	12A	DPWA	Multichannel
202 ± 7	PENNER	02C	DPWA	Multichannel
143 ± 42	VRANA	00	DPWA	Multichannel

<sup>1</sup>Statistical error only.

### Δ(1620) DECAY MODES

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

Mode	Fraction ( $\Gamma_i/\Gamma$ )
$\Gamma_1$ $N\pi$	25–35 %
$\Gamma_2$ $N\pi\pi$	55–80 %
$\Gamma_3$ $\Delta(1232)\pi$	
$\Gamma_4$ $\Delta(1232)\pi, D\text{-wave}$	52–72 %
$\Gamma_5$ $N\rho$	
$\Gamma_6$ $N\rho, S=1/2, S\text{-wave}$	seen
$\Gamma_7$ $N\rho, S=3/2, D\text{-wave}$	seen
$\Gamma_8$ $N(1440)\pi$	3–9 %
$\Gamma_9$ $N\gamma, \text{helicity}=1/2$	0.03–0.10 %

### Δ(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	<sup>1</sup> HUNT	19	DPWA	Multichannel
28 ± 3	SOKHOYAN	15A	DPWA	Multichannel

31.5±0.1	<sup>1</sup> 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	<sup>1</sup> SHRESTHA	12A	DPWA	Multichannel
34 ±1	PENNER	02C	DPWA	Multichannel
45 ±5	VRANA	00	DPWA	Multichannel

<sup>1</sup>Statistical error only.

$\Gamma(N\pi\pi)/\Gamma_{\text{total}}$					$\Gamma_2/\Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT		
<b>0.90±0.10</b>	GOLOVATCH	19	DPWA	$\gamma p \rightarrow \pi^+ \pi^- p$	

$\Gamma(\Delta(1232)\pi, D\text{-wave})/\Gamma_{\text{total}}$					$\Gamma_4/\Gamma$
VALUE (%)	DOCUMENT ID	TECN	COMMENT		
48± 4	<sup>1</sup> 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	<sup>1</sup> SHRESTHA	12A	DPWA	Multichannel	
39± 2	VRANA	00	DPWA	Multichannel	

<sup>1</sup>Statistical error only.

$\Gamma(N\rho, S=1/2, S\text{-wave})/\Gamma_{\text{total}}$					$\Gamma_6/\Gamma$
VALUE (%)	DOCUMENT ID	TECN	COMMENT		
27±4	<sup>1</sup> HUNT	19	DPWA	Multichannel	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
26±2	<sup>1</sup> SHRESTHA	12A	DPWA	Multichannel	
14±3	VRANA	00	DPWA	Multichannel	

<sup>1</sup>Statistical error only.

$\Gamma(N\rho, S=3/2, D\text{-wave})/\Gamma_{\text{total}}$					$\Gamma_7/\Gamma$
VALUE (%)	DOCUMENT ID	TECN	COMMENT		
<0.04	<sup>1</sup> HUNT	19	DPWA	Multichannel	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
2 ±1	VRANA	00	DPWA	Multichannel	

<sup>1</sup>Statistical error only.

$\Gamma(N(1440)\pi)/\Gamma_{\text{total}}$					$\Gamma_8/\Gamma$
VALUE (%)	DOCUMENT ID	TECN	COMMENT		
<0.02	<sup>1</sup> HUNT	19	DPWA	Multichannel	
6 ±3	SOKHOYAN	15A	DPWA	Multichannel	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
9 ±1	<sup>1</sup> SHRESTHA	12A	DPWA	Multichannel	
0 ±1	VRANA	00	DPWA	Multichannel	

<sup>1</sup>Statistical error only.

**$\Delta(1620)$  PHOTON DECAY AMPLITUDES AT THE POLE** **$\Delta(1620) \rightarrow N\gamma$ , helicity-1/2 amplitude  $A_{1/2}$** 

<u>MODULUS (<math>\text{GeV}^{-1/2}</math>)</u>	<u>PHASE (<math>^\circ</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$0.054 \pm 0.007$	$-6 \pm 7$	SOKHOYAN	15A	DPWA Multichannel
$-0.028^{+0.006}_{-0.002}$	$-166^{+1}_{-4}$	ROENCHEN	14	DPWA
● ● ● 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  $A_{1/2}$** 

<u>VALUE (<math>\text{GeV}^{-1/2}</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.030 to 0.060 (<math>\approx 0.050</math>) OUR ESTIMATE</b>			
$0.029 \pm 0.0062$	GOLOVATCH 19	DPWA	$\gamma p \rightarrow \pi^+ \pi^- p$
$0.0124 \pm 0.0007$	<sup>1</sup> HUNT 19	DPWA	Multichannel
$0.055 \pm 0.007$	SOKHOYAN 15A	DPWA	Multichannel
$0.029 \pm 0.003$	<sup>1</sup> WORKMAN 12A	DPWA	$\gamma N \rightarrow N\pi$
$0.050 \pm 0.002$	<sup>1</sup> 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
$-0.003 \pm 0.003$	<sup>1</sup> SHRESTHA 12A	DPWA	Multichannel
0.066	DRECHSEL 07	DPWA	$\gamma N \rightarrow \pi N$
-0.050	PENNER 02D	DPWA	Multichannel

<sup>1</sup>Statistical error only. **$\Delta(1620)$  REFERENCES**For early references, see Physics Letters **111B** 1 (1982).

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.)
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	$\pi N$ 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