

$$\Delta(1930) \ 5/2^-$$

$$I(J^P) = \frac{3}{2}(\frac{5}{2}^-) \text{ Status: } ***$$

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

$\Delta(1930)$ POLE POSITION

REAL PART

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
1820 to 1880 (\approx 1850) OUR ESTIMATE			
1821 \pm 2	ROENCHEN	22	DPWA Multichannel
1848 \pm 9 \pm 19	¹ SVARC	14	L+P $\pi N \rightarrow \pi N$
1890 \pm 50	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1863	HUNT	19	DPWA Multichannel
1836	ROENCHEN	15A	DPWA Multichannel
2001	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
1883	VRANA	00	DPWA Multichannel
1850	HOEHLER	93	SPED $\pi N \rightarrow \pi N$

¹Fit to the amplitudes of HOEHLER 79.

-2xIMAGINARY PART

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
300 to 450 (\approx 320) OUR ESTIMATE			
447 \pm 7	ROENCHEN	22	DPWA Multichannel
321 \pm 17 \pm 7	¹ SVARC	14	L+P $\pi N \rightarrow \pi N$
260 \pm 60	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
260	HUNT	19	DPWA Multichannel
724	ROENCHEN	15A	DPWA Multichannel
387	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
250	VRANA	00	DPWA Multichannel
180	HOEHLER	93	SPED $\pi N \rightarrow \pi N$

¹Fit to the amplitudes of HOEHLER 79.

$\Delta(1930)$ ELASTIC POLE RESIDUE

MODULUS $|r|$

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
8 to 20 (\approx 14) OUR ESTIMATE			
15 \pm 2	ROENCHEN	22	DPWA Multichannel
9 \pm 1 \pm 1	¹ SVARC	14	L+P $\pi N \rightarrow \pi N$
18 \pm 6	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
34	ROENCHEN	15A	DPWA Multichannel
7	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
20	HOEHLER	93	SPED $\pi N \rightarrow \pi N$

¹Fit to the amplitudes of HOEHLER 79.

PHASE θ

<u>VALUE ($^{\circ}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
–100 to –10 (\approx –50) OUR ESTIMATE			
–108 \pm 5	ROENCHEN	22	DPWA Multichannel
– 37 \pm 3 \pm 7	¹ SVARC	14	L+P $\pi N \rightarrow \pi N$
– 20 \pm 40	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
–155	ROENCHEN	15A	DPWA Multichannel
– 12	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
¹ Fit to the amplitudes of HOEHLER 79.			

 $\Delta(1930)$ INELASTIC POLE RESIDUE

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

Normalized residue in $N\pi \rightarrow \Delta(1930) \rightarrow \Sigma K$

<u>MODULUS</u>	<u>PHASE ($^{\circ}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.010 \pm 0.001	49 \pm 5	ROENCHEN	22	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.043	–0.5	ROENCHEN	15A	DPWA Multichannel

Normalized residue in $N\pi \rightarrow \Delta(1930) \rightarrow \Delta\pi, D$ -wave

<u>MODULUS</u>	<u>PHASE ($^{\circ}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.12 \pm 0.02	64 \pm 4	ROENCHEN	22	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.15	30	ROENCHEN	15A	DPWA Multichannel

Normalized residue in $N\pi \rightarrow \Delta(1930) \rightarrow \Delta\pi, G$ -wave

<u>MODULUS</u>	<u>PHASE ($^{\circ}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.008 \pm 0.001	148 \pm 2	ROENCHEN	22	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.009	121	ROENCHEN	15A	DPWA Multichannel

 $\Delta(1930)$ BREIT-WIGNER MASS

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1900 to 2000 (\approx 1950) OUR ESTIMATE			
1988 \pm 32	¹ HUNT	19	DPWA Multichannel
2233 \pm 53	¹ ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
1940 \pm 30	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
1901 \pm 15	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
1930 \pm 12	¹ SHRESTHA	12A	DPWA Multichannel
1932 \pm 100	VRANA	00	DPWA Multichannel
¹ Statistical error only.			

$\Delta(1930)$ BREIT-WIGNER WIDTH

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
200 to 400 (≈ 300) OUR ESTIMATE			
500 \pm 160	¹ HUNT	19	DPWA Multichannel
773 \pm 187	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
320 \pm 60	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
195 \pm 60	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
235 \pm 39	¹ SHRESTHA	12A	DPWA Multichannel
316 \pm 237	VRANA	00	DPWA Multichannel

¹Statistical error only. **$\Delta(1930)$ DECAY MODES**

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

Mode	Fraction (Γ_i/Γ)
Γ_1 $N\pi$	5–15 %
Γ_2 $N\gamma$	0.0–0.01 %
Γ_3 $N\gamma$, helicity=1/2	0.0–0.005 %
Γ_4 $N\gamma$, helicity=3/2	0.0–0.004 %

 $\Delta(1930)$ BRANCHING RATIOS

<u>$\Gamma(N\pi)/\Gamma_{\text{total}}$</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	<u>Γ_1/Γ</u>
5 to 15 (≈ 10) OUR ESTIMATE				
9.5 \pm 0.1	¹ HUNT	19	DPWA Multichannel	
8.1 \pm 1.2	¹ ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$	
14 \pm 4	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$	
4 \pm 3	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
7.9 \pm 0.4	¹ SHRESTHA	12A	DPWA Multichannel	
9 \pm 8	VRANA	00	DPWA Multichannel	

¹Statistical error only. **$\Delta(1930)$ PHOTON DECAY AMPLITUDES AT THE POLE** **$\Delta(1930) \rightarrow N\gamma$, 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>
0.104 \pm 0.009	129 \pm 8	ROENCHEN	22	DPWA Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
–0.270	33	ROENCHEN	15A	DPWA Multichannel

$\Delta(1930) \rightarrow N\gamma$, helicity-3/2 amplitude $A_{3/2}$

<u>MODULUS ($\text{GeV}^{-1/2}$)</u>	<u>PHASE ($^\circ$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.322 ± 0.022	142 ± 4	ROENCHEN	22	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.153	81	ROENCHEN	15A	DPWA Multichannel

 $\Delta(1930)$ BREIT-WIGNER PHOTON DECAY AMPLITUDES **$\Delta(1930) \rightarrow N\gamma$, helicity-1/2 amplitude $A_{1/2}$**

<u>VALUE ($\text{GeV}^{-1/2}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-0.043 ± 0.008	¹ HUNT	19	DPWA Multichannel
-0.007 ± 0.010	¹ ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
0.011 ± 0.003	¹ SHRESTHA	12A	DPWA Multichannel

¹Statistical error only. **$\Delta(1930) \rightarrow N\gamma$, helicity-3/2 amplitude $A_{3/2}$**

<u>VALUE ($\text{GeV}^{-1/2}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-0.020 ± 0.017	¹ HUNT	19	DPWA Multichannel
0.005 ± 0.010	¹ ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
0.002 ± 0.002	¹ SHRESTHA	12A	DPWA Multichannel

¹Statistical error only. **$\Delta(1930)$ REFERENCES**For early references, see Physics Letters **111B** 1 (1982).

ROENCHEN	22	EPJ A58 229	D. Roenchen <i>et al.</i>	(JULI, GWU, BONN+)
HUNT	19	PR C99 055205	B.C. Hunt, D.M. Manley	
ROENCHEN	15A	EPJ A51 70	D. Roenchen <i>et al.</i>	
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)
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)
ARNDT	06	PR C74 045205	R.A. Arndt <i>et al.</i>	(GWU)
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman, T.-S.H. Lee	(PITT, ANL)
ARNDT	96	PR C53 430	R.A. Arndt, I.I. Strakovsky, R.L. Workman	(VPI)
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