NODE=B117

# $\Delta(1920)$ $P_{33}$

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

NODE=B117

Most of the results published before 1975 were last included in our 1982 edition, Physics Letters **111B** 1 (1982). Some further obsolete results published before 1984 were last included in our 2006 edition, Journal of Physics, G **33** 1 (2006).

The latest GWU analysis (ARNDT 06) finds no evidence for this resonance.

## $\Delta(1920)$ BREIT-WIGNER MASS

NODE=B117205

NODE=B117M

→ NOT CHECKED ←

| *VALUE* (MeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **1900 to 1970 (≈ 1920) OUR ESTIMATE** | | | | |
| 2014 ± 16 | MANLEY | 92 | IPWA | $\pi N \to \pi N$ & $N\pi\pi$ |
| 1920 ± 80 | CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ |
| 1868 ± 10 | HOEHLER | 79 | IPWA | $\pi N \to \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 2057 ± 1 | PENNER | 02C | DPWA | Multichannel |
| 1889 ±100 | VRANA | 00 | DPWA | Multichannel |
| 1840 ± 40 | CANDLIN | 84 | DPWA | $\pi^+ p \to \Sigma^+ K^+$ |
| 1955.0± 13.0 | [1] CHEW | 80 | BPWA | $\pi^+ p \to \pi^+ p$ |
| $2065.0^{+13.6}_{-12.9}$ | [1] CHEW | 80 | BPWA | $\pi^+ p \to \pi^+ p$ |

OCCUR=2

## $\Delta(1920)$ BREIT-WIGNER WIDTH

NODE=B117210

NODE=B117W

→ NOT CHECKED ←

| *VALUE* (MeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **150 to 300 (≈ 200) OUR ESTIMATE** | | | | |
| 152 ± 55 | MANLEY | 92 | IPWA | $\pi N \to \pi N$ & $N\pi\pi$ |
| 300 ±100 | CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ |
| 220 ± 80 | HOEHLER | 79 | IPWA | $\pi N \to \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 525 ± 32 | PENNER | 02C | DPWA | Multichannel |
| 123 ± 53 | VRANA | 00 | DPWA | Multichannel |
| 200 ± 40 | CANDLIN | 84 | DPWA | $\pi^+ p \to \Sigma^+ K^+$ |
| 88.3± 35.0 | [1] CHEW | 80 | BPWA | $\pi^+ p \to \pi^+ p$ |
| 62.0± 44.0 | [1] CHEW | 80 | BPWA | $\pi^+ p \to \pi^+ p$ |

OCCUR=2

## $\Delta(1920)$ POLE POSITION

NODE=B117215

### REAL PART

NODE=B117RE

NODE=B117RE

→ NOT CHECKED ←

| *VALUE* (MeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **1850 to 1950 (≈ 1900) OUR ESTIMATE** | | | | |
| 1900 | [2] HOEHLER | 93 | SPED | $\pi N \to \pi N$ |
| 1900±80 | CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 1880 | VRANA | 00 | DPWA | Multichannel |
| not seen | ARNDT | 91 | DPWA | $\pi N \to \pi N$ Soln SM90 |

### −2×IMAGINARY PART

NODE=B117IM

NODE=B117IM

→ NOT CHECKED ←

| *VALUE* (MeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **200 to 400 (≈ 300) OUR ESTIMATE** | | | | |
| 300±100 | CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 120 | VRANA | 00 | DPWA | Multichannel |
| not seen | ARNDT | 91 | DPWA | $\pi N \to \pi N$ Soln SM90 |

## $\Delta(1920)$ ELASTIC POLE RESIDUE

NODE=B117220

### MODULUS $|r|$

NODE=B117RER

NODE=B117RER

| *VALUE* (MeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| 24±4 | CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ |

### PHASE $\theta$ NODE=B117IMR

| VALUE (°) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $-150\pm30$ | CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ |

NODE=B117IMR

## $\Delta(1920)$ DECAY MODES NODE=B117225;NODE=B117

The following branching fractions are our estimates, not fits or averages. NODE=B117

| | Mode | Fraction ($\Gamma_i/\Gamma$) | |
|---|---|---|---|
| $\Gamma_1$ | $N\pi$ | 5–20 % | DESIG=1;OUR EST |
| $\Gamma_2$ | $\Sigma K$ | $(2.10\pm0.30)$ % | DESIG=2 |
| $\Gamma_3$ | $N\pi\pi$ | | DESIG=7 |
| $\Gamma_4$ | $\Delta(1232)\pi$, $P$-wave | | DESIG=3 |
| $\Gamma_5$ | $N(1440)\pi$, $P$-wave | | DESIG=4 |
| $\Gamma_6$ | $N\gamma$, helicity=1/2 | | DESIG=5 |
| $\Gamma_7$ | $N\gamma$, helicity=3/2 | | DESIG=6 |

## $\Delta(1920)$ BRANCHING RATIOS NODE=B117230

### $\Gamma(N\pi)/\Gamma_{total}$ $\Gamma_1/\Gamma$ NODE=B117R1

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **0.05 to 0.2 OUR ESTIMATE** | | | | |
| $0.02\pm0.02$ | MANLEY | 92 | IPWA | $\pi N \to \pi N$ & $N\pi\pi$ |
| $0.20\pm0.05$ | CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ |
| $0.14\pm0.04$ | HOEHLER | 79 | IPWA | $\pi N \to \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| $0.15\pm0.01$ | PENNER | 02C | DPWA | Multichannel |
| $0.05\pm0.04$ | VRANA | 00 | DPWA | Multichannel |
| 0.24 | [1] CHEW | 80 | BPWA | $\pi^+ p \to \pi^+ p$ |
| 0.18 | [1] CHEW | 80 | BPWA | $\pi^+ p \to \pi^+ p$ |

NODE=B117R1
→ NOT CHECKED ←
OCCUR=2

### $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to \Delta(1920) \to \Sigma K$ $(\Gamma_1\Gamma_2)^{1/2}/\Gamma$ NODE=B117R2

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $-0.052\pm0.015$ | CANDLIN | 84 | DPWA | $\pi^+ p \to \Sigma^+ K^+$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| $-0.049$ | LIVANOS | 80 | DPWA | $\pi p \to \Sigma K$ |

NODE=B117R2

### $\Gamma(\Sigma K)/\Gamma_{total}$ $\Gamma_2/\Gamma$ NODE=B117R7

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **$0.021\pm0.003$** | PENNER | 02C | DPWA | Multichannel |

NODE=B117R7

### $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to \Delta(1920) \to \Delta(1232)\pi$, $P$-wave $(\Gamma_1\Gamma_4)^{1/2}/\Gamma$ NODE=B117R3

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $-0.13\pm0.04$ | MANLEY | 92 | IPWA | $\pi N \to \pi N$ & $N\pi\pi$ |

NODE=B117R3

### $\Gamma(\Delta(1232)\pi, P\text{-wave})/\Gamma_{total}$ $\Gamma_4/\Gamma$ NODE=B117R5

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $0.41\pm0.03$ | VRANA | 00 | DPWA | Multichannel |

NODE=B117R5

### $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to \Delta(1920) \to N(1440)\pi$, $P$-wave $(\Gamma_1\Gamma_5)^{1/2}/\Gamma$ NODE=B117R4

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $+0.06\pm0.07$ | MANLEY | 92 | IPWA | $\pi N \to \pi N$ & $N\pi\pi$ |

NODE=B117R4

### $\Gamma(N(1440)\pi, P\text{-wave})/\Gamma_{total}$ $\Gamma_5/\Gamma$ NODE=B117R6

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $0.53\pm0.08$ | VRANA | 00 | DPWA | Multichannel |

NODE=B117R6

## $\Delta(1920)$ PHOTON DECAY AMPLITUDES NODE=B117235

Papers on $\gamma N$ amplitudes predating 1981 may be found in our 2006 edition, Journal of Physics, G **33** 1 (2006). NODE=B117235

### $\Delta(1920) \to N\gamma$, helicity-1/2 amplitude $A_{1/2}$ NODE=B117A1

| VALUE ($GeV^{-1/2}$) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $0.040\pm0.014$ | AWAJI | 81 | DPWA | $\gamma N \to \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| $-0.007$ | PENNER | 02D | DPWA | Multichannel |

NODE=B117A1

### $\Delta(1920) \rightarrow N\gamma$, helicity-3/2 amplitude $A_{3/2}$

NODE=B117A2

NODE=B117A2

| *VALUE* (GeV$^{-1/2}$) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| 0.023±0.017 | AWAJI | 81 | DPWA | $\gamma N \rightarrow \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| −0.001 | PENNER | 02D | DPWA | Multichannel |

## $\Delta(1920)$ FOOTNOTES

NODE=B117

[1] CHEW 80 reports two $P_{33}$ resonances in this mass region. Problems with this analysis are discussed in section 2.1.11 of HOEHLER 83.

NODE=B117;LINKAGE=A

[2] See HOEHLER 93 for a detailed discussion of the evidence for and the pole parameters of $N$ and $\Delta$ resonances as determined from Argand diagrams of $\pi N$ elastic partial-wave amplitudes and from plots of the speeds with which the amplitudes traverse the diagrams.

NODE=B010;LINKAGE=H9

## $\Delta(1920)$ REFERENCES

NODE=B117

For early references, see Physics Letters **111B** 1 (1982).

NODE=B117


| | | | | | |
|---|---|---|---|---|---|
| ARNDT | 06 | PR C74 045205 | R.A. Arndt *et al.* | (GWU) | REFID=51535 |
| PDG | 06 | JPG 33 1 | W.-M. Yao *et al.* | (PDG Collab.) | REFID=51004 |
| PENNER | 02C | PR C66 055211 | G. Penner, U. Mosel | (GIES) | REFID=49129 |
| PENNER | 02D | PR C66 055212 | G. Penner, U. Mosel | (GIES) | REFID=49130 |
| VRANA | 00 | PRPL 328 181 | T.P. Vrana, S.A. Dytman,, T.-S.H. Lee | (PITT+) | REFID=47593 |
| HOEHLER | 93 | $\pi N$ Newsletter 9 1 | G. Hohler | (KARL) | REFID=43821 |
| MANLEY | 92 | PR D45 4002 | D.M. Manley, E.M. Saleski | (KENT) IJP | REFID=41535 |
| Also | | PR D30 904 | D.M. Manley *et al.* | (VPI) | REFID=30071 |
| ARNDT | 91 | PR D43 2131 | R.A. Arndt *et al.* | (VPI, TELE) IJP | REFID=41467 |
| CANDLIN | 84 | NP B238 477 | D.J. Candlin *et al.* | (EDIN, RAL, LOWC) | REFID=40339 |
| HOEHLER | 83 | Landolt-Boernstein 1/9B2 | G. Hohler | (KARLT) | REFID=31158 |
| PDG | 82 | PL 111B 1 | M. Roos *et al.* | (HELS, CIT, CERN) | REFID=41167 |
| AWAJI | 81 | Bonn Conf. 352 | N. Awaji, R. Kajikawa | (NAGO) | REFID=30067 |
| Also | | NP B197 365 | K. Fujii *et al.* | (NAGO) | REFID=30068 |
| CHEW | 80 | Toronto Conf. 123 | D.M. Chew | (LBL) IJP | REFID=31151 |
| CUTKOSKY | 80 | Toronto Conf. 19 | R.E. Cutkosky *et al.* | (CMU, LBL) IJP | REFID=30064 |
| Also | | PR D20 2839 | R.E. Cutkosky *et al.* | (CMU, LBL) IJP | REFID=40096 |
| LIVANOS | 80 | Toronto Conf. 35 | P. Livanos *et al.* | (SACL) IJP | REFID=30402 |
| HOEHLER | 79 | PDAT 12-1 | G. Hohler *et al.* | (KARLT) IJP | REFID=30058 |
| Also | | Toronto Conf. 3 | R. Koch | (KARLT) IJP | REFID=30859 |