NODE=B061

$N(1440)\ 1/2^+$

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

NODE=B061

N(1440) BREIT-WIGNER MASS

NODE=B061M

NODE=B061M

→ UNCHECKED ←

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1420 to 1470 (≈ 1440) OUR ESTIMATE				
1430 ± 8	ANISOVICH	12A	DPWA	Multichannel
1485.0 ± 1.2	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
1440 ±30	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
1410 ±12	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1412 ± 2	SHRESTHA	12A	DPWA	Multichannel
1440 ±12	ANISOVICH	10	DPWA	Multichannel
1439 ±19	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
1436 ±15	SARANTSEV	08	DPWA	Multichannel
1468.0 ± 4.5	ARNDT	04	DPWA	$\pi N \to \pi N$, ηN
1518 ± 5	PENNER	02C	DPWA	Multichannel
1479 ±80	VRANA	00	DPWA	Multichannel
1463 ± 7	ARNDT	96	IPWA	$\gamma N \to \pi N$
1467	ARNDT	95	DPWA	$\pi N \to N\pi$
1465	LI	93	IPWA	$\gamma N \to \pi N$
1462 ±10	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
1471	CUTKOSKY	90	IPWA	$\pi N \to \pi N$
1380	[1] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
1390	[2] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$

N(1440) BREIT-WIGNER WIDTH

NODE=B061W

NODE=B061W

→ UNCHECKED ←

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
200 to 450 (≈ 300) OUR ESTIMATE				
365 ± 35	ANISOVICH	12A	DPWA	Multichannel
284 ± 18	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
340 ± 70	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
135 ± 10	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
248 ± 5	SHRESTHA	12A	DPWA	Multichannel
335 ± 50	ANISOVICH	10	DPWA	Multichannel
437 ±141	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
335 ± 40	SARANTSEV	08	DPWA	Multichannel
360 ± 26	ARNDT	04	DPWA	$\pi N \to \pi N$, ηN
668 ± 41	PENNER	02C	DPWA	Multichannel
490 ±120	VRANA	00	DPWA	Multichannel
360 ± 20	ARNDT	96	IPWA	$\gamma N \to \pi N$
440	ARNDT	95	DPWA	$\pi N \to N\pi$
315	LI	93	IPWA	$\gamma N \to \pi N$
391 ± 34	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
545 ±170	CUTKOSKY	90	IPWA	$\pi N \to \pi N$
200	[1] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
200	[2] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$

N(1440) POLE POSITION

NODE=B061215

REAL PART

NODE=B061RE
NODE=B061RE

→ UNCHECKED ←

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1350 to 1380 (≈ 1365) OUR ESTIMATE				
1370 ± 4	ANISOVICH	12A	DPWA	Multichannel
1359	[3] ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
1385	[4] HOEHLER	93	SPED	$\pi N \to \pi N$
1375 ±30	CUTKOSKY	80	IPWA	$\pi N \to \pi N$

• • • We do not use the following data for averages, fits, limits, etc. • • •

1370	SHRESTHA	12A	DPWA	Multichannel
1370 ± 4	ANISOVICH	10	DPWA	Multichannel
1363 ± 11	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
1371 ± 7	SARANTSEV	08	DPWA	Multichannel
1357	[5] ARNDT	04	DPWA	$\pi N \to \pi N$, ηN
1383	VRANA	00	DPWA	Multichannel
1346	[6] ARNDT	95	DPWA	$\pi N \to N\pi$
1360	[7] ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90
1370	CUTKOSKY	90	IPWA	$\pi N \to \pi N$
1381 or 1379	[8] LONGACRE	78	IPWA	$\pi N \to N\pi\pi$
1360 or 1333	[1] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$

−2×IMAGINARY PART

NODE=B061IM
NODE=B061IM

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
160 to 220 (≈ 190) OUR ESTIMATE				→ UNCHECKED ←
190 ± 7	ANISOVICH	12A	DPWA	Multichannel
162	[3] ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
164	[4] HOEHLER	93	SPED	$\pi N \to \pi N$
180 ± 40	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
214	SHRESTHA	12A	DPWA	Multichannel
193 ± 7	ANISOVICH	10	DPWA	Multichannel
151 ± 13	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
192 ± 20	SARANTSEV	08	DPWA	Multichannel
160	[5] ARNDT	04	DPWA	$\pi N \to \pi N$, ηN
316	VRANA	00	DPWA	Multichannel
176	[6] ARNDT	95	DPWA	$\pi N \to N\pi$
252	[7] ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90
228	CUTKOSKY	90	IPWA	$\pi N \to \pi N$
209 or 210	[8] LONGACRE	78	IPWA	$\pi N \to N\pi\pi$
167 or 234	[1] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$

N(1440) ELASTIC POLE RESIDUE

NODE=B061220

MODULUS |r|

NODE=B061RER
NODE=B061RER

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
40 to 52 (≈ 46) OUR ESTIMATE				→ UNCHECKED ←
48 ± 3	ANISOVICH	12A	DPWA	Multichannel
38	[3] ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
40	HOEHLER	93	SPED	$\pi N \to \pi N$
52 ± 5	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
44	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
36	[5] ARNDT	04	DPWA	$\pi N \to \pi N$, ηN
42	[6] ARNDT	95	DPWA	$\pi N \to N\pi$
109	[7] ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90
74	CUTKOSKY	90	IPWA	$\pi N \to \pi N$

PHASE θ

NODE=B061IMR
NODE=B061IMR

VALUE (°)	DOCUMENT ID		TECN	COMMENT
75 to 100 (≈ 85) OUR ESTIMATE				→ UNCHECKED ←
− 78 ± 4	ANISOVICH	12A	DPWA	Multichannel
− 98	[3] ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
− 100 ± 35	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
− 88	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
− 102	[5] ARNDT	04	DPWA	$\pi N \to \pi N$, ηN
− 101	[6] ARNDT	95	DPWA	$\pi N \to N\pi$
− 93	[7] ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90
− 84	CUTKOSKY	90	IPWA	$\pi N \to \pi N$

N(1440) INELASTIC POLE RESIDUE

NODE=B061250

The "normalized residue" is the residue divided by $\Gamma_{pole}/2$.

NODE=B061250

Normalized residue in $N\pi \to N(1440) \to \Delta\pi$, P-wave

NODE=B061RS1
NODE=B061RS1

MODULUS (%)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
27 ± 2	**40 ± 5**	ANISOVICH	12A	DPWA	Multichannel

Normalized residue in $N\pi \rightarrow N(1440) \rightarrow N(\pi\pi)^{I=0}_{S-wave}$

NODE=B061RS2
NODE=B061RS2

MODULUS (%)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
21±5	**−135 ± 7**	ANISOVICH	12A	DPWA	Multichannel

$N(1440)$ DECAY MODES

NODE=B061230;NODE=B061

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

NODE=B061

	Mode	Fraction (Γ_i/Γ)	
Γ_1	$N\pi$	55–75 %	DESIG=1;OUR EST
Γ_2	$N\eta$	(0.0±1.0) %	DESIG=2
Γ_3	$N\pi\pi$	30–40 %	DESIG=4;OUR EST
Γ_4	$\Delta\pi$	20–30 %	DESIG=181;OUR EST
Γ_5	$\Delta(1232)\pi$, P-wave	15–30 %	DESIG=5;OUR EST
Γ_6	$N\rho$	<8 %	DESIG=182;OUR EST
Γ_7	$N\rho$, S=1/2, P-wave	(0.0±1.0) %	DESIG=6
Γ_8	$N\rho$, S=3/2, P-wave		DESIG=7
Γ_9	$N(\pi\pi)^{I=0}_{S\text{-wave}}$	10–20 %	DESIG=8;OUR EST
Γ_{10}	$p\gamma$	0.035–0.048 %	DESIG=184;OUR EST
Γ_{11}	$p\gamma$, helicity=1/2	0.035–0.048 %	DESIG=9;OUR EST
Γ_{12}	$n\gamma$	0.02–0.04 %	DESIG=185;OUR EST
Γ_{13}	$n\gamma$, helicity=1/2	0.02–0.04 %	DESIG=10;OUR EST

$N(1440)$ BRANCHING RATIOS

NODE=B061235

$\Gamma(N\pi)/\Gamma_{total}$ — Γ_1/Γ

NODE=B061R1
NODE=B061R1

VALUE (%)	DOCUMENT ID		TECN	COMMENT
55 to 75 OUR ESTIMATE				→ UNCHECKED ←
62 ±3	ANISOVICH	12A	DPWA	Multichannel
78.7±1.6	ARNDT	06	DPWA	$\pi N \rightarrow \pi N$, ηN
68 ±4	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
51 ±5	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
64.8±0.9	SHRESTHA	12A	DPWA	Multichannel
60 ±6	ANISOVICH	10	DPWA	Multichannel
62 ±4	BATINIC	10	DPWA	$\pi N \rightarrow N\pi$, $N\eta$
75.0±2.4	ARNDT	04	DPWA	$\pi N \rightarrow \pi N$, ηN
57 ±1	PENNER	02C	DPWA	Multichannel
72 ±5	VRANA	00	DPWA	Multichannel
68	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
69 ±3	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$

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

NODE=B061R7
NODE=B061R7

VALUE (%)	DOCUMENT ID		TECN	COMMENT
0±1	VRANA	00	DPWA	Multichannel

Note: Signs of couplings from $\pi N \rightarrow N\pi\pi$ 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 $\Delta(1232)\pi$.

NODE=B061310

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \rightarrow N(1440) \rightarrow \Delta(1232)\pi$, P-wave — $(\Gamma_1\Gamma_5)^{1/2}/\Gamma$

NODE=B061R3
NODE=B061R3

VALUE	DOCUMENT ID		TECN	COMMENT
+0.37 to +0.41 OUR ESTIMATE				→ UNCHECKED ←
+0.41	[1,9] LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$
+0.37	[2] LONGACRE	75	IPWA	$\pi N \rightarrow N\pi\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
+0.39±0.02	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$

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

NODE=B061R8
NODE=B061R8

VALUE (%)	DOCUMENT ID		TECN	COMMENT
15 to 30 (≈ 20) OUR ESTIMATE				→ UNCHECKED ←
21 ±8	ANISOVICH	12A	DPWA	Multichannel
16 ±1	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
6.5±0.8	SHRESTHA	12A	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1440) \to N\rho$, S=1/2, P-wave — $(\Gamma_1\Gamma_7)^{1/2}/\Gamma$

NODE=B061R4
NODE=B061R4

VALUE	DOCUMENT ID		TECN	COMMENT
±0.07 to ±0.25 OUR ESTIMATE				→ UNCHECKED ←
−0.11	[1,9] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
+0.23	[2] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$

$\Gamma(N\rho, S$=1/2, P-wave$)/\Gamma_{total}$ — Γ_7/Γ

NODE=B061R9
NODE=B061R9

VALUE (%)	DOCUMENT ID		TECN	COMMENT
0 ±1	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1.3±0.4	SHRESTHA	12A	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1440) \to N\rho$, S=3/2, P-wave — $(\Gamma_1\Gamma_8)^{1/2}/\Gamma$

NODE=B061R5
NODE=B061R5

VALUE	DOCUMENT ID		TECN	COMMENT
+0.18	[1,9] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1440) \to N(\pi\pi)^{I=0}_{S\text{-wave}}$ — $(\Gamma_1\Gamma_9)^{1/2}/\Gamma$

NODE=B061R6
NODE=B061R6

VALUE	DOCUMENT ID		TECN	COMMENT
±0.17 to ±0.25 OUR ESTIMATE				→ UNCHECKED ←
−0.18	[1,9] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
−0.23	[2] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
+0.24±0.03	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$

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

NODE=B061R10
NODE=B061R10

VALUE (%)	DOCUMENT ID		TECN	COMMENT
10 to 20 (≈ 15) OUR ESTIMATE				→ UNCHECKED ←
17±7	ANISOVICH	12A	DPWA	Multichannel
12±1	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
27±1	SHRESTHA	12A	DPWA	Multichannel

$N(1440)$ PHOTON DECAY AMPLITUDES

NODE=B061240

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

NODE=B061240

$N(1440) \to p\gamma$, helicity-1/2 amplitude $A_{1/2}$

NODE=B061A1
NODE=B061A1

VALUE (GeV$^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.060±0.004 OUR ESTIMATE				→ UNCHECKED ←
−0.061±0.008	ANISOVICH	12A	DPWA	Multichannel
−0.056±0.001	WORKMAN	12A	DPWA	$\gamma N \to N\pi$
−0.051±0.002	DUGGER	07	DPWA	$\gamma N \to \pi N$
−0.069±0.018	CRAWFORD	83	IPWA	$\gamma N \to \pi N$
−0.063±0.008	AWAJI	81	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.084±0.003	SHRESTHA	12A	DPWA	Multichannel
−0.052±0.010	ANISOVICH	10	DPWA	Multichannel
−0.061	DRECHSEL	07	DPWA	$\gamma N \to \pi N$
−0.087	PENNER	02D	DPWA	Multichannel
−0.063±0.005	ARNDT	96	IPWA	$\gamma N \to \pi N$
−0.085±0.003	LI	93	IPWA	$\gamma N \to \pi N$
−0.129	[10] WADA	84	DPWA	Compton scattering

$N(1440) \rightarrow n\gamma$, helicity-1/2 amplitude $A_{1/2}$

NODE=B061A2
NODE=B061A2

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
+0.040±0.010 OUR ESTIMATE				→ UNCHECKED ←
0.048±0.004	CHEN	12A	DPWA	$\gamma N \rightarrow \pi N$
0.037±0.010	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
0.030±0.003	FUJII	81	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.040±0.005	SHRESTHA	12A	DPWA	Multichannel
0.054	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$
0.121	PENNER	02D	DPWA	Multichannel
0.045±0.015	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
0.085±0.006	LI	93	IPWA	$\gamma N \rightarrow \pi N$

N(1440) FOOTNOTES

NODE=B061

[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. NODE=B061;LINKAGE=L7

[2] From method II of LONGACRE 75: eyeball fits with Breit-Wigner circles to the T-matrix amplitudes. NODE=B061;LINKAGE=L5

[3] ARNDT 06 also finds a second-sheet pole with real part = 1388 MeV, −2 × imaginary part = 165 MeV, and residue with modulus 86 MeV and phase = −46 degrees. NODE=B061RE;LINKAGE=AR

[4] 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. NODE=B010;LINKAGE=H9

[5] ARNDT 04 also finds a second-sheet pole with real part = 1385 MeV, −2 × imaginary part = 166 MeV, and residue with modulus 82 MeV and phase = -51°. NODE=B061;LINKAGE=AR

[6] ARNDT 95 also finds a second-sheet pole with real part = 1383 MeV, −2×imaginary part = 210 MeV, and residue with modulus 92 MeV and phase = -54°. NODE=B061;LINKAGE=B

[7] ARNDT 91 (Soln SM90) also finds a second-sheet pole with real part = 1413 MeV, −2 × imaginary part = 256 MeV, and residue = (78−153i) MeV. NODE=B061;LINKAGE=A

[8] 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. NODE=B061;LINKAGE=L8

[9] LONGACRE 77 considers this coupling to be well determined. NODE=B061;LINKAGE=X

[10] WADA 84 is inconsistent with other analyses; see the Note on N and Δ Resonances. NODE=B061;LINKAGE=P

N(1440) REFERENCES

NODE=B061

For early references, see Physics Letters **111B** 1 (1982). NODE=B061

ANISOVICH	12A	EPJ A48 15	A.V. Anisovich *et al.*	(BONN, PNPI)	REFID=54041
CHEN	12A	PR C86 015206	W. Chen *et al.*	(DUKE, GWU, MSST, ITEP+)	REFID=54337
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)	REFID=54862
WORKMAN	12A	PR C86 015202	R. Workman *et al.*	(GWU)	REFID=54335
ANISOVICH	10	EPJ A44 203	A.V. Anisovich *et al.*	(BONN, PNPI)	REFID=53280
BATINIC	10	PR C82 038203	M. Batinic *et al.*	(ZAGR)	REFID=53552
SARANTSEV	08	PL B659 94	A.V. Sarantsev *et al.*	(CB-ELSA/A2-TAPS Collab.)	REFID=52088
DRECHSEL	07	EPJ A34 69	D. Drechsel, S.S. Kamalov, L. Tiator	(MAINZ, JINR)	REFID=52105
DUGGER	07	PR C76 025211	M. Dugger *et al.*	(Jefferson Lab CLAS Collab.)	REFID=52039
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
ARNDT	04	PR C69 035213	R.A. Arndt *et al.*	(GWU, TRIU)	REFID=49947
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
ARNDT	96	PR C53 430	R.A. Arndt, I.I. Strakovsky, R.L. Workman	(VPI)	REFID=44675
ARNDT	95	PR C52 2120	R.A. Arndt *et al.*	(VPI, BRCO)	REFID=44535
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)	REFID=43821
LI	93	PR C47 2759	Z.J. Li *et al.*	(VPI)	REFID=43327
MANLEY	92	PR D45 4002	D.M. Manley, E.M. Saleski	(KSA) 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
CUTKOSKY	90	PR D42 235	R.E. Cutkosky, S. Wang	(CMU)	REFID=41262
WADA	84	NP B247 313	Y. Wada *et al.*	(INUS)	REFID=30072
CRAWFORD	83	NP B211 1	R.L. Crawford, W.T. Morton	(GLAS)	REFID=30070
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
FUJII	81	NP B187 53	K. Fujii *et al.*	(NAGO, OSAK)	REFID=30069
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
HOEHLER	79	PDAT 12-1	G. Hohler *et al.*	(KARLT) IJP	REFID=30058
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP	REFID=30859
LONGACRE	78	PR D17 1795	R.S. Longacre *et al.*	(LBL, SLAC)	REFID=30054
LONGACRE	77	NP B122 493	R.S. Longacre, J. Dolbeau	(SACL) IJP	REFID=30051
Also		NP B108 365	J. Dolbeau *et al.*	(SACL) IJP	REFID=30052
LONGACRE	75	PL 55B 415	R.S. Longacre *et al.*	(LBL, SLAC) IJP	REFID=30047