

**$N(1680) F_{15}$**

$$I(J^P) = \frac{1}{2}(\frac{5}{2}^+) \text{ Status: } ****$$

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).

### **$N(1680)$ BREIT-WIGNER MASS**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>1675 to 1690 (<math>\approx 1680</math>) OUR ESTIMATE</b>			
1684 $\pm$ 4	MANLEY	92	IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$
1680 $\pm$ 10	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
1684 $\pm$ 3	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1679 $\pm$ 5	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
1678	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
1674 $\pm$ 12	BATINIC	95	DPWA $\pi N \rightarrow N\pi, N\eta$
1682	CRAWFORD	80	DPWA $\gamma N \rightarrow \pi N$
1680	BARBOUR	78	DPWA $\gamma N \rightarrow \pi N$
1660	<sup>1</sup> LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$
1685	KNASEL	75	DPWA $\pi^- p \rightarrow \Lambda K^0$
1670	<sup>2</sup> LONGACRE	75	IPWA $\pi N \rightarrow N\pi\pi$

### **$N(1680)$ BREIT-WIGNER WIDTH**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>120 to 140 (<math>\approx 130</math>) OUR ESTIMATE</b>			
139 $\pm$ 8	MANLEY	92	IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$
120 $\pm$ 10	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
128 $\pm$ 8	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
124 $\pm$ 4	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
126	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
126 $\pm$ 20	BATINIC	95	DPWA $\pi N \rightarrow N\pi, N\eta$
121	CRAWFORD	80	DPWA $\gamma N \rightarrow \pi N$
119	BARBOUR	78	DPWA $\gamma N \rightarrow \pi N$
150	<sup>1</sup> LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$
155	KNASEL	75	DPWA $\pi^- p \rightarrow \Lambda K^0$
130	<sup>2</sup> LONGACRE	75	IPWA $\pi N \rightarrow N\pi\pi$

### **$N(1680)$ POLE POSITION**

#### **REAL PART**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>1665 to 1675 (<math>\approx 1670</math>) OUR ESTIMATE</b>			
1670	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
1673	<sup>3</sup> HOEHLER	93	ARGD $\pi N \rightarrow \pi N$
1667 $\pm$ 5	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$

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

1670	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$	Soln SM90
1668 or 1674	<sup>4</sup> LONGACRE	78	IPWA	$\pi N \rightarrow N\pi\pi$	
1656 or 1653	<sup>1</sup> LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$	

### –2×IMAGINARY PART

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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#### 105 to 135 (≈ 120) OUR ESTIMATE

120	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$	
135	<sup>3</sup> HOEHLER	93	ARGD	$\pi N \rightarrow \pi N$	
110±10	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$	

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

116	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$	Soln SM90
132 or 137	<sup>4</sup> LONGACRE	78	IPWA	$\pi N \rightarrow N\pi\pi$	
145 or 143	<sup>1</sup> LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$	

## N(1680) ELASTIC POLE RESIDUE

### MODULUS |r|

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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40	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$	
44	HOEHLER	93	ARGD	$\pi N \rightarrow \pi N$	
34±2	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$	

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

37	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$	Soln SM90
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### PHASE $\theta$

<u>VALUE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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+ 1	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$	
–17	HOEHLER	93	ARGD	$\pi N \rightarrow \pi N$	
–25±5	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$	

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

–14	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$	Soln SM90
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## N(1680) DECAY MODES

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

Mode	Fraction ( $\Gamma_i/\Gamma$ )
$\Gamma_1$ $N\pi$	60–70 %
$\Gamma_2$ $N\eta$	
$\Gamma_3$ $\Lambda K$	
$\Gamma_4$ $\Sigma K$	
$\Gamma_5$ $N\pi\pi$	30–40 %
$\Gamma_6$ $\Delta\pi$	5–15 %
$\Gamma_7$ $\Delta(1232)\pi$ , <i>P</i> -wave	6–14 %
$\Gamma_8$ $\Delta(1232)\pi$ , <i>F</i> -wave	<2 %
$\Gamma_9$ $N\rho$	3–15 %

$\Gamma_{10}$	$N\rho, S=1/2, F\text{-wave}$	
$\Gamma_{11}$	$N\rho, S=3/2, P\text{-wave}$	<12 %
$\Gamma_{12}$	$N\rho, S=3/2, F\text{-wave}$	1-5 %
$\Gamma_{13}$	$N(\pi\pi)_{S\text{-wave}}^{I=0}$	5-20 %
$\Gamma_{14}$	$p\gamma$	0.21-0.32 %
$\Gamma_{15}$	$p\gamma, \text{helicity}=1/2$	0.001-0.011 %
$\Gamma_{16}$	$p\gamma, \text{helicity}=3/2$	0.20-0.32 %
$\Gamma_{17}$	$n\gamma$	0.021-0.046 %
$\Gamma_{18}$	$n\gamma, \text{helicity}=1/2$	0.004-0.029 %
$\Gamma_{19}$	$n\gamma, \text{helicity}=3/2$	0.01-0.024 %

### **$N(1680)$ BRANCHING RATIOS**

#### **$\Gamma(N\pi)/\Gamma_{\text{total}}$ $\Gamma_1/\Gamma$**

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.6 to 0.7 OUR ESTIMATE</b>			
0.70±0.03	MANLEY	92	IPWA $\pi N \rightarrow \pi N \& N\pi\pi$
0.62±0.05	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
0.65±0.02	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.68	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
0.69±0.04	BATINIC	95	DPWA $\pi N \rightarrow N\pi, N\eta$

#### **$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow N(1680) \rightarrow N\eta$ $(\Gamma_1\Gamma_2)^{1/2}/\Gamma$**

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
not seen	BAKER	79	DPWA $\pi^- p \rightarrow n\eta$

#### **$\Gamma(N\eta)/\Gamma_{\text{total}}$ $\Gamma_2/\Gamma$**

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.01 ±0.004	BATINIC	95	DPWA $\pi N \rightarrow N\pi, N\eta$
0.0005 or 0.001	<sup>5</sup> CARRERAS	70	MPWA $t$ pole + resonance
0.0004	<sup>5</sup> BOTKE	69	MPWA $t$ pole + resonance
0.003 ±0.002	<sup>5</sup> DEANS	69	MPWA $t$ pole + resonance

#### **$\Gamma(N\eta)/\Gamma(N\pi)$ $\Gamma_2/\Gamma_1$**

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
<0.027	HEUSCH	66	RVUE $\pi^0, \eta$ photoproduction

#### **$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow N(1680) \rightarrow \Lambda K$ $(\Gamma_1\Gamma_3)^{1/2}/\Gamma$**

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.01	KNASEL	75	DPWA $\pi^- p \rightarrow \Lambda K^0$
-0.009±0.009	DEVENISH	74B	Fixed- $t$ dispersion rel.

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$  in  $N\pi \rightarrow N(1680) \rightarrow \Sigma K$   $(\Gamma_1 \Gamma_4)^{1/2} / \Gamma$   
VALUE DOCUMENT ID TECN COMMENT

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

<0.001 <sup>6</sup> DEANS 75 DPWA  $\pi N \rightarrow \Sigma K$

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  $\Delta(1232)\pi$ .

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$  in  $N\pi \rightarrow N(1680) \rightarrow \Delta(1232)\pi$ , *P-wave*  $(\Gamma_1 \Gamma_7)^{1/2} / \Gamma$   
VALUE DOCUMENT ID TECN COMMENT

**-0.31 to -0.21 OUR ESTIMATE**

-0.26 ± 0.04 MANLEY 92 IPWA  $\pi N \rightarrow \pi N \& N\pi\pi$   
 -0.27 <sup>1,7</sup> LONGACRE 77 IPWA  $\pi N \rightarrow N\pi\pi$   
 -0.25 <sup>2</sup> LONGACRE 75 IPWA  $\pi N \rightarrow N\pi\pi$

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

-0.38 <sup>8</sup> NOVOSELLER 78 IPWA  $\pi N \rightarrow N\pi\pi$

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$  in  $N\pi \rightarrow N(1680) \rightarrow \Delta(1232)\pi$ , *F-wave*  $(\Gamma_1 \Gamma_8)^{1/2} / \Gamma$   
VALUE DOCUMENT ID TECN COMMENT

**+0.03 to +0.11 OUR ESTIMATE**

+0.07 ± 0.03 MANLEY 92 IPWA  $\pi N \rightarrow \pi N \& N\pi\pi$   
 +0.07 <sup>1,7</sup> LONGACRE 77 IPWA  $\pi N \rightarrow N\pi\pi$   
 +0.08 <sup>2</sup> LONGACRE 75 IPWA  $\pi N \rightarrow N\pi\pi$

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

+0.05 <sup>8</sup> NOVOSELLER 78 IPWA  $\pi N \rightarrow N\pi\pi$

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$  in  $N\pi \rightarrow N(1680) \rightarrow N\rho$ , *S=3/2, P-wave*  $(\Gamma_1 \Gamma_{11})^{1/2} / \Gamma$   
VALUE DOCUMENT ID TECN COMMENT

**-0.30 to -0.10 OUR ESTIMATE**

-0.20 ± 0.05 MANLEY 92 IPWA  $\pi N \rightarrow \pi N \& N\pi\pi$   
 -0.23 <sup>1,7</sup> LONGACRE 77 IPWA  $\pi N \rightarrow N\pi\pi$   
 -0.30 <sup>2</sup> LONGACRE 75 IPWA  $\pi N \rightarrow N\pi\pi$

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

-0.34 <sup>8</sup> NOVOSELLER 78 IPWA  $\pi N \rightarrow N\pi\pi$

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$  in  $N\pi \rightarrow N(1680) \rightarrow N\rho$ , *S=3/2, F-wave*  $(\Gamma_1 \Gamma_{12})^{1/2} / \Gamma$   
VALUE DOCUMENT ID TECN COMMENT

**-0.18 to -0.10 OUR ESTIMATE**

-0.13 ± 0.03 MANLEY 92 IPWA  $\pi N \rightarrow \pi N \& N\pi\pi$   
 -0.15 <sup>1,7</sup> LONGACRE 77 IPWA  $\pi N \rightarrow N\pi\pi$

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow N(1680) \rightarrow N(\pi\pi)_{S\text{-wave}}^{I=0}$				$(\Gamma_1 \Gamma_{13})^{1/2} / \Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
<b>+0.25 to +0.35 OUR ESTIMATE</b>				
+0.29±0.04	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$
+0.31	<sup>1,7</sup> LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$
+0.30	<sup>2</sup> LONGACRE	75	IPWA	$\pi N \rightarrow N\pi\pi$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
+0.42	<sup>8</sup> NOVOSELLER	78	IPWA	$\pi N \rightarrow N\pi\pi$

## N(1680) PHOTON DECAY AMPLITUDES

### N(1680) → pγ, helicity-1/2 amplitude A<sub>1/2</sub>

VALUE (GeV <sup>-1/2</sup> )	DOCUMENT ID	TECN	COMMENT	
<b>-0.015±0.006 OUR ESTIMATE</b>				
-0.010±0.004	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
-0.017±0.018	CRAWFORD	83	IPWA	$\gamma N \rightarrow \pi N$
-0.009±0.006	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
-0.028±0.003	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 1)
-0.026±0.003	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 2)
-0.018±0.014	CRAWFORD	80	DPWA	$\gamma N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
-0.006±0.002	LI	93	IPWA	$\gamma N \rightarrow \pi N$
-0.005±0.015	BARBOUR	78	DPWA	$\gamma N \rightarrow \pi N$
-0.009±0.002	FELLER	76	DPWA	$\gamma N \rightarrow \pi N$

### N(1680) → pγ, helicity-3/2 amplitude A<sub>3/2</sub>

VALUE (GeV <sup>-1/2</sup> )	DOCUMENT ID	TECN	COMMENT	
<b>+0.133±0.012 OUR ESTIMATE</b>				
0.145±0.005	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
0.132±0.010	CRAWFORD	83	IPWA	$\gamma N \rightarrow \pi N$
0.115±0.008	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
0.115±0.003	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 1)
0.122±0.003	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 2)
0.141±0.014	CRAWFORD	80	DPWA	$\gamma N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
0.154±0.002	LI	93	IPWA	$\gamma N \rightarrow \pi N$
+0.138±0.021	BARBOUR	78	DPWA	$\gamma N \rightarrow \pi N$
+0.121±0.010	FELLER	76	DPWA	$\gamma N \rightarrow \pi N$

### N(1680) → nγ, helicity-1/2 amplitude A<sub>1/2</sub>

VALUE (GeV <sup>-1/2</sup> )	DOCUMENT ID	TECN	COMMENT	
<b>+0.029±0.010 OUR ESTIMATE</b>				
0.030±0.005	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
0.017±0.014	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
0.032±0.003	FUJII	81	DPWA	$\gamma N \rightarrow \pi N$
0.026±0.005	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 1)
0.028±0.014	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 2)
0.044±0.012	CRAWFORD	80	DPWA	$\gamma N \rightarrow \pi N$
0.025±0.010	TAKEDA	80	DPWA	$\gamma N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				

$0.022 \pm 0.002$	LI	93	IPWA	$\gamma N \rightarrow \pi N$
$+0.037 \pm 0.010$	BARBOUR	78	DPWA	$\gamma N \rightarrow \pi N$

### $N(1680) \rightarrow n\gamma$ , helicity-3/2 amplitude $A_{3/2}$

VALUE ( $\text{GeV}^{-1/2}$ )	DOCUMENT ID	TECN	COMMENT
<b>-0.033 ± 0.009 OUR ESTIMATE</b>			
-0.040 ± 0.015	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
-0.033 ± 0.013	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$
-0.023 ± 0.005	FUJII	81	DPWA $\gamma N \rightarrow \pi N$
-0.024 ± 0.009	ARAI	80	DPWA $\gamma N \rightarrow \pi N$ (fit 1)
-0.029 ± 0.017	ARAI	80	DPWA $\gamma N \rightarrow \pi N$ (fit 2)
-0.033 ± 0.015	CRAWFORD	80	DPWA $\gamma N \rightarrow \pi N$
-0.035 ± 0.012	TAKEDA	80	DPWA $\gamma N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
-0.048 ± 0.002	LI	93	IPWA $\gamma N \rightarrow \pi N$
-0.038 ± 0.018	BARBOUR	78	DPWA $\gamma N \rightarrow \pi N$

### $N(1680)$ FOOTNOTES

- <sup>1</sup> 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.
- <sup>2</sup> From method II of LONGACRE 75: eyeball fits with Breit-Wigner circles to the T-matrix amplitudes.
- <sup>3</sup> 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.
- <sup>4</sup> 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.
- <sup>5</sup> The parametrization used may be double counting.
- <sup>6</sup> The range given is from 3 of 4 best solutions; not present in solution 1. DEANS 75 disagrees with  $\pi^+ p \rightarrow \Sigma^+ K^+$  data of WINNIK 77 around 1920 MeV.
- <sup>7</sup> LONGACRE 77 considers this coupling to be well determined.
- <sup>8</sup> A Breit-Wigner fit to the HERNDON 75 IPWA.

### $N(1680)$ REFERENCES

For early references, see Physics Letters **111B** 70 (1982). For very early references, see Reviews of Modern Physics **37** 633 (1965).

ARNDT	96	PR C53 430	+Strakovsky, Workman	(VPI)
ARNDT	95	PR C52 2120	+Strakovsky, Workman, Pavan	(VPI, BRCO)
BATINIC	95	PR C51 2310	+Slaus, Svarc, Nefkens	(BOSK, UCLA)
Also	98	PR C57 1004 (erratum)	M. Batinic+	
HOEHLER	93	$\pi N$ 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
BELL	83	NP B222 389	+Blissett, Broome, Daley, Hart, Lintern+	(RL) IJP
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)
FUJII	81	NP B187 53	+Hayashii, Iwata, Kajikawa+	(NAGO, OSAK)

ARAI	80	Toronto Conf. 93		(INUS)
Also	82	NP B194 251	Arai, Fujii	(INUS)
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
SAXON	80	NP B162 522	+Baker, Bell, Blissett, Bloodworth+	(RHEL, BRIS) IJP
TAKEDA	80	NP B168 17	+Arai, Fujii, Ikeda, Iwasaki+	(TOKY, INUS)
BAKER	79	NP B156 93	+Brown, Clark, Davies, Depagter, Evans+	(RHEL) 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)
NOVOSELLER	78	NP B137 509		(CIT) IJP
Also	78B	NP B137 445	Novoseller	(CIT) IJP
BAKER	77	NP B126 365	+Blissett, Bloodworth, Broome, Hart+	(RHEL) IJP
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
HERNDON	75	PR D11 3183	+Longacre, Miller, Rosenfeld+	(LBL, SLAC)
KNASEL	75	PR D11 1	+Lindquist, Nelson+	(CHIC, WUSL, OSU, ANL) IJP
LONGACRE	75	PL 55B 415	+Rosenfeld, Lasinski, Smadja+	(LBL, SLAC) IJP
DEVENISH	74B	NP B81 330	+Froggatt, Martin	(DESY, NORD, LOUC)
CARRERAS	70	NP B16 35	+Donnachie	(DARE, MCHS)
BOTKE	69	PR 180 1417		(UCSB)
DEANS	69	PR 185 1797	+Wooten	(SFLA)
HEUSCH	66	PRL 17 1019	+Prescott, Dashen	(CIT)