

$$\Delta(1920) \ 3/2^+$$

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

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

## $\Delta(1920)$ POLE POSITION

### REAL PART

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>1850 to 1950 (<math>\approx</math> 1900) OUR ESTIMATE</b>			
1875 $\pm$ 30	SOKHOYAN	15A	DPWA Multichannel
1906 $\pm$ 10 $\pm$ 2	<sup>1</sup> SVARC	14	L+P $\pi N \rightarrow \pi N$
1900 $\pm$ 80	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1910	HUNT	19	DPWA Multichannel
1715	ROENCHEN	15A	DPWA Multichannel
1875 $\pm$ 30	GUTZ	14	DPWA Multichannel
1890 $\pm$ 30	ANISOVICH	12A	DPWA Multichannel
1880	VRANA	00	DPWA Multichannel
1900	HOEHLER	93	SPED $\pi N \rightarrow \pi N$

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

### –2×IMAGINARY PART

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>200 to 400 (<math>\approx</math> 300) OUR ESTIMATE</b>			
300 $\pm$ 40	SOKHOYAN	15A	DPWA Multichannel
310 $\pm$ 20 $\pm$ 11	<sup>1</sup> SVARC	14	L+P $\pi N \rightarrow \pi N$
300 $\pm$ 100	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
472	HUNT	19	DPWA Multichannel
882	ROENCHEN	15A	DPWA Multichannel
300 $\pm$ 40	GUTZ	14	DPWA Multichannel
300 $\pm$ 60	ANISOVICH	12A	DPWA Multichannel
120	VRANA	00	DPWA Multichannel

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

## $\Delta(1920)$ ELASTIC POLE RESIDUE

### MODULUS $|r|$

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>8 to 24 (<math>\approx</math> 16) OUR ESTIMATE</b>			
16 $\pm$ 6	SOKHOYAN	15A	DPWA Multichannel
26 $\pm$ 3 $\pm$ 2	<sup>1</sup> SVARC	14	L+P $\pi N \rightarrow \pi N$
24 $\pm$ 4	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
38	ROENCHEN	15A	DPWA Multichannel
16 $\pm$ 6	GUTZ	14	DPWA Multichannel
17 $\pm$ 8	ANISOVICH	12A	DPWA Multichannel

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

**PHASE  $\theta$** 

<u>VALUE (<math>^{\circ}</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>–150 to –50 (<math>\approx</math> –100) OUR ESTIMATE</b>			
– 50 $\pm$ 25	SOKHOYAN	15A DPWA	Multichannel
–130 $\pm$ 5 $\pm$ 3	<sup>1</sup> SVARC	14 L+P	$\pi N \rightarrow \pi N$
–150 $\pm$ 30	CUTKOSKY	80 IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
146	ROENCHEN	15A DPWA	Multichannel
– 50 $\pm$ 25	GUTZ	14 DPWA	Multichannel
– 40 $\pm$ 20	ANISOVICH	12A DPWA	Multichannel
<sup>1</sup> Fit to the amplitudes of HOEHLER 79.			

 **$\Delta(1920)$  INELASTIC POLE RESIDUE**

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

**Normalized residue in  $N\pi \rightarrow \Delta(1920) \rightarrow \Delta\eta$** 

<u>MODULUS</u>	<u>PHASE (<math>^{\circ}</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.15 $\pm$ 0.04	70 $\pm$ 20	GUTZ	14 DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.17 $\pm$ 0.08	70 $\pm$ 20	ANISOVICH	12A DPWA	Multichannel

**Normalized residue in  $N\pi \rightarrow \Delta(1920) \rightarrow \Sigma K$** 

<u>MODULUS</u>	<u>PHASE (<math>^{\circ}</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.09 $\pm$ 0.03	80 $\pm$ 40	ANISOVICH	12A DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.17	–35	ROENCHEN	15A DPWA	Multichannel

**Normalized residue in  $N\pi \rightarrow \Delta(1920) \rightarrow \Delta\pi, P$ -wave**

<u>MODULUS</u>	<u>PHASE (<math>^{\circ}</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.20 $\pm$ 0.08	–105 $\pm$ 25	SOKHOYAN	15A DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.069	131	ROENCHEN	15A DPWA	Multichannel
0.20 $\pm$ 0.12	–120 $\pm$ 30	ANISOVICH	12A DPWA	Multichannel

**Normalized residue in  $N\pi \rightarrow \Delta(1920) \rightarrow \Delta\pi, F$ -wave**

<u>MODULUS</u>	<u>PHASE (<math>^{\circ}</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.37 $\pm$ 0.10	–90 $\pm$ 20	SOKHOYAN	15A DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.013	–115	ROENCHEN	15A DPWA	Multichannel
0.28 $\pm$ 0.07	–95 $\pm$ 35	ANISOVICH	12A DPWA	Multichannel

**Normalized residue in  $N\pi \rightarrow \Delta(1920) \rightarrow N(1535)\pi$** 

<u>MODULUS</u>	<u>PHASE (<math>^{\circ}</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.03 $\pm$ 0.02	35 $\pm$ 45	GUTZ	14 DPWA	Multichannel

**Normalized residue in  $N\pi \rightarrow \Delta(1920) \rightarrow N_{a_0}(980)$** 

<u>MODULUS</u>	<u>PHASE (<math>^{\circ}</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.03 $\pm$ 0.02	–85 $\pm$ 45	GUTZ	14 DPWA	Multichannel

**Normalized residue in  $N\pi \rightarrow \Delta(1920) \rightarrow N(1440)\pi$** 

<u>MODULUS</u>	<u>PHASE (<math>^\circ</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.04±0.03	undefined	SOKHOYAN	15A DPWA	Multichannel

**Normalized residue in  $N\pi \rightarrow \Delta(1920) \rightarrow N(1520)\pi$ , S-wave**

<u>MODULUS</u>	<u>PHASE (<math>^\circ</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.05±0.05	undefined	SOKHOYAN	15A DPWA	Multichannel

 **$\Delta(1920)$  BREIT-WIGNER MASS**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>1870 to 1970 (<math>\approx</math> 1920) OUR ESTIMATE</b>			
1976± 49	HUNT	19	DPWA Multichannel
1880± 30	SOKHOYAN	15A	DPWA Multichannel
2146± 32	<sup>1</sup> SHRESTHA	12A	DPWA Multichannel
1920± 80	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
1868± 10	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1880± 30	GUTZ	14	DPWA Multichannel
1900± 30	ANISOVICH	12A	DPWA Multichannel
2057± 1	PENNER	02C	DPWA Multichannel
1889±100	VRANA	00	DPWA Multichannel

<sup>1</sup>Statistical error only. **$\Delta(1920)$  BREIT-WIGNER WIDTH**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>240 to 360 (<math>\approx</math> 300) OUR ESTIMATE</b>			
509±170	HUNT	19	DPWA Multichannel
300± 40	SOKHOYAN	15A	DPWA Multichannel
400± 80	<sup>1</sup> SHRESTHA	12A	DPWA Multichannel
300±100	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
220± 80	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
300± 40	GUTZ	14	DPWA Multichannel
310± 60	ANISOVICH	12A	DPWA Multichannel
525± 32	PENNER	02C	DPWA Multichannel
123± 53	VRANA	00	DPWA Multichannel

<sup>1</sup>Statistical error only. **$\Delta(1920)$  DECAY MODES**

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

Mode	Fraction ( $\Gamma_i/\Gamma$ )
$\Gamma_1$ $N\pi$	5–20 %
$\Gamma_2$ $\Sigma K$	2–6 %
$\Gamma_3$ $N\pi\pi$	
$\Gamma_4$ $\Delta(1232)\pi$	50–90 %

$\Gamma_5$	$\Delta(1232)\pi$ , <i>P</i> -wave	8–28 %
$\Gamma_6$	$\Delta(1232)\pi$ , <i>F</i> -wave	44–72 %
$\Gamma_7$	$N(1440)\pi$ , <i>P</i> -wave	<4 %
$\Gamma_8$	$N(1520)\pi$ , <i>S</i> -wave	<5 %
$\Gamma_9$	$N(1535)\pi$	<2 %
$\Gamma_{10}$	$N a_0(980)$	seen
$\Gamma_{11}$	$\Delta(1232)\eta$	5–17 %

### $\Delta(1920)$ BRANCHING RATIOS

#### $\Gamma(N\pi)/\Gamma_{\text{total}}$ $\Gamma_1/\Gamma$

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>5 to 20 (<math>\approx 12</math>) OUR ESTIMATE</b>			
10.5 $\pm$ 3.0	<sup>1</sup> HUNT	19	DPWA Multichannel
8 $\pm$ 4	SOKHOYAN	15A	DPWA Multichannel
20 $\pm$ 5	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
14 $\pm$ 4	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
8 $\pm$ 4	GUTZ	14	DPWA Multichannel
8 $\pm$ 4	ANISOVICH	12A	DPWA Multichannel
16 $\pm$ 4	<sup>1</sup> SHRESTHA	12A	DPWA Multichannel
15 $\pm$ 1	PENNER	02C	DPWA Multichannel
5 $\pm$ 4	VRANA	00	DPWA Multichannel

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

#### $\Gamma(\Sigma K)/\Gamma_{\text{total}}$ $\Gamma_2/\Gamma$

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
4 $\pm$ 2	ANISOVICH	12A	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
2.1 $\pm$ 0.3	PENNER	02C	DPWA Multichannel

#### $\Gamma(\Delta(1232)\pi, P\text{-wave})/\Gamma_{\text{total}}$ $\Gamma_5/\Gamma$

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
< 1.6	<sup>1</sup> HUNT	19	DPWA Multichannel
18 $\pm$ 10	SOKHOYAN	15A	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
22 $\pm$ 12	ANISOVICH	12A	DPWA Multichannel
7 $\pm$ 5	<sup>1</sup> SHRESTHA	12A	DPWA Multichannel
41 $\pm$ 3	VRANA	00	DPWA Multichannel

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

#### $\Gamma(\Delta(1232)\pi, F\text{-wave})/\Gamma_{\text{total}}$ $\Gamma_6/\Gamma$

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
58 $\pm$ 14	SOKHOYAN	15A	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
45 $\pm$ 20	ANISOVICH	12A	DPWA Multichannel

$\Gamma(N(1440)\pi, P\text{-wave})/\Gamma_{\text{total}}$   $\Gamma_7/\Gamma$ 

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
77±9	<sup>1</sup> HUNT 19	DPWA	Multichannel
< 4	SOKHOYAN 15A	DPWA	Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
<20	<sup>1</sup> SHRESTHA 12A	DPWA	Multichannel
53±8	VRANA 00	DPWA	Multichannel

<sup>1</sup> Statistical error only. $\Gamma(N(1520)\pi, S\text{-wave})/\Gamma_{\text{total}}$   $\Gamma_8/\Gamma$ 

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<5	SOKHOYAN 15A	DPWA	Multichannel

 $\Gamma(N(1535)\pi)/\Gamma_{\text{total}}$   $\Gamma_9/\Gamma$ 

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<2	GUTZ 14	DPWA	Multichannel

 $\Gamma(N a_0(980))/\Gamma_{\text{total}}$   $\Gamma_{10}/\Gamma$ 

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
4±2	HORN 08A	DPWA	Multichannel

 $\Gamma(\Delta(1232)\eta)/\Gamma_{\text{total}}$   $\Gamma_{11}/\Gamma$ 

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
11±6	GUTZ 14	DPWA	Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
15±8	ANISOVICH 12A	DPWA	Multichannel

 **$\Delta(1920)$  PHOTON DECAY AMPLITUDES AT THE POLE** **$\Delta(1920) \rightarrow N\gamma$ , 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>
0.110±0.030	-50 ± 20	SOKHOYAN 15A	DPWA	Multichannel
0.190 <sup>+0.050</sup> <sub>-0.022</sub>	-160 <sup>+24</sup> <sub>-11</sub>	ROENCHEN 14	DPWA	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
-0.192	46	ROENCHEN 15A	DPWA	Multichannel

 **$\Delta(1920) \rightarrow N\gamma$ , helicity-3/2 amplitude  $A_{3/2}$** 

<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>
-0.100±0.040	0 ± 20	SOKHOYAN 15A	DPWA	Multichannel
-0.398 <sup>+0.070</sup> <sub>-0.067</sub>	-110 <sup>+4</sup> <sub>-5</sub>	ROENCHEN 14	DPWA	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
0.522	67	ROENCHEN 15A	DPWA	Multichannel

**$\Delta(1920)$  BREIT-WIGNER PHOTON DECAY AMPLITUDES** **$\Delta(1920) \rightarrow N\gamma$ , helicity-1/2 amplitude  $A_{1/2}$** 

<u>VALUE (GeV<sup>-1/2</sup>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-0.028±0.010	<sup>1</sup> HUNT	19	DPWA Multichannel
0.110±0.030	SOKHOYAN	15A	DPWA Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.110±0.030	GUTZ	14	DPWA Multichannel
0.130 <sup>+0.030</sup> <sub>-0.060</sub>	ANISOVICH	12A	DPWA Multichannel
0.051±0.010	<sup>1</sup> SHRESTHA	12A	DPWA Multichannel
-0.007	PENNER	02D	DPWA Multichannel

<sup>1</sup>Statistical error only. **$\Delta(1920) \rightarrow N\gamma$ , helicity-3/2 amplitude  $A_{3/2}$** 

<u>VALUE (GeV<sup>-1/2</sup>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-0.043±0.014	<sup>1</sup> HUNT	19	DPWA Multichannel
-0.105±0.035	SOKHOYAN	15A	DPWA Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
-0.105±0.035	GUTZ	14	DPWA Multichannel
-0.115 <sup>+0.025</sup> <sub>-0.050</sub>	ANISOVICH	12A	DPWA Multichannel
0.017±0.015	<sup>1</sup> SHRESTHA	12A	DPWA Multichannel
-0.001	PENNER	02D	DPWA Multichannel

<sup>1</sup>Statistical error only. **$\Delta(1920)$  REFERENCES**For early references, see Physics Letters **111B** 1 (1982).

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.)
GUTZ	14	EPJ A50 74	E. Gutz <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)
HORN	08A	EPJ A38 173	I. Horn <i>et al.</i>	(CB-ELSA Collab.)
Also		PRL 101 202002	I. Horn <i>et al.</i>	(CB-ELSA Collab.)
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