

$\Delta(1900) S_{31}$

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

OMITTED FROM SUMMARY TABLE

 $\Delta(1900)$ BREIT-WIGNER MASS

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1850 to 1950 (≈ 1900) OUR ESTIMATE			
1920 ± 24	MANLEY	92	IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$
1890 ± 50	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
1908 ± 30	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1802 ± 87	VRANA	00	DPWA Multichannel
1918.5 ± 23.0	CHEW	80	BPWA $\pi^+ p \rightarrow \pi^+ p$
1803	CRAWFORD	80	DPWA $\gamma N \rightarrow \pi N$

 $\Delta(1900)$ BREIT-WIGNER WIDTH

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
140 to 240 (≈ 200) OUR ESTIMATE			
263 ± 39	MANLEY	92	IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$
170 ± 50	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
140 ± 40	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
48 ± 45	VRANA	00	DPWA Multichannel
93.5 ± 54.0	CHEW	80	BPWA $\pi^+ p \rightarrow \pi^+ p$
137	CRAWFORD	80	DPWA $\gamma N \rightarrow \pi N$

 $\Delta(1900)$ POLE POSITION**REAL PART**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1780	¹ HOEHLER	93	SPED $\pi N \rightarrow \pi N$
1870 ± 40	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1795	VRANA	00	DPWA Multichannel
not seen	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90
2029 or 2025	² LONGACRE	78	IPWA $\pi N \rightarrow N\pi\pi$

-2xIMAGINARY PART

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
180 ± 50	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
58	VRANA	00	DPWA Multichannel
not seen	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90
164 or 163	² LONGACRE	78	IPWA $\pi N \rightarrow N\pi\pi$

$\Delta(1900)$ ELASTIC POLE RESIDUE

MODULUS $|r|$

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
10±3	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$

PHASE θ

<u>VALUE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
+20±40	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$

$\Delta(1900)$ DECAY MODES

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

Mode	Fraction (Γ_i/Γ)
Γ_1 $N\pi$	10–30 %
Γ_2 ΣK	
Γ_3 $N\pi\pi$	
Γ_4 $\Delta\pi$	
Γ_5 $\Delta(1232)\pi$, <i>D-wave</i>	
Γ_6 $N\rho$	
Γ_7 $N\rho$, <i>S=1/2, S-wave</i>	
Γ_8 $N\rho$, <i>S=3/2, D-wave</i>	
Γ_9 $N(1440)\pi$, <i>S-wave</i>	
Γ_{10} $N\gamma$, <i>helicity=1/2</i>	

$\Delta(1900)$ BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{\text{total}}$ Γ_1/Γ

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.1 to 0.3 OUR ESTIMATE			
0.41±0.04	MANLEY	92	IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$
0.10±0.03	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
0.08±0.04	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.33±0.10	VRANA	00	DPWA Multichannel
0.28	CHEW	80	BPWA $\pi^+ p \rightarrow \pi^+ p$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1900) \rightarrow \Sigma K$ $(\Gamma_1\Gamma_2)^{1/2}/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<0.03	CANDLIN	84	DPWA $\pi^+ p \rightarrow \Sigma^+ K^+$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.076	³ DEANS	75	DPWA $\pi N \rightarrow \Sigma K$
0.11	LANGBEIN	73	IPWA $\pi N \rightarrow \Sigma K$ (sol. 1)
0.12	LANGBEIN	73	IPWA $\pi N \rightarrow \Sigma K$ (sol. 2)

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1900) \rightarrow \Delta(1232)\pi$, <i>D-wave</i>	$(\Gamma_1 \Gamma_5)^{1/2} / \Gamma$
VALUE	DOCUMENT ID TECN COMMENT
$+0.25 \pm 0.07$	MANLEY 92 IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$

$\Gamma(\Delta(1232)\pi)$, <i>D-wave</i> / Γ_{total}	Γ_5 / Γ
VALUE	DOCUMENT ID TECN COMMENT
0.28 ± 0.01	VRANA 00 DPWA Multichannel

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1900) \rightarrow N\rho$, <i>S=1/2, S-wave</i>	$(\Gamma_1 \Gamma_7)^{1/2} / \Gamma$
VALUE	DOCUMENT ID TECN COMMENT
-0.14 ± 0.11	MANLEY 92 IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$

$\Gamma(N\rho)$, <i>S=1/2, S-wave</i> / Γ_{total}	Γ_7 / Γ
VALUE	DOCUMENT ID TECN COMMENT
0.30 ± 0.02	VRANA 00 DPWA Multichannel

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1900) \rightarrow N\rho$, <i>S=3/2, D-wave</i>	$(\Gamma_1 \Gamma_8)^{1/2} / \Gamma$
VALUE	DOCUMENT ID TECN COMMENT
-0.37 ± 0.07	MANLEY 92 IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$

$\Gamma(N\rho)$, <i>S=3/2, D-wave</i> / Γ_{total}	Γ_8 / Γ
VALUE	DOCUMENT ID TECN COMMENT
0.05 ± 0.01	VRANA 00 DPWA Multichannel

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1900) \rightarrow N(1440)\pi$, <i>S-wave</i>	$(\Gamma_1 \Gamma_9)^{1/2} / \Gamma$
VALUE	DOCUMENT ID TECN COMMENT
-0.16 ± 0.11	MANLEY 92 IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$

$\Gamma(N(1440)\pi)$, <i>S-wave</i> / Γ_{total}	Γ_9 / Γ
VALUE	DOCUMENT ID TECN COMMENT
0.04 ± 0.01	VRANA 00 DPWA Multichannel

$\Delta(1900)$ PHOTON DECAY AMPLITUDES

$\Delta(1900) \rightarrow N\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE (GeV ^{-1/2})	DOCUMENT ID	TECN	COMMENT
-0.004 ± 0.016	CRAWFORD	83	IPWA $\gamma N \rightarrow \pi N$
0.029 ± 0.008	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
-0.006 to -0.025	CRAWFORD	80	DPWA $\gamma N \rightarrow \pi N$

$\Delta(1900)$ 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 LONGACRE 78 values are from a search for poles in the unitarized T-matrix. The first (second) value uses, in addition to $\pi N \rightarrow N\pi\pi$ data, elastic amplitudes from a Saclay (CERN) partial-wave analysis.

³ The value given is from solution 1; the resonance is not present in solutions 2, 3, or 4.

Δ(1900) REFERENCES

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

VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman,, T.-S.H. Lee	(PITT+)
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)
MANLEY	92	PR D45 4002	D.M. Manley, E.M. Saleski	(KENT) IJP
Also	84	PR D30 904	D.M. Manley <i>et al.</i>	(VPI)
ARNDT	91	PR D43 2131	R.A. Arndt <i>et al.</i>	(VPI, TELE) IJP
CANDLIN	84	NP B238 477	D.J. Candlin <i>et al.</i>	(EDIN, RAL, LOWC)
CRAWFORD	83	NP B211 1	R.L. Crawford, W.T. Morton	(GLAS)
AWAJI	81	Bonn Conf. 352	N. Awaji, R. Kajikawa	(NAGO)
Also	82	NP B197 365	K. Fujii <i>et al.</i>	(NAGO)
CHEW	80	Toronto Conf. 123	D.M. Chew	(LBL) IJP
CRAWFORD	80	Toronto Conf. 107	R.L. Crawford	(GLAS)
CUTKOSKY	80	Toronto Conf. 19	R.E. Cutkosky <i>et al.</i>	(CMU, LBL) IJP
Also	79	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	80	Toronto Conf. 3	R. Koch	(KARLT) IJP
LONGACRE	78	PR D17 1795	R.S. Longacre <i>et al.</i>	(LBL, SLAC)
DEANS	75	NP B96 90	S.R. Deans <i>et al.</i>	(SFLA, ALAH) IJP
LANGBEIN	73	NP B53 251	W. Langbein, F. Wagner	(MUNI) IJP
