$N(1520)\ 3/2^-$

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

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).

N(1520) BREIT-WIGNER MASS

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1515 to 1525 (≈ 1520) OUR ESTIMATE				
1517 ± 3	ANISOVICH	12A	DPWA	Multichannel
1514.5 ± 0.2	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
1524 ± 4	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N \pi\pi$
1525 ± 10	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
1519 ± 4	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1524 ± 4	ANISOVICH	10	DPWA	Multichannel
1522 ± 8	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
1520 ± 10	THOMA	08	DPWA	Multichannel
1516.3 ± 0.8	ARNDT	04	DPWA	$\pi N \to \pi N$, ηN
1509 ± 1	PENNER	02C	DPWA	Multichannel
1518 ± 3	VRANA	00	DPWA	Multichannel
1516 ± 10	ARNDT	96	IPWA	$\gamma N \to \pi N$
1515	ARNDT	95	DPWA	$\pi N \to N\pi$
1510	LI	93	IPWA	$\gamma N \to \pi N$
1510	[1] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
1520	[2] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$

N(1520) BREIT-WIGNER WIDTH

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
100 to 125 (≈ 115) OUR ESTIMATE				
114 ± 5	ANISOVICH	12A	DPWA	Multichannel
103.6 ± 0.4	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
124 ± 8	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N \pi\pi$
120 ± 15	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
114 ± 7	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
117 ± 6	ANISOVICH	10	DPWA	Multichannel
132 ± 11	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
125 ± 15	THOMA	08	DPWA	Multichannel
98.6 ± 2.6	ARNDT	04	DPWA	$\pi N \to \pi N$, ηN
100 ± 2	PENNER	02C	DPWA	Multichannel
124 ± 4	VRANA	00	DPWA	Multichannel

106 ± 4	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
106	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
120	LI	93	IPWA	$\gamma N \rightarrow \pi N$
110	[1] LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$
150	[2] LONGACRE	75	IPWA	$\pi N \rightarrow N\pi\pi$

N(1520) POLE POSITION

REAL PART

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1505 to 1515 (≈ 1510) OUR ESTIMATE				
1507±3	ANISOVICH	12A	DPWA	Multichannel
1515	ARNDT	06	DPWA	$\pi N \rightarrow \pi N$, ηN
1510	[3] HOEHLER	93	ARGD	$\pi N \rightarrow \pi N$
1510±5	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1512±3	ANISOVICH	10	DPWA	Multichannel
1506±9	BATINIC	10	DPWA	$\pi N \rightarrow N\pi$, $N\eta$
1509±7	THOMA	08	DPWA	Multichannel
1514	ARNDT	04	DPWA	$\pi N \rightarrow \pi N$, ηN
1504	VRANA	00	DPWA	Multichannel
1515	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
1511	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90
1514 or 1511	[4] LONGACRE	78	IPWA	$\pi N \rightarrow N\pi\pi$
1508 or 1505	[1] LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$

−2×IMAGINARY PART

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
105 to 120 (≈ 110) OUR ESTIMATE				
111± 5	ANISOVICH	12A	DPWA	Multichannel
113	ARNDT	06	DPWA	$\pi N \rightarrow \pi N$, ηN
120	[3] HOEHLER	93	ARGD	$\pi N \rightarrow \pi N$
114±10	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
110± 6	ANISOVICH	10	DPWA	Multichannel
122± 9	BATINIC	10	DPWA	$\pi N \rightarrow N\pi$, $N\eta$
113±12	THOMA	08	DPWA	Multichannel
102	ARNDT	04	DPWA	$\pi N \rightarrow \pi N$, ηN
112	VRANA	00	DPWA	Multichannel
110	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
108	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90
146 or 137	[4] LONGACRE	78	IPWA	$\pi N \rightarrow N\pi\pi$
109 or 107	[1] LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$

$N(1520)$ ELASTIC POLE RESIDUE

MODULUS $|r|$

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
35±3 OUR ESTIMATE				
36±3	ANISOVICH	12A	DPWA	Multichannel
38	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
32	HOEHLER	93	ARGD	$\pi N \rightarrow \pi N$
35±2	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
35	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$
35	ARNDT	04	DPWA	$\pi N \rightarrow \pi N, \eta N$
34	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
33	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90

PHASE θ

VALUE (°)	DOCUMENT ID		TECN	COMMENT
−10±5 OUR ESTIMATE				
−14±3	ANISOVICH	12A	DPWA	Multichannel
− 5	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
− 8	HOEHLER	93	ARGD	$\pi N \rightarrow \pi N$
−12±5	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
− 7	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$
− 6	ARNDT	04	DPWA	$\pi N \rightarrow \pi N, \eta N$
7	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
−10	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90

$N(1520)$ INELASTIC POLE RESIDUE

The "normalized residue" is the residue divided by Γ_{pole}.

Normalized residue in $N\pi \rightarrow N(1520) \rightarrow \Delta\pi$, S-wave

MODULUS (%)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
33±5	**150 ± 20**	ANISOVICH	12A	DPWA	Multichannel

Normalized residue in $N\pi \rightarrow N(1520) \rightarrow \Delta\pi$, D-wave

MODULUS (%)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
25±3	**100 ± 20**	ANISOVICH	12A	DPWA	Multichannel

$N(1520)$ DECAY MODES

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

	Mode	Fraction (Γ_i/Γ)
Γ_1	$N\pi$	55–65 %
Γ_2	$N\eta$	$(2.3\pm0.4) \times 10^{-3}$
Γ_3	$N\pi\pi$	20–30 %
Γ_4	$\Delta\pi$	15–25 %
Γ_5	$\Delta(1232)\pi$, S-wave	10–20 %

Γ_6	$\Delta(1232)\pi$, D-wave	10–15 %
Γ_7	$N\rho$	15–25 %
Γ_8	$N\rho$, S=3/2, S-wave	(9.0±1.0) %
Γ_9	$N(\pi\pi)^{I=0}_{S\text{-wave}}$	<8 %
Γ_{10}	$p\gamma$	0.31–0.52 %
Γ_{11}	$p\gamma$, helicity=1/2	0.01–0.02 %
Γ_{12}	$p\gamma$, helicity=3/2	0.30–0.50 %
Γ_{13}	$n\gamma$	0.30–0.53 %
Γ_{14}	$n\gamma$, helicity=1/2	0.04–0.10 %
Γ_{15}	$n\gamma$, helicity=3/2	0.25–0.45 %

N(1520) BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{total}$ — Γ_1/Γ

VALUE (%)	*DOCUMENT ID*		*TECN*	*COMMENT*
55 to 65 OUR ESTIMATE				
62 ±3	ANISOVICH	12A	DPWA	Multichannel
63.2±0.1	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
59 ±3	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
58 ±3	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
54 ±3	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
57 ±5	ANISOVICH	10	DPWA	Multichannel
55 ±5	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
58 ±8	THOMA	08	DPWA	Multichannel
64.0±0.5	ARNDT	04	DPWA	$\pi N \to \pi N$, ηN
56 ±1	PENNER	02C	DPWA	Multichannel
63 ±2	VRANA	00	DPWA	Multichannel
61	ARNDT	95	DPWA	$\pi N \to N\pi$

$\Gamma(N\eta)/\Gamma_{total}$ — Γ_2/Γ

VALUE (%)	*DOCUMENT ID*		*TECN*	*COMMENT*
0.23±0.04 OUR AVERAGE				
0.23±0.04	PENNER	02C	DPWA	Multichannel
0 ±1	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.1 ±0.1	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
0.2 ±0.1	THOMA	08	DPWA	Multichannel
0.08 to 0.12	ARNDT	05	DPWA	Multichannel
0.08±0.01	TIATOR	99	DPWA	$\gamma p \to p\eta$

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 $\Delta(1232)\pi$.

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1520) \to \Delta(1232)\pi$, S-wave — $(\Gamma_1\Gamma_5)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
−0.26 to −0.20 OUR ESTIMATE				
−0.18±0.05	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
−0.26	[1,5] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
−0.24	[2] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$

$\Gamma(\Delta(1232)\pi$, S-wave$)/\Gamma_{total}$ — Γ_5/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
10 to 20 OUR ESTIMATE				
19±4	ANISOVICH	12A	DPWA	Multichannel
15±2	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
12±4	THOMA	08	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1520) \to \Delta(1232)\pi$, D-wave — $(\Gamma_1\Gamma_6)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
−0.28 to −0.24 OUR ESTIMATE				
−0.29±0.03	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
−0.21	[1,5] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
−0.30	[2] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$

$\Gamma(\Delta(1232)\pi$, D-wave$)/\Gamma_{total}$ — Γ_6/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
10 to 15 OUR ESTIMATE				
9±2	ANISOVICH	12A	DPWA	Multichannel
11±2	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
14±5	THOMA	08	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1520) \to N\rho$, S=3/2, S-wave — $(\Gamma_1\Gamma_8)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
−0.35 to −0.31 OUR ESTIMATE				
−0.35±0.03	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
−0.35	[1,5] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
−0.24	[2] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$

$\Gamma(N\rho$, S=3/2, S-wave$)/\Gamma_{total}$ — Γ_8/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
9±1	VRANA	00	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1520) \to N(\pi\pi)^{I=0}_{S\text{-wave}}$ — $(\Gamma_1\Gamma_9)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
−0.22 to −0.06 OUR ESTIMATE				
−0.13	[1,5] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
−0.17	[2] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$

$\Gamma(N(\pi\pi)^{I=0}_{S\text{-wave}})/\Gamma_{\text{total}}$ Γ_9/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
1±1	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<4	THOMA	08	DPWA	Multichannel

$N(1520)$ PHOTON DECAY AMPLITUDES

Papers on γN amplitudes predating 1981 may be found in our 2006 edition, Journal of Physics, G **33** 1 (2006).

$N(1520) \to p\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE (GeV$^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.024±0.009 OUR ESTIMATE				
−0.022±0.004	ANISOVICH	12A	DPWA	Multichannel
−0.028±0.002	DUGGER	07	DPWA	$\gamma N \to \pi N$
−0.038±0.003	AHRENS	02	DPWA	$\gamma N \to \pi N$
−0.020±0.007	ARNDT	96	IPWA	$\gamma N \to \pi N$
−0.028±0.014	CRAWFORD	83	IPWA	$\gamma N \to \pi N$
−0.007±0.004	AWAJI	81	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.032±0.006	ANISOVICH	10	DPWA	Multichannel
−0.027	DRECHSEL	07	DPWA	$\gamma N \to \pi N$
−0.003	PENNER	02D	DPWA	Multichannel
−0.052±0.010±0.007	[6] MUKHOPAD...	98		$\gamma p \to \eta p$
−0.020±0.002	LI	93	IPWA	$\gamma N \to \pi N$
−0.012	WADA	84	DPWA	Compton scattering

$N(1520) \to p\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE (GeV$^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
0.150±0.015 OUR ESTIMATE				
0.131±0.010	ANISOVICH	12A	DPWA	Multichannel
0.143±0.002	DUGGER	07	DPWA	$\gamma N \to \pi N$
0.147±0.010	AHRENS	02	DPWA	$\gamma N \to \pi N$
0.167±0.005	ARNDT	96	IPWA	$\gamma N \to \pi N$
0.156±0.022	CRAWFORD	83	IPWA	$\gamma N \to \pi N$
0.168±0.013	AWAJI	81	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.138±0.008	ANISOVICH	10	DPWA	Multichannel
0.161	DRECHSEL	07	DPWA	$\gamma N \to \pi N$
0.151	PENNER	02D	DPWA	Multichannel
0.130±0.020±0.015	[6] MUKHOPAD...	98		$\gamma p \to \eta p$
0.167±0.002	LI	93	IPWA	$\gamma N \to \pi N$
0.168	WADA	84	DPWA	Compton scattering

$N(1520) \rightarrow n\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE (GeV$^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
$-$0.059$\pm$0.009 OUR ESTIMATE				
-0.048 ± 0.008	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
-0.066 ± 0.013	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
-0.067 ± 0.004	FUJII	81	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
-0.077	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$
-0.084	PENNER	02D	DPWA	Multichannel
-0.058 ± 0.003	LI	93	IPWA	$\gamma N \rightarrow \pi N$

$N(1520) \rightarrow n\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE (GeV$^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
$-$0.139$\pm$0.011 OUR ESTIMATE				
-0.140 ± 0.010	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
-0.124 ± 0.009	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
-0.158 ± 0.003	FUJII	81	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
-0.154	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$
-0.159	PENNER	02D	DPWA	Multichannel
-0.131 ± 0.003	LI	93	IPWA	$\gamma N \rightarrow \pi N$

N(1520) 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 $\pi N \rightarrow N\pi\pi$ 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 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 $\pi N \rightarrow N\pi\pi$ data, elastic amplitudes from a Saclay (CERN) partial-wave analysis.

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

[6] MUKHOPADHYAY 98 uses an effective Lagrangian approach to analyze η photoproduction data. The *ratio* of the $A_{3/2}$ and $A_{1/2}$ amplitudes is determined, with less model dependence than the amplitudes themselves, to be $A_{3/2}/A_{1/2} = -2.5 \pm 0.5 \pm 0.4$.

N(1520) REFERENCES

For early references, see Physics Letters **111B** 1 (1982). For very early references, see Reviews of Modern Physics **37** 633 (1965).

ANISOVICH	12A	EPJ A48 15	A.V. Anisovich *et al.*	(BONN, PNPI)
ANISOVICH	10	EPJ A44 203	A.V. Anisovich *et al.*	(BONN, PNPI)
BATINIC	10	PR C82 038203	M. Batinic *et al.*	(ZAGR)
THOMA	08	PL B659 87	U. Thoma *et al.*	(CB-ELSA Collab.)
DRECHSEL	07	EPJ A34 69	D. Drechsel, S.S. Kamalov, L. Tiator	(MAINZ, JINR)
DUGGER	07	PR C76 025211	M. Dugger *et al.*	(Jefferson Lab CLAS Collab.)
ARNDT	06	PR C74 045205	R.A. Arndt *et al.*	(GWU)
PDG	06	JPG 33 1	W.-M. Yao *et al.*	(PDG Collab.)

ARNDT	05	PR C72 045202	R.A. Arndt *et al.*	(GWU, PNPI)
ARNDT	04	PR C69 035213	R.A. Arndt *et al.*	(GWU, TRIU)
AHRENS	02	PRL 88 232002	J. Ahrens *et al.*	(Mainz MAMI GDH/A2 Collab.)
PENNER	02C	PR C66 055211	G. Penner, U. Mosel	(GIES)
PENNER	02D	PR C66 055212	G. Penner, U. Mosel	(GIES)
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman,, T.-S.H. Lee	(PITT+)
TIATOR	99	PR C60 035210	L. Tiator *et al.*	
MUKHOPAD...	98	PL B444 7	N.C. Mukhopadhyay, N. Mathur	
ARNDT	96	PR C53 430	R.A. Arndt, I.I. Strakovsky, R.L. Workman	(VPI)
ARNDT	95	PR C52 2120	R.A. Arndt *et al.*	(VPI, BRCO)
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)
LI	93	PR C47 2759	Z.J. Li *et al.*	(VPI)
MANLEY	92	PR D45 4002	D.M. Manley, E.M. Saleski	(KENT) IJP
Also		PR D30 904	D.M. Manley *et al.*	(VPI)
ARNDT	91	PR D43 2131	R.A. Arndt *et al.*	(VPI, TELE) IJP
WADA	84	NP B247 313	Y. Wada *et al.*	(INUS)
CRAWFORD	83	NP B211 1	R.L. Crawford, W.T. Morton	(GLAS)
PDG	82	PL 111B 1	M. Roos *et al.*	(HELS, CIT, CERN)
AWAJI	81	Bonn Conf. 352	N. Awaji, R. Kajikawa	(NAGO)
Also		NP B197 365	K. Fujii *et al.*	(NAGO)
FUJII	81	NP B187 53	K. Fujii *et al.*	(NAGO, OSAK)
CUTKOSKY	80	Toronto Conf. 19	R.E. Cutkosky *et al.*	(CMU, LBL) IJP
Also		PR D20 2839	R.E. Cutkosky *et al.*	(CMU, LBL) IJP
HOEHLER	79	PDAT 12-1	G. Hohler *et al.*	(KARLT) IJP
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP
LONGACRE	78	PR D17 1795	R.S. Longacre *et al.*	(LBL, SLAC)
LONGACRE	77	NP B122 493	R.S. Longacre, J. Dolbeau	(SACL) IJP
Also		NP B108 365	J. Dolbeau *et al.*	(SACL) IJP
LONGACRE	75	PL 55B 415	R.S. Longacre *et al.*	(LBL, SLAC) IJP