NATIONAL RADIO ASTRONOMY OBSERVATORY

QUARTERLY REPORT

April 1, 1986 - June 30, 1986

TABLE OF CONTENTS

A. TELESCOPE USAGE

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

	140-ft	300-ft	12-m	VLA
Scheduled observing (hrs)	1713.75	945.50	1901.00	1691.80
Scheduled maintenance and equipment changes	154.75	1238.50	91.75	232.80
Scheduled tests and calibrations	302.50	0.00	180.75	264.50
Time lost	121.50	47.50	128.75	
Actual observing	1592.25	898.00	1772.25	1551.88

B. 140-FT OBSERVING PROGRAMS

The following continuum programs were conducted during this quarter.

No.	Observer(s)	Program
S-283	Seielstad, G. Lehto, H. (Virginia)	Observations at 1.5 cm of periodic variations in OJ 287 and other extra-galactic radio sources.
U-22	Uson, J.	Continued 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-84	Anantharamaiah, K. Erickson, W. (Maryland) Payne, H.	Observations in the range of 60-65 MHz for H and C-recombination lines towards Cas A.
B-440	Bell, M. (Herzberg) Avery, L. (Herzberg) Matthews, H. (Herzberg)	Search at 14.78 GHz for H_2CC, an isomer of acetylene.

No.	Observer(s)	Program
B-445	Batrla, W. (Illinois)	Search over the range of 12-16 GHz and 18-25 GHz for molecular line transitions from Halley's Comet.
B-448	Bennett, C. (Goddard) Petuchowski, S. (Goddard)	Search for the 10.3 GHz line of HDO.
E-48	Erickson, W. (Maryland) Payne, H.	Observations at 500 cm to search for low-frequency absorption lines in the galactic center region.
E-49	Elvis, M. (CFA) Wrobel, J. (NMIMT) Lockman, F. J.	Observations to study HI toward extragalactic X-ray sources.
H-209	Batrla, W. (Illinois) Gusten, R. (MPIR, Bonn) Henkel, C. (MPIR, Bonn)	Observations at 6030 MHz of extragalactic OH masers.
I-5	Irvine, W. (Massachusetts) Friberg, P. (Chalmers) Hjalmarson, A. (Chalmers) Madden, S. (Massachusetts) Ziurys, L. (Massachusetts) Turner, B.	Spectral scan at 19-22 GHz of molecular clouds, particularly the cold clouds TMC-1 and L134N.
L-159	Lockman, F. J.	Deep systematic recombination-line survey at 5 cm of continuum sources in the galaxy.
L-195	Lockman, F. J. Hobbs, L. (Wisconsin) Jahoda, K. (Wisconsin) McCammon, D. (Wisconsin)	Observations to study HI in low column density directions.
M-249	Maddalena, R. Morris, M. (UCLA) 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.
S-294	Seaquist, E. (Toronto) Bell, M. (Herzberg)	Search at 18.3 GHz for C_3H_2 (cyclopropenylidene) in several galaxies.

No.	Observer(s)	Program
T-187	Thuan, T. (Virginia)	Survey of neutral hydrogen and redshifts in dwarf galaxies found in the ESO catalog.
W-201	Batrla, W. (Illinois) Walmsley, C. (MPIR, Bonn)	Observations at 12 GHz of methanol absorption in interstellar clouds.

The following Very Long Baseline programs were conducted, and the stations used for the observations are coded as follows:

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

No.	Observer(s)	Program
B-65V	Bartel, N. (CFA)	Observations at 6 cm of SN 1979c with telescopes B, G, O, and Yn.
B-72V	Barthel, P. (Caltech) Hooimeyer, J. (Leiden) Preuss, E. (MPIR, Bonn) Schilizzi, R. (NFRA)	Search at 6 cm for changes in the small-scale core structure of three large, double-lobed quasars with telescopes B, G, Km, Lm, O, So, Wn, and Yn.
C-36V	Cordes, J. (Cornell) Simonetti, J.	Observations at 6 cm of the angular sizes of radio sources showing flicker on day-like time scales with telescopes B, G, I, Km, O, and Yn.
C-42V	Canzian, B. (Caltech) Barthel, P. (Caltech) Cohen, M. (Caltech) Lind, K. (Caltech) Readhead, A. (Caltech)	Observations at 6 cm of new superluminal sources with telescopes B, F, G, H, I, Jb, Km, Lm, O, So, Wn, and Yn.

No.	Observer(s)	Program
C-43V	Cohen, M. (Caltech) Aller, H. (Michigan) Aller, M. (Michigan) Barthel, P. (Caltech) Canzian, B. (Caltech) Unwin, S. (Caltech) Zensus, A. (Caltech)	Observations at 6 cm of a peak flux-limited sample of sources with telescopes A, B, E, F, G, H, I, Jb, Km, Lm, N, O, So, Wn, and Yn.
D-12V	Diamond, P. (MPIR, Bonn) Nyman, L. (Goddard)	Observations at 1.3 cm of the proper motion of the masers in W 43 with telescopes B, G, Km, O, Sn, and Yn.
F-10V	Felli, M. (Arcetri) Catarzi, M. (Arcetri) Massi, M. (Arcetri) Palagi, F. (Arcetri) Pallavicini, R. (Arcetri) Tofani, G. (Arcetri)	Observations at 6 cm of RS CVN and Algol-type binaries with telescopes of the European VLB network, G, and Yn.
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.
H-18V	Hodges, M. (Caltech) Mutel, R. (Iowa)	Observations at 6 cm of the compact double DA 344 with telescopes F, G, H, I, Km, O, and Yn.
H-20V	Hough, D. (Caltech) Myers, S. (Caltech) Readhead, A. (Caltech) Perley, R.	Snapshot mapping at 6 cm of D2 candidates for superluminal motion with telescopes B, F, G, H, I, Jb, Km, Lm, O, So, Wn, and Yn.
H-25V	Hooimeyer, J. (Leiden) Barthel, P. (Caltech) Miley, G. (STScI) Schilizzi, R. (NFRA)	Observations at 6 cm of compact structure in extended quasars with telescopes B, G, Km, Lm, O, So, Wn, and Yn.
I-2V	Irwin, J. (Toronto) Seaquist, E. (Toronto)	Observations at 6 cm of NGC 3079 with telescopes B, F, G, Km, O, and Yn.
K-17V	Kus, A. (Chalmers) Pearson, T. (Caltech) Readhead, A. (Caltech) Wilkinson, P. (Manchester)	Study at 6 cm of the K-H helical mode instabilities in the 3C 309.1 jet with telescopes B, F, G, H, Jb, Km, Lm, N, O, R, So, T, Wn, and Yn

No.	Observer(s)	Program
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-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.
M-78V	McHardy, I. (Leicester) Gear, W. (Lancashire Polytech) Marscher, A. (Boston)	Observations at 1.3 cm of Blazar 1156+295 with telescopes B, G, Km, N, O, Sn, and Yn.
P-58V	Pearson, T. (Caltech) Readhead, A. (Caltech)	Second epoch observations at 6 cm of a complete sample of 20 sources with telescopes B, F, G, H, I, Km, O, and Yn.
P-71V	Padrielli, L. (Bologna) Bartel, N. (CFA) Fanti, R. (Bologna) Ficarra, A. (Bologna) Gregorini, L. (Bologna) Mantovani, F. (Bologna) Nicolson, G. (Hartebeesthoek) Weiler, K. (NRL) Romney, J.	Observations at 6 cm of higher resolution sources showing structural changes at 18 cm with telescopes B, E, F, G, Jb, Km, Lm, So, and Yn.
P-73V	Porcas, R. (MPIR, Bonn) Banhatti, D. (MPIR, Bonn) Gopal-Krishna (TIFR)	Second epoch VLBI observations at 6 cm of CTD 93 with telescopes B, G, Km, Lm, O, So, Wn, and Yn.
R-36V	Roberts, D. (Brandeis) Brown, L. (Brandeis) Gabuzda, D. (Brandeis) Rogers, A. (Haystack) Wardle, J. (Brandeis)	Monitoring at 6 cm of the millarcsecond polarization structure of the superluminal sources 3C 120, 3C 273, 3C 345, and BL Lacertae with telescopes B, F, G, Km, O, and Yn.

No.	Observer(s)	Program
R-39V	Reid, M. (CFA) Bloemhoef, 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.
W-38V	Witzel, A. (MPIR, Bonn) Biermann, P. (MPIR, Bonn) Eckart, A. (MPIR, Bonn) Johnston, K. (NRL) Schalinski, C. (MPIR, Bonn) Simon, R. (NRL)	Observations at 6 cm of a complete sample of extragalactic radio sources with telescopes B, G, Jb, Km, Lm, O, So, Wn, and Yn.
W-39V	Witzel, A. (MPIR, Bonn) Biermann, P. (MPIR, Bonn) Eckart, A. (MPIR, Bonn) Johnston, K. (NRL) Schalinski, C. (MPIR, Bonn) Simon, R. (NRL)	Observations at 1.3 cm of the submill-arcsecond structure of a complete sample of extragalactic radio sources with telescopes B, G, Km, O, Sn, and Yn.
W-42V	Walker, R. C. Unwin, S. (Caltech) Benson, J.	Monitoring at 6 cm of superluminal motions in 3C 120 with telescopes A, B, F, G, H, I, Km, O, So, and Yn.
Z-13V	Zensus, A. (Caltech) Baath, L. (Chalmers) Biretta, J. (CFA) Cohen, M. (Caltech) Unwin, S. (Caltech)	Monitoring of the superluminal motion at 1.3 cm of 3C 273 and 3C 345 with telescopes B, G, Jb, Km, N, O, Sn, and Yn.

C. 300-FT OBSERVING PROGRAMS

The following continuum programs were conducted during this quarter.

No.	Observer(s)	Program
A-82	Aller, H. (Michigan) Aller, M. (Michigan) Payne, H.	Observations at 880, 1400, and 2700 MHz of low-frequency variable sources.

No.	Observer(s)s	Programs
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 δ = 20° < δ < 45°.
O-32	O'Dea, C. Balonek, T. (Colgate)	Polarization and flux density measurements of variable sources at 2695 MHz. Dent, W. (Massachusetts) Kinzel, W. (Massachusetts)

The following line programs were conducted during this quarter.

No.	Observer(s)	Programs
F-94	Fisher, J. R.	Observations at 21 cm for intergalactic hydrogen.
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 programs were conducted during this quarter.

No.	Observer(s)	Programs
B-442	Backer, D. (Berkeley) Foster, R. (Berkeley) Heiles, C. (Berkeley) Kulkarni, S. (Caltech) Rand, R. (Berkeley) Werthimer, D. (Berkeley)	Real-time, fast pulsar search of the galactic plane at 825 MHz.
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 PROGRAMS

The following line programs were conducted during this quarter.

No.	Observer(s)	Programs
A-80	Arquilla, R. (Calgary, Canada) Kwok, S. (Calgary, Canada)	CO observations of IRAS sources showing SiC dust emission lines.

No.	Observer(s)	Programs
B-452	Brown, R.	Study of the gas content of QSO-host galaxies.
C-236	Churchwell, E. (Wisconsin) Woods, R. (Wisconsin)	Further study of interstellar SO^+.
D-146	Dent, W. (Massachusetts) Balonek, T. (Colgate)	Study of long-term, flux density changes in variable extragalactic radio sources.
D-150	Devereux, N. (Hawaii) Scoville, N. (Caltech) Sanders, D. (Caltech)	CO observations of infrared, luminous, barred spiral galaxies.
E-50	Emerson, D. (IRAM, France) Jewell, P. Martin, R. (Arizona) Salter, C. (IRAM, France)	A complete survey of ^{12}CO emission from M31.
F-90	Fuller, G. (Berkeley) Myers, P. (CFA)	$C_{18}O$ and CS mapping of dense cores.
G-276	Gordon, M. Jewell, P. Kaftan Kassim, M. (Unaffiliated) Salter, C. (IRAM, France)	Study of dust emission from Orion A and other HII regions.
G-279	Gordon, M.	Search for carbon recombination lines in in cool molecular clouds.
H-216	Hollis, J. M. (Goddard) Seaquist, E. (Toronto)	Complementary 1-mm and 3-mm continuum observations of symbiotic stars.
H-217	Huggins, P. (New York) Healy, A. (New York)	Study of the circumstellar envelopes of oxygen-rich stars.
H-219	Huggins, P. (New York) Healy, A. (New York)	Study of CO in the Helix and Dumbbell Nebulae.
J-111	Jewell, P. Dickinson, D. (Lockheed) Schenewerk, M. Snyder, L. (Illinois)	A study of high J, SiO maser transitions.
L-196	Lasenby, A. (Cambridge, UK) Lewtas, J. (Cambridge, UK)	Continuation of 1-mm observations of SO_2 and CH_3CN in Sgr B2.
M-237	Margulis, M. (Arizona) Lada, C. (Arizona)	Study of CO emission from the NGC 2264 molecular cloud.

No.	Observer(s)	Programs
M-243	Martin, H. Mundy, L. (Caltech)	Study of bumpy lines from clumpy clouds.
M-246	Mebold, U. (Arizona) Martin, R. (Arizona)	Study of CO lines at the interface between the Draco Nebula and high-velocity clouds.
M-247	Martin, R. (Arizona) Ho, P. (CFA) Turner, J. (CFA)	2-1 CO study of nearby spiral galaxies.
M-251	McCutcheon, W. (British Columbia) Purton, C. (DRAO, Canada) Dewdney, P. (DRAO, Canada)	CO observations of IRAS source RAFGL5124.
M-254	Maloney, P. (Arizona) Latter, W. (Arizona)	CO J=1-0 observations of NGC 5128 (Centaurus A).
R-226	Rickard, L. (NRL) Turner, B. Palmer, P. (Chicago)	Study of the J=2-1 CO structures of nearby galaxies.
R-227	Rickard, L. (NRL) Blitz, L. (Maryland)	Study of apparent variations in CO isotope ratios within galaxies.
R-233	Rickard, L. (NRL) Palmer, P. (Chicago)	Studies of the CO structures of bright galaxies.
S-295	Sahai, S. (Texas)	Search for SiO in carbon-rich circumstellar envelopes of red giants.
S-296	Barrett, J. (SUNY) Solomon, P. (SUNY) Sage, L. (SUNY)	CO observations of a flux-limited sample of IRAS galaxies.
S-301	Sanders, D. (Caltech) Mirabel, I. (Puerto Rico)	CO (2-1) observations of galaxies with strong radio continuum fluxes.
T-207	Terebey, S. (HAO) Fich, M. (Washington)	Study of the nature of moderate to massive star formation in the outer galaxy.
T-209	Turner, B. Ziurys, L. (Massachusetts)	Study of the new interstellar molecular ion $NCNH^+$.
V-55	Vanden Bout, P.	Study of bipolar flows in the S88B molecular cloud.

No.	Observer(s)	Programs
W-206	Wolf, G. (Arizona) Lada, C. (Arizona)	Structure and kinematics of molecular disks in star formation regions.
Z-48	Zuckerman, B. (UCLA) Dyck, H. (Hawaii)	Study of mass loss from red giant stars.
Z-57	Ziurys, L. (Massachusetts) Turner, B.	A search for the free radical NCO.

E. VLA OBSERVING PROGRAMS

The following 160 research programs were conducted with the VLA during this quarter.

No.	Observer(s)	Program
AA-54	Antonucci, R. (STScI) Ford, H. (STScI)	A Space Telescope/VLA study of Quasar Fuzz. 20 cm.
AA-55	Antonucci, R. (STScI) Barvainis, R. Wills, B. (Texas) Wills, D. (Texas)	Extended radio emission around newly discovered blazars. 20 cm.
AB-129	Burke, B. (MIT) Hewitt, J. (MIT) Roberts, D. (Brandeis)	Time variations in 0957+561. 6 cm.
AB-324	Blaha, C. (Minnesota) Pedelty, J. (Minnesota) Dickey, J. (Minnesota) Kennicutt, R. (Minnesota)	Hot spot nuclei. 20 cm.
AB-357	Becker, R. (Calif., Davis) White, R. (STScI)	Monitoring the radio flux of the radio star HD193793. 6 cm.

No.	Observer(s)	Programs
AB-369	Bridle, A. Browne, I. (NRAL, UK) Burns, J. (New Mexico) Dreher, J. (MIT) Hough, D. (Caltech) Laing, R. (RGO) Owen, F. Readhead, A. (Caltech) Scheuer, P. (MRAO) Wardle, J. (Brandeis) Londsale, 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-371	Baldwin, J. (MRAO, UK) Rossitter, D. (MRAO, UK)	Evolution of high power sources - redshifts greater than 1.5. 20 cm.
AB-374	Brebner, G. (NRAL, UK) Cohen, R. (NRAL, UK) Pedlar, A.	Masers associated with bipolar outflow. 1.3 and 18-cm line.
AB-375	Burke, B. (MIT) Lawrence, C. (Caltech) Hewitt, J. (MIT) Langston, G. (MIT) Turner, E. (Princeton)	Search for gravitational lenses. 6 cm.
AB-376	Baum, S. (Maryland) Bridle, A. Heckman, T. (Maryland) Miley, G. (STScI) van Breugel, W. (Berkeley)	Complete sample of equatorial, extragalactic radio sources. 2, 6, 18, and 20 cm.
AB-378	Barvainis, R. Deguchi, S. (Illinois)	Magnetic field mapping using linear polarization of H_2O masers. 1.3 cm.
AB-379	Barvainis, R. O'Dea, C.	Polarization observations of low-frequency variable sources. 90 cm.
AB-388	Backer, D. (Berkeley) Sramek, R.	Proper motion of Sgr A. 2, 6 and 20 cm.

No.	Observer(s)	Programs
AB-389	Baum, S. (Maryland) Bridle, A. Heckman, T. (Maryland) Miley, G. (STScI) van Breugel, W. (Berkeley)	Multifrequency mapping of 1717-00 = 3C 353. 6 and 20 cm.
AB-390	Briggs, F. (Pittsburgh) Wolfe, A. (Pittsburgh)	Radio structure of PKS 0458-02: a QSO with 21-cm absorption at z = 2.04. 6, 20 and 90 cm.
AB-391	Boisse, P. (ENS, Paris) Kazes, I. (Meudon) Bergeron, J. (Inst. d'Astrophy., Paris) Dickey, J. (Minnesota)	HI absorption in QSO galaxy pairs. 20-cm line.
AB-393	Branch, D. (Oklahoma) Cowan, J. (Oklahoma)	Search for 20-cm emission from two of the nearest extragalactic-type I SN. 20 cm.
AB-394	Bastian, T. (Colorado) Dulk, G. (Colorado) Bookbinder, J. (JILA)	dMe flare stars. 6 and 20-cm line.
AB-395	Brown, A. (Colorado/JILA) Drake, S. (Goddard) Mundt, R. (MPI, Heidelberg)	Inner emission regions of HL Tau and XZ Tau. 2 and 6 cm.
AB-397	Bookbinder, J. (Colorado)	A search for a planetary companion to Barnard's Star. 6 cm.
AC-146	Churchwell, E. (Wisconsin) Felli, M. (Arcetri) Massi, M. (Arcetri)	High dynamic range continuum mapping of Orion A. 6 and 20 cm.
AC-147	Crane, P. van der Hulst, J. (NFRA) Ford, H. (STScI) Lawrie, D. (Ohio State) Jacoby, G. (NOAO)	Nuclear region of M51. 6 cm.
AC-148	Cameron, R. (Mt. Stromlo & Siding Springs Obs.) Parma, P. (Bologna) de Ruiter, H. (Bologna)	The structure of dumbbell galaxy radio sources. 20 cm.

No.	Observer(s)	Programs
AC-149	Clarke, D. (New Mexico) Burns, J. (New Mexico) Norman, M. (LANL) Christiansen, W. (North Carolina)	Search for active magnetic field effects in extragalactic sources. 6 and 20 cm.
AC-153	Cooke, B. (Leicester) Ponman, T. (Birmingham) McHardy, I. (Leicester)	Further observations of a source in the error box of the X-ray source GX349+2. 6 and 20 cm.
AC-155	Caillault, J-P. (JILA)	Microwave observations of M-Dwarfs in the Hyades. 6 cm.
AC-156	Carral, P. (Berkeley) Turner, J. (CFA) Ho, P. (CFA)	15-GHz mapping of compact structure in galactic nuclei. 2 cm.
AC-158	Cowan, J. (Oklahoma) Branch, D. (Oklahoma)	Observations of the historical supernova 1959d in NGC 7331. 20 cm.
AC-159	Campbell, B. (Mt. Wilson) Torbett, M. (Kentucky)	Bipolar wind morphologies in cataclysmic variables. 2 cm.
AC-161	Clifton, T. (Berkeley) Kulkarni, S. (Caltech) Backer, D. (Berkeley)	Investigation of new high-dispersion pulsars and the scattering associated with inner regions of the galaxy. 20 and 90 cm.
AC-162	Cordes, J. (Cornell) Dewey, R. (Cornell) Hankins, T. (Dartmouth) Thiering, I. (Cornell)	Astrometry of pulsars. 6 and 20 cm.
AD-167	de Pater, I. (Berkeley) Ip, W-H. (MPIR, Lindau) Snyder, L. (Illinois) Palmer, P. (Chicago) Bolton, S. (Berkeley)	Radio source occultations by Comet Halley. 18 and 20-cm line.
AD-181	de Pater, I. (Berkeley) Dickel, J. (Los Alamos/Illinois)	Saturn. 2, 6 and 20 cm.
AD-184	Drake, S. (SASC Technologies) Reimers, D. (Hamburg) Brown, A. (JILA)	Study of Zeta Aurigae and similar binaries containing B dwarf secondaries. 2 and 6 cm.

No.	Observer(s)	Programs
AE-45	Ekers, R. Sramek, R. Cowan, J. (Oklahoma) Branch, D. (Oklahoma) Goss, W. M. (Kapteyn Lab)	Search for very young SNRs. 20 cm.
AE-46	Emerson, D. (IRAM, Grenoble) Forveille, T. (IRAM, Grenoble) Weliachew, L. (IRAM, Grenoble)	Nature of compact HII region in in the bipolar source Cep A. 1.3, 2 and 6 cm.
AF-113	Feigelson, E. (Penn State) Clarke, D. (New Mexico) Burns, J. (New Mexico)	Search for motion in jet knots of Centaurus A. 2 and 6 cm.
AF-114	Fanti, R. (Bologna) Mantovani, F. (Bologna) Padrielli, L. (Bologna)	Steep spectrum, low-frequency variables. 6 cm.
AF-117	Fomalont, E. Geldzahler, B. (NRL)	Further observations of Sco X-1. 2 and 6 cm.
AF-118	Fomalont, E. Goss, W. M. (Kapteyn Lab) Lyne, A. (NRAL) Manchester, R. (CSIRO)	Pulsar positions and proper motions. 20-cm line.
AF-122	Fich, M. (Washington)	Compact flat spectrum sources in the outer galaxy. 6 cm.
AF-125	Feretti, L. (Bologna) Giovannini, G. (Bologna) Gregorini, L. (Bologna)	High-resolution observations of the NAT galaxy in Abell 115. 20 cm.
AF-126	Forster, J. (CSIRO) Caswell, J. (CSIRO) Komesaroff, M. (CSIRO)	Ultracompact HII with OH/H_2O masers. 1.3-cm line.
AF-127	Fricke, J. (Gottingen) Kollatschny, W. (Gottingen) Courvoisier, (ESO) Jorsater, S. (ESO) Veron, P. (ESO)	Radio morphology of galaxies with low-level nuclear activity. 6 and 20 cm.
AF-128	Fiedler, R. (NRL) Dennison, B. (VPI&SU) Johnston, K. (NRL)	Search for refractive scintillation in CTA 26. 20 and 90 cm.
AF-129	Fix, J. (Iowa)	OH emission from TW Aql. 18-cm line.

No.	Observer(s)	Programs
AG-116	Gibson, D. (NMIMT) Priedhorsky, W. (LANL)	Search for 300-day periodicity in Cyg X-1. 2, 6 and 20 cm.
AG-209	Glendenning, B. (Toronto) Kronberg, P. (Toronto)	Further observations of NGC 2146. 2 and 6 cm.
AG-214	Green, D. (MRAO) Gull, S. (MRAO)	HI absorption towards point source in Tycho's SNR. 20-cm line.
AG-215	Giovannini, G. (Bologna) Feretti, L. (Bologna)	High-resolution observations of NGC 4869. 6 and 20 cm.
AG-218	Garcia, M. (CFA) Grindlay, J. (CFA) Molnar, L. (CFA) Reid, M. (CFA)	Origin and evolution of radio flares from GX13+1. 2, 6 and 20 cm.
AG-220	Garrington, S. (NRAL) Leahy, J. (NRAL) Conway, R. (NRAL) Laing, R. (RGO)	Depolarization asymmetries and jet sidedness. 20 cm.
AH-201	Hintzen, P. (Goddard) Owen, F.	Snapshot survey of QSOs to identify distorted sources. 20 cm.
AH-202	Hollis, J. M. (Goddard) Michalitsianos, A. (Goddard) Kafatos, M. (George Mason)	Investigating the sub-arcsec structure of RX Puppis. 1.3 and 2 cm.
AH-204	Hollis, J. (Goddard) Furenlid, I. (Georgia State)	Mass loss of BW Vulpeculae. 6 cm.
AH-211	Ho, P. (CFA) Turner, J. (CFA)	HI synthesis mapping of NGC 253. 21-cm line.
AH-220	Hughes, V. (Queen's)	Star formation in Cep A. 2, 6 and 20 cm.
AH-221	Helfand, D. (Columbia) Zoonematkermani, S. (Columbia) Becker, R. (Calif., Davis)	Search for Crab-like SNRs in M31. 6 and 20 cm.
AH-224	Hjellming, R. Johnston, K. (NRL) Schilizzi, R. (NFRA)	High resolution imaging of the SS433 radio source. 2 and 6 cm.
AH-227	Hjellming, R.	1741-038: a rapid "scintillator." 1.3, 2, 6, 20 and 90 cm.

No.	Observer(s)	Programs
AH-230	Hummel, E. (MPIR, Bonn) Kotanyi, C. (ESO) van Gorkom, J. (Princeton)	Peculiar radio features in NGC 4388 and NGC 4438. 6 and 20 cm.
AH-231	Hummel, E. (MPI, Bonn) Jorsater, S. (ESO) Lindblad, P. (Stockholm Obs.) Sandqvist, A. (Stockholm Obs.)	Central region of NGC 613, a peculiar radio source. 6 cm.
AH-232	Hewitt, J. (MIT) Burke, B. (MIT) Turner, E. (Princeton) Lawrence, C. (Caltech)	Multifrequency maps of the probable gravitational lens 0023+171. 2, 6, 18 and 20 cm.
AJ-131	Johnston, K. (NRL) Florkowski, D. (USNO) de Vegt, C. (Hamburger Stern.) Wade, C.	Parallax of the nearby stars UX Ari and HR 5110. 6 cm.
AJ-133	Johnston, K. (NRL) Florkowski, D. (USNO) Wade, C. de Vegt, C. (Hamburger Stern.)	Relationship of the radio and optical reference frames. 6 cm.
AJ-136	Johnston, K. (NRL) Odenwald, S. (NRL-SFA) Kuhr, H. (MPIR, Bonn)	VLA survey of QSO galaxy pairs. 2 and 6 cm.
AJ-138	Jorsater, S. (ESO) van Moorsel, G. (ESO) Lindblad, P. (Stockholm Obs.)	High-resolution HI study of the barred spiral galaxy NGC 1365. 20-cm line.
AK-119	Kailey, W. (Arizona) Elston, R. (Arizona)	Search for supernova remnants near the nucleus of M33. 20 cm.
AK-132	Kazes, I. (Meudon) Dickey, J. (Minnesota)	Extragalactic OH absorption in B2 1506+34. 20-cm line.
AK-139	Kapahi, V. (TIFR) Kulkarni, V. (TIFR)	Epoch dependence of the sizes and spectra of radio galaxies. 20 cm.
AK-142	Kwok, S. (Calgary) Aaquist, O. (Calgary)	Radio survey of compact planetary nebulae. 2 and 6 cm.
AK-144	Kronberg, P. (Toronto) Sramek, R.	Monitor M82. 1.3, 2 and 6 cm.

No.	Observer(s)	Programs
AK-145	Kulkarni, S. (Caltech) Backer, D. (Berkeley) Clifton, T. (Berkeley)	Astrometry of binary pulsars and proper motion of two pulsars. 20 cm.
AK-148	Karoji, H. (Inst. d'Astrophy., Paris) Dennefeld, M. (Inst. d'Astrophy., Paris)	IRAS galaxies with violent star formation. 6 cm.
AL-113	Leahy, J. (NRAL)	Faraday rotation and depolarization in classical double radio sources. 6, 18 and 20 cm.
AL-117	Lang, K. (Tufts) Willson, R. (Tufts)	Simultaneous VLA/SMM observations of the inner solar corona. 20 and 90 cm.
AL-118	Lang, K. (Tufts) Willson, R. (Tufts)	Slowly-varying microwave emission and stellar bursts from dwarf M flare stars. 6 and 20 cm.
AL-119	Lonsdale, C. (Penn State) Barthel, P. (Caltech)	High redshift quasars. 2 and 6 cm.
AM-124	McHardy, I. (Leicester) Smith, A. (ESTEC) Warwick, R. (Leicester)	Coordinated radio, optical, and X-ray observations of optically variable extragalactic sources (OVVs) and BL Lacertae objects. 2, 6, and 20 cm.
AM-167	Molnar, L. (CFA) Reid, M. (CFA)	Scattering size of Cygnus X-3. 20 and 90 cm.
AM-171	McClintock, J. (CFA) Remillard, R. (MIT) Molnar, L. (CFA)	Search for emission from the black-hole binary A0620-00. 6 and 20 cm.
AM-173	Morris, M. (UCLA) Yusef-Zadeh, F. (Columbia)	High-resolution mosaic of galactic center arc. 6 cm.
AM-174	Miley, G. (STScI) van Breugel, W. (Berkeley) Chambers, K. (Johns Hopkins)	Properties of ultra-steep-spectrum radio sources. 20 cm.
AM-175	Masson, C. (Caltech)	Motions of OH masers in Orion A. 18-cm line.

No.	Observer(s)	Programs
AM-177	Meurs, E. (Inst. Ast., Cambridge)	Radio cores in Seyfert galaxies. 2 and 6 cm.
AM-178	Mutel, R. (Iowa) Gopal-Krishna (TIFR)	Compact double radio sources. 20 cm.
AM-179	Muhleman, D. (Caltech) Berge, G. (Caltech) Grossman, A. (Caltech)	Saturn: properties of the atmosphere and rings. 20 cm.
AM-181	Menten, K. (MPIR, Bonn) Wilson, T. (MPIR, Bonn) Walmsley, C. (MPIR, Bonn) Henkel, C. (MPIR, Bonn) Wadiak, E. J. Johnston, K. (NRL)	High-resolution measurements of the W3(OH) methanol masers. 1.3-cm line.
AN-37	Neff, S. (Goddard) Joseph, R. (Imperial College) Rickard, L. (NRL) Johnston, K. (NRL)	High-resolution observations of merging galaxies. 2, 6 and 20 cm.
AO-62	O'Donoghue, A. (NMIMT) Owen, F. Eilek, J. (NMIMT)	Wide angle tail sources. 6 and 20 cm.
AO-65	Oort, M. (Leiden) Katgert, P. (Leiden)	Morphology of blue radio galaxies and deep identifications of radio sources from a very deep survey. 6 and 20 cm.
AO-67	Owen, F. Cornwell, T. Hardee, P. (Alabama) Biretta, J. (Caltech)	M87. 1.3, 18 and 20 cm.
AO-70	O'Dea, C. Barvainis, R.	Polarization observations of core-dominated sources. 2 and 6 cm.
AO-71	Ondrechen, M. (Minnesota) Dickey, J. (Minnesota) van der Hulst, J. (NFRA)	HI absorption in the nuclei of two barred spiral galaxies. 20 cm.
AP-113	Parsons, S. (STScI) Bopp, B. (Toledo) Feldman, P. (Herzberg)	Luminous F supergiants and giants with hot binary companions. 2 and 6 cm.

No.	Observer(s)	Programs
AP-115	Payne, H. Terzian, Y. (Cornell)	OH observations of NGC 6302. 18 cm line.
AP-116	Pottasch, S. (Kapteyn Lab) Bignell, R. C. Zijlstra, A. (Groningen)	Radio emission from planetary nebulae. 6 cm.
AP-117	Pedlar, A. (Jodrell Bank) Unger, S. (NRAL) Whittle, M. (Inst. Ast., Cambridge)	Seyfert II nucleus of Mkn 78. 2 and 6 cm.
AR-119	Rao, A. (TIFR) Subrahmanyan, R. (TIFR)	Double source showing peaked spectrum. 1.3, 2 and 6 cm.
AR-139	Reid, M. (CFA) Moran, J. (CFA) Guinn, C. (CFA) Schneps, M. (CFA) Genzel, R. (Berkeley)	Statistical parallax of the Sgr B2 water masers. 1.3 single antenna VLB.
AR-141	Rao, A. (TIFR) Ananthakrishnan, S. (TIFR) Ulvestad, J. (JPL)	Structure of compact sources in the galactic plane. 2, 6 and 20 cm.
AR-144	Rodriguez, L. (UNAM) Gomez, U. (UNAM) Garcia-Barreto, J. (UNAM)	Mapping of peculiar structures in Vy 2-2. 2 and 6 cm.
AR-145	Reid, A. (NRAL) Walsh, D. (NRAL) Shone, D. (NRAL)	Quasars from the Jodrell Bank complete sample. 6 and 20 cm.
AR-147	Rucinski, S. (Toronto) Gibson, D. (NMIMT)	Survey of evolved W Ursa Majoris stars. 2, 6 and 20 cm.
AR-148	Rudnick, L. (Minnesota) Pedelty, J. (Minnesota) Chan, V. (Minnesota)	Structural details of extragalactic radio source hot spots: 3C 33 and other sources. 6 and 20 cm.
AR-151	Rickard, L. (NRL-SFA) Turner, B.	A study of the 1667-MHz "Megamaser" in UGC 8696. 18-cm line.
AS-80	Sramek, R. van der Hulst, J. (NFRA) Weiler, K. (NRL)	Monitoring SN1980 in NGC 6946 and SN1979c in M100. 2, 6 and 20 cm.

No.	Observer(s)	Programs
AS-211	Sramek, R. Weiler, K. (NSF) van der Hulst, J. (Westerbork) Panagia, N. (STScI)	Statistical properties of radio supernovae. 2, 6 and 20 cm.
AS-226	Sumi, D. (Illinois) Smarr, L. (Illinois) Owen, F.	Detailed mapping of emission from the cD galaxy in Abell 2029. 6 and 20 cm.
AS-230	Sramek, R. Skillman, E. (NFRA)	The SNR in NGC 5471. 6 cm.
AS-248	Stewart, R. (CSIRO) Slee, O. (CSIRO) Nelson, G. (CSIRO) Vaughan, A. (Macquarie, Aust.) Coates, D. (Monash, Aust.)	Quiescent emission from late type stars. 6 and 20 cm.
AS-249	Sanders, R. (Kapteyn Lab) Bridle, A. Clark, B.	Alignment of sources in the B3 survey. 20 cm.
AS-255	Schwartz, P. (NRL) Johnston, K. (NRL) de Vegt, C. (Hamburger Stern.)	Precise position of T Tau. 1.3 and 2 cm.
AS-256	Sandqvist, A. (Stockholm Obs.) Karlsson, R. (Stockholm Obs.)	OH in the Sgr A molecular clouds. 18-cm line.
AS-261	Spangler, S. (Iowa) Mutel, R. (Iowa) Cordes, J. (Cornell)	Inspection of candidate VLBI sources behind the Cygnus OB1 association. 1.3, 2, 6 and 20 cm.
AT-64	Taylor, A. (Kapteyn Lab) Pottasch, S. (Kapteyn Lab) Seaquist, E. (Toronto)	Monitoring of Nova Vulpeculae 1984 No. 2. 2, 6 and 20 cm.
AT-69	Taylor, A. (Kapteyn Lab) Seaquist, E. (Toronto)	Two epoch, multifrequency mapping of the CH Cyg radio jet. 1.3, 2, 6 and 20 cm.
AT-71	Turner, J. (CFA) Ho, P. (CFA)	Polarization and spectral indices of nuclear hot spots in NGC 253. 1.3 and 2 cm.
AT-73	Taylor, A. (Kapteyn Lab) Kwok, S. (Calgary) Pottasch, S. (Kapteyn Lab)	Multifrequency, high-resolution maps of compact planetary nebulae. 1.3, 2, 6 and 20 cm.

No.	Observer(s)	Programs
AU-23	Unger, S. (NRAL) Pedlar, A. (Jodrell Bank) Wolstencroft, R. (Royal Obs.) Savage, A. (Royal Obs.) Leggett, S. (Royal Obs.)	Studies of a complete far-infrared, selected sample of galaxies. 6 and 20 cm.
AU-25	Unger, S. (NRAL) Axon, D. (NRAL) Pedlar, A. (Jodrell Bank) Taylor, K. (RGO) Wolstencroft, R. (Royal Obs.)	Gas ejection in the hotspot galaxy NGC 1808. 6 and 20-cm line.
AU-26	Unger, S. (NRAL) Chapman, J. (NRAL) Staveley-Smith, L. (NRAL) Cohen, R. (NRAL) Pedlar, A. (Jodrell Bank)	OH megamaser in III Zw 35. 6 and 18-cm line.
AV-96	van der Hulst, J. (NFRA) Sramek, R. Weiler, K. (NRL)	Monitoring the supernova in NGC 4258. 6 and 20 cm.
AV-117	Veron, P. (ESO) Roland, J. (Inst. d'Astrophy. Paris)	Compact radio sources with very steep radio spectra. 6 and 20 cm.
AV-127	van Breugel, W. (Berkeley) McCarthy, P. (Berkeley) Heckman, T. (Maryland) Miley, G. (STScI)	Three radio galaxies with extended emission lines. 2, 6, and 21 cm.
AV-133	van Breugel, W. (Berkeley) Spinrad, H. (Berkeley) Djorgovski, S. (CFA)	Evolution of powerful radio galaxies. 2 and 6 cm.
AV-134	Vanden Bout, P.	Compact HII regions in S88B. 6 cm.
AW-141	Winglee, R. (Colorado) Dulk, G. (Colorado) Bastian, T. (Colorado)	Substellar and planet-like companions. 20 and 90 cm.
AW-143	Whiteoak, J. (CSIRO) Gardner, F. (CSIRO)	OH observations of molecular clouds near Sgr A (West). 18-cm line.

No.	Observer(s)	Programs
AW-147	Whiteoak, J. (CSIRO) Gardner, F. CSIRO) Forster, J. (CSIRO)	A search for H_2CO masers in NGC 6334. 6-cm line.
AW-150	White, R. (STScI) Becker, R. (Calif., Davis)	High-resolution observations of point sources near LkHα 101. 2 and 6 cm.
AW-152	Wilson, A. (Maryland) Keel, W. (Leiden)	Seyfert galaxy NGC 5929. 2 cm.
AW-155	Wilson, A. (Maryland)	Seyfert galaxy ESO263-G13. 6 and 20 cm.
AW-156	Wynn-Williams, G. (Hawaii) Becklin, E. (Hawaii)	Search for non-stellar activity in luminous IRAS galaxies. 6 and 20 cm.
AW-158	Wood, D. (Wisconsin) Churchwell, E. (Wisconsin)	Ultracompact HII regions. 6 cm.
AW-159	Wehrle, A. (UCLA) Morris, M. (UCLA)	Nuclei of edge-on spiral galaxies N891, N3628, N4565, N4594 (M104), and Seyfert galaxy N5506. 2 and 6 cm.
AY-12	Yee, H. (Montreal) Hintzen, P. (Goddard)	Snapshot survey of Southern Parkes quasars. 6 and 20 cm.
AY-13	Yusef-Zadeh, F. (Columbia) Morris, M. (UCLA)	Compact sources in the galactic center region. 2, 6 and 20 cm.
VM-78	McHardy, I. (Leicester) Gear, W. (Lancashire Polytech) Marscher, A. (Boston)	Blazar 1156+295. 1.3-cm, three antenna, VLB.

F. SCIENTIFIC HIGHLIGHTS

A Collapsing Protostar in Ophiuchus

Observations with the 12-meter telescope have been made toward IRAS 16293-2422, an extremely cold infrared source associated with a high-velocity molecular outflow in the Rho Ophiuchi molecular cloud. The continuum between 25 μ and 2.7 mm is well modelled with dust emission at 38 K. The bolometric luminosity is 23 $L_{\odot}$. Spectral-line observations of the J = 5-4 and J = 2-1 transitions of CS show that the infrared source is embedded in a compact, dense molecular core.

The $C^{32}S$ line profiles show strong self-absorption with the J = 5-4 line showing a prominent asymmetry, which has been explained by the presence of infalling material in the inner regions of the cloud.

Enigmatic Feature in Sgr A West

High-resolution, A-array data at 6 and 2 cm have been obtained with the VLA of the three-armed spiral feature, Sgr A West, at the center of the Galaxy. A 2-cm image of the northern arm reveals a sinuous, serpentine structure along the ridge line of the arm. The regular oscillation has an apparent wavelength at ~8" (0.4 pc). The southern and eastern arms have not yet been adequately imaged to reveal similar structures. Although the general spiral features of Sgr A West have thermal characteristics, high-resolution spectral index and polarization studies have not yet been made in order to differentiate the various suggested models of the source. Infrared polarimetry of dust grains along the northern and eastern arms suggest the existence of a strong magnetic field. Similarities with oscillations commonly seen in extragalactic radio jets have been noted.

Methanol Masers

During a search for possible absorption of the 2_0-3_{-1} transition of E-type methanol against the continua of a number of galactic HII regions, strong methanol maser transitions were discovered. The 140-foot telescope observations of CH_3OH at a frequency of 12.1786 GHz, intended to test the present understanding of excitation conditions for the molecule and as a probe to derive methanol abundances, instead found the strong maser emission. Of the few sources studied so far, only NGC 7538 and one other HII region exhibit the maser emission. Further investigations should indicate how the pump mechanisms and physical conditions intercompare for the three known masering molecules, methanol, hydroxyl, and silicon monoxide.

Another Binary Radio Jet System

A VLA survey of radio sources identified with optical dumbbell galaxies has turned up PKS 2149-158 to be a binary system of extragalactic radio jet sources similar to 3C 75, earlier independently found in the Abell cluster A400. A-configuration, 20-cm images show both optical nuclei of PKS 2149-158 to consist of a compact radio core with jets emanating from both sides for each core. The linear core separation is 30 kps. D-configuration, 6-cm observations reveal the large-scale C symmetry and superimposed smaller-scale oscillations that are present in the overall structure of the source. Further observation and analysis of the detailed radio jet trajectories for evidence of bending and interaction should prove to be an interesting comparision to the 3C 75 sources. Similar mechanisms may be responsible for the observed structures in both systems and may be applicable to other extended radio sources in clusters of galaxies.

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. Construction of the front ends has begun. The first unit utilizing FET amplifiers was delivered to the VLA in February 1986, and the construction schedule will be completed by the end of 1987. Three units using HEMT devices are being constructed, and the decision as to whether to complete the schedule with FET or HEMT devices has not yet been made.

During this quarter a second production receiver utilizing HEMT devices was delivered with noise temperature of 1 ~ 15 K measured at the room-temperature waveguide flange. A third system has been completed. A problem has been noted concerning calibration directional-couplers with coupling value changing with each cool-down. This will be corrected by tighter tolerance control by the coupler manufacturer (Mac Technology) and testing of each unit by NRAO.

23-GHz HEMT/FET Amplifier Development

Two four-stage FET amplifiers giving ~120 K noise temperature from 22 to 25 GHz have been delivered to the VLA for incorporation in a front-end upgrade. These amplifiers utilize commercially-available transistors (NE045) and are repeatable. Efforts will continue to find a source of HEMT devices for the first stage and to lower noise temperatures to ~60 K.

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.

The prototype one-eighth system was completed this quarter and shipped to Tucson for telescope tests. A problem of residual baselines and increased RMS noise fluctuation at long integration times (24 hours) persists. It appears to be due to self-generated RFI and efforts will continue to correct the problem.

Superconducting (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 50 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.

Receiver noise temperatures below 100 K SSB are now routinely obtained in the laboratory in the 90-120 GHz band using NBS Pb-alloy junctions cooled to 2.5 K. These mixers are now in use on the Kitt Peak 12-meter telescope, where the receiver noise temperatures are substantially higher (150 K SSB) because of excessive RF and IF losses in the present receiver. Recently we have tested all-Nb junctions made by Hypres, which can be operated at 4.2 K, a significant advantage as there is no need to pump on the liquid helium, and the cryogen hold-time is increased. At 4.2 K, in the laboratory, we measure receiver noise temperatures below 100 K SSB with the receiver tuned for true single-sideband reception and around 60 K DSB with the receiver tuned for broadband reception. Close collaboration with the Semiconductor Device Laboratory at the University of Virginia continues as we develop refractory SIS junctions incorporating on-chip microwave tuning circuits for operation up to 360 GHz.

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 soon.

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) Measurements were made on three specially made low-stress mixer diodes from the University of Virginia. Although these diodes are mostly free of the "camel-hump" feature in their DC noise characteristics, their mixer noise temperatures were still inferior to those achieved with the old 2P9-400 devices. An additional batch of UVA diodes with a specially tailored doping profile is now available and is expected to perform better. (ii) We have experienced great difficulty in obtaining reproducible performance from Schottky diode mixers in the shorter millimeter bands, and believe the problem lies in the mechanical differences between the mixer blocks, and even in the differences between successive "whiskers" used in the same mixer. We have started using the large-chamber scanning electron microscope at the UVA Semiconductor Device Laboratory for contacting diodes and making accurate photographs of mixers every time they are contacted. Servo-mechanisms in the SEM allow positioning of the diode whisker within a fraction of a micron. (iii) Substantial losses have been found in the quasi-optics of the standard NRAO millimeter test receivers. We have lost much time trying to improve already good mixers. (iv) The first of three room temperature, 225-GHz radiometers for millimeter array site testing is now almost complete, and has a noise temperature of 1500 K DSB. Additional mixers are being fabricated in this band, and those which operate well cryogenically will be supplied to the 12-meter telescope for the eight-beam, 230 GHz receiver.

Planar Mixer-Antenna Development

The goal of this research is to develop compact, multi-beam receivers using planar arrays of closely spaced antenna feed elements coupled to SIS junctions. The receivers can be designed to operate either as direct detectors or in heterodyne mode. With direct detectors, the receiver array is located at the focal plane of the telescope and gives a "photographic" image with one output for each pixel. With heterodyne receivers, the array is located either in the focal plane or at a virtual (i.e., transformed) aperture plane of the telescope, in which case it operates as a phased array, forming many beams simultaneously by appropriate combining and phasing of the individual IF signals. 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.

We have begun designing a waveguide tripler for the new 290-310 GHz receiver at Kitt Peak. We hope this will cover 280-360 GHz, thereby superceding the old quasi-optical tripler. As a backup, work is continuing on re-optimizing the quasi-optical tripler, which has not worked properly since its varactor was re-whiskered over a year ago.

I. GREEN BANK ELECTRONICS

300-foot Modernization

During this quarter, an extensive remodeling of the 300-foot control room was done. The new Masscomp control computer was installed and interfaces with existing systems tested. The control room was 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 was improved by replacing most of the screens, insuring that they were grounded to the building shield, and installing RFI gaskets on the doors. The new control system is now in use on a regular basis, although all features are not yet implemented and occasional bugs still appear.

The control electronics for the north-south lateral focusing mechanisms was installed. Addition of north-south receiver motion should result in improvements in the aperture efficiency at large zenith angles. The control electronics was tested and operated correctly with the DDP-316 control program. However, tests have shown that the mechanism that supports and drives the Sterling mount in the north-south direction has inadequate stiffness, resulting in non-repeatability that is not acceptable. Design work by the Telescope Operations division to stiffen the mechanism, and also to install the necessary limit switches, is proceeding.

300-foot Telescope Spectral Processor

Development of the new spectrometer for the 300-foot telescope has continued. The spectrometer will provide a total of 2048 frequency points which may be divided into two channels with 40-MHz maximum bandwidth each, or up to eight channels with 10 MHz maximum bandwidth each. Many features that will enhance pulsar observations are being designed into the spectrometer, including 12-microsecond timing resolution, spectra dedispersion, spectra frequency and time averaging capability, and interference excision capability.

Ninety percent of the tests on the Memory Buffer card and associated test card have been completed. The FAST logic circuits used on this card appear to function at greater than the required 20-MHz clock rate.

Design of the Timing Generator cards, which generate clock and syncronization signals for the entire system, is proceeding. The wire-wrap card used in this functional block has been constructed and operates satisfactorily, and tests have started on the printed circuit card.

A paper design of the A/D Interface card has been completed. This card takes the 80 MHz data stream from the A/D converters and splits it into four 20-MHz streams that are passed into the Memory Buffer card.

The Spectral Processor control computer has arrived, and work has started on the digital rack layout.

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. Tests have shown that, at right ascensions six hours from the meridian and at 1.3-cm wavelength, source antenna temperatures increase by 50% when the lateral focusing mechanism is used. Some additional improvement is feasible when the correction coefficients are optimized; good observing weather will be required to do that optimization.

5 GHz, 7-Feed Receiver

A multi-feed receiver is being developed which will significantly improve continuum mapping capabilities of the 300-foot telescope. The receiver is designed to cover the frequency range 4.6-5.1 GHz. Seven feeds are arranged in a filled circular array, connected to cooled, dual-circular polarizers.

All fourteen of the cooled FET amplifiers have been completed and installed, and cooling tests of the refrigeration system have been performed. The cool-down time is satisfactory and the refrigerator capacity is sufficient. Cooled calibration couplers identical to those used in this system gave non-repeatable coupling values in another receiver. Tests were done on the units in this system, and they appear to be working fine.

A prototype, balanced square-law detector was tested and found to provide the performance required; identical units were then purchased for the complete system. Linearity adjustments on the detectors in their final configuration remain to be done.

Most of the system wiring has been completed and debugged, and layouts of the last printed circuit cards are almost finished. It is hoped that the system will be ready for check-out on the 140-foot at the end of July as scheduled.

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 during the 1985/86 observing season. The only modification planned for this receiver is to replace the klystron local oscillator system with Gunn oscillators. The 200-270 GHz receiver also performed well, with an effective system temperature at 230 GHz of below 1000 K (single sideband). Work planned for this system this summer includes the improvement of the noise temperature in the range 240-270 GHz, the replacement of the klystrons by Gunns, and an attempt to extend the frequency coverage from the current limit of 270 GHz to a limit of 310 GHz.

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 receiver temperature of approximately 125 K (single sideband).

Following a test of the SIS receiver on the telescope in March, a number of modifications were made and the second channel, which failed during the tests, was repaired. The receiver was installed on the telescope for scheduled observations at the end of May and was in almost constant use for four weeks. Observations have been made at 100, 110, 115, and 116 GHz with single sideband receiver noise temperatures in the range 170-280 K and image rejection of order 20 dB. At 115 GHz the system temperature was as low as 600 K. The aperture efficiency is around 35%, but some progress has been made in understanding this low value and an efficiency similar to that of the Schottky receiver should be achieved by next season.

During operations it was found that retuning the LO and mixers can be time-consuming, though it is less of a problem now that more experience with the process has been acquired. The Gunn oscillator and phase lock have generally been satisfactory; the main problem being loss of lock due to temperature changes between day and night. Helium fills are scheduled three times a week and take about one hour.

8-Feed, 230-GHz Receiver

Many proposals are now received requiring large amounts of observing time in order to map the distribution of intensity 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 have begun the design of a multifeed system for use at 230 GHz. We envision it as having eight feeds and associated receivers. In the ultimate system the receivers will be of the SIS type, although initially the system will be equipped with Schottky mixers of the type now in use at this frequency. As an aid to the design and to provide a basis for developing the software required to support multifeed observing, we have begun the construction of a four-feed prototype. It is planned to make some tests of the prototype during the next observing season.

Hybrid Spectrometer

One consequence of the introduction of receivers in the 230 and 345-GHz windows is that there is a requirement for larger total bandwidths than have been customary in the past. For example, studies of galaxies whose velocity dispersions are 500 km/s require bandwidths at 345 GHz of order 600 MHz merely to include the whole line. At the same time, very sensitive receivers in the 3-mm window have enabled studies of narrow lines, especially in cold compact clouds. To resolve these lines, the channel width must be 25 kHz or less. Finally, the interest in rapid mapping of sources has prompted the design of multi-feed systems; each feed-receiver unit in such a system must have its own spectral analysis device.

The increased demands of the new spectral-line projects have strained the capacity of the existing filter banks. Not only is it difficult to provide filterbanks with the full range of resolutions needed, but also changes from one filterbank to another require recabling and can therefore be quite time-consuming. In order to provide the needed flexibility in resolution and to enable the analysis of larger bandwidths, a new spectrometer is now under construction. The spectrometer is a hybrid of analog-filter and digital-correlator techniques, and provides 1536 channels and a 2.4 GHz total bandwidth. The highest resolution is 24 kHz. The spectrometer is comprised of eight identical subassemblies, so that it will be well-suited for use with a multi-feed receiver.

A prototype unit, effectively one-eighth of the entire hybrid spectrometer, was tested on the 12-meter telescope in June. The digital portion performed satisfactorily and within specifications. The IF portion worked reasonably well, but some additional experiments will be run in the next few months in an attempt to further improve this part of the spectrometer. Construction of the digital section of the entire spectrometer will begin immediately, while that of the IF section will be started towards the end of the year.

Digital Continuum Backend

A digital continuum backend for the 12-meter telescope has been completed. The device accommodates two receiver channels and records four switching phases per channel (signal, reference, signal+cal, and reference+cal). The backend is based loosely upon the approach of the Green Bank digital backend. To achieve the flexibility required by millimeter-wave observing, the signal from the digital backend is integrated in the telescope control computer. Final signal processing is performed in the analysis computer.

The digital backend passed a series of tests this spring and more tests are scheduled before summer shutdown. The digital backend will be available for routine use during the next observing season, although certain features will not be implemented because of limitations imposed by the existing control computer.

These limitations will be removed in the new control system which is now being designed.

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 beamwidth 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 5°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 arcminute. This problem is being cured by coating the critical parts of the antenna structure with insulation to reduce the temperature differentials. Twenty-two 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 arcsecs 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 arcmin 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.

Thirteen antennas now have 327-MHz receivers installed, and this system is undergoing test and evaluation. The final feed configurations has been determined. To reduce local RFI, two RFI enclosures for the vertex mounted "B" racks in antennas 20 and 21 have been installed (see RFI Improvements).

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 augment the NASA/JPL DSN 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. 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 GaAs FET amplifiers. Improved HEMT (High Electron Mobility Transistor) amplifiers were incorporated into the third system this quarter.

Four 8.4-GHz front-ends have been received from the Central Development Laboratory in Charlottesville and have been installed on Antennas 20, 21 and 24.

Interferometer and phased-up sum measurements with these antennas on Voyager 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 remaining 25 X-band systems will continue through 1988.

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. A modification to allow the Monitor and Control system to free run eliminated the coherent RFI between antennas.

Two RFI enclosures for the vertex mounted "B" racks have been installed and tested, eliminating the remaining locally generated interference at 327 MHz. There is still some locally generated RFI noticeable at 75 MHz. A method to reduce this interference is being investigated.

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 (no progress has been completed this quarter).

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; this HEMT amplifier is now in operational use.

Receiver Upgrade

Many important ammonia-line experiments, such as accretion disks, circumstellar material, distant star-forming complexes, and extragalactic ammonia, will benefit from the upgrade in K-band performance. The projected improvement at 24 GHz by a factor of 5-6 means a tremendous boost in speed and sensitivity. Experiments will be 20-30 times faster. Eight-hour experiments will then take only a little over 30 minutes. Instead of one region per u-v track, 20-30 regions can be studied at once. This is a very significant step forward.

The extension of the frequency coverage to 25.1 GHz is of particular interest because of the (J,K) = (6,6) line of NH_3. Together with the (J,K) = (3,3) line at 23.9 GHz, this will offer a pair of transitions belonging to the ortho (K = 3n) species of NH_3. Because of their different excitation and radiative lifetimes, the ortho and para species of NH_3 are independent of each other, and have been suggested to be representative of conditions at different ages for the molecular material. Hence those ortho lines are particularly important spectroscopic tools for understanding some of the underlying physics.

A new "A" Rack will be fabricated, including a revised dewar layout. This new dewar assembly will contain a new 1.3-cm GaAs FET amplifier or HEMT amplifier presently under development at the Central Development Laboratory. This amplifier will reduce the system temperature to 150 K and increase the bandwidth above and below the current bandwidth of 22.0-24.0 GHz. Also, a 5-GHz GaAs FET being developed in the Green Bank Electronics Division will be used to replace present 5-GHz paramps. The prototype "A" Rack is presently under construction and is expected to be installed on an antenna during the next quarter.

1.3-1.7 GHz T_{sys} Improvements

HI imaging is the most important class of spectral-line project at the VLA. The observation of HI in emission (either galactic or extragalactic) is almost always sensitivity limited, either because the HI has to be followed to the faint outermost regions of galaxies or because more angular or frequency resolutions are desirable.

The VLA 18-21 cm wavelength feed currently has system temperatures of approximately 60 and 50 K. A significant fraction of this system temperature results from the need to locate all front-ends in the same cryogenic dewar. This results in longer input waveguide runs than would usually be required and prevents the polarization splitters from being cooled.

For example, using similar cryogenically cooled GaAs FET amplifiers as those used on the VLA, it is predicted that the fully optimized receivers on the VLBA will have system noise temperatures of 29 K at 18-21 cm.

Although some effects, such as subreflector diffraction, will prevent VLA noise temperatures from ever being quite as low as these VLBA values, it does seem worthwhile to investigate the possibility of replacing the VLA receivers with a separate, optimized receiver. It is planned to use a VLBA front-end to test their performance for use on the VLA. Another worthwhile area of investigation would be a modification to the 18-21 cm feed to improve its spillover performance.

A VLBA front-end receiver dewar assembly has been received from the Green Bank Electronics Division. The dewar assembly, along with a VLBA polarizer, will be installed on a VLA antenna during the next quarter.

L. AIPS

During this quarter considerable progress was made both in the area of porting AIPS to non-VMS systems and in applications code. UNIX Z routines and procedures were developed on the Convex to bring the UNIX version completely up to date. Automatic procedures are available to insure that the code on the Convex remains in step with that on the primary VAX repository of AIPS code. Similar procedures run nightly to keep the VLA VAXes current with the Charlottesville VAX. The machine-specific code for UNIX and Cray COS systems is now stored on this VAX rather than being scattered among several machines. The conversion to all floating-point images has progressed and, with that, the test and verification package, DDT, was improved. Additions to the applications code included UTESS (MEM mosaicing for images with real negative values), UVDIF (compare uv files), STARS (read and plot star positions), TAPLT and TAFLG (plot and flag table files), and PUTVALUE (store user values in images). Major improvements include APCLN (to handle cubes and non-symmetric beams), increased storage for the language processor, RM (cleaned up), and PBCOR (to handle cubes in any transportation).

M. VLA COMPUTER DIVISION

On-Line System

The upgrade of the VLA on-line computer system continues to progress slowly because of a remaining problem with the vendor-supplied software. The ModComp 32/85 systems are nevertheless being used for development on the new on-line control system. The replacement for the SPECTRE on-line computer (a ModComp Classic II) arrived in April and was installed without problem. It is being used for development in conjunction with the 32/85 systems. NRAO and JPL are jointly planning the purchase of the backup ModComp computer for the new on-line system, and this final item in the upgrade will probably be purchased in the fourth quarter of 1986. Work has begun on the definition of the new on-line archive tape format and user interface to the new on-line control system.

Pipeline

A new version of the RSX operating system was installed on all the VLA PDP-11 computers. A variety of useful features were added by DEC with this release. W. Brouw spent three weeks at the VLA improving and extending the GRIDER mapping software. Changes included implementation of the W term into the mapping algorithms, averaging of spectral-line channels over a user-selected set of channels and improvements in the handling of large maps (4096x4096 and 8192x8192 pixels).

VAX Systems

All three VLA VAX systems were updated to VMS 4.4 and remain very busy with AIPS processing and general computing. The IRAF image processing system was installed on OUTBAX (VAX 11/750).

N. VERY LONG BASELINE ARRAY

Project Management

The planned order of station construction has again been changed in the interest of optimizing "early science" from the VLBA, during the time when relatively few completed stations are available. The order now is: (1) Pie Town, NM, (2) Kitt Peak, AZ, (3) Los Alamos, NM, (4) North Liberty, IA, (5) Brewster, WA, (6) St. Croix, USVI, (7) Mauna Loa or Mauna Kea, HI, (8) Fort Davis, TX, (9) Owens Valley, CA, (10) "Northeast Site," not decided.

Systems Engineering

The fourth Design Review of the Project was held May 13, 14 and 15 at Green Bank. Long discussions over differing approaches to technical problems are becoming gratifyingly fewer as designs have firmed up and construction of prototypes has progressed.

Sites/Stations

At Pie Town, utilities are in service and concrete pouring for the antenna foundation is nearly complete. The foundation will be ready in July, and the building early this fall.

Clearing and grading are complete at Kitt Peak, construction bids are in, and a contract for both foundation and building should be in place in July.

Bids for the construction work at Los Alamos are due July 11. Negotiations between the NSF and the Department of Energy for use of this site are still in progress.

The University of Iowa has offered its present North Liberty site for a VLBA station, and negotiations are in progress. The chosen site near Brewster, WA, has been acquired, and negotiations have begun for the purchase of a site near Harvard's George R. Agassiz Station, Fort Davis, TX.

Antennas

Fabrication of the steel structure of the first antenna is proceeding smoothly at the Texas plant of Mexia Fabricators, a subsidiary of Radiation Systems, Inc., the antenna contractor. A special VLBA assembly building has been constructed, inside which assembly of the transition section ("cone structure") has been completed and the backup structure for the reflector itself is now being built. The pedestal is being built on a concrete pad outside. All of the steel is on hand at the Mexia plant for the four antennas NRAO now has on order.

The aluminum surface panels are being built at RSI's Sterling, VA plant. The inner tier panels for the first antenna have been completed, with an RMS accuracy better than the 0.005" specification. The Tier 2 panels, the second largest, are now going through a series of iterations to bring them within the specification. Aluminum stock for the panels of all ten VLBA antennas has been purchased.

Regrettably, the once-favorable antenna contract is now in renegotiation, since the 1986 funding could not support the provision calling for advance, mass purchases of long-lead items for the last nine antennas. Besides losing the price advantage on these items, this has opened the way for escalation of other costs.

The first of the feed cone shells is nearly complete and will go to the VLA site for outfitting in late July.

A contract with Milliflect Microwave Antenna Specialists, Newark, CA, for the subreflectors will be in place shortly, with the first unit to be delivered in December. The rather complex focussing mount (FRM), which also rotates the subreflector as a means of selecting a particular feed, will be built by IMC Corporation, Lynchburg, VA. NRAO retains responsibility for the servo drive systems, motors and amplifiers which are now being ordered from Industrial Drives, a division of Kollmorgen. Delivery of the first FRM, which is critical to the antenna schedule, cannot be expected before November, following which NRAO will require some eight weeks for outfitting, including wiring and servo installation.

Electronics

Under the first phase of their subcontract, the hydrogen maser vendor, Sigma Tau Standards, has begun construction of the first three units, all to be delivered on or before July 15, 1987. Long-lead items for the remaining seven are being ordered, although their construction cannot be funded before 1987 (3 each) and 1988 (4 each).

At Green Bank, the LO Transmitter, LO Receiver and Round-trip Monitor modules required to provide calibrated LO reference signals from the Maser Room to the receivers on the antenna were completed in breadboard form, and packaging has begun. The two prototype (Pie Town) 2-16 GHz LO Synthesizers that develop the actual LO frequencies required at the several receivers were completed, and stability tests are in progress.

Three 1.4-GHz front ends have been completed at Green Bank, one of which is under test on an antenna of the VLA. At Green Bank also, the first 4.8-GHz front end was cooled down successfully for the first time. The 15-GHz front end is being assembled in Charlottesville, where an amplifier for 22-25 GHz has also been developed using one HEMT and two FET stages. A noise temperature of about 100 K and a gain of about 25 dB were achieved over this band.

To investigate the source of temperature fluctuations in some of the refrigerators on the life-test setup at Green Bank, gas samples were sent to CTI for analysis, and one of the units is being opened for inspection.

Prototypes of the frequency converters have been completed and tested, and parts are being assembled for production units for the later stations. Back-plane wiring of the electronics equipment racks for Pie Town commenced in late June.

With the first feed-cone shell due shortly, drawings of many of the feed-mounting brackets have been completed. The 4.8-GHz feed is complete, and the 10.7-GHz feed is in fabrication at Green Bank, where the 15- and 23-GHz units will also be made. In the interest of costs, the 1.5-GHz horn will also be built by NRAO, although some parts will be made outside.

Data Recording

The currently funded contract covers the prototype phase, under which Haystack Observatory will provide two Data Acquisition Systems (DAS), plus one prototype Data Playback System (DPS). Each DAS comprises an electronics rack and a recorder rack, and has a 256 Mb/s recording capability. Each fully-instrumented VLBA station will have two such DAS units, but initial operation is possible with only one.

Although DAS prototype development is progressing well, Haystack has requested a no-cost extension of this phase of the contract to June 30, 1987, to allow time to develop and deliver the prototype DPS. This will not affect the overall VLBA schedule, since it will be some time before the Correlator development will require a DPS unit. Since both prototype DAS units will be installed at Pie Town by the end of this year, a change order is also being written to provide additional funds to begin production of single DAS units for initial operation of the Kitt Peak, Los Alamos, and North Liberty stations.

The analog portion of the first Baseband Converter has been completed and partially tested. The digital interface to the station Monitor/Control Bus (MCB) is complete, and tests of the Baseband Converter are being made using a personal computer to simulate the MCB. Preliminary tests of the first IF Distributor show that it meets specifications. An additional module needed for the first DAS electronics rack is almost complete. Most of the detailed design for the

Formatter is now in FUTURENET. The first DAS electronics rack will be available at the VLA for system tests late this summer.

Detailed design of the Recorder controller is well under way. Other Recorder modules are similar to existing Mark IIIA modules, requiring mainly repackaging. It now appears, however, that the first complete Recorder rack may not be delivered before November, 1986, which could make it a critical item in the Pie Town outfitting schedule.

Monitoring and Control

The Monitor/Control Group completed the production run of the standard interface boards for the Pie Town equipment. The Pie Town station computer was specified and procurement was initiated. The control modules for the Focus/Rotation Mount (FRM) were designed, and breadboards (probably upgradable to the final modules) were laid out and mostly constructed. Specifications for the weather stations were nearly completed.

The software to drive the Monitor/Control Bus was completed and installed. An extensive package of subroutines to handle screen displays was completed in VersaDos and VAX versions.

Work is continuing on a general-purpose screen display (for handling devices for which a special display has not yet been written) and on the suite of programs which convert the ASCII text string constructed by an observer into those internal constructs that the station computer will use while observing.

Work has begun on that portion of the monitor data handling system in the station computer needed for conducting stand-alone pointing observations. An internal time-keeping system appropriate to the station computer is also under development.

A significant amount of time was spent installing new versions of both the Alcyon C compiler and the VersaDos operating systems. This fixed major bugs or limitations in our previous versions, but unfortunately introduced some new problems that must be solved.

Correlator

Progress in the study of the spectral-domain or FX correlator architecture was such that by early May a "benchmark" correlator design could be specified and described in a series of memoranda. While merely an overall outline of a possible VLBA spectral correlator, this design includes the essential elements and unique features of an FX architecture, and served well as a basis for further discussion.

One major feature of the benchmark design is a new approach to configuration flexibility. It was decided to abandon all tradeoffs of the number of station inputs against other parameters and to plan a fixed 20-station capacity. The combinatorial relationships between station inputs and baseline outputs requires complex switching to support such tradeoffs in any architecture, and indeed much of the complexity of the previous VLBA correlator design can be attributed to this capability. The benchmark design emphasizes instead tradeoffs between the spectral resolution, number of input (IF) channels, cross-polarization modes, and several of the more specialized features mentioned below. The resulting simplifications in the hardware, as well as the inherent economies of the FX architecture, can be expected to allow this full flexibility for all 20 station inputs at relatively low cost.

The benchmark FX design was discussed in depth at the Design Review workshop held in mid-May. A number of points raised there were among those considered during the remainder of the quarter. The technique of interpolating the station spectra to maintain full effective sampling of the correlation function will probably have to be supported in order to maintain the sensitivity, and perhaps the accuracy, of spectroscopic measurements. However, since interpolation is of insignificant value for observations of continuum emission, it can be supported without additional cost as a tradeoff against the number of input channels or resolution.

Weighting of the input data samples to improve spectral dynamic range is another area where tradeoffs are attractive. The accompanying reduction in sensitivity can be made up by overlapped sampling, again easily supported with reduced resolution or fewer input channels for those observations requiring this feature. Whether the ability to observe weak spectral lines in the presence of strong ones justifies the cost of the weighting hardware remains undecided.

Finally, the representation of data values within the correlator was considered at length. Floating-point formats appear to provide adequate accuracy with fewer bits, and without requiring rescaling throughout the FFT computation. A specialized "complex floating point" format, consisting of two mantissas with a common exponent, was found particularly appropriate to the complex values involved. The precision required for these quantities is still under study.

Data Processing

Most of the software needed for normal processing of astronomical data from the VLBA is already in routine production use. Three general areas in which development is needed are: (1) the interface to the correlator and monitor data base; (2) calibration and editing of correlator output; and (3) geometric analysis of the data (i.e., astrometry and geodesy).

(1) A preliminary version of the distribution tape has been designed. Implementation of this design is under way, especially as related to Item (2).

2) The preliminary design of the calibration software has been done and is now being implemented. Most progress has been in the area of the handling of tables in AIPS and on tape.

3) The concerns of geometric accountability are being included in the design of all software and data structures, although little direct effort in this area has been possible this quarter.

O. PERSONNEL CHANGES

The following new appointments, promotions, and departures occurred during the reporting period:

Appointments

Name	Title	Location
W-H. Chiang	Visit. Asst. Scientist	Basic Research - CV

Terminations

Name	Title	Location
R. G. Noble	Visit. Sci. Prog. Analyst	Computer Div. - SOC
H. M. Martin	Research Associate	Basic Research - TUC
W. C. Erickson	Visit. Scientist	Basic Research - SOC

Changes in Status

Name	Title	Location
L. J. King	to Chief Engineer/ VLBA Antennas	VLBA Project - CV
G. C. Hunt	to Senior Systems Sci.	VLA Operations - SOC

Other

Name	Title	Location
G. C. Hunt	Return from Leave of Absence	

Death

Name	Title	Location
W. C. Horne	Chief Engineer/VLBA Antennas	VLBA Project - SOC

PREPRINTS RECEIVED, APRIL – JUNE, 1986

ALBERT, C.E.; SCHWARTZ, P.R.; BOWERS, P.F.; RICKARD, L.J Multispectral Observations of FIRSSE Sources. I. Radio Observations of Optically Identified Objects.

ARENDT, R.G.; DICKEL, J.R. Resolution of Compact Knots in Cassiopeia A.

BASART, J.P.; ZHENG, Y. Modeling VLA Phase Data by the Box–Jenkins Method.

BAUM, S.; HOBAN, S. A Search for the Millimeter Wave Transitions of CO+ in Comet P/Halley.

BIEGING, J.H.; CRUTCHER, R.M. VLA Observations of 1667 MHz OH Absorption toward Cas A.

BREGMAN, J.N.; MARASCHI, L.; URRY, C.M. Ultraviolet Observations of Blazars.

BRIDLE, A.H.; PERLEY, R.A.; HENRIKSEN, R.N. Collimation and Polarization of the Jets in 3C219.

BROWNE, I.W.A.; PERLEY, R.A. Extended Radio Emission Round Core–Dominated Quasars – Constraints on Relativistic Beaming Models.

CORNWELL, T.J.; SAIKIA, D.J.; SHASTRI, P.; FERETTI, L.; ET AL Extragalactic Sources with Asymmetric Radio Structure II. Further Observations of the Quasar B2 1320 + 299.

DE PATER, I.; DICKEL, J.R. Jupiter's Zone–Belt Structure at Radio Wavelengths: I. Observations.

DEWEY, R.J.; MAGUIRE, C.M.; RAWLEY, L.A.; STOKES, G.H.; TAYLOR, J.H. Binary Pulsar with a Very Small Mass Function.

DICKINSON, D.F.; TURNER, B.E.; JEWELL, P.R.; BENSON, P.J. OH Masers in Short–Period Mira and Semi–Regular Variable Stars.

EVANS, N.J. II; MUNDY, L.G.; DAVIS, J.H.; VANDEN BOUT, P. Sub–Millimeter Spectral Line Observations in Very Dense Regions.

FORSTER, J.R.; CASWELL, J.L. Relationship of OH and H2O Masers.

GARDNER, F.F.; WHITEOAK, J.B. Observations of 1.4 GHz HI and 1.667 GHz OH Transitions in NGC 5793, a Spiral Galaxy with a Very Luminous Radio Nucleus.

GARDNER, F.F.; WHITEOAK, J.B.; PALMER, P. VLA Observations of 5 GHz Excited OH Lines towards Sgr B2.

GAVAZZI, G.; JAFFE, W. Radio Continuum Survey of the Coma/A1367 Supercluster III: Radio Properties of Galaxies in Different Density Environments.

GELDZAHLER, B.J.; FOMALONT, E.B. Scorpius X–1: An Evolving Double Radio Source.

GOWER, A.C.; HUTCHINGS, J.B. The Core and Halo Structure of the Quasar 4C18.68.

GREEN, D.A.; GULL, S.F. Neutral Hydrogen Absorption towards G227.1+1.0.

GREGORY, P.C.; TAYLOR, A.R. Radio Patrol of the Northern Milky Way: A Catalog of Sources. II.

GRINDLAY, J.E.; SEAQUIST, E.R. Radio Observations of Galactic Bulge and Globular Cluster X–ray Sources.

PREPRINTS RECEIVED, APRIL – JUNE, 1986

HEBDEN, J.C.; CHRISTOU, J.C.; CHENG, A.Y.S.; HEGE, E.K.; ET AL Two Dimensional Images of Alpha Orionis.

HENKEL, C.; HASCHICK, A.D.; GUSTEN, R. H2O Maser Emission from HH6 and Other Star Forming Regions.

HIGGS, L.A.; VALLEE, J.P. Radio Observations of a Neglected 3C Source: 3C428.

HOBBS, L.M.; BLITZ, L.; MAGNANI, L. A Molecular Cloud in the Local, Hot Interstellar Medium.

HOLLIS, J.M.; CHURCHWELL, E.B.; HERBST, E.; DE LUCIA, F.C. An Interstellar Line Coincident with the P(2,1) Transition of Hydronium (H3O+)

HUMMEL, E.; DETTMAR, R.-J.; WIELEBINSKI, R. Neutral Hydrogen and Radio Continuum Observations of NGC 55.

ISRAEL, F.P.; BURTON, W.B. Search for 12CO Emission from Twelve Irregular Dwarf Galaxies.

JAHODA, K.; MCCAMMON, D.; LOCKMAN, F.J. Small Scale H I Structure and the Soft X-ray Background.

JOHNSTON, K.J.; SPENCER, J.H.; SIMON, R.S.; WALTMAN, E.B.; ET AL Radio Flux Density Variations of Cyg X-3.

KUNDU, M.R.; MELOZZI, M.; SHEVGAONKAR, R.K. A Study of Solar Filaments from High Resolution Microwave Observations.

LOCKMAN, F.J. Twenty-One Centimeter Studies of the Galactic Halo.

LOREN, R.B.; WOOTTEN, A. Sub-Millimeter Molecular Spectroscopy with the Texas MWO Radio Telescope.

MATTHEWS, H.E.; BAUDRY, A.; GUILLOTEAU, S.; WINNBERG, A. Observations of Rotationally-Excited OH.

MUFSON, S.L.; MCCOLLOUGH, M.L.; DICKEL, J.R.; PETRE, R.; ET AL A Multiwavelength Investigation of the Supernova Remnant IC 443.

NGUYEN-Q-RIEU; WINNBERG, A.; BUJARRABAL, V. VLA Observations of NH3 and HC7N in the Egg Nebula (CRL 2688): The Shell Kinematics.

NOREAU, L.; KRONBERG, P.P. The Amorphous Galaxy NGC 3448, I: Dynamics and Photometry.

O'DEA, C.P.; OWEN, F.N. Astrophysical Implications of the Multifrequency VLA Observations of NGC 1265.

ODENWALD, S.F. The UMa I(S) Galaxy Group: 12CO and Far-Infrared Observations.

REPHAELI, Y.; SASLAW, W.C. Correlated Statistical Fluctuations and Galaxy Formation.

SCHENEWERK, M.S.; PALMER, P.; SNYDER, L.E.; DE PATER, I. VLA Limits for Comets Austin (1982 VI) and p/Crommelin (1983n): Evidence for a Diffuse OH Halo.

SCHMELZ, J.T.; FEIGELSON, E.D.; SCHWARTZ, D.A. A VLA Survey of Unidentified HEAO-1 X-Ray Sources.

SEGELSTEIN, D.J.; RAWLEY, L.A.; STINEBRING, D.R.; FRUCHTER, A.S.; TAYLOR, J.H. A New Millisecond Pulsar in a Binary System.

PREPRINTS RECEIVED, APRIL – JUNE, 1986

SHONE, D.L.; BROWNE, I.W.A. A Remarkable Jet in the Quasar 0800+608.

SNYDER, L.E.; JEWELL, P.R.; DINGER, A.S.; DICKINSON, D.F.; BUHL, D. Monitoring Observations of Selected SiO Maser Sources at 7mm Wavelength: 1977–1979.

SPENCER, R.E.; SWINNEY, R.W.; JOHNSTON, K.J.; HJELLMING, R.M. The 1983 September Radio Outburst of Cygnus X-3: Relativistic Expansion at 0.35 c.

STOKES, G.H.; SEGELSTEIN, D.J.; TAYLOR, J.H.; DEWEY, R.J. Results of Two Surveys for Fast Pulsars.

TACCONI, L.J.; YOUNG, J.S. The Distribution of Interstellar Matter in the Scd Galaxy NGC 6946. I. The Neutral Hydrogen Disk.

TEREBEY, S.; FICH, M.; BLITZ, L.; HENKEL, C. The Size Spectrum of Molecular Clouds in the Outer Galaxy.

THRONSON, H.A. JR; BALLY, J. Carbon Monoxide Emission from Small Galaxies.

VAN BREUGEL, W.J.M.; HECKMAN, T.M.; MILEY, G.K.; FILIPPENKO, A.V. 4C 29.30: Extended Optical Line and Radio Emission in a Probable Galaxy Merger.

VAN GORKOM, J.H.; SCHECKTER, P.L.; KRISTIAN, J. H I Maps of SO Galaxies with Polar Rings.

WHITE, S.M.; KUNDU, M.R.; JACKSON, P.D. Narrowband Radio Flares from Red Dwarf Stars.

WHITEOAK, J.B.; GARDNER, F.F.; FORSTER, J.R.; PALMER, P.; PANKONIN, V. Masers in Sgr B2: Sites of Star-Forming Regions.

WHITTLE, M.; SASLAW, W.C. Cloud Models for the Nuclei of Active Galaxies: A Distribution Function Description.

WILLIAMS, B.A.; ROOD, H.J. Neutral Hydrogen in Compact Groups of Galaxies.

WILLSON, R.F.; LANG, K.R. VLA Observations of Compact, Variable Sources on the Sun.

WOOTTEN, A.; BOULANGER, F.; ZIURYS, L.M.; BOGEY, M.; ET AL A Search for Interstellar H3O+

WYNN-WILLIAMS, C.G.; BECKLIN, E.E. Infrared and Radio Emission from IIZw40 and Other Blue Dwarf Galaxies.

YUSEF-ZADEH, F.; MORRIS, M. Structural Details of the Sgr A Complex: Possible Evidence for a Large-Scale Poloidal Magnetic Field in the Galactic Center Region.