

$\Delta(1930) D_{35}$

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

Most of the results published before 1975 are now obsolete and have been omitted. They may be found in our 1982 edition, Physics Letters **111B** (1982).

The various analyses are not in good agreement.

$\Delta(1930)$ BREIT-WIGNER MASS

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
1920 to 1970 (≈ 1930) OUR ESTIMATE			
1956 ± 22	MANLEY	92	IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$
1940 ± 30	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
1901 ± 15	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1955 ± 15	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
2056	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
1963	LI	93	IPWA $\gamma N \rightarrow \pi N$
1910.0 $^{+15.0}_{-17.2}$	CHEW	80	BPWA $\pi^+ p \rightarrow \pi^+ p$
2000	CRAWFORD	80	DPWA $\gamma N \rightarrow \pi N$
2024	BARBOUR	78	DPWA $\gamma N \rightarrow \pi N$

$\Delta(1930)$ BREIT-WIGNER WIDTH

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
250 to 450 (≈ 350) OUR ESTIMATE			
530 ± 140	MANLEY	92	IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$
320 ± 60	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
195 ± 60	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
350 ± 20	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
590	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
260	LI	93	IPWA $\gamma N \rightarrow \pi N$
74.8 $^{+17.0}_{-16.0}$	CHEW	80	BPWA $\pi^+ p \rightarrow \pi^+ p$
442	CRAWFORD	80	DPWA $\gamma N \rightarrow \pi N$
462	BARBOUR	78	DPWA $\gamma N \rightarrow \pi N$

$\Delta(1930)$ POLE POSITION

REAL PART

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
1840 to 1940 (≈ 1890) OUR ESTIMATE			
1913	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
1850	¹ HOEHLER	93	SPED $\pi N \rightarrow \pi N$
1890 ± 50	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
2018	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90

– 2×IMAGINARY PART

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
200 to 300 (≈ 250) OUR ESTIMATE			
246	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
180	¹ HOEHLER	93	SPED $\pi N \rightarrow \pi N$
260±60	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
398	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90

 $\Delta(1930)$ ELASTIC POLE RESIDUE
MODULUS $|r|$

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
8	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
20	HOEHLER	93	SPED $\pi N \rightarrow \pi N$
18±6	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
15	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90

PHASE θ

<u>VALUE ($^\circ$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
–47	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
–20±40	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
–24	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90

 $\Delta(1930)$ DECAY MODES

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

Mode	Fraction (Γ_i/Γ)
Γ_1 $N\pi$	10–20 %
Γ_2 ΣK	
Γ_3 $N\pi\pi$	
Γ_4 $N\gamma$	0.0–0.02 %
Γ_5 $N\gamma$, helicity=1/2	0.0–0.01 %
Γ_6 $N\gamma$, helicity=3/2	0.0–0.01 %

 $\Delta(1930)$ 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>
0.1 to 0.2 OUR ESTIMATE				
0.18±0.02	MANLEY	92	IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$	
0.14±0.04	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$	
0.04±0.03	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
0.11	ARNDT	95	DPWA $\pi N \rightarrow N\pi$	
0.11	CHEW	80	BPWA $\pi^+ p \rightarrow \pi^+ p$	

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1930) \rightarrow \Sigma K$				$(\Gamma_1 \Gamma_2)^{1/2} / \Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
< 0.015	CANDLIN	84	DPWA	$\pi^+ p \rightarrow \Sigma^+ K^+$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
-0.031	LIVANOS	80	DPWA	$\pi p \rightarrow \Sigma K$
0.018 to 0.035	² DEANS	75	DPWA	$\pi N \rightarrow \Sigma K$

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1930) \rightarrow N\pi\pi$				$(\Gamma_1 \Gamma_3)^{1/2} / \Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
not seen	LONGACRE	75	IPWA	$\pi N \rightarrow N\pi\pi$

$\Delta(1930)$ PHOTON DECAY AMPLITUDES

$\Delta(1930) \rightarrow N\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($\text{GeV}^{-1/2}$)	DOCUMENT ID	TECN	COMMENT
-0.009 ± 0.028 OUR ESTIMATE			
-0.007 ± 0.010	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
0.009 ± 0.009	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$
-0.030 ± 0.047	CRAWFORD	80	DPWA $\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
-0.019 ± 0.001	LI	93	IPWA $\gamma N \rightarrow \pi N$
-0.062 ± 0.064	BARBOUR	78	DPWA $\gamma N \rightarrow \pi N$

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

VALUE ($\text{GeV}^{-1/2}$)	DOCUMENT ID	TECN	COMMENT
-0.018 ± 0.028 OUR ESTIMATE			
0.005 ± 0.010	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
-0.025 ± 0.011	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$
-0.033 ± 0.060	CRAWFORD	80	DPWA $\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
0.009 ± 0.001	LI	93	IPWA $\gamma N \rightarrow \pi N$
+0.019 ± 0.054	BARBOUR	78	DPWA $\gamma N \rightarrow \pi N$

$\Delta(1930)$ FOOTNOTES

¹ See HOEHLER 93 for a detailed discussion of the evidence for and the pole parameters of N and Δ resonances as determined from Argand diagrams of πN elastic partial-wave amplitudes and from plots of the speeds with which the amplitudes traverse the diagrams.

² The range given for DEANS 75 is from the four best solutions.

Δ(1930) REFERENCES

For early references, see Physics Letters **111B** 70 (1982).

ARNDT	96	PR C53 430	+Strakovsky, Workman	(VPI)
ARNDT	95	PR C52 2120	+Strakovsky, Workman, Pavan	(VPI, BRCO)
HOEHLER	93	π <i>N</i> Newsletter 9 1		(KARL)
LI	93	PR C47 2759	+Arndt, Roper, Workman	(VPI)
MANLEY	92	PR D45 4002	+Saleski	(KENT) IJP
Also	84	PR D30 904	Manley, Arndt, Goradia, Teplitz	(VPI)
ARNDT	91	PR D43 2131	+Li, Roper, Workman, Ford	(VPI, TELE) IJP
CANDLIN	84	NP B238 477	+Lowe, Peach, Scotland+	(EDIN, RAL, LOWC)
PDG	82	PL 111B	Roos, Porter, Aguilar-Benitez+	(HELS, CIT, CERN)
AWAJI	81	Bonn Conf. 352	+Kajikawa	(NAGO)
Also	82	NP B197 365	Fujii, Hayashii, Iwata, Kajikawa+	(NAGO)
CHEW	80	Toronto Conf. 123		(LBL) IJP
CRAWFORD	80	Toronto Conf. 107		(GLAS)
CUTKOSKY	80	Toronto Conf. 19	+Forsyth, Babcock, Kelly, Hendrick	(CMU, LBL) IJP
Also	79	PR D20 2839	Cutkosky, Forsyth, Hendrick, Kelly	(CMU, LBL) IJP
LIVANOS	80	Toronto Conf. 35	+Baton, Coutures, Kochowski, Neveu	(SACL) IJP
HOEHLER	79	PDAT 12-1	+Kaiser, Koch, Pietarinen	(KARLT) IJP
Also	80	Toronto Conf. 3	Koch	(KARLT) IJP
BARBOUR	78	NP B141 253	+Crawford, Parsons	(GLAS)
DEANS	75	NP B96 90	+Mitchell, Montgomery+	(SFLA, ALAH) IJP
LONGACRE	75	PL 55B 415	+Rosenfeld, Lasinski, Smadja+	(LBL, SLAC) IJP