$\Delta(1600)$ DECAY MODES

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

	Mode	Fraction (Γ_i/Γ)
Γ_1	$N\pi$	10–25 %
Γ_2	ΣK	
Γ_3	$N\pi\pi$	75–90 %
Γ_4	$\Delta\pi$	40–70 %
Γ_5	$\Delta(1232)\pi$, P-wave	
Γ_6	$\Delta(1232)\pi$, F-wave	
Γ_7	$N\rho$	<25 %
Γ_8	$N\rho$, S=1/2, P-wave	
Γ_9	$N\rho$, S=3/2, P-wave	
Γ_{10}	$N\rho$, S=3/2, F-wave	
Γ_{11}	$N(1440)\pi$	10–35 %
Γ_{12}	$N(1440)\pi$, P-wave	
Γ_{13}	$p\gamma$	~ 0 %
Γ_{14}	$N\gamma$, helicity=1/2	
Γ_{15}	$N\gamma$, helicity=3/2	

$\Delta(1600)$ BRANCHING RATIOS

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

VALUE	DOCUMENT ID		TECN	COMMENT
0.10 to 0.25 OUR ESTIMATE				
0.12±0.02	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
0.18±0.04	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
0.21±0.06	HOEHLER	79	IPWA	$\pi N \to \pi N$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \to \Delta(1600) \to \Sigma K$ $(\Gamma_1\Gamma_2)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
−0.36 to −0.28 OUR ESTIMATE				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.006 to 0.042	[5] DEANS	75	DPWA	$\pi N \to \Sigma K$

Note: Signs of couplings from $\pi N \to N\pi\pi$ analyses were changed in the 1986 edition to agree with the baryon-first convention; the overall phase ambiguity is resolved by choosing a negative sign for the $\Delta(1620)$ S_{31} coupling to $\Delta(1232)\pi$.

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \to \Delta(1600) \to \Delta(1232)\pi$, P-wave $(\Gamma_1\Gamma_5)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
+0.27 to +0.33 OUR ESTIMATE				
+0.29±0.02	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
+0.24±0.05	BARNHAM	80	IPWA	$\pi N \to N\pi\pi$
+0.34	[1,6] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
+0.30	[2] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \to \Delta(1600) \to \Delta(1232)\pi$, F-wave $(\Gamma_1\Gamma_6)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
−0.15 to −0.03 OUR ESTIMATE				
−0.07	[1,6] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \to \Delta(1600) \to N\rho$, S=1/2, P-wave $(\Gamma_1\Gamma_8)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
+0.10	[1,6] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \to \Delta(1600) \to N\rho$, S=3/2, P-wave $(\Gamma_1\Gamma_9)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
+0.10	[1,6] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \to \Delta(1600) \to N(1440)\pi$, P-wave $(\Gamma_1\Gamma_{12})^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
+0.15 to +0.23 OUR ESTIMATE				
+0.16±0.02	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
+0.23±0.04	BARNHAM	80	IPWA	$\pi N \to N\pi\pi$

$\Delta(1600)$ PHOTON DECAY AMPLITUDES

$\Delta(1600) \to N\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($\text{GeV}^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.026±0.020 OUR ESTIMATE				
−0.026±0.002	LI	93	IPWA	$\gamma N \to \pi N$
−0.039±0.030	CRAWFORD	83	IPWA	$\gamma N \to \pi N$
−0.046±0.013	AWAJI	81	DPWA	$\gamma N \to \pi N$
0.005±0.020	CRAWFORD	80	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.200	[7] WADA	84	DPWA	Compton scattering
0.000±0.030	BARBOUR	78	DPWA	$\gamma N \to \pi N$
0.0 ±0.020	FELLER	76	DPWA	$\gamma N \to \pi N$

$\Delta(1600) \to N\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE ($\text{GeV}^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.006±0.017 OUR ESTIMATE				
−0.016±0.002	LI	93	IPWA	$\gamma N \to \pi N$
−0.013±0.014	CRAWFORD	83	IPWA	$\gamma N \to \pi N$
0.025±0.031	AWAJI	81	DPWA	$\gamma N \to \pi N$
−0.009±0.020	CRAWFORD	80	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.023	WADA	84	DPWA	Compton scattering
0.000±0.045	BARBOUR	78	DPWA	$\gamma N \to \pi N$
0.0 ±0.015	FELLER	76	DPWA	$\gamma N \to \pi N$

$\Delta(1600)$ FOOTNOTES

[1] LONGACRE 77 pole positions 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. The other LONGACRE 77 values are from eyeball fits with Breit-Wigner circles to the T-matrix amplitudes.

[2] From method II of LONGACRE 75: eyeball fits with Breit-Wigner circles to the T-matrix amplitudes.

[3] See HOEHLER 93 and HOEHLER 94 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.

[4] 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.

[5] The range given is from the four best solutions. DEANS 75 disagrees with $\pi^+ p \to \Sigma^+ K^+$ data of WINNIK 77 around 1920 MeV.

[6] LONGACRE 77 considers this coupling to be well determined.

[7] WADA 84 is inconsistent with other analyses — see the Note on N and Δ Resonances.

$\Delta(1600)$ REFERENCES

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

HOEHLER	94	πN Newsletter 10 (to be pub.)	(KARL)
HOEHLER	93	πN 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
ARNDT	85	PR D32 1085 +Ford, Roper	(VPI)
WADA	84	NP B247 313 +Egawa, Imanishi, Ishii, Kato, Ukai+	(INUS)
CRAWFORD	83	NP B211 1 +Morton	(GLAS)
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)
BARNHAM	80	NP B168 243 +Glickman, Mier-Jedrzejowicz+	(LOIC)
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
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)
LONGACRE	78	PR D17 1795 +Lasinski, Rosenfeld, Smadja+	(LBL, SLAC)
LONGACRE	77	NP B122 493 +Dolbeau	(SACL) IJP
Also	76	NP B108 365 Dolbeau, Triantis, Neveu, Cadiet	(SACL) IJP
WINNIK	77	NP B128 66 +Toaff, Revel, Goldberg, Berny	(HAIF) I
FELLER	76	NP B104 219 +Fukushima, Horikawa, Kajikawa+	(NAGO, OSAK) IJP
DEANS	75	NP B96 90 +Mitchell, Montgomery+	(SFLA, ALAH) IJP
LONGACRE	75	PL 55B 415 +Rosenfeld, Lasinski, Smadja+	(LBL, SLAC) IJP

$\Delta(1620)$ S_{31}

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

$\Delta(1620)$ MASS

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1615 to 1675 (≈ 1620) OUR ESTIMATE				
1672 ± 7	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
1620 ±20	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
1610 ± 7	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1669	LI	93	IPWA	$\gamma N \to \pi N$
1620	BARNHAM	80	IPWA	$\pi N \to N\pi\pi$
1712.8± 6.0	[1] CHEW	80	BPWA	$\pi^+ p \to \pi^+ p$
1786.7± 2.0	[1] CHEW	80	BPWA	$\pi^+ p \to \pi^+ p$
1657	CRAWFORD	80	DPWA	$\gamma N \to \pi N$
1662	BARBOUR	78	DPWA	$\gamma N \to \pi N$
1580	[2] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
1600	[3] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$