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NATIONAL RADIO ASTRONOMY OBSERVATORY

QUARTERLY REPORT

January 1 - March 31, 1986

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A. TELESCOPE USAGE

The following telescopes have been scheduled for research and maintenance in the following manner during the first quarter of 1986.

	140-ft	300-ft	12-m	VLA
Scheduled observing (hrs)	1978.00	1972.75	1742.00	1605.0
Scheduled maintenance and equipment changes	105.75	114.50	99.25	223.9
Scheduled tests and calibrations	54.75	0.00	292.50	321.1
Time lost	213.75	11.50	363.75	
Actual observing	1819.00	1961.25	1378.25	1419.6

B. 140-FT OBSERVING PROGRAMS

The following continuum programs were conducted during this quarter.

No.	Observer(s)	Program
M-250	Maddalena, R.	Observations at 1.5 cm for star formation associated with very young molecular clouds.
S-283	Seielstad, G. Lehto, H. (Virginia)	Observations at 1.5 cm of periodic variations in OJ 287 and other extragalactic radio sources.
U-22	Uson, J.	Continue search at 19.5 GHz for small scale anisotropy of the microwave background.
U-23	Uson, J.	Observations of the Sunyaev-Zeldovich effect at 19.5 GHz.

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
A-77	Avery, L. (Herzberg Inst.) MacLeod, J. (Herzberg Inst.) Matthews, H. (Herzberg Inst.)	Observations at 1.25 cm of triangular molecules in dark clouds.
B-431	Batrla, W. (Illinois)	Observations at 1.2 cm of $^{15}NH3$ in cloud L1544 to precisely determine the ^{15}N to ^{14}N ratio.

No.	Observer(s)	Program
B-436	Batrla, W. (Illinois) Wilson, T. (MPIR, Bonn)	Observations at 1.26 cm of NH_3 at the Orion molecular cloud/HII region interface.
B-445	Batrla, W. (Illinois)	Search over the range 12-16 GHz and 18-25 GHz for molecular line transitions from Halley's Comet.
B-451	Baan, W. (NAIC) Haschick, A. (Haystack)	Observations at 1.6 cm of ammonia and methanol in megamaser galaxies.
I-5	Irvine, W. (Massachusetts) Friberg, P. (Chalmers) Hjalmarson, A. (Chalmers) Madden, S. (Massachusetts) Ziurys, L. (Massachusetts) Turner, B.	A 19-22 GHz spectral scan of molecular clouds, including particularly the cold clouds TMC-1 and L134N.
M-242	Matthews, H. (Herzberg Inst.) Avery, L. (Herzberg Inst.) Irvine, W. (Massachusetts) Thaddeus, P. (Inst. for Space Studies) Maddalena, R.	Observations at 18.2, 18.3, and 21.6 GHz of the ring molecule C_3H_2.
M-244	Myers, P. (CFA) Goodman, A. (CFA) Torrelles, J. (IAAG-Spain)	Observations of NH_3 at 23.694 GHz and C_3H_2 at 18.343 GHz in dense cores of dark clouds.
M-249	Maddalena, R. Morris, M. (Calif., Los Angeles) Yusef-Zadeh, F. (Columbia)	Observations at discrete frequencies over the range of 23.6-24.2 GHz for NH_3 emission from the arched continuum filaments of the galactic center.
S-289	Schloerb, F. (Massachusetts) Claussen, M. (Massachusetts)	Observations of the 18-cm OH transitions in Halley's Comet.
X-41	Maddalena, R.	Observations of OH in Orion filaments at 18 cm.
Z-50	Ziurys, L. (Massachusetts) Turner, B.	Observations at 1.6 cm for interstellar nitric acid.

The following very long baseline programs were conducted, and the stations used for the observations are coded as follows:

A – Arecibo 1000 ft	Lm – Medicina 32 m
B – Effelsberg, MPIR 100 m	N – NRL Maryland PT 85 ft
F – Fort Davis 85 ft	O – Owens Valley 130 ft
G – Green Bank 140 ft	R – Crimea USSR 30 m
H – Hat Creek 85 ft	Sn – Onsala 20 m
I – Iowa 60 ft	So – Onsala 25 m
Jb – Jodrell Bank Mk II	T – Torun 15 m
Jm – Jodrell Bank 250 ft	Wn – Westerbork n=1–14x26 m
Km – Haystack 120 ft	Yn – Socorro n=1–27x25 m
Lb – Bologna 25 m	

No.	Observer(s)	Program
B-64V	Bloemhof, E. (CFA) Moran, J. (CFA) Reid, M. (CFA)	Observations at 18 cm of W30H, 3C 84, and NRAO 150, with telescopes F, G, H, Jb, Km, O, and Yn.
B-67V	Backer, D. (Berkeley) Plambeck, R. (Berkeley) Readhead, A. (Caltech) van Breugel, W. (Berkeley)	Observations at 1.3 cm of the structure of compact components in NGC 1275, with telescopes B, G, Km, O, Sn, and Yn.
C-32V	Cotton, W. Baath, L. (Chalmers) Geldzahler, B. (NRL)	Observations at 92 cm of optically quiet quasars, with telescopes G, H, Jb, Km, N, O, Wn, and Yn.
C-41V	Corey, B. (Haystack) Jones, D. (JPL) Shapiro, I. (CFA) Whitney, B. (Haystack)	Observations at 1.3 cm for source structure changes in 0235+164 and 0234+285, with telescopes B, G, Km, N, O, Sn, and Yn.
D-11V	Davis, R. (Manchester) Conway, R. (Manchester) Porcas, R. (MPIR, Bonn) Unwin, S. (Caltech)	Observations at 18 cm of the 70 mas jet of 3C 273, with telescopes A, B, F, G, Jb, Km, R, So, Wn, and Yn.
G-47V	Gwinn, C. (CFA) Bartel, N. (CFA) Cordes, J. (Cornell) Mutel, R. (Iowa) Wolszczan, A. (Arecibo)	Observations at 92 cm of pulsar interstellar scattering, with telescopes A, F, G, I, Jm, Km, N, O, and Wn.
G-49V	Greybe, A. (MPIR, Bonn) Porcas, R. (MPIR, Bonn)	Observations at 2.8 cm of sources exhibiting variable polarization, with telescopes B, G, Km, Lm, and O.

No.	Observer(s)	Program
H-24V	Hough, D. (Caltech) Readhead, A. (Caltech)	Observations at 2.8 cm of the central components of the double-lobed quasars 3C 245 and 3C 207, with telescopes B, G, Km, and O.
L-33V	Lo, K. (Caltech) Backer, D. (Berkeley) Cohen, M. (Caltech) Johnston, K. (NRL) Moran, J. (CFA) Ekers, R. Kellermann, K.	Mapping at 1.35 cm of the Sgr A compact radio source, with telescopes G, Km, N, O, and Yn.
L-41V	Lestrade, J-P. (JPL) Mutel, R. (Iowa) Niell, A. (JPL) Preston, R. (JPL)	Observations at 2.8 cm of core motions in three RS CVn binary systems, with telescopes B, G, Km, and O.
L-43V	Lawrence, C. (Caltech) Burke, B. (MIT) Booth, R. (Chalmers) Linfield, R. (JPL) Payne, D. (JPL) Porcas, R. (MPIR, Bonn) Preston, R. (JPL) Readhead, A. (Caltech) Schilizzi, R. (NFRA)	Survey of strong sources at 1.3 cm, with telescopes B, G, Km, O, Sn, and Yn.
M-63V	Mutel, R. (Iowa) Phillips, R. (Haystack)	Monitor at 2.8 cm of superluminal motion in BL Lac, with telescopes B, F, G, H, Km, and O.
M-67V	Marcaide, J. (MPIR, Bonn)	Observations at 2.8 cm of 4C 39.25, with telescopes B, F, G, H, Km, Lm, and O.
M-70V	Mutel, R. (Iowa) Cordes, J. (Cornell) Spangler, S. (Iowa)	Observations at 18 cm of angular broadening in the vicinity of the Cygnus Superbubble, with telescopes B, G, H, I, Jb, Km, O, So, and Yn.
M-73V	Mantovani, F. (Bologna) Fanti, R. (Bologna) Ficarra, A. (Bologna) Padrielli, L. (Bologna)	Observations at 18 cm of steep spectrum radio sources showing low-frequency variability, with telescopes B, F, G, Jb, Km, Lm, O, So, and Wn.
M-75V	Mutel, R. (Iowa) Bucciferro, R. (Iowa) Hodges, M. (Caltech) Phillips, R. (Haystack)	Investigation at 18 cm of two new compact doubles, with telescopes B, F, G, H, I, Jb, Km, Lm, O, So, Wn, and Yn.

No.	Observer(s)	Program
M-255V	Mutel, R. (Iowa) Hodges, M. (Caltech) Krishna, G. (Tata, India)	Observations at 18 cm of peaked spectrum radio sources, with telescopes G, I, and O.
P-66V	Pauliny-Toth, I. (MPIR, Bonn) Porcas, R. (MPIR, Bonn) Porcas, R. (MPIR, Bonn) Zensus, A. (Caltech) Kellermann, K.	Monitor at 2.8 cm of 3C 454.3, with telescopes B, G, Km, and O.
P-68V	Porcas, R. (MPIR, Bonn)	Observations at 2.8 cm of the superluminally expanding quasar 3C 179, with telescopes B, G, Km, and O.
P-69V	Pauliny-Toth, I. (MPIR, Bonn) Porcas, R. (MPIR, Bonn)	Observations at 92 cm of the hotspot and jet in 3C 454.3, with telescopes F, G, Jb, Km, O, R, T, and Wn.
R-39V	Reid, M. (CFA) Bloemhof, E. (CFA) Genzel, R. (Berkeley) Gwinn, C. (CFA) Moran, J. (CFA) Schneps, M. (CFA)	Observations at 1.3 cm to determine the distance to the galactic center region via a statistical parallax of the Sgr B2 H_2O masers, with telescopes G, Km, O, and Yn.
S-52V	Schilizzi, R. (NFRA) Barthel, P. (Caltech) Hooimeyer, J. (Leiden) Miley, G. (STScI)	Observations at 2.8 cm of compact cores in extended quasars, with telescopes B, F, G, H, Km, Lm, and O.
S-53V	Simon, R. (NRL) Rickett, B. (Calif., San Diego) Cotton, W.	Observations at 92 cm of the refractive scintillation model for low-frequency variability, with telescopes F, G, H, I, Jb, Km, N, O, Wn, and Yn.
S-54V	Schalinski, C. (MPIR, Bonn) Eckart, A. (MPIR, Bonn) Johnston, K. (NRL) Krichbaum, T. (MPIR, Bonn) Simon, R. (NRL) Witzel, A. (MPIR, Bonn)	Search at 92 cm for subarcsecond structures in four S5 sources, with telescopes F, G, H, Jb, Km, N, O, and Wn.
S-58V	Spangler, S. (Iowa) Cordes, J. (Cornell) Mutel, R. (Iowa) Benson, J.	Observations at 92 cm of a source near the supernova remnant HB 9, with telescopes F, G, H, I, Jb, N, O, Wn, and Yn.

No.	Observer(s)	Program
W-41V	Wilkinson, P. (Manchester) Conway, J. (Manchester)	Combined array imaging at 18 cm of 3C 371 with telescopes B, F, G, H, Jb, Km, Lb, N, O, R, So, Wn, and Yn.
X-39V	Walker, R. C. Unwin, S. (Caltech) Benson, J. Seielstad, G.	Monitor at 2.8 cm of 3C 120 with telescopes, F, G, H, Km, and O.
X-40V	van Breugel, W. (Berkeley) Fanti, C. (Bologna) Parma, P. (Bologna) Schilizzi, R. (NFRA)	Observations at 18 cm of three compact steep spectrum quasars, with telescopes B, G, H, I, Jb, Km, O, Sn, Wn, and Yn.
X-42V	Altschuler, A. (Pennsylvania) Dennison, B. (NRL) Graham, D. (MPIR, Bonn)	Observations at 326-328 MHz to test for different models of variable radio sources, with telescopes F, G, I, Jb, Km, N, O, Wn, and Yn.
Z-11V	Zensus, A. (Caltech) Biretta, J. (Caltech) Cohen, M. (Caltech) Unwin, S. (Caltech) Wrobel, J. (NMIMT)	Observations at 2.9 cm of kinematics and polarization of 3C 345, with telescopes B, F, G, Km, Lm, and O.

C. 300-FT OBSERVING PROGRAM

The following continuum programs were conducted during this quarter.

No.	Observer(s)	Program
A-59	Aller, H. (Michigan) Aller, M. (Michigan) Fanti, R. (Bologna) Ficarra, A. (Bologna) Mantovani, F. (Bologna) Padrielli, L. (Bologna)	Observations at 1400 and 2695 MHz of low-frequency variable sources selected from the Bologna-Michigan program.
B-412	Burke, B. (MIT) Carilli, C. (MIT) Heflin, M. (MIT) Langston, G. (MIT)	Observations at 6 cm to continue the MIT-Green Bank survey at $\delta = 20 < \delta < 45$.
E-51	Erickson, W. (Maryland) Kassim, N. (Maryland) Knowles, S. (NRL)	Observations at 396 and 606 MHz for radio pulsations in 0314+577.

No.	Observer(s)	Program
O-32	O'Dea, C. Balonek, T. (Colgate) Dent, W. (Massachusetts) Kinzel, W. (Massachusetts)	Polarization and flux density measurements of variable sources at 2695 MHz.

The following programs were conducted during this quarter.

No.	Observer(s)	Program
B-441	Bushouse, H. (Illinois) Gallagher, J. (KPNO)	Hydrogen emission-line survey of strongly interacting galaxies.
T-195	Tifft, W. (Arizona) Cocke, W. (Arizona)	Observations at 21 cm to obtain precision redshifts and profile widths.
T-198	Thuan, T. (Virginia) Schneider, S. (Virginia)	Survey of dwarf galaxies in the Nilson Catalog for neutral hydrogen and to determine redshifts.
U-21	Uson, J. Fisher, J. R.	Search over the range of 280-350 MHz for redshifted hydrogen from Zeldovich pancake objects.

The following pulsar program was conducted during this quarter.

No.	Observer(s)	Program
D-139	Dewey, R. (Cornell) Stokes, G. (Princeton) Taylor, J. (Princeton) Weisberg, J. (Princeton)	Monitoring at 390 MHz of the timing of pulsars discovered in the Princeton-NRAO survey.

D. 12-M OBSERVING PROGRAM

The following programs were conducted during this quarter.

No.	Observer(s)	Program
B-437	Barvainis, R. Antonucci, R.	Observations at 1 and 3-mm of radio quiet quasars detected by IRAS.
B-438	Black, J. (Arizona) Thronson, H. (Wyoming) Hayward, T. (Wyoming)	Study of the NML Cygni molecular cloud.

No.	Observer(s)	Program
B-444	Brown, R. Heeschen, D.	1.4-mm continuum observations of circumstellar shells.
B-447	Bogey, M. (Lille, France) Combes, F. (Meudon, France) Encrenaz, T. (Meudon, France) Gerin, M. (Meudon, France) Wootten, H. A.	Search for 307 and 364-GHz lines of H_3O^+ ion in the interstellar medium.
D-142	Deul, E. R. (Leiden) Burton, W. B. (Leiden)	Study of holes observed in the ISM of M33; empty or full?
E-50	Emerson, D. (IRAM, France) Jewell, P. Martin, R. (Arizona) Salter, C. (IRAM, France)	A complete survey of ^{12}CO emission from M31.
G-276	Gordon, M. Jewell, P. Salter, C. Kaftan-Kassim, M. (unaffiliated)	Study of dust emission from Orion A and other HII regions.
G-287	Gear, W. (Preston Poly.) Robson, E. (Preston Poly.) Marscher, A. (Boston) Ade, P. (Queen Mary College) Brown, L. (Preston Poly.)	Multifrequency continuum measurements of a sample of Blazars.
H-206	Ho, P. (CFA) Turner, J. (CFA) Martin, R. (Arizona)	J=3-2 CO line study of the galactic center.
H-207	Ho, P. (CFA) Martin, R. (Arizona) Turner, J. (CFA)	J=3-2 CO survey of nearby external galaxies.
H-212	Heckman, T. (Maryland) Blitz, L. (Maryland) Wilson, A. (Maryland) Miley, G. (STScI)	J=1-0 and 2-1 CO emission in bright, nearby Seyfert galaxies.
H-214	Heiles, C. (Berkeley)	Investigation of IRAS "cirrus" point sources.
H-218	Hollis, J. (GSFC-NASA) Churchwell, E. (Wisconsin) DeLucia, F. (Duke) Herbst, E. (Duke)	A search for H_3O^+.

No.	Observer(s)	Program
I-4	Israel, F. (Leiden) Burton, W. B. (Leiden)	CO observations of dwarf galaxies.
J-115	Jewell, P. Salter, C. (IRAM) Schenewerk, M. (Illinois) Snyder, L. (Illinois)	Observations of 345-GHz CO in evolved stars.
M-215	Myers, P. (CFA) Moran, J. (CFA) Reid, M. (CFA)	Measurement of millimeter-wave flux from Vega.
M-239	Maloney, P. (Arizona) Black, J. (Arizona)	CO J=2-1 observations of starburst galaxies.
M-257	Margulis, M. (Arizona)	Observations of an IRAS serendipity source.
R-220	Rickard, L. J (Howard) Schwartz, P. (NRL)	Search for thermal Bremsstrahlung emission from galaxies.
R-225	Rodriguez, L. (Mexico) Torrelles, J. (Mexico) Canto, J. (Mexico) Ho, P. (CFA) Moran, J. (CFA)	CO mapping of high-velocity gas associated with source of HH1 and 2.
R-229	Rickard, L. J (NRL) Fischer, J. (NRL)	High-resolution study of the Lynds 1592/93 IRAS source.
S-290	Sahai, R. (Texas) Howe, J. (Texas)	A search for SO in oxygen-rich circumstellar envelopes.
S-293	Sandqvist, A. (Stockholm) Elfhag, T. (Stockholm) Joersaeter, S. (Stockholm) Lindblad, P. (Stockholm)	Observations of the J=2-1 CO line in Seyfert galaxy, NGC 1365.
T-197	Thronson, H. (Wyoming)	Study of 1-mm continuum emission from galaxies.
W-200	Walker, C. (Arizona) Lada, C. (Arizona) Margulis, M. (Arizona) Young, E. (Arizona) Wilking, B. (Missouri)	Search for energetic outflows in Ophiuchus.

No.	Observer(s)	Program
Z-52	Ziurys, L. (Massachusetts) Turner, B.	Searches and confirmations of vibrationally-excited molecules.
Z-53	Ziurys, L. (Massachusetts) Turner, B. Evenson, K. (Colorado) Luipold, K. (Colorado) Zink, L. (Colorado)	A search for interstellar MgH (N=1->0).
Z-56	Ziurys, L. (Massachusetts) Turner, B.	Search for H_3O^+ at 307 GHz.

E. VERY LARGE ARRAY OBSERVING PROGRAM

The following 153 research programs were conducted with the VLA during this quarter.

No.	Observer(s)	Program
AA-52	Alexander, P. (Cambridge) Eales, S. (Hawaii) Pooley, G. (Cambridge)	Structural evolution in high-redshift quasars and galaxies. 2, 6, and 20 cm.
AB-129	Burke, B. (MIT) Hewitt, J. (MIT) Roberts, D. (Brandeis)	Time variations in 0957+561. 6 cm.
AB-318	Brown, A. (Colorado) Drake, S. (Goddard) Walter, F. (Colorado)	Southern PMS stars. 6 cm.
AB-347	Brown, A. (Colorado) Mundt, R. (MPI, Heidelberg) Drake, S. (Goddard)	Extended microwave-emitting regions around HL and XZ Tau. 2 cm.
AB-351	Birkinshaw, M. (CFA) Moffet, A. (Caltech)	Radio sources confusing observations of the microwave background decrement. 2 and 6 cm.
AB-353	Bhattacharya, D. (Raman Inst.) Srinivasan, G. (Raman Inst.) van Gorkom, J. (Princeton)	H110α-recombination line toward compact sources in the Galactic plane. 6-cm line.
AB-357	Becker, R. (Calif, Davis) White, R. (STScI)	Monitoring the radio flux of the radio star HD193793. 6 cm.

No.	Observer(s)	Program
AB-367	Bode, M. (Manchester) Seaquist, E. (Toronto) Evans, A. (Keele, UK) Albinson, J. (Keele, UK)	Follow-up survey of extended nova remnants. 6 and 20 cm.
AB-368	Baan, W. (Arecibo) Gusten, R. (Berkeley/MPIR, Bonn) Haschick, A. (Haystack)	The H_2CO maser in IC 4553. 6-cm line.
AB-369	Bridle, A. Browne, I. (Jodrell Bank) Burns, J. (New Mexico) Dreher, J. (MIT) Hough, D. (Caltech) Laing, R. (RGO) Owen, F. Readhead, A. (Caltech) Scheuer, P. (Cambridge) Wardle, J. (Brandeis) Lonsdale, C. (Penn State)	Sidedness of jets in high-luminosity sources. 6 cm.
AB-370	Bushouse, H. (Illinois/NOAO) Gallagher, J. (NOAO)	Survey of strongly interacting galaxies. 20 cm.
AB-373	Bowers, P. (NRL) Johnston, K. (NRL)	OH/IR stars. 18-cm line.
AB-376	Baum, S. Bridle, A. Heckman, T. (Maryland) Miley, G. (STScI) van Breugel, W. (Berkeley)	Complete sample of equatorial extra-galactic radio sources. 2, 6, 18, and 20 cm.
AB-381	Beckwith, S. (Caltech/Cornell) Cordes, J. (Cornell) Sargent, A. (Caltech)	Young stellar object HL Tau: search for dust emission. 1.3 cm.
AB-382	Brown, A. (Colorado)	Variability of CQ Dra: a red giant "AM Her" system? 6 cm.
AB-383	Bookbinder, J. (Colorado) Lamb, D. (Chicago)	Monitoring radio emission from AE Aqr. 6 and 20 cm.
AB-384	Bookbinder, J. (Colorado) Golub, L. (CFA)	Search for radio emission from K and M stars. 6 cm.
AB-385	Barsony, M. (Caltech) Scoville, N. (Caltech)	R Mon star-forming region. 1.3, 2, and 6 cm.

No.	Observer(s)	Program
AB-386	Bottinelli, L. (Meudon) Gouguenheim, L. (Meudon) Le Squeren, A. (Meudon) Martin, J. (Meudon) Dennefeld, M. (Inst. Astrophys.,Paris)	OH megamaser in IRAS 17208-0014. 18 and 20-cm line.
AB-391	Boisse, P. (Ecole Normale, Paris) Kazes, I. (Meudon) Bergeron, J. (Inst. de Ap., Paris) Dickey, J. (Minnesota)	HI absorption in QSO galaxy pairs. 20-cm line.
AC-101	Condon, J.	Continuum survey of bright spiral galaxies. 20 cm.
AC-138	Christiansen, W. (North Carolina) Stocke, J. (Steward Obs.)	Helical jet in 3C 436. 6 and 20 cm.
AC-146	Churchwell, E. (Wisconsin) Felli, M. (Arcetri) Massi, M. (Arcetri)	Orion A. 6 and 20 cm.
AC-148	Cameron, R. (Austr. Nat. U.) Parma, P. (Bologna) de Ruiter, H. (Bologna)	Structure of dumbbell radio galaxies. 6 cm.
AC-150	Conway, J. (NRAL) Wilkinson, P. (NRAL) Cornwell, T.	Complementary VLA/MERLIN observations of 3C sources. 6 and 18 cm.
AC-151	Caillault, J-P. (Colorado)	BY Draconis variables. 6 cm.
AC-152	Chance, D. (Columbia) Yusef-Zadeh, F. (Columbia)	Filamentary features in the outer Orion Nebula. 6 and 20 cm.
AD-166	Dulk, G. (Colorado) Bastian, T. (Colorado) Lang, K. (Tufts) Willson, R. (Tufts)	Solar transition region and Corona. 6 and 20 cm.
AD-167	de Pater, I. (Berkeley) Ip, W-H. (MPI, Lindau) Snyder, L. (Illinois) Palmer, P. (Chicago) Bolton, S. (Berkeley)	Radio source occultations by Comet Halley. 18 and 20-cm line.
AD-173	Dickey, J. (Minnesota) Salpeter, E. (Cornell)	HI in galaxies in the cluster A400. 20-cm line.

No.	Observer(s)	Program
AD-176	Davies, R. (Jodrell Bank) Hummel, E. (MPI, Bonn) Pedlar, A. van der Hulst, J. (NFRA) Wolstencroft, R. (ROE)	Nuclei of Sbc galaxies. 20 cm.
AD-177	Duric, N. (British Columbia) Seaquist, E. (Toronto) Irwin, J. (Toronto) Crane, P.	NGC 3079. 2, 6 and 20 cm.
AD-178	Drake, S. (Goddard) Simon, T. (Hawaii) Linsky, J. (Colorado)	Radio survey of confirmed and proposed RS Canum venaticorum binaries. 6 cm.
AD-179	Djorgovski, S. (CFA) Spinrad, H. (Berkeley) Perley, R.	A galaxy with z = 3.218. 20 cm.
AE-40	Emerson, D. (IRAM) Forveille, T. (IRAM) Weliachew, L. (IRAM)	Compact HII regions in Cep A. 1.3, 2 and 6 cm.
AE-42	Ekers, R. Fanti, R. (Bologna) Fanti, C. (Bologna) Parma, P. (Bologna)	B2 1637+28. 6 cm.
AE-43	Elston, R. (Steward Obs.)	Three interacting galaxies with extended radio emission. 2 cm.
AE-44	Erickson, W. (Maryland) Mahoney, M. (Maryland) Kassim, N. (Maryland)	0314+577. 90 cm.
AE-45	Ekers, R. Sramek, R. Cowan, J. (Oklahoma) Branch, D. (Oklahoma) Goss, W. M. (Groningen)	Search for very young SNRs. 2 and 20-cm line.
AF-113	Feigelson, E. (Penn State) Clarke, D. (New Mexico) Burns, J. (New Mexico)	Search for motion in the jet knots of Centaurus A. 2 and 6 cm.
AF-116	Feigelson, E. (Penn State)	Multi-band observations of rapidly variable BL Lac H0323+022. 2, 6, and 20 cm.

No.	Observer(s)	Program
AF-117	Fomalont, E. Geldzahler, B. (NRL)	Sco X-1. 6 and 20 cm.
AF-119	Feldman, P. (Herzberg) Bopp, B. (Toledo)	FK Comae stars. 2 and 6 cm.
AF-120	Florkowski, D. (USNO) Johnston, K. (NRL)	Search for radio emission stars from two Cyg X-3 -like binaries: 2A/4U 1822-371 and 4U 2129+470. 6 cm.
AG-116	Gibson, D. (NMIMT) Priedhorsky, W. (Los Alamos)	Search for 300-day periodicity in Cyg X-1. 2, 6 and 20 cm.
AG-145	Geldzahler, B. (NRL) Schwartz, P. (NRL) Gear, W. (Queen Mary College) Ade, P. (Queen Mary College) Robson, I. (UKIRT) Nolt, I. (Oregon) Smith, M. (ROE)	Spectra of Blazars. 1.3, 2, 6, and 20 cm.
AG-191	Gavazzi, G. (Milano) Jaffe, W. (STScI)	Coma/A1367 supercluster survey. 20 cm.
AG-205	Garay, G. (ESO, FRG) Andersson, M. (Onsala)	Ammonia observations of the hot molecular gas associated with the ultracompact HII region G34.3+0.2. 1.3-cm line.
AG-206	Gardner, F. (CSIRO) Whiteoak, J. (CSIRO)	Galaxy NGC 5793. 2 and 6 cm.
AG-208	Geldzahler, B. (NRL)	Low-mass X-ray binaries. 6 cm.
AG-210	Gwinn, C. (CFA) Bartel, N. (CFA)	Search for reference sources for pulsar astrometry. 2, 6 and 20 cm.
AG-211	Gwinn, C. (CFA) Reid, M. (CFA) Moran, J. (CFA) Bloemhof, E. (CFA)	Search for reference sources for maser astrometry. 1.3, 6 and 20 cm.
AH-195	Hjellming, R. Davis, R. (Jodrell Bank)	Recurrent nova RS Oph. 1.3, 2, 6, and 20 cm.
AH-201	Hintzen, P. (NASA-GSFC) Owen, F.	Survey of radio QSOs to identify distorted sources. 20 cm.

No.	Observer(s)	Program
AH-206	Helfand, D. (Columbia) Becker, R. (Calif, Davis) Zoonermatkermani, S. (Columbia)	Field surrounding G12.0-0.1: a cluster of supernova remnants? 21-cm line.
AH-207	Helou, G. (Caltech) Salpeter, E. (Cornell) Hoffman, G. (Lafayette College)	HI mapping irregular and dwarf galaxies. 21-cm line.
AH-210	Ho, P. (CFA) Haschick, A. (Haystack Obs) Klein, R. (Berkeley)	Dynamics of ionized gas surrounding OB clusters. 6-cm line.
AH-214	Higdon, J. (Texas)	HI in ring galaxies. 21-cm line.
AH-218	Ho, P. (CFA) Heiles, C. (Berkeley)	Survey for OH emission in magnetic(?) disk-like structures. 18-cm line.
AH-222	Hardy, E. (Univ. Laval) Noreau, L. (Univ. Laval)	HI environment of high redshift quasars. 90-cm line.
AH-223	Harrison, B. (Jodrell Bank) Unger, S. (Jodrell Bank) Pedlar, A. Axon, D. (Jodrell Bank)	NGC 7674. 2 cm.
AH-224	Hjellming, R. Johnston, K. (NRL) Schilizzi, R. (NFRA)	High-resolution imaging of the S 443 radio source. 2 and 6 cm.
AH-225	Hjellming, R. Davis, R. (Jodrell Bank)	Radio remnant of the Jan 1985 outburst of RS Oph. 2 cm.
AH-226	Hjellming, R.	Radio-source evolution in VV Cep-type binaries. 2, 6 and 20 cm.
AH-227	Hjellming, R.	1741-038: a rapid "scintillator." 1.3, 2, 6, 20 and 90 cm.
AI-24	Irwin, J. (Toronto) Seaquist, E. (Toronto) Duric, N. (British Columbia) Taylor, A. (Groningen)	Neutral-hydrogen observations of NGC 3079. 21-cm line.
AJ-129	Joseph, R. (Imperial College) Collins, C. (Imperial College)	Discovery of a primeval galaxy? 6 and 20 cm.

No.	Observer(s)	Program
AJ-130	Johnston, K. (NRL) Wadiak, E. J. Rood, R. (Virginia) Wilson, T. (MPI, Bonn)	Protostars in Orion: Formaldehyde in the peaks north of BN/KL. 2-cm line.
AJ-131	Johnston, K. (NRL) Florkowski, D. (USNO) deVegt, C. (Hamburger Stern.,FRG) Wade, C.	Parallax of the nearby stars: HR 5510, search for comparison sources. 20 cm.
AJ-133	Johnston, K. (NRL) Florkowski, D. (USNO) Wade, C. de Vegt, C. (Hamburger Stern., FRG)	Relationship of the radio and optical reference frames. 6 cm.
AJ-134	Johnston, K. (NRL) Eckart, A. (Arizona) Witzel, A. (MPI, Bonn) Schalinski, C. (MPI, Bonn)	Search for extended structure in bright S5 sources. 20 cm.
AJ-137	Jauncey, D. (CSIRO) White, G. (CSIRO) Johnston, K. (NRL)	Complementary high-resolution observations of gravitational lens candidates. 2 and 6 cm.
AK-132	Kazes, I. (Paris Obs) Dickey, J. (Minnesota)	Extragalactic OH absorption in B2 1506+34. 21-cm line.
AK-133	Keto, E. (CFA) Ho, P. (CFA) Haschick, A. (Haystack)	Spin-up and accretion in molecular cloud cores around OB clusters. 1.3-cm line.
AK-139	Kapahi, V. (Tata) Kulkarni, V. (Tata)	Epoch dependence of the sizes and spectra of radio galaxies. 20 cm.
AK-140	Kailey, W. (Steward Obs.) Elston, R. (Steward Obs.)	Search for supernova remnants near the nucleus of M33. 6 cm.
AK-141	Kronberg, P. (Toronto)	Polarization of quasars from the Molongolo survey. 1.3, 2, 6 and 20 cm.
AK-142	Kwok, S. (Calgary) Aaquist, O. (Calgary)	Radio survey of compact planetary nebulae. 2 and 6 cm.
AL-95	Lane, A. (Boston) Reynolds, S. (N. C.State) White, N. (ESOC)	Simultaneous radio, X-ray, and UV observations of flares from RS CVn stars and Algol. 2, 6, and 20 cm.

No.	Observer(s)	Program
AL-107	Little, L. (Kent, UK) Heaton, B. (Kent, UK) Davies, S. (Kent, UK) Dent, W. (Kent, UK)	Interactions of HII regions and stellar winds with surrounding molecular material. 1.3-cm line.
AL-108	Liszt, H. Briggs, F. (Pittsburgh) Wolfe, A. (Pittsburgh)	Search for H_2CO absorption at z = 2.04 towards PKS0458-02. 18-cm line.
AL-109	Liszt, H.	Sgr C. 6 cm.
AL-110	Lyne, A. (Jodrell Bank) Goss, W. M. (Groningen)	Two young pulsars. 20 cm.
AL-111	Lake, G. (Bell Labs) Schommer, R. (Rutgers) van Gorkom, J. (Princeton)	Rotation curve of NGC 5666. 20-cm line.
AL-112	Lake, G. (Bell Labs) Schommer, R. (Rutgers) van Gorkom, J. (Princeton)	Rotation curves of dwarf galaxies. 21-cm line.
AL-114	Lang, K. (Tufts) Willson, R. (Tufts)	Compact, transient sources on the sun. 2 cm.
AL-115	Lang, K. (Tufts) Willson, R. (Tufts)	Search for microwave radiation from magnetic stars. 6 and 20 cm.
AL-116	Lang, K. (Tufts) Willson, R. (Tufts)	Dwarf M flare stars YZ CMi, UV Ceti, YY Gem, Wolf 630. 20 cm.
AM-124	McHardy, I. (Leicester) Warwick, R. (Leicester) Smith, A. (ESTEC)	Coordinated radio, optical and X-ray observations of OVVs and BL Lacertae objects. 2, 6 and 20 cm.
AM-157	Mirabel, I. (Puerto Rico) Rodriguez, L. (UNAM) Canto, J. (UNAM) Ruiz, A. (Puerto Rico)	High-velocity OH in absorption toward selected sources. 18-cm line.
AM-168	Mutel, R. (Iowa) Morris, D. (Iowa) Collier, A. (Cambridge) Lestrade, J-P. (B. de Long., Paris)	Test of radio luminosity - Rossby number correlation in close binary systems. 6 cm.
AM-169	Masson, C. (Caltech)	Evolution of compact HII regions. 1.3 and and 2 cm.

No.	Observer(s)	Program
M-170	Morris, M. (Calif, Los Angeles) Yusef-Zadeh, F. (Columbia)	Radio extensions and the fine-scale structure of Sgr A. 2 and 6 cm.
AN-36	Neff, S. (Goddard) Hanisch, R. (STScI) Kassim, N. (Maryland)	Seyfert and related objects. 90 cm.
AO-61	Oznovich, I. (NMIMT) Gibson, D. (NMIMT)	Magnetic activity in five late-type giants and supergiants. 6 cm.
AO-62	O'Donoghue, A. (NMIMT) Owen, F. Eilek, J. (NMIMT)	Wide angle tail sources. 20 cm.
AO-64	Owen, F.	Large-scale structure of M87. 18 and 20 cm.
AO-70	O'Dea, C. Barvainis, R.	Polarization observations of core-dominated sources. 2 and 6 cm.
AP-108	Phillips, J. (Queen Mary College) Mampaso, A. (IAC, SPAIN)	Core mapping of post-main-sequence bipolars. 2, 6, and 20 cm.
AP-109	Partridge, R. B. (Haverford) Windhorst, R. (Mt. Wilson)	Spectral indices of mJy and sub-mJy sources. 6 cm.
AP-110	Pottasch, S. (Groningen) Bignell, R. C. Zijlstra, A. (Groningen)	Survey of planetary nebulae. 6 and 20 cm.
AP-111	Pedlar, A. Ekers, R. van Gorkom, J. (Princeton) Anantharamaiah, K.	Galactic centre. 90-cm line.
AP-112	Pedlar, A. Perley, R. Crane, P. Davies, R. (Jodrell Bank)	NGC 1275. 90 cm.
AP-113	Parsons, S. (STScI) Bopp, B. (Toledo) Feldman, P. (Herzberg)	Radio observations of luminous F supergiants and giants with hot binary companions. 2 and 6 cm.
AP-114	Pedelty, J. (Minnesota) Rudnick, L. (Minnesota) Spinrad, H. (Berkeley) van Breugel, W. (Berkeley)	Extended extra-nuclear emission-line gas in 3C 337. 2 and 6 cm.

No.	Observer(s)	Program
AR-119	Rao, A. (TIFR) Subrahmanyan, R. (TIFR)	Double source showing peaked spectrum. 6 cm.
AR-131	Rodriguez, L. (UNAM) Torrelles, J. (UNAM) Canto, J. (UNAM) Curiel, S. (UNAM) Ho, P. (CFA) Pravdo, S. (JPL)	Herbig-Haro 1 and 2 region. 2 and 6 cm.
AR-135	Rickard, L. J (NRL) Turner, B.	1667-MHz "Megamaser" in UGC 8696. 18-cm line.
AR-138	Rickard, L. J (NRL) Weiland, J. (Maryland) Hauser, M. (Goddard) Magnani, L. (Maryland) Blitz, L. (Maryland)	Study of the HI structures of high-latitude molecular clouds. 21-cm line.
AR-139	Reid, M. (CFA) Moran, J. (CFA) Gwinn, C. (CFA) Schneps, M. (CFA) Genzel, R. (Berkeley)	Distance to the Galactic center region via a statistical parallax of the Sgr B2 H_2O masers. 1.3-cm single antenna VLB.
AR-146	Rodriguez, L. (UNAM)	Dwarf novae. 2 and 6 cm.
AS-80	Sramek, R. van der Hulst, J. (NFRA) Weiler, K. (NRL)	Supernovae SN1980 in NGC 6946 and SN1979c in M100. 6 and 20 cm.
AS-211	Sramek, R. Weiler, K. (NSF) van der Hulst, J. (NFRA) Panagia, N. (STScI)	Statistical properties of radio supernovae. 2, 6, and 20 cm.
AS-246	Schmelz, J. (Arecibo) Haschick, A. (Haystack) Baan, W. (Arecibo)	HI and OH characteristics of Mrk 273. 21-cm line.
AS-247	Seaquist, E. (Toronto) Frail, D. (Toronto) Bode, M. (Manchester) Evans, A. (Keele, UK) Albinson, J. (Keele, UK)	HI absorption observations of GK Per. 21-cm line.

No.	Observer(s)	Program
AS-250	Seaquist, E. (Toronto) Henriksen, R. (Queen's) Bell, M. (NRC)	Search for a galactic wind from the nuclear region of M82. 6 and 20 cm.
AS-254	Schwartz, P. (NRL)	Radio emission from bright rims. 2 and 6 cm.
AS-257	Snyder, L. (Illinois) de Pater, I. (Berkeley) Palmer, P. (Chicago)	Search for formaldehyde in Comet Halley. 6-cm line.
AT-60	Taylor, A. (Groningen) Seaquist, E. (Toronto) Kenyon, S. (CFA)	Radio-optical-UV monitoring of symbiotic stars. 1.3, 2, 6, and 20 cm.
AT-64	Taylor, A. (Groningen) Pottasch, S. (Groningen) Seaquist, E. (Toronto)	Radio monitoring of Nova Vulpeculae 1984, No. 2. 2, 6, and 20 cm.
AT-68	Torrelles, J. (UNAM) Rodriguez, L. (UNAM) Canto, J. (UNAM) Ho, P. (CFA)	Broad ammonia emission from L1551 and Cep A. 1.3-cm line.
AT-69	Taylor, A. (Kapteyn Lab) Seaquist, E. (Toronto)	Two epoch mapping of the CH Cyg radio jet. 1.3, 2, 6, and 20 cm.
AT-70	Taylor, A. (Groningen)	Radio survey of yellow supergiants with hot companions. 6 cm.
AT-72	Tyson, J. (Bell Labs) Partridge, R. B. (Haverford College) Windhorst, R. (Mt Wilson) Seitzer, P. (NOAO)	Radio survey of ultra-deep optical fields. 20 cm.
AU-22	Uson, J.	Background sources contaminating measurements of the Sunyaev-Zeldovich effect. 2 and 6 cm.
AV-96	van der Hulst, J. (NFRA) Sramek, R. Weiler, K. (NRL)	Radio supernova in NGC 4258. 6 and 20 cm.
AV-126	Vallee, J. (NRC) Bignell, R. C.	Rotation measures and magnetic fields in the Scutum and Norma spiral arms of our Galaxy. 6, 18, and 20 cm.

No.	Observer(s)	Program
AV-128	van Buren, D. (Colorado)	M1-67, a rapidly expanding shell of ejecta from the WR star BAC209. 2 cm.
AV-130	Velusamy, T. (Tata) Goss, W. M. (Groningen)	G54.7+06, a very steep spectrum source. 6 and 20 cm.
AV-131	Vilhu, O. (Colorado) Caillault, J-P. (Colorado)	Radio and X-ray emission in contact binaries: VW Cep. 6 cm.
AW-114	Wadiak, E. J. Rood, R. (Virginia) Wilson, T. (MPI, Bonn) Batrla, W. (Illinois)	H_2CO absorption towards W49. 6-cm line.
AW-141	Winglee, R. (Colorado) Dulk, G. (Colorado) Bastian, T. (Colorado)	Substellar and planet-like companions. 20 and 90 cm.
AW-148	Wilson, A. (Maryland) Halpern, J. (Columbia)	A new X-ray selected BL Lac object. 2, 6, and 20 cm.
AW-149	Wrobel, J. (NMIMT) Cohen, M. (Caltech) Lind, K. (Caltech) Pearson, T. (Caltech) Readhead, A. (Caltech)	Rotation measures of VLBI survey core-jet sources. 6, 18, and 20 cm.
AW-151	White, R. (STScI) Becker, R. (Calif., Davis)	Nebulosity around Lk Hα101. 6 cm.
AW-153	Wouterloot, J. (MPI, Bonn) Brand, J. (Leiden) Blitz, L. (Maryland)	Star formation in the Outer Galaxy. 6 cm.
AW-154	Walmsley, C. M. (MPI, Bonn) Wouterloot, J. (MPI, Bonn) Johnston, K. (NRL) Wilson, T. (MPI, Bonn)	Position and 6-cm flux density of IRAS 05413-0104. 1.3 and 6-cm line.

F. SCIENTIFIC HIGHLIGHTS

CO in Planetary Nebulae

Carbon monoxide emission has been detected in several planetary nebulae with the 12-meter telescope. The CO (2→1) line at 230 GHz at a level of about 1 K was mapped over the images of both the Ring and the Helix nebulae and detected in the Dumbbell nebula. Previous negative searches on other telescopes have been improved upon by the on other telescopes have been improved upon by the smaller size of the 12-meter beam at 230 GHz. As in the case of recent successful surveys of CO emission from circumstellar envelopes, these dramatic new detections come primarily as a result of the short wavelength efficiency of the newly resurfaced 12-meter combined with the sensitivity of the improved 1-mm receiver. The ability to detect molecules in the outer, neutral shells of planetary nebulae is potentially a very important tool for understanding the origin and physical evolution of these objects once a diverse statistically significant database from many nebulae is assembled.

Redshift Survey Beyond the Local Supercluster

Observations with the 300-foot telescope have been combined with observations from the Effelsberg 100-meter telescope to complete an extensive survey of the HI content of galaxies in the area of $9^h30^m \leqq$ R.A. $\leqq 14^h30^m$ and $-30° \leqq$ Dec $\leqq 0°$. The catalogue covers the region of the sky which lies between the Local supercluster and the Hydra/Centaurus supercluster and more than 50% of all galaxies searched for HI were detected. Redshift surveys of distant superclusters have generally found filamentary chains of galaxies to be a commonplace component of the universe; however, this has proven difficult to detect in the neighborhood of the Local supercluster, which is completely dominated by the Virgo complex. The catalogued 300-foot HI observations now result in a redshift distribution of the galaxies in that area that is indicative of filamentary links between the Local and the Hydra/Centaurus superclusters.

M83 HI Observations

Medium resolution VLA maps of the HI morphology of the nearly face-on bright spiral galaxy M83 have been used to study the large-scale dissociation of molecular gas by newly formed stars in galaxies. The HI resolution is sufficiently high enough to permit a direct comparison of the HI distribution, the dust lanes, and the young stars (as traced by Hβ emission from ionized hydrogen) in a section of the inner eastern spiral arm of M83. For the region studied, there is a clear displacement of order 700 pc in the radial direction between the inner dust lane of the spiral arm and the parallel distribution of atomic and ionized hydrogen. In the framework of a density wave induced shock front producing cloud collapse and star formation in the interstellar medium, the observational results have been interpreted to suggest that, on a large scale, spiral structure orders this process and broadly affects the relationship between atomic and molecular gas in galaxies.

Compact HII Region G10.6-0.4

VLA observations have detected rapid rotation and collapse motions in the core of the compact HII region G10.6-10.4. The aperture synthesis spectral-line observations for the first time provide firm evidence for a contracting molecular cloud core that may be forming a central cluster of young massive stars. Velocity-spatial maps were derived from observations of the main and inner satellite hyperfine components of the (J,K) = (1,1) NH_3 inversion transition. Direct evidence for collapse is seen in the redshifted absorption and blueshifted emission in the direction of the compact HII region. There is also a projected velocity gradient of ~10 km s^{-1} pc^{-1} across the rapidly rotating core, but much slower rotational motion in the extended envelope. Rapid rotation of the core, resulting from angular momentum-conserving spin-up provides indirect evidence for the occurrence of a collapse process in G10.6-0.4. The existence of an embedded central cluster of OB stars evidently resulted from an earlier or faster collapse of a portion of the core.

1400-MHz Sky Atlas

The NRAO 300-foot telescope and rebuilt four-feed receiver were used to make a 1400-MHz sky survey covering the 6.8 sr declination band $-5° < \delta < +82°$, with approximately 12.7 arcmin x 11.1 arcmin resolution. The resulting sky maps are confusion limited and contain $\sim 3 \times 10^3$ sources per steradian stronger than $S = 0.15$ Jy, which is about six times the rms extragalactic confusion and more than ten times the rms noise. The maps are available in either tape or atlas form. The machine-readable, FITS-format, digital tapes can be displayed and analyzed with standard AIPS programs or special procedures written in POPS, the AIPS command language. The loose-leaf bound atlas presents the survey as convenient contour plots supplemented with transparent coordinate-grid overlays from which source positions and peak flux densities can be estimated. The tape version is available from Charlottesville for the cost of the magnetic tape plus shipping. The bound copy is available from Green Bank for $10 plus shipping. This 1400-MHz version of the optical Palomar Sky Survey will provide invaluable reference for multiwavelength and/or time variable source studies in the future.

G. PUBLICATIONS

Attached as Appendix A is a tabulation of all preprints received in the NRAO Charlottesville library authored by NRAO staff members or based on observations obtained on NRAO telescopes during the reporting period.

H. CHARLOTTESVILLE ELECTRONICS

Neptune/Voyager Project

On June 1, 1985, work began on the further development and construction of thirty 8.4-GHz receivers for use on the VLA for reception of telemetry signals from the Voyager 2 spacecraft. The VLA will be used for reception of television pictures of Neptune during a brief period centered on August 24, 1989. A schedule for construction of the front-ends has been made and shows delivery of a first unit by January 1986 and last unit by October 1987. The first three front-ends will utilize FET amplifiers and the construction of the amplifiers has started. HEMT devices will be evaluated between January and April 1986, and a decision as to whether to use FET or HEMT devices will be made in June 1986.

During this quarter, the first production receiver was delivered, and construction of several additional units is in process. Parts for all remaining receivers are on order. Two types of HEMT devices have been evaluated and both give excellent performance - 8 K minimum noise temperature at 8.4 GHz.

23-GHz HEMT/FET Amplifier Development

Development of a four-stage amplifier for use in the VLA and VLBA continues. Due to repeated failures of epoxy and solder joints between chip resistors and alumina substrates, a thin-film deposited tantalum-nitride resistor fabrication technique has been adopted. A reliable amplifier utilizing a TRW HEMT first stage followed by three NEC FET stages has been constructed and produces 25.5 $\pm$ 2 dB gain and 85 to 115 K noise temperature from 22 to 25 GHz. An earlier narrow-band, all-HEMT three-stage amplifier with 60 K noise temperature at 22.2 GHz has been in operation at the VLA since December 1985.

Hybrid-Spectrometer

A spectrometer which is a hybrid of analog-filter and digital-correlator techniques is under construction for providing 1536 channels and 2.4-GHz bandwidth on the Tucson 12-meter telescope. It is shown in NRAO Electronic Division Internal Report No. 248 that this hybrid approach gives much lower cost than an all-digital or all-analog system; this is very important for future millimeter-wave astronomy arrays.

One-eighth of the final system has been completed and 90% of the software is complete. Tests are in progress to measure the RMS fluctuation as a function of integration time and to measure the shape of artificial spectral lines. The system is giving theoretical fluctuation for integration times up to a few hours but has higher than theoretical fluctuation for integration times of the order of a day. The increased fluctuation has been found to be due to RFI internal to the system, and a modification is in process. Telescope tests during the summer are planned.

Schottky-Diode Millimeter-Wave Mixer Development

Cryogenically cooled Schottky-diode mixers have been in use for almost all millimeter-wave astronomy for the past ten years. NRAO has pioneered the development of the mixers, both in circuit design and, by contract to the University of Virginia, in the development of the diode devices.

During this quarter: (i) Further attempts were made to restore the noise temperature of the damaged 80-120 GHz mixer to its earlier low value. There are no more diodes from the original batch, and all the available diodes have given inferior results. This mixer is now available as a backup while we evaluate new "stress-relieved" diodes from the University of Virginia which are expected to have better performance. (ii) Work continues on the three 225-GHz radiometers for millimeter array site evaluation. A prototype front-end plate is nearly complete. Considerable difficulty has been experienced with load-pulling of the 75-GHz Gunn oscillators, and their temperature coefficients are so large that it wil be necessary to regulate their temperature independently of the rest of the receiver. The manufacturer, Millitech, has agreed to attempt to improve these shortcomings at no cost to us. (iii) The 270-290-GHz mixer was returned from Tucson with a degraded noise temperature and changes in the diode characteristics. New diodes are now available from the University of Virginia which may give better results in this band, and these will be evaluated if time permits.

Superconducting Junction (SIS) Millimeter-Wave Mixer Development

Theoretically, SIS mixers have noise temperatures many times lower than Schottky diode mixers, and experiment has already demonstrated a factor of two advantage in sensitivity at 115 GHz. It is believed that most future spectral-line astronomy in the range 40 to 500 GHz will be performed with SIS mixer receivers. The development involves circuit design and testing at NRAO and SIS device fabrication by contracts with the University of Virginia and the National Bureau of Standards.

Recent studies have shown that SIS direct detectors for millimeter wavelength continuum astronomy should have extremely good sensitivity, and saturation power levels far above those for SIS mixers. It is planned to conduct tests of SIS direct detectors to see if a suitable post-detector amplifier can be found which will result in low overall NEP.

Experimental mixer junctions for 70-120 GHz are being fabricated to our design by IBM (Watson Research Laboratory) under a joint study agreement and should be delivered early in 1986.

A batch of junctions received from Hypres, under an old NRL-NASA contract, was found to have almost all devices open circuit. A further batch of devices has since been received from Hypres, and will be evaluated in the forthcoming quarter.

Work continues in close collaboration with the University of Virginia on the construction of apparatus for making all-niobium junctions. We hope these will be suitable for operation at least to 340 GHz, both as mixers and direct detectors for continuum observations.

Planar Mixer-Antenna Development

The goal of this research is to provide the millimeter-wave equivalent of the optical photographic plate; i.e., a substrate patterned with a close-spaced array of antenna-feed elements and either SIS devices or planar Schottky-diodes forming many receivers. This "multi-beaming" would greatly advance the speed or sensitivity of millimeter-wave astronomy. The planar log-periodic antenna has been studied using lower-frequency scale models, and appears suitable as the basic element of an array. Problems of DC and IF coupling to the diodes, and achieving uniform LO coupling to all the elements of an array remain to be investigated.

This work is of low priority at present because of the heavy burden of servicing existing Tucson equipment.

Millimeter Local Oscillator Sources

Millimeter-wave frequency multipliers developed at NRAO are now used as local oscillators for virtually all observations on the 12-meter telescope. Planar (whiskerless) Schottky diodes being developed under the University of Virginia contract promise improved performance and reliability in the future.

During this quarter considerable time was spent repairing and optimizing the 280-350-GHz quasi-optical frequency tripler from Tucson. Three triplers required re-contacting as a result of damaged diodes. At Tucson it had been found impossible to obtain sufficient LO power over much of the tuning range. We re-designed the dichroic second-harmonic filter plate and quartz tuning plates in an effort to increase the efficiency, but without achieving anywhere near the original published performance. It now appears that the original measurements of tripler output power may have included a substantial amount of second harmonic. We are investigating this.

I. GREEN BANK ELECTRONICS

300-foot Modernization

During this quarter, preparations for the shut-down of the 300-foot telescope on April 7 were carried out. During this shut-down, an extensive remodeling of the 300-foot control room and systems will be done. The new Masscomp control computer will be installed and interfaces with existing systems tested. The control room will be rearranged, separating digital and analog systems to the extent possible in order to reduce self-inflicted EMI/RFI problems. Shielding of the control room doors and windows will also be improved to reduce radiation from the building.

During the shut-down, the control electronics for the north-south lateral focusing mechanisms will also be installed. Addition of north-south receiver motion should result in improvements in the aperture efficiency at large zenith angles.

300-foot Telescope Spectral Processor

Development of the new spectrometer for the 300-foot telescope has continued. The memory addressing card has been redesigned and the new version has been constructed and now awaits tests. Testing of the high-speed, complicated circuit cards used in this system presents many challenges in itself. In order to speed development, a computer controlled test fixture that can be used for any of the digital cards has been built. A test card specific to each of the system cards under test, in conjunction with the test fixture and a personal computer, will allow careful and extensive tests of each of the spectrometer functional blocks.

Design of the timing generator module, which generates clock and syncronization signals for the entire system, is proceeding. The layout of a printed circuit card is complete and has been sent to a vendor for fabrication. Design of a wirewrap card that completes the timing generator has been done and the card is being fabricated in-house.

The Spectral Processor control computer has been ordered and delivery is expected during the coming quarter. Other major components, such as the shielded digital racks, are being selected and will soon be ordered.

140-Foot Lateral Focus

It has long been known that the best fit focus of the 140-foot telescope changes with telescope position, causing the generation of coma lobes and the accompanying deterioration of the beam shape and aperture efficiency. The project that has been underway to allow tilting of the subreflector to compensate for this effect is now complete. Test and calibration periods have been scheduled in May so that the staff can detect and correct any problems. The system should be available for general use shortly thereafter.

J. TUCSON ELECTRONICS

Schottky Mixer Receivers

The two Schottky mixer receivers are the workhorse instruments at the 12-meter telescope. The 70-120 GHz receiver has performed well since its installation in September. The 200-270 GHz receiver was installed in November, and it too has performed well, with effective system temperature at 230 GHz of below 1000 K (single sideband). Little work on them has been required during the observing season. The next major modifications to them will be to replace the klystron LO sources with solid-state Gunn diodes.

Bolometer Receiver

The 0.8-2.0 mm bolometer is intended to be the principal high-frequency continuum receiver. It was tested on the telescope and used for one experiment this quarter. During good weather the bolometer sensitivity was measured to be as high as 3 Jy sec^{-1} at 1.3 mm, better than the 5-6 Jy sec^{-1} achieved by the Schottky receiver. However, the better sensitivity could not be achieved routinely, and during poorer periods went as low as 15 Jy sec^{-1}. Some of the problem undoubtedly was with the weather. However, laboratory tests subsequent to the observing period showed that the bolometer gain was a slow function of time, with changes of a factor of up to three occurring in the course of a few days. The problem is now being investigated, and the possibility of replacing the bolometer element with a new one is under active consideration.

SIS CO (J=1-0) Receiver

The pressure for improved system sensitivity in the J=1-0 transition of the CO molecule continues to mount, as observations push the Schottky mixer to the limit. Among the programs which would benefit immediately from the improved sensitivity are the study of galaxies at large redshift (10,000 km s^{-1}); the search for the relic ejecta in young planetary nebulae; and the study of structure on small angular scales using lunar occultations.

To meet the demand for better sensitivity, we are developing an SIS receiver for use in the principal CO lines, at 110 and 115 GHz. The receiver has two channels, with a design goal for the system temperature of approximately 125 K (single sideband).

The receiver was tested on the 12-meter for a week in March. The tests were successful, although they revealed a number of areas in which further work is required. The system temperature of 180 K is higher than expected, and the coupling of the receiver to the antenna is less efficient than it should be. The receiver will undergo further tests in the laboratory, and will be put back on the telescope towards the end of the second quarter.

300/345-GHz Receiver

While observation of any one rotational transition of CO is adequate to tell the astronomer about the presence of molecular gas and the kinematics of that material, it is not adequate to provide information about the amount of gas present or about its temperature and excitation. For the latter purpose it is necessary to observe more than one rotational transition and, if possible, more than one isotopic species. The J=3-2 rotational transition of CO at 345 GHz is very desirable for such studies of the excitation of molecular clouds. This line, together with the J=2-1 line at 230 GHz and the J=1-0 line at 115 GHz, provides a very complete picture of the mass, kinematics, and thermodynamics of molecular clouds.

Additional interest in the 345-GHz band, and in the band at 300 GHz, stems from the possibility of detecting line emission from certain molecules thought to be important in interstellar chemistry. Particularly notable in this regard are the hydrides of sodium and magnesium.

A one-channel Schottky receiver was tested at 345 GHz, and three experiments were run this quarter. The receiver performed well, with single sideband receiver temperature of 2000 K. The aperture efficiency of the telescope was measured to be approximately 12 percent. The weather was generally good, with opacities on several days between 0.5 and 0.7. The minimum effective system temperature was 7500 K.

Tests of the 300-GHz mixer showed that it did not work, and a new design will be undertaken to provide a mixer for this range. However, the 345-GHz mixer could be retuned to 307 GHz, enabling searches for the important ion molecule H_3O^+ to be conducted.

8-Feed, 230-GHz Receiver

Many proposals are now received requiring large amounts of observing time in the J-2-1 transition of CO. The value of this transition lies in part because of considerations involving excitation conditions, optical depths, and the like, and in part, because of the higher angular resolution in comparison with the J=1-0 transition. This latter effect however requires increased observing time—typically by a factor of four. Compounding the problem is the fact that observations at the higher frequency are more sensitive to weather conditions so that fewer days are available during the observing season.

To address this problem we are actively considering a multifeed system. The initial design has been started for an 8-feed system. The system probably will use Schottky mixers at the outset, but will be able to be converted to SIS junctions when these devices become available.

K. VLA ELECTRONICS

Improvements in Antenna Pointing

Antenna pointing errors degrade the performance of synthesis telescopes at both low and high frequencies. At low frequencies strong background sources are randomly located in the primary beam, and pointing errors then limit the achievable dynamic range. At high frequencies the pointing errors become a significant fraction of the primary beam width so the source being imaged is effected directly. For example, at 44 GHz a 20" pointing error causes a 30% change in amplitude.

When the VLA antennas are heated by the sun at low-elevation angle, differential temperatures of up to 50 C have been observed across the antenna structure. Under these conditions the pedestal and yoke of the antenna can bend significantly and cause pointing errors of up to one arc min. This problem is being cured by coating the critical parts of the antenna structure with insulation to reduce the temperature differentials. Twenty antennas currently have insulation installed, and coating of all antennas will be finished in 1987.

Another, lesser, pointing problem which will be addressed in the future is the occurrence of tilts of up to 20 arc secs in the azimuth axis of a few antennas at certain azimuth angles. This effect is presumably caused by deformations or perturbations in the azimuth bearings. This, and other problems such as an antenna tilt caused by constant wind force, could be corrected in the future by an active correction scheme utilizing electronic tilt-meters mounted on the antenna structure.

75-MHz Array Development

The proposed array will provide a major, new observing capability by giving 20" resolution at a frequency where the current best resolutions are many arcminutes. This capability will enable useful observations of thousands of previously unresolved extragalactic, galactic, and solar system objects. Current capabilities at this frequency enable only total fluxes from the stronger objects, so the proposed array will be truly a ground-breaking instrument. In particular, the array will be especially useful in observing the extended steep-spectrum emission associated with extragalactic radio sources, galactic objects such as supernova remnants, and small-scale, time-variable emission from the Sun, Jupiter, and nearby stars.

The single, major obstacle to using such an array lies in the calibration of the data. It is felt that modern computers with self-calibration techniques provide the means to remove the strong phase perturbations introduced by the ionosphere. However, testing of these techniques at these low frequencies is required to better understand the type of algorithm needed. To do this, we wish to equip the current 25-meter antennas with simple dipole-type feeds. If modest efficiency results (anything more than 15% will be adequate), we should be able to collect sufficient data from the 25-meter antennas at this frequency for testing purposes. Note that if every 25-meter antenna had such a feed, the entire 3C and 4C catalog could be mapped at 75 MHz with the same resolution as the original 1400-MHz aperture synthesis catalog done at Cambridge. The cost of this outfitting is very modest.

Four antennas now have 75-MHz receivers and a log-periodic antenna outrigged on the side of the 25-meter reflectors. Two new dipole feeds have been designed; one a crossed dipole type, the other a quad dipole type. These were installed on two antennas and testing is to continue during the next quarter. With the new feeds installed near the focus of the antenna, locally generated radio frequency interference became a significant problem (see RFI Improvements).

VLA 300-MHz Receiver

Observations of a large number of astronomical objects would benefit from a lower observing frequency than 1.35 GHz, the lowest frequency currently supported on the VLA. Some objects radiate more strongly at lower frequencies while others are so large that a larger field of view than the 30 arc min available at 1.35 GHz is needed.

The receiver will be designed so that observations in the range 300-350 MHz can be made with an instantaneous bandwidth of approximately 5 MHz. At this low frequency, the VLA 25-meter diameter antennas can only be used in prime focus mode. It is known that radio-frequency interference, both locally generated at the VLA and from external sources, will be a significant problem.

Eleven antennas now have 327-MHz receivers installed, and this system is undergoing test and evaluation. The final feed configurations is expected to be determined next quarter. To reduce local RFI, modification to some modules has been undertaken.

VLA 8-GHz Receivers

Feeds and front-ends covering the frequency range 8.0-8.8 GHz will be installed on the VLA primarily to allow reception of the Voyager signal from Neptune at 8415 MHz. Other scientific benefits include the provision of an additional frequency for measurements of continuous spectra and joint observations with the VLB array. There are also some molecular lines of limited interest between 8.8 and 9.2 GHz which may be covered. Finally, the 8.4 GHz front-ends would enable the VLA to be used in planetary radar experiments with the Goldstone transmitter. The NRAO Central Development Laboratory has developed this front-end which is presently using a GaAs FET amplifier. An improved HEMT (High Electron Mobility Transistor) amplifier may be incorporated into this system later this year.

Three 8.4-GHz front-ends have been received from the Central Development Laboratory in Charlottesville and have been installed on Antennas 20 and 21. Interferometer measurements with Antennas 20 and 21 on both Voyager I and II have been completed with the appropriate signal-to-noise ratio, and other test programs are continuing.

JPL has provided funding for this project and antennas being overhauled will be outfitted with X-band feed towers. Installation of the next X-band system is scheduled for the second quarter in 1986.

RFI Improvements

The sensitivity of the 327-MHz and 75-MHz systems will be limited partly by radio-frequency interference locally generated at each antenna. Modifications to various modules to reduce this interference and increase the instantaneous useable bandwidth was investigated.

Three modules appear to be the present major source of RFI. One set of these modules have been modified and preliminary tests indicate good improvement at 327-MHz. When the new 75-MHz feeds were installed, it appeared as though these module modifications did not reduce the locally generated RFI to a reasonablre limit. Two RFI enclosures for the vertex mounted "B" racks have been installed with testing in the next quarter.

Water-Vapor Radiometers

The development of a system to measure the total precipitable water in a path through the atmosphere will serve three purposes. First, the radiometer developed in this project can be used as a prototype of the device which is required at each VLBA station. Second, the radiometer can be used at the VLA to provide estimates of the extinction, giving corrections for observations at 1.3 cm, and serving as a historical record of the quality of the VLA site. Finally, if a reliable system can be built at a sufficiently low cost, it would be attractive to add them to the VLA itself.

The device will consist of two radiometers; one operating at about 20.5 GHz, the other at about 31 GHz. The radiometers will probably be built around room temperature mixers, with system temperatures of approximately 600 K. The system will be mounted so that it can cover the full range of elevation, and probably the full range in azimuth as well. The concept is straightforward. The engineering effort will concentrate on the problem of achieving high gain stability at a reasonable cost.

The R.F. components for the water-vapor radiometers have been procured and are being assembled for testing. The project is manpower limited.

K-Band Maser Replacement

A prototype, HEMT, 22-GHz amplifier has been delivered from the Central Development Laboratory. This amplifier was installed on Antenna 23 in the "C-D" IF. The measured system temperature was 115 K at 22.485 GHz. New waveguide between the dewar and feed system was fabricated and installed.

L. CHARLOTTESVILLE COMPUTER DIVISION

Convex Changeover

The Convex has been put into routine use and a number of changeover activities have begun.

A number of physical plant changes have been made. The computer room has been rewired. The AIPS "caiges" have been moved downstairs, and some lighting and noise improvements made to create a better AIPS user environment.

Work has begun on interfacing the IIS display to the Convex.

The Convex has been networked to the VAX, so file transfer and remote log-on are now possible.

The Calcomp plotter, previously attached to the IBM, has been moved and interfaced to the VAX.

The Charlottesville tape library is being phased out. The new library will be limited to the storage of tapes in support of persons visiting or permanently located in Charlottesville or persons planning to do remote processing in the near future. The library will no longer be used simply for the storage of old tapes. The library has been reduced from approximately 4,000 tapes to approximately 1400 tapes.

Under the new system, Green Bank will handle its own single-dish tapes and maintain its own library for these.

As a whole, users seem happy with the Convex, particularly with its speed. The FORTRAN vectorizing compiler is excellent, probably the best there is. UNIX, in many respects, is not as nice as VMS but it is more than usable.

M. SUPERCOMPUTER INITIATIVE

Supercomputer Access Time

The Observatory has used all the computer access time made available on the Digital Productions Cray. The NSF will not make additonal time available on this machine, and has suggested that the NRAO investigate the use of alternative centers.

Several centers are being examined; it appears that it will be several months before we will be able to support additional processing. Requests are still sought, but should be made (to Ron Ekers) with the understanding that considerable delay will be involved.

N. AIPS

Work on the AIPS system continued in application areas while we continued to clean up from the last major system change (to a new directory structure). A variety of fixes were required for the VAX directories, procedures, and Z routines, and work on developing corresponding UNIX versions has made considerable progress. AIPS will now handle images only in floating-point disk format and many image-writing tasks have been modified (and generally simplified and streamlined) to enforce this. Many vector computation routines have been improved, particularly for the Convex and Cray, but also for the VAX pseudo array processor version. FFTs of real images are now done correctly, without the assumption that the outermost row is essentially zero. Major improvements in handling bandwidth-synthesis data have also been realized. All printing tasks now support the DOCRT option and have flexible formats to handle printers and terminals of various widths. All geometry routines support three new coordinate types: "global sinusoidal," Mercator, and Aitoff. Use of the host computer's batch system has been made more convenient by adding an AIPS parameter to allow the user to specify that an apparently-interactive AIPS job is to be treated as a batch job.

O. VLA COMPUTER DIVISION

On-Line System

The upgrade of the VLA on-line computer system has progressed very slowly, mainly because of slow delivery of the hardware and software from the vendor (Modcomp). The new 32-bit, dual-processor computer arrived at the end of January and, after initial hardware problems, is being used for software development. Some serious problems remain with access to shared memory from the two CPUs and with the pre-production version of the operating system delivered with the computers. At the end of the quarter, the computers have not yet been found to be technically acceptable to NRAO, and ModComp has been advised of the problems encountered. If the problems can be resolved quickly, the new system should have the capacity to replace the existing VLA on-line control system by mid-1987.

Pipeline

Additional capabilities have been added to the Pipeline, allowing users to directly load images into the AIPS software system running on the OUTBAX display computer. Experimental versions of programs to apply AIPS-generated self-calibration solutions during Pipeline mapping and a data-flagging option from Pipeline displays are currently being developed.

The NRAO-designed Image Storage Unit (ISU)I has been integrated into the Pipeline display system and can be loaded with images directly from the Pipeline mapping computer. The ISU allows convenient storage and replay of up to 512 separate images; this is especially useful for spectral-line data where replay can be done in fast succession.

Filling of VLA visibility data into the Pipeline SORTER computer is again possible and is being used for reduction of 327-MHz VLA spectral-line observations.

During the past quarter, the Pipeline was used extensively for reduction of D-array data; it is currently (while in A-array) being used only occasionally.

VAX Systems

The VLA VAXs continue to be heavily used for VLA data reduction using AIPS. In addition, more general use is increasing for program development, electronic mail, and general-purpose computing for various projects (including the VLBA). The "midnight" job to transfer the latest verison of AIPS software to the VLA VAXs has been running almost every day, giving users at the VLA access to the most current versions of AIPS tasks. Some additional disk space was added to one of the VLA VAX systems.

P. VERY LONG BASELINE ARRAY

Project Management

A further change to the planned order of station construction is being considered in the interest of optimizing "early science" from the VLBA in the face of the construction slowdown due to funding limitations. This will be a factor in the forthcoming negotiations of a revised antennas contract.

Systems Engineering

Perhaps the most important overall systems question remaining is the choice of approach to the design of the correlator. The Systems and Correlator groups are now evaluating the FX type of correlator as an alternative to the more traditional lag type considered in the Caltech study. The term FX was coined to indicate that, in this approach, Fourier transformation (time to frequency domain) <u>precedes</u> cross correlation. As indicated in the Correlator section below, significant overall savings in the hardware seem possible.

A technical review at Haystack Observatory of their work on development of the data acquisition system (Data Recording) yielded decisions regarding configuration of modules within racks, packaging standards and interfacing details. The outfitting schedule for the Pie Town Station was also discussed.

Design details of the hydrogen masers were reviewed at Sigma Tau Standards Corporation. Acquisition of components for the first three masers, and design and testing of printed circuit boards for the electronics are progressing well.

System cabling requirements for the Station, including the antenna, are being defined. Optimum dimensions for the cable wrap assembly are being worked out with the antenna manufacturer.

Sites/Stations

Construction at the Pie Town site began 24 February, and is progressing on schedule. Site clearing and access road are complete, excavation for the antenna foundation is done, the water line is in, and the electric power line to the transformer pad is laid.

The site plan for Kitt Peak is complete, ready for solicitation of bids for site preparation. A formal request to NOAO for use of the site awaits action by the AURA board.

The NSF has submitted a formal request to the Department of Energy for the site at Los Alamos. A three-acre site near Brewster, Washington has been purchased, and the final deed is now being drawn up.

Array Operations Center (AOC)

The New Mexico legislature has appropriated $3M toward the construction of a joint VLBA/VLA Operations Center on the campus of the New Mexico Institute of Mining and Technology in Socorro, a conceptual design for which has been completed by the A/E contractor.

Antennas

Fabrication work has begun in the Mexia, Texas plant of Universal Antennas, Inc. (UAI). An interface template for the reflector and cone structures is being built in their new VLBA assembly building. Some of the antenna structural steel has been delivered, and the balance is expected in two weeks.

Purchase orders have been placed for servo systems, angle encoders, gear boxes, tracks, wheels and axles, sector gears and bearings.

Radiation Systems, Inc. (RSI) is working on the assembly tooling and measuring system for the surface panels. Tier 1 panel material has been delivered, and the remainder is on order. The first panel should be produced in April.

Scheduled delivery of the first antenna to Pie Town has been delayed until September, 1986, with installation ready for NRAO's feed cone and other heavy components by January, 1987.

A vendor for the subreflectors has been chosen and a contract is being prepared. A request for proposals (RFP) to provide feed cones was issued, and the RFP for focussing subreflector mounts (FRM) is nearly ready.

Electronics

Evaluation of the 4.8-GHz feed has been completed. The performance is excellent, with a return loss of over 25 dB over the entire band. This feed will serve as a scale model for all feeds from 2.3 GHz upwards. A scale model of the 1.5 GHz feed has also been satisfactorily tested, and an RFP for the full-size horn has been issued.

Testing of the 330/610-MHz and 1.5-GHz front ends is almost complete. Work on the first 4.8-GHz front end is continuing. Parts for the 15-GHz front end for the first antenna have been procured and will be assembled next quarter.

The 2-16 GHz synthesizer modules, which provide coarse tuning at the antennas, are in test and working well. Work continues on the prototype system for the two modules (LO Transmitter and LO Receiver) that transmit the reference signals from the maser to the antenna vertex room, and the first tests of the round-trip phase measuring system will be made next quarter. Tests of the prototype converter modules that convert signals from the frequencies received to the 500-1000 MHz intermediate frequency have been made for all frequencies planned for the initial outfitting of the first antenna.

Because of funding cuts, it has been decided to construct in 1986 the initial-outfitting electronics for only the first three antennas, rather than the first four. It has also been decided that, from Station 2 onwards, the initial outfitting will include only receiving systems for the 1.5, 4.8 and 23 GHz bands. The strong water maser sources at 23 GHz can thus be used in the early system tests. The 330/610-MHz and 15-GHz front ends will be deferred until late in the construction program.

Data Recording (Data Acquisition/Playback Systems)

It was finally decided that the data acquisition arrangement at a fully outfitted Station will comprise two identical DAS equipments, each having a single recorder with 256-Mb/s capability. Maximum bandwidth recording (512 Mb/s) will require two DAS's working simultaneously. However, initial operation of a station can be supported at half maximum bandwidth capability using only one DAS. Due to current funding limitations, the first few stations will initially be operated in this fashion, with the second DAS to be provided later in the Program.

Prototype development continued on baseband converters, IF distributors and formatters. NRAO has ordered and will provide required standard racks for the electronics modules. The electronics for the recorder proper are still in the design phase due to unforeseen problems. Although it is still anticipated that a complete prototype DAS can be delivered to the VLA in August, 1986, in time for scheduled system tests, the recorder electronics could delay delivery until November.

The currently funded contract covers the prototype phase, under which Haystack will provide two (2) DAS's as described above, plus one prototype Data Playback System (DPS). Given present and expected 1986-7 VLBA funding, only three (3) more DAS's can be ordered before 1988, and the unit price is expected to increase accordingly.

Monitoring and Control

Components have been ordered for the first production run of the standard M/C interface boards which permit monitoring and control of the various Station subsystems from the M/C bus.

Design of the remote control system for the focussing subreflector mount (FRM) has begun.

Software efforts in progress include development of screen-handling and bus-handling programs, and antenna-pointing software.

Correlator

As stated earlier, an extensive investigation of the spectral-domain ("FX") correlator concept is in progress, including analytic studies and computer simulations as well as architectural development. Spectral-domain correlation has been far less extensively studied than conventional lag correlation, and only one other implementation has been reported, i.e., the FX correlator at Nobeyama. We nonetheless believe that this approach will lead to a significantly less expensive as well as technically superior VLBA correlator.

The advantages of the spectral correlator derive almost entirely from exploiting the Fast Fourier Transform (FFT) algorithm to perform the necessary frequency analysis on individual station data streams before, rather than on a baseline basis after, correlation. The "convolution theorem" of Fourier theory ensures that pairwise multiplication of the Fourier-analyzed station spectra is mathematically equivalent to applying the FFT to the conventionally formed baseline lag correlation functions. By applying the FFT before correlation, however, the need to form large numbers of lag products is eliminated. Formation of stationary baseline quantities which can be accumulated is reduced from correlation at the input sample rate to multiplication at the transform rate, which is lower by 1 to 3 orders of magnitude. For the range of 10 to 20 stations we plan for the VLBA, a spectral correlator requires a factor of about 20 smaller aggregate multiplication rate for the worst-case continuum observations; this factor improves to about 400 for high-resolution spectroscopy. Other advantages follow from the organization of processing in an ultimately station-based fashion, and the availability of the station-based data in both time and frequency domains prior to correlation, both of which factors allow the necessary instrumental corrections to be performed efficiently.

During this quarter, theoretical analyses concentrated on the implications of sample quantization and invalid samples in the input data, consequences of data segmentation and interleaving for sensitivity, the effects of multi-level digital fringe rotation, and optimization of register precision throughout the FFT processor. Other areas studied included accountability requirements for astrometric/geodetic observations, and the adaptability of the correlator to orbiting stations. A computer simulation of the main data path was constructed using the vectorizing compiler on the Observatory's new Convex C-1, capable of generating and analyzing several millions of samples; its primary application in this period was to the study of the multi-level digital fringe rotator. The effort in hardware design started with the overall system architecture, including the main data path, local and high-level control elements, and general configuration flexibility in tradeoffs among stations, channels, and resolution.

Data Processing

Almost all of the work this quarter has been in the area of defining the correlator distribution tape. Conversion of the NRAO Mark II correlator (and possibly also the Caltech correlator) distribution to the VLBA format is under discussion. If carried out, this should help greatly in the development of the necessary post-correlation software.

Q. PERSONNEL CHANGES

New Hires

E. James Wadiak	Research Assistant	1/20
William C. Erickson	Visiting Scientist	1/02
Geoffrey V. Bicknell	Visiting Scientist	3/05
James R. Ruff	Mechanical Engineer I	3/17
Mark S. Schenewerk	Systems Scientist	3/20
Kuduvalli R. Anantharamaiah	Research Associate	2/18

Terminations

(none)

Changes in Status

Peter J. Napier	to Deputy VLBA Project Mgr./Scientist	1/01
Edward B. Fomalont	to Scientist	1/01

APPENDIX

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