NATIONAL RADIO ASTRONOMY OBSERVATORY

QUARTERLY REPORT

APRIL - JUNE 1987

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A. TELESCOPE USAGE

The following telescopes have been scheduled for research and maintenance in the following manner during the second quarter of 1987.

	140-ft	300-ft	12-m	VLA
Scheduled observing (hrs)	1860.50	1979.75	1665.00	1673.0
Scheduled maintenance and equipment changes	156.25	204.25	91.75	189.3
Scheduled tests and calibrations	166.25	0.00	414.50	326.7
Time lost	143.75	49.75	185.50	--
Actual observing	1716.75	1930.00	1479.50	1514.1

B. 140-FT OBSERVING PROGRAMS

The following continuum programs were conducted during this quarter.

No.	Observer(s)	Program
F-95	Fomalont, E. Ebneter, K. (Berkeley) van Breugel, W. (Berkeley) Ekers, R.	Mapping of Fornax A at 1380, 1640, and 4700 MHz.
S-305	Steffes, P. (Georgia Tech) Jenkins, J. (Georgia Tech)	Observations at 1.6 and 2.25 cm of Venus.
W-166	Wilkinson, D. (Princeton) Uson, J.	Observations at 19.5 GHz of small scale polarization of the cosmic microwave background.

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
B-462	Brown, R.	Observations at 25 cm of molecules in extragalactic HI absorption-line clouds.
B-463	Brown, R.	Observations at 9 cm of redshifted H_2CO toward 3C 196.

No.	Observer(s)	Program
B-470	Batrla, W. (Illinois) Henkel, C. (MPIR, Bonn)	Search at 7.8 GHz for $^2\pi_{1/2}$, J=3/2 OH transition.
B-479	Batrla, W. (Illinois) Menten, K. (MPIR, Bonn)	A search at 12.2 and 20 GHz for methanol maser emission from OH-megamaser galaxies.
B-480	Batrla, W. (Illinois) Menten, K. (MPIR, Bonn) Walmsely, C. M. (MPIR, Bonn)	Observations of K-band methanol lines toward NGC 6334.
B-481	Bell, M. (Herzberg) Matthews, H. (Herzberg)	Observations of K-band transitions of C_8H in TMC-1.
C-241	Clifton, T. (Berkeley) Frail, D. (Toronto) Kulkarni, S. (Caltech)	Observations of HI absorption in distant pulsars.
C-249	Claussen, M. (Massachusetts) Cobb, M. (Arizona) Kleinmann, S. (Massachusetts)	Observations of 18 cm OH emission in spectral class M stars selected from the IRAS Point Source Catalog.
H-236	Hoban, S. (Maryland) Baum, S. (Maryland)	Observations at 18.3 GHz to search for C_3H_2 in Comet Wilson.
L-195	Lockman, F. J. Hobbs, L. (Chicago) Jahoda, K. (Goddard) McCammon, D. (Wisconsin)	Observations of HI in low column density directions.
L-205	Likkel, L. (UCLA) Morris, M. (UCLA)	Observations of OH at 1612 and 1667 MHz toward stars with dense cold circumstellar shells.
M-249	Morris, M. (UCLA) Yusef-Zadeh, F. (Goddard) Maddalena, R.	Observations at discrete frequencies over the range 23.6-24.2 GHz for NH_3 emission from the arched continuum filaments of the Galactic Center.
M-261	Madden, S. (Massachusetts) Irvine, W. (Massachusetts) Matthews, H. (Herzberg)	Observations at 1.3 and 1.6 cm of the ^{13}C isotopic species of C_3H_2.
M-264	Matthews, H. (Herzberg) Friberg, P. (Caltech) Irvine, W. (Massachusetts)	Study at discrete frequencies between 18.2 and 22.5 GHz of low-lying rotational states of oxygen bearing interstellar molecules.

No.	Observer(s)	Program
M-272	Menten, K. (MPIR, Bonn) Batrla, W. (Illinois) Matthews, H. (Herzberg) Walmsley, C. M. (MPIR, Bonn)	Observations at 2.5 cm for weak absorption and emission lines from the 2_0-3_{-1} transition of methanol.
S-314	Snyder, L. (Illinois) Batrla, W. (Illinois) Henkel, C. (MPIR, Bonn) Walmsley, C. M. (MPIR, Bonn) Wilson, T. (MPIR, Bonn) Jewell, P.	Observations at 1.5 cm to confirm the detection of CH_3C_5N in TMC-1.
T-219	Thuan, T. (Virginia) Fouque, P. (Meudon) Mangum, J. (Virginia)	Survey of southern dwarf galaxies found in the ESO catalog for hydrogen content and redshifts.
T-225	Tacconi-Garman, L. (Massachusetts) Claussen, M. (Massachusetts) Schloerb, F. (Massachusetts)	Observations at 18 cm of OH in Comet Wilson.
W-208	Wadiak, E. J. Rood, R. (Virginia) Wilson, T. (MPIR, Bonn) Mangum, J. (Virginia)	Observations at 13.7 GHz of $H_2{}^{13}CO$ in molecular clouds.
X-50	Bregman, J.	Study of HI in M86.
Z-55	Ziurys, L. (Massachusetts)	Search at 1.7 cm for SiS in dark clouds.

The following pulsar program was conducted during this quarter.

No.	Observer(s)	Program
B-484	Backer, D. (Berkeley) Clifton, T. (Berkeley) Foster, R. (Berkeley) Kulkarni, S. (Caltech) Taylor, J. (Princeton)	Timing observations of PSR 1821-24 and other millisecond pulsars.

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

- A - Arecibo 1000 ft
- EVN - European Network Telescopes
- B - Effelsberg, MPIR 100 m
- Dv - Goldstone 64 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
- Km - Haystack 120 ft
- Lb - Bologna 25 m
- Lm - Medicina
- M - Nobeyama 45 m
- N - NRL Mayland Pt 85 ft
- O - Owens Valley 130 ft
- Sn - Onsala 20 m
- So - Onsala 25 m
- Wn - Westerbork n=1-14x26 m
- Yn - Socorro n=1-27x25 m

No.	Observer(s)	Program
B-76V	Bartel, N. (CFA) Rupen, M. (CFA) Shapiro, I. (CFA)	Observations at 6 cm of SN1986J with telescopes G, H, Km, O, and Yn.
B-78V	Barthel, P. (Caltech) Miley, G. (STScI) Schilizzi, R. (NFRA)	Observations at 6 cm of the small scale core morphology in the giant radio galaxy 3C 236 with telescopes B, G, Km, Lm, O, So, Wn, and Yn.
C-46V	Cohen, M. (Caltech) Aller, H. (Michigan) Aller, M. (Michigan) Baath, L. (Chalmers) Barthel, P. (Caltech) Nicholson, G. (Hartebeesthoek) Unwin, S. (Caltech) Zensus, A. (Caltech)	Study at 6 cm of a (peak-flux)-limited sample with telescopes EVN, G, H, I, Km, N, O, and Yn.
F-13V	Fey, A. (Iowa) Cordes, J. (Cornell) Dickey, J. (Minnesota) Mutel, R. (Iowa) Spangler, S. (Iowa)	Observations at 6 cm of angular broadening at galactic latitudes with telescopes B, F, G, H, I, Km, Lb, O, and Yn.
G-53V	Gorenstein, M. (CFA) Burke, B. (MIT) Falco, E. (CFA) Heflin, M. (MIT) Hewitt, J. (Haystack) Lawrence, C. (Caltech)	First epoch observations at 6 cm of the gravitational lens system 2016+112 with telescopes B, F, G, Km, O, and Yn.
L-34V	Lo, K. (Caltech) Backer, D. (Berkeley) Cohen, M. (Caltech) Johnston, K. (NRL)	Mapping at 3.6 cm of the Sgr A compact radio source with telescopes Dv, G, H, Km, N, and O.
L-45V	Lawrence, C. (Caltech) Booth, R. (Chalmers) Burke, B. (MIT) Jones, D. (JPL) Linfield, R. (JPL) Porcas, R. (MPIR, Bonn) Preston, R. (JPL) Readhead, A. (Caltech) Schilizzi, R. (NFRA)	Strong source survey at 1.3 cm with telescopes B, G, Km, O, Sn, and Yn.

No.	Observer(s)	Program
L-49V	Lestrade, J-F. (JPL) Boloh, R. (JPL) Mutel, R. (Iowa) Niell, A. (Haystack) Preston, R. (JPL)	Observations at 6 cm of 15 RS Cvn binaries with telescopes B, G, Lb, O, and Yn.
M-82V	Moran, J. (CFA) Downes, D. (IRAM) Genzel, R. (Berkeley) Greenhill, L. (CFA) Gwinn, C. (CFA) Reid, M. (CFA)	Precise measurements at 1.3 cm of the H_2O maser positions in M33/IC 133 with telescopes B, G, Km, M, O, and Yn.
M-84V	Morabito, D. (JPL) Newhall, X. (JPL)	Mapping at 6 cm of the close pair GC 1342+662 and GC 1342+663 with telescopes B, F, G, I, Km, Lm, O, and Yn.
M-86V	McHardy, I. (Leicester) Gear, W. (Edinburgh) Marscher, A. (Boston)	Observations at 6 cm of the variable quasar 1156+295 with telescopes B, F, G, H, I, Jb, Km, Lb, N, O, So, Wn, and Yn.
M-87V	Marr, J. (Berkeley) Backer, D. (Berkeley)	Observations at 1.3 cm of the compact structure in NGC 1275 with telescopes B, G, Jb, Km, Lb, N, O, Sn, and Yn.
M-88V	Moran, J. (CFA) Downes, D. (IRAM) Genzel, R. (Berkeley) Greenhill, L. (CFA) Gwinn, C. (CFA) Hirabayashi, H. (NRO) Reid, M. (CFA)	Observations at 1.3 cm to determine the distance to M33 based on the statistical and orbital parallax of H_2O masers with telescopes B, G, Km, M, O, and Yn.
R-41V	Roberts, D. (Brandeis) Brown, L (Brandeis) Cawthorne, T. (Brandeis) Gabuzda, D. (Brandeis) Wardle, J. (Brandeis)	Observations at 6 cm of linear polarization of BL Lacertae objects with telescopes B, F, G, H, Km, Lb, O, Wn, and Yn.
S-68V	Shaffer, D. (Interferometrics)	Observations at 6 cm of a compact radio source in the infrared-loud quasar, IRAS 13349+2438, with telescopes B, G, O, and Yn.

No.	Observer(s)	Program
S-71V	Schalinski, C. (MPIR, Bonn) Biermann, P. (MPIR, Bonn) Hummel, C. (MPIR, Bonn) Johnston, K, (NRL) Krichbaum, T. (MPIR, Bonn) Simon, R. (NRL) Witzel, A. (MPIR, Bonn)	Observations at 6 cm of four new superluminal candidates with telescopes EVN, F, G, H, Km, N, O, and Yn.
S-72V	Strom, R. (NFRA) de Bruyn, A. (NFRA) Foley, A. (NFRA) Skillman, E. (NFRA) van der Hulst, J. (NFRA) Watt, G. (NFRA)	Observations at 6 cm of SN1986J with telescopes B, G, Lm, O, So, and Yn.
V-59V	Vermeulen, R. (Leiden) Fejes, I. (NFRA) Icke, V. (Leiden) Schilizzi, R. (NFRA) Spencer, R. (Manchester) Romney, J.	Observations at 6 cm of dynamics of radio jets as exemplified by the jet source SS 433 with telescopes EVN, and G.
W-42V	Walker, R. C. Unwin, S. (Caltech) Benson, J.	Monitoring at 6 cm of superluminal motions in 3C 120 with telescopes B, G, H, I, Jb, Km, Lb, O, So, and Yn.
W-45V	Witzel, A. (MPIR, Bonn) Johnston, K. (NRL) Schalinski, C. (MPIR, Bonn)	Monitoring at 1.3 cm of the structure of the superluminal source 1928+738 with telescopes B, G, Km, O, Sn, and Yn.
X-49V	Geldzahler, B. (NRL) Cohen, N. (Bentley College)	Observations at 6 cm of a possible Sco X-1 like object with telescopes G, Km, O, and Yn.
Z-13V	Zensus, A. (Caltech) Baath, L. (Chalmers) Biretta, J. (CFA) Cohen, M. (Caltech) Unwin, S. (Caltech)	Observations at 1.3 cm of the superluminal motion 3C 273 and 3C 345 with telescopes B, G, 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)	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 δ = 20° $<\delta<$ 45°.
D-155	Dennison, B. (VPI & SU) Fiedler, R. (NRL) Johnston, K. (NRL) Simon, R. (NRL)	A patrol survey for occultation events.
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 line programs were conducted during this quarter.

No.	Observer(s)	Program
B-471	Baan, W. (Arecibo) Haschick, A. (Haystack) Henkel, C. (MPIR, Bonn)	Observations at 18 cm for OH in selected IRAS galaxies.
B-485	Brown, R.	Search at 886 MHz for low frequency redshifted recombination lines toward quasars with redshifted 21 cm absorption lines.
T-224	Tifft, W. (Arizona) Cocke, W. (Arizona)	Observations at 21 cm of quantization and time variability in galaxy redshifts.

The following pulsar programs were conducted during this quarter.

No.	Observer(s)	Program
B-442	Backer, D. (Berkeley) Clifton, T. (Berkeley) Dey, A. (Berkeley) Foster, R. (Berkeley) Kulkarni, S. (Caltech) Werthimer, D. (Berkeley)	Real-time fast pulsar search of the galactic plane at 825 MHz.
D-139	Dewey, R. (Cornell) Taylor, J. (Princeton)	Monitoring at 390 MHz of the timing of pulsars discovered in the Princeton-NRAO Pulsar Survey.

The following SETI search, commensurate with other programs, was conducted during this quarter.

No.	Observer(s)	Program
B-454	Bowyer, S. (Berkeley) Backer, D. (Berkeley) Clifton, T. (Berkeley) Kulkarni, S. (Caltech) Werthimer. D. (Berkeley)	Observations at 390, 825, 1400, and 2695 MHz for narrow band radio signals of extraterrestrial origin simultaneous with B442 and other programs.

D. 12-M OBSERVING PROGRAMS

The following line programs were conducted during this quarter.

No.	Observer(s)	Programs
B-474	Bernath, P. (Arizona) Black, J. (Arizona) Thorne, L. (Sandia Labs) Maloney, P. (Arizona)	A search for interstellar CP.
B-475	Butner, H. (Texas) Loren, R. (Texas)	Study of DCO^+ emission as a tracer of the dawn of protostellar heating.
B-476	Baudry, A. (Bordeaux, France) Brouillet, N. (Bordeaux, France) Combes, F. (Meudon, France)	High sensitivity search for CO emission in Messier 81.
B-477	Barvainis, R. Antonucci, R. (Johns Hopkins)	CO observations of radio quiet quasars.
B-478	Butner, H. (Texas) Loren, R. (Texas)	High resolution mapping of the cold dense cores around young stellar objects.
C-239	Wootten, H. A. Combes, F. (Meudon) Encrenaz, T. (Meudon) Gerin, M. (Meudon) Bogey, M. (Lille, France) Demuynca, C. (Lille, France) Destombes, J. (Lille, France)	Verification of interstellar C_3H_2: Search for isotopic variants.
C-242	Crane, P. (ESO - FRG, Chile) Hegyi, D. (Michigan) Kutner, M. (Rensselaer)	Improved determination of the CBR temperature at 2.64 mm.
C-243	Churchwell, E. (Wisconsin) Woods, R. (Wisconsin)	Observations of interstellar SO^+ ($J = 11/2 - 9/2$).
D-153	Dent, W. (Massachusetts) Balonek, T. (Colgate)	Study of the evolution of extragalactic radio sources at millimeter wavelengths.

No.	Observer(s)	Program
E-50	Emerson, D. Jewell, P. Martin, R. (Arizona) Salter, C. (unaffiliated)	A complete survey of ^{12}CO emission from M31.
G-291	Emerson, D. Mead, K. (NRL) Hasegawa, T. (Nobeyama)	J=2-1 CO observations of the DR21 molecular jets.
G-296	Guilloteau, S. (Grenoble) Lucas, R. (Grenoble) Omont, A. (Grenoble)	Search for (1) HCN maser in CIT6 (2) HCO^+(3-2) in pre-planetary nebula.
H-233	Huggins, P. (New York) Healy, A. (New York)	Study of CO in planetary nebulae.
H-234	Hogg, D.	A search for CO associated with stellar wind bubbles.
J-116	Jewell, P.	Study of gas outflows in the evolved bipolar nebula OH 231.8+4.2.
K-302	Knapp, G. (Princeton) Rupen, M. (Princeton) van Gorkom, J.	Observations of CO J=2-1 emission in NGC 891, NGC 4565, and NGC 7814.
K-304	Kutner, M. (Rensselaer) Evans, N. (Texas) Mead, K. (NRL) Natta, A. (Arcetri)	Study of high density structures in bipolar flows.
L-209	Lubowich, D. (Hofstra U.)	Observational tests of deuterium nucleosynthesis: DCO^+ and DCN in the shocked molecular cloud associated with the IC 443 SNR.
L-210	Lubowich, D. (Hofstra U.)	Observational tests of lithium nucleosynthesis: LiOH in the galactic center.
L-219	Margulis, M. (Arizona) Lada, C. (Arizona)	Study of molecular clouds in M31.
M-270	Maloney, P. (Arizona) Walker, C. (Arizona) Black, J. (Arizona)	HCS^+ observations of the protostellar source IRAS 1629a.
P-139	Pompea, S. (Arizona) Reike, G. (Arizona)	Study of the inhibition of starburst in Sa galaxies.

No.	Observers	Program
S-309	Sanders, D. (Caltech) Scoville, N. (Caltech) Soifer, B. (Caltech)	^{13}CO and ^{12}CO observations of high luminosity IRAS galaxies.
S-311	Scoville, N. (Caltech) Sanders, D. (Caltech) Soifer, B. (Caltech)	CO observations of intermediate luminosity IRAS galaxies.
S-313	Kerr, F. (Maryland) Salter, C. (unaffiliated) Sinha, R. (ST Systems, Maryland) Emerson, D. Stobie, E. Hobbs, R. (Computer Tech Assoc)	90 and 230 GHz observation of the galactic center.
T-222	Thronson, H. (Wyoming)	Study of J=1-0 carbon monoxide emission from small galaxies.
T-226	Turner, B. Bally, J. (Bell Labs)	Confirmation of interstellar PN.
T-227	Thronson, H. (Wyoming)	Study of molecular gas in "gas-free" galaxies.
T-228	Terebey, S. (Caltech) Fich, M. (Waterloo)	Study of the nature of moderate to massive star formation in the outer galaxy.
V-62	Verter, F. (Rensselaer) Rickard, L. J (NRL)	Proposal to test the CO-far IR correlation at high luminosities.
W-229	Wootten, H. A. Loren, R. (Texas) Wilking, B. (Missouri)	Study of the structure of dense cores in Rho Ophiuchus clouds.
Z-63	Zuckerman, B. (UCLA) Dyck, H. (Wyoming)	Study of circumstellar CO emission from Red Giant stars.

E. VLA OBSERVING PROGRAMS

The quarter was scheduled 100 percent of the time. The average downtime was 9.50 percent.

The following 131 research programs were conducted with the VLA during this quarter.

No.	Observer(s)	Program
AA-67	Anantharamaiah, K. Goss, W. M. Dewdney, P. (DRAO)	Recombination line observations of Orion B. 20 cm line.
AA-68	Anantharamaiah, K. Radhakrishnan, V. (Raman) Shukre, C. (Raman)	Positronium recombination lines. 6 cm line.
AB-414	Becker, R. (Calif., Davis) White, R. (STScI)	Monitoring flux of HD 193793 and P Cygni. 2 and 6 cm.
AB-426	Bowers, P. (NRL) Knapp, G. (Princeton)	HI toward Alpha Orionis. 21 cm line.
AB-431	Bowers, P. (NRL) Knapp, G. (Princeton)	Search for HI in circumstellar envelopes of o Ceti, IRC+10216 and CRL2688. 20 cm line.
AB-433	Bothun, G. (Michigan) Skillman, E. (NFRA)	HI in IC 3475--a stripped dwarf galaxy in the Virgo cluster. 20 cm line.
AB-434	Braun, R. Perley, R. Gull, S. (MRAO) Rudnick, L. (Minnesota)	Physical processes in Cassiopeia A. 2 and 6 cm.
AB-435	Brown, R. Gordon, M.	Photodissociation regions in dark clouds. 20 cm line.
AB-436	Bietenholz, M. (Toronto) Kronberg, P. (Toronto)	High resolution studies of the Crab Nebula. 2, 6 and 20 cm.
AB-437	Beck, R. (MPIR, Bonn) Hummel, E. (MPIR, Bonn) Loiseau, N. (MPIR, Bonn) Berkhuijsen, E. (MPIR, Bonn)	The magnetic field in M31. 20 cm.
AB-438	Baldwin, J. (MRAO) Dingley, S. (MRAO) Warner, P. (MRAO)	The evolution function of large radio galaxies. 6 cm.
AB-439	Birkinshaw, M. (CFA) Mandolesi, N. (Bologna) Partridge, R. B. (Haverford) Perley, R.	The Sunyaev-Zel'dovich effect--preliminary looks at more clusters. 6 and 20 cm.
AB-442	Backer, D. (Berkeley) Cordes, J. (Cornell)	Steep spectrum 4C sources. 18 and 20 cm.

No.	Observer(s)	Program
AB-443	Buta, R. (Texas) Higdon, J. (Texas)	Neutral hydrogen observations of ringed barred spiral galaxies. 20 cm line.
AB-447	Barthel, P. (Caltech)	Radio spectra of very high redshift quasars. 1.3, 2, 6, 18 and 20 cm.
AC-135	Cameron, R. (Mt. Stromlo) Parma, P. (Bologna) de Ruiter, H. (Bologna)	Statistical study of structure dumbbell galaxy radio sources. 20 cm.
AC-186	Chapman, B. (JPL) Pettengill, G. (MIT)	The moon. 20 and 90 cm.
AC-194	Clifton, T. (Berkeley) Kulkarni, S. (Caltech) Frail, D. (Toronto)	HI absorption towards two galactic SNRs. 20 cm line.
AD-188	Drake, S. (Goddard) Simon, T. (Hawaii) Florkowski, D. (USNO) Stencel, R. (Colorado) Bookbinder, J. (Colorado) Linsky, J. (Colorado)	Variability of emission in M super-giants: Alpha Ori, Alpha Sco, and Alpha Sco, and Alpha 1 Her. 2 and 6 cm.
AD-192	Dressel, L. (Rice)	Neutral hydrogen in normal giant elliptical galaxies: NGC 938 and UGC 04170. 20 cm line.
AD-198	de Grijp, M. (Leiden) Miley, G. (STScI) Keel, W. (Leiden)	Study of faint WIRs--searching for High-z IR Seyferts. 6 cm.
AD-200	Dulk, G. (Colorado) Bastian, T. (Colorado) McKean, M. (Colorado) Bookbinder, J. (Colorado) Le Queau, D. (CRPE) Klein, L. (Obs. de Paris) Bourgois, G. (Obs. de Paris) Lecacheux, A. (Obs. de Paris)	Dynamic spectroscopy of stellar radio sources. 2, 6, 20 and 90 cm line.
AE-52	Erickson, W. (Maryland) Jacobson, A. (Los Alamos)	Radio refraction study of ionospheric shock wave phenomena. 90 cm.
AF-138	Fomalont, E. Geldzahler, B. (NRL)	Component variability in Sco X-1. 6 cm.
AF-140	Fich, M. (Waterloo) Terebey, S. (Caltech)	Star formation within extended IRAS sources in the galaxy. 6 cm.

No.	Observer(s)	Program
AF-141	Fich, M. (Waterloo)	Survey of small HII regions in the outer galaxy. 6 and 20 cm.
AF-143	Fischer, M. (LaPlata Jr. High) Gonzalez, P. (LaPlata Jr. High) Gibson, D. (NMIMT)	Globular cluster X-ray binary 4UI820-30. 20 cm.
AG-145	Geldzahler, B. (NRL) Schwartz, P. (NRL) Gear, W. (Queen Mary College) Ade, P. (Queen Mary College) Robson, I. (Preston Polytechnic) Nolt, I. (Oregon) Smith, M. (Royal Obs.)	Simultaneous multifrequency observations of blazars. 1.3, 2, 6, 20 and 90 cm.
AG-242	Green, D. (MRAO) Gull, S. (MRAO)	SNR G74.9+1.2 at 1.4 GHz: Distance and limits on any shell. 20 cm line.
AG-245	Goss, W. M. Anantharamaiah, K.	Recombination lines from external galaxies M82 and NGC 253. 6, 20, and 90 cm line.
AG-246	Goldstein, R. (JPL) Muhleman, D. (Caltech) Grossman, A. (Caltech)	Radar echo reception from Saturn's rings. 3.6 cm line.
AH-253	Hanisch, R. (STScI) Neff, S. (Goddard)	The radio halo source in the Coma cluster. 90 cm.
AH-260	Henkel, C. (MPIR, Bonn) Gusten, R. (MPIR, Bonn) Zylka, R. (MPIR, Bonn)	On the nature of the galactic center molecular jet. 18 cm line.
AH-261	Herter, T. (Cornell) Helfer, H. (Rochester) Ho, P. (Harvard)	Helium abundances in galactic HII regions. 2 cm line.
AH-262	Higdon, J. (Texas)	Neutral hydrogen observations of the peculiar ring galaxy ARP 144. 20 cm line.
AH-263	Heiles, C. (Berkeley) Koo, B. (Berkeley) Reach, W. (Berkeley)	Survey of 60 selected IRAS point sources. 20 cm.
AH-264	Hughes, V. (Queen's Univ.)	Large scale structure in Cep A. 6 and 20 cm.
AH-265	Hollis, J. M. (Goddard) Yusef-Zadeh, F. (Goddard)	Imaging of M20 and M8. 6 and 20 cm.

No.	Observer(s)	Program
AH-266	Hollis, J. M. (Goddard) Michalitsianos, A. (Goddard) Kafatos, M. (George Mason)	Large scale structure of the R Aquarii circumbinary nebulosity. 6 and 20 cm.
AH-268	Hogan, C. (Steward Obs.) Martin, H. (Steward Obs) Perley, R. Partridge, R. B. (Haverford)	Search for cosmic microwave background fluctuations. 2 cm.
AH-269	Hester, J. (Caltech) Braun, R. Cox, D. (Wisconsin) Raymond, J. (CFA)	Relativistically supported recombination regions in the Cygnus loop. 2 and 6 cm.
AH-272	Higdon, J. (Texas)	Neutral hydrogen observations of a sample of ring galaxies. 20 cm line.
AH-273	Ho, P. (Harvard) Klein, R. (Berkeley) Haschick, A. (Haystack)	Dynamics of ionized flows around OB clusters. 6 cm line.
AH-274	Hardy, E. (Laval) Noreau, L. (Laval)	The HI environment of high redshift quasars. 90 cm line.
AI-31	Irwin, J. (Toronto) Seaquist, E. (Toronto)	A survey of edge-on spiral galaxies. 6 and 20 cm.
AJ-146	Jura, M. (UCLA) Kim, D. (UCLA) Knapp, G. (Princeton) van Gorkom, J. Guhathakurta, P. (Princeton)	Interstellar HI in two southern elliptical galaxies. 20 cm line.
AJ-147	Jackson, J. (Berkeley) Ho, P. (Harvard)	NH_3 toward the galactic center. 1.3 cm line.
AJ-150	Jackson, J. (Berkeley) Welch, W. J. (Berkeley) Dreher, J. (MIT)	NH_3 (2,2) and (3,3) in W49. 1.3 cm line.
AJ-151	Jackson, P. (Maryland) Kundu, M. (Maryland) White, S. (Maryland)	High spatial resolution observations of three flare star systems. 2, 6, 20 and 90 cm.
AJ-153	Johnston, K. (NRL) Florkowski, D. (USNO) de Vegt, C. (Hamburg Sternwarte)	Search for calibrators near radio stars. 20 cm.

No.	Observer(s)	Program
AJ-154	Johnston, K. (NRL) Hjellming, R. Vermeulen, R. (Leiden) Schilizzi, R. (NFRA-Dwingeloo)	Spectrum of SS 433. 1.3, 2, 6, and 20 cm.
AK-158	Kogut, A. (Berkeley) Smoot, G. (Berkeley) Petuchowski, S. (Goddard) Bennett, C. (Goddard)	Determination of CBR temperature using H_2CO: W51. 2 cm line.
AK-163	Kundu, M. (Maryland) Schmahl, E. (Maryland) White, S. (Maryland)	Three dimensional structures of coronal bright points. 2, 6 and 20 cm.
AK-165	Kutner, M. (Rensselaer) Evans, N. (Texas) Mundy, L. (Caltech)	Use of formaldyhyde anomalous absorption to study clumping in globules. 6 cm line.
AK-166	Keto, E. (Harvard) Ho, P. (Harvard) Haschick, A. (Haystack)	High excitation NH_3 around W33-main. 1.3 cm line.
AK-172	Kristian, J. (Mt. Wilson) Windhorst, R. (Mt. Wilson) Fomalont, E. Kellermann, K.	Deep survey in a Space Telescope/WFPC ultra-deep survey area. 6 cm.
AK-173	Killeen, N. Ekers, R.	Neutral hydrogen in NGC 1399. 20 cm line.
AK-175	Keto, E. (Harvard) Ho, P. (Harvard)	Defining the kinematics of molecular material around DR21. 1.3 cm line.
AL-137	Lang, K. (Tufts) Willson, R. (Tufts)	Physical properties of RS CVn systems. 2, 6 and 20 cm.
AL-139	Lang, K. (Tufts) Willson, R. (Tufts) Trottet, G. (Meudon)	Solar noise storms. 90 cm.
AL-140	Lestrade, J-F. (JPL/BDL) Preston, R. (JPL) Mutel, R. (Iowa) Boloh, L. (CNES) Charlot, P. (IGN)	Search for compact extragalactic sources near RS CVn stars. 6 and 20 cm.
AL-141	Lang, K. (Tufts) Willson, R. (Tufts)	Survey of active BY Draconis and W Ursae Majoris stars. 6 and 20 cm.

No.	Observer(s)	Program
AL-147	Lubowich, D. (Am. Inst. Phys.) Anantharamaiah, K. Pasachoff, J. (Williams Coll.)	Search for a localized source of deuterium near the galactic center. 90 cm line.
AL-149	Lo, K. (Caltech) Backer, D. (Berkeley) Johnston, K. (NRL) Ekers, R.	VLBI observation of Sgr A*. 3.6 cm phased array MK III VLB.
AL-150	Lestrade, J-F. (JPL) Preston, R. (JPL)	Statistical properties of RS CVn stars. 6 cm.
AL-160	Lestrade, J. (JPL) Niell, A. (JPL) Preston, R. (JPL)	Phase referenced VLBI observations of two RS CVn binary systems. 3.6 cm single antenna VLB.
AM-195	Myers, P. (SAO-CFA) Terebey, S. (NCAR) Rodriguez, L. (UNAM) Cruz-Gonzalez, I. (UNAM)	Radio continuum from IRAS sources embedded in dense molecular cores. 6 cm.
AM-199	Mazzarella, J. (Michigan) Aller, H. (Michigan) Gaume, R. (Michigan)	HI properties of double nucleus Markarian galaxies. 20 cm line.
AM-207	Molnar, L. (CFA) Edelson, R. (Caltech)	Mapping the region around Cyg X-3. 2, 6 and 20 cm.
AM-211	Morris, M. (UCLA) Yusef-Zadeh, F. (Goddard)	The radio streamers near Sgr A. 6 cm.
AM-216	McCutcheon, W. (British Columbia) Dewdney, P. (DRAO) Purton, C. (DRAO)	Observations of S211, S212 and an IR/CO source. 6 cm line.
AM-217	Morris, D. (Iowa) Mutel, R. (Iowa)	Investigation of emission in RS CVn binaries and comparable single stars. 6 cm.
AN-45	Nelson, R. (NRAL) Spencer, R. (NRAL)	Measurement of spectra and positions of X-ray binaries. 2, 6 and 20 cm.
AO-76	O'Dea, C. Gregorini, L. (Bologna) Feretti, L. (Bologna) Giovannini, G. (Bologna)	Complex radio emission in Abell 568. 6 cm.
AP-129	Payne, H. Anantharamaiah, K. Erickson, W. (Maryland)	Recombination lines towards the Crab nebula. 90 cm line.

No.	Observer(s)	Program
AP-130	Pompea, S. (Steward Obs.) Elston, R. (Steward Obs.) Rieke, G. (Steward Obs.)	Starburst inhibition in Sa galaxies. 6 cm.
AP-132	Pottasch, S. (Kapteyn Lab) Zijlstra, A. Bignell, R. C.	A search for objects in transition between OH/IR stars and planetary nebulae. 2 cm.
AP-136	Pottasch, S. (Kapteyn Lab) Zijlstra, A. Bignell, R. C.	Additional measurements for a general survey of planetary nebulae. 6 and 20 cm.
AP-137	Pottasch, S. (Kapteyn Lab) Feast, M. (SAAO) Zijlstra, A.	Measurements of planetary nebulae with very low intrinsic brightness. 6 cm.
AP-138	Pedlar, A. (NRAL) Anantharamaiah, K. van Gorkom, J. Ekers, R.	Continuum and recombination lines towards the galactic center. 90 cm line.
AP-139	Palmer, P. (Chicago) Yusef-Zadeh, F. (Goddard) Goss, W. M. Lasenby, A. (Cambridge) Lasenby, J. (Cambridge)	H110α line in Sgr B1 and Sgr B2. 6 cm line.
AP-140	Palmer, P. (Chicago) Yusef-Zadeh, F. (Goddard)	Recombination lines from the Orion nebula. 6 cm line.
AR-147	Rucinski, S. (David Dunlap Obs.) Gibson, D. (NMIMT)	Survey of evolved W Ursa Majoris stars. 2, 6 and 20 cm.
AR-157	Rodriguez, L. (UNAM) Anglada, G. (Barcelona)	An attempt to detect dust emission. 2 and 6 cm.
AR-158	Rudolph, A. (Chicago) Palmer, P. (Chicago) Ho, P. (Harvard)	Ammonia in HH7-11IR. 1.3 cm line.
AR-159	Ricker, G. (MIT) Vanderspek, R. (MIT)	Search for radio emission from a recurrent optical flash source. 6 and 20 cm.
AS-80	Sramek, R. van der Hulst, J. (NFRA) Weiler, K. (NRL)	Monitoring supernovae SN1980 in NGC 6946 and SN1979c in M100. 2, 6 and 20 cm.

No.	Observer(s)	Program
AS-211	Sramek, R. Weiler, K. (NRL) van der Hulst, J. (NFRA) Panagia, N. (STScI)	Statistical properties of radio supernovae. 2, 6 and 20 cm.
AS-275	Stine, P. (Penn State) Feigelson, E. (Penn State) Myers, P. (CFA) Mathieu, R. (CFA)	Search for continuum flares in windless pre-main sequence stars. 6 cm.
AS-283	Sancisi, R. (Kapteyn Lab) van Gorkom, J. van Albada, T. (Kapteyn Lab)	The size of the dark halo of the spiral galaxy NGC 3198. 20 cm line.
AS-284	Seaquist, E. (Toronto) Taylor, A. (Groningen)	Radio spectra of selected symbiotic stars. 2, 6 and 20 cm.
AS-296	Salpeter, E. (Cornell) Dickey, J. (Minnesota) Condon, J.	Luminosity function of distant cluster galaxies. 20 cm.
AS-297	Schneider, S. (Virginia)	Extended HI around NGC 5701. 20 cm line.
AS-300	Siemieniec, G. (Krakow) Urbanik, M. (Krakow) Beck, R. (MPIR, Bonn) Hummel, E. (MPIR, Bonn)	The radio disks of NGC 891 and NGC 3628. 20 cm.
AT-60	Taylor, A. (Kapteyn Lab) Seaquist, E. (Toronto) Kenyon, S. (SAO)	Radio-Optical-UV monitoring of symbiotic stars. 1.3, 2, 6 and 20 cm.
AU-27	Umana, G. (NMIMT) Catalano, S. (Catania) Gibson, D. (NMIMT)	Survey of nearby Be stars. 2 cm.
AU-31	Uson, J. Cornwell, T. Ekers, R. Laing, R. (RGO)	Observations of the Sunyaev-Zel'dovich effect. 2 cm.
AU-32	Umana, G. (NMIMT) Shore, S. (NMIMT)	Observations of UU-Her type stars. 6 and 20 cm.
AV-96	van der Hulst, J. (NFRA) Sramek, R. Weiler, K. (NRL)	Radio supernova in NGC 4258. 6 and 20 cm.

No.	Observer(s)	Program
AV-139	van Gorkom, J. Knapp, G. (Princeton) Raimond, E. (NFRA) Faber, S. (Lick Obs.) Gallagher, J. (Lowell Obs.)	HI distribution and kinematics in the active elliptical NGC 4278. 20 cm line.
AV-143	van Buren, D. (Johns Hopkins) Fich, M. (Waterloo) Chu, Y. (Illinois) Abbott, D. (Colorado)	Search for neutral hydrogen shells associated with stellar wind bubbles. 21 cm line.
AV-148	Viallefond, F. Zheng, X. (CFA)	Low frequency survey of M33 radio sources and large scale disk emission. 90 cm.
AW-157	Williams, B. (Delaware) van Gorkom, J.	HI study of two compact groups of galaxies. 20 cm line.
AW-165	Wiklind, T. (Onsala) Rydbeck, G. (Onsala) Winnberg, A. (Onsala)	Detailed mapping of HI in the dwarf elliptical galaxy NGC 185. 20 cm line.
AW-169	Winglee, R. (Colorado) Dulk, G. (Colorado) McKean, M. (Colorado)	Search for burst radiation from nearby stars. 20 and 90 cm.
AW-171	White, N. (ESA/ESOC) Stella, L. (ESA/ESOC) Smith, A. (ESA/ESOC)	Survey of radio emission from X-ray binaries. 6 cm.
AW-173	Wilking, B. (Missouri) Mundy, L. (Caltech) Howe, J. (Texas)	Survey of cold IRAS sources. 2 and 6 cm.
AW-185	Wootten, H. A. Butner, H. (Texas) Loren, R. (Texas)	Water maser location in the binary protostar in L1689N(IR). 1.3 cm line.
AW-187	Weinberg, D. (Princeton) Guhathakurta, P. (Princeton) van Gorkom, J.	The HI rotation curve of UGC 12591. 20 cm line.
AY-17	Yusef-Zadeh, F. (Goddard) Morris, M. (UCLA)	The galactic center threads. 2 and 6 cm.
AY-18	Young, J. (Massachusetts) Kenney, J. (Massachusetts) Tacconi, L. (Massachusetts)	Atomic hydrogen distributions in isolated, interacting and Virgo galaxies. 20 cm line.
AY-20	Yusef-Zadah, F. (Goddard) Cornwell, T.	The HH 34 complex. 2, 6, and 20 cm.

No.	Observer(s)	Program
VAH-54	Geldzahler, B. (NRL) Cohen, N. (Bentley Coll.)	X-ray binary. 6 cm phased array MK III VLB.
	JPL Staff	Voyager image transmission. 4 cm.

F. SCIENTIFIC HIGHLIGHTS

Interstellar C_2S and C_3S

Measurements with the Green Bank 140-ft telescope have recently confirmed the presence of the sulfur-containing molecules C_2S and C_3S in cold, dark clouds. Japanese laboratory investigators had previously assigned a number of unidentified millimeter lines to these species, including the strong 45.379 GHz transition. The ground-state centimeter-wave lines near 23 GHz were seen with the 140-ft in most of the dense, cold clouds observed, in marked contrast to the total lack of success in detecting the 45 GHz line in all but one cloud. Indications are that the kinetic temperature in dense cloud cores is significantly lower than the value of 6 K to 10 K usually assumed. The abundance of these molecules is vastly greater than that of the oxygen analogs C_2O and C_3O, showing that there are significant differences between oxygen and sulfur chemistry in cold clouds.

Investigators: H. E. Matthews, P. A. Feldman, L. W. Avery, and M. B. Bell (Herzberg Institute)

Proper Motion of Sgr A*

VLA observations of the compact object Sgr A* at the galactic center are being obtained on a continuing basis in order to determine its peculiar motion. Measurements during four epochs between 1981 and 1985 have already resulted in the first two-axis measurements of the Sgr A* proper motion and are a considerable improvement over past single-axis measurements. The motion is consistent with that expected for an object in the galactic center whose peculiar velocity is no larger than 40 km sec^{-1}. The differential astrometry experiment measures the position of Sgr A* with respect to three reference sources spaced in a triangle around Sgr A* at an average distance of 0°.5. The current estimated level of error of the technique is ± 0.50 milli-arcseconds per year. Ultimately it is hoped that improved analysis techniques and reduced errors will lead to much lower limits on the size of the peculiar motion of Sgr A* and the possibility that it is a massive object.

Investigators: D. Backer (Berkeley) and R. Sramek (NRAO)

Unexpected CO Outflows?

Observations with the 12-m telescope are being used to investigate unusual CO spectral line features in several high-latitude molecular clouds. Broad low-level pedestal emission features have been detected in the wings of CO (1-0) in directions towards diffuse clouds where there are no other discernible traces of star formation activity. The clouds all lie at latitudes above 25°, exhibit visual extinctions of order one magnitude, and do not show any nearby IRAS point sources. At present the nature of the mechanism which creates the high velocities is unclear. An alternative to the wind driven outflow model involves the simple evaporation of gas from molecular cloud clumps, but a further understanding of the peculiar phenomena is dependent on observations to determine their extent, morphology, temperature, and densities.

Investigators: L. Blitz, A. Wandel, L. Margnani (Maryland), P. Schwartz (NRL)

VLA-Goldstone Saturn Radar Experiment

The VLA has been successfully used to detect the radar echo from Saturn's rings employing the JPL/NASA 64-m antenna at Goldstone as the transmitter to the planet during the mutual viewing time of Saturn at the two sites. The signal presented to the VLA was treated like a spectral-line astronomical source and was observed with the subarray of the ten antennae equipped with X-band receivers. The CW-transmitted signal was spread over ± 1.1 MHz by the Doppler shifts from the motion of the individual particles in the rings that move in Keplerian orbits about Saturn. The X-band flux from the Saturn system was mapped in 64 channels with resolution of 97 kHz per channel. In a given channel the unresolved thermal flux density from the atmosphere of Saturn was 2000 mJy, that from an average ring area about 20 mJy while the mean "radar" flux density was 3-8 mJy. The performance of the X-band mixers was excellent, and the average noise in the channel maps was about 3-4 mJy/beam in a 4-hour integration. The weak echo power can be clearly seen in nearly all of the channel maps within the ± 1.1 MHz Doppler-spread spectrum.

Radar echoes from Saturn's rings have been made with the Goldstone and Arecibo Planetary Radars in the monostatic mode and important information in the ring structure has been obtained. However, the VLA allows the spatial mapping of the echo in addition to the Doppler mapping which will enable the ring system to be studied for suspected structure around the rings and variations from ring-to-ring. The full array of X-band antennae will be required for this work. The above feasibility experiment also demonstrates the tremendous capability of the VLA to radar map Venus and Mars with at least a factor of 6-8 improvement over the Goldstone monostatic radar.

Investigators: D. Muhleman, A. Grossman (Caltech), and R. Goldstein (JPL)

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

Work started during June 1985 on the further development and construction of thirty 8.4 GHz receivers for use on the VLA for reception of television pictures of Neptune during a brief period centered on August 24, 1989.

The first production receiver utilizing FET amplifiers was delivered to the VLA in February 1986. The latest receiver (No. 19) was delivered June 1987, and all thirty are scheduled to be completed by the end of 1987.

Further improvements have occurred recently due to the incorporation of HEMT's obtained via the JPL/NASA supported contract with GE. The latest receivers now have a typical $T_R \leq 13$ K, an improvement of at least 3 K over the Fujitsu HEMT's. It is likely that some of the early receivers will be retrofitted with GE HEMT's to improve system sensitivity before the Neptune flyby during August 1989.

L-Band HEMT Amplifier Development

A program to retrofit some of the NRAO designed L-band FET amplifiers with HEMT devices has begun. Use of Fujitsu HEMT's gives amplifier noise of $\leq$ 3.5 K in the 1.2-1.8 GHz frequency range. The GE HEMT's produced for the Neptune project give amplifier noise of $\leq$ 1.5 K over the same frequency range. The limited supply of GE devices will only allow their use for the most critical applications. The L-band receiver in Green Bank and the 3 mm SIS receiver (L-band IF) at the 12-m telescope will both benefit significantly from the incorporation of these devices.

23 GHz HEMT/FET Amplifier Development

Ten four-stage FET amplifiers (NE045) have been delivered to the VLA for the K-band receiver upgrade. These amplifiers give $\approx$ 110 K average noise temperature from 22-25 GHz. Last quarter two additional amplifiers were delivered using Fujitsu HEMT devices. These gave 50 K minimum noise temperatures at 22 GHz and maximum of 75 K at 25 GHz.

During this quarter six additional amplifiers utilizing the Fujitsu HEMT have been constructed and delivered to the VLA; performance was similar to the first two amplifiers with Fujitsu transistors. A test of an amplifier with GE HEMT transistors gave poor performance due to improper DC operation of the devices at cryogenic temperatures. Further development of the GE HEMT's is taking place.

43 GHz HEMT Amplifier Development

A program to develop an amplifier at 43 GHz for possible VLBA and Green Bank use has been continuing. A 22 GHz waveguide adjustable mount for the optimization of amplifier performance at cryogenic temperatures is still being developed. A technical report has been written on its progress. Further tests are needed before the 43 GHz version can be successfully constructed.

Suitable HEMT's are also required and are expected from GE by November 1987.

Hybrid Spectrometer

The full-scale version of the digital section of the 1536 channel and 2.4 GHz bandwidth hybrid correlator is in the final stages of construction in Charlottesville. Testing will start in the near future and it is expected that shipment to Tucson will occur during September 1987.

The analog section will then be interfaced and complete system testing should occur before the end of 1987.

Superconducting (SIS) Millimeter-Wave Mixer Development

Receiver noise temperatures below 100 K SSB at 115 GHz are now routinely obtained using all-Nb junctions manufactured by Hypres. These junctions have been used since 1986 on the 12-m Kitt Peak telescope and give receiver noise temperatures between 80 K and 145 K SSB over the 90-116 GHz band. These numbers include all input optic losses (beam-splitter, lens, and vacuum window).

We have completed DC tests on the first developmental junctions made under a joint project with UVA. These are $Nb/Al-Al_2O_3/Nb$ devices, similar to the Hypres junctions. They have extremely sharp I-V curves--essential for good SIS mixers. Based on recent tests on Hypres junctions, it should be possible to heat these to 150°C for prolonged periods (e.g., for bonding), and even to 200°C for a few minutes. Storage at room temperature in the open atmosphere causes no degradation. The present mask set contains mixers for 90-120 GHz and 230 GHz, as well as special circuits for characterizing the material.

Schottky Diode, Millimeter-Wave Mixer Development

A number of 200-240 GHz mixers are being fabricated for the eight-beam, 230 GHz receiver on the 12-m telescope and for the 225 GHz site testing receivers (see below). The mixers with the best cryogenic performance are being kept for the multi-beam receiver, and the less good ones are being used for the site-testing receivers.

While it has long been NRAO's policy to use millimeter-wave mixers with no adjustable tuning elements, we have decided to use tunable mixers for the 300 and 345 GHz bands in the future. There are two reasons for this: (i) It should be possible to obtain better performance over the operating band of the receiver. (ii) It will greatly reduce the labor involved in optimizing a new or repaired mixer (weeks of testing were required with the older fixed-backshort designs, which could only be retuned by warming up the refrigerator, making the adjustment, and re-cooling the system--a 24-hour cycle).

Site Testing Receivers

The first three of four compact, room-temperature, 225 GHz radiometers for site evaluation have been completed. The remaining unit is almost complete. These will be located at the VLA, Mt. Baldy, Mauna Kea, and Kitt Peak to aid in selecting a site for the future millimeter-wave array. These radiometers have a DSB noise temperature of ~ 1500 K and operate unattended at remote sites.

Millimeter Local Oscillator Sources

Millimeter-wave doublers, triplers, and quadruplers are now available commercially with sufficient power for all our millimeter-wave receivers. This is largely a result of the pioneering work on multiplier design at NRAO by J. Archer and on varactor diodes at UVA by R. J. Mattauch (under NRAO contracts). There is, therefore, little need for the Central Development Laboratory to devote further effort to multiplier work beyond maintaining the many units in use in our receivers.

I. GREEN BANK ELECTRONICS

300-ft Spectral Processor

The Spectral Processor project continues in the design phase. The custom wire-wrap boards for the FFT are on order. The first of two Real Correction boards and its associated test board are being fabricated, and the second Real Correction board is in the final design phase. The Accumulator board design is in progress. The conceptual design for the Rack Controller portion of the system is almost complete. It has been decided to include a single-board computer to download most of the control and monitor functions from the Masscomp. This has been selected and will be ordered shortly.

An engineer has worked full-time this quarter on the IF/Video converters, completing the conceptual design and ordering components. The PLL for a fixed 160 MHz synthesizer has been designed and the prototype is under construction. Testing of a baseband amplifier and components needed in the 90° network was done in preparation for breadboarding the SSB mixers.

Receiver Upgrades

During April, the cooled FET amplifiers in the 1.3-1.8 GHz receiver were replaced with similar amplifiers using Fujitsu High Electron Mobility Transistors (HEMT) in the first stages. On the 300-ft, the zenith system temperatures now measure 22 ± 2 K over the 1350-1430 MHz and the 1600-1730 MHz frequency ranges. Measurements on the 140-ft yield zenith system temperatures of 20 ± 1.5 K over these frequency ranges. These results indicate a decrease of approximately 4 K from the previous system temperatures.

An upgrade of the 300-1000 MHz receiver was also completed this quarter. Balanced, cooled FET amplifiers were installed, replacing the previous upconverter/amplifier system. System temperatures on the 300-ft are now 47 to 62 degrees over the 700 to 1000 MHz band. From 280 to 420 MHz the system temperature is 105 to 60 degrees. Because of the improved performance of the FET amps at the upper end of this band, the 350 to 410 MHz feed will be retuned to cover 350 to 420 MHz. Since the receiver was upgraded, the 500 to 700 MHz feed has not yet been used. System temperatures in this band will be measured when the feed is installed. A new frequency band selection system also was installed. Provisions are made for an inactive mode which switches off all the FET amplifiers and oscillators to avoid interfering with other receivers, and for computer control of the band selection.

Circuitry was added to the 140-ft Cassegrain system so that users can now select noise balancing in both receivers in the C, X, and Ku bands. This is useful in some types of continuum observing.

Eleven 5 GHz HEMT amplifiers were completed this quarter. These will be used in the VLA K-band upgrade project and in VLBA receivers.

Adaptive Array Receiver

The Adaptive Array Receiver is designed to increase the effective hour angle tracking range of the 300-ft antenna and minimize the scan loss when compared with a single feed receiver. It provides frequency coverage over the 400-500 MHz band with instantaneous bandwidths of 5 to 10 MHz. A 2 x 8 array of feeds will be used. With this array, we predict the efficiency will be one-half of the on-axis value at ± 15 feet offset (± 27 minutes tracking time). This compares to the ± 5.5 feet (± 10 minutes) with a single feed.

This quarter, testing of amplifier and feed prototypes continued and replication of the voltage-controlled phase shifters proceeded.

J. 12-M ELECTRONICS

Receiver Status

The status of the various receivers is largely unchanged since the last quarterly report. We have just completed our first year of observing using solid state L.O. systems and operation has been fairly smooth. Klystrons and their associated power supplies have now been eliminated.

70-115 GHz Schottky Mixer Receiver

This receiver is unchanged since the last quarterly report. It is the only receiver to cover the frequency range 70-90 GHz and is used as a back-up to the SIS receiver in the 90-115 GHz band.

200-270 GHz Schottky Mixer Receiver

This receiver is unchanged since the last quarterly report. The receiver has given reliable performance during the last observing season and we hope to make several changes to the receiver during the next few months. Extending the range of the receiver to cover the band 270-305 GHz with two channels now appears to be feasible and we hope to accomplish this before the next observing season. We also hope to improve the performance of the receiver in the 200-270 GHz band with improved mixers.

270-305 GHz Schottky Mixer Receiver

This receiver was used during the last observing season. The noise temperature was higher than hoped for and the aperture efficiency was low. We hope to fix these problems with the incorporation of the receiver into the 200-270 GHz receiver as indicated above.

330-370 GHz Schottky Mixer Receiver

This receiver has been used on the telescope this season. The noise temperature was higher than expected (about 2000 K SSB at 345 GHz) and we will attempt to improve this in the next few months.

90-115 GHz SIS Receiver

This receiver has been modified during the last quarter by replacing the GASFET I.F. amplifiers with HEMT amplifiers. Noise temperatures as low as 80K SSB at 115 GHz and 50K SSB at 95 GHz have now been measured for the complete receiver. Several problems have been identified during the observing season and these will be worked on during the summer shutdown.

Multifeed 230 GHz Receiver

The four-feed prototype was tested on the telescope during this quarter and performed well. No problems were found and work has continued during this quarter on expanding the receiver to eight feeds. A beam rotator has been incorporated into the receiver and initial laboratory tests indicate satisfactory performance. We hope to test the final receiver on the telescope before the end of the year, although manpower limitations may prevent this.

Other Electronic Equipment

VLBI Equipment

A dichroic system for the 12-m telescope was used successfully for a VLBI experiment during this quarter. Simultaneous observations at 6 cm and 3 mm were possible during the course of the VLBI experiment. Fringes were obtained at both 6 cm and 3 mm between Kitt Peak and stations in California and Massachusetts.

Hybrid Spectrometer

Work continues on the hybrid spectrometer and we are hoping for telescope tests before the end of the year.

Holography

The surface of the 12-m telescope has been remeasured recently using the Lincoln Laboratory LES 8 Satellite. A preliminary analysis of the results has been made and the data looks satisfactory. We may attempt a resetting of the surface based on these results at a later date.

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 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 arc min. This problem is being cured by coating the critical parts of the antenna structure with insulation to reduce the temperature differentials. Twenty-eight antennas currently have insulation installed, and coating of the last antenna was finished this quarter.

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. Some preliminary tests have been completed. Testing of the stability of two tilt-meter units was started during this quarter.

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-m 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-m antennas at this frequency for testing purposes. Note that if every 25-m 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.

Two new dipole feeds have been designed; one a crossed dipole type, the other a quad dipole type. The crossed dipole was chosen as the easiest to implement. Testing of this feed and its effect on other frequencies will continue into next quarter. With the new feed installed near the focus of the antenna locally generated radio frequency interference became a significant problem (see RFI Improvements). Four antennas are equipped with the 75 MHz system.

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-m 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.

Twenty 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, RFI enclosures for the vertex mounted "B" racks have been installed on four antennas (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. The 8.4 GHz front-ends enabled the VLA to be used in a successful planetary radar experiment with the Goldstone transmitter. The NRAO Central Development Laboratory has developed this front-end which was using GaAs FET amplifiers. Improved HEMT (High Electron Mobility Transistor) amplifiers are being incorporated into these systems during this quarter and next quarter.

Nineteen 8.4 GHz front-ends have been received from the Central Development Laboratory in Charlottesville and have been installed on ten antennas. 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 eighteen 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 usable bandwidth was investigated. A modification to allow the Monitor and Control system to free run eliminated the coherent RFI between antennas.

Four RFI enclosures for the vertex mounted "B" racks have been installed and tested. The remaining RFI enclosure will be installed during the first part of the next quarter, 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).

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 one-half hour. 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 has been 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 GB Electronics Division will be used to replace present 5 GHz paramps. The new "A" Rack has been installed on five antennas. Testing of this system was completed this 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 separate, optimized receivers. 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 GB Electronics Division. This dewar assembly, along with a VLBA polarizer was installed on VLA Antenna 23. Satisfactory testing of this receiver was completed during the first quarter of this year.

L. AIPS

During the quarter, attention was placed on developing polarization calibration, spectral bandpass calibration, interactive editing of visibility data, and a restructuring of the machine-dependent code. By the end of the quarter, none of these major projects had been completed, but all are nearing their initial release.

Several new tasks were released this quarter. MATHS performs various mathematical functions on an image. PADIM pads an image with areas of constant value. SQASH averages or sums the planes of a three (or more) dimensional image. UVIMG grids visibility data into an image, applying calibration, with axes specified by the current sort order. MULTI converts single-source visibility data sets into multi-source data sets suitable for the calibration tasks. The area of tape input/output also received significant attention. In particular, the pseudo-tape disk files for FITS format data were converted to a more useful format for interchange between computers and between image analysis systems. The task VTESS was also improved in several ways, including the new, faster convolution routines.

M. VLA COMPUTER DIVISION

The backup computer for the new on-line system was delivered and installed. The tape subsystem delivered with this computer replaces the obsolescent tape units that were delivered with the main computers. The installation was not as smooth as had been hoped, however. Because of the time spent on the installation and the discovery of some unforeseen incompatibilities between the new and the old system, the installation date for the new on-line system is now projected for October.

It has been decided to abandon the concept of the real-time Filler into the asynchronous computer (DEC-10). This was the means by which the observers could perform preliminary analysis of their data in the DEC-10 in nearly real-time to assess the data quality. It has not been in use for the last three years.

Modifications to the image storage unit (ISU) attached to the Outbax computer were started. These will enhance its functionality and to increase its capacity by more than 50 percent. A second unit will also be fabricated for use on the display attached to the Convex computer at the VLA.

A new digital data switch (DDS) is under construction for the Socorro office. This permits flexible connection of terminals and personal computers to the mainframe computers. The new capability will allow all terminals to communicate with the microVax in the Socorro office. By the end of the next quarter a full connection of this DDS to the other DDS units at the VLA site and in Charlottesville will be completed.

N. VERY LONG BASELINE ARRAY

Antennas and Site Preparation

With painting and a number of final "punch list" items now completed, the Pie Town antenna has been accepted. The surface has been set such that the rms deviation in the positions of the 820 optical targets used for setting is approximately 0.004 inch. "Outfitting" by NRAO personnel is in progress, comprising installation of all cables, cryogenics, electronics and other equipment required for operation. At Kitt Peak (#2), site preparation and building are complete, the antenna structure is erected, surface panels have been installed, and setting of the surface is in progress. The Los Alamos (#3) site and building were ready on schedule. However, shipment to site of the completed antenna was delayed until late June, since the contractor's erecting crew was not yet available. At North Liberty (#4), site work, save for the building, is complete. Manufacture of the antenna for this station is well along.

Site construction at both Fort Davis (#5) and Brewster (#6) is on schedule. However, manufacture of antennas for these two stations has only recently been authorized, due to the length of the negotiations to reduce antenna procurements from three to two per year. A site on St. Croix, U.S. Virgin Islands, has been selected, and negotiations for its acquisition are in progress.

The first focus and rotation mount (FRM) for the subreflector was delivered. In testing, however, it was found that some redesign is necessary, and this is in progress. The mold for the subreflector itself was completed. The first unit, to be completed shortly, will be carefully measured both at the plant and in the facility at the University of Arizona.

Electronics

The initial-outfitting electronics system for Kitt Peak (#2) was completed and shipped to the VLA site in early June, and the Los Alamos (#3) system neared completion at month's end. With the arrival of system 2 at the VLA site, a series of laboratory tests of phase stability requiring two sets of electronics has begun, and should be completed by late July when electronics system 1 is required for installation at Pie Town.

Redesign of the LO Transmitter and LO Receiver modules has been completed, and the prototype units of the new design are included in the system-2 electronics. The design of the converter module which will handle signals from both the 8.4 GHz and 23 GHz front ends has also been completed. The first 23 GHz front end, using HEMT amplifiers, has been assembled and is in the initial test phase. This front end differs from the lower frequency front ends in that the uncooled post-amplifier section incorporates a mixer to the 8.4 GHz band and amplification at that frequency. Late delivery of the mixer may delay the 23 GHz front end by about four weeks, but should not impact the Pie Town schedule.

At Sigma Tau Standards Corporation, decontamination of the first maser (see Quarterly Report for January-March 1987) resulted in an improvement in operation. However, the vac-ion pumps of the outer section of the vacuum system still drew excessive current. This problem was eventually traced to contaminated O-rings, changing of which required a further disassembly and bakeout of the maser. Maser #1 is now operating satisfactorily. Masers #2 and #3 have had the defective parts replaced and are coming into operation again. Detailed stability tests will then follow. The estimated delivery date for the first three masers has slipped from July 15 to September 15, 1987. The impact is not serious.

Data Recording

The first Data Acquisition Rack (DAR1), less its Formatter, continues in pre-installation testing at the VLA with other components of the VLBA electronic systems. At Haystack, the checkout of the first Formatter is nearing completion. The first VLBA Recorder (REC1) rack is now complete. Panels and cables have been designed and fabricated. The controller boards are complete and bench tested. The analog electronics and the controller software are being tested, and tests of the integrated system are scheduled to start in early July. The Recorder is to be delivered to NRAO in August. This first (prototype) Data Acquisition System (DAS1=DAR1+REC1) will be installed this fall at Pie Town, after stability tests at the VLA.

Construction of DAR2, save for Formatter 2, is complete, and module checkout is nearly done. Since all four boards of Formatter 1 have now been fully tested, the boards for Formatter 2 will be sent out for wire-wrapping as soon as wire lists have been updated. Transport, rack and other basic components for REC2 are in hand, and replication of electronics modules for this unit will start as checkout of REC1 modules confirms performance.

Haystack is preparing a proposal to NRAO for a pre-production phase comprising two additional DAR's, one REC and one Playback recorder (PYB1).

A block diagram for the so-called Data Playback (electronics) Crate (DPC), which constitutes the interface between the PYB and the Correlator, has been worked out at Haystack and discussed with NRAO in preparation for detailed engineering design. It was decided that the Playback System will have a fixed, rather than programmable, format in order to speed delivery and reduce cost. Although Haystack has stated informally that detailed design of the DPC cannot begin until December, 1987, with delivery of the first unit a year later, NRAO is negotiating to better these dates so as not to delay the Correlator development.

Schedule slippages in the Data Recording area have prompted NRAO to consider direct participation in the development and/or production of some of the subsystems. Whether, and to what extent, such participation will take place remains to be decided. The problem has become serious in both data recording and data playback areas.

Monitoring and Control

Development of operator interface software continues, with a program for observation sequencing and control now added to those already completed for the synthesizers, baseband converters, front end cryogenics, IF distributors, front end switch control module and station timing.

The relatively small logical gaps in the astronomical observing programs are being filled in, and as much checkout is being done as is possible in the absence of the actual antenna. Attacked second quarter were the pointing algorithms and data logging for the antenna operating in local pointing mode.

Work continues on the monitor data system of programs. The overall logical structure for the program which informs the correlator about the beginning of good data for a given observation has been set up, although the actual implementation of the checks is not complete.

The MicroVax II main Monitor/Control computer for the Array Operations Center was brought up in April, and we have been exploring various software which is, within NRAO, unique to this computer. We have been doing preliminary programming work with the DEC database system, and have started work with the DEC packet switching network interface, which we intend to use as a software interface to the station microcomputers. We are also wiring up a copy of the NRAO digital data switch (DPBX) so that terminals in the Socorro office will have free access to either the MicroVAX or the VAXen at the VLA.

The Motorola X-25 product planned for use at the VLBA stations for the software interface to the central VAX has been delayed. We are currently trying to obtain pre-release copies of the associated software so that our own software development may proceed, as well as investigating other products which, with some locally written software, might serve the purpose.

Correlator

Development of the conceptual outline from the recently completed FX study into a final design for an FX Correlator for the VLBA continues. These plans are now sufficiently advanced to form the basis for the first realistic cost estimate and construction schedule. The total hardware cost (including outside services) is less than half that of the lag correlator design of 1985, exceeding the savings anticipated when the FX study was undertaken. The schedule foresees completion of the 7-station, 2-channel subset by the end of 1989, although checkout may extend into the first quarter of 1990. Both these milestones depend critically on timely delivery of data playback units, as alluded to above.

Design effort focussed on the critical area of the gate-array specifications. Persuaded by the cost and compactness advantages, and the attendant enhancement of flexibility, we selected a format which incorporates an on-chip, fast, random access memory. The memory will be used for inter-stage storage and reordering in the FFT section and for short-term accumulation in the multiplier. In turn, this change makes it feasible to support variable-length transforms, sc that each FFT stage will be designed to accommodate radix-4, radix-2 and null ("radix 1") operations. These two decisions free the architecture from almost all artificial limitations based on intermediate storage, and the correlator's modes now allow the available hardware to be exploited fully. The 160 FFT chains can be allocated with complete flexibility among stations, channels, and a variety of multi-processing options. Moreover, the long-term accumulator and maximum archive data rate specifications allow any trade-off of achievable resolution against baselines, channels, and polarization cross-products. Preliminary specifications for the FX gate array have been written for use in soliciting potential vendors.

Both the (mini-)supercomputer and the microprocessor-based FX simulator systems have now been thoroughly debugged, and a successful intercomparison has demonstrated identical spectral artifacts in both results. These artifacts are already weak enough to be acceptable with the data representation originally planned, but will be reduced further because the gate array selected will provide sufficient additional gates to increase the precision of the inter-stage data words.

Other activities begun include development of the delay and phase models for the correlator and specification of the tracking algorithms, and evaluation of the vulnerability to pulsed interference from balloon-borne radars.

Data Processing

Most of the software needed for normal processing of astronomical data from the VLBA is already in routine production use. Development is needed in three general areas: 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) The preliminary version of the distribution tape has been designed. Software has been written to convert data from the NRAO MkII VLBI correlator into the form of the proposed VLBA distribution tape. This software is now operational and is used to read data for developing item 2).

2) The preliminary design of the calibration software is still being implemented. The continuum calibration routines are in production use. Development this quarter has been in the areas of polarization, spectral line calibration and interactive editing of data.

3) The concerns of geometric accountability are being included in the design of all software and data structures. Examination of existing geodetic software is continuing to see if it can be adapted for NRAO uses.

Array Operations Center

Construction of the Array Operations Center has been scheduled to start in early August, following the June 25 receipt of bids and the June 26 groundbreaking ceremony.

O. PERSONNEL

New Hires

Fleck, Robert	Visiting Scientist	4/27
Cordes, James	Visiting Scientist	5/16
Arora, Radhe	Visiting Electronic Engineer	6/15

Terminations

Barker, Richard	Electronics Engineer	4/03
Walter, William	Mechanical Engineer	4/24
Olsson, David	Sr. Scientific Programmer	5/15
Siegel, Peter	Electronics Engineer	5/29

Changes in Status

Hvatum, Hein	to Deputy VLBA Project Manager/Scientist	4/01
Napier, Peter	to Assistant Director/VLBA Project Manager	4/01

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