Citation: K. Hagiwara *et al.* (Particle Data Group), Phys. Rev. D **66**, 010001 (2002) and 2003 partial update for edition 2004 (URL: http://pdg.lbl.gov)

$\Delta(1900)\ S_{31}$

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

OMITTED FROM SUMMARY TABLE

Δ(1900) BREIT-WIGNER MASS

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
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	$\gamma N \rightarrow \pi N$

Δ(1900) BREIT-WIGNER WIDTH

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
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	$\gamma N \rightarrow \pi N$

Δ(1900) POLE POSITION

REAL PART

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
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	$\pi N \rightarrow N\pi\pi$

−2×IMAGINARY PART

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
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 $|r|$

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
10 ± 3	CUTKOSKY	80	IPWA	$\pi N \to \pi N$

PHASE θ

VALUE (°)	*DOCUMENT ID*		*TECN*	*COMMENT*
$+20\pm40$	CUTKOSKY	80	IPWA	$\pi N \to \pi N$

$\Delta(1900)$ 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	$\Delta(1232)\pi$, *D*-wave	
Γ_6	$N\rho$	
Γ_7	$N\rho$, S=1/2, *S*-wave	
Γ_8	$N\rho$, S=3/2, *D*-wave	
Γ_9	$N(1440)\pi$, *S*-wave	
Γ_{10}	$N\gamma$, helicity=1/2	

$\Delta(1900)$ BRANCHING RATIOS

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

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
0.1 to 0.3 OUR ESTIMATE				
0.41 ± 0.04	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
0.10 ± 0.03	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
0.08 ± 0.04	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • 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	$\pi^+ p \to \pi^+ p$

$(\Gamma_i\Gamma_f)^{½}/\Gamma_{\text{total}}$ in $N\pi \to \Delta(1900) \to \Sigma K$ $(\Gamma_1\Gamma_2)^{½}/\Gamma$

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

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \to \Delta(1900) \to \Delta(1232)\pi$, D-wave $(\Gamma_1\Gamma_5)^{1/2}/\Gamma$

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
$+0.25\pm0.07$	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$

$\Gamma(\Delta(1232)\pi, D\text{-wave})/\Gamma_{\text{total}}$ 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 $N\pi \to \Delta(1900) \to N\rho$, S=1/2, S-wave $(\Gamma_1\Gamma_7)^{1/2}/\Gamma$

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
-0.14 ± 0.11	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$

$\Gamma(N\rho, S{=}1/2, S\text{-wave})/\Gamma_{\text{total}}$ 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 $N\pi \to \Delta(1900) \to N\rho$, S=3/2, D-wave $(\Gamma_1\Gamma_8)^{1/2}/\Gamma$

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
-0.37 ± 0.07	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$

$\Gamma(N\rho, S{=}3/2, D\text{-wave})/\Gamma_{\text{total}}$ 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 $N\pi \to \Delta(1900) \to N(1440)\pi$, S-wave $(\Gamma_1\Gamma_9)^{1/2}/\Gamma$

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
-0.16 ± 0.11	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$

$\Gamma(N(1440)\pi, S\text{-wave})/\Gamma_{\text{total}}$ Γ_9/Γ

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
0.04 ± 0.01	VRANA	00	DPWA	Multichannel

Δ(1900) PHOTON DECAY AMPLITUDES

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

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

Δ(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 $\pi N \to N\pi\pi$ 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.

$\Delta(1900)$ 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 *et al.*	(VPI)	
ARNDT	91	PR D43 2131	R.A. Arndt *et al.*	(VPI, TELE)	IJP
CANDLIN	84	NP B238 477	D.J. Candlin *et al.*	(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 *et al.*	(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 *et al.*	(CMU, LBL)	IJP
Also	79	PR D20 2839	R.E. Cutkosky *et al.*	(CMU, LBL)	IJP
HOEHLER	79	PDAT 12-1	G. Hohler *et al.*	(KARLT)	IJP
Also	80	Toronto Conf. 3	R. Koch	(KARLT)	IJP
LONGACRE	78	PR D17 1795	R.S. Longacre *et al.*	(LBL, SLAC)	
DEANS	75	NP B96 90	S.R. Deans *et al.*	(SFLA, ALAH)	IJP
LANGBEIN	73	NP B53 251	W. Langbein, F. Wagner	(MUNI)	IJP